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March 4, 2020
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GLG Programming Reference Manual

This book provides information about programming with GLG and using different GLG Run-Time environments, including C/C++, Java, C#/.NET, JavaScript and ActiveX Control.

The first section of this manual describes the C API, while the rest of the book describes the C++, Java, C#/.NET, JavaScript and ActiveX Control versions.

Although various programming environments such as C, C++, Java, C#/.NET, JavaScript and ActiveX, use different syntax to invoke the GLG API, the semantics of the API methods is the same in either environment. The C programming section provides the most detailed description of each method in terms of its effect on the underlying GLG objects. It also provides more examples and may be used as a reference for C, C++, Java, C#/.NET and JavaScript programmers.

The book contains the following chapters:

Table of Contents

Integrating GLG Drawings into a Program
   A general overview of the process of programming with the GLG Toolkit.
Using the C/C++ version of the Toolkit
   Displaying a GLG Drawing
      How to load and display a GLG drawing in an application program in different programming environments.
Compiling and Linking GLG Programs
   The details of compiling and linking an application program with the GLG libraries.
The GLG Generic API
   Describes functions of the GLG Generic API for loading a displaying a GLG drawing is a cross-platform way.
Animating a GLG Drawing with Data Using the Standard API
   Describes functions of the GLG Standard API used to animate a drawing with real-time data.
Handling User Input and Other Events
   A description of the ways in which a GLG drawing can be used to get input from an application program user.
GLG Intermediate and Extended API
   How to query the content of a drawing and modify the drawing from an application program.
Real-Time Chart Functions
   A description of functions used with the GLG Real Time Chart object.
GIS Object Functions
   A description functions used to handle user interaction with the GLG GIS Object.
GLG Installable Interface Handlers
   A description of installable interface handles that may be used to handle complex editor-like user interaction.
GLG C++ Bindings
A description of GLG C++ Bindings and the GLG MFC class.

Using the ActiveX Control
A description of the GLG ActiveX Control methods.

Using the Java and C# Versions of the Toolkit
A description of the Java and C#/.NET versions of the GLG Class Library.

GLG Programming Tools and Utilities
Descriptions of the utility tools that come with the GLG Toolkit.

C/C++ Graph Layout Component
The graph layout component for the GLG C/C++ library.

Appendices

Appendix A: Global Configuration Resources
A list of global configuration resources.

Appendix B: Message Object Resources
A table of the GLG event types and their message object resources.

Appendix C: GLG Object Attribute Table
A list of the default attribute names for all object types.

Index

This guide assumes that you are conversant with the basic concepts of computer graphics programming. For a comprehensive discussion of three dimensional computer graphics, we recommend Computer Graphics: Principles and Practice, Foley, Van Dam, Feiner, and Hughes. Second edition, 1990; Addison-Wesley, Reading MA.

Please note that although the illustrations in this document represent the UNIX/Linux version of the GLG Graphics Builder, the information it contains is equally relevant to Microsoft Windows users. The two versions present the same functionality in equivalent user interfaces, with minimal, cosmetic differences caused by the different platforms.
Chapter 1  Integrating GLG Drawings into a Program ....................... 23

Creating a Widget Drawing .................................................................................................................. 24
Displaying a Drawing .......................................................................................................................... 25
Animating a Drawing with Real-Time Data ......................................................................................... 26
Handling User Input ............................................................................................................................ 26
H and V Resources ............................................................................................................................... 27
Utilities ................................................................................................................................................ 29

Chapter 2  Using the C/C++ version of the Toolkit ................................................................. 31

2.1 Displaying a GLG Drawing ............................................................................................................ 31

X Windows and GLG Wrapper Widget .................................................................................................. 32
  Creating the Wrapper Widget ............................................................................................................. 32
  Wrapper Widget Resources ............................................................................................................... 33
  Obtaining a Viewport Handle ......................................................................................................... 37
  Closing the Wrapper Widget ............................................................................................................ 38
GLG Custom Control for Windows .................................................................................................... 38
  Creating the GLG Custom Control ................................................................................................. 39
  Setting Initial Resources ............................................................................................................... 39
  Obtaining a Viewport Handle ......................................................................................................... 40
  Closing the Custom Control .......................................................................................................... 41
  Messages .......................................................................................................................................... 41
Loading and Displaying a GLG Drawing using Generic API .......................................................... 42
Coding Examples of Displaying and Animating a GLG Drawing ..................................................... 43
  Compiling and running Example Programs ................................................................................... 43

2.2 Compiling and Linking GLG Programs ............................................................................... 43

Building GLG Demos and Examples ............................................................................................... 43
  Visual Studio Projects for Windows ............................................................................................... 43
  Makefiles for Unix/Linux ............................................................................................................... 43
Using Constant Strings ............................................................................................................ 44
Linking with the GLG Libraries ..................................................................................................... 44
  X Windows on UNIX/Linux ................................................................................................... 44
  Windows ............................................................................................................................... 46
  OpenGL Libraries .............................................................................................................. 47
Qt and GTK Integration.................................................................................................................. 47
Error Processing ............................................................................................................................. 47

2.3 The GLG Generic API ........................................................................................................ 49
Function Summary ......................................................................................................................... 49
    Generic Program Entry Point ................................................................................................. 50
GLG Generic API Function Descriptions ...................................................................................... 50
    GlgAddCallback ................................................................................................................... 51
    GlgAddTimeOut ..................................................................................................................... 52
    GlgAddWorkProc .................................................................................................................. 52
    GlgBell ................................................................................................................................. 53
    GlgInit ................................................................................................................................. 53
    GlgInitLocale ....................................................................................................................... 55
    GlgInitialDraw ....................................................................................................................... 55
    GlgLoadWidgetFromFile ........................................................................................................ 55
    GlgLoadWidgetFromImage .................................................................................................... 56
    GlgLoadWidgetFromObject ................................................................................................... 56
    GlgMainLoop .......................................................................................................................... 57
    GlgRand ................................................................................................................................ 57
    GlgRemoveTimeOut ............................................................................................................... 57
    GlgRemoveWorkProc ............................................................................................................. 58
    GlgResetHierarchy ................................................................................................................ 58
    GlgSetupHierarchy ................................................................................................................. 58
    GlgSleep ............................................................................................................................... 59
    GlgTerminate ....................................................................................................................... 59

2.4 Animating a GLG Drawing with Data Using the Standard API ........................................ 61
Overview ........................................................................................................................................ 61
Function Descriptions ..................................................................................................................... 64
    GlgAlloc ............................................................................................................................... 64
<table>
<thead>
<tr>
<th>Function</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>GlgChangeObject</td>
<td>65</td>
</tr>
<tr>
<td>GlgConcatResNames</td>
<td>65</td>
</tr>
<tr>
<td>GlgConcatStrings</td>
<td>66</td>
</tr>
<tr>
<td>GlgCreateIndexedName</td>
<td>66</td>
</tr>
<tr>
<td>GlgCreateTagList</td>
<td>68</td>
</tr>
<tr>
<td>GlgError</td>
<td>69</td>
</tr>
<tr>
<td>GlgExportStrings</td>
<td>69</td>
</tr>
<tr>
<td>GlgExportTags</td>
<td>70</td>
</tr>
<tr>
<td>GlgFindFile</td>
<td>70</td>
</tr>
<tr>
<td>GlgFree</td>
<td>71</td>
</tr>
<tr>
<td>GlgGetDataType</td>
<td>71</td>
</tr>
<tr>
<td>GlgGetDResource</td>
<td>71</td>
</tr>
<tr>
<td>GlgGetGResource</td>
<td>72</td>
</tr>
<tr>
<td>GlgGetLParameter</td>
<td>73</td>
</tr>
<tr>
<td>GlgGetMajorVersion</td>
<td>73</td>
</tr>
<tr>
<td>GlgGetModifierState</td>
<td>73</td>
</tr>
<tr>
<td>GlgGetNativeComponent</td>
<td>73</td>
</tr>
<tr>
<td>GlgGetObjectEntry</td>
<td>74</td>
</tr>
<tr>
<td>GlgGetObjectEntry</td>
<td>75</td>
</tr>
<tr>
<td>GlgGetSelectionButton</td>
<td>75</td>
</tr>
<tr>
<td>GlgGetSResource</td>
<td>75</td>
</tr>
<tr>
<td>GlgHasResourceObject</td>
<td>76</td>
</tr>
<tr>
<td>GlgHasTagName</td>
<td>76</td>
</tr>
<tr>
<td>GlgImportStrings</td>
<td>77</td>
</tr>
<tr>
<td>GlgImportTags</td>
<td>77</td>
</tr>
<tr>
<td>GlgOnDrawMetafile</td>
<td>78</td>
</tr>
<tr>
<td>GlgOnPrint</td>
<td>78</td>
</tr>
<tr>
<td>GlgPreAlloc</td>
<td>78</td>
</tr>
<tr>
<td>GlgPrint</td>
<td>79</td>
</tr>
<tr>
<td>GlgReset</td>
<td>80</td>
</tr>
<tr>
<td>GlgSaveImage</td>
<td>81</td>
</tr>
<tr>
<td>GlgGenerateImage</td>
<td>82</td>
</tr>
<tr>
<td>GlgSendMessage</td>
<td>83</td>
</tr>
<tr>
<td>GlgSetAlarmHandler</td>
<td>84</td>
</tr>
<tr>
<td>GlgSetBrowserObject</td>
<td>84</td>
</tr>
</tbody>
</table>
2.5 Handling User Input and Other Events....................................... 101

Callback Events .................................................................................. 101
Attaching Callbacks to a Viewport Object ................................................. 101
Adding Callbacks to a GLG Wrapper Widget .............................................. 102
Selection Callback .............................................................................. 103
Input Callback ................................................................................... 105
Trace Callbacks .................................................................................. 106
Hierarchy Callback ............................................................................ 107
Message Object .................................................................................. 108

Examples of Using Callbacks in Application Code .............................. 109
Adding callbacks ................................................................................ 110
Processing Selected Objects using Selection Callback ......................... 110
Processing Selected Objects Using Input Callback ............................... 110
Processing Input Object Events .......................................................... 113
Refining Input Object Selection .......................................................... 115
Trace Callback examples .......................................................................................................117
Hierarchy Callback examples ................................................................................................117

2.6 GLG Intermediate and Extended API............................................................................ 119
   Overview .......................................................................................................................................119
   Handling GLG Objects ..................................................................................................................122
      The Reference Count .................................................................................................................122
      Using Mouse Coordinates and Pixel Mapping ......................................................................122
   Include Files ..................................................................................................................................123
   Intermediate API Function Descriptions.......................................................................................123
      GlgConstrainObject ...............................................................................................................123
      GlgContainsObject ............................................................................................................. 124
      GlgConvertViewportType .....................................................................................................124
      GlgCreateInversedMatrix ......................................................................................................124
      GlgCreatePointArray .............................................................................................................125
      GlgCreateResourceList ..........................................................................................................125
      GlgCreateSelectionMessage ..................................................................................................127
      GlgCreateSelectionNames .....................................................................................................127
      GlgCreateSelection ................................................................................................................128
      GlgDropObject ................................................................................................................. 129
      GlgFindObject ................................................................................................................. 129
      GlgFindMatchingObjects .......................................................................................................130
      GlgFitObject .................................................................................................................. 133
      GlgGetAlarmObject .............................................................................................................133
      GlgGetBoxPtr .................................................................................................................. 134
      GlgGetDrawingMatrix .......................................................................................................135
      GlgGetElement ................................................................................................................ 135
      GlgGetIndex ................................................................................................................... 135
      GlgGetMatrixData .............................................................................................................136
      GlgGetNamedObject .............................................................................................................136
      GlgGetParent .................................................................................................................. 137
      GlgGetParentViewport .......................................................................................................... 137
      GlgGetResourceObject ..........................................................................................................138
      GlgGetSize .................................................................................................................... 138
      GlgGetStringIndex ............................................................................................................138
<table>
<thead>
<tr>
<th>Function Name</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>GlgGetTagObject</td>
<td>139</td>
</tr>
<tr>
<td>GlgIsDrawable</td>
<td>140</td>
</tr>
<tr>
<td>GlgIterate</td>
<td>140</td>
</tr>
<tr>
<td>GlgLayoutObjects</td>
<td>141</td>
</tr>
<tr>
<td>GlgLoadObject</td>
<td>143</td>
</tr>
<tr>
<td>GlgLoadObjectFromImage</td>
<td>143</td>
</tr>
<tr>
<td>GlgMoveObject</td>
<td>144</td>
</tr>
<tr>
<td>GlgMoveObjectBy</td>
<td>145</td>
</tr>
<tr>
<td>GlgPositionObject</td>
<td>145</td>
</tr>
<tr>
<td>GlgReferenceObject</td>
<td>146</td>
</tr>
<tr>
<td>GlgReleaseObject</td>
<td>147</td>
</tr>
<tr>
<td>GlgReorderElement</td>
<td>148</td>
</tr>
<tr>
<td>GlgRootToScreenCoord</td>
<td>148</td>
</tr>
<tr>
<td>GlgRotateObject</td>
<td>149</td>
</tr>
<tr>
<td>GlgSaveObject</td>
<td>149</td>
</tr>
<tr>
<td>GlgScaleObject</td>
<td>150</td>
</tr>
<tr>
<td>GlgScreenToWorld</td>
<td>151</td>
</tr>
<tr>
<td>GlgSetMatrixData</td>
<td>152</td>
</tr>
<tr>
<td>GlgSetStart</td>
<td>152</td>
</tr>
<tr>
<td>GlgSuspendObject</td>
<td>152</td>
</tr>
<tr>
<td>GlgTransformObject</td>
<td>153</td>
</tr>
<tr>
<td>GlgTransformPoint</td>
<td>154</td>
</tr>
<tr>
<td>GlgTranslatePointOrigin</td>
<td>154</td>
</tr>
<tr>
<td>GlgTraceObject</td>
<td>155</td>
</tr>
<tr>
<td>GlgTraverseObjects</td>
<td>156</td>
</tr>
<tr>
<td>GlgUnconstrainObject</td>
<td>156</td>
</tr>
<tr>
<td>GlgWorldToScreen</td>
<td>157</td>
</tr>
<tr>
<td>Get and Set Resource Function Extension</td>
<td>157</td>
</tr>
<tr>
<td>Extended API Function Descriptions</td>
<td>159</td>
</tr>
<tr>
<td>GlgCreateObject</td>
<td>159</td>
</tr>
<tr>
<td>Using GlgCreateObject</td>
<td>160</td>
</tr>
<tr>
<td>GlgAddObjectToTop</td>
<td>172</td>
</tr>
<tr>
<td>GlgAddObjectToBottom</td>
<td>172</td>
</tr>
<tr>
<td>GlgAddObjectAt</td>
<td>172</td>
</tr>
<tr>
<td>GlgAddObject</td>
<td>173</td>
</tr>
<tr>
<td>Function</td>
<td>Page</td>
</tr>
<tr>
<td>------------------------------------------------------</td>
<td>------</td>
</tr>
<tr>
<td>GlgCopyObject</td>
<td>175</td>
</tr>
<tr>
<td>GlgCloneObject</td>
<td>175</td>
</tr>
<tr>
<td>GlgDeleteTopObject</td>
<td>177</td>
</tr>
<tr>
<td>GlgDeleteBottomObject</td>
<td>177</td>
</tr>
<tr>
<td>GlgDeleteObjectAt</td>
<td>177</td>
</tr>
<tr>
<td>GlgDeleteObject</td>
<td>177</td>
</tr>
<tr>
<td>GlgDeleteThisObject</td>
<td>179</td>
</tr>
<tr>
<td>GlgFlush</td>
<td>179</td>
</tr>
<tr>
<td>GlgSetElement</td>
<td>179</td>
</tr>
<tr>
<td>GlgSetResourceObject</td>
<td>180</td>
</tr>
<tr>
<td>GlgSetXform</td>
<td>181</td>
</tr>
</tbody>
</table>

### 2.7 Real-Time Chart Functions

#### Chart Functions of the Standard API

<table>
<thead>
<tr>
<th>Function</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>GlgAddAnnotation</td>
<td>183</td>
</tr>
<tr>
<td>GlgAddPlot</td>
<td>184</td>
</tr>
<tr>
<td>GlgAddTimeLine</td>
<td>184</td>
</tr>
<tr>
<td>GlgClearDataBuffer</td>
<td>185</td>
</tr>
<tr>
<td>GlgDeleteAnnotation</td>
<td>185</td>
</tr>
<tr>
<td>GlgDeletePlot</td>
<td>186</td>
</tr>
<tr>
<td>GlgDeleteTimeLine</td>
<td>186</td>
</tr>
<tr>
<td>GlgGetDataExtent</td>
<td>187</td>
</tr>
<tr>
<td>GlgGetNamedPlot</td>
<td>188</td>
</tr>
<tr>
<td>GlgGetSelectedPlot</td>
<td>188</td>
</tr>
<tr>
<td>GlgSetLinkedAxis</td>
<td>188</td>
</tr>
<tr>
<td>GlgSetLabelFormatter</td>
<td>189</td>
</tr>
<tr>
<td>GlgSetChartFilter</td>
<td>190</td>
</tr>
</tbody>
</table>

#### Chart Functions of the Intermediate API

<table>
<thead>
<tr>
<th>Function</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>GlgAddDataSample</td>
<td>191</td>
</tr>
<tr>
<td>GlgCreateChartSelection</td>
<td>192</td>
</tr>
<tr>
<td>GlgCreateDataSample</td>
<td>193</td>
</tr>
<tr>
<td>GlgCreateTooltipString</td>
<td>193</td>
</tr>
<tr>
<td>GlgGetLegendSelection</td>
<td>194</td>
</tr>
<tr>
<td>GlgPositionToValue</td>
<td>194</td>
</tr>
</tbody>
</table>
2.8 GIS Object Functions .................................................................................. 195

GIS Function Descriptions ................................................................................ 196
GlgGISConvert ........................................................................................................ 196
GlgGISCreateSelection ....................................................................................... 197
GlgGISGetDataset ............................................................................................... 198
GlgGISGetElevation ............................................................................................ 198
GlmConvert .......................................................................................................... 199

2.9 GLG Installable Interface Handlers ......................................................... 201

Overview ............................................................................................................. 201
List of Functions .................................................................................................. 202
Function Descriptions .......................................................................................... 204
GlgIHInit .............................................................................................................. 204
GlgIHTerminate ..................................................................................................... 204
GlgIHGlobalData ................................................................................................... 204
GlgIHInstall ......................................................................................................... 204
GlgIStart .............................................................................................................. 205
GlgIHResetup ....................................................................................................... 206
GlgIHUninstall .................................................................................................... 207
GlgIHUninstallWithToken .................................................................................... 207
GlgIHUninstallWithEvent .................................................................................... 207
GlgIHGetType ...................................................................................................... 208
GlgIHGetToken ..................................................................................................... 208
GlgIHCallCurrIHWithToken .................................................................................. 208
GlgIHCallCurrIHWithModifToken ........................................................................ 208
GlgIHCallCurrIH ................................................................................................. 209
GlgIHCallCurrIHWithToken .................................................................................. 209
GlgIHCallPrevIH ................................................................................................. 209
GlgIHCallPrevIHWithToken .................................................................................. 209
GlgIHCallPrevIHWithModifToken ........................................................................ 209
GlgIHGetCurrIH ................................................................................................. 209
GlgIHGetFunction .............................................................................................. 209
GlgIHGetPrevIH ................................................................................................. 210
GlgIHGetPrevFunction ....................................................................................... 210
GlgIHPassToken ................................................................................................. 210
GlgIHSetIPParameter ......................................................................................... 211
GlgIHSetDParameter ......................................................................................... 211
# Table of Contents

<table>
<thead>
<tr>
<th>Function</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>GlgIHSetSPParameter</td>
<td>211</td>
</tr>
<tr>
<td>GlgIHSetOParameter</td>
<td>211</td>
</tr>
<tr>
<td>GlgIHSetPParameter</td>
<td>211</td>
</tr>
<tr>
<td>GlgIHSetOParameterFromD</td>
<td>211</td>
</tr>
<tr>
<td>GlgIHSetOParameterFromG</td>
<td>211</td>
</tr>
<tr>
<td>GlgIHChangeIParameter</td>
<td>212</td>
</tr>
<tr>
<td>GlgIHChangeDParameter</td>
<td>212</td>
</tr>
<tr>
<td>GlgIHChangeSParameter</td>
<td>212</td>
</tr>
<tr>
<td>GlgIHChangeOParameter</td>
<td>212</td>
</tr>
<tr>
<td>GlgIHChangePParameter</td>
<td>212</td>
</tr>
<tr>
<td>GlgIHGetIParameter</td>
<td>212</td>
</tr>
<tr>
<td>GlgIHGetDParameter</td>
<td>212</td>
</tr>
<tr>
<td>GlgIHGetSParameter</td>
<td>212</td>
</tr>
<tr>
<td>GlgIHGetOParameter</td>
<td>212</td>
</tr>
<tr>
<td>GlgIHGetPParameter</td>
<td>212</td>
</tr>
<tr>
<td>GlgIHGetOptIParameter</td>
<td>212</td>
</tr>
<tr>
<td>GlgIHGetOptDParameter</td>
<td>212</td>
</tr>
<tr>
<td>GlgIHGetOptSParameter</td>
<td>212</td>
</tr>
<tr>
<td>GlgIHGetOptOParameter</td>
<td>212</td>
</tr>
<tr>
<td>GlgIHGetOptPParameter</td>
<td>212</td>
</tr>
</tbody>
</table>

## 2.10 GLG C++ Bindings

Standard, Intermediate and Extended API Macros ........................................... 215
Handling of Constant Strings ........................................................................ 216
C++ API Files and Libraries ............................................................................ 216

- GlgClass.h ......................................................................................... 216
- GlgClass.cpp .................................................................................... 216
- stdafx.h ........................................................................................ 216
Using GLG Objects ......................................................................................... 216
Automatic Referencing and Dereferencing .................................................... 218
Comparison Operators ................................................................................... 218
Using Input and Selection Callbacks ......................................................... 219
Miscellaneous Utility Classes ........................................................................ 219
Programming Examples .................................................................................. 219
List of Classes and Methods in the GLG C++ Bindings .................................... 219
Chapter 3 Using the ActiveX Control ..................................................... 239

Overview ......................................................................................................................... 239

GLG ActiveX Control Properties ........................................................................................ 240
  General Page ...................................................................................................................... 240
  HProperties Page .............................................................................................................. 242
  VProperties Page .............................................................................................................. 242
  DLinks Page ..................................................................................................................... 243
  SLinks Page ..................................................................................................................... 243
  GLinks Page ..................................................................................................................... 243

Dynamic Resource String Syntax ....................................................................................... 243

Persistency Support ........................................................................................................... 244

GLG ActiveX Control Events ............................................................................................. 244

ActiveX Control Methods ................................................................................................. 246

Intermediate and Extended API Methods ........................................................................... 257

GLG ActiveX Control Security .......................................................................................... 269

GLG ActiveX Control Environment Variables ............................................................... 270

Chapter 4 Using the Java and C# Versions of the Toolkit ......................... 271

Introduction ....................................................................................................................... 271

Overview ............................................................................................................................ 271

Class Library Files for Java and C#/.NET ......................................................................... 277

Interfaces ............................................................................................................................ 278

GlgInputListener .............................................................................................................. 278

GlgSelectListener ............................................................................................................ 278

GlgTraceListener ............................................................................................................. 278

GlgHierarchyListener ...................................................................................................... 279

GlgHListener .................................................................................................................... 279

GlgVListener ..................................................................................................................... 280

GlgReadyListener ........................................................................................................... 280
# Table of Contents

<table>
<thead>
<tr>
<th>Class</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>GlgErrorHandler</td>
<td>281</td>
</tr>
<tr>
<td>GlgAlarmHandler</td>
<td>281</td>
</tr>
<tr>
<td>GlgLabelFormatter</td>
<td>282</td>
</tr>
<tr>
<td>GlgChartFilter</td>
<td>282</td>
</tr>
<tr>
<td>GlgTooltipFormatter</td>
<td>283</td>
</tr>
<tr>
<td>GlgObjectActionInterface</td>
<td>283</td>
</tr>
<tr>
<td>GlgGISRequestObserver</td>
<td>284</td>
</tr>
</tbody>
</table>

### Enums

- GLG Integrated Component Classes | 285
- GlgBean Java class | 285
- GlgJBean Java class | 285
- GlgJLWBean Java class | 285
- GlgControl C# class | 286

#### Fields

- C# Properties | 287
- Java Bean Properties | 287
- Constructors | 289

#### Standard API Methods of GlgBean and GlgControl Containers

- Intermediate and Extended API Methods of GlgBean and GlgControl Containers | 298

#### GlgObject class

- Constants | 303

#### Standard API Methods

- Intermediate API Methods | 314

#### Extended API

- Chart-Related Methods of GlgObject | 324

#### GIS-Related Methods of GlgObject

#### GLG Utility Classes

- GlgDouble class | 332
- GlgPoint class | 333
- GlgCube class | 334
- GlgMatrixData class | 335
- GlgHierarchyData class | 335
- GlgTraceData class | 336
- GlgEvent class (C# only) | 336
- GlgEventArgs class (C# only) | 337
GLG objects classes

Overview ............................................................... 345
GlgArc class .......................................................... 346
GlgAxis class .......................................................... 346
GlgBoxAttr class ....................................................... 346
GlgChart class ............................................................ 347
GlgDynArray class ..................................................... 347
GlgFont class ........................................................... 347
GlgFontTable class ................................................... 348
GlgFrame class .......................................................... 348
GlgFunction class ...................................................... 348
GlgHistory class ....................................................... 348
GlgImage class .......................................................... 349
GlgLevelLine class .......................................................... 349
GlgLineAttr class ....................................................... 349
GlgList class .......................................................... 349
GlgLight class ........................................................ 350
GlgMarker class ......................................................... 350
GlgParallelogram class .................................................. 350
GlgPlot class .......................................................... 351
GlgPolySurface class .................................................... 351
GlgPolygon class .......................................................... 351
GlgPolyline class .......................................................... 351

GlgInputEventArgs class (C# only) ........................................................ 337
GlgSelectEventArgs class (C# only) ........................................................ 337
GlgHierarchyEventArgs class (C# only) ......................................................... 338
GlgTraceEventArgs class (C# only) ............................................................... 338
GlgMinMax class .......................................................................................... 338
GlgDataSample class .......................................................................................... 339
GlgDataSampleExt class ......................................................................................... 340
GlgFindMatchingObjectsData class ........................................................................ 341
GlgGISRequestData class ...................................................................................... 342
GlgLatLonPoint class ............................................................................................. 343
GlgUtmPoint class ................................................................................................. 344
GlgUtmMGRS class ................................................................................................. 344

GLG objects classes

Overview ............................................................... 345
<table>
<thead>
<tr>
<th>Class</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>GlgReference class</td>
<td>352</td>
</tr>
<tr>
<td>GlgRenderingAttr class</td>
<td>352</td>
</tr>
<tr>
<td>GlgResourceReference class</td>
<td>352</td>
</tr>
<tr>
<td>GlgScreen class</td>
<td>352</td>
</tr>
<tr>
<td>GlgSeries class</td>
<td>353</td>
</tr>
<tr>
<td>GlgSpline class</td>
<td>353</td>
</tr>
<tr>
<td>GlgSquareSeries class</td>
<td>353</td>
</tr>
<tr>
<td>GlgTag class</td>
<td>353</td>
</tr>
<tr>
<td>GlgText class</td>
<td>354</td>
</tr>
<tr>
<td>GlgViewport class</td>
<td>354</td>
</tr>
<tr>
<td>GlgXform class</td>
<td>354</td>
</tr>
<tr>
<td>Attribute classes</td>
<td>355</td>
</tr>
<tr>
<td>GlgDataPoint class</td>
<td>355</td>
</tr>
<tr>
<td>GlgDDataPoint class</td>
<td>355</td>
</tr>
<tr>
<td>GlgGDataPoint class</td>
<td>355</td>
</tr>
<tr>
<td>GlgSDataPoint class</td>
<td>355</td>
</tr>
<tr>
<td>Data Value classes</td>
<td>355</td>
</tr>
<tr>
<td>GlgDataValue class</td>
<td>355</td>
</tr>
<tr>
<td>GlgDDataValue class</td>
<td>356</td>
</tr>
<tr>
<td>GlgGDataValue class</td>
<td>356</td>
</tr>
<tr>
<td>GlgSDataValue class</td>
<td>356</td>
</tr>
<tr>
<td>GlgMatrix class</td>
<td>356</td>
</tr>
<tr>
<td>GLG Graphics Server Support Classes for ASP.NET</td>
<td>357</td>
</tr>
<tr>
<td>GlgHttpRequestProcessor class</td>
<td>357</td>
</tr>
<tr>
<td>GlgHttpRequestData class</td>
<td>357</td>
</tr>
<tr>
<td>Graph Layout Classes</td>
<td>358</td>
</tr>
<tr>
<td>Overview</td>
<td>358</td>
</tr>
<tr>
<td>GlgGraphNode class</td>
<td>359</td>
</tr>
<tr>
<td>GlgGraphEdge class</td>
<td>359</td>
</tr>
<tr>
<td>GlgGraphLayout class</td>
<td>360</td>
</tr>
</tbody>
</table>

**Chapter 5**  
*Using the JavaScript Version of the Toolkit*  
Introduction .................................................................................................................. 367  
JavaScript Library ........................................................................................................ 367  
JavaScript API .............................................................................................................. 368
Overview ............................................................................................................................... 368
Using JavaScript API Methods ............................................................................................. 368
Comparing GLG Objects ...................................................................................................... 369
Predefined Constants ............................................................................................................. 369
Asynchronous Load ............................................................................................................. . 370
Additional Programming Notes ............................................................................................ 370
Deploying GLG JavaScript Library ........................................................................................... 370
JavaScript Library Layout ..................................................................................................... 370
Deploying JavaScript Library in HTML ..................................................................................... 371
Windows IIS Web Server Notes ............................................................................................. 371
Debugging Version of the GLG JavaScript Library..................................................................... 372
Global Configuration Resources .............................................................................................. 373
Using HTML Cascading Style Sheets ....................................................................................... 373
Deploying GLG Drawings Created in Different System Locales .................................................. 373
JavaScript Encodings ............................................................................................................. .. 373
Using GLG Drawings in JavaScript .......................................................................................... 373

Chapter 6  GLG Programming Tools and Utilities......................................................... 375

6.1 The Data Generation Utility ............................................................ 376
Command Line Arguments and Options .................................................................................. 376
Data Set Specification ........................................................................................................... 377
Data Set Options .............................................................................................................. ..... 377
Data File Format .............................................................................................................. ..... 379

6.2 GLG Script........................................................................................ 380
Overview .............................................................................................................................. 380
Standard Command Set ......................................................................................................... 380
# <comment> ................................................................................................................... ..... 380
set_value ................................................................................................................................ 380
set_tag ................................................................................................................................ 381
update ........................................................................................................................ ............ 381
print ......................................................................................................................... .............. 381
Database Record Support Commands ....................................................................................... 382
create_record ......................................................................................................................... 382
add_field ................................................................................................................................ 382
<table>
<thead>
<tr>
<th>Command</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>delete_record</td>
<td>382</td>
</tr>
<tr>
<td>read_records</td>
<td>383</td>
</tr>
<tr>
<td>end_read</td>
<td>383</td>
</tr>
<tr>
<td>read_one_record</td>
<td>383</td>
</tr>
<tr>
<td>Database Record Support Example</td>
<td>383</td>
</tr>
<tr>
<td>Extended Command Set</td>
<td>384</td>
</tr>
<tr>
<td>skip_if_no_resource</td>
<td>384</td>
</tr>
<tr>
<td>skip_if_resource</td>
<td>385</td>
</tr>
<tr>
<td>skip_end</td>
<td>385</td>
</tr>
<tr>
<td>get_value</td>
<td>385</td>
</tr>
<tr>
<td>get_tag</td>
<td>385</td>
</tr>
<tr>
<td>select_object</td>
<td>385</td>
</tr>
<tr>
<td>select_container</td>
<td>386</td>
</tr>
<tr>
<td>select_element</td>
<td>387</td>
</tr>
<tr>
<td>load_object</td>
<td>387</td>
</tr>
<tr>
<td>set_resource_object</td>
<td>387</td>
</tr>
<tr>
<td>reference</td>
<td>387</td>
</tr>
<tr>
<td>drop</td>
<td>387</td>
</tr>
<tr>
<td>add_custom_property</td>
<td>388</td>
</tr>
<tr>
<td>add_public_property</td>
<td>388</td>
</tr>
<tr>
<td>add_export_tag</td>
<td>388</td>
</tr>
<tr>
<td>add_data_tag</td>
<td>389</td>
</tr>
<tr>
<td>get_export_tag</td>
<td>389</td>
</tr>
<tr>
<td>delete_custom_property</td>
<td>389</td>
</tr>
<tr>
<td>delete_public_property</td>
<td>389</td>
</tr>
<tr>
<td>delete_export_tag</td>
<td>389</td>
</tr>
<tr>
<td>delete_data_tag</td>
<td>390</td>
</tr>
<tr>
<td>create</td>
<td>390</td>
</tr>
<tr>
<td>add_new</td>
<td>392</td>
</tr>
<tr>
<td>add_copy</td>
<td>392</td>
</tr>
<tr>
<td>copy</td>
<td>393</td>
</tr>
<tr>
<td>delete</td>
<td>393</td>
</tr>
<tr>
<td>constrain_object</td>
<td>394</td>
</tr>
</tbody>
</table>
6.3 Code Generation Utility ................................................................. 395
6.4 Drawing File Conversion Utility .................................................... 396
6.5 C/C++ Graph Layout Component ................................................... 401
   Overview .......................................................................................... 401
   Data Access Macros ........................................................................... 401
   Function Descriptions ....................................................................... 403
Appendices .......................................................................................... 413
7.1 Appendix A: Global Configuration Resources ............................... 413
7.2 Appendix B: Message Object Resources ......................................... 427
   Generic Resources of the Message Object ...................................... 427
   Specific Resources of the Message Object ..................................... 428
   Slider Message Object ..................................................................... 429
   Knob Message Object ...................................................................... 430
   Button Message Object .................................................................... 431
   Text Message Object ........................................................................ 432
   Spinner Message Object .................................................................... 433
   List Message Object ......................................................................... 433
   Option Message Object ...................................................................... 434
   Menu Message Object ........................................................................ 434
   Clock and Stopwatch Message Object .......................................... 435
   Timer Message Object ....................................................................... 435
   Palette Message Object ....................................................................... 436
   Font Browser Message Object ...................................................... 436
   Browser Message Object ................................................................... 437
   Zoom Message Object ....................................................................... 438
   Custom Event Message Object ...................................................... 439
   Command Message Object ................................................................ 442
   Tooltip Message Object ..................................................................... 443
   UpdateDrawing Message Object ................................................... 444
   ImageLoad Message Object ............................................................ 444
   TemplateLoad Message Object ........................................................ 445
Table of Contents

Object Selection Message Object ................................................................. 445
Chart Selection Message Object ................................................................. 446
Chart Message Object .................................................................................. 447
Window Message Object .............................................................................. 447

7.3 Appendix C: GLG Object Attribute Table ............................................. 448

Generic Attributes ...................................................................................... 448
Generic Attributes of Drawable objects ....................................................... 448
Polygon Attributes ..................................................................................... 448
Rendering Object Attributes ....................................................................... 449
Marker Attributes ....................................................................................... 449
Text Object Attributes ............................................................................... 449
Box Attributes Object Attributes ............................................................... 450
Arc Attributes .......................................................................................... 450
Parallelogram Attributes ........................................................................... 450
Spline Object Attributes ............................................................................ 451
Rounded Object Attributes ....................................................................... 451
Image Object attributes ............................................................................ 451
GIS Object attributes .............................................................................. 452
Group and List Objects’ Attributes ............................................................. 452
Connector Object Attributes ..................................................................... 452
Reference Object Attributes .................................................................... 452
Series Object Attributes ........................................................................... 453
Square Series Object Attributes ................................................................. 453
Polyline Attributes ................................................................................... 454
Polysurface Attributes ............................................................................... 454
Frame Object Attributes ............................................................................ 454
Viewport Attributes .................................................................................. 455
Screen Object Attributes .......................................................................... 456
Light Viewport Attributes ........................................................................ 457
Chart Object Attributes ............................................................................ 458
Plot Object Attributes ............................................................................... 459
Level Line Object Attributes ..................................................................... 459
Annotation Object Attributes ................................................................... 460
Legend Object Attributes ......................................................................... 460
Axis Object Attributes ........................................................................................................ .. 461
Line Attributes Object ........................................................................................................ 461
Light Object Attributes ..................................................................................................... 462
Colortable Object Attributes .............................................................................................. 462
Font Table Object Attributes .............................................................................................. 462
Font Object Attributes ....................................................................................................... 462
Transformation Object Attributes ....................................................................................... 463
Action Object Attributes .................................................................................................... 463
Alias Object Attributes ...................................................................................................... 463
History Object Attributes .................................................................................................. 463
Data Object Attributes ....................................................................................................... 464
Attribute Object Attributes ............................................................................................... 464
Tag Object Attributes ......................................................................................................... 464
Function Object Attributes ................................................................................................. 464

7.4 Appendix D: Global Parameters....................................................................................... 465
Chapter 1

Integrating GLG Drawings into a Program

The GLG Graphics Builder is a flexible and powerful tool for the creation and animation of GLG drawings. The GLG Toolkit also provides a variety of ways to incorporate GLG drawings into your applications and supplies several facilities designed to draw and control a GLG drawing from within a user’s application program at run time.

The steps for integrating a GLG drawing into a program are straightforward, and most of them are platform-independent:

1. Create a GLG drawing in the GLG Builder using one of the File, New, Widget options and add graphical objects, such as predefined components from the Palettes menu or graphical primitives with dynamic actions.

   The drawing is encapsulated in a GLG widget, which is a top-level viewport named $Widget with its HasResources attribute set to YES. The drawing is saved in a file with a .g extension. In addition to creating a drawing interactively with the GLG Graphics Builder, it may also be created programmatically at run time using the GLG Extended API Library.

2. Load the saved drawing (.g file) into a program and display it in a window. This can be done either using the cross-platform GLG Generic API, or via platform-specific containers:

   **C/C++**

   - The GLG Generic API Library is a platform-independent solution for applications that need source code portability. The GlgInitialDraw method of the Generic API performs all platform-specific initialization, creates a window and displays a drawing in it. Cross-platform methods for handling user interaction are also provided. An application developed using the Generic API can be compiled and executed with no source code changes on both Unix/Linux and Windows.

   - On Windows, the GLG Custom Control, the GlgControlCMFC class or the GLG ActiveX Control can be used to display a drawing in the C/C++ program.

   - In Unix/Linux and X Windows environment, several flavors of the GLG Wrapper Widget are provided for integration in the X Windows C/C++ programs.

   - Qt and GTK wrapper widgets are also provided for integrating drawings into these environments on both Windows and Unix/Linux platforms (refer to the Qt and GTK Integration section on page 47 for more information).

   **Java**

   - A GLG Java Bean is used to integrate GLG drawings in a Java application, both Swing and JavaFX. The GLG Bean is available as a heavyweight (GlgJBean) or lightweight (GlgJLWBean) Swing component. The GLG Java Class library provides a 100% pure Java version of the GLG Run Time engine.

   - The Generic API is also available for Java as the InitialDraw method of the GlgObject class.
• The GLG Graphics Server class library can be used with the JavaEE Framework to
develop server-side AJAX-based applications for web and mobile applications using
Java Servlet technology.

C#/.NET
• A native Windows Form User Control is provided as the GlgControl class, and the
GLG .NET DLL provides the GLG Run Time engine for the .NET Framework. The
GLG .NET DLL can be used in a cross-platform way using Mono on Linux. On
Windows, C#/.NET applications can also use the GLG ActiveX Control.
• The Generic API is also available for C#/.NET as the InitialDraw method of the
GlgObject class.

VB.NET and VB6
• VB.NET applications can use either the C#-based GLG User Control or the GLG
ActiveX Control. The GLG ActiveX Control can also be used in VB6 applications.

JavaScript
• The GLG Generic API is used in JavaScript applications to load and display a GLG
drawing on a web page.

3. Animate the drawing with real-time data by setting either resources or tags defined in the
drawing. This is done using methods of the GLG Standard API.

4. Handle user interaction, such as button clicks, mouse click actions, etc.

The following sections of this chapter provide details about each of these steps, and about issues
important to GLG Toolkit programmers.

Creating a Widget Drawing

To use a GLG drawing in a program, it has to be encapsulated in a GLG Widget by placing the
drawing in a viewport named $Widget. Most drawings are created with the GLG Graphics Builder.
Any GLG drawing with a viewport at the top level of its resource hierarchy can become a GLG
widget, simply by defining the name of that viewport to be $Widget. The viewport’s HasResources
attribute must be set to YES in order for its resources to appear inside the viewport.

A drawing can also be created from a program, using the GLG Extended API. The Extended API
is described in detail in the GLG Intermediate and Extended API chapter on page 119.

If you save a GLG drawing into a file, there are three different file formats it may use:

• The binary format is the fastest format to use for loading drawing files, but not compatible
between hardware platforms with different binary data representations. The binary format dif-
fers between the C/C++ and Java/C# versions of the Toolkit as well, since Java and C# use
their own binary representations of data. The JavaScript API does not support the binary for-
mat. The binary format is primarily used for the drawings which are embedded into the C/C++
executables using the code generation option, and should not be used for drawings that will be
used on different platforms or with the Java/C#/JavaScript programs.
• The **ASCII** format is slightly slower to load (though more compact) than the binary format and is compatible between different hardware platforms. It is also compatible across the C/C++ and Java/C#/.NET versions of the Toolkit. The ASCII format is the default save format and is also the preferred format for the Java, C#/.NET and JavaScript versions of the Toolkit.

• The **extended** format is the slowest and the least compact, but provides the ability to transfer drawing files between different versions of the Toolkit. It may be used to import the drawings saved using a newer release of the Toolkit into an older version (if the drawing uses the new features of the newer release, the conversion for these features or for the whole drawing may fail). The extended format is not supported in Java, C#/.NET and JavaScript.

**Displaying a Drawing**

Unless the GLG Generic API is used, displaying a drawing is one of the few platform-dependent steps in the process of animating it with input data. The necessary steps for displaying a drawing under X Windows or Microsoft Windows are both covered in the *Displaying a GLG Drawing* chapter on page 31. You only need to read the sections of that chapter that apply to the windowing environment and the version of the Toolkit you intend to use for your application (C/C++, ActiveX, Java, C#/.NET or JavaScript).

Before a drawing can be displayed by a program, it must be loaded into memory. There are three ways to do this:

• A drawing may be stored in a separate file. This lets the user of an application customize the appearance of the widget by editing the file using the GLG Graphics Builder. This option is also very convenient in the development stage, allowing you to modify the drawing without additional compile/debug cycles.

• A drawing may also be converted into a memory image in a C language format using the Toolkit’s `gcodegen` utility. This allows you to compile and link the drawing directly into the program's executable. Embedding a drawing into the executable increases its size, and prevents users from modifying the drawing, but reduces the number of additional files needed by an application. See the Code Generation Utility section on page 395 in the GLG Programming Tools and Utilities chapter for more details. Memory images are not supported in the Java, C#/.NET and JavaScript versions of the Toolkit. In Java, the drawing may be placed inside the application’s JAR file.

• A program may also generate a drawing from scratch using the GLG Extended API. Although this is possible, it is usually simpler to load a drawing template from a file and reserve these functions for modifying the template drawing and adding new objects to it. The Extended API is described in the GLG Intermediate and Extended API chapter on page 119. The Extended API for the Java and C#/.NET versions of the Toolkit is described in the Using the Java and C# Versions of the Toolkit chapter. The JavaScript Extended API is almost identical to the Java and C# Extended API and is described in the GLG JavaScript Online Documentation.
**Animating a Drawing with Real-Time Data**

A program animates a GLG drawing with application data by setting drawing’s resources or tags using methods of the GLG Standard API. These functions are described in the *Animating a GLG Drawing with Data Using the Standard API* chapter on page 61.

Resources are hierarchical and can be used to set properties of specific objects in the drawing when the content of the drawing is known in advance. Tags are global and can be used to animate an arbitrary drawing without knowing its content or resource hierarchy. Tags can be assigned by end users in the GLG HMI Configurator or the GLG Builder to specify the tag source of the process database used to animate a particular dynamic parameter. At run time, an application can query a list of tags defined in the drawing and use information in each tag to obtain data from the process database, animating the drawing with the retrieved data.

A *SimpleViewer* example provides a sample implementation of a generic GLG viewer that animates an arbitrary drawing using tags. The example provides source code for various programming environments (C/C++/C#.NET/Java/VB.NET). A *SCADA Viewer* example provides a sample framework for a more elaborate viewer that also handles drawing navigation, object commands, popup menus and dialogs, as well as alarm display and acknowledgement.

**Controlling a Drawing from a Program**

A GLG drawing is controlled from a program in the same way it is controlled from the GLG Graphics Builder: by setting and querying resources. Resources can be used to change values of any object properties, from a fill color to object visibility, to a number of plots in a chart. Methods for querying or setting resource values are provided in the GLG Standard API.

The GLG Intermediate API provides additional methods that can be used to traverse all objects defined in the drawing to discover the structure of the drawing, constraint object attributes, perform coordinate conversion or implement custom object manipulation, such as dragging objects with the mouse.

Finally, the GLG Extended API provides methods for creating drawings programmatically at run time. It includes methods for creating objects, adding or deleting objects from the drawing, as well as creating and attaching dynamics to objects.

The Intermediate and Extended APIs are described in the *GLG Intermediate and Extended API* chapter on page 119.

**Handling User Input**

If the drawing is to accept input from a user, some extra steps must be taken to build it. You may need to add input objects (such as buttons or text boxes) to the drawing, or attach actions (such as a mouse click or a mouse over) to objects in the drawing. The *ProcessMouse* attribute of a viewport must be set to the desired set of action types to activate processing of actions attached to objects in the drawing.
At run-time, user interaction is handled in the **input callback**, which is a callback function supplied by the programmer and executed by the GLG Toolkit in response to various possible user actions. A **select callback** can be used for simplified object selection, and a **trace callback** can be used to access low-level events of the native windowing system.

A number of pre-built input objects is provided, accessible in the GLG Graphics Builder via the *Palettes* menu. Custom input objects may also be created as described in the **Input Objects** chapter of the GLG User’s Guide.

Object selection, custom event and command action handling is described in the *Integrated Features of the GLG Drawing* chapter of the GLG User’s Guide. The structure of a callback function is described in the *Handling User Input and Other Events* chapter of this manual.

**H and V Resources**

In the static picture of the GLG drawing architecture that was sketched in the introductory chapters of this guide, all resources are of equal status. All resources are attributes of some object, and they can all be modified or created as the need arises. However, while a drawing is in flux (while it is being drawn, for example), some resources need to be treated differently than others. Because of this need, two different categories of resources exist: those that affect simple values and those that affect the resource hierarchy itself.

The **H** (hierarchy) and **V** (value) drawing resources differ in when they are processed by the widget. The H resources are processed *before* creating the drawing hierarchy, while the V resources are processed *after* it has been established. The H resources can affect the structure of the hierarchy itself, for example by controlling the number of objects in a series, while the V resources are processed after the specified number of objects in the drawing hierarchy have been created.

A series object, for example, replicates its template object to produce a number of instances. The series’ factor defines how many objects appear in that series. Referencing the eighth object in a series makes no sense before the instances of objects are created. The value of the series factor is another example of an H resource. Setting the factor value with a V resource would work, but would introduce inefficiency, since the drawing hierarchy would first be created with the number of series instances defined by the old value, then destroyed and the new number of instances would be created. Other example of H resources are the non-global attributes of a series template. The template is replicated at the time of hierarchy setup, and its attributes have to be set before the hierarchy is set up in order for the instances to inherit the template’s attribute values. All H resources are processed before the drawing hierarchy is created, which guarantees that all resources depending on the number of objects in the drawing hierarchy are accessible.

V resources are used for setting resources that depend on the structure of the drawing hierarchy or that do not exist or are inaccessible before creating the hierarchy. Consider an example where the GLG Toolkit, in a program called “example,” reads a bar graph with 10 data samples from a drawing file. We’d like to change the number of data samples to 100 and to have the color of the 25th data sample appear red when the widget is displayed.
Using H and V Properties of Native Controls

Let's start with setting the value of the "DataGroup/Factor" resource of the widget to 100. Because this resource affects the hierarchy of the drawing, we use an H resource. Using the X Windows protocol for setting resource values, we might use a line in the configuration file such as:

```
example*XtNglgHResource0 "DataGroup/Factor d 100"
```

Using the OCX control for Microsoft Windows, it would be:

```
HProperty0:   DataGroup/Factor d 100
```

Using a V resource to set this value would make the GLG Toolkit create a drawing with 10 data samples, discard it, and create another drawing with 100 data samples. Careful use of H and V resources can avoid this kind of inefficiency.

Now we want to set the color of the 25th data sample to be red. However, the original drawing has only 10 data samples; so the 25th data sample does not exist in the drawing. Because of the 25th data sample does not exist until all the H resources are processed, its color cannot be set using H resources. Trying to do so generates an error message saying that the resource cannot be accessed.

To change the color of a graphical object, you only change the value of a data object in the hierarchy; you do not change the hierarchy. Therefore, a V resource is appropriate for this purpose. These are treated after the specified data sample has been created and is accessible. The line in the configuration file for our example program would then look like this:

```
example*XtNglgVResource0 "DataGroup/DataSample24/FillColor g 1. 0. 0."
```

Note that since the index is zero-based, the number 24 is used to access the 25th data sample.

Using the OCX control for Microsoft Windows, it would be:

```
VProperty0:   DataGroup/DataSample24/FillColor g 1. 0. 0.
```

To set the resources that do not depend on the number of objects in the drawing hierarchy, you may use either H or V resources. For example, you can set a background color of the widget's drawing using either kind of resource. Note, however, that many resource names depend on the structure of the resource hierarchy to be accurately interpreted.

Handling H and V Resources in the Program Code

When the GLG API is used to set drawing resources, the same considerations apply. To increase the efficiency of your application program and avoid errors, insure that all the H resources that need setting are set first, before the V resources. In our example above, the Factor resource should be set first, then the GlgUpdate function should be called, and then the V resources set:

```
GlgSetDResource( drawing, "BarGraph/DataGroup/Factor", 100. );
GlgUpdate( drawing );
GlgSetGResource( drawing,
    "BarGraph/DataGroup/DataSample24/FillColor", 1., 0., 0. );
```
Utilities

The GLG Toolkit contains a small number of utility programs for use by an application programmer:

**datagen**
Generates a variety of data streams used for testing and prototyping. It is primarily used inside the GLG Graphics Builder for animating the drawing with simulated data in the Run mode.

**gcodegen**
Creates a memory image of a GLG drawing in the C language format. The output of the utility is a file with .c extension, containing the image of the drawing in a form of the C source code. The output file can be compiled into the program’s executable, making it possible to create a single program executable and eliminate a need to distribute additional drawing files.

**gconvert**
Converts drawing files from one GLG format to another; can also be used to change resources of a drawing in a batch mode using the *-command or -script* command line options.
A GLG drawing file may have one of three different formats: binary, ASCII, or extended. Binary drawings are the fastest to load from the memory image, but ASCII drawings are more portable. The extended format is used to port drawings to different versions of the toolkit.

These tools are described in detail in the *GLG Programming Tools and Utilities* chapter on page 375.
Chapter 2
Using the C/C++ version of the Toolkit

2.1 Displaying a GLG Drawing

The first step in operating a GLG drawing from a program is to display that drawing. GLG drawings are environment and platform-independent, as are many of the aspects of controlling and modifying the drawings. The task of displaying the drawings in a display window, however, is peculiar to the windowing system and environment in use.

This chapter describes the task of creating and displaying a GLG drawing in C and C++ programs used in different windowing environments: X Windows on Unix/Linux and Windows.

This chapter contains three sections:

- The first section describes the task of loading and displaying a GLG drawing in a window in the X Windows and Linux/Unix environment using either a Motif or Xt-based GLG Wrapper widget.

- The second section of this chapter on page 38 provides information on loading and displaying a GLG drawing on Windows.

- The third section on page 49 describes a platform-independent GLG Generic API, which can be used for loading and displaying a GLG drawing in cross-platform way. The source code of the applications created using the Generic API is portable between Linux/Unix and Windows environments.

The Windows version of the GLG Toolkit also includes the GLG ActiveX Control, an ActiveX component providing full GLG functionality. The GLG ActiveX control allows GLG drawings to be embedded and used in a variety of user applications and environments supporting ActiveX controls, such as VB.NET, C++ and C#/.NET. For more information, see the Using the ActiveX Control chapter on page 239.

C++ applications may also use provided C++ classes to instantiate a GLG drawing as a class in a C++ program. The GLG Toolkit provides classes for instantiating a GLG drawing in both Xt, Motif and MFC environments, as well as cross-platform classes that use GLG Generic API and may be used in either environment. See the GLG C++ Bindings chapter on page 215 for more information.

The provided Qt and GTK integration examples demonstrate how to deploy GLG drawings in the Qt and GTK applications.

The Java version of the toolkit uses either the GLG Java Bean or the GLG Generic API provided by the GlgObject class to load and display the drawing.

The C#/NET version uses either the native .NET GlgControl or the GLG Generic API. Refer to the Using the Java and C# Versions of the Toolkit chapter on page 271 for more information.

The JavaScript version of the toolkit uses the GLG Generic API to load and display the drawing on a web page in HTML.
X Windows and GLG Wrapper Widget

This section describes how to use the C/C++ version of the GLG library in the Linux/Unix and X Windows environment. Refer to the GLG C++ Bindings chapter on page 215 for details on the GLG C++ classes. Refer to the GLG Custom Control for Windows section on page 38 for a description of using GLG on Windows.

The GLG Wrapper Widget is a widget wrapper around the GLG library used to embed GLG drawings into existing Xt and Motif interfaces. After the wrapper widget is instantiated in an application’s widget hierarchy, it loads and displays a GLG drawing, providing the GLG API to update the display with new data and access GLG objects in the drawing.

There are three basic steps involved in displaying a GLG drawing within an X Windows graphical environment. The first step is creating a GLG Wrapper Widget to contain the drawing. The GLG Toolkit provides both a Motif version of this widget, which inherits its attributes from the XmManager Motif class, and the Xt version of the widget, which inherits its attributes from the simpler Constraint class.

The two versions of the GLG Wrapper Widget are nearly identical in usage. The only difference is that the Xt version of the wrapper widget doesn’t support native Motif input objects (buttons, scrollbars, etc.), which will be displayed as empty boxes when displayed in the Xt version of the widget. Use the Motif version when Motif compliance is necessary for your application, or if your drawing includes native input widgets. If neither of these are true, you can use the Xt version. You choose whether to use the Motif or the Xt version of the GLG Wrapper Widget at link time, by specifying either the Motif or Xt-based GLG library. The Xt-based GLG library is provided for Linux and certain other platforms. For information about linking with GLG libraries, see the Integrating GLG Drawings into a Program chapter.

After the widget is created and the drawing displayed, a program must acquire a viewport handle (or object ID) to use with the rest of the GLG API. Finally, when the program’s execution is completed, it must close the widget and drawing. Briefly, the tools for these steps are as follows:

• To create a GLG Wrapper Widget instance, use XtCreateWidget and specify the class variable GlgWrapperWidgetClass and either the XtNglgDrawingFile, XtNglgDrawingObject, or XtNglgDrawingImage resource.

• To destroy a GLG Wrapper Widget, use XtDestroyWidget and specify the widget ID of the GLG wrapper.

• To manipulate objects in a viewport of the GLG Wrapper Widget, use XglgGetWidgetViewport to create an object ID.

These steps are described in detail in the sections that follow.

Creating the Wrapper Widget

An application program creates a GLG Wrapper Widget the same way it creates any other widget. Use the XtCreateWidget function from the X Toolkit, and the GlgWrapperWidgetClass from the GLG Toolkit.
Graphical objects to be displayed inside the widget are defined by a supplied GLG drawing. The
drawing used for a widget defines the type of the widget and its appearance.

Synopsis

To create a GLG Wrapper Widget with the `XtCreateWidget` function, use the following arrangement
of include files in your program:

```c
#include <X11/StringDefs.h>
#include <X11/Intrinsic.h>
#include "GlgWrapper.h"
```

Create the widget with a call to the X toolkit:

```c
widget = XtCreateWidget( name, glgWrapperWidgetClass, ... );
```

Wrapper Widget Resources

The Xt version of the GLG Wrapper Widget is a subclass of the Xt `Constraint` class, while the Motif
version is a subclass of the `XmManager` class. Like other widgets, the GLG Wrapper Widget is
controlled by querying and setting resources.

Warning: The resources of an X widget like the GLG Wrapper Widget are part of a different set of
resources from the resources of a GLG drawing. The structure is similar, but the application is
different. X resources refer to the data structure that makes up an entire screen, while the GLG
resources only refer to the animated drawing. The two sets do interact; you can use the X resources
of the GLG Wrapper Widget to set values for the GLG drawing resources. However, the two must
not be confused.

The following sections describe the resources of the GLG Wrapper Widget. The entire list of
resources is summarized in the table on page 37.

Loading the Drawing

There are three resources of the GLG Wrapper Widget you can use to define the source of the GLG
drawing to be displayed:

**XtNglgDrawingFile**

A character string specifying the name of the GLG drawing file.

**XtNglgDrawingObject**

An object ID of an already-loaded viewport object to be used by the GLG Wrapper Widget.
The drawing might have been loaded from a file or an image, or generated with the GLG
Extended API.

**XtNglgDrawingImage**

A long integer specifying the memory address of the drawing’s memory image. This must be
used in conjunction with `XtNglgImageSize`, which must contain an integer defining the size of
that memory image. This is acquired from the `gcodegen` utility.

**NOTE:** `XtNglgDrawingImage` does not work with compressed drawing files. Save drawings
with the drawing compression option disabled to use them as images.
One of these three resources must be defined when a GLG Wrapper Widget is created. If all three are defined, XtNglgDrawingFile is used. If the file cannot be read, a warning message is generated, then XtNglgDrawingImage is used as a fall back resource. If none of these resources are defined or none of them are readable, an Xt error message is generated.

The drawing specified by the XtNglgDrawingFile or XtNglgDrawingImage resource must have a viewport named $Widget at the top level of the drawing’s hierarchy. If this condition is not satisfied, the drawing is not recognized as a valid drawing for the GLG Wrapper Widget. The HasResources flag of the viewport should be set to YES. For information about drawing resources, see the Structure of a GLG Drawing chapter.

The GLG Wrapper Widget manages the geometry of GLG graphical objects inside it, including any children GLG widgets represented by viewport objects. When the geometry of the widget is changed, it rubberbands all contained objects accordingly.

Setting the Drawing Resources

The GLG Wrapper Widget allows access to all the resources of the GLG drawing it contains in two different ways. After a drawing is displayed, you can use functions from the GLG API to manipulate drawing resources. The manipulation can happen either within the same process that started the GLG Wrapper Widget or from a remote process.

You can also set initial values for drawing resources using the resources of the GLG Wrapper Widget itself. Because the resource hierarchy of a drawing is infinitely variable, it is not feasible to allocate a separate GLG Wrapper Widget resource for every corresponding GLG drawing resource. Instead, the wrapper widget has a fixed number of dynamic resources which are not associated with any particular drawing resource but are simply used as entry points to access the drawing resource hierarchy.

You can also use the XtSetArgs function to manipulate the drawing resources through the GLG Wrapper Widget resources. However, this is a clumsy mechanism for an application program, and is not recommended. Using the GLG API gives an application program much finer control over when the drawing is updated and does not incur Xt resource setting overhead.

The GLG Wrapper Widget contains two sets of twenty resources, named XtNglgHResource0 to XtNglgHResource19 and from XtNglgVResource0 to XtNglgVResource19. (The difference between H and V resources is discussed in the H and V Resources section of the Integrating GLG Drawings into a Program chapter.) These resources contain character strings which in turn contain the names and values of GLG drawing resources. The strings have the following syntax:

```
<resource_name>  <resource_type>  <values>
```

**<resource_name>**

The name of the GLG drawing resource, including the complete path (omitting the “$Widget”). For example, “XLabelGroup/XLabel4/String” accesses the text string of the fifth label on the X axis in a graph widget.

**<resource_type>**

The type of the resource and can be one of the following:
**Using the C/C++ version of the Toolkit**

- **d** Indicates the resource value is represented by a single floating point number (a scalar), like a line width, a font number or a value of a data sample
- **s** The resource value is a string, like a text string of a label text object
- **g** The resource value is a set of three floating point numbers, like a geometrical point with X, Y and Z coordinates or a color, in which case the three components represent the color's Red, Green, and Blue values.

**<values>**

A value or a set of values for the resource. The values given depend on the resource type.

The following strings are examples of specifying resources:

- "DataGroup/DataSample3/Value d 2.5"
- "DataGroup/DataSample5/Value d 4"
- "XLabelGroup/XLabel4/String s April"
- "DataGroup/DataSample6/FillColor g 0.5 0.0 0.9"

The GLG Wrapper Widget does not need forty different dynamic resources of this type. In one sense, it would be adequate to have just one, and call it repeatedly. However, it is often useful to be able to keep the initial values of drawing resource in the X resource database, or in the X configuration files. Having many of these dynamic resources allows an application program to set several different drawing resources from the X resource database.

In the event that there are not enough GLG Wrapper Widget dynamic resources for your purpose, you can use the **XtNglgHInitCB** and **XtNglgVInitCB** callbacks to set the initial resources using functions of the GLG API.

**Callback Resources**

The **XtNglgHInitCB** callback is called after the viewport object containing the widget’s drawing has been created, but before the drawing hierarchy is created, allowing you to set H resources from the callback function itself. You can use the GLG API functions to do this, although you cannot modify the drawing itself with the Extended API from within one of these callback functions.

Setting H resources in this callback before the hierarchy is created eliminates the possible inefficiencies that arise when setting an H resource overrides an already existing part of the object hierarchy. The *call_data* parameter of the callback is not used.

The **XtNglgVInitCB** callback is called after the widget’s drawing hierarchy has been created, but before its graphical objects are drawn, allowing you to set V resources that depend on the number of objects in the hierarchy. These resources may be used to set the attributes of the created instances of objects for the initial appearance.

The **XtNglgSelectCB** callback is invoked after each mouse click event and provides a list of objects selected with the mouse.

The **XtNglgInputCB** callback is invoked after each user interaction with objects in the drawing and provides additional information which may be used to handle input events.
Trace callbacks (XtNglgTraceCB and XtNglgTrace2CB) can be used in addition to the input and selection callbacks to handle low-level events. If attached, these callbacks are invoked for any native event received by any of the drawing’s viewports. The trace callback is invoked just before processing the event by the select and input callbacks, and the trace2 callback is invoked after the event has been processed.

The XtNglgHierarchyCB callback is invoked when SubWindow or SubDrawing objects in the widget’s drawing load their templates. The callback is invoked twice: before the hierarchy setup of the template and after the hierarchy setup but before the template is drawn.

For more information about the input, select, trace and hierarchy callbacks, refer to the Callback Events chapter on page 101 of this manual.

The Motif version of the GLG Wrapper Widget also provides Motif-style XtNglgMotifSelectCB and XtNglgMotifInputCB callbacks, which receive the GlgInputCBStruct and GlgSelectCBStruct callback structures as parameters. These structures are defined in the GlgWrapper.h include file and provide a Motif-style callback interface. The GlgInputCBStruct structure contains message_obj parameter, and the GlgSelectCBStruct structure contains the selection_list parameter, providing the same functionality as the other styles of these callbacks. Refer to the Callback Events chapter on page 101 of this manual for details.

Sequence of Events

When a GLG Wrapper Widget is realized with a GLG drawing in it, the following sequence of events occurs:

1. The GLG drawing (supplied by the XtNglgDrawingFile or XtNglgDrawingImage resource) is loaded.

2. All current values of XtNglgHResource<N> resources are applied to the drawing.

3. The XtNglgHInitCB callback is invoked (if supplied).

4. The drawing hierarchy is set up.

5. All current values of XtNglgVResource<N> resources are applied to the drawing.

6. The XtNglgVInitCB callbacks is invoked (if supplied).

Setting the XtNglgDrawingFile and XtNglgDrawingImage resources after the widget has been realized loads the new drawing and discards all changes made to the old drawing. After reloading a new drawing file or image, the widget executes the same initialization sequence described above. Note that applying the current values of the GLG Wrapper Widget resources may generate an error message if some of the drawing resources specified are not applicable for the new drawing. To avoid the error message, set the offending wrapper widget resource to NULL.
Summary of GLG Wrapper Widget Resources

When creating a GlgWrapper widget instance, the following resources are retrieved from the argument list or from the resource database:

### GLG Wrapper Widget Resource Summary

<table>
<thead>
<tr>
<th>Name</th>
<th>Type</th>
<th>Default</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>XtNglgDrawingFile</td>
<td>String</td>
<td>NULL</td>
<td>Name of the file containing a GLG drawing.</td>
</tr>
<tr>
<td>XtNglgDrawingImage</td>
<td>XtPointer</td>
<td>NULL</td>
<td>Address of the memory image of a GLG drawing.</td>
</tr>
<tr>
<td>XtNglgImageSize</td>
<td>long</td>
<td>0</td>
<td>Size of the memory image.</td>
</tr>
<tr>
<td>XtNglgHResource0</td>
<td>String</td>
<td>NULL</td>
<td>Entry points for accessing (H) resources of graphical objects in the drawing.</td>
</tr>
<tr>
<td>XtNglgHResource1 ...</td>
<td>String</td>
<td>NULL</td>
<td></td>
</tr>
<tr>
<td>XtNglgHResource19</td>
<td>String</td>
<td>NULL</td>
<td></td>
</tr>
<tr>
<td>XtNglgVResource0</td>
<td>String</td>
<td>NULL</td>
<td>Entry points for accessing (V) resources of graphical objects in the drawing.</td>
</tr>
<tr>
<td>XtNglgVResource1 ...</td>
<td>String</td>
<td>NULL</td>
<td></td>
</tr>
<tr>
<td>XtNglgVResource19</td>
<td>String</td>
<td>NULL</td>
<td></td>
</tr>
<tr>
<td>XtNglgHInitCB</td>
<td>XtCallback list</td>
<td>NULL</td>
<td>Callback list for setting initial values of (H) resources using convenience functions.</td>
</tr>
<tr>
<td>XtNglgVInitCB</td>
<td>XtCallback list</td>
<td>NULL</td>
<td>Callback list for setting initial values of (V) resources using convenience functions.</td>
</tr>
<tr>
<td>XtNglgSelectCB</td>
<td>XtCallback list</td>
<td>NULL</td>
<td>Callback list for selecting objects in the widget.</td>
</tr>
<tr>
<td>XtNglgMotifSelectCB</td>
<td>XtCallback list</td>
<td>NULL</td>
<td>Callback list for selecting objects in the widget, Motif-style callback structure format.</td>
</tr>
<tr>
<td>XtNglgInputCB</td>
<td>XtCallback list</td>
<td>NULL</td>
<td>Callback list for the input activity in the widget.</td>
</tr>
<tr>
<td>XtNglgMotifInputCB</td>
<td>XtCallback list</td>
<td>NULL</td>
<td>Callback list for the input activity in the widget, Motif-style callback structure format.</td>
</tr>
<tr>
<td>XtNglgTraceCB</td>
<td>XtCallback list</td>
<td>NULL</td>
<td>Callback list for trace callbacks.</td>
</tr>
<tr>
<td>XtNglgTrace2CB</td>
<td>XtCallback list</td>
<td>NULL</td>
<td>Callback list for trace2 callbacks.</td>
</tr>
<tr>
<td>XtNglgHierarchyCB</td>
<td>XtCallback list</td>
<td>NULL</td>
<td>Callback list for hierarchy callbacks.</td>
</tr>
</tbody>
</table>

### Obtaining a Viewport Handle

To use any of the functions from the GLG API, you must get an object ID for the main viewport of the drawing. This is the one called $Widget. (See page 34.) To obtain this object ID from the widget, use the XglgGetWidgetViewport function.

```c
GlgObject XglgGetWidgetViewport( widget )
    Widget widget;
```
Parameters

widget

The Xt widget ID that specifies the GLG Wrapper Widget.

The GLG Wrapper Widget contains a viewport. The viewport manages all aspects of the drawing widget’s behavior and appearance. When accessing resources or performing any other operations on a GLG drawing, the object ID returned by \textit{XglgGetWidgetViewport} is passed as a “handle” identifying the viewport. The viewport is created only after the GLG Wrapper Widget has been realized, so this function returns NULL if called before then.

Closing the Wrapper Widget

To close the GLG Wrapper Widget gracefully, use the \textit{XtDestroyWidget} function from the X Toolkit. It accepts only one argument, the widget ID returned by the \textit{XtCreateWidget} function.

\begin{verbatim}
XtDestroyWidget( widget )
    Widget widget;
\end{verbatim}

GLG Custom Control for Windows

This section describes how to use the C/C++ version of the GLG library on Windows using the \textbf{Win32 API}. Refer to the \textit{GLG C++ Bindings} chapter on page 215 for details of the GLG C++ and \textbf{MFC classes}. Refer to the \textit{Using the ActiveX Control} chapter on page 239 for a description of using the \textbf{GLG ActiveX control}.

The GLG Custom Control is a Windows wrapper designed for embedding GLG drawings in the programs using a \textbf{Win32 API}. It allows embedding GLG drawings into the Windows interface hierarchy as a custom window control (a window with a custom window type). The GLG Custom Control manages the geometry of GLG graphical objects in it, including any child GLG widgets represented by nested viewport objects. When the geometry of the Control window changes, it proportionally resizes all the GLG objects inside it.

The first step in displaying a GLG drawing in the Windows environment is creating a window data structure to contain that drawing. This is the \textbf{GLG Custom Control}. After the window is created and the drawing displayed, a program must acquire a \textit{viewport handle} (or \textit{object ID}) which is used for updating the drawing with data via the GLG API. Finally, when the program’s execution is completed, it must close the window and drawing. Briefly, the tools for these steps are as follows:

- To create a GLG Custom Control instance, load the GLG drawing and use \textit{CreateWindow}. Other functions from the GLG API are used to set up the drawing hierarchy and display the drawing.
- To destroy a GLG Custom Control, use \textit{DestroyWindow} and specify the Window ID of the control.
- To manipulate objects in a viewport of the GLG Wrapper Widget, use \textit{GlgGetWindowViewport} to obtain an object ID of the viewport.

These steps are described in detail in the sections that follow.
Creating the GLG Custom Control

There are four steps involved in displaying a GLG drawing within the Microsoft Windows environment:

1. Read a GLG drawing into the program. This can be done from a file, with `GlgLoadWidgetFromFile`, or from memory, with `GlgLoadWidgetFromImage`.

2. Use `GlgSetDefaultViewport` to identify the viewport to be used as the drawing widget.

3. Create a Custom Control using the drawing. This is done with the `CreateWindow` function from the Microsoft Windows API. The Microsoft Windows class of the GLG Custom Control is `GlgControl`.

4. Use `GlgInitialDraw` to draw the initial drawing. You can delay this step until after you use `GlgGetWindowViewport` to create a widget ID for the GLG drawing. At that point, you can use either `GlgInitialDraw` or a combination of `GlgSetupHierarchy` and `GlgUpdate`.

The following example shows how to create a GLG Custom Control:

```c
#include "GlgApi.h"

HWND GlgControl;
GlgObject drawing;

drawing = GlgLoadWidgetFromFile( "BarGraph.g" );
GlgSetDefaultViewport( drawing );
GlgControl = CreateWindow( "GlgControl", "GlgControlTest", WS_VISIBLE | WS_CHILD | WS_BORDER, 50, 50, 100, 150, parent, NULL, hInstance, NULL );
(LPVOID) GlgInitialDraw( drawing );
```

Note that only one GLG Custom Control can be attached to each instance of the loaded drawing. To display several copies of a drawing, you must load or copy several instances of it into memory, creating each control with the `CreateWindow` function.

Setting Initial Resources

A GLG drawing represents a hierarchy of graphical objects. This hierarchy is created when the drawing is used in a GLG Custom Control. If your application needs to change a resource that affects the structure of a drawing’s resource hierarchy, the most efficient way is to do it before the drawing hierarchy is created (that is, before using the drawing to create a GLG Custom Control).

For example, if you want to change the number of bars in a bar graph's drawing, you should do it before using the drawing for creating a GLG Custom Control:

```c
HWND GlgControl;
GlgObject BarGraphDrawing;

BarGraphDrawing = GlgLoadWidgetFromFile( "BarGraph.g" );
```
/* Setting the number of bars in the bar graph to 30. */
GlgSetDResource( BarGraphDrawing, "DataGroup/Factor", 30. );

GlgControl = CreateWindow( "GlgControl", "BarGraph Custom Control",
WS_VISIBLE | WS_CHILD | WS_BORDER, 50, 50, 100, 150,
parent, NULL, hInstance, NULL );
GlgInitialDraw( BarGraphDrawing );

Resources that must be set before creating the hierarchy include factors of series objects, templates of series objects, Global attribute flags and some others. These are called H resources, and are described in the *H and V Resources* section of the *Integrating GLG Drawings into a Program* chapter.

Some resources, like attributes of an individual instance of the series object's template, may be accessed only after the drawing hierarchy is created. These are the V resources. For example, setting an initial value of the first bar in the bar graph must be done after the bar instances are created:

double GetData();
HWND GlgControl;
GlgObject BarGraphDrawing;

BarGraphDrawing = GlgLoadWidgetFromFile( "BarGraph.g" );

GlgControl = CreateWindow( "GlgControl", "BarGraph Custom Control",
WS_VISIBLE | WS_CHILD | WS_BORDER, 50, 50, 100, 150,
parent, NULL, hInstance, NULL );
GlgSetupHierarchy( BarGraphDrawing );

/* Setting the value of the first data sample for the initial appearance. */
GlgSetDResource( BarGraphDrawing, "DataGroup/EntryPoint", GetData() );
GlgUpdate( BarGraphDrawing ); /* Draw control's graphics */

The rest of the resources may be changed at any time, although remember that if you want to change some resources for the initial appearance of the control, do it before the call to the *GlgUpdate* or *GlgInitialDraw* functions.

### Obtaining a Viewport Handle

To use any of the functions from the GLG API, you must get an object ID for the main viewport of the drawing. This is the one called $Widget$. (See page 34.) To obtain this object ID from the widget, use the *GlgGetWindowViewport* function.

```c
GlgObject GlgGetWindowViewport( glg_control_window )

HWND glg_control_window;
```

The $glg_control_window$ argument is the Window ID returned by the *CreateWindow* function. If a window other than a GLG Custom Control is passed as a parameter, the result is undefined. The *viewport handle* is the return value of this function.
A viewport is a GLG Toolkit object which manages all aspects of the GLG Custom Control’s behavior and appearance. When accessing resources or performing any other operations on the Control, the viewport handle is passed as a parameter to the functions of the GLG API Library.

**Closing the Custom Control**

At the end of a program’s execution, you should use the `DestroyWindow` Windows function to close the GLG Custom Control in an orderly fashion. By default, this is done for you when you exit the program.

**Messages**

The GLG Custom Control provides a window procedure to work with the Windows environment. The GLG Custom Control creates its own color palette and handles palette related messages. However, Microsoft Windows sends palette messages to the top level window only, therefore the application program must be responsible for propagating these messages to the GLG Custom Control. A similar situation obtains with some focus messages, as shown in the example below.

An example of how messages are propagated to the GLG Custom Control is shown in the following example:

```c
extern HWND GlgControl;    /* A children window. */
LRESULT CALLBACK MyWindowProc( hWnd, iMessage, wParam, lParam )
    HWND hWnd;
    UINT iMessage;
    WPARAM wParam;
    LPARAM lParam;
{
    switch( iMessage )
    {
    /* Propagate palette messages to the Control. */
    case WM_PALETTECHANGED:
    case WM_QUERYNEWPALETTE:
        if( GlgControl )
            return
            GlgControlWindowProc( GlgControl, iMessage, wParam,
            lParam );
    /* Let the Control know about focus change, etc. */
    case WM_SETFOCUS:
    case WM_KILLFOCUS:
    case WM_CANCELMODE:
    if( GlgControl )
        GlgControlWindowProc( GlgControl, iMessage, wParam,
        lParam );
    break;
    ...
    /* Some other application specific cases. */
    } 
```
return DefWindowProc( hWnd, iMessage, wParam, lParam );
}

The GlgControlWindowProc function has the standard arrangement of windows procedure parameters, whose definitions can be found in Windows programming manuals. It is included in the Windows version of the GLG API library.

### Loading and Displaying a GLG Drawing using Generic API

The GLG Generic API can be used to load the drawing into a program and display it in a cross-platform way, freeing the programmer from a need to use platform-specific native integration code. An application written using the simple GLG Generic API can be compiled and run on either Windows or Unix/Linux without any changes to the source code. GLG demos and most of the coding examples use the GLG Generic API and may be compiled and run under both Windows and Unix/Linux X Windows environments.

The following example loads and displays a GLG drawing using the GLG Generic API:

```c
#include "GlgApi.h"
#include "GlgMain.h"

int GlgMain( argc, argv, InitialAppContext )
{
    int argc;
    char * argv[];
    GlgAppContext InitialAppContext;
{
    GlgObject viewport;

    GlgInit( False, InitialAppContext, argc, argv );

    viewport = GlgLoadWidgetFromFile( "bar1.g" );
    GlgInitialDraw( viewport );

    return GlgMain( InitialAppContext );
}

The GlgMain.h include file defines a cross-platform program entry point, GlgMain.

The GlgInitialDraw function creates a top-level window and displays a GLG drawing in it in a cross-platform way. This code may be compiled and run on both Unix/Linux and Windows platforms. Refer to the GLG programming examples in the examples directory for a complete example of an application that loads, displays and updates GLG drawing with data.

Alternatively, a call to GlgInitialDraw can be split into two equivalent calls, GlgSetupHierarchy and GlgUpdate, to perform any required initialization before displaying the drawing:

```
GlgSetDResource( viewport, "Chart/NumPlots", 3. );
GlgSetupHierarchy( viewport ); /* Creates 3 plots in the chart. */

/* Set any required plot properties. */
GlgSetDResource( viewport, "Chart/Plots/Plot#2/LineWidth", 3. );
GlgUpdate( viewport ); /* Display the drawing. */
```
Refer to the *The GLG Generic API* section on page 49 for the list of Generic API methods, and to the *GLG C++ Bindings* chapter on page 215 for information on using the **C++ version** of the GLG Generic API.

**Coding Examples of Displaying and Animating a GLG Drawing**

Subdirectories `examples_c_cpp/animation` and `examples_c_cpp/BarGraph2D` in the GLG installation directory contain examples of loading, displaying and animating a GLG drawing using both the Generic API and the native windowing system controls:

- The version with name ending with a capital “G” uses the GLG Generic API which can be used on both X Windows (Unix/Linux) and Windows.
- The version ending with “X” shows an example using the GLG Wrapper Widget under X Windows.
- The version ending with “W” uses the GLG Custom Control on Windows.
- The files with a “.c” extension demonstrate the C version, and files with a “.cpp” extension present the C++ version of the same example.

**Compiling and running Example Programs**

Visual Studio projects are provided in each directory for building demos and most of the examples on Windows. On Unix/Linux, makefiles for building demos and examples are provided in the `src` subdirectory of the GLG installation directory. Refer to the *Building GLG Demos and Examples* section below for more information.

**2.2 Compiling and Linking GLG Programs**

**Building GLG Demos and Examples**

**Visual Studio Projects for Windows**

On Windows, Visual Studio projects are provided for all GLG demos and most of the example programs. The project files are located in each demo or example directory. To build, simply open a project file in the Visual Studio, select the desired platform (Win32 or x64) and build the solution.

The sample projects use the GLG library in a form of a DLL. Refer to the *Using Static GLG Libraries* section on page 46 for information about using GLG static libraries.

**Makefiles for Unix/Linux**

On Unix/Linux, makefiles for building demos and examples are provided in the `src` subdirectory of the GLG installation directory:
• **makefile** grabs all source files in the current directory and links them in a single executable. It can be used for building demos which have source files for each demo in a separate directory.

• **makefile2** may be used to compile and link individual source files, in case a current directory contains several example programs, such as the example in the *examples_c_cpp/animation* directory. The **makefile2** file should be edited to define source files that have to be included in the build.

To build a project on Unix/Linux, copy one of the above mentioned makefiles into the project’s directory, edit it to define a path to the GLG installation directory and other platform options listed at the beginning of the makefile, then change to the project’s directory and use **make** to build the project using **makefile**:

```
cd <project_dir>
make
```

To use **makefile2**, rename **makefile2** to **makefile** in the project directory or use the **-f** option:

```
cd <project_dir>
make -f makefile2
```

### Using Constant Strings

By default, C++ bindings use constant strings. This may be changed by defining the `CONST_CHAR_PTR` macro with a value of 0 before including the *GlgClass.h* file.

The C API uses non-constant strings by default. This can be changed by defining the `GLG_C_CONST_CHAR_PTR` macro with the value of 1 before including the *GlgApi.h* file.

### Linking with the GLG Libraries

The details of the process of linking an application program with the GLG Toolkit library depends on the operating system and windowing environment where the application will run.

#### X Windows on UNIX/Linux

The *libglg* library supplied with the GLG Toolkit contains all functions described in this guide, including the GLG Standard Library and GLG Generic API Library. There are several versions of the library for different programming environments:

• **libglg.a**
  The Motif version of the library. On Linux, it was built using OpenMotif 2.3 to support Unicode locales. On other Unix platforms, it was built with the Motif version provided by a vendor.

• **libglg_xt.a**
  Linux only: The Xt-based version of the library that does not use Motif. This version does not support native widgets, such as Motif sliders, buttons and toggles. The GLG version of these controls must be used with this version of the library.
Using the C/C++ version of the Toolkit

• *libglg_x11.a*

  The X11 version of the library for use with the GTK and Qt integrations. This version uses an X11 window as a drawing surface instead of an Xt or Motif widget. It still requires *libXt* for linking, but does not use it for graphics, which is completely X11-based.

  The linking process also requires *libz*\(^1\), *libjpeg*\(^2\), *libpng*\(^3\) and *libfreetype*\(^4\) libraries. For applications that use map server functionality, the *libglg_map* map server library and the *libtiff*\(^5\) library are also required. All these libraries are provided in the *lib* subdirectory of the GLG Toolkit installation. The GLG libraries must be included in the link list before the X and Motif libraries. Sample makefiles provided in the *src* subdirectory of the GLG installation contain additional platform-dependent libraries that may be selected by uncommenting them depending on the platform (refer to the *Makefiles for Unix/Linux* section on page 43 for more information).

  If a static Motif library is used instead of the default shared library, the following libraries must also be included: *libXm*, *libXt*, *libXext* and *libXp*. On Solaris and AIX, some extra system libraries (*libnsl* and *libsocket* for Solaris, and *libiconv* for AIX) must also be included, as shown in the sample makefiles.

  The following line shows a sample of the link statement for the GLG program using the Standard API and the Map Server on Linux platform:

  ```
  ... -lglg -lglg_map -lXm -lXt -lX11 -lz -ljpeg -lpng -ltiff \\
  -lfreetype -lm -ldl -lpthread ...
  ```

  If an application does not use the Map Server and GIS functionality, the *libglg_map* library may be replaced with the *libglg_map_stub* stub, and the *libtiff* library may be omitted. The following line shows a fragment of the link statement for the GLG program using the Standard API without the Map Server and GIS functionality:

  ```
  ... -lglg -lglg_map_stub -lXm -lXt -lX11 -lz -ljpeg -lpng \\
  -lfreetype -lm -ldl -lpthread ...
  ```

  The GLG Extended Library is called *libglg_ext*. It requires the Standard API library (*libglg*) as well as all libraries described above. The following two lines show examples of linking with and without the Map Server and GIS functionality:

  ```
  ... -lglg_ext -lglg -lglg_map -lXm -lXt -lX11 -lz -ljpeg -lpng -ltiff \\
  -lfreetype -lm -ldl -lpthread ...
  ... -lglg_ext -lglg -lglg_map_stub -lXm -lXt -lX11 -lz -ljpeg -lpng \\
  -lfreetype -lm -ldl -lpthread ...
  ```

  The GLG Extended Library can be omitted if an application does not use any of the Extended API functions.

  The GLG Intermediate Library *libglg_int* may be used instead of the GLG Extended Library *libglg_ext*.

---

On platforms that support both the 32 and 64 bit executables, the 64 bit versions of libraries and utilities are provided in the \textit{lib_64} directory.

\textbf{Windows}

\textit{Using GLG DLLs}

The DLL version of the GLG Standard Library is called \textit{Glg.dll}. To use it, link your application with the \textit{Glg.lib} library.

The GLG Intermediate Library DLL is called \textit{GlgIn.dll} and includes the GLG Standard API. This means you don’t have to link with the \textit{Glg.lib} if using \textit{GlgIn.dll}. Link only with the \textit{GlgIn.lib} library to use the Intermediate API DLL.

The GLG Extended Library DLL is called \textit{GlgEx.dll} and includes the GLG Standard and Extended APIs. This means you don’t have to link with the \textit{Glg.lib} if using \textit{GlgEx.dll}. Link only with the \textit{GlgEx.lib} library to use the Extended API DLL.

\textit{Using Static GLG Libraries}

Under Microsoft Windows, an application can be linked with either a static or dynamic GLG library. Two versions of static libraries are provided: one compiled with the \textit{multi-threaded DLL (/MD)} option, and another compiled with the \textit{multi-threaded (/MT)} option. The libraries compiled with the /MT option use the MT suffix to differentiate them from the libraries compiled with /MD, for example: \textit{GlgLibMT.lib} vs. \textit{GlgLib.lib}. A version of the library matching the compilation options of the application code should be used for linking with the GLG static libraries.

The static versions of the GLG Standard API Library are called \textit{GlgLib.lib} and \textit{GlgLibMT.lib}.

The static versions of the GLG Intermediate Library are called \textit{GlgInLib.lib} and \textit{GlgInLibMT.lib}. They also require linking with the corresponding version of the GLG Standard Library: \textit{GlgLib.lib} or \textit{GlgLibMT.lib}.

The static versions of the GLG Extended Library are called \textit{GlgExLib.lib} and \textit{GlgExLibMT.lib}. They also require linking with the corresponding version of the GLG Standard Library: \textit{GlgLib.lib} or \textit{GlgLibMT.lib}.

The project files supplied with the Toolkit use dynamic linking with the GLG DLLs by default. In order to use the static version of the GLG libraries, define GLG\_STATIC in your code:

\begin{verbatim}
#define GLG_STATIC
\end{verbatim}

This must appear before the \textit{GlgApi.h} file, or it may be specified as a preprocessor definition in the project’s settings.

To use the static GLG library, an application code must also include a call to the \textit{GlgInit} method, passing an explicit application instance as the application context parameter. (If the dynamic library is used, this is done automatically by the DLL’s \textit{DllMain} entry point.)
**OpenGL Libraries**

The OpenGL libraries for the OpenGL renderer - *libGL* and *libGLU* - are dynamically loaded by the Toolkit and do not need to be linked in the application executable. If an application uses OpenGL calls itself, it can link the OpenGL libraries, and the Toolkit will use the linked-in libraries.

The same application executable may be run in either the OpenGL rendering mode or the native windowing system (GDI) mode. Refer to the *Command-line Options* section on page 259 of the GLG User’s Guide and Builder Reference Manual for information on the command-line options that specify rendering mode to be used at run-time.

Refer to the OpenGL or GDI (Native Windowing System) Renderer section on page 27 of the GLG User’s Guide and Builder Reference Manual for information on the OpenGL and GDI drivers.

If the graphics card supports OpenGL version 3.00 and above, a shader-based Core profile may be used for rendering. Refer to the OpenGL Versions, Compatibility and Core Profiles section on page 29 of the GLG User’s Guide and Builder Reference Manual for more information on OpenGL versions.

Refer to the OpenGL Libraries section on page 30 of the GLG User’s Guide and Builder Reference Manual for a detailed description of the libraries used by both hardware and software OpenGL renderers.

Refer to the OpenGL Setup and Diagnostics section on page 30 of the GLG User’s Guide and Builder Reference Manual for setup and diagnostic options of the OpenGL driver.

**Qt and GTK Integration**

The GLG Toolkit provides the Qt, GTK and GTKMM integration files in the *integration* directory which contains a separate subdirectory for each of the environments. Each subdirectory contains an integration example with a source code of a specialized GLG widget for the corresponding environment: *QtGLGWidget*, *GTKGlgWidget* and *GTKMMGlgWidget*. All files required to build the project are also provided.

In the Linux/Unix environment, the *libglg_x11* library described above must be used with the integration, since both Qt and GTK do not use Xt.

In the Microsoft Windows environment, the standard GLG library is used with the integration.

**Error Processing**

All GLG library errors are reported using the default error handler. In the X Windows environment, this prints an error message on the console, and under Microsoft Windows, displays a message box with an error message. On both platforms the default handler also emits an audio beep and logs the error into the *glg_error.log* file.

The log file will be created in the directory specified by the following environment variables:
The environmental variables are searched in the order they are listed above. The \texttt{<Major>} and \texttt{<Minor>} are replaced by the major and minor version numbers, for example \texttt{GLG\_DIR\_3\_6}. If neither variable is defined, the current directory will be used.

In the Java version, the errors are printed on the standard output stream or in the Java Console, and the errors are not logged in a file.

The C#/.NET version displays an error message box, beeps and logs the errors into the \texttt{glg\_error.log} file, the same as the C/C++ version.

In the JavaScript version, the errors are printed on the browser console and are not logged in a file.

The Map Server errors are logged in the \texttt{glm\_error.log} file, which will be created in the directory specified by the \texttt{GLM\_LOG\_DIR\_<Major>_\_<Minor>} and \texttt{GLM\_LOG\_DIR} environment variables. If they are not set, either \texttt{GLG\_LOG\_DIR} or \texttt{GLG\_DIR} versions of environment variables listed above are used to determine the directory in which the Map Server log file will be created. If neither environment variable is defined, the current directory is used.

To intercept errors or to change this behavior, you may install a custom error handler using the \texttt{GlgSetErrorHandler} function. (This is part of the standard GLG API; see the the \textit{Animating a GLG Drawing with Data Using the Standard API} chapter.). Severe internal errors (like invalid object handles) will still be logged into the \texttt{glg\_error.log} file, but errors involved with the use of the GLG Toolkit, like not being able to set or get a resource, will not.

In the X Windows environment, the \texttt{XtError} function is used to report widget-related errors (such as an error setting the wrapper widget’s resource). You can use \texttt{XSetErrorHandler} function to install a custom error handler for Xt errors. The \texttt{XSetErrorHandler} function can be used to install a custom error handler for X Windows errors.
2.3 The GLG Generic API

This section describes the GLG Generic API for C. Refer to the GLG C++ Bindings chapter on page 215 for information on using the C++ version of the GLG Generic API.

If it is important for your application to be cross-platform compatible (or if you don’t want to learn another windowing API), you may use the GLG Generic API instead of the GLG Custom Control on Windows or the GLG Wrapper Widget for Unix/Linux. It contains a generic, platform independent API for creating and manipulating a GLG Widget, as well as a small set of functions for cross-platform development. An application written using the GLG Generic API may be ported between Windows and the Unix/Linux environment by simply recompiling the code. The supplied demos and other coding examples of GLG Generic API may be compiled and run under both Windows and X Windows Unix/Linux environments.

The GLG Generic API is a subset of the GLG Standard API that provides functions for initializing the Toolkit’s run time environment, loading a drawing and displaying it in a program using the capabilities of the native windowing system: Windows or X Windows on Unix/Linux. After loading and displaying the drawing, it is animated using the rest of the functions of the GLG Standard API, which are also cross-platform. A coding example of using the Generic API is provided in the Loading and Displaying a GLG Drawing using Generic API section on page 42.

Though the functions provided are all platform-independent, the GLG Generic API library is not intended as a complete cross-platform development library. Instead, it supplies a small set of functions which are sufficient for a platform-independent use of GLG drawings and the GLG Toolkit. It is up to the application developer to write the rest of the application in a platform-independent way.

Function Summary

The GLG Generic API includes the following functions:

- **GlgInitLocale** sets locale.
- **GlgInit** initializes the Toolkit.
- **GlgTerminate** terminates the Toolkit and frees any allocated memory.
- **GlgLoadWidgetFromFile** loads a GLG Widget drawing from a file.
- **GlgLoadWidgetFromImage** loads a GLG Widget drawing from a generated memory image.
- **GlgLoadWidgetFromObject** extracts a GLG widget drawing from a GLG object.
- **GlgSetupHierarchy** sets up a GLG Widget’s drawing hierarchy.
- **GlgResetHierarchy** resets a GLG Widget’s drawing hierarchy in preparation for being dereferenced with GlgDropObject.
- **GlgInitialDraw** draws a GLG Widget for the first time.
- **GlgMainLoop** polls for events.
- **GlgAddCallback** adds input, selection and other callbacks to a GLG drawing.
• **GlgAddWorkProc** adds a work procedure.
• **GlgRemoveWorkProc** removes an active work procedure.
• **GlgAddTimeOut** adds an interval timer.
• **GlgRemoveTimeOut** removes an active interval timer.
• **GlgSleep** suspends program’s execution.
• **GlgBell** produces a bell sound.
• **GlgRand** generates a random number.

These functions are described in detail in the following pages.

Two functions of the GLG Extended API are often used with and are included in the GLG Generic API:

• **GlgReferenceObject** increments the reference count of an object.
• **GlgDropObject** decrements the reference count of an object.

For description of these functions, see the *GLG Intermediate and Extended API* chapter.

**Generic Program Entry Point**

To define a cross-platform application program’s entry point both Unix/Linux and Windows environments, include the *GlgMain.h* header file at the beginning of the program and define the *GlgMain* function in the following way:

```c
#include "GlgApi.h"
#include "GlgMain.h"

int GlgMain( argc, argv, InitialAppContext )
{
    int argc;
    char * argv[];
    GlgAppContext InitialAppContext;

    GlgInit( False, InitialAppContext, argc, argv );

    ... /* Place code here. */
}
```

The defined *GlgMain* function will be called when the program is started. The *argc* and *argv* parameters are analogous to the corresponding parameters of the standard main() function. The *InitialAppContext* parameter must be passed to the *GlgInit* function as shown above.

**GLG Generic API Function Descriptions**

In order to use any of the functions in the GLG Generic API, you must include the following header file in your program:

```c
#include "GlgApi.h"
```
**GlgAddCallback**

Add a callback function to a GLG Widget.

```c
void GlgAddCallback( viewport, callback_type, callback, client_data )
    GlgObject viewport;
    GlgCallbackType callback_type;
    GlgCallbackProc callback;
    GlgAnyType client_data;
```

**Parameters**

**viewport**

Specifies the viewport of a GLG Widget. For the GLG_INPUT_CB callback, it may be a light viewport.

**callback_type**

Specifies the type of a callback to be added, such as GLG_SELECT_CB, GLG_INPUT_CB, GLG_TRACE_CB, GLG_TRACE2_CB or GLG_HIERARCHY_CB. See the *Callback Events* section of the *Handling User Input and Other Events* chapter for a description of callback functions. There are also special callbacks used with the GLG Wrapper Widget; see page 35.

**callback**

Specifies a callback function to be called.

**client_data**

Specifies client data to be passed to the callback function when it is called. See the *Callback Events* section of the *Handling User Input and Other Events* chapter for a description of this data.

This function adds a selection or input callback to a GLG Widget. A callback is a user-supplied function that is called by the GLG Toolkit upon some action. A selection callback is issued when a user selects an object in the widget’s drawing area. An input callback function is invoked when a viewport input handler has received some data.

Only one callback of each callback type may be added to one widget or an individual viewport. Any subsequent invocations of this function will overwrite the previous value of the callbacks. To remove a callback, call *GlgAddCallback* with NULL as a value of the callback parameter.

Callbacks must be added before the drawing's hierarchy is set up. Several input and selection callbacks may be added to different viewports on different levels of the drawing hierarchy. However, only the first encountered callback on the lowest level of the hierarchy will be called.

For details on the form and use of callback functions, see the *Callback Events* section of the *Handling User Input and Other Events* chapter.
**GlgAddTimeOut**

Adds an interval timer in a platform-independent way.

```c
GlgLong GlgAddTimeOut( app_context, interval, timer_callback, client_data )
GlgAppContext app_context;
GlgLong interval;
GlgTimerProc timer_callback;
GlgAnyType client_data;
```

**Parameters**

- **app_context**
  Specifies the application context returned by the *GlgInit* function.

- **interval**
  Specifies the time interval in milliseconds.

- **timer_callback**
  Specifies a procedure to be called when the time expires.

- **client_data**
  Specifies the client data to be passed to the specified procedure when it is called.

This function adds a procedure which is called when the specified time interval expires. It returns the **timer ID** which can be used with *GlgRemoveTimeOut*. The interval timer is called only once and is removed immediately after it has been called. The *GlgRemoveTimeOut* function may be used to remove an active timeout. If you want the timer procedure to be called continuously, the timer procedure itself should call *GlgAddTimeOut*.

The following is a prototype for a timer procedure function:

```c
typedef void (*GlgTimerProc)( client_data, timer_id )
GlgAnyType client_data;
GlgLong * timer_id;
```

The **timer_id** parameter is the same as the one returned by the *GlgAddTimeOut* function. The **client_data** argument is the same as the one supplied in the *GlgAddTimeOut* function.

**GlgAddWorkProc**

Adds a work procedure in a platform-independent way.

```c
GlgLong GlgAddWorkProc( app_context, work_proc, client_data )
GlgAppContext app_context;
GlgWorkProc work_proc;
GlgAnyType client_data;
```

**Parameters**

- **app_context**
  Specifies the application context returned by the *GlgInit* function.
work_proc
Specifies a work procedure function to be called repeatedly.

client_data
Specifies client data to be passed to the work procedure when it is called.

This function adds a work procedure to a widget. A work procedure is simply a function to be called repeatedly while the application is waiting for an event. It returns a work procedure ID that can be used by GlgRemoveWorkProc.

The following code is the prototype for a work procedure function:

\[
\text{typedef GlgBoolean (*GlgWorkProc)( client_data )}
\]

\[
\text{GlgAnyType client_data;}
\]

The client_data argument provides user-defined data to the work procedure. It is defined by the call to GlgAddWorkProc.

If a work procedure returns TRUE, it is removed and will not be called again. If it returns FALSE, it will be called continuously until the application calls the GlgRemoveWorkProc function. You can register several work procedures and they will be performed one at a time. Work procedures must return quickly to avoid response time delays.

GlgBell

Produces a bell sound in a platform-independent way.

\[
\text{void GlgBell( viewport )}
\]

\[
\text{GlgObject viewport;}
\]

Parameters

viewport
Specifies a viewport or a light viewport. This viewport object must be displayed; it specifies the display at which to produce the bell. On Microsoft Windows, this parameter is ignored and may be NULL.

GlgInit

Initializes the GLG Toolkit.

\[
\text{GlgAppContext GlgInit( tk_initialized, app_context, argc, argv )}
\]

\[
\text{GlgBoolean tk_initialized;}
\]

\[
\text{GlgAppContext app_context;}
\]

\[
\text{int argc;}
\]

\[
\text{char ** argv;}
\]

Parameters

tk_initialized
Specifies whether or not X Toolkit was already initialized by the program. It allows using the GLG Toolkit in an application that creates its own application context. If this parameter is
FALSE, the X Toolkit will be initialized by the function. Otherwise, it is assumed that the program has already initialized it. This parameter is for use only in the X Windows environment and must be FALSE on Microsoft Windows.

app_context

For X Windows, this argument specifies the Xt application context if one has already been created by the program. If NULL is passed, an application context will be created by this function. Otherwise it uses the passed application context.

In Microsoft Windows environment, the argument specifies an application instance handle, which is supplied by a parameter of the GlgMain or WinMain program entry points. In an MFC application, a call to `AfxGetInstanceHandle` function may be used to obtain application instance handle. If the GLG library is used in the form of a DLL, the application instance handle is obtained automatically and the value of NULL may be used for the argument. If a static GLG library is used, an application instance handle must be supplied explicitly.

argc

Specifies the number of command line parameters. Use zero on Microsoft Windows.

argv

Specifies the command line parameter list. NULL may be used on Microsoft Windows.

If the function creates an application context, it returns the created context, otherwise it returns the application context that was passed to it. The return value is later used with some other functions of the GLG Generic API.

In the X Windows environment, this function is not needed if the GLG is deployed in the form of the GLG Wrapper Widget, which invokes the function automatically. Under Microsoft Windows, this function has to be called only if your program is linked with the static version of the GLG API library. The dynamically linked library (DLL) version calls this function automatically. In both cases, the function may be called explicitly to process command line options recognized by the Toolkit, such as:

- **-verbose**
  generates extended diagnostic output. A verbose mode can also be set by setting the `GLG_VERBOSE` environment variable to True. The output is saved in the `glg_error.log` file. On Unix/Linux, the output is also displayed in the terminal.

- **-glg-debug-opengl**
  generates extended diagnostic output for the OpenGL driver. The output can also be activated by setting the `GLG_DEBUG_OPENGL` environment variable to True. The output is saved in the `glg_error.log` file. On Unix/Linux, the output is also displayed in the terminal.

- **-glg-disable-error-dialogs**
  Disables error and warning message dialogs on Windows. Alternatively, the dialogs can also be disabled by setting the `GLG_DISABLE_ERROR_DIALOGS` environment variable to True. The messages will still be logged in the `glg_error.log` file.

- **-glg-disable-opengl**
  disables OpenGL driver in favor of the native windowing driver.
-glg-enable-opengl
  enables OpenGL driver if present. The OpenGL driver will be used only for the viewports
  which have their OpenGLHint attribute set to ON.

The OpenGL driver may also be enabled or disabled by setting either the GlgOpenGLMode global
configuration resource or the GLG_OPENGL_MODE environment variable to the following
values:

  0 - disable the OpenGL driver
  1 - enable the OpenGL driver
  -1 - don’t change the default setting.

GlgInitLocale

Sets the program locale.

GlgBoolean GlgInitLocale( locale )
  char * locale;

Parameters

locale

  Specifies program locale. The value of NULL may be passed to use the current system locale.

The function invokes setlocale( LC_ALL, locale ) and performs any other platform-dependent
locale initialization activity. On Unix platforms, this function must be used before the GlgInit
function.

GlgInitialDraw

Draws a GLG widget for the first time after it has been created or loaded.

  void GlgInitialDraw( viewport )
  GlgObject viewport;

Parameters

viewport

  Specifies the viewport of a GLG Widget.

This function is used when a GLG Widget is created. Creating the widget, in this case, means
constructing the internal data structures that are the widget. The widget must still be rendered with
GLGInitialDraw to be seen by a user. If the GLG Wrapper Widget is used in the X environment,
this function is called automatically, and need not be explicitly called.

GlgLoadWidgetFromFile

Loads a GLG widget from a file.

  GlgObject GlgLoadWidgetFromFile( filename )
  char * filename;
Parameters

filename

Specifies the name of the widget's drawing file.

This function loads a drawing from a file and searches the drawing for a viewport object named "$Widget." If the viewport is found, it references and returns a handle to it, otherwise it produces an error message and returns NULL. After the viewport has been used to create a GLG Wrapper Widget or GLG Custom Control, it may be dereferenced using the GlgDropObject function to avoid memory leaks.

GlgLoadWidgetFromImage

Loads a GLG widget from a memory image.

GlgObject GlgLoadWidgetFromImage( image_address, image_size )
void * image_address;
GlgLong image_size;

Parameters

image_address

Specifies the address of the widget's drawing image generated by the GLG Code Generation Utility.

image_size

Specifies the image size. This is also generated by codegen.

This function loads a drawing from the drawing image and searches the drawing for a viewport named "$Widget." If the viewport is found, it references and returns it, otherwise it produces an error message and returns NULL. After the viewport has been used, it may be dereferenced using the GlgDropObject function.

NOTE: this function does not work with compressed drawing files. Save drawings with the drawing compression option disabled to use them with GlgLoadWidgetFromImage.

GlgLoadWidgetFromObject

Loads a widget from a GLG object.

GlgObject GlgLoadWidgetFromObject( object )
GlgObject object;

Parameters

object

Specifies a GLG object to be used as a widget's drawing.
This function searches the object to be used as a drawing for a viewport named "$Widget." If the viewport is found, it references and returns it, otherwise it produces an error message and returns NULL. This function could be used to load a widget created by using the GLG Extended API, or to load a sub-section of an already loaded drawing. After the viewport has been used, it may be dereferenced using the GlgDropObject function.

**GlgMainLoop**

Implements an event polling loop in a platform independent way.

```c
GlgLong GlgMainLoop( app_context )
GlgAppContext app_context;
```

**Parameters**

- **app_context**
  - Specifies the application context returned by the GlgInit function.

On Microsoft Windows, the return value of this function may be used as the return value of the GlgMain function.

**GlgRand**

Produces a random number in a platform-independent way.

```c
double GlgRand( low, high )
double low;
double high;
```

**Parameters**

- **low, high**
  - Specify the low and high range of the random numbers generated.

This function produces a random number in the specified range by using the platform’s `rand` function.

**GlgRemoveTimeOut**

Removes a timer procedure.

```c
void GlgRemoveWorkProc( timer_id )
GlgLong timer_id;
```

**Parameters**

- **timer_id**
  - Specifies the ID of the timer procedure to be removed. The ID was returned by GlgAddTimeOut.

This function removes an active timer. If the timer has already been removed and is not active, the results are undefined.
**GlRemoveWorkProc**

Removes a work procedure.

```c
void GlgRemoveWorkProc( workproc_id )
GlLong workproc_id;
```

**Parameters**

- **workproc_id**
  
  Specifies an id of the work procedure to be removed. The id was returned by *GlAddWorkProc*.

  This function removes an active work procedure. If the work procedure has already been removed and is not active, the results are undefined.

**GlgResetHierarchy**

Resets the object hierarchy.

```c
void GlgResetHierarchy( object )
GlgObject object;
```

**Parameters**

- **viewport**
  
  Specifies an object to be reset.

  Resets the object hierarchy of a top-level viewport or drawing. This function must be called before destroying a top-level object with *GlgDropObject* when the object was displayed using the Generic API. This function should not be called for viewports used in the GLG integrated containers, such as the GLG Wrapper Widget or GLG Custom Control.

  **Warning:** Do not confuse this function with the *GlgReset* function of the standard API. *GlgReset* is used to redraw a displayed drawing and to regenerate the object hierarchy.

**GlgSetupHierarchy**

Provides an explicit request to set up the object hierarchy.

```c
void GlgSetupHierarchy( object )
GlgObject object;
```

**Parameters**

- **object**
  
  Specifies an object to be set up.

  When invoked on a drawing which has been loaded but not yet displayed, the method sets up the drawing’s object hierarchy to prepare the drawing for rendering. The drawing should contain either a top-level viewport object, or a group containing several top-level viewports.
After the initial draw (when the object hierarchy has already been set up), the method can be used to set up any type of object after its resources were changed. Unlike the \texttt{GlgUpdate} method, \texttt{GlgSetupHierarchy} sets up the object without repainting it.

\textbf{GlgSleep}

Suspends the application execution for a specified interval in a platform independent way.

\begin{verbatim}
void GlgSleep( sleep_interval )
GlgLong sleep_interval;
\end{verbatim}

\textit{Parameters}

\textbf{sleep\_interval}

Specifies a sleep interval in milliseconds.

\textbf{GlgTerminate}

Terminates the application’s use of the GLG Toolkit.

\begin{verbatim}
void GlgTerminate( void )
\end{verbatim}

This function destroys all created GLG structures and frees allocated memory, flushing the internal memory pools. No GLG functions may be called after a call to \texttt{GlgTerminate}. 
2.4 Animating a GLG Drawing with Data Using the Standard API

The GLG Application Program Interface (API) provides a way for a user’s C program to animate a GLG drawing. The API consists of a set of functions for querying and changing the resources of a GLG drawing. As a convenience to the programmer, it also provides some functions for frequently needed functions, such as specialized string manipulation, etc.

Note that the drawing must be displayed before it can be animated. For information on displaying a GLG drawing from a program, see the Displaying a GLG Drawing chapter on page 31. Though the details of displaying a drawing are platform-dependent, the functions described in this chapter are not. The syntax of the API described in this chapter is the same on X Windows or in Microsoft Windows.

There are three flavors of the GLG API:

- The **Standard API** enables an application to display a GLG drawing, animate it via the use of either resources or data tags, as well as handle user interaction.

- The **GLG Intermediate API** is a subset of the Extended API that provides all of the Extended API methods for manipulating the drawing, except for the methods for creating, adding or deleting objects from the drawing at run time. It is typically used for introspection (examining the content of a drawing), advanced input handling, as well as for obtaining object IDs for direct data updates, which increases update performance by shortcutting the resource name-based resource search.

- The **GLG Extended API** adds functionality that allows an application program to edit or create the drawing at run time.

The rest of this chapter describes functions of the GLG Standard API.

**Overview**

Once a GLG drawing is created and displayed, it is a simple matter to animate it. Animating a GLG drawing is done simply by manipulating its resources. This means that the only actions a program need take is to query or to set some resource value, and occasionally to redisplay the drawing with the new resource values.

The simplicity of operation means that the GLG API is quite a small one. It consists of the following functions:

- **GlgSetDResource**, **GlgSetDResourceIf** and **GlgSetDTag** set a scalar resource or tag. For information about the different attribute data types (geometrical, scalar, and string), see the The Attribute Object section in the Structure of a GLG Drawing chapter.

- **GlgSetGResource**, **GlgSetGResourceIf** and **GlgSetGTag** set a geometrical resource or tag.

- **GlgSetSResource**, **GlgSetSResourceIf** and **GlgSetSTag** set a string resource or tag.

- **GlgSetSResourceFromD**, **GlgSetSResourceFromDIf** and **GlgSetSTagFromD** set a string resource or tag from a scalar according to a chosen format.

- **GlgSetResourceFromObject** Sets a resource using another object.
- **GlGGetDResource** and **GlGGetDTag** return a scalar resource or tag.
- **GlGGetGResource** and **GlGGetGTag** return a geometrical resource or tag.
- **GlGGetSResource** and **GlGGetSTag** return a string resource or tag.
- **GlGHasResourceObject** checks if a named resource exists.
- **GlGHasTagName** and **GlGHasTagSource** check if a tag with a specified tag name or tag source exists.
- **GlGCreateTagList** returns a list of tags defined in the drawing.
- **GlGSetZoom** provides programmatic access to the integrated zooming and panning features.
- **GlGSetZoomMode** sets or resets the GIS or Chart zoom mode.
- **GlGUpdate** redisplay the drawing using the current resource values. All resource changes are stored until this function is called or until an Expose event (or paint event on Windows) is received.
- **GlGPrint** saves a PostScript image of the widget’s current state into a file.
- **GlGWinPrint** (Windows only) invokes the native Microsoft Windows printing function.
- **GlGSaveImage** and **GlGSaveImageCustom** save an image of the drawing in the JPEG or PNG format.
- **GlGGenerateImage** and **GlGGenerateImageCustom** create an image of the drawing and return it as a pixmap on Linux/Unix, or a bitmap on Windows.
- **GlGReset** reinitializes a widget drawing.
- **GlGSendMessage** sends a message to an object to request some action to be performed.
- **GlGSetAlarmHandler** defines a function that will process alarm messages.
- **GlGSetTooltipFormatter** sets a custom tooltip formatter.

The GLG Standard API also includes the following container methods described the *GLG Intermediate and Extended API* chapter:

- **GlGGetElement** returns the object at the specified index in a container.
- **GlGGetSize** queries the size of a container object.

The **GlGSetResourceObject** function of the Intermediate API may also be used with the Standard API for setting global configuration resources.

The **GlGAddCallback** function is used to add callbacks for handling user input in the form of input, selection and other events. While this function is a part of the GLG Standard API, it is described in detail in the *Callback Events* chapter on page 101.

**GlGSetDefaultViewport** is provided in the Windows version of the API and is used for setting a default drawing to be used by the GLG Wrapper Widget or GLG Custom Control.

The Standard API also includes functions specific to the **Real-Time Chart** and **GIS** objects. These functions are described in the *Real-Time Chart Functions* chapter on page 182 and the *GIS Object Functions* chapter on page 195.
The GLG Standard API also includes the following convenience and utility functions that simplify tasks common to GLG C programs.

- **GlgGetObjectName**, **GlgGetObjectType** and **GlgGetDataType** provide convenient shortcuts for querying corresponding properties of an object.

- **GlgStrClone** creates a copy of a string.

- **GlgCreateIndexedName** creates an enumerated resource name.

- **GlgConcatResNames** creates composite resource names from components.

- **GlgConcatStrings** creates a new string from two input stings.

- **GlgAlloc** allocates memory using the Toolkit’s memory allocator.

- **GlgFree** frees the memory allocated by **GlgAlloc** and GLG string utility functions.

- **GlgSetErrorHandler** replaces the GLG Toolkit error handler.

- **GlgGetSelectionButton** is used inside a selection callback procedure to query the mouse button that caused the selection event.

- **GlgGetModifierState** provides a cross-platform way to query the state of the *Control* and *Shift* keys, as well as the type of the mouse click: a single or double click.

- **GlgSetFocus** provides a cross-platform way to set the keyboard focus.

- **GlgExportStrings** exports all text strings defined in the drawing into a string translation file.

- **GlgImportStrings** imports translated text strings from a string translation file.

- **GlgExportTags** exports tag names and tag sources of all tags defined in a drawing into a file.

- **GlgImportTags** replaces tag names and tag sources in a drawing with the information imported from a tag translation file.

- **GlgChangeObject** sends a change message to the object without actually changing the object’s properties, may be used to force the object to redraw.

- **GlgGetNativeComponent** returns an ID of a native windowing system component used to render the viewport.

- **GlgSetBrowserObject** defines the object whose resources will be displayed by the resource, tag and alarm browser widgets.

- **GlgSetBrowserSelection** sets a new value of a browser’s selection and filter text boxes for the resource, tag, alarm and data browser widgets after the browser has been set up.

- **GlgSetEditMode** disables viewport’s input objects for editing.

- **GlgSetLParameter** and **GlgGetLParameter** are used to set or query values of global parameters that control memory allocation at run time.

- **GlgPreAlloc** is used to preallocate memory under the control of a mission-critical real-time application.

- **GlgSetCursor** is used to set a custom cursor for a drawing or one of its child viewports (Windows only).

- **GlgFindFile** may be used to find a file in the GLG search path.
• **GlgError** displays error and information messages.

• **GlgXPrintDefaultError** prints information about an X error on a console or logs it into a file.

• **GlgGetMajorVersion** and **GlgGetMinorVersion** retrieve the library’s version numbers.

**Note:** Several resources in a GLG drawing may affect the actual object hierarchy of the drawing. The *Factor* attribute of a series object, for example, controls the number of objects that appear to be members of that series. When manipulating the resources of a drawing with the GLG API, it is useful to set the resources that affect the object hierarchy first, then call **GlgUpdate**, and then set the resources that only affect the value of objects in that hierarchy. For more information about this distinction between resources, see the *H and V Resources* section of the *Integrating GLG Drawings into a Program* chapter.

### Function Descriptions

To use any of the functions described in this chapter, the application program must include the function definitions from the GLG API header file. Use the following line to include these definitions:

```c
#include "GlgApi.h"
```

Some resources have enumerated values. For example, the *ScrollType* resource of a graph may have values GLG_SCROLLED or GLG_WRAPPED. The *GlgApi.h* file has defined constants to use for setting these resource values.

Note that virtually all of the GLG API library functions have the same first argument: a *GlgObject* parameter called *object*. This argument is a handle pointing to an object in the drawing. Usually, it indicates the viewport object that is the widget in the drawing. This handle is returned by the platform-specific display functions described in the *Using the C/C++ version of the Toolkit* chapter. The *object* parameter may also provide an object ID of a graphical object inside the viewport.

The following describes the interfaces of the GLG Standard Library functions.

**GlgAlloc**

Allocates memory using the Toolkit’s memory allocator.

```c
void * GlgAlloc( size )
    GlgLong size;
```

**Parameters**

**size**

Specifies the size of a memory block in bytes.

The memory must be freed with **GlgAlloc** when it is no longer used.
**GlgChangeObject**

Sends a change message to the object without actually changing the object’s properties.

```c
void GlgChangeObject( object, resource_name )
GlLObject object;
char * resource_name;
```

*Parameters*

**object**

If the `resource_name` parameter is NULL, specifies the object to send the message to. If the `resource_name` parameter is not NULL, specifies the object’s parent.

**resource_name**

If not NULL, specifies the resource name of the object inside the parent object specified by the `object` parameter.

The function may be used to force a drawable object (such as a viewport) to redraw its content. It may also be used to send a change message to the `Factor` attribute of a series object to force the series to recreate its instances without actually changing the value of the `Factor`. If a change message is sent to the `ImageFile` attribute of an image object, the image will reload the image file (the image’s `EnableCache` attribute should be set to NO to disable cache for images that need to be reloaded).

---

**GlgConcatResNames**

Creates a composite resource name from two components.

```c
char * GlgConcatResNames( resource_name1, resource_name2 )
char * resource_name1, * resource_name2;
```

*Parameters*

**resource_name1**

Specifies the first path component.

**resource_name2**

Specifies the second path component.

This function creates and returns a resource name formed by concatenating the two components with the `/` character between them. Either argument may be NULL, in which case the returned string will precisely equal the input value of the other argument. The string containing the returned resource name should be freed later with the `GlgFree` function.

For example, the following code fragment:

```c
char * resource_name;

resource_name =
    GlgConcatResNames( "DataGroup", "DataSample2" );
printf( "resource_name = %s\n", resource_name );
GlgFree( resource_name );
```
produces the following output:

```
  resource_name = DataGroup/DataSample2
```

Multiple calls to the `GlgConcatResNames` function may be used to create composite names from more than two components:

```c
char
* temp_name,
* resource_name;

  temp_name =
      GlgConcatResNames( "DataGroup", "DataSample2" );
  resource_name = GlgConcatResNames( temp_name, "Value" );
  GlgFree( temp_name )
  printf( "resource_name = %s\n", resource_name );
  GlgFree( resource_name );
```

produces the following output:

```
  resource_name = DataGroup/DataSample2/Value
```

**GlgConcatStrings**

Concatenates two character strings.

```c
char * GlgConcatStrings( string1, string2 )
    char * string1, string2;
```

*Parameters*

**string1, string2**

The strings to be concatenated.

This function creates a new string from two input strings. Either input string may be NULL, in which case the returned string is a copy of the non-NULL input string. If both strings are NULL, then NULL is returned. The output of this function must be freed with the `GlgFree` function. That function also understands null data, so the following code may be used without needing to check for NULL values:

```c
  string3 = GlgConcatStrings( string1, string2 );
  ...
  GlgFree( string3 );
```

**GlgCreateIndexedName**

Creates a string with a name for an enumerated resource.

```c
char * GlgCreateIndexedName( template_name, resource_index )
    char * template_name;
    GlgLong resource_index;
```
Parameters

**template_name**

A character string containing the template name to be expanded. This name uses the `%` character to define the expansion position.

**resource_index**

Specifies the number to use for expanding a `%` character in the template name.

This function creates and returns a resource name by replacing the first (leftmost) occurrence of the `%` expansion character within the template name with the number corresponding to the `resource_index` parameter. If the template name does not contain the expansion character, the number is added to the end of the name. The returned expanded name should later be freed with the `GlgFree` function.

Example

The following code fragment:

```c
char * name;
int i;
for( i=0; i<3; ++i )
{
    name = GlgCreateIndexedName( "XLabelGroup/XLabel%/String", i );
    printf( "Name: %s\n", name );
    GlgFree( name );
}
```

produces the following output:

```
Name: XLabelGroup/XLabel0/String
Name: XLabelGroup/XLabel1/String
Name: XLabelGroup/XLabel2/String
```

The `GlgCreateIndexedName` function may be used repeatedly if a template name has more than one expansion character. For example, the following code fragment:

```c
char * name1, * name2;
nname1 = GlgCreateIndexedName( "Graph%/DataSample%/Value", 4 );
nname2 = GlgCreateIndexedName( name1, 5 );
GlgFree( name1 );
printf( "Name: %s\n", name2 );
GlgFree( name2 );
```

produces the following output:

```
Name: /Graph4/DataSample5/Value
```
**GlgCreateTagList**

Creates and returns a list of tags.

```c
GlgObject GlgCreateTagList( object, unique_tag_sources )
    GlgObject object;
    GlgBoolean unique_tags;
```

**Parameters**

**object**

An object whose tags are queried. The top level viewport may be used to query the list of tags of the whole drawing.

**unique_tag_sources**

If set to `GlgTrue`, only one instance of tags with same tag source will be added to the list. If the parameter value is set to `GlgFalse`, all instances with the same tag source will be reported.

This function creates and returns a group containing all named tag objects, or NULL if no tags were found. Each element of the group is an attribute object whose tag field is not empty. The `GlgGetElement` and `GlgGetSize` functions may be used within the Standard API to handle the returned group object. The returned group object must be dereferenced using the `GlgDropObject` function when it is no longer needed.

If an object is not a viewport, the returned list of tags will include only the tags contained inside the object. For a viewport, the tag list will contain all tags defined in the viewport's drawing.

**Example**

The following code fragment prints tag information for all tags defined in the drawing:

```c
char * tag_name, * tag_source;
int i, size;
GlgObject tag_list, tag_object;

tag_list = GlgCreateTagList( viewport, GlgFalse );
if( tag_list )
{
    size = GlgGetSize( tag_list );
    for( i=0; i<size; ++i )
    {
        tag_object = GlgGetElement( group, i );
        GlgGetSResource( tag_object, "TagName", &tag_name );
        GlgGetSResource( tag_object, "TagSource", &tag_source );
        printf( "TagName: %s, TagSource: %s\n", tag_name, tag_source );
    }
    GlgDropObject( tag_list );
}
```
**GlgError**

Displays error and information messages using the currently installed error handler.

```c
void GlgError( error_type, message )
    GlgErrorType error_type;
    char * message;
```

**Parameters**

**error_type**

Specifies the type of the message, may have the values listed below. The list includes a description of the action performed by the default error handler for each message type:

- **GLG_INTERNAL_ERROR**
  - reserved for the Toolkit’s internal use; generates an error message, emits an audio beep and logs the error into the *glg_error.log* file

- **GLG_USER_ERROR**
  - generates an error message and emits an audio beep; on Windows, also logs the error into the *glg_error.log* file

- **GLG_WARNING**
  - generates a warning message and emits an audio beep; on Windows, also logs the warning into the *glg_error.log* file

- **GLG_INFO**
  - on Windows, logs the message into the *glg_error.log* file; on Unix/Linux, prints the message on the terminal.

The location of the *glg_error.log* file is determined by the GLG_LOG_DIR and GLG_DIR environment variables as described in the *Error Processing* section on page 47. In the Unix environment, all messages are printed in the program standard error output regardless of their message types.

**message**

The message to be displayed.

**GlgExportStrings**

Writes all text strings defined in the drawing into a string translation file:

```c
GlgLong GlgExportStrings( object, filename, separator1, separator2 )
    GlgObject object;
    char * filename;
    GglLong separator1;
    GglLong separator2;
```

**Parameters**

**object**

Specifies a viewport or drawing object whose text strings to export.

**filename**

Specifies the string translation file to write.
separator1, separator2

Defines characters to be used as string separators in the generated file.

The function returns the number of exported strings or -1 in case of an error. Refer to the Localization Support chapter on page 72 of the GLG User’s Guide and Builder Reference Manual for information about the string translation file format.

**GlgExportTags**

Writes tag names and tag sources of all tags defined in a drawing into a file:

```c
GlgLong GlgExportTags( object, filename, separator1, separator2 )

GlgObject object;
char * filename;
GlgLong separator1;
GlgLong separator2;
```

**Parameters**

- **object**
  Specifies a viewport or drawing object whose tags to export.

- **filename**
  Specifies the tag file to write.

- **separator1, separator2**
  Defines characters to be used as string separators in the generated file.

The function uses the same file format as the GlgExportStrings function. Refer to the Localization Support chapter on page 72 of the GLG User’s Guide and Builder Reference Manual for information about the file format.

The function returns the number of exported tags or -1 in case of an error.

**GlgFindFile**

Searches for a file, first in the current directory, then in the directory provided by the path parameter and then in the GLG search path. Returns a file path name if the file was found, on NULL otherwise.

```c
void GlgFindFile( filename, path, check_glg_path )
char * filename;
char * path;
GlgBoolean check_glg_path;
```

**Parameters**

- **filename**
  Specifies a relative filename to search for.

- **path**
  Specifies an additional search path to be searched before the GLG search path.
check_glg_path

If set to GlgTrue, the GLG search path will be included in the search.

GlgFree

Frees the memory used to store character strings.

```c
void GlgFree( pointer )
    char * pointer;
```

Parameters

pointer

Specifies a character string that is no longer needed by the application.

This function is used to free memory allocated by GlgAlloc and GLG string utilities. This is not to be used to free the memory occupied by any GLG object (GlgObject). Use GlgDropObject and GlgReferenceObject to manage those objects. The function checks for NULL address pointers, and will not fail or generate an error message if one is passed.

GlgGetDataType

Returns the data type (GLG_D, GLG_S or GLG_G) of a data or attribute object.

```c
GlgDataType GlgGetDataType( data_object )
    GlgObject data_object;
```

Parameters

data_object

Specifies a data or attribute object to query.

GlgGetDResource

GlgGetDTag

Return the current value of a scalar resource or tag.

```c
GlgBoolean GlgGetDResource( object, resource_name, d_value_ptr )
    GlgObject object;
    char * resource_name;
    double * d_value_ptr;

GlgBoolean GlgGetDTag( object, tag_source, d_value_ptr )
    GlgObject object;
    char * tag_source;
    double * d_value_ptr;
```
Parameters

**object**

Specifies a GLG object.

**resource_name, tag_source**

Specifies the name of the double resource or tag to query.

**d_value_ptr**

Specifies a pointer with which to return the resource or tag value.

If a scalar resource or tag with the input name exists, this function copies its current value into the address specified by `d_value_ptr` and returns `GlgTrue`, otherwise it generates an error message and returns `GlgFalse`.

---

**GlgGetGResource**

**GlgGetGTag**

Return the set of three values making up a geometrical resource or tag:

```c
GlgBoolean GlgGetGResource( object, resource_name, g_value1_ptr, g_value2_ptr, g_value3_ptr )
GlgObject object;
char * resource_name;
double * g_value1_ptr, * g_value2_ptr, * g_value3_ptr;
```

```c
GlgBoolean GlgGetGTag( object, tag_source, g_value1_ptr, g_value2_ptr, g_value3_ptr )
GlgObject object;
char * tag_source;
double * g_value1_ptr, * g_value2_ptr, * g_value3_ptr;
```

Parameters

**object**

Specifies a GLG object.

**resource_name, tag_source**

Specifies the name of the geometrical resource or tag to query.

**g_value0_ptr, g_value1_ptr, g_value2_ptr**

Specify pointers to the locations to which the XYZ or RGB values of the resource or tag are returned.

If a geometrical resource or tag with the input name exists, this function copies its current three values to the addresses specified with the `g_value` pointers and returns `GlgTrue`. Otherwise it generates an error message and returns `GlgFalse`. 
For a geometrical point, \( g\_value0\_ptr \), \( g\_value1\_ptr \) and \( g\_value2\_ptr \) are set to the X, Y and Z coordinates of the point, respectively. For a color resource or tag, they will be set to the R, G and B values of the color, respectively.

**GlgGetLParameter**

Sets a value of a global parameter.

```c
GlgBoolean GlgSetLParameter( char * name, GlgLong * value )
    char * name;
    GlgLong value;
```

**Parameters**

- **name**
  - Specifies parameter name.

- **value**
  - A pointer used to return a parameter’s value.

Refer to the *Appendix D: Global Parameters* section on page 465 for information on available global parameters. The function returns *GlgTrue* on success.

**GlgGetMajorVersion**

**GlgGetMinorVersion**

Return library’s major and minor version numbers.

```c
GlgLong GlgGetMajorVersion( void )
GlgLong GlgGetMinorVersion( void )
```

**GlgGetModifierState**

Return the state of the requested modifier.

```c
GlgBoolean GlgGetModifierState( modifier )
    GlgModifierType modifier;
```

**Parameters**

- **modifier**
  - Specifies a modifier to query: GLG_SHIFT_MOD, GLG_CONTROL_MOD or GLG_DOUBLE_CLICK_MOD.

**GlgGetNativeComponent**

Returns an ID of a native windowing system component used to render the viewport:

```c
GlgAnyType GlgGetNativeComponent( GlgObject object,
    char * resource_name, GlgComponentQueryType type )
```
Parameters

object
Specifies a viewport or a viewport’s parent.

resource_name
Specifies a resource name for accessing the child viewport inside its parent. Use NULL when the object parameter specifies the viewport.

type
Specifies the type of a component to retrieve:

GLG_WIDGET_QUERY
Returns an ID of the native component used to render the viewport: a widget ID when using libglg.a on X Windows, a window ID when using libglg_X11.a on X Windows and a window handle on Windows.

GLG_SHELL_QUERY
If the top-level window was created by the GLG library, the function returns the widget ID of the top level shell the viewport belongs to on X Windows, or the window handle of the top-level window on Windows.

GLG_CHILD_WIDGET_QUERY
For native widgets on X Windows that use scroll panes, such as text edit and list widgets, returns a widget ID of child widget inside the pane. For these widgets, GLG_WIDGET_QUERY returns the widget ID of the scroll pane.

GLG_V_SCROLLBAR_QUERY
GLG_H_SCROLLBAR_QUERY
Returns a widget ID of a scrollbar widget for native widgets on X Windows that use scrollbars.

GLG_DISPLAY_QUERY
On X Windows, returns the display pointer for the viewport’s widget.

GlgGetObjectName

Returns an object’s name. It returns a pointer to the internal string that should not be modified or freed.

    char * GlgGetObjectName( object )
    GlgObject object;

Parameters

object
Specifies an object to query.
**GlgGetObjectType**

Returns an object’s type (GLG_PLOYGON, GLG_TEXT, etc.).

```c
GlgObjectType GlgGetObjectType( object )
    GlgObject object;
```

**Parameters**

- **object**
  - Specifies an object to query.

**GlgGetSelectionButton**

Queries which mouse button initiated the selection callback.

```c
GlgLong GlgGetSelectionButton( void )
```

This function returns 1, 2, or 3 to indicate which button caused the callback to be invoked. It may be used only inside a selection callback function. If it is called outside of a selection callback, the return value is undefined.

**GlgGetSResource**

**GlgGetSTag**

Return the value of a string resource or tag.

```c
GlgBoolean GlgGetSResource( object, resource_name, s_value_ptr )
    GlgObject object;
    char * resource_name;
    char ** s_value_ptr;
```

```c
GlgBoolean GlgGetSTag( object, tag_source, s_value_ptr )
    GlgObject object;
    char * tag_source;
    char ** s_value_ptr;
```

**Parameters**

- **object**
  - Specifies a GLG object.
- **resource_name, tag_source**
  - Specifies the name of the string resource or tag to query.
- **s_value_ptr**
  - A pointer with which to return the resource or tag value.

If a string resource or tag with the given name exists, this function copies the current resource or tag string into an internal buffer, sets the `s_value_ptr` to point to the buffer and returns `GlgTrue`. Otherwise it returns `GlgFalse`. 
**Warning:** The returned pointer points to GLG internal data structures and should not be modified. The pointer is valid only immediately after a call to the `GlgGetSResource` function. To store the returned string, create a copy of it using the `GlgStrClone` function.

**GlgHasResourceObject**

Checks if a named resource exists:

```c
GlgBoolean GlgHasResourceObject( object, resource_name )
GlgObject object;
char * resource_name;
```

**Parameters**

- **object**
  Specifies a GLG object whose resource or tag to query.

- **resource_name**
  Specifies the name of the resource object to query.

If a resource object with the input name exists, this function returns `GlgTrue`, otherwise it returns `GlgFalse`.

**GlgHasTagName**

**GlgHasTagSource**

Check if a tag with a specified tag name or tag source exists:

```c
GlgBoolean GlgHasTagName( object, tag_name )
GlgObject object;
char * tag_name;

GlgBoolean GlgHasTagSource( object, tag_source )
GlgObject object;
char * tag_source;
```

**Parameters**

- **object**
  Specifies a GLG object whose tag to query.

- **tag_name, tag_source**
  Specifies the tag name or tag source to query.

If a tag with the input tag name or tag source exists, this function returns `GlgTrue`, otherwise it returns `GlgFalse`. 
**GlgImportStrings**

Replaces text strings in the drawing with the strings loaded from a string translation file:

```c
GlgLong GlgImportStrings( object, filename )
    GlgObject object;
    char * filename;
```

**Parameters**

object

Specifies the viewport or drawing object whose text strings to replace.

filename

Specifies the string translation file to load.

The function returns the number of imported strings or -1 in case of an error. Refer to the Localization Support chapter on page 72 of the GLG User’s Guide and Builder Reference Manual for information about the string translation file format.

**GlgImportTags**

Replaces tag names and tag sources of tags in a drawing with information loaded from a tag translation file:

```c
GlgLong GlgImportTags( object, filename )
    GlgObject object;
    char * filename;
```

**Parameters**

object

Specifies the viewport or drawing object whose tag to change.

filename

Specifies the tags translation file to load.

The function uses the same file format as the GlgImportStrings function. Refer to the Localization Support chapter on page 72 of the GLG User’s Guide and Builder Reference Manual for information about the file format.

The function returns the number of imported tags or -1 in case of an error.
**GlgOnDrawMetafile**

Provides MFC metafile output support (Windows only). Is used by the MFC container’s OnDrawMetafile method to produce metafile for the GLG child window.

```c
GlgBoolean GlgOnDrawMetafile( viewport, print_dc )
GlgObject viewport;
HDC print_dc;
```

**Parameters**

**viewport**

Specifies a viewport object.

**print_dc**

Specifies the printing device context for metafile output.

Returns *GlgTrue* if metafile generation succeeds, otherwise returns *GlgFalse*.

**GlgOnPrint**

Provides MFC printing support (Windows only). Is used by the MFC container’s OnPrint method to print GLG child window.

```c
GlgBoolean GlgOnPrint( viewport, print_dc )
GlgObject viewport;
HDC print_dc;
```

**Parameters**

**viewport**

Specifies a viewport. If *viewport* is a light viewport, the output will be generated for its parent viewport.

**print_dc**

Specifies the printing device context.

Returns *GlgTrue* if printing succeeds, otherwise returns *GlgFalse*.

**GlgPreAlloc**

Preallocates memory under the control of mission critical real-time applications:

```c
GlgBoolean GlgPreAlloc( size, type )
GlgLong size;
GlgPreAllocType type;
```

**Parameters**

**size**

Specifies the size of the memory to allocate.
type

Specifies the allocation type. The following lists available types and the meaning of the corresponding size parameter:

- **GLG_PREALLOC_MEMORY** - allocates a specified number of spare memory blocks.
- **GLG_PREALLOC_POLYGON_POINT_BUFFERS** - allocates a buffer of the requested size to be used for rendering large polygons. It can be set to the maximum expected number of points in one polygon.
- **GLG_PREALLOC_GRAPH_POINT_BUFFERS** - allocates a buffer of the requested size used for rendering plots of real-time charts. It can be set to the maximum expected number of points in one plot.
- **GLG_PREALLOC_TESS_BUFFERS** - allocates a buffer of the requested size for tessellation vertices. The buffer is used by the OpenGL driver for tessellating filled polygons; it is not used by the GDI driver.

Mission-critical applications can use this function to preallocate memory on start-up and then allocate more memory as needed outside of the application’s critical sections. The GlgGetLParameter function can be used to query the amount of spare memory in the preallocated memory blocks.

If the buffers are not preallocated, they are allocated and automatically adjusted as needed.

The function returns GlgTrue on success.

**GlgPrint**

Generates a PostScript output of the current state of the viewport's graphics.

```c
GlgBoolean GlgPrint( object, file, xpos, ypos, width, height, portrait, stretch )
GlgObject object;
char * file;
double xpos, ypos, width, height;
GlgBoolean portrait, stretch;
```

Parameters

**object**

Specifies a viewport. If object is a light viewport, the output will be generated for its parent viewport.

**file**

Specifies a filename in which to save the generated PostScript output.

**xpos, ypos, width, height**

Specify the rectangle on the page that will contain the Postscript output: xpos and ypos define the coordinates of the upper left corner of the rectangle, width and height define its dimensions. All coordinates are specified in the world coordinate system, which maps a rectangle defined by the points (-1000 -1000) and (1000 1000) to a page.
Specifies the orientation of the PostScript output on the page. If the value of this parameter is GlgTrue, a portrait orientation is used. Otherwise, a landscape orientation is used.

Specifies whether or not PostScript output should be stretched when mapping it to the specified rectangle. If the value of this parameter is GlgTrue, the PostScript output will be stretched to fit the rectangle exactly. This may distort printed objects. If the value is GlgFalse, the ratio of height to width of the widget will be preserved in the PostScript output. This may leave some parts of the specified rectangle blank.

This function saves a PostScript image of the current state of the drawing into the specified file. The xpos, ypos, width, and height parameters define the PostScript page layout. The origin is defined to be in the middle of the page, the left edge of the page is at -1000, and the right edge is at 1000. The top and bottom of the page are similarly defined to be at 1000 and -1000, respectively. The xpos and ypos parameters define the lower left corner of the drawing, while width, and height give the dimensions of the drawing area. As an example, the default page layout you get when you print a drawing by setting the PrintFile property puts the lower left corner of the drawing area at (-900, 900), while the dimensions are 1800 by 1800. This makes the drawing about as large as it can be while still keeping a small border all the way around a page. The portrait parameter defines portrait (TRUE) or landscape (FALSE) mode. If the stretch parameter is set to GlgFalse, the X/Y ratio of the drawing is preserved.

The drawing’s hierarchy must be set up in order to generate PostScript output. Use the GlgUpdate function before calling GlgPrint to make sure the widget is up to date. The function returns GlgTrue if PostScript output is successfully written into the file.

GlgReset

Reinitializes the widget.

GlbOOLEAN GlgReset( object )
GlbObject object;

Parameters

object
Specifies a viewport object.

Calling GlgReset restores all volatile resource changes to the values the resources had when the widget was first drawn. This discards currently displayed graph data, unless the data group series of a graph was exploded.

The function returns GlgTrue if the widget is successfully reinitialized; otherwise it returns GlgFalse.
**GlgSaveImage**

**GlgSaveImageCustom**

Generate a JPEG image of the current state of the viewport's graphics and saves it into a file:

```c
GlgBoolean GlgSaveImage( object, resource_name, filename, format )
GlgObject object;
char * resource_name;
char * filename;
GlgImageFormat format;
```

```c
GlgBoolean GlgSaveImageCustom( object, resource_name, filename,
format, x, y, width, height, gap )
GlgObject object;
char * resource_name;
char * filename;
GlgImageFormat format;
GlgLong x, y, width, height, gap;
```

**Parameters**

**object**

Specifies a viewport object.

**resource_name**

Specifies the resource name of a child viewport whose image to save, or NULL to save the image of the viewport specified by the `object` parameter. The resource name is relative to the viewport specified by the `object` parameter.

**filename**

Specifies a filename in which to save the generated image.

**format**

Specifies an image format, must be GLG_JPEG or GLG_PNG.

**x, y, width, height**

Specifies the area of the drawing for generating an image with `GlgSaveImageCustom`, which can be bigger or smaller than the visible area of the viewport. The x and y parameters define the offset in screen pixels relative to the origin of the viewport’s window, which has screen coordinates of (0,0). The width and height parameters define the width and height of the generated image in screen pixels. These parameters may be obtained by querying the bounding box of either the whole drawing or of the area of the drawing for which the image needs to be generated.

If the width and height parameters are 0, the image for the whole drawing is generated using the drawing’s bounding rectangle as the image generation extent. If the viewport is zoomed in, this area may be significantly bigger than the visible area of the viewport, and the image size may be quite large. The viewport’s zoom factor defines the scaling factor for objects in the drawing when the image is saved.

**gap**

Specifies the padding space between the extent of the drawing and the border of the generated image in case when zero width and height parameters are specified for `GlgSaveImageCustom`. 
For a light viewport, the output will be generated for its parent viewport.

The *GlgSaveImage* function saves image of the visible part of the viewport, clipping out the parts of the drawing that extends outside of it. The *GlgSaveImageCustom* saves the whole drawing without such clipping (if width and height parameters are 0), or saves just the specified area of the drawing.

The drawing’s hierarchy must be set up in order to generate an image. The function returns *GlgTrue* if the image was successfully generated.

### *GlgGenerateImage*

### *GlgGenerateImageCustom*

Creates an image of the current state of the viewport’s graphics and returns it as a pixmap on Linux/Unix, or a bitmap on Windows. The *PIXMAP* is defined as *Pixmap* on Linux/Unix, and *HBITMAP* on Windows.

```c
PIXMAP GlgGenerateImage( object, resource_name, image )
    GlgObject object;
    char * resource_name;
    PIXMAP image;

PIXMAP GlgGenerateImageCustom( object, resource_name, pixmap,
                              x, y, width, height, gap )
    GlgObject object;
    char * resource_name;
    PIXMAP image;
    GlgLong x, y, width, height, gap;
```

**Parameters**

**object**

Specifies a viewport object.

**resource_name**

Specifies the resource name of a child viewport whose image to generate, or NULL to generate the image of the viewport specified by the *object* parameter. The resource name is relative to the viewport specified by the *object* parameter.

**image**

If not NULL, specifies the pixmap or the bitmap to be used. This pixmap or bitmap will be filled and returned instead of creating and returning a new pixmap or bitmap.

**x, y, width, height, gap**

Specify parameters of a custom image. Refer to the *GlgSaveImageCustom* function described above for detailed information.
**GlgSendMessage**

Sends a message to an object to request some action to be performed.

```c
GlgAnyType GlgSendMessage( object, resource_name, message, param1, param2, param3, param4 )
GlgObject object;
char * resource_name;
char * message;
GlgAnyType param1, param2, param3, param4;
```

Refer to the *Input Objects* chapter on page 229 of the *GLG User’s Guide and Builder Reference Manual* for a list of messages supported by each type of the available input handlers.

**Parameters**

- **object**
  Specifies an object to send the message to. In most cases, it is a viewport with a GLG input handler attached, such as a button or a slider.

- **resource_name**
  If the parameter is set to NULL, the message is sent to the object specified by the *object* parameter. Otherwise, the message is sent to the *object’s* child specified by the resource name. The resource path is relative to the *object* parameter. For example, to send the message to a viewport’s handler, use the viewport as the *object* parameter and “Handler” as the value of the *resource_name* parameter.

- **message**
  A string defining the type of the message.

- **param1, param2, param3, param4**
  Message parameters whose type depends on the message type.

The function serves as an escape mechanism for actions that can not be easily accomplished by setting or querying a single resource, such us adding items to a list widget or querying a state of a multiple-selection list. For messages that execute some query, the function returns the query result, otherwise it just executes the requested action.

Refer to the *Input Objects* chapter on page 229 of the *GLG User’s Guide and Builder Reference Manual* for the description of the function’s parameters and returned value for each of the GLG input handlers.
**GlgSetAlarmHandler**

Sets the function that will process alarm messages.

```c
void GlgSetAlarmHandler( alarm_handler )
    GlgAlarmHandler alarm_handler;
```

**Parameters**

**alarm_handle**

Specifies a global function that will be invoked to process all alarm messages generated by application’s drawings.

An alarm handler has the following function prototype:

```c
typedef void (*GlgAlarmHandler)( data_object, alarm_object,
    alarm_label, action, subaction, reserved )
    GlgObject data_object;
    GlgObject alarm_object;
    char * alarm_label;
    char * action;
    char * subaction;
    GlgAnyType reserved;
```

The `data_object` parameter is the resource whose value has changed. The `alarm_object` parameter is the alarm attached to the `data_object` to monitor its value; it is the alarm that generated the alarm message. The `alarm_label` parameter supplies the `AlarmLabel` used to identify `alarm_object`. The `action` and `subaction` parameters provide details about the condition that caused the alarm; refer to the Alarm Messages section on page 211 of the GLG User’s Guide and Builder Reference Manual for more information.

An alarm handler should not change object hierarchy by actions such as adding or deleting objects from the drawing or changing a factor of a series object.

**GlgSetBrowserObject**

Sets the object for browsing with the GLG resource, tag or alarm browser widgets.

```c
void GlgSetBrowserObject( browser, object )
    GlgObject browser;
    GlgObject object;
```

**Parameters**

**browser**

Specifies a viewport of the browser widget.

**object**

Specifies an object to browse.

The browser will display the object’s resources, tags or alarms.
**GlgSetBrowserSelection**

Sets a new value of a browser’s selection and filter text boxes for resource, tag, alarm and data browsers after the browser object has been set up. Setting a new selection will display a new list of matching entries.

```c
void GlgSetBrowserSelection( object, resource_name, selection, filter )
GlgObject object;
char * resource_name;
char * selection;
char * filter;
```

**Parameters**

**object**

Specifies a viewport of the browser widget or its parent.

**resource_name**

Specifies a resource path to access the browser from the parent supplied by the `object` parameter, or NULL if the `object` parameter supplies the browser’s viewport.

**selection**

Specifies a new selection string.

**filter**

Specifies a new filter string.

The browser will display a new list of matching items. Before the browser’s drawing hierarchy has been set up, the selection and filter may be set via corresponding resources. To change selection or filter after hierarchy setup, this function should be used.

**GlgSetCursor**

Sets a custom cursor for a drawing or one of its child viewports (Windows only).

```c
GlgBoolean GlgSetCursor( viewport, resource_name, cursor )
GlgObject viewport;
char * cursor
GlgLong cursor;
```

**Parameters**

**viewport**

Specifies a viewport.

**resource_name**

Specifies the resource name of a child viewport to set the cursor of, or NULL to set the cursor of the viewport specified by the `viewport` parameter. The resource name is relative to the viewport specified by the `viewport` parameter.

**cursor**

Specifies one of the predefined Windows cursor types.
The custom cursor will be used when the mouse moves inside the viewport the custom cursor is assigned to.

**GlgSetDefaultViewport**

Sets a drawing to be used by the GLG Custom Control on Windows.

```c
void GlgSetDefaultViewport( viewport )
    GlgObject viewport;
```

**Parameters**

**viewport**

Specifies a GLG viewport object to be used as a widget. The viewport object may be loaded using `GlgLoadWidgetFromFile`, `GlgLoadWidgetFromImage`, or `GlgLoadWidgetFromObject` functions. It may also be created programmatically using functions from the GLG Extended API.

One instance of a viewport may be used to create only one GLG Custom Control since every control needs its own copy of the viewport. To create several custom controls with the same drawing, load a new instance of the drawing for each control or use `GlgCopyObject` to create instances of the drawing, then select them using `GlgSetDefaultViewport` before creating each control or widget. This function references the viewport object.

**GlgSetDResource**

**GlgSetDResourceIf**

**GlgSetDTag**

Set a new value for a resource or tag of type D. For information about the data types used by GLG objects, see the *Structure of a GLG Drawing* chapter.

```c
GlgBoolean GlgSetDResource( object, resource_name, d_value )
    GlgObject object;
    char * resource_name;
    double d_value;

GlgBoolean GlgSetDResourceIf( object, resource_name, d_value,
                             if_changed )
    GlgObject object;
    char * resource_name;
    double d_value;
    GlgBoolean if_changed;

GlgBoolean GlgSetDTag( object, tag_source, d_value, if_changed )
    GlgObject object;
    char * tag_source;
    double d_value;
    GlgBoolean if_changed;
```
Parameters

**object**
Specifies a GLG object.

**resource_name, tag_source**
Specifies the name of the scalar resource or tag to be set.

**d_value**
Specifies a new value for the resource or tag.

**if_changed**
If set to `GlgFalse`, the graphical updates will be performed even if the new value is the same as the old one (equivalent to `GlgSetDResource` function). Setting the parameter to `GlgTrue` optimizes performance of applications that set resource or tag values regardless whether the values have changed. The parameter is ignored when updating chart entry points to allow plotting straight lines when the plotted value does not change over time.

If a scalar resource or tag with the given name exists, this function sets it to a new value and returns `GlgTrue`, otherwise it prints an error message and returns `GlgFalse`.

**GlgSetEditMode**
Sets the viewport’s edit mode which disables input objects in the viewport while the drawing is being edited.

```c
GlgBoolean GlgSetEditMode( viewport, resource_name, edit_mode )
GlgObject viewport;
char * resource_name;
GlgBoolean edit_mode;
```

Parameters

**viewport**
Specifies a viewport object (either a viewport or a light viewport).

**resource_name**
Specifies the resource name of a child viewport to set the editing mode of, or NULL to set the editing mode of the viewport specified by the `viewport` parameter. The resource name is relative to the viewport specified by the `viewport` parameter.

**edit_mode**
`GlgTrue` to set the editing mode, or `GlgFalse` to reset.

If the viewport’s edit mode is turned on, the input objects in the viewport will not react to the mouse and keyboard events. The rest of the input objects outside of the viewport will still be active. The edit mode is usually set for viewports that serve as a drawing area; the edit mode ensures that the input objects do not react to mouse clicks when they are dragged with the mouse to a new position. This is similar to the behavior of the Builder’s *Drawing Area*. 

The edit mode is global and may be set only for one viewport used as a drawing area. Setting the edit mode of a new viewport resets the edit mode of the previous viewport. The viewport’s edit mode is inherited by all its child viewports. The function returns *GlgTrue* for success, otherwise it generates an error message and returns *GlgFalse*.

**GlgSetErrorHandler**

Replaces the GLG Toolkit error handler and returns the previous error handler.

```c
GlgErrorHandler GlgSetErrorHandler( new_handler )
GlgErrorHandler new_handler;
```

**Parameters**

**new_handler**

Specifies a new error handler, supplied by the user, to be called on an error condition. This does not include internal errors of the GLG Toolkit, if any are detected: they are still reported using the default handler.

The function prototype for the new handler is as follows:

```c
void new_handler( error_message, error_type )
    char * error_message;
    GlgErrorType error_type;
```

The *error_type* parameter may have the following values:

- GLG_INTERNAL_ERROR
- GLG_USER_ERROR
- GLG_WARNING
- GLG_INFO

Refer to the description of the *GlgError* function on page 69 for more information on the error types.

For more information about error handlers, see the *Error Processing* section on page 47.

**GlgSetFocus**

Sets the keyboard focus to an object’s viewport. If the object is a viewport, sets the focus to this viewport, otherwise sets the focus to the parent viewport of the object.

```c
void GlgSetFocus( object, resource_name )
    GlgObject object;
    char * resource_name;
```

**Parameters**

**object**

Specifies an object.
resource_name

Specifies the resource name of a child object to use, or NULL to use the object specified by the object parameter. The resource name is relative to the object specified by the object parameter.

GlgSetGResource
GlgSetGResourceIf
GlgSetGTag

Set the values of a geometrical resource or tag.

GlgBoolean GlgSetGResource( object, resource_name, g_value1, g_value2, g_value3 )
GlgObject object;
char * resource_name;
double g_value1, g_value2, g_value3;

GlgBoolean GlgSetGResourceIf( object, resource_name, g_value1, g_value2, g_value3, if_changed )
GlgObject object;
char * resource_name;
double g_value1, g_value2, g_value3;
GlgBoolean if_changed;

GlgBoolean GlgSetGTag( object, tag_source, g_value1, g_value2, g_value3, if_changed )
GlgObject object;
char * tag_source;
double g_value1, g_value2, g_value3;
GlgBoolean if_changed;

Parameters

object

Specifies a GLG object.

resource_name, tag_source

Specifies the name of the geometrical resource or tag to be set.

g_value0, g_value1, g_value2

Specify the new XYZ or RGB values for the resource or tag.

if_changed

If set to GlgFalse, the graphical updates will be performed even if the new value is the same as the old one (equivalent to GlgSetDResource function). Setting the parameter to GlgTrue optimizes performance of applications that set resource or tag values regardless whether the values have changed. The parameter is ignored when updating chart entry points to allow plotting straight lines when the plotted value does not change over time.

If a geometrical resource or tag with the given name exists, this function sets it to the input values and returns GlgTrue. Otherwise, the function prints an error message and returns GlgFalse.
**GlgSetLParameter**

Sets a value of a global parameter.

\[
\text{GlgBoolean GlgSetLParameter( char * name, GlgLong value )}
\]

char * name;
GlgLong value;

**Parameters**

- **name**
  
  Specifies parameter name.

- **value**
  
  Specifies parameter value.

Refer to the *Appendix D: Global Parameters* section on page 465 for information on available global parameters. The function returns *GlgTrue* on success.

**GlgSetResourceFromObject**

Sets a data or matrix resource object’s value using another object.

\[
\text{GlgBoolean GlgSetResourceFromObject( object, resource_name, data_or_matrix_object )}
\]

GlgObject object;
char * resource_name;
GlgObject data_or_matrix_object;

Sets the value of the resource specified with the object and resource name to a value defined by the *data_or_matrix_object*. The object type (and data type for the data object) of the resource specified by the resource name should match the type of the *data_or_matrix_object*.

Note that unlike the rest of the resource functions, this function does not work from a remote process.

Also unlike the rest of the resource functions, The *GlgGetResourceObject* function returns NULL without generating an error message if the resource cannot be found. This allows this function to be used to query the presence or absence of an object. The rest of the functions (*GlgGet/SetXResource*) return *GlgFalse* and generate an error message, which may be intercepted by installing a custom error handler. (See *GlgSetErrorHandler*, page 88.)

**GlgSetSResource**

**GlgSetSResourceIf**

**GlgSetSTag**

Replace the string in a string resource or tag.

\[
\text{GlgBoolean GlgSetSResource( object, resource_name, s_value )}
\]

GlgObject object;
char * resource_name;
char * s_value;
GlgBoolean GlgSetSResourceIf( object, resource_name, s_value, 
    if_changed )
GlgObject object;
char * resource_name;
char * s_value;
GlgBoolean if_changed;

GlgBoolean GlgSetSTag( object, tag_source, s_value, if_changed )
GlgObject object;
char * tag_source;
char * s_value;
GlgBoolean if_changed;

Parameters

object
Specifies a GLG object.

resource_name, tag_source
Specifies the name of the string resource or tag to be set.

s_value
Specifies the new string for the resource or tag.

if_changed
If set to GlgFalse, the graphical updates will be performed even if the new value is the same as
the old one (equivalent to GlgSetDResource function). Setting the parameter to GlgTrue
optimizes performance of applications that set resource or tag values regardless whether the
values have changed. The parameter is ignored when updating chart entry points to allow
plotting straight lines when the plotted value does not change over time.

If a string resource or tag with the given name exists, this function creates a copy of the input string,
and sets that copy as the new value of the resource or tag. The function returns GlgTrue if the
resource or tag has been successfully changed, otherwise it generates an error message and returns
GlgFalse. The memory associated with the old string is automatically freed.

GlgSetSResourceFromD
GlgSetSResourceFromDIf
GlgSetSTagFromD

Replace the string in a string resource or tag with a value specified by an input number and a format
string.

GlgBoolean GlgSetSResourceFromD( object, resource_name, format, 
        d_value )
GlgObject object;
char * resource_name;
char * format;
double d_value;
GlgBoolean GlgSetSResourceFromDIf( object, resource_name, format, d_value, if_changed )
GlgObject object;
char * resource_name;
char * format;
double d_value;
GlgBoolean if_changed;

GlgBoolean GlgSetSTagFromDIf( object, tag_source, format, d_value, if_changed )
GlgObject object;
char * tag_source;
char * format;
double d_value;
GlgBoolean if_changed;

Parameters

object
Specifies a GLG object.

resource_name, tag_source
Specifies the name of the string resource or tag to be set.

format
Specifies the format to use when setting the resource or tag string. This is a printf-style format string.

d_value
Specifies the numerical value to be converted to a string according to the format.

if_changed
If set to GlgFalse, the graphical updates will be performed even if the new value is the same as the old one (equivalent to GlgSetDResource function). Setting the parameter to GlgTrue optimizes performance of applications that set resource or tag values regardless whether the values have changed. The parameter is ignored when updating chart entry points to allow plotting straight lines when the plotted value does not change over time.

If a string resource or tag with the input name exists, this function sets it to a new string containing the d_value parameter in the format specified with the format argument. The function returns GlgTrue for success, otherwise it generates an error message and returns GlgFalse.

GlgSetTooltipFormatter

Supplies a custom tooltip formatter, returns the previously set formatter, if any.

GlgTooltipFormatter GlgSetTooltipFormatter( formatter )
GlgTooltipFormatter formatter;
Parameters

**formatter**

Specifies a custom tooltip formatter.

A tooltip formatter is a function which is invoked every time a new tooltip string needs to be generated. It can create and return a tooltip string, or return NULL to use a default tooltip string. When the tooltip string is no longer needed, it will be freed by the Toolkit using the `GlgFree` call. Therefore, it must be allocated using `GlgAlloc` or one of the GLG string utility functions, such as `GlgStrClone` or `GlgConcatStrings`.

A custom tooltip formatter has the following function prototype:

```c
typedef char * (*GlgTooltipFormatter)( GlgObject viewport, GlgObject object, GlgObject tooltip_string, GlgLong root_x, GlgLong root_y )
```

A custom tooltip formatter is invoked with the following parameters:

**viewport**

The parent viewport of the object.

**object**

The object with the tooltip action.

**tooltip_string**

The data object of S (string) type containing the tooltip string.

**root_x**

The X coordinate of the cursor relative to the root window.

**root_y**

The Y coordinate of the cursor relative to the root window.

**GlgSetZoom**

Provides a programmatic interface to integrated zooming and panning.

```c
GlgBoolean GlgSetZoom( object, resource_name, type, value )
GlgObject object;
char * resource_name;
GlgLong type;
double value;
```

Parameters

**object**

Specifies a viewport or a light viewport.

**resource_name**

Specifies the resource name of a child viewport to zoom or pan, or NULL to zoom or pan the
viewport specified by the object parameter. The resource name is relative to the viewport specified by the object parameter.

**type**

Specifies the type of the zoom or pan operation to perform. The value of this parameter matches the corresponding zooming and panning accelerators and may have the following values:

- ‘i’ - zoom in by the factor specified by the value parameter (the value of 2 is used as a default if value=0). **In the Chart Zoom Mode**, it zooms in only in the X/Time direction.
- ‘I’ - same as ‘i’, but zooms in only in the Y direction; is available only in the Chart Zoom Mode.
- ‘o’ - zoom out by the factor specified by the value parameter (the value of 2 is used as a default if value=0). **In the Chart Zoom Mode**, it zooms out only in the X/Time direction.
- ‘O’ - same as ‘o’, but zooms out only in the Y direction; is available only in the Chart Zoom Mode.
- ‘t’ - start generic ZoomTo mode (left-click and drag the mouse to finish, value is ignored). **In the Chart Zoom Mode**, if the first point of the ZoomTo box is located within the X or Y axis area, zooming will be performed only in the direction of the selected axis. For example, if the user defines the ZoomTo box in the X axis area, the chart will be zoomed only in the X direction.
- ‘_’ - start ZoomToX mode, which zooms only in the X direction and preserves the Y scale (left-click and drag the mouse to finish, value is ignored). It is especially useful in the Chart Zoom Mode.
- ‘|’ - start ZoomToY mode, which zooms only in the Y direction preserves the X scale (left-click and drag the mouse to finish, value is ignored). It is especially useful in the Chart Zoom Mode.
- ‘@’ - start ZoomToXY mode (left-click and drag the mouse to finish, value is ignored)
- ‘T’ - start custom ZoomTo mode (left-click and drag the mouse to ZoomTo, value is ignored). A custom zoom mode lets the user define the ZoomTo area without performing the zoom operation. An application can use the selected ZoomTo rectangle as the input to implement custom zooming or object selection logic. An application can handle Zoom events in input callback to perform a custom zoom operation. Refer to the Appendix B: Message Object Resources section of the GLG Programming Reference Manual for details of the Zoom event.
- ‘e’ - abort ZoomTo mode, value is ignored
- ‘s’ - start generic dragging mode (left-click and drag the drawing with the mouse to pan or scroll).
  **In the Chart Zoom Mode**, if the user clicks and drags the mouse within the X or Y axis area, scrolling will be performed in the direction matching the direction of the selected axis.
- ‘^’ - start vertical dragging mode (left-click and drag the drawing with the mouse to pan or scroll in the vertical direction). It is especially useful in the Chart Zoom Mode.
- ‘>’ - start horizontal dragging mode (left-click and drag the drawing with the mouse to pan or scroll in the horizontal direction). It is especially useful in the Chart Zoom Mode.
- ‘&’ - start XY dragging mode (left-click and drag the drawing with the mouse to pan or scroll).
- ‘f’ - fit the drawing to the visible area of the viewport, value is ignored (Drawing Zoom Mode only)
‘F’ - fit the area of the drawing defined by an object named GlgFitArea to the visible area of the viewport, value is ignored (Drawing Zoom Mode only)

‘n’ - reset zoom, value is ignored.
In the GIS zoom mode with map in the ORTHOGRAPHIC projection, resets zooming, but keeps the GIS center unchanged. In the RECTANGULAR projection, resets zooming and paning, but keeps the rotation angle unchanged.
In the Chart Zoom Mode, resets the Y range to fit all chart plots in the visible area of the chart in Y direction.

‘N’ - reset zoom, value is ignored.
In the Chart Zoom Mode, resets the Y range and changes the chart’s X span to show all accumulated data samples in the visible area of the chart.

‘u’ - pan up by the fraction of the widow height specified by the value parameter (the value of 0.5 is used as a default if value=0).
In the Chart Zoom Mode, scroll the chart up by a fraction of the chart’s data area height.

‘d’ - pan down by the fraction of the widow height specified by the value parameter (the value of 0.5 is used as a default if value=0).
In the Chart Zoom Mode, scroll the chart down by a fraction of the chart’s data area height.

‘l’ - pan left by the fraction of the widow width specified by the value parameter (the value of 0.5 is used as a default if value=0).
In the Chart Zoom Mode, scroll the chart left by a fraction of the chart’s data area width.

‘r’ - pan right by the fraction of the widow width specified by the value parameter (the value of 0.5 is used as a default if value=0).
In the Chart Zoom Mode, scroll the chart right by a fraction of the chart’s data area width.

‘x’ - pan horizontally by the distance in screen coordinates specified by the value parameter, the sign of the value defines the pan direction

‘y’ - pan vertically by the distance in screen coordinates specified by the value parameter, the sign of the value defines the pan direction

‘X’ - pan horizontally by the distance in world coordinates specified by the value parameter, the sign of the value defines the pan direction.
In the GIS Zoom Mode, pans by the latitude degrees.
In the Chart Zoom Mode, scrolls by the units of the X axis.

‘Y’ - pan vertically by the distance in world coordinates specified by the value parameter, the sign of the value defines the pan direction.
In the GIS Zoom Mode, pans by the longitude degrees.
In the Chart Zoom Mode, scrolls by the units of the first Y axis.

‘U’ - anchor on the upper edge, value is ignored (Drawing Zoom Mode only)

‘D’ - anchor on the lower edge, value is ignored (Drawing Zoom Mode only)

‘R’ - anchor on the right edge, value is ignored (Drawing Zoom Mode only)

‘L’ - anchor on the lower edge, value is ignored (Drawing Zoom Mode only)

‘A’ - rotate the drawing clockwise around X axis by the angle specified by the value parameter (Drawing Zoom Mode only)

‘a’ - rotate the drawing counterclockwise around X axis by the angle specified by the value parameter (Drawing Zoom Mode only)

‘B’ - rotate the drawing clockwise around Y axis by the angle specified by the value parameter (Drawing Zoom Mode only)

‘b’ - rotate the drawing counterclockwise around Y axis by the angle specified by the value parameter (Drawing Zoom Mode only)
value

Specifies a value for zoom and pan operations as described above.

The function performs a specified zoom or pan operation regardless of the setting of the viewport’s Pan and ZoomEnabled attributes. In the Drawing Zoom Mode, if the function attempts to set a very large zoom factor which would result in the overflow of the integer coordinate values used by the native windowing system, the zoom operation is not performed and the function returns GlgFalse.

The left mouse button is the default button for performing the ZoomTo operation, as well as for panning and scrolling the drawing by dragging it with the mouse. These defaults can be changed by setting the GlgZoomToButton and GlgPanDragButton global configuration resources. If the default is changed, the left-click used in the description of the affected operations changes to the click with the mouse button assigned to the respective ZoomTo or Pan operation.

GlgSetZoomMode

Sets or resets a viewport’s zoom mode by supplying a GIS or Chart object to be zoomed. In the Drawing Zoom Mode (default), the drawing displayed in the viewport is zoomed and panned. If the GIS Zoom Mode is set, any zooming and panning operation performed by the GlgSetZoom method will zoom and pan the map displayed in the viewport’s GIS Object, instead of being applied to the viewport’s drawing. In the Chart Zoom Mode, the content of the chart is zoomed and panned.

GlgBoolean GlgSetZoom( object, resource_name, zoom_object, zoom_object_name )
GlgObject object;
char * resource_name;
GlgObject zoom_object;
char * zoom_object_name;

Parameters

object

Specifies a viewport object.

resource_name

Specifies the resource name of a child viewport whose zoom mode to set, or NULL to set the Zoom Mode of the viewport specified by the object parameter. The resource name is relative to the viewport specified by the object parameter.

zoom_object

Specifies a GIS or Chart object (or its parent if zoom_object_name is not NULL).

zoom_object_name

If the parameter is NULL, the GIS or Chart object supplied by the zoom_object parameter is selected as the GIS or Chart object to be zoomed. If the parameter is not NULL, it specifies the resource name of the GIS or Chart object to be zoomed. The resource name is relative to the
The function may be invoked with \texttt{zoom\_object=NULL} and \texttt{zoom\_name=NULL} to reset the zoom mode to the default Drawing Zoom Mode.

\textit{GlgStrClone}

Creates a copy of a character string.

\begin{verbatim}
c char * GlgStrClone(string)
   char * string;
\end{verbatim}

\textbf{Parameters}

\begin{itemize}
  \item \textbf{string}
    \begin{itemize}
      \item The string to be copied. This can be a NULL pointer, in which case the return value is also NULL.
    \end{itemize}
\end{itemize}

This function creates and returns a copy of the input string. The copy should later be freed with the \textit{GlgFree} function.

\textit{GlgUpdate}

Updates a widget to show new resource values.

\begin{verbatim}
GlgBoolean GlgUpdate(object)
   GlgObject object;
\end{verbatim}

\textbf{Parameters}

\begin{itemize}
  \item \textbf{object}
    \begin{itemize}
      \item Specifies a viewport to update. If \texttt{object} is a light viewport, update of its parent viewport will be performed.
    \end{itemize}
\end{itemize}

All resource changes are held until the \textit{GlgUpdate} function is called or until the widget window receives an expose event. (That is, it must be redrawn because another window that had obscured part of the window has been moved.) This causes the widget to redraw itself, using its new data. The function returns \textit{GlgTrue} if the widget has been successfully updated; otherwise it returns \textit{GlgFalse}.

\textbf{Note:} Some GLG drawing resources affect the object hierarchy of the drawing (these are the H resources), while others affect the values of objects in the hierarchy (V resources). The Factor attribute of a series affects whether or not there is a Sample5/FillColor instance object in that series. A request to change the Factor resource to 3 might therefore conflict with a request to change the Sample5/FillColor resource to red. Even if Factor was changed to 6 in the same batch of resource changes, the act of redrawing the series to accommodate the new attribute value might delete the color change of a series instance. To avoid these conflicts, it is advisable to execute \textit{GlgUpdate} after any H resources have been changed, and before changing any other resources. For more information about these resources, see the \textit{H and V Resources} section of the Introducing GLG Drawings into a Program chapter.
**GlgWinPrint**

Invokes Microsoft Windows native printing.

```c
void GlgWinPrint( viewport, print_dc, x, y, width, height, reserved,
                 stretch )
GlgObject viewport;
HDC print_dc;
double xpos, ypos, width, height;
GlgBoolean reserved, stretch;
```

**Parameters**

**viewport**
Specifies the viewport whose contents are to be printed. If `viewport` is a light viewport, the output will be generated for its parent viewport.

**print_dc**
The printer device context, acquired from a call to the `PrintDlg` function.

**xpos, ypos, width, height, stretch**
These arguments are used in the same way as the corresponding arguments to the `GlgPrint` function, described above.

Given the printer device context, this function prints the contents of a viewport and all its children viewports into that device context. It is the responsibility of the application to set the abort procedure, provide a cancel printing dialog, disable the application window during printing, and call the `StartDoc`, `StartPage`, `EndDoc`, and `EndPage` functions before and after calling this function. These procedures and the use of these functions is described in the *Win32 Programmer’s Reference*.

There is no orientation parameter with the Microsoft Windows native printing. The page orientation is determined by the user through the print dialog.

The `GlgWinPrint` function can be used to add GLG printing output to a page which already had some output on it. In this case, that other output may set the printer device context parameters to values incompatible with the GLG output. Before calling this function, therefore, the device transformations must be reset to the state they were in right after calling the `PrintDlg` function.

This function is only available under the Microsoft Windows environment.

**GlgXPrintDefaultError**

Prints information about an X error on a console or logs it into a file. The function can be used for printing error information in custom X error handlers and is available only under the X Windows environment on Linux/Unix.
GlgBoolean GlgXPrintDefaultError( display, event, file )
    Display *display;
    XErrorEvent *event;
    FILE * file;

Parameters

display
    Specifies the connection to the X server.

event
    X error event.

file
    File to log the output to. stdout may be used to print the output on the console.

The function returns GlgTrue if it detects OpenGL GLX errors, otherwise it returns GlgFalse.
2.5 Handling User Input and Other Events

Callback Events

A **callback** is a function or method that is invoked under certain conditions. For example, a callback is called each time a user selects something in a GLG drawing with the mouse. The code is supplied by the application developer.

A callback can be invoked for one of a few possible reasons:

- The user has used the mouse to select some graphical object in the drawing area of the widget, generating object selection and custom selection events.
- The user has moved the mouse over some object in the drawing, which may generate selection events as well.
- An input widget, such as button or slider, has received some input from the user. This usually arrives in the form of mouse motion or button clicking, although the text widget accepts typed input as well.
- The window has received some window event, such as a window closing request, resize event, etc.
- A `SubWindow` object has loaded the drawing that will be displayed in it, or a `SubDrawing` object has loaded its template.
- The GLG Wrapper Widget also invokes callback functions at startup, when resources are set. For information about the wrapper widget and its callback lists, see the *Callback Resources* section of the *X Windows and GLG Wrapper Widget* chapter on page 35.
- An alarm handler is a special global callback that handles alarm events. Refer to the *GlgSetAlarmHandler* section on page 84 for more information.

In addition to these callbacks, the GLG Toolkit provides **trace** callbacks that are invoked whenever a GLG viewport receives any event. The trace callbacks are used as an escape mechanism to provide low-level access to native windowing events. There are two trace callbacks: a **trace** callback invoked before dispatching the event for processing, and a **trace2** callback invoked after the event has been processed by the Toolkit.

**Attaching Callbacks to a Viewport Object**

A callbacks is attached to a viewport with the `GlgAddCallback` function, which takes the callback type and the callback function as parameters:

```c
void GlgAddCallback( viewport, type, callback, client data )
    GlgObject viewport;
    GlgCallbackType type;
    GlgCallbackProc callback;
    GlgAnyType client_data;
```

The callback type may be one of `GLG_INPUT_CB`, `GLG_SELECT_CB`, `GLG_TRACE_CB`, `GLG_TRACE2_CB` or `GLG_HIERARCHY_CB` values defined in the `GlgApi.h` file.
All callbacks use the same function prototype:

```c
typedef void (*GlgCallbackProc)( viewport, client_data, call_data )
GlpObject viewport;
GlpAnyType client_data;
GlpAnyType call_data;
```

**Parameters**

**viewport**

A viewport handle corresponding to the viewport to which the callback was attached. For the
GLG_INPUT_CB callback, it may be a light viewport.

**client_data**

Application defined data specified by the `GlpAddCallback` function.

**call_data**

Callback-specific data supplying information about the event which caused the callback.

A callback must be attached to a viewport before the viewport’s object hierarchy is set up (after the
viewport is loaded but before it is drawn). Child viewports may have their own callbacks attached,
different from the callbacks of their parent viewport. Only one callback of each type can be attached
to one viewport object. To remove a callback, use NULL as a callback parameter.

**Adding Callbacks to a GLG Wrapper Widget**

In the Motif/Xt environment, a GLG callback can also be attached to the top level viewport of the
GLG Wrapper Widget’s drawing as an Xt callback using the `XtAddCallback` function. The
callback types include

- `XtNglgSelectCB`
- `XtNglgMotifSelectCB`
- `XtNglgInputCB`
- `XtNglgMotifInputCB`
- `XtNglgTraceCB`
- `XtNglgTrace2CB`
- `XtNglgHierarchyCB`
- `XtNglgHInitCB`
- `XtNglgVInitCB`

Notice that for the select and input callbacks two callback types are provided: one following the
GLG generic cross-platform format and one following the Motif calling convention. The callbacks
must be added before the widget is realized and its drawing hierarchy is set up.
There are two widget initialization callbacks: \texttt{HInit} and \texttt{VInit}, which allow an application to initialize drawing’s resources before it is displayed in the widget. The \texttt{HInit} callback is invoked after the widget’s drawing is loaded, but before its hierarchy is setup. It may be used to initialize values of H resources, such as a number of instances in a series object or a number of points in a graph. The \texttt{VInit} callback is invoked after the hierarchy setup, but before the drawing is displayed. It may be used for initializing V resources, such as initial data values for a graph.

The Xt callbacks use the standard \texttt{XtCallbackProc} prototype and pass the callback information to the application using the callback’s \texttt{call_data} parameter. The following description of specific callback types includes the description of Motif-style callbacks.

\textit{Selection Callback}

The \textbf{selection callback} provides a simplified name-based interface to handle object selection. The input callback provides a more elaborate alternative for handling selection events using either object IDs, or custom events and selection commands which can be attached to objects in the Graphics Builder.

A selection callback is called when the user selects objects in the widget with a mouse click. If no objects are selected, the \texttt{call_data} parameter will be NULL. If some objects are selected by the click, the \texttt{call_data} parameter will contain a list of names of all selected objects. This list is a NULL-terminated list of pointers to strings, each of which represents the complete path name of one object selected by the mouse click. If more than one object is selected, the list will contain several strings. The objects drawn on top will be listed first. The pointer to the list as well as pointers to the individual strings point to internal data structures which should not be modified.

The \texttt{GlgGetSelectionButton} function may be used to find out which mouse button was pressed to activate the selection callback.

The path name obtained in the selection callback may be used to query or access resources of the selected object. For example, if the fifth bar of a bar graph was selected, one of the path names will be \texttt{DataGroup/DataSample4}. To query the value of this data sample, concatenate this path name with “Value” using the \texttt{GlgConcatResNames} function and use the resulting \texttt{DataGroup/DataSample4/Value} path name in a call to \texttt{GlgGetDResource}. 
The following example shows how to highlight the selected data sample of a graph with a different color in the selection callback:

```c
void Select( viewport, client_data, call_data )
    GlgObject viewport;
    GlgAnyType client_data;
    GlgAnyType call_data;
{
    int i;
    char
        ** name_array,
        * name,
        * resource_name;

    if( !name_array )
        return;

    for( i=0; name = name_array[ i ]; ++i )
        if( strstr( name, "DataGroup/DataSample" ) )
            {
                /* Concatenate the name of the data sample with "FillColor". */
                resource_name = GlgConcatResNames( name, "FillColor" );
                GlgSetGResource( viewport, resource_name, 1., 0., 0. ); /* Red. */
                GlgFree( resource_name );
            }
}
```

**Motif Widget Selection Callback**

The Motif version of the GLG Wrapper Widget provides the Motif-style select callback (`XtNglgMotifSelectionCB`) in addition to the standard GLG callback (`XtNglgSelectionCB`). The `call_data` argument supplied to Motif version of the selection callback function is a structure defined as follows:

```c
typedef struct _GlgSelectCBStruct
{
    GlgCallbackType reason;
    XEvent * event; /* Event that triggered the callback */
    GlgObject viewport; /* Viewport that received the mouse click that triggered the selection callback */
    Widget widget; /* Wrapper's widget ID */
    long num_selected; /* The length of the selection list */
    char ** selection_list; /* Same as in the Xt selection callback */
} GlgSelectCBStruct;
```

Note that the structure contains the same list of selected objects that is sent to a callback function when using the Xt version of the Wrapper Widget.
Input Callback

The Toolkit translates the low-level events of the native windowing system, such as mouse moves, and mouse clicks, into high-level GLG events, such as object selection events, custom events and command actions associated with GLG objects, as well as input events such as slider moves and button presses. An **input callback** is the primary mechanism for handling any GLG events occurring in an application. It is invoked for several types of input activities:

- When some input activity is detected by an input widget, like moving a slider or a knob with the mouse. The widget has an input handler attached to the widget's viewport to process incoming events, and the type of the widget is defined by the type of the handler.
- When objects in the drawing are selected with the mouse over or mouse click events.
- When custom events or command actions associated with objects in the drawing are triggered in response to mouse move or click events.
- When window events occur, such as closing a top level GLG window.

To activate processing of selection and custom selection events on the mouse click and mouse move, the viewport’s `ProcessMouse` attribute must be set to `GLG_MOUSE_CLICK` or `GLG_MOUSE_MOVE_AND_CLICK`, respectively. The rest of the event are always processed and do not require any additional settings.

If a system event in a viewport is translated into some GLG event, the input callback of the viewport object is invoked. If the viewport doesn’t have an input callback attached, the input callback of its closest parent with input callback is invoked. The `call_data` parameter of the callback contains a `message` object used to pass all information about the event to the callback. This information is present in the message object in the form of named resources of the message object and may be obtained from it by using methods for querying resources (`GlgGetSResource`, `GlgGetDResource` and `GlgGetGResource`). The message object should be passed as the first parameter, and a resource name defining the resource to query should be passed as the second parameter. For example, the following code extracts the value of the message object’s `Origin` resource:

```c
char * origin;
GlgGetSResource( message_object, "Origin", &origin );
```

If the input callback was invoked in response to an activation of an action or a command attached to an object, the message will also contain the `ActionObject` resource that may be used to access all information associated with the action or command.

The details of the message object for each event type are described in the *Message Object* section on page 108.
Motif Widget Input Callback

The Motif version of the GLG Wrapper Widget provides the Motif-style input callback 
(XtNglgMotifInputCB) in addition to the standard GLG callback (XtNglgInputCB). The call_data 
argument supplied to Motif version of the input callback is a structure defined as follows:

```c
typedef struct _GlgInputCBStruct
{
    GlgCallbackType reason;
    GlgObject viewport; /* Viewport that received the event that
                          triggered the input callback. */
    Widget widget; /* Wrapper's widget ID */
    GlgObject message_obj; /* Same as in the Xt input callback */
} GlgInputCBStruct;
```

Note that the structure contains the same message object that is sent to a callback function when 
using the Xt version of the Wrapper Widget; see the Message Object section, below.

Trace Callbacks

The trace callbacks are used as an escape mechanism to provide low-level access to native 
windowing events. They are invoked whenever a viewport receives a native windowing event and 
passes the event to the application code for processing. If a viewport object has a trace callback 
attached, the trace callback will be invoked for all events received by the viewport and all of its child 
viewports. There are two trace callbacks: the trace callback is invoked before the event is 
dispatched for processing, and the trace2 callback is invoked after the event has been processed.

As with the other callbacks, it is attached to a viewport with the GlgAddCallback function, or 
through the resources of the GLG Wrapper Widget.

The information necessary to completely identify an event may be gathered by parsing window data 
returned to the callback function, or by invoking functions in the GLG Standard or Extended API.

The call_data passed to these callback functions is a structure of platform-specific window data 
given by the following. In the X Windows environment, the call_data structure looks like this:

```c
typedef _GlgTraceCBStruct
{
    GlgCallbackType reason; /* GLG_TRACE_CB or GLG_TRACE2_CB */
    GlgObject viewport; /* Viewport that received the event. */
    GlgObject light_viewport; /* Light viewport of the event or NULL. */
    XEvent * event; /* Event that triggered the callback. */
    Widget widget; /* Widget ID of the event viewport. */
    Window window; /* Window ID of the event viewport. */
    Display * display; /* Display of the event viewport. */
    XEvent * event1; /* Reserved */
} GlgTraceCBStruct;
```

The callback structure contains enough information to determine which viewport received the event 
(indicated by the viewport field), and where it is. It also contains a pointer to an XEvent structure, 
which may be used to provide details of the event. For the mouse and key events, the light_viewport
field contains the light viewport under the mouse (if any), or NULL otherwise. The widget, window
and display fields provide information about the corresponding parameters of the viewport’s native
components. The reason field is set to the type of the callback: GLG_TRACE_CB or
GLG_TRACE2_CB. The event1 pointer is reserved for future use.

Under Microsoft Windows, the trace callback structure looks like this:

```c
typedef _GlgTraceCallbackStruct
{
    GlgCallbackType reason; /* GLG_TRACE_CB or GLG_TRACE2_CB */
    GlgObject viewport; /* Viewport that received the event. */
    GlgObject light_viewport; /* Light viewport of the event or NULL. */
    MSG * event; /* Event that triggered the callback. */
    HWND widget; /* Window of the event viewport. */
    HWND window; /* Window of the event viewport. */
    void * display; /* NULL */
    void * event1; /* Reserved */
} GlgTraceCallbackStruct;
```

As with the X Windows version, this structure contains information enough to identify the viewport
and light viewport that received the event, and to provide more detail about the event itself in the
event field. The widget and window fields contain the handle of the viewport’s native window. The
callback_type field is set to the type of the callback: GLG_TRACE_CB or GLG_TRACE2_CB.
The display field is set to NULL and the event1 pointer is reserved for future use.

In addition to native windowing system events, the trace callbacks may receive a few events
generated by the GLG object engine for light viewports: GLG_LV_ENTER_NOTIFY,
GLG_LV_LEAVE_NOTIFY and GLG_LV_RESIZE. Under Microsoft Windows, the GLG engine
also generates viewport enter notify and leave notify events which are not generated by the native
windowing system: GLG_MSW_ENTER_NOTIFY and GLG_MSW_LEAVE_NOTIFY.

**Hierarchy Callback**

The hierarchy callback is used to get access to the drawing to be displayed in the SubWindow
object before the drawing is displayed. SubWindows may be used to switch drawings displayed in
them, and an application may want to install a separate input callback for each loaded drawing to
handle user interaction instead of having one giant input callback that handles input events from all
drawings. An input callback has to be added to the viewport of a drawing displayed in the
subwindow before the drawing is set up and drawn. The hierarchy callback is invoked with the ID
of the subwindow’s drawing after it is loaded but before its hierarchy is setup, making it possible to
add input callbacks as well as initialize the drawing with data before it is painted on the screen.

Similarly, the hierarchy callback is also invoked for the SubDrawing objects when they load their
template drawings; the callback provides an object ID of the loaded object that will be displayed in
the subdrawing.

The hierarchy callback is attached to a viewport with the GlgAddCallback function. A hierarchy
callback may be added to the top level viewport or any of its children viewports. If any of a
subwindow’s (or subdrawing’s) parent viewports has a hierarchy callback added, the callback of the
closest parent viewport will be invoked each time the subwindow loads a new drawing or the
subdrawing loads its template. The hierarchy callback is invoked twice for each template drawing: the first time when the drawing is loaded but before it is set up, and the second time when the drawing is setup but before it is drawn.

The call_data passed to the hierarchy callback is a structure that provides an object ID of the SubWindow object that triggered the callback, as well as an object ID of the viewport of the loaded drawing:

```c
typedef _GlgHierarchyCallbackStruct
{
    GlgCallbackType reason; /* GLG_HIERARCHY_CB */
    /* GLG_BEFORE_SETUP_CB or GLG_AFTER_SETUP_CB */
    GlgHierarchyCallbackType condition;
    /* Subwindow or subdrawing object that loaded its template. */
    GlgObject object;
    /* Template instance of the subwindow or subdrawing. */
    GlgObject subobject;
} GlgHierarchyCallbackStruct;
```

The reason field of the callback structure is always set to GLG_HIERARCHY_CB. The condition field indicates when the callback is invoked: it is set to GLG_BEFORE_SETUP_CB when the callback is called before the hierarchy setup and to GLG_AFTER_SETUP_CB when it is invoked after the setup.

The object field provides an object ID of the SubWindow or SubDrawing object that triggered the callback. The subobject field contains an ID of the drawing that will be displayed in the subwindow, or ID of the object that will be shown in the subdrawing (the Instance attribute).

The source code of the SCADA Viewer demo provides an example of using the callback.

**Message Object**

A message object is a GLG object like any other. It is a group object, containing data in the form of named attributes just like other GLG objects. It is used to pass data to the input callbacks that may be associated with a viewport.

Any message object has the following named attributes:

<table>
<thead>
<tr>
<th>Resource Name</th>
<th>Data Type</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Format</td>
<td>String</td>
<td>Defines the format of the message object and the resources present in it. It is defined by the event type and, for input messages, the type of the input handler which detected the input activity and sent the message. It may have values such as Button, Slider, Knob, ObjectSelection, CustomEvent.</td>
</tr>
</tbody>
</table>
A message object can have other resources as well, depending on the type of the event and, for input object events, the type of the input handler that generated the event. For events triggered by an Action attached to an object, such as Command or Custom Event, the message contains the ActionObject resource.

For events generated by input objects, such as a slider or a button, the message object includes handler-related resources of the input widget. For example, the message object coming from a GLG slider object may also contain such resources as ValueX, ValueY, Granularity, Increment, DisableMotion and others. These resources may be queried from either the message object or the viewport object that generated the message.

Refer to the Appendix B: Message Object Resources on page 427 for a complete list of all message types and their resources. Refer to the Input Handlers chapter of the GLG User’s Guide for a complete list of resources for each input handler type.

**Examples of Using Callbacks in Application Code**

The following examples demonstrate how to use GLG callbacks. Refer to the source code of the GLG demos for additional examples.
Adding callbacks

The following code adds both selection and input callbacks to the drawing viewport object:

```c
GlgAddCallback( drawing, GLG_SELECT_CB, SelectCB, callback_data );
GlgAddCallback( drawing, GLG_INPUT_CB, InputCB, callback_data );
```

**Processing Selected Objects using Selection Callback**

A selection callback has several parameters, one of which is a list of names of all selected objects, including complete path identifying the place of objects in the drawing hierarchy. The following example shows a selection callback which prints names of all selected objects:

```c
void SelectCB( drawing, client_data, call_data )

GlgObject drawing;
GlgAnyType client_data;
GlgAnyType call_data;
{
    char ** name_ array;
    char * name;
    int i;

    name_array = (char **) call_data;
    if( !name_array )
        PrintOnConsole( "Nothing was selected." );
    else
        for( i=0; name = name_array[ i ]; ++i )
            PrintOnConsole( name );
}
```

The selection callback may be used with a minimal GLG configuration, such as the Basic Edition of the Graphics Builder and the GLG Standard API.

**Processing Selected Objects Using Input Callback**

While the select callback provides a simplified name-based interface for handling object selection, the input callback provides a more elaborate mechanism based on object IDs. Several object selection techniques are available:

- A targeted object selection via the use of a custom event or command action attached to an object at design time. When an object is selected with the mouse, the input callback is invoked with a message that contains detailed information about the action that triggered the callback.

- An **ObjectSelection** message that provides a list of IDs of all selected objects on the lowest level of the object hierarchy. It does not require anything to be done at design time, but uses the Intermediate API in the application code to retrieve IDs of selected objects.

The object selection event is generated when the mouse is moved over an object in the drawing, or an object is selected with a mouse click. The custom selection events and commands are generated when the selected object has a custom event or command action. The **ProcessMouse** attribute of the viewport object has to include a combination of the **Move** and **Click** masks to enable object selection.
and custom selection events on the corresponding mouse events. Refer to the *Integrated Features of the GLG Drawing* chapter on page 57 of the *GLG User’s Guide and Builder Reference Manual* for more information on object selection and custom selection events.

The following example shows how to process selection using both types of object selection messages.

```c
void InputCB( viewport, client_data, call_data )

GlgObject viewport;
GlgAnyType client_data;
GlgAnyType call_data;
{

GlgObject
message_obj,
selection_array,
selected_object,
command,
action_object,
action_data;
char
* format,/* Message format */
* action,/* Message action */
* selecte_object_name, /* Name of the selected object. */
* event_label, /* Event label of a custom event or command. */
* command_type; /* Type of a command to be executed on object
selection. */
double button_index; /* Button that caused object selection. */
int i, size;

message_obj = (GlgObject) call_data;
GlgGetSResource( message_obj, "Format", &format );
GlgGetSResource( message_obj, "Action", &action );

if( strcmp( format, "Command" ) == 0 )
{

/* This code handles command actions attached to an object. */

/* Retrive command information using the Standard API. */
GlgGetSResource( message_obj,
"ActionObject/Command/CommandType", &command_type );
GlgGetSResource( message_obj, "EventLabel", &event_label );
GlgGetSResource( message_obj, "Object/Name",
&selected_object_name );

/* Retrieve the object IDs of the command and the selected
object using the Intermediate API. */
selected_object = GlgGetResourceObject( message_obj, "Object" );
command =
GlgGetResourceObject( message_obj, "ActionObject/Command" );

ExecuteCommand( selected_object, command_type, command );
}
else if( strcmp( format, "CustomEvent" ) == 0 )
{
/* This code handles custom events attached to an object. This code handles both custom event actions and the old-style custom events. */

GlgGetSResource( message_obj, "EventLabel", &event_label );

/* Don't process events with empty EventLabel. An event with an empty EventLabel is generated for MouseOver events when the mouse moves away from the object, and for MouseClick events when the mouse button is released. */
if( strcmp( event_label, "" ) == 0 )
    return;

/* Retrieve command and selected object (Intermediate API). */
selected_object = GlgGetResourceObject( message_obj, "Object" );

/* Retrieve the selected object's name using Standard API. */
GlgGetSResource( message_obj, "Object/Name", &selected_object_name );

/* For the old-style MouseClick actions, query the mouse button that generated this custom selection event (0 for custom MouseOver events). */
GlgGetDResource( message_obj, "ButtonIndex", &button_index );

/* Prints MouseClick or MouseOver. */
PrintOnConsole2( "Custom event action: ", action );
PrintOnConsole2( "Selected object: ", selected_object_name );

/* Retrieve ActionObject resources of the message object (Intermediate API). ActionObject will be NULL for custom events added prior to GLG v.3.5. */
action_obj =
    GlgGetResourceObject( message_obj, "ActionObject" );

/* Retrieve the action's ActionData. If present, its properties may be used for processing the event. */
if( action_obj )
    action_data =
        GlgGetResourceObject( action_obj, "ActionData" );

} /* Handle default object selection message. */
else if( strcmp( format, "ObjectSelection" ) == 0 )
{
    selection_array =
        GlgGetResourceObject( message_obj, "SelectionArray" );
    if( !selection_array )
    {
        PrintToConsole( "No objects selected by ", action );
        return;
    }
For MouseClick actions, query the mouse button that caused the selection (0 for MouseMove events). */
GlgGetDResource( message_obj, "ButtonIndex", &button_index );

size = GlgGetSize( selection_array );
for( i=0; i < size; ++i )
{
    selected_object = GlgGetElement( selection_array, i );
    GlgGetSResource( selected_object, "Name",
                       &selected_object_name );
    /* Print MouseMove or MouseClick. */
    PrintToConsole2( "Selected by: ", action );
    if( !selected_object_name || !*selected_object_name )
        PrintToConsole( "Unnamed object is selected." );
    else
        PrintToConsole2( "Selected object: ",
                           selected_object_name );
}

The Enterprise Edition of the Graphics Builder is required to add Command actions or custom event actions to objects at design time. The GLG HMI Configurator can be also used to add Command actions to objects. The GLG Intermediate API may be used for more efficient and flexible processing of the Command and Custom Event actions in the application code. In the above example, the GlgGetResourceObject Intermediate API call is used to retrieve object ID of the selected object as well as the command object.

Handling the ObjectSelection message requires the use of the GLG Intermediate API to retrieve IDs of the selected objects.

**Processing Input Object Events**

There are two methods for processing user input from input objects, such as a button, a slider or a text input field, in an application code:

- using low-level input object events based on input object names
- using targeted input commands via the use of Input Command actions attached to input objects at design time. The InputAction parameter of the action object specifies the condition that triggers the input callback. When an input object receives user input, the input callback is invoked with a message that contains detailed information about the event.

The following example demonstrates a very simple input callback which terminates the application when a Quit button is pressed. The example demonstrates how to handle the default input object events, as well as an attached command actions.

```c
void InputCB( drawing, client_data, call_data )
{  
    GlgObject drawing;
    GlgAnyType client_data;
    GlgAnyType call_data;
```
The Enterprise Edition of the Graphics Builder is required to add Input Command actions to input objects at design time. The GLG HMI Configurator can be also used to add Input Command actions. The GLG Intermediate API may be used for more efficient and flexible processing of the Input Command actions in the application code.
Refining Input Object Selection

Default Input Object Events

The following code fragment shows an example of an input callback that uses default input object events. The code determines which of the two sliders in the drawing (the temperature slider or pressure slider) received user input, and calls the appropriate function to process the new value specified by the user.

```c
void InputCallback( viewport, client_data, call_data )
{
    GlgObject message_obj;
    char
        * format,
        * action,
        * full_origin;
    double value;

    message_obj = (GlgObject)call_data;
    /* Extract callback data from the message object. */
    GlgGetSResource( message_obj, "Format", &format );
    GlgGetSResource( message_obj, "Action", &action );
    GlgGetSResource( message_obj, "FullOrigin", &full_origin );

    /* Ignore if message came not from a slider or not a ValueChanged. */
    if( strcmp( format, "Slider" ) != 0 || strcmp( action, "ValueChanged" ) != 0 )
        return;

    /* Obtain the new value of the slider. */
    GlgGetDResource( message_obj, "Value", &value );

    /* Call an appropriate function depending on the slider name. */
    if( strcmp( full_origin, "TemperatureBlock/Slider" ) == 0 )
        ProcessTemperatureInput( widget, value );
    else if( strcmp( full_origin, "PressureBlock/Slider" ) == 0 )
        ProcessPressureInput( widget, value );
    else
        Error( "Unknown name." );
}
```

Alternatively, Input Command actions may be attached to the sliders to execute the attached command as shown below.
**Input Commands**

The following input callback code demonstrates handling Input Command actions attached to the temperature and pressure sliders in the drawing. The code is completely generic and may be used with any drawing, since it uses the command data to execute the command without any reliance on the names of input objects in the drawing. The GLG Intermediate API is used to retrieve IDs of the input object and the command object.

```c
void InputCallback( viewport, client_data, call_data )
GlgObject viewport;
GlgAnyType client_data;
GlgAnyType call_data;
{
    GlgObject message_obj,
    command_obj,
    input_obj;
    char
    * format,
    * command_type,
    * value_resource,
    * tag;
    double value;
    message_obj = (GlgObject)call_data;

    /* Extract callback data from the message object. */
    GlgGetSResource( message_obj, "Format", &format );
    if( strcmp( format, "Command" ) != 0 )
        return;

    GlgGetSResource( message_obj, "ActionObject/Command/CommandType",
                    &command_type );
    if( strcmp( command_type, "WriteValueFromWidget" ) == 0 )
    {
        command_obj =
            GlgGetResourceObject( message_obj, "ActionObject/Command" );

        /* Input object that triggered the message. */
        input_obj = GlgGetResourceObject( message_obj, "Object" );

        /* The resource path to the input object's value. */
        GlgGetSResource( command, "ValueResource", &value_resource );

        /* New value of input object. */
        GlgGetDResource( input_obj, value_resource, &value );

        /* The process controller tag to write the value to. */
        GlgGetSResource( command, "OutputTagHolder/TagSource", &tag );

        /* Write the new value. */
        SendValueToController( tag, value );
    }
}
```
Trace Callback examples

For examples of using the trace callback, refer to the source code of the GLG Diagram demo.

Hierarchy Callback examples

For examples of using the hierarchy callback, refer to the source code of the GlgSCADAViewer demo.
2.6 GLG Intermediate and Extended API

The GLG Standard API enables an application to display a GLG drawing and animate it by querying and setting resources. The GLG Extended API adds functionality that allows an application program to edit or create the drawing at run time. The GLG Intermediate API is a subset of the Extended API that provides all of the Extended API methods for manipulating the drawing, except for the methods for creating, adding or deleting objects from the drawing at run time.

The **GLG Intermediate API** may be used to modify GLG drawings created in the GLG Graphics Builder and to implement elaborate custom logic to handle user interaction. The Intermediate API may also be used to obtain object IDs of resources in the drawing to access them directly, eliminating the resource path parsing required by the Standard API methods and increasing update performance of large drawings. The Intermediate API provides extensive functionality for changing an object’s geometry and layout, creating and removing constraints, as well as advanced introspection capabilities for traversing the drawing and determining its content at run time.

The **GLG Extended API** includes all method of the Standard and Intermediate APIs and adds methods for creating, copying and adding objects to the drawing at run time. The Extended API may be used for adding objects to the drawing at run time or creating a drawing on the fly based on a configuration file. It may also be used for adding dynamics, tags and custom properties to objects at run time.

Both the Intermediate and Extended APIs are available in all deployment options supported by the Toolkit, including C/C++, Java, C#/.NET, JavaScript and (on Windows) ActiveX Control.

Refer to the DEMOS and examples directories for examples of using the Intermediate and Extended API methods in various programming environments.

**Overview**

Because of the abstract approach of the GLG architecture, the Extended API is small and simple, with very few functions to worry about, while still providing all the tools you need to create highly elaborate drawings. The power of the library comes from the symmetry of the architecture, where everything in a drawing is represented as a data object. This lets you use the same functions in many different combinations to obtain different effects, using the resource notation to control their actions.

There are two libraries that provide the Extended API functionality: **GLG Intermediate Library** and **GLG Extended Library**. The Intermediate Library provides all of the Extended API methods, except for the methods for creating and deleting objects at run time. The Extended Library contains all Extended API functions, including the methods for creating objects at run time.

In order to minimize the size of the API, all GLG functions are **generic** in the sense that some of their arguments are of the *GlgAnyType* type. The actual type of these parameters is determined dynamically at run time by their context (as defined by the values of the other parameters).
The GLG Intermediate API includes the following functions:

- **GlgLoadObject** loads a GLG object from a file.
- **GlgLoadObjectFromImage** loads a GLG object from a memory image created by the GLG Code Generation Utility.
- **GlgSaveObject** saves a GLG object into a file.
- **GlgReferenceObject** references an object.
- **GlgDropObject** dereferences an object.
- **GlgReorderElement** changes the object’s position inside a container.
- **GlgContainsObject** finds if the object belongs to a container.
- **GlgGetNamedObject** finds a named object in a container.
- **GlgGetElement** returns the object at the specified index in a container.
- **GlgGetIndex** returns the index of the first occurrence of the object in a container.
- **GlgGetStringIndex** returns the index of the first occurrence of the string in a string container.
- **GlgFindObject** finds an object in a container.
- **GlgGetSize** queries the size of a container object.
- **GlgSetStart** initializes a container object for traversing.
- **GlgIterate** traverses a container object.
- **GlgGetResourceObject** gets the object ID of a resource object.
- **GlgCreateResourceList** returns a list of an object’s resources.
- **GlgGetTagObject** returns a tag object with a specified tag name or tag source, or a list of tags matching the specified tag name or tag source pattern.
- **GlgGetAlarmObject** returns an alarm object with a specified alarm label, or a list of alarms matching the specified alarm label pattern.
- **GlgConstrainObject** adds constraints.
- **GlgUnconstrainObject** removes constraints.
- **GlgSuspendObject** suspends the object for editing.
- **GlgReleaseObject** releases the object after editing.
- **GlgGetParent** returns an object’s parent object, if one exists.
- **GlgGetBoxPtr** returns an object’s bounding box.
- **GlgCreateSelectionNames** returns the names of all the objects intersecting a given rectangle.
- **GlgCreateSelectionMessage** finds an object selected by a given selection criteria in a rectangular area and returns a selection message for the first found matching action attached to the object.
- **GlgCreateSelection** returns an array of objects intersecting a given rectangle.
- **GlgGetDrawingMatrix** returns the matrix corresponding to the input object.
• **GlgCreateInversedMatrix** inverts a transformation matrix object.

• **GlgTransformPoint** transforms a single point.

• **GlgCreatePointArray** creates and returns an array containing all control points of an object.

• **GlgMoveObjectBy, GlgMoveObject, GlgScaleObject, GlgRotateObject, GlgPositionObject, GlgFitObject** and **GlgTransformObject** transform an object in various ways.

• **GlgLayoutObjects** performs various alignment and layout operations.

• **GlgGetMatrixData** and **GlgSetMatrixData** query and set matrix data values.

• **GlgScreenToWorld** and **GlgWorldToScreen** convert coordinates between the screen and world coordinate systems.

• **GlgTranslatePointOrigin** converts screen coordinates of a point in one viewport to the screen coordinates relative to another viewport.

• **GlgRootToScreenCoord** converts screen coordinates relative to the root window to the screen coordinates in the specified viewport.

• **GlgGetParentViewport** returns a parent viewport or a parent light viewport of a GLG object.

• **GlgConvertViewportType** converts a viewport to a light viewport, or a light viewport to a viewport.

• **GlgFindMatchingObjects** finds an object’s parents or children that match the supplied criteria.

• **GlgTraverseObjects** traverses all object’s children, invoking the supplied custom function for each traversed object.

• **GlgTraceObject** highlights all objects in the drawing that depend on a tag or resource object.

• **GlgIsDrawable** tests if the object is drawable.

The Intermediate API also includes functions specific to the **Real-Time Chart** and **GIS** objects. These functions are described in the **Real-Time Chart Functions** chapter on page 182 and the **GIS Object Functions** chapter on page 195.

The GLG Extended API includes the following functions:

• **GlgCreateObject** creates a GLG object of any type.

• **GlgCopyObject** creates a copy of an object.

• **GlgCloneObject** creates a specialized copy (clone) of an object.

• **GlgAddObjectToTop, GlgAddObjectToBottom, GlgAddObjectAt** and **GlgAddObject** add an object to some container object. This can be used to add an object to a group or viewport as well as to add a point to a polygon.

• **GlgDeleteTopObject, GlgDeleteBottomObject, GlgDeleteObjectAt, GlgDeleteThisObject** and **GlgDeleteObject** delete an object from a container object.

• **GlgFlush** sets container size to the requested size.

• **GlgSetElement** replaces the object at the specified index in a container.
• **GlgSetXform** attaches a transformation to an object.

• **GlgSetResourceObject** replaces the resource with a new object.

### Handling GLG Objects

As with the standard GLG API library, the programmer’s task is made simpler by the dynamic typing of GLG objects. Most of the functions in the Extended API operate on several different kinds of objects. The action each one takes often depends on the type of its input object.

### The Reference Count

Each GLG object occupies space in the computer memory. Some objects are larger than others, but all of them take up some space. In order to make certain that only objects used by a program are kept in memory, each object is equipped with a reference count. This is simply an integer with which an object keeps track of the number of operations that care about its existence. The GLG Extended API provides functions to increase and decrease the reference count: *GlgReferenceObject* and *GlgDropObject*. When an object’s reference count reaches zero, it is deleted, and its memory reclaimed.

When an object is created, its reference count is 1. Adding the object to a group increases its reference count, making sure that the object is kept around while it is needed. If you want the object to be deleted when the group is deleted, you can decrease the reference count once that object is safely contained in the group. This restores the reference count to 1. This is the standard sequence for creating GLG objects: create object, place in group or viewport, drop reference count. If the group is deleted or exploded, its members may be deleted, unless they are referenced beforehand.

An object is “responsible” for managing the reference count of its subsidiary objects. For example, a polygon object is responsible for managing the reference counts of its attribute objects. Similarly, when an object is inserted into a container, the container increments that object’s reference count. When the object is removed from the group, its reference count is decremented. (Note that this can cause an object to be inadvertently deleted if the group was the only current reference to the object. If you want to remove an object from a group and put it somewhere else, you must increment its reference count before removing it.)

If these guidelines are met, any object with a reference count of zero may be safely deleted, and its memory reclaimed. This will prevent memory leaks, keeping all the system’s memory available to the application.

### Using Mouse Coordinates and Pixel Mapping

The Toolkit’s rendering engine uses the OpenGL-style pixel mapping for consistent rendering across all windowing systems and programming environments. The integer pixel values are mapped to the center of the pixel, which means that the x and y coordinates of the center of the upper left pixel of a window are \((0.5; 0.5)\) instead of \((0; 0)\). When using the mouse position to obtain screen coordinates passed to the GLG functions, add GLG_COORD_MAPPING_ADJ (defined as 0.5 in *GlgApi.h*) to the x and y screen coordinates of the mouse for better precision.
Include Files

To use any of the functions described in this chapter, the application program must include the function definitions from the GLG API header file. Use the following line to include those definitions:

```c
#include "GlgApi.h"
```

Intermediate API Function Descriptions

GlgConstrainObject

Constrains an attribute or point of an object to an attribute or point of another.

```c
GlgBoolean GlgConstrainObject( from_attribute, to_attribute )
    GlgObject from_attribute;
    GlgObject to_attribute;
```

Parameters

from_attribute

Specifies the attribute or point object to be constrained. To obtain the object ID of the from_attribute, the GlgGetResourceObject function must be used with a default resource name rather than a user-defined resource name as the last part of resource path. For example, the “object1/FillColor” must be used to get the object ID of the FillColor attribute of object1, and not “object1/color1”.

For objects that have a fixed number of control points (arc, text, etc.), use the default attribute name (“PointN”) to access an object’s Nth control point. For objects which do not have a fixed number of points (e.g. polygons), use the GlgGetElement or GlgIterate function to get its points and use them as the from_attribute.

to_attribute

Specifies the attribute or point to constrain to. This object may be queried by using either the default or a user-defined resource name.

This function constrains the attribute or point specified by the from_attribute parameter to the attribute or point specified by the to_attribute parameter. If two attributes are constrained, changing the value of either attribute changes the values of both. For more information about constraining, see the Constraints section in the Structure of a GLG Drawing chapter.

If the object whose attribute (from_attribute) is being constrained has already been drawn, an error message will be generated. You should either constrain object attributes before drawing the object or use the GlgSuspendObject function to suspend drawn objects before constraining their attributes.

You cannot constrain any objects beside attribute objects (a control point is an attribute object as well). The from_attribute and to_attribute attribute objects should be of the same data subtype. That is, you cannot constrain a color attribute object (G type) to the line width attribute object (D type) because they have different data types.
If any of the conditions above are not satisfied, the function fails and returns `GlgFalse`. If constraining is successful, the function returns `GlgTrue`.

Note that constraining an attribute object causes all the attributes of the attribute object to be identical to the attributes of the object to which it is constrained, including its name, transformation and value. If a transformation is added to an attribute object, it is automatically added to all the attribute objects that are constrained to this attribute object in order to maintain the constraints. Similarly, if the object name is changed, it is automatically changed for all the objects that are constrained to the object. These changes are permanent and remain in effect even after the constraints are removed.

**GlgContainsObject**

Checks if object belongs to a container.

```c
GlgBoolean GlgContainsObject( container, object )
GlgObject container;
GlgObject object;
```

**Parameters**

- **container**
  Specifies the container object.

- **object**
  Specifies the object to search for.

This function returns `GlgTrue` if the object belongs to the container and `GlgFalse` otherwise.

**GlgConvertViewportType**

Converts a viewport to a light viewport, or a light viewport to a viewport.

Returns a newly created object on success or NULL on error.

```c
GlgObject GlgConvertViewportType( object )
GlgObject object;
```

**Parameters**

- **object**
  A viewport or a light viewport to be converted.

If a converted object is added to the drawing, the original object must be deleted, since both objects reuse the graphical objects inside the viewport and cannot be both displayed at the same time.

**GlgCreateInversedMatrix**

Inverts a matrix object.

```c
GlgObject GlgCreateInversedMatrix( matrix )
GlgObject matrix;
```
**Parameters**

**matrix**

Specifies the matrix to be inverted.

Creates and returns the matrix inverse of the input one. The returned matrix must be dereferenced using `GlgDropObject` when not needed any more.

This function may be used to invert the drawing transformation obtained with the `GlgGetDrawingMatrix` function. While the drawing transformation converts world to screen coordinates, the inverse of it may be used to convert the screen coordinates of objects and object bounding boxes back to world coordinates.

**GlgCreatePointArray**

Creates and returns an array containing all of an object’s control points:

```c
GlgObject GlgCreatePointArray( object, type )
GlgObject object;
GlgControlPointType type;
```

**Parameters**

**object**

Specifies the object.

**type**

Reserved for future use, must be 0.

**GlgCreateResourceList**

Returns a list of an object’s resources.

```c
GlgObject GlgCreateResourceList( object, list_named_res, list_def_attr, list_aliases )
GlgObject object;
GlgBoolean list_named_res, list_def_attr, list_aliases;
```

**Parameters**

**object**

The input object.

**list_named_res**

A boolean value indicating whether the returned list should include the input object’s named resources.

**list_def_attr**

A boolean value indicating whether the returned list should include the input object’s default attributes. The resource objects referred to by the default resource names are not actually included in the list. Instead a dummy scalar data object (type D) is included whose name is the same as the default attribute.
list_aliases

Indicates whether the returned list should include aliases. The resource objects referred to by the aliases are not included in the list. Instead a dummy scalar data object (type D) is included whose name is the same as the alias.

This function creates and returns the array of an object’s resources. The list_named_res, list_def_attr and list_aliases parameters let you choose whether the array should include named resources, default attributes, aliases or any combination of the above.

The returned array has one entry for each resource. The entries are not sorted and are listed in the order of the occurrence inside their category. The named resources (if any) are listed first, then default resources and finally the aliases. The returned array must be dereferenced when finished.

For named resources, the entries are the object IDs of the resource objects themselves. For default resources and aliases, the entries are dummy scalar data objects named after the default attributes or aliases. For both types of entries, the name of the entry object is the name of the resource listed.

The following code fragment shows how to print the list of resources:

```c
GlgObject object, list, list_element;
GlgLong size, i;
char * name;

list = GlgCreateResourceList( object, GlgTrue, GlgTrue, GlgFalse );
if( list )
{
    size = GlgGetSize( list );
    for( i=0; i < size; ++i )
    {
        list_element = GlgGetElement( list, i);
        GlgGetSResource( list_element, "Name", name );
        printf( "Resource Name: %s\n", name );
    }
    GlgDropObject( list );
}
```

The `GlgCreateResourceList` function returns the resource list on only one level of the resource hierarchy. To see the resource lists of the returned resources, invoke the `GlgCreateResourceList` recursively using one of the following techniques:

- Use `GlgCreateResourceList` on the resources in the returned list. This will only work for the named resources since the default resources and aliases are represented by dummy objects.
- Get the name of a resource in the returned resource list and use the `GlgGetResourceObject` function to obtain its object ID, then call `GlgCreateResourceList` with that object ID. This method is slower but will work for both named resources, default attributes and aliases.
**GlgCreateSelectionMessage**

Searches all objects inside the given rectangle for an action with the specified selection trigger type attached to an object and returns a selection message for the first found action attached to the object:

```c
GlgObject GlgCreateSelectionMessage( top_vp, rectangle, selected_vp, selection_type, button )
GlgObject top_vp;
GlgRectangle * rectangle;
GlgObject selected_vp;
GlgSelectionEventType selection_type;
GlgLong button;
```

**Parameters**

**top_vp**

The top viewport of the selection query (must be an ancestor of `selected_vp`). It may be either a viewport or a light viewport.

**rectangle**

The bounding rectangle in screen coordinates of the `selected_vp` viewport. Any graphical shape whose rendering intersects this rectangle is included in the search.

**selected_vp**

The viewport relatively to which the bounding rectangle is defined. When used with the mouse events, this is the viewport in which the mouse event occurred. It may be either a viewport or a light viewport.

**selection_type**

This is an enumerated value specifying the selection type. The GLG_MOVE_SELECTION value selects custom mouse move events attached to an object, GLG_CLICK_SELECTION selects mouse click events and GLG_TOOLTIP_SELECTION selects the tooltip events.

**button**

The mouse button for the GLG_CLICK_SELECTION selection type.

This function may be used in a trace callback to determine whether a mouse event was meant to trigger an action attached to a graphical object in a drawing. The function returns a message equivalent to the message received in the input callback. If no matching actions were found, `NULL` is returned.

**GlgCreateSelectionNames**

Returns a list of names of objects intersecting a given rectangle.

```c
GlgObject GlgCreateSelectionNames( top_vp, rectangle, selected_vp )
GlgObject top_vp;
GlgRectangle * rectangle;
GlgObject selected_vp;
```
Parameters

**top_vp**

The top viewport or light viewport of the selection query (must be an ancestor of `selected_vp`). It may be either a viewport or a light viewport.

**rectangle**

The bounding rectangle in screen coordinates of the `selected_vp` viewport. Any graphical shape whose rendering intersects this rectangle is included in the selection list.

**selected_vp**

The viewport or light viewport relatively to which the bounding rectangle is defined. When used with the mouse events, this is the viewport in which the mouse event occurred. It may be either a viewport or a light viewport.

This function may be used to determine whether a mouse event was meant to select graphical objects in a drawing. The function returns an array of strings containing the names of the objects that overlap with the given rectangle completely or partially. The name string is a complete resource path name (relative to the `top_vp`) which can be used to get the object ID of the object:

```c
GlgObject selected_object = GlgGetResourceObject( top_vp, path_name );
```

This function may be called from a trace callback function to implement the custom handling of mouse events. For example, it may be used to implement the “hot spot” functionality, highlighting objects when the cursor moves over them. The function returns NULL if no objects intersect the input rectangle, or if none of the intersected objects have names. The `GlgCreateSelection` function described below may be used to handle unnamed objects.

The array returned by this function must be dereferenced with the `GlgDropObject` function when the program is finished using it.

### GlgCreateSelection

Returns a list of the objects intersecting a given rectangle.

```c
GlgObject GlgCreateSelection( top_vp, rectangle, selected_vp )
    GlgObject top_vp;
    GlgRectangle * rectangle;
    GlgObject selected_vp;
```

**Parameters**

**top_vp**

The top viewport or light viewport of the selection query (must be an ancestor of `selected_vp`). It may be either a viewport or a light viewport.

**rectangle**

The bounding rectangle in screen coordinates of the `selected_vp` viewport. Any graphical shape whose rendering intersects this rectangle is included in the selection list.

**selected_vp**

The viewport or light viewport relatively to which the bounding rectangle is defined. When
used with the mouse events, this is the viewport in which the mouse event occurred. It may be either a viewport or a light viewport.

This function is similar to the `GlgCreateSelectionNames` function, but it returns an array of objects instead of an array of object names. The objects in the array are listed in the reversed order compared to their drawing order, so that the objects that are at the bottom of the drawing list and are drawn on top of other objects will be listed first in the array.

While `GlgCreateSelectionNames` reports both the selected objects on the bottom of the hierarchy and all their parents, this function reports only objects at the bottom and doesn’t include their parents. For example, if a polygon in a group is selected, only the polygon is reported and not the group. To get information about the parents of selected objects, use the `GlgGetParent` function.

The function returns NULL if no objects intersect the input rectangle. The returned array must be dereferenced with the `GlgDropObject` function when the program is finished using it.

**GlgDropObject**

Decrements an object’s reference count.

```c
void GlgDropObject( object )
GlgObject object;
```

**Parameters**

**object**

Specifies the object to be dereferenced.

This function decreases the object’s reference count by 1. If the reference count goes to 0, the object is destroyed. Destroying an object dereferences all its subsidiary objects and may destroy them as well if their reference counts become zero.

The `GlgDropObject` function should be used to dereference the object after creating, copying, loading or referencing the object, as was shown in the first coding example for the `GlgReferenceObject` function.

**GlgFindObject**

A generic find function: finds an object in a container. Use `GlgContainsObject`, `GlgGetNamedObject`, `GlgGetElement` or `GlgGetIndex` convenience functions for specialized tasks.

```c
GlgObject GlgFindObject( container, object, search_type, reserved )
GlgObject container;
void * object;
GlgSearchType search_type;
void * reserved;
```

**Parameters**

**container**

Specifies the container object.
object
Specifies the data to search for. Depending on the search type, it may be an object ID, object name, or object’s index in the container’s object list.

search_type
Specifies the search type and may have the following values:

**GLG\_FIND\_OBJECT**
Finds an object by the object ID (pass the object ID as the value of the *object* parameter).

**GLG\_FIND\_BY\_NAME**
Find an object by its name (pass the name as the value of the object parameter).

**GLG\_FIND\_BY\_INDEX**
Finds an object by its position in the container object list (pass the zero-based position index as the value of the *object* parameter).

**Reserved**
A reserved parameter for future extensions; must be NULL.

This function searches for an object based on the specified name, index, or object ID. If the object is found, the function modifies the container’s internal position pointer to point to the found object and returns the object; otherwise it leaves the position pointer intact and returns NULL. The container’s position pointer may be affected by other *GlgFindObject*, *GlgAddObject* and *GlgDeleteObject* calls. Any function using the position pointer (*GLG\_CURRENT* access type) must be called immediately after the *GlgFindObject* call before any other call which may affect the pointer.

**GlgFindMatchingObjects**
Finds either one or all parents or children of the specified object that match the supplied criteria:

```c
GlgBoolean GlgFindMatchingObjects( object, data )
GlgObject object;
GlgFindMatchingObjectsData * data;
```

**Parameters**

object
Specifies the object whose parents or children to search.
data

The structure that specifies search criteria and returns the search results:

typedef struct _GlgFindMatchingObjectsData
{
  GlgObjectMatchType match_type;
  GlgBoolean find_parents;
  GlgBoolean find_first_match;
  GlgBoolean search_inside;
  GlgBoolean search_drawable_only;
  GlgBoolean (*custom_match)( GlgObject object, void * custom_data );
  void * custom_data;
  GlgObjectType object_type;
  char * object_name;
  char * resource_name;
  GlgObject object_id;
  GlgObject found_object;
  GlgBoolean found_multiple;
} GlgFindMatchingObjectsData;

The structure’s fields control the way the search is performed:

match_type

Specifies a bitwise mask of the object matching criteria:
- GLG_OBJECT_TYPE_MATCH finds objects with an object type matching the type specified by the object_type field.
- GLG_OBJECT_NAME_MATCH finds objects with a name matching the name specified by the object_name field.
- GLG_RESOURCE_MATCH finds objects that have the resource specified by the resource_name field.
- GLG_OBJECT_ID_MATCH finds an object with the ID specified by the object_id field. This can be used to find out if the object supplied as the object parameter is a child or a parent of the object provided by object_id.
- GLG_CUSTOM_MATCH finds objects that match a custom matching criterion supplied by a custom function in the custom_match field.

Multiple criteria can be ORed together. All of the criteria in the mask must be true in order for an object to match.

find_parents

If set to GlgTrue, ancestors (parents, grandparents and so on) of the object are searched. Otherwise, the object’s descendents (children, grandchildren and so on) are searched.

find_first_match

If set to GlgTrue, the search is stopped after the first match and the first matching object is returned, otherwise all matching objects are returned.

search_inside

If set to GlgFalse, the object's children or parents are not searched if the object itself matches. Otherwise, the search proceeds to process the object’s children or parents even if the object matches.
search_drawable_only

If set to GlgTrue when searching descendents, only drawable objects are searched. For example, when this flag is set, a polygon object’s attributes such as FillColor and EdgeColor, will not be searched, which can be used to speed up the search. Refer to the description of the GlgIsDrawable method on page 140 for more information.

custom_match

Provides a custom matching function that is invoked for each searched object. The function can perform a custom matching and should return GlgTrue to indicate a match. The function will also receive custom data supplied by the custom_data field.

custom_data

Custom data for the custom_match function.

object_type

The type for the GLG_OBJECT_TYPE_MATCH search. Only objects of this type will be matched.

object_name

The name for the GLG_OBJECT_NAME_MATCH search. Only objects with this name will be matched.

resource_name

The resource name for the GLGRESOURCE_MATCH search. Only objects that have this resource will be matched. The resource has to be an object.

object_id

The name for the GLG_OBJECT_ID_MATCH search. Only the object with this object ID will be matched. This type of search can be used to find out if an object is either a child or a parent of another object.

found_object

Returns a single found object or a group containing multiple found objects, according to the state of the found_multiple parameter. If a group containing multiple objects is returned, the group should be dereferenced using GlgDropObject to avoid memory leaks. It is set to NULL if no matching objects were found.

found_multiple

Will be set to GlgTrue or GlgFalse to indicate the type of the returned result. If it is set to GlgTrue, the result of the search stored in the found_object field contains a group of several matching objects. Otherwise (GlgFalse), found_object contains a single matching object.

The function returns GlgTrue if at least one matching object was found.
**GlgFitObject**

Fits an object to a specified rectangular area:

```c
GlgBoolean GlgFitObject( object, coord_type, anchoring, x, y, z )
GlgObject object;
GlgCoordType coord_type;
GlgBoolean keep_ratio;
GlgCube * box;
```

**Parameters**

**object**

Specifies the object to fit.

**coord_type**

Specifies the coordinate system to interpret the fit area in. If GLG_SCREENCOORD is used, the area is defined in screen pixels. If GLG_OBJECTCOORD is used, the area is defined in the GLG world coordinates.

**box**

The area to fit the object to. If the Z extent of the box is 0, 2D fitting is performed and the object is not scaled in the Z dimension. If Z extent is not 0, 3D fitting is performed.

**keep_ratio**

If the parameter is set to GlgTrue, the function preserves the object’s X/Y ratio by using the smallest of the required X and Y scale factors for both directions. If keep_ratio is set to GlgFalse, different scale factors may be used for X and Y scaling to fit the object to the box more precisely.

This function transforms the object to fit it to the area, calculating new control point values. The object’s hierarchy must be setup to use this function.

The following types defined in the GlgApi.h file are used:

```c
typedef struct _GlgCube
{
    GlgPoint p1; /* Lower left */
    GlgPoint p2; /* Upper right */
} GlgCube;
```

**GlgGetAlarmObject**

Returns a tag object with a specified alarm label, or a list of alarms matching the specified alarm label pattern.

```c
GlgObject GlgGetAlarmObject( object, search_string, single_alarm, reserved )
GlgObject object;
char * search_string;
GlgBoolean single_alarm;
GlgLong reserved;
```
Parameters

object
Specifies the object whose alarms to query.

search_string
Specifies a string or a pattern for the search (may include ? and * wildcards).

single_alarm
Defines a single alarm (GlgTrue) or multiple alarm (GlgFalse) mode.

reserved
Reserved for future use, must be 0.

In a single alarm mode, the function returns the alarm that has an alarm label matching the search criteria.

In the multiple alarm mode, a list containing all alarms with matching alarm labels will be returned. The returned list must be dereferenced using GlgDropObject when it is no longer needed.

GlgGetBoxPtr

Returns an object’s bounding box.

GlgCube * GlgGetBoxPtr( object )
GlgObject object;

Parameters

object
Specifies the object whose bounds are to be returned.

Returns a pointer to the object’s 3-D bounding box. The box boundaries are in absolute screen coordinates (pixels) and are valid only after the object has been drawn. (That is, after the hierarchy has been set up.) The returned pointer points to internal structures which are valid only while the object exists and should not be modified. The object box may be converted to world coordinates by using the GlgGetDrawingMatrix, GlgCreateInversedMatrix and GlgTransformPoint functions.

The following types defined in the GlgApi.h file are used:

typedef struct _GlgPoint
{
    double x, y, z;
} GlgPoint;

typedef struct _GlgCube
{
    GlgPoint p1; /* Lower left */
    GlgPoint p2; /* Upper right */
} GlgCube;
**GlgGetDrawingMatrix**

Returns the transformation matrix attached to the input object.

```c
GlgObject GlgGetDrawingMatrix( object )
GlgObject object;
```

**Parameters**

- **object**
  
  Specifies the input object.

Returns the transformation matrix for the set of all transformations attached to an input object. Transformation matrices are only used for geometric transformations, so this function may be called only for graphical objects, like polygons and polylines. This function must be called after the object has been drawn. (That is, after its hierarchy has been set up.) The function returns the internal matrix object which is valid only immediately after the function call. The matrix should not be modified or destroyed. To prevent the matrix from being destroyed, you may reference it with `GlgReferenceObject` (and dereference later), or, even better, create a copy.

Querying the drawing matrix of a viewport returns the drawing matrix used to position the viewport’s control points, and not the matrix used to render the objects inside it. To get the drawing matrix the viewport uses to draw objects inside it, query the drawing list of the viewport (the `Array` resource of the viewport) and use it as a parameter of the `GlgGetDrawingMatrix` function.

**GlgGetElement**

Returns the object at the specified position in a container.

```c
GlgObject GlgGetElement( container, index )
GlgObject container;
GlgLong index;
```

**Parameters**

- **container**
  
  Specifies the container object.

- **index**
  
  Specifies the object position inside the container.

This function returns NULL if the specified index is invalid. While the function provides the Intermediate API functionality, it is also available in the Standard API when used with the group object, such as querying elements of a message object.

**GlgGetIndex**

Returns the index of the first occurrence of an object in a container.
GLG Programming Reference Manual

GlgLong GlgGetIndex( container, object)
    GlgObject container;
    GlgObject object;

Parameters

container
    Specifies the container object.

object
    Specifies the object to search for.

This function returns -1 if the object wasn’t found in the container.

GlgGetMatrixData

Queries matrix coefficients:

void GlgGetMatrixData( matrix, matrix_data )
    GlgObject matrix;
    GlgMatrixData * matrix_data;

Parameters

matrix
    Specifies the matrix object to query.

matrix_data
    The structure to hold the matrix’s coefficients.

The GlgMatrixData data type is defined in the GlgApi.h file:

typedef struct _GlgMatrixData
{
    long type;
    double matrix[4][4];
} GlgMatrixData;

GlgGetNamedObject

Returns an object ID of the object in a container with the specified name.

GlgObject GlgGetNamedObject( container, name )
    GlgObject container;
    char * name;

Parameters

container
    Specifies the container object.

name
    Specifies the object’s name.
This function returns named objects of a container with no regards to the resource hierarchy, and is different from the `GlgGetResourceObject` function (which returns named resources on the current level of the resource hierarchy but not necessarily the elements of the container).

This function returns NULL if the object with the specified name wasn’t found in the container.

**GlgGetParent**

Returns an object’s parent object, if one exists.

```c
GlgObject GlgGetParent( object, num_parents )
    GlgObject object;
    GlgLong * num_parents;
```

**Parameters**

- **object**
  Specifies the object whose parents are to be returned.

- **num_parents**
  Used to return the number of parents attached to the input objects. If this is NULL on input, an error message will be generated if the object has more than one parent.

This function returns an ID for an object’s parent object. For constrained objects, there may be more than one parent object. In this case, the function returns an array of parent object IDs. (This may be used to check whether an object is constrained.)

The returned object ID is a pointer to an internal data structures and it should not be dereferenced. To keep it from being destroyed when the object is destroyed, you can reference it with `GlgReferenceObject` (and dereference later). If the return value is an array of parents and you want to keep it around, the safer method to keep it is to create a copy. This prevents the array’s elements from being modified by the GLG internals.

This function must be called after the hierarchy is created.

**GlgGetParentViewport**

Returns a parent viewport of a drawable GLG object.

```c
GlgObject GlgGetParentViewport( object, heavy_weight )
    GlgObject object;
    GlgBoolean heavy_weight;
```

**Parameters**

- **object**
  A drawable GLG object.

- **heavy_weight**
  Controls the type of a parent viewport to be returned. If set to `GlgFalse`, the method returns the closest parent viewport regardless of its type: either a heavyweight or light viewport. If set to
GlGL True, it returns the closest heavyweight parent viewport. For example, if the object is inside a light viewport, it will return the heavyweight viewport which is a parent of the light viewport.

The object’s hierarchy must be setup to use this function.

**GlGL GetResourceObject**

 Returns the ID of a resource object.

```c
GlGLObject GlGLGetResourceObject( object, resource_name )
GlGLObject object;
char * resource_name;
```

**Parameters**

- **object**
  - Specifies the object whose resources are queried.

- **resource_name**
  - A character string that specifies the resource name.

This function finds and returns a named resource of an object or an object ID of the object’s attribute. The *resource_name* parameter should identify an object, such as an attribute object or a named object of a group. If the resource is not found, the function returns NULL. No error message is generated in this case, so this function can be used to query an object’s existence. The object ID returned by the function is not referenced and is valid only immediately after the function call. Reference the object if the resource ID has to be stored for later use to make sure the object is not destroyed.

**GlGL GetSize**

 Queries the size of a container object.

```c
GlGLong GlGLGetSize( container )
GlGLObject container;
```

**Parameters**

- **container**
  - Specifies the container object.

This function returns the size of a container object. For a viewport or group object, the size is the number of objects in the viewport or group. For a polygon, the size is the number of vertices. While the function provides the Intermediate API functionality, it is also available in the Standard API when used with a group object.

**GlGL GetStringIndex**

 Returns the index of the first occurrence of the string in a string container.
GlgLong GlgGetStringIndex( container, string)
   GlgObject container;
   char * string;

Parameters

container
   Specifies the container object.

string
   Specifies the string to search for.

This function returns -1 if the string wasn’t found in the container.

GlgGetTagObject

Returns a tag object with a specified tag name or tag source, or a list of tags matching the specified

tag name or tag source pattern.

GlgObject GlgGetTagObject( object, search_string, by_name,
   unique_tags, single_tag, tag_type_mask)
   GlgObject object;
   char * search_string;
   GlgBoolean by_name;
   GlgBoolean unique_tags;
   GlgBoolean single_tag;
   GlgTagType tag_type_mask;

Parameters

object
   Specifies the object whose tags to query.

search_string
   Specifies a string or a pattern for the search (may include ? and * wildcards).

by_name
   If set to GlgTrue, the search is performed by matching the tag names, otherwise the search is
done by matching the tag sources. Tag sources can be used only for data tags.

unique_tags
   If set to GlgTrue, only one tag instance will be listed when several tags with the same tag name
or tag source exist in the drawing, otherwise all tags with the same tag name or tag source will
be included in the returned list. The parameter is ignored in the single tag mode.

single_tag
   Defines the single tag (GlgTrue) or multiple tag (GlgFalse) mode.

tag_type_mask
   Defines the type of tags to query: data tags or export tags. Tag type constants may be ORed to
query tags of several types.

In a single tag mode, the function returns the first attribute that has a tag matching the search criteria.
In the multiple tag mode, a list containing all attributes with matching tags will be returned. The `unique_tags` controls if only one tag is included in case there are multiple tags with the same tag name or tag source. It is ignored in the single tag mode. The returned list must be dereferenced using `GlgDropObject` when it is no longer needed.

### GlgIsDrawable

Returns `GlgTrue` if the object is drawable.

```c
GlgBoolean GlgIsDrawable( object )
GlgObject object;
```

**Parameters**

- **object**
  - Specifies the object.

Drawable objects can be placed directly in a drawing area, have control points and a bounding box, have the `Visibility` attribute and can contain custom properties, actions and aliases.

For a chart object, the chart itself is drawable, but its plots are not.

### GlgIterate

Traverses the container object.

```c
GlgObject GlgIterate( container )
GlgObject container;
```

**Parameters**

- **container**
  - Specifies the container object.

Returns the next element of `container`. The `GlgSetStart` function must be used to initialize the container for iterating before `Iterate` is invoked the first time. The add, delete and search operations affect the iteration state and should not be performed on the container while it is being iterated.

To perform a safe iteration that is not affected by the add and delete operations, a copy of the container can be created using the `GlgCloneObject` function with the SHALLOW_CLONE clone type. The shallow copy will return a container with a list of objects IDs, and it can be safely iterated while objects are added or deleted from the original container.

Alternatively, `GlgGetElement` can be used to traverse elements of the container using an element index, which is not affected by the search operations on the container.
The following coding example shows how to iterate all objects in a container using GlgIterate:

```c
int i, size;
GlgObject object;

size = GlgGetSize( container );
if( size != 0 )
{
    GlgSetStart( polygon );     /* Initialize traversing. */
    for( i=0; i<size; ++i )
    {
        object = GlgIterate( container );
        ... /* Code to process the object */
    }
}
```

**GlgLayoutObjects**

Performs operations ranging from setting the object’s width and height to align and layout of groups of objects.

```c
GlgBoolean GlgLayoutObjects( object, sel_elem, type, distance,
                            use_box, process_subobjects )
```

**Parameters**

- **object**
  Specifies the object or group of objects to perform the requested operations upon.

- **sel_elem**
  Specifies the anchor object for alignment operations. If null value is specified, the first encountered object in the specified alignment direction is used.

- **type**
  Specifies the type of the layout action to perform. May have the following values:

  **ALIGN_LEFT**
  Align the left edge of elements within the group with the left edge of the anchor element.

  **ALIGN_RIGHT**
  Align the right edge of elements within the group with the right edge of the anchor element.

  **ALIGN_HCENTER**
  Align the center of elements within the group with the center of the anchor element horizontally.
ALIGN_TOP
Align the top edge of elements within the group with the top edge of the anchor element.

ALIGN_BOTTOM
Align the bottom edge of elements within the group with the bottom edge of the anchor element.

ALIGN_VCENTER
Align the center of elements within the group with the center of the anchor element vertically.

SET_EQUAL_VSIZE
Set the height of elements within the group to the height of the anchor.

SET_EQUAL_HSIZE
Set the width of elements within the group to the width of the anchor.

SET_EQUAL_SIZE
Set the width and height of elements within the group to the width and height of the anchor.

SET_EQUAL_VDISTANCE
Equally distributes the group's elements in vertical direction as measured by the distance between their centers.

SET_EQUAL_HDISTANCE
Equally distributes the group's elements in horizontal direction as measured by the distance between their centers.

SET_EQUAL_VSPACE
Equally distributes space gaps between group's elements in vertical direction.

SET_EQUAL_HSPACE
Equally distributes space gaps between group's elements in horizontal direction.

SET_VSIZE
If anchor is null, sets the object's height; if anchor in not null, sets the height of all elements within the group. The height is defined by the value of the distance parameter.

SET_HSIZE
If anchor is null, sets the object's width; if anchor in not null, sets the width of all elements within the group. The width is defined by the value of the distance parameter.

SET_VDISTANCE
Set vertical distance between centers of the group's elements to a value defined by the distance parameter.

SET_HDISTANCE
Set horizontal distance between centers of the group's elements to a value defined by the distance parameter.
**SET_VSPACE**
Sets space gaps between group's elements in vertical direction to a value defined by the
distance parameter.

**SET_HSPACE**
Sets space gaps between group's elements in horizontal direction to a value defined by the
distance parameter.

distance
The distance in screen coordinates for positioning objects, depending on the layout action.

use_box
If set to GlgTrue, the object's bounding box is used to align objects, otherwise the control
points will be used to determine the object’s extent.

process_subobjects
Controls how to apply the layout action if the object is a group. If set to GlgTrue, the action is
applied to all objects contained in the group, otherwise the action (such as SET_HSIZE) is
applied to the group itself.

The function returns GlgFalse if errors were encountered during the requested layout action.

**GlgLoadObject**
Loads an object from a file in GLG format.

GlgObject GlgLoadObject( filename )
char * filename;

Parameters

**filename**
Specifies the name of the file to load the object from.

This function loads an object from the specified file and returns the object ID. If the file is not
accessible or is not in the GLG save format, an error message is generated and NULL is returned.
If the object is loaded successfully, the reference count of the returned object is set to 1. The loaded
object has to be explicitly dereferenced after it has been used to avoid memory leaks. Refer to the
description of the GlgReferenceObject function for details on the reference counting.

**GlgLoadObjectFromImage**
Loads an object from a memory image created by the GLG Code Generation Utility.

GlgObject GlgLoadObjectFromImage( image_address, image_size )
void * image_address;
GlgLong image_size;

Parameters

**image_address**
Specifies the address of the drawing image generated by the GLG Code Generation Utility.
image_size

Specifies the image size.

This function loads an object from the specified drawing’s memory image and returns the object ID. If the memory is corrupted, an error message is generated and NULL is returned. If the object is loaded successfully, the reference count of the returned object is set to 1. The loaded object must be explicitly dereferenced after it has been used to avoid memory leaks. Refer to the description of the GlgReferenceObject function for details on the reference counting. For information about the Code Generation Utility, see the GLG Programming Tools and Utilities chapter.

NOTE: this function does not work with compressed drawing files. Save drawings with the drawing compression option disabled to use them with GlgLoadObjectFromImage.

GlgMoveObject

Moves an object by a move vector:

GlgBoolean GlgMoveObject( object, coord_type, start_point, end_point )
GlgObject object;
GlgCoordType coord_type;
GlgPoint * start_point;
GlgPoint * end_point;

Parameters

object

Specifies the object to be moved.

coord_type

Specifies the coordinate system for interpreting the move vector. If GLG_SCREEN_COORD is used, the move vector is in screen pixels. For example, this may be used to move the object by the number of screen pixels as defined by the mouse move. If GLG_OBJECT_COORD is used, the move vector is in the GLG world coordinates.

start_point

The start point of the move vector. If the parameter is NULL, (0,0,0) is used as the start point.

end_point

The end point of the move vector.

This function moves an object’s control points by the distance defined by the move vector, calculating new control point values. The object’s hierarchy must be setup to use this function.

The GlgPoint data type is defined in the GlgApi.h file:

typedef struct _GlgPoint
{
    double x, y, z;
} GlgPoint;
**GlgMoveObjectBy**

Moves an object by a move distance:

```c
GlgBoolean GlgMoveObjectBy( object, coord_type, x, y, z )
GlgObject object;
GlgCoordType coord_type;
double x, y, z;
```

**Parameters**

**object**

Specifies the object to move.

**coord_type**

Specifies the coordinate system for interpreting the move distance. If GLG_SCREENCOORD is used, the move distance is in screen pixels. For example, this may be used to move the object by the number of screen pixels as defined by the mouse move. If GLG_OBJECTCOORD is used, the move distance is specified in the GLG world coordinates.

**x, y, z**

The X, Y and Z move distances.

This function moves an object’s control points by the X, Y and Z distances, calculating new control point values. The object’s hierarchy must be setup to use this function.

**GlgPositionObject**

Positions an object at the specified location:

```c
GlgBoolean GlgPositionObject( object, coord_type, anchoring, x, y, z )
GlgObject object;
GlgCoordType coord_type;
GlgLong anchoring;
double x, y, z;
```

**Parameters**

**object**

Specifies the object to position.

**coord_type**

Specifies the coordinate system for interpreting the position. If GLG_SCREENCOORD is used, the position is defined in screen pixels. If GLG_OBJECTCOORD is used, the position is defined in the GLG world coordinates.

**anchoring**

Specifies what part of the object’s bounding box will be anchored at the specified position. It’s formed as a bitwise “or” of the horizontal anchoring constant (GLG_LEFT, GLG_HCENTER or GLG_RIGHT) with the vertical anchoring constants (GLG_TOP, GLG_VCENTER or GLG_BOTTOM). For example, using (GLG_TOP | GLG_LEFT) causes the upper left corner of the object’s bounding box to be positioned at the specified location.
The X, Y and Z coordinates of the desired object position.

This function positions the object, calculating new control point values. The object’s hierarchy must be setup to use this function.

**GlgReferenceObject**

Increments an object’s reference count.

```c
GlgObject GlgReferenceObject( object )
GlgObject object;
```

**Parameters**

**object**

Specifies the object to be referenced.

This function increases the reference count of an object by 1 and returns the object’s ID. The **GlgDropObject** function may be used to dereference the object when it is not needed any more.

When an object is created, its reference count is set to 1. Any object you create programmatically has to be explicitly dereferenced using the **GlgDropObject** function after the object has been used, otherwise memory leaks will occur. It is a good practice to dereference objects immediately after they have been added to a group or used as a part of other objects; this guarantees that you will not forget to dereference the object later. The following example illustrates this:

```c
{
    GlgObject polygon;
    /* Create a polygon object with default values of the attributes. */
    polygon = GlgCreateObject( GLG_POLYGON, NULL, NULL, NULL, NULL, NULL );
    /* Add the polygon to a group. */
    GlgAddObject( group, polygon, GLG_BOTTOM, 0 );
    /* Adding polygon to a group references it; we may dereference it now to let the group manage it. */
    GlgDropObject( polygon );
}
```

Dereferencing an object does not necessarily destroy the object. The object may still be referenced by groups it was added to or by other objects that use it. An object may also be referenced programmatically to make sure it is kept around and is not destroyed automatically by the Toolkit. The object is actually destroyed only when the last reference to it is dropped.

You can use the **GlgReferenceObject** function to keep objects around, and to make sure that an object ID is still valid. Simply use the function to increment the reference count of the object, and then decrement the count with the **GlgDropObject** function when the object is no longer needed.
The `GlgReferenceObject` function may also be used to keep an object while it is being deleted from one group and added to another group. Deleting the object from a group decrements its reference count and may destroy the object if it is not referenced by anything else. Referencing the object using `GlgReferenceObject` prevents the object from being destroyed. The `GlgDropObject` function is used after the operation is completed to return the object’s reference count to its initial state.

The following code fragment illustrates this:

```c
GlgReferenceObject( object );   /* Keeping the object around. */

/* Deleting the object from group1 automatically dereferences the object and may destroy it if it’s not referenced. */
if( GlgFindObject( group1, object, GLG_FIND_OBJECT, 0 ) )
    GlgDeleteObject( group1, NULL, GLG_CURRENT, 0 );

/* Adding the object to the group2 automatically references it, so that it is safe to dereference it now. */
GlgAddObject( group2, object, GLG_BOTTOM, 0 );
GlgDropObject( object );      /* We may drop it now. */
```

In general, it is good practice to increment the reference count of an object before performing any operation on it and then dereference the object when the operation is complete. This provides a guarantee that the object will not be inadvertently destroyed during the operation.

**GlgReleaseObject**

Releases a suspended object after editing.

```c
void GlgReleaseObject( object, suspend_info )
    GlgObject object;
    GlgObject suspend_info;
```

*Parameters*

**object**

Specifies the object to be released after it was suspended for editing.

**suspend_info**

Suspension information returned by the previous call to the `GlgSuspendObject` function.

This function releases previously suspended object and is intended to be used only with the `GlgSuspendObject` function.
**GlgReorderElement**

Changes the object’s position inside a container.

```c
void GlgReorderElement( container, old_index, new_index )

GlgObject object;
GlgLong old_index;
GlgLong new_index;
```

**Parameters**

- **container**
  Specifies the container object.

- **old_index**
  Specifies the index of an object to be reordered.

- **new_index**
  Specifies a new position for the object.

This function moves the object at the `old_index` to the `new_index` position. It returns `GlgFalse` if indexes are out of range.

**GlgRootToScreenCoord**

Converts screen coordinates relative to the root window to the screen coordinates in the specified viewport.

```c
GlgBoolean GlgRootToScreenCoord( viewport, point )

GlgObject viewport;
GlpPoint2 * point;
```

**Parameters**

- **viewport**
  Specifies the viewport whose screen coordinate system to convert to.

- **point**
  The point to be converted. The result is placed back into the structure pointed by this pointer.

The viewport’s hierarchy must be set up to use this function.

The `GlpPoint2` data type is defined in the `GlgApi.h` file:

```c
typedef struct _GlpPoint2
{
    double x, y;
} GlpPoint2;
```
**GlgRotateObject**

Rotates an object:

```c
GlbBoolean GlgRotateObject( object, coord_type, center, x, y, z )
GlbObject object;
GlbCoordType coord_type;
GlbPoint * center;
double x, y, z;
```

**Parameters**

**object**

Specifies the object to rotate.

**coord_type**

Specifies the coordinate system for interpreting the rotation center. If
GLG_SCREEN_COORD is used, the center is defined in screen pixels. If
GLG_OBJECT_COORD is used, the center is defined in the GLG world coordinates.

**center**

The center of rotation. If the parameter is NULL, the object is rotated relative to the center of
its bounding box.

**x, y, z**

The X, Y and Z rotation angles.

This function rotates an object’s control points by the specified rotation angles and relative to the
specified center, calculating new control point values. If more than one rotation angle is specified,
X rotation is applied the first, then Y and Z. The object’s hierarchy must be setup to use this
function.

The *GlbPoint* data type is defined in the *GlbApi.h* file:

```c
typedef struct _GlbPoint
{
    double x, y, z;
} GlbPoint;
```

**GlgSaveObject**

Saves an object into a file.

```c
GlbBoolean GlgSaveObject( object, filename )
GlbObject object;
char * filename;
```

**Parameters**

**object**

Specifies the object to be saved; it may be any GLG object.

**filename**

Specifies the name of the file to save the object into.
This function saves the specified object and all its subsidiary objects into a file. If the file is not accessible for writing, the function returns `GlgFalse`, otherwise it returns `GlgTrue`. A GLG object of any type may be saved in this fashion and later loaded using the `GlgLoadObject` function. You can use the `GlgSaveFormat` configuration resource described the Appendices chapter to modify the save type.

For applications that load a drawing, modify it and save it back into a file, the drawing should be loaded using the `GlgLoadObject` function instead of `GlgLoadWidget`. `GlgLoadWidget` extracts the $Widget viewport from the loaded drawing, discarding the rest of the drawing, while `GlgLoadObject` returns an object that represents the whole drawing. Using `GlgSaveObject` to save a viewport loaded with `GlgLoadWidget` will result in a loss of information contained in the discarded part of the drawing, such as the type of the coordinate system used to display the viewport, which will make it difficult to load and edit the drawing in the Builder. The following example demonstrates the proper technique:

```c
GlgObject drawing = GlgLoadObject( "drawing.g" );
GlgObject viewport = GlgLoadWidgetFromObject( drawing ); /* Extracts $Widget viewport */
... /* Code that modifies the drawing. */
GlgSaveObject( drawing, "new_drawing.g" );
```

### GlgScaleObject

Scales an object:

```c
GlgBoolean GlgScaleObject( object, coord_type, center, x, y, z )
GlgObject object;
GlgCoordType coord_type;
GlpPoint * center;
double x, y, z;
```

#### Parameters

**object**

Specifies the object to scale.

**coord_type**

Specifies the coordinate system for interpreting the scale center. If GLG SCREEN_COORD is used, the center is defined in screen pixels. If GLG OBJECT_COORD is used, the center is defined in the GLG world coordinates.

**center**

The center of scaling. If the parameter is NULL, the object is scaled relative to the center of its bounding box.

**x, y, z**

The X, Y and Z scaling factors. Use (1,1,1) to scale the object uniformly in all dimensions.

This function scales an object’s control points by the specified scale factors and relative to the specified center, calculating new control point values. The object’s hierarchy must be setup to use this function.
The `GlgPoint` data type is defined in the `GlgApi.h` file:

```c
typedef struct _GlgPoint
{
    double x, y, z;
} GlgPoint;
```

**GlgScreenToWorld**

Converts a point’s coordinates from the screen to the GLG world coordinate system.

```c
GlgBoolean GlgScreenToWorld( object, inside_vp, in_point, out_point )
GlgObject object;
GlbBoolean inside_vp;
GlgPoint * in_point;
GlgPoint * out_point;
```

**Parameters**

- **object**
  Specifies the object whose world coordinate system to convert to. The world coordinate system of an object includes the effect of all drawing transformations attached to the object and all its parents.

- **inside_vp**
  If `object` is a viewport or a light viewport, `inside_vp` specifies which world coordinate system to use. If `inside_vp=GlbTrue`, the method will use the world coordinate system used to draw objects inside this `(object)` viewport. If `inside_vp=GlbFalse`, the method will use the world coordinate system used to draw this `object` viewport inside its parent viewport.

  The value of this parameter is ignored for objects other than a viewport or light viewport.

- **in_point**
  The point to be converted.

- **out_point**
  The point structure to hold the converted value.

The object’s hierarchy must be setup to use this function.

The `GlgPoint` data type is defined in the `GlgApi.h` file:

```c
typedef struct _GlgPoint
{
    double x, y, z;
} GlgPoint;
```

When converting the cursor position to world coordinates, add `GLG_COORD_MAPPING_ADJ` to the cursor’s x and y screen coordinates for precise mapping.
**GlgSetMatrixData**

Sets matrix coefficients:

```c
void GlgSetMatrixData( matrix, matrix_data )
GlgObject matrix;
GlgMatrixData * matrix_data;
```

**Parameters**

**matrix**

Specifies the matrix object.

**matrix_data**

The new matrix’s coefficients.

The `GlgMatrixData` data type is defined in the `GlgApi.h` file:

```c
typedef struct _GlgMatrixData {
    long type;
    double matrix[4][4];
} GlgMatrixData;
```

**GlgSetStart**

Initializes the container object for traversing.

```c
void GlgSetStart( container )
GlgObject container;
```

**Parameters**

**container**

Specifies the container object.

This function sets the current position pointer before the beginning of the object list, preparing the container object for traversing with `GlgIterate`.

**GlgSuspendObject**

Suspends an object for editing.

```c
GlgObject GlgSuspendObject( object )
GlgObject object;
```

**Parameters**

**object**

Specifies an object to be suspended.
Some operations, such as attaching a transformation to an object, constraining the object’s attribute and some others, may be carried out only before the object has been drawn. If the object has been drawn and you still need to perform these operations, the GlgSuspendObject functions must be used to suspend the object for editing. If the GlgSuspendObject function is not used, any attempt to perform these modifications fails, producing an error message.

The GlgSuspendObject function may be called only for the graphical objects, such as a viewport, group, polygon, or others.

The GlgReleaseObject function must be called after the editing operations have been completed. If an object is suspended, it is not allowed to call an update function before the object has been released.

The GlgSuspendObject function returns an object which keeps suspension information. This information should be passed to the GlgReleaseObject function when the object is released.

**GlgTransformObject**

Transforms all control points of an object with an arbitrary transformation:

```c
GlgBoolean GlgTransformObject( object, xform, coord_type, parent )
GlxObject object;
GlxObject xform;
GlxCoordType coord_type;
GlxObject parent;
```

**Parameters**

- **object**
  Specifies the object to transform.

- **xform**
  Specifies the transformation to be applied to the object’s points.

- **coord_type**
  Specifies the coordinate system to interpret the transformation in. If GLG_SCREENCOORD is used, the parameters of the transformation are considered to be in screen pixels. For example, this may be used to move the object by the number of screen pixels as defined by the mouse move. If GLG_OBJECTCOORD is used, the transformation parameters are interpreted as GLG world coordinates.

- **parent**
  The object’s parent. It is required in the GLG_OBJECTCOORD mode, may be NULL for GLG_SCREENCOORD mode.

This function applies the given transformation to an object’s control points, calculating new control point values. The object’s hierarchy must be setup to use this function.
**GlgTransformPoint**

Transforms a single point.

```c
void GlgTransformPoint( matrix, in_point, out_point )

GlgObject matrix;
GlgPoint * in_point;
GlgPoint * out_point;
```

**Parameters**

**matrix**

Specifies the matrix to be applied to the input point.

**in_point**

The input point to be transformed.

**out_point**

The transformed point.

This function applies the given transformation matrix to the `in_point` parameter, and returns the result in `out_point`.

The `GlgPoint` data type is defined in the `GlgApi.h` file:

```c
typedef struct _GlgPoint
{
    double x, y, z;
} GlgPoint;
```

**GlgTranslatePointOrigin**

Converts screen coordinates of a point in one viewport to the screen coordinates of another viewport.

```c
void GlgTranslatePointOrigin( from_viewport, to_viewport, point )

GlgObject from_viewport;
GlgObject to_viewport;
GlgPoint * point;
```

**Parameters**

**from_viewport**

Specifies the viewport in which the point’s screen coordinates are defined.

**to_viewport**

Specifies the viewport whose screen coordinate system to convert to.

**in_point**

The point to be converted. The result is placed back into the structure pointed by this pointer.

The objects’ hierarchy must be setup to use this function.
The `GlgPoint` data type is defined in the `GlgApi.h` file:

```c
typedef struct _GlgPoint
{
    double x, y, z;
} GlgPoint;
```

### `GlgTraceObject`

Highlights all objects in the drawing that depend on the tag or resource object that is being traced.

```c
GlgBoolean GlgTraceObject( object, state, is_widget, top_parent,
                              func, data )
```

- **Parameters**
  - **object**
    Specifies the object to trace. The object must be set up.
  - **state**
    May be set to True to highlight the objects in the drawing that depend on the traced object or set to False to unhighlight them.
  - **is_widget**
    If set to True, the parent objects that have resource named `IsWidget` will be highlighted or unhighlighted depending on the **state** parameter.
  - **top_parent**
    If non-null, the parent objects that are direct children of **top_parent** will be highlighted or unhighlighted.
  - **func**
    An optional function that provides a custom condition. The function will be invoked for each parent of a traced object to check if a custom condition is satisfied. If the function returns True, the parent will be highlighted or unhighlighted.
  - **data**
    Specifies a pointer to the custom data passed to the **func** function.

`GlgTraceObject` searches all parents of the traced object and highlights or unhighlights them (as directed by the **state** parameter) based on the specified conditions. The parent search is performed until any of the specified conditions (`is_widget`, **top_parent** or a custom criteria evaluated by the supplied function) is satisfied. If no conditions are specified, all immediate drawable parents of the traced object will be highlighted or unhighlighted.

The function returns True if any parents were highlighted or unhighlighted.
The dependent parent objects are highlighted with an outline. The attributes of the outline are defined by the `GlgHighlightPolygon` global configuration resource.

Internally, object highlighting is done setting an object’s `HighlightFlag` attribute to True. An application can also set and reset this attribute of drawable objects via the `GlgSetDResource` function to highlight or unhighlight individual objects of interest.

### GlgTraverseObjects

Traverses the object hierarchy of the object and invokes the supplied function on the object itself and all its subobjects, including object attributes.

```c
void GlgTraverseObjects( object, func, data )
    GlgObject object;
    GlgBoolean (*func)( GlgObject object, void * data );
    void * data;
```

**Parameters**

- **object**
  - Specifies the object to traverse.

- **func**
  - Specifies the custom function to be invoked. The function return result is used to modify the traversal: if the function returns `GlgFalse` for a subobject, the traversal of objects inside the subobject will not be performed.

- **data**
  - Specifies a pointer to the custom data passed to the function.

### GlgUnconstrainObject

Unconstrains an object.

```c
GlgBoolean GlgUnconstrainObject( attribute )
    GlgObject attribute;
```

**Parameters**

- **attribute**
  - Specifies the attribute or point object to be unconstrained.

This function removes any constraints applied to an attribute object. Any changes made to the object while it was constrained to another object are permanent and will be in effect even after the constraints are removed. The removal of the constraints only means that changes to this object are no longer copied to the other objects to which it was once constrained.

If any of the objects which are using this attribute object (or any objects with attributes constrained to it) have already been drawn, an error message will be produced. Use the `GlgSuspendObject` function to suspend drawn objects before removing constraints from their attributes.
**GlglWorldToScreen**

Converts a point’s coordinates from the GLG world coordinate system to the screen coordinate system.

```c
GlglBoolean GlglWorldToScreen( object, inside_vp, in_point, out_point )
    GlglObject object;
    GlglBoolean inside_vp;
    GlglPoint * in_point;
    GlglPoint * out_point;
```

**Parameters**

**object**

Specifies the object whose world coordinate system to convert from. The world coordinate system of an object includes the effect of all drawing transformations attached to the object and all its parents.

**inside_vp**

If `object` is a viewport or a light viewport, `inside_vp` specifies which world coordinate system to use. If `inside_vp=GlgTrue`, the method will use the world coordinate system used to draw objects inside this `object` viewport. If `inside_vp=GlgFalse`, the method will use the world coordinate system used to draw this `object` viewport inside its parent viewport.

The value of this parameter is ignored for objects other than a viewport or light viewport.

**in_point**

The point to be converted.

**out_point**

The point structure to hold the converted value.

The object’s hierarchy must be setup to use this function.

The `GlgPoint` data type is defined in the `GlgApi.h` file:

```c
typedef struct _GlgPoint
{
    double x, y, z;
} GlglPoint;
```

**Get and Set Resource Function Extension**

The `GlglGet*Resource` and `GlglSet*Resource` functions may be used to set or query the value of an attribute object directly, without searching for the resource name. To do this, pass the attribute object ID as the `object` parameter and use NULL as the `resource_name` parameter. It will set the attribute object directly, speeding up the operation by eliminating the search for the resource name.
The following example shows how to use this feature in a function that moves a polygon:

```
GlgBoolean MovePolygon( polygon, by, direction )

GlgObject polygon;
double by;
GlgLong direction;
{
    long i, size;
    GlgObject polygon;
    double x, y, z;

    size = GlgGetSize( polygon );
    GlgSetStart( polygon );     /* Initialize traversing. */
    for( i=0; i<size; ++i )
    {
        /* Get the next point. */
        point = GlgIterate( polygon );

        /* Query the point's coordinates. */
        GlgGetGResource( point, NULL, &x, &y, &z );

        /* Move the point in the desired direction. */
        switch( direction )
        {
            case 'x':
                GlgSetGResource( point, NULL, x + by, y, z );
                break;
            case 'y':
                GlgSetGResource( point, NULL, x, y + by, z );
                break;
            case 'z':
                GlgSetGResource( point, NULL, x, y, z + by );
                break;
            default:
                fprintf( stderr, "Invalid direction.\n" );
                return False;
        }
    }
    return True;
}
```

The above source code is used for example purpose only. The same functionality may be accomplished by the `GlgMoveObjectBy` function.
Extended API Function Descriptions

GlgCreateObject

Creates a GLG object of any type.

GlgObject GlgCreateObject( type, name, data1, data2, data3, data4 )
  GlgObjectType type;
  char * name;
  GlgAnyType data1;
  GlgAnyType data2;
  GlgAnyType data3;
  GlgAnyType data4;

Parameters

type

Specifies the type of GLG object to be created.

name

An optional argument specifying a name to be assigned to the object. This name can be used later for accessing the object and its attributes without keeping the object ID returned by *GlgCreateObject*. Use NULL as the value of this parameter to create an object without a name. The object’s name is an editable attribute of the object, so the name can be assigned or changed later using the resource access functions.

Using the object ID is the fastest method for accessing the object, but it requires keeping the object ID and referencing the object to make sure it is not destroyed while the ID is being used.

Using the object name to access the object via the resource mechanism is slightly slower, but it is fast enough for most applications and it ensures the proper use of the object ID.

data1, data2, data3, data4

Parameters which depend on the type of the object to be created. These are described below.

This function creates and returns an object of the specified type. The reference count of the created object is set to 1. Any created object has to be explicitly dereferenced when it is not needed any more or has been referenced by some other object (for example, adding an object to a group references the object). Refer to the description of the *GlgReferenceObject* function for the details on reference counting and object usage.

Most of the entities in the GLG Toolkit, such as graphical objects, container objects, transformations and even attributes, are objects. The *GlgCreateObject* function is used to create any of these objects and is probably the most complex function of the API.
Using `GlgCreateObject`

The `type` parameter specifies the kind of object to be created. Its possible values and the usage of the accompanying data parameters are outlined in the table below. More detailed descriptions of their use follow the table.

The following table summarizes the usage of the data parameters:

<table>
<thead>
<tr>
<th>Object Type</th>
<th>data1</th>
<th>data2</th>
<th>data3</th>
<th>data4</th>
</tr>
</thead>
<tbody>
<tr>
<td>GLG_ARC</td>
<td>NULL</td>
<td>NULL</td>
<td>NULL</td>
<td>NULL</td>
</tr>
<tr>
<td>GLG_MARKER</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>GLG_PARALLELOGRAM</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>GLG_POLYLINE</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>GLG_POLYSURFACE</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>GLG_VIEWPORT</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>GLG_BOX_ATTR</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>GLG_RENDERING</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>GLG_LIGHT</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>GLG_POLYGON</td>
<td>number of vertices GlgLong optional polygon default: 2 spline default: 3</td>
<td>NULL</td>
<td>NULL</td>
<td>NULL</td>
</tr>
<tr>
<td>GLG_SPLINE</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>GLG_TEXT</td>
<td>string char * optional default: empty string</td>
<td>text subtype GlgTextType optional default: GLG_FIXED</td>
<td>NULL</td>
<td>NULL</td>
</tr>
<tr>
<td>GLG_IMAGE</td>
<td>image filename char* optional default: NULL</td>
<td>image subtype GlgImageType optional default: GLG_FIXED _IMAGE</td>
<td>NULL</td>
<td>NULL</td>
</tr>
<tr>
<td>GLG_GROUP</td>
<td>type of group GlgContainerType optional default: NULL</td>
<td>number of objects GlgLong optional default: NULL</td>
<td>NULL</td>
<td>NULL</td>
</tr>
<tr>
<td>GLG_ARRAY</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>GLG_LIST</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>GLG_REFERENCE</td>
<td>template GlgObject mandatory for all reference types (use NULL for file references)</td>
<td>referencing type GlgRefType optional default: GLG_REFERENCE_REF</td>
<td>NULL</td>
<td>NULL</td>
</tr>
<tr>
<td>GLG_SERIES</td>
<td>template GlgObject mandatory</td>
<td>NULL</td>
<td>NULL</td>
<td>NULL</td>
</tr>
<tr>
<td>GLG SQUARE SERIES</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Object Type</td>
<td>data1</td>
<td>data2</td>
<td>data3</td>
<td>data4</td>
</tr>
<tr>
<td>------------</td>
<td>-----------------------------</td>
<td>------------------------------------------------------------</td>
<td>---------------------------</td>
<td>-------</td>
</tr>
<tr>
<td>GLG_CONNECTOR</td>
<td>connector subtype</td>
<td>number of points for recta-linear path or NULL</td>
<td>NULL</td>
<td>NULL</td>
</tr>
<tr>
<td></td>
<td>GlgObjectType mandatory</td>
<td>optional default: 2</td>
<td></td>
<td></td>
</tr>
<tr>
<td>GLG_FRAME</td>
<td>frame subtype</td>
<td>frame factor</td>
<td>NULL</td>
<td>NULL</td>
</tr>
<tr>
<td></td>
<td>GlgFrameType mandatory</td>
<td>mandatory</td>
<td></td>
<td></td>
</tr>
<tr>
<td>GLG_GIS</td>
<td>dataset file</td>
<td>string value (S data only)</td>
<td>NULL</td>
<td>NULL</td>
</tr>
<tr>
<td></td>
<td>char *</td>
<td>optional</td>
<td>default: NULL</td>
<td></td>
</tr>
<tr>
<td>GLG_DATA</td>
<td>data type (D, S or G)</td>
<td>attribute role</td>
<td>NULL</td>
<td>NULL</td>
</tr>
<tr>
<td></td>
<td>GlgDataType mandatory</td>
<td>mandatory</td>
<td></td>
<td></td>
</tr>
<tr>
<td>GLG_ATTRIBUTE</td>
<td>data type (D, S or G)</td>
<td>resource path</td>
<td>NULL</td>
<td>NULL</td>
</tr>
<tr>
<td></td>
<td>GlgDataType mandatory</td>
<td>optional</td>
<td>default: NULL</td>
<td></td>
</tr>
<tr>
<td>GLG_ALIAS</td>
<td>alias name</td>
<td>entry point data type (D, S or G)</td>
<td>NULL</td>
<td>NULL</td>
</tr>
<tr>
<td></td>
<td>char *</td>
<td>mandatory</td>
<td>default: NULL</td>
<td></td>
</tr>
<tr>
<td>GLG_HISTORY</td>
<td>resource name</td>
<td>entry point data type (D, S or G)</td>
<td>NULL</td>
<td>NULL</td>
</tr>
<tr>
<td></td>
<td>mask</td>
<td>mandatory</td>
<td>default: NULL</td>
<td></td>
</tr>
<tr>
<td>GLG_XFORM</td>
<td>xform role</td>
<td>xform subtype</td>
<td>xform object</td>
<td>xform object</td>
</tr>
<tr>
<td></td>
<td>GlgXformRole mandatory</td>
<td>mandatory</td>
<td>GlgObject</td>
<td>GlgObject</td>
</tr>
<tr>
<td></td>
<td>xform object</td>
<td>mandatory</td>
<td>optional default: NULL</td>
<td></td>
</tr>
<tr>
<td>GLG_TAG</td>
<td>tag name</td>
<td>tag source</td>
<td>tag source</td>
<td>NULL</td>
</tr>
<tr>
<td></td>
<td>char *</td>
<td>mandatory</td>
<td>optional default: NULL</td>
<td></td>
</tr>
<tr>
<td></td>
<td>tag comment</td>
<td>mandatory</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Usage Summary for `GlgCreateObject`  

Some object types, such as the attribute, font, and colortable, are not included in the table, or in the lists below. These object types are created automatically when you create some other objects. For example, creating a polygon object automatically creates all the necessary attribute objects including the specified number of points. After a polygon object has been created, the polygon’s attribute objects may be accessed and their values may be changed through the resource mechanism.

When an object is created, it is created with default values for its attributes. After the object has been created, the attributes may be assigned values different from the default ones using the resource access functions in the standard API.

Graphical Objects

Graphical objects are displayable objects used to represent graphical shapes in the drawing. The usage of the `GlgCreateObject` data parameters for the graphical objects is outlined in the following list:

**GLG_ARC**

No data parameters are used. Use NULL for each parameter value.

**GLG_CONNECTOR**

- **data1**
  
  Specifies a *mandatory* connector subtype (`GlgObjectType`) which may have the following values:

  - **GLG_POLYGON**
    
    Recta-linear connectors
  
  - **GLG_ARC**
    
    Arc connectors

- **data2**

  An optional number of control points for the recta-linear connectors (use NULL for arc connectors). The default value for the recta-linear connectors is 2, resulting in one path segment connecting the two control points. By using a value greater than two, more than one path segment is produced (i.e. using a value of 4 yields 3 path segments connecting 4 control points).

- **data3, data4**

  Not used. Use NULL for each parameter’s value.

**GLG_FRAME**

- **data1**

  Specifies a *mandatory* frame subtype (`GlgFrameType`), which can have the following values:

  - **GLG_1D**
  
  - **GLG_2D**
  
  - **GLG_3D**
  
  - **GLG_FREE**

  Refer to the *GLG Objects* chapter for the details on the frame subtypes. The point frame is the same as a free frame with only one point.
data2
Specifies a mandatory frame factor. The frame factor value defines the number of frame intervals, which is one smaller than the number of control points. The frame factor is a creation-time parameter and can’t be changed after the frame has been created.

data3, data4
Not used. Use NULL as the parameter’s value.

GLG_IMAGE
data1
A filename (char*) of an image file in the GIF, JPEG, PNG or BMP (Windows only) format.
data2
An optional image object subtype (GlgImageType) which may have the following values:
   GLG_FIXED_IMAGE
   GLG_SCALED_IMAGE
   GLG_FIT_TO_BOX_IMAGE
   GLG_FIXED_IMAGE
Refer to the GLG Objects chapter for details on the image subtypes. The default value is GLG_FIXED_IMAGE.
data3, data4
Not used. Use NULL for each parameter’s value.

GLG_MARKER
No data parameters are used. Use NULL for each parameter value.

GLG_PARALLELOGRAM
No data parameters are used. Use NULL for each parameter value.

GLG_POLYGON
data1
Specifies an optional number of polygon points (GlgLong). If NULL is used as the parameter’s value, a default value of two (2) is used and a polygon with two points is created.
data2, data3, data4
Not used. Use NULL for each parameter’s value.

GLG_POLYLINE
No data parameters are used. Use NULL for each parameter value.

GLG_POLYSURFACE
No data parameters are used. Use NULL for each parameter value.

GLG_TEXT
data1
An optional string (char*) to be assigned to the text object. The text object will create a copy of the string. Using NULL causes the default value (the empty string) to be used.
data2
The optional text object subtype (GlgTextType) which may have the following values:
   GLG_FIXED_TEXT
   GLG_FIT_TO_BOX_TEXT
Refer to the GLG Objects chapter for the details on the text subtypes. The default value is GLG_FIXED_TEXT.

**data3, data4**

Not used. Use NULL for each parameter’s value.

**Example: Creating a Polygon**

The following example shows a fragment of code which creates a polygon with three points, sets values of some attributes, and adds the polygon to a viewport:

```c
{Glgo
GlgObject polygon;

/* Create a polygon with 3 points named "Polygon1". */
polygon = GlgCreateObject( GLG_POLYGON, "Polygon1",
    (GlgAnyType)3, 0, 0, 0 );
/* Set some of the polygon’s attributes, use the default
    attribute values for the rest of the attributes. */
GlgSetDResource( polygon, "OpenType", (double) GLG_CLOSED );
GlgSetDResource( polygon, "FillType", (double) GLG_EDGE );
GlgSetGResource( polygon, "FillColor", /* Green */ 0., 1., 0. );
/* Add the polygon to a viewport object for displaying. */
GlgAddObject( viewport, polygon, GLG_BOTTOM, 0 );
/* The group have referenced the added polygon.
    Dereference the polygon to let the group manage it.
    This is required since any object is created with the
    reference count set to 1. */
GlgDropObject( polygon );
}
```

Since the GLG polygon is a container of points, its points may be accessed via the GlgGetElement or GlgIterate function. Each point is a GLG data object of G type, and its coordinates may be set using the GlgSetGResource function, using the point as the object parameter and NULL as the resource_name parameter.

Refer to the demos and examples directories for examples of complete programs using the GLG Extended API.

**Containers and Composite Objects**

A container object may hold elements of different types as defined by the creation parameters described below and may be used to keep, save, load, and copy collections of user-defined values. A container may be used to group graphical objects in the drawing, in which case the container is a graphical object which may be added to the drawing. There are two types of containers, different in
their internal representation: **GLG_ARRAY** (dynamic array) and **GLG_LIST** (linked list). There is also a **GLG_GROUP** type, which may be used to create a container object when the internal representation of the container is not important and whose default value is **GLG_ARRAY**.

Other GLG objects may inherit container functionality. For example, a viewport object serves as a container of graphical objects, and a polygon is a container of points.

**GLG_GROUP**

**GLG_ARRAY**

**GLG_LIST**

data1

Specifies the type of the container’s elements and may have the following values:

**GLG_OBJECT**

for containers to hold GLG objects of any type or hierarchies of GLG objects. This may also be used to hold double floating values, strings or geometrical points in form of the GLG data or attribute objects. Objects are referenced when added to the container, and dereferenced when they are deleted or their container gets destroyed.

**GLG_NON_DRAWABLE_OBJECT**

ADVANCED: same as **GLG_OBJECT**, but used when the container object will not be drawn. This may be used for creating lightweight containers which are never added to the drawing to be displayed, as well as for creating custom properties that should not be setup. For example, if a group of custom properties contains drawable objects, it should not be setup to avoid the drawable objects being drawn when the custom properties are setup.

**GLG_STRING**

for containers to hold C character strings. The strings added to the container will be clones of the input strings. Note that the **GlgFindObject** and **GlgIterate** functions return pointers to the internal strings which must not be altered or freed. Deleting a string from a container will automatically free it. Empty strings and NULL pointers are allowed in the container.

**GLG_LONG**

for containers to hold integer values or addresses. The container’s elements will be of the longest integer type and are guaranteed to hold memory pointers. The memory pointed to by a pointer is not copied or freed automatically: this must be handled by the application which uses the container.

data2

Specifies a maximum number of objects in the group (**GlgLong**). This parameter is optional and is used only for **GLG_GROUP** and **GLG_ARRAY** containers. If you know the maximum number of objects in the group in advance, you may use this parameter to slightly optimize the group’s performance. If the number is not known in advance, use NULL as the parameter’s value. It will not cause an error to exceed the specified number of objects in the group at run time.

data3, data4

Not used. Use NULL as the parameter’s value.

**GLG_VIEWPORT**.

No data parameters are used. Use NULL for each parameter’s value.
GLG_SERIES

GLG_SQUARE_SERIES

data1
Specifies a mandatory template object (GlgObject). This object is replicated by the series according to the series’ factors. The series objects are created with the default value of the Factor attribute equal to one. The same template object should not be used for more than one series.

data2, data3, data4
Not used. Use NULL as the parameter’s value.

GLG_REFERENCE

data1
A mandatory template object (GlgObject) for a container or object reference. Use NULL for file reference objects.

data2
An optional reference subtype (GlgRefType) which may have the following values:

- GLG_REFERENCE_REF
  Template and file reference objects.
- GLG_CONTAINER_REF
  Container objects.

Refer to the GLG Objects chapter for details on the reference subtypes. The default value is GLG_REFERENCE_REF.

data3, data4
Not used. Use NULL for each parameter’s value.

Non-Graphical Objects

Non-graphical objects are used to keep data values as well as control a wide variety of the visible features of graphical objects. Refer to the GLG Objects chapter of the GLG User’s Guide and Builder Reference Manual for more information. The following list outlines the usage of the GlgCreateObject data parameters for non-graphical objects:

GLG_DATA.

data1
Specifies a mandatory data type (GlgDataType) which may have the following values:

- GLG_D
  D data (double)
- GLG_S
  S data (string)
- GLG_G
  G data (triplet of double values to define XYZ or RGB)

data2
Specifies an optional string value for the S data type. Use NULL for D and G data types.

data3, data4
Not used. Use NULL as the parameter’s value.
GLG_ATTRIBUTE.

data1
   Specifies a mandatory data type (GlgDataType) which may have the following values:
   
   GLG_D
      D attribute (double)
   
   GLG_S
      S attribute (string)
   
   GLG_G
      G attribute (triplet of double values to define XYZ or RGB)

data2
   Specifies a mandatory attribute role (GlgXformRole) which may have the following values:
   
   GLG_GEOM_XR
   GLG_COLOR_XR
   GLG_GDATA_XR
   GLG_DDATA_XR
   GLG_SDATA_XR

   The attribute’s role determines the type of transformations that will affect the object. Refer to the GLG Objects chapter for more information.

data3, data4
   Not used. Use NULL as the parameter’s value.

GLG_ALIAS

data1
   Specifies the alias name (char*). This is an alternative (logical) name for accessing the resource pointed to by the alias. The default value is NULL.

data2
   Specifies the resource path for the alias (char*). The default value is NULL.

data3, data4
   Not used. Use NULL as the parameter’s value.

GLG_HISTORY

data1
   Specifies the resource name mask (char*) used to access resources to be scrolled. The default value is NULL.

data2
   Not used. Use NULL as the parameter’s value.

data3
   Specifies the data type of the entry point. Possible values are GLG_D, GLG_S and GLG_G. This data type must match the data type of the resources pointed to by the resource name mask. The default value is GLG_D.

data4
   Not used. Use NULL as the parameter’s value.
Transformation Objects

This section details procedures for creating the transformation objects. An introduction to these objects can be found in the GLG Objects chapter.

**GLG_XFORM**

*data1*

Specifies the role the transformation plays in the object hierarchy (*GlgXformRole*). It is a mandatory parameter and may have the following values:

- **GLG_GEOM_XR** - for a geometrical transformation
- **GLG_COLOR_XR** - for a color transformation
- **GLG_DDATA_XR** - for a scalar transformation.
- **GLG_SDATA_XR** - for a string transformation.

*data2*

The *data2* parameter is a mandatory parameter, and specifies the type of the transformation (*GlgXformType*) and may have the following values. Its possible values vary with the value of the *data1* parameter.

The parameters used to control a transformation are set using the resource mechanism after the transformation object is created. So, for example, to create a move transformation that moves a geometric object 50 units in the X direction takes two steps. First, you create a MoveX transformation object (**GLG_TRANSLATE_X_XF**), and only then do you set its attributes to move the desired amount. For geometric transformations, the most commonly manipulated resource is divided into two attributes, and the transformation depends on the product of the two. For a MoveX transformation, the two attributes are the X distance and the *Factor* attributes. This allows the application to scale to the data it is to receive.

The following transformations may be attached to an attribute of any type (D, S or G), and use the following values of the *data2* parameter:

**GLG_LIST_XF**

The transformed value is selected from a list of values based on the transformation’s index attribute, which is 0-based. When a list transformation is created, the *data3* parameter can be used to pass an array of values using a group containing GLG_ATTRIBUTE objects. The type of attribute object in the group should match the type of attribute the transformation is attached to (D, S or G).

**GLG_THRESHOLD_XF**

The transformed value is selected from a list of values based on the transformation’s input value, which is compared with a list of thresholds. When a list transformation is created, the *data3* parameter can be used to pass an array of values using a group containing GLG_ATTRIBUTE objects. The type of attribute object in the group should match the type of attribute the transformation is attached to (D, S or G). The *data4* parameter can be used to pass an array of thresholds, which is a group containing GLG_ATTRIBUTE objects of scalar (D) type.

**GLG_SMAP_XF**

**GLG_DMAP_XF**

The transformed value is selected by mapping an input key to an output value by matching the input key with the list of keys. The type of the keys is determined by the type of the transformation: D (double) or S (string). The type of the output values is determined by the
type of the attribute the transformation is attached to. When a transformation is created, the data3 and data4 parameters can be used to pass a list of values and a list of keys. The lists are passed using a group containing GLG_ATTRIBUTE objects of an appropriate type.

**GLG_TRANSFER_XF**

This transformation is used to transfer a value from one attribute object to another. It can be used to implement a “one-way” constraint, where changes in one object affect another, but not vice versa. It has only two attributes. The first attribute is meant to be constrained to the source attribute, while the second may be used to attach a transformation to the constrained value.

**GLG_IDENTITY_XF**

This transformation is used to transfer a value from one attribute object to another. It is used in the internal design of the GLG Control Widgets.

For a transformation attached to a scalar (D) value, the data2 values can be:

**GLG_RANGE_CONVERSION_XF**

Creates a Range Conversion transformation used to map an input range to an output range of scalars. For example, if the input range is (0,1) and the output range is (100,200), then an input value of 0.5 will produce a transformed value of 150.

**GLG_RANGE_CHECK_XF**

Creates a Range Check transformation that changes the output value when its input value goes out of range.

**GLG_TIMER_XF**

Creates a Timer transformation which periodically changes a value of an object’s attribute to implement blinking or other types of animation.

**GLG_DIVIDE_XF**

Creates a Divide transformation used to divide an attribute value by the Divisor attribute.

**GLG_LINEAR3_XF**

Creates a Linear transformation that calculates the output value as a linear combination of the transformation’s parameters.

**GLG_BOOLEAN_XF**

Creates a Boolean transformation that sets the output value to a boolean combination of the transformation’s parameters.

For a transformation attached to a string (S) value, the data2 values can have the following values:

**GLG_S_FORMAT_XF**

Creates a Format S transformation. The transformed value of the string attribute is equal to an input string value formatted with a format string.

**GLG_D_FORMAT_XF**

Creates a Format D transformation. The transformed value of the string attribute is equal to an input scalar value formatted with a format string.

**GLG_TIME_FORMAT_XF**

Creates a Time Format transformation to format POSIX time values and display them as strings.

**GLG_STRING_CONCAT_XF**

Creates a String Concatenation transformation that concatenates several strings.

Transformations for the geometrical or color attributes can have the following values:

**GLG_TRANSLATE_X_XF**
GLG_TRANSLATE_Y_XF
GLG_TRANSLATE_Z_XF
GLG_TRANSLATE_XYZ_XF
  Create a parametric translation transformation along the specified axis or axes.

GLG_TRANSLATE_XF
  Creates a parametric translation transformation defined by a vector with a start and end point.

GLG_SCALE_X_XF
GLG_SCALE_Y_XF
GLG_SCALE_Z_XF
  Create a parametric scale transformation; scaling affects only the specified coordinate.

GLG_SCALE_XYZ_XF
  Creates a parametric scale transformation.

GLG_ROTA T_E_X_XF
GLG_R oTA T_E_Y_XF
GLG_R oTA T_E_Z_XF
  Create a parametric rotate transformation around the axis defined by the transformation type.

GLG_SHEAR_X_XF
GLG_SHEAR_Y_XF
GLG_SHEAR_Z_XF
  Create a parametric shear transformation; the shear amount increases along the axis defined by the transformation type.

GLG_MATRIX_XF
  Creates a matrix transformation. A matrix transformation is more compact than the parametric, although its action cannot be easily controlled by accessing resources. To create a matrix transformation, first create the parametric transformation which defines the desired transformations and then use this transformation as the value of the data3 parameter. The data4 parameter is not used; use NULL for its value. After the matrix transformation has been created, the parametric transformation is not needed any more and may be dropped using the GlgDropObject function. To create a complex matrix transformation, a concatenation of several transformations may be used as the data3 parameter.

Once a matrix transformation is created, it can be changed with the SetResourceFromObject function.

GLG CONCATENATE_XF
  Creates a concatenate transformation; it may be a concatenation of two matrix, parametric, or concatenate transformations. In this case data3 and data4 should contain the two transformation objects to be linked. Since a concatenate transformation references its components, they may be dereferenced using the GlgDropObject function after the concatenate transformation has been created.

The order of the transformation objects in the argument list corresponds to the order in which the transformations are applied when the resulting concatenate transformation is used to draw any object. The object is transformed with the first transformation, then with the second. Either object may itself be a concatenate transformation object, containing two or more other transformations.
A transformation may be used to create several concatenate transformations. In this case the corresponding transformations of the created concatenate transformations are constrained to have the same parameter values. Use the `GlgCopyObject` function to create copies of the transformation before passing them to the `GlgCreateObject` function to avoid constraints.

**GLG_PATH_XF**

Creates a parametric path transformation. When a path transformation is created, the `data3` parameter can be used to pass an array of path points. This array may be extracted from any polygon with its `Array` resource. Use a copy of the array if you don’t want the path of the transformation to be constrained to the path polygon. If the `data3` parameter is NULL, a default path transformation with two points is created.

**Example: Concatenate Transformation**

The following fragment of code shows an example of creating a concatenate transformation. It creates a rotate and translate transformations and then combines them in a concatenate transformation:

```c
{  
  GlgObject rotate_xform, move_xform;
  
  /* Create a rotate transformation. */
  rotate_xform =
      GlgCreateObject( GLG_XFORM, "Rotate", GLG_GEOM_XR,  
                        GLG_ROTATE_Z_XF, NULL, NULL );

  /* Change the center of rotation from a default value (0;0;0) to the 
   value (500; 0; 0). */
  GlgSetGResource( rotate_xform, "XformAttr1", 500., 0., 0. );

  /* Set the rotation angle to 90 degrees. */
  GlgSetDResource( rotate_xform, "XformAttr2", 90. );

  /* Create a translate transformation. */
  move_xform =
      GlgCreateObject( GLG_XFORM, "Move", GLG_GEOM_XR,  
                        GLG_TRANSLATE_X_XF, NULL, NULL );

  /* Set the move amount to 500 in world coordinates. */
  GlgSetDResource( move_xform, "XformAttr2", 500. );
  /* Create a concatenate transformation. */
  concat_xform =
      GlgCreateObject( GLG_XFORM, "Concat", GLG_GEOM_XR,  
                        GLG_CONCATENATE_XF, rotate_xform, move_xform );

  /* Dereference transformations; we do not need them any more. */
  GlgDropObject( rotate_xform );
  GlgDropObject( move_xform );
}
```
Example: Matrix Transformation

The following example shows how to create a matrix transformations using the concatenate transformation from the previous example. It creates two different matrix transformations from the same concatenate transformation using different transformation parameters:

```c
{  
  GlgObject matrix_xform1, matrix_xform2;

  /* Set transformation parameters for the first matrix. */  
  GlgSetDResource( concat, "Rotate/XformAttr2", 60. ); /* Angle */  
  GlgSetDResource( concat, "Move/XformAttr1", 500. ); /* Amount */

  /* Create the first matrix transformation. */
  matrix_xform1 =
    GlgCreateObject( GLG_XFORM, "Matrix", GLG_GEOM_XR,
                    GLG_MATRIX_XF, concat_xform, NULL );

  /* Set transformation parameters for the second matrix. */
  GlgSetDResource( concat, "Rotate/XformAttr2", 30. ); /* Angle */
  GlgSetDResource( concat, "Move/XformAttr1", 1500. ); /* Amount */

  /* Create the second matrix transformation. */
  matrix_xform2 =
    GlgCreateObject( GLG_XFORM, "Matrix", GLG_GEOM_XR,
                    GLG_MATRIX_XF, concat_xform, NULL );

  /* Dereference the concatenation transformation if not needed any more. */
  GlgDropObject( concat_xform );
}
```

Refer to the GLG Objects chapter for a description of all the transformation attributes.

**GlgAddObjectToTop**
**GlgAddObjectToBottom**
**GlgAddObjectAt**

Add an object to a container at the specified position: top, bottom or position defined by the index.

```c
GlgBoolean GlgAddObjectToTop( container, object )  
  GlgObject container;
  GlgObject object;

GlgBoolean GlgAddObjectToBottom( container, object )  
  GlgObject container;
  GlgObject object;

GlgBoolean GlgAddObjectAt( container, object, index )  
  GlgObject container;
  GlgObject object;
  GlgLong index;
```
Parameters

container
  Specifies the container object.

object
  Specifies the object to be added to the container object.

index
  Specifies the position in a container.

These functions add an object to a container object at the specified position and return \textit{GlgTrue} if the object was successfully added or \textit{GlgFalse} otherwise. The container object may have different types: it may be a group, a viewport or a polygon.

If the container object is a group or viewport, you may add any graphical object to it. Any attempt to add a non-graphical object will fail and an error message will be generated. The objects at the end (the bottom) of the list are drawn last and will appear in front of other objects.

If a polygon is passed as a container object parameter to this function, you may add points to the polygon. Any attempt to add an object different from a geometrical data object will fail, generating an error message.

\textbf{Note:} For viewports with integrated scrolling enabled by the viewport’s \textit{Pan} attribute, child viewport objects added to the bottom of the viewport object list will appear in front of the integrated scrollbars until the viewport is reset. Resetting the viewport reorders the scrollbars to be the last in the object list. To achieve proper rendering without resetting the viewport, use \textit{GlgAddObjectAt} to add the child viewport at a proper position before the integrated scrollbars. If a single X or Y scrollbar is used, the position index will be \textit{list\_size - 1}, where \textit{list\_size} is the number of objects in the viewport. If both X and Y scrollbars are active, \textit{list\_size - 3} position should be used.

\textit{GlgAddObject}

A generic function for adding an object to a container.

\begin{verbatim}
GlgBoolean GlgAddObject( container, object, access_type, pos_modifier )
  GlgObject container;
  GlgObject object;
  GlgAccessType access_type;
  GlgPositionModifier pos_modifier;
\end{verbatim}

Parameters

container
  Specifies the container object.

object
  Specifies the object to be added to the container object.

access\_type
  Specifies the position at which the object is inserted. This parameter may have the following values:
GLG_TOP
Adds the object at the beginning of the object list.

GLG_BOTTOM
Adds the object at the end of the object list.

GLG_CURRENT
Adds the object at the position defined by the last call to GlgFindObject.

pos_modifier
Used only with the GLG_CURRENT access type and may have the following values:

GLG_BEFORE
Adds object before the object defined by the last call to GlgFindObject.

GLG_AFTER
Adds input object after the object defined by the last call to GlgFindObject.

If the access type is not GLG_CURRENT, use 0 as the value of this parameter.

This function adds an object to a container object and returns GlgTrue if the object was successfully added or GlgFalse otherwise. The container object may have different types: it may be a group, a viewport or a polygon.

If the container object is a group or viewport, you may add any graphical object to it. Any attempt to add a non-graphical object will fail and an error message will be generated. The objects at the end (the bottom) of the list are drawn last and will appear in front of other objects.

If a polygon is passed as a container object parameter to this function, you may add points to the polygon. Any attempt to add an object different from a geometrical data object will fail, generating an error message.

A container object keeps an internal current position pointer, which is set by a successful call to the GlgFindObject function. For a call to GlgAddObject immediately following the GlgFindObject call, the pos_modifier parameter defines where to add the new object: right before or right after the object returned by GlgFindObject. The position modifier also defines how the insert position defined by the current position pointer is adjusted after the insertion. For GLG_BEFORE, the current position is left unchanged, for GLG_AFTER it is incremented by 1. This allows you to call GlgAddObject repeatedly after an initial call to GlgFindObject.

For example, the following sequence of calls:

```
GlgFindObject( container, object_B, GLG_FIND_OBJECT, 0 );
GlgAddObject( container, object_1, GLG_CURRENT, GLG_BEFORE );
GlgAddObject( container, object_2, GLG_CURRENT, GLG_BEFORE );
GlgAddObject( container, object_3, GLG_CURRENT, GLG_BEFORE );
```

for a group with objects:

```
(object_A, object_B, object_C)
```

results in a group with the following object order:

```
(object_A, object_1, object_2, object_3, object_B, object_C).
```
The sequence of calls:

```c
GlgFindObject( container, object_B, GLG_FIND_OBJECT, 0 );
GlgAddObject( container, object_1, GLG_CURRENT, GLG_AFTER );
GlgAddObject( container, object_2, GLG_CURRENT, GLG_AFTER );
GlgAddObject( container, object_3, GLG_CURRENT, GLG_AFTER );
```

for the same group results in:

```c
(object_A, object_B, object_1, object_2, object_3, object_C).
```

Keep in mind that any other calls to `GlgFindObject`, `GlgAddObject`, and `GlgDeleteObject` may affect the current position pointer.

**GlgCopyObject**

Creates a copy of an object.

```c
GlgObject GlgCopyObject( object )
GlgObject object;
```

**Parameters**

- **object**
  - Specifies the object to be copied.

This function creates and returns a copy of an object. The reference count of the created copy is set to 1. The created copy must be explicitly dereferenced after it has been used to avoid memory leaks. Refer to the description of the `GlgReferenceObject` function for details on reference counting.

GlgCopyObject is equivalent to using GlgCloneObject with the FULL_CLONE cloning type. Refer to the `GlgCloneObject` section below for more details on cloning types.

The `GlgCopyObject` function may be used to create multiple instances of an object after the object has been created and its attributes have been set to the desired values. Using `GlgCopyObject` can also save repeated calls to the resource-setting functions.

**GlgCloneObject**

Creates a specialized copy (clone) of an object.

```c
GlgObject GlgCloneObject( object, clone_type )
GlgObject object;
GlcCloneType clone_type;
```

**Parameters**

- **object**
  - Specifies the object to be cloned.

- **clone_type**
  - This is an enumerated value, specifying the type of clone desired. The possible value are GLG_FULL_CLONE, GLG_STRONG_CLONE, GLG_WEAK_CLONE,
GLG_CONSTRAINED_CLONE and GLG_SHALLOW_CLONE.

This function creates a copy of an object, according to the rules of cloning. There are four different kinds of clones available for a given object. The difference between them depends on their treatment of the original object’s attributes according to the Global flag. There is also a special shallow clone type which can be applied only to the GLG group objects.

**Full Clone**

A full clone is a copy of the original object. No attributes of the copy are constrained to the attributes of the original.

**Constrained Clone**

A constrained clone is a copy of the original object all of whose attributes are constrained to the corresponding attributes of the original.

**Exception:** The Constrained Clone does not constrain the attributes that have their Global flag set to NONE, such as the constrained points of the parallelogram, frame and connector objects, the Buffer attribute of the Transfer transformation and some other special attributes.

**Strong Clone**

A strong clone is a copy of the original object. If any of the object’s attributes are global or semi-global (have their Global flags set to GLG_GLOBAL or GLG_SEMI_GLOBAL), they will be constrained to the corresponding attribute of the original.

**Weak Clone**

A weak clone interprets SEMI-GLOBAL to mean the same as LOCAL. It is similar to a strong clone, but only the global attributes are constrained.

**Shallow Clone**

A shallow clone is a special clone type that can be applied only to the group objects. When a shallow copy of a group is created, the copy will contain the same object IDs as the original group, as opposed to the other clone types which clone elements of the group, creating new objects with new object IDs. The shallow clone may be used by a program to create a list of objects in the original group, for example for safe traversing of the list while deleting the objects from the original group.
Delete an object from a specified position in a container: top, bottom or a position defined by an index.

\[\text{GlgDeleteTopObject( container )} \]
\[\text{GlgObject container;}\]

\[\text{GlgDeleteBottomObject( container )} \]
\[\text{GlgObject container;}\]

\[\text{GlgDeleteObjectAt( container, index )} \]
\[\text{GlgObject container;}
\[\text{Gglong index;}\]

**Parameters**

**container**

Specifies a container object.

**index**

Specifies an index of the object to be deleted from the container.

These functions delete an object from the container object and returns \text{GlgTrue} if the object was successfully deleted or \text{GlgFalse} otherwise.

**GlgDeleteObject**

A generic function for deleting an object from a container.

\[\text{GlgDeleteObject( container, reserved, access_type, pos_modifier )} \]
\[\text{GlgObject container;}
\[\text{void * reserved;}
\[\text{GlgAccessType access_type;}
\[\text{GlgPositionModifier pos_modifier;}\]

**Parameters**

**container**

Specifies a container object.

**reserved**

A reserved parameter for the future extensions; must be NULL.

**access_type**

Specifies the position of the object to be deleted and may have the following values:

- **GLG_TOP**
  Deletes the object at the beginning of the object list.
**GLG_BOTTOM**
Deletes the object at the bottom of the object list.

**GLG_CURRENT**
Deletes the object at the position defined by the last call to *GlgFindObject*.

**pos_modifier**
Used only with the GLG_CURRENT access type. It defines how to adjust the current position after the delete operation. This parameter allows using the function repeatedly to delete several objects before or after the object defined by the previous call to the *GlgFindObject* function. It may have the following values:

**GLG_BEFORE**
Moves the current position pointer to the previous object in the list.

**GLG_AFTER**
Moves the current position pointer to the next object in the list.

If the access type is not GLG_CURRENT, use 0 as the value of the parameter.

This function deletes an object from the container object and returns *GlgTrue* if the object was successfully deleted or *GlgFalse* otherwise.

The object to be deleted is defined by the *access_type* parameter and may be the first (GLG_TOP) or the last object (GLG_BOTTOM) in the container’s object list. It may also be an object defined by the previous successful call to *GlgFindObject* (GLG_CURRENT).

For example, the following sequence of calls:

```c
GlgFindObject( container, object_D, GLG_FIND_OBJECT, 0 );
GlgDeleteObject( container, NULL, GLG_CURRENT, GLG_AFTER );
GlgDeleteObject( container, NULL, GLG_CURRENT, GLG_AFTER );
GlgDeleteObject( container, NULL, GLG_CURRENT, GLG_AFTER );
```

for a group with objects:

object_A, object_B, object_C, object_D, object_E, object_F, object_G

results in deleting objects *object_D*, *object_E*, and *object_F*.

The sequence of calls:

```c
GlgFindObject( container, object_B, GLG_FIND_OBJECT, 0 );
GlgDeleteObject( container, NULL, GLG_CURRENT, GLG_BEFORE );
GlgDeleteObject( container, NULL, GLG_CURRENT, GLG_BEFORE );
GlgDeleteObject( container, NULL, GLG_CURRENT, GLG_BEFORE );
```

for the same group deletes objects *object_D*, *object_C*, and *object_B*, in that order.

Keep in mind that any other calls to *GlgFindObject*, *GlgAddObject*, and *GlgDeleteObject* may affect the current position pointer. The current position pointer must be used immediately after the *GlgFindObject* call.
**GlgDeleteThisObject**

Finds and deletes the object from a container.

```c
GlgBoolean GlgDeleteThisObject( container, object )
    GlgObject container;
    GlgObject object;
```

**Parameters**

- **container**
  - Specifies a container object.
- **object**
  - Specifies an object to be deleted from the container.

This function finds and deletes an object from the container object. It returns `GlgTrue` if the object was successfully deleted or `GlgFalse` if object was not found in the container.

**GlgFlush**

Set the container object’s size:

```c
void GlgGetSize( container, size)
    GlgObject container;
    GlgLong size;
```

**Parameters**

- **container**
  - Specifies the container object.
- **size**
  - Specifies the new size.

This function sets the container size to the requested size. If the new size is less than the current container size, extra elements are removed. If the new size is greater than the current size, the function adds elements by making a copy of the last element in the container.

The container may be a group, a viewport, a polygon (as a container of points), a spline or a connector. The function can only be invoked if the container is not set up. If the container is set up (drawn), the function must be surrounded by the `GlgSuspendObject` and `GlgReleaseObject` calls.

**GlgSetElement**

Replaces the object at the specified position in a container.

```c
GlgBoolean GlgSetElement( container, index, new_object )
    GlgObject container;
    GlgLong index;
    GlgObject new_object;
```
Parameters

container

Specifies the container object.

index

Specifies the position inside the container at which the object will be replaced.

new_object

Specifies the new object.

This function returns GlgFalse if the specified index is invalid.

GlgSetResourceObject

Replaces a resource object:

    GlgBoolean GlgSetResourceObject( object, resource_name, o_value )
    GlgObject object;
    char * filename;
    GlgObject o_value;

Parameters

object

Specifies the object whose resource is being set or replaced.

resource_name

Specifies a default attribute name of a resource that is being set or replaced.

o_value

Specifies a new resource object.

This function sets or replaces the resource object specified by the resource name. It may be used to attach custom properties (CustomData resource), history (History resource) and aliases (Aliases resource) to the object, or to replace them with new values. A container object may be used as the o_value to attach a list of properties or other objects. If objects have been drawn, they must be suspended with GlgSuspendObject before using GlgSetResourceObject and released with GlgReleaseObject when finished.

This function may also be used to set or replace values of other resources. For example, it may be used instead of the GlgSetXform function to set the object’s transformation using the Xform resource name. However, GlgSetResourceObject provides direct manipulation capabilities and doesn’t do any error checking, making the user responsible for the proper handling of objects.

The function returns GlgTrue if the operation was successful.

While this function provides the Intermediate API functionality, it may also be used with the Standard API for setting global configuration resources.
**GlgSetXform**

Adds or deletes transformations attached to an object.

```c
GlgBoolean GlgSetXform( object, xform )
  GlgObject object;
  GlgObject xform;
```

**Parameters**

**object**

Specifies the object to which a transformation is to be attached.

**xform**

Specifies the transformation object to be attached to the object.

This function replaces the current object’s transformation with a new one. The NULL pointer may be used as the value of the transformation parameter to just delete the existing transformation (use the Xform resource name to query the existence of the transformation with the GlgGetResourceObject function). The function returns GlgTrue upon successful completion, and GlgFalse for failure.

A transformation may be added only to a drawable object (such as a viewport, group, polygon, etc.) or to the object’s attributes. Any attempt to add a transformation to a non-drawable object generates an error message.

The attributes of an object differ by their data type. It is important not to try to attach a transformation of an inappropriate type to these objects. For example, GlgSetXform fails if you try to attach a string transformation to a geometrical object.

A transformation may be added to an object only before it has been drawn. To add a transformation after the object has been drawn, use the GlgSuspendObject function. Use the GlgReleaseObject when done. Adding a transformation without using the GlgSuspendObject function after the object has been drawn generates an error message.
2.7 Real-Time Chart Functions

The following Standard and Intermediate API methods may be used to handle specific aspects of the GLG Real-Time Chart object:

*Standard API*

- **GlgGetSelectedPlot** returns the plot object corresponding to the legend item selected with the mouse, if any.
- **GlgGetNamedPlot** queries a chart’s plot by its name.
- **GlgAddPlot** adds a plot to a chart.
- **GlgDeletePlot** deletes a plot from a chart.
- **GlgAddTimeLine** adds a vertical time line to a chart.
- **GlgDeleteTimeLine** deletes a vertical time line from a chart.
- **GlgAddAnnotation** adds an annotation object to a chart.
- **GlgDeleteTimeLine** deletes an annotation from a chart.
- **GlgClearDataBuffer** clears accumulated data samples of a real-time chart or one of its plots.
- **GlgGetDataExtent** queries the extent of the data accumulated in the chart’s plots.
- **GlgSetLabelFormatter** attaches a custom label formatter to a stand-alone axis or an axis of a chart.
- **GlgSetLinkedAxis** links a chart’s plot or a level line level with an axis for automatic rescaling.
- **GlgSetChartFilter** attaches a custom data filter to a chart’s plot.

*Intermediate API*

- **GlgCreateChartSelection** returns information about a chart’s sample under the cursor.
- **GlgGetLegendSelection** returns a plot object corresponding to the legend item under the cursor.
- **GlgCreateTooltipString** creates and returns a tooltip string corresponding to the current cursor position on top of a chart or axis object.
- **GlgPositionToValue** returns a chart, plot or axis value corresponding to the cursor position.
- **GlgCreateDataSample** creates a new data sample to be used with **GlgAddDataSample**.
- **GlgAddDataSample** adds a data sample to a chart, is used to prefill a chart with a large number of samples.

The following sections provide detailed description of these methods.
Chart Functions of the Standard API

GlgAddAnnotation

Adds an annotation to a chart object.

GlgObject GlgAddAnnotation( object, resource_name, annotation,
        position_x, position_y, add_box )

GlgObject object;
        char * resource_name;
        GlgObject time_line;
        double position_x;
        double position_y;
        GlgBoolean add_box;

Parameters

object
        Specifies a chart or a container object containing the chart.

resource_name
        Specifies a resource name for accessing the chart inside the container. Use NULL when the
        object parameter specifies the chart.

annotation
        Specifies an object ID of an annotation object to add. NULL may be used to create a new
        annotation.

position_x
        Specifies an annotation’s position relative to the X axis.

position_y
        Specifies an annotation’s position relative to the Y axis.

add_box
        If set to GlgTrue, a text box will be added to the annotation’s text object.

The function returns an object ID of the added annotation on success, or NULL on failure. The
returned annotation is referenced only by the chart’s annotation array it has been added to and may
be destroyed when the chart scrolls. The program should increase the annotation’s reference count
if it needs to keep a persistent reference to it.

The NumAnnotations attribute of the chart should be set to -1 in order to use this function.
**GlgAddPlot**

Adds a plot to a chart object.

```c
GlgObject GlgAddPlot( object, resource_name, plot )
GlgObject object;
char * resource_name;
GlgObject plot;
```

**Parameters**

- **object**
  Specifies a chart or a container object containing the chart.

- **resource_name**
  Specifies a resource name for accessing the chart inside the container. Use NULL when the `object` parameter specifies the chart.

- **plot**
  Specifies an object ID of a plot object. NULL may be used to create a new plot.

The function returns an object ID of the added plot on success, or NULL if it fails. The returned plot is referenced only by the chart’s plot array it has been added to and may be destroyed when the number of plots changes. The program should increase the plot’s reference count if it needs to keep a persistent reference to the plot.

**GlgAddTimeLine**

Adds a vertical time line to a chart object.

```c
GlgObject GlgAddTimeLine( object, resource_name, time_line, time_stamp )
GlgObject object;
char * resource_name;
GlgObject time_line;
double time_stamp;
```

**Parameters**

- **object**
  Specifies a chart or a container object containing the chart.

- **resource_name**
  Specifies a resource name for accessing the chart inside the container. Use NULL when the `object` parameter specifies the chart.

- **time_line**
  Specifies an object ID of a level line object to be used as a time line. NULL may be used to create a new time line.

- **time_stamp**
  Specifies the time stamp to position the time line at. This value will be assigned to the time
line’s Level attribute.

The function returns an object ID of the added time line on success, or NULL on failure. The
returned time line is referenced only by the chart’s time line array it has been added to and may be
destroyed when the chart scrolls. The program should increase the time line’s reference count if it
needs to keep a persistent reference to the time line.

The NumTimeLines attribute of the chart should be set to -1 in order to use this function.

**GlgClearDataBuffer**

Clears accumulated data samples of a real-time chart or one of its plots.

`GlgBoolean GlgClearDataBuffer( object, resource_name )`

GlgObject object;
char * resource_name;
GlgObject plot;

**Parameters**

- **object**
  Specifies a chart, a plot or a container object containing the chart.

- **resource_name**
  If not NULL, specifies a resource name for accessing the chart or one of its plots inside the
  container specified by the object parameter. Use NULL when the object parameter specifies a
  chart or plot object.

For a Chart object, GlgClearDataBuffer discards data samples in all plots of the chart. For a Plot
object, it discards only the data samples of that plot. The method returns GlgTrue on success

**GlgDeleteAnnotation**

Deletes an annotation from a chart.

`GlgBoolean GlgDeletePlot( object, resource_name, annotation, position_x, position_y )`

GlgObject object;
char * resource_name;
GlgObject annotation
double position_x;
double position_y;

**Parameters**

- **object**
  Specifies a chart or a container object containing the chart.

- **resource_name**
  Specifies a resource name for accessing the chart inside the container. Use NULL when the
  object parameter specifies the chart.
**annotation**

Specifies the annotation object to delete. If set to NULL, the annotation with the time stamp specified by the `position_x` and `position_y` attributes will be deleted.

**position_x, position_y**

Specify the position of the annotation to be deleted when the `annotation` parameter is NULL. The parameter is ignored if `annotation` is not NULL.

The function returns `GlgTrue` if the annotation was successfully deleted. The `NumAnnotations` attribute of the chart should be set to -1 in order to use this function.

---

**GlgDeletePlot**

Deletes a plot from a chart.

```c
GlgBoolean GlgDeletePlot( object, resource_name, plot )
GlgObject object;
char * resource_name;
GlgObject plot;
```

**Parameters**

**object**

Specifies a chart or a container object containing the chart.

**resource_name**

Specifies a resource name for accessing the chart inside the container. Use NULL when the `object` parameter specifies the chart.

**plot**

Specifies the plot to delete. The `GlgGetNamedPlot` method may be used to obtain a plot’s object ID.

The function returns `GlgTrue` if the plot was successfully deleted.

---

**GlgDeleteTimeLine**

Deletes a time line from a chart.

```c
GlgBoolean GlgDeleteTimeLine(object, resource_name, time_line, time_stamp )
GlgObject object;
char * resource_name;
GlgObject time_line;
double time_stamp;
```

**Parameters**

**object**

Specifies a chart or a container object containing the chart.
resource_name
   Specifies a resource name for accessing the chart inside the container. Use NULL when the object parameter specifies the chart.

time_line
   Specifies the time line to delete. If set to NULL, the time line with the time stamp specified by the time_stamp attribute will be deleted.

time_stamp
   Specifies the time stamp of the time line to be deleted when the time_line parameter is NULL. The parameter is ignored if time_line is not NULL.

The function returns GlgTrue if the time line was successfully deleted. The NumTimeLines attribute of the chart should be set to -1 in order to use this function.

GlgGetDataExtent
Queries the minimum and maximum extent of the data accumulated in a chart or in one of its plots.

GlgBoolean GlgGetDataExtent( object, resource_name, min_max, x_extent )
   GlgObject object;
   char * resource_name;
   GlgMinMax min_max;
   GlgBoolean x_extent;

Parameters

object
   Specifies a chart, a plot or a container object containing the chart.

resource_name
   Specifies a resource name to access the chart inside the container, or a plot inside the chart. Use NULL when the object parameter specifies the chart or its plot.

min_max
   Returned data extent. It is defined in the GlgApi.h file:

   typedef struct _GlgMinMax
   {
      double min, max;
   } GlgMinMax;

x_extent
   If GlgTrue, the function returns the X extent, otherwise it returns the Y extent.

If the object and resource_name parameters point to a chart object, the data extent of all plots in the chart is returned. If object and resource_name point to a plot, the data extent of that plot is returned. The object hierarchy must be set up for this function to succeed. The function returns GlgTrue on success.
**GlGGetNamedPlot**

Given a name of a chart’s plot, returns the plot’s object ID. The function returns NULL if a plot with the specified name was not found.

```c
GlGObject GlGGetNamedPlot( object, resource_name, plot_name )
GlGObject object;
char * resource_name;
char * plot_name;
```

**Parameters**

- **object**
  Specifies a chart or a container object containing a chart.

- **resource_name**
  Specifies a resource name for accessing the chart inside the container. Use NULL when the `object` parameter specifies the chart.

- **plot_name**
  Specifies the plot name.

**GlGGetSelectedPlot**

Returns the plot object corresponding to the last legend item selected with the mouse, if any.

```c
GlGObject GlGGetSelectedPlot( void )
```

If a legend item is selected with the mouse, the corresponding plot is stored internally and returned when the function is invoked. The selected plot is stored indefinitely until it is replaced by a new plot selection. Therefore, if the last mouse selection did not select any legend items, the function returns a previously selected plot, or NULL if no plots were previously selected.

**GlGSetLinkedAxis**

Associates a chart's plot or a level line with an Y axis for automatic rescaling, returns `GlGTrue` on success.

```c
GlGBoolean GlGSetLinkedAxis( object, resource_name, axis_object, axis_resource_name )
GlGObject object;
char * resource_name;
GlGObject axis;
char * axis_resource_name;
```

**Parameters**

- **object**
  Specifies a plot or a level line, or a parent object containing the plot or the level line.

- **resource_name**
  Specifies a resource name for accessing the plot or the level line inside the parent. Use NULL
when the object parameter specifies the plot or the level line.

axis_object
Specifies the axis to link with, or a parent of the axis.

axis_resource_name
Specifies a resource name for accessing the axis inside the parent. Use NULL when the axis_object parameter specifies an axis.

**GlgSetLabelFormatter**

Attaches a custom label formatter to a stand-alone axis object or an axis of a chart, returns GlgTrue on success.

```c
GlgBoolean GlgSetLabelFormatter( object, resource_name, formatter )
GlgObject object;
char * resource_name;
GlgLabelFormatter formatter;
```

**Parameters**

**object**
Specifies a chart or a container object containing the chart.

**resource_name**
Specifies a resource name for accessing the chart inside the container. Use NULL when the object parameter specifies the chart.

**formatter**
Specifies a custom label formatter.

A label formatter is a function which is invoked every time a new label string needs to be generated. It can create and return a label string, or return NULL to use a default label string. When the created label string is no longer needed, it will be freed by the Toolkit using the GlgFree call. Therefore, it must be allocated using GlgAlloc or one of the GLG string utility functions, such as GlgStrClone or GlgConcatStrings. All custom label formatters have the following function prototype:

```c
typedef char * (*GlgLabelFormatter) ( GlgObject object, GlgLong label_type,
GlgLong value_type, double value, time_t sec,
double fractional_sec, void * reserved );
```

A custom label formatter is invoked with the following parameters:

**object**
The axis object the formatter is attached to.

**label_type**
The type of an axis label to be generated: GLG_TICK_LABEL_TYPE for major tick labels, GLG_SELECTION_LABEL_TYPE for chart selection labels and GLG_TOOLTIP_LABEL_TYPE for chart tooltip labels.
A label formatter may be invoked by the chart selection or chart tooltip methods if an axis label is requested by the selection or tooltip formats.

**value_type**
The type of the axis value: GLG_TIME_VALUE or GLG_NUMERICAL_VALUE.

**value**
The label’s X value or time stamp.

**sec**
An integer number of seconds since the Epoch corresponding to the label position (time axes only).

**fractional_sec**
A label’s fractional number of seconds.

**reserved**
Is reserved for future use, must be NULL.

**GlgSetChartFilter**
Attaches a custom data filter to a chart’s plot, returns *GlgTrue* on success.

```c
GlgBoolean GlgSetChartFilter( object, resource_name, filter, client_data )
```

**Parameters**

**object**
Specifies a chart’s plot, a chart or a container object containing the chart.

**resource_name**
Specifies a resource name for accessing the plot inside the container. Use NULL when the `object` parameter specifies the plot.

**filter**
Specifies a custom data filter.

**client_data**
Specifies data to be passed to the custom filter.

A data filter is a function which is invoked by a chart to aggregate the plot’s data. A custom data filter has the following function prototype:


typedef GlgLong (*GlgChartFilter)
  ( GlgChartFilterCBReason reason,
    GlgChartFilterData * filter_data, void * client_data );

A custom data filter is invoked with the following parameters:

reason
  The reason the filter is invoked.

filter_data
  Contains data passed to the filter by the chart.

client_data
  Contains client data passed to the filter by the application when the filter was attached to the plot.

The src subdirectory of the GLG installation contains source code of custom filter examples for various programming environments (CustomChartFilter.c, CustomChartFilter.java and CustomChartFilter.cs) that provide extensive self-documented examples of custom filters. Each example implements several types of custom filters (MIN_MAX, AVERAGE and DISCARD), and contains detailed explanation of all possible values of the reason parameter, as well as the fields of the filter_data structure.

**Chart Functions of the Intermediate API**

**GlgAddDataSample**

Adds a data sample to a chart, is used to prefill the chart with large number of samples:

```c
void GlgAddDataSample( plot, datasample )
  GlgObject plot;
  GlgDataSample * datasample;
```

**Parameters**

plot
  A chart’s plot to add datasample to.

datasample
  A data sample to be added, a pointer to either the GlgDataSample or GlgDataSampleExt structure. The GlgCreateDataSample function may be used to create a new data sample.

This function is used to enhance performance when prefilling a chart with a large number of data samples. For periodic updates, new data may be pushed into the plot’s entry points using GlgSetDResource.
**GlgCreateChartSelection**

Selects a chart’s data sample closest to the specified position and returns a message object containing the selected sample’s information.

```c
GlgObject GlgCreateChartSelection( object, plot, x, y, dx, dy,
    screen_coord, include_invalid,
    x_priority )
```

**Parameters**

**object**

Specifies a chart object. If the `plot` parameter is NULL, the function queries samples in all plots of the chart and selects the sample closest to the specified position.

**plot**

Specifies an optional plot object. If it is not NULL, the function queries only the samples in that plot.

**x, y**

Specifies the position inside the chart. If the `screen_coord` parameter is set to `GlgTrue`, the position is defined in the screen coordinates of the chart’s parent viewport. If `screen_coord` is set to `GlgFalse`, the x position is defined as an X or time value, and the y position is defined in relative coordinates in the range [0; 1] to allow the chart to process selection for plots with different ranges (0 corresponds to the `Low` range of each plot, and 1 to the `High` range).

When the mouse position is used, add GLG_COORD_MAPPING_ADJ to the x and y screen coordinates of the mouse for precise mapping.

**dx, dy**

Specify an extent around the point defined by the x and y parameters. The extent is defined in the same coordinates as x and y, depending on the value of the `screen_coord` parameter. Only the data samples located within the dx and dy distances of the specified position are considered for the selection.

**screen_coord**

Specifies the type of the x and y coordinates. If set to `GlgTrue`, the x and y parameters supply screen coordinates in the chart’s parent viewport, otherwise they supply relative coordinates.

**include_invalid**

If set to `GlgTrue`, invalid data samples are considered for selection, otherwise invalid samples are never selected.

**x_priority**

If set to `GlgTrue`, the function selects the data sample closest to the specified position in the
horizontal direction with no regards to its distance from the specified position in the vertical direction. If it is set to `GlgFalse`, a data sample with the closest distance from the specified position is selected.

The information about the selected data sample is returned in the form of a message object described in the *Chart Selection Message Object* section on page 446. The function returns NULL if no data sample matching the selection criteria was found. The returned message object must be dereferenced using the `GlgDropObject` function when finished.

**GlgCreateDataSample**

Creates a data sample structure to be used with the `GlgAddDataSample` function:

```c
GlgDataSample * GlgCreateDataSample( extended )
GlgBoolean extended;
```

**Parameters**

- **extended**

  Specifies the type of the data sample to be created. If set to `GlgTrue`, an extended data sample (`GlgDataSampleExt`) is created, otherwise a data sample (`GlgDataSample`) is created.

  The fields of the data sample structure must be filled before adding it to the plot.

**GlgCreateTooltipString**

Creates and returns a chart or axis tooltip string corresponding to the specified position in screen coordinates. The string can be used to provide cursor feedback and display information about the data sample under the current mouse position, as shown in the Real-Time Strip-Chart demo.

```c
char * GlgCreateTooltipString( object, x, y, dx, dy, format )
GlgObject object;
double x, y;
double dx, dy;
char * format;
```

**Parameters**

- **object**

  Specifies a chart or axis object for creating the tooltip.

- **x, y**

  Specifies a screen position on top of a chart or an axis. When using the cursor position, add `GLG_COORD_MAPPING_ADJ` to the cursor’s x and y screen coordinates for precise mapping.

- **dx, dy**

  Specify the maximum extent in screen pixels around the specified position.

- **format**

  Provides a custom format for creating a tooltip string and uses the same syntax as the `TooltipFormat` attributes of the chart and axis objects. If it is set to NULL or an empty string,
the format provided by the TooltipFormat attribute of the chart or the axis will be used. A special “<single_line>” tag may be prepended to the format string to force the function to remove all line breaks from the returned tooltip string. A “<chart_only>” tag may also be prepended to search only for a chart tooltip and disable search for the axes’ tooltips when the function is invoked for a chart object.

If the object parameter specifies a chart, and the selected position is within the chart’s data area, the function selects a data sample closest to the specified position and returns a tooltip string containing information about the sample. The $dx$ and $dy$ parameters define the maximum extent for selecting a data sample, and the TooltipMode attribute of the chart defines the data sample selection mode: X or XY. The function returns NULL if no samples matching the selection criteria were found.

If the object parameter specifies an axis, or if the object parameter specifies a chart and the selected position is on top of one of the chart’s axes, the function returns a tooltip string that displays the axis value corresponding to the specified position.

The returned string must be freed using the GlgFree function.

**GlgGetLegendSelection**

Returns the plot object corresponding to the legend item at the specified position, if any. If no legend item is found at the specified position, NULL is returned.

```c
glgobject GlgGetLegendSelection( object, x, y )
object;
double x, y;
```

**Parameters**

- **object**
  - Specifies a legend object.
- **x, y**
  - Specifies the position in screen coordinates of the viewport containing the legend.

**GlgPositionToValue**

Returns a value corresponding to the specified position on top of a chart or an axis object.

```c
glgboolean GlgPositionToValue( object, resource_name, x, y, outside_x, outside_y, value )
object;
char * resource_name;
double x, y,
Glbble boolean outside_x, outside_y;
double * value;
```

**Parameters**

- **object**
  - If resource_name is NULL, specifies a chart, a plot or an axis object, otherwise it specifies a container object containing a chart, a plot or an axis.
resource_name

Specifies a resource path of a child chart, plot or axis object relative to the container object.

x, y

Specify a position in the screen coordinates of the parent viewport. When using the cursor position, add GLG_COORD_MAPPING_ADJ to the cursor’s x and y coordinates for precise mapping.

outside_x, outside_y

If set to GlgFalse, the function returns GlgFalse if the specified position is outside of the chart or the axis in the corresponding direction.

value

A pointer to the returned value.

For a plot, the function converts the specified position to a Y value in the Low/High range of the plot and returns the value through the value pointer.

For an axis, the function converts the specified position to the axis value and returns the value.

For a chart, the function converts the specified position to the X or time value of the chart’s X axis and returns the value.

The function returns GlgTrue on success.

2.8 GIS Object Functions

The following Standard API methods may be used to handle user interaction with the GLG GIS object:

- GlgGISConvert performs coordinate conversion from the GIS coordinates of the GIS Object to the GLG coordinates of the drawing and vise versa.
- GlgGISGetElevation returns an elevation of a specified lat/lon point on a map.
- GlgGISCreateSelection returns information about GIS features located at a specified map location.
- GlgGISGetDataset retrieves the dataset object of a GIS object
- GlmConvert performs coordinate conversion from the GIS coordinates of a map to the GLG coordinates of the drawing and visa versa without the help of a GLG GIS Object.
GIS Function Descriptions

GlgGISConvert

Performs coordinate conversion from the GIS coordinates of the GIS Object to the GLG coordinates of the drawing and visa versa.

GlgBoolean GlgGISConvert( object, resource_name, coord_type, coord_to_lat_lon, in_point, out_point )
GlgObject object;
char * resource_name;
GlgCoordType coord_type;
GlgBoolean coord_to_lat_lon;
GlpPoint * in_point;
GlpPoint * out_point;

Parameters

object
If the resource_name parameter is NULL, specifies the GIS Object whose coordinate system to use for conversion. If the resource_name parameter is not NULL, specifies a parent of the GIS Object.

resource_name
If not NULL, specifies the resource name of the GIS Object inside the parent object specified by the object parameter.

coordinate_type
The type of the GLG coordinate system to convert to or from: GLG_SCREEN_COORD for screen coordinates or GLG_OBJECT_COORD for world coordinates.

coord_to_lat_lon
GlgTrue to convert from GLG coordinates to GIS longitude and latitude, GlgFalse to convert from GIS to GLG coordinates.

in_point
A pointer to the GlpPoint structure containing coordinate values to be converted.

out_point
A pointer to the GlpPoint structure that receives converted coordinate values.

The function returns GlgTrue if conversion succeeds. When converting from GLG to GIS coordinates, the Z coordinate is set to a negative GLG_GIS_OUTSIDE_VALUE value for points on the invisible part of the globe.

The GlmConvert function of may be used to perform coordinate conversion between GIS and GLG coordinates without the use of the GIS object.
**GlgGISCreateSelection**

Provides a high-level interface to the map server’s `GlmGetSelection` function; returns a message object containing information about GIS features located at a specified position on the map.

```c
GlgObject GlgGISCreateSelection( object, resource_name, layers, x, y, select_labels)
```

- **object**
  If the `resource_name` parameter is NULL, specifies the GIS Object to query. If the `resource_name` parameter is not NULL, specifies a parent of the GIS Object.

- **resource_name**
  If not NULL, specifies the resource name of the GIS Object inside the parent object specified by the `object` parameter.

- **layers**
  A list of layers to query.

- **x, y**
  Specifies coordinates of a point in the screen coordinates of a viewport that contains the GIS object.

- **select_labels**
  Specifies the label selection mode, can have the following values (defined in the `GlmLabelSelectionMode` enum in the `GlmApi.h` file):
  - GLM_LBL_SEL_NONE - GIS features’ labels are not considered for the GIS selection.
  - GLM_LBL_SEL_IN_TILE_PRECISION - enables labels to be considered for the GIS selection. For a faster selection, this option does not check labels that belong to GIS features in a different tile, but extend to the current tile.
  - GLM_LBL_SEL_MAX_PRECISION - enables labels to be considered for the GIS selection and performs selection with the maximum label precision.

The layer’s settings have precedence over the `select_labels` parameter. The labels will be considered for selection only for the layers that do not override it by setting their LABEL SELECTION MODE = NONE in the layer’s LIF file. If LABEL SELECTION MODE = INTILE, the labels will always be considered using the IN_TILE precision.

The function returns a message object containing information about the selected GIS features. The message object has to be dereferenced using the `GlgDropObject` function when finished.

If the GIS verbosity level is set to 2000 or 2001, extended information is also written into the error log file and printed to the terminal on Linux/Unix for debugging purposes.
Refer to the \textit{GlmGetSelection} section on page 127 of the \textit{GLG Map Server Reference Manual} for information on the structure of the returned message object as well as a programming example that demonstrates how to handle it.

\textbf{GlgGISGetDataset}

Returns a dataset object associated with the GIS object:

\begin{verbatim}
GlgObject GlgGISGetDataset( object, resource_name )
    GlgObject object;
    char * resource_name;
\end{verbatim}

\textbf{Parameters}

\begin{itemize}
    \item \textbf{object}:
        If the \texttt{resource_name} parameter is NULL, specifies the GIS Object to query. If the \texttt{resource_name} parameter is not NULL, specifies a parent of the GIS Object.
    \item \textbf{resource_name}:
        If not NULL, specifies the resource name of the GIS Object inside the parent object specified by the \texttt{object} parameter.
\end{itemize}

The function may be invoked after the GIS object has been setup to retrieve its dataset. The dataset may be used to dynamically change attributes of individual layers displayed in the GIS object. The program can use \texttt{GlgSetResource} methods for changing layer attributes. Refer to the \textit{GLG Map Server Reference Manual} for information on layer attributes. The \textit{GLG GIS Demo} provides an example of changing layer attributes programmatically.

\textbf{GlgGISGetElevation}

Returns an elevation of a lat/lon point on a map:

\begin{verbatim}
GlgBoolean GlgGISGetElevation( object, resource_name, layer_name, lon, lat, elevation )
    GlgObject object;
    char * resource_name;
    double lon, lat;
    double * elevation;
\end{verbatim}

\textbf{Parameters}

\begin{itemize}
    \item \textbf{object}:
        If the \texttt{resource_name} parameter is NULL, specifies the GIS Object to query. If the \texttt{resource_name} parameter is not NULL, specifies a parent of the GIS Object.
    \item \textbf{resource_name}:
        If not NULL, specifies the resource name of the GIS Object inside the parent object specified by the \texttt{object} parameter.
    \item \textbf{layer_name}:
        The name of the layer with elevation data to query.
\end{itemize}
**lon, lat**

The lon/lat coordinates of a point on the map.

**elevation**

A pointer to the variable of a double type that will receive the returned elevation data.

The function returns *GlgFalse* if the point is outside of the map in the ORTHOGRAPHIC projection or if there is no elevation data for the specified location. If the function returns *GlgTrue*, the elevation value is returned in the units (such as meters or feet) defined by the elevation data file.

**GlmConvert**

A low level function that performs coordinate conversion from the GIS coordinates of a map to the GLG coordinates of the drawing and visa versa without the help of a GLG GIS Object. Since the function does not rely on a GIS Object being displayed and set up, it may be used before the drawing is rendered or without a drawing at all.

```c
void GlmConvert( projection, stretch, coord_type, coord_to_lat_lon, 
    center, extent, angle, 
    min_x, max_x, min_y, max_y, in_point, out_point )
```

- `projection`: A GIS map projection, may have values of GLG_RECTANGULAR or GLG_ORTHOGRAPHIC.
- `stretch`: Specifies if the map preserves the X/Y ratio (GlgFalse) or not (GlgTrue).
- `coord_type`: The type of the GLG coordinate system to convert to or from: *GLG_SCREENCOORD* for screen coordinates or *GLG_OBJECTCOORD* for world coordinates.
- `coord_to_lat_lon`: *GlgTrue* to convert from GLG coordinates to GIS longitude and latitude, *GlgFalse* to convert from GIS to GLG coordinates.
- `center`: A pointer to the *GlgPoint* structure containing lat/lon coordinates of the map center. The Z coordinate must be set to 0.
**extent**

A pointer to the `GlgPoint` structure containing X and Y extent of the map in the selected projection: in degrees for the rectangular projection or in meters for orthographic. The Z extent must be set to 0. Refer to the *GIS Object* section on page 99 of the *GLG User's Guide and Builder Reference Manual* for more details.

**angle**

A map rotation angle in degrees.

**min_x, max_x, min_y, max_y**

A map extent in the selected coordinate system. To get X/Y coordinates relative to the map image origin, use `min_x=0, min_y=0, max_x=image_width, max_y=image_height`.

**in_point**

A pointer to the `GlgPoint` structure containing coordinate values to be converted.

**out_point**

A pointer to the `GlgPoint` structure that receives converted coordinate values.

When converting from X/Y to lat/lon coordinates in the orthographic projection, the Z coordinate is set to a negative value for points on the invisible part of the globe or outside the globe area, and to zero for points on the edge of the globe. The coordinates of the returned point may be outside of the visible portion of the map for all projections.


2.9 GLG Installable Interface Handlers

GLG Installable Interface Handler Utilities assist an application developer with implementing functionality of complex user interactions usually encountered in editor-style applications. The utilities include a collection of methods as part of the GLG Intermediate API library and are available for the C/C++, Java, C#.NET and JavaScript environments. The GLG Diagram demo provides an example of a custom diagraming editor application implemented using the GLG Installable Interface Handlers functionality.

The mechanism of interface handlers facilitates rapid application development for writing elaborate GUI with sophisticated application functionality for handling user interaction.

Overview

Installable Interface Handlers (referred to as interface handlers in the rest of this manual) provide a mechanism for handling user interaction where persistency is necessary to handle interrelated sequences of user actions. The interface handlers are hierarchical, allowing an application to handle nested operations, such as nested dialogs or chained operations. Internally, a stack is used to maintain a hierarchy of handlers, making it possible to handle arbitrary nested sequences, for example display a confirmation dialog based on the action of the parent dialog (such as parent dialog closing).

The use of the stack allows to easily pass control to the previous handler in the stack after the currently active handler is uninstalled and deleted from the stack. The handlers also automate the flow of control: if the currently active handler on the bottom of the stack is not interested in the event, it can uninstall itself from the stack and pass the event to the previous handler on the stack, which, in turn, can pass the event further to the next handler in the stack.

For example, a top-level handler can be used to handle events from toolbar icons and main pull-down menu, and a nested second-level handler can be installed to handle a popup dialog. A third-level handler can be used to confirm closing of the dialog managed by the second handler. When the dialog closing is confirmed, the third and then the second handlers are uninstalled (get removed from the stack), and the control returns to the main top-level handler.

Each handler maintains its own persistent data storage for intermediate data, which is automatically cleaned up when the handler is uninstalled. A variable number of dynamic parameters can be supplied to each handler to modify its behavior as needed. Parameters can be either optional or mandatory. Optional parameters allow the developer to extend a handler's functionality while maintaining backward compatibility.

User interaction events passed to an interface handler are encoded as integer tokens for efficiency and are passed to the currently active handler (the bottom handler currently stored on a stack).

The source code for each handler is provided by an application; the code handles a set of user interaction events identified by the tokens. A handler is typically designed to handle a particular set of tokens, for example tokens for an Apply or Cancel button for a specific dialog. If an unrecognized
token is encountered, the handler can either ignore the event to implement a modal dialog, or it can
uninstall itself and pass the event to the parent handler, which, in turn, can pass it to its parent, and
so on.

Interface handlers extend functionality of event handling callbacks and listeners (referred
collectively as callbacks in the rest of this section). A disadvantage of a callback is that it does not
provide data persistency: when a callback is invoked to handle a particular event, any changes to an
application state have to be kept in an external global structure shared by all callbacks. A callback
exits after processing each event and does not provide any means for storing intermediate
interaction state in the callback itself. For example, if a dialog has several buttons, individual
callbacks are invoked on each button press event, making it difficult to implement a single
integrated event handler for the dialog as a whole.

GLG interface handlers address this problem by providing event handlers that support persistency
and provide data storage for intermediate data that control user interaction. An interface handler
stays active to process all events for a dialog or a page, until the handler is uninstalled when dialog
closes or a page is switched to display another page. The interface handlers provide a flexible
alternative to the Hierarchical State Machines (HMS) that are often used to handle the state of the
user interface transitions. Unlike HMS, interface handlers allow a developer to extend the handler
functionality by adding handler parameters and augment the handler source code based on the
parameter values passed to it, which could be easier than adding new states to the state machine.

The GLG Diagram demo provides examples of implementing several design patterns for handling
various types of user interaction. Many other alternative options of using the interface handlers are
possible, and an application can implement any desirable design pattern depending on the
application requirements.

List of Functions

The following Installable Interaction Handlers functions are provided as a part of the GLG
Intermediate API library:

- GlgIHInit initializes installable handler utilities.
- GlgIHTerminate terminates handler utilities.
- GlgIHGlobalData provides access to the global data storage.
- GlgIHInstall installs a handler.
- GlgIHSStart starts a handler.
- GlgIHResetup restarts a handler.
- GlgIHUninstall uninstalls a handler.
- GlgIHUninstallWithTag uninstalls a handler and passes a token to the parent handler.
- GlgIHUninstallWithTagEvent uninstalls a handler and passes an event to the parent handler.
- GlgIHGetCurrIH returns the current handler.
- GlgIHGetPrevIH returns the current handler’s parent handler.
• `GlgIHGetFunction` returns the entry point of the current handler.
• `GlgIHGetPrevFunction` returns the entry point of the current handler’s parent handler.
• `GlgIHGetType` returns a type of an interface event.
• `GlgIHGetToken` returns an event’s token.
• `GlgIHCallCurrIH` passes an interface event to the current handler.
• `GlgIHCallCurrIHWithToken` passes a token to the current handler.
• `GlgIHCallCurrIHWithModifToken` modifies the event’s token and passes it to the current handler.
• `GlgIHCallPrevIHWithToken` passes a token to the current handler’s parent handler.
• `GlgIHCallPrevIHWithModifToken` modifies the event’s token and passes it to the current handler’s parent.
• `GlgIHPassToken` installs a handler and passes it a token; it can be used to implement pass-through handlers for processing global accelerators, stateless options, as well as managing floating stay-open dialogs.

• `GlgIHSetIParameter`  
  `GlgIHSetPParameter`  
  `GlgIHSetSParameter`  
  `GlgIHSetOParameter`  
  `GlgIHSetDParameter`  
  `GlgIHSetOParameterFromD`  
  `GlgIHSetOParameterFromG`  
  set handler parameters of various data types.

• `GlgIHChangeIParameter`  
  `GlgIHChangePParameter`  
  `GlgIHChangeSParameter`  
  `GlgIHChangeOParameter`  
  `GlgIHChangeDParameter`  
  change handler parameters.

• `GlgIHGetIParameter`  
  `GlgIHGetPParameter`  
  `GlgIHGetSParameter`  
  `GlgIHGetOParameter`  
  `GlgIHGetDParameter`  
  queries handler parameters.

• `GlgIHGetOptIParameter`  
  `GlgIHGetOptPParameter`  
  `GlgIHGetOptSParameter`  
  `GlgIHGetOptOParameter`  
  `GlgIHGetOptDParameter`  
  queries optional handler parameters.
Function Descriptions

To use any of the functions described in this chapter, the application program must include the function definitions from the GLG API header file. Use the following line to include those definitions:

```c
#include "GlgApi.h"
```

### GlgIHInit

Initializes installable handler utilities, must be invoked after GlgInit, but before any installable handler methods.

```c
void GlgIHInit()
```

### GlgIHTerminate

Terminates installable handler utilities. All currently installed handlers must be uninstalled before invoking this method.

```c
void GlgIHTerminate()
```

### GlgIHGlobalData

Returns the global data container.

```c
void GlgIHGlobalData()
```

### GlgIHInstall

Creates a handler with the specified entry point and installs the handler.

```c
GlgIH GlgIHInstall( GlgIHEntryPoint func )
```

The function creates the handler, adds it to a stack of handlers and returns the handler’s ID. The stack of handlers is used to keep track of nested handlers; the last handler pushed onto the stack becomes the active handler, referred to as the current handler in the rest of this manual.

The `func` parameter specifies the entry point function of the new handler with the following function prototype:

```c
void GlgIHEntryPoint( GlgIH ih, GlgCallEvent call_event )
```

The handler’s entry point is invoked with the `call_event` parameter that provides the user interface event. The `ih` parameter provides the ID of the handler the entry point belongs to, and can be used to access parameters stored in the handler’s data storage. The code of this function implements functionality of the handler. Parameters can be passed to a handler after is has been installed. An example of a handler code is shown in the description of the GlgIHStart function below.
**GlgIHStart**

Invokes the handler’s entry point with the GLG_HI_SETUP_EVENT event, which allows the handler to perform any desired initialization, such as displaying a dialog associated with the handler, if any.

```c
void GlgIHStart()
```

Parameters can be passed to a handler by storing them in the installed handler’s data storage via `SetParameter` methods prior to invoking `GlgIHStart`, as shown in the following example:

```c
GlgIHInstall( ConfirmIH )
GlgIHSetOParameter( GLG_IH_NEW, “ok_dialog", ok_dialog );
GlgIHSetSParameter( GLG_IH_NEW, “message", “OK to discard changes?” );
GlgIHStart();
```

The first argument of the `SetParameter` methods defines the handler to add parameters to. For convenience, a GLG_IH_NEW macro can be used to supply the ID of the just installed handler instead of using the handler ID returned by `GlgIHInstall`, as shown in the above example.

The following shows an example of a handler code that uses parameters from the above example to initialize the handler. The handler displays a confirmation dialog with a supplied message on start up and closes it when the handler is uninstalled. An optional modal parameter specifies if the dialog is modal.

```c
void ConfirmIH( GlgIH ih, GlgCallEvent call_event )
{
    GlgObject ok_dialog;
    char * message;
    GlgCallEventType event_type;
    GlgIHToken token;

    ok_dialog = GlgGetOParameter( ih, dialog );
    event_type = GlgIHGetType( call_event );
    switch( event_type )
    {
    case GLG_HI_SETUP_EVENT:
        message = GlgIHGetOptSParameter( ih, "message" );
        GlgSetSResource( ok_dialog, "DialogMessageString", message );
        GlgSetDResource( ok_dialog, "Visibility", 1. );
        GlgUpdate( ok_dialog );
        break;

    case GLG_MESSAGE_EVENT:
        token = GlgIHGetToken( call_event );
        switch( token )
        {
        case IH_OK:
        case IHCANCEL:
        /* Pass selection to the parent. */
        GlgIHUninstallWithToken( token );
        break;
```
default:
    if( GlgIHGetOptIParameter( ih, "modal_dialog", GlgFalse ) )
        /* Don’t allow to leave in a modal mode. */
        GlgBell( Viewport );
    else
        /* Pass event to the parent. */
        GlgIHUninstallWithEvent( call_event );
    break;

case GLG_CLEANUP_EVENT:
    GlgSetDResource( ok_dialog, "Visibility", 0. );
    GlgUpdate( ok_dialog );
    break;
}

The IH_OK and IHCANCEL tokens used in the above example are generated by the GLG Input
callback that converts interface events to integer tokens for efficiency. The tokens are then passed
to the currently active handler via the GlgIHCallCurrIHWithToken function call. Refer to the GLG
Diagram demo for a complete source code example.

GlglIHResetup

Invokes the handler’s entry point with the GLG_HI_RESETUP_EVENT event.

    void GlgIHResetup( GlgIH ih )

GlglIHResetup can be used to reinitialize the handler by sharing some of the
GLG_HI_SETUP_EVENT code, as shown in the following example:
void ConfirmIH( GlgIH ih, GlgCallEvent call_event )
{
    GlgObject ok_dialog;
    char * message;
    GlgCallEventType event_type;
    int token;

    ok_dialog = GlgGetOParameter( ih, dialog );
    event_type = GlgIHGetType( call_event );
    switch( event_type )
    {
        case GLG_HI_SETUP_EVENT:
            message = GlgIHGetOptSParameter( ih, "message" );
            GlgSetSResource( ok_dialog, "DialogMessageString", message );
            /* Fall through to popup the dialog. */
        case GLG_HI_RESETUP_EVENT: /* Popup the dialog again. */
            GlgSetDResource( ok_dialog, "Visibility", 1. );
            GlgUpdate( dialog );
            break;

        ...

    }
}

GlgIHUninstall

Uninstalls the current handler (the last handler on the stack).

void GlgIHUninstall()

The handler’s entry point is invoked with the GLG CLEANUP_EVENT event prior to uninstalling to let the handler perform any required cleanup. After the handler is uninstalled, a previous handler in the stack (if any) becomes the active current handler.

Uninstalling a handler deletes its stored data and invalidates its ID; the ID should not be used after the handler has been uninstalled.

GlgIHUninstallWithToken

Uninstalls the handler using GlgIHUninstall and invokes the previous handler (which becomes current after GlgIHUninstall is invoked) with the specified token.

void GlgIHUninstallWithToken( GlgIHToken token )

GlgIHUninstallWithEvent

Uninstalls the handler using GlgIHUninstall and passes the event to the previous handler (which becomes current after GlgIHUninstall is invoked).

void GlgIHUninstallWithEvent( GlgCallEvent call_event )
**GlgIHGetType**

Returns event’s type.

```c
GlgCallEventType GlgIHGetType( GlgCallEvent call_event )
```

The type can be one of the following:

- **GLG_HI_SETUP_EVENT**
  received when the handler is started using `GlgIHStart`; is used to perform any required initialization.

- **GLG_HI_RESETUP_EVENT**
  received when the handler is reinitialized via `GlgIHRestart`.

- **GLG_CLEANUP_EVENT**
  received before destroying the handler when it is uninstalled; is used to perform any required cleanup.

- **GLG_MESSAGE_EVENT**
  a message event that is further identified by an associated token.

**GlgIHGetToken**

Returns a token associated with the GLG_MESSAGE_EVENT event.

```c
GlgIHToken GlgIHGetToken( GlgCallEvent call_event )
```

Tokens are application-defined integer values used to uniquely identify each user interaction event. For example, IH_OK token can be associated with pressing dialog’s OK button, and IH_MOUSE_MOVED can identify a mouse move event that provides coordinates of the cursor. Integer values are used to allow efficient event processing using switch statements. An enum is usually used to define tokens, for example:

```c
enum MyTokens
{
    IH_UNDEFINED_TOKEN = 0,
    IH_OK,
    IHCANCEL
}
```

In a GLG application, Input and Trace callbacks are used to convert interface events to tokens, as shown in the GLG Diagram demo. The tokens are then passed to the currently active handler via the `GlgIHCallCurrIHWithToken` function call.

**GlgIHCallCurrIHWithToken**

Invokes the entry point of the current handler (the last handler on the stack) with the specified token.

```c
GlgBoolean GlgIHCallCurrIHWithToken( GlgIHToken token )
```

Returns `GlgTrue` if the handler was uninstalled as a result of processing the token.
The function creates a call event object used to pass the token to the handler, and destroys the event object when done.

**GlgIHCallCurrIHWithModifToken**

Same as *GlgIHCallCurrIHWithToken*, but it reuses the existing event by setting its token instead of creating a new call event to pass the token to the handler.

```c
GlgBoolean GlgIHCallCurrIHWithModifToken( GlgCallEvent call_event,
                                        GlgIHToken token )
```

Returns *GlgTrue* if the handler was uninstalled as a result of processing the token.

**GlgIHCallCurrIH**

Passes the event to the entry pointy of the current handler.

```c
GlgBoolean GlgIHCallCurrIH( GlgCallEvent call_event )
```

Returns *GlgTrue* if the handler was uninstalled as a result of processing the event.

**GlgIHCallPrevIHWithToken**

Passes the token to the parent handler of the currently active handler. The parent handler is the handler preceding the current handler on the stack.

```c
void GlgIHCallPrevIHWithToken( GlgIHToken token )
```

Please note that when the parent handler is invoked, the current handler is not the parent handler, but the handler that invoked it. Therefore, the parent handler cannot uninstall itself by simply calling *GlgIHUninstall*.

**GlgIHCallPrevIHWithModifToken**

Same as *GlgIHCallPrevIHWithToken*, but reuses the event object for efficiency, the same way as *GlgIHCallCurrIHWithModifToken*.

```c
void GlgIHCallPrevIHWithModifToken( GlgCallEvent call_event,
                                    GlgIHToken token )
```

**GlgIHGetCurrIH**

Returns the ID of the current handler.

```c
GlgIH GlgIHGetCurrIH()
```

**GlgIHGetFunction**

Returns the function used to implement the handler.
GlgIHEntryPoint GlgIHGetFunction( GlgIH ih )

The GLG_IH_CURR macro can be used as the ih parameter to access the current handler.

The following example demonstrates the use of GlgIHGetFunction to identify the currently active handler.

```c
extern GlgIHEntryPoint MyIH;
if( GlgIHGetFunction( GLG_IH_CURR ) == MyIH )
...
```

**GlgIHGetPrevIH**

Returns the ID of the current handler’s parent handler.

```c
GlgIH GlgIHGetPrevIH()
```

**GlgIHGetPrevFunction**

Returns the function used to implement the parent handler of the currently active handler. The parent handler is the handler preceding the current handler on the stack.

```c
GlgIHEntryPoint GlgIHGetPrevFunction()
```

**GlgIHPassToken**

Installs the specified handler and invokes its entry point with the specified token.

```c
void GlgIHPassToken( GlgIHEntryPoint func, GlgIHToken token,
                     GlgBoolean uninstall )
```

If the uninstall parameter is GlgTrue, the handler is uninstalled after processing the token, unless the handler has already uninstalled itself. If the handler installs other handlers while processing the token, the last installed handler (the current handler) will be uninstalled instead of the handler the token is passed to.

This function is used to implement pass-through handlers for processing global accelerators, stateless options, as well as managing floating stay-open dialogs, such as the Edit Properties dialog shown on the GlgDiagram demo.
GlgIHSetIParameter
GlgIHSetDParameter
GlgIHSetSParameter
GlgIHSetOParameter
GlgIHSetPParameter
GlgIHSetOParameterFromD
GlgIHSetOParameterFromG

Create a named parameter of a requested type: I (integer), D (double), S (string), O (GLG object) or P (pointer).

GlgIHSetOParameterFromD and GlgIHSetOParameterFromG create a GLG data object parameter containing double (D) or geometrical (G) data.

```c
void GlgIHSetIParameter( GlgIH ih, char * name, GlgLong value )
void GlgIHSetDParameter( GlgIH ih, char * name, double value )
void GlgIHSetSParameter( GlgIH ih, char * name, char * value )
void GlgIHSetOParameter( GlgIH ih, char * name, GlgObject value )
void GlgIHSetPParameter( GlgIH ih, char * name, void * value )
void GlgIHSetOParameterFromD( GlgIH ih, char * name, double value );
void GlgIHSetOParameterFromG( GlgIH ih, char * name, double value1,
                              double value2, double value3 );
```

The `name` argument specifies the name of the parameter; this name can be used to query the value of the parameter using `GetParameter` functions. If a parameter with the specified name already exists, it will be replaced, which can change the type of the parameter associated with the name.

A parameter is added to the data storage of the handler specified by the `ih` argument. The GLG_IH_CURR macro can be used to specify the currently active handler, which can eliminate the need to pass the handler ID into all functions the handler may invoke.

The GLG_IH_GLOBAL macro can be used to add parameters to the global data storage.

When parameters are added, string parameters are cloned and object parameters are referenced. When the handler is uninstalled, all parameters stored in its data storage are automatically cleaned: string parameters are freed and object parameters are dereferenced. If pointer parameters are used to store addresses of allocated memory, the memory should be freed, as shown in the following example.

```c
case GLG_HI_SETUP:
    ptr = malloc( sizeof my_struct );
    GlgIHSetPParameter( ih, "my__struct", ptr );
    break;

...  

case GLG_IH_CLEANUP:
    ptr = GlgIGGetPParameter( ptr );
    free( ptr );
    break;
```
**GlgIHChangeIParameter**  
**GlgIHChangeDParameter**  
**GlgIHChangeSParameter**  
**GlgIHChangeOParameter**  
**GlgIHChangePParameter**

Same as corresponding SetParameter functions, except that the named parameter must exist. If the parameter does not exist, a GLG error is generated.

```c
void GlgIHChangeIParameter( GlgIH ih, char * name, GlgLong value )
void GlgIHChangeDParameter( GlgIH ih, char * name, double value )
void GlgIHChangeSParameter( GlgIH ih, char * name, char * value )
void GlgIHChangeOParameter( GlgIH ih, char * name, GlgObject value )
void GlgIHChangePParameter( GlgIH ih, char * name, void * value )
```

**GlgIHGetIParameter**  
**GlgIHGetDParameter**  
**GlgIHGetSParameter**  
**GlgIHGetOParameter**  
**GlgIHGetPParameter**

Return a value of a named parameter of a requested type: I (integer), D (double), S (string), O (GLG object) or P (pointer).

```c
GlgLong GlgIHGetIParameter( GlgIH ih, char * name )
double GlgIHGetDParameter( GlgIH ih, char * name )
char * GlgIHGetSParameter( GlgIH ih, char * name )
GlgObject GlgIHGetOParameter( GlgIH ih, char * name )
void * GlgIHGetPParameter( GlgIH ih, char * name )
```

A GLG error is generated if a requested named parameter does not exist, or if its value cannot be converted to the requested type.

For string parameters, a returned string pointer is not allocated and should not be modified, as it points to the internal string stored in the data storage.

**GlgIHGetOptIParameter**  
**GlgIHGetOptDParameter**  
**GlgIHGetOptSParameter**  
**GlgIHGetOptOParameter**  
**GlgIHGetOptPParameter**

Same as the corresponding GetParameter functions, except that the named parameter is optional. If a parameter with the requested name does not exist, a default value provided by the `default_value` argument is returned.
GlgLong GlgIHGetOptIParameter( GlgIH ih, char * name,
    GlgLong default_value )

double GlgIHGetOptDParameter( GlgIH ih, char * name,
    double default_value )

char * GlgIHGetOptSParameter( GlgIH ih, char * name,
    char * default_value )

GlgObject GlgIHGetOptOParameter( GlgIH ih, char * name,
    GlgObject default_value )

void * GlgIHGetOptPParameter( GlgIH ih, char * name,
    void * default_value )
2.10 GLG C++ Bindings

C++ bindings allow you to use the GLG Toolkit with C++ applications as a C++ class library. The bindings are implemented in such a way that every GLG object may be used as a C++ object, and other C++ classes may be derived from it as needed. The source code for the C++ bindings is provided, allowing compiling and using the bindings with any C++ compiler. The underlying GLG library does not depend on a C++ compiler used and may be used with any of them.

As with the GLG C API, the C++ bindings provide you with several ways of using them. If you are programming in a Motif or a Microsoft Windows environment, you can use native features of the corresponding platform, such as `GlgWrapperC` class for a Motif widget or MFC `CWnd` derived `GlgControlC` Class on Microsoft Windows.

If you want to write a cross-platform C++ program that can be compiled without changes in ether Linux/Unix or Windows environment, you may use `GlgObjectC` class, which uses the generic API and not depend on the windowing system. The `InitialDraw()` method of the class provides a platform-independent API for creating a window with a GLG drawing displayed inside it.

The C++ API methods mimic the methods of the GLG C API. This chapter provides only a brief description of each API method; refer to the Animating a GLG Drawing with Data Using the Standard API chapter on page 61 for a detailed description of each method’s functionality. Refer to the Handling User Input and Other Events chapter on page 101 for details of the Input callback. Refer to the GLG Intermediate and Extended API chapter on page 119 for a detailed description of the Intermediate and Extended API methods.

**Standard, Intermediate and Extended API Macros**

The C++ bindings for all GLG APIs (Standard, Intermediate and Extended) are implemented in a single source code file, `GlgClass.cpp`. The `GlgClass.h` include file provides declarations for all classes and methods used by the C++ bindings. To use methods of the Standard, Intermediate or Extended API, the application has to link with the corresponding GLG library.

The following preprocessor macros control the use of the GLG API libraries in the C++ bindings:

**GLG_CPP_STANDARD_API**

Activates methods of the Standard API and disables Intermediate and Extended API methods.

**GLG_CPP_INTERMEDIATE_API**

Activates methods of the Standard and Intermediate APIs and disables the Extended API.

**GLG_CPP_EXTENDED_API**

Activates methods of the Standard, Intermediate and Extended APIs.

To enable a required API, define one of the macros before including the `GlgClass.h` file. Passing a defined symbol to a compiler using the `-D` option is the most convenient way of defining a macro. In the Visual Studio environment, a preprocessor symbol can be defined in the project settings.
Only one of the API macros should be defined. If no API macro is defined, the Extended API will be activated by default, which can result in linking errors if the program is not linked with the Extended API library.

Handling of Constant Strings

Starting with the GLG version 3.3, strings passed as parameters to the GLG C++ methods are considered constant (const char *) by default to avoid compilation warnings. This is accomplished by the CONST_CHAR_PTR preprocessor macro which is defined as True by default.

The macro can be set to False for compatibility with the previous releases, or for performance optimization using writable strings where this option is available. The macro has to be defined before including the GlgClass.h file, in the same way as the API macros described above.

In the method prototypes listed below, the optional const modifier is not shown for string and string array parameters.

C++ API Files and Libraries

The C++ API consists of the following files:

GlgClass.h

Include file, located in the GLG include directory, declares all GLG C++ classes.

GlgClass.cpp

Source file, located in the GLG source directory (named “src”), has to be compiled with the project.

stdafx.h

Include stub file, is needed on UNIX only to make the source code generic. It allows you to get around the special handling that Visual C++ provides for this file in case of precompiled headers.

No additional libraries are required for GLG C++ bindings.

Using GLG Objects

No matter which C++ API you use in your application, platform-specific or generic, you always use the main GlgObjectC C++ class. In the Motif environment, the GlgWrapperC widget class is derived from the GlgObjectC class and inherits its methods. In Microsoft Windows environment, the GlgControlC class is derived from CWnd to inherit its window functionality, but it has a viewport object of the GlgObjectC class as it’s publicly accessible attribute that provides GLG functionality.
The \textit{GlgObjectC} class is the central class of the GLG C++ API. It keeps an object ID of the associated GLG object as one of its data members, in the same way as MFC’s \textit{CWnd} class keep a window ID of the associated window.

The \textit{GlgObjectC} class has several constructors, allowing several ways of creating of the associated GLG object: by loading it from a file, loading from a generated memory image, or by referencing a named resource inside another GLG object.

There is also a default constructor with no arguments, which creates a \textit{GlgObjectC} class with a \textit{NULL} GLG object. The GLG object may be associated with this instance of the class later, by using several available \textit{Load()} methods, which allow loading it from a file, memory image or associating a reference of some named resource of another object. If a \textit{Load()} method is used for a class instance which already has an associated GLG object, it is dissociated from the previous object and associated with the new one.

The \textit{GlgObjectC} class also provides an overloaded assignment operator, which associates the left hand side class instance with a reference to the same GLG object of the right hand class instance. Any previous associations are discarded.

There are type converters to and from \textit{GlgObject} ID, which allows assigning the \textit{GlgObject} ID to a class and using both the \textit{GlgObject} ID and the instance of the \textit{GlgObjectC} class interchangeably.

The \textit{GlgObject} ID is used as a return value of some methods of the class, allowing you to avoid returning temporary instances of the class or class pointers, both of which may lead to memory leaks or dangling pointers. The \textit{GlgObject} return value may then be assigned to an instance of the class as in the following example:

```cpp
GlgObjectC car( "car.g" );
GlgObjectC wheel = car.GetResourceObject( "Wheel0" );
```

In this example, the object from “car.g” drawing file gets loaded and associated with a car class instance. Then the first wheel of the car gets associated with the wheel class instance. The above example may be rewritten using constructors only:

```cpp
GlgObjectC car( "car.g" );
GlgObjectC wheel( car, "Wheel0" );
```

Notice that the wheel class instance is associated with an GLG object which is the part of another object. You cannot add that wheel object to the car object again, because it is already a part of it. You can use the \textit{Copy()} method to create a new copy of a wheel object and associate that new copy with the class instance:

```cpp
wheel.Copy();
wheel.SetResource( "Name", "SpareWheel" ); // Use distinct name
car.Add( wheel );
```
The same thing can also be accomplished by using a copy constructor:

```cpp
{  
    GlgObjectC spare_wheel( wheel );  
    spare_wheel.SetResource( "Name", "SpareWheel" );  
    car.Add( spare_wheel );
}
```

### Automatic Referencing and Dereferencing

The `GlgObjectC` class provides automatic referencing and dereferencing of the associated GLG object, freeing the developer from keeping track of temporary objects. For example, the `spare_wheel` object in the above example gets automatically dereferenced in its destructor when it goes out of scope after being added to a car.

Some methods, such as `CreateTagList`, create and return a new GLG object (a list of tags in the case of `CreateTagList`). The return value of these methods has to be explicitly dereferenced using the `Drop` method to avoid memory leaks, as shown in the following example:

```cpp
GlgObjectC tag_list = drawing.CreateTagList( True );  
tag_list.Drop();  
ProcessTags( tag_list );
```

In the above example, the tag list object created by `CreateTagList` gets extra referenced when it is assigned to the `tag_list` variable. Therefore, it is safe to dereference it by calling the `Drop` method right after the call to `CreateTagList`, even though the tag list is still used in the program. The tag list will be destroyed when the `tag_list` variable goes out of scope (unless the tag list is referenced inside the `ProcessTags` method by assigning it to a global variable to keep the tag list).

In addition to the explicit `Reference()` and `Drop()` methods, the `GlgObjectC` class also implements overloaded increment (`++`) and decrement (`--`) operators providing the same functionality. Note that calling the `Drop()` method explicitly without referencing the object first may cause destruction of the object and a crash due to an invalid GLG object ID.

### Comparison Operators

The `IsNull()` method returns `TRUE` if there is no GLG object associated with the class instance (`NULL GlgObjectC` ID). There is also an overloaded logical negation operator which performs the same function: `!object` yields `TRUE` when there is no associated GLG object.

Notice an interesting usage of double negation: `!!object` returns `TRUE` when there is a GLG object associated with the class instance.

The `Same()` method of the `GlgObjectC` class provides a logical equality operator: it returns `TRUE` if the instances of the class is associated with the same GLG object as the instance of the class passed as a parameter.
Using Input and Selection Callbacks

The input and selection callbacks are virtual methods of all three main GLG API classes: GlgObjectC, GlgWrapperC and GlgControlC. To use these callbacks, derive your class from any of these classes and provide your implementation of Input() and Selection() callbacks that overrides the ones of the base class. Use the EnableCallbacks() method of the base class to enable the callbacks. Refer to the programming examples described below for more details.

Miscellaneous Utility Classes

The GlgSessionC class handles initialization of the GLG Toolkit. One instance of this class has to be created to initialize the Toolkit. In some cases the initialization may be skipped, as describer later.

In the Motif environment, the Toolkit is initialized automatically when the Create() method of the Wrapper Widget class is invoked.

In the Microsoft Windows environment, the toolkit is initialized automatically if a .dll version of the library is used, or when a Create() method of the GlgControlC class is invoked.

In both cases, the initialization may be skipped only if there are no other GLG calls were issued before invoking the Create() method. An explicit initialization is mandatory when the Generic C++ API is used. It is always safe to use explicit initialization in either case.

The MainLoop() method of the GlgSessionC class also provides a generic interface to the window system specific event loop.

The GlgLinkC class is derived from the GlgObjectC class and provides additional ICC functionality for communicating between GLG processes using link objects. The class provides methods for establishing a link to a GLG ICC viewport server. The rest of functionality for setting resources and updating through a link is inherited from it’s base GlgObjectC class.

Programming Examples

The examples_c_cpp directory contains source code examples for both C and C++. On Windows, the examples_mfc directory contains MFC examples.

List of Classes and Methods in the GLG C++ Bindings

GlgSessionC

Provides an interface for initializing the GLG Toolkit.

Data Members:

GlgApplicationContext app_context;

Application context returned by GlgInit().
Methods:

\textit{GlgSessionC( \textit{void} );}

Default constructor.

\textit{GlgSessionC( \textit{GlgBoolean initialized, GlgAppContext application\_context, int argc = 0, char ** argv = NULL} );}

Constructor: calls \textit{GlgInit()}. 

\textit{virtual ~GlgSessionC( \textit{void} );}

Destructor.

\textit{GlgAppContext GetAppContext( \textit{void} );}

Returns the application context.

\textit{GlgBoolean MainLoop( \textit{void} );}

Provides a generic interface to the event loop.

\textit{void Create( \textit{GlgBoolean initialized = False, GlgAppContext application\_context = NULL, int argc = 0, char ** argv = NULL} );}

Calls \textit{GlgInit()}. 

\textit{GlgObjectC}

This is the main class of the GLG C++ bindings. It has the functionality of the regular and Extended API.

Data Members:

\textit{GlgObject glg\_obj;}

An object ID of associated GLG object.

\textit{GlgObject suspend\_obj;}

Suspension information object. Is not \textit{NULL} if the object was suspended for editing.

Methods:

\textit{GlgObjectC( \textit{void} );}

Default constructor: Creates a null object.

\textit{GlgObjectC( \textit{GlgObjectType type, char * name = NULL, GlgAnyType data1 = NULL, GlgAnyType data2 = NULL, GlgAnyType data3 = NULL, GlgAnyType data4 = NULL} );}

Constructor: creates a new object of the type using default attributes.


```cpp
GlgObjectC( char * filename );

Constructor: loads an object from a file.

GlgObjectC( long object_data[], long object_data_size );

Constructor: loads an object from a generated memory image.

GlgObjectC( GlgObjectC& object,
    GlgCloneType clone_type = GLG_FULL_CLONE );

Copy constructor: creates a copy of the object. The type of copying is defined by a clone_type parameter. Default type is GLG_FULL_CLONE.

GlgObjectC( GlgObjectC& object, char * resource_name );

Constructor: associates with a named resource object inside another and references it.

GlgObjectC( GlgObject object );

Constructor: creates a C++ class from GlgObject to allow assigning GlgObject to a GlgObjectC object class:

    GlgObjectC object = GetResourceObject( ... );

GlgObjectC( GlgObjectC * object );

Constructor: creates a C++ class from a GlgObjectC pointer. This constructor is needed by some C++ compilers for proper handling of temporary objects.

virtual ~GlgObjectC( void );

Destructor: Deletes or dereferences the GLG object.

operator GlgObject( void );

Type converter to GlgObject.

GlgObjectC& operator=( const GlgObjectC& object );

Assignment operator: associates the GLG object and references it.

GlgObjectC& operator++( void ); // prefix ++
GlgObjectC& operator++( int ); // postfix ++
GlgObjectC& operator--( void ); // prefix --
GlgObjectC& operator--( int ); // postfix --

Overloaded ++; --, both infix and postfix. Overloaded to reference/dereference.
```
void Reference( void );

void Drop( void );
    Explicit reference/dereference.

GlgBoolean Save( char * filename );
    Saves the associated GLG object into a file.

GlgBoolean Load( char * filename, char * object_name = NULL );
    Explicit Load(). Replaces the associated GLG object with the loaded one. Two sets of overloaded load functions: one for loading the whole drawing or its named components, and another for extracting just the “$Widget” viewport.

    Loads an object from a file. If object_name is not NULL, extracts and loads just that named resource of the object.

GlgBoolean Load( void * object_data, long object_data_size, char * object_name = NULL );
    Loads an object from a generated memory image.

GlgBoolean Load( GlgObjectC& object, char * object_name = NULL );
    Associates with an object inside another object and references it. If object_name is NULL, uses the parameter object itself.

GlgBoolean LoadWidget( char * filename );
    Loads a “$Widget” viewport from a file.

GlgBoolean LoadWidget( void * object_data, long object_data_size );
    Loads a “$Widget” viewport from a generated memory image.

GlgBoolean LoadWidget( GlgObjectC& object );
    Loads a “$Widget” viewport from another object.

void LoadNullObject( void );
    Dissociates and sets the GLG object ID to NULL.

void Create( GlgObjectType type, char * name = NULL,
            GlgAnyType data1 = NULL, GlgAnyType data2 = NULL,
            GlgAnyType data3 = NULL, GlgAnyType data4 = NULL );
    Replaces the current object with a created object.

void Copy( GlgCloneType clone_type = GLG_FULL_CLONE );
    Replaces the current object with a copy of it.
GlgBoolean GetResource( char * resource_name, double * value );  // D-type
GlgBoolean GetResource( char * resource_name, char ** s_value );  // S-type
GlgBoolean GetResource( char *resource_name, double *x_value, 
                      double *y_value, double *z_value );  // G-type
GlgBoolean GetTag( char * tag_source, double * value );  // D-type
GlgBoolean GetTag( char * tag_source, char ** s_value );    // S-type
GlgBoolean GetTag( char * tag_source, double x_value, double y_value, double z_value);  // G-type
  Get resource or tag values.
GlgBoolean SetResource( char * resource_name, double value );  // D-type
GlgBoolean SetResource( char * resource_name, char * s_value ); // S-type
GlgBoolean SetResource( char * resource_name, 
                        double x_value, double y_value, double z_value);  // G-type
GlgBoolean SetResource( char * resource_name, double value, GlgBoolean if_changed );  // D-type
GlgBoolean SetResource( char * resource_name, char * s_value, GlgBoolean if_changed ); // S-type
GlgBoolean SetResource( char * resource_name, 
                        double x_value, double y_value, double z_value, GlgBoolean if_changed );  // G-type
GlgBoolean SetTag( char * tag_source, double value, GlgBoolean if_changed );     // D-type
GlgBoolean SetTag( char * tag_source, char * s_value, GlgBoolean if_changed );     // S-type
GlgBoolean SetTag( char * tag_source, 
                   double x_value, double y_value, double z_value, GlgBoolean if_changed );  // G-type
  Set resource or tag values.
GlgBoolean SetResource( char * resource_name, char * format, double value );
GlgBoolean SetResource( char * resource_name, char * format, double value, 
                        GlgBoolean if_changed );
GlgBoolean SetTag( char * tag_source, char * format, double value, GlgBoolean if_changed );
  Set S resource or tag from a double value according to the specified format.
GlgBoolean SetResource( char * resource_name, GlgObjectC& object );
  Set resource from object.
GlgBoolean HasResourceObject( char * resource_name );
  Checks if a named resource exists.
GlgBoolean HasTagName( char * tag_name );

GlgBoolean HasTagSource( char * tag_source );

Checks if a tag with the specified tag name or tag source exists.

GlgObject CreateTagList( GlgBoolean unique_tags );

Creates and returns a list of the object’s tags.

Since the method creates a new object, its returned value must be explicitly dereferenced. This can be done by invoking the Drop method on the GlgObjectC object the return value is assigned to.

GlgObject CreateAlarmList( void );

Creates and returns a list of alarms attached to the object.

Since the method creates a new object, its returned value must be explicitly dereferenced. This can be done by invoking the Drop method on the GlgObjectC object the return value is assigned to.

GlgObject GetGlgObject( void );

Returns an object ID of the associated GLG object.

void SetGlgObject( GlgObject object );

Low-level object manipulation function: sets the associated GLG object.

GlgBoolean IsNull( void );

GlgBoolean operator!( void );

NULL check to use after Load/GetResourceObject/etc.

GlgBoolean Same( GlgObjectC& object );

Returns TRUE if the object refers to the same object ID as the parameter object.

void InitialDraw( void );

void SetupHierarchy( void );

void ResetHierarchy( void );

GlgBoolean Reset( void );

Other viewport-related GLG API functions.

GlgBoolean Sync( void );

Flushes all graphic requests and waits for their completion.

GlgBoolean Update( void );

Updates the viewport’s graphic with the new data.
void EnableCallback( GlgCallbackType callback_type, GlgObject callback_viewport = NULL );

Enables selection and input callbacks of the object. If callback_viewport is not NULL, adds GLG callbacks to it, otherwise adds it to this object (which must be a viewport).

virtual void Input( GlgObjectC& callback_viewport, GlgObjectC& message );
virtual void Select( GlgObjectC& callback_viewport, char ** name_array );
virtual void Trace( GlgObjectC& callback_viewport, GlgTraceCBStruct * trace_info );
virtual void Trace2( GlgObjectC& callback_viewport, GlgTraceCBStruct * trace_info );
virtual void Hierarchy( GlgObjectC& callback_viewport, GlgHierarchyCBStruct * hierarchy_info );

Virtual callback functions to be overridden by a derived class.

GlgBoolean SetZoom( char * resource_name, GlgLong type, double value )

Performs a zoom or pan operation specified by the type parameter. If the resource_name parameter is null, the viewport itself is zoomed. Otherwise, the zoom operation will be performed on its child viewport specified by the resource_name parameter. The value parameter defines the zoom factor or pan distance. Refer to the GlgSetZoom section on page 93 for a complete list of all zoom and pan types.

GlgBoolean SetZoomMode( char * resource_name, GlgObjectC * zoom_object, char * zoom_object_name )

Sets or resets a viewport’s zoom mode by supplying a GIS or Chart object to be zoomed. In the Drawing Zoom Mode (default), the drawing displayed in the viewport is zoomed and panned. If the GIS Zoom Mode is set, any zooming and panning operation performed by the GlgSetZoom method will zoom and pan the map displayed in the viewport’s GIS Object, instead of being applied to the viewport’s drawing. In the Chart Zoom Mode, the content of the chart is zoomed and panned. If the resource_name parameter is null, the zoom mode of the viewport itself will be set. Otherwise, the zoom mode will be set for its child viewport specified by the resource_name parameter. If the zoom_name parameter is not null, it specifies the resource path of a GIS or Chart object relative to the zoom_object parameter, or relative to the viewport if the zoom_object parameter is null. The method may be invoked with zoom_object=null and zoom_object_name=null to reset the zoom mode to the default Drawing Zoom Mode.

GlgBoolean Print( char * filename = ”out.ps”, double x=-1000., double y=-1000.,
                    double width = 2000., double height = 2000.,
                    GlgBoolean portrait = True, GlgBoolean stretch = True );

Printing method.

GlgBoolean SaveImage( char * resource_name, char * filename, GlgImageFormat format )

Method for saving an image of the visible area of the drawing’s viewport.
GLGBoolean SaveImageCustom( char * resource_name, char * filename, GlgImageFormat format, GlgLong x, GlgLong y, GlgLong width, GlgLong height, GlgLong gap )

Method for saving an unclipped image of the whole drawing.

void MetaDraw( char * filename="out.meta",
                double x=-1000., double y=-1000., double width = 2000., double height = 2000.,
                GlgBoolean portrait = True, GlgBoolean stretch = True );

GLG Metafile support.

GLGBoolean Print( CDC * dc,
                  double x=-1000., double y=-1000., double width = 2000., double height = 2000.,
                  GlgBoolean portrait = True, GlgBoolean stretch = True );

MICROSOFT WINDOWS ONLY: Native windows printing, GLG controlled page layout.

void OnPrint( CDC * dc );

MICROSOFT WINDOWS ONLY: Native window printing, windows-controlled page layout.

void OnDrawMetafile( CDC * dc );

MICROSOFT WINDOWS ONLY: Native window printing with clipping disabled.

GlgAnyType SendMessage( char * resource_name, char * message, GlgAnyType param1,
                         GlgAnyType param2, GlgAnyType param3, GlgAnyType param4 )

Sends a message specified by the message parameter. If the resource_name parameter is null, the message is sent to the object itself. Otherwise, the message is sent to the object’s child specified by the resource_name parameter. The param<n> arguments define additional parameters of the message depending on the message type.

GlgObject GetNamedPlot( char * resource_name, char * plot_name )

Finds a chart’s plot by name and returns it’s object ID. If the resource_name parameter is NULL, a named plot of this chart is returned. Otherwise, the resource_name parameter points to a child chart of this object. The method returns NULL if a plot with the specified name has not been found.

GlgObject AddPlot( char * resource_name, GlgObject& plot )

Adds a plot to a chart object. If the resource_name parameter is NULL, the plot is added to this chart. Otherwise, the plot is added to a child chart of this object pointed to by the resource_name parameter. The plot parameter specifies the plot object to add; NULL can be used to create a new plot. The method returns the added plot object on success, or NULL on failure.

GLGBoolean DeletePlot( char * resource_name, GlgObject& plot )

Deletes a plot from a chart object. If the resource_name parameter is NULL, the plot is deleted from this chart. Otherwise, the plot is deleted from a child chart of this object pointed to by the resource_name parameter. The plot parameter specifies the plot object to delete. The method returns True if the plot was successfully deleted.
**GlgBoolean GetDataExtent( char * resource_name, GlgMinMax * min_max, GlgBoolean x_extent )**

Queries the minimum and maximum extent of the data accumulated in a chart or in one of its plots. If the `resource_name` parameter is NULL, the data extent of this chart or plot object is returned. Otherwise, the `resource_name` parameter points to a child chart or a child plot of this object. If `x_extent` is True, the X extent of the data is returned in `min_max`, otherwise the method returns the Y extent of the data. `GlgMinMax` is defined in the `GlgApi.h` file:

```c
typedef struct _GlgMinMax
{
    double min, max;
} GlgMinMax;
```

For a chart object, the method returns the data extent of all plots in the chart. For a plot, the data extent of that plot is returned. The object hierarchy must be set up for this function to succeed. The method returns True on success.

**Additional Standard API Methods**

The `GetElement` and `GetSize` methods described in the Intermediate and Extended API Methods section are also available in the Standard API.

**Extended and Intermediate API**

There are two flavors of the Extended API: **GLG Intermediate API** and **GLG Extended API**. The Intermediate API provides all Extended API methods except for the methods for creating and deleting objects at run time. The list below describes methods of both APIs, with an availability comment for methods that are available only with the Extended API.

**Intermediate and Extended API Methods**

**GlgObject GetResourceObject( char * resource_name );**

Explicit `GetResourceObject()`. The return value may be assigned to a `GlgObjectC` class.

**GlgBoolean SetResourceObject( char * resource_name, GlgObjectC& o_value );**

Sets the new value of the object’s attribute specified by the `resource_name` (Extended API only). It is used for attaching Custom Property objects and aliases.

**GlgObject GetTagObject( char * search_string, GlgBoolean by_name, GlgBoolean unique_tags, GlgBoolean single_tag )**

Finds a single tag with a given tag name or tag source, or creates a list of tags matching the wildcard. The `search_string` specifies either the exact tag name or tag source to search for, or a search pattern which may contain the `?` and `*` wildcards. The `by_name` parameter defines the search mode: by a tag name or tag source. In the single tag mode, the first tag matching the search criteria is returned. The `unique_tags` controls if only one tag is included in case there are multiple tags with the same tag name or tag source. The `unique_tags` flag is ignored in the single tag mode.
In the single tag mode, the method returns the first attribute that has a tag matching the search criteria. In the multiple tag mode, a list containing all attributes with matching tags will be returned. The return value may be assigned to a `GlgObjectC` class.

In the multiple tag mode, the method creates a new list object and its returned value must be explicitly dereferenced. This can be done by invoking the `Drop` method on the `GlgObjectC` object the return value is assigned to.

```c
GlgObject QueryTags( GlgTagType tag_type_mask )
```

Returns a list of all tags of the specified tag type. Since the method creates a new list object, its returned value must be explicitly dereferenced. This can be done by invoking the `Drop` method on the `GlgObjectC` object the return value is assigned to.

```c
GlgObject GetAlarmObject( char * search_string, GlgBoolean single_alarm )
```

Finds a single alarm with a given alarm label, or creates a list of alarms with alarm labels matching the specified wildcard. The `search_string` specifies either the exact alarm label or a search pattern which may contain the `?` and `*` wildcards.

In the single alarm mode, the method returns the first alarm object with an alarm label matching the search criteria. In the multiple alarm mode, a list containing all alarms with matching alarm labels will be returned.

In the multiple alarm mode, the method creates a new list object and its returned value must be explicitly dereferenced. This can be done by invoking the `Drop` method on the `GlgObjectC` object the return value is assigned to.

```c
GlgBoolean SetXform( GlgObjectC& xform );
```

Adds a transformation to the object (Extended API only).

```c
GlgObject GetParent( GlgLong * num_parents );
```

Gets a parent object or array of parents if `num_parents` > 1.

```c
GlgCube * GetBoxPtr( void );
```

Returns 3D bounding box of an object.

```c
GlgObject GetDrawingMatrix( void );
```

Returns a drawing matrix object used to render the object.

```c
void SuspendObject( void );
```

Suspends or releases the object.
GlgObject CreateResourceList( GlgBoolean list_named, GlgBoolean list_default,  
GlgBoolean list_aliases );

Returns a list of resources of the object.

Since the method creates a new object, its returned value must be explicitly dereferenced. This can  
be done by invoking the Drop method on the GlgObjectC object the return value is assigned to.

GlgObject CreatePointArray( GlgCoordType type );

Returns a list of resources of the object. The type parameter is reserved for a future use and must be  
set to 0.

Since the method creates a new object, its returned value must be explicitly dereferenced. This can  
be done by invoking the Drop method on the GlgObjectC object the return value is assigned to.

GlgBoolean MoveObject( GlgCoordType coord_type, GlgPoint * start_point, GlgPoint * end_point );

Moves an object by the specified vector.

GlgBoolean MoveObjectBy( GlgCoordType coord_type, double x, double y, double z );

Moves an object by the specified X, Y and Z distances.

GlgBoolean ScaleObject( GlgCoordType coord_type, GlgPoint * center, double x, double y, double z );

Scales an object relative to the center by the specified X, Y and Z scale factors.

GlgBoolean RotateObject( GlgCoordType coord_type, GlgPoint * center, double x, double y, double z );

Rotates an object around the specified center by the specified X, Y and Z angles.

GlgBoolean PositionObject( GlgCoordType coord_type, GlgLong anchoring,  
double x, double y, double z );

Positions an object at the specified location using the specified anchoring.

GlgBoolean FitObject( GlgCoordType coord_type, GlgCube * box, GlgBoolean keep_ratio );

Fits the object to the specified area.

GlgBoolean LayoutObjects( GlgObject sel_elem, GlgLayoutType type, double distance,  
GlgBoolean use_box, GlgBoolean process_subobjects )

Performs a requested layout operation. Refer to the GLG Intermediate and Extended API chapter  
on page 119 for more details.

GlgBoolean ScreenToWorld( GlgBoolean inside_vp, GlgPoint * in_point, GlgPoint * out_point );

Converts a point coordinates from the screen to the GLG world coordinate system. The inside_vp  
flag must be set to GlgTrue for viewport objects to convert to the world coordinate system inside  
the viewport. When converting the cursor position to world coordinates, add  
GLG_COORD_MAPPING_ADJ to the cursor’s x and y screen coordinates for precise mapping.
GLGBoolean WorldToScreen( GlgBoolean inside_vp, GlgPoint * in_point, GlgPoint * out_point );

Converts a point coordinates from the GLG world to the screen coordinate system. The inside_vp flag must be set to GlgTrue for viewport objects to convert from the world coordinate system inside the viewport.

GLGBoolean PositionToValue( char * resource_name, double x, double y,
                           GlgBoolean outside_x, GlgBoolean outside_y, double * value )

Returns a value corresponding to the specified x, y position on top of a chart or an axis object. If the resource_name parameter is null, the value corresponding to this object is returned. Otherwise, the resource_name parameter points to a child chart, a child plot or a child axis of this object.

If outside_x or outside_y are set to True, the method returns NULL if the specified position is outside of the chart or the axis in the corresponding direction.

For a plot, the method converts the specified position to a Y value in the Low/High range of the plot and returns it via the value pointer.

For an axis, the function converts the specified position to the axis value and returns the value.

For a chart, the function converts the specified position to the X or time value of the chart’s X axis and returns the value.

When using the cursor position, add GLG_COORD_MAPPING_ADJ to the cursor’s x and y coordinates for precise mapping.

GLGObject CreateChartSelection( GlgObjectC plot, double x, double y, GlgBoolean screen_coord,
                               GlgBoolean include_invalid, GlgBoolean x_priority )

Selects a chart’s data sample closest to the specified x, y position and returns a message object containing the selected sample’s information. If plot contains a null GLG object, the method queries samples in all plots of the chart and selects the sample closest to the specified position. If plot contains a non-null GLG object, the method queries only the samples in that plot.

If the screen_coord parameter is set to True, the position is defined in the screen coordinates of the chart’s parent viewport. If screen_coord is set to False, the x position is defined as an X or time value, and the y position is defined in relative coordinates in the range [0; 1] to allow the chart to process selection for plots with different ranges (0 corresponds to the Low range of each plot, and 1 to the High range). When the mouse position is used, add GLG_COORD_MAPPING_ADJ to the x and y screen coordinates of the mouse for precise mapping.

The dx and dy parameters specify an extent around the point defined by the x and y parameters. The extent is defined in the same coordinates as x and y, depending on the value of the screen_coord parameter. A data sample in a chart is selected only if its x and y coordinates differ from the specified position by amounts less or equal to the values of the corresponding dx or dy parameters.
If `include_invalid` is set to `True`, invalid data samples are considered for selection, otherwise they are never included. If `x_priority` is set to `True`, the method selects the data sample closest to the specified position in the horizontal direction, with no regards to its distance from the specified position in the vertical direction. If `x_priority` is set to `False`, a data sample with the closest distance from the specified position is selected.

The information about the selected data sample is returned in the form of a message object described in the *Chart Selection Message Object* section on page 446. The method returns NULL if no data sample matching the selection criteria was found.

Since the method creates a new object, its returned value must be explicitly dereferenced. This can be done by invoking the *Drop* method on the `GlgObjectC` object the return value is assigned to.

```c
char * CreateTooltipString( double x, double y, double dx, double dy, char * format )
```

Creates and returns a chart or axis tooltip string corresponding to the specified `x, y` position in screen coordinates. The string can be used to provide cursor feedback and display information about the data sample under the current mouse position, as shown in the Real-Time Strip-Chart demo.

The `format` parameter provides a custom format for creating a tooltip string and uses the same syntax as the `TooltipFormat` attributes of the chart and axis objects. If it is set to NULL or an empty string, the format provided by the `TooltipFormat` attribute of this chart or axis object will be used. A special “"<single_line>"” tag may be prepended to the format string to force the method to remove all line breaks from the returned tooltip string.

If *this* object is a chart and the selected position is within the chart’s data area, the method selects a data sample closest to the specified position and returns a tooltip string containing information about the sample. The `dx` and `dy` parameters define the maximum extent in pixels around the specified position for selecting a data sample, and the `TooltipMode` attribute of the chart defines the data sample selection mode: X or XY. The method returns NULL if no samples matching the selected criteria were found.

If *this* object is an axis, or if *this* object is a chart and the selected position is on top of one of the chart’s axes, the function returns a tooltip string that displays the axis value corresponding to the specified position.

When using the cursor position, add `GLG_COORD_MAPPING_ADJ` to the cursor’s `x` and `y` screen coordinates for precise mapping.

The returned string must be freed using the `GlgFree` function.

*Attribute Objects*

```c
GlgBoolean ConstrainObject( GlgObjectC& to_attribute );
```

```c
GlgBoolean UnconstrainObject( void );
```

Constrains or unconstrains the attribute object.
Matrix Objects

\texttt{GlgObject \textbf{InverseMatrix( void );}}

Creates and returns a new matrix. Since the method creates a new matrix object, its returned value must be explicitly dereferenced. This can be done by invoking the \texttt{Drop} method on the \texttt{GlgObjectC} object the return value is assigned to.

\texttt{void \textbf{TransformPoint( GlgPoint \ast in\_point, GlgPoint \ast out\_point );}}

Transforms point using the GLG matrix object associated with this class instance.

\texttt{void \textbf{GetMatrixData( GlgMatrixData \ast matrix\_data );}}

Queries matrix coefficients.

\texttt{void \textbf{SetMatrixData( GlgMatrixData \ast matrix\_data );}}

Sets matrix coefficients.

Container Functionality

\texttt{GlgBoolean \textbf{IsContainer( void );}}

Returns \texttt{TRUE} if the associated GLG object is a GLG container (viewport,

\texttt{void \textbf{SetStart( void );}}

Initializes container for traversing.

\texttt{GlgObject \textbf{Iterate( void );}}

Returns the next subobject of the associated container object.

\texttt{GlgLong \textbf{GetSize( void );}}

Returns the size of the associated container object.

\texttt{GlgBoolean \textbf{AddToTop( GlgObjectC& object );}}

\texttt{GlgBoolean \textbf{AddToBottom( GlgObjectC& object );}}

\texttt{GlgBoolean \textbf{AddAt( GlgObjectC& object, GlgLong index );}}

Add object to container (Extended API only).

\texttt{GlgBoolean \textbf{DeleteTopObject( void );}}

\texttt{GlgBoolean \textbf{DeleteBottomObject( void );}}

\texttt{GlgBoolean \textbf{DeleteObjectAt( GlgLong index );}}

\texttt{GlgBoolean \textbf{DeleteObject( GlgObjectC& object );}}

Delete this object from container (Extended API only).
GlgObject ReorderElement( GlgLong old_index, GlgLong new_index );

Reorder elements of the container.

GlglBoolean ContainsObject( GlgObjectC& object );
GlglObject GetElement( GlgLong index );
GlglObject GetNamedObject( char * name );
GlgLong GetIndex( GlgObjectC& object );
GlglLong GetStringIndex( char * string );

Search functions for finding elements of a container.

void Inverse();

Inverses the order of container’s elements.

**GlglLinkC**

GlglLinkC is subclassed from GlgObjectC to inherit SetResource() and GetResource() and other methods. Provides methods for establishing links between GLG processes by using GLG ICC. Some inherited methods of extended API are not implemented yet for links. Note also that there is a type converter to GlgObject that is inherited from GlgObjectC.

**Methods:**

GlglLinkC( void );

Default constructor: creates a null link object.

GlglLinkC( char * display_name, char * server_name );

Constructor: creates a link object and connects it to a named GLG ICC Server.

GlglLinkC( GlgObjectC& object );

Constructor: creates a link from a GlgObjectC class:

```
GlglObjectC some_object;
GlglLinkC link = some_object;
```

GlglLinkC( GlgObject object );

Constructor: creates a link from a GlgObject.

GlglLinkC( GlglLinkC& object );

Copy constructor. The server connection is not copied.

virtual ~GlglLinkC( void );

Destructor, calls GlgDestroyLink().
Connect( char * display_name, char * server_name );

Establish a connection to a named GLG ICC Server.

Disconnect( void );

Explicit link closing, calls GlgDestroyLink().

GlgLinkC& operator= ( const GlgLinkC& object );

Assignment operator, the server connection is not copied.

GlgBoolean IsActive();

Interface to GlgLinkActive: returns TRUE is the link is active.

**GlgControlC (Microsoft Windows Only)**

MFC CWnd derived class providing a window for displaying a GLG drawing.

Data Members:

GlgObjectC viewport;

An object ID of the associated GLG viewport object with the drawing.

Methods:

GlgControlC( void );

Default constructor: creates an empty control.

virtual ~GlgControlC( void );

Destructor. Destroys the window and dereferences the viewport object.

void Create( char * drawing_file, CWnd * parent,
            char * control_name = "GlgControl", CRect * in_rect = NULL, int IDC_id = 0 );

Creates a control’s window and loads drawing from a file into it.

void Create( void * drawing_image, long image_size, CWnd * parent,
             char * control_name = "GlgControl", CRect * in_rect = NULL, int IDC_id = 0 );

Creates a control’s window and loads drawing from a generated memory image.

void Create( GlgObjectC& object, CWnd * parent,
             char * control_name = "GlgControl", CRect * in_rect = NULL, int IDC_id = 0 );

Creates a control’s window and uses the "$Widget” viewport of another GLG object as a drawing.

void InitialDraw();

Draws the graphics the first time.
GlgBoolean Update( void );

Updates the displayed graphics.

void SetDrawing( char * filename );

Changes the drawing, load a new drawing from a file.

void SetDrawing( void * drawing_image, long drawing_image_size );

Changes the drawing, load a new drawing from a generated memory image.

void SetDrawing( GlgObjectC& object );

Changes the drawing, use the "$Widget" viewport of another object as a new drawing.

virtual void EnableCallback( GlgCallbackType callback_type,
GlgObject callback_viewport = NULL );

Enables selection and input callbacks of the control. If callback_viewport is not NULL, adds GLG callbacks to it, otherwise adds it to the control’s viewport.

virtual void Input( GlgObjectC& callback_viewport, GlgObjectC& message );

virtual void Select( GlgObjectC& callback_viewport, char ** name_array );

virtual void Trace( GlgObjectC& callback_viewport, GlgTraceCBStruct * trace_info );

virtual void Trace2( GlgObjectC& callback_viewport, GlgTraceCBStruct * trace_info );

virtual void Hierarchy( GlgObjectC& callback_viewport, GlgHierarchyCBStruct * hierarchy_info );

Virtual callback functions to be overridden by a derived class.

void Print( CDC * pDC, DWORD dwFlags );

Native Windows print method.

GlgObject GetViewport( void );

Returns an object ID of the control’s viewport.

GlgWrapperC (X Windows Only)

C++ wrapper around the GlgWrapper widget. It is a subclass of a GlgObjectC and inherits GLG API and GLG Extended API from it. Note that the GetViewport() method has to be called explicitly after the widget has been realized and before any API functions are used. The GlgGetViewport() method associates a viewport object with the instance of a class. While the widget is being realized, the widget creates a viewport. The viewport is set to NULL initially and its object ID has to be obtained from the widget after the widget has been realized. Since the widget may be realized by its parent, it is difficult to encapsulate GetViewport() functionality into the GlgWrapperC class so that it is transparent to the user. Trying to do so causes a lot of code duplication and will lead to problems in the future, so invoking this call is left as the responsibility of the user.
Data Members:

Widget widget;

Methods:

GlgWrapperC( void );

Default constructor: creates an empty wrapper widget with no drawing.

virtual ~GlgWrapperC( void );

Destructor. Destroys the wrapper widget. Be careful to set the widget to NULL if it is destroyed by destroying its parent to avoid XtDestroyWidget() being called with an invalid widget ID.

void Create( char * filename, Widget parent, char * widget_name = "GlgWrapper", long width = 400, long height = 300 );

Creates the widget and loads drawing from a file into it.

void Create( void * image_data, long image_data_size, Widget parent, char * widget_name = "GlgWrapper", long width = 400, long height = 300 );

Creates a widget and loads drawing from a generated memory image.

void Create( GlgObjectC& object, Widget parent, char * widget_name = "GlgWrapper", long width = 400, long height = 300 );

Creates a widget and uses the "$Widget" viewport of another GLG object as a drawing.

The following collection of SetDrawing() methods change the drawing using a particular wrapper widget resource. The actual drawing displayed is still subject to the priority of a particular wrapper widget drawing resource. Setting the drawing by using one of the SetDrawing() functions may interfere with others.

void SetDrawing( char * filename );

Loads a new drawing from a file (uses XtNglgDrawingFile resource).

void SetDrawing( void * image_data, long image_data_size );

Loads a new drawing from a generated memory image (uses XtNglgDrawingImage resource).

void SetDrawing( GlgObjectC& object );

Uses the "$Widget" viewport of another object as a new drawing (uses XtNglgDrawingObject resource).

Widget GetWidget( void );

Returns a widget id.
GlgoObject GetViewport();

Associates a viewport object of the wrapper widget with the instance of the class after the widget has been realized.

void EnableCallback( GlgCallbackType callback_type, GlgoObject callback_viewport = NULL );

Enables selection and input callbacks of the control. If callback_viewport is not NULL, adds GLG callbacks to it, otherwise adds it to the widget’s viewport.

virtual void Input( GlgObjectC& callback_viewport, GlgObjectC& message );

virtual void Select( GlgObjectC& callback_viewport, char ** name_array );

virtual void Trace( GlgObjectC& callback_viewport, GlgTraceCBStruct * trace_info );

virtual void Trace2( GlgObjectC& callback_viewport, GlgTraceCBStruct * trace_info );

virtual void Hierarchy( GlgObjectC& callback_viewport, GlgHierarchyCBStruct * hierarchy_info );

Virtual callback functions to be overridden by a derived class.

void SetXtResource( String xt_resource_name, char * res_value );

void GetXtResource( String xt_resource_name, char ** res_value_ptr );

Sets and gets Xt resources of string type (is primarily used with XtNglgHResource* and XtNglgVResource* resources).
Chapter 3

Using the ActiveX Control

Overview

The GLG ActiveX Control provides GLG Toolkit functionality and a complete GLG Programming API in the form of the Windows’ ActiveX control. The ActiveX may be used in Visual Studio.NET with C++, C# and Visual Basic. It may also be used with other products that support embedded ActiveX controls.

The GLG ActiveX Control is implemented as a dynamic link library with the .OCX extension. When registered and loaded, this single .ocx file may be used to display an extensive set of GLG widgets and custom drawings that can be accessed by users and applications. There are several versions of the GLG ActiveX control in the commercial version of the Toolkit:

- `glg_std.ocx` - includes GLG Standard API
- `glg_int.ocx` - includes GLG Intermediate API
- `glg_ext.ocx` - includes GLG Extended API

The demo and Community Edition of the GLG Toolkit contains a single `glg.ocx` that combines all three GLG APIs.

The flexibility of the GLG drawing architecture translates into flexibility for the GLG ActiveX Control. Any GLG drawing may be used as a custom control by loading it into the ActiveX control. For example, loading a custom process control drawing into the GLG ActiveX control makes it a custom control with the functionality of the loaded drawing. The GLG ActiveX Control includes properties and methods to dynamically change the resources of a GLG drawing as your application’s data change, allowing you to bind your real-time data to the attributes of the drawing displayed by the control.

For example, in a business application you may bind real-time data like a current stock price, as well as the high and low values, to a graph to display a history of changes. In a chemical process monitoring application, you may bind the temperature and level of fluid in a tank to the color and height of the tank’s filling in the drawing, to display these parameters graphically.

The GLG ActiveX Control also generates custom `Input`, `Select`, `Alarm` and other events. These events provide user feedback, allowing an application to react to user input or determine which graphical objects were selected with the mouse.

The ActiveX Control’s API methods mimic the methods of the GLG API. This chapter describes specific details of using the GLG ActiveX Control and provides only a brief description of each API method; refer to the `Animating a GLG Drawing with Data Using the Standard API` chapter on page 61 for a detailed description of each method’s functionality. Refer to the `Handling User Input and Other Events` chapter on page 101 for details of the Input callback. Refer to the `GLG Intermediate and Extended API` chapter on page 119 for details of the Extended API methods.

The `examples_csharp` and `examples_vbnet` directories contain source code examples of using the GLG ActiveX Control in the respective programming environments.
GLG ActiveX Control Properties

GLG ActiveX Control has the following properties:

General Page

DrawingFile

Specifies a GLG drawing to display in a control. The drawing file must exist at the time the control is created. This property has priority over the DrawingImageFile property described below. The drawing must contain a viewport object named $Widget with HasResources flag set to YES.

DrawingImageFile

Specifies a drawing to be used and stored in a control. The drawing file must exist at the time this property is set, and a copy of it is stored in the control. Saving the control with this property set saves a copy of the drawing with the control, allowing loading and using the control later with no separate drawing file. The DrawingFile property has higher priority: if both DrawingFile and DrawingImageFile properties are set, the control will use the drawing defined by the DrawingFile property, and only if loading that drawing fails, DrawingImageFile property is used. To discard the stored drawing, set this property to an empty string.

NOTE: the DrawingImageFile property doesn’t support compressed drawings. Save drawings with the drawing compression option disabled for use them with this property.

DrawingURL

Specifies a URL address to load a drawing from a Web. The drawing is cached. If other drawing properties are used to define the drawing, they have higher priority. DrawingURL property has the lowest priority and is used when other drawing properties are not specified or can’t be used. Local drawings may be loaded using this property by specifying "file://" at the beginning of the complete path name.

SetupDataURL

Specifies the URL used for the setup data script. The script has the standard GLG script format, described in the The Data Generation Utility section of the GLG Programming Tools and Utilities chapter. The script is invoked after the hierarchy has been setup and may access any resources of the drawing. The H properties of the control may be used to change resources before the hierarchy has been setup. The script is invoked only once when the drawing is loaded and initializes it with data. The script is not cached and is loaded asynchronously.

DataURL

Specifies the URL of the script to supply data. The script has the standard GLG script format, described in the The Data Generation Utility section of the GLG Programming Tools and Utilities chapter. The script is first invoked after the SetupData script and fills the control with data. If the UpdatePeriod property is set, the script at the DataURL location is invoked repeatedly with the interval defined by the UpdatePeriod property. This enables the ActiveX control to periodically reload data to update display with the latest data.
**UpdatePeriod**

Defines a periodic interval in seconds for running the *DataURL* script.

**PrintFile**

Specifies a filename for printing the current content of a drawing in the encapsulated PostScript format, which may later imported into most word processors. Setting this property saves a PostScript output into the specified file using a default page layout. The control’s *Print* method described later may be used to control page layout.

**InputEnabled**

Controls whether input events are sent (default: TRUE). Input events are generated when a user activates sliders, dials, buttons or other input controls inside the GLG ActiveX Control. Generating input events is disabled if this property is set to FALSE.

**SelectEnabled**

Controls whether selection events are sent (default: TRUE). Selection events are generated when a user selects a graphical object inside the GLG ActiveX Control with the mouse. Generating selection events is disabled if this property is set to FALSE. Set this property to FALSE to increase performance for GLG ActiveX Controls which do not need selection feedback.

**TraceEnabled**

Controls whether trace events are sent (default: FALSE). Trace events are low level Windows events which may be used to trace the mouse position inside the ActiveX control, handle mouse and keyboard events, etc. Set this property to FALSE to increase performance for GLG ActiveX Controls which do not need trace events.

**AlarmsEnabled**

Controls whether alarm events are generated (default: FALSE). Alarm events are generated by alarm objects attached to dynamic attributes to monitor their values when the values go out of range.

**SupressErrors**

When set to TRUE (default value), suppresses the error message dialogs and recording errors in a “*glg_err.log*” log file. Set the property to FALSE to enable debugging GLG ActiveX Control problems.

**UseOpenGL**

Controls the use of the OpenGL driver (default: FALSE). When set to TRUE, the OpenGL driver is enabled for the viewports that have the OpenGLHint=ON. When set to FALSE, the OpenGL driver is disabled and the GDI driver is used for all viewports.
UseMapURL

Controls the usage mode of the map server (default: FALSE). When set to FALSE, the maps are rendered using local datasets defined by the GISDataFile property of the GIS Object. When set to TRUE, a web-based map server defined by the GISMapServerURL property of the GIS Object is used to render maps from a centralized web server, without installing map datasets on each client computer.

HProperties Page

HProperty0 - HProperty4

These are character strings that specify five pre-creation properties. These properties serve as entry points to the GLG drawing resource hierarchy and may be used for setting resources before the drawing’s object hierarchy is created. They should be used for setting a drawing’s H resources, which control the structure of a GLG drawing’s hierarchy. For information about H resources, refer to the H and V Resources section in the Integrating GLG Drawings into a Program chapter. The syntax for the character strings is described in the Dynamic Resource String Syntax section of this chapter. These properties are persistent and may be used for customizing a drawing’s appearance before saving the control.

The GLG ActiveX Control does not need five different dynamic properties of this type. In one sense, it would be adequate to have just one, and use it repeatedly. However, it is often useful to be able to set the initial values of several drawing resources, so multiple dynamic properties like these are provided. The same is true of the V properties described in the following section.

In the event that there are not enough GLG ActiveX Control dynamic properties for your purpose, you can use the GLG ActiveX Control’s Ready event and call the GLG ActiveX Control’s methods to set the initial resources. The GLG ActiveX Control’s custom events and methods are described later in this chapter.

VProperties Page

VProperty0 - VProperty4

These are five character strings that specify five post-creation properties. These properties serve as entry points to the GLG drawing resource hierarchy and may be used for setting resources after the drawing’s object hierarchy is created. They should be used for setting a drawing’s V resources, which only control the values of attributes within the structure of a GLG drawing’s hierarchy. For information about V resources, refer to the H and V Resources section in the Integrating GLG Drawings into a Program chapter. The syntax for the character strings is described in the Dynamic Resource String Syntax section of this chapter. These properties are persistent and may be used for customizing a drawing’s appearance before saving the control.
**DLinks Page**

*DLinkName0 - DLinkName4*

Specify resource names to be used for accessing scalar (D) resources of a drawing.

*DLinkValue0 - DLinkValue4*

Specify double-precision values to be set for scalar resources whose names are defined by the corresponding *DLinkName* properties. Use these properties to access frequently used double resources, an entry point of a graph’s data samples, for example. These properties are bindable and not persistent.

**SLinks Page**

*SLinkName0 - SLinkName4*

Specify resource names to be used for accessing string (S) resources of a drawing.

*SLinkValue0 - SLinkValue4*

Specify values to be set for string resources whose names are defined by the corresponding *SLinkName* properties. Use these properties to access frequently used string resources, an entry point of a graph’s labels, for example. These properties are bindable and not persistent.

**GLinks Page**

*GLinkName*

Specify resource names to be used for accessing geometric (G) resources of a drawing (colors and control points defined by triplets of double values).

*GLinkValueX, GLinkValueY, GLinkValueZ*

Specify values to be set for a geometric resource whose name is defined by *GLinkName* property. These properties are bindable and not persistent.

**Dynamic Resource String Syntax**

The H and V Properties are dynamic properties of the GLG ActiveX Control. These properties contain character strings which in turn contain the names and values of GLG drawing resources. The strings have the following syntax:

```
<resource_name>  <resource_type>  <values>
```

*resource_name*

The name of the GLG drawing resource, including the complete path (omitting the “$Widget”). For example, “XLabelGroup/XLabel4/String” accesses the text string of the fifth label on the X axis in a graph widget.
<resource_type>

The type of the resource and can be one of the following:

- **d** Indicates the resource value is represented by a single floating point number (a scalar), like a line width, a font number or a value of a data sample
- **s** The resource value is a string, like a text string of a label text object
- **g** The resource value is a set of three floating point numbers, like a geometrical point with X, Y and Z coordinates or a color, in which case the three components represent the color's Red, Green, and Blue values.

<values>

A value or a set of values for the resource. The values given depend on the resource type.

The following strings are examples of specifying resources:

```plaintext
"DataGroup/DataSample3/Value d 2.5"
"DataGroup/DataSample5/Value d 4"
"XLabelGroup/XLabel4/String s April"
"DataGroup/DataSample6/FillColor g 0.5 0 0.9"
```

**Persistency Support**

The following properties are persistent and keep their values when the control is saved and loaded:

- **DrawingFile** (saves the file name only)
- **DrawingImageFile** (saves a copy of the drawing)
- **PrintFile** (saves the file name only)
- **InputEnabled**
- **SelectEnabled**
- **HProperty0-HProperty4** (the last property resource setting is stored)
- **VProperty0-VProperty4** (the last property resource setting is stored)

The remaining properties are not persistent and are initialized to their default values when loaded.

**GLG ActiveX Control Events**

GLG ActiveX Control has the following custom events:

**Input( String Format, String Origin, String FullOrigin, String Action, String SubAction )**

`Input` event is fired on user input, for example when a slider in the ActiveX control drawing is moved. It’s parameters are identical to the resources of message object in the GLG API’s `Input callback`. The last input message objects is stored by the ActiveX control, and its resources may also be accessed as resources by prepending "$message/" to the resource name. For example, "$message/ValueX" may be used to query the value of a slider using methods of the Standard API.
**Input2** (long message_obj)

*Input2* is an alternative form of the *Input* event which provides a message object parameter containing all resources of the input event. The message object may be passed to the Extended API methods to query its resources. The *Input* event may be used with the Standard API methods. Refer to the Appendix B: *Message Object Resources* chapter on page 427 for more information.

**Select** (String selected_name, short button)

*Selection* event is fired when objects in the ActiveX control drawing are selected with a mouse click (button press). The parameters define the complete resource name of the selected object and the mouse button which was used for selection. If several closely positioned objects are selected with a mouse click, the callback is called repeatedly with a name of each selected object. The first and last call have "@@SelectionStart@@" and "@@SelectionEnd@@" as values of the selected_name parameter, allowing to detect the start and the end of a single mouse selection sequence of events. The name of the selected object and the mouse button used to select it may also be queried using the *GetSelectedName* and *GetSelectionButton* methods of the ActiveX control.

The *Input2* event provides a more elaborate alternative for handling object selection using either object IDs or custom events and command actions attached to objects in the Graphics Builder.

**Select2** (long selection_array, short button)

Same as the *Select* event, but invoked just once with an array of resource names of all selected objects. The *getElementExt* method of the Extended API may be used to retrieve resource names of selected objects.

**Trace** (long top_viewport, long viewport, long message, long wParam, long lParam)

**Trace2** (long top_viewport, long viewport, long message, long wParam, long lParam)

Generated for all low-level windowing events such as mouse move, mouse click, button press, etc. May be used to trace the position of the mouse inside the drawing or handle native low-level events. The *top_viewport* parameter is the top-level viewport of the drawing. The *viewport* parameter is the viewport where the event occurred. The *message* parameter is the Windows’ message number. The *wParam* and *lParam* are message-dependent data parameters. By default, trace events are activated for the top level viewport of the ActiveX control. The SetTraceViewport method may be used to activate trace events only for a child viewport of the control.

The Trace event is generated before the event has been dispatched for processing. The Trace2 event is generated after the event has been processed.

**Alarm** (long object, long alarm, String alarm_label, String action, String subaction, long reserved)

Generated by alarm objects based on the specified alarm condition. The *object* parameter is the resource whose value has changed. The *alarm* parameter is the alarm attached to the *data* object to monitor its value; it is the alarm that generated the alarm message. The *alarm_label* parameter supplies the *AlarmLabel* used to identify the *alarm object*. The *action* and *subaction* parameters provide details about the condition that caused the alarm; refer to the *Alarm Messages* section on page 211 of the *GLG User’s Guide and Builder Reference Manual* for more information.
**HCallback()**

Generated after loading the control’s drawing but *before* its hierarchy was set up. It may be used to initialize values of H resources, such as a number of instances in a series object or a number of datasamples in a graph.

**VCallback()**

Generated *after* the hierarchy setup, but before the drawing is displayed for the first time. It may be used for initializing V resources, such as filling the graph with data for the initial appearance.

**Ready()**

Generated when the control finished loading the drawing and was painted for the first time.

---

**ActiveX Control Methods**

The methods of the ActiveX control’s API allow you to animate control’s drawing with application data from a VC++ or VB application.

The GLG ActiveX Control provides the following methods:

```csharp
double GetDResource( String resource_name )
double GetDTag( String tag_source )
```

Return the value of the drawing’s scalar resource or tag. Returns zero if the resource or tag was not found.

```csharp
BOOL SetDResource( String resource_name, double dvalue )
BOOL SetDTag( String tag_source, double dvalue, BOOL if_changed )
```

Set the value of the drawing’s scalar resource or tag. Returns TRUE if the resource or tag exists and the setting was successful, FALSE otherwise.

**NOTE:** Use SetDResourceIfExt with null object parameter for SetDResourceIf functionality.

```csharp
String GetSResource( String resource_name )
String GetSTag( String tag_source )
```

Return the value of the drawing’s string resource or tag. Returns the empty string ("") if the resource or tag was not found.
BOOL SetSResource( String resource_name, String svalue )
BOOL SetSTag( String resource_name, String svalue, BOOL if_changed )

Set the value of the drawing’s string resource or tag. Returns TRUE if the resource or tag exists and the setting was successful; otherwise returns FALSE.

NOTE: Use SetSResourceIfExt with null object parameter for SetSResourceIf functionality.

BOOL SetSResourceFromD( String resource_name, String format, double dvalue )

Set the value of the drawing’s string resource to a string obtained by converting the supplied double value according to the format. The format parameter is a C format string. Returns TRUE if the resource exists and the setting was successful; otherwise returns FALSE.

NOTE: Use SetSResourceFromDIfExt with null object parameter for SetSResourceFromDIf functionality.

void GetGResource( String resource_name, double * x, double * y, double * z )
void GetGTag( String tag_source, double * x, double * y, double * z )

Query the value of the drawing’s geometrical resource or tag and return it via the x, y and z parameters.

double GetXResource( String resource_name )
double GetXTag( String tag_source )

double GetYResource( String resource_name )
double GetYTag( String tag_source )

double GetZResource( String resource_name )
double GetZTag( String tag_source )

Return the X, Y, or Z value of the drawing’s geometric resource or tag. Returns zero if the resource was not found.

BOOL SetGResource( String resource_name, double dvalue1, double dvalue2, double dvalue3 )
BOOL SetGTag( String tag_source, double dvalue1, double dvalue2, double dvalue3, BOOL if_changed )

Set the value of the drawing’s geometric resource or tag. Returns TRUE if the resource or tag exists and the setting was successful.

NOTE: Use SetGResourceIfExt with null object parameter for SetGResourceIf functionality.

BOOL HasResourceObject( long object, String resource_name )
BOOL HasTagName( long object, String tag_name )
BOOL HasTagSource( long object, String tag_source )

Return TRUE if a tag with a specified tag name or tag source exists, returns FALSE otherwise.
long CreateTagList( long object, BOOL unique_tags )

Creates and returns a list of object’s tags, or null if no tags were found. If unique_tags parameter is set to TRUE, the list will include only one tag instance in case there are multiple tags sharing the same name. The list must be destroyed using DropObject when it is no longer needed.

void UpdateGlg()

Forces GLG ActiveX Control to update the displayed drawing to reflect the new data. Several resource changes may be effected at once by invoking several resource setting methods and then invoking the update method once to display all changes at once. This also increases performance. Note, however, that setting some resources may interfere with setting other resources, and that it may be necessary to invoke either the UpdateGlg or SetupHierarchy methods in between setting these two kinds of resources. For example, before you know that a series has eight members, it makes no sense to query the eighth member. You must set the series Factor resource, execute the UpdateGlg method, and then query the series members.

void Update() (deprecated)

Same as the UpdateGlg method, deprecated due to a conflict with the .NET environment, where the Update method of the GLG ActiveX Control is shadowed by the object’s Update method of the .NET framework. Use the UpdateGlg method instead.

BOOL SetAutoUpdateOnInput( BOOL update )

Enables or disables automatic updates on input events. Returns the previous setting of the parameter.

Automatic updates on input events are enabled by default, but may be disabled to prevent slowing down scrolling and other operations of the real-time charts.

If automatic updates are turned off, input objects redraw themselves on user input event. However, an explicit Update() call has to be used to redraw any objects constrained to input objects and located outside of them.

When automatic updates are turned off, the application code also has to explicitly invoke UpdateGlg() for timer events (Format="Timer") to update objects in the drawing with the timer transformation attached.

BOOL SetZoom( long viewport, String resource_name, short type, double value )

Performs a zoom or pan operation specified by the type parameter. If the resource_name parameter is null, the viewport or the light viewport specified by the viewport parameter will be zoomed. Otherwise, the zoom operation will be performed on its child viewport specified by the resource_name parameter. If the viewport parameter is null, the viewport of the ActiveX control’s drawing is used. The value parameter defines the zoom factor or pan distance. Refer to the GlgSetZoom section on page 93 for a complete list of all zoom and pan types.

In the Drawing Zoom Mode, if the method attempts to set a very large zoom factor which would result in the overflow of the integer coordinate values used by the native windowing system, the zoom operation is not performed and the method returns FALSE.
BOOL SetZoomMode( long viewport, String resource_name, long zoom_object,
String zoom_object_name)

Sets or resets a viewport’s zoom mode by supplying a GIS or Chart object to be zoomed. In the
Drawing Zoom Mode (default), the drawing displayed in the viewport is zoomed and panned. If the
GIS Zoom Mode is set, any zooming and panning operation performed by the SetZoom method will
zoom and pan the map displayed in the viewport’s GIS Object, instead of being applied to the
viewport’s drawing. In the Chart Zoom Mode, the content of the chart is zoomed and panned. If the
resource_name parameter is null, the zoom mode of the viewport itself will be set. Otherwise, the
zoom mode will be set for its child viewport specified by the resource_name parameter. If the
zoom_name parameter is not null, it specifies the resource path of a GIS or Chart object relative to
the zoom_object parameter, or relative to the viewport if the zoom_object parameter is null. The
method may be invoked with zoom_object=null and zoom_object_name=null to reset the zoom
mode to the default Drawing Zoom Mode.

BOOL GISGetElevation( long object, String resource_name, String layer_name,
double lon, double lat, double * elevation )

Returns elevation of a lat/lon point on a map. If the resource_name parameter is null, the object
parameter specifies the GIS object, otherwise it specifies the GIS object’s parent and
resource_name specifies the resource path of the GIS Object relative to the parent. The layer_name
specifies the name of the elevation layer to query. The elevation value is returned via the elevation
parameter. The method returns TRUE if the query was successful.

long GISCreateSelection( long object, String resource_name, String layers, double x, double y,
int select_labels )

Returns a message object containing information about GIS features located at the specified
position on the map. If the resource_name parameter is null, the object parameter specifies the GIS
object, otherwise object specifies the GIS object’s parent and resource_name specifies the resource
path of the GIS Object relative to the parent. The layers parameter specifies a list of layers to query.
The x and y parameters specify location on the map in the screen coordinates of the GIS object’s
parent viewport. The select_label parameter specifies the label selection policy. It can have the
following values:

- GIS_LBL_SEL_NONE - disables label selection
- GIS_LBL_SEL_IN_TILE_PRECISION - enables label selection
- GIS_LBL_SEL_MAX_PRECISION - enables label selection with the maximum precision.

Refer to page 197 for more information on the label selection.

The function returns a message object containing information about the selected GIS features. Refer
to the GlmGetSelection section on page 127 of the GLG Map Server Reference Manual for
information on the structure of the returned message object as well as a programming example that
demonstrates how to handle it.
long GISGetDataset( long object, String resource_name )

Returns a dataset object associated with the GIS object. If the resource_name parameter is null, the object parameter specifies the GIS object, otherwise it specifies the GIS object’s parent and resource_name specifies the resource path of the GIS Object relative to the parent. The method may be invoked after the GIS object has been setup to retrieve its dataset. The dataset may be used to dynamically change attributes of individual layers displayed in the GIS object. The program can use SetResource methods for changing layer attributes. Refer to the GLG Map Server Reference Manual for information on layer attributes.

BOOL GISConvert( long object, String resource_name, long coord_type, BOOL coord_to_lat_lon, double x1, double y1, double z1, double * x2, double * y2, double * z2 )

Converts coordinates between the GIS coordinate system of the GIS Object and GLG coordinate system of the drawing. If the resource_name parameter is null, object specifies the GIS Object whose coordinate system to use for conversion. If the resource_name parameter is not null, object specifies a parent of the GIS Object. The resource_name parameter specifies the resource name of the GIS Object inside the parent object specified by the object parameter. The coord_type parameter specifies the type of the GLG coordinate system type to convert to or from: GLG_SCREEN_COORD for screen coordinates or GLG_OBJECT_COORD for world coordinates. If the coord_to_lat_lon parameter is TRUE, coordinates are converted from GLG to GIS coordinate system. If it is FALSE, the coordinates are converted from GIS to GLG coordinate system. The x1, y1 and z1 parameters specify coordinates to be converted. The x2, y2 and z2 parameters point to the variables that will receive converted coordinate values. The function returns TRUE if conversion succeeds. When converting from GLG to GIS coordinates, the Z coordinate is set to a negative GLG_GIS_OUTSIDE_VALUE value for points on the invisible part of the globe.

long SendMessage( String resource_name, String message, long param1, long param2, long param3, long param4 )

Sends a message specified by the message parameter. If the resource_name parameter is null, the message is sent to the object itself. Otherwise, the message is sent to the object’s child specified by the resource_name parameter. The param<n> arguments define additional parameters of the message depending on the message type.

Refer to the Input Objects chapter on page 229 of the GLG User’s Guide and Builder Reference Manual for a list of messages supported by each type of the available input handlers.

long SendMessageStr( String resource_name, String message, String param1, long param2, long param3, long param4 )

Same as SendMessage, but sends the first parameter as a string. It is intended for use in VB.net environment that does not provide type casts.
long ExportStrings( long object, String filename, long separator1, long separator2 )

Writes all text strings defined in the drawing specified by the object parameter into a string translation file using requested separator characters. Refer to the Localization Support chapter on page 72 of the GLG User’s Guide and Builder Reference Manual for information about the string translation file format. The method returns the number of exported strings or -1 in case of an error.

long ImportStrings( long object, String filename )

Replaces text strings in the drawing defined by the object parameter with the strings loaded from a string translation file. Refer to the Localization Support chapter on page 72 of the GLG User’s Guide and Builder Reference Manual for information about the string translation file format. The method returns the number of imported strings or -1 in case of an error.

long ExportTags( long object, String filename, long separator1, long separator2 )

Writes tag names and tag sources of all tags defined in the drawing specified by the object parameter into a file using requested separator characters. The method uses the same file format as the ExportStrings method. Refer to the Localization Support chapter on page 72 of the GLG User’s Guide and Builder Reference Manual for information about the file format. The method returns the number of exported tags or -1 in case of an error.

long ImportTags( long object, String filename )

Replaces tag names and tag sources of tags in the drawing defined by the object parameter with information loaded from a tag translation file. The method uses the same file format as the ImportStrings method. Refer to the Localization Support chapter on page 72 of the GLG User’s Guide and Builder Reference Manual for information about the tag translation file format. The function returns the number of imported tags or -1 in case of an error.

void Print( String filename, double x, double y, double width, double height, BOOL portrait, BOOL stretch )

Saves encapsulated PostScript output with the current state of the drawing into the specified file. The x, y, width, and height parameters define the PostScript page layout. The origin is defined to be in the middle of the page, the left edge of the page is at -1000, and the right edge is at 1000. The top and bottom of the page are similarly defined to be at 1000 and -1000, respectively. The x and y parameters define the lower left corner of the drawing, while width, and height give the dimensions of the drawing area. As an example, the default page layout you get when you print a drawing by setting the PrintFile property puts the lower left corner of the drawing area at (-900, -900), while the dimensions are 1800 by 1800. This makes the drawing about as large as it can be while still keeping a small border all the way around the page. The portrait parameter specifies portrait (TRUE) or landscape (FALSE) mode. If the stretch parameter is set to FALSE, the X/Y ratio of the drawing is preserved.

BOOL SaveImage( long object, String resource_name, String filename, long format )

Saves a JPEG or PNG image of the visible area of the viewport’s drawing into a file. Returns TRUE if the image was successfully saved. This method is disabled in Secure mode if GLG_ACTIVEX_SAVE_FILE environment variable is not set. Both the JPEG (format=2) and
PNG (format=4) image formats are supported. The resource_name parameter specifies the resource name of a child viewport whose image to generate, or null to generate the image of the viewport itself. For a light viewport, the output will be generated for its parent viewport.

BOOL SaveImageCustom( long object, String resource_name, String filename, long format, long x, long y, long width, long height, long gap )

Saves a JPEG or PNG image of the specified area of the drawing into a file. Returns TRUE if the image was successfully saved. This method is disabled in Secure mode if GLG_ACTIVEX_SAVE_FILE environment variable is not set. Both the JPEG (format=2) and PNG (format=4) image formats are supported. The resource_name parameter specifies the resource name of a child viewport whose image to generate, or null to generate the image of the viewport itself. For a light viewport, the output will be generated for its parent viewport.

The x, y, width and height parameters specify the area of the drawing in screen pixels for generating the image. If both the width and height parameters are set to 0, the image of the whole drawing is generated, which may be bigger than the visible area of the viewport if the drawing is zoomed in. The gap parameter specifies the padding space between the extent of the drawing and the edge of the image when width and height equal 0. The viewport’s zoom factor defines the scaling factor for objects in the drawing when the image is saved.

long GenerateImage( long object, String resource_name, long bitmap )

Same as the SaveImage method, but returns the image as a bitmap. If the bitmap parameter is not NULL, fills and returns the bitmap provided by the parameter instead of creating and returning a new bitmap.

long GenerateImageCustom( long object, String resource_name, long bitmap, long format, long x, long y, long width, long height, long gap )

Same as the SaveImageCustom method, but returns the image as a bitmap. If the bitmap parameter is not NULL, fills and returns the bitmap provided by the parameter instead of creating and returning a new bitmap.

void AboutBox()

Displays version number and other GLG ActiveX Control information in a box on the screen.

String GetSelectedName()

Returns the name of the last selected object reported by the Select event. It may be used to access the Select event information by using the control’s methods in cases when there is no access to the events’ parameters (scripting usage).

short GetSelectionButton()

Returns the mouse button which was pressed to generate the last Select event. Similar to GetSelectedName, it may be used to access the Select event information by using the control’s methods.
**BOOL GetModifierState( int modifier )**

Returns the state of the modifier requested by the modifier parameter. Use 1 to query the state of the Shift key, 2 for the Control key and 3 for a double click: these values correspond to the elements of the GlgModifierType enum defined in the GlgApi.h file.

**long CreateSelectionNamesExt( long top_vp, long selected_vp,**

  **double x1, double y1, double x2, double y2 )**

ADVANCED: Given the top viewport of the drawing and a screen coordinates rectangle in a selected viewport, returns an array of names of all objects within the rectangle. This method may be used in the Trace event handler to implement custom selection logic based on the mouse events. Either a viewport or a light viewport can be used for the top_vp and selected_vp parameters.

**long CreateSelectionMessage( long top_vp, long selected_vp,**

  **double x1, double y1, double x2, double y2,**

  **long selection_type,**

  **long button )**

ADVANCED: Given the top viewport of the drawing and a screen coordinates rectangle in a selected viewport, the method searches all objects inside the rectangle for the action with the specified selection trigger type attached to an object. Either a viewport or a light viewport can be used for the top_vp and selected_vp parameters.

The method returns a selection message for the first matching action it finds, and may be used in the Trace event handler to retrieve an action which would be triggered by a specified mouse event in the rectangular area. The selection message is a message equivalent to the message received in the input callback. The selection_type parameter may specify one of the following predefined selection types: GLG_MOVE_SELECTION, GLG_CLICK_SELECTION or GLG_TOOLTIP_SELECTION defined in the GlgAPI.h file.

**void ChangeObject( long object, String resource_name )**

Sends a change message to the object without actually changing the object’s attributes, may be used to redraw the object.

If the resource_name parameter is null, the change message will be sent to the object specified by the object argument. Otherwise, the message will be sent to its child object specified by the resource_name parameter.

**void SetBrowserObject( long browser, long object )**

Sets the object for browsing with the GLG resource, tag or alarm browser widgets.
void SetBrowserSelection( long object, String resource_name, String selection, String filter )

Sets a new value of a browser’s selection and filter text boxes for resource, tag, alarm and data browsers. Setting a new selection will display a new list of matching entries.

If the resource_name parameter is null, a new selection will be set for the browser supplied by the object argument. Otherwise, it will be set for its child object specified by the resource_name parameter.

BOOL SetEditMode( long viewport, String resource_name, BOOL edit_mode )

Sets the viewport’s edit mode which disables input objects in the viewport while the drawing is being edited; returns TRUE on success. The viewport could be either a viewport or a light viewport. If the resource_name parameter is null, the edit mode of the viewport itself is set. Otherwise, the edit mode of its child viewport specified by the resource_name parameter will be set. If the viewport parameter is null, the viewport of the ActiveX control’s drawing is used. The edit mode is global and may be set only for one viewport used as a drawing area. Setting the edit mode of a new viewport resets the edit mode of the previous viewport. The viewport’s edit mode is inherited by its all child viewports. Returns TRUE on success.

void SetTraceViewport( long viewport, String resource_name )

Specifies the viewport for which the trace events will be activated. If the resource_name parameter is null, the trace events will be activated for the viewport itself. Otherwise, trace events will be activated for the child viewport specified by the resource_name parameter. If the viewport parameter is null, the viewport of the ActiveX control’s drawing is used. The trace events will be generated only if the control’s TraceEnabled property is set.

void SetFocus( long object, String resource_name )

Sets keyboard focus to the parent viewport of an object, or to the object itself if it is a viewport. If resource_name is null, the object is specified by the object parameter. If resource_name is not null, it specifies the child object of the object that will be used for setting focus.

void DropObject( long object )

Dereferences an object.

long GetStringID( String string )

Converts the string to a persistent GLG string and returns its handle. The handle has to be freed with FreeStringID method when done. This function provides conversion between the String and GLG string types for the .NET environment.

void FreeStringID( long string_id )

Frees the GLG string identified by its string_id handle in the .NET environment.

BOOL SetCursor( long viewport, long cursor_type )

Sets the Windows cursor type to be used by the viewport. If the viewport parameter is null, the cursor of the main viewport of the ActiveX Control is used. The cursor_type parameter specifies one of the predefined Windows cursor types. Returns TRUE on success.
void GlgGetMajorVersion()

void GlgGetMinorVersion()

Return major and minor version numbers of the GLG Toolkit.

long GetSelectedPlot()

Returns the plot object corresponding to the last legend item selected with the mouse, if any, or NULL if no plots were previously selected.

long GetNamedPlot( long object, String resource_name, String plot_name )

Finds a chart’s plot by name and returns its object ID. If the resource_name parameter is null, a named plot of the chart specified by the object parameter is returned. Otherwise, the resource_name parameter points to a child chart of the object. The method returns 0 if a plot with the specified name has not been found.

long AddPlot( long object, String resource_name, long plot )

Adds a plot to a chart object. If the resource_name parameter is null, the plot is added to the chart specified by the object parameter. Otherwise, the plot is added to a child chart of the object pointed to by the resource_name parameter. The plot parameter specifies the object ID of the plot object to add; 0 can be used to create a new plot. The method returns the object ID of the added plot on success, or 0 on failure.

BOOL DeletePlot( long object, String resource_name, long plot )

Deletes a plot from a chart object. If the resource_name parameter is null, the plot is deleted from the chart specified by the object parameter. Otherwise, the plot is deleted from a child chart of the object pointed to by the resource_name parameter. The plot parameter specifies the plot object to delete. The method returns TRUE if the plot was successfully deleted.

long AddTimeLine( long object, String resource_name, long time_line, double time_stamp )

Adds a time line to a chart object. If the resource_name parameter is null, the time line is added to the chart specified by the object parameter. Otherwise, the time line is added to a child chart of the object pointed to by the resource_name parameter. The time line parameter specifies the level line object to be used as a time line; 0 can be used to create a new time line. The time_stamp parameter specifies the time stamp to position the time line at and is assigned to the time line’s Level attribute. The method returns the added time line object on success, or 0 on failure. The returned time line is referenced only by the chart’s time line array it has been added to and may be destroyed when the chart scrolls. The program should increase the time line’s reference count if it needs to keep a persistent reference to the time line. The NumTimeLines attribute of the chart should be set to -1 in order to use this function.

BOOL DeleteTimeLine( long object, String resource_name, long time_line, double time_stamp )

Deletes a time line from a chart object. If the resource_name parameter is null, the time line is deleted from the chart specified by the object parameter. Otherwise, the time line is deleted from a child chart of the object pointed to by the resource_name parameter. The time_line parameter specifies the time line object to delete. If time_line is set to 0, the time line with the time stamp
specified by the time_stamp attribute will be deleted. If time_line is not 0, the time_stamp parameter is ignored. The method returns TRUE if the time line was successfully deleted. The NumTimeLines attribute of the chart should be set to -1 in order to use this function.

long AddAnnotation( long object, String resource_name, long annotation, double position_x, double position_y, BOOL add_box )

Adds an annotation to a chart object. If the resource_name parameter is null, the annotation is added to the chart specified by the object parameter. Otherwise, the annotation is added to a child chart of the object pointed to by the resource_name parameter. The annotation parameter specifies the annotation object to be added; 0 can be used to create a new annotation. The position_x and position_y parameters specify the annotation’s position. If add_box is set to TRUE, a text box will be added to the annotation’s text object. The method returns the added annotation object on success, or 0 on failure. The NumAnnotations attribute of the chart should be set to -1 in order to use this function.

BOOL DeleteAnnotation( long object, String resource_name, long time_line, double position_x, double position_y )

Deletes an annotation from a chart object. If the resource_name parameter is null, the annotation is deleted from the chart specified by the object parameter. Otherwise, the annotation is deleted from a child chart of the object pointed to by the resource_name parameter. The annotation parameter specifies the annotation object to delete. If annotation is set to 0, the annotation at the position specified by the position_x and position_y attributes will be deleted. If annotation is not 0, position parameters are ignored. The method returns TRUE if the annotation was successfully deleted. The NumAnnotations attribute of the chart should be set to -1 in order to use this function.

BOOL ClearDataBuffer( long object, String resource_name )

Clears accumulated data samples of a real-time chart or one of its plots. If resource_name is null, the object parameter supplies an object ID of the chart or plot object. If resource_name is not null, it supplies a resource name of a child chart or plot object inside the parent object specified by the object parameter. For a chart, ClearDataBuffer discards data samples in all plots of the chart. For a plot, it discards only the data samples of that plot. The method returns TRUE on success.

BOOL GetDataExtent( long object, String resource_name, double * min, double * max, BOOL x_extent )

Queries the minimum and maximum extent of the data accumulated in a chart or in one of its plots. If the resource_name parameter is null, the method returns the data extent of the chart or the plot specified by the object parameter. Otherwise, the resource_name parameter points to a child chart or a child plot of the object. If x_extent is TRUE, the X extent of the data is returned in min and max parameters, otherwise the method returns the Y extent of the data.

For a chart object, the method returns the data extent of all plots in the chart. For a plot, the data extent of that plot is returned. The object hierarchy must be set up for this function to succeed. The method returns TRUE on success.
BOOL SetLinkedAxis( long object, String resource_name, long axis_object, String axis_resource_name )

Associates a chart's plot or a level line with an Y axis for automatic rescaling, returns TRUE on success. If resource_name is null, associates the object, otherwise associates a child plot or a child level line of the object pointed to by the resource_name parameter. If axis_resource_name is null, associates with axis_object, otherwise associates with the child axis of axis_object pointed to by the axis_resource_name parameter.

long GetNativeComponent( long object, String resource_name, short type )

Returns an ID of a native windowing system component used to render the viewport. If resource_name is null, a native component of the viewport specified by the object parameter is returned, otherwise a native component of a child viewport of the object pointed by the resource_name parameter is returned. The type parameter defines the type of the native component to query, as described on page 74. The value of zero may be used to retrieve the handle of a viewport’s window.

String GetObjectName( long object )

String GetObjectType( long object )

String GetDataType( long object )

Convenience functions for querying Name and Type properties of an object, as well as a DataType property of data and attribute objects.

Additional Standard API Methods

The GetElementExt and GetSizeExt methods described in the Intermediate and Extended API Methods section are also available in the Standard API.

Intermediate and Extended API Methods

The GLG Extended API provides methods that allows an application program to add objects on the fly or edit the drawing at run time, as well as query objects and resources contained in the drawing. This may be used to create sophisticated applications using C# or VB.NET.

The ActiveX Control provides two flavors of the Extended API: Intermediate API and Extended API. The Intermediate API provides all Extended API methods except methods for creating and deleting objects at run time.

The ActiveX Control’s Extended API methods mimic the methods of the GLG Extended API. This chapter provides only a brief description of each method; refer to the GLG Intermediate and Extended API chapter on page 119 for a detailed description of each method’s functionality.

The methods of the ActiveX control Extended API listed below have parameters identical to the corresponding methods of the C API, unless mentioned otherwise. A long value is used to represent an object id. This object id has meaning only inside a particular ActiveX control and can’t be used...
interchangeably between several ActiveX controls. Refer to the GlgApi.h file for the values of the enumerated parameters of the methods. In most of the cases a null value may be used as a reasonable default.

There are several methods of Extended API which are identical to the corresponding methods of the regular API with the only difference of having an additional object parameter. For example,

\[
\text{SetDResource( resource\_name, resource\_value )}
\]

and

\[
\text{SetDResourceExt( object, resource\_name, resource\_value )}
\]

The Extended API method above allows setting resources of the specific object while the regular API method sets the resource of the main viewport of the drawing (viewport named "$Widget").

If the null value is used as an object parameter of such Extended API methods, the object defaults to the main viewport of the drawing and the result will be identical to the corresponding regular API method invocation. This is also true even for the Extended API method which do not have corresponding regular API methods. For example, to add objects to the main viewport of the drawing using \text{AddObjectExt} method, you can use \text{null} as the first parameter, which results in using the main viewport of the drawing as a container. For the \text{Get/SetResource} methods of the Extended API passing \text{null} value for the object parameter allows using the methods even if the Extended API is disabled.

All Extended API methods have the \text{Ext} suffix, allowing to differentiate them from methods of the regular API.

The GLG ActiveX Control provides the following Extended API methods:

\textbf{BOOL AddObjectToTopExt( long container, long object )}

Adds the object to the beginning of the \textit{container} (Extended API only). Returns \textit{true} if the object was successfully added.

\textbf{BOOL AddObjectToBottomExt( long container, long object )}

Adds the object to the end of \textit{container} (Extended API only). Returns \textit{true} if the object was successfully added.

\textbf{BOOL AddObjectAtExt( long container, long index )}

Adds the object to the \textit{container} at the \textit{index} position (Extended API only). Returns \textit{false} if \textit{index} is invalid.

\textbf{BOOL AddObjectExt( long container, long object, long access\_type, long position\_modifier )}

Adds an object to the \textit{container} at the position indicated by the \textit{access\_type} (BOTTOM, TOP or CURRENT) (Extended API only). If the access type is CURRENT, the object is added before or after the element indicated by the container’s current position, as indicated by the \textit{position\_modifier} parameter (BEFORE or AFTER). Sets the container’s current position to point to the added object. Returns \textit{true} if the object was successfully added.
BOOL ContainsObjectExt( long container, long object )

Returns true if the object is contained in container.

long CloneObjectExt( long object, long clone_type )

Creates and returns a copy of an object according the clone_type (Extended API only).

BOOL ConstrainObjectExt( long from_object, long to_object )

Constrains an attribute object.

long ConvertViewportType( long object )

ADVANCED: Converts a viewport to a light viewport, or a light viewport to a viewport, returning a newly created object on success or null on error. The object parameter supplies the object to be converted. If a converted object is added to the drawing, the original object must be deleted, since both objects reuse the graphical objects inside the viewport and cannot be both displayed at the same time.

long CopyObjectExt( long object )

Creates and returns a copy of the object (Extended API only).

long CreateChartSelectionExt( long chart, long plot, double x, double y, BOOL screen_coord, BOOL include_invalid, BOOL x_priority )

ADVANCED: Selects a chart’s data sample closest to the specified x, y position and returns a message object containing the selected sample’s information. If plot is NULL, the method queries samples in all plots of the chart and selects the sample closest to the specified position. If plot is not NULL, the method queries only the samples in that plot.

If the screen_coord parameter is set to TRUE, the position is defined in the screen coordinates of the chart’s parent viewport. If screen_coord is set to FALSE, the x position is defined as an X or time value, and the y position is defined in relative coordinates in the range [0; 1] to allow the chart to process selection for plots with different ranges (0 corresponds to the Low range of each plot, and 1 to the High range). When the mouse position is used, add GLG_COORD_MAPPING_ADJ to the x and y screen coordinates of the mouse for precise mapping.

The dx and dy parameters specify an extent around the point defined by the x and y parameters. The extent is defined in the same coordinates as x and y depending on the value of the screen_coord parameter. Only the data samples located within the dx and dy distances from the specified position are considered for the selection.

If include_invalid if set to TRUE, invalid data samples are considered for selection, otherwise they are never included. If x_priority is set to TRUE, the method selects a data sample closest to the specified position in the horizontal direction, with no regards to its distance from the specified position in the vertical direction. If x_priority is set to FALSE, a data sample with the closest distance from the specified position is selected.
The information about the selected data sample is returned in the form of a message object described in the Chart Selection Message Object section on page 446. The method returns null if no data sample matching the selection criteria was found. The returned message object must be dereferenced using the DropObject method when finished.

```c
long CreateObjectExt( long object_type, String object_name,
    long data1, long data2, long data3, long data4 )
```

Creates and returns an object of a specified type (Extended API only). The object has to be explicitly added to the drawing in order to be displayed.

```c
long CreateSelectionExt( long top_vp, long selected_vp, double x1, double y1, double x2, double y2 )
```

ADVANCED: Given the top viewport of the drawing and a screen coordinates rectangle in a selected viewport, returns an array of all objects within the rectangle. This method may be used in the Trace event handler to implement custom selection logic based on the mouse events. Either a viewport or a light viewport can be used for the `top_vp` and `selected_vp` parameters.

```c
String CreateTooltipStringExt( long object, double x, double y, double dx, double dy,
    String format )
```

ADVANCED: Creates and returns a chart or axis tooltip string corresponding to the specified `x`, `y` position in screen coordinates. The string can be used to provide cursor feedback and display information about the data sample under the current mouse position, as shown in the Real-Time Strip-Chart demo.

The `format` parameter provides a custom format for creating a tooltip string and uses the same syntax as the `TooltipFormat` attributes of the chart and axis objects. If it is set to NULL or an empty string, the format provided by the `TooltipFormat` attribute of the chart or the axis will be used. A special “<single_line>” tag may be prepended to the format string to force the method to remove all line breaks from the returned tooltip string.

If the `object` is a chart and the selected position is within the chart’s data area, the method selects a data sample closest to the specified position and returns a tooltip string containing information about the sample. The `dx` and `dy` parameters define the maximum extent in pixels around the specified position for selecting a data sample, and the `TooltipMode` attribute of the chart defines the data sample selection mode: X or XY. The method returns NULL if no samples matching the selected criteria were found.

If the `object` is an axis, or if the `object` is a chart and the selected position is on top of one of the chart’s axes, the function returns a tooltip string that displays the axis value corresponding to the specified position.

When using the cursor position, add GLG_COORD_MAPPING_ADJ to the cursor’s x and y screen coordinates for precise mapping.

The returned string must be freed using the FreeStringID function.
BOOL DeleteObjectAtExt( long container, long index )

Deletes the object of the container at the index position (Extended API only). Returns false if index is invalid.

BOOL DeleteBottomObjectExt( long container )

Deletes the first object of this container (Extended API only). Returns true if the object was successfully deleted.

BOOL DeleteTopObjectExt( long container )

Deletes the first object of this container (Extended API only). Returns true if the object was successfully deleted.

BOOL DeleteThisObjectExt( long container, long object )

Deletes an object from container (Extended API only). Returns true if the object was successfully deleted.

BOOL DeleteObjectExt( long container, long reserved, long access_type, long position_modifier )

Deletes an object from a container (Extended API only).

long FindObjectExt( long container, long object, long search_type, long reserved )

Finds an object in the container according to the search type and returns it.

long FindMatchingObjectsExt( long object, long match_type, BOOL find_parents, BOOL find_first_match, BOOL search_inside, BOOL search_drawable_only, long object_type, LPCTSTR object_name, LPCTSTR resource_name, long object_id )

Finds either one or all parents or children of the specified object that match the supplied criteria (Extended API only).

The match_type parameter specifies a bitwise mask of the object matching criteria using the following constants defined in the GlgApi.h file:

- GLG_OBJECT_TYPE_MATCH = 1 finds objects with an object type matching the type specified by the object_type parameter.
- GLG_OBJECT_NAME_MATCH = 2 finds objects with a name matching the name specified by the object_name parameter.
- GLG_RESOURCE_MATCH = 4 finds objects that have the resource specified by the resource_name parameter.
- GLG_OBJECT_ID_MATCH = 8 finds an object with the ID specified by the object_id parameter. This can be used to find out if the object supplied as the object parameter is a child or a parent of the object provided by object_id.

Multiple criteria can be ORed together. All of the criteria in the mask must be true in order for an object to match.
If find_parents is set to true, ancestors (parents, grandparents and so on) of the object are searched. Otherwise, the object’s descendents (children, grandchildren and so on) are searched. If find_first_match is set to true, the search is stopped after the first match and the first matching object is returned, otherwise all matching objects will be returned.

If search_inside is set to false, the object's children or parents are not searched if the object itself matches. If search_drawable_only is set to true when searching descendents, only drawable objects are searched. For example, when this flag is set, a polygon object’s attributes such as FillColor and EdgeColor, will not be searched, which can increase the search speed. Refer to the description of the IsDrawableExt method on page 264 for more information.

If find_first_match is set to true, the method returns the first found matching object. If find_first_match is set to false, a group containing all matching objects is returned. If no matching objects were found, 0 is returned.

double GetDResourceExt( long object, String resource_name )
double GetDTagExt( long object, String tag_source )

Return a value of an object’s resource or tag.

String GetSResourceExt( long object, String resource_name )
String GetSTagExt( long object, String tag_source )

Return the value of a string resource or tag.

double GetGResourceExt( long object, String resource_name, double * x, double * y, double * z )
double GetGTagExt( long object, String tag_source, double * x, double * y, double * z )

Query the value of the drawing’s geometrical resource or tag and return it via the x, y and z parameters.

doubleGetXResourceExt( long object, String resource_name )
double GetXTagExt( long object, String tag_source )

doubleGetYResourceExt( long object, String resource_name )
double GetYTagExt( long object, String tag_source )

doubleGetZResourceExt( long object, String resource_name )
double GetZTagExt( long object, String tag_source )

Return the value of the X, Y or Z coordinates of a G-type resource or tag.

long GetElementExt( long container, long index )

Returns the element of the container indicated by the index.

BSTR GetElementAsString( long container, long index )

Returns a string of the string list (container) indicated by the index. This method is intended for VB.net environment which does not provide type casts.
long GetIndexExt( long container, long object)

Returns the index of the first occurrence of the object in the container or -1 if the object wasn’t found in the container.

long GetStringIndexExt( long container, String string)

Returns the index of the first occurrence of the string in the container or -1 if the string wasn’t found in the container.

long GetLegendSelectionExt( long object, double x, double y)

Returns the plot object corresponding to the legend item at the specified position, if any. If no legend item is found at the specified position, NULL is returned. The object parameter specifies the legend object, and the x and y parameters specify position in screen coordinates of the viewport that contains the legend.

long GetNamedObjectExt( long container, String name)

Returns the named element of the container defined by the name parameter.

long GetNumParents( long object)

Returns the number of parents of an object. Used to determine a type of the return value of the GetParentsExt method.

long GetParentExt( long object)

Returns the objects’ parent if object has one parent. If object has more than one parent, returns an array of parents. The type of the return value may be determined by using GetNumParents method.

long GetParentViewportExt( long object, BOOL heavy_weight)

Returns the parent viewport of a drawable GLG object specified by the object parameter. The heavy_weight parameter controls the type of a parent viewport to be returned. If set to False, the method returns the closest parent viewport regardless of its type: either a heavyweight or light viewport. If set to True, it returns the closest heavyweight parent viewport. For example, if the object is inside a light viewport, it will return the heavyweight viewport which is a parent of the light viewport.

long GetResourceObjectExt( long object, String resource_name)

Finds and returns an object ID of the object’s attribute or named resource.

long GetTagObjectExt( long object, String search_string, BOOL by_name, BOOL unique_tags, BOOL single_tag)

Finds a single tag with a given tag name or tag source, or creates a list of tags matching the wildcard. The search_string specifies either the exact tag name or tag source to search for, or a search pattern which may contain the ? and * wildcards. The by_name parameter defines the search mode: by a tag name or tag source. In the single tag mode, the first tag matching the search criteria is returned. The unique_tags controls if only one tag is included in case there are multiple tags with the same tag name or tag source. The unique_tags flag is ignored in the single tag mode.
In a single tag mode, the function returns an object ID of the first attribute that has a tag matching the search criteria. In the multiple tag mode, it returns an object ID of a group containing all attributes with matching tags. The returned list must be dereferenced using DropObject when it is no longer needed.

```c
long GetAlarmObjectExt( long object, String search_string, BOOL single_alarm, long reserved )
```

Finds a single alarm with a given alarm label, or creates a list of alarms matching the specified wildcard. The `search_string` specifies either the exact alarm label to search for or a search pattern which may contain the ? and * wildcards. The `reserved` parameter is reserved for future use and must be set to 0.

In a single alarm mode, the function returns an object ID of the first alarm that has an alarm label matching the search criteria. In the multiple alarm mode, it returns an object ID of a group containing all alarms with matching alarm labels. The returned list must be dereferenced using DropObject when it is no longer needed.

```c
long GetSizeExt( long container )
```

Returns the size of a container object.

```c
long GetViewportExt( void )
```

Returns the object ID of the main viewport of the drawing (the viewport named "$Widget")

```c
BOOL IsDemoExt( void )
```

Returns TRUE if the a Free Non-Commercial version of the ActiveX Extended API is used.

```c
BOOL IsDrawableExt( long object )
```

Returns true if the object is drawable. Drawable objects can be placed directly in a drawing area, have control points and a bounding box, have the visibility attribute and can contain custom properties, actions and aliases. For a chart object, the chart itself is drawable, but its plots are not.

```c
void InverseExt( long container )
```

Inverses the order of components inside the container.

```c
long IterateExt( long container )
```

Returns the next element of the container. The SetStartExt method must be used to initialize the container for iterating before IterateExt is invoked the first time, see page 141 for an example. The add, delete and search operations affect the iteration state and should not be performed on the container while it is being iterated.

To perform a safe iteration that is not affected by the add and delete operations, a copy of the container can be created using the CloneObjectExt method with the SHALLOW_CLONE clone type. The shallow copy will return a container with a list of objects IDs, and it can be safely iterated while objects are added or deleted from the original container.
Alternatively, *GetElementExt* can be used to traverse elements of the container using an element index, which is not affected by the search operations on the container.

```c
long LoadObjectExt( String filename )
```

Loads an object from a file and returns its object ID. The object has to be added to the drawing to be displayed.

```c
long LoadWidgetFromFileExt( String filename )
```

Loads a viewport named "$Widget" from a file and returns its object ID. The viewport has to be added to the drawing to be displayed.

```c
long LoadWidgetFromObjectExt( long object )
```

Finds a viewport named "$Widget" inside the object returns its object ID.

```c
BOOL MoveObjectExt( long object, long coord_type, double start_x, double start_y, double start_z,
                    double end_x, double end_y, double end_z )
```

Moves an object by the specified vector.

```c
BOOL MoveObjectByExt( long object, long coord_type, double x, double y, double z )
```

Moves an object by the specified X, Y and Z distances.

```c
BOOL ScaleObjectExt( long object, long coord_type,
                     double center_x, double center_y, double center_z, BOOL around_center,
                     double scale_x, double scale_y, double scale_z )
```

If *around_center* equals TRUE, scales an object relative to the center by the specified X, Y and Z scale factors, otherwise scales the object relative to the center of the object’s bounding box.

```c
BOOL RotateObjectExt( long object, long coord_type,
                      double center_x, double center_y, double center_z, BOOL around_center,
                      double x_angle, double y_angle, double z_angle )
```

If *around_center* equals TRUE, rotates an object around the specified center by the specified X, Y and Z angles, otherwise rotates the object relatively to the center of the object’s bounding box.

```c
BOOL PositionObjectExt( long object, long coord_type, long anchoring, double x, double y, double z )
```

Positions an object at the specified location using the specified anchoring.

```c
BOOL FitObjectExt( long object, long coord_type, double x1, double y1, double z1,
                   double x2, double y2, double z2, BOOL keep_ratio )
```

Fits the object to the specified area.

```c
BOOL LayoutObjectsExt( long object, long sel_elem, int type, double distance, BOOL use_box,
                       BOOL process_subobjects )
```

Performs a requested layout operation. Refer to the *GLG Intermediate and Extended API* chapter on page 119 for more details.
BOOL ScreenToWorldExt( long object, BOOL inside_vp,
    double screen_x, double screen_y, double screen_z,
    double * world_x, double * world_y, double * world_z )

Converts a point coordinates from the screen to the world coordinate system of the object.

If object is a viewport or a light viewport, inside_vp specifies which world coordinate system to use. If inside_vp=TRUE, the method will use the world coordinate system used to draw objects inside this (object) viewport. If inside_vp=FALSE, the method will use the world coordinate system used to draw this object viewport inside its parent viewport. The value of this parameter is ignored for objects other than a viewport or light viewport.

When converting the cursor position to world coordinates, add GLG_COORD_MAPPING_ADJ to the cursor’s x and y screen coordinates for precise mapping.

BOOL WorldToScreenExt( long object, BOOL inside_vp,
    double world_x, double world_y, double world_z,
    double * screen_x, double * screen_y, double * screen_z )

Converts a point coordinates from the object’s world coordinate system to the screen coordinate system.

If object is a viewport or a light viewport, inside_vp specifies which world coordinate system to use. If inside_vp=TRUE, the method will use the world coordinate system used to draw objects inside this (object) viewport. If inside_vp=FALSE, the method will use the world coordinate system used to draw this object viewport inside its parent viewport. The value of this parameter is ignored for objects other than a viewport or light viewport.

void TranslatePointOriginExt( long from_viewport, long to_viewport,
    double * x, double * y, double * z )

Converts screen coordinates of a point in the viewport specified by the from_viewport parameter to the screen coordinates of the viewport specified by to_viewport. The x, y and z parameters specify the input values and return the output value.

BOOL RootToScreenCoordExt( long viewport, double * x, double * y )

converts screen coordinates relative to the root window to the screen coordinates in the specified viewport. The x and y parameters specify the input values and return the output value.

BOOL PositionToValueExt( long object, String resource_name, double x, double y,
    BOOL outside_x, BOOL outside_y, double * value )

Returns a value corresponding to the specified x, y position on top of a chart or an axis object. Otherwise, the resource_name parameter points to a child chart, a child plot or a child axis of this object.

If outside_x or outside_y are set to TRUE, the method returns FALSE if the specified position is outside of the chart or the axis in the corresponding direction.

For a plot, the function converts the specified position to a Y value in the Low/High range of the plot and returns the value through the value pointer.
For an axis, the function converts the specified position to the axis value and returns the value.

For a chart, the function converts the specified position to the X or time value of the chart’s X axis and returns the value.

When using the cursor position, add GLG_COORD_MAPPING_ADJ to the cursor’s x and y coordinates for precise mapping.

The function returns TRUE on success.

**BOOL PrintExt( long object, String filename, double x, double y, double width, double height, BOOL portrait, BOOL stretch )**

Saves a PostScript image of the specified viewport object into a file. This method is disabled in Secure mode if GLG_ACTIVEX_PRINT_FILE environment variable is not set. If object is a light viewport, the output will be generated for its parent viewport.

**long ReferenceObjectExt( long object )**

References the object and returns its object ID.

**void ReleaseObjectExt( long object, long suspend_info )**

Releases a previously suspended for editing object. The suspend_info parameter is a returned value of a previous call to SuspendObjectExt.

**BOOL ReorderElementExt( long container, long old_index, long new_index )**

Moves the container’s element from the old_index to the new_index position. The function returns false if indexes are out of range.

**void ResetHierarchyExt( long object )**

Resets the hierarchy of the object.

**BOOL SaveObjectExt( long object, String filename )**

Saves object into a file. Returns TRUE if the object was successfully saved. This method is disabled in Secure mode if GLG_ACTIVEX_SAVE_FILE environment variable is not set.

**BOOL SetDResourceExt( long object, String resource_name, double dvalue )**

**BOOL SetDResourceIfExt( long object, String resource_name, double dvalue, BOOL if_changed)**

**BOOL SetDTagExt( long object, String tag_source, double dvalue, BOOL if_changed)**

Set a new value of a scalar resource or tag. Returns TRUE if the value of the resource or tag was successfully changed.

**BOOL SetElementExt( long container, long index, long new_object )**

Replaces the element of the container indicated by the index with new_object (Extended API only).
BOOL SetGResourceExt( long object, String resource_name, double dvalue1, dvalue2, dvalue3 )
BOOL SetGResourceIfExt( long object, String resource_name, double dvalue1, dvalue2, dvalue3,
            BOOL if_changed )
BOOL SetGTagExt( long object, String tag_source, double dvalue1, dvalue2, dvalue3,
            BOOL if_changed )

Set a new value of the G-type resource or tag. Returns TRUE if the value of the resource or tag was successfully changed.

BOOL SetResourceFromObjectExt( long object, String resource_name, long ovalue )

Sets a value of the data or matrix resource object defined by the resource_name to the value of the ovalue object (Extended API only). The resource types should match. Returns TRUE if the value of the resource was successfully changed.

BOOL SetResourceObjectExt( long object, String resource_name, long ovalue )

Sets a new value of the object’s attribute specified by the resource_name. It is used for attaching Custom Property objects and aliases.

BOOL SetSResourceExt( long object, String resource_name, String svalue )
BOOL SetSResourceIfExt( long object, String resource_name, String svalue, BOOL if_changed )
BOOL SetSTagExt( long object, String tag_source, String svalue, BOOL if_changed )

Set a new value of a string resource or tag. Returns TRUE if the value of the resource or tag was successfully changed.

BOOL SetSResourceFromDExt( long object, String resource_name, String format, double dvalue )
BOOL SetSResourceFromDIfExt( long object, String resource_name, String format, double dvalue,
            BOOL if_changed )
BOOL SetSTagFromDExt( long object, String tag_source, String format, double dvalue,
            BOOL if_changed )

Set a new value of a string resource or tag to a string obtained by converting the supplied double value according to the format. The format parameter is a C format string. Returns TRUE if the value of the resource or tag was successfully changed.

void SetStartExt( long container )

Initializes the container for traversing, should be called before using IterateExt method.

BOOL SetViewportExt( long viewport )

Sets the new drawing of the ActiveX control. The setting the drawing by using SetViewportExt method has the highest priority and overrides all other drawing properties.

BOOL SetXformExt( long object, long xform )

Sets the object transformation to a constrained copy of the xform parameter (Extended API only). If the xform parameter is null, removes any object transformations. The CloneObjectExt method may be used in conjunction with SetXformExt to add unconstrained copies of a transformation to several objects. Returns True if a transformation was successfully added.
Using the ActiveX Control

void SetupHierarchyExt( long object )

Sets up the object hierarchy of the object without repainting the object.

long SuspendObjectExt( long object )

Suspends object for editing. It must be called before adding a transformation or constraining attributes of the object whose object hierarchy has been setup (the object has been drawn). The method returns an object ID of the suspend_info object, which is used in a consequent call to the ReleaseObjectExt method.

BOOL UnconstrainObjectExt( long object )

Unconstrains the attribute object. Returns TRUE if the object was successfully unconstrained.

void UpdateExt( long object )

Updates the viewport object to display the latest resource settings. If object is a light viewport, update of its parent viewport will be performed.

BOOL TraceObjectExt( long object, BOOL state, BOOL is_widget, long top_parent )

Searches all parents of the traced object and highlights or unhighlights them based on the specified conditions. The parent search is performed until any of the specified conditions (is_widget or top_parent) is satisfied. The objects will be highlighted if the state parameter is TRUE and unhighlighted otherwise.

If is_widget=TRUE, the parent objects that have resource named IsWidget will be highlighted or unhighlighted depending on the state parameter. If top_parent is non-zero, the parent objects that are direct children of top_parent will be highlighted or unhighlighted. If no conditions are specified, all immediate drawable parents of the traced object will be highlighted or unhighlighted.

The function returns TRUE if any parents were highlighted.

The dependent parent objects are highlighted with an outline. The attributes of the outline are defined by the GlgHighlightPolygon global configuration resource.

GLG ActiveX Control Security

By default, the GLG ActiveX Control is allowed to save files on a local file system. The GLG_ACTIVEX_SECURE_MODE environment variable may be set to True to activate a Secure mode, which prevents the control from saving files.

In the secure mode, a user can enable saving files to a file system using predefined filenames by setting the GLG_ACTIVEX_SAVE_FILE, GLG_ACTIVEX_IMAGE_FILE and GLG_ACTIVEX_PRINT_FILE environment variables described later in this document. These variables define filenames used for saving drawings, images and the PostScript files.
**GLG ActiveX Control Environment Variables**

Several environment variables may be used to modify GLG ActiveX Control’s behavior. This is optional and not required for a typical GLG ActiveX Control usage.

The environment variables may be set using the system’s Control Panel.

**GLG_ACTIVEX_SECURE_MODE**

Turns on the Secure mode, which prohibits the ActiveX control from saving arbitrary files in the file system.

**GLG_ACTIVEX_SAVE_FILE**

Provides a filename to be used for the ActiveX Control’s `SaveObjectExt` method. In the Secure mode, saving is allowed only if this environment variable is set, in which case the `filename` parameter of the `Save` method is ignored and the name defined by GLG_ACTIVEX_SAVE_FILE will be used.

**GLG_ACTIVEX_IMAGE_FILE**

Provides a filename to be used for the ActiveX Control’s `SaveImage` methods. In the Secure mode, saving is allowed only if this environment variable is set, in which case the `filename` parameter of the `SaveImage` method is ignored and the name defined by GLG_ACTIVEX_IMAGE_FILE will be used.

**GLG_ACTIVEX_PRINT_FILE**

Provides a filename to be used for the ActiveX Control’s `Print` methods. In the Secure mode, `Print` methods are enabled only if this variable is set, in which case it provides a name of a PostScript file to be generated.
Chapter 4

Using the Java and C# Versions of the Toolkit

Introduction

The Java and C# versions of the GLG Toolkit provide Java and C# class libraries for native Java and C# applications. The class libraries are very similar, with majority of the methods, fields and interfaces being the same for both Java and C#. This chapter describes both class libraries in one document, listing environment-specific differences as applicable.

C# Note: Documentation for the C# methods uses the boolean alias for boolean values for brevity and uniformity with the corresponding Java methods. In the actual C# code, the bool type is used. All other differences between the Java and C# versions are explicitly noted.

Using the Documentation

This chapter describes the language-specific details of using the Java and C# versions of the Toolkit. It does not go into details of the GLG objects behavior when the class library methods are listed.

Refer to the Using the C/C++ version of the Toolkit chapter on page 31 for a detailed description of semantics of the API methods, as well as details of handling user input (described in the Handling User Input and Other Events section on page 101). The semantics of all API methods is the same in all versions of the Toolkit, and the C/C++ section provides examples and details of using them.

Refer to the GLG Programming Tutorial for Java for detailed examples and a walk-through tutorial.

An on-line documentation for the Java and C# class library (in the JavaDoc and XMLDoc formats, respectively) is also provided. The online documentation is intended as a quick reference for the Java and C# classes and methods, but not as a definitive guide to using the Toolkit. This chapter provides more detailed information specific to the use of the GLG Java and C# class libraries. Refer to the Using the C/C++ version of the Toolkit chapter for more information about the semantics of the GLG objects usage that is common across all supported platforms.

Numerous demos and examples for both Java and C# are also provided (in the DEMOS_JAVA and examples_java directories for Java, and DEMOS_CSHARP, examples_csharp.NET and examples_csharp_ocx for C#).

Overview

The Java and C# versions of the GLG Toolkit provide Java and C# class libraries that load and display GLG drawings in Java and C# applications. Both class libraries support all GLG Toolkit features and are available in all forms of the GLG API: Standard, Intermediate and Extended.

The Java and C# versions of the Toolkit use GLG drawings saved with the GLG Graphics Builder. The drawings imported from the Builder must be saved in ASCII format, either compressed or uncompressed. The same drawing may be used in both Java, C# and C/C++ versions of the Toolkit. The drawing can also be generated on the fly using the Extended API, which provides methods to create and copy objects at run-time.
Class Hierarchy

*GlgObject* is the main class of the Java version of the GLG Toolkit. The *GlgObject* class contains all the functionality available to GLG objects. Since all objects implement the *Get* and *SetResource* functions central to the GLG architecture, it’s only natural that the *GlgObject* superclass is heavily used, making it a Superclass in a more general sense. Using one main superclass also makes it easier to deal with GLG objects by limiting the number of classes and methods one has to learn.

The GLG Toolkit also contains classes for different GLG objects: polygons, arcs, etc. However, only the constructors of these classes are used. Once the object is created, all further object manipulation is done by using the *GlgObject* methods.

The GLG Toolkit also provides classes such as *GlpPoint*, *GlgCube* and some other utility classes, mainly used to exchange information between different object methods.

Integrated Components for Java and .NET

The *Java class library* provides the *GlgBean*, a Java bean component that seamlessly integrates GLG Toolkit into a Java environment, embedding Java-based GLG components into Java application frameworks and Java IDEs. Several types of the GLG Bean are provided for AWT and Swing.

The *C# class library* provides the *GlgControl* component which integrates GLG Toolkit in the .NET and Visual Studio environment, providing properties and events that can be used in the Visual Studio Design Mode.

The GLG component (*GlgBean* in Java or *GlgControl* in C#) encapsulates a GLG viewport object that loads, displays and animates a GLG drawing. The component provides several properties that facilitate loading the drawing: *DrawingFile*, *DrawingURL*, *DrawingName* and *DrawingObject*.

Two Ways to use the GLG API

There are two alternatives for most of the GLG API methods: the methods of the *GlgObject* class, and the methods of the *GlgBean* or *GlgControl* integrated component.

While the *GlgObject* methods have to be invoked for individual objects, the component provides a central place for invoking methods on any object or any resource inside the component’s drawing. The methods exposed by the GLG component are similar to the methods of the *GlgObject* class, and decision which methods to use depends on the complexity of the application’s interaction with the drawing displayed in the component:

- If an application loads a GLG drawing, initializes it by setting a few resources and starts updating it with real-time data, the methods of *GlgBean* or *GlgControl* are sufficient.

- If an application needs to perform elaborate custom actions, traverse objects in the drawing to determine the content of the drawing, or to perform other actions that require obtaining IDs of objects in the drawing, it may use the *GlgBean* or *GlgControl* to integrate a GLG drawing in the program and then use methods of the *GlgObject* class for all further processing. After loading the drawing, the viewport object (a *GlgObject*) of the loaded drawing may be extracted by calling the component’s *GetViewport* method.
In the rest of this chapter, the *GlgBean* and *GlgControl* integrated components may be referred generically using the term *component*.

**Events and Input Handling**

GLG integrated components (*GlgBean* in Java and *GlgControl* in C#) provide two mechanisms for handing user input: listeners or callbacks. In the C# environment, the *GlgControl* component also supports C# events.

Listeners can be added to a GLG component to handle events of different types, such as input or object selection. A listener must implement an interface to handle events of the corresponding type. For example, *GlgInputListener* must implement the *InputCallback* method.

The following listeners are supported for *GlgBean* and *GlgControl* components:

- *GlgInputListener*, *GlgSelectListener* are used to handle user interaction and object selection.
- *GlgHListener* and *GlgVListener* may be used for initializing the drawing’s initial appearance.
- *GlgHierarchyListener* is used for initializing drawings displayed in the *SubWindow* objects or instances of the *SubDrawing* objects.
- *GlgReadyListener* is invoked after the drawing has finished initializing and has been drawn for the first time; it is often used to start timers used for animation.
- *GlgTraceListener* and *GlgTrace2Listener* may be used to process native events not handled by the listeners listed above.

By default, the GLG Component (*GlgBean* or *GlgControl*) is used as a default listener for all event types and implements callback methods required by the listener interfaces: *InputCallback*, *ReadyCallback* and so on. This makes it more convenient to create custom components by subclassing *GlgBean* or *GlgControl* and overriding some or all of its listener interfaces. An application can also add listeners to the component (via the *AddListener* method) to handle events without subclassing the component.

In addition to the GlgBean or GlgControl listeners, event listeners may also be added to individual child viewports displayed in the component’s drawing using methods of the *GlgObject* class. This allows an application to provide a custom input handler for each child viewport displayed in the drawing if needed. *Input*, *Select*, *Trace* and *Hierarchy* listeners may be added to individual GLG objects, while *H*, *V* and *Ready* listeners are supported only for the GLG component, as they are not needed at the *GlgObject* level.

**In the C#/NET environment**, GlgControl events are also implemented for the convenience of using the control in the VisualStudio’s design mode. The supported .NET event types match the types of the event listeners: *GlgInput*, *GlgSelect*, *GlgH*, *GlgV*, *GlgHierarchy*, *GlgReady*, *GlgTrace* and *GlgTrace2*. 
Installable Interface Handlers API

GLG Installable Interface Handler Utilities assist an application developer with implementing functionality of complex user interactions usually encountered in editor-style applications. The utilities include a collection of methods as part of the GLG Intermediate API library. The GLG Diagram demo provides an example of a custom diagraming editor application implemented using the GLG Installable Interface Handlers functionality.

Refer to the the GLG Installable Interface Handlers chapter on page 201 for an overview of the Installable Interface Handlers functionality. Refer to the GLG Java, C# or JavaScript online documentation for descriptions of the interface handler methods for the respective APIs.

Using Threads in Java and C#/\.NET

Threads are commonly used in Java and C# applications for getting data from various sources over a network. Using threads for querying data allows an application to continuously stream incoming data independently from the user interface.

GLG Toolkit uses Swing in Java and .NET graphics framework in C#. These graphical frameworks are single-threaded and do not allow asynchronous access to graphics. All access to graphics should be done only from the event dispatching thread in Java and the UI thread in C#. Since GLG uses native interface components and graphics for displaying GLG drawings, all calls to the GLG API methods must be performed from the event dispatching thread as well.

This applies to all GLG calls, including GetResource and SetResource methods. These methods are not simple getters and setters, but rather complex methods that traverse the GLG object hierarchy to perform the requested operation. This traversal operation is not thread-safe.

If an application uses a thread-safe timer to obtain new data, it can update GLG drawings by invoking GLG SetResource and Update methods directly from the timer callback.

If an application uses data threads for querying new data, the thread code can not invoke SetResource and Update methods directly, and instead should pass the accumulated data to the event thread where the data will be used to update the graphics. In Java, this can be accomplished by using the SwingUtilities.invokeLater method. In C#/\.NET, the data thread can use the GlgControl’s Invoke method or the InvokeRequired property to execute SetResource and Update calls on the UI thread.

An alternative way to implement multi-threaded design would be have a data thread continuously accumulating data, and use a thread-safe timer to periodically (several times per second) check if new data from the data thread are available. If the new data came in, the timer code can issue SetResource calls for all new data values and then invoke the Update method to redraw the drawing just once for optimum performance.

With either design, it is the application’s responsibility to properly synchronize access to all data structures if data threads are used.
Types of GLG Bean (Java Only)

Several GLG Bean classes are provided:

- **GlgBean**
  AWT-based Java bean.

- **GlgJBean**
  Heavyweight Swing-based Java bean.

- **GlgJLWBean**
  Lightweight Swing-based Java bean for use with JDesktopPane and JInternalFrame.

All GLG Bean classes have the same GLG-inherited interface and differ only in the methods inherited from respective AWT or Swing superclasses. The AWT and Swing-based GLG beans should not be intermixed in one application. The light-weight version of the GLG bean (GlgJLWBean) uses Swing’s light-weight model which imposes a performance penalty related to the absence of a native window and a necessity to handle clipping in software. Although it is OK to use the light-weight component for small to medium drawings, a heavy-weight component is recommended for large graphically-intensive drawings.

The type of the top level bean may be different from the type of the components used to render GLG viewport objects displayed inside the GlgBean and GlgJBean. By default, the GlgBean uses AWT components, while the GlgJBean and GlgJLWBean use Swing-based components.

GLG Graphics Server

**GLG Graphics Server for JSP / Java**

A separate GLG class library for the JSP environment is provided in the GlgServer.jar file. This class library provides the GLG Extended API, and also supports headless operation as well as a multi-threaded access by the servlet threads. When used in a servlet, the GlgObject classes should be used instead of the GLG Bean. The examples.jsp directory contains elaborate examples of the GLG servlets with the source code.

**GLG Graphics Server for ASP.NET / C#**

The Glg.NETServer.dll file provides the GLG DLL for the ASP.NET environment. In addition to providing the GLG Extended API, this DLL provides the GlgHttpRequestProcessor class used to implement custom HTTP handlers in the ASP.NET environment. The DLL also supports headless operation and multi-threaded ASP.NET handlers. The examples.ASP.NET directory contains elaborate source code examples of custom GLG-based ASP.NET HTTP handlers.

Error Handling and Miscellaneous Features

**Error Handling**

The Toolkit provides the GlgErrorHandler interface for custom error handling. A custom error handler can be installed using the SetErrorHandler method. The Error method of the error handler will be invoked with the error message string as a parameter when a GLG error is detected, such as trying to access a null or non-existing resource.
The default error handler emits an audio beep and displays the error message in the Java console or in a message dialog for C#/NET. The error message includes a stack trace showing the location where the error occurred.

**In the C#/NET version** of the class library, the default error handler also logs the error message in the *glg_error.log* log file. The location of the log file is determined by the GLG_LOG_DIR and GLG_DIR environment variables as described in the *Error Processing* section on page 47. An application can use the *GlgObject.Error* method to signal errors or log messages into the *glg_error.log* log file.

**Anti-aliasing and Point Coordinates Precision**

**In the Java version** of the GLG class library, a global *GlgAntiAliasing* configuration resource, described on page 418 of the *Appendices* chapter, controls default anti-aliasing setting for all drawings in an application. The anti-aliasing behavior of individual viewports can be controlled at run time by the viewport’s *AntiAliasing* attribute. The *AntiAliasing* attribute of individual polygons is ignored.

In the Java environment, point coordinates are passed as integer values, and the only available settings of the *GlgAntiAliasing* global configuration resource are ANTI_ALIASING_OFF and ANTI_ALIASING_INT.

**In the C# version**, the anti-aliasing behavior of polygons is controlled on per-object basis depending on the setting of the object’s *AntiAliasing* attribute.

In the .NET environment, point coordinates are passed as double values and the ANTI_ALIASING_DBL setting of the attribute is supported in addition to ANTI_ALIASING_OFF and ANTI_ALIASING_INT. If an object’s *AntiAliasing* attribute is set to ANTI_ALIASING_UNSET (default, displayed as INHERIT in the Builder), the anti-aliasing setting is inherited from the viewport the object is displayed in, or from the global *GlgAntiAliasing* configuration resource.

**Generic API**

While the most common way to display a GLG drawing in a Java or .NET application is using integrated GlgBean and GlgControl components described above, an application can also display a GLG drawing using only the methods of the *GlgObject* class:

**Java:**
```
GlgObject drawing = GlgObject.LoadWidget( “my_drawing.g”, GlgObject.FILE );
drawing.AddListener( GlgObject.INPUT_CB, my_input_handler );
drawing.InitialDraw();
```

**C#:**
```
GlgObject drawing = GlgObject.LoadWidget( “my_drawing.g”, GlgMediumType.FILE );
drawing.AddListener( GlgCallbackType.INPUT_CB, my_input_handler );
drawing.InitialDraw();
```

The InitialDraw method in the above code creates a window for the top-level viewport of the drawing and displays the drawing in it.
Class Library Files for Java and C#/.NET

Java Jar Files

The following JAR files are available for the Java version of the Toolkit:

- **Glg2.jar** - a commercial version of the Standard API. It is used to display the drawing, update it with dynamic data and handle user input.
- **GlgInt2.jar** - a commercial version of the Intermediate API. It includes the Standard API and extends it with methods to manipulate objects in the drawing at run time and implement elaborate logic for handling user input.
- **GlgExt2.jar** - a commercial version of the Extended API, includes all methods of the Standard and Intermediate APIs and adds methods for creating and adding objects to the drawing at run time.

**GlgGraphLayout.jar** provides the graph layout functionality.

**GlgDemo.jar** contains the class files of the GLG demos.

The following GLG Graphics Server JAR files are provided:

- **GlgServerCE.jar** - a free Evaluation and Community Edition version
- **GlgServer.jar** - a commercial version of the GLG Graphics Server for JSP.

Both Graphic Server JARs include all GLG APIs: Standard, Intermediate and Extended.

C#/.NET DLLs

The following DLLs are available for the C#/.NET version of the Toolkit:

- **Glg.Net.dll** - a commercial version with the Standard API. It is used to display the drawing, update it with dynamic data and handle user input.
- **Glg.NetInt.dll** - a commercial version with the Intermediate API. It includes the Standard API and extends it with methods to manipulate objects in the drawing at run time and implement elaborate logic for handling user input.
- **Glg.NetExt.dll** - a commercial version with the Extended API, includes all methods of the Standard and Intermediate API and adds methods for creating and adding objects to the drawing at run time.

**Glg.Net.GraphLayout.dll** provides the commercial version of the graph layout library, while **Glg.Net.GraphLayoutCE.dll** can be used with the free Community Edition.

The following GLG Graphics Server DLLs provide all GLG APIs (Standard, Intermediate and Extended):

- **Glg.NetServer.dll** - a commercial version of the GLG Graphics Server for ASP.NET.
JurassicGLG.dll provides the JavaScript interpreter used by the above DLLs.

**Interfaces**

Interfaces are used for event listeners, custom error and alarm handlers, label and tooltip formatters, as well as utility functions.

**Event listeners note:** Only a single event listener for each event type is enabled per an instance of a GLG object or a GLG component. The GLG component is a default listener for all events, and adding a listener to a component disables the component’s callback for the corresponding event. Multiple listeners can be added to different child viewports inside the component’s drawing, so that each viewport can have its own event listener if required.

**GlgInputListener**

`public interface GlgInputListener`

The main listener interface for handling user interaction and object selection.

**Methods**

`public void InputCallback( GlgObject object, GlgObject message_object )`

This callback method is invoked every time a user interacts with input objects in the drawing or selects objects in the drawing with the mouse. More information about the type of the input activity may be extracted from the message object passed by the `message_object` parameter. The `object` parameter is the viewport the listener is attached to (or the top viewport of the drawing if the listener was added to `GlgBean` or `GlgControl`). Refer to the `Input Callback` section of the `Handling User Input and Other Events` chapter on page 105 for more details.

**GlgSelectListener**

`public interface GlgSelectListener`

Listener interface used to handle an object selection with the mouse, provides a simplified name-based interface for object selection handling.

`GlgInputListener` provides a more elaborate alternative for handling selection events using either object IDs, or custom event and command actions which can be attached to objects in the Graphics Builder.

**Methods**

`public void SelectCallback( GlgObject object, Object[] name_array, int button )`

This callback is invoked every time the user selects one or more objects with the mouse. The `name_array` parameter is a `null`-terminated array containing names of the selected objects. Each name includes a complete GLG resource path that ends with the object’s name. The `button` parameter is the mouse button used for selection (1, 2 or 3). The `object` parameter is the viewport
the listener is attached to (or the top viewport of the drawing if the listener was added to GlgBean or GlgControl). Refer to the Selection Callback section of the Handling User Input and Other Events chapter on page 103 for more details.

**GlgTraceListener**

```java
class GlgTraceListener
{
    public interface GlgTraceListener
    {
        Listener interface used to handle low-level native events.

        Methods
        public void TraceCallback( GlgObject object, GlgTraceData trace_info )
        {
            This callback is invoked for every event occurring in any of the drawing’s viewports and may be used to implement custom selection or hot-spots logic and to handle low-level native events. The object parameter is the viewport the listener is attached to (or the top viewport of the drawing if the listener was added to GlgBean or GlgControl). Refer to the Trace Callbacks section of the Handling User Input and Other Events chapter on page 106 for more details.
        }
    }
}
```

**GlgHierarchyListener**

```java
class GlgHierarchyListener
{
    public interface GlgHierarchyListener
    {
        Listener interface used for initialization of drawings displayed in SubWindows or instances of the SubDrawings.

        Methods
        public void HierarchyCallback( GlgObject object, GlgHierarchyData hierarchy_info )
        {
            This callback is invoked every time a SubWindow object loads a new drawing to be displayed, or a SubDrawing object loads its template. The callback may be used to attach different Input listeners for each drawing displayed in the subwindow to handle user interaction in each drawing. It may also be used to initialize the subwindow’s drawing or subdrawing’s template before it is drawn.

            The object parameter is the viewport the listener is attached to (or the top viewport of the drawing if the listener was added to GlgBean or GlgControl). Refer to the Hierarchy Callback section of the Handling User Input and Other Events chapter on page 107 for more details.
        }
    }
}
```

**GlgHListener**

```java
class GlgHListener
{
    public interface GlgHListener
    {
        Interface for setting the initial values of resources of the drawing displayed in the GlgBean or GlgControl.
    }
}
```
Methods

public void HCallback( GlgObject viewport )

This callback is invoked after the component’s drawing is loaded, but before the drawing hierarchy is set up. It may be used to set the initial resources of the drawing, such as the number of samples in a GLG graph object. The viewport parameter is the top viewport of the drawing displayed in the GlgBean or GlgControl.

GlgVListener

public interface GlgVListener

Interface for setting the initial values of resources of the drawing displayed in the GlgBean or GlgControl.

Methods

public void VCallback( GlgObject viewport )

This callback is invoked after the component’s drawing is loaded and set up, but before it is displayed for the first time. It may be used to set the initial resources of the drawing. For example, it may be used to supply data for the initial appearance of a GLG graph object. The viewport parameter is the top viewport of the drawing displayed in the GlgBean or GlgControl.

GlgReadyListener

public interface GlgReadyListener

Interface for detecting the Ready event.

Methods

public void ReadyCallback( GlgObject viewport )

This callback is invoked after the component’s drawing is loaded, setup and displayed for the first time. It may be used to detect when the GlgBean or GlgControl is ready and begin updating the drawing with data. The viewport parameter is the top viewport of the drawing displayed in the GlgBean or GlgControl.
**GlgErrorHandler**

```java
public interface GlgErrorHandler

    Error handling interface.
```

**Methods**

```java
public void Error( String message, int error_type, Exception exception ) (Java)
public void Error( String message, GlgErrorType error_type, Exception exception ) (C#)
```

Displays the error message. The `message` parameter is the text of the error message; `exception` is an optional parameter that, if not `null`, supplies exception information and the exact location of the error shown in the stack trace. The `error_type` parameter specifies the type of the error message and may have the following values:

- `INTERNAL_ERROR`
- `USER_ERROR`
- `USER_ERROR_NO_STACK`
- `WARNING`
- `INFO` (Java)
- `LOGGING` (C#)

Refer to the description of the `Error` method on page 312 for more information on the error types.

**GlgAlarmHandler**

```java
public interface GlgAlarmHandler

    Alarm handling interface.
```

**Methods**

```java
public void Alarm( GlgObject data_object, GlgObject alarm_object, String alarm_label, String action, String subaction, Object reserved )
```

Processes the alarm message. The `data_object` parameter is the resource whose value has changed. The `alarm_object` parameter is the alarm attached to the `data_object` to monitor its value; it is the alarm that generated the alarm message. The `alarm_label` parameter supplies the `AlarmLabel` used to identify `alarm_object`. The `action` and `subaction` parameters provide details about the condition that caused the alarm; refer to the `Alarm Messages` section on page 211 for more information.
**GlgLabelFormatter**

*public interface GlgLabelFormatter*

An interface for supplying custom axis labels.

**Methods**

*public void GetString( GlgObject axis, int label_type, int value_type, double value, long sec, double fractional_sec, Object reserved ) (Java)*

*public void GetString( GlgObject axis, GlgLabelType label_type, GlgValueType value_type, double value, long sec, double fractional_sec, Object reserved ) (C#)*

The method is invoked every time a new label string needs to be generated. It can create and return a label string, or return `null` to use a default label string.

The `axis` parameter is the axis the formatter is attached to.

The `label_type` parameter specifies the type of the label to be generated: TICK_LABEL_TYPE, SELECTION_LABEL_TYPE or TOOLTIP_LABEL_TYPE.

The `value_type` parameter is the type of the axis value: NUMERICAL_VALUE or TIME_VALUE.

The `value` parameter provides the X value corresponding to the label position.

The `sec` parameter supplies an integer number of seconds since the Epoch corresponding to the label position.

The `fractional_sec` parameter supplies the fractional number of seconds.

The reserved parameter must be `null`.

**GlgChartFilter**

*public interface GlgChartFilter*

An interface for a custom chart filter. All chart filter methods receive input filter data via the `filter_data` parameter. The `client_data` parameter contains data passed to the filter by the application when the filter was attached to a plot.

Refer to the `CustomChartFilter.java` file (`CustomChartFilter.cs` file for C#) in the `src` directory of the GLG installation for an extensive self-documented coding example of implementing several types of custom filters.

**Methods**

*int Start( GlgChartFilterData filter_data, Object client_data );*

Invoked before drawing plot's data, must return CHART_FILTER_VERSION constant.

*void AddSample( GlgChartFilterData filter_data, Object client_data );*

Invoked by the plot to supply a next data sample to filter.
Using the Java and C# Versions of the Toolkit

int Flush( GlgChartFilterData filter_data, Object client_data );  \hspace{1cm} (Java)

GlgChartFilterRval Flush( GlgChartFilterData filter_data, Object client_data );  \hspace{1cm} (C#)

Invoked before starting a new filter interval (defined by the filter precision) to flush accumulated aggregate data for the previous interval. Must returns one of the following values:

- SKIP_DATA to indicate there are no accumulated data to plot
- USE_DATA1 to indicate the accumulated data are to be plotted as a single data sample
- USE_DATA2 to indicate the accumulated data are to be plotted as two data samples.

void Finish( GlgChartFilterData filter_data, Object client_data );

Invoked after drawing plot's data.

GlgTooltipFormatter

public interface GlgTooltipFormatter

An interface for supplying custom tooltip labels.

Methods

public void GetString( GlgObject viewport, GlgObject object, GlgObject tooltip_obj,
int root_x, int root_y )

The method is invoked every time a new tooltip string needs to be generated. It can create and return a tooltip string, or return null to use a default tooltip string.

The viewport parameter is the parent viewport of the object.
The object parameter is the object with the tooltip action.
The tooltip_obj is a data object of S (string) type that contains the tooltip string.
The root_x parameter is the X coordinate of the cursor relative to the root window.
The root_y parameter is the Y coordinate of the cursor relative to the root window.

GlgObjectActionInterface

public interface GlgObjectActionInterface

An interface used for performing special queries, such as FindMatchingObjects.

Methods

public boolean Action( GlgObject object )

The method is invoked for every object that is tested and should return true if the object matches a desired custom search criterion.

The object parameter is the object being tested.
GlGGISRequestObserver

public interface GlgGISRequestObserver

A GIS request observer interface used to notify the program about the status of the asynchronous
GIS map requests.

Methods

public void RequestUpdate( GlgObject gis_object, GlgGISRequestStatus status)

This method is invoked with the status of the GIS request when the GIS request becomes ready or
is aborted. The gis_object parameter is set to the request’s GIS object. The status parameter
specifies the reason this method is invoked and may be one of the following constants (defined in
the GlgObject class for Java or the GlgGISRequestStatus enum for C#):

• GIS_ABORT_ON_GIS_CHANGE - aborted by the change in the GIS object's parameters
• GIS_ABORT_ON_NEW_REQUEST - aborted by a new GIS request
• GIS_ABORT_OF_ZOOM_MODE - ZoomTo request was aborted by the application
• GIS_ABORT_ON_LOAD_ERROR - aborted due the map image generation errors
• GIS_ABORT_ON_RESET - aborted due to the GIS object reset
• GIS_ABORT_BY_API - aborted by the AbortGISRequest API method.
• GIS_REQUEST_READY - the GIS request is ready to be installed using the
  InstallGISRequest method.

public boolean RequestAdjustment()

This method is invoked before proceeding with the request to specify if any adjustments need to be
done. If the method returns true, the AdjustRequest method will be invoked to adjust request
parameters before proceeding with the request. For example, a map projection or displayed GIS
layers may need to be changed depending on the map zoom factor.

public boolean AdjustRequest( GlgGISRequestData request_data )

If RequestAdjustment returns true, this method is invoked before proceeding with the request to
perform any desired adjustments to the request parameters. This may be used to adjust parameters
of the request created by the RequestGISZoom method before the request is used to generate a new
map image. The method must return true if any request parameters were modified.

The request_data object supplies GIS parameters of the request, which can be modified in place to
adjust them. See the GlgGISRequestData class section on page 342 for more information.

Enums

Enums are used in the C# version of the class library. The enums are defined at the top level of the
GenLogic package namespace. Refer to the online documentation in the XMLDoc format for a list
of all enums of the GenLogic namespace.
In the **Java version**, integer constants named the same way as enum elements are used. The constants are defined at the `GlgObject` class level. Refer to the online documentation in the JavaDoc format for a list of all enums of the `GenLogic` namespace.

**GLG Integrated Component Classes**

The `GlgBean` and `GlgControl` integrated components are provided for Java and C#/.NET deployment. While the classes have different constructors, the API methods described below are common for both Java and C# components.

**GlgBean Java class**

**GlgJBean Java class**

**GlgJLWBean Java class**

```java
public class GlgBean extends Applet implements GlgInputListener, GlgSelectListener,
        GlgTraceListener, GlgHierarchyListener, GlgHListener, GlgVListener,
        GlgReadyListener, GlgErrorHandler

AWT-based Java bean.

public class GlgJBean extends JApplet implements GlgInputListener, GlgSelectListener,
        GlgTraceListener, GlgHierarchyListener, GlgHListener, GlgVListener,
        GlgReadyListener, GlgErrorHandler

Heavyweight Swing-based Java bean.

public class GlgJLWBean extends JPanel implements GlgInputListener, GlgSelectListener,
        GlgTraceListener, GlgHierarchyListener, GlgHListener, GlgVListener,
        GlgReadyListener, GlgErrorHandler

Lightweight Swing-based Java bean for use with `JDesktopPane` and `JInternalFrame`.
```

**Description**

GLG Beans are Java bean components that integrate GLG objects into the Java environment. The GLG Bean is a Java Bean encapsulation of a GLG viewport object that loads, displays and animates a GLG drawing. All GLG Bean classes have the same GLG-inherited interface and differ only in the methods inherited from their respective AWT or Swing superclasses. The AWT and Swing-based GLG beans should not be intermixed in one application.

The GLG Bean provides methods similar to those of `GlgObject`. Methods of the GLG Bean and the bean’s viewport `GlgObject` may be used interchangeably.

The GLG Bean implements all GLG listener interfaces and is used as a default listener for all GLG events. The bean’s listener interface methods may be overridden by the bean’s subclasses.

When the GLG Bean is used as an applet, it provides functionality for following HTML links on mouse clicks. If an object contains an S resource named "$href", the value of the resource is interpreted as a URL which defines an HTML link. If the user selects an object in the drawing which has an HTML link, the link’s URL will be automatically loaded. Custom Properties may be used to attach the "$href" property to objects in the Builder. The HRefTarget property of the bean may be used to define an html target name to open the link in a different browser window.
The functionality for following HTML links is activated by setting the TraceHRef bean property to true. The property is set to false by default. The value of the ProcessMouse attribute of the viewport containing the drawing displayed in the bean also has to include the Click mask to activate processing of the mouse selection events. If the mask include the Move mask, the bean will also trace the link’s hot spot, changing the cursor shape when cursor hovers over an object that represents a link and displaying the link’s URL in the status bar.

**GlgControl C# class**

```csharp
public class GlgControl : System.Windows.Controls.Control, GlgInputListener, GlgSelectListener,
     GlgTraceListener, GlgHierarchyListener, GlgHLListener, GlgVLListener,
     GlgReadyListener, GlgErrorHandler
```

GLG .NET control.

**Description**

*GlgControl* is a .NET-based custom control component that integrates GLG drawings into the .NET and Visual Studio environment. The *GlgControl* is a .NET encapsulation of a GLG viewport object that loads, displays and animates a GLG drawing.

*GlgControl* provides methods similar to those of GlgObject. Methods of *GlgControl* and the control’s viewport GlgObject may be used interchangeably.

*GlgControl* implements all GLG listener interfaces and is used as a default listener for all GLG events. The control’s listener interface methods may be overridden by the control’s subclasses.

**Fields**

- **public boolean SelectEnabled**
  Enables or disables the Select callback, listener and event; is set to true by default.

  To increase performance when the Select callback is not used, set SelectEnabled to false before loading the component's drawing.

- **public boolean HierarchyEnabled**
  Enables or disables the Hierarchy callback, listener and event; is set to true by default.

  To increase performance when the Hierarchy callback is not used, set HierarchyEnabled to false before loading the component's drawing.

- **public boolean TraceEnabled**
  Enables or disables the Trace and Trace2 callbacks, listeners and events. The Trace callback is invoked before the native event is processed by the Input and Select callbacks, and Trace2 is invoked after the native event is processed. The properties are set to false by default. To enable the callbacks, set the corresponding property to true before loading the component's drawing.
The `GlgTraceData` class contains information about the native event and is passed to trace callbacks and events as the `trace_info` parameter. A single method can handle both `Trace` and `Trace2` events, using the `trace_info.trace2` field to differentiate between them. The field is set to `false` for the `Trace` events and to `true` for `Trace2`.

### C# Properties

**DrawingFile**

The filename of the drawing to be loaded into the control.

```csharp
public String DrawingFile { get; set; }
```

**DrawingURL**

The URL of the drawing to be loaded into the `GlgBean` or `GlgControl`.

```csharp
public String DrawingURL { get; set; }
```

### Using Properties in the Visual Studio Design Mode

An application can add C# event handlers and set the `DrawingFile` or `DrawingURL` properties of `GlgControl` using the Visual Studio Design Mode.

### Java Bean Properties

**DrawingFile**

The filename of the drawing to be loaded into the bean.

**DrawingURL**

The URL of the drawing to be loaded into the `GlgBean` or `GlgControl`.

If a relative filename, such as “drawing.g”, is specified when the bean is used as an applet, it will be interpreted relatively to the applet’s `DocumentBase`.

**DrawingName**

A relative drawing name. This can be used to transparently specify the drawing location for both the applet and stand-alone Java application. For an applet, it is relative to it’s `DocumentBase`. For a stand-alone application, it is relative to the current directory.

**DrawingResource**

The name of the drawing file in a jar file.

**CharsetName**

The name of a Java charset to be used for decoding strings in the drawing when it is loaded. It should match the locale in which the drawing was created in the GLG Graphics Builder. If it is set to `null`, the default charset will be used.
**SetupDataURL**

The URL of the setup script in the GLG Script Format to use for initializing drawing’s resources.

**DataURL**

The URL of the data script in the GLG Script Format to use for periodic updates of the drawing’s resources.

**UpdatePeriod**

Double value that defines an update interval for reading DataURL, in seconds.

**HResource0**  
**HResource1**  
**HResource2**  
**HResource3**  
**HResource4**

String properties used to initialize drawing’s resources before hierarchy setup. For information about the format of the strings see the *Dynamic Resource String Syntax* chapter on page 243.

**VResource0**  
**VResource1**  
**VResource2**  
**VResource3**  
**VResource4**

String properties used to initialize drawing’s resources after hierarchy setup. For information about the format of the strings see the *Dynamic Resource String Syntax* chapter on page 243.

**TraceHRef**

If set to *true*, the bean will trace the hot spots for http links which are defined in the drawing. To make a graphical object a hot spot, it needs to have a custom property of an $S$ type named “$href”.

The value of the custom property defines link’s URL. When the mouse moves over an object with a link, the cursor will change and, if the bean is used inside the browser, the links’ URLs will be displayed in the browser’s status area. The default value of the property is *false*.

**HRefTarget**

Specifies a name of the browser frame to use when opening http links defined in the drawing. The default value is *null*, causing link’s URL to replace the bean.

**JavaLog**

Enables Java Console logging of bean events for debugging bean problems.

**ResourceLog**

Enables Java Console logging of resource settings from the SetupDataURL and DataURL to debug data scripts.
Using the Java and C# Versions of the Toolkit

**APILog**

Enables Java Console logging of the bean’s GLG API methods.

**Constructors**

*Java Constructors*

```java
public GlgBean()
public GlgJBean()
public GlgJLWBean()
```

Create a GLG bean.

*C# Constructors*

```csharp
public GlgControl()
```

Creates a GLG control.

**Standard API Methods of GlgBean and GlgControl Containers**

*Public void SetDrawingFile( String drawing_file )*

Sets a new value of the `DrawingFile` property, loads the drawing from the file and displays it in the component.

*Public String GetDrawingFile()*

Returns the current value of the `DrawingFile` property.

*Public void SetDrawingURL( String drawing_url )*

Sets a new value of the `DrawingURL` property, loads the drawing from the URL and displays it in the component.

*Public String GetDrawingURL()*

Returns the current value of the `DrawingURL` property.

*Public GlgObject GetDrawingObject()*

Returns the viewport object of the component’s drawing.

*Public boolean SetDrawingObject( GlgObject viewport )*

Sets a new viewport object as a component’s drawing and displays the new drawing.

*Public String GetCharsetName() (Java)*

*Public Encoding GetCharsetName() (C#)*

Returns the name of a Java charset or a C# encoding used to decode strings in the drawing when it is loaded.
public boolean SetCharsetName( String charset ) (Java)
public boolean SetCharsetName( Encoding charset ) (C#)

Sets the name of a Java charset or a C# encoding used to decode strings in the drawing when it is loaded.

public double GetDResource( String resource_name )
public double GetDTag( String tag_source )

Return the value of the D-type resource or tag of the component’s drawing.

public String GetSResource( String resource_name )
public String GetSTag( String tag_source )

Return the value of the S-type resource or tag of the component’s drawing.

public double GetXResource( String resource_name )
public double GetYResource( String resource_name )
public double GetZResource( String resource_name )

public double GetXTag( String tag_source )
public double GetYTag( String tag_source )
public double GetZTag( String tag_source )

Return the X, Y or Z values of the G-type resource or tag of the component’s drawing.

public boolean HasResourceObject( String resource_name )
Returns true if the component’s drawing contains a resource with the specified name.

public boolean HasTagName( String tag_name )
public boolean HasTagSource( String tag_source )
Return true if the component’s drawing contains a tag with a specified tag name or tag source.

public boolean SetDResource( String resource_name, double dvalue )
public boolean SetDResource( String resource_name, double dvalue, boolean if_changed )
public boolean SetDTag( String tag_source, double dvalue, boolean if_changed )

Set the value of the D-type resource or tag of the component’s drawing. Returns true if the value of the resource or tag was successfully changed.

public boolean SetSResource( String resource_name, String svalue )
public boolean SetSResource( String resource_name, String svalue, boolean if_changed )
public boolean SetSTag( String tag_source, String svalue, boolean if_changed )

Set the value of the S-type resource or tag of the component’s drawing. Returns true if the value of the resource or tag was successfully changed.
public boolean SetGResource( String resource_name, 
       double dvalue1, double dvalue2, double dvalue3 )

public boolean SetGResource( String resource_name, double dvalue1, double dvalue2, double dvalue3, 
       boolean if_changed )

public boolean SetGTag( String tag_source, double dvalue1, double dvalue2, double dvalue3, 
       boolean if_changed )

Set the values of the G-type resource or tag of the component’s drawing (x, y and z values of a point 
or R, G and B values or a color). Returns true if the value of the resource or tag was successfully 
changed.

public boolean SetSResourceFromD( String resource_name, String format, double dvalue )

Sets the value of the S-type resource of the component’s drawing to a string obtained by converting 
the supplied double value (dvalue) according to the given format. The format parameter is a C-like 
format string. Returns true if the value of the resource was successfully changed.

public void Update() (Java)

public void UpdateGlg() (C#)

Updates the component’s drawing to display the latest resource settings.

In C#, the method is named UpdateGlg to avoid a conflict with the Update method of the 
component’s base class.

public void Reset()

Resets the object hierarchy of the component’s drawing.

public GlgObject LoadWidget( String filename, int medium_type )

public GlgObject LoadWidget( String filename, int medium_type, String charset ) (Java)

public GlgObject LoadWidget( String filename, int medium_type, Encoding charset ) (C#)

Loads a viewport named “$Widget” from a file or URL, and returns the viewport object. The 
medium_type parameter defines the loading type (URL or FILE). Returns null if the drawing can’t 
be loaded or if it the “$Widget” viewport can’t be found.

The charset parameter specifies the name of a Java charset or a C# encoding to be used for decoding 
strings in the loaded drawing. It should match either the locale in which the drawing was created 
using the GLG Graphics Builder, or the charset used when saving the drawing from a Java or .C# 
application. If the charset name is not specified or null, the default charset is used.

public GlgObject LoadWidget( GlgObject object )

Finds a viewport named “$Widget” inside the object and returns the viewport. Returns null if the 
“$Widget” viewport can’t be found.

public static GlgObject LoadObject( String filename, int medium_type )

public static GlgObject LoadObject( String filename, int medium_type, String charset ) (Java)

public static GlgObject LoadObject( String filename, int medium_type, Encoding charset ) (C#)

Loads an object from a file or URL, and returns the loaded object. The medium_type parameter 
defines the loading type (URL or FILE). Returns null if the object can’t be loaded.
The `charset` parameter specifies the name of a Java charset or a C# encoding to be used for decoding strings in the loaded drawing. It should match either the locale in which the drawing was created using the GLG Graphics Builder, or the charset used when saving the drawing from a Java or C# application. If the charset name is not specified or `null`, the default charset is used.

```java
public void InitialDraw( GlgObject object )
```

Sets up the hierarchy and draws the component’s drawing.

If the `object` parameter is not `null`, the viewport object supplied by the parameter is set up and drawn instead of the top viewport of the component’s drawing. If the viewport object does not have a parent, it will appear as a separate top level window.

```java
public void SetupHierarchy( GlgObject object )
```

Sets up the hierarchy of the component’s drawing.

If the `object` parameter is not `null`, the viewport object supplied by the parameter is set up instead of the top viewport of the component’s drawing. Refer to the `GlgObject.SetupHierarchy` method on page 303 for more information.

```java
public void ResetHierarchy( GlgObject object )
```

Resets the component’s drawing.

If the `object` parameter is not `null`, the viewport object supplied by the parameter is reset instead of the top viewport of the component’s drawing.

```java
public void Bell()
```

Emits an audio beep.

```java
public boolean Print( String filename, double x, double y, double width, double height, boolean portrait, boolean stretch )
```

Prints the component’s drawing and saves it in a PostScript file. Returns `true` if the drawing was successfully printed.

The `NativePrint` method of the drawing’s viewport may be used for native Java and .NET printing.

```java
public String CreateIndexedName( String template_name, int resource_index )
```

Creates and returns a resource name string by inserting a number (`resource_index`) to the template string (`template_name`). The number is inserted at the position indicated by the “%” character, or at the end of the template name if it does not contain the “%” character.

```java
public boolean IsDemo()
```

Returns `true` if the Evaluation Version or the Community Edition of the class library is used.
public boolean SetAutoUpdateOnInput( boolean update )

Enables or disables automatic updates on input events. Returns the previous setting of the parameter.

Automatic updates on input events are enabled by default, but may be disabled to prevent slowing down scrolling and other operations of the real-time charts. If automatic updates are turned off, input objects redraw themselves on user input event, but an explicit Update() call has to be used to redraw any objects constrained to input objects and located outside them.

If automatic updates are turned off, input objects redraw themselves on user input event. However, an explicit Update() call has to be used to redraw any objects constrained to input objects and located outside of them.

When automatic updates are turned off, the application code also has to explicitly invoke Update() for timer events (Format="Timer") to update objects in the drawing with the timer transformation attached.

public void AddListener( int callback_type, Object listener) (Java)
public void AddListener( GlgCallbackType callback_type, Object listener) (C#)

Adds a GLG event listener to the component. The callback_type parameter may have one of the following values: SELECT_CB, INPUT_CB, TRACE_CB, TRACE2_CB, HIERARCHY_CB, H_CB, V_CB or READY_CB. The type of the listener provided by the second parameter must match the type parameter and may have one of the following values: GlgSelectListener, GlgInputListener, GlgTraceListener, GlgHierarchyListener, GlgHListener, GlgVListener or GlgReadyListener, respectively. Only one listener of each type may be added. Use with null as the listener parameter to remove the listener specified by the callback_type parameter.

If no listener was added for some event types, the component is used as a default listener, invoking the component’s callback methods: InputCallback, SelectCallback, etc. The component’s callback methods can be overridden by the component’s subclasses to implement custom event handling.

The Trace and Trace2 listeners use the same GlgTraceListener interface. If the same object (for example, a GLG Bean) is added as both the Trace and Trace2 listener, the same TraceCallback method of the object will be invoked for either event, with the trace2 field of the trace_data parameter set to false for Trace event and to true for Trace2 event. However, if Trace and Trace2 events are activated by the bean’s SetTraceEnabled and SetTrace2Enabled methods, the bean’s TraceCallback will be invoked for the Trace events and the Trace2Callback will be invoked for the Trace2 events.

The AddListener method of the GlgObject class may be used to add different event listeners to individual child viewports inside the component’s drawing.

public void HCallback( GlgObject viewport )

The default HCallback invoked after the component’s drawing is loaded, but before its object hierarchy is set up. The component’s AddListener method may be used to change the default callback. The viewport parameter is the top level viewport of the component’s drawing.
public void VCallback( GlgObject viewport )

The default VCallback invoked after the component’s drawing is loaded and set up, but before it is displayed for the first time. The component’s AddListener method may be used to change the default callback. The viewport parameter is the top level viewport of the component’s drawing.

synchronized public void ReadyCallback( GlgObject viewport )

The default ReadyCallback invoked after the component has finished loading the drawing and reading its data. The component’s AddListener method may be used to change the default callback. The viewport parameter is the top level viewport of the component’s drawing.

public void InputCallback( GlgObject top_viewport, GlgObject message_object )

The default InputCallback invoked every time the user interacts with input objects in the drawing. More information about the type of the input activity may be extracted from the message_object parameter. Refer to the Input Callback section on page 105 for more details. The component’s AddListener method may be used to change the default callback. The top_viewport parameter is the top level viewport of the component’s drawing.

public void SelectCallback( GlgObject top_viewport, Object[] name_array, int button )

The default SelectCallback invoked every time the user selects one or more objects in the drawing with the mouse. The name_array parameter is a null-terminated array of names of selected objects. The button parameter is the mouse button used for selection (1, 2 or 3). Refer to the Selection Callback section on page 103 for more details. The component’s AddListener method may be used to change the default callback. The top_viewport parameter is the top level viewport of the component’s drawing.

public void TraceCallback( GlgObject top_viewport, GlgTraceData trace_info )

The TraceCallback and Trace2Callback are invoked for every event occurring in any of the drawing’s viewports. They may be used as an escape mechanism to handle low-level Java or C# events. The TraceCallback is invoked before dispatching the event for processing, while the Trace2Callback is invoked after the event has been processed. The top_viewport parameter is the top level viewport of the component’s drawing.

public void HierarchyCallback( GlgObject top_viewport, GlgHierarchyData hierarchy_info )

The HierarchyCallback is invoked every time SubWindow or SubDrawing objects in the component’s drawing load their templates. The hierarchy_info parameter provides information about the SubWindow or SubDrawing object that triggered the callback and about the copy of template to be displayed. Refer the Hierarchy Callback section on page 107 for more details. The top_viewport parameter is the top level viewport of the component’s drawing.

public boolean IsReady()

Returns the Ready status of the component. The component is ready when it finished loading the drawing (and finished reading setup data and data URLs for a Java bean).
public String GetFullPath(String filename)

Given a relative filename, returns a full path relative to the path of the loaded drawing. If the filename is not a relative path, it is returned unchanged.

In Java, if a bean is used as an applet or a part of another applet (the SetParentApplet method was used), the returned path is relative to the applet’s document base.

Additional Standard API Methods

The GetElement and GetSize methods described in the Intermediate and Extended API Methods of GlgBean and GlgControl Containers section are also available in the Standard API.

Java-only Methods

public void PrintToJavaConsole(String message)

Prints the message to the Java Console. Provided for convenience when used with Java Script in a web browser.

public void SetDrawingName(String drawing_resource)

Sets a new value of the DrawingName property, loads the drawing and displays it in the bean. If the bean is used as an applet or part of another applet (bean’s SetParentApplet method was used), the DrawingName is interpreted as a URL relative to the applet’s document base directory. Otherwise, the DrawingName is interpreted as a file relative to the current directory.

public String GetDrawingName()

Returns the current value of the DrawingName property.

public void SetDataURL(String data_url)

Sets a new value of the DataURL property, reads and executes the new DataURL script. If the UpdatePeriod property is greater than 0, the DataURL will be read periodically with the period defined by the UpdatePeriod. The data script will be read once each time the drawing is reloaded using the SetDrawing methods, and then periodically if the UpdatePeriod property is set.

public String GetDataURL()

Returns the current value of the DataURL property.

public void SetSetupDataURL(String setup_data_url)

Sets a new value of the SetupDataURL property. The SetupDataURL script is read and executed once after a new drawing is loaded into a bean and every time the drawing is reloaded by using the SetDrawing methods.

public String GetSetupDataURL()

Returns the current value of the SetupDataURL property.
public void SetUpdatePeriod( double update_period )

Sets a new value of the UpdatePeriod property and starts or stops periodic reading of DataURL if necessary. The DataURL is read periodically if the UpdatePeriod is greater than 0.

public double GetUpdatePeriod()

Returns the current value of the UpdatePeriod property.

public void SetJavaLog( boolean active )

Activates logging debugging messages to stdout or the Java Console.

public boolean GetJavaLog()

Returns the current value of the JavaLog property.

public void SetResourceLog( boolean active )

Activates logging messages for setting resources from data scripts.

public boolean GetResourceLog()

Returns the current value of the ResourceLog property.

public void SetAPILog( boolean active )

Activates logging API calls, which is convenient for debugging Java Scripts in a web browser.

public boolean GetAPILog()

Returns the current value of the APILog property.

public void SetHResource0( String value )
public void SetHResource1( String value )
public void SetHResource2( String value )
public void SetHResource3( String value )
public void SetHResource4( String value )

Set the value of the H properties. These properties are used to set resources of the bean’s drawing before the drawing’s object hierarchy is created.

The syntax of these properties is described in the Dynamic Resource String Syntax section of page 243. Refer to the H and V Resources section on page 27 for more details on H and V resources.

public String GetHResource0()
public String GetHResource1()
public String GetHResource2()
public String GetHResource3()
public String GetHResource4()

Return the current value of H properties.
public void SetVResource0( String value )
public void SetVResource1( String value )
public void SetVResource2( String value )
public void SetVResource3( String value )
public void SetVResource4( String value )

Set the value of the V properties. These properties are used to set resources of the bean’s drawing after the drawing’s object hierarchy is created.

The syntax of these properties is described in the Dynamic Resource String Syntax section of page 243. Refer to the Dynamic Resource String Syntax section on page 243 for more details on H and V resources.

public String GetVResource0()
public String GetVResource1()
public String GetVResource2()
public String GetVResource3()
public String GetVResource4()

Return the current value of V properties.

public void SetTraceHRef( boolean trace )

Sets the value of the TraceHRef property. If the property is set to true, the bean traces the mouse movements and changes the cursor shape when cursor moves over objects in the drawing which have HTML links. If an object contains an S resource named "$href", the value of the resource is interpreted as a URL which defines an HTML link.

public boolean GetTraceHRef()

Returns the current value of the TraceHRef property.

public void SetHRefTarget( String target )

Sets the value of the TraceHRef property which defines the target name for showing html links. If set to null, clicking on the hot spot defined by the "$href" property with the left mouse button opens the link in the same browser window, or in a separate window with the "_blank" target name if other mouse buttons are used. If HRefTarget property is not null, the link is always opened in a separate window with the target name defined by the HRefTarget property.

public String GetHTarget()

Returns the current value of the HRefTarget property.

public void SetIgnoreErrors( boolean ignore )

Sets the value of the IgnoreErrors properties. If set to true, suppresses GLG error messages.

This is useful in the bean box test program, which tries to set the value of a string property on every starting change before the entry is finished, which results in errors for the string properties that define URLs.
public boolean GetIgnoreErrors()

Returns the current value of the IgnoreErrors property.

public Applet SetParentApplet( Applet parent_applet )

Sets the parent applet used to determine the document base when the bean is used as part of another applet. Use null for the parent_applet parameter to unset the parent applet.

public void UpdateCallback()

This callback is invoked after the bean finished reading data on periodic updates. The ReadyCallback is invoked the first time, and the UpdateCallback is invoked on any subsequent data updates.

Intermediate and Extended API Methods of GlgBean and GlgControl Containers

Overview

While the Standard API methods of the GlgBean and GlgControl operate on the component’s drawing as a whole, the methods of the Intermediate and Extended API take an object ID and can be applied to individual objects inside the drawing.

The first argument of the Intermediate and Extended API methods of the GlgBean and GlgControl specifies the object to apply the method to. If null is passed as the argument value, the method is applied to the top viewport of the component’s drawing.

The corresponding methods of the GlgObject class can also be used for even greater flexibility.

Intermediate API Methods

public boolean SaveObject( GlgObject object, String filename )
public boolean SaveObject( GlgObject object, String filename, String charset ) (Java)
public boolean SaveObject( GlgObject object, String filename, Encoding charset ) (C#)

Saves the object into a file with the given filename. Returns true if the object was successfully saved.

The charset parameter specifies the name of a Java charset or a C# encoding to be used for encoding strings in the saved drawing. If charset is not specified or null, the default charset is used.

For applications that load a drawing, modify it and save it back into a file, the drawing should be loaded using the LoadObject function instead of LoadWidget. LoadWidget extracts the $Widget viewport from the loaded drawing, discarding the rest of the drawing, while LoadObject returns an object that represents the whole drawing. Using SaveObject to save a viewport loaded with LoadWidget will result in a loss of information contained in the discarded part of the drawing, such as the type of the coordinate system used to display the viewport, which will make it difficult to load and edit the drawing in the Builder. The following example demonstrates the proper technique:

```
GlgObject drawing = LoadObject( "drawing.g" );
GlgObject viewport = LoadWidgetFromObject( drawing ); /* Extracts $Widget viewport */
... /* Code that modifies the drawing */
SaveObject( drawing, "new_drawing.g" );
```
public boolean ContainsObject( GlgObject container, Object object )

Returns true if the object is contained in container.

public Object GetElement( GlgObject container, int index )

Returns the element of the container indicated by the index.

public int GetIndex( Object object )

Returns the index of the first occurrence of the object in the container or -1 if the object wasn’t found in the container.

public GlgObject GetNamedObject( GlgObject container, String name )

Returns the named element of the container defined by the name parameter.

public boolean ReorderElement( GlgObject container, int old_index, int new_index )

Moves the container’s element from the old_index to the new_index position. The function returns false if indexes are out of range.

public void SetStart( GlgObject container )

Initializes the container for traversing. This function should be called before invoking the container’s Iterate method.

public Object Iterate( GlgObject container )

Returns the next element of container. The SetStart method must be used to initialize the container for iterating before Iterate is invoked the first time, see page 141 for an example. The add, delete and search operations affect the iteration state and should not be performed on the container while it is being iterated.

To perform a safe iteration that is not affected by the add and delete operations, a copy of the container can be created using the CloneObject method with the SHALLOW_CLONE clone type. The shallow copy will return a container with a list of objects IDs, and it can be safely iterated while objects are added or deleted from the original container.

Alternatively, GetElement can be used to traverse elements of the container using an element index, which is not affected by the search operations on the container.

public int GetSize( GlgObject container )

Returns the size of container.

public GlgObject GetResourceObject( GlgObject object, String resource_name )

Finds and returns a named resource or an attribute of the object. The resource or attribute must be of the GlgObject type, and is specified with the resource_name parameter.
public Object GetResource( GlgObject object, String resource_name )

Finds and returns a named resource or an attribute of the object. The resource or attribute may be of the Object type or any subclass of the Object.

public boolean ConstrainObject( GlgObject from_object, GlgObject to_object )

Constrains an attribute object (from_object) to the object defined by the to_object attribute parameter. The attribute object being constrained must be obtained by using either a default attribute name at the end of the resource path name, or using the container access functions. If the object has already been drawn, a SuspendObject method should be invoked on either the attribute object or its parent before constraining.

public boolean UnconstrainObject( GlgObject object )

Unconstrains the input attribute object. The input object is obtained by using either a default attribute name at the end of the resource path name, or using container access functions. If the object has already been drawn, a SuspendObject method should be invoked on either the attribute object or its parent before constraining.

public GlgObject SuspendObject( GlgObject object )

Suspends the object for editing. This function must be called before adding a transformation or constraining attributes of the object whose object hierarchy has been setup (the object has been drawn). The method returns a GlgObject, which can be used as the suspend_info parameter to a subsequent call to the ReleaseObject method.

public void ReleaseObject( GlgObject object, GlgObject suspend_info )

Releases the object after suspending for editing. The suspend_info parameter is a returned value of a previous call to SuspendObject.

public int GetNumParents( GlgObject object )

Returns the number of parents of the object. Used to determine a type of the return value of the GetParent method.

public GlgObject GetParent( GlgObject object )

Returns the objects’ parent if the object has one parent. If object has more than one parent, returns an array of parents. The type of the return value may be determined by using GetNumParents method.

public void Inverse( GlgObject container )

Reverses the order of objects in the container.

public double GetDResource( GlgObject object, String resource_name )

Returns the value of an object’s D-type resource specified by resource_name.

public String GetSResource( GlgObject object, String resource_name )

Returns the value of an object’s S-type resource specified by resource_name.
public double GetXResource( GlgObject object, String resource_name )
public double GetYResource( GlgObject object, String resource_name )
public double GetZResource( GlgObject object, String resource_name )

Return the X, Y or Z values of an object’s G-type resource specified by resource_name.

public boolean SetDResource( GlgObject object, String resource_name, double dvalue )

Sets the value of the D-type resource (specified by resource_name) of object to dvalue. Returns true if the value of the resource was successfully changed.

public boolean SetSResource( GlgObject object, String resource_name, String svalue )

Sets the value of the S-type resource (specified by resource_name) of the object. Returns true if the value of the resource was successfully changed.

public boolean SetGResource( GlgObject object, String resource_name, double dvalue1, double dvalue2, double dvalue3 )

Sets the new values of the G-type resource (specified by resource_name) of the object. Returns true if the value of the resource was successfully changed.

public void Update( GlgObject viewport ) (Java)
public void UpdateGlg( GlgObject viewport ) (C#)

Updates the viewport to display the latest resource settings.

public boolean Print( GlgObject object, String filename, double x, double y, double width, double height, boolean portrait, boolean stretch )

Prints a drawing of the viewport to a PostScript file. If object is a light viewport, the output will be generated for its parent viewport. The x, y, width and height parameters define the page layout of the print output in the GLG coordinate system (use x=-1000, y=-1000, width=2000, height = 2000 to use the whole page). The portrait parameter defines the portrait or landscape orientation. If the stretch parameter is false, the aspect ratio of the drawing is preserved. The function returns true if the drawing was successfully printed.

The NativePrint method of the drawing’s viewport may be used for native Java and .NET printing.

public boolean SetResourceFromObject( GlgObject object, String resource_name, GlgObject o_value )

Sets the value of the data or matrix resource (specified by resource_name) to the value of the o_value object. The resource types should match, otherwise false is returned. Returns true if the value of the resource was successfully changed.

public boolean SetSResourceFromD( GlgObject object, String resource_name, String format, double dvalue )

Sets the value of the input object’s S-type resource (specified by resource_name) to a string obtained by converting the supplied double value (dvalue) according to the format. The format parameter is a C-like format string. Returns true if the value of the resource was successfully changed.
Extended API Methods

```
public GlgObject CopyObject( GlgObject object )

Creates and returns a copy of the object.

public GlgObject CloneObject( GlgObject object, int clone_type ) (Java)
public GlgObject CloneObject( GlgObject object, GlgCloneType clone_type ) (C#)

Creates and returns a full or constrained copy of an object according the clone_type
(WEAK_CLONE, STRONG_CLONE, FULL_CLONE or CONSTRAINED_CLONE).
```

```
public boolean AddObjectToTop( GlgObject container, Object object )

Adds the object to the beginning of the container. Returns true if the object was successfully added.

public boolean AddObjectToBottom( GlgObject container, Object object )

Adds the object to the end of container. Returns true if the object was successfully added.

public boolean AddObjectAt( GlgObject container, int index )

Adds the object to the container at the index position. Returns false if index is invalid.

public boolean AddObject( GlgObject container, Object object, int access_type, int position_modifier ) (Java)
public boolean AddObject( GlgObject container, Object object, GlgAccessType access_type, GlgPositionModifier position_modifier ) (C#)

Adds an object to the container at the position indicated by the access_type (BOTTOM, TOP or CURRENT). If the access type is CURRENT, the object is added before or after the element indicated by the container’s current position, as indicated by the position_modifier parameter (BEFORE or AFTER). Sets the container’s current position to point to the added object. Returns true if the object was successfully added.

```
public boolean DeleteTopObject( GlgObject container )

Deletes the first object of this container. Returns true if the object was successfully deleted.

public boolean DeleteBottomObject( GlgObject container )

Deletes the first object of this container. Returns true if the object was successfully deleted.

public boolean DeleteObjectAt( GlgObject container, int index )

Deletes the object of the container at the index position. Returns false if index is invalid.

public boolean DeleteObject( GlgObject container, Object object )

Deletes an object from container. Returns true if the object was successfully deleted.
public boolean SetXform( GlgObject object, GlgObject xform )

Sets the object’s transformation to a constrained copy of the xform parameter. If the object has already been drawn, it has to be suspended with the SuspendObject method before setting its transformation. If the xform parameter is null, the function removes any object transformations. The CopyObject and CloneObject methods may be used in conjunction with the SetXform to add unconstrained copies of the same transformation to several objects.

public boolean SetResourceObject( String resource_name, GlgObject value )

Sets the new value of the object’s attribute specified by the resource_name. It is used for attaching Custom Property objects and aliases.

**GlgObject class**

abstract public class GlgObject

The base class for all GLG objects.

**Description**

GlgObject is the main class of the Java and .NET implementations of the GLG Toolkit. It provides functionality available to all GLG objects. The instances of this class are never created directly. Instead, GLG objects are either loaded from a GLG drawing created using the GLG Graphics Builder, or, for advanced users, created using one of the constructors for the GLG graphical objects (see the the GLG objects classes section later in this chapter) and then accessed using the GlgObject superclass.

**Constants**

Enums are used in the **C# version** of the class library. The enums are defined at the top level of the GenLogic namespace. Refer to the online documentation in the XMLDoc format for a list of all enums of the GenLogic namespace.

In the **Java version**, integer constant fields named the same way as enum elements are used. The constants are defined at the GlgObject class level. Refer to the online documentation in the JavaDoc format for a list of all fields of the GenLogic package.

**Standard API Methods**

The GlgObject class provides the following public methods.

public void SetupHierarchy()

When invoked on a drawing which has been loaded but not yet displayed, the method sets up the drawing’s object hierarchy to prepare the drawing for rendering. The drawing should contain either a top-level viewport object, or a group containing several top-level viewports.
After the initial draw (when the object hierarchy has already been set up), the method can be used to set up any type of object after its resources were changed. Unlike the Update method, SetupHierarchy sets up the object without repainting it.

**public void ResetHierarchy()**

Resets the object hierarchy of a top-level viewport or drawing displayed using the Generic API. This function should not be used for viewports displayed in the GlgBean and GlgControl containers.

**public void InitialDraw()**

Draws a viewport object for the first time. If the viewport object does not have a parent, it will appear as a separate top level window. Sets up the hierarchy if it hasn’t been set up yet.

**public boolean SetZoom( String resource_name, char type, double value )**

Performs a zoom or pan operation specified by the type parameter. If the resource_name parameter is null, the viewport itself is zoomed. Otherwise, the zoom operation will be performed on its child viewport specified by the resource_name parameter. The method may be invoked on either a viewport or a light viewport.

The value parameter defines the zoom factor or pan distance. The type parameter specifies the type of the zoom or pan action. Refer to the GlgSetZoom section on page 93 for a complete list of all zoom and pan types.

In the Drawing Zoom Mode, if the method attempts to set a very large zoom factor which would result in the overflow of the integer coordinate values used by the native windowing system, the zoom operation is not performed and the method returns false.

**public boolean SetZoomMode( String resource_name, GlgObject zoom_object, String zoom_object_name )**

Sets or resets a viewport’s Zoom Mode by supplying a GIS or Chart object to be zoomed. In the default Drawing Zoom Mode, the drawing displayed in the viewport is zoomed and panned. If the GIS Zoom Mode is set, any zooming and panning operation performed by the SetZoom method will zoom and pan the map displayed in the viewport’s GIS Object, instead of being applied to the viewport’s drawing. In the Chart Zoom Mode, the content of the chart is zoomed and panned. If the resource_name parameter is null, the zoom mode of the viewport itself will be set. Otherwise, the zoom mode will be set for its child viewport specified by the resource_name parameter. If the zoom_name parameter is not null, it specifies the resource path of a GIS or Chart object relative to the zoom_object parameter, or relative to the viewport if the zoom_object parameter is null. The method may be invoked with zoom_object=null and zoom_object_name=null to reset the zoom mode to the default Drawing Zoom Mode.
Using the Java and C# Versions of the Toolkit

public static GlgObject LoadObject( String filename, int meduim_type ) (Java)
public static GlgObject LoadObject( String filename, int meduim_type, String charset ) (Java)
public static GlgObject LoadObject( String filename, GlgMediumType meduim_type ) (C#)
public static GlgObject LoadObject( String filename, GlgMediumType meduim_type, Encoding charset ) (C#)

Loads an object from a file or URL (given by filename) and returns it. The meduim_type parameter defines the loading type (URL or FILE). Returns null if the object can’t be loaded.

The charset parameter specifies the name of a Java charset or a C# encoding to be used for decoding strings in the loaded drawing. It should match either the locale in which the drawing was created using the GLG Graphics Builder, or the charset used when saving the drawing from a Java or .NET application. If the charset name is not specified or null, the default charset is used.

public static GlgObject LoadObject( Object stream, int meduim_type ) (Java)
public static GlgObject LoadObject( Object stream, int meduim_type, String charset) (Java)
public static GlgObject LoadObject( Object stream, GlgMediumType meduim_type ) (C#)
public static GlgObject LoadObject( Object stream, GlgMediumType meduim_type, Encoding charset) (C#)

Loads an object from a stream (given by filename) and returns it. The meduim_type parameter defines the loading type (STREAM). Returns null if the object can’t be loaded.

The charset parameter specifies the name of a Java charset or a C# encoding to be used for decoding strings in the loaded drawing. It should match either the locale in which the drawing was created using the GLG Graphics Builder, or the charset used when saving the drawing from a Java or .NET application. If the charset name is not specified or null, the default charset is used.

public static GlgObject LoadWidget( String filename, int meduim_type ) (Java)
public static GlgObject LoadWidget( String filename, int meduim_type, String charset ) (Java)
public static GlgObject LoadWidget( String filename, GlgMediumType meduim_type ) (C#)
public static GlgObject LoadWidget( String filename, GlgMediumType meduim_type, Encoding charset ) (C#)

Loads a viewport named "$Widget" from a file or URL, and returns it. The meduim_type parameter defines the loading type (URL or FILE). Returns null if the drawing can’t be loaded or if the "$Widget" viewport can’t be found.

The charset parameter specifies the name of a Java charset or a C# encoding to be used for decoding strings in the loaded drawing. It should match either the locale in which the drawing was created using the GLG Graphics Builder, or the charset used when saving the drawing from a Java or .NET application. If the charset name is not specified or null, the default charset is used.

public static GlgObject LoadWidget( GlgObject object )

Finds a viewport named "$Widget" inside the object and returns it. Returns null if the "$Widget" viewport can’t be found.
public boolean Update() (Java)
public boolean UpdateGlg() (C#)

Updates the viewport to display the latest resource settings. If this object is a light viewport, update of its parent viewport will be performed.

In C#, the method is named UpdateGlg for consistency with the UpdateGlg method of the GLG C# Control, which avoids a conflict with the Update method of the control’s base class.

public boolean UpdateImmediately()

Updates the viewport immediately without waiting for the next paint event. Does not repaint children viewports. If this object is a light viewport, update of its parent viewport will be performed.

public boolean Reset()

Resets the viewport.

public Object SendMessage( String resource_name, char * message, Object param1, Object param2, Object param3, Object param4 )

Sends a message specified by the message parameter. If the resource_name parameter is null, the message is sent to the object itself. Otherwise, the message is sent to the object’s child specified by the resource_name parameter. The param<n> arguments define additional parameters of the message depending on the message type. The Integer object must be used to pass integer values to the message. Integer values returned by the query messages are returned as Integer objects.

Refer to the Input Objects chapter on page 229 of the GLG User’s Guide and Builder Reference Manual for a list of messages supported by each type of the available input handlers.

public static GlgAlarmHandler SetAlarmHandler( GlgAlarmHandler alarm_handler )

Specifies a global alarm handler that will process all alarms generated by an application’s drawings.

int ExportStrings( GlgObject object, String filename, char separator1, char separator2, String charset ) (Java)
int ExportStrings( GlgObject object, String filename, char separator1, char separator2, Encoding charset ) (C#)

Writes all text strings defined in the drawing specified by the object parameter into a string translation file using requested separator characters and an encoding charset. Refer to the Localization Support chapter on page 72 of the GLG User’s Guide and Builder Reference Manual for information about the string translation file format. The method returns the number of exported strings or -1 in case of an error.
Using the Java and C# Versions of the Toolkit

**int ImportStrings( GlgObject object, String filename, String charset )** (Java)

**int ImportStrings( GlgObject object, String filename, Encoding charset )** (C#)

Replaces text strings in the drawing defined by the *object* parameter with the strings loaded from a string translation file using the specified charset for string decoding. Refer to the Localization Support chapter on page 72 of the GLG User’s Guide and Builder Reference Manual for information about the string translation file format. The method returns the number of imported strings or -1 in case of an error.

**int ExportTags( GlgObject object, String filename, char separator1, char separator2, String charset )** (Java)

**int ExportTags( GlgObject object, String filename, char separator1, char separator2, Encoding charset )** (C#)

Writes tag names and tag sources of all tags defined in the drawing specified by the *object* parameter into a file using requested separator characters and an encoding charset. The method uses the same file format as the ExportStrings method. Refer to the Localization Support chapter on page 72 of the GLG User’s Guide and Builder Reference Manual for information about the file format. The method returns the number of exported tags or -1 in case of an error.

**int ImportTags( GlgObject object, String filename, String charset )** (Java)

**int ImportTags( GlgObject object, String filename, Encoding charset )** (C#)

Replaces tag names and tag sources of tags in the drawing defined by the *object* parameter with information loaded from a tag translation file using the specified charset for string decoding. The method uses the same file format as the ImportStrings method. Refer to the Localization Support chapter on page 72 of the GLG User’s Guide and Builder Reference Manual for information about the tag translation file format. The method returns the number of imported tags or -1 in case of an error.

**public boolean Print( String file, double x, double y, double width, double height, boolean portrait, boolean stretch )**

Prints the viewport object’s drawing and saves it as a PostScript file. If *this* object is a light viewport, the output will be generated for its parent viewport.

The x, y, width and height parameters define the page layout of the print output in the GLG coordinate system (use x=-1000, y=-1000, width=2000, height=2000 to use the whole page). The portrait parameter defines the portrait or landscape orientation. If the stretch parameter is false, the aspect ratio of the drawing is preserved. The function returns true if the drawing was successfully printed.

The NativePrint method may be used for native Java and .NET printing.

**public boolean NativePrint( Graphics graphics )**

Prints the viewport object’s drawing into a provided graphics object. If *this* object is a light viewport, the output will be generated for its parent viewport. The origin of graphics is assumed to be (0,0) and clipping is assumed to be set the viewport’s window width and height. Returns true if the drawing was successfully printed.
Generates an image of the visible area of the viewport’s drawing and returns it in a form of the Image object for Java or a C# Bitmap for .NET. The resource_name parameter specifies the resource name of a child viewport whose image to generate, or null to generate the image of the viewport itself. For a light viewport, the output will be generated for its parent viewport. The function returns null if image creation fails.

Generates an image of the area of the drawing defined by the image_area (in the screen pixels), and returns it in a form of the Image object for Java or a C# Bitmap for .NET. If image_area is null, the image of the whole drawing is generated, which may be bigger than the visible area of the viewport if the drawing is zoomed in. The gap parameter specifies the padding space between the extent of the drawing and the edge of the image when the image_area is null. The viewport’s zoom factor defines the scaling factor for objects in the drawing when the image is saved.

The resource_name parameter specifies the resource name of a child viewport whose image to generate, or null to generate the image of the viewport itself. For a light viewport, the output will be generated for its parent viewport. The function returns null if image creation fails.

Creates and returns a resource name string by inserting the given number (resource_index) to the template_name string. The index is inserted at the position indicated by the “%” character, or at the end of the template name if it does not contain the “%” character.

Creates a “/”-separated resource name by appending the second resource name to the first one, and inserting the “/” separator is necessary.

Returns an object’s name.

Returns an object’s type.

Returns a data type (D, S or G) of a data or attribute object.
public Double GetDResource( String resource_name )  (Java)
public Double GetDTag( String tag_source )  (Java)

public GlgDouble GetDResource( String resource_name )  (C#)
public GlgDouble GetDTag( String tag_source )  (C#)

Return the value of a scalar resource or tag.

public GlgDouble GetDResourceObj( String resource_name )  (Java)
public GlgDouble GetDTagObj( String tag_source )  (Java)

More efficient versions of the corresponding methods, return a cached GlgDouble object. For efficiency, if the returned object is not null, it can be returned to the cache using its ReleaseToCache method.

public GlgPoint GetGResource( String resource_name )
public GlgPoint GetGTag( String tag_source )

Return the value of a G-type resource or tag.

public String GetSResource( String resource_name )
public String GetSTag( String tag_source )

Return the value of a string resource or tag.

public boolean SetDResource( String resource_name, double d_value )
public boolean SetDResource( String resource_name, double d_value, boolean if_changed )
public boolean SetDTag( String tag_source, double d_value, boolean if_changed )

public boolean SetDResource( String resource_name, Double d_value )  (Java)
public boolean SetDResource( String resource_name, Double d_value, boolean if_changed )  (Java)
public boolean SetDTag( String tag_source, Double d_value, boolean if_changed )  (Java)

public boolean SetDResource( String resource_name, GlgDouble d_value )
public boolean SetDResource( String resource_name, GlgDouble d_value, boolean if_changed )
public boolean SetDTag( String tag_source, GlgDouble d_value, boolean if_changed )

Set the value of scalar resource or tag. Returns true if the value of the resource or tag was successfully changed.

public boolean SetGResource( String resource_name, double g_value1, double g_value2, double g_value3 )
public boolean SetGResource( String resource_name, GlgPoint g_value )

public boolean SetGResource( String resource_name, double g_value1, double g_value2, double g_value3, boolean if_changed )
public boolean SetGResource( String resource_name, GlgPoint g_value, boolean if_changed )

public boolean SetGTag( String tag_source, double g_value1, double g_value2, double g_value3, boolean if_changed )
public boolean SetGTag( String tag_source, GlgPoint g_value, boolean if_changed )

Set the value of a G-type resource or tag. Returns true if the value of the resource or tag was successfully changed.
public boolean SetSResource( String resource_name, String s_value )
public boolean SetSResource( String resource_name, String s_value, boolean if_changed )
public boolean SetSTag( String tag_source, String s_value, boolean if_changed )

Set the value of a string resource or tag. Returns true if the value of the resource or tag was successfully changed.

public boolean SetSResourceFromD( String resource_name, String format, double d_value )
public boolean SetSResourceFromD( String resource_name, String format, double d_value, boolean if_changed )

public boolean SetSTagFromD( String tag_source, String format, double d_value, boolean if_changed )

public boolean SetSResourceFromD( String resource_name, String format, Double d_value ) (Java)
public boolean SetSResourceFromD( String resource_name, String format, Double d_value, boolean if_changed ) (Java)
public boolean SetSTagFromD( String tag_source, String format, Double d_value, boolean if_changed ) (Java)

public boolean SetSResourceFromD( String resource_name, String format, GlgDouble d_value ) (C#)
public boolean SetSResourceFromD( String resource_name, String format, GlgDouble d_value, boolean if_changed ) (C#)
public boolean SetSTagFromD( String tag_source, String format, GlgDouble d_value, boolean if_changed ) (C#)

Set the value of a string resource or tag to a string obtained by converting the supplied double value according to the specified format. The format parameter is a C-like format string. Returns true if the value of the resource or tag was successfully changed.

public boolean SetResourceFromObject( String resource_name, GlgObject o_value )

Sets the new value of the resource object defined by the resource name to the value of the o_value object. The resource types should match. Returns true if the value of the resource was successfully changed.

public GlgObject CreateTagList( boolean unique_tags )

Returns a list of all object’s tags.

public boolean HasResourceObject( String resource_name )

Returns true if a named resource exists.

public boolean HasTagName( String tag_name )
public boolean HasTagSource( String tag_source )

Return true if a tag with a specified tag name or tag source exists.

public static void Init()

Initializes the GLG Toolkit. If an integrated GlgBean or GlgControl component is not used, this method must be invoked before using any other GLG methods. If the component is used, it will invoke this method automatically in its constructor.
public static void Terminate()

May be used to free internal structures allocated by the Toolkit if the Toolkit will not be used any more by the program.

public static boolean Sync()

Synchronizes the Toolkit’s graphical state by flushing any buffered graphics events.

public void AddListener( int type, Object callback ) (Java)
public void AddListener( GlgCallbackType type, Object callback ) (C#)

Adds an input, selection or event listener to a viewport object depending on the type parameter (INPUT_CB, SELECT_CB, TRACE_CB, TRACE2_CB or HIERARCHY_CB). The INPUT_CB listener may also be attached to a light viewport. The listener should implement the GlgInputListener, GlgSelectListener, GlgTraceListener or GlgHierarchyListener interface, depending on the specified type. Only one listener of a particular type may be added to one viewport. The listeners must be added before setting the drawing hierarchy or displaying the drawing for the first time. The method can be used to add one event listener to the top-level viewport, and different listeners to its children viewports.

public static void Lock() (Java JSP Servlet only)
public static void Unlock() (Java JSP Servlet only)

Locks and unlocks the object for synchronization of object access in the JSP Servlets. These methods may be used to lock an object to avoid an access to object’s components while it is being manipulated. The locking may also be used to prevent a thread being killed in the middle of the object manipulation, which would result in an unpredictable object state.

The calls to the Lock and Unlock methods must be balanced. If a thread was locked with a several calls to the Lock method, an equal number of calls to the Unlock method must be used to unlock the thread.

In Swing applications, asynchronous access is not allowed and these functions should not be used.

public static void UnlockThread() (Java JSP Servlet only)

Unconditionally unlocks the current thread regardless of the number of the Lock calls made to lock the thread. It may be used at the end of the JSP Servlet’s doGet method to unlock the thread after an exception that interrupts the normal flow of control, or to ensure that the thread is unlocked even if there was an unbalanced number of the Lock nd Unlock calls due to a programming error.

public static GlgErrorHandler SetErrorHandler( GlgErrorHandler new_handler )

Replaces a default GLG error handler with a custom one. If the new_handler parameter is null, the method restores the default error handler.

The default error handler emits an audio beep and displays the error message on a Java console or in a message dialog for C#/.NET. The error message includes a stack trace showing where the error occurred.
In the C#/.NET version of the class library, the default error handler also logs error messages into the glg_error.log file. The location of the log file is determined by the GLG_LOG_DIR and GLG_DIR environment variables as described in the Error Processing section on page 47. An application can use the GlgObject.Error method to display error messages or log messages into the glg_error.log log file using the current error handler.

```java
public static void Error( String message, int error_type, Exception exception) { (Java)
public static void Error( String message, GlgErrorType error_type, Exception exception ) { (C#)
```

Invokes a currently installed error handler to display an error message or to log a message to the glg_error.log file. The message parameter specifies the error message. exception is an optional parameter that, if not null, supplies exception information and the exact location of the error shown in the stack trace. The error_type parameter specifies the type of action to perform and may be one of the following:

**INTERNAL_ERROR**
- Reserved for the Toolkit’s internal use.
- **In Java,** prints the error message and the stack trace on the Java console and emits an audio beep.
- **In C#,** displays an error dialog with the stack trace, emits an audio beep and logs the error message and the stack trace into the glg_error.log file.

**USER_ERROR**
- **In Java,** prints the error message and the stack trace on the Java console and emits an audio beep.
- **In C#,** displays an error dialog with the stack trace, emits an audio beep and logs the error message and the stack trace into the glg_error.log file.

**USER_ERROR_NO_STACK**
- **In Java,** prints the error message on the Java console and emits an audio beep.
- **In C#,** displays an error dialog, emits an audio beep and logs the message into the glg_error.log file.

**WARNING**
- **In Java,** prints the warning message on the Java console and emits an audio beep.
- **In C#,** displays a warning dialog, emits an audio beep and logs the message into the glg_error.log file.

**INFO** (Java only)
Prints the message on the Java console.

**LOGGING** (C# only)
Logs the message into the glg_error.log file.

The location of the glg_error.log file is determined by the GLG_LOG_DIR and GLG_DIR environment variables as described in the Error Processing section on page 47.

```java
public static void CatchGlobalErrors( boolean catch_all, boolean exit ) { (C# only)
```

May be invoked on application start-up to log exceptions and display stack trace for application errors via the GLG error handler.

If the catch_all parameter is set to true, catches all exceptions, otherwise catches only thread exceptions. If the exit parameter is set to true, the application exits after displaying an error message.
public static String GetStackTraceAsString()

    Returns the current stack trace as a string which may be used for logging.

public static String GetStackTraceAsString( Exception e )

    Returns the stack trace of the specified exception as a string.

public static boolean GetModifierState( int modifier ) (Java)

public static boolean GetModifierState( GlgModifierType modifier ) (C#)

    Returns the state of the modifier specified by the modifier parameter: SHIFT_MOD, CONTROL_MOD or DOUBLE_CLICK_MOD.

public static void Bell()

    Emits an audio beep.

public static boolean Sleep( long milisec )

    Sleeps for the specified number of milliseconds. In Java, returns false if the sleep was interrupted. In C#, always returns true.

public static double Rand( double low, double high )

    Returns a random number in the defined range.

void ChangeObject( GlgObject object, String resource_name )

    Sends a change method to the object without actually changing the object’s attributes, may be used to redraw the object.

    If the resource_name parameter is null, the change message will be sent to the object specified by the object parameter. Otherwise, the message will be sent to its child object specified by the resource_name parameter.

public static void SetBrowserObject( GlgObject browser, GlgObject object )

    Sets an object to be browsed by the GLG resource, tag or alarm browser widgets.

public static void SetBrowserSelection( GlgObject object, String resource_name, String selection, String filter )

    Sets a new value of a browser’s selection and filter text boxes for resource, tag, alarm and data browsers after the browser object has been set up. Setting a new selection will display a new list of matching entries. If the resource_name parameter is null, selection of the object itself is set. Otherwise, selection of its child viewport specified by the resource_name parameter will be set.

public static boolean SetEditMode( GlgObject viewport, String resource_name, boolean edit_mode )

    Sets the viewport’s edit mode which disables input objects in the viewport while the drawing is edited; returns true on success. The viewport could be either a viewport or a light viewport. If the resource_name parameter is null, the edit mode of the viewport itself is set. Otherwise, the edit mode of its child viewport specified by the resource_name parameter will be set. The edit mode is
global and may be set only for one viewport used as a drawing area. Setting the edit mode of a new viewport resets editing mode of the previous viewport. The viewport’s edit mode is inherited by its all child viewports.

public void SetFocus( String resource_name )

If resource_name is null, sets the keyboard focus to the parent viewport of this object, or to this object if it is a viewport. If resource_name is not null, it specifies the resource name of a child object to use for setting focus.

public void SetImageSize( int width, int height ) (Graphics Server only, JSP and ASP.NET)

Sets the size of the image to be generated for the drawing represented by a viewport object.

public static GlgTooltipFormatter SetTooltipFormatter( GlgTooltipFormatter formatter )

Supplies a custom tooltip formatter, returns the previously set formatter, if any.

public char[] GetWidgetPassword( String resource_name ) (Java only)

Returns the password string entered into the password text widget. A separate method for querying entered password is required to comply with the Java security model. If the resource_name parameter is null, the password of this text input object is returned. Otherwise, the resource_name parameter points to a child text input object of this object.

public Object GetNativeComponent( String resource_name, String type ) (Java)
public Object GetNativeComponent( String resource_name, GlgComponentQueryType type ) (C#)

Returns a native component used to render the viewport according to the query type specified by the type parameter. It returns the component itself for the WIDGET_QUERY query type, or the ID of the top-level form (in case if the form was created by the GLG class library) for the SHELL_QUERY query type. In Java, the CHILD_WIDGET_QUERY query type can be used to query a child component of the text edit and list widgets that use a scroll pane; for these widgets the WIDGET_QUERY query type returns the scroll pane.

Additional Standard API Methods

The GetElement and GetSize methods described in the Intermediate API Methods section are also available in the Standard API. The SetResourceObject method of the Extended API may be used for setting global configuration resources with the Standard and Intermediate APIs.

Intermediate API Methods

public boolean SaveObject( String filename )
public boolean SaveObject( String filename, String charset ) (Java)
public boolean SaveObject( String filename, Encoding charset ) (C#)

Saves the object into a file. Returns true if the object was successfully saved.

The charset parameter specifies the name of a Java charset or a C# encoding to be used for encoding strings in the saved drawing. If the charset name is not specified or null, the default charset is used.
public boolean SaveObject( Object stream, int medium_type ) (Java)
public boolean SaveObject( Object stream, int medium_type, String charset ) (Java)
public boolean SaveObject( Object stream, GlgMediumType medium_type ) (C#)
public boolean SaveObject( Object stream, GlgMediumType medium_type, Encoding charset ) (C#)

Serializes the object by saving it into a stream specified by the stream parameter. The medium_type parameter specifies medium type (STREAM). Returns true if the object was successfully saved. The LoadObject method may be used to restore the object from a stream.

The charset parameter specifies the name of a Java charset or a C# encoding to be used for encoding strings in the saved drawing. If the charset name is not specified or null, the default charset is used.

public boolean ContainsObject( Object object )

Returns true if the object is contained in this container.

public Object GetElement( int index )

Returns the element of this container indicated by index or null if index is invalid.

public int GetIndex( Object object )

Returns the index of the first occurrence of the object in the container or -1 if the object wasn’t found in the container.

public int GetStringIndex( String string )

Returns the index of the first occurrence of the string in the container or -1 if the string wasn’t found in the container.

public GlgObject GetNamedObject( String name )

Returns the named element of this container defined by the name parameter.

public boolean ReorderElement( int old_index, int new_index )

Moves an element of this container from the position specified by old_index to the position defined by new_index. Returns false if indexes are out of range.

public void SetStart()

Initializes this container for traversing, should be called before invoking the container’s Iterate method.

public Object Iterate()

Returns the next object in the drawing. The add, delete and search operations affect the iteration state and should not be performed on the drawing while it is being iterated. Refer to the Iterate method of the GlgObject class on page 299 for more information on safe traversing.

public int GetSize()

Returns the size of this container.
public void Flush( int size )

Sets a new container size. If the new size is less than the current container size, extra elements are removed. If the new size is greater than the current size, the function adds elements by making a copy of the last element in the container.

The container may be a group, a viewport, a polygon (as a container of points), a spline or a connector. The function can only be invoked if the container is not set up. If the container is set up (drawn), the function must be surrounded by the SuspendObject and ReleaseObject calls.

public void Inverse()

Reverses the order of the objects in this container.

public boolean SetResource( String resource_name, int type, Object value,
    boolean if_changed_only, boolean is_attribute ) (Java)

public boolean SetResource( String resource_name, GlgDataType type, Object value,
    boolean if_changed_only, boolean is_attribute ) (C#)

ADVANCED: Sets the value of a generic resource of a type defined by the type parameter (D, S, G or O). For D resources, the type of the value parameter must be Double type in Java and GlgDouble in C#. For the rest of the resource types, the type of the value parameter must be String for S resources, GlgPoint for G resources, and Object for O (object) resources. If the if_changed_only parameter is true, the value change event will be generated only if value of the resource was different. The is_attribute parameter may be set to true to speed up setting default attributes of an object. The method returns null if the resource can’t be set.

public GlgObject GetResourceObject( String resource_name )

Finds and returns a named resource or an attribute of this object. The resource or attribute must be of the GlgObject type.

public Object GetResource( String resource_name )

Finds and returns a named resource or an attribute of this object. The resource or attribute must be of the Object type.

public Object GetResource( String resource_name, int type, boolean mandatory,
    boolean is_attribute, boolean dont_cache ) (Java)

public Object GetResource( String resource_name, GlgDataType type, boolean mandatory,
    boolean is_attribute, boolean dont_cache ) (C#)

ADVANCED: Gets the value of a generic resource of a type defined by the type parameter. (D, S, G or O). For resources of the D type, the type of the returned value is Double in Java and GlgDouble in C#. For the rest of the resource types, the type of the returned value is String for S resources, GlgPoint for G resources and Object for all other resources that are objects. The method returns null if the resource can’t be found.

For resources that are infrequently accessed, passing dont_cache=true suppresses adding the resource to the resource cache to conserve memory.
public GlgObject GetTagObject( String search_string, boolean by_name, boolean unique_tags, boolean single_tag )

Finds a single tag with a given tag name or tag source, or creates a list of tags matching the wildcard. The search_string specifies either the exact tag name or tag source to search for, or a search pattern which may contain the ? and * wildcards. The by_name parameter defines the search mode: by a tag name or tag source. In the single tag mode, the first tag matching the search criteria is returned. The unique_tags controls if only one tag is included in case there are multiple tags with the same tag name or tag source. The unique_tags flag is ignored in the single tag mode.

In a single tag mode, the function returns the first attribute that has a tag matching the search criteria. In the multiple tag mode, a list containing all attributes with matching tags will be returned.

public GlgObject GetAlarmObject( String search_string, boolean single_alarm )

Finds a single alarm with a given alarm label, or creates a list of alarms matching the specified wildcard. The search_string specifies either the exact alarm label to search for, or a search pattern which may contain the ? and * wildcards. In a single tag mode, the function returns the first alarm that has an alarm label matching the search criteria. In the multiple alarm mode, a list containing all alarms with matching alarm labels is returned.

public boolean ConstrainObject( GlgObject to_attribute )

Constrains this attribute object to the object defined by the to_attribute parameter. The attribute object being constrained must be obtained by using either a default attribute name at the end of the resource path name, or using the container access functions. If the object has already been drawn, a SuspendObject method should be invoked on either the attribute object or its parent before constraining.

public boolean UnconstrainObject() 

Unconstrain this attribute object. The attribute object being unconstrained must be obtained by using either a default attribute name at the end of the resource path name, or using container access functions. If the object has already been drawn, the SuspendObject method should be invoked on either the attribute object or its parent before constraining.

public boolean UnconstrainObject( int clone_type ) (Java)  
public boolean UnconstrainObject( GlgCloneType clone_type ) (C#)

ADVANCED: Unconstrain this attribute object using clone_type parameter (WEAK_CLONE, STRONG_CLONE, FULL_CLONE or CONSTRAINED_CLONE) to unconstrain the transformation attached to the object, if any. The attribute object being unconstrained must be obtained by using either a default attribute name at the end of the resource path name, or using container access functions. If the object has already been drawn, a SuspendObject method should be invoked on either the attribute object or its parent before constraining.
public GlgObject SuspendObject()

Suspends this object for editing. It must be called before adding a transformation or constraining attributes of the object whose object hierarchy has been setup (the object has been drawn). The method returns a GlgObject, which can be used as the suspend_info argument to the ReleaseObject method.

public void ReleaseObject( GlgObject suspend_info )

Releases this object after suspending for editing. The suspend_info parameter is a returned value of a previous call to SuspendObject.

public int GetNumParents()

ADVANCED: Returns the number of parents of this object. Used to determine the type of the return value of the GetParent method.

public GlgObject GetParent()

ADVANCED: Returns the objects’ parent if this object has one parent. If object has more than one parent, returns an array of parents. The type of the return value may be determined with the GetNumParents method.

public GlgCube GetBox()

ADVANCED: Returns a 3D bounding box of the object that can be used for collision detection. The coordinates of the bounding box are valid only after the object has been drawn.

public GlgObject GetDrawingMatrix()

ADVANCED: Returns a matrix object of the transformation used to draw the object on the screen.

public GlgObject CreateInversedMatrix()

ADVANCED: Creates and returns an matrix inversed relative to this one.

public void GetMatrixData( GlgMatrixData matrix_data );

ADVANCED: Queries matrix coefficients.

public void SetMatrixData( GlgMatrixData matrix_data );

ADVANCED: Sets matrix coefficients.

public void TransformPoint( GlgPoint in_point, GlgPoint out_point )

ADVANCED: Transforms the in_point with this matrix and places the result into the out_point.

public boolean MoveObject( int coord_type, GlgPoint start_point, GlgPoint end_point );  (Java)
public boolean MoveObject( GlgCoordType coord_type,
    GlgPoint start_point, GlgPoint end_point );  (C#)

Moves an object by the specified vector in the specified coordinate system (SCREEN_COORD or WORLD_COORD). If start_point is null, (0,0,0) is used as the start point of the move vector.
public boolean MoveObjectBy( int coord_type, double x, double y, double z ); (Java)
public boolean MoveObjectBy( GlgCoordType coord_type, double x, double y, double z ); (C#)

Moves an object by the specified X, Y and Z distances in the specified coordinate system
(SCREEN_COORD or WORLD_COORD).

public boolean ScaleObject( int coord_type, GlgPoint * center, double x, double y, double z ); (Java)
public boolean ScaleObject( GlgCoordType coord_type, GlgPoint * center, double x, double y, double z ); (C#)

Scales an object relative to the specified center in the specified coordinate system
(SCREEN_COORD or WORLD_COORD) by the specified X, Y and Z scale factors.

public boolean RotateObject( int coord_type, GlgPoint * center, double x, double y, double z ); (Java)
public boolean RotateObject( GlgCoordType coord_type, GlgPoint * center, double x, double y, double z ); (C#)

Rotates an object around the specified center in the specified coordinate system
(SCREEN_COORD or WORLD_COORD) by the specified X, Y and Z angles.

public boolean PositionObject( int coord_type, int anchoring, double x, double y, double z ); (Java)
public boolean PositionObject( GlgCoordType coord_type, GlgAnchoringType anchoring, double x, double y, double z ); (C#)

Positions an object at the specified location in the specified coordinate system (SCREEN_COORD
or WORLD_COORD) using the specified anchoring. The value of anchoring is formed as a bitwise
“or” of the horizontal anchoring constant (HLEFT, HCENTER or HRIGHT) with the vertical
anchoring constants (VTOP, VCENTER or VBOTTOM). The object’s bounding box is used to
anchor an object’s edges.

public boolean FitObject( int coord_type, GlgCube box, boolean keep_ratio ); (Java)
public boolean FitObject( GlgCoordType coord_type, GlgCube box, boolean keep_ratio ); (C#)

Fits the object to the specified area in the specified coordinate system (SCREENCOORD or
WORLD_COORD).

public boolean LayoutObjects( GlgObject sel_elem, int type, double distance,
    boolean use_box, boolean process_subobjects ) (Java)
public boolean LayoutObjects( GlgObject sel_elem, GlgLayoutType type, double distance,
    boolean use_box, boolean process_subobjects ) (C#)

Performs a requested layout operation. Refer to the GLG Intermediate and Extended API chapter
on page 119 for more details.

public void TransformObject( GlgObject xform, int coord_type, GlgObject parent ) (Java)
public void TransformObject( GlgObject xform, GlgCoordType coord_type, GlgObject parent ) (C#)

ADVANCED: Transforms all control points of an object with the transformation, calculating new
control points values. The coord_type specifies the coordinate system to interpret the transformation
in. If SCREENCOORD is used, the parameters of the transformation are considered to be in screen
pixels. For example, this may be used to move the object by the number of screen pixels as defined
by the mouse move. If OBJECTCOORD is used, the transformation parameters are interpreted as
GLG world coordinates. The \textit{parent} parameter specifies the object’s parent in the \texttt{OBJECT\_COORD} mode, \texttt{null} may be used in the \texttt{SCREEN\_COORD} mode. The object’s hierarchy must be set to use this method.

```java
public boolean ScreenToWorld( boolean inside_vp, GlgPoint in_point, GlgPoint out_point );
```

Converts a point coordinates from the screen coordinate system to the world coordinate system of the object.

If \textit{this} object is a viewport or a light viewport, \texttt{inside\_vp} specifies which world coordinate system to use. If \texttt{inside\_vp=true}, the method will use the world coordinate system used to draw objects inside \textit{this} viewport. If \texttt{inside\_vp=false}, the method will use the world coordinate system used to draw \textit{this} viewport inside its parent viewport. The value of this parameter is ignored for objects other than a viewport or light viewport.

When converting the cursor position to world coordinates, add \texttt{GlgObject.COORD\_MAPPING\_ADJ} to the cursor’s x and y screen coordinates for precise mapping.

```java
public boolean WorldToScreen( boolean inside_vp, GlgPoint in_point, GlgPoint out_point );
```

Converts a point coordinates from the object’s world coordinate system to the screen coordinate system.

If \textit{this} object is a viewport or a light viewport, \texttt{inside\_vp} specifies which world coordinate system to use. If \texttt{inside\_vp=true}, the method will use the world coordinate system used to draw objects inside \textit{this} viewport. If \texttt{inside\_vp=false}, the method will use the world coordinate system used to draw \textit{this} viewport inside its parent viewport. The value of this parameter is ignored for objects other than a viewport or light viewport.

```java
public static void TranslatePointOrigin( GlgObject from_viewport, GlgObject to_viewport, GlgPoint point )
```

Converts screen coordinates of a point in the viewport specified by the \texttt{from\_viewport} parameter to the screen coordinates of the viewport specified by \texttt{to\_viewport}. The \texttt{point} parameter supplies the input coordinates and is used to return the converted coordinates.

```java
public static boolean RootToScreenCoord( GlgObject viewport, GlgPoint point )
```

Converts screen coordinates relative to the root window to the screen coordinates of the specified \texttt{viewport}. The \texttt{point} parameter supplies the input coordinates and is used to return the converted coordinates.

```java
public GlgObject GetParentViewport( boolean heavy_weight )
```

Returns the parent viewport of a drawable GLG object. The \texttt{heavy\_weight} parameter controls the type of a parent viewport to be returned. If set to \texttt{False}, the method returns the closest parent viewport regardless of its type: either a heavyweight or light viewport. If set to \texttt{True}, it returns the closest heavyweight parent viewport. For example, if the \textit{object} is inside a light viewport, it will return the heavyweight viewport which is a parent of the light viewport.
public static GlgObject CreateSelectionNames( GlgObject top_vp, GlgCube rectangle, 
   GlgObject selected_vp )

ADVANCED: Given the top viewport of the drawing, and a screen coordinates rectangle in a
selected viewport, returns an array of names of all objects within the rectangle. This method may
be used inside the TraceListener to implement custom selection logic based on the mouse events.
Either a viewport or a light viewport can be used for the top_vp and selected_vp parameters.

public static GlgObject CreateSelectionNames( MouseEvent event, int delta, GlgObject top_vp, 
   GlgObject selected_vp )

ADVANCED: Given the top viewport of the drawing, a mouse event, a viewport in which the
mouse event occurred and the selection distance (delta), returns an array of names of all objects
selected by the mouse event. This method may be used inside the TraceListener to implement
custom selection logic based on the mouse events. Either a viewport or a light viewport can be used
for the top_vp and selected_vp parameters.

public static GlgObject CreateSelectionMessage( GlgObject top_vp, GlgCube rectangle, 
   GlgObject selected_vp, int selection_type, 
   int button ) (Java)
public static GlgObject CreateSelectionMessage( GlgObject top_vp, GlgCube rectangle, 
   GlgObject selected_vp, 
   GlgSelectionEventType selection_type, 
   int button ) (C#)

ADVANCED: Given the top viewport of the drawing and a screen coordinates rectangle in a
selected viewport, the method searches all objects inside the rectangle for the action with the
specified selection trigger type attached to an object. Either a viewport or a light viewport can be
used for the top_vp and selected_vp parameters.

The method returns a selection message for the first matching action it finds, and may be used in
the Trace event handler to retrieve an action which would be triggered by a specified mouse event
in the rectangular area. The selection message is a message equivalent to the message received in
the input callback. The selection_type parameter may specify one of the following predefined
selection types: MOVE_SELECTION, CLICK_SELECTION or TOOLTIP_SELECTION.

public static GlgObject CreateSelection( GlgObject top_vp, GlgCube rectangle, 
   GlgObject selected_vp )

ADVANCED: This is the same as the corresponding CreateSelectionNames, but returns an array of
selected objects on the bottom of the hierarchy instead of an array of names. Either a viewport or a
light viewport can be used for the top_vp and selected_vp parameters.

public static GlgObject CreateSelection( MouseEvent event, int delta, GlgObject top_vp, 
   GlgObject selected_vp )

ADVANCED: Same as the corresponding CreateSelectionNames, but returns an array of selected
objects on the bottom of the hierarchy instead of an array of names. Either a viewport or a light
viewport can be used for the top_vp and selected_vp parameters.
public GlgObject CreateResourceList( boolean list_named_res, boolean list_def_attr,
                                   boolean list_aliases )

ADVANCED: Creates an array of all resource names of this object on one level of hierarchy. If
list_def_attr is true, the default attributes are included. The list_aliases parameter is reserved for
the future use and must be false.

public GlgObject CreatePointArray( int type )  (Java)
public GlgObject CreatePointArray( GlgControlPointType type )  (C#)

ADVANCED: Creates and returns an array containing all of an object’s control points. The type
parameter is reserved for future use, must be DEFAULT_POINT_TYPE.

public boolean IsDrawable()

Returns true if the object is drawable. Drawable objects can be placed directly in a drawing area,
have control points and a bounding box, have the visibility attribute and can contain custom
properties, actions and aliases. For a chart object, the chart itself is drawable, but its plots are not.

public boolean FindMatchingObjects( GlgFindMatchingObjectsData data )

Finds either one or all parents or children of the specified object that match the supplied criteria.
The data parameter contains parameters of the search and is also used to return found objects, see
the GlgFindMatchingObjectsData class section on page 341 for more information. The method
returns true if at least one matching objects was found.

public GlgObject ConvertViewportType( GlgObject object )

ADVANCED: Converts a viewport to a light viewport, or a light viewport to a viewport, returning
a newly created object on success or null on error. The object parameter supplies the object to be
converted. If a converted object is added to the drawing, the original object must be deleted, since
both objects reuse the graphical objects inside the viewport and cannot be both displayed at the
same time.

public static void TraceObject( GlgObject object, boolean state, boolean is_widget,
                               GlgObject top_parent, GlgObjectActionInterface action )

Searches all parents of the traced object and highlights or unhighlights them based on the specified
conditions. The parent search is performed until any of the specified conditions (is_widget,
top_parent or a custom criteria evaluated by the supplied action interface) is satisfied. The objects
will be highlighted if the state parameter is true and unhighlighted otherwise.

If is_widget=true, the parent objects that have resource named IsWidget will be highlighted or
unhighlighted depending on the state parameter. If top_parent is non-null, the parent objects that
are direct children of top_parent will be highlighted or unhighlighted. If the action parameter is
non-null, its Action method will be invoked for each parent of a traced object to check if a custom
condition is satisfied. If the method returns true, the parent will be highlighted or unhighlighted.

If no conditions are specified, all immediate drawable parents of the traced object will be
highlighted or unhighlighted.

The method returns true if any parents were highlighted.
The dependent parent objects are highlighted with an outline. The attributes of the outline are defined by the GlgHighlightPolygon global configuration resource.

**Extended API**

```java
public GlgObject CopyObject()

Creates and returns a copy of the object.
```

```java
public GlgObject CloneObject( int clone_type )

Creates and returns a full or constrained copy of an object according to the clone_type (WEAK_CLONE, STRONG_CLONE, FULL_CLONE or CONSTRAINED_CLONE).
```

```java
public boolean AddObjectToTop( Object object )

Adds the object to the beginning of this container. Returns true if the object was successfully added.
```

```java
public boolean AddObjectToBottom( Object object )

Adds the object to the end of this container. Returns true if the object was successfully added.
```

```java
public boolean AddObjectAt( Object object, int index )

Adds the object to the container at the position specified by index. Returns true if the object was successfully added.
```

```java
public boolean AddObject( Object object, int access_type, int position_modifier )

Adds the object to this container at the position indicated by the access type (BOTTOM, TOP or CURRENT). If access_type is CURRENT, adds before or after the element indicated by the container’s current position, as indicated by the position_modifier parameter (BEFORE or AFTER). Sets the container’s current position to point to the added object. Returns true if the object was successfully added.
```

```java
public boolean DeleteTopObject()

Deletes the first object of this container. Returns true if the object was successfully deleted.
```

```java
public boolean DeleteBottomObject()

Deletes the last object of this container. Returns true if the object was successfully deleted.
```

```java
public boolean DeleteObjectAt( int index )

Deletes an object at the specified position in this container.
```

```java
public boolean DeleteObject( Object object )

Deletes the given object from this container. Returns true if the object was successfully deleted.
```
public boolean DeleteObject( int access_type, int pos_modifier )  
Deletes an object from this container and adjusts the current position according to the pos_modifier (BEFORE or AFTER). The object is deleted from the position indicated by the access_type (BOTTOM, TOP or CURRENT). Returns true if the object was successfully deleted.

public boolean SetElement( int index, GlgObject new_object )  
Replaces the element of this container indicated by index. Returns false if index is invalid.

public boolean SetXform( GlgObject xform )  
Sets this object’s transformation to a constrained copy of the xform parameter. If the object has already been drawn, it has to be suspended with the SuspendObject method before setting its transformation. If the xform parameter is null, this function removes any object transformations. The CopyObject and CloneObject methods may be used in conjunction with the SetXform to add unconstrained copies of the same transformation to several objects.

public boolean SetResourceObject( String resource_name, GlgObject value )  
Sets the new value of the object’s attribute specified by the resource_name. It is used for attaching Custom Property objects and aliases. This method may also be used with the Standard and Intermediate APIs for setting global configuration resources.

Chart-Related Methods of GlgObject

The following methods provide an API for handling specific aspects of the GLG Real-Time Chart object.

Standard API

public GlgObject GetSelectedPlot( )  
Returns the plot object corresponding to the last legend item selected with the mouse, if any, or null if no plots were previously selected.

public GlgObject GetNamedPlot( String resource_name, String plot_name )  
Finds a chart’s plot by name and returns the plot object. If the resource_name parameter is null, a named plot of this chart object is returned. Otherwise, the resource_name parameter points to a child chart of this object. The method returns null if a plot with the specified name has not been found.

public GlgObject AddPlot( String resource_name, GlgObject plot )  
Adds a plot to a chart object. If the resource_name parameter is null, the plot is added to this chart object. Otherwise, the plot is added to a child chart of this object pointed to by the resource_name parameter. The plot parameter specifies the plot object to add; null can be used to create a new plot. The method returns the added plot object on success, or null on failure.
public boolean DeletePlot( String resource_name, GlgObject plot )

Deletes a plot from a chart object. If the resource_name parameter is null, the plot is deleted from this chart. Otherwise, the plot is deleted from a child chart of this object pointed to by the resource_name parameter. The plot parameter specifies the plot object to delete. The method returns true if the plot was successfully deleted.

public GlgObject AddTimeLine( String resource_name, GlgObject time_line, double time_stamp )

Adds a vertical time line to a chart object. If the resource_name parameter is null, the time line is added to this chart object. Otherwise, the time line is added to a child chart of this object pointed to by the resource_name parameter. The time line parameter specifies the level line object to be used as a time line; null can be used to create a new time line. The time_stamp parameter specifies the time stamp to position the time line at and is assigned to the time line’s Level attribute. The method returns the added time line object on success, or null on failure. The NumTimeLines attribute of the chart should be set to -1 in order to use this function.

public boolean DeleteTimeLine( String resource_name, GlgObject time_line, double time_stamp )

Deletes a time line from a chart object. If the resource_name parameter is null, the time line is deleted from this chart. Otherwise, the time line is deleted from a child chart of this object pointed to by the resource_name parameter. The time_line parameter specifies the time line object to delete. If time_line is set to null, the time line with the time stamp specified by the time_stamp attribute will be deleted. If time_line is not null, the time_stamp parameter is ignored. The method returns true if the time line was successfully deleted. The NumTimeLines attribute of the chart should be set to -1 in order to use this function.

public GlgObject AddAnnotation( String resource_name, GlgObject annotation, double position_x, double position_y, boolean add_box )

Adds an annotation to a chart object. If the resource_name parameter is null, the annotation is added to this chart object. Otherwise, the annotation is added to a child chart of this object pointed to by the resource_name parameter. The annotation parameter specifies the annotation object to be added; null can be used to create a new annotation. The position_x and position_y parameters specify the annotation’s position. If add_box is set to true, a text box will be added to the annotation’s text object. The method returns the added annotation object on success, or null on failure. The NumAnnotations attribute of the chart should be set to -1 in order to use this function.

public boolean DeleteAnnotation( String resource_name, GlgObject time_line, double position_x, double position_y )

Deletes an annotation from a chart object. If the resource_name parameter is null, the annotation is deleted from this chart. Otherwise, the annotation is deleted from a child chart of this object pointed to by the resource_name parameter. The annotation parameter specifies the annotation object to delete. If annotation is set to null, the annotation at the position specified by the position_x and position_y attributes will be deleted. If annotation is not null, position parameters are ignored. The method returns true if the annotation was successfully deleted. The NumAnnotations attribute of the chart should be set to -1 in order to use this function.
public boolean ClearDataBuffer( String resource_name )

Clears accumulated data samples of a real-time chart or one of its plots. If resource_name is not null, it supplies a resource name of a child chart or plot object. For a chart, ClearDataBuffer discards data samples in all plots of the chart. For a plot, it discards only the data samples of that plot. The method returns true on success.

public boolean GetDataExtent( String resource_name, GlgMinMax min_max, boolean x_extent )

Queries the minimum and maximum extent of the data accumulated in a chart or in one of its plots. If the resource_name parameter is null, the data extent of this chart or plot object is returned in min_max. Otherwise, the resource_name parameter points to a child chart or a child plot of this object. If x_extent is true, the X extent of the data is returned in min_max, otherwise the method returns the Y extent of the data.

For a chart object, the method returns the data extent of all plots in the chart. For a plot, the data extent of that plot is returned. The object hierarchy must be set up for this function to succeed. The method returns true on success.

public boolean SetLinkedAxis( String resource_name, GlgObject axis_object, String axis_resource_name )

Associates a chart's plot or a level line with an Y axis for automatic rescaling, returns true on success. If resource_name is null, associates this object, otherwise associates a child plot or a child level line of this object pointed to by the resource_name parameter. If axis_resource_name is null, associates with axis_object, otherwise associates with the child axis of axis_object pointed to by the axis_resource_name parameter.

public boolean SetLabelFormatter( String resource_name, GlgLabelFormatter formatter )

Attaches a custom label formatter to a stand-alone axis object or an axis of a chart if resource_name is null, otherwise attaches the formatter to a child axis or a child chart of this object pointed to by the resource_name parameter. The method returns true on success.

public boolean SetChartFilter( String resource_name, GlgChartFilter filter, Object client_data )

Attaches a custom data filter to a chart’s plot if resource_name is null, otherwise attaches the formatter to a child plot of this object pointed to by the resource_name parameter. The method returns true on success. Refer to the CustomChartFilter.java file (CustomChartFilter.cs file for C#) for an extensive self-documented coding example of implementing MIN_MAX, AVERAGE and DISCARD custom filter types.

Intermediate API

public void AddDataSample( GlgObject plot, GlgDataSample datasample )

Adds a data sample to a chart’s plot, is used to enhance performance when prefilling the chart with a large number of samples. For periodic updates, new data may be pushed into the plot’s entry points using SetDResource. The CreateDataSample method should be used to obtain a new data sample to be added.
public GlgDataSample CreateDataSample( boolean extended )

Is used to obtain a (possibly cached) data sample to be added to a chart via the AddDataSample method. Returns a cached datasample if available, otherwise creates a new one. If the extended parameter is set to true, an extended data sample (GlgDataSampleExt) is returned, otherwise a GlgDataSample object is returned. Since freed datasamples are cached, this method should be used instead of the datasample constructor to avoid a large number of data samples accumulating in a cache. The fields of the data sample must be filled before adding it to the plot.

public GlgObject GetLegendSelection( long object, double x, double y )

Returns the plot object corresponding to the legend item at the specified position, if any. If no legend item is found at the specified position, null is returned. The object parameter specifies the legend object, and the x and y parameters specify position in screen coordinates of the viewport that contains the legend.

public GlgObject CreateChartSelection( GlgObject plot, double x, double y, boolean screen_coord, boolean include_invalid, boolean x_priority )

Selects a chart’s data sample closest to the specified x, y position and returns a message object containing the selected sample’s information. If plot is null, the method queries samples in all plots of the chart and selects the sample closest to the specified position. If plot is not null, the method queries only the samples in that plot.

If the screen_coord parameter is set to true, the position is defined in the screen coordinates of the chart’s parent viewport. If screen_coord is set to false, the x position is defined as an X or time value, and the y position is defined in relative coordinates in the range [0; 1] to allow the chart to process selection for plots with different ranges (0 corresponds to the Low range of each plot, and 1 to the High range). When the mouse position is used, add GlgObject.COORD_MAPPING_ADJ to the x and y screen coordinates of the mouse for precise mapping.

The dx and dy parameters specify an extent around the point defined by the x and y parameters. The extent is defined in the same coordinates as x and y, depending on the value of the screen_coord parameter. Only the data samples located within the dx and dy distances from the specified position are considered for the selection.

If include_invalid if set to true, invalid data samples are considered for selection, otherwise they are never included. If x_priority is set to true, the method selects a data sample closest to the specified position in the horizontal direction, with no regards to its distance from the specified position in the vertical direction. If x_priority is set to false, a data sample with the closest distance from the specified position is selected.

The information about the selected data sample is returned in the form of a message object described in the Chart Selection Message Object section on page 446. The method returns null if no data sample matching the selection criteria was found.
public String CreateTooltipString( double x, double y, double dx, double dy, String format )

Creates and returns a chart or axis tooltip string corresponding to the specified x, y position in screen coordinates. The string can be used to provide cursor feedback and display information about the data sample under the current mouse position, as shown in the Real-Time Strip-Chart demo.

The format parameter provides a custom format for creating a tooltip string and uses the same syntax as the TooltipFormat attributes of the chart and axis objects. If it is set to null or an empty string, the format provided by the TooltipFormat attribute of the chart or the axis will be used. A special “<single_line>” tag may be prepended to the format string to force the method to remove all line breaks from the returned tooltip string.

If this object is a chart and the selected position is within the chart’s data area, the method selects a data sample closest to the specified position and returns a tooltip string containing information about the sample. The dx and dy parameters define the maximum extent in pixels around the specified position for selecting a data sample, and the TooltipMode attribute of the chart defines the data sample selection mode: X or XY. The method returns null if no samples matching the selection criteria were found.

If this object is an axis, or if this object is a chart and the selected position is on top of one of the chart’s axes, the function returns a tooltip string that displays the axis value corresponding to the specified position.

When using the cursor position, add GlgObject.COORD_MAPPING_ADJ to the cursor’s x and y screen coordinates for precise mapping.

public Double PositionToValue( String resource_name, double x, double y, boolean outside_x, boolean outside_y ) (Java)
public GlgDouble PositionToValueObj( String resource_name, double x, double y, boolean outside_x, boolean outside_y ) (Java)
public GlgDouble PositionToValue( String resource_name, double x, double y, boolean outside_x, boolean outside_y ) (C#)

Returns a value corresponding to the specified x, y position on top of a chart or an axis object. If the resource_name parameter is null, the value corresponding to this object is returned. Otherwise, the resource_name parameter points to a child chart, a child plot or a child axis of this object.

If outside_x or outside_y are set to true, the method returns null if the specified position is outside of the chart or the axis in the corresponding direction.

If this object is a plot, the method converts the specified position to a Y value in the Low/High range of the plot and returns the value.

If this object is an axis, the function converts the specified position to the axis value and returns the value.

If this object is a chart, the function converts the specified position to the X or time value of the chart’s X axis and returns the value.
When using the cursor position, add GlgObject.COORD_MAPPING_ADJ to the cursor’s x and y coordinates for precise mapping.

For efficiency, if the returned GlgDouble object is not null, it can be returned to the internal cache using its ReleaseToCache method.

**GIS-Related Methods of GlgObject**

**Standard API**

```java
public boolean GISConvert( String resource_name, int coord_type, boolean coord_to_lat_lon, GlgPoint in_point, GlgPoint out_point ) (Java)
```

```csharp
public boolean GISConvert( String resource_name, GlgCoordType coord_type, boolean coord_to_lat_lon, GlgPoint in_point, GlgPoint out_point ) (C#)
```

Converts coordinates between the GIS coordinate system of the GIS Object and GLG coordinate system of the drawing. If the resource_name parameter is null, the coordinate system of this object is used for conversion. If the resource_name parameter is not null, it specifies the resource name of the GIS Object that is contained inside this object and whose coordinate system will be used for conversion. The coord_type parameter specifies the type of the GLG coordinate system type to convert to or from: SCREEN_COORD for screen coordinates or OBJECT_COORD for world coordinates. If the coord_to_lat_lon parameter is true, coordinates are converted from GLG to GIS coordinate system. If it is false, the coordinates are converted from GIS to GLG coordinate system. When converting from GLG to GIS coordinates, the Z coordinate is set to a negative GLG_GIS_OUTSIDE_VALUE value for points on the invisible part of the globe.

```java
public static boolean GlmConvert( int projection, boolean stretch, int coord_type, boolean coord_to_lat_lon, GlgPoint center, GlgPoint extent, double angle, double min_x, double max_x, double min_y, double max_y, GlgPoint in_point, GlgPoint out_point ) (Java)
```

```csharp
public static boolean GlmConvert( GlgProjectionType projection, boolean stretch, GlgCoordType coord_type, boolean coord_to_lat_lon, GlgPoint center, GlgPoint extent, double angle, double min_x, double max_x, double min_y, double max_y, GlgPoint in_point, GlgPoint out_point ) (C#)
```

Low-level function similar to GISConvert, but without the use of the GIS Object. The projection, stretch, center, extent and angle parameters provide information about the GIS Object’s attributes, and min_x, max_x, min_y and max_y parameters provide information about the extent of the GIS Object in the drawing using a coordinate system (screen or object) matching the coord_type parameter. Refer to the GlmConvert function description in the GLG Map Server Reference Manual for details.
public GlgDouble GISGetElevation( String resource_name, String layer_name, double lon, double lat )

Returns an elevation of a lat/lon point on a map. If the resource_name parameter is null, the elevation query will be executed on this GIS object. If the resource_name parameter is not null, it specifies the resource name of the GIS Object contained inside this object. The layer_name parameter specifies the name of the layer with elevation data to query.

The method returns null if the point is outside of the map in the ORTHOGRAPHIC projection or if there is no elevation data for the specified location. Otherwise, the method returns the elevation value in the units (such as meters or feet) defined by the elevation data file.

For efficiency, if the returned GlgDouble object is not null, it can be returned to the internal cache using its ReleaseToCache method.

public GlgObject GISCreateSelection( String resource_name, String layers, double x, double y, int select_labels ) (Java)

public GlgObject GISCreateSelection( String resource_name, String layers, double x, double y, GlmLabelSelectionMode select_labels ) (C#)

Returns a message object containing information about GIS features located at the specified position on the map. If the resource_name parameter is null, the query will be executed on this GIS object. If the resource_name parameter is not null, it specifies the resource name of the GIS Object inside this object. The layers parameter specifies a list of layers to query. The x and y parameters specify location on the map in the screen coordinates of the GIS object’s parent viewport. The select_labels parameter specifies the label selection policy. It can have the following values:

- GIS_LBL_SEL_NONE - disables label selection
- GIS_LBL_SEL_IN_TILE_PRECISION - enables label selection
- GIS_LBL_SEL_MAX_PRECISION - enables label selection with the maximum precision.

Refer to page 197 for more information on the label selection.

The function returns a message object containing information about the selected GIS features. Refer to the GlmGetSelection section on page 127 of the GLG Map Server Reference Manual for information on the structure of the returned message object as well as a programming example that shows how to handle it.

Intermediate API

public boolean RequestGISZoom( String res_name, char type, double value, GlgGISRequestObserver request_observer )

Requests a GIS zoom or pan operation to be performed on a viewport with the GIS Zoom mode using an asynchronous GIS request in a way compatible with the SetZoom method. The application will continue to operate with the current map view until the new map is ready. When the new map image is either ready or aborted, the request observer's RequestUpdate method will be invoked with
the status information. The observer can install a successfully prepared request via the 
*InstallGISRequest* method, or do nothing to cancel the request. See the *GlgGISRequestObserver*
section on page 284 for more information.

If the *res_name* parameter is not *null*, it specifies the resource path of a child viewport to be zoomed, otherwise this viewport will be used.

The *value* parameter defines the zoom factor or pan distance. The *type* parameter specifies the type of the zoom or pan action. Refer to the *GlgSetZoom* section on page 93 for a complete list of all zoom and pan types.

```java
public boolean RequestGISMap( String res_name, double extent_x, double extent_y, 
double center_x, double center_y, double angle, 
int projection, String layers, int flags, 
GlgGISRequestObserver request_observer ) (Java)
```

```csharp
public boolean RequestGISMap( String res_name, double extent_x, double extent_y, 
double center_x, double center_y, double angle, 
GlgProjectionType projection, String layers, 
GlgGISRequestFlags flags, 
GlgGISRequestObserver request_observer ) (C#)
```

Requests a new GIS map to be prepared for the GIS object using an asynchronous GIS request. The application will continue to operate with the current map view until the new map is ready. When the new map image is either ready or aborted, the request observer's *RequestUpdate* method will be invoked with the status information. The observer can install a successfully prepared request via the *InstallGISRequest* method, or do nothing to cancel the request. See the *GlgGISRequestObserver* section on page 284 for more information.

If the *res_name* parameter is not *null*, it specifies the resource path of a child GIS object, otherwise this GIS object will be used.

The *extent_x, extent_y, center_x, center_y, angle, projection* and *layers* parameters define the new attribute values for the GIS object.

The *flags* parameter controls which GIS object's parameters will be updated and may have any OR combination of the following flags (defined in the *GlgObject* class for Java or *GlgGISRequestStatus* enum for C#): GIS_REQUEST_EXTENT, GIS_REQUEST_CENTER, GIS_REQUEST_ANGLE, GIS_REQUEST_PROJECTION or GIS_REQUEST_LAYERS.

```java
public boolean InstallGISRequest( String res_name )
```

Installs the GIS object's GIS request. This method may be invoked only from inside of a request observer's *RequestUpdate* method invoked with the GIS_REQUEST_READY status.

If the *res_name* parameter is not *null*, it specifies the resource path of a child GIS object, otherwise this GIS object will be used.

```java
public void AbortGISRequest( String res_name )
```

Aborts the GIS request in progress, if any.
If the `res_name` parameter is not null, it specifies the resource path of a child GIS object, otherwise this GIS object will be used.

```java
public GlgGISRequestObserver GetGISRequestInfo( String res_name )
```

Obtains information about a GIS object’s current GIS request being processed; returns a request observer of a GIS request in progress, or null if the GIS object has no pending GIS requests.

If the `res_name` parameter is not null, it specifies the resource path of a child GIS object, otherwise this GIS object will be used.

```java
public GlgGISRequestObserver SetScrollbarObserver( String res_name, 
                        GlgGISRequestObserver request_observer )
```

Controls the way integrated scrollbars work for the GIS object.

If a non-null request observer is specified, integrated scrollbars will use an asynchronous request to scroll the map. The observer’s `RequestUpdate` method will be invoked with status updates. If null is specified, the new map will be loaded without the use of an asynchronous request.

If the `res_name` parameter is not null, it specifies the resource path of a child GIS object, otherwise this GIS object will be used.

**GLG Utility Classes**

These classes are used for incidental tasks associated with the `GlgBean`, `GlgControl` and `GlgObject` classes.

**GlgDouble class**

```java
public class GlgDouble
```

A mutable double object.

**Variables**

```java
public double dvalue;
```

The object’s value.

**Constructors**

```java
public GlgDouble()
```

Creates a new point with a default value of 0.

```java
public GlgDouble( double value )
public GlgPoint( GlgDouble value )
```

Create a new `GlgDouble` with a defined value.
Methods

\texttt{public void CopyFrom( GlgDouble value )}

Copies a value of the object defined by the \texttt{value} parameter to this object.

\texttt{public void intValue() (Java)}
\texttt{public void IntValue() (C#)}

Returns the value of the object as an integer.

\texttt{public void doubleValue() (Java)}
\texttt{public void DoubleValue() (C#)}

Returns the value of the object as a double.

\texttt{public static GlgDouble GetFromCache( double value )}

Returns an object from an internal cache and initializes it to the specified value. Creates an object if the cache is empty.

\texttt{public static void ReleaseToCache( GlgDouble obj )}

Releases an object to the internal cache for reuse. Only objects obtained with \texttt{GetFromCache} should be released to the cache. Releasing objects created with \texttt{new} would result in increasing resource consumption due to the growth of the cache size. The object should not be accessed after it has been released to the cache.

\textit{GlgPoint class}

\texttt{public class GlgPoint}

Variables

\texttt{public double x, y, z;}

X, Y and Z values of the point.

Constructors

\texttt{public GlgPoint()}

Creates a new point with a default (0;0;0) value.

\texttt{public GlgPoint( double x, double y, double z )}
\texttt{public GlgPoint( GlgPoint point )}

Create a new point with a defined value.

Methods

\texttt{public void CopyFrom( GlgPoint point )}

Copies x, y and z values from the point defined by the \texttt{point} parameter to \textit{this} point.
public static GlgPoint GetFromCache()

Returns an object from an internal cache. Creates an object if the cache is empty.

public static void ReleaseToCache( GlgPoint obj )

Releases an object to the internal cache for reuse. Only objects obtained with GetFromCache should be released to the cache. Releasing objects created with new would result in increasing resource consumption due to the growth of the cache size. The object should not be accessed after it is released to the cache.

GlgCube class

public class GlgCube

Defines a rectangular parallelepiped in 3D space (usually an object's bounding box) by its two diagonal points. The faces of the parallelepiped are parallel to the coordinate planes.

Variables

public GlgPoint p1;

The first corner of the cube. Always has the lowest X, Y and Z.

public GlgPoint p2;

The second corner of the cube. Always has the biggest X, Y and Z.

Constructors

public GlgCube()

Creates a new bounding box with default (0;0;0) values for both corner points.

public GlgCube( GlgCube cube )

Creates a copy of a cube.

public static GlgCube GetFromCache()

Returns an object from an internal cache. Creates an object if the cache is empty.

public static void ReleaseToCache( GlgCube obj )

Releases an object to the internal cache for reuse. Only objects obtained with GetFromCache should be released to the cache. Releasing objects created with new would result in increasing resource consumption due to the growth of the cache size. The object should not be accessed after it is released to the cache.
**GlgMatrixData class**

```java
public class GlgMatrixData

Variables

public byte type;
    Matrix type.

public double matrix[4][4];
    Matrix coefficients.

Constructors

public GlgMatrixData()
    Creates an empty matrix data object.

public GlgMatrixData( GlgMatrixData matrix_data )
    Create a new matrix data fills it with data from another matrix data object.

Methods

public void CopyFrom( GlgMatrixData )
    Copies matrix data from another matrix data object.
```

**GlgHierarchyData class**

```java
public class GlgHierarchyData

Is used to pass information to GlgHierarchyListener.

Variables

public int condition;  // (Java)
public GlgHierarchyCallbackType condition;  // (C#)
    Indicates when the listener is invoked: before hierarchy setup (BEFORE_SETUP_CB) or after the setup but before the template is drawn (AFTER_SETUP_CB).

public GlgObject object;  // (Java)
public GlgObject glg_object;  // (C#)
    The SubWindow or SubDrawing object that triggered the callback.

public GlgObject subobject;
    The instance of the subwindow or subdrawing template that is about to be displayed.
```
GlgTraceData class

public class GlgTraceData

Is used to pass information for GlgTraceListener.

Variables

public GlgObject viewport;

The viewport object that received the event.

public Object widget;

The window component or control of the viewport (Swing or AWT component in Java, Windows.Forms.Control in C#).

public AWTEvent event; (Java)
public GlgEvent event; (C#)

The event that caused GlgTraceListener to be invoked.

public boolean trace2;

Indicates the type of TraceListener, is set to true for Trace2 events and false for Trace.

GlgEvent class (C# only)

public class GlgEvent

Is used to pass event information to GlgTraceListener.

Variables

public GlgEventType type;

The event type:

PAINT
UPDATE
COMPONENT_SHOWN
COMPONENT_HIDDEN
COMPONENT_MOVED
COMPONENT_RESIZED
MOUSE_ENTERED
MOUSE_EXITED
MOUSE_MOVED
MOUSE_WHEEL
MOUSE_PRESSED
MOUSE_RELEASED
KEY_DOWN
KEY_PRESSED
KEY_UP
FOCUS_LOST
FOCUS_GAINED
LV_ENTER_NOTIFY - GLG event: mouse entered light viewport
LV_LEAVE_NOTIFY - GLG event: mouse exited light viewport
LV_RESIZE - GLG event: light viewport resized

public EventArgs event_args;

Event arguments of the C# event.

_GlgEventArgs class (C# only)_

public class GlgEventArgs : EventArgs

    Generic GLG event arguments object; provides data for _Glh, Glv_ and _GlgReady_ events.

Variables

    public GlgObject viewport;

    The top-level viewport of the _GlgControl_’s drawing.

__GlgInputEventArgs class (C# only)___

public class GlgInputEventArgs : GlgEventArgs

    Provides data for the _GlgInput_ event.

Variables

    public GlgObject viewport;

    The top-level viewport of the _GlgControl_’s drawing.

    public GlgObject message_obj;

    The message object containing information about the GLG input event.

_GlgSelectEventArgs class (C# only)___

public class GlgSelectEventArgs : GlgEventArgs

    Provides data for the _GlgSelect_ event.

Variables

    public GlgObject viewport;

    The top-level viewport of the _GlgControl_’s drawing.

    public Object[] name_array;

    Null-terminated array containing names of all selected objects, including a complete path name.
public int button;
   Specifies which mouse button was pressed to select objects.

**GlgHierarchyEventArgs class (C# only)**

public class GlgHierarchyEventArgs : GlgEventArgs
   Provides data for the GlgHierarchy event.

*Variables*

public GlgObject viewport;
   The top-level viewport of the GlgControl's drawing.

public GlgHierarchyData hierarchy_info;
   Contains detailed information about the GlgHierarchy event.

**GlgTraceEventArgs class (C# only)**

public class GlgTraceEventArgs : GlgEventArgs
   Provides data for the GlgTrace event.

*Variables*

public GlgObject viewport;
   The top-level viewport of the GlgControl's drawing.

public GlgTraceData trace_info;
   Contains detailed event information.

**GlgMinMax class**

public class GlgMinMax
   Used to return the extent of data in a chart.

*Variables*

public double min;
   The minimum of the data extent.

public double max;
   The maximum of the data extent.
Constructors

public GlgMinMax()

Creates a new data extent object and sets all its variables to zero.

public GlgMinMax( double min, double max)

Creates a data extent object with the specified values.

GlgDataSample class

public class GlgDataSample

Used by a chart object to store data for one data sample.

Variables

public double value;

Y value.

public double time;

Time stamp (or X value in an XY Scatter charts).

public boolean valid;

Data sample’s Valid flag.

Constructors

public GlgDataSample()

Default constructor.

Methods

public static GlgDataSample GetFromCache()

Returns an object from an internal cache. Creates an object if the cache is empty.

public static void ReleaseToCache( GlgDataSample obj )

Releases an object to the internal cache for reuse. Only objects obtained with GetFromCache should be released to the cache. Releasing objects created with new would result in increasing resource consumption due to the growth of the cache size. The object should not be accessed after it is released to the cache.
**GlgDataSampleExt class**

`public class GlgDataSampleExt extends GlgDataSample`

Used by a chart object to store extended data for one data sample, including YLow value for the Hi/Lo Bar Chart, as well as rendering attributes for individual bars and markers that need to be rendered with different colors and marker types.

**Variables**

`public double y_low;`

YLow value of a Hi/Lo bar chart.

`public int fill_color;`

Fill color of a bar or marker in a hex notation (0xRRGGBB)

`public int edge_color;`

Edge color of a bar or marker in a hex notation (0xRRGGBB)

`public int drawn_size;`

Bar width or marker size.

`public int drawn_type;`

Bar fill type or marker type.

`public int line_width;`

Bar line width.

**Constructors**

`public GlgDataSampleExt()`

Default constructor.

**Methods**

`public static GlgDataSampleExt GetFromCache()`

Returns an object from an internal cache. Creates an object if the cache is empty.

`public static void ReleaseToCache( GlgDataSampleExt obj )`

Releases an object to the internal cache for reuse. Only objects obtained with GetFromCache should be released to the cache. Releasing objects created with new would result in increasing resource consumption due to the growth of the cache size. The object should not be accessed after it is released to the cache.
**GlgFindMatchingObjectsData class**

```java
public class GlgFindMatchingObject
```

A utility class used by the `FindMatchingObjects` method.

**Variables**

```java
public int match_type;  // (Java)
public GlgObjectMatchType match_type;  // (C#)
```

Specifies a bitwise mask of the following object matching criteria:

- **OBJECT_TYPE_MATCH** finds objects with an object type matching the type provided by the `object_type` variable.
- **OBJECT_NAME_MATCH** finds objects with a name matching the name provided by `object_name`.
- **RESOURCE_MATCH** finds objects that have the resource specified by `resource_name`.
- **OBJECT_ID_MATCH** finds an object with the ID provided by `object_id`. This can be used to find out if an object is a child or a parent of the object provided by `object_id`.
- **CUSTOM_MATCH** finds objects that match a custom search criterion provided by the instance of the `GlgObjectActionInterface` interface specified by `custom_match`.

Multiple criteria can be ORed together. All of the criteria in the mask must be true in order for an object to match.

```java
public boolean find_parents;
```

Specifies search direction. If it is set to `true`, ancestors (parents, grandparents and so on) of the object are searched. Otherwise, the object's descendents (children, grandchildren and so on) are searched.

```java
public boolean find_first_match;
```

Controls whether the search is stopped after finding the first matching object. If is set to `true`, the search is stopped after the first match and the first matching object is returned, otherwise all matching objects will be returned.

```java
public boolean search_inside;
```

Controls the search inside the matching objects. If it is set to `false`, the object's children or parents are not searched if the object itself matches.

```java
public boolean search_drawable_only;
```

Controls the search inside drawable objects when searching for descendents (`find_parents=false`). If it is set to `true`, only drawable objects are searched. For example, when this flag is set, a polygon object's attributes such as `FillColor` and `EdgeColor`, will not be searched, which can increase the search speed. Refer to the description of the `IsDrawable` method on page 322 for more information.
public int object_type;  
    (Java)
public GlgObjectType type;  
    (C#)

    Object type for the object type search.

public String object_name;

    Object name for the object name search.

public String resource_name;

    Resource name for the resource search.

public GlgObject object_id;

    Object ID for the object id search.

public GlgObjectActionInterface custom_match;

    Specifies an instance of the GlgObjectActionInterface interface that provides custom matching logic. The Action method of the interface instance should return true for objects that match the custom matching criterion. See the GlgObjectActionInterface section on page 283 for more information.

public GlgObject found_object;

    Contains the result of the search, or null if no matching objects were found. If the result is a single object, the found_multiple variable will be set false. If the result is a group of several matching objects, found_multiple will be set to true.

public boolean found_multiple;

    Will be set to true or false to indicate the type of the returned result. If true, the result of the search stored in the found_object variable contains a group of several matching objects. Otherwise (false), the stored result is a single matching object.

Constructors

public GlgFindMatchingObjectsData()

    Creates a new instance of the class.

GlgGISRequestData class

public class GlgGISRequestData

    Used to pass information to the AdjustRequest method of GlgGISRequestObserver. The object's variables may be changed in place to adjust the request’s parameters.

Variables

public GlgPoint extent;

    Requested GIS extent.
public GlgPoint center;
    Requested GIS center.

public double angle;
    Requested GIS angle.

public String layers;
    Requested GIS layers.

public int projection; (Java)

public GlgProjectionType projection; (C#)
    Requested GIS projection.

public int flags; (Java)

public GlgGISRequestFlags flags; (C#)
    Indicates which GIS object's parameters were requested to be changed, may have any OR
    combination of the following flags (defined in the GlgObject class for Java and in the
    GlgGISRequestStatus enum for C#):

    GIS_REQUEST_EXTENT
    GIS_REQUEST_CENTER
    GIS_REQUEST_ANGLE
    GIS_REQUEST_PROJECTION
    GIS_REQUEST_LAYERS

GlgLatLonPoint class

public class GlgLatLonPoint
    Used in the UTM coordinate conversion methods.

Variables

    public double lat;
    public double lon;

Constructors

public GlgLatLonPoint()
    Default constructor.

public GlgLatLonPoint( double lat, double lon )
    Constructs new GlgLatLonPoint with the specified coordinates.
Methods

public void FromString( String string )
Fills GlgLatLonPoint lat/lon coordinates from a space separated string, for example: "42.5 -75".

public void CopyFrom( GlgLatLonPoint point )
Copies values from another GlgLatLonPoint.

GlgUtmPoint class

public class GlgUtmPoint

Used by the UTM coordinate conversion methods.

Variables

public long northing;
public long easting;
public long zone_number;
public char zone_letter;

Constructors

public GlgUtmPoint()
Default constructor.

public GlgUtmPoint( long northing, long easting, long zone_number, char zone_letter )
Constructs new GlgUTMPoint with the specified coordinates.

Methods

public void FromString( String string )
Fills GlgUTMPoint values taking UTM coordinates from a space separated string, for example: "19T 251535 4654131".

public void CopyFrom( GlgUtmPoint point )
Copies values from another GlgUtmPoint.

GlgUtmMGRS class

public class GlgUtmMGRS

Utility class that provides UTM coordinate conversion methods.
Accuracy Constants

Java:

static final int GLM_FAILED_ACCURACY;
static final int GLM_10000_METER;
static final int GLM_1000_METER;
static final int GLM_100_METER;
static final int GLM_10_METER;
static final int GLM_1_METER;

C#:

static const int GLM_FAILED_ACCURACY;
static const int GLM_10000_METER;
static const int GLM_1000_METER;
static const int GLM_100_METER;
static const int GLM_10_METER;
static const int GLM_1_METER;

Methods

static void LatLonPointToUtm( GlgLatLonPoint lat_lon_point, GlgUtmPoint utm_point )
Converts lat/lon coordinates to UTM.

static boolean LatLonPointToUtm( GlgLatLonPoint lat_lon_point, GlgUtmPoint utm_point )
Converts UTM coordinates to lat/lon. Returns true if conversion succeeds.

static String UtmToMgrs( GlgUtmPoint utm_point, int accuracy )
Converts UTM coordinates to the MGRS string and returns the string. The accuracy parameter specifies the accuracy of the conversion using one of the values of the accuracy constants.

static int MgrsToUtm( String mgrs_coord, GlgUtmPoint utm_point )
Converts an MGRS string to UTM coordinates; returns accuracy of a successful conversion (one of the accuracy constants), or GLM_FAILED_ACCURACY if conversion fails.

GLG objects classes

Overview

GLG objects classes provide the actual implementation for specific drawing primitives used in the Toolkit. However, these classes are rarely used by the end user, since the GlgObject superclass delivers most of the GLG API. Unless you are dealing with some advanced uses of the Toolkit, you can skip this section of the manual. For details regarding a particular type of a GLG object, refer to the GLG Objects chapter.

The GLG objects classes are used only to create objects using their public constructors. After they are created, you use the GlgObject superclass methods for any further processing.
Most of the time the drawing and objects in it will be created interactively using the GLG Graphics Builder. These object classes are provided for the advanced users who may want to build the drawing programmatically for applications that generate objects in the drawing based on some kind of a configuration file or table.

When the constructors are used, the objects are initially created with default attributes (attribute values set to 0). The values may later be set using the `GlgObject` `SetResource` methods.

Most of the constructors may be called with `null` parameters to create an object instance with default attribute values. Where the non-`null` parameters are required, it will be explicitly mentioned.

All constants used by these classes are defined in the `GlgObject` superclass.

**GlgArc class**

```
public class GlgArc extends GlgObject

An arc object.
```

**Constructor**

```
public GlgArc()

Creates an arc object.
```

**GlgAxis class**

```
public class GlgAxis extends GlgObject

An axis object.
```

**Constructor**

```
public GlgAxis()

Creates an axis object.
```

**GlgBoxAttr class**

```
public class GlgBoxAttr extends GlgObject

A text box attributes object.
```

**Constructor**

```
public GlgBoxAttr()

Creates an text box attributes object.
```
**GlgChart class**

```java
public class GlgChart extends GlgObject

A real-time chart object.
```

*Constructor*

```java
public GlgChart()

Creates a chart object.
```

**GlgDynArray class**

```java
public class GlgDynArray extends GlgObject

A dynamic array. The array automatically increase its size when new elements are added.
```

*Constructor*

```java
public GlgDynArray( int type, int n_slots, int increment ) (Java)
public GlgDynArray( GlgContainerType type, int n_slots, int increment ) (C#)

Creates a dynamic array.
```

The `type` parameter defines the type of objects that will be stored in the array and may be one of `GLG_OBJECT`, `STRING`, `INT_VALUE` or `NATIVE_OBJECT`. The `GLG_OBJECT` default value is used if the value of 0 is passed.

The `n_slots` parameter defines the initial size of the array. A default value is used if the value 0 is passed.

The `increment` parameter specifies the initial increment to be used when the size of the array has to be increased. A default value is used if the value 0 is passed.

**GlfFont class**

```java
public class GlfFont extends GlgObject

A GLG font object.
```

*Constructor*

```java
public GlfFont( String font_name, String ps_name )

Creates a font object. The `font_name` parameter defines the name of the font to use, while `ps_name` defines the name to use for the font when producing a PostScript output. If these parameters are `null`, default names are used.
```
**GlgFontTable class**

```java
public class GlgFontTable extends GlgObject

A font table object.
```

**Constructor**

```java
public GlgFontTable( int num_types, int num_sizes, GlgObject font_array )
```

Creates a font table. The `num_types` parameter specifies the number of font types in the table, and `num_sizes` specifies the number of font sizes. The `font_array` parameter may specify a GLG group object containing an array of strings to be used as font names. If the length of the array is less than the product of the first two parameters, default font names will be used for the remaining fonts. If `null` values are passed for the number of font types, sizes, or the `font_array`, the default values will be used.

**GlgFrame class**

```java
public class GlgFrame extends GlgObject

A GLG frame object.
```

**Constructor**

```java
public GlgFrame( int type, int factor, GlgObject reserved )
```

Creates a frame object. The `type` parameter specifies a type of frame to create and must be `FRAME_1D`, `FRAME_2D` or `FRAME_3D`. The `factor` parameter must specify the number of intervals the frame uses to create frame points. The last parameter is reserved and a `null` value must be used.

**GlgFunction class**

```java
public class GlgFunction extends GlgObject

A helper class for implementing GLG interaction handlers.
```

**Constructors:**

```java
public GlgFunction( String name, GlgHandler reserved, String arguments )
```

Creates an interaction handler that can be attached to a viewport object. The `name` parameter specifies a name of one of GLG’s interaction handlers (`GlgButton`, `GlgKnob`, etc.). The second and third parameters are reserved and a `null` value must be used.

**GlgHistory class**

```java
public class GlgHistory extends GlgObject
```

---

A history object that implements a scrolling behavior of the GLG graphs.

Constructor

```
public GlgHistory( String var_name, GlgObject reserved1, int reserved2 )
```

Creates a history object. The var_name parameter specifies the name of the resource to scroll. The second and third parameters are reserved and null values (null and 0) must be used.

**GlgImage class**

```
public class GlgImage extends GlgObject
```

An image object, integrates GIF, JPEG, PNG and BMP images into a GLG drawing.

Constructors

```
public GlgImage( int image_type, String filename, String load_path )
```

Creates a GLG image object. The image_type parameter defines the type of image: FIXED_IMAGE or SCALED_IMAGE. The filename defines the image file to use and may be a local file or a URL. The load_path parameter is reserved for future use and must be null.

**GlgLevelLine class**

```
public class GlgLevelLine extends GlgObject
```

A level line object.

Constructor

```
public GlgLevelLine()
```

Creates a level line object.

**GlgLineAttr class**

```
public class GlgLineAttr extends GlgObject
```

A line attributes object.

Constructor

```
public GlgLineAttr()
```

Creates a line attributes object.

**GlgList class**

```
public class GlgList extends GlgObject
```
A linked list object.

**Constructors**

```java
public GlgList( int type ) (Java)
public GlgList( GlgContainerType type ) (C#)
```

Creates a GLG list object. The `type` parameter defines the type of objects that will be stored in the array and may be one of `GLG_OBJECT`, `STRING`, `INT_VALUE` or `NATIVE_OBJECT`. The `GLG_OBJECT` default value is used if the value of 0 is passed.

**GlgLight class**

```java
public class GlgLight extends GlgObject
```

A light object.

**Constructors**

```java
public GlgLight()
```

Creates a light object.

**GlgMarker class**

```java
public class GlgMarker extends GlgObject
```

A GLG marker object.

**Constructor**

```java
public GlgMarker()
```

Creates a marker object.

**GlgParallelogram class**

```java
public class GlgParallelogram extends GlgObject
```

A parallelogram object.

**Constructor**

```java
public GlgParallelogram( int subtype ) (Java)
public GlgParallelogram( GlgParallType subtype ) (C#)
```

Creates a parallelogram object of the subtype requested by the `subtype` parameter: a real parallelogram with 3 point (PA_PA), or a rectangular parallelogram with 2 points (RECT_PA).
**GlgPlot class**

```java
public class GlgPlot extends GlgObject
```

A plot object.

**Constructor**

```java
public GlgPlot()
```

Creates a plot object.

**GlgPolySurface class**

```java
public class GlgPolySurface extends GlgObject
```

A polysurface object.

**Constructor**

```java
public GlgPolySurface( GlgObject marker, GlgObject polygon, GlgObject reserved )
```

Creates a polysurface object. The first two parameters are optional and `null` values may be used, the last parameter is reserved and a `null` value must be used. The `marker` parameter specifies a template marker object to use, and the `polygon` parameter specifies a template polygon.

**GlgPolygon class**

```java
public class GlgPolygon extends GlgObject
```

A polygon object.

**Constructor**

```java
public GlgPolygon( int size, GlgObject reserved )
```

Creates a polygon object. The optional `size` parameter specifies the number of points in the polygon. If the values of 0 or 1 are used, a default polygon with two points is created. After the polygon is created, more points may be added or existing points may be deleted by using `Add` and `Delete` methods of the `GlgObject` superclass. The value of -1 may be used to create a polygon with no points. The second parameter is reserved and a `null` value must be used.

**GlgPolyline class**

```java
public class GlgPolyline extends GlgObject
```

A polyline object.
Constructor

public GlgPolyline( GlgObject marker, GlgObject polygon, GlgObject reserved )

Creates a polyline object. The first two parameters are optional and null values may be used, the last parameter is reserved and a null value must be used. The marker parameter specifies a template marker object to use, and the polygon parameter specifies a template polygon.

GlgReference class

public class GlgReference extends GlgObject

A reference object.

Constructor

public GlgReference( GlgObject template, GlgObject reserved )

Creates a reference object. A mandatory template parameter specifies the object to be used as the reference’s template. The second parameter is reserved and a null value must be used.

GlgRenderingAttr class

public class GlgRenderingAttr extends GlgObject

A rendering attributes object.

Constructor

public GlgRenderingAttr()

Creates a rendering attributes object.

GlgResourceReference class

public class GlgResourceReference extends GlgObject

An alias object.

Constructor

public GlgResourceReference( String from_name, String to_name, GlgObject reserved )

Creates an alias object. The from_name parameter specifies the new logical name for the resource hierarchy pointed to by the alias. The to_name specifies the resource path to the aliased resource. The third parameter is reserved and a null value must be used.

GlgScreen class

abstract class GlgScreen extends GlgObject
This class implements window-related properties of the viewport object. The class is never created directly. Instead, it is created by the viewport object.

**GlgSeries class**

```java
public class GlgSeries extends GlgObject
```

A series object.

**Constructor**

```java
public GlgSeries( GlgObject template, GlgObject reserved )
```

Creates a series object. A mandatory `template` parameter specifies the object to be used as the series template. The second parameter is reserved and a `null` value must be used.

**GlgSpline class**

```java
public class GlgSpline extends GlgObject
```

A spline object.

**Constructor**

```java
public GlgSpline( int size, GlgObject reserved )
```

Creates a spline object. The `size` parameter specifies the number of control points. The second parameter is reserved and a `null` value must be used.

**GlgSquareSeries class**

```java
public class GlgSquareSeries extends GlgObject
```

A square series object.

**Constructor**

```java
public GlgSquareSeries( GlgObject template )
```

Creates a square series object. A mandatory `template` parameter specifies the object to be used as the series template.

**GlgTag class**

```java
public class GlgTag extends GlgObject
```

A tag object which is attached to object attributes to hold data connectivity information.
Constructor

```java
public GlgTag( String tag_name, String tag_source, String tag_comment )
```

Creates a tag object. Optional String parameters supply tag name, tag source and tag comment. The default value for these parameters is `null`.

**GlgText class**

```java
public class GlgText extends GlgObject
```

A text object.

Constructor

```java
public GlgText( String string, int type ) // (Java)
public GlgText( String string, GlgTextType type ) // (C#)
```

Creates a text object. An optional `string` parameter defines the string to display in the text object. If this parameter is `null`, an empty string is used as a default. The `type` parameter defines the type of the text object to create and may be `FIXED_TEXT`, `FIT_TO_BOX_TEXT`, `WRAPPED_TEXT`, `TRUNCATED_TEXT`, `WRAPPED_TRUNCATED_TEXT` or `SPACED_TEXT`. If the value of 0 is passed, the `FIT_TO_BOX_TEXT` type is used as a default.

**GlgViewport class**

```java
public class GlgViewport extends GlgObject
```

A viewport object.

Constructor

```java
public GlgViewport( GlgObject reserved )
```

Creates a viewport object. The constructor’s parameter is reserved and a `null` value must be used.

**GlgXform class**

```java
public class GlgXform extends GlgObject
```

A transformation object.

Constructor

```java
public GlgXform( int role, int type, GlgObject reserved1, GlgObject reserved2 ) // (Java)
public GlgXform( GlgRole role, GlgXformType type, GlgObject reserved1, GlgObject reserved2 ) // (C#)
```

Creates a transformation object used to animate objects.
Using the Java and C# Versions of the Toolkit

The role parameter specifies the role transformation plays and may have the value of one of the transformation role constants defined in the `GlgObject` superclass. `POINT.XR` is the most common value of this parameter that is used to transform geometrical points in 3D space.

The type parameter specifies the type of the transformation to create and may have the value of one of the transformation type constants defined in the `GlgObject` superclass, for example: `TRANSLATE_XF`, `SCALE_XYZ_XF`, `ROTATE.Z_XF`, and so on.

After the transformation of a desired type is created, its parameters (such as the scale, rotation angle and others) may be set by using `SetResource` methods of the `GlgObject` superclass.

The last two parameters are reserved and `null` values must be used.

**Attribute classes**

**GlgDataPoint class**

`abstract class GlgDataPoint extends GlgObject`

**GlgDDataPoint class**

`class GlgDDataPoint extends GlgDataPoint`

**GlgGDataPoint class**

`class GlgGDataPoint extends GlgDataPoint`

**GlgSDataPoint class**

`class GlgSDataPoint extends GlgDataPoint`

These classes implement object attributes. These classes are not used by the end user and are listed here for the sake of completeness, so that they can be used in the instanceof operator.

**Data Value classes**

These classes implement an atomic data value holder. The data object may be used in user applications to hold D, S, or G data. One of the GLG containers may be used to hold a collection of data objects. The data may be assigned or queried using the `GetResource` and `SetResource` methods using `null` as a resource name. The type of the Get/Set method to use (D, S or G) is defined by the type of the data value.

**GlgDataValue class**

`abstract class GlgDataValue extends GlgObject`

An abstract superclass for all data value classes
GlgDDataValue class

public class GlgDDataValue extends GlgDataValue

Holds one double data value

Constructors

public GlgDDataValue( double value )
public GlgDDataValue( GlgObject ddatavalue )

Creates a D data value from a double or another GlgDDataValue object. If created from a null ddatavalue, the values of 0 is used as a default value.

GlgGDataValue class

public class GlgGDataValue extends GlgDataValue

Hold one triplet of X, Y, Z or R, G and B values.

Constructors

public GlgGDataValue( double x, double y, double z )
public GlgGDataValue( GlgObject gdatavalue )

Creates a G data value from X, Y and Z values or another GlgGDataValue object. If created from null gdatavalue, the values of 0 are used for X, Y and Z.

GlgSDataValue class

public class GlgSDataValue extends GlgDataValue

Holds one string value as a GLG object

Constructors

public GlgSDataValue( GlgObject sdatavalue )
public GlgSDataValue( String value )

Creates an S data value from a sting or another GlgSDataValue object. If created with null parameters, holds an empty string.

GlgMatrix class

abstract class GlgMatrix extends GlgObject

The GlgMatrix class implements a matrix object that is used for 3D transformations. The matrix holds the “value” of the transformation and is considered to be a data object. The matrix is never created directly by a user application. To create a matrix, a GlgXform transformation object of a required type is created with the required transformation parameters, and then either the xform object or its matrix is used.
GLG Graphics Server Support Classes for ASP.NET

The following classes are used with the GLG Graphics Server for ASP.NET.

GlgHttpRequestProcessor class

public class GlgHttpRequestProcessor

The request processor class for implementing custom HTTP handlers for ASP.NET.

GlgHttpRequestProcessor is used in the ASP.NET environment for implementing custom HTTP handlers. The class handles access to the GLG API from asynchronous ASP.NET handlers. All calls to the GLG API should be performed from inside the GlgHttpRequestProcessor class instance, which is accomplished by providing a custom method to the GlgHttpRequestProcessor instance via a delegate. This custom method will be invoked by GlgHttpRequestProcessor to perform any activity that requires GLG API calls.

Constructors

public delegate void GlgProcessRequestDataFunc( GlgHttpRequestData data )

public GlgHttpRequestProcessor( GlgProcessRequestDataFunc func )

Creates an instance of GlgHttpRequestProcessor with a custom request processing method supplied by the func parameter. The GlgProcessRequestDataFunc delegate declares the type of the func parameter.

Methods

public GlgHttpRequestData ProcessRequest( System.Web.HttpContext context )

The main method of the request processor. It will invoke a custom method supplied to the GlgHttpRequestProcessor constructor to perform custom GLG-related actions that will process the HTTP request. The context parameter provides HTTP request data to be processed.

If an application needs to use a custom error handler to log errors, the GlgObject.SetErrorHandler method should be invoked inside the ProcessRequest method to set a custom error handler for the GlgHttpRequestProcessor instance.

Refer to examples in the examples_ASP.NET directory of the GLG installation on Windows for source code examples of using the GlgHttpRequestProcessor class.

GlgHttpRequestData class

public class GlgHttpRequestData extends GlgErrorHandler

This is an auxiliary class used by GlgHttpRequestProcessor to pass the HTML request data to its custom request processing method and to return generated data. It does not have a public constructor and is created by GlgHttpRequestProcessor.
Fields

public HttpContext context;

Supplies an HTTP request to be processed by the custom method.

public Bitmap image;

Contains the generated image (if it was generated).

public String html_response;

Contains non-image html response that may be created when processing a mouse selection request, such as a tooltip.

public Object custom_data;

This field may be used to return any additional custom data generated as a result of the HTML request processing.

public bool got_errors;

An error indicator that may be set to true by the custom processing method to indicate an error, causing GlgHttpRequestProcessor to return null. While the default error handler automatically sets got_errors to true if an error is encountered, the got_errors field may be used by a custom error handler to indicate an error.

Graph Layout Classes

Overview

The GLG Graph Layout package implements the spring embedder graph layout algorithm used for automatic layout of graphs containing nodes connected with edges. The spring embedder algorithm performs a series of iterations optimizing the graph layout and minimizing the number of node intersections. The GLG Graph Layout Demo shows an example of an application that creates and automatically lays out a graph containing connected nodes of a network. The demo’s source code may be used as an example of using the Graph Layout module.

As seen in the demo, GLG Graph Layout may be used together with the GLG graphical engine, using GLG to display the graph and its nodes. In this case, the GLG Graphics Builder may be used to define a palette of graphical objects containing icons for the graph’s nodes.

The Graph Layout may also be used to lay out non-GLG objects, for example, Swing components or .NET controls representing an application’s objects. In this case, the application uses the Graph Layout’s relative node position output (in the range from 0 to 1) to position an application’s objects on the page.

The Graph Layout Component is provided with the GLG Extended API.
**GlgGraphNode class**

*Fields:*

- `public int type;`
  
  Node type (0-based index used to associate the node with the node icon from the palette).

- `public Object data;`
  
  Data object associated with the node.

- `public GlgPoint display_position;`
  
  Node’s display position in GLG coordinates.

- `public GlgPoint position;`
  
  Node’s position in normalized coordinates (in the range from 0 to 1).

- `public GlgObject graphics;`
  
  *GlgObject* actually used to display the node.

- `public GlgObject template;`
  
  Custom *GlgObject* used to display the node. If the template is `null`, an icon from the palette is used.

- `public GlgObject link_array;`
  
  A group (*GlgObject*) containing the list of links (of the *GlgGraphEdge* type) attached to this node.

- `public boolean anchor;`
  
  The node’s anchor flag. Setting this flag to `true` anchors the node: the node does not move, the rest move around this node.

*Methods:*

- `public GlgGraphNode();`
  
  Default constructor.

**GlgGraphEdge class**

*Fields:*

- `public int type;`
  
  Edge type (0-based index used to associate the node with the edge icon from the palette). It is 0 in the current implementation.

- `public Object data;`
  
  Data object associated with the edge.
public GlgObject graphics;
    
GlgObject actually used to display the edge.

public GlgObject template;
    
Custom GlgObject used to display the edge. If the template null, an icon from the palette is used.

public GlgGraphNode start_node;
    
The node the start of the edge is connected to.

public GlgGraphNode end_node;
    
The node the end of the edge is connected to.

Methods:

    public GlgGraphEdge();

Default constructor.

**GlgGraphLayout class**

C# Enums:

```csharp
public enum GlgCreateGraphType
{
    RANDOM_GRAPH,
    CIRCULAR_GRAPH,
    STAR_GRAPH
}
```

Defines types of graphs that can be created via the CreateRandom method.

Java Constants:

```java
public static CIRCULAR_GRAPH;
    
Graph type constant for creating circular demo graphs.

public static RANDOM_GRAPH;
    
Graph type constant for creating random demo graphs.

public static STAR_GRAPH;
    
Graph type constant for creating demo graphs with a star shape.
```

Fields:

```java
public static GlgObject DefNodeIcon;
```

A group of node icons to use if no palette is defined.
public static GlgObject DefEdgeIcon;
    An edge icon to use if no palette is defined.

public static GlgObject DefViewportIcon;
    A default viewport to use to render the graph.

public GlgObject palette;
    The graph’s palette.

public GlgPoint dimensions;
    The extent of the graph’s drawing, [-800;800] by default.

public GlgObject node_array;
    A group containing all graph nodes (GlgGraphNode).

public GlgObject edge_array;
    A group containing all graph edges (GlgGraphEdge).

public double end_temperature;
    The final “temperature” of the graph (in the range from 0 to 1) defining the end of the layout
    process, 0.2 by default. A higher value will result in the process finishing faster but with less
    precision. A lower value will cause the layout process to last longer, trying to produce a finer layout.

public boolean finished;
    Is set to true when the graph layout finishes positioning the nodes.

public boolean iteration;
    The current iteration number.

public int update_rate;
    The graph’s update rate: the graph is redrawn after each update_rate iterations.

Methods:

public GlgGraphLayout();
    Constructor.

public void GlgGraphDestroy();
    Destroys all internal structures used by the instance of the graph:

public void GlgGraphSetPalette( GlgObject palette_drawing )
    Sets the graph’s icon palette. The palette drawing must contain node icons named Node0, Node1,
    Node2, etc. Each node must contain a G-type resource named Position, which is used by the graph
layout to position the node. The palette must also contain an edge icon (a polygon named Edge), which is used to define the edges’ attributes.

Parameters:

palette_drawing

Specifies the palette to use for the graph.

public void SetDefaultPalette( GlgObject palette_drawing );

Sets the default palette to be used by all graphs:

Parameters:

palette_drawing

Specifies the palette to use as a default palette.

public void UnloadDefaultPalette();

Resets the default palette to null and destroys any stored objects.

public void CreateGraphics( GlgObject viewport );

Loads icons from the palette and creates a GLG drawing to render the graph.

Parameters:

viewport

An optional viewport. If it is not null, it is used as a container for the graph’s drawing, rendering the graph in the existing object hierarchy. If it is null, the graph will create a new viewport to render the graph.

public void DestroyGraphics();

Destroys the graph’s drawing and all graphical objects used to render nodes and edges.

public GlgObject GetViewport();

Returns the viewport of the graph’s drawing.

public void SpringIterate();

Performs one iteration of the spring embedder layout, returns true if the layout process has finished.

public void Update() (Java)
public void UpdateGlg() (C#)

Updates the display to show the results of the spring layout. There is no need to update the display after every iteration: it may be updated every N iterations, or just once when the layout is finished.
public void AddNode( GlgObject graphics, int node_type, Object data );

Creates a new node and adds it to the graph.

Parameters:

graphics
An optional custom node icon to override the icon from the palette.

node_type
The palette index, specifies what icon to use from the node palette if no custom icons are specified.

data
Custom data to attach to the node.

public void AddEdge( GlgGraphNode start_node, GlgGraphNode end_node, GlgObject graphics, int edge_type, Object data );

Creates a new edge and adds it to the graph.

Parameters:

graph
Specifies the graph.

graphics
An optional custom edge icon to override the icon from the palette.

edge_type
The palette index, specifies what icon to use from the edge palette if no custom graphics are specified (reserved for future use).

data
Custom data to attach to the edge.

public void DeleteNode();

Deletes node from the graph.

Parameters:

node
Node to delete.

public void DeleteEdge();

Deletes edge from the graph.

Parameters:

edge
Edge to delete.
public GLGPoint GetNodePosition(GLGGraphNode node);

Returns the node position in GLG coordinates (in the range from -1000 to 1000).

Parameters:

node

Node object

public void SetNodePosition(GLGGraphNode node, double x, double y, double z);

Sets the node position in GLG coordinates (in the range from -1000 to 1000).

Parameters:

node

Node object.

x, y, z

New coordinate values.

public GLGGraphNode FindNode(GLObject node_graphics);

Finds the node object by its graphics and is used to handle mouse selection.

Parameters:

node_graphics

The graphical object used to render the node in the drawing.

public GLGGraphEdge FindEdge(GLObject edge_graphics);

Finds the edge object by its graphics and is used to handle mouse selection.

Parameters:

edge_graphics

The graphical object used to render the edge in the drawing.

public boolean NodesConnected(GLGGraphNode node1, GLGGraphNode node2);

Connectivity test, returns true if there is an edge connecting the two nodes.

Parameters:

node1, node2

Node objects.
public void IncreaseTemperature( boolean init );

Forces the graph to continue layout after it is finished by increasing the temperature of the graph by a small increment.

Parameters:
init

Specifies if large increment should be used to re-layout the graph if true.

public boolean GetUntangle();

Returns true if the untangling algorithm is enabled. The untangling algorithm helps the graph layout to avoid local minima in the form of intersecting edges. Using this algorithm roughly doubles the time it takes to finish the layout.

public void SetUntangle( boolean untangle );

Enables or disables the untangling algorithm.

Parameters:
untangle

Specifies whether untangling should be used.

public void Error( String string );

Prints an error message.

Parameters:
string

Error message to print.

public void Scramble();

Randomly scrambles the graph’s nodes and is mostly used by demo programs.

public static GlgGraphLayout CreateRandom( int num_nodes, int num_node_types, int graph_type );

The demo constructor, creates and returns a graph layout of a requested type, populating it with nodes and edges.

Parameters:
num_nodes

Number of graph nodes to create.

num_node_types

Number of node types to use for rendering.

type

Graph type constant: RANDOM_GRAPH, CIRCULAR_GRAPH or STAR_GRAPH.
Chapter 5

Using the JavaScript Version of the Toolkit

Introduction

The JavaScript version of the GLG Toolkit provides an HTML5 JavaScript library that is used to deploy a GLG application on a web page in a browser. The library provides the same complete GLG API as the GLG C/C++, Java and C# libraries used to develop desktop applications. With the JavaScript API, these applications can be ported to HTML5 and deployed in a web browser with the client-side JavaScript.

The supported browser include Firefox, Chrome, Safari and Microsoft Edge, including both the desktop and mobile versions.

Standard, Intermediate and Extended APIs

The JavaScript API provides three levels of a programming interface:

- **Standard API** provides methods for loading drawings created in the Graphics Builder or HMI Configurator, animating them with dynamic data, as well as handling basic user interaction (selecting objects with the mouse, pressing buttons, etc.)
- **Intermediate API** provides additional functionality for manipulating objects in the drawing, handling elaborate user interaction, object selection and processing commands defined in the drawing.
- **Extended API** extends the Intermediate API with methods for creating objects programmatically at run time. It makes it possible to add and delete objects, create new drawings at run time, add custom properties and commands to objects, as well as implement other functionality available in the Graphics Builder.

JavaScript Library

The GLG JavaScript Library is a JavaScript object engine that renders GLG objects in the Web environment via HTML5 and JavaScript. The Toolkit takes care of the low-level details of the rendering process, such as optimized damage repair, screen-resolution independent coordinate conversion, transparent zooming and panning, double-buffering and other coding-intensive driver-level tasks.

The Toolkit provides a high-level graphical object model which allows an application developer to concentrate on the application logic, speeding up the development process and dramatically increasing the developer's productivity.

The Toolkit contains the Graphics Builder, a graphical editor used to create graphical objects and define their attributes and dynamic properties without tedious programming. The resulting drawing is then saved into a file and loaded into a web application on a web page using a provided GLG JavaScript library.
JavaScript API

Overview

The GLG JavaScript API methods mimic the corresponding methods of Java and C# GLG APIs described in the previous chapter, with minor differences related to the JavaScript syntax. This allows to share not only the drawings but also the programming logic between the desktop and Web versions of an application.

The GLG JavaScript Online Documentation contains descriptions of all JavaScript API methods. It may be found on the GLG web site at the following location:

http://www.genlogic.com/doc_html/start.html#JavaScriptDoc

Even though the JavaScript is a dynamically typed language, this documentation uses "class" and "type" terms to describe GLG methods and their parameters. The GlgObject "class" is an object that provides methods that can be applied to an instance of GlgObject of any type, such as a polygon or a viewport.

The majority of the GLG methods are listed in the GlgObject section of the documentation.

A few utility "classes", such as GlgPoint, GlgCube, GlgTraceData, etc., are used to pass data to and from the GLG object engine.

There are also several helper classes, such as GlgInputListener, GlgTraceListener, etc., that define type signature of various callback functions.

Using JavaScript API Methods

The vast majority of the JavaScript API methods are the same as the corresponding Java or C# methods of the GLG API. The only exception are the methods that initialize the GLG API and load the GLG drawing. The JavaScript demos and examples provide source code examples of using these methods.

The JavaScript API methods use the same arguments as their corresponding Java or C# equivalents. For example, the SetDResource( resource_name, value ) method expects a string as the first parameter and a double value as the second parameter.

For methods that expect integer parameters, such as GetElement( element_index ), it is an error to pass a numerical value that is not an integer, such as 3.5. Such errors will be detected if a debugging version of the library (described on page 372) is used during development. If a production version of the GLG library is used, the error may be undetected and cause errors later in the program.

Static methods are invoked on a GLG handle obtained via a call to the GlgToolkit method at the beginning of the program:
// Get a handle to the GLG Toolkit library.
var GLG = new GlgToolkit();

// Load GLG drawing.
GLG.LoadWidgetFromURL( "process.g", null, LoadCB, null );

Instance methods are invoked on the object instance:

viewport.SetGResource( "FillColor", 0.7, 0.7, 0.7 );

Comparing GLG Objects

Some methods, such as GetResourceObject, return an instance of GlgObject. The returned object is actually a wrapper around the internal representation of the object used by the GLG object engine. As a result, two different wrapper instances may actually refer to the same internal GlgObject.

To avoid incorrect results, the Equals instance method should be used instead of the == operator in the JavaScript code to check if two GLG objects are the same:

var same = obj1.Equals( obj2 );

A static ObjectsEqual method can also be used to compare two objects, in case obj1 may be null:

GLG.ObjectsEqual( obj1, obj2 );

Predefined Constants

For methods that use predefined integer constants, the constants are grouped using an "enum" concept, with the "enum" name listed as a “type” in the online documentation. For example, the GetObjectType method returns an integer object type using constants defined in the GlgObjectType "enum", which is an object containing GLG object type constants.

Another example is a WRAPPED_TEXT constant that is defined in the GlgTextType “enum” and may be used to set TextType of a GLG text object:

text.SetDResource( "TextType, GLG.GlgTextType.WRAPPED_TEXT");

The WRAPPED_TEXT constant shown above should be used instead of its numerical value to provide the required integer value.

All "enums" are defined as properties of the global GLG handle object, which makes it easier to find constants using auto-completion.

The complete list of all enums can be found at the end of the GlgToolkit*.js files and can also be accessed online at the following link:

Asynchronous Load

In JavaScript, all operations that load any file from a server, such as a drawing, data or any other resource, are asynchronous. As a result, the GLG methods that load files, such as LoadDrawingFromURL, take a callback parameter. The callback will be invoked synchronously when the loading request has been completed. A JavaScript application that loads any file from a web server should be aware of the asynchronous nature of the load requests and use an appropriate design.

A simplified LoadAsset method of the GLG API may be used by an application instead of handing HTTP requests in JavaScript to load any type of data the application may need.

Additional Programming Notes

1. The GlgObject instances received as parameters of a callback function, such as the Input or Trace callback, are valid only inside the callback and the assignment operator (=) cannot be used to store them in global variables to be used outside of the callback (the only exception are GlgObject instances received as parameters of the load callbacks). The static GetReference method must be used to store GlgObject in a global variable in a way that allows it to be used outside of the callback.

2. To minimize garbage collection, the ReleaseToCache instance method may be used to collect temporary objects, such as GlgPoint or GlgCube, after they have been used. ReleaseToCache may also be invoked on temporary GlgObject instances, in which case it will release to the cache the object's wrapper instance without affecting the internal GLG object the wrapper refers to.

Deploying GLG JavaScript Library

JavaScript Library Layout

The GLG JavaScript Library consists of two parts: the GLG object engine and the API bindings. A debugging version of the library described below is also provided. Depending on the flavor of the GLG API, several versions of the library are provided:

Standard API

Glg.js - GLG object engine
GlgDebug.js - debugging version of the GLG object engine
GlgToolkit.js - API bindings

Intermediate API

GlgInt.js - GLG object engine
GlgIntDebug.js - debugging version of the GLG object engine
GlgToolkitInt.js - API bindings
Extended API

GlgExt.js - GLG object engine
GlgExtDebug.js - debugging version of the GLG object engine
GlgToolkitExt.js - API bindings

Community Edition

GlgCE.js - GLG object engine
GlgCEDebug.js - debugging version of the GLG object engine
GlgCEDebugSafari.js - debugging version of the GLG object engine for the Safari browser
GlgToolkitCE.js - API bindings

The libraries are located in the lib directory of the GLG installation.

GLG Demo Note

GLG demos in the DEMOS_HTML directory use the demo version of the GLG libraries:

GlgDemo.js
GlgToolkitDemo.js

To use the source code of any demo as a template for the application development and evaluation, use GlgCE.js and GlgToolkitCE.js in the .html file instead of GlgDemo.js and GlgToolkitDemo.js.

To run the demos, place the demo files on a web server, since most browsers will not allow running JavaScript demos from a local file system due to the security restrictions.

Deploying JavaScript Library in HTML

The GLG JavaScript library is deployed in the form of two files: Glg<V>.js and GlgToolkit<V>.js, where <V> is replaced with the type of the GLG API as described above. We will use the Standard API examples in the rest of this chapter.

The library also uses the gunzip.min.js file for uncompressing GLG drawings saved in the compressed format. These three script files must be included in the html file before the application script as follows:

```html
<script defer src="Glg.js"></script>
<script defer src="GlgToolkit.js"></script>
<script defer src="gunzip.min.js"></script>
<script defer src="application_script.js"></script>
```

The application_script.js file provides custom application code.

Windows IIS Web Server Notes

Custom application/x-glg MIME type should be added for the GLG drawing files with the .g extension. To add a MIME type:

1. Start IIS Manager
2. Select MIME Types
3. Right-click, *Add*

4. In the *Add MIME Type* dialog, specify MIME type "application/x-glg",
   File name extension ".g"

5. If the project uses subdrawings that were saved using an *.sd* extension, the extension would
   also need to be assigned the *application/x-glg* MIME type using the above steps. The *.sd*
   extension is filtered by the IIS by default, resulting in the “File Not Found” error for the
   subdrawings. To disable filtering of the *.sd* extension, a *web.config* file containing the
   following lines needs to be placed in the root directory of the project:

   ```xml
   <?xml version="1.0" encoding="UTF-8"?>
   <configuration>
   <system.webServer>
   <security>
   <requestFiltering>
   <fileExtensions allowUnlisted="true">
   <remove fileExtension=".sd" />
   <add fileExtension=".sd" allowed="true" />
   </fileExtensions>
   </requestFiltering>
   </security>
   </system.webServer>
   </configuration>
   
   A sample *web.config* file is provided in the *src* directory of the GLG installation.

---

**Debugging Version of the GLG JavaScript Library**

The debugging version of the JavaScript library file can be used for debugging purposes during
application development. While it executes slower than the highly optimized production library, the
debugging library contains various verification checks that help catch errors at the application
development stage.

The debugging library performs type checking of all method parameters and generates an exception
if an incorrect parameter type is detected. It is recommended that the debugging library is used for
the development, and a production library is used only for the deployment, after thorough testing of
all code branches.

The *ThrowExceptionOnError* method shown in the demos and examples code may be used to stop
execution on the GLG errors: the stack trace in the browser’s debugger will show the location of the
code that caused the GLG error.

By default, GLG errors, such as “Can’t find resource”, generate an error message on the browser
console, but do not stop execution of the program. Throwing an exception on error can help find the
exact code in the application script that generated the error.

**NOTE:** The *GlgCEDebugSafari.js* file provided with the Community Edition can be used for
debugging with the Safari browser on macOS.
Global Configuration Resources

GLG global configuration resources may be used to control some aspects of the GLG Toolkit runtime behavior. For example, `GlgDisableMouseButtonCheck` and `GlgDisableControlKeyCheck` resources may be used to adjust application behavior for mobile devices with a touch screen, and `GlgWrapNativeLabels` may be used to control label wrapping in native buttons and toggles. The `GlgSetNativeAttributes` resource may be used to obtain a more complete control over the native widgets’ appearance inside a GLG drawing.

Refer to the Appendix A: Global Configuration Resources chapter on page 413 for a list of the global configuration resources.

Using HTML Cascading Style Sheets

HTML attributes of native widgets inside a GLG drawing, such as buttons, toggles, text boxes, etc.) may be controlled by the HTML style sheets using each widget class type. The browser’s Inspector feature may be used to find the class assigned to a native widget of each type.

The HTML attributes of native widgets may also be set in the JavaScript code by using the `GetNativeComponent` method of a native widget’s viewport to get the ID of the widget’s HTML element and then using this ID to set the element’s style attributes.

Deploying GLG Drawings Created in Different System Locales

JavaScript Encodings

Internally, JavaScript uses UTF-16 encoding to represent strings. When external strings are loaded in JavaScript, they are converted from an external encoding to UTF-16.

JavaScript supports a limited number of external encodings for importing strings, such as ASCII, Latin1 and UTF-8, and does not support all possible system locales for individual languages. Instead, it uses UTF-8 encoding for importing strings in different languages.

GLG JavaScript API uses Latin1 encoding as a default, which allows loading drawings containing both ASCII and Latin1 characters without a need to convert them to UTF-8. Drawings containing characters other than Latin1 stored in non-UTF-8 encodings need to be converted to UTF-8 as described below.

Using GLG Drawings in JavaScript

ASCII Drawings

GLG Drawings that contain strings with only ASCII characters do not require any special handling, since these characters are the same in the ASCII, Latin1 and UTF-8 encodings.
**Latin1 Drawings**

GLG drawings created in Latin1 locale and containing strings with Latin1 characters do not require any special handling either, since GLG JavaScript API uses Latin1 as a default encoding.

**Non-ASCII Drawings Created on Linux/Unix in UTF-8 Locale**

If GLG drawings containing non-ASCII characters (either Latin1 or in any other language) were created in the UTF-8 locale on Linux/Unix, they can be loaded into a GLG JavaScript program by either setting the `GlgDefaultEncodingName` global configuration resource to “utf8” to define a default encoding, or by specifying “utf8” as the encoding parameter value of the GLG drawing loading methods, such as `LoadWidgetFromURL`.

**Non-Latin1 Drawings Created on Windows or on Linux in non-UTF-8 Locale**

GLG drawings created in Latin1 locale do not require any special handling as described above.

If a GLG drawing containing characters in any other language was created in any system locale other than UTF-8, the strings have to be converted to UTF-8 by re-encoding them in UTF-8 and setting their `UTF8Encoding` flag. In the Graphics Builder or HMI Configurator, it may be done on per-string basis by clicking on the `DEF` toggle, which will change to `UTF`.

The GLG Drawing File Conversion Utility (`gconvert`) may be used to convert the entire drawing, or all drawings in a directory tree. The `-convert-to-utf8` command-line option of the `gconvert` utility is used to convert all strings in a drawing to the UTF-8 encoding. The `-r` converter option may be used to recursively convert all drawing files in a directory tree.

Refer to the the *Drawing File Conversion Utility* chapter on page 396 for more information.

The converter should be run in the system locale in which the drawing was created. All strings in the drawing will be converted to UTF-8 and marked as UTF-8-encoded in the converted drawing by setting their `UTF8Encoding` flag. When the drawing is loaded by the GLG JavaScript library, the strings are automatically recognized as UTF-8 encoded and will be properly handled automatically.

The UTF-8 conversion makes the strings independent from the encoding specified in JavaScript. As a result, the converted drawing may be loaded in the GLG JavaScript program using the default (or any other) encoding settings.

The UTF-8 conversion is performed on string attributes that are objects, such as the `TextString` attribute of a text object. String attributes that are not objects, such as object names, tag names and tag sources, will not be converted.
The GLG Toolkit includes three utility programs of some use to GLG application programmers:

**datagen**
Generates a variety of test data suitable for testing and prototyping GLG drawings.

**geodegen**
Creates a memory image of a GLG drawing in the C language format. The output of the utility is a file with \*.c extension, containing the image of the drawing in a form of the C source code. The output file can be compiled into the program’s executable, saving users from having to supply a separate drawing file.

**gconvert**
A GLG drawing file may have one of three different formats: Binary, ASCII, or Extended. The Binary files are the fastest to load, but the Extended and ASCII files are more portable. The gconvert program converts drawing files from one format to another. The utility can also be used to change resources of a drawing in a batch mode using the script command option.

These tools are described in more detail in this chapter.

The GLG Toolkit also provides support for scripting. Scripting may be used for creating drawings using a script as well as editing drawings in the batch mode. Scripting is only one of the ways to create a GLG drawing. The GLG Extended API may also be used to generate a drawing programmatically and provide full access to all GLG functionality at run time.

While this usage is not common, scripting could also be used to supply data for prototyping a drawing in the Builder.

The GLG Script format as well as the command-line options for using the GLG Builder for scripting are also described in this chapter.
6.1 The Data Generation Utility

The data generation utility is included with the Toolkit and can be used to supply animation data for a GLG drawing during development. It can generate random or incremental data, take data for animation from a file or execute a script.

The datagen utility is embedded into the GLG Builder, which invokes the utility to generate data for prototyping the drawing in the Run mode using the $datagen command in the Run dialog. $datagen instructs the Builder to use an internal version of the datagen utility.

The datagen utility can also be used in stand-alone mode with the -print option to write animation commands into a script file which can be later used with the GLG Builder. The datagen utility is a symbolic link to the GLG Builder executable and can be invoked in the following way:

```
datagen <datagen options>
```

On Windows, links are not supported, and the following command must be used:

```
GlgBuilder -datagen <datagen options>
```

Command Line Arguments and Options

Datagen requires several parameters, including the name and type of the resource to be set and the low and high range for that resource.

```
datagen <options> [data_set] [data_set...]
```

<options>

are optional parameters applicable to all data sets and may include:

-sleep num_secs

Specifies the number of seconds to sleep after each update

-pack number

Allows supplying a few data iterations for one update. The update is performed only once per specified number of the data values sent. This option also affects generation of string data. If the option is specified, and string data is requested, only one value of the string type data is generated for each pack.

-argf argfile

Allows some or all of the datagen arguments to be specified in the text file specified by this option. The arguments read from the file are placed at the position in the command line where this option is located. Several files may be chained using this option.

-script scriptfile

Specifies a file to use as an input script. The script may have commands for setting specific resources and updating the drawing. The script commands are listed in the GLG Script section on page 380. If this option is used, the data_set parameters are ignored and may be omitted.

-print scriptfile

Writes animation commands into an output script file. The script file can be read with the -script option.
-restore

This option sets the value of any named resource to zero, ignoring the range and data set options.

**Data Set Specification**

Several data sets may be specified. Each data set specification is composed of a collection of one or more data set options, three parameters defining the type and range of the desired data set, and the name of a resource in the drawing. The data set options and parameters are used to generate a stream of data, and that data is applied to the specified drawing resource.

The data set specification looks like this:

```
<data_set_options> type low_range high_range resource_name
```

The data set arguments are defined as follows:

**type**

Specifies the type of the data to be supplied. It should correspond to the type of the resource the data will be assigned, which is specified by `resource_name`. The type may be one of the following:

- `d` - a double-precision scalar value
- `g` - a “geometrical” value consisting of a set of three scalar values
- `s` - a string

Unless the `-datafile` or `-script` option is used, the string data produced by `datagen` are numerical strings formed by converting a double-precision scalar value into a string using the C-style `%d` format. Therefore, the difference between `low_range` and `high_range` should be more than 1 to obtain strings different from the low range value. The geometrical data generated by `datagen` has identical x, y, and z coordinates.

**low_range**

Specifies the lower limit of the data to be generated.

**high_range**

Specifies the upper limit of the data to be generated.

**resource_name**

Specifies the name of the resource (or tag if `-tag` dataset option is used) to which the generated data values are assigned. The actual type of the resource or tag should match the type specified by the `type` parameter. The resource name or tag source must be defined relative to the viewport whose server receives the `datagen` message.

**Data Set Options**

The data set options are applied only to the data set specification in which they are found. If no data set options are specified, `datagen` produces random data between the data limits. The data set options are:
-tag
   The datagen will handle the resource_name parameter as a tag source.

-lin
-lincr
Generates linear data. The data start at the range lower limit and increase monotonically until the upper limit is reached. After the upper limit is reached, the generated data start again from the lower limit. The increment added to the data between iterations is determined by the total range and the defined data period. The default period is 100 iterations.

-sin
Generates data using a sine function. The data start at the range lower limit and vary sinusoidally between the range limits. The oscillation period is measured in data iterations, and can be controlled with the -period option. The default period is 100 iterations.

-cos
Generates data using a cosine function. The data start at the range higher limit and vary sinusoidally between the range limits. The oscillation period is measured in data iterations, and can be controlled with the -period option. The default period is 100 iterations.

-int
Truncates generated values to integers.

-period number
Specifies a period of the sinusoidal or incremental data for the -sin, -cos or -incr option. The supplied number defines the number of iterations that compose one period. The default period is 100 iterations.

-surf
Generates data for animating a surface graph. The number of rows and columns has to be specified with the -row and -column options. The -pack option may be used to update a graph just once when the complete surface is generated. In this case a pack number should be greater than or equal to the number of rows times the number of columns.

-row number
Specifies the number of points in a row on a polysurface. This is one greater than the number of polygon patches in the row.

-col number
Specifies the number of points in a column on a polysurface. This is one greater than the number of polygon patches in the column.

-datafile data_file
Specifies the name of a data file. If such a file is specified, the data is read from this data file instead of being generated. The low_range and high_range parameters are ignored, but still must be included in the data set specification. The format of the data file is outlined below.
**Data File Format**

The data file is used when testing a drawing requires data not easily generated with the available *datagen* data set options. The file contains ASCII data corresponding to the type of the resource. For a scalar resource the file should be an array of numbers separated by spaces or new lines. A scalar data file might look like this:

```
1 1.1 1.2 1.3 1.4 1.5
1.6 1.7 1.8 1.9 2 2.1
2.2 2.3 2.4 2.5 2.6 2.7
...
```

For a geometrical resource the file should be an array of numbers as well, but the number of values in the array should be a factor of 3, and there must be an integral number of points per line of data.

```
1 1 0
1.1 1.1 -0.1
1.2 1.2 -0.2
1.3 1.3 -0.3
...
```

There may be more than one geometrical value per line. The following is also a valid way to specify the same geometrical series shown above:

```
1 1 0 1.1 1.1 -0.1 1.2 1.2 -0.2
1.3 1.3 -0.3 1.4 1.4 -0.4 1.5 1.5 -0.5
...
```

For a string resource, the array should have strings separated by the new line character:

```
October 1996
November 1996
December 1996
January 1997
February 1997
March 1997
April 1997
...
```
6.2 GLG Script

Overview

The GLG Script serves a variety of functions in the Toolkit:

- used with the -script option of the datagen Data Generation Utility to prototype a drawing in the GLG Graphics Builder with custom data.
- used with the -command and -script options of the gconvert File Conversion Utility to edit a collection of drawings using the batch mode or create a drawing using a script.
- may be used to supply data for animating a drawing in the Builder’s Run mode.

GLG Script includes a small set of commands which can be used to set the value of some resource, update the drawing, synchronize the connection or produce a PostScript output. A script file is an ASCII file with a single command on each line. The script provides Database Record Support extension to simplify usage of database records to supply data for animation.

The script also provides an extended command set for creating and deleting objects. These commands may be used for creating drawings using a script, or for editing drawings using the batch mode of the GLG Builder. The extended command set is available only in the Enterprise Edition of the GLG Graphics Builder. To create drawings programmatically at run time, use the GLG Extended API, which provides this functionality and more.

The syntax of the script commands is described below.

Standard Command Set

# <comment>

Specifies a comment line. Any line that starts with the “#” character is interpreted as a comment. The “#” character can be preceded with spaces and tabs.

set_value

Sets the value of a particular resource.

set_value <resource_name> <resource_type> <value(s)>

The command arguments define the name, type, and new value of the resource. This syntax is the same as the syntax for the dynamic resources, described in the Setting the Drawing Resources section of the Using the C/C++ version of the Toolkit chapter on page 31.

The strings used for setting values of resources of the S (string) type can be surrounded with double quotes, in which case they may contain spaces as well as the new line characters for multi-line strings. The ‘\’ escape character may also be used to define simple escape sequences, such as “\n”, “\r”, “\t”, “\b”, “\’” and “\"”. Use “$null” to set the new attribute value to null.
Using set_value with the Extended Command Set

The “.” and “/” symbols may be used in resource_name to reference the current object and the container selected with the select_object or select_container commands of the extended command set, respectively (see page 384). For example, /FillColor may be used to access the FillColor attribute of the current object, and /Visibility may be used to access the visibility of the selected container.

Registers may be used in script commands instead of resource names. For example, %3/FillColor may be used to access the FillColor attribute of the object stored in register 3. The content of a register is set using the select_object command of the extended command set described on page 384.

The $last_value symbol may be used instead of the value parameters, to refer to the value(s) obtained by the last get_value or get_tag command of the extended command set.

set_tag

Same as set_value, but uses a tag_source.

set_tag <tag_source> <tag_type> <value(s)>

update

Updates the drawing to reflect the new values of resources.

update

For more information about the update action, see the GlgStrClone section of the Animating a GLG Drawing with Data Using the Standard API chapter.

print

Print the server's viewport by producing a PostScript output and saving it into a specified file:

print <filename> <x> <y> <width> <height> <portrait> <stretch>

The x, y, width, and height parameters define the PostScript page layout. The origin is defined to be in the middle of the page, the left edge of the page is at -1000, and the right edge is at 1000. The top and bottom of the page are similarly defined to be at 1000 and -1000, respectively. The x and y parameters define the lower left corner of the drawing, while width, and height give the dimensions of the drawing area. As an example, the default page layout you get when you print a drawing by setting the PrintFile property puts the lower left corner of the drawing area at (-900 -900), while the dimensions are 1800 by 1800. This makes the drawing about as large as it can be while still keeping a small border all the way around the page. The portrait parameter defines portrait (TRUE) or landscape (FALSE) mode. If the stretch parameter is set to FALSE, the aspect ratio of the drawing is preserved.
The generated PostScript output corresponds to the currently visible state of the server’s viewport after the last update command or expose event. The PostScript output is saved on the server’s side, so the filename should be defined for the file system of the server host machine. If the filename is defined relative to the current directory, the current directory of the process is assumed.

**Database Record Support Commands**

Database record support is a feature of a GLG script that allows using the output of database report generators as input data for GLG ActiveX control or as prototyping data for the GLG Graphics Builder.

If a regular GLG script is used, each supplied data value needs resource name and type information. Using database record support feature, the information for associating the value with a resource may be supplied just once in a separate setup script and the data file will contain just the raw data generated by a database report generator.

The database record support consists of the following additional GLG script commands:

**create_record**

Creates a record with a named defined by the `record_name` parameter:

```
create_record record_name
```

**add_field**

Adds a field to a record defined by the `record_name` parameter:

```
add_field
    record_name resource_name resource_type <separator>
```

`resource_name` parameter specifies a resource to be associated with the field and the `resource_type` parameter supplies the GLG resource type - `d` for double resources, `s` for string resources, and `g` for points and colors defined by 3 coordinates. A dummy field with "u" as a separator value may be used to update the drawing in the middle of reading records, in which case the resource_name and resource_type fields are ignored.

The `separator` parameter has to be enclosed in angle brackets and supplies a character used to separate the next field. If a space is used as a separator, spaces and tabulation characters may be used as actual separators.

**delete_record**

Deletes a record defined by the `record_name` parameter.
delete_record record_name

**read_records**

Starts reading records from a script:

```
read_records record_name
```

The format of the records is defined by the `record_name` parameter. Each record should start on a new line and should not continue to the next line. A dummy field with "u" as a separator value may be used to update the drawing in the middle of reading records.

**end_read**

Stops the process of reading records defined by the last `read_records` command.

**read_one_record**

Reads one records from a script.

```
read_one_record record_name
```

The format of the records is defined by the `record_name` parameter.

**Database Record Support Example**

The following is an example of a GLG script that reads data records containing a value and a label and updates the drawing after reading each record. The script consists of two parts: a header that describes the record structure, and a list of records with data. The following show an example of a header:

```
create_record graph_record
   add_field graph_record DataGroup/EntryPoint d <,>
   add_field graph_record XLabelGroup/EntryPoint s < >
   add_field graph_record dummy u <,>
```

The last field is a dummy field which causes display to be updated after reading each record without waiting for all of them to be read.

The following shows the remaining part of the script containing data that may be generated by a database report generator:

```
read_records graph_record
0.1,Label 1
0.2,Label 2
0.3,Label 3
0.4,Label 4
0.5,Label 5
0.6,Label 6
0.7,Label 7
0.8,Label 8
```
Extended Command Set

The extended command set includes commands for creating and deleting objects, properties and tags using script. The extended command set is available only with the Enterprise Edition of the GLG Graphics Builder and can be used to modify multiple drawings with a script in a batch mode using the -script option of the Drawing File Conversion utility. The utility can be used to apply the script to multiple files, and can also be used to process all files in a directory and all its subdirectories using the recursive mode. Refer to the Drawing File Conversion Utility chapter on page 396 for more information.

The extended command set provides a subset of the Extended API functionality in the scripting mode, making it possible to perform elaborate drawing modifications without a need to write a program. Alternatively, the GLG Extended API can be used at run time to modify the drawings or create drawings programmatically.

The extended command set introduces the notion of a current object and a selected container. The current object and container may be selected using the select_object and select_container commands, and then used by other script commands, providing a way to access them efficiently.

The “.” and “/” symbols may be used in resource names to reference the current object and the selected container, respectively. For example, ./FillColor may be used to access the FillColor attribute of the current object, and /Visibility may be used to access the visibility of the selected container.

The script engine also provides 10 registers that can be used to store object IDs. The registers are referred in the script using the %n notation, where n is a number from 0 to 9 that specifies the register’s index. Registers may be used in script commands instead of resource names. For example, %3/FillColor may be used to access the FillColor attribute of the object stored in register 3. The content of a register is set using the select_object command.

The $last_value symbol may be used instead of the value parameters of the set_value and set_tag command to refer to the value(s) obtained by the last get_value or get_tag command of the extended command set.

Quotes can be used to define strings that contain spaces, such as values of the S resources and tag comments. The $null symbol may be used to define a NULL string.

The following list contains the commands of the extended command set:

skip_if_no_resource

If no resource is found, suspends processing of the script’s commands until the skip_end command is read or the end of the script is reached, whichever comes first:

skip_if_no_resource <resource_name>
The resource_name parameter specifies the resource name to be tested. Nested skip commands are supported.

**skip_if_resource**

If the resource is found, suspends processing of the script’s commands until the skip_end command is read or the end of the script is reached, whichever comes first:

```plaintext
skip_if_resource <resource_name>
```

The resource_name parameter specifies the resource name to be tested. Nested skip commands are supported.

**skip_end**

Resumes processing of the script’s commands:

```plaintext
skip_end
```

**get_value**

Queries the value(s) of a particular resource and stores them for later use:

```plaintext
get_value <resource_name> <resource_type>
```

The command arguments define the name and type of the resource. Use the $last_value symbol instead of the value parameters of the set_value or set_tag command to reference the values returned by the last get_value or get_tag command.

**get_tag**

Same as get_value, but uses a tag source:

```plaintext
get_tag <tag_source> <resource_type>
```

**select_object**

Selects an object for later access:

```plaintext
select_object <resource_name> [destination]
```

The resource_name parameter defines the resource name of the object to be selected. Use the “$null” string as the resource_name to unselect the object at the targeted destination.

A destination parameter can be used to specify one of the registers that can store selected objects. Registers are specified using the %n notation, where n is a register’s index in the range from 0 to 9. An object stored in a register can be referenced in other script commands, for example:

```plaintext
# Store the $Widget viewport in register 0
select_object $Widget %0
```
# Set the FillColor of the object stored in register 0
set_value %0/FillColor g 1 1 1

# Store an object from register 0 in register 3
select_object %0 %3

The “." string may be used as a destination to store the object as the current object, which can be referenced in other script commands as “.":

# Select the $Widget viewport as the current object
select $Widget .

# Set the FillColor of the current object
set_value ./FillColor g 1 1 1

# Store the current object in register 2
select_object . %2

The destination parameter is optional. If it is committed, the current object is used as a destination.

Note: The setting of the current object is volatile: some commands, such as create, add_custom_property, add_public_property, etc., store the created object or the added property as the current object for a possible later access. To persistently store an object for referencing it later in the script use registers described above.

The current object is also used as an implicit argument for other script commands (such as reference or drop).

**select_container**

Selects a container for adding or deleting elements:

```
select_container <resource_name>
```

The resource_name argument defines the resource name of the object to be selected as the container. Use $null to unselect the currently selected container. The container is used as an implicit argument by commands that add or delete objects.

The selected container can be referenced in other script commands by using the “/” symbol:

```
# Set visibility of the currently selected container to 1
set_value /Visibility d 1
```
**select_element**

Selects an element of a container object, such as a group or a viewport, or selects a control point of a polygon:

```
select_element <resource_name> <element_index> [destination]
```

The command arguments define the resource name of the container object and the index of the element inside the container to select. The `destination` parameter can specify a register to store the selected element using the `%n` notation, where `n` is a register’s index in the range from 0 to 9. If the “.” string is used as the destination parameter, or the parameter is omitted, the selected element is stored as the current object.

The stored element can then be accessed using the “.” or “%n” notation, depending on where it was stored.

**load_object**

Loads an object from a file and selects it:

```
load_object <filename>
```

The loaded object is stored as the current object and can be accessed using the “.” symbol.

**set_resource_object**

ADVANCED: Sets a new value of the specified resource of the selected object:

```
set_resource_object <resource_name> <resource_name_of_new_value>
```

The `resource_name` parameter defines the name of the selected object’s attribute. The `resource_name_of_new_value` parameter specifies the object to be used as a new value of the attribute. Use “$null” to set the new attribute value to null.

**reference**

Increases the reference count of the current object:

```
reference
```

This command uses the current object set by the `select_object` command as an implicit argument. If the current object is not set, an error is generated.

**drop**

Decreases the reference count of the current object:

```
drop
```

This command uses the current object set by the `select_object` command as an implicit argument. If the current object is not set, an error is generated.
**add_custom_property**

Adds a custom property to an object:

```
   add_custom_property <target> <property_name> <type> <value>
```

The `target` parameter specifies the resource path of the object the custom property is added to.

The `property_name`, `type` (d, s or g) and `value` parameters provide the corresponding attributes of the custom property. For custom properties of D and S types, the value parameter provides a double or string value, respectively. For custom properties of the G type, the value is supplied as a triplet of double values.

The added custom property is stored as the *current object* for a possible later use.

Refer to the *Drawing File Conversion Utility* chapter on page 396 for description of command-line options that control verbosity of the diagnostic output.

**add_public_property**

Adds a public property to an object attribute:

```
   add_public_property <target> <property_name> [ <comment> ]
```

The `target` parameter specifies the resource path of the object attribute the public property is added to.

The `property_name` and an optional `comment` parameters provide the corresponding attributes of the public property.

The added export tag is stored as the *current object* for a possible later use.

**Note:** The `-setup` command-line option of the utility must be used to set up the drawing hierarchy, which is needed to process this command in case when the target is specified using a named resource instead of a default resource name. Refer to the *Drawing File Conversion Utility* chapter on page 396 for description of this and other command-line options that control verbosity of the diagnostic output.

**add_export_tag**

Same as `add_public_property`, but also allows specifying an export tag type:

```
   add_export_tag <target> <tag_name> <type> [ <comment> ]
```

The `type` parameter specifies the export tag type and may be set to the following string values: `EXPORT`, `EXPORT_DYN` or `EXPORT_BOTH`. Refer to the *Drawing File Conversion Utility* chapter on page 396 for description of command-line options that control verbosity of the diagnostic output.

The added export tag is stored as the *current object* for a possible later use.
**add_data_tag**

Adds a data tag to an object attribute:

```
add_data_tag <target> <tag_name> <tag_source> <access_type>
    [ <comment>]  
```

The `target` parameter specifies the resource path of the object attribute the data tag is added to. The `tag_name`, `tag_source` and an optional `comment` parameters provide the corresponding attributes of the public property. The `access_type` parameter specifies the tag’s access type and may be set to the following values: 0 for INPUT tags, 1 for INIT tags and 2 for OUTPUT tags.

The $null string can be used to specify NULL values for string parameters, such as `tag_name`, `tag_source` and `comment`. Refer to the Drawing File Conversion Utility chapter on page 396 for description of command-line options that control verbosity of the diagnostic output.

The added data tag is stored as the current object for a possible later use.

**get_export_tag**

Finds a named custom property of an object:

```
get_export_tag <target> <property_name>
```

The `target` parameter specifies the resource path of the object to search for, and `property_name` specifies the name of the custom property. If found, the custom property is stored as the current object accessible via the “.” symbol. If a named custom property is not found, NULL is stored.

**delete_custom_property**

Deletes a custom property from an object:

```
delete_custom_property <target> <property_name>
```

The `target` parameter specifies the resource path of the object to delete the custom property from, and `property_name` specifies the name of the custom property to be deleted.

Refer to the Drawing File Conversion Utility chapter on page 396 for description of command-line options that control verbosity of the diagnostic output.

**delete_public_property**

**delete_export_tag**

Deletes a public property or an export tag from an object’s attribute:

```
delete_public_property <target>
```

```
delete_export_tag <target>
```

The `target` parameter specifies the resource path of the object attribute to delete the public property or the export tag from.
Refer to the *Drawing File Conversion Utility* chapter on page 396 for description of command-line options that control verbosity of the diagnostic output.

### delete_data_tag

Deletes a data tag from an object’s attribute:

```plaintext
delete_data_tag <target>
```

The `target` parameter specifies the resource path of the object attribute to delete the data tag from.

Refer to the *Drawing File Conversion Utility* chapter on page 396 for description of command-line options that control verbosity of the diagnostic output.

### create

Creates an object of the specified type, and stores it as the *current object* for later use:

```plaintext
create <object_type> <name> <parameters>
```

The command arguments define the type of object and its name, as well as any parameters required by some object types. The rest of the attribute values may be set using the script’s `set_value` command after the object has been created. The following lists the supported object types and parameters:

#### polygon

**Parameters:**

```plaintext
<num_points> x1 y1 z1 x2 y2 z2 ... xn yn zn
```

Creates a polygon. Requires the number of points and a list of vertex values for polygon points. The rest of the polygon’s attributes may be set using the `set_value` command.

#### parallelogram

**Parameters:**

```plaintext
x1 y1 z1 x2 y2 z2 x3 y3 z3
```

Creates a parallelogram. Requires the list of values of the parallelogram’s three vertices. The rest of the parallelogram’s attributes may be set using the `set_value` command.

#### rectangle

**Parameters:**

```plaintext
x y width height
```

Creates a rectangle; requires the rectangle’s origin, width and height parameters. The rest of the rectangle’s attributes may be set using the `set_value` command.
text

**Parameters:**

```
<text_string>
```

Creates a text object. Requires a text string. The position and other attributes of the text object may be set using the `set_value` command.

image

**Parameters:**

```
<image_file>
```

Creates an image object. Requires the name of an image file. The position and other attributes of the image object may be set using the `set_value` command.

arc

**Parameters:** None

Creates an arc. The arc’s parameters may be set using the `set_value` command.

rounded

**Parameters:**

```
x1 y1 z1 x2 y2 z2 x3 y3 z3
```

Creates a rounded rectangle (or ellipse, depending on the values of the object’s attributes). Requires a list of values for the object’s three vertices. The rest of the attributes may be set using the `set_value` command.

marker

**Parameters:** None

Creates a marker. The marker’s position and other attributes may be set using the `set_value` command.

viewport

**Parameters:** None

Creates a viewport. The viewport’s position and the rest of its attributes may be set using the `set_value` command. The viewport may be selected as a container in order to add other objects to it.

group

**Parameters:** None

Creates a group. The group may be selected as a container in order to add other objects to it.
gis

**Parameters:**

```plaintext
<image_file>
```

Creates a GIS Object. Requires the name of a data file. The position and other attributes of the GIS Object may be set using the `set_value` command.

**rendering_attr**

**Parameters:** None

Creates a rendering object containing extended rendering attributes, such as gradient. The rendering may be added to an object by using the `set_resource_object` script command.

**box_attr**

**Parameters:** None

Creates a text box attributes object. The text box may be added to a text object by using the `set_resource_object` script command.

The created object is stored as the `current object` that can be accessed using the “.” symbol.

**add_new**

Same as `create`, but also adds the created object to the selected `container`:

```plaintext
add_new <object_type> <name> <options>
```

This command has the same arguments as `create`; see description of the `create` command for details. The selected `container` is used as an implicit argument and must be set externally using the `select_container` command, otherwise an error is generated.

**add_copy**

Creates a strong copy of the `current object`, names it, adds it to the selected `container` and stores the copy as the `current object`:

```plaintext
add_copy <copy_name>
```

The command argument define the name of the copy. Both the `current object` and the selected `container` are used as implicit arguments and must be set, otherwise an error is generated.

The command may be used repeatedly to add a number of copies, so that `add_copy` may be used instead of `create` in cases when a number of objects with similar attributes have to be created. The attributes of individual copies may be set using the `set_value` command that uses the “.” symbol (`current object`) in the `resource_name` parameter to reference the newly added copy.

The attributes of the copies may be constrained by setting the attribute’s `Global` flag to `GLOBAL` before copying the object.
For example, the following script may be used to add 3 text labels to the drawing:

```glg
# Select the $Widget viewport as a container to add the labels to
select_container $Widget

# Create a text object and set its font type and size.
# Creating the text selects it for use in add_copy.
create text Label
set_value ./FontType 2
set_value ./FontSize 2
# Set TextType to FIXED
set_value ./TextType 1

# Add three copies of the text setting their position and label.
# Adding a copy stores it as the current object, accessed as "." later.
add_copy Label1
set_value ./String This is Label1
set_value Point -500 500 0

add_copy Label2
set_value ./String This is Label2
set_value Point -500 0 0

add_copy Label3
set_value ./String This is Label3
set_value Point -500 -500 0
```

copy

Creates a copy of an object using a specified clone type and stores the copy as the current object:

```glg
copy <resource_name> <clone_type>
```

The `resource_name` argument defines an object to copy. The `clone_type` parameter may have the following values:

- `f` - full clone
- `w` - weak clone
- `s` - strong clone
- `c` - constrained clone

Use the "." symbol (current object) in the `resource_name` parameter of other commands to reference the cloned object.

delete

Deletes the current object from the selected container:

```glg
delete
```

The deleted object is still stored as the current object and may be added to another container. Both the current object and selected container are used as implicit arguments and must be set, otherwise an error is generated.
**constrain_object**

ADVANCED: Constraints one object’s attribute to another:

```
constrain_object <from_resource_name> <to_resource_name>
```

The `from_resource_name` parameter specifies the attribute to be constrained and must use default attribute name to reference the attribute. The `to_resource_name` parameter specifies the attribute to constrain to.
6.3 Code Generation Utility

The GLG Code Generation Utility is used to convert a drawing file in one of the GLG file formats into plain C code. The generated code represents a memory image of the drawing, which can be later compiled and linked with the program in order to have all necessary drawings included in the executable. This increases the size of the executable file, but makes it unnecessary to supply additional files with an application.

NOTE: loading drawings from memory images doesn’t support drawing compression. Save drawings with the drawing compression option disabled to use them as images.

The generated C code takes the form of an array, which is used by the GlgLoadObjectFromImage function. For more information about this function, see the GlgLoadObjectFromImage section of the the GLG Intermediate and Extended API chapter.

The Code Generation Utility is called gcodegen and requires three command line arguments:

```
gcodegen  in_file  out_file  variable
```

The arguments are defined as follows:

**in_file**
- Specifies the name of the drawing file. This file may exist in any of the three GLG file formats (ASCII, binary, or extended).

**out_file**
- Specifies the name of the file containing the generated code.

**variable**
- Specifies the name of the program variable to be used for the array with produced data.

For example, the following command:

```
gcodegen bar1.g bar1.c bar1_data
```

produces a file called `bar1.c` containing the image of the `bar1.g` drawing in the following format:

```c
/* Generated by the Generic Logic Toolkit */
unsigned long bar1_data[] =
{ <...data for the memory image are placed here...> };
long bar1_dataSize = sizeof( bar1_data );
```

The address of `bar1_data` array and the value of the `bar1_dataSize` variable are required to load a drawing from an image with the GlgLoadObjectFromImage function.

Code generation does not change the saved format of the drawing, so you must make sure the drawing file is in the correct format before running `gcodegen`. If the drawing was saved in the ASCII or EXTENDED format, the generated memory image is in that format, increasing the size of the produced code and making loading the drawing from the resulting image slower. Since the version of the linked memory image is guaranteed to match the version of the library after it has been linked correctly, it is safe to use the BINARY format, which makes loading drawings faster.
6.4 Drawing File Conversion Utility

The GLG Drawing File Format Conversion Utility is supplied with the Toolkit and can be used to convert a drawing file into a different saved format. It may also be used for setting resource values of GLG drawings in a batch mode using scripting commands.

The utility is a symbolic link to the GLG Builder executable and may be invoked in the following way:

```
gconvert <conversion utility options>
```

On Windows, symbolic links are not supported and the following command must be used:

```
GlgBuilder -convert <conversion utility options>
```

A GLG drawing can be saved in one of three different formats:

- **BINARY** format is the fastest format to use for loading drawing files, but not compatible between hardware platforms with different binary data representations.
- **ASCII** format is slower to load than BINARY and is compatible between different hardware platforms, but is not compatible between different versions of the Toolkit.
- **EXTENDED** format is the slowest format to load, but provides the ability to transfer drawing files between different versions of the Toolkit as well as between different hardware platforms.

In addition to converting the drawing file format, the utility can be used to export or import strings and tags, modify drawings using the supplied script, adjust font sizes, as well as change other drawing settings.

On Unix/Linux, error and information messages are displayed in the terminal. On Windows, the messages are stored in the `glg_error.log` file in the GLG installation directory. The `GLG_LOG_DIR` environment variable may be set locally to define a different directory for the generated `glg_error.log` file.

The utility is invoked in the following way:

```
On Unix/Linux:  gconvert <options> file [file...]
```

```
On Windows:  GlgBuilder -convert <options> file [file...]
```

The `file` argument specifies the name of the drawing file to be converted. By default, converted files are saved under their original names, overwriting the original files. The available options are as follows:

- `-a`
  - Converts file into the ASCII format. This is the default if none of the conversion options (`-a`, `-b`, or `-e`) are specified.

- `-b`
  - Converts file into the BINARY format.
-e

Convert file into the EXTENDED format, is available with the Enterprise Edition of the Graphics Builder.

-c

Compresses the converted drawing. This is the default if none of the compression options (-c or -u) are specified.

-u

Saves the converted drawing uncompressed.

-r

If this option is specified, and the file argument is a directory, gconvert converts all the files in that directory, recursively descending into all subdirectories.

-p pattern

A regular expression pattern that can be used with the -r option for processing multiple files in the directory and all its subdirectories: only files with pathnames matching the pattern will be processed. The pattern can contain ? and * wildcard characters for matching a single or multiple characters in a filename. On Unix/Linux, the special characters must be either escaped using the backslash character (\), or the pattern string should be surrounded with quotes.

Pattern matching is performed on a complete filename path, not just on the filename. For example, while the *.g pattern will match files with the .g extension in any directory, the following pattern should be used to match files in any subdirectory with filenames starting with button and ending with the .g extension:

```
"*/button*.g"           (Unix/Linux)
"\button*.g"            (Windows)
```

However, using the button*.g pattern instead of the above examples would not select any files, since it would not match a complete filename path that starts with the directory path.

The following pattern could be used to process button files in all subdirectories whose name starts with controls (i.e. controls1, controls2, controls_misc, etc.):

```
"*/controls*/button\*.g"  (Unix/Linux)
"\controls*\button*.g"   (Windows)
```

-verbose-pattern-match

-vpm

Generates diagnostic information about files skipped due to a pattern mismatch.

-quiet

Suppresses information messages about processed files.

-o out_file

Defines the name of the output file. When this option is omitted, the converted file replaces the original file. This option is ignored if more than one input file is specified or if the -r option is used.
-export-strings strings_file
  Instead of converting the drawing file to a new format, save all text strings defined in the
drawing into the specified strings file.

-import-strings strings_file
  In addition to converting the drawing file, replace its strings with the corresponding strings
from the specified string translation file.

-export-tags tags_file
  Instead of converting the drawing file to a new format, save all tags defined in the drawing into
the specified tags file.

-import-tags tags_file
  In addition to converting the drawing file, replace tags defined in the drawing with the
  corresponding tags from the specified tags file.

-multiple-export-import
  -mei
  When this option is specified, the supplied string_file and tag_file parameters of the strings
and tags export/import options are interpreted as suffixes to be added to the input filename to
form the filename of the corresponding strings or tags file for each of the processed files. In
the absence of this option, the strings_file and tags_file parameters are treated literally, and the
same strings or tags file is used for all input files.

-convert-viewports
  Converts all viewports in the drawing to light viewports, except for viewports with native
widgets and dialogs (viewport with non-default settings of WidgetType or ShellType attribute).

-convert-native-viewports
  Forces conversion of viewports with native widgets.

-skip-widget-viewport
  Skips viewport conversion for viewports named $Widget.

-convert-light-viewports
  Converts all light viewports in the drawing to viewports.

-command "scripting_command"
  Defines the set_value or set_tag command in the GLG Script Format to be executed on each
converted drawing, and is used to change a resource value of the converted drawing. Refer to
the GLG Script chapter on page 380 for more information.

-script script_file
  Defines the name of a script file in the GLG Script Format containing script commands to be
executed on each converted drawing. It is used to change resource values of the converted
drawing, as well as add or delete objects and properties from the converted file using advanced
script commands. Refer to the GLG Script chapter on page 380 for more information.

-print-commands
  -pc
  Used with the -script option to print script commands as they are executed to assist debugging
of the script errors.

**-new**

Used with the `-script` option in cases when the file doesn’t exist and the drawing will be created by the script. The new drawing will be saved into a file specified by the `-o` option.

**-setup**

Used with the `-script` option to set up the hierarchy of the loaded drawing before executing the script. This may be required to process the `add_public_property` and `add_export_tag` script commands.

**-skip-missing-targets**

**-smt**

Used with the `-script` option to skip missing targets of the commands that add or delete properties or tags. In the absence of the option, error messages are generated for missing targets of these commands.

**-skip-duplicate-properties**

**-sdp**

Used with the `-script` option to skip duplicate properties or tags in the commands that add properties or tags. In the absence of the option, error messages are generated when trying to add duplicate properties or tags.

**-skip-missing-properties**

**-smp**

Used with the `-script` option to skip missing properties or tags in the commands that delete properties or tags. In the absence of the option, error messages are generated when trying to delete non-existent properties or tags.

**-verbose-skip**

**-vs**

Used with the `-script` option to provide diagnostic output about skipped commands without generating an error.

**-font-size-change int_value**

Used to adjust the size of all text objects in the drawing by a specified integer value.

**-set-utf8**

Sets the `UTF8Encoding` flag of all S data objects in the drawing without re-encoding their strings.

**-reset-utf8**

Resets the `UTF8Encoding` flag of all S data objects in the drawing without re-encoding their strings.

**-convert-to-utf8**

Re-encodes strings of all S data objects in the drawing with an unset `UTF8Encoding` flag from the current locale’s encoding to UTF8 and sets the flag.

**-convert-from-utf8**

Re-encodes strings of all S data objects in the drawing with an unset `UTF8Encoding` flag from
UTF8 to the current locale and resets the flag.

-convert-all-from-utf8

Re-encodes strings of all S data objects in the drawing (regardless of the setting of the UTF8Encoding flag) from UTF8 to the current locale and resets the flag.

-reset-utf8-locale-flag

Sets LocaleType=Inherit for all viewports in the drawing that have their screen’s LocaleType=UTF8.

-set-locale-flag int_value

Sets the LocaleType flag of all viewports in the drawing to the specified value. The value must be one of the values of the GlgLocaleType enum defined in the GlgApi.h file.

For example,

```
gconvert *.g
```

converts all the GLG drawing files in the current directory (indicated with the “.g” suffix) into the ASCII format. The following command:

```
gconvert -b -r directory1
```

converts all the GLG files in the directory named “directory1” into the BINARY save format. All the GLG drawing files in any subdirectory will also be converted. The following command:

```
gconvert -o file2.g file1.g
```

converts the GLG drawing file named file1.g into the ASCII format and saves the new file under name file2.g.

The following command:

```
gconvert -command "set_value \$Widget/FillColor g 0. 0. 1." drawing.g
```

is an example of using the utility for setting resources of a drawing.
### 6.5 C/C++ Graph Layout Component

#### Overview

The GLG Graph Layout Library is a collection of functions implementing the spring embedder graph layout algorithm used for automatic layout of graphs containing nodes connected with edges. The spring embedder algorithm performs a number of iterations optimizing the graph layout and minimizing the number of node intersections. The GLG Graph Layout Demo is an example of an application that creates and automatically lays out a graph containing the connected nodes of a network. The demo’s source code may be used as an example of using the Graph Layout module.

As seen in the demo, GLG Graph Layout may be used together with the GLG graphical engine, using GLG to display the graph and its nodes. In this case, the GLG Graphics Builder may be used to define a palette of graphical objects containing icons for the graph’s nodes.

The Graph Layout may also be used to lay out non-GLG objects, for example, widgets or controls representing an application’s objects. In this case, the application uses the Graph Layout’s relative node position output (in the range of 0 to 1) to position an application’s objects on the page.

The Graph Layout Component is provided with the GLG Extended API. Java and C#/.NET versions of the Graph Layout are also provided with the corresponding version of the GLG Class Library. This chapter describes the C/C++ version of the Graph Layout Component. The Java and C#/.NET versions of the GraphLayout class are described in the *Using the Java and C# Versions of the Toolkit* chapter.

#### Data Access Macros

The following macros are defined in the GlgGraphLayout.h file and can be used to access or change data stored in the `GlgGraphLayout`, `GlgGraphNode` and `GlgGraphEdge` structures.

**GlgGraphNode Macros**

*GlgNodeType( node )*

Returns the node type (0-based index used to associate the node with the node icon from the palette).

*GlgNodeData( node )*

Returns the data pointer associated with the node.

*GlgNodeDisplayPosition( node )*

Returns a pointer to the `GlgPoint` structure containing the node’s display position in GLG coordinates (in the range from -1000 to 1000).
**GlgNodePosition( node )**

Returns a pointer to the GlgPoint structure containing the node’s position in normalized coordinates (in the range from 0 to 1).

**GlgNodeGraphics( node )**

Returns the GlgObject actually used to display the node.

**GlgNodeTemplate( node )**

Returns a custom GlgObject used to display the node. If the template is NULL, an icon from the palette is used.

**GlgNodeLinkArray( node )**

Returns a group (GlgObject) containing the list of links (of the GlgGraphEdge type) attached to this node.

**GlgNodeAnchor( node )**

Returns the node’s anchor flag. Setting this flag to True anchors the node: the node remains stationary, while the rest of the nodes move around it.

**GlgGraphEdge Macros**

**GlgEdgeType( edge )**

Returns the edge type (0-based index used to associate the node with the edge icon from the palette). It is 0 in the current implementation.

**GlgEdgeData( edge )**

Returns the data pointer associated with the edge.

**GlgEdgeGraphics( edge )**

Returns the GlgObject actually used to display the edge.

**GlgEdgeTemplate( edge )**

Returns a custom GlgObject used to display the edge. If the template is NULL, an icon from the palette is used.

**GlgEdgeStartNode( edge )**

Returns the GlgGraphNode the start of the edge is connected to.

**GlgEdgeEndNode( edge )**

Returns the GlgGraphNode the end of the edge is connected to.
**GlgGraphLayout Macros**

*GlgGraphDefNodeIcons()*

Returns a group of node icons to use if no palette is defined (global).

*GlgGraphDefEdgeIcon()*

Returns an edge icon to use if no palette is defined (global).

*GlgGraphDefViewportIcon()*

Returns the default viewport to use to render the graph (global).

*GlgGraphPalette( graph_layout )*

Returns the *GlgObject* used as the graph’s palette.

*GlgGraphDimensions( graph_layout )*

Returns a pointer to the *GlgCube* structure that defines the extent of the graph’s drawing, [-800;800] by default.

*GlgGraphNodeArray( graph_layout )*

Returns a group (*GlgObject*) containing all graph nodes (*GlgGraphNode*).

*GlgGraphEdgeArray( graph_layout )*

Returns a group (*GlgObject*) containing all graph edges (*GlgGraphEdge*).

*GlgGraphEndTemperature( graph_layout )*

The final “temperature” of the graph (in the range from 0 to 1) defining the end of the layout process, 0.2 by default. A higher value will result in the process finishing faster but with less precision. A lower value will cause the layout process to last longer, trying to produce a finer layout.

*GlgGraphFinished( graph_layout )*

Returns True when the graph layout finishes positioning the nodes.

*GlgGraphIteration( graph_layout )*

Returns the current iteration number.

*GlgGraphUpdateRate( graph_layout )*

Returns the update rate: the graph is redrawn after each *update_rate* iterations.

**Function Descriptions**

To use any of the functions described in this chapter, the application program must include the function definitions from the GLG Graph Layout header file. Use the following line to include these definitions:
The following section describes the interfaces of the GLG Graph Layout Library:

**GlgGraphCreate**

Creates a new GlgGraphLayout:

```c
GlgGraphLayout GlgGraphCreate()
```

**GlgGraphDestroy**

Destroys all internal structures used by the instance of the graph:

```c
void GlgGraphDestroy( GlgGraphLayout graph )
```

*Parameters*

- **graph**
  Specifies the graph to destroy.

**GlgGraphTerminate**

Destroys all internal structures used by the Graph Layout module:

```c
void GlgGraphTerminate()
```

**GlgGraphSetPalette**

Sets the graph’s icon palette:

```c
void GlgGraphSetPalette( GlgGraphLayout graph, GlgObject palette_drawing )
```

*Parameters*

- **graph**
  Specifies the graph.

- **palette_drawing**
  Specifies the palette to use for the graph.

The palette drawing must contain node icons named Node0, Node1, Node2, etc. Each node must contain a G-type resource named Position, which is used by the graph layout to position the node. The palette must also contain an edge icon (a polygon named Edge), which is used to define the edges’ attributes.
**GlgGraphSetDefaultPalette**

Sets the default palette to be used by all graphs:

```c
void GlgGraphSetDefPalette( GlgObject palette_drawing )
```

**Parameters**

- **palette_drawing**
  
  Specifies the palette to use as a default palette.

**GlgGraphUnloadDefaultPalette**

Resets the default palette to NULL and destroys any stored objects:

```c
void GlgGraphUnloadDefPalette()
```

**GlgGraphCreateGraphics**

Loads icons from the palette and creates a GLG drawing to render the graph:

```c
void GlgGraphCreateGraphics( GlgGraphLayout graph,
                              GlgObject viewport )
```

**Parameters**

- **graph**
  
  Specifies the graph.

- **viewport**
  
  An optional viewport. If it is not NULL, it is used as a container for the graph’s drawing, rendering the graph in the existing object hierarchy. If it is NULL, the graph will create a new viewport to render the graph.

**GlgGraphDestroyGraphics**

Destroys the graph’s drawing and all graphical objects used to render nodes and edges:

```c
void GlgGraphDestroyGraphics( GlgGraphLayout graph )
```

**Parameters:**

- **graph**
  
  Specifies the graph.
**GlgGraphGetViewport**

Returns the viewport of the graph’s drawing:

```c
GlgObject GlgGraphGetViewport( GlgGraphLayout graph )
```

**Parameters:**

`graph`

Specifies the graph.

**GlgGraphSpringIterate**

Performs one iteration of the sprint embedder layout:

```c
GlgBoolean GlgGraphSpringIterate( GlgGraphLayout graph )
```

**Parameters:**

`graph`

Specifies the graph to layout.

This function returns True if the layout process has finished.

**GlgGraphUpdate**

Updates the display to show the results of the spring layout:

```c
void GlgGraphUpdate( GlgGraphLayout graph )
```

**Parameters:**

`graph`

Specifies the graph to update.

There is no need to update the display after every iteration: it may be updated every N iterations, or just once when the layout is finished.

**GlgGraphAddNode**

Creates a new node and adds it to the graph:

```c
GlgGraphNode GlgGraphAddNode( GlgGraphLayout graph, 
                              GlgObject graphics, 
                              long node_type, 
                              void * data )
```

**Parameters:**

`graph`

Specifies the graph.
graphics

An optional custom node icon to override the icon from the palette.

node_type

The palette index which specifies what icon to use from the node palette if no custom graphics is specified.

data

The custom data to attach to the node.

GlgGraphAddEdge

Creates a new edge and adds it to the graph:

```c
GlgGraphEdge GlgGraphAddEdge( GlgGraphLayout graph,
                                   GlgGraphNode start_node,
                                   GlgGraphNode end_node,
                                   GlgObject graphics,
                                   long edge_type,
                                   void * data )
```

Parameters:

- **graph**
  Specifies the graph.

- **graphics**
  An optional custom edge icon to override the icon from the palette.

- **edge_type**
  The palette index which specifies what icon to use from the edge palette if no custom graphics is specified (reserved for future use).

- **data**
  The custom data to attach to the edge.

GlgGraphDeleteNode

Deletes a node from the graph:

```c
void GlgGraphDeleteNode( GlgGraphLayout graph,
                          GlgGraphNode node )
```

Parameters:

- **graph**
  Specifies the graph.

- **node**
  The node to delete.
GlgGraphDeleteEdge

Deletes an edge from the graph:

```c
void GlgGraphDeleteEdge( GlgGraphLayout graph,
                        GlgGraphEdge edge );
```

**Parameters:**

- **graph**
  Specifies the graph.

- **edge**
  The edge to delete.

GlgGraphGetNodePosition

Returns the node position in GLG coordinates (in the range from -1000 to 1000):

```c
void GlgGraphGetNodePosition( GlgGraphLayout graph,
                               GlgGraphNode node,
                               double * x, double * y,
                               double * z );
```

**Parameters:**

- **graph**
  Specifies the graph.

- **node**
  The node object

- **x, y, z**
  The returned coordinate values.

GlgGraphSetNodePosition

Sets the node position in GLG coordinates (in the range from -1000 to 1000):

```c
void GlgGraphSetNodePosition( GlgGraphLayout graph,
                               GlgGraphNode node,
                               double x, double y,
                               double z );
```

**Parameters:**

- **graph**
  Specifies the graph.

- **node**
  The node object.
\[ x, y, z \]
The new coordinate values.

**GlgGraphFindNode**

Finds the node object by its graphics:

\[
\text{GlgGraphNode} \text{ GlgGraphFindNode( GlgGraphLayout \text{ graph}, } \\
\text{ GlgObject \text{ node_graphics} )}
\]

**Parameters:**

- **graph**
  
  Specifies the graph.

- **node_graphics**
  
  The graphical object used to render the node in the drawing.

This function is used to handle mouse selection and returns the node object.

**GlgGraphFindEdge**

Finds the edge object by its graphics:

\[
\text{GlgGraphNode} \text{ GlgGraphFindEdge( GlgGraphLayout \text{ graph}, } \\
\text{ GlgObject \text{ edge_graphics} )}
\]

**Parameters:**

- **graph**
  
  Specifies the graph.

- **edge_graphics**
  
  The graphical object used to render the edge in the drawing.

This function is used to handle mouse selection and returns the edge object.

**GlgGraphNodesConnected**

A connectivity test which returns True if there is an edge connecting the two specified nodes:

\[
\text{GlgBoolean} \text{ GlgGraphNodesConnected( GlgGraphNode \text{ node1}, } \\
\text{ GlgGraphNode \text{ node2} )}
\]

**Parameters:**

- **graph**
  
  Specifies the graph.

- **node1**, **node2**
  
  The node objects.
**GlgGraphIncreaseTemperature**

Forces the graph to continue the layout after it is finished by increasing the temperature of the graph by a small increment:

```c
void GlgGraphIncreaseTemperature( GlgGraphLayout graph,
                                  GlgBoolean init )
```

*Parameters:*

- **graph**
  - Specifies the graph.
- **init**
  - Specifies whether a large increment should be used to re-layout the graph if True.

**GlgGraphGetUntangle**

Returns True if the untangling algorithm is enabled:

```c
GlgBoolean GlgGraphGetUntangle( GlgGraphLayout graph )
```

*Parameters:*

- **graph**
  - Specifies the graph.

The untangling algorithm helps the graph layout to avoid local minima in the form of intersecting edges. Using it roughly doubles the time it takes to finish the layout.

**GlgGraphSetUntangle**

Enables or disables the untangling algorithm:

```c
void GlgGraphSetUntangle( GlgGraphLayout graph,
                          GlgBoolean untangle )
```

*Parameters:*

- **graph**
  - Specifies the graph.
- **untangle**
  - Specifies whether untangling should be used.
**GlgGraphError**

Prints an error message:

```c
void GlgGraphError( char * string )
```

*Parameters:*

- **string**
  The error message to print.

**GlgGraphScramble**

Randomly scrambles the graph’s nodes:

```c
void GlgGraphScramble( GlgGraphLayout graph )
```

*Parameters:*

- **graph**
  Specifies the graph to scramble.
  
  This method is used mostly by demo programs.

**GlgGraphCreateRandom**

The demo constructor which creates and returns a graph layout, populating it with nodes and edges:

```c
GlgGraphLayout GlgGraphCreateRandom( long num_nodes,
                                      long num_node_types,
                                      GraphType type );
```

*Parameters:*

- **num_nodes**
  The number of graph nodes to create.

- **num_node_types**
  The number of node types to use for rendering.

- **type**
  A graph type constant: RANDOM_GRAPH, CIRCULAR_GRAPH or STAR_GRAPH.
Appendices

7.1 Appendix A: Global Configuration Resources

There are a small number of drawing features that can’t be said to belong to any particular object in a GLG drawing. When a drawing is displayed in the GLG Graphics Builder, those drawing features, such as the file save format, are managed by the Builder. When a drawing is displayed in an application program, that program must assume the responsibility of managing those features. Rather than include more functions in the GLG API, the Toolkit provides configuration resources to control these features. These resources can be queried and modified with the same resource access functions you use to control any other feature of a drawing.

The path name of a configuration resource starts with $config followed by the configuration resource name. For example, $config/GlgSaveFormat is the name of the configuration parameter that controls the default save format. When configuration parameters are accessed in C, the object parameter of functions that query or set resource values may be NULL. In the object-oriented environment, any GLG object can be used to access global parameters.

The glg_config configuration file may be used to set global configuration resources for the GLG Graphics Builder, and the glg_hmi_config file may be used for HMI Configurator. At run time, the GLG API may be used to query or set these global resources in a program.

The configuration resources, their types and possible values, are listed in the following table. The table also lists environment variables which can be used as an alternative way of setting some global configuration resources for quick testing, or for the cases when the application code can not be accessed. The environment variables settings do not apply to the Java, C#/.NET and JavaScript versions of the Toolkit.

<table>
<thead>
<tr>
<th>Name</th>
<th>Type</th>
<th>Default</th>
<th>Description (possible values)</th>
</tr>
</thead>
<tbody>
<tr>
<td>GlgGridPolygon</td>
<td>polygon object</td>
<td>solid black line, one pixel wide</td>
<td>Defines grid attributes such as a line width and a color (the grid spacing is controlled by an attribute of the viewport screen object). The polygon is not accessed directly, but its attributes are, for example: $config/GlgGridPolygon/LineWidth</td>
</tr>
<tr>
<td>GlgArrowShape</td>
<td>polygon object</td>
<td>default arrow shape as seen in the Graphics Builder</td>
<td>3-point polygon defining the pixel dimensions and the shape of the arrowheads drawn by the rendering object. To change the arrowheads, change the coordinates of the polygon’s points.</td>
</tr>
<tr>
<td>GlgHighlightPolygon</td>
<td>polygon object</td>
<td>thin red line as seen in the Graphics Builder</td>
<td>Defines the line attributes of the outline used to highlight traced objects.</td>
</tr>
<tr>
<td>Name</td>
<td>Type</td>
<td>Default</td>
<td>Description (possible values)</td>
</tr>
<tr>
<td>------------------</td>
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<td>---------------------------------------------------------------------------------------------------------------------------------------------------------------</td>
</tr>
<tr>
<td>GlgTooltipErase-Distance</td>
<td>Double</td>
<td>5</td>
<td>Specifies the maximum distance in pixels the mouse can move without erasing the currently displayed tooltip. It is used to avoid erasing the tooltip on accidental small mouse movements. If a mouse moves over another object, the tooltip for the new object will be activated only when the current tooltip is erased due to the mouse move exceeding the tooltip erase distance. For environments other than Java, C# or JavaScript, the GLG_TOOLTIP_ERASE_DISTANCE environment variable may also be used to specify the erase distance.</td>
</tr>
<tr>
<td>GlgTooltipLabelColor</td>
<td>G - holds 3 RGB color values</td>
<td></td>
<td>Specifies the tooltip label color. If unset, uses the default color inherited from the environment.</td>
</tr>
<tr>
<td>GlgTooltipBGColor</td>
<td>G - holds 3 RGB color values</td>
<td>(1;1;1) in X Windows, (1;1;0.9) in JavaScript, unset (-1;-1;-1) on Windows and in Java/C#</td>
<td>Specifies the background color of the tooltip. If unset, uses the default color inherited from the environment.</td>
</tr>
<tr>
<td>GlgTooltipText-Alignment</td>
<td>String</td>
<td>“left”</td>
<td>Specifies the row alignment of a multi-line tooltip: “left”, “right” or “center”. For environments other than Java, C# or JavaScript, the GLG_TOOLTIP_TEXT_ALIGNMENT environment variable can also be used and set to one of the following strings: LEFT, RIGHT or CENTER.</td>
</tr>
</tbody>
</table>
| GlgNativeTooltip (Java and C# only) | Double       | GLG_TOOLTIP | Controls the type of the tooltips in the Java and C#/.NET environments; may be set to the following values:  
• GLG_TOOLTIP - uses GLG tooltips. In Java, this setting should be used to properly handle dynamically changing tooltips for buttons with the GlgButton and GlgNButton interaction handlers.  
• BOX_TOOLTIP - enables native tooltips of the box style. In Java, native tooltips are used only for buttons with the GlgButton and GlgNButton interaction handlers, and GLG tooltips are still used for object tooltips.  
• BALLOON_TOOLTIP (C# only) - enables C# balloon tooltips. |
<table>
<thead>
<tr>
<th>Name</th>
<th>Type</th>
<th>Default</th>
<th>Description (possible values)</th>
</tr>
</thead>
<tbody>
<tr>
<td>GlgButtonTooltip-Timeout</td>
<td>Double</td>
<td>0.5</td>
<td>The button tooltip timeout in seconds. For environments other than Java, C# or JavaScript, the GLG_BUTTON_TOOLTIP_TIMEOUT environment variable may also be used to specify the timeout.</td>
</tr>
<tr>
<td>GlgMouseTooltip-Timeout</td>
<td>Double</td>
<td>0.5</td>
<td>The “object mouse over” tooltip timeout in seconds. For environments other than Java, C# or JavaScript, the GLG_MOUSE_TOOLTIP_TIMEOUT environment variable may also be used to specify the timeout.</td>
</tr>
<tr>
<td>GlgTouchTooltip-Timeout</td>
<td>Double</td>
<td>1.0</td>
<td>The “touch and hold” tooltip timeout in seconds for JavaScript deployed on mobile devices with a touch screen.</td>
</tr>
<tr>
<td>GlgDoubleClick-Timeout</td>
<td>Double</td>
<td>0.5</td>
<td>The maximum time interval in seconds between two consecutive mouse clicks interpreted as a double-click. Two mouse clicks separated by a time interval greater than this interval will be reported as single clicks. For environments other than Java, C# or JavaScript, the GLG_DOUBLE_CLICK_TIMEOUT environment variable may also be used to specify the timeout.</td>
</tr>
<tr>
<td>GlgDoubleClickDelta</td>
<td>Double</td>
<td>5</td>
<td>The maximum distance in pixels between two consecutive mouse clicks interpreted as a double-click. Two mouse clicks separated by a distance greater than this value will be reported as single clicks. For environments other than Java, C# or JavaScript, the GLG_DOUBLE_CLICK_DELTA environment variable may also be used to specify the timeout.</td>
</tr>
<tr>
<td>GlgURLTimeout (Java and C# only)</td>
<td>Double</td>
<td>-1</td>
<td>Defines the URL load timeout in seconds. If it is set to a value greater than zero, loading operations that use a URL as a source will timeout and generate an error after the timeout interval specified by this resource. It may be used in mission-critical applications to abort loading remote resources from URLs if it takes too long for the remote server to respond.</td>
</tr>
<tr>
<td>GlgZoomToButton</td>
<td>Double</td>
<td>1</td>
<td>The mouse button used by the ZoomTo operation.</td>
</tr>
<tr>
<td>GlgPanDragButton</td>
<td>Double</td>
<td>1</td>
<td>The mouse button used for panning and scrolling by dragging the drawing with the mouse.</td>
</tr>
<tr>
<td>GlgPickResolution</td>
<td>Double</td>
<td>5</td>
<td>Defines pick resolution for user input. When the mouse is within this many pixels of a point, it is considered to be on that point.</td>
</tr>
<tr>
<td>GlgGISPickResolution</td>
<td>Double</td>
<td>2</td>
<td>Defines pick resolution in pixels for the GIS selection. All objects within this distance from the selection point will be reported in the GIS selection.</td>
</tr>
<tr>
<td>Name</td>
<td>Type</td>
<td>Default</td>
<td>Description (possible values)</td>
</tr>
<tr>
<td>--------------</td>
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</tr>
<tr>
<td>GlgSaveFormat</td>
<td>String</td>
<td>&quot;ascii&quot;</td>
<td>Defines a default save format (&quot;binary&quot;, &quot;ascii&quot; or &quot;extended&quot;).</td>
</tr>
<tr>
<td>GlgLocaleType (C/C++ only)</td>
<td>String</td>
<td>null</td>
<td>Specifies the default locale type which will be used by all viewports with the LocaleType attribute set to Default, and all top-level viewports with LocaleType=Inherit. It may be set to the following values defined in the GlgApi.h file: GLG_DEFAULT_LOCALE = 0 GLG_UTF8_LOCALE = 2 GLG_XFT_CHAR8_LOCALE = 3 (Linux/Unix only) The GLG_LOCALE_TYPE environment variable can also be used and set to one of the following strings: DEFAULT, UTF8 or XFT_LATIN1. Alternatively, the -glg-utf8, -glg-default-locale and -glg-xft-latin1 command-line options can be used.</td>
</tr>
<tr>
<td>GlgDefaultCharset (Java only)</td>
<td>String</td>
<td>null</td>
<td>Specifies the name of a Java charset that will be used as the default charset. If it is set to null, the platform’s default charset will be used. The default charset controls string decoding in the loaded GLG drawings if the load method does not explicitly specify a charset name.</td>
</tr>
<tr>
<td>GlgDefaultEncoding (C# and JavaScript only)</td>
<td>Encoding</td>
<td>null</td>
<td>Specifies the name of a C# or JavaScript encoding that will be used as the default encoding. If it is set to null, the platform’s default encoding will be used. The default encoding controls string decoding in the loaded GLG drawings if the load method does not explicitly specify an encoding. For the JavaScript, the following encodings are supported: ASCII, UTF8 and LATIN1 (ISO-8859-1).</td>
</tr>
<tr>
<td>GlgCompressFormat</td>
<td>String</td>
<td>&quot;uncompressed&quot;</td>
<td>Enables saved drawing compression (&quot;compressed&quot; or &quot;uncompressed&quot;).</td>
</tr>
<tr>
<td>GlgPSLevel</td>
<td>Double</td>
<td>2</td>
<td>The level of the PostScript output (1 or 2).</td>
</tr>
<tr>
<td>GlgSearchPath (C/C++ and ActiveX only)</td>
<td>String</td>
<td>GLG_PATH env. var. or NULL</td>
<td>The search path used to resolve not found relative file names. May be changed from a program. The GLG_PATH environment variable can also be used to define a search path. The search path can contain multiple directory entries separated by a colon on Linux/Unix or by a semicolon on Windows.</td>
</tr>
<tr>
<td>GlgCustomDataLib (C/C++ and ActiveX only)</td>
<td>String</td>
<td>NULL</td>
<td>The filename of a custom data browser DLL. The GLG_CUSTOM_DATA_LIB environment variable can also be used to define the DLL filename.</td>
</tr>
<tr>
<td>Name</td>
<td>Type</td>
<td>Default</td>
<td>Description (possible values)</td>
</tr>
<tr>
<td>-----------------------------</td>
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<td>-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------</td>
</tr>
</tbody>
</table>
| **GlgLogLevel** (all environments except Java and JavaScript) | Double  | 5       | Controls logging of errors and warnings, may be set to the following values defined in the `GlgApi.h` file: GLG_DISABLE_LOGGING = 0  
GLG_LOG_INTERNAL_ERRORS = 1  
GLG_LOG_USER_ERRORS = 2  
GLG_LOG_WARNINGS = 3  
GLG_LOG_INFO_MESSAGES = 4  
GLG_LOG_ALL = 5  
For C/C++ and ActiveX environments, the GLG_LOG_LEVEL environment variable can also be used and set to a desired numerical value.                                                                                                                                                                        |
| **GlgSelectAllOnFocus**     | Double  | 0       | May be used to override highlighting behavior of text boxes. If set to 0 (default), the text will be highlighted on gaining focus for all text boxes in the GLG editors, and also for the text boxes in the drawing that have their SelectAllOnFocus resource set. If set to 1, the text will always be highlighted on focus in all text boxes regardless of the setting of their SelectAllOnFocus resources. If set to -1, the text will not be highlighted. |
| **GlgTabNavigation** (all environments except Java and JavaScript) | Double  | 1       | Controls tab navigation traversal order, may be set to the following values defined in the `GlgApi.h` file: GLG_TAB_NONE = 0  
GLG_TAB_TEXT_BOXES = 1  
GLG_TAB_BUTTONS = 2  
GLG_TAB_TEXT_AND_BUTTONS = 3  
For C/C++ and ActiveX environments, the GLG_TAB_NAVIGATION environment variable can also be used and set to a desired numerical value.                                                                                                                                                                        |
<p>| <strong>GlgJavaScriptFile</strong> (all environments except JavaScript) | String  | NULL    | Specifies a global JavaScript file that contains definitions of global functions. For environments other than Java, C# or JavaScript, the GLG_JAVA_SCRIPT_FILE environment variable or the -glg-java-script-file command-line option may also be used to specify the file. In the JavaScript environment, a global JavaScript file can be included in HTML as a script file. |
| <strong>GlgJavaScriptArgCheck</strong> (C/C++ and ActiveX only) | Double  | 1       | The setting of 1 activates a slower strict mode that performs additional check of the script expression’s arguments. When set to 0, a relaxed mode is used for faster execution.                                                                                                                                                      |
| <strong>GlgAsyncImageLoading</strong> (Java and C# only) | Double  | 0       | Controls the global image and GIS map loading mode for the entire application. May be set to 0 for the synchronous loading mode, or to 1 for asynchronous loading. The AsyncMode attribute may be used to override the global setting for the image and GIS objects. |</p>
<table>
<thead>
<tr>
<th>Name</th>
<th>Type</th>
<th>Default</th>
<th>Description (possible values)</th>
</tr>
</thead>
<tbody>
<tr>
<td>GlgChangeCursorOn-</td>
<td>Double</td>
<td>1</td>
<td>If set to 1, slider and knob widgets will change cursor when they are moved or dragged with the mouse. Setting the resource to 0 disables cursor change. Alternatively (for environments other than Java, C# or JavaScript), the cursor change behavior may be controlled by setting the GLG_CHANGE_CURSOR_ON_GRAB environment variable to either True or False.</td>
</tr>
</tbody>
</table>
| GlgAntiAliasing         | Double   | GLG_ANTI_ALIasing_INT | In C/C++/C# and ActiveX, controls the default antialiasing setting of the OpenGL renderer. In C# and JavaScript, controls the default antialiasing setting of the GDI+ or web browser renderer. The default setting is inherited by all polygons with the INHERIT (default) setting of the AntiAliasing attribute. The following values are supported:  
  • GLG_ANTI_ALIasing_OFF - disables antialiasing.  
  • GLG_ANTI_ALIasing_INT - enables antialiasing and maps vertices to integer pixel boundaries.  
  • GLG_ANTI_ALIasing_DBL - enables antialiasing and uses double vertex coordinates.  
In C#, the above constants are elements of the GlgAntiAliasingType enum. In Java, the resource controls the default antialiasing setting and may be set to 1 to enable antialiasing, or to 0 to disable it. Alternatively (for environments other than Java, C# or JavaScript), the antialiasing may be disabled by setting the GLG_ANTI_ALIasing environment variable to False. |
<p>| GlgDisableMouseButtonCheck | Double   | 0         | If set to 1, disables the test of the mouse button number in the mouse click actions. It may be used to deploy applications on devices with a touch screen, so that actions that use the right mouse button will be activated on touch without checking the mouse button number. One example is deploying a GLG application on mobile phones using the GLG JavaScript API. |
| GlgDisableControlKeyCheck | Double   | 0         | If set to 1, disables the test of the Control key state in the mouse actions with the ProcessArmed condition. It may be used to deploy an application on devices with a touch screen and no physical keyboard, so that actions with the ProcessArmed condition will be activated on touch without checking the state of the Control key. |</p>
<table>
<thead>
<tr>
<th>Name</th>
<th>Type</th>
<th>Default</th>
<th>Description (possible values)</th>
</tr>
</thead>
<tbody>
<tr>
<td>GlgSliderTouchDrag (JavaScript only)</td>
<td>Double</td>
<td>1</td>
<td>May be set to 0 to disable dragging sliders and knobs with a touch and drag on mobile devices with a touch screen, in case when it interferes with scrolling the page via touch and drag.</td>
</tr>
<tr>
<td>GlgWrapNativeLabels (JavaScript only)</td>
<td>Double</td>
<td>1</td>
<td>May be set to 0 to disable wrapping text labels in native buttons and toggles. The wrapping is enabled by default, unless it is disabled by GlgSetNativeAttributes set to 0.</td>
</tr>
<tr>
<td>GlgAdjustNativeLabelColor (JavaScript only)</td>
<td>Double</td>
<td>1</td>
<td>May be set to 0 to disable color adjustment for text labels in native widgets, such as buttons, toggles, lists, combo boxes, etc. If the background color of a native widget is dark, the color of the text label is set to white by default to improve label visibility. The color adjustment is enabled by default, unless it is disabled by GlgSetNativeAttributes set to 0.</td>
</tr>
<tr>
<td>GlgSetNativeAttributes (JavaScript only)</td>
<td>Double</td>
<td>1</td>
<td>May be set to 0 to disable setting HTML attributes of native widgets, such as buttons, toggles, lists, combo boxes, etc. By default, the GLG rendering engine will set the background color and border attributes of the native widgets to match the attributes defined in the drawing, which overrides any settings inherited from the HTML style sheets. Setting the resource value to 0 also disables native label wrapping and label color adjustment. When setting HTML attributes by the GLG rendering engine is disabled, the attributes may be controlled by the HTML style sheets using each widget class type. The browser’s Inspector feature may be used to find classes assigned to the native widgets of each type.</td>
</tr>
<tr>
<td>GlgOpenGLMode (C/C++ and ActiveX only)</td>
<td>Double</td>
<td>1</td>
<td>Controls the use of the OpenGL renderer. If set to 1, the OpenGL renderer is used for the viewports with OpenGLHint=ON if the OpenGL renderer is available. Setting the resource to 0 suppresses the use of the OpenGL renderer. Alternatively, the OpenGL renderer may be enabled or disabled by setting the GLG_OPENGL_MODE environment variable to true or false, as well as using the -glg-enable-opengl and -glg-disable-opengl command-line options.</td>
</tr>
<tr>
<td>Name</td>
<td>Type</td>
<td>Default</td>
<td>Description (possible values)</td>
</tr>
<tr>
<td>------</td>
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<td>------------------------------</td>
</tr>
<tr>
<td>GlgOpenGLVersion (C/C++ and ActiveX only)</td>
<td>Double</td>
<td>100</td>
<td>Requests the OpenGL version to be used. The shader-based core OpenGL profile is used for OpenGL versions higher than 3.00, and the Compatibility profile is used for older OpenGL versions. The Compatibility profile is used by default; an OpenGL version needs to be explicitly specified to use the Core profile. Alternatively, the GLG_OPENGL_VERSION environment variable or the -glg-opengl-version &lt;NNN&gt; command-line option may be used to define the OpenGL version at run time.</td>
</tr>
<tr>
<td>GlgOpenGLHardwareThreshold (C/C++ and ActiveX only)</td>
<td>Double</td>
<td>1</td>
<td>Controls the runtime mapping of the OpenGL priorities specified by a viewport’s OpenGLHint attribute. All viewports with a non-zero value of the attribute, less than or equal to the threshold value, will be rendered using the hardware OpenGL renderer (if available). Viewports with attribute values between the GlgOpenGLHardwareThreshold and GlgOpenGLThreshold will be rendered using the software OpenGL renderer (if available). Alternatively, the GLG_OPENGL_HARDWARE_THRESHOLD environment variable or the -glg-opengl-hardware-threshold &lt;N&gt; command-line option may be used to define the threshold at run time.</td>
</tr>
<tr>
<td>GlgOpenGLThreshold (C/C++ and ActiveX only)</td>
<td>Double</td>
<td>10</td>
<td>Controls the runtime mapping of the OpenGL priorities specified by a viewport’s OpenGLHint attribute. All viewports with attribute values greater than the threshold value will be rendered using the GDI renderer. Alternatively, the GLG_OPENGL_THRESHOLD environment variable or the -glg-opengl-threshold &lt;N&gt; command-line option may be used to define the threshold at run time.</td>
</tr>
<tr>
<td>GlgOpenGLZSort (C/C++ and ActiveX only)</td>
<td>Double</td>
<td>2</td>
<td>Controls the number of passes used to eliminate pixel artifacts when drawing polygons with both fill and edges. If polygons have only fill or only edges, the resource can be set to 1 to use a single pass for increased performance. Setting the resource to 0 disables OpenGL hidden surface removal and resorts to the slower non-OpenGL depth-sorting technique. Alternatively, the GLG_OPENGL_ZSORT environment variable may be used to define the number of passes.</td>
</tr>
<tr>
<td>Name</td>
<td>Type</td>
<td>Default</td>
<td>Description (possible values)</td>
</tr>
<tr>
<td>-------------------------------------------</td>
<td>----------</td>
<td>---------</td>
<td>---------------------------------------------------------------------------------------------------------------------------------------------------------------</td>
</tr>
<tr>
<td>GlgOpenGLDepth-Offset</td>
<td>Double</td>
<td>100</td>
<td>Controls the depth offset used by the second pass of the hidden surface removal to offset edges of polygons. Alternatively, the GLG_OPENGL_DEPTH_OFFSET environment variable may be used to define the offset.</td>
</tr>
<tr>
<td>GlgMapServerUsage</td>
<td>Double</td>
<td>0</td>
<td>Controls the use of Map Server in C/C++ and ActiveX versions of GLG and may have one of the following values defined in the GlgApi.h file:</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>• GLG_LOCAL_MAP_SERVER - uses the Map Server from the GLG library.</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>• GLG_REMOTE_MAP_SERVER - uses the Map Server from a web server defined by the GISMapServerURL attribute of the GIS Object.</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>• GLG_AUTO_MAP_SERVER (default) - if the drawing was loaded from a URL, use a remote Map Server, otherwise use a local Map Server.</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>May also be defined by setting GLG_MAP_SERVER_USAGE environment variable to the “auto”, “local” or “remote” values.</td>
</tr>
<tr>
<td>GlgGISElevationLayer</td>
<td>String</td>
<td>NULL</td>
<td>Specifies the GIS elevation layer to be used for querying elevation in the map displayed in the GLG Builder or HMI Configurator.</td>
</tr>
<tr>
<td>GlgXftFonts</td>
<td>Double</td>
<td>1</td>
<td>Controls the use of the XFT fonts: setting the resource to 0 disables XFT fonts, and setting it to 1 enables XFT fonts.</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Alternatively, setting the GLG_XFT_FONTS environment variable to true or false, or using the -glg-enable-xft-fonts and -glg-disable-xft-fonts command-line options may be used to enable or disable XFT fonts.</td>
</tr>
<tr>
<td>GlgDebugXftFonts</td>
<td>Double</td>
<td>0</td>
<td>If set to 1, enables diagnostic output for troubleshooting XFT fonts. The output is displayed in the terminal, and is also saved in the glg_error.log file.</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Alternatively, the GLG_DEBUG_XFT_FONTS environment variable may be set to true, or the -glg-debug-xft-fonts may be used.</td>
</tr>
<tr>
<td>GlgDebugFonts</td>
<td>Double</td>
<td>0</td>
<td>If set to 1, enables diagnostic output for troubleshooting font sets. Alternatively, the GLG_DEBUG_FONTS environment variable may be set to true, or the -glg-debug-fonts may be used. The output is displayed in the terminal, and is also saved in the glg_error.log file.</td>
</tr>
<tr>
<td>Name</td>
<td>Type</td>
<td>Default</td>
<td>Description (possible values)</td>
</tr>
<tr>
<td>-------------------------------------------</td>
<td>-----------------</td>
<td>---------</td>
<td>-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------</td>
</tr>
<tr>
<td><em>GlgDebugEncoding</em> (C/C++ and ActiveX only)</td>
<td>Double</td>
<td>0</td>
<td>If set to 1, enables diagnostic output for troubleshooting string encoding conversions. Alternatively, the <code>GLG_DEBUG_ENCODING</code> environment variable may be set to <code>true</code>, or the <code>-glg-debug-encoding</code> command-line option may be used. The output is displayed in the terminal on Linux/Unix, and is also saved in the <code>glg_error.log</code> file.</td>
</tr>
<tr>
<td><em>GlgDefaultFontTable-File</em> (except JavaScript)</td>
<td>String</td>
<td>NULL</td>
<td>The name of a drawing file containing a saved <code>FontTable</code> object to be used as a default font table. For C/C++ and ActiveX environments, it may also be defined by setting the <code>GLG_DEFAULT_FONT_TABLE_FILE</code> environment variable. The font table may be saved using the <code>Save Font Table</code> option of the viewport's <code>FontTable</code> object. The drawing can also contain a viewport object with a custom font table attached. In this case, the font table is searched using <code>$Fonttable</code> and then <code>$Widget/Fonttable</code> resource names. If still not found, the fonttable of a <code>$Widget</code> viewport is also considered.</td>
</tr>
<tr>
<td><em>GlgDefaultFontTable</em></td>
<td>GIoObject</td>
<td>NULL</td>
<td>The <code>FontTable</code> object to be used as a default font table. This resource can be used in a program that creates or loads a font table object at run time.</td>
</tr>
<tr>
<td><em>GlgDefaultFontFile</em> (except JavaScript)</td>
<td>String</td>
<td>NULL</td>
<td>Specifies name of an ASCII file that contains a list of font names for the default font table. Each font in the file is listed on a separate line. For C/C++ and ActiveX environments, it may also be defined by setting the <code>GLG_DEFAULT_FONT_FILE_NAME</code> environment variable. The number of font types and sizes for the font table is specified using the <code>GlgDefaultNumFontTypes</code> and <code>GlgDefaultNumFontSizes</code> variables described below.</td>
</tr>
<tr>
<td><em>GlgDefaultFontURL</em> (Java and C# only)</td>
<td>String</td>
<td>NULL</td>
<td>Specifies a URL of an ASCII file that contains a list of font names for the default font table. Each font in the file is listed on a separate line. The number of font types and sizes for the font table is specified using the <code>GlgDefaultNumFontTypes</code> and <code>GlgDefaultNumFontSizes</code> variables described below.</td>
</tr>
<tr>
<td><em>GlgDefaultFontList</em> (JavaScript only)</td>
<td>String</td>
<td>NULL</td>
<td>A string containing a list of font names for the default font table in the format of <code>GlgDefaultFontFile</code>. The number of font types and sizes for the font table is specified using the <code>GlgDefaultNumFontTypes</code> and <code>GlgDefaultNumFontSizes</code> variables described below.</td>
</tr>
<tr>
<td>Name</td>
<td>Type</td>
<td>Default</td>
<td>Description (possible values)</td>
</tr>
<tr>
<td>-------------------------------</td>
<td>---------</td>
<td>---------</td>
<td>---------------------------------------------------------------------------------------------------------------------------------------------------------------</td>
</tr>
<tr>
<td>GlgDefaultXftFontFile</td>
<td>String</td>
<td>NULL</td>
<td>Specifies name of an ASCII file that contains a list of XFT font names for the default font table. Each font in the file is listed on a separate line. For the C/C++ environment, it may also be defined by setting the GLG_DEFAULT_XFT_FONT_FILE_NAME environment variable. The number of font types and sizes for the font table is specified using the GlgDefaultNumFontTypes and GlgDefaultNumFontSizes variables described below.</td>
</tr>
<tr>
<td>GlgDefaultPSFontFile</td>
<td>String</td>
<td>NULL</td>
<td>Specifies name of the file that contains a list of PostScript font names for the default font table. For C/C++ and ActiveX environments, it may also be defined by setting the GLG_DEFAULT_PS_FONT_FILE_NAME environment variable. The number of font types and sizes for the font table is specified using the GlgDefaultNumFontTypes and GlgDefaultNumFontSizes variables described below.</td>
</tr>
<tr>
<td>GlgDefaultPSFontURL</td>
<td>String</td>
<td>NULL</td>
<td>Specifies a URL of the file that contains a list of PostScript font names for the default font table. The number of font types and sizes for the font table is specified using the GlgDefaultNumFontTypes and GlgDefaultNumFontSizes variables described below.</td>
</tr>
<tr>
<td>GlgDefaultNumFontTypes</td>
<td>Double</td>
<td>12</td>
<td>Defines NumTypes attribute of the default font table. For C/C++ and ActiveX environments, it may also be defined by setting the GLG_DEFAULT_NUM_FONT_TYPES environment variable to the desired integer value.</td>
</tr>
<tr>
<td>GlgDefaultNumFontSizes</td>
<td>Double</td>
<td>7</td>
<td>Defines NumSizes attribute of the default font table. For C/C++ and ActiveX environments, it may also be defined by setting the GLG_DEFAULT_NUM_FONT_SIZES environment variable to the desired integer value.</td>
</tr>
<tr>
<td>GlgFontCharset</td>
<td>Double</td>
<td>0</td>
<td>Defines a charset to use for fonts with DEFAULT_CHARSET, providing a simple way to change the charset of all fonts in the default font table. May also be defined by setting GLG_FONT_CHARSET environment variable to the integer value of the desired font charset. If not set, the charset of the current system locale is used.</td>
</tr>
</tbody>
</table>
## GLG Multibyte Flag

(C/C++ and ActiveX only)

Double 0

Defines the value of the multi-byte flag to use for fonts with DEFAULT_CHARSET on Windows or for all fonts on X Windows. It provides a simple way to change the multi-byte flag setting for all fonts in the default font table and may also be defined by setting GLG_MULTIBYTE_FLAG environment variable to the “SINGLE_BYTE”, “MULTI_BYTE” or “UTF8” values. If not set, the setting matching the current system locale (SINGLE_BYTE or MULTI_BYTE) is used.

## GLG Default Color Table Type

Double 1

Defines type of the default color table: RAINBOW (value of 1) or STANDARD (value of 2). For C/C++ and ActiveX environments, it may also be defined by setting the GLG_DEFAULT_COLOR_TABLE_TYPE environment variable to “rainbow” or “standard”.

## GLG Default Color Factor

Double 19

Defines ColorFactor of the default color table. For C/C++ and ActiveX environments, it may also be defined by setting the GLG_DEFAULT_COLOR_FACTOR environment variable to the desired integer value.

## GLG Default Num Color Grades

Double 1

Defines GradeHint of the default color table. For C/C++ and ActiveX environments, it may also be defined by setting the GLG_DEFAULT_NUM_COLOR_GRADES environment variable to the desired integer value.

## GLG Default Dialog Color

(C/C++ on Unix, Java and JavaScript)

G - holds 3 RGB color values

(-1;-1;-1) Specifies default fill color for the dialog area widget type. If it is set to (-1;-1;-1), the FillColor of the dialog widget is used when the widget is displayed. On Windows, the system setting for the dialog color is used.

## GLG Indexed Color Table File

(except JavaScript)

String NULL

A filename of a custom color palette drawing that defines a list of indexed colors. For environments other than Java, C# or JavaScript, it may also be defined via the GLG_INDEXED_COLOR_TABLE_FILE environment variable.

## GLG Indexed Color File

(except JavaScript)

String NULL

A filename of an ASCII file that defines a list of indexed colors. For environments other than Java, C# or JavaScript, it may also be defined via the GLG_INDEXED_COLOR_FILE environment variable.

## GLG Indexed Color Table

(JavaScript only)

GlgObject NULL

An object ID of a loaded custom color palette drawing that defines a list of indexed colors. This is the same drawing that is used for GLGIndexedColorTableFile in other environments.

## GLG Indexed Color List

(JavaScript only)

String NULL

A string containing a list of indexed colors in the format of GLGIndexedColorTableFile.

<table>
<thead>
<tr>
<th>Name</th>
<th>Type</th>
<th>Default</th>
<th>Description (possible values)</th>
</tr>
</thead>
<tbody>
<tr>
<td>GLGMultibyteFlag</td>
<td>Double</td>
<td>0</td>
<td>Defines the value of the multi-byte flag to use for fonts with DEFAULT_CHARSET on Windows or for all fonts on X Windows. It provides a simple way to change the multi-byte flag setting for all fonts in the default font table and may also be defined by setting GLG_MULTIBYTE_FLAG environment variable to the “SINGLE_BYTE”, “MULTI_BYTE” or “UTF8” values. If not set, the setting matching the current system locale (SINGLE_BYTE or MULTI_BYTE) is used.</td>
</tr>
<tr>
<td>GLGDefaultColorTableType</td>
<td>Double</td>
<td>1</td>
<td>Defines type of the default color table: RAINBOW (value of 1) or STANDARD (value of 2). For C/C++ and ActiveX environments, it may also be defined by setting the GLG_DEFAULT_COLOR_TABLE_TYPE environment variable to “rainbow” or “standard”.</td>
</tr>
<tr>
<td>GLGDefaultColorFactor</td>
<td>Double</td>
<td>19</td>
<td>Defines ColorFactor of the default color table. For C/C++ and ActiveX environments, it may also be defined by setting the GLG_DEFAULT_COLOR_FACTOR environment variable to the desired integer value.</td>
</tr>
<tr>
<td>GLGDefaultNumColorGrades</td>
<td>Double</td>
<td>1</td>
<td>Defines GradeHint of the default color table. For C/C++ and ActiveX environments, it may also be defined by setting the GLG_DEFAULT_NUM_COLOR_GRADES environment variable to the desired integer value.</td>
</tr>
<tr>
<td>GLGDefaultDialogColor</td>
<td>G - holds 3 RGB color values</td>
<td>(-1;-1;-1)</td>
<td>Specifies default fill color for the dialog area widget type. If it is set to (-1;-1;-1), the FillColor of the dialog widget is used when the widget is displayed. On Windows, the system setting for the dialog color is used.</td>
</tr>
<tr>
<td>GLGIndexedColorTableFile</td>
<td>String</td>
<td>NULL</td>
<td>A filename of a custom color palette drawing that defines a list of indexed colors. For environments other than Java, C# or JavaScript, it may also be defined via the GLG_INDEXED_COLOR_TABLE_FILE environment variable.</td>
</tr>
<tr>
<td>GLGIndexedColorFile</td>
<td>String</td>
<td>NULL</td>
<td>A filename of an ASCII file that defines a list of indexed colors. For environments other than Java, C# or JavaScript, it may also be defined via the GLG_INDEXED_COLOR_FILE environment variable.</td>
</tr>
<tr>
<td>GLGIndexedColorTable</td>
<td>GlgObject</td>
<td>NULL</td>
<td>An object ID of a loaded custom color palette drawing that defines a list of indexed colors. This is the same drawing that is used for GLGIndexedColorTableFile in other environments.</td>
</tr>
<tr>
<td>GLGIndexedColorList</td>
<td>String</td>
<td>NULL</td>
<td>A string containing a list of indexed colors in the format of GLGIndexedColorTableFile.</td>
</tr>
<tr>
<td>Name</td>
<td>Type</td>
<td>Default</td>
<td>Description (possible values)</td>
</tr>
<tr>
<td>-------------------------------</td>
<td>------</td>
<td>---------</td>
<td>---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------</td>
</tr>
<tr>
<td>GlgDisableIndexed-Colors</td>
<td>Double</td>
<td>0</td>
<td>If set to 1, disables the use of indexed colors for compatibility with any possible special use of RGB values in older releases. For environments other than Java, C# or JavaScript, the GLG_DISABLE_INDEXED_COLORS environment variable may be set to true or false to control the use of indexed colors.</td>
</tr>
<tr>
<td>GlgIHArray</td>
<td>group object</td>
<td>an array holding default GLG interaction handlers</td>
<td>The array of GLG Interaction Handlers (GlgButton, GlgSlider, etc.) used to resolve interaction handlers names. It may be used by a program to add custom interaction handlers.</td>
</tr>
<tr>
<td>GlgCompatibility-Mode</td>
<td>Double</td>
<td>GLG_LATEST_RELEASE constant</td>
<td>Specifies compatibility mode. For example, when it is set to the GLG_PRE_2_9 constant, the release 2.9 changes which affect code compatibility with the older versions will be disabled. For C/C++ and ActiveX environments, this resource may also be defined by setting the GLG_COMPATIBILITY_MODE environment variable to the integer value corresponding to the desired constant.</td>
</tr>
<tr>
<td>GlgMaxDBFactor</td>
<td>Double</td>
<td>1.25</td>
<td>Controls the threshold for disabling double buffering for exceedingly large children viewports to avoid system slow-down due to swapping at high zoom factors. If the value of GlgMaxDBFactor is non-negative, the viewport’s double buffering is disabled if:  [ w \times h &gt; F \times W \times H ] where ( w ) and ( h ) are the pixel width and height of the viewport, ( W ) and ( H ) are the width and height of the display, and ( F ) is the value of GlgMaxDBFactor. If the value of GlgMaxDBFactor is negative, the double-buffering check is suppressed and the double-buffering is never disabled regardless of the viewport size. In JavaScript, the GLG double buffering is disabled by default, since canvas in the browser is already double buffered. For environments other than Java, C# or JavaScript, the GLG_MAX_DB_FACTOR environment variable may be set to specify the GlgMaxDBFactor value.</td>
</tr>
<tr>
<td>GlgDisablePre35-ObjectEvents</td>
<td>Double</td>
<td>1</td>
<td>When set to 0, disables processing of the old-style (prior to v. 3.5) tooltips, custom events and mouse feedback, which may reduce the CPU load when the mouse moves over a large drawing. For C/C++ and ActiveX environments, this resource may also be defined by setting the GLG_DISABLE_PRE35_OBJECT_EVENTS environment variable to True or False.</td>
</tr>
<tr>
<td>Name</td>
<td>Type</td>
<td>Default</td>
<td>Description (possible values)</td>
</tr>
<tr>
<td>-----------------------------</td>
<td>------</td>
<td>---------</td>
<td>-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------</td>
</tr>
<tr>
<td>GlmMaxIterations (C/C++ and ActiveX)</td>
<td>Double</td>
<td>10000</td>
<td>Defines the maximum number of internal iterations used to render filled polygons in the map server, which prevents rendering delays if the map is zoomed in too much. This parameter may need to be increased if large filled polygons (such as OSM country or state areas) are rendered with very high zoom levels. This value may be overridden by the MAX ITERATIONS parameter in the dataset’s SDF file.</td>
</tr>
</tbody>
</table>
7.2 Appendix B: Message Object Resources

A message object is a GLG object used by the Toolkit to pass information about GLG input, object selection and other events to the Input callback. It is a group object containing data in the form of named resources. The Input callback code can query resources of the message object using the GLG GetResource methods. Refer to the Handling User Input and Other Events section of the Using the C/C++ version of the Toolkit chapter for more information on handling input events.

A message object is also used for returning multiple pieces of information from methods such as GlgCreateChartSelection, in which case the message does not include generic resources listed in the following section.

Generic Resources of the Message Object

All message objects received in the Input and other callbacks have the following named attributes:

<table>
<thead>
<tr>
<th>Resource Name</th>
<th>Data Type</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Format</strong></td>
<td>String</td>
<td>Defines the format of the message object and the resources present in it. It is defined by the event type and, for input messages, the type of the input handler which detected the input activity and sent the message. It may have values such as Button, Slider, Knob, ObjectSelection and CustomEvent.</td>
</tr>
<tr>
<td><strong>Origin</strong></td>
<td>String</td>
<td>Contains one of the following values:</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• The name of the viewport with an input handler that generated the input message</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• The name of the object that generated the custom event message</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• The name of the viewport that generated the window message</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• An empty string for object selection and other message types.</td>
</tr>
<tr>
<td><strong>FullOrigin</strong></td>
<td>String</td>
<td>Contains the full path name of the viewport that initiated an input or window message, or the full path name of the object that initiated a custom event message. This resource will be set to an empty string for other types of messages.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>For composite input objects, such as a spinner, Origin and FullOrigin can point to different objects. For example, when an Increase or Decrease button of the spinner is activated, the Origin resource contains the name of the button that was pressed, while the FullOrigin resource contains the full path to the spinner that contains the button. Another example when Origin and FullOrigin point to a different object is when a text object of a spinner gains or loses focus, generating corresponding events</td>
</tr>
</tbody>
</table>
Specific Resources of the Message Object

A message object can have other resources as well, depending on the type of the input handler (for input events) or the type of the message (for object selection and custom events).

In the case of an input event, the message object includes all handler resources of the widget. For example, the message object coming from a GLG slider object may also contain such resources as ValueX, ValueY, Granularity, Increment, DisableMotion and others. These resources may be queried from either the message object or the viewport object that generated the message.

Handler resources not present in the viewport are not present in the message object. For example, a one-dimensional slider uses only one of its ValueX and ValueY resources, and the second resource will be absent from the message object. Several handlers define resources that appear only in the message object. For example, the GlgMenu input handler defines SelectedIndex and other resources used by the handler during its operation. All such resources are defined in the sections below.

The following sections describe the format of message objects generated by various input handlers as well as object selection and custom events. Refer to the Input Handlers section of the GLG User’s Guide for a complete list of resources of various GLG input handlers.
**Slider Message Object**

This message object is generated by the `GlgSlider` or `GlgNSlider` input handlers whenever a user acts to change the position of the slider or scrollbar controlled by these input handlers.

### Slider Message Object Resources

<table>
<thead>
<tr>
<th>Resource</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Format</strong></td>
<td>Slider</td>
</tr>
<tr>
<td><strong>Action</strong></td>
<td>• <em>ValueChanged</em> indicates when a value change has resulted from a mouse click.</td>
</tr>
<tr>
<td></td>
<td>• <em>GrabPointer</em> is issued when the mouse button is pressed over the slider active area, causing the mouse to assume control of the slider position. The <em>SubAction</em> is NULL.</td>
</tr>
<tr>
<td></td>
<td>• <em>UngrabPointer</em> is issued when the mouse button is released, ending mouse control of the slider position. The <em>SubAction</em> is NULL.</td>
</tr>
<tr>
<td></td>
<td>• <em>RepeatStart</em> and <em>RepeatEnd</em> are issued before and after the <em>ValueChange</em> messages that were generated by one of the slider’s buttons (such as <em>Increase</em> or <em>Decrease</em>) and a button’s repeated action was enabled by its <em>RepeatTimeout</em> resource.</td>
</tr>
<tr>
<td><strong>SubAction</strong></td>
<td>• <em>Click</em> when a value change has resulted from a mouse click</td>
</tr>
<tr>
<td></td>
<td>• <em>Motion</em> when a value change has resulted from a mouse motion while the left mouse button is held down</td>
</tr>
<tr>
<td></td>
<td>• <em>Increase</em>, <em>Decrease</em>, <em>PageIncrease</em> or <em>PageDecrease</em> when a value change has resulted from activating the corresponding button.</td>
</tr>
<tr>
<td><strong>Object</strong></td>
<td>The slider’s viewport.</td>
</tr>
</tbody>
</table>

The *ValueX*, *ValueY*, *Granularity*, *Increment*, *DisableMotion* and other slider resources are also present in the message object.
Knob Message Object

This message object is generated by the `GlgKnob` input handler whenever a user acts to change the position of the knob.

### Knob Message Object Resources

<table>
<thead>
<tr>
<th>Resource</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Format</strong></td>
<td>Knob</td>
</tr>
<tr>
<td><strong>Action</strong></td>
<td></td>
</tr>
<tr>
<td>• <code>ValueChanged</code> indicates when a value change has resulted from a mouse click</td>
<td></td>
</tr>
<tr>
<td>• <code>GrabPointer</code> is issued when the mouse button is pressed over the slider active area, causing the mouse to assume control of the slider position. The <code>SubAction</code> is NULL.</td>
<td></td>
</tr>
<tr>
<td>• <code>UngrabPointer</code> is issued when the mouse button is released, ending mouse control of the slider position. The <code>SubAction</code> is NULL.</td>
<td></td>
</tr>
<tr>
<td>• <code>RepeatStart</code> and <code>RepeatEnd</code> are issued before and after the <code>ValueChange</code> messages that were generated by one of the knob’s buttons (such as <code>Increase</code> or <code>Decrease</code>) and a button’s repeated action was enabled by its <code>RepeatTimeout</code> resource.</td>
<td></td>
</tr>
<tr>
<td><strong>SubAction</strong></td>
<td></td>
</tr>
<tr>
<td>• <code>Click</code> when a value change has resulted from a mouse click</td>
<td></td>
</tr>
<tr>
<td>• <code>Motion</code> when a value change has resulted from a mouse motion while the left mouse button is held down</td>
<td></td>
</tr>
<tr>
<td>• <code>Increase</code>, <code>Decrease</code>, <code>PageIncrease</code> or <code>PageDecrease</code> when a value change has resulted from activating the corresponding button.</td>
<td></td>
</tr>
<tr>
<td><strong>Object</strong></td>
<td>The knob’s viewport.</td>
</tr>
</tbody>
</table>

The `Value`, `Granularity`, `Increment`, `DisableMotion` and other knob resources are also present in the message object.
**Button Message Object**

This message object is generated by the `GlgButton` or `GlgNButton` input handlers whenever a user presses the button or toggle controlled by these handlers.

### Button Message Object Resources

<table>
<thead>
<tr>
<th>Resource</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Format</strong></td>
<td>Button</td>
</tr>
</tbody>
</table>
| **Action** | • *Activate* when activating push buttons without *OnState* resource or native push buttons.  
|            | • *ValueChanged* when activating toggle buttons with *OnState* resource or native toggle buttons.  
|            | • *RepeatStart* and *RepeatEnd* are issued before and after the *Activate* messages if the button’s repeated action was enabled by its *RepeatTimeout* resource.  
|            | • *Update* for various miscellaneous actions, in which case *SubAction* will indicate the action type.  |
| **SubAction** | • *InState* when *InState* changes (*GlgButton*)  
|            | • *PressedState* when *PressedState* changes (*GlgButton*)  
|            | • *ArmedState* when *ArmedState* changes (*GlgButton*)  
|            | • *Press or Released* (X/Motif push button with the *GlgNButton* handler)  |
| **Object** | The button’s viewport.                                                 |

As with all the message objects, the button message object also includes the handler resources that are used in the widget, such as *PressedState*, *OnState* and others. Refer to the *Input Handlers* section of the GLG User’s Guide for a complete list of resources of the *GlgButton* and *GlgNButton* input handlers.
Text Message Object

This message object is generated by the GlgText or GlgNText input handlers whenever a user enters text into the text input widget controlled by these input handlers.

Text Widget Message Object Resources

<table>
<thead>
<tr>
<th>Resource</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Format</strong></td>
<td>Text</td>
</tr>
<tr>
<td><strong>Action</strong></td>
<td></td>
</tr>
<tr>
<td>Activate</td>
<td>if the Enter key was pressed at the end of text input.</td>
</tr>
<tr>
<td>ValueChanged</td>
<td>is generated for one of the following events:</td>
</tr>
<tr>
<td>-</td>
<td>if a key press changes the string displayed in a string text input</td>
</tr>
<tr>
<td>-</td>
<td>if the Enter key is pressed at the end of a numerical text input</td>
</tr>
<tr>
<td>-</td>
<td>if the value of a numerical text input has changed and the text input is about to lose focus.</td>
</tr>
<tr>
<td>Focus</td>
<td>if the text input gained the input focus (GlgNText handler only).</td>
</tr>
<tr>
<td>LosingFocus</td>
<td>if the text input lost the input focus (GlgNText handler only).</td>
</tr>
<tr>
<td>Update</td>
<td>for any other key press or user action. This includes changing the current value displayed in a numerical text input, in which case the ValueChanged action will be generated when the user finishes entering a new value and either presses Enter or moves focus away from the text input.</td>
</tr>
<tr>
<td><strong>SubAction</strong></td>
<td>none</td>
</tr>
<tr>
<td><strong>Object</strong></td>
<td>The text widget's viewport.</td>
</tr>
</tbody>
</table>

The TextString resource and, for numerical inputs, Value resource are present in the message object even if they do not exist in the Text Widget's viewport, allowing the current values to be passed in the message. The MaxLength and, for numerical inputs, the MinValue, MaxValue, EnforceRange, InputInvalid and ValueFormat resources are also present in the message object.
**Spinner Message Object**

This message object is generated by the `GlgSpinner` input handlers whenever a user changes the spinner’s value.

### Spinner Widget Message Object Resources

<table>
<thead>
<tr>
<th>Resource</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Format</td>
<td><code>Spinner</code></td>
</tr>
<tr>
<td><strong>Action</strong></td>
<td></td>
</tr>
<tr>
<td>• <code>ValueChanged</code></td>
<td>if the spinner’s value has changed</td>
</tr>
<tr>
<td>• <code>Update</code></td>
<td>for any other user interaction.</td>
</tr>
<tr>
<td>• <code>Activate</code></td>
<td>if the spinner’s Done button was pressed. The <code>Activate</code> action of</td>
</tr>
<tr>
<td></td>
<td>the spinner’s text input object is also propagated to the spinner.</td>
</tr>
<tr>
<td>• <code>RepeatStart</code> and</td>
<td><code>RepeatEnd</code> are issued before and after the <code>ValueChanged</code></td>
</tr>
<tr>
<td><code>RepeatEnd</code></td>
<td>messages that were generated by one of the spinner’s or spinner</td>
</tr>
<tr>
<td></td>
<td>slider’s buttons (such as <code>Increase</code> or <code>Decrease</code>) and a button’s</td>
</tr>
<tr>
<td></td>
<td>repeated action was enabled by its <code>RepeatTimeout</code> resource.</td>
</tr>
<tr>
<td><strong>SubAction</strong></td>
<td>For <code>ValueChanged</code> actions, indicates the origin of the action, such</td>
</tr>
<tr>
<td></td>
<td>as <code>Slider</code>, <code>TextInput</code>, <code>Increase</code> or <code>Decrease</code> buttons. It is</td>
</tr>
<tr>
<td></td>
<td>set to NULL otherwise.</td>
</tr>
<tr>
<td><strong>Object</strong></td>
<td>The spinner widget’s viewport.</td>
</tr>
</tbody>
</table>

All resources of the spinner, such as `Value`, `MinValue`, `MaxValue`, `Increment`, etc. are also present in the message object.

**List Message Object**

This message object is generated by the `GlgNList` input handlers when a user selects items in a list widget controlled by this input handler.

### List Widget Message Object Resources

<table>
<thead>
<tr>
<th>Resource</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Format</td>
<td><code>List</code></td>
</tr>
<tr>
<td><strong>Action</strong></td>
<td></td>
</tr>
<tr>
<td>• <code>Select</code></td>
<td>if an item was selected or deselected.</td>
</tr>
<tr>
<td>• <code>Update</code></td>
<td>for any other key.</td>
</tr>
<tr>
<td><strong>SubAction</strong></td>
<td><code>DoubleClick</code> if the item was selected using a double-click, otherwise</td>
</tr>
<tr>
<td></td>
<td><code>NULL</code>.</td>
</tr>
<tr>
<td><strong>Object</strong></td>
<td>The list’s viewport.</td>
</tr>
</tbody>
</table>

The `GlgSendMessage` method may be used to get extended selection information for a multiple selection list widget.
Option Message Object

This message object is generated by the GlgNOption input handlers when a user changes an option selection in an option menu or combo box widget controlled by this input handler.

List Widget Message Object Resources

<table>
<thead>
<tr>
<th>Resource</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Format</td>
<td>Option</td>
</tr>
</tbody>
</table>
| Action   | • Select if a new option was selected.  
            • Update for any other key. |
| SubAction| none                   |
| Object   | The option widget’s viewport. |

Menu Message Object

This message object is generated by the GlgMenu input handler whenever a user presses a button in the menu.

Menu Message Object Resources

<table>
<thead>
<tr>
<th>Resource</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Format</td>
<td>Menu</td>
</tr>
<tr>
<td>Action</td>
<td>Activate</td>
</tr>
<tr>
<td>SubAction</td>
<td>none</td>
</tr>
<tr>
<td>Object</td>
<td>The menu’s viewport.</td>
</tr>
</tbody>
</table>

The SelectedIndex, SelectedValue and SelectedString resources are present in the message object even if they do not exist in the menu viewport, allowing the menu to pass information about the selection with the message.
Clock and Stopwatch Message Object

The first message is generated by the clock and stopwatch widgets (GlgClock input handler) when they update the graphical representation of the clock. This is invoked automatically every second. If seconds are not displayed, the callback is invoked once per minute, instead.

The second message is only called from a stopwatch widget, whenever a user presses one of the control buttons.

Clock Widget Message Object Resources

<table>
<thead>
<tr>
<th>Resource</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Format</td>
<td>Clock</td>
</tr>
<tr>
<td>Action</td>
<td>Update</td>
</tr>
<tr>
<td>SubAction</td>
<td>none</td>
</tr>
<tr>
<td>Object</td>
<td>The widget’s viewport.</td>
</tr>
</tbody>
</table>

Stopwatch Widget Message Object Resources

<table>
<thead>
<tr>
<th>Resource</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Format</td>
<td>Clock</td>
</tr>
<tr>
<td>Action</td>
<td>Start, Stop, or Reset depending on the corresponding stopwatch button.</td>
</tr>
<tr>
<td>SubAction</td>
<td>none</td>
</tr>
<tr>
<td>Object</td>
<td>The widget’s viewport.</td>
</tr>
</tbody>
</table>

Either message object will also contain resources of GlgClock input handler such as Sec, ValueSec, and so on. For the Stopwatch Widget, the Sec resource is present in the message object even if it does not exist in the stopwatch’s viewport.

Timer Message Object

This message object is generated automatically by the GlgTimer input handler upon every update of the timer output Value.

Timer Widget Message Object Resources

<table>
<thead>
<tr>
<th>Resource</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Format</td>
<td>Timer</td>
</tr>
<tr>
<td>Action</td>
<td>Update</td>
</tr>
<tr>
<td>SubAction</td>
<td>none</td>
</tr>
<tr>
<td>Object</td>
<td>The timer’s viewport.</td>
</tr>
</tbody>
</table>
The program should call the `GlgUpdate()` function to make the changes caused by the timer visible. The remaining resources of the message object (`Interval`, `Period`, `ActiveState`, and so on) can be used to change the timer’s state and parameters. The timer handler has been superseded by the timer transformation in the release 2.8 of GLG.

**Palette Message Object**

This message object is generated by the `GlgPalette` input handler whenever a user selects one of the objects in the palette with the left mouse button, or changes the selection by dragging the mouse over the palette.

**Palette Message Object Resources**

<table>
<thead>
<tr>
<th>Resource</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Format</td>
<td>Palette</td>
</tr>
</tbody>
</table>
| Action   | • Activate when a selection is made with a mouse click  
           | • ValueChanged when the selection is changed due to a mouse dragging. |
| SubAction| Click or Motion |
| Object   | The widget’s viewport. |

The palette’s message object also has a resource named `SelectedObject`. This resource refers to the object selected and is used to get values of the that object’s attributes. For example, for a color palette, the `SelectedObject/FillColor` resource of the message object yields the chosen color.

**Font Browser Message Object**

This message object is generated by the `GlgBrowser` input handler whenever any input activity is detected in the font browser controlled by the input handler.

**Font Browser Message Object Resources**

<table>
<thead>
<tr>
<th>Resource</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Format</td>
<td>FontBrowser</td>
</tr>
</tbody>
</table>
| Action     | • Activate when the Done button of the Font Browser is activated  
           | • Cancel when the Cancel button is pressed.  
           | • Update on any other activity in the Font Browser. |
| SubAction  | none |
| Object     | The widget’s viewport. |

All the resources of the font browser widget are also present in the message object, allowing the font selection to be passed in the message.
Browser Message Object

This message object is generated by the `GlgBrowser` input handler whenever any input activity is detected in the resource, tag, alarm or custom data browser controlled by the input handler.

<table>
<thead>
<tr>
<th>Resource</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Format</strong></td>
<td>Browser</td>
</tr>
</tbody>
</table>
| **Action** | • *Activate* when the *Done* button of the Browser is pressed.  
• *Cancel* when the *Cancel* button is pressed.  
• Select when the user clicks on a list entry.  
• *Update* on any other activity in the Browser. |
| **SubAction** | For the *Update* action, the *SubAction* may be *DoubleClick* when the user double-clicks to open another hierarchy level. Otherwise, this resource is not used. |
| **Object** | The browser’s viewport. |

The `Input` callback is called with *Activate* as the value of the *Action* resource when the *Done* button of the file browser is activated, or when the *Enter* key is pressed with the keyboard focus in the *Path* text widget and the string is a valid ID (resource name, tag name, etc.) of some element in the browser list.
Zoom Message Object

This message object is generated when a zoom or pan operation is performed, activated either by user interaction or programmatically.

Zoom Message Object Resources

<table>
<thead>
<tr>
<th>Resource</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Format</strong></td>
<td>Zoom</td>
</tr>
</tbody>
</table>
| **Action** | • Zoom  
• Pan  
• ScrollbarChange  
Generated when an X or Y scrollbar is drawn or erased in the AutoPan mode. |
| **SubAction** | • Left, Right, Up, Down, X, Y, x or y for the Pan action.  
• ZoomIn, ZoomOut or Reset for the Zoom action.  
• Set for the fit to box Zoom actions (‘F’ and ‘f’).  
• ResetX or ResetY for corresponding ‘N’ and ‘n’ Zoom actions in the Chart Zoom mode.  
• Start, End or Abort for the ZoomTo mode of the Zoom action or the Dragging mode of the Pan action: notifies about the start, end or abort of the action.  
• Drag for the Dragging mode of the Pan action. Repeated messages are generated to notify about the drag action in progress.  
• ZoomRectangle for the ZoomTo mode of the Zoom action: notifies that zoom rectangle was created and is accessible.  
• ZoomRectangleChange for the ZoomTo mode of the Zoom action: notifies that the ZoomTo rectangle was resized by the mouse move.  
• ZoomRectangleEnd for the ZoomTo mode of the Zoom action: notifies that the ZoomTo rectangle is about to be destroyed and may be used to extract the final ZoomTo extent. |
| **Object** | The viewport that triggered the message. |

The Start and End subactions are generated when the ZoomTo, custom zoom or dragging operation is started or finished. The Reset subaction is generated when the zooming state is reset using the ‘n’ or ‘N’ zoom action. The Set subaction is generated when the drawing is zoomed, paned or rotated using any zoom actions other than ZoomTo, custom zoom or Reset. The ZoomRectangle subaction indicates that the ZoomTo rectangle has been created and is accessible via the GlgZoomRect resource of the viewport in the ZoomTo mode. The ZoomRectangleChange and ZoomRectangleEnd subactions notify the application that the zoom rectangle is resized with the mouse or about to be destroyed at the end of the ZoomTo action.
**Custom Event Message Object**

This message object is generated by a GLG drawing when a mouse event triggers a custom event action (with ActionType=SEND_EVENT) attached to an object. Depending on the action’s Trigger, an action is triggered when an object it is attached to is either clicked on with the mouse, the mouse moved over the object, or, for input objects, a matching input activity has occurred. Alternatively, the message may also be generated by the old-style (prior to v. 3.5) MouseClickEvent or MouseOverEvent custom properties attached to the object instead of an action object.

For actions with the MOUSE_CLICK and MOUSE_OVER triggers, two types of messages are generated: an activation message is generated when the action is activated by a mouse click or mouse over event, and a deactivation message is generated when the action ends due to the mouse button being released or the mouse moving away from the object.

Actions that are sensitive to the state of the Control key (actions with ProcessArmed set to a value other than NONE) may also be activated and deactivated by changes of the state of the Control key, in which case the SubAction parameter of the message in the Input callback will be set to ArmedChange:

- MOUSE_OVER (but not MOUSE_CLICK) actions with ProcessArmed set to ARMED_ONLY or UNARMED_ONLY are activated when the state of the Control key changes to a matching state while the mouse is over the object.
- MOUSE_CLICK actions get activated only on the mouse click, and only if the Control key is in a matching state at the time of the click.
- Active MOUSE_OVER and MOUSE_CLICK actions with ProcessArmed set to ARMED_ONLY or UNARMED_ONLY are deactivated if the Control key changes to a non-matching state.
- For MOUSE_OVER actions with ProcessArmed=ARMED_AND_UNARMED, an activation message with SubAction=ArmedChange is generated each time the state of the Control key changes while the mouse is over the object.

For the MOUSE_OVER actions, the deactivation message may not be generated if the mouse moves to another object, triggering an activation message for a MOUSE_OVER action attached to another object.

Messages generated when an action is activated contain information about the action, its EventLabel and the object the action is attached to.

Messages generated on action deactivation have an empty EventLabel and do not contain any additional information. If a program need this information, it can store it when the action is activated.

The viewport’s ProcessMouse attribute has to include an appropriate Move and/or Click mask to enable custom event processing (except for actions with Trigger=INPUT). The Input callback can use the message object’s resources to process the custom event. This message is invoked for any viewport object and does not require an input handler.
## Custom Event Message Object Resources

<table>
<thead>
<tr>
<th>Resource</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Format</strong></td>
<td>CustomEvent</td>
</tr>
<tr>
<td><strong>Action</strong></td>
<td></td>
</tr>
</tbody>
</table>
| • MouseOver when a MOUSE_OVER action is activated or deactivated.  
• MouseClick or DoubleClick when a MOUSE_CLICK action is activated, depending on the type of the click and the setting of the ProcessDoubleClick action attribute.  
• MouseRelease when a MOUSE_CLICK action is deactivated.  
• InputObject for actions with Trigger=INPUT. | |
| **SubAction** |  |
| • Armed if the Control key was pressed when activating actions with ProcessArmed set to ARMED_ONLY or ARMED_AND_UNARMED.  
• ArmedChange if an action was activated or deactivated due to a change of the state of the Control key.  
• none (an empty string) for all other actions. | |
| **EventLabel** |  |
| • When activating an action: the value of the action’s EventLabel attribute, or the string value of the old-style (prior to v. 3.5) MouseOverEvent or MouseClickEvent properties if the custom event was generated by these properties.  
• When deactivating an action: none (an empty string). | |
| **ButtonIndex** |  |
| • When activating MOUSE_CLICK actions: an index of the button that generated the custom event.  
• A value of 0 for all other actions. | |
| **ActionObject** |  |
| • When activating an action: the action that generated the message.  
• NULL when deactivation an action, or when activating a custom event generated by the old (prior to v. 3.5) custom event properties. | |
| **Object** |  |
| • When activating mouse actions: the top-level object that generated the custom event. For example, if a group object has a MOUSE_CLICK action attached, the group will be used as the Object resource when any object in the group is selected with the mouse.  
• When deactivating mouse actions: NULL.  
• For input actions (Trigger=INPUT): the input object the action is attached to. | |
Custom Event Message Object Resources

<table>
<thead>
<tr>
<th>Resource</th>
<th>Value</th>
</tr>
</thead>
</table>
| OrigObject | • When activating mouse actions: the low-level object that generated the custom event. If a group object has a MOUSE_CLICK action attached, the Object resource is the group and OrigObject is the object inside the group that was actually selected with the mouse.  
• When deactivating mouse actions: NULL.  
• For input actions (Trigger=INPUT): the input object the action is attached to. |

The GetResourceObject method may be used to get the object ID of the object and origin object from the message using the Object and OrigObject resource names:

```
GlgObject object = GlgGetResourceObject( message_object, "Object" );
```

The resources of the object and origin object may be accessed through the message object using the Standard API. For example, the Object/FillColor resource name may be used to access the FillColor attribute of the object as a resource of the message object:

```
GlgSetGResource( message_object, "Object/FillColor", 1., 0., 0. );
```

If the ActionObject resource of the message is not NULL, the action data may be accessed via the ActionObject/ActionData resource.
Command Message Object

This message object is generated by a GLG drawing when a command action is triggered by a mouse event or an input object. The viewport’s ProcessMouse attribute has to include an appropriate Move and/or Click mask to enable processing of command actions (except for actions with Trigger=INPUT). The Input callback can use the message object’s resources to process the command. This message is invoked for any viewport object and does not require an input handler.

Command Message Object Resources

<table>
<thead>
<tr>
<th>Resource</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Format</td>
<td>Command</td>
</tr>
<tr>
<td>Action</td>
<td>• MouseClick for commands with Trigger=MOUSE_CLICK.</td>
</tr>
<tr>
<td></td>
<td>• MouseOver for commands with Trigger=MOUSE_OVER.</td>
</tr>
<tr>
<td></td>
<td>• Input for commands with Trigger=INPUT.</td>
</tr>
<tr>
<td>SubAction</td>
<td>• Armed when activating actions with ProcessArmed=ARMED_ONLY, or if the Control key was pressed when an action with ProcessArmed=ARMED_AND_UNARMED was activated.</td>
</tr>
<tr>
<td></td>
<td>• none (an empty string) for all other actions.</td>
</tr>
<tr>
<td>EventLabel</td>
<td>The value of the action’s EventLabel attribute.</td>
</tr>
<tr>
<td>ActionObject</td>
<td>The action that generated the message.</td>
</tr>
<tr>
<td>Object</td>
<td>• For commands activated by the mouse: the top-level object that generated the command. For example, if a group object has a MOUSE_CLICK command action, the group will be used as the Object resource when any object in the group is selected with the mouse.</td>
</tr>
<tr>
<td></td>
<td>• For input object commands (Trigger=INPUT): the input object the action is attached.</td>
</tr>
<tr>
<td>OrigObject</td>
<td>• For commands activated by the mouse: the low-level object that originated the command. If a group object has a MOUSE_CLICK action attached, the Object resource is the group and OrigObject is the object inside the group that was actually selected with the mouse.</td>
</tr>
<tr>
<td></td>
<td>• For input object commands (Trigger=INPUT): the input object the action is attached.</td>
</tr>
</tbody>
</table>
**Tooltip Message Object**

This message object is generated by a GLG drawing when a tooltip is activated or erased. The viewport’s `ProcessMouse` attribute has to include `Tooltip` mask to enable object tooltips in the drawing (button tooltips do not require the mask and are always active). The `Input` callback can use the message object’s resources to process the tooltip event. This message is invoked for any viewport object and does not require an input handler.

### Tooltip Message Object Resources

<table>
<thead>
<tr>
<th>Resource</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Format</td>
<td><code>Tooltip</code></td>
</tr>
<tr>
<td><strong>Action</strong></td>
<td></td>
</tr>
<tr>
<td>• <code>ObjectTooltip</code> when an object tooltip is activated, or when a non-button tooltip (object or special) is erased.</td>
<td></td>
</tr>
<tr>
<td>• <code>ButtonTooltip</code> when a button tooltip is activated or erased.</td>
<td></td>
</tr>
<tr>
<td>• <code>SpecialTooltip</code> when a chart or axis tooltip is activated.</td>
<td></td>
</tr>
<tr>
<td><strong>SubAction</strong></td>
<td>none</td>
</tr>
<tr>
<td><strong>EventLabel</strong></td>
<td></td>
</tr>
<tr>
<td>• The tooltip string for the tooltip display events</td>
<td></td>
</tr>
<tr>
<td>• An empty string if the tooltip event is generated when the mouse moves away from the object and the tooltip is erased.</td>
<td></td>
</tr>
<tr>
<td><strong>ActionObject</strong></td>
<td></td>
</tr>
<tr>
<td>• The tooltip action that generated object tooltip.</td>
<td></td>
</tr>
<tr>
<td>• NULL for old-style (prior to v. 3.5) and button tooltips, as well as when the message is generated on erasing a tooltip.</td>
<td></td>
</tr>
<tr>
<td><strong>Object</strong></td>
<td></td>
</tr>
<tr>
<td>• The top-level object that has a tooltip attached. For example, if a group object has a tooltip, the group will be used as the <code>Object</code> resource when a mouse hovers over any object in the group.</td>
<td></td>
</tr>
<tr>
<td>• NULL if the message is invoked on erasing a tooltip.</td>
<td></td>
</tr>
<tr>
<td><strong>OrigObject</strong></td>
<td></td>
</tr>
<tr>
<td>• The low-level object the mouse is hovering at. If a group object has the custom events defined, the <code>Object</code> resource is the group and <code>OrigObject</code> is the object inside the group that is under the mouse.</td>
<td></td>
</tr>
<tr>
<td>• NULL if the message is invoked on erasing a tooltip.</td>
<td></td>
</tr>
</tbody>
</table>
**UpdateDrawing Message Object**

This message object is generated by a GLG drawing when a SET_STATE, RESET_STATE or TOGGLE_STATE action type is triggered. The *Input* callback can use this message to update the top-level drawing when the *State* attribute of the action is constrained to an object in another viewport, and that viewport needs to be redrawn when the value of the *State* object changes. This message is invoked for any viewport object and does not require an input handler.

<table>
<thead>
<tr>
<th>Resource</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Format</td>
<td>UpdateDrawing</td>
</tr>
<tr>
<td>Action</td>
<td>Update</td>
</tr>
<tr>
<td>SubAction</td>
<td>none</td>
</tr>
</tbody>
</table>

**ImageLoad Message Object**

This message object is generated by a GLG drawing in the Java, C# and JavaScript environments when an image with an asynchronous load type finishes loading its data. The *Input* callback can use this message to update the drawing. This message is invoked for any viewport object and does not require an input handler.

<table>
<thead>
<tr>
<th>Resource</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Format</td>
<td>ImageLoad</td>
</tr>
<tr>
<td>Action</td>
<td>Update</td>
</tr>
<tr>
<td>SubAction</td>
<td>none</td>
</tr>
</tbody>
</table>
**TemplateLoad Message Object**

This message object is generated by a GLG drawing in the JavaScript environment every time a template of a reference object gets loaded. The *Input* callback can use this message to update the drawing. This message is invoked for any viewport object and does not require an input handler.

The `GetPendingTemplates` and `GetPendingInstances` methods of the JavaScript API may be used to query the number of templates being loaded and the number of reference object instances waiting for their templates to be loaded.

**TemplateLoad Message Object Resources**

<table>
<thead>
<tr>
<th>Resource</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Format</td>
<td>TemplateLoad</td>
</tr>
<tr>
<td>Action</td>
<td>Update</td>
</tr>
<tr>
<td>SubAction</td>
<td>none</td>
</tr>
</tbody>
</table>

**Object Selection Message Object**

This message object is generated by a GLG drawing when objects in the drawing are selected via the mouse over or mouse click events. The viewport’s `ProcessMouse` attribute has include one or both of the `Click` and `Move` masks to enable object selection processing. The *Input* callback can use the message object’s resources to process the object selection. This message is invoked for any viewport object and does not require an input handler.

**Object Selection Message Object Resources**

<table>
<thead>
<tr>
<th>Resource</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Format</td>
<td><code>ObjectSelection</code></td>
</tr>
</tbody>
</table>
| Action          | - *MouseMove* when user moves the mouse over objects in the drawing.  
|                 | - *MouseClick* when the user clicks on the objects in the drawing.  |
| SubAction       | none                                       |
| ButtonIndex     | - The index of the button that generated the selection event.  
|                 | - 0 for selections generated by mouse over events.  |
| SelectionArray  | A group object containing object IDs of all objects on the lowest level of the hierarchy selected by the mouse event.  |

The objects selected by the mouse event may be queried from the `SelectionArray` using the `GetElement` method of the Extended API:
GlgObject selection_array =
    GlgGetResourceObject( message_object, "SelectionArray" );
for( i=0; i<GlgGetSize( selection_array ); ++i )
    GlgObject selected_object = GlgGetElement( selection_array, i );

The array contains the selected objects on the lowest level of the hierarchy. For example, if the object is part of a group, it will contain the object itself and not the group. The parents of the selected objects may be queried by using the selected object’s GetParent method.

**Chart Selection Message Object**

This message object is returned by the `GlgCreateChartSelection` method and contains information describing the selected data sample. It does not have generic message object resources such as Format or Action, and contains only the resources listed in the following table.

<table>
<thead>
<tr>
<th>Resource</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>InputX</td>
<td>The X or time value corresponding to the specified input position.</td>
</tr>
<tr>
<td>InputY</td>
<td>The Y value corresponding to the specified input position.</td>
</tr>
<tr>
<td>SampleX</td>
<td>The X or time value of the selected data sample.</td>
</tr>
<tr>
<td>SampleY</td>
<td>The Y value of the selected data sample.</td>
</tr>
<tr>
<td>SampleValid</td>
<td>The value of the selected data sample’s valid flag: 0 or 1.</td>
</tr>
<tr>
<td>InputXString</td>
<td>A string with the X or time value of the input position in the format of the X axis’s label.</td>
</tr>
<tr>
<td>SampleXString</td>
<td>A string with the X or time value of the selected data sample in the format of the X axis’s label.</td>
</tr>
<tr>
<td>SelectedPlot</td>
<td>An object ID of the selected plot.</td>
</tr>
</tbody>
</table>
**Chart Message Object**

This message object is generated every time a chart’s cross-hair cursor is drawn or erased. When the mouse moves over the chart, a repeated draw message for each cross-hair cursor position is generated.

**Chart Message Object Resources**

<table>
<thead>
<tr>
<th>Resource</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Format</td>
<td>Chart</td>
</tr>
<tr>
<td>Action</td>
<td>CrossHairUpdate</td>
</tr>
<tr>
<td>SubAction</td>
<td>Draw or Erase.</td>
</tr>
<tr>
<td>Object</td>
<td>The chart object that triggered the message.</td>
</tr>
</tbody>
</table>

**Window Message Object**

This message object is generated by a viewport object when it becomes visible for the first time or receives a message to delete or close its window. The delete window request is received when the user activates the window’s controls to close the window. The Input callback gives the program a chance to react to the user’s request. This message is invoked for any viewport object and does not require an input handler.

**Window Message Object Resources**

<table>
<thead>
<tr>
<th>Resource</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Format</td>
<td>Window</td>
</tr>
</tbody>
</table>
| Action   | • DeleteWindow when user closes the viewport’s window.  
          | • FirstExposure when the viewport’s window is becoming visible for the first time. |
| SubAction| none        |
| Object   | The viewport that triggered the message. |
7.3 Appendix C: GLG Object Attribute Table

The following lists the Default Attribute Names that may be used by a program to access attributes of various objects. The generic attributes are common attributes that may be used for objects of any type. The rest of the attributes exist only in certain types of objects and are listed under their corresponding object types.

Most of the attribute names are either self-explanatory or are described in the corresponding section the GLG Objects chapter of the GLG User’s Guide. There are some attributes that are not described in the User’s Guide and may be used only by a program to access some objects’ internal structures. Such attributes may have an explanation next to the attribute name.

**Generic Attributes**

- **Type**
  - Object type.

- **Name**
- **HasResources**
- **Global**
- **MoveMode**
- **CoordFlag**
- **HISetup**
  - Indicates if the object’s hierarchy has been set up.
- **Xform**
  - An optional transformation object attached to the object.

**Generic Attributes of Drawable objects**

- **Visibility**
- **HighlightFlag**
- **History**
  - A group containing all history objects attached to the object, if any.
- **CustomData**
  - A group containing all custom properties attached to the object, if any.
- **NoCustomDataSetup**
  - A flag to disable setup of custom properties when complex objects are attached as properties.
- **Aliases**
  - A group containing all aliases attached to the object, if any.
- **Actions**
  - A group containing all actions and commands attached to the object, if any.
- **RenderingAttr**
  - The rendering object attached to the object, if any. Objects that have a rendering object attached, inherit the rendering object’s attributes. In this case, rendering attributes may be queried directly from the object the rendering object is attached to.

**Polygon Attributes**

- **EdgeColor**
- **FillColor**
- **LineWidth**
- **LineType**
- **FillType**
OpenType
SelectionType
Shading
  Controls shading of the polygon’s fill and edges.
AntiAliasing
Array
  A group object containing polygon points.

**Rendering Object Attributes**

- GradientResolution
- GradientType
- GradientColor
- GradientCenter
- GradientLength
- GradientAngle
- ArrowType
- ShadowOffset
- ShadowColor
- FillDirection
- FillAmount

If an object has a rendering object attached, the object inherits all of the rendering object’s attributes, so that they can be queried directly from the object.

**Marker Attributes**

- MarkerType
- MarkerSize
- Point
  - Control point
- EdgeColor
- FillColor
- AntiAliasing

**Text Object Attributes**

- TextType
- String
- Point1, Point2, Point3
  - Control Points
-TextColor
- FontType
- FontSize
- MinFontSize
- Anchoring
- AnchorOffset
- TextDirection
- TextScaling
- BoxAttr
  - Box Attributes object attached to the text object (if any).
- CursorType
  - Cursor type (SCROLLED TEXT only).
CursorPosition
Cursor position (SCROLLED TEXT only).

TextStart
Start index of the first visible character (SCROLLED TEXT only).

The text object also inherits attributes from its attached Box Attributes object. These attributes may be queried directly from the text object.

**Box Attributes Object Attributes**

BoxOffset  
AnchorOnBox

FillColor  
EdgeColor  
LineWidth  
LineType  
FillType

Generic resource names

BoxEdgeColor  
BoxFillColor  
BoxLineWidth  
BoxLineType  
BoxFillType

Box-specific resource names

**Arc Attributes**

Radius  
StartAngle  
EndAngle  
AngleType  
Center

Center control point.

Vector

Vector control point.

Resolution, ArcResolution  
ArcFillType  
FillType  
OpenType  
EdgeColor  
FillColor  
LineWidth  
LineType  
SelectionType  
Shading  
AntiAliasing

Polygon

The polygon object used to render the arc.

**Parallelogram Attributes**

EdgeColor
FillColor
LineWidth
LineType
FillType
SelectionType
Shading
  Controls shading of the object’s fill and edges.
AntiAliasing
Polygon
  The polygon object used to render the parallelogram.

*Spline Object Attributes*

SplineType
Resolution, SplineResolution
EdgeColor
FillColor
LineWidth
LineType
FillType
SelectionType
Shading
  Controls shading of the object’s fill and edges.
CPArray
  A group containing the spline’s control points.
Polygon
  The polygon object used to render the spline.

*Rounded Object Attributes*

Radius1
Radius2
UnitType
Resolution, CornerResolution
EdgeColor
FillColor
LineWidth
LineType
FillType
SelectionType
Shading
  Controls shading of the object’s fill and edges.
AntiAliasing
Polygon
  The polygon object used to render the object.

*Image Object attributes*

ImageType
Anchoring
ImageFile
EnableCache
AsyncMode
  Java, C# and JavaScript only.
ImageLoaded
Java, C# and JavaScript only.
Point1, Point2
Control points.

GIS Object attributes
FillColor
GISDisabled
GISProjection
GISCenter
GISUsedCenter
The actual center value used by the map server (read-only).
GISExtent
GISUsedExtent
The actual extent value used by the map server (read-only).
GISAngle
GISStretch
GISDataFile
GISMMapServerURL
GISLayers
GISVerbosity
GISDiscardData
AsyncMode
Java, C# and JavaScript only.
ImageLoaded
Java, C# and JavaScript only.
Point1, Point2
Control points.

Group and List Objects’ Attributes
ZSort

Connector Object Attributes
EdgeType
EdgeDirection
EdgeColor
LineType
CPArray
A group containing the control points.
Rendering
The polygon or arc object used to render the connector.

Reference Object Attributes
ReferenceType
Source
SourcePath (previously DrawingFile)
A path for the drawing file or resource path for a palette object in the drawing.
ObjectPath
Resource path for the object in the template, may contain an origin resource path after a colon.
Point
  Control point.
Reference
  The template object.
Origin
  The template’s origin.
CloneType
EnableCache
KeepEditRatio (SubWindow only)
ContainerXform
  The transformation used to scale or otherwise transform the reference’s instance.
Bindings
  An array of bindings for rebinding instance’s attributes.

Series Object Attributes
  Factor
  CloneType
  LogType
  ZSort
  Inversed
  Persistent
  Shift
    Controls instance positioning. Changing the value of the attribute in the range of 0 to 1 may be used to animate the series by moving its instances along the path.
Path
  The transformation object used as a path.
StartOrigin
  The first point of the path transformation.
Origin
  The template’s origin point.
Template
  The template object.
InstanceArray
  A group containing template instances.

Square Series Object Attributes
  Rows
  Columns
  ZSort
  ColumnsFirst
  CloneType
  Persistent
  KeepEditRatio
  Point1, Point2, Point3
    Control points.
Template
  The template object.
InstanceArray
  A group containing template instances.
**Polyline Attributes**

- **Factor**
- **DrawMarkers**
- **DrawLines**
- **Segments**
- **CloneType**
- **Inversed**
- **Path**
  - The transformation object used as a path.

- **Polygon**
  - The line or segment’s template.

- **Point**
  - The marker’s template.

- **Points**
  - A group containing marker instances.

- **InstanceArray**
  - A group containing segment instances.

The polyline object also inherits attributes of its polygon template. These attributes may be accessed directly by querying the polyline.

**Polysurface Attributes**

- **Rows**
- **Columns**
- **DrawMarkers**
- **DrawLines**
- **ZSort**
- **CloneType**
- **Polygon**
  - The surface segment’s template.

- **Point1, Point2, Point3**
  - Control points.

- **Point**
  - The marker’s template.

- **Points**
  - A group containing marker instances.

- **InstanceArray**
  - A group containing segment instances.

The polysurface object also inherits attributes of its polygon template. These attributes may be accessed directly by querying the polysurface.

**Frame Object Attributes**

- **FrameType**
- **FrameFactor**
- **CPArray**
  - A group containing the frame’s control points.

- **CNArray**
  - A group containing the frame’s constrained points.
**Viewport Attributes**

- **Point1, Point2**
  Control points.
- **EdgeColor**
- **FillColor**
- **LineWidth**
- **ZSort**
- **Pan**
- **ActivePan**
  Read-only attribute, contains a bit mask composed of the GLG_PAN_X and GLG_PAN_Y binary flags indicating which scrollbars are currently displayed.
- **PanX**
  The horizontal scrollbar (viewport) of the integrated panning and zooming (if PanX is enabled).
- **PanY**
  The vertical scrollbar (viewport) of the integrated panning and zooming (if PanY is enabled).
- **PanSpacer**
  The spacer viewport of the integrated panning and zooming used in the lower right corner (if both PanX and PanY scrollbars are enabled).
- **ZoomEnabled**
- **ZoomFactor**
  Read-only attribute which may be queried to get the viewport’s current zoom factor.
- **ZoomToMode**
  Read-only attribute which may be queried to get the current state of multi-state zoom and pan actions: GLG_ZOOM_TO_STATE or GLG_PAN_DRAG_STATE. It may also contain the GLG_X исп or GLG_Y исп binary flags ORed with the return value to indicate ZoomToX / ZoomToY actions or the direction of the pan dragging.
- **ZoomModeObject**
  Read-only attribute which may be queried to get the chart or GIS object used for the Chart or GIS Zoom Mode.
- **XYRatio**
  Read-only attribute which may be queried to get the X/Y ratio of the viewport’s window.
- **InnerWidth**
- **InnerHeight**
  Read-only attributes which may be queried to get the viewport’s inner width and height.
- **ProcessMouse**
  Enables mouse event processing.
- **KeepEditRatio**
- **OwnsInputCB**
- **JavaScriptFile**
- **BaseWidth**
  A base width used for scaling text objects in the viewport.
- **Handler**
  A function object attached to the viewport as a handler.
- **DisableInput**
  Disables input events in the viewport.
- **Array**
  The group used by the viewport to contain the objects drawn in the viewport. The view and zoom transformations are attached to this group.
Screen

The screen object associated with the viewport.

The viewport also inherits most of the screen object’s attributes and all attributes of the light object attached to the viewport, so that they may be queried directly from the viewport.

**Screen Object Attributes**

- **DoubleBuffering**
- **Stretch**
- **PushIn**
- **CoordSystem**
- **ShellType**
- **WidgetType**
- **ShadowWidth**
- **AntiAliasing**
  - Controls anti-aliasing for the screen’s viewport. The default is ON.
- **Colortable**
- **Fonttable**
- **FonttableFile**
  - A filename of a GLG drawing containing a font table to be used for the viewport’s drawing.
- **ScreenName**
  - Window title when the screen is used as a top-level window.
- ** ExactColor**
- **GridInterval**
- **SpanX**
- **SpanY**
- **PreciseSize**
- **OpenGLHint**
  - A requested OpenGL mode.
- **OpenGL**
  - The current OpenGL mode (read-only).
- **ScreenName**
  - For screens of top-level viewports: Title to be used for the viewport’s window.
- **XHint**
- **YHint**
- **WidthHint**
- **HeightHint**
  - For screens of top-level viewports with both of viewports control points set to (0,0,0): requested position and dimensions of the viewport on initial appearance.
- **Width**
- **Height**
  - The current width and height of the screen’s viewport (read-only).
- **Widget**
  - Returns the Widget ID of the native widget used to render the screen and viewport.
- **Shell**
  - Returns the Widget ID of the highest level parent.
- **Drawable**
  - The drawable used for rendering. Returns the ID of the double-buffering pixmap when double-buffering is enabled.
- **Display**
  - Returns the Display pointer (X Windows only).
Display Name
Returns the display name.

TrueColor
Read-only attribute, is set to a non-zero value when the screen is displayed on a TrueColor display.

The screen also inherits most of the colortable object’s attributes which may be queried directly from both the screen and viewport object.

Light Viewport Attributes
Point1, Point2
Control points.

Background
A Line Attributes object containing attributes used to render the light viewport’s background.

ShadowWidth
Stretch
PushIn
CoordSystem
SpanX
SpanY
GridInterval
ZSort
ProcessMouse
Enables mouse event processing.

Handler
A function object attached to the viewport as a handler.

DisableInput
Disables input events in the viewport.

KeepEditRatio
OwnsInputCB
ZoomEnabled
ZoomFactor
Read-only attribute which may be queried to get the viewport’s current zoom factor.

ZoomToMode
Read-only attribute which may be queried to get the current state of multi-state zoom and pan actions: GLG_ZOOM_TO_STATE or GLG_PAN_DRAG_STATE. It may also contain the GLG_X_STATE or GLG_Y_STATE binary flags ORed with the return value to indicate ZoomToX / ZoomToY actions or the direction of the pan dragging.

XYRatio
Read-only attribute which may be queried to get the X/Y ratio of the viewport’s window.

InnerWidth

InnerHeight
Read-only attributes which may be queried to get the viewport’s inner width and height.

BaseWidth
A base width used for scaling text objects in the viewport.

Array
The group used by the viewport to contain the objects drawn in the viewport. The view and zoom transformations are attached to this group.

The light viewport also inherits attributes of its background object, so that they may be queried directly from the light viewport.
Chart Object Attributes

Point1, Point2
    Control points.
NumPlots
NumYAxes
NumLevels
NumTimeLines
NumAnnotations
CommonRange
AutoScroll
AutoScale
DrawGrid
Persistent
SortInput
BufferXSpan
BufferSize
YAxesOffset
TooltipMode
TooltipFormat
DrawOrder
DrawCrossHair
Plots
    A group containing the chart’s plots.
Levels
    A group containing the chart’s level objects.
TimeLines
    A group containing the chart’s time lines.
Annotations
    A group containing the chart’s annotations.
XAxis
    The chart’s X axis.
YAxisGroup
    A group containing the chart’s Y axes.
YAxis
    The first Y axis of the chart.
Background
    A Line Attributes object containing attributes of the chart’s drawing area.
Grid
    A Line Attributes object containing attributes of the chart’s grid.
SelectionMarker
    A Marker object used for annotating the selected data sample.
CrossHair
    A Line Attributes object containing attributes of the chart’s cross-hair cursor.
DrawSelected
    Controls drawing of the selection marker; may be reset to 0 at run time to erase the selection marker for a previous selection.
LegendContainer
    The chart’s legend, or the legend’s parent viewport if the legend is placed in a separate viewport.
SelectedDataSample
    A pointer to the GlgDataSample structure, may be used to query information about the selected sample at run time.
Plot Object Attributes

- **PlotType**
- **Enabled**
- **Annotation**
- **YLow**
- **YHigh**
- **ValueEntryPoint**
- **TimeEntryPoint**
- **ValidEntryPoint**
- **AutoScaleDelta**
- **LinkedAxis**
  - An object ID of the linked axis.
- **FilterType**
- **FilterPrecision**
- **FilterMarkers**
- **IncludeZero**
- **ExtendedData**
- **RangeLock**
- **NumSamples**
  - Read-only resource for querying the number of accumulated samples.
- **EdgeColor**
- **FillColor**
  - Fill color of a bar plot.
- **FillType**
  - Fill type of a bar plot.
- **LineWidth**
- **LineType**
- **Opacity**
- **AntiAliasing**
- **BarWidth**
  - The width of bars in a bar plot.
- **BarYLow**
  - The level of the bars’ lower edge in a bar plot.
- **LineAttr**
  - The Line Attributes object used to keep rendering attributes of the plot. The plot inherits the **EdgeColor, FillColor, LineWidth** and other line and bar rendering properties from this object.
- **Marker**
  - Defines marker attributes.
- **Array**
  - An internal group containing the plot’s data samples. Data samples are represented by the **GlgDataSample** structure.
- **Counter**
  - Keeps the incrementing current sample index for scrolling index charts.

Level Line Object Attributes

- **Level**
- **YLow**
- **YHigh**
- **Enabled**
- **RangeLock**
- **EdgeColor**
- **LineWidth**
LineType
Opacity
AntiAliasing
LineAttr
The Line Attributes object used to keep rendering attributes of the level line. The level line inherits the EdgeColor, LineWidth and other line resources from this object.

LinkedAxis
An object ID of the linked axis.

Annotation Object Attributes
AnnotationType
PositionX
PositionY
AbsoluteX
AbsoluteY
YLow
YHigh
Enabled
RangeLock
LinkedAxis
An object ID of the linked axis.
LabelFormat
Label
The Text object used to render the annotation’s label.
Marker
The Marker object used to render the annotation’s marker.

Legend Object Attributes
Point1, Point2
Control points.
LayoutType
AutoLayout
Anchoring
RowAnchoring
MinRowSize
MaxRowSize
DisplayValue
ValueFormat
LineLength
MinLineWidth
BarHeight
XOffset
YOffset
XSpacing
YSpacing
LabelXOffset
LabelYOffset
LabelMaxWidth
LabelMaxHeight
Label
A Text object whose attributes are used to render the legend’s labels.
Background
   A Line Attributes object that defines rendering attributes of a background box drawn around
   the legend.

Axis Object Attributes
   Point1, Point2
      Control points.
   AxisType
   AxisPosition
   Inversed
   DrawOutline
   RangeLock
   Low (range axis only)
   High (range axis only)
   EndValue (scrolling axis only)
   Span (scrolling axis only)
   RulerStart (ruler axis only)
   RulerScale (ruler axis only)
   LabelFormat (non-time axis only)
   TimeFormat (time axis only)
   MilliSecFormat (non-time axis only)
   MajorInterval
   MinorInterval
   AxisLabelString
   LowOffset (non-time axis only)
   HighOffset (non-time axis only)
   RoundedPlacement
   FixLeapYears (time axis only)
   MajorTickSize
   MinorTickSize
   LabelOffset
   LabelExtentRel
   LabelExtentAbs
   MajorOffset
   TimeOrigin (relative time axis only)
   TooltipFormat
   AxisLabelOffset
   AxisLabelPosition
   AxisLabelAnchoring
   Tick
      A Line Attributes object that defines rendering attributes of the axis’s minor and major ticks, as
      well as the attributes of the outline.
   TickLabel
      A Text object that defines rendering attributes used to draw the major tick labels.
   AxisLabel
      A Text object that used to draw the axis’s label.
   LabelFormatter
      A pointer to the label formatting function associated with the axis.

Line Attributes Object
   EdgeColor
   LineWidth
LineType
FillType
FillColor
Opacity
AntiAliasing

Light Object Attributes
LightType
LightPoint
LightDirection
LightCoefficient
AmbientCoefficient

Colortable Object Attributes
ColortableType
ColorFactor
  The requested number of colors.
NumColors
  The actual number of colors.
GradeHint
  The requested number of color grades.
NumGrades
  The actual number of color grades.
PatternFactor
  The requested number of dithering patterns.
NumPatterns
  The actual number of dithering patterns.
RenderColor
  The color to use for B&W rendering (when NumColors=1).
ColorCorrection
  If set to True, increases the brightness of dark colors.
PastelLevel
  A pastel color coefficient with a value between 0 and 1.

Font Table Object Attributes
NumFontTypes
NumFontSizes
FontArray
  A group used to hold the font table’s fonts

Font Object Attributes
FontName
XFontName
WinFontName
JavaFontName
FontPSName
MBFlag
  Multi-byte flag.
FontCharset
**Transformation Object Attributes**

- **XformType**
- **XformAttr1**
  - The first attribute object (any type).
- **XformAttr2**
  - The second attribute object (any type).
- **XformAttr3**
  - The third attribute object (any type).
- **XformAttr4**
  - The fourth attribute object (any type).
- **XformAttr5**
  - The fifth attribute object (any type).
- **XformAttr6**
  - The sixth attribute object (any type).
- **XformAttr7**
  - The seventh attribute object (any type).
- **Matrix**
  - The transformation’s matrix object.

**Action Object Attributes**

- **ActionType**
- **Trigger**
- **ProcessArmed**
- **ProcessDoubleClick**
- **MouseButton**
- **Enabled**
- **Tooltip**
  - Tooltip string for tooltip actions.
- **StateObj**
  - The object whose value is to be set for mouse feedback actions.
- **EventLabel**
- **ActionData**
  - Action data for SEND_EVENT actions.
- **Command**
  - Command data for SEND_COMMAND actions.

**Alias Object Attributes**

- **Alias**
  - The alias name.
- **ResPath**
  - The resource path to associate with the alias.

**History Object Attributes**

- **ScrollType**
- **VarName**
- **EntryPoint**
- **Inversed**
- **RollBack**
- **HistoryIndex**
  - The index of the current scroll iteration.
Data Object Attributes

- **DataType**
  The value of the data object, accessed using NULL as the resource name.
- **Value**
- **XfValue**
  The transformed value (value transformed with an xform attached to the data object; in world coordinates for control points).
- **UTF8Encoding** (S data objects only)
- **AlwaysChanged**
- **TagObject**
  An optional tag object attached to the data object. If a tag object is attached, the data object inherits the `TagName`, `TagSource`, `TagEnabled` and other tag attributes from the tag object.

Attribute Object Attributes

- **DataType**
- **DataRole**
  Creation type resource that determines the type of transformations that will affect the attribute.
- **Value**
  The value of the attribute object, accessed using NULL as the resource name.
- **XfValue**
  The absolute value (in screen coordinates for drawable control points).
- **UTF8Encoding** (S attribute object only)
- **AlwaysChanged**
- **TagObject**
  An optional tag object attached to the attribute object. If a tag object is attached, the attribute object inherits the `TagName`, `TagSource` and `TagComment` attributes from the tag object.
- **ExportTag**
  An optional export tag attached to the attribute object to define a public property.
- **DataObject**
  The base data object used for storing the attribute’s value.

Tag Object Attributes

- **TagType**
  Identifies the tag as a data or export tag (OEM).
- **TagName**
  Used to persistently identify the tag when browsing.
- **TagSource**
  Defines the mapping to a database field.
- **TagComment**
  Contains any user-defined information.
- **TagEnabled**
- **TagAccessType**
  May be used to designate the tag as output-only.

Function Object Attributes

- **FunctionName**
  The name of the function object (`GlgSlider`, `GlgButton`, etc.).
7.4 Appendix D: Global Parameters

The following lists names of global parameters used in the *GlgSetLParameter* and *GlgGetLParameter* functions:

- **“GlgReadOnlyStrings”** - controls if strings are writable (0) or read-only (1). Strings are read-only by default. May be changed only before the first call to *GlgInit*, and only if a static library is used.

- **“GlgFastAlloc”** - if set to 0, disables the GLG memory allocator and uses the system memory allocator. May be changed only before the first call to *GlgInit*, and only if a static library is used.

- **“GlgAllocBlockSize”** - controls the size of memory blocks requested from the system (1MB by default). May be changed only before the first call to *GlgInit*, and only if a static library is used.

- **“GlgMaxAllocSizeIndex”** - controls the maximum size of memory allocation requests handled by the GLG memory allocator. The maximum size is calculated by multiplying the value of the parameter by 8 (size of a double). Requests with the size greater or equal to the maximum size are passed to the system memory allocator. The default maximum size is 1KB. May be changed only before the first call to *GlgInit*, and only if a static library is used.

- **“GlgAllocBlockBytesLeft”** (read-only) - indicates the number of bytes left in the current memory block.

- **“GlgUsedAllocBlockCount”** (read-only) - contains the number of used memory blocks.

- **“GlgSpareAllocBlockCount”** (read-only) - contains the number of spare preallocated memory blocks.

- **“GlgSmallAllocCount”** (read-only) - contains the total number of memory allocations with sizes less than the maximum size controlled by the by *GlgMaxAllocSizeIndex*.

- **“GlgBigAllocCount”** (read-only) - contains the total number of memory allocations with sizes bigger than the maximum size.

- **“GlgAllocCount”** (read-only) - contains the total number of all memory allocations.

- **“GlgSmallAllocSize”** (read-only) - contains the combined size of all memory allocations with sizes less than the maximum size.

- **“GlgBigAllocSize”** (read-only) - contains the combined size of all memory allocations with sizes bigger than the maximum size.

- **“GlgAllocSize”** (read-only) - contains the combined size of all memory allocations.
$config, 413
$message, 244
64 bit, 46

A
Action, 428
ActiveX control
environment variables, 270
events, 244
extended API methods, 257
methods, 246
persistent properties, 244
properties, 240
security, 269
using from other applications, 239
ActiveX control API method
AddAnnotation, 256
AddPlot, 255
AddTimeLine, 255
ChangeObject, 253
ClearDataBuffer, 256
CreateTooltipStringExt, 260
DeleteAnnotation, 256
DeletePlot, 255
DeleteTimeLine, 255
DropObject, 254
GenerateImage, 252
GenerateImageCustom, 252
GetDataExtent, 256
GetDataType, 257
GetNamedPlot, 255
GetNativeComponent, 257
GetObjectName, 257
GetObjectType, 257
GetSelectedPlot, 255
GISConvert, 250
GISCreateSelection, 249
GISGetDataset, 250
GISGetElevation, 249
GlgGetMajorVersion, 255
GlgGetMinorVersion, 255
SaveImage, 251
SaveImageCustom, 252
SetAutoUpdateOnInput, 248
SetBrowserObject, 253
SetBrowserSelection, 254
SetEditMode, 254
SetLinkedAxis, 257
SetTraceViewport, 254
SetZoom, 248
SetZoomMode, 249
ActiveX control environment variable
GLG_ACTIVEV_IMAGE_FILE, 270
GLG_ACTIVEV_NON_SECURE_MODE, 270
GLG_ACTIVEV_PRINT_FILE, 270
GLG_ACTIVEV_SAVE_FILE, 270
ActiveX control event
HCallback, 246
Input, 244
Input2, 245
Ready, 246
Select, 245
Trace, 245
Trace2, 245
VCallback, 246
ActiveX control Extended API method
AddObjectAtExt, 258
AddObjectExt, 258
AddObjectToBottomExt, 258
AddObjectToTopExt, 258
CloneObjectExt, 259
ConstrainObjectExt, 259
ContainsObjectExt, 259
ConvertViewportType, 259
CopyObjectExt, 259
CreateObjectExt, 260
DeleteBottomObjectExt, 261
DeleteObjectExt, 261
DeleteTopObjectExt, 261
FindMatchingObjectsExt, 261
FindObjectExt, 261
FitObjectExt, 265
GetAlarmObjectExt, 264
GetDResourceExt, 262
GetDTagExt, 262
GetElementAsString, 262
GetElementExt, 262
GetGResourceExt, 262
GetGTagExt, 262
GetIndexExt, 263
GetLegendSelection, 263
GetNamedObjectExt, 263
<table>
<thead>
<tr>
<th>Function</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>GetNumParents</td>
<td>263</td>
</tr>
<tr>
<td>GetParentExt</td>
<td>263</td>
</tr>
<tr>
<td>GetParentViewportExt</td>
<td>263</td>
</tr>
<tr>
<td>GetResourceObjectExt</td>
<td>263</td>
</tr>
<tr>
<td>GetSizeExt</td>
<td>264</td>
</tr>
<tr>
<td>GetSResourceExt</td>
<td>262</td>
</tr>
<tr>
<td>GetSTagExt</td>
<td>262</td>
</tr>
<tr>
<td>GetStringIndexExt</td>
<td>263</td>
</tr>
<tr>
<td>GetTagObjectExt</td>
<td>263</td>
</tr>
<tr>
<td>GetViewportExt</td>
<td>264</td>
</tr>
<tr>
<td>GetXResourceExt</td>
<td>262</td>
</tr>
<tr>
<td>GetXTagExt</td>
<td>262</td>
</tr>
<tr>
<td>GetYResourceExt</td>
<td>262</td>
</tr>
<tr>
<td>GetYTagExt</td>
<td>262</td>
</tr>
<tr>
<td>GetZResourceExt</td>
<td>262</td>
</tr>
<tr>
<td>GetZTagExt</td>
<td>262</td>
</tr>
<tr>
<td>InverseExt</td>
<td>264</td>
</tr>
<tr>
<td>IsDemoExt</td>
<td>264</td>
</tr>
<tr>
<td>IsDrawableExt</td>
<td>264</td>
</tr>
<tr>
<td>IterateExt</td>
<td>264</td>
</tr>
<tr>
<td>LayoutObjectsExt</td>
<td>265</td>
</tr>
<tr>
<td>LoadObjectExt</td>
<td>265</td>
</tr>
<tr>
<td>LoadWidgetFromExt</td>
<td>265</td>
</tr>
<tr>
<td>LoadWidgetFromObjectExt</td>
<td>265</td>
</tr>
<tr>
<td>MoveObjectByExt</td>
<td>265</td>
</tr>
<tr>
<td>MoveObjectExt</td>
<td>265</td>
</tr>
<tr>
<td>PositionObjectExt</td>
<td>265</td>
</tr>
<tr>
<td>PrintExt</td>
<td>267</td>
</tr>
<tr>
<td>ReferenceObjectExt</td>
<td>267</td>
</tr>
<tr>
<td>ReleaseObjectExt</td>
<td>267</td>
</tr>
<tr>
<td>ReorderElementExt</td>
<td>267</td>
</tr>
<tr>
<td>ResetHierarchyExt</td>
<td>267</td>
</tr>
<tr>
<td>RootToScreenCoordExt</td>
<td>266</td>
</tr>
<tr>
<td>RotateObjectExt</td>
<td>265</td>
</tr>
<tr>
<td>SaveObjectExt</td>
<td>267</td>
</tr>
<tr>
<td>ScaleObjectExt</td>
<td>265</td>
</tr>
<tr>
<td>ScreenToWorldExt</td>
<td>266</td>
</tr>
<tr>
<td>SetDResourceExt</td>
<td>267</td>
</tr>
<tr>
<td>SetDResourceIfExt</td>
<td>267</td>
</tr>
<tr>
<td>SetDTagExt</td>
<td>267</td>
</tr>
<tr>
<td>SetElementExt</td>
<td>267</td>
</tr>
<tr>
<td>SetGResourceExt</td>
<td>268</td>
</tr>
<tr>
<td>SetGResourceIfExt</td>
<td>268</td>
</tr>
<tr>
<td>SetGTagExt</td>
<td>268</td>
</tr>
<tr>
<td>SetResourceFromObjectExt</td>
<td>268</td>
</tr>
<tr>
<td>SetResourceObjectExt</td>
<td>268</td>
</tr>
<tr>
<td>SetSResourceExt</td>
<td>268</td>
</tr>
<tr>
<td>SetSResourceFromDExt</td>
<td>268</td>
</tr>
<tr>
<td>SetSResourceFromDIfExt</td>
<td>268</td>
</tr>
<tr>
<td>SetSResourceFromD Ext</td>
<td>268</td>
</tr>
<tr>
<td>SetSTagExt</td>
<td>268</td>
</tr>
<tr>
<td>SetSTagFromDEXT</td>
<td>268</td>
</tr>
<tr>
<td>SetStartExt</td>
<td>268</td>
</tr>
<tr>
<td>SetupHierarchyExt</td>
<td>269</td>
</tr>
<tr>
<td>SetViewportExt</td>
<td>268</td>
</tr>
<tr>
<td>SetXformExt</td>
<td>268</td>
</tr>
<tr>
<td>SuspendObjectExt</td>
<td>269</td>
</tr>
<tr>
<td>TraceObjectExt</td>
<td>269</td>
</tr>
<tr>
<td>TranslatePointOriginExt</td>
<td>266</td>
</tr>
<tr>
<td>UnconstrainObjectExt</td>
<td>269</td>
</tr>
<tr>
<td>UpdateExt</td>
<td>269</td>
</tr>
<tr>
<td>WorldToScreenExt</td>
<td>266</td>
</tr>
</tbody>
</table>

**ActiveX control method**

<table>
<thead>
<tr>
<th>Function</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>AboutBox</td>
<td>252</td>
</tr>
<tr>
<td>CreateChartSelectionExt</td>
<td>259</td>
</tr>
<tr>
<td>CreateSelectionExt</td>
<td>260</td>
</tr>
<tr>
<td>CreateSelectionMessage</td>
<td>253</td>
</tr>
<tr>
<td>CreateSelectionNamesExt</td>
<td>253</td>
</tr>
<tr>
<td>CreateTagList</td>
<td>248</td>
</tr>
<tr>
<td>ExportStrings</td>
<td>251</td>
</tr>
<tr>
<td>ExportTags</td>
<td>251</td>
</tr>
<tr>
<td>GetDResource</td>
<td>246</td>
</tr>
<tr>
<td>GetDTag</td>
<td>246</td>
</tr>
<tr>
<td>GetGResource</td>
<td>247</td>
</tr>
<tr>
<td>GetGTag</td>
<td>247</td>
</tr>
<tr>
<td>GetModifierState</td>
<td>253, 254</td>
</tr>
<tr>
<td>GetSelectedName</td>
<td>252</td>
</tr>
<tr>
<td>GetSelectionButton</td>
<td>252</td>
</tr>
<tr>
<td>GetSResource</td>
<td>246</td>
</tr>
<tr>
<td>GetSTag</td>
<td>246</td>
</tr>
<tr>
<td>GetXResource</td>
<td>247</td>
</tr>
<tr>
<td>GetXTag</td>
<td>247</td>
</tr>
<tr>
<td>GetYResource</td>
<td>247</td>
</tr>
<tr>
<td>GetYTag</td>
<td>247</td>
</tr>
<tr>
<td>GetZResource</td>
<td>247</td>
</tr>
<tr>
<td>GetZTag</td>
<td>247</td>
</tr>
<tr>
<td>HasResourceObject</td>
<td>247</td>
</tr>
<tr>
<td>HasTagName</td>
<td>247</td>
</tr>
<tr>
<td>HasTagSource</td>
<td>247</td>
</tr>
<tr>
<td>ImportStrings</td>
<td>251</td>
</tr>
<tr>
<td>ImportTags</td>
<td>251</td>
</tr>
<tr>
<td>Print</td>
<td>251</td>
</tr>
<tr>
<td>SendMessage</td>
<td>250</td>
</tr>
<tr>
<td>SendMessageStr</td>
<td>250</td>
</tr>
<tr>
<td>SetDResource</td>
<td>246</td>
</tr>
<tr>
<td>SetDTag</td>
<td>246</td>
</tr>
<tr>
<td>SetGResource</td>
<td>247</td>
</tr>
<tr>
<td>SetGTag</td>
<td>247</td>
</tr>
<tr>
<td>SetSResource</td>
<td>247</td>
</tr>
<tr>
<td>SetSResourceFromD</td>
<td>247</td>
</tr>
</tbody>
</table>
SetSTag, 247
Update, 248
UpdateGlg, 248
ActiveX Control Properties, 240
using to set drawing resources, 242
ActiveX control property
AlarmsEnabled, 241
DataURL, 240
DLinkName, 243
DLinkValue, 243
DrawingFile, 240
DrawingImageFile, 240
DrawingURL, 240
GLinkName, 243
GLinkValue, 243
HProperty0, 242
InputEnabled, 241
PrintFile, 241
SelectEnabled, 241
SetupDataURL, 240
SLinkName, 243
SLinkValue, 243
SupressErrors, 241
TraceEnabled, 241
UpdatePeriod, 241
UseMapURL, 242
UseOpenGL, 241
VProperty0, 242
alarm
query by alarm label, 133
alarm events, 101
alarm handler, 101
prototype, 84
alias object
creating, 167
animating a drawing, 26
animation
manipulating resources, 61
arc
creating, 162
array
creating, 165
ASCII format, 25
converting files, 396
attribute
constraining, 123
Attribute classes, 355
attribute objects
creating, 167
Automatic Referencing and Dereferencing, 218
B
balloon tooltips, 414
bell, 53
binary format, 24
converting files, 396
boolean transformation
creating, 169
bounding box, 134
browser widget
message object, 437
button widget
message object, 431
C
C# class
GLG objects classes, 345
GLG utility classes, 332
C# enums, 284
C#/.NET applications, 24
C++
Extended API, 215
Intermediate API, 215
linking errors, 216
Standard API, 215
C++ API, 216
C/C++ applications, 23
call_data
input callback, 105
Motif input callback, 106
Motif selection callback, 104
selection callback, 103
trace callback, 106, 108
callback, 101
add before hierarchy setup, 51
adding, 51
removing, 51
timer, 52
callback data
see call_data
callback function
example, 113
input, 105
prototype, 102
selection, 103
selection example, 104
trace, 106, 107
callbacks
HInit, 103
multiple viewports, 51
VInit, 103
creating, 168
drawing
  animating, 26
  controlling, 26
  creating an image, 82
  displaying, 25
generating using a script, 375
generating using Extended API, 375
initializing, 53, 55
loading a sub-section, 57
loading by object ID, 33
loading from a file, 240
loading from file, 55
loading from memory, 56
memory image, 33
printing, 79, 251
saving an image, 81
setting default, 86
  using from MS Windows applications, 239
drawing compression, 395
drawing file
  save formats, 24
drawing file conversion utility, 396
drawing file format
  conversion utility, 396
drawing preparation, 25
dynamic resources, 34

E
editing an object, 152
entry point
  application program, 42, 50
enums
  C#, 284
environment variables
  ActiveX control environment variables, 270
  GLG_COMPATIBILITY_MODE, 425
  GLG_DEFAULT_COLOR_FACTOR, 424
  GLG_DEFAULT_COLOR_TABLE_TYPE, 424
  GLG_DEFAULT_FONT_FILE_NAME, 422, 423
  GLG_DEFAULT_FONT_TABLE_FILE, 422
  GLG_DEFAULT_NUM_COLOR_GRADES, 424
  GLG_DEFAULT_NUM_FONT_SIZES, 423
  GLG_DEFAULT_NUM_FONT_TYPES, 423
  GLG_DISABLE_PRE35_OBJECT_EVENTS, 425
  GLG_FONT_CHARSET, 423
  GLG_MAP_SERVER_USAGE, 421
  GLG_MAX_DB_FACTOR, 425
  GLG_MULTIBYTE_FLAG, 424
  error handler, 88
    custom, 48
  error log, 47
  error log file, 47
  error logging, 417
  error processing, 47
  event polling, 57
  example
    concatenate transformation, 171
    creating a polygon, 164
    input callback, 113, 115
    matrix transformation, 172
    selection callback, 110, 111
    selection callback function, 104
    expose event, 62
  Extended API, 119, 227
    function descriptions, 159
  extended API
    function descriptions, 204
  extended format, 25
    converting files, 396

F
  file conversion utility, 396
  focus messages
    propagating to Custom Control, 41
  font browser widget
    message object, 436
  Format, 427
  format
    ASCII, 25
    binary, 24
    extended, 25
  Format D transformation
    creating, 169
  Format S transformation
    creating, 169
  frame object
    creating, 162
    freeing a string, 71
    FreeStringID, 254
    full clone, 176
    FullOrigin, 427

G
  gcdegen, 25, 29, 33, 395
  gconvert, 29
  generating data, 376
Generic API, 49
  function summary, 49
  geometrical resource
    query, 72
GetFromCache, 333, 334, 339, 340
GetSelectedName, 245
GetStringID, 333
GLG, 32, 48
GLG C++ Bindings, 215
GLG Generic API, 49
  functions, 49
  Library, 44
GLG script, 380
GLG_COMPATIBILITY_MODE, 425
  glg_control_window, 40
GLG_CPP_EXTENDED_API, 215
GLG_CPP_INTERMEDIATE_API, 215
GLG_CPP_STANDARD_API, 215
GLG_DEFAULT_COLOR_FACTOR, 424
GLG_DEFAULT_COLOR_TABLE_TYPE, 424
GLG_DEFAULT_FONT_FILE_NAME, 422, 423
GLG_DEFAULT_FONT_TABLE_FILE, 422
GLG_DEFAULT_NUM_COLOR_GRADES, 424
GLG_DEFAULT_NUM_FONT_SIZES, 423
GLG_DEFAULT_NUM_FONT_TYPES, 423
GLG_DEFAULT_PS_FONT_FILE_NAME, 423
GLG_DIR environment variable, 48
GLG_DISABLE_PRE35_OBJECT_EVENTS, 425
  glg_error.log, 47
GLG_FONT_CHARSET_FLAG, 423
GLG_IH_NEW, 205
GLG_LOG_DIR environment variable, 48
GLG_MAP_SERVER_USAGE, 421
GLG_MAX_DB_FACTOR, 425
GLG_MULTIBYTE_FLAG, 424
GlgAddAnnotation, 183
GlgAddCallback, 191
GlgAddDataSample, 191
GlgAddObject, 173, 174
GlgAddObjectAt, 172
GlgAddObjectToBottom, 172
GlgAddObjectToTop, 172
GlgAddPlot, 184
GlgAddTimeLine, 184
GlgAddTimeOut, 52
GlgAddWorkProc, 52
GlgAlloc, 64
GlgAntiAliasing, 418
GlgApi.h, 50
GlgArc class, 346
GlgArrowShape, 413
GlgAxis class, 346
GlgBean
  Intermediate and Extended API, 298
    methods, 289
  Standard API, 289
GLGBean Extended API method
  AddObject, 302
  AddObjectToBottom, 302
  AddObjectToTop, 302
  CloneObject, 302
  ConstrainObject, 300
  ContainsObject, 299
  CopyObject, 302
  DeleteBottomObject, 302
  DeleteObject, 302
  DeleteTopObject, 302
  GetDResource, 300
  GetElement, 299
  GetIndex, 299
  GetNamedObject, 299
  GetNumParents, 300
  GetParent, 300
  GetResource, 300
  GetResourceId, 299, 303
  GetSize, 299
  GetSResource, 300
  GetXResource, 301
  GetYResource, 301
  GetZResource, 301
  Inverse, 300
  Iterate, 299
  Print, 301
  ReleaseObject, 300
  ReorderElement, 299
  SaveObject, 298
  SetDResource, 301
  SetGResource, 301
  SetResourceIdFromObject, 301
  SetSResource, 301
  SetSResourceIdFromD, 301
  SetStart, 299
  SetXform, 303
  SuspendObject, 300
  UnconstrainObject, 300
  Update, 301
  UpdateGLG, 301
GLGBean Java class, 285
GlgBean method
GetDrawingURL, 289, 295
Bell, 292
CreateIndexedName, 292
GetAPILog, 296
GetDataURL, 295
GetDrawingObject, 289
GetDTag, 290
GetFullPath, 295
GetHResource0, 296
GetHResource1, 296
GetHResource2, 296
GetHResource3, 296
GetHResource4, 296
GetIgnoreErrors, 298
GetJavaLog, 296
GetResourceLog, 296
GetSetupDataURL, 295
GetSTag, 290
GetSResource, 290
GetXTag, 290
GetTraceHref, 297
GetUpdatePeriod, 296
GetXResource, 290
GetYResource, 290
GetZResource, 290
TraceCallback, 294
Update, 291, 362
UpdateCallback, 298
GlgBell, 53
GlbBoxAttr class, 346
GlgButtonTooltipTimeout, 415
GlgChangeCursorOnGrab, 418
GlgChart class, 347
GlgChartFilter, 191
GlgClass.cpp, 216
GlgClass.h, 216
GlgClearDataBuffer, 185
GlgCloneObject, 175
GlgCompatibilityMode, 425
GlgCompressFormat, 416
GlgConcatResNames, 65
GlgConcatStrings, 66
GlgConstrainObject, 123
GlgContainsObject, 124
GlgControl, 286
Intermediate and Extended API, 298
methods, 289
SetAutoUpdateOnInput, 293
SetDataURL, 295
SetDrawingObject, 289, 290
SetDrawingURL, 289, 295
SetDResource, 290
SetGResource, 291
SetGTag, 291
SetHResource0, 296
SetHResource1, 296
SetHResource2, 296
SetHResource3, 296
SetHResource4, 296
SetIgnoreErrors, 297
SetJavaLog, 296
SetResourceLog, 296
SetSetupDataURL, 295
SetSResource, 290
SetSResourceFromD, 291
SetSTag, 290
SetTraceHref, 297
SetUpdatePeriod, 296
SetupHierarchy, 292
SetVResource0, 297
SetVResource1, 297
SetVResource2, 297
SetVResource3, 297
SetVResource4, 297
SetIgnoreErrors, 298
SetJavaLog, 296
SetResourceLog, 296
SetSetupDataURL, 295
SetSResource, 290
SetSResourceFromD, 291
SetSTag, 290
SetTraceHref, 297
SetUpdatePeriod, 296
SetupHierarchy, 292
SetVResource0, 297
SetVResource1, 297
SetVResource2, 297
SetVResource3, 297
SetVResource4, 297
TraceCallback, 294
Update, 291, 362
UpdateCallback, 298
GlgBell, 53
GlgBoxAttr class, 346
GlgButtonTooltipTimeout, 415
GlgChangeCursorOnGrab, 418
GlgChart class, 347
GlgChartFilter, 191
GlgClass.cpp, 216
GlgClass.h, 216
GlgClearDataBuffer, 185
GlgCloneObject, 175
GlgCompatibilityMode, 425
GlgCompressFormat, 416
GlgConcatResNames, 65
GlgConcatStrings, 66
GlgConstrainObject, 123
GlgContainsObject, 124
GlgControl, 286
Intermediate and Extended API, 298
methods, 289
Standard API, 289
GlgControlC, 234
GlgControlWindowProc, 42
GlgConvertViewportType, 124
GlgCopyObject, 175
GlgCreateChartSelection, 192, 446
   returned message, 427
GlgCreateDataSample, 193
GlgCreateIndexedName, 66
GlgCreateInversedMatrix, 124
GlgCreateObject, 172
GlgCreatePointArray, 125
GlgCreateResourceList, 125
GlgCreateSelection, 128
GlgCreateSelectionMessage, 127
GlgCreateSelectionNames, 127
GlgCreateTagList, 68
GlgCreateTooltipString, 193
GlgCube class, 334
GlgCustomDataLib, 416
GlgDataPoint class, 355
GlgDataSample class, 339
GlgDataSampleExt class, 340
GlgDataValue class, 355
GlgDDataPoint class, 355
GlgDDDataValue class, 356
GlgDebugEncoding, 422
GlgDebugFonts, 421
GlgDefaultCharset, 423
GlgDefaultColorFactor, 424
GlgDefaultColorTableType, 424
GlgDefaultDialogColor, 424
GlgDefaultFontFile, 422
GlgDefaultFontList, 422
GlgDefaultFontTable, 422
GlgDefaultFontTableFile, 422
GlgDefaultFontURL, 422
GlgDefaultNumColorGrades, 424
GlgDefaultNumFontSizes, 423
GlgDefaultNumFontTypes, 423
GlgDefaultPSFontFile, 423
GlgDefaultPSFontURL, 423
GlgDefaultXftFontFile, 423
GlgDeleteAnnotation, 185
GlgDeleteBottomObject, 177
GlgDeleteDataSample, 193
GlgDeleteObject, 177
GlgDeleteObjectAt, 177
GlgDeletePlot, 186
GlgDeleteThisObject, 179
GlgDeleteTimeLine, 186
GlgDeleteTopObject, 177
GlgDisableIndexedColors, 425
GlgDisablePre35ObjectEvents, 425
GlgDouble class, 332
GlgDoubleClickDelta, 415
GlgDoubleClickTimeout, 415
GlgDropObject, 129
GlgDynArray class, 347
GlgEdgeData, 402
GlgEdgeEndNode, 402
GlgEdgeGraphics, 402
GlgEdgeStartNode, 402
GlgEdgeTemplate, 402
GlgEdgeType, 402
GlgError, 69
GlgEvent C# class, 336
GlgEventArgs C# class, 337
GlgExportStrings, 69
GlgExportTags, 70
GlgFindFile, 70
GlgFindMatchingObjects, 130
GlgFindMatchingObjectsData, 131
GlgFindMatchingObjectsData class, 341
GlgFindObject, 129
GlgFitObject, 133
GlgFlush, 179
GlgFont class, 347
GlgFontCharset, 423
GlgFontTable class, 348
GlgFrame class, 348
GlgFree, 71
GlgFunction class, 348
GlgGDataPoint class, 355
GlgGDataValue class, 356
GlgGenerateImage, 82
GlgGenerateImageCustom, 82
GlgGenerateImageCustom, 82
GlgGetAlarmObject, 133
GlgGetBoxPtr, 134
GlgGetDataType, 71
GlgGetDResource, 71
GlgGetDTag, 71
GlgGetElement, 135
GlgGetGResource, 72
GlgGetGTag, 72
GlgGetIndex, 135
GlgGetLegendSelection, 194
GlgGetLParameter, 465
GlgGetMajorVersion, 73
GlgGetMatrixData, 136
GlgGetMinorVersion, 73
GlgGetModifierState, 73
GlgGetNamedObject, 136
GlgGetNativeComponent, 73
GlgGetObjectName, 74
GlgGetObjectType, 75
GlgGetParent, 137
GlgGetParentViewport, 137, 156
GlgGetResourceObject, 138
GlgGetSelectedPlot, 188
GlgGetSelectionButton, 75, 103
GlgGetSize, 138
GlgGetSResource, 75
GlgGetSTag, 75
GlgGetStringIndex, 138
GlgGetTagObject, 139
GlgGetWindowViewport, 40
GlgGISConvert, 196
GlgGISCreateSelection, 197
GlgGISGetDataset, 198
GlgGISGetElevation, 198
GlgGISPickResolution, 415
GlgGISRequestData class, 342
GlgGraphAddEdge, 407
GlgGraphAddNode, 406
GlgGraphCreate, 404
GlgGraphCreateGraphics, 405
GlgGraphCreateRandom, 411
GlgGraphDefEdgeIcon, 403
GlgGraphDefNodeIcons, 403
GlgGraphDefViewportIcon, 403
GlgGraphDeleteEdge, 408
GlgGraphDeleteNode, 407
GlgGraphDestroy, 361, 404
GlgGraphDestroyGraphics, 405
GlgGraphDimensions, 403
GlgGraphEdge class, 359
GlgGraphEdge Macros, 402
GlgGraphEdgeArray, 403
GlgGraphEndTemperature, 403
GlgGraphError, 411
GlgGraphFindEdge, 409
GlgGraphFindNode, 409
GlgGraphFinished, 403
GlgGraphGetNodePosition, 408
GlgGraphGetUntangle, 410
GlgGraphGetViewport, 406
GlgGraphIncreaseTemperature, 410
GlgGraphIteration, 403
GlgGraphLayout class, 360
GlgGraphLayout Macros, 403
GlgGraphNode class, 359
GlgGraphNode Macros, 401
GlgGraphNodeArray, 403
GlgGraphNodeConnected, 409
GlgGraphPalette, 403
GlgGraphScramble, 411
GlgGraphSetDefaultPalette, 405
GlgGraphSetNodePosition, 408
GlgGraphSetPalette, 404
GlgGraphSetUntangle, 410
GlgGraphSpringIterate, 406
GlgGraphTerminate, 404
GlgGraphUnloadDefaultPalette, 405
GlgGraphUpdate, 406
GlgGraphUpdateRate, 403
GlgGridPolygon, 413
GlgHasResourceObject, 76
GlgHasTagName, 76
GlgHasTagSource, 76
GlgHierarchyData class, 335
GlgHierarchyEventArgs C# class, 338
GlgHighlightPolygon, 413
GlgHistory class, 348
GlgHttpRequestData class, 357
GlgHttpRequestProcessor class, 357
GlgIHArray, 425
GlgIHCallCurrIH, 209
GlgIHCallCurrIHWithModifToken, 209
GlgIHCallCurrIHWithToken, 208
GlgIHCallPrevIHWithModifToken, 209
GlgIHCallPrevIHWithToken, 209
GlgIHChangeDParameter, 212
GlgIHChangeIParameter, 212
GlgIHChangeOParameter, 212
GlgIHChangePParameter, 212
GlgIHChangeSParameter, 212
GlgIHGetCurrIH, 209
GlgIHGetCurrIHWithModifToken, 209
GlgIHGetCurrIHWithToken, 208
GlgIHGetPrevIHWithModifToken, 209
GlgIHGetPrevIHWithToken, 209
GlgIHChangeDParameter, 212
GlgIHChangeIParameter, 212
GlgIHChangeOParameter, 212
GlgIHChangePParameter, 212
GlgIHChangeSParameter, 212
GlgIHGetCurrIH, 209
GlgIHGetDParameter, 212
GlgIHGetFunction, 209
GlgIHGetIParameter, 209
GlgIHGetOParameter, 212
GlgIHGetOptDParameter, 212
GlgIHGetOptOParameter, 212
GlgIHGetOptPParameter, 212
GlgIHGetOptSParameter, 212
GlgIHGetPParameter, 212
GlgIHGetPrevFunction, 210
GlgIHGetPrevIH, 210
GlgIHGetSParameter, 212
GlgIHGetToken, 210
GlgIHGetType, 208
GlgIHGlobalData, 204
GlgIHInit, 204
GlgIHInstall, 204
GlgIHPassToken, 210
GlgIHRsetup, 206
GlgIHSetDParameter, 211
GlgIHSetIParameter, 211
GlgIHSetOParameter, 211
GlgIHSetPParameter, 211
GlgIHSetSParameter, 211
GlgIHStart, 205
GlgIHTerminate, 204
GlgIHUninstall, 207
GlgIHUninstallWithEvent, 207
GlgIHUninstallWithToken, 207
GlgImage class, 349
GlgImportStrings, 77
GlgImportTags, 77
GlgIndexedColorData, 424
GlgIndexedColorFile, 424
GlgIndexedColorTable, 424
GlgIndexedColorTableFile, 424
GlgInit, 53, 55
GlgInitialDraw, 55
GlgInputEventArgs C# class, 337
GlgIsDrawable, 140
GlgIterate, 140
GlgJavaScriptArgCheck, 417
GlgJavaScriptFile, 417
GlgJBean Java class, 285
GlgJLWBean Java class, 285
GlgLabelFormatter, 189
GlgLatLonPoint class, 343
GlgLayoutObjects, 141
GlgLineAttr class, 349
GlgLevelLine class, 349
GlgLight class, 350
GlgLineAttr class, 349
GlgLinkC, 233
GlgList class, 349
GlgLoadObject, 143
GlgLoadObjectFromImage, 143, 395
GlgLoadObjectFromFile, 55
GlgLoadWidgetFromFile, 55
GlgLoadWidgetFromImage, 56
GlgLoadWidgetFromObject, 56
GlgLocaleType, 416
GlgLogLevel, 417
GlgMain, 42, 50
GlgMain.h, 42, 50
GlgMainLoop, 57
GlgMapServerUsage, 421
GlgMarker class, 350
GlgMatrix class, 356
GlgMaxDBFactor, 425
GlgMinMax class, 338
GlgMouseTooltipTimeout, 415
GlgMoveObject, 144
GlgMoveObjectBy, 145
GlgMultibyteFlag, 424
GlgNativeTooltip, 414
GlgNodeAnchor, 402
GlgNodeData, 401
GlgNodeDisplayPosition, 401
GlgNodeGraphics, 402
GlgNodeLinkArray, 402
GlgNodePosition, 402
GlgNodeTemplate, 402
GlgNodeType, 401
GlgObject class, 303
C# enums, 303
Chart-related methods, 324
Extended API methods, 323
Intermediate API methods, 314
Java constants, 303
methods, 303
Standard API, 303
GlgObject class Extended API method
AddObject, 323
AddObjectToBottom, 323
AddObjectToTop, 323
CloneObject, 323
ContainsObject, 315
CopyObject, 323
DeleteBottomObject, 323
DeleteObject, 323, 324
DeleteTopObject, 323
GetResourceObject, 324
SetElement, 324
SetXForm, 324
GlgObject class Intermediate API method
AbortGISRequest, 331
AddDataSample, 326
ConstrainObject, 317
ConvertViewportType, 322
CreateChartSelection, 327
CreateDataSample, 327
CreateInversedMatrix, 318
CreatePointArray, 322
CreateResourceList, 322
CreateSelection, 321
CreateSelectionMessage, 321
CreateSelectionNames, 321
CreateTooltipString, 328
FindMatchingObjects, 322
FitObject, 319
Flush, 316
GetAlarmObject, 317
GetBox, 318
GetDrawingMatrix, 318
GetElement, 315
GetGISRequestInfo, 332
GetIndex, 315
GetLegendSelection, 327
GetMatrixData, 318
GetNamedObject, 315
GetNumParents, 318
GetParent, 318
GetParentViewport, 320
GetResource, 316
GetResourceObject, 316
GetSize, 315
GetStringIndex, 315
GetTagObject, 317
InstallGISRequest, 331
Inverse, 316
IsDrawable, 322
Itrate, 315
LayoutObjects, 319
MoveObject, 318
MoveObjectBy, 319
PositionObject, 319
PositionToValue, 328
ReleaseObject, 318
ReorderElement, 315
RequestGISMap, 331
RequestGISZoom, 330
RootToScreenCoord, 320
RotateObject, 319
SaveObject, 314
ScaleObject, 319
ScreenToWorld, 320
SetMatrixData, 320
SetResource, 316
SetStart, 315
SuspendObject, 318
TraceObject, 322
TransformPoint, 318, 319
TranslatePointOrigin, 320
UnconstrainObject, 317
WorldToScreen, 320
GlgObject class method
AddAnnotation, 325
AddListener, 311
AddPlot, 324
AddTimeLine, 325
Bell, 313
CatchGlobalErrors, 312
ChangeObject, 313
ClearDataBuffer, 326
ConcatResNames, 308
CreateImage, 308
CreateImageCustom, 308
CreateIndexedName, 308
CreateTagList, 310
DeleteAnnotation, 325
DeletePlot, 325
DeleteTimeLine, 325
Error, 312
ExportStrings, 306
ExportTags, 307
GetDataExtent, 326
GetDResource, 309
GetDTag, 309
GetGResource, 309
GetGTag, 309
GetModifierState, 313
GetNamedPlot, 324
GetNativeComponent, 314
GetSelectedPlot, 324
GetSResource, 309
GetSTag, 309
GetStackTraceAsString, 313
GetSTag, 309
GetWidgetPassword, 314
GISConvert, 329
GISCreateSelection, 330
GISGetElevation, 330
GlmConvert, 329
HasResourceObject, 310
HasTagName, 310
HasTagSource, 310
ImportStrings, 307
ImportTags, 307
Init, 310
InitialDraw, 304
LoadObject, 305
LoadWidget, 305
Lock, 311
NativePrint, 307
Print, 307
Rand, 313
Reset, 306
ResetHierarchy, 304
SendMessage, 306
SetBrowserObject, 313
SetBrowserSelection, 313
SetChartFilter, 326
SetDResource, 309
SetDTag, 309
SetEditMode, 313
SetErrorHandler, 306, 311
SetGResource, 309
SetGTag, 309
SetImageSize, 314
SetLabelFormatter, 326
SetLinkedAxis, 326
SetResourceFromObject, 310
SetResource, 310
SetResourceFromD, 310
SetSTag, 310
Set TooltipFormatter, 314
SetUpHierarchy, 303
SetZoom, 304
SetZoomMode, 304
Sleep, 313
Sync, 311
Terminate, 311
Unlock, 311
UnlockThread, 311
Update, 306
UpdateImmediately, 306

G1gObject Java class Extended API method
  CreateTooltipString, 231
  PositionToValueExt, 266
G1gObjectC, 220
G1gOnDrawMetafile, 78
G1gOnPrint, 78
G1gOpenGLDepthOffset, 421
G1gOpenGLHardwareThreshold, 420
G1gOpenGLMode, 419
G1gOpenGLThreshold, 420
G1gOpenGLVersion, 420
G1gPanDragButton, 415
G1gParallelogram class, 350
G1gPickResolution, 415
G1gPlot class, 351
G1gPoint class, 333, 335
G1gPolygon class, 351
G1gPolyline class, 351
G1gPolySurface class, 351
G1gPositionObject, 145
G1gPositionToValue, 194
G1gPrint, 79
G1gPSLevel, 416
G1gRand, 57
G1gReference class, 352
G1gReferenceObject, 146
G1gReleaseObject, 147
G1gRemoveTimeOut, 57
G1gRemoveWorkProc, 58
G1gReorderElement, 148
G1gReset, 80
G1gResetHierarchy, 58
G1gResourceReference class, 352
G1gRootToScreenCoord, 148
G1gRotateObject, 149
G1gSaveFormat, 416
G1gSaveImage, 81
G1gSaveImageCustom, 81
G1gSaveObject, 149
G1gScaleObject, 150
G1gScreen class, 352
G1gScreenToWorld, 151
G1gSDataPoint class, 355
G1gSDataValue class, 356
G1gSearchPath, 416
G1gSelectAllOnFocus, 417
G1gSelectEventArgs C# class, 337
G1gSendMessage, 83
G1gSeries class, 353
G1gSessionC, 219
G1gSetAlarmHandler, 84
G1gSetBrowserObject, 84
G1gSetBrowserSelection, 85
G1gSetChartFilter, 190
G1gSetCursor, 85
G1gSetDefaultViewport, 86
G1gSetDResource, 86
G1gSetDResourceIf, 86
G1gSetDTag, 86
G1gSetEditMode, 87
G1gSetElement, 179
G1gSetFocus, 88
GlgSetGResourceIf, 89
GlgSetGTag, 89
GlgSetLabelFormatter, 189
GlgSetLinkedAxis, 188
GlgSetLParameter, 73, 465
GlgSetMatrixData, 152
GlgSetResourceObject, 180
GlgSetSResourceFromDIF, 91
GlgSetSResourceIf, 90
GlgSetSTag, 90
GlgSetSTagFromD, 91
GlgSetStart, 152
GlgSetTooltipFormatter, 92
GlgSetupHierarchy, 58
GlgSetXform, 181
GlgSetZoom, 93
GlgSetZoomMode, 96
GlgSleep, 59
GlgSpline class, 353
GlgSquareSeries class, 353
GlgStrClone, 97
GlgSuspendObject, 152
GlgTabNavigation, 417
GlgTag class, 353
GlgTerminate, 59
GlgText class, 354
GlgTooltipBGColor, 414
GlgTooltipEraseDistance, 414
GlgTooltipFormatter, 92
GlgTooltipLabelColor, 414
GlgTouchTooltipTimeout, 415
GlgTraceData class, 336
GlgTraceEventArgs C# class, 338
GlgTraceObject, 155
GlgTransformObject, 153
GlgTransformPoint, 154
GlgTranslatePointOrigin, 154
GlgTraverseObjects, 156
GlgUnconstrainObject, 156
GlgUpdate, 97
GlgUtMgrs class, 344
GlgUtMPoint class, 344
GlgViewport class, 354
GlgWinPrint, 98
GlgWorldToScreen, 157
GlgWrapperC, 235
GlgXform class, 354
GlgXftFonts, 421
GlgXPrintDefaultError, 98
GlgZoomToButton, 415

glm_error.log, 48
GLM_LOG_DIR environment variable, 48
GlmConvert, 199
GlmMaxIterations, 426
global configuration resources, 413
global resources
GlgAntiAliasing, 418
GlgArrowShape, 413
GlgButtonTooltipTimeout, 415
GlgChangeCursorOnGrab, 418
GlgCompatibilityMode, 425
GlgCompressFormat, 416
GlgCustomDataLib, 416
GlgDebugEncoding, 422
GlgDebugFonts, 421
GlgDebugXftFonts, 421
GlgDefaultCharset, 416
GlgDefaultColorFactor, 424
GlgDefaultColorTableType, 424
GlgDefaultDialogColor, 424
GlgDefaultFontFile, 422
GlgDefaultFontList, 422
GlgDefaultFontTable, 422
GlgDefaultFontTableFile, 422
GlgDefaultNumColorGrades, 424
GlgDefaultNumFontSizes, 423
GlgDefaultNumFontTypes, 423
GlgDefaultPSFontFile, 423
GlgDefaultPSFontURL, 423
GlgDefaultXftFontFile, 423
GlgDisableIndexedColors, 425
GlgDisablePre35ObjectEvents, 425
GlgDoubleClickDelta, 415
GlgDoubleClickTimeout, 415
GlgFontCharset, 423
GlgGISElevationLayer, 421
GlgGISPickResolution, 415
GlgGridPolygon, 413
GlgHighlightPolygon, 413
GlgIHAarray, 425
GlgIndexedColorData, 424
GlgIndexedColorFile, 424
GlgIndexedColorTable, 424
GlgIndexedColorTableFile, 424
GlgJavaScriptArgCheck, 417
GlgJavaScriptFile, 417
GlgLocaleType, 416
GlgLogLevel, 417
GlgMapServerUsage, 421
GlgMaxY Factor, 425
GlgMultibyteFlag, 424
GlgNativeTooltip, 414
GlgOpenGLDepthOffset, 421
GlgOpenGLHardwareThreshold, 420
GlgOpenGLMode, 419
GlgOpenGLThreshold, 420
GlgOpenGLVersion, 420
GlgOpenGLZSort, 420
GlpPanDragButton, 415
GlgPickResolution, 415
GlgPSLevel, 416
GlgSaveFormat, 416
GlgSearchPath, 416
GlgSelectAllOnFocus, 417
GlgTabNavigation, 417
GlgTooltipBackgroundColor, 414
GlgTooltipEraseDistance, 414
GlgTooltipLabelColor, 414
GlgTooltipTextAlignment, 414
GlgTouchTooltipTimeout, 415
GlgXftFonts, 421
GlgZoomToButton, 415
GlmMaxIterations, 426
GrabPointer, 429
Graph Layout
  java package, 358
grid attributes
  defining from a program, 413
group
  adding to, 172, 173
  creating, 165
  current position, 174
  deleting object from, 177
  finding object in, 129
  getting the size, 138, 179
  initializing current position, 152
  traversing, 140
GTK integration, 23, 47

I
  identity transformation
    creating, 169
  Image generation, 81, 82
  image object
    creating, 163
  ImageLoad event
    input callback, 444
  include files, 123
  input callback, 27, 101, 105
    adding, 51
    browser, 437
    button, 431
    clock, 435
    command event, 442
    custom event, 439
    example, 111, 113, 115
    font browser, 436
    ImageLoad event, 444
    knob, 430
    list, 433
    menu, 434
    object selection, 445
    option, 434
    palette, 436
    slider, 429
    TemplateLoad event, 445
    text, 432, 433
    timer, 435
    tooltip event, 443
    UpdateDrawing event, 444
    window event, 447
input object
  disable for editing, 87
  Installable Interface Handlers API, 201
  integer data
    generating, 378
  Interaction handlers
    adding custom handlers from a program, 425
    Intermediate API, 119, 227
    function descriptions, 123
    invoking the file conversion utility, 396
    iterate
      over members of a group, 140

J
  Java applications, 23
  Java bean, 272
  Java class
    GLG objects classes, 345
GLG utility classes, 332
Java interface
   GlgAlarmHandler, 281
   GlgChartFilter, 282
   GlgErrorHandler, 281
   GlgGISRequestObserver, 284
   GlgHierarchyListener, 279
   GlgHLListener, 279
   GlgInputListener, 278
   GlgLabelFormatter, 282
   GlgObjectActionInterface, 283
   GlgReadyListener, 280
   GlgSelectListener, 278
   GlgTooltipFormatter, 283
   GlgTraceListener, 279
   GlgVListener, 280
JavaScript applications, 24

K
knob widget
   message object, 430

L
libglg, 44
libglg_x11, 47
linear data
   generating, 378
linear transformation
   creating, 169
linking
   MS Windows, 46
   static, 46
   under X Windows, 44
list
   creating, 165
list transformation
   creating, 168
list widget
   message object, 433
load drawing file, 143
load drawing from memory, 143
loading a widget into memory, 25
loading drawing files, 24
loading from memory image
   creating the image, 395
logging, 417
logging errors, 47

M
main loop, 57
marker
   creating, 163
matrix
   invert, 124
matrix transformation
   creating, 170
   example, 172
   invert matrix, 124
   query matrix, 135
memory image
   creating, 395
memory management
   freeing unused memory, 70, 71
   reference count, 122
menu widget
   message object, 434
message object, 108, 427
   browser, 437
   button, 431
   chart, 447
   chart selection, 446
   clock, 435
   command event, 442
   cross-hair, 447
   custom event, 439
   font browser, 436
   ImageLoad event, 444
   input callback data, 105
   knob, 430
   list, 433
   menu, 434
   object selection, 445
   option, 434
   palette, 436
   slider, 429
   TemplateLoad event, 445
   text, 432, 433
   timer, 435
   tooltip event, 443
   UpdateDrawing event, 444
   window event, 447
   zooming, 438
messages
   propagating with Custom Control, 41
MFC
   OnPrint method, 78
Motif
   selection callback, 104
Motif input callback, 106
Motif wrapper widget, 32
mouse buttons, 75
move transformation
    creating, 170
MS Windows
    printing, 98

N
named resource
    finding object ID, 138
native printing, 98
native widgets
    Motif wrapper widget, 32

O
Object, 428
object
    adding to container, 172
    align and layout operations, 141
    bounding box, 134
    copying, 175
    creation, 159
    deleting from container, 177
dereferencing, 129
editing, 152
example, 164
find parent, 137
finding, 129
loading from file, 143
loading from memory, 143
parent, 137
release, 147
saving to file, 149
selection, 127, 128
setting width and height, 141
unconstraining, 156
object hierarchy
    creating, 36
    resetting, 58
    setting up, 58
object ID, 33, 64
    obtaining, 37, 40
object selection
    input callback, 445
OpenGL
    core profile, 47
    shaders, 47
OpenGL libraries, linking with, 47
option widget
    message object, 434
Origin, 427

P
palette messages
    propagating to Custom Control, 41
palette widget
    message object, 436
    pan, 93
parallelogram
    creating, 163
    parent object, 137
path transformation
    creating, 171
pick resolution
    defining from a program, 415
polygon
    as container, 173, 174
    creating, 163
polyline
    creating, 163
polysurface
    creating, 163
PostScript, 79
    setting level from a program, 416
printing
    drawing, 79, 81, 82
    program entry point, 42, 50
programming tools, 29
programming utilities, 29

Q
Qt integration, 23, 47

R
random data
    generating, 377
random number generation, 57
range check transformation
    creating, 169
range conversion transformation
    creating, 169
read-only strings mode, 465
Rectangle class, 334
reference count, 122
    decrementing, 122
    incrementing, 146
reference object
    creating, 166
release object, 147
ReleaseToCache, 333, 334, 339, 340
RepeatEnd, 429
RepeatStart, 429
resetting a widget, 80
resource
  composite name, 65
  configuration, 413
  create list, 125
  enumerated name, 66
  existence check, 76
  geometrical, 72
  query object ID, 138
  querying, 246
  scalar, query, 71
  scalar, setting, 86
  setting, 246
  setting initial value, 39
  string, query, 75, 78
  update values, 97
resource browser widget
  setting an object to browse, 84, 85
resources
  affecting hierarchy, 27
  wrapper widget, 33
  wrapper widget summary, 37
rotate transformation
  creating, 170

S
save format
  conversion utility, 396
  enabling compression from a program, 416
  specifying from a program, 416
save formats, 24
saving object to file, 149
scalar resource
  query, 71
  setting, 84, 85, 86
scale transformation
  creating, 170
scriping, 375
script, 380
script commands, 380
  add_copy, 392
  add_custom_property, 388
  add_data_tag, 389
  add_export_tag, 388
  add_field, 382
  add_new, 392
  add_public_property, 388
  constrain_object, 394
  copy, 393
  create, 390
create_record, 382
delete, 393
delete_custom_property, 389
delete_data_tag, 390
delete_export_tag, 389
delete_public_property, 389
delete_record, 383
drop, 387
end_read, 383
get_export_tag, 389
get_tag, 385
get_value, 385
GLG Graphics Builder, 380
load_object, 387
print, 381
read_one_record, 383
read_records, 383
reference, 387
select_container, 386
select_element, 387
select_object, 385
set_resource_object, 387
set_tag, 381
set_value, 380
skip_end, 385
skip_if_no_resource, 384
skip_if_resource, 385
update, 381
scroll, 93
Search path
  setting from a program, 416
Secure mode, 269
security
  ActiveX control security, 269
select callback, 27
SelectEnabled, 286
selecting named objects, 127
selecting objects, 128
selection callback, 103
  example, 104, 110
  query, 75
serialization method, 315
series
  creating, 166
SetCursor, 254
shallow clone, 176
shear transformation
  creating, 170
sine function
  generating data, 378
sleep, 59
slider widget
message object, 429
smap transformation
creating, 168
square series
creating, 166
stdio.h, 216
stochastic simulation, 57
stopwatch widget
message object, 435
string
copying, 97
freeing, 71
string array
creating, 165
String Concatenation transformation
creating, 169
string manipulation
GlgConcatResNames, 65
GlgConcatStrings, 66
GlgCreateIndexedName, 66
string resource
query, 75
string tag
query, 75
strong clone, 176
SubAction, 428
supplying animation data, 376
suspending
application program, 59
suspension
for editing, 152
release, 147

T

tab navigation, 417
tag
animating with data, 378
existence check, 76
geometrical, 72
query by tag name or tag source, 139
scalar, query, 71
scalar, setting, 86
tag list query
GlgCreateTagList, 68
TemplateLoad event
input callback, 445
text object
creating, 163
text widget
message object, 432, 433, 435
threshold transformation
creating, 168
Time Format transformation
creating, 169
timer callback, 52
removing, 57
timer ID, 52
timer procedure
adding, 52
timer transformation
creating, 169
timer widget
message object, 435
tools, 29
tooltip event
input callback, 443
touch screen support, 418
trace callback, 27, 128
trace callbacks, 106
Trace2Enabled, 286
TraceEnabled, 286
transfer transformation
creating, 169
transformation
adding and deleting, 181
all object points, 153, 319
creating, 168
fitting an object, 133
moving an object by a vector, 144
moving an object by distance, 145
positioning an object, 145
rotating an object, 149
scaling an object, 150
single point, 154
transformation matrix
invert, 124
query, 135
translation transformation
creating, 170
traversal order, 417

U

unconstraining an object, 156
UngrabPointer, 429
update, 97
UpdateDrawing event
input callback, 444
V
resources, 27
ValueChanged, 429
VB.NET and VB6 applications, 24
viewport
   as container, 173, 174
   creating, 165
   handle, 64
viewport handle, 40
obtaining, 37, 40

W
weak clone, 176
widget
   creating, 24
   destroying, 59
   initial drawing, 55
   initializing, 53
   loading from file, 55
   loading from memory, 56
   loading from object, 56
   loading into memory, 25
   pan, 93
   printing, 79, 81, 82
   resetting, 80
   update, 97
   using from MS Windows applications, 239
   zoom, 93
window procedure, 42
   example, 41
work procedure
   adding, 52
   removing, 58
Wrapper Widget, 32
wrapper widget, 32
   callback resources, 35
   creating, 32
   destroying, 38
   dynamic resources, 34
   multiple, 86
   platform-independent substitute, 49
   resource summary, 37
   resources, 33
   sequence of events, 36
   setting drawing resources, 34
   writable strings mode, 465

X
X resources
   using to set drawing resources, 35

XoglGetWidgetViewport, 32, 37
XmManager, 32, 33
XSetErrorHandler, 48
Xt wrapper widget, 32
XtCreateWidget, 32
XtDestroyWidget, 32, 38
XtError, 48
XtNoglDrawingFile, 33
XtNoglDrawingImage, 33
XtNoglDrawingObject, 33
XtNoglHResource0, 34
XtNoglImageSize, 33
XtNoglVResource0, 34
XtSetArgs, 34
zoom, 93
zooming
   message object, 438