OpenGL® ES Native Platform Graphics Interface
(Version 1.0)

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Chapter 1

Overview

This document describes EGL, the interface between OpenGL ES and the underlying native platform window system. It refers to concepts discussed in the OpenGL ES specification, and may be viewed as an appendix to that document. EGL uses OpenGL ES conventions for naming entry points and macros.

EGL provides mechanisms for creating rendering surfaces onto which OpenGL ES can draw, and synchronizing drawing by both OpenGL ES and native platform rendering APIs. EGL does not explicitly support remote or indirect rendering, unlike the similar GLX API.
Chapter 2

EGL Operation

2.1 Native Window System and Rendering APIs

EGL is intended to be implementable on multiple operating systems (such as Symbian, embedded Linux, Unix, and Windows) and native window systems (such as X and Microsoft Windows). Implementations may also choose to allow rendering into specific types of EGL surfaces via other supported native rendering APIs, such as Xlib or GDI. Native rendering is described in more detail in section 2.2.3.

To the extent possible, EGL itself is independent of definitions and concepts specific to any native window system or rendering API. However, there are a few places where native concepts must be mapped into EGL-specific concepts, including the definition of the display on which graphics are drawn, and the definition of native windows and pixmaps which can also support OpenGL ES rendering.

2.1.1 Scalar Types

EGLBoolean is an integral type representing a boolean value, and should only take on the values EGL_TRUE (1) and EGL_FALSE (0). If boolean parameters passed to EGL take on other values, behavior is undefined, although typically any non-zero value will be interpreted as EGL_TRUE.

EGLint is an integral type used because EGL may need to represent scalar values larger than the native platform "int" type. All legal attribute names and values, whether their type is boolean, bitmask, enumerant (symbolic constant), integer, handle, or other, may be converted to and from EGLint without loss of information.
2.1.2 Displays

Most EGL calls include an EGLDisplay parameter. This represents the abstract display on which graphics are drawn. In most environments a display corresponds to a single physical screen. The initialization routines described in section 3.2 include a method for querying a default display, and platform-specific EGL extensions may be defined to obtain other displays.

2.2 Rendering Contexts and Drawing Surfaces

The OpenGL ES specification is intentionally vague on how a rendering context (an abstract OpenGL ES state machine) is created. One of the purposes of EGL is to provide a means to create an OpenGL ES context and associate it with a surface.

EGL defines several types of drawing surfaces collectively referred to as EGLSurfaces. These include windows, used for onscreen rendering; pbuffers, used for offscreen rendering; and pixmaps, used for offscreen rendering into buffers that may be accessed through native APIs. EGL windows and pixmaps are tied to native window system windows and pixmaps.

EGLSurfaces are created with respect to an EGLConfig. The EGLConfig describes the depth of the color buffer components and the types, quantities and sizes of the ancillary buffers (i.e., the depth, multisample, and stencil buffers).

Ancillary buffers are associated with an EGLSurface, not with a rendering context. If several rendering contexts are all writing to the same window, they will share those buffers. Rendering operations to one window never affect the unobscured pixels of another window, or the corresponding pixels of ancillary buffers of that window.

A rendering context can be used with any EGLSurface that it is compatible with (subject to the restrictions discussed in the section on address space). A surface and context are compatible if they

- have color buffers and ancillary buffers of the same depth.
- were created with respect to the same EGLDisplay (in environments supporting multiple displays).

As long as the compatibility constraint and the address space requirement are satisfied, clients can render into the same EGLSurface using different rendering contexts. It is also possible to use a single context to render into multiple EGLSurfaces.

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2.2.1 Using Rendering Contexts

OpenGL ES defines both client state and server state. Thus a rendering context consists of two parts: one to hold the client state and one to hold the server state.

Each thread can have at most one current rendering context. In addition, a rendering context can be current for only one thread at a time. The client is responsible for creating a rendering context and a surface.

2.2.2 Rendering Models

EGL and OpenGL ES supports two rendering models: back buffered and single buffered.

Back buffered rendering is used by window and pbuffer surfaces. Memory for the color buffer used during rendering is allocated and owned by EGL. When the client is finished drawing a frame, the back buffer may be copied to a visible window using eglSwapBuffers. Pbuffer surfaces have a back buffer but no associated window, so the back buffer need not be copied.

Single buffered rendering is used by pixmap surfaces. Memory for the color buffer is specified at surface creation time in the form of a native pixmap, and OpenGL ES is required to use that memory during rendering. When the client is finished drawing a frame, the native pixmap contains the final image. Pixmap surfaces typically do not support multisampling, since the native pixmap used as the color buffer is unlikely to provide space to store multisample information.

Both back and single buffered surfaces may also be copied to a specified native pixmap using eglCopyBuffers.

Window Resizing

EGL window surfaces need to be resized when their corresponding native window is resized. Implementations typically use hooks into the OS and native window system to perform this resizing on demand, transparently to the client. Some implementations may instead define an EGL extension giving explicit control of surface resizing.

Implementations which cannot resize EGL window surfaces on demand must instead respond to native window size changes in eglSwapBuffers (see section 3.8.3).

2.2.3 Interaction With Native Rendering

Native rendering will always be supported by pixmap surfaces (to the extent that native rendering APIs can draw to native pixmaps). Pixmap surfaces are typically
used when mixing native and OpenGL ES rendering is desirable, since there is no need to move data between the back buffer visible to OpenGL ES and the native pixmap visible to native rendering APIs. However, pixmap surfaces may, for the same reason, have restricted capabilities and performance relative to window and pbuffer surfaces.

Native rendering will not be supported by pbuffer surfaces, since the color buffers of pbuffers are allocated internally by EGL and are not accessible through any other means.

Native rendering may be supported by window surfaces, but only if the native window system has a compatible rendering model allowing it to share the OpenGL ES back buffer.

When both native rendering APIs and OpenGL ES are drawing into the same underlying surface, no guarantees are placed on the relative order of completion of operations in the different rendering streams other than those provided by the synchronization primitives discussed in section 3.7.

Some state is shared between OpenGL ES and the underlying native window system and rendering APIs, including pixel values in the visible frame buffer and, in the case of pixmaps, color buffer values.

2.3 Direct Rendering and Address Spaces

EGL is assumed to support only direct rendering, unlike similar APIs such as GLX. EGL objects and related OpenGL ES client and server state cannot be used outside of the address space in which they are created. In a single-threaded environment, each process has its own address space. In a multi-threaded environment, all threads may share the same virtual address space; however, this capability is not required, and implementations may choose to restrict their address space to be per-thread even in an environment supporting multiple application threads.

Both the client context state and the server context state of a rendering context exist in the client’s address space; this state cannot be shared by a client in another process.

Support of indirect rendering (in those environments where this concept makes sense) may have the effect of relaxing these limits on sharing. However, such support is beyond the scope of this document.

2.4 Shared State

Most OpenGL ES state is small. However, some types are of state are potentially large and/or expensive to copy, in which case it may be desirable for multiple
rendering contexts to share such state rather than replicating it in each context.

EGL provides for sharing certain types of server state among contexts existing in a single address space. At present such state includes only texture objects; additional types of state may be shared in future revisions of OpenGL ES where such types of state (for example, display lists) are defined and where such sharing makes sense.

### 2.4.1 Texture Objects

OpenGL ES texture state can be encapsulated in a named texture object. A texture object is created by binding an unused name to the texture target `GL_TEXTURE_2D` of a rendering context. When a texture object is bound, OpenGL ES operations on the target to which it is bound affect the bound texture object, and queries of the target to which it is bound return state from the bound texture object.

OpenGL ES makes no attempt to synchronize access to texture objects. If a texture object is bound to more than one context, then it is up to the programmer to ensure that the contents of the object are not being changed via one context while another context is using the texture object for rendering. The results of changing a texture object while another context is using it are undefined.

All modifications to shared context state as a result of executing `glBindTexture` are atomic. Also, a texture object will not be deleted while it is still bound to any rendering context.

### 2.5 Multiple Threads

The EGL and OpenGL ES client side libraries must be threadsafe. Interrupt routines may not share a rendering context with their main thread.

EGL guarantees sequentiality within a command stream for OpenGL ES, but not between OpenGL ES and other rendering APIs which may be rendering into the same surface. It is possible, for example, that a native drawing command issued by a single threaded client after an OpenGL ES command might be executed before that OpenGL ES command.

OpenGL ES commands are not guaranteed to be atomic. Some OpenGL ES rendering commands might otherwise impair interactive use of the windowing system by the user. For instance, rendering a large texture mapped polygon on a system with no graphics hardware could prevent a user from popping up a menu soon enough to be usable.

Synchronization is in the hands of the client. It can be maintained at moderate cost with the judicious use of the `glFinish`, `eglWaitGL`, and `eglWaitNative`
commands, as well as (if they exist) synchronization commands present in native rendering APIs. OpenGL ES and native rendering can be done in parallel so long as the client does not preclude it with explicit synchronization calls.

Some performance degradation may be experienced if needless switching between OpenGL ES and native rendering is done.

## 2.6 Power Management

EGL 1.0 does not address power management issues. Although this is an important area for developing robust applications on mobile devices, we instead encourage implementations to provide platform notes documenting interaction of EGL and OpenGL ES with platform-specific power management issues, including event detection, scope and nature of resource loss, behavior of EGL and OpenGL ES calls under resource loss, and recommended techniques for recovering from events.

Implementations are expected to develop EGL extensions to assist with power management. Future versions of EGL are expected to develop crossplatform power management support based on these extensions.
Chapter 3

EGL Functions and Errors

3.1 Errors

Where possible, when an EGL function fails it has no side effects.

EGL functions usually return an indicator of success or failure; either an
EGLBoolean EGL_TRUE or EGL_FALSE value, or in the form of an out-of-band
return value indicating failure, such as returning EGL_NO_CONTEXT instead of a re-
quested context handle Additional information about the success or failure of the
most recent EGL function called in a specific thread, in the form of an error code,
can be obtained by calling

        EGLint eglGetError();

The error codes that may be returned from eglGetError, and their meanings, are:

EGL_SUCCESS
    Function succeeded.

EGL_NOT_INITIALIZED
    EGL is not initialized, or could not be initialized, for the specified display.

EGL_BAD_ACCESS
    EGL cannot access a requested resource (for example, a context is bound in
    another thread).

EGL_BAD_ALLOC
    EGL failed to allocate resources for the requested operation.
3.1. **ERRORS**

EGL_BAD_ATTRIBUTE
   An unrecognized attribute or attribute value was passed in an attribute list.

EGL_BAD_CONTEXT
   An EGLContext argument does not name a valid EGLContext.

EGL_BAD_CONFIG
   An EGLConfig argument does not name a valid EGLConfig.

EGL_BAD_CURRENT_SURFACE
   The current surface of the calling thread is a window, pbuffer, or pixmap that is no longer valid.

EGL_BAD_DISPLAY
   An EGLDisplay argument does not name a valid EGLDisplay; or, EGL is not initialized on the specified EGLDisplay.

EGL_BAD_SURFACE
   An EGLSurface argument does not name a valid surface (window, pbuffer, or pixmap) configured for OpenGL ES rendering.

EGL_BAD_MATCH
   Arguments are inconsistent; for example, an otherwise valid context requires buffers (e.g. depth or stencil) not allocated by an otherwise valid surface.

EGL_BAD_PARAMETER
   One or more argument values are invalid.

EGL_BAD_NATIVE_PIXMAP
   A NativePixmapType argument does not refer to a valid native pixmap.

EGL_BAD_NATIVE_WINDOW
   A NativeWindowType argument does not refer to a valid native window.

Some specific error codes that may be generated by a failed EGL function, and their meanings, are described together with each function. However, not all possible errors are described with each function. Errors whose meanings are identical across many functions (such as returning EGL_BAD_DISPLAY or EGL_NOT_INITIALIZED for an unsuitable EGLDisplay argument) may not be described repeatedly.

EGL normally checks the validity of objects passed into it, but detecting invalid native objects (pixmaps, windows, and displays) may not always be possible. Specifying such invalid handles may result in undefined behavior, although implement-
tations should generate `EGL_BAD_NATIVE_PIXMAP` and `EGL_BAD_NATIVE_WINDOW` errors if possible.

### 3.2 Initialization

Initialization must be performed once for each display prior to calling most other EGL functions. A display can be obtained by calling

```c
EGLDisplay eglGetDisplay(NativeDisplayType display_id);
```

The type and format of `display_id` are implementation-specific, and it describes a specific display provided by the system EGL is running on. For example, an EGL implementation under X windows would require `display_id` to be an X Display, while an implementation under Microsoft Windows would require `display_id` to be a Windows Device Context. If `display_id` is `EGL_DEFAULT_DISPLAY`, a default display is returned.

If no display matching `display_id` is available, `EGL_NO_DISPLAY` is returned; no error condition is raised in this case.

EGL may be initialized on a display by calling

```c
EGLBoolean eglInitialize(EGLDisplay dpy, EGLint *major, EGLint *minor);
```

`EGL_TRUE` is returned on success, and `major` and `minor` are updated with the major and minor version numbers of the EGL implementation. `major` and `minor` are not updated if they are specified as `NULL`.

`EGL_FALSE` is returned on failure and `major` and `minor` are not updated. An `EGL_BAD_DISPLAY` error is generated if the `dpy` argument does not refer to a valid `EGLDisplay`. An `EGL_NOT_INITIALIZED` error is generated if EGL cannot be initialized for an otherwise valid `dpy`.

Initializing an already-initialized display is allowed, but the only effect of such a call is to return `EGL_TRUE` and update the EGL version numbers. An initialized display may be used from other threads in the same address space without being initialized again in those threads.

To release resources associated with use of EGL and OpenGL ES on a display, call

```c
EGLBoolean eglTerminate(EGLDisplay dpy);
```
Termination marks all EGL-specific resources associated with the specified display for deletion. If contexts or surfaces created with respect to \textit{dpy} are current (see section 3.6.3) to any thread, then they are not actually released while they remain current. Such contexts and surfaces will be destroyed, and all future references to them will become invalid, as soon as any otherwise valid \texttt{eglMakeCurrent} call is made from the thread they are bound to.

\texttt{eglTerminate} returns \texttt{EGL_TRUE} on success.

If the \textit{dpy} argument does not refer to a valid \texttt{EGLDisplay}, \texttt{EGL_FALSE} is returned, and an \texttt{EGL_BAD_DISPLAY} error is generated.

Termination of a display that has already been terminated, or has not yet been initialized, is allowed, but the only effect of such a call is to return \texttt{EGL_TRUE}, since there are no EGL resources associated with the display to release. A terminated display may be re-initialized by calling \texttt{eglInitialize} again. When re-initializing a terminated display, resources which were marked for deletion as a result of the earlier termination remain so marked, and references to them are not valid.

### 3.3 EGL Versioning

\begin{verbatim}
const char *eglQueryString (EGLDisplay dpy, EGLint name);
\end{verbatim}

\texttt{eglQueryString} returns a pointer to a static, zero-terminated string describing some aspect of the EGL implementation. \textit{name} may be \texttt{EGL_VENDOR}, \texttt{EGL_VERSION}, or \texttt{EGL_EXTENSIONS}. The format and contents of the \texttt{EGL_VENDOR} string is implementation dependent. The \texttt{EGL_EXTENSIONS} string describes which EGL extensions are supported by the EGL implementation running on the specified display. The string is zero-terminated and contains a space-separated list of extension names; extension names themselves do not contain spaces. If there are no extensions to EGL, then the empty string is returned. The \texttt{EGL_VERSION} string is laid out as follows:

\begin{verbatim}
<major_version.minor_version><space><vendor-specific info>
\end{verbatim}

Both the major and minor portions of the version number are of arbitrary length. The vendor-specific information is optional; if present, its format and contents are implementation specific.

On failure, \texttt{NULL} is returned. An \texttt{EGL_NOT_INITIALIZED} error is generated if EGL is not initialized for \textit{dpy}. An \texttt{EGL_BAD_PARAMETER} error is generated if \textit{name} is not one of the values described above.

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3.4 Configuration Management

An EGLConfig describes the format, type and size of the color buffers and ancillary buffers for an EGLSurface. If the EGLSurface is a window, then the EGLConfig describing it may have an associated native visual type.

Names of EGLConfig attributes are shown in Table 3.1. These names may be passed to eglChooseConfig to specify required attribute properties.

EGL_CONFIG_ID is a unique integer identifying different EGLConfigs. Configuration IDs must be small positive integers starting at 1 and ID assignment should be compact; that is, if there are $N$ EGLConfigs defined by the EGL implementation, their configuration IDs should be in the range $[1, N]$. Small gaps in the sequence are allowed, but should only occur when removing configurations defined in previous revisions of an EGL implementation.

EGL_BUFFER_SIZE gives the total depth of the color buffer in bits; this is the sum of EGL_RED_SIZE, EGL_GREEN_SIZE, EGL_BLUE_SIZE, and EGL_ALPHA_SIZE.

EGL_SAMPLE_BUFFERS indicates the number of multisample buffers, which must be zero or one. EGL_SAMPLES gives the number of samples per pixel; if EGL_SAMPLE_BUFFERS is zero, then EGL_SAMPLES will also be zero. If EGL_SAMPLE_BUFFERS is one, then the number of color, depth, and stencil bits for each sample in the multisample buffer are as specified by the EGL_*_SIZE attributes.

There are no single-sample depth or stencil buffers for a multisample EGLConfig; the only depth and stencil buffers are those in the multisample buffer. If the color samples in the multisample buffer store fewer bits than are stored in the color buffers, this fact will not be reported accurately. Presumably a compression scheme is being employed, and is expected to maintain an aggregate resolution equal to that of the color buffers.

EGL_SURFACE_TYPE is a mask indicating the surface types that can be created with the corresponding EGLConfig (the config is said to support these surface types). The valid bit settings are shown in Table 3.2.

For example, an EGLConfig for which the value of the EGL_SURFACE_TYPE attribute is

EGL_WINDOW_BIT | EGL_PIXMAP_BIT | EGL_PBUFFER_BIT

can be used to create any type of EGL surface, while an EGLConfig for which this attribute value is EGL_WINDOW_BIT cannot be used to create a pbuffer or pixmap.

EGL_NATIVE_RENDERABLE is an EGLBoolean indicating whether the native window system can be used to render into a surface created with the EGLConfig. Constraints on native rendering are discussed in more detail in sections 2.2.2 and 2.2.3.
### 3.4. Configuration Management

#### Table 3.1: EGLConfig attributes.

<table>
<thead>
<tr>
<th>Attribute</th>
<th>Type</th>
<th>Notes</th>
</tr>
</thead>
<tbody>
<tr>
<td>EGL_BUFFER_SIZE</td>
<td>integer</td>
<td>depth of the color buffer</td>
</tr>
<tr>
<td>EGL_RED_SIZE</td>
<td>integer</td>
<td>bits of Red in the color buffer</td>
</tr>
<tr>
<td>EGL_GREEN_SIZE</td>
<td>integer</td>
<td>bits of Green in the color buffer</td>
</tr>
<tr>
<td>EGL_BLUE_SIZE</td>
<td>integer</td>
<td>bits of Blue in the color buffer</td>
</tr>
<tr>
<td>EGL_ALPHA_SIZE</td>
<td>integer</td>
<td>bits of Alpha in the color buffer</td>
</tr>
<tr>
<td>EGL_CONFIG_CAVEAT</td>
<td>enum</td>
<td>any caveats for the configuration</td>
</tr>
<tr>
<td>EGL_CONFIG_ID</td>
<td>integer</td>
<td>unique EGLConfig identifier</td>
</tr>
<tr>
<td>EGL_DEPTH_SIZE</td>
<td>integer</td>
<td>bits of Z in the depth buffer</td>
</tr>
<tr>
<td>EGL_LEVEL</td>
<td>integer</td>
<td>frame buffer level</td>
</tr>
<tr>
<td>EGL_MAX_PBUFFER_WIDTH</td>
<td>integer</td>
<td>maximum width of pbuffer</td>
</tr>
<tr>
<td>EGL_MAX_PBUFFER_HEIGHT</td>
<td>integer</td>
<td>maximum height of pbuffer</td>
</tr>
<tr>
<td>EGL_MAX_PBUFFER_PIXELS</td>
<td>integer</td>
<td>maximum size of pbuffer</td>
</tr>
<tr>
<td>EGL_NATIVE_RENDERABLE</td>
<td>boolean</td>
<td>EGL_TRUE if native rendering APIs can render to surface</td>
</tr>
<tr>
<td>EGL_NATIVE_VISUAL_ID</td>
<td>integer</td>
<td>handle of corresponding native visual</td>
</tr>
<tr>
<td>EGL_NATIVE_VISUAL_TYPE</td>
<td>integer</td>
<td>native visual type of the associated visual</td>
</tr>
<tr>
<td>EGL_SAMPLE_BUFFERS</td>
<td>integer</td>
<td>number of multisample buffers</td>
</tr>
<tr>
<td>EGL_SAMPLES</td>
<td>integer</td>
<td>number of samples per pixel</td>
</tr>
<tr>
<td>EGL_STENCIL_SIZE</td>
<td>integer</td>
<td>bits of Stencil in the stencil buffer</td>
</tr>
<tr>
<td>EGL_SURFACE_TYPE</td>
<td>bitmask</td>
<td>which types of EGL surfaces are supported.</td>
</tr>
<tr>
<td>EGL_TRANSPARENT_TYPE</td>
<td>enum</td>
<td>type of transparency supported</td>
</tr>
<tr>
<td>EGL_TRANSPARENT_RED_VALUE</td>
<td>integer</td>
<td>transparent red value</td>
</tr>
<tr>
<td>EGL_TRANSPARENT_GREEN_VALUE</td>
<td>integer</td>
<td>transparent green value</td>
</tr>
<tr>
<td>EGL_TRANSPARENT_BLUE_VALUE</td>
<td>integer</td>
<td>transparent blue value</td>
</tr>
</tbody>
</table>

#### Table 3.2: Types of surfaces supported by an EGLConfig

<table>
<thead>
<tr>
<th>EGL Token Name</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>EGL_WINDOW_BIT</td>
<td>EGLConfig supports windows</td>
</tr>
<tr>
<td>EGL_PIXMAP_BIT</td>
<td>EGLConfig supports pixmaps</td>
</tr>
<tr>
<td>EGL_PBUFFER_BIT</td>
<td>EGLConfig supports pbuffers</td>
</tr>
</tbody>
</table>

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If an EGLConfig supports windows then it may have an associated native visual. EGL_NATIVE_VISUAL_ID specifies an identifier for this visual, and EGL_NATIVE_VISUAL_TYPE specifies its type. If an EGLConfig does not support windows, or if there is no associated native visual type, then querying EGL_NATIVE_VISUAL_ID will return 0 and querying EGL_NATIVE_VISUAL_TYPE will return EGL_NONE.

The interpretation of the native visual identifier and type is platform-dependent. For example, if the native window system is X, then the identifier will be the XID of an X Visual.

The EGL_CONFIG_CAVEAT attribute may be set to one of the following values: EGL_NONE, EGL_SLOW_CONFIG or EGL_NON_CONFORMANT_CONFIG. If the attribute is set to EGL_NONE then the configuration has no caveats; if it is set to EGL_SLOW_CONFIG then rendering to a surface with this configuration may run at reduced performance (for example, the hardware may not support the color buffer depths described by the configuration); if it is set to EGL_NON_CONFORMANT_CONFIG then rendering to a surface with this configuration will not pass the required OpenGL ES conformance tests.

OpenGL ES conformance requires that a set of EGLConfigs supporting certain defined minimum attributes (such as the number, type, and depth of supported buffers) be supplied by any conformant implementation. Those requirements are documented only in the conformance specification.

EGL_TRANSPARENT_TYPE indicates whether or not a configuration supports transparency. If the attribute is set to EGL_NONE then windows created with the EGLConfig will not have any transparent pixels. If the attribute is EGL_TRANSPARENT_RGB, then the EGLConfig supports transparency; a transparent pixel will be drawn when the red, green and blue values which are read from the framebuffer are equal to EGL_TRANSPARENT_RED_VALUE, EGL_TRANSPARENT_GREEN_VALUE and EGL_TRANSPARENT_BLUE_VALUE, respectively.

If EGL_TRANSPARENT_TYPE is EGL_NONE, then the values for EGL_TRANSPARENT_RED_VALUE, EGL_TRANSPARENT_GREEN_VALUE, and EGL_TRANSPARENT_BLUE_VALUE are undefined. Otherwise, they are interpreted as integer framebuffer values between 0 and the maximum framebuffer value for the component. For example, EGL_TRANSPARENT_RED_VALUE will range between 0 and \((2^{EGL_RED_SIZE})-1\).

EGL_MAX_PBUFFER_WIDTH and EGL_MAX_PBUFFER_HEIGHT indicate the maximum width and height that can be passed into eglCreatePbufferSurface, and EGL_MAX_PBUFFER_PIXELS indicates the maximum number of pixels (width times height) for a pbuffer surface. Note that an implementation may return a value for EGL_MAX_PBUFFER_PIXELS that is less than the maximum width times the
maximum height. The value for \texttt{EGL\_MAX\_PBUFFER\_PIXELS} is static and assumes that no other pbuffers or native resources are contending for the framebuffer memory. Thus it may not be possible to allocate a pbuffer of the size given by \texttt{EGL\_MAX\_PBUFFER\_PIXELS}.

### 3.4.1 Querying Configurations

Use

\begin{verbatim}
EGLBoolean eglGetConfigs(EGLDisplay dpy,
    EGLConfig *configs, EGLint config_size,
    EGLint *num_config);
\end{verbatim}

to get the list of all \texttt{EGLConfig}s that are available on the specified display. \texttt{configs} is a pointer to a buffer containing \texttt{config\_size} elements. On success, \texttt{EGL\_TRUE} is returned. The number of configurations is returned in \texttt{num\_config}, and elements 0 through \texttt{num\_config} - 1 of \texttt{configs} are filled in with the valid \texttt{EGLConfig}s. No more than \texttt{config\_size} \texttt{EGLConfig}s will be returned even if more are available on the specified display. However, if \texttt{eglGetConfigs} is called with \texttt{configs} = \texttt{NULL}, then no configurations are returned, but the total number of configurations available will be returned in \texttt{num\_config}.

On failure, \texttt{EGL\_FALSE} is returned. An \texttt{EGL\_NOT\_INITIALIZED} error is generated if EGL is not initialized on \texttt{dpy}. An \texttt{EGL\_BAD\_PARAMETER} error is generated if \texttt{num\_config} is \texttt{NULL}.

Use

\begin{verbatim}
EGLBoolean eglChooseConfig(EGLDisplay dpy, const
    EGLint *attrib_list, EGLConfig *configs,
    EGLint config_size, EGLint *num_config);
\end{verbatim}

to get \texttt{EGLConfig}s that match a list of attributes. The return value and the meaning of \texttt{configs}, \texttt{config\_size}, and \texttt{num\_config} are the same as for \texttt{eglGetConfigs}. However, only configurations matching \texttt{attrib\_list}, as discussed below, will be returned.

On failure, \texttt{EGL\_FALSE} is returned. An \texttt{EGL\_BAD\_ATTRIBUTE} error is generated if \texttt{attrib\_list} contains an undefined EGL attribute or an attribute value that is unrecognized or out of range.

All attribute names in \texttt{attrib\_list} are immediately followed by the corresponding desired value. The list is terminated with \texttt{EGL\_NONE}. If an attribute is not specified in \texttt{attrib\_list}, then the default value (listed in Table 3.3) is used (it is said to be specified implicitly). If \texttt{EGL\_DONT\_CARE} is specified as an attribute value, then the...
attribute will not be checked. \texttt{EGL\_DONT\_CARE} may be specified for all attributes except \texttt{EGL\_LEVEL}. If \texttt{attrib\_list} is NULL or empty (first attribute is \texttt{EGL\_NONE}), then selection and sorting of \texttt{EGLConfig}s is done according to the default criteria in Tables 3.3 and 3.1, as described below under Selection and Sorting.

Selection of \texttt{EGLConfig}s

Attributes are matched in an attribute-specific manner, as shown in Table 3.3. The match criteria listed in the table have the following meanings\(^1\):

- \textit{Smaller} \texttt{EGLConfig}s with an attribute value that meets or exceeds the specified value are matched.

- \textit{Larger} \texttt{EGLConfig}s with an attribute value that meets or exceeds the specified value are matched.

- \textit{Exact} \texttt{EGLConfig}s whose attribute value equals the requested value are matched.

- \textit{Mask} \texttt{EGLConfig}s for which the set bits of attribute include all the bits that are set in the requested value are matched. (Additional bits might be set in the attribute).

Some of the attributes must match the specified value exactly; others, such as \texttt{EGL\_RED\_SIZE}, must meet or exceed the specified minimum values.

To retrieve an \texttt{EGLConfig} given its unique integer ID, use the \texttt{EGL\_CONFIG\_ID} attribute. When \texttt{EGL\_CONFIG\_ID} is specified, all other attributes are ignored, and only the \texttt{EGLConfig} with the given ID is returned.

If \texttt{EGL\_MAX\_BUFFER\_WIDTH}, \texttt{EGL\_MAX\_BUFFER\_HEIGHT}, \texttt{EGL\_MAX\_BUFFER\_PIXELS}, or \texttt{EGL\_NATIVE\_VISUAL\_ID} are specified in \texttt{attrib\_list}, then they are ignored (however, if present, these attributes must still be followed by an attribute value in \texttt{attrib\_list}). If \texttt{EGL\_SURFACE\_TYPE} is specified in \texttt{attrib\_list} and the mask that follows does not have \texttt{EGL\_WINDOW\_BIT} set, or if there are no native visual types, then the \texttt{EGL\_NATIVE\_VISUAL\_TYPE} attribute is ignored.

If \texttt{EGL\_TRANSPARENT\_TYPE} is set to \texttt{EGL\_NONE} in \texttt{attrib\_list}, then the \texttt{EGL\_TRANSPARENT\_RED\_VALUE}, \texttt{EGL\_TRANSPARENT\_GREEN\_VALUE}, and \texttt{EGL\_TRANSPARENT\_BLUE\_VALUE} attributes are ignored.

---

\(^1\) The distinction between Smaller and Larger, which affects only sorting, not selection, has proven confusing. We will update table 3.3 with separate selection criteria and sort order columns in the next EGL revision.

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### 3.4. CONFIGURATION MANAGEMENT

<table>
<thead>
<tr>
<th>Attribute</th>
<th>Default</th>
<th>Selection and Sorting Criteria</th>
<th>Sort Priority</th>
</tr>
</thead>
<tbody>
<tr>
<td>EGL_BUFFER_SIZE</td>
<td>0</td>
<td>Smaller</td>
<td>3</td>
</tr>
<tr>
<td>EGL_RED_SIZE</td>
<td>0</td>
<td>Larger</td>
<td>2</td>
</tr>
<tr>
<td>EGL_GREEN_SIZE</td>
<td>0</td>
<td>Larger</td>
<td>2</td>
</tr>
<tr>
<td>EGL_BLUE_SIZE</td>
<td>0</td>
<td>Larger</td>
<td>2</td>
</tr>
<tr>
<td>EGL_ALPHA_SIZE</td>
<td>0</td>
<td>Larger</td>
<td>2</td>
</tr>
<tr>
<td>EGL_CONFIG_CAVEAT</td>
<td>EGL_DONT_CARE</td>
<td>Exact</td>
<td>1</td>
</tr>
<tr>
<td>EGL_CONFIG_ID</td>
<td>EGL_DONT_CARE</td>
<td>Exact</td>
<td>9 (last)</td>
</tr>
<tr>
<td>EGL_DEPTH_SIZE</td>
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<td>Smaller</td>
<td>6</td>
</tr>
<tr>
<td>EGL_LEVEL</td>
<td>0</td>
<td>Exact</td>
<td></td>
</tr>
<tr>
<td>EGL_NATIVE_RENDERABLE</td>
<td>EGL_DONT_CARE</td>
<td>Exact</td>
<td></td>
</tr>
<tr>
<td>EGL_NATIVE_VISUAL_TYPE</td>
<td>EGL_DONT_CARE</td>
<td>Exact</td>
<td>8</td>
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<td>EGL_SAMPLE_BUFFERS</td>
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<td>Smaller</td>
<td>4</td>
</tr>
<tr>
<td>EGL_SAMPLES</td>
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<td>Smaller</td>
<td>5</td>
</tr>
<tr>
<td>EGL_STENCIL_SIZE</td>
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<td>Smaller</td>
<td>7</td>
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<td>EGL_SURFACE_TYPE</td>
<td>EGL_WINDOW_BIT</td>
<td>Mask</td>
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</tr>
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<td>EGL_TRANSPARENT_TYPE</td>
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</tr>
<tr>
<td>EGL_TRANSPARENT_RED_VALUE</td>
<td>EGL_DONT_CARE</td>
<td>Exact</td>
<td></td>
</tr>
<tr>
<td>EGL_TRANSPARENT_GREEN_VALUE</td>
<td>EGL_DONT_CARE</td>
<td>Exact</td>
<td></td>
</tr>
<tr>
<td>EGL_TRANSPARENT_BLUE_VALUE</td>
<td>EGL_DONT_CARE</td>
<td>Exact</td>
<td></td>
</tr>
</tbody>
</table>

Table 3.3: Default values and match criteria for EGLConfig attributes.
If no EGLConfig matching the attribute list exists, then the call succeeds, but
num_config is set to 0.

**Sorting of EGLConfigs**

If more than one matching EGLConfig is found, then a list of EGLConfigs,
sorted according to the best match criteria, is returned. The list is sorted according
to the following precedence rules that are applied in ascending order (i.e., configu-
trations that are considered equal by lower numbered rule are sorted by the higher
numbered rule):

1. By EGL_CONFIG CAVEAT where the precedence is EGL_NONE,
   EGL_SLOW_CONFIG, EGL_NON_CONFORMANT_CONFIG.

2. Larger total number of RGBA color bits (EGL_RED_SIZE, EGL_GREEN_SIZE,
   EGL_BLUE_SIZE, plus EGL_ALPHA_SIZE). If the requested number of bits in
   attrib_list for a particular color component is 0 or EGL_DONT_CARE, then the
   number of bits for that component is not considered.

3. Smaller EGL_BUFFER_SIZE.

4. Smaller EGL_SAMPLE_BUFFERS.

5. Smaller EGL_SAMPLES.

6. Smaller EGL_DEPTH_SIZE.

7. Smaller EGL_STENCIL_SIZE.

8. By EGL_NATIVE_VISUAL_TYPE (the actual sort order is implementation-
defined, depending on the meaning of native visual types).

9. Smaller EGL_CONFIG_ID (this is always the last sorting rule, and guarantees
   a unique ordering).

**3.4.2 Lifetime of Configurations**

Configuration handles (EGLConfigs) returned by eglGetConfigs and egl-
ChooseConfig remain valid so long as the EGLDisplay from which the handles
were obtained is not terminated. Implementations supporting a large number of dif-
ferent configurations, where it might be burdensome to instantiate data structures
for each configuration so queried (but never used), may choose to return handles
encoding sufficient information to instantiate the corresponding configurations dy-
amically, when needed to create EGL resources or query configuration attributes.
3.4.3 Querying Configuration Attributes

To get the value of an EGLConfig attribute, use

```c
EGLBoolean eglGetConfigAttrib(EGLDisplay dpy, 
    EGLConfig config, EGLint attribute, EGLInt *value);
```

If `eglGetConfigAttrib` succeeds then it returns `EGL_TRUE` and the value for the specified attribute is returned in `value`. Otherwise it returns `EGL_FALSE`. If `attribute` is not a valid attribute then `EGL_BAD_ATTRIBUTE` is generated.

Refer to Table 3.1 and Table 3.3 for a list of valid EGL attributes.

3.5 Rendering Surfaces

3.5.1 Creating On-Screen Rendering Surfaces

To create an on-screen rendering surface, first create a native platform window with attributes corresponding to the desired EGLConfig (e.g. with the same color depth, with other constraints specific to the platform). Using a platform-specific type (here called `NativeWindowType`) referring to a handle to that native window, then call:

```c
EGLSurface eglCreateWindowSurface(EGLDisplay dpy, 
    EGLConfig config, NativeWindowType win, 
    const EGLint *attrib_list);
```

`eglCreateWindowSurface` creates an onscreen EGLSurface and returns a handle to it. Any EGL rendering context created with a compatible EGLConfig can be used to render into this surface.

`attrib_list` specifies a list of attributes for the window. The list has the same structure as described for `eglChooseConfig`. Currently no attributes are recognized, so `attrib_list` will normally be NULL or empty (first attribute of `EGL_NONE`). However, it is possible that some platforms will define attributes specific to those environments, as an EGL extension.

On failure `eglCreateWindowSurface` returns `EGL_NO_SURFACE`. If the attributes of `win` do not correspond to `config`, then an `EGL_BAD_MATCH` error is generated. If `config` does not support rendering to windows (the `EGL_SURFACE_TYPE` attribute does not contain `EGL_WINDOW_BIT`), an `EGL_BAD_MATCH` error is generated. If `config` is not a valid EGLConfig, an `EGL_BAD_CONFIG` error is generated. If `win` is not a valid native window handle, then an `EGL_BAD_NATIVE_WINDOW` error
should be generated. If there is already an EGLConfig associated with \( \text{win} \) (as a result of a previous \texttt{eglCreateWindowSurface} call), then an \texttt{EGL\_BAD\_ALLOC} error is generated. Finally, if the implementation cannot allocate resources for the new EGL window, an \texttt{EGL\_BAD\_ALLOC} error is generated.

### 3.5.2 Creating Off-Screen Rendering Surfaces

EGL supports off-screen rendering surfaces in pbuffers. Pbuffers differ from windows in the following ways:

1. Pbuffers are typically allocated in offscreen (non-visible) graphics memory and are intended only for accelerated offscreen rendering. Allocation can fail if there are insufficient graphics resources (implementations are not required to virtualize framebuffer memory). Clients should deallocate pbuffers when they are no longer in use, since graphics memory is often a scarce resource.

2. Pbuffers are EGL resources and have no associated native window or native window type. It may not be possible to render to pbuffers using APIs other than OpenGL ES and EGL.

To create a pbuffer, call

\[
\text{EGLSurface} \quad \texttt{eglCreatePbufferSurface} (\texttt{EGLDisplay dpy},
\texttt{EGLConfig config, const EGLint *attrib\_list});
\]

This creates a single pbuffer surface and returns a handle to it.

\texttt{attrib\_list} specifies a list of attributes for the pbuffer. The list has the same structure as described for \texttt{eglChooseConfig}. Currently only three attributes can be specified in \texttt{attrib\_list}: \texttt{EGL\_WIDTH}, \texttt{EGL\_HEIGHT}, and \texttt{EGL\_LARGEST\_PBUFFER}. It is possible that some platforms will define additional attributes specific to those environments, as an EGL extension.

\texttt{attrib\_list} may be NULL or empty (first attribute of \texttt{EGL\_NONE}), in which case all the attributes assume their default values as described below.

\texttt{EGL\_WIDTH} and \texttt{EGL\_HEIGHT} specify the pixel width and height of the rectangular pbuffer. The default values for \texttt{EGL\_WIDTH} and \texttt{EGL\_HEIGHT} are zero.

Use \texttt{EGL\_LARGEST\_PBUFFER} to get the largest available pbuffer when the allocation of the pbuffer would otherwise fail. The width and height of the allocated pbuffer will never exceed the values of \texttt{EGL\_WIDTH} and \texttt{EGL\_HEIGHT}, respectively. Use \texttt{eglQuerySurface} to retrieve the dimensions of the allocated pbuffer. By default, \texttt{EGL\_LARGEST\_PBUFFER} is \texttt{EGL\_FALSE}.
3.5. RENDERING SURFACES

The resulting pbuffer will contain color buffers and ancillary buffers as specified by \texttt{config}.

On failure \texttt{eglCreatePbufferSurface} returns \texttt{EGL\_NO\_SURFACE}. If the pbuffer could not be created due to insufficient resources, then an \texttt{EGL\_BAD\_ALLOC} error is generated. If \texttt{config} is not a valid \texttt{EGLConfig}, an \texttt{EGL\_BAD\_CONFIG} error is generated. If \texttt{config} does not support pbuffers, an \texttt{EGL\_BAD\_MATCH} error is generated.

3.5.3 Creating Native Pixmap Rendering Surfaces

EGL also supports rendering surfaces whose color buffers are stored in native pixmaps. Pixmaps differ from windows in that they are typically allocated in off-screen (non-visible) graphics or CPU memory. Pixmaps differ from pbuffers in that they do have an associated native pixmap and native pixmap type, and it may be possible to render to pixmaps using APIs other than OpenGL ES and EGL.

To create a pixmap rendering surface, first create a native platform pixmap with attributes corresponding to the desired \texttt{EGLConfig} (e.g. with the same color depth, with other constraints specific to the platform). Using a platform-specific type (here called \texttt{NativePixmapType}) referring to a handle to that native pixmap, then call:

\begin{verbatim}
EGLSurface eglCreatePixmapSurface(EGLDisplay dpy, 
    EGLConfig config, NativePixmapType pixmap, 
    const EGLint *attrib_list);
\end{verbatim}

\texttt{eglCreatePixmapSurface} creates an offscreen \texttt{EGLSurface} and returns a handle to it. Any EGL rendering context created with a compatible \texttt{EGLConfig} can be used to render into this surface.

\texttt{attrib_list} specifies a list of attributes for the pixmap. The list has the same structure as described for \texttt{eglChooseConfig}. Currently no attributes are recognized, so \texttt{attrib_list} will normally be \texttt{NULL} or empty (first attribute of \texttt{EGL\_NONE}). However, it is possible that some platforms will define attributes specific to those environments, as an EGL extension.

On failure \texttt{eglCreatePixmapSurface} returns \texttt{EGL\_NO\_SURFACE}. If the attributes of \texttt{pixmap} do not correspond to \texttt{config}, then an \texttt{EGL\_BAD\_MATCH} error is generated. If \texttt{config} does not support rendering to pixmaps (the \texttt{EGL\_SURFACE\_TYPE} attribute does not contain \texttt{EGL\_PIXMAP\_BIT}), an \texttt{EGL\_BAD\_MATCH} error is generated. If \texttt{config} is not a valid \texttt{EGLConfig}, an \texttt{EGL\_BAD\_CONFIG} error is generated. If \texttt{pixmap} is not a valid native pixmap handle, then an \texttt{EGL\_BAD\_NATIVE\_PIXMAP} error should be generated. If there is already an \texttt{EGLSurface} associated with \texttt{pixmap} (as a result of a previous
eglCreatePixmapSurface call), then a EGL_BAD_ALLOC error is generated. Finally, if the implementation cannot allocate resources for the new EGL pixmap, an EGL_BAD_ALLOC error is generated.

3.5.4 Destroying Rendering Surfaces

An EGLSurface of any type (window, pbuffer, or pixmap) is destroyed by calling

```c
EGLBoolean eglDestroySurface(EGLDisplay dpy,
                               EGLSurface surface);
```

All resources associated with `surface` are marked for deletion as soon as possible. If `surface` is current to any thread (see section 3.6.3), resources are not actually released while the surface remains current. Future references to `surface` remain valid only so long as it is current; it will be destroyed, and all future references to it will become invalid, as soon as any otherwise valid `eglMakeCurrent` call is made from the thread it is bound to.

`eglDestroySurface` returns EGL_FALSE on failure. An EGL_BAD_SURFACE error is generated if `surface` is not a valid rendering surface.

3.5.5 Querying Surface Attributes

To query an attribute associated with an EGLSurface call:

```c
EGLBoolean eglQuerySurface(EGLDisplay dpy,
                            EGLSurface surface, EGLint attribute,
                            EGLint *value);
```

`eglQuerySurface` returns in `value` the value of `attribute` for `surface`. `attribute` must be set to one of EGL_WIDTH, EGL_HEIGHT, EGL_LARGEST_PBUFFER, or EGL_CONFIG_ID.

Querying EGL_CONFIG_ID returns the ID of the EGLConfig with respect to which the surface was created.

Querying EGL_LARGEST_PBUFFER for a pbuffer surface returns the same attribute value specified when the surface was created with `eglCreatePbufferSurface`. For a window or pixmap surface, the contents of `value` are not modified.

Querying EGL_WIDTH and EGL_HEIGHT returns respectively the width and height, in pixels, of the surface. For a window or pixmap surface, these values are initially equal to the width and height of the native window or pixmap with respect to which the surface was created. If a native window is resized, the corresponding
window surface will eventually be resized by the implementation to match (as dis-
cussed in section 3.8.1). If there is a discrepancy because EGL has not yet resized
the window surface, the size returned by eglQuerySurface will always be that of
the EGL surface, not the corresponding native window.

For a pbuffer, they will be the actual allocated size of the pbuffer (which may
be less than the requested size if EGL\_LARGEST\_PBUFFER is EGL\_TRUE).

eglQuerySurface returns EGL\_FALSE on failure and value is not updated. If
attribute is not a valid EGL surface attribute, then an EGL\_BAD\_ATTRIBUTE error
is generated. If surface is not a valid EGLSurface then an EGL\_BAD\_SURFACE
error is generated.

### 3.6 Rendering Contexts

#### 3.6.1 Creating Rendering Contexts

To create an OpenGL ES rendering context, call

```c
EGLContext eglCreateContext(EGLDisplay dpy,
                             EGLConfig config, EGLContext share_context,
                             const EGLint *attrib_list);
```

If eglCreateContext succeeds, it initializes the rendering context to the initial
OpenGL ES state and returns a handle to it. The handle can be used to render
to any compatible EGLSurface.

If share\_context is not EGL\_NO\_CONTEXT, then all shareable data (except texture
objects named 0) will be shared by share\_context, all other contexts share\_context
already shares with, and the newly created rendering context. An arbitrary number
of EGLContexts can share data in this fashion. The server context state for all
sharing contexts must exist in a single address space or an EGL\_BAD\_MATCH error
is generated.

Currently no attributes are recognized, so attrib\_list will normally be NULL or
empty (first attribute of EGL\_NONE). However, it is possible that some platforms
will define attributes specific to those environments, as an EGL extension.

On failure eglCreateContext returns EGL\_NO\_CONTEXT. If share\_context is
neither zero nor a valid EGL rendering context, then an EGL\_BAD\_CONTEXT error
is generated. If config is not a valid EGLConfig, then an EGL\_BAD\_CONFIG error
is generated. If the server context state for share\_context exists in an address space
that cannot be shared with the newly created context, if share\_context was created
on a different display than the one referenced by config, or if the contexts are oth-
erwise incompatible (for example, one context being associated with a hardware
device driver and the other with a software renderer), then an EGL_BAD_MATCH error is generated. If the server does not have enough resources to allocate the new context, then an EGL_BAD_ALLOC error is generated.

3.6.2 Destroying Rendering Contexts

A rendering context is destroyed by calling

```c
EGLBoolean eglDestroyContext(EGLDisplay dpy,
                              EGLContext ctx);
```

All resources associated with `ctx` are marked for deletion as soon as possible. If `ctx` is current to any thread (see section 3.6.3), resources are not actually released while the context remains current. Future references to `ctx` remain valid only so long as it is current; it will be destroyed, and all future references to it will become invalid, as soon as any otherwise valid `eglMakeCurrent` call is made from the thread it is bound to).

`eglDestroyContext` returns `EGL_FALSE` on failure. An `EGL_BAD_CONTEXT` error is generated if `ctx` is not a valid rendering context.

3.6.3 Binding Contexts and Drawables

To make a context current, call

```c
EGLBoolean eglMakeCurrent(EGLDisplay dpy,
                           EGLSurface draw, EGLSurface read,
                           EGLContext ctx);
```

`eglMakeCurrent` binds `ctx` to the current rendering thread and to the `draw` and `read` surfaces. `draw` is used for all OpenGL ES operations except for any pixel data read back, which is taken from the frame buffer values of `read`. Note that the same EGLSurface may be specified for both `draw` and `read`.

If the calling thread already has a current rendering context, then that context is flushed and marked as no longer current. `ctx` is made the current context for the calling thread.

`eglMakeCurrent` returns `EGL_FALSE` on failure. If `draw` or `read` are not compatible with `ctx`, then an `EGL_BAD_MATCH` error is generated. If `ctx` is current to some other thread, or if either `draw` or `read` are bound to contexts in another thread, an `EGL_BAD_ACCESS` error is generated. If `ctx` is not a valid EGL rendering context, an `EGL_BAD_CONTEXT` error is generated. If either `draw` or `read` are not valid EGL surfaces, an `EGL_BAD_SURFACE` error is generated. If a native window
underlying either draw or read is no longer valid, an EGL_BAD_NATIVE_WINDOW error is generated. If draw and read cannot fit into graphics memory simultaneously, an EGL_BAD_MATCH error is generated. If the previous context of the calling thread has unflushed commands, and the previous surface is no longer valid, an EGL_BAD_CURRENT_SURFACE error is generated. If the ancillary buffers for draw and read cannot be allocated, an EGL_BAD_ALLOC error will be generated.

Other errors may arise when the context state is inconsistent with the surface state, as described in the following paragraphs.

If draw is destroyed after eglMakeCurrent is called, then subsequent rendering commands will be processed and the context state will be updated, but the frame buffer state becomes undefined. If read is destroyed after eglMakeCurrent then pixel values read from the framebuffer (e.g., as result of calling glReadPixels) are undefined. If a native window or pixmap underlying the draw or read surfaces is destroyed, rendering and readback are handled as above.

To release the current context without assigning a new one, set ctx to EGL_NO_CONTEXT and set draw and read to EGL_NO_SURFACE. If ctx is EGL_NO_CONTEXT and draw and read are not EGL_NO_SURFACE, or if draw or read are set to EGL_NO_SURFACE and ctx is not EGL_NO_CONTEXT, then an EGL_BAD_MATCH error will be generated.

The first time ctx is made current, the viewport and scissor dimensions are set to the size of the draw surface (as though glViewport(0, 0, w, h) and glScissor(0, 0, w, h) were called, where w and h are the width and height of the surface, respectively). However, the viewport and scissor dimensions are not modified when ctx is subsequently made current. The client is responsible for resetting the viewport and scissor in this case.

Only one rendering context may be in use, or current, for a particular thread at a given time, and only one context may be bound to a particular surface at a given time.

The minimum number of current rendering contexts that must be supported by an EGL implementation is one.

To get the current context, call

```c
EGLContext eglGetCurrentContext(void);
```

If there is no current context, EGL_NO_CONTEXT is returned (this is not an error).

To get the surfaces used for rendering by the current context, call

```c
EGLSurface eglGetCurrentSurface(EGLint readdraw);
```

readdraw is either EGL_READ or EGL_DRAW to respectively return the read or draw surfaces. If there is no corresponding surface, EGL_NO_SURFACE is returned (this is
CHAPTER 3. EGL FUNCTIONS AND ERRORS

not an error) If *readdraw* is neither EGL_READ nor EGL_DRAW, EGL_NO_SURFACE is returned and an EGL_BAD_PARAMETER error is generated.

To get the display associated with the current context, call

```c
EGLDisplay eglGetCurrentDisplay(void);
```

If there is no current context, EGL_NO_DISPLAY is returned.

To obtain the value of context attributes, use

```c
EGLBoolean eglQueryContext(EGLDisplay dpy,
  EGLContext ctx, EGLint attribute, EGLint *value);
```

eglQueryContext returns in value the value of attribute for ctx. attribute must be set to EGL_CONFIG_ID.

Querying EGL_CONFIG_ID returns the ID of the EGLConfig with respect to which the context was created.

eglQueryContext returns EGL_FALSE on failure and value is not updated. If attribute is not a valid EGL context attribute, then an EGL_BAD_ATTRIBUTE error is generated. If ctx is invalid, an EGL_BAD_CONTEXT error is generated.

### 3.7 Synchronization Primitives

To prevent native rendering API functions from executing until any outstanding OpenGL ES rendering affecting the same surface is complete, call

```c
EGLBoolean eglWaitGL(void);
```

OpenGL ES calls made prior to eglWaitGL are guaranteed to be executed before native rendering calls made after eglWaitGL which affect the surface associated with the calling thread’s current context. The same result can be achieved using glFinish. Clients rendering to single buffered surfaces (e.g. pixmap surfaces) should call eglWaitGL before accessing the native pixmap from the client.

eglWaitGL returns EGL_TRUE on success. If there is no current rendering context, the function has no effect but still returns EGL_TRUE. If the surface associated with the calling thread’s current context is no longer valid, EGL_FALSE is returned and an EGL_BAD_CURRENT_SURFACE error is generated.

To prevent the OpenGL ES command sequence from executing until any outstanding native rendering affecting the same surface is complete, call

```c
EGLBoolean eglWaitNative(EGLint engine);
```
3.8. POSTING THE COLOR BUFFER

Native rendering calls made with the specified marking engine, and which affect the surface associated with the calling thread’s current context, are guaranteed to be executed before OpenGL ES rendering calls made after eglWaitNative. The same result may be (but is not necessarily) achievable using native synchronization calls.

*engine* denotes a particular marking engine (another drawing API, such as GDI, Xlib) to be waited on. Valid values of *engine* are defined by EGL extensions specific to implementations, but implementations will always recognize the symbolic constant EGL_CORE_NATIVE_ENGINE, which denotes the most commonly used marking engine other than OpenGL ES itself.

eglWaitNative returns EGL_TRUE on success. If there is no current rendering context, the function has no effect but still returns EGL_TRUE. If the surface does not support native rendering (e.g., pbuffer and in most cases window surfaces), the function has no effect but still returns EGL_TRUE. If the surface associated with the calling thread’s current context is no longer valid, EGL_FALSE is returned and an EGL_BAD_CURRENT_SURFACE error is generated. If *engine* does not denote a recognized marking engine, EGL_FALSE is returned and an EGL_BAD_PARAMETER error is generated.

3.8 Posting the Color Buffer

After completing rendering, the contents of the color buffer can be made visible in a native window, or copied to a native pixmap.

3.8.1 Posting to a Window

To post the color buffer to a window, call

```c
EGLBoolean eglSwapBuffers(EGLDisplay dpy,
                          EGLSurface surface);
```

If *surface* is a window surface, then the color buffer is copied to the native window associated with that surface. If *surface* is a pixmap or pbuffer surface, eglSwapBuffers has no effect.

The color buffer of *surface* is left in an undefined state after calling eglSwapBuffers.

Native Window Resizing

If the native window corresponding to *surface* has been resized prior to the swap, *surface* must be resized to match. *surface* will normally be resized by the EGL
implementation at the time the native window is resized. If the implementation
cannot do this transparently to the client, then eglSwapBuffers must detect the
change and resize surface prior to copying its pixels to the native window.

If surface shrinks as a result of resizing, some rendered pixels are lost. If
surface grows, the newly allocated buffer contents are undefined. The resizing
behavior described here only maintains consistency of EGL surfaces and native
windows; clients are still responsible for detecting window size changes (using
platform-specific means) and changing their viewport and scissor regions accord-
ingly.

3.8.2 Copying to a Native Pixmap

To copy the color buffer to a native pixmap, call

```c
EGLBoolean eglCopyBuffers(EGLDisplay dpy,
   EGLSurface surface, NativePixmapType target);
```

The color buffer is copied to the specified target, which must be a valid native
pixmap handle.

The target pixmap should have the same number of components and component
sizes as the color buffer it’s being copied from. Implementations may choose to
relax this restriction by converting data to the native pixmap formats. If they do
so, they should define an EGL extension specifying which pixmap formats are
supported, and specifying the conversion arithmetic used.

The mapping of pixels in the color buffer to pixels in the pixmap is platform-
dependent, since the native platform pixel coordinate system may differ from that
of OpenGL ES.

The color buffer of surface is left unchanged after calling eglCopyBuffers.

3.8.3 Posting Semantics

In EGL 1.0, surface must be bound to the current context. This restriction is ex-
pected to be lifted in future EGL revisions.

If dpy and surface are the display and surface for the calling thread’s current
context, eglSwapBuffers and eglCopyBuffers perform an implicit glFlush. Sub-
sequent OpenGL ES commands can be issued immediately, but will not be ex-
cuted until posting is completed (for eglSwapBuffers, this is typically during
vertical retrace of the display).

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3.9. OBTAINING EXTENSION FUNCTION POINTERS

3.8.4 Posting Errors

eglSwapBuffers and eglCopyBuffers return EGL_FALSE on failure. If surface is not a valid EGL surface, an EGL_BAD_SURFACE error is generated. If surface is not bound to the calling thread’s current context, an EGL_BAD_SURFACE error is generated. If target is not a valid native pixmap handle, an EGL_BAD_NATIVE_PIXMAP error should be generated. If the format of target is not compatible with the color buffer, or if the size of target is not the same as the size of the color buffer, an EGL_BAD_MATCH error is generated. If eglSwapBuffers is called and the native window associated with surface is no longer valid, an EGL_BAD_NATIVE_WINDOW error is generated. If eglCopyBuffers is called and the implementation does not support native pixmaps, an EGL_BAD_NATIVE_PIXMAP error is generated.

3.9 Obtaining Extension Function Pointers

The GL and EGL extensions which are available to a client may vary at runtime, depending on factors such as the rendering path being used (hardware or software), resources available to the implementation, or updated device drivers. Therefore, the address of extension functions may be queried at runtime. The function

```c
void (*eglGetProcAddress(const char *procname))();
```

returns the address of the extension function named by procName. procName must be a NULL-terminated string. The pointer returned should be cast to a function pointer type matching the extension function’s definition in that extension specification. A return value of NULL indicates that the specified function does not exist for the implementation.

A non-NULL return value for eglGetProcAddress does not guarantee that an extension function is actually supported at runtime. The client must also query glGetString(GL_EXTENSIONS) (for OpenGL ES extensions) or eglQueryString(dpy, EGL_EXTENSIONS) (for EGL extensions) to determine if an extension is supported by a particular context.

Function pointers returned by eglGetProcAddress are independent of the display and the currently bound context, and may be used by any context which supports the extension.

eglGetProcAddress may be queried for all of the following functions:

- All GL and EGL extension functions supported by the implementation (whether those extensions are supported by the current context or not). This includes any mandatory OpenGL ES extensions.
eglGetProcAddress may not be queried for core (non-extension) functions in GL and EGL. For functions that are queryable with eglGetProcAddress, implementations may choose to also export those functions statically from the OpenGL ES link library. However, portable clients cannot rely on this behavior.
Chapter 4

Extending EGL

EGL implementors may extend EGL by adding new commands or additional enumerated values for existing EGL commands.

New names for EGL functions and enumerated types must clearly indicate whether some particular feature is in the core EGL or is vendor specific. To make a vendor-specific name, append a company identifier (in upper case) and any additional vendor-specific tags (e.g. machine names). For instance, SGI might add new commands and manifest constants of the form eglNewCommandSGI and EGL_NEW_DEFINITION_SGI. If two or more vendors agree in good faith to implement the same extension, and to make the specification of that extension publicly available, the procedures and tokens that are defined by the extension can be suffixed by EXT. Extensions approved by supra-vendor organizations such as the Khronos SIG and the OpenGL ARB use similar identifiers (OML and OES for Khronos, and ARB for the ARB).

It is critically important for interoperability that enumerants and entry point names be unique across vendors. The OpenGL ARB Secretary maintains a registry of enumerants, and all shipping enumerant values must be determined by requesting blocks of enumerants from the registry. See

http://oss.sgi.com/projects/ogl-sample/registry/

for more information on defining extensions.
Chapter 5

EGL Versions and Enumerants

Each version of EGL supports a specified OpenGL ES version, and all prior versions of OpenGL ES up to that version. EGL 1.0 supports OpenGL ES 1.0, including both Common and Common-Lite profiles.

5.1 Compile-Time Version Detection

To allow code to be written portably against future EGL versions, the compile-time environment must make it possible to determine which EGL version interfaces are available. The details of such detection are language-specific and should be specified in the language binding documents for each language. The base EGL specification defines an ISO C language binding, and in that environment, the EGL header file <GLES/egl.h> must define a C preprocessor symbol:

```
#define EGL_VERSION_1_0 1
```

Future versions of EGL will define additional preprocessor symbols corresponding to the major and minor numbers of those versions.

5.2 Enumerant Values

Enumerant values for EGL tokens are required to be common across all implementations. A reference version of the egl.h header file, including defined values for all EGL enumerants, accompanies this specification and can be downloaded from

http://www.khronos.org/
Chapter 6

Glossary

**Address Space** the set of objects or memory locations accessible through a single name space. In other words, it is a data region that one or more processes may share through pointers.

**Client** an application, which communicates with the underlying EGL implementation and underlying native window system by some path. The application program is referred to as a client of the window system server. To the server, the client is the communication path itself. A program with multiple connections is viewed as multiple clients to the server. The resource lifetimes are controlled by the connection lifetimes, not the application program lifetimes.

**Compatible** an OpenGL ES rendering context is compatible with (may be used to render into) a surface if they meet the constraints specified in section 2.2.

**Connection** a bidirectional byte stream that carries the X (and EGL) protocol between the client and the server. A client typically has only one connection to a server.

**(Rendering) Context** an OpenGL ES rendering context. This is a virtual OpenGL ES machine. All OpenGL ES rendering is done with respect to a context. The state maintained by one rendering context is not affected by another except in case of state that may be explicitly shared at context creation time, such as textures.

**EGLContext** a handle to a rendering context. Rendering contexts consist of client side state and server side state.

**(Drawing) Surface** an onscreen or offscreen buffer where pixel values resulting from rendering through OpenGL ES or other APIs are written.
Thread one of a group of processes all sharing the same address space. Typically, each thread will have its own program counter and stack pointer, but the text and data spaces are visible to each of the threads. A thread that is the only member of its group is equivalent to a process.
Appendix A

Version 1.0

EGL version 1.0, approved on July 23, 2003, is the original version of EGL. EGL was loosely based on GLX 1.3, generalized to be implementable on many different operating systems and window systems and simplified to reflect the needs of embedded devices running OpenGL ES.

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