OpenGL ES 2.x SDK

User Guide

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1. OpenGL ES 2 SDK Content

1.1. Introduction

The POWERVR OpenGL ES 2 SDK provides a set of documentation, source code and utilities to help developers to create applications using the OpenGL ES 2 graphics library on POWERVR platforms. This document describes the contents of the SDK and gives guidelines for installing it on different platforms.

1.2. Documentation

The following documents are located in `\SDKPackage` or in `\SDKPackage\Documents`.

OpenGL ES 2.x SDK.User Guide
Description of OpenGL ES 2 SDK contents and installation.

Migration from OpenGL ES 1.x to OpenGL ES 2.0 API
This document describes the differences between the fixed function OpenGL ES 1.x API and the OpenGL ES 2.x programmable shader based API.

Migration From Software Rendering To 3D accelerated Graphics Using OpenGL ES.Khronos Kolumn
An article posted in the Khronos Kolumn (http://www.gamedev.net/reference/articles/article2268.asp) which will help developers who are now starting to code for hardware accelerated devices.

POWERVR Shader Based Water Effects
This document describes how to achieve the optimised water effect implemented in the OGLES2Water demo included in the SDK.

POWERVR Effect File (PFX)
This document describes the PFX file format. This format is used to encapsulate vertex shaders, fragment shaders and textures for an easy definition of a material. It is used by PVRShaman. The API to handle this format in OpenGL ES 2.0 is part of PVRTools.

POWERVR SGX.Application Development Recommendations
This document gives performance recommendations for POWERVR SGX hardware and explains how to analyse an application to detect bottlenecks.

PVR Texture Compression
Whitepaper describing PVRTC texture compression in detail. This whitepaper was issued at the presentation that was given at the Graphics Hardware 2003 conference.

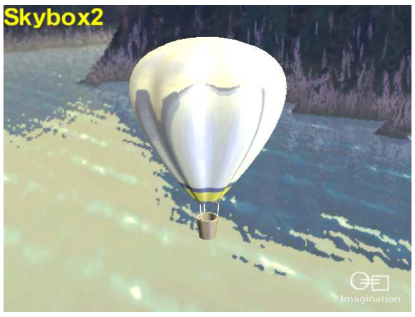
1.3. Demos

The OpenGL ES 2.0 SDK contains a variety of technology demos whose aim is to demonstrate a particular feature of the hardware or software API. Each demo is provided with an executable and associated source code. For a description of the command-line options supported by the demos see the Shell section below.

The demos are located in the `\SDKPackage\Demos` folder.

Note: Some of the Demos or Training Courses listed below might not be present on your specific SDKs. This will depend on the capabilities and features of your target platform.

Shaders	
Shaders Shader: envmap Mesh: Torus Imagination	This demo demonstrates several procedural texturing methods like 'wood', 'phong shading', 'environment mapping', etc. using fragment shaders. These shaders are applied to different geometry objects. Use the cursor key to select. Please keep the folder called 'Shaders' (which contains all the shaders files) in the same location as the application. The application will quit if it cannot find these files. This demo supports command-line input where '-s=' specifies the shader (from 0 to 5) and '-m=' the mesh (from 0 to 5): `e.g. OGLES2Shaders -s=2 –m=0`

SkyBox2	
	This is a new version of the SkyBox demo from our OpenGL ES1.1 SDK but, in this case, using different vertex and fragment shaders to show the capabilities of OpenGL ES 2.0 API.

Coverflow	
Coverflow DANGER 33,000 VOLTS	Demonstrates how to implement a simple version of 'cover flow'.

Chameleon Man	
	Shows a matrix skinned character in combination with DOT3 per pixel lighting.

Phantom Mask	
	Shows a mask lit using spherical harmonics and regular diffuse vertex lighting.

Water	
	Shows how to render a water effect on a given plane.

FilmTV	
	Demonstrates render to texture.

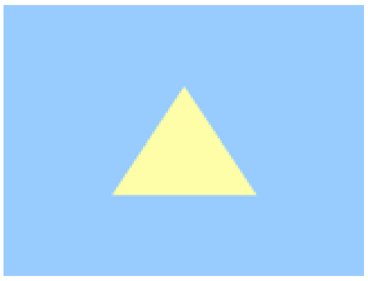
1.4. Training course

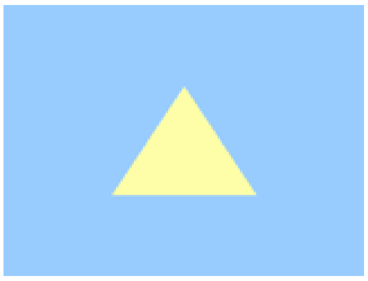
Several simple applications are provided to show specific features in a simplified form. The code has been thoroughly commented to help developers to understand the API and get started.

The Training Course demos are located in the `\SDKPackage\TrainingCourse` folder.

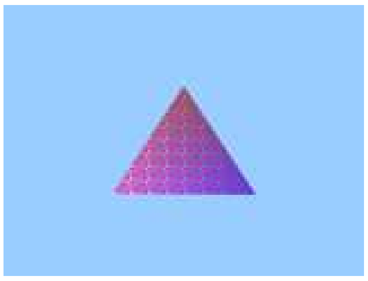
Note: The demos in the TrainingCourse folder do not handle screen rotation to keep the code as simple as possible. On devices with a portrait display the images below might be shown stretched.

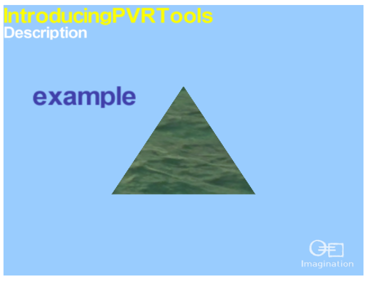
Initialization	
	Shows how to initialise OpenGL ES. It does a simple background clear.

HelloTriangle	
	Shows how to draw simple untextured geometry.

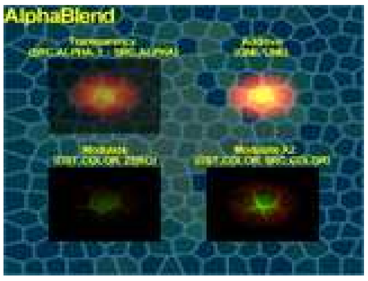
IntroducingPVRShell	
	Shows how to use PVRShell as the OS and API initialisation framework using the same geometry as the previous example.

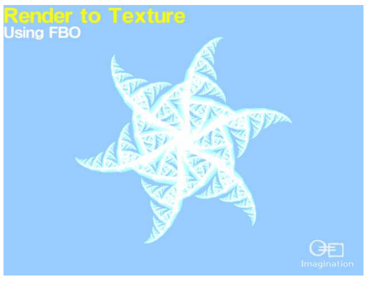
Texturing	
	Shows how to load and use textures.

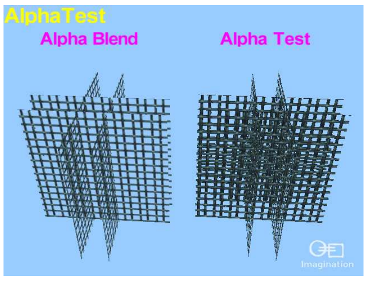
BasicTnL	
	Shows how to transform and light simple geometry using the same geometry as the previous example.

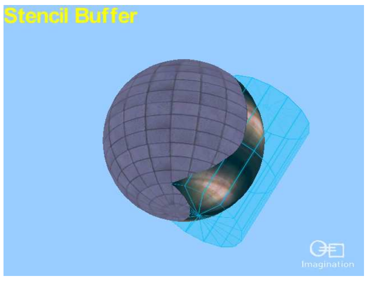
IntroducingPVRTools	
	Shows some of the features available in the PVRTools supplied with the SDK. In this case, shows how to load textures and display text on the screen.

IntroducingPOD	
	Shows how to load and display a POWERVR POD file exported from 3DS MAX.

AlphaBlend	
	Shows 4 different types of blending mode.

RenderToTexture	
	How to perform render to texture using frame buffer objects (FBOs). It renders to two surfaces to create a recursive fractal effect.

AlphaTest	
	Demonstrates how to use the Alpha Test.

StencilBuffer	
	Demonstrates how to use the Stencil Buffer.

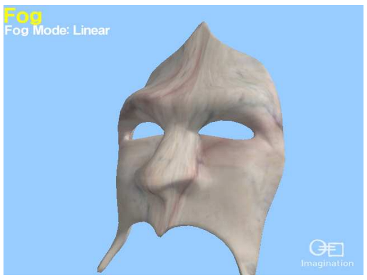
IntroducingPFX	
	Shows how to use our tools to load a PFX file.

FastTnL	
	Shows how to use our fast transformation and lighting vertex shader. This technique is appropriate when a high performance shader is required.

LightMap	
	Shows how to use ‘pre-baked’ Light Maps.

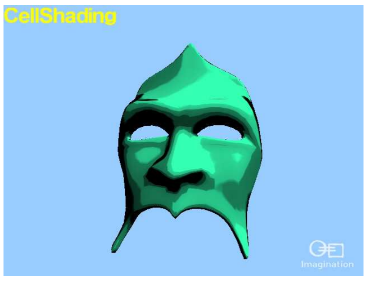
Reflections	
	How to use reflections, 2D Mapping and Cube Mapping.

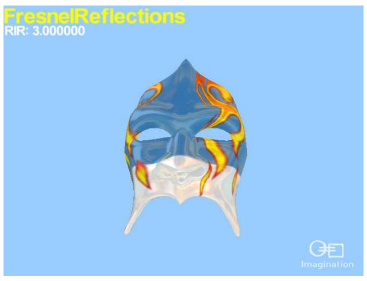
ComplexLighting	
ComplexLighting Directional Light (Diffuse) Imagination	Shows how to implement directional, point, and spot lighting.

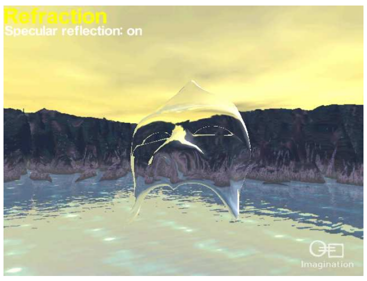
Fog	
	Shows how to implement a fog effect using shaders.

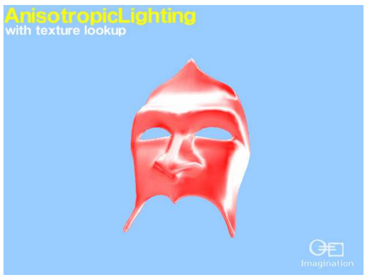
Bumpmap	
Bumpmap Imagination	Shows how to use a normal map for bump mapping.

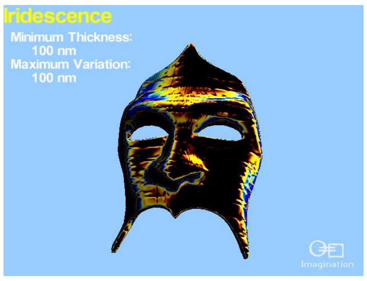
PerturbedUVs	
PerturbedUvs Imagination	Shows how to use a normal map to perturb uvs.

CellShading	
	How to implement cell shading.

FresnelReflections	
	Shows how to implement fresnel reflections. It looks similar to a car body surface with wax.

Refraction	
	How to create glass like materials and Phong's specular reflection.

AnisotropicLighting	
	This example demonstrates two techniques for generating an anisotropic lighting effect on the mask. One calculates the shading for each pixel on the fly; the other is optimised by using a texture to lookup the shading values. Anisotropic lighting simulates the effect of surfaces with a grain, or grooves. This includes materials such as brushed metal, velvet and records.

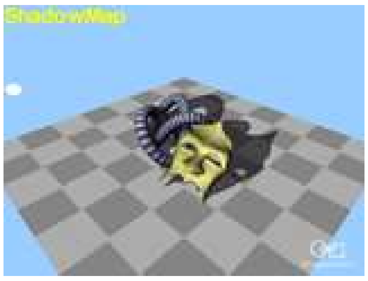
Iridescence	
 Iridescence Minimum Thickness: 100 nm Maximum Variation: 100 nm Imagination	How to implement an iridescence effect by using shaders to mimic the behaviour of light reflecting off a surface covered by a translucent film of variable thickness.

Skinning	
Skinning Imagination	Demonstrates how to perform skinning.

LevelOfDetail	
Level of detail Detail: high Imagination	Demonstrates the use of a low and high detail method for displaying an object where detail further away can be lower without compromising appearance in order to save performance.

ShadowVolume	
ShadowVolumes Imagination	Shows how to use our tools to create and use stencil buffer shadow volumes.

DisplacementMap	
DisplacementMapping	Shows how to displace geometry in the vertex shader using a texture.

ShadowMapping	
	Demonstrates shadow mapping using GL_OES_depth_texture extension.

Bloom	
	This training course demonstrates a simple implementation of a Bloom effect.

1.5. PVRShell

The POWERVR shell is used in all Demos and Training Courses to provide a common framework for developing OpenGL ES 2 applications on any POWERVR platform. The shell takes a set of command-line arguments which allow things like the position and size of the demo to be controlled. The table below shows these options.

PVRShell also provides a limited keyboard input option which may vary depending on your actual platform. If your platform has full keyboard support, the Q key will quit the application and the cursor keys will allow looping through the application options.

Table 1 - Shell command-line options

Option	Description
-width=N	Sets the viewport width to N.
-height=N	Sets the viewport height to N.
-posx=N	Sets the x coordinate of the viewport.
-posy=N	Sets the y coordinate of the viewport

Option	Description
-FSAAMode=N or –aa=N	Sets full screen anti-aliasing. N can be: 0=no AA , 1=2x AA , 2=4x AA
-fullscreen=[1,0]	Runs in full-screen mode(1) or windowed (0)
-powersaving=[1,0]	Where available enable/disable power saving.
-quitaftertime=N or –qat=N	Quits after N seconds
-quitafterframe=N or –qaf=N	Quits after N frames
-vsync=N	Where available modify the apps vsync parameters
-version	Output the SDK version to the debug output.
-info	Output setup information to the debug output.
-rotatekeys=N	Sets the orientation of the keyboard input. N can be: 0-3, 0 is no rotation.
-c=N	Save a single screenshot or a range. e.g. -c=1-10, -c=14.
-priority=N	Sets the priority of the EGL context.
-colourbpp=N	When choosing an EGL config N will be used as the value for EGL_BUFFER_SIZE.
-config=N	Force the shell to use the EGL config with ID N.

1.6. PVRTools

The tools library consists of various modules designed to help developers achieve common tasks associated with 3D graphics rendering, e.g. model loading, extensions handling, matrix functions, 3D font, etc. All SDK demos make use of the OpenGL ES 2 Tools library.

The Tools library is located in the `\SDKPackage\Tools` folder.

1.7. Utilities

These are utility programs or libraries useful for 3D application development.

All utilities are located in the `\SDKPackage\Utilities` folder.

PVRTexTool PVRTexLib PVRTC
Tools to convert bitmap files (e.g. BMP, TGA, etc.) to any texture type supported by POWERVR hardware.

PVRGeoPOD
Plug-in for 3DStudio MAX and Maya to export optimized 3D data in POD format.

Collada2POD
Command-line and GUI utility to convert Khronos intermediate format to POWERVR POD format.

PVRShaman
POWERVR Shader Composer and POD file viewer for OpenGL ES 2

PVRUniSCo
SGX shader compiler. *Note: This tool might not be available in all releases.*

PVRUniSCo Editor
Shader editor and GUI front end for PVRUniSCo.

Filewrap
Utility to wrap a text or binary file into a C++ source file that can be compiled and linked to an application. See the description of the memory file system below.

2. Memory File System and FileWrap

All file read access in the PVRTools library uses the CPVRTResourceFile class. This not only simplifies code, it also allows the use of a “memory file system”. Any file can be statically linked into the application and looked up by name at run time. This is useful for platforms without a file system and keeps all the required data in one place, the application executable.

When looking for a file, CPVRTResourceFile will first look in the read path the application set by calling CPVRTResourceFile::SetReadPath. This is usually a platform dependent path which can be obtained from PVRShell. If the file is not there, CPVRTResourceFile will look for the file in the memory file system. This way “internal” files linked in the executable can be overridden by external ones. When using the memory file system filenames passed to PVRTools, functions should always be given without a path.

2.1. Using the Memory File System in your own Projects

In order to use the memory file system in your own projects, you need to link to the PVRTools library. Furthermore, you need to turn the files you want to add into C++ sources using the Filewrap utility. Typically this would be done with a command line like this:

```
filewrap –o Memfilesystem.cpp file1 file2 file3 ...
```

Note that the name of the .cpp file is not important; the files will be registered in the memory file system under their original name (in this case file1, file2, file3). You can also generate multiple .cpp files and compile them into the same application. However, the memory file system is just a list of files without any directory structure, so make sure not to use duplicate file names within an application.

After you have generated the .cpp files, all you need to do is add them to your project like you would add other C++ source files. Now you are ready to use CPVRTResourceFile to read files from the memory file system. Of course this wrapping can also be automated using makefiles or custom build steps in Visual Studio projects.

To automate Filewrap using custom build steps in Visual Studio, first add the file you want in the memory file system to your project (“Add existing item…”). Then select this file in the Solution Explorer and open the property page for it. Choose “All Configurations”, and then select “Custom Build Step”.

Set “Command Line” to:

```
Filewrap.exe -o "$(InputDir)Outputfile.cpp" "$(InputPath)"
```

Set “Outputs” to:

```
$(InputDir)Outputfile.cpp
```

Make sure Filewrap.exe is on your PATH environment variable or use an absolute path to Filewrap.exe. Replace Outputfile.cpp with a file name of your choice.

Following this, close the property page, right-click on the file and select “Compile”. This should produce the .cpp file which you should also add to your project.

3. OpenGL ES 2 SDK Installation

See below the SDK installation and build notes for all platforms supported by POWERVR cores. Please, refer to the platform you are using.

3.1. PCEmulation

Note: PCEmulation library is not an accurate representation of POWERVR hardware. This tool is a wrapper around desktop OpenGL so its capabilities will depend on the 3D acceleration present in your system.

3.1.1. Windows PC Emulation

Requires a PC equipped with the Windows XP and Microsoft Visual Studio .NET 2003 or .NET 2005. Note: If you use Microsoft Visual C++ Express Edition be sure to follow all of the instructions in the Microsoft Platform SDK.

1. Unpack the contents of this package to a local folder in the system. The project and solution files provided (.vcproj and .sln, for Microsoft Visual Studio 2003) do not require the SDK to be installed in a pre-defined location and are configured to use relative paths.
2. The OpenGL ES 2 emulation “drivers” are called libEGL.lib and libGLESv2x.lib and are located by default in the following directory:
   SDKPackage\Builds\OGLES2\WindowsPC\Lib
   Those files must be copied to a DLL-accessible directory prior to running the SDK applications (e.g. standard Windows directory or local directory).

Note: The Tools and Demos can be launched directly from their project files.

3.1.2. Linux PC Emulation

1. Unpack the contents of this package to a local folder on a PC equipped with a Linux operating system using “tar –zxvf”.
2. The OpenGL ES 2 emulation “drivers” are called libEGL.so and libGLESv2.so and are located by default in the following directory: SDKPackage\Builds\OGLES2\LinuxPC\Lib
   Those files must be accessible by the OS. To do so put them into your library path by using: “export LD_LIBRARY_PATH=(folder containing the .so files)”
3. Demos and benchmarks can be launched directly from the “Binaries” folder.
4. To build a component, first set the platform to LinuxPC using “export PLATFORM=LinuxPC”
5. Then go into the component’s Build/LinuxGeneric folder and type ‘make’. The resulting executable will go into a subfolder of Build/LinuxPC.
6. In some of distributions of Linux you encounter a problem when running applications using PCEmulation then you may need to install glew libraries. On Ubuntu it may be done with commands :

   sudo apt-get install libglut3-dev -y

   sudo apt-get install libglew-dev -y

   sudo apt-get install glew-utils -y

Note: Running OGLES2 PC Emulation is currently not supported in 64 bit Linux environments

3.2. Linux

1. OpenGL ES 2 libraries are not distributed with the POWERVR Linux SDKs. Ask your platform provider for these libraries if you do not have them.
2. Define the environment variable LIBDIR to point to the directory containing the OpenGL ES 2 libraries, e.g. “export LIBDIR=/home/user/Linux_Baseport/target/usr/lib”
3. Install the latest platform toolchain for your target platform.

4. Define the TOOLCHAIN environment variable to the toolchain directory, e.g. “export TOOLCHAIN=/data/omap_binaries/linux/arm/”, or add the path to the toolchain to the PATH environment variable (i.e. run “export PATH=”<path to the toolchain>:$PATH”).
5. If you want an X11 build and it is available, define the environment variable X11ROOT to point to the freedesktop directory (i.e. “export X11ROOT=/usr/X11R6_SGX”)

   To build individual components go to the directory Demos/<DemoName>/OGLES2/Build/LinuxGeneric or TrainingCourse/<TCName>/OGLES2/Build/LinuxGeneric and run the command**:**

   LinuxRaw: “make PLATFORM=<platform>”

   LinuxX11: “make PLATFORM=<platform> X11BUILD=1”

   where platform consists of the word “Linux” followed by the name of the device you are building the application for, e.g. LinuxOMAP3, LinuxX86

   Depending on the chosen platform and the value of X11BUILD, the executables for the demos and training courses will go to: Demos/<DemoName>/OGLES2/Build/<platform>/<ReleaseDir> or TrainingCourse/<DemoName>/OGLES2/Build/<platform>/<ReleaseDir>, where ReleaseDir is one of: ReleaseRaw, ReleaseX11
6. Ensure that the POWERVR drivers are installed on the target device (please refer to DDK / driver installation instructions).
7. If the standard c++ libraries are not present on your target device, copy libc++ from the toolchain into /usr/lib. libdl and libgcc may also be required.
   Note: *libc++ lives at /usr/lib if you have installed the drivers, or can be found as part of a binary driver release package.*
8. Ensure the drivers are running (e.g. type /etc/init.d/rc/pvr start, then run an X session if required).

   Under X11 window sizes can be specified for the executables using the command line arguments -posx=n and -posy=n to define the top right hand corner, and -width=n and -height=n to define width and height, respectively. E.g.

   ./OGLES2IntroducingPOD -posx=10 -posy=10 -width=100 -height=100
9. If you attempt to run an SDK training course or demo and it fails with the message: “Can’t open display” produced by the X client then make sure that the DISPLAY variable is set with the shell command: “set | grep –e DISPLAY”. If this command doesn’t yield any output then type (in shell): “DISPLAY=:0.0; export DISPLAY”

3.3. Symbian

1. Install latest Symbian release.
   Note: In the following [SYMBIAN] is used to refer to the Symbian installation directory.
2. To build individual components go to the /Build/SymbianTextShell or Build/SymbianTechView sub-directory of the component to build and type:

   bldmake bldfiles
   abld build <platform> urel

   Note: For OMAP systems use armv5 as platform

   The .exe will be automatically copied in the correct place in the Symbian SDK tree to be included in the image through the OBY file.

   Pre-built binaries can be found in the Binaries folder ready to be dropped in your Symbian SDK (exes and IBY for TechView and TextShell, and resources for TechView)

   Refer to your platform BasePort documentation to know how to build an image and how to download it to the platform. We supply in the package the OBY and IBY files that will allow you to include the SDK demos in the image.

Note: Due to a Symbian DevKit problem with long path names the SDK apps may not build out of the package. To keep the paths short please install SDKPackage/ in your root path and/or rename it to a shorter name (e.g. SP/) to be able to build the applications.

3.4. uITRON

To build for uITRON you will need to setup the following environment variables, alternatively they can be passed to the makefile on the command line.

WORKROOT	Refers to the folder that contains the Eurasia folder of the DDK.
PLATFORM	Refers to the name of the folder within *\eurasia\eurasiacon\build\uitron*.
SHC_DIR	The tools you wish to use, e.g. \Tools\Renesas\sh\8_05.

The following variables only need to be defined when using some versions of the DDK

SGXBUILD	SGXBUILD's value is taken from the first 6 characters of the suffix attached to the folder name *uiton_shmobile_release* in ***\PLATFORM****\tools*. It will be of the form SGX***xxx***
SGX_CORE_REV	SGX_CORE_REV takes its value from the remainder of the suffix.

To build individual components go to the /Build/uitronSHMobile sub-directory of the component to build and type:

```
nmake Makefile.mak
```

3.5. Symbian S60 5th Edition

3.5.1. Building for hardware

1. If you haven't already done so you will need to download and install the Symbian S60 5th Edition SDK from www.forum.nokia.com. Currently the SDK doesn't come with the required libraries for compiling OGLES2 applications. You should be able to get these from your mobile phone manufacturer and these will go in epoc32\release\armv5\lib.

2. From a command-line go to the /Build/SymbianS60 sub-directory of the component to build. If it is not already you need to make the Symbian S60 5th Edition SDK the default device for building. To check that it is type:

   ```
   devices
   ```

   The default SDK will have "–default" next to it. If it is not the default then type

   ```
   devices –setdefault [symbianSDK]
   ```

   where [symbianSDK] is the SDK you want listed by devices

   e.g. S60_5th_Edition_SDK_v1.0:com.nokia.s60.

Once ready you can build the app by typing:

```
bldmake bldfiles
abld build armv5 urel
```

3. To create an installation package (.SIS file), type:

   ```
   makesis –d%EPOCROOT% [packagename].pkg
   ```

   where [packagename] is the name of the .pkg file in the /Build/SymbianS60 directory.

4. Before the .SIS file can be installed on the phone it needs to be signed. To do this type:

   ```
   signsis [sisname] [sisname] [certificate] [key] [pass]
   ```

   where [sisname] is the name of the .SIS file, [certificate], [key] and [pass] are the certificate, key and password to use. You can either create and use your own certificate and key for signing or you can use the ones provided in /Builds/Symbian which have the password “ImgTec”. To do this type

   ```
   signsis [sisname]
   [sisname] ..\..\..\..\..\Builds\Symbian\ImgTec.cer ..\..\..\..\..\Builds\Symbian\ImgTec.key ImgTec
   ```

5. Pre-built .SIS files can be found in the ‘Binaries’ folder.
6. Please follow the manufacturer’s instructions on how to install the .SIS files onto your phone.

3.6. Windows Mobile 7

1. Open a command prompt and setup your Windows Mobile 7 build environment.
2. Set the environment variable SDKROOT to the root of the installed SDKPackage

   ```
   e.g. set SDKROOT=c:\SDKPackage
   ```

3. To build all SDK apps at the root of the SDKPackage type

   ```
   build –c
   ```

4. To build an individual app navigate to the application’s folder and type

   ```
   build –c
   ```

   The makefiles for the majority of apps are kept in [app]\OGLES2\Build\PlatformBuilder and the executables are built in [app]\OGLES2\Build\PlatformBuilder\oak\target\ARMV4I\retail.

3.7. Windows CE 5 (x86)

1. Open a command prompt and setup your Windows CE 5 build environment.
2. Set the environment variable SDKROOT to the root of the installed SDKPackage

   ```
   e.g. set SDKROOT=c:\SDKPackage
   ```

3. To build an individual app navigate to the application's folder and type

   build –c

   The makefiles for the majority of apps are kept in [app]\OGLES2\Build\PlatformBuilder and the executables are built in [app]\OGLES2\Build\PlatformBuilder\oak\target\ARMV4I\retail.

3.8. Windows Mobile 6.1, Standard

1. Download and install the Windows Mobile 6.1 Standard SDK from the following location: http://www.microsoft.com
2. Unpack the contents of this package to a local folder on a PC equipped with the Windows XP operating system. The project and solution files provided (.vcproj and .sln, for Microsoft Visual Studio 2005) do not require the SDK to be installed in a pre-defined location and are configured to use relative-paths.

   The OpenGL ES 2 libraries should be in the folder Builds/OGLES2/<platform>/Lib.
3. For building in the "Configuration Manager" dialog box, make sure the "Active solution platform" is set to "Windows Mobile 6 Standard SDK (ARMV4I)".

3.9. Windows CE 6 CEPC (x86)

1. Copy the POWERVR and third party folders from the DDK into your `\WINCE600\PUBLIC` folder.
2. Create a new OS Design Project in Visual Studio 2005 (with Platform Builder 6 installed).
   a. When choosing the BSP select "CEPC: x86".
   b. Choose a device and press finish.
3. In the "Catalog Items View" window under Third Party tick "POWERVR XXX – OpenGL ES 2.0".
4. In the "Catalog Items View" window tick
5. Core OS -> CEBASE -> Applications and Services Development -> C Libraries and Runtimes -> C++ Runtime Support for Exception Handling and Runtime Type Information.
6. Build the OS Design.
7. Copy the SDK Binaries into the release directory and execute from the command line when your device has been attached.

3.9.1. Note

1. To build the SDK examples you need to install "**WindowsCE 6 CEPC Default SDK.msi**" included in the package.
2. When building our tools if you get an error message similar to

   PVRTGeometry.cpp
   cwchar(75) : error C2039: 'wcsftime' : is not a member of '`global namespace''
   cwchar(75) : error C2873: 'wcsftime' : symbol cannot be used in a using-declaration
   malloc.h(45) : error C2143: syntax error : missing ',' before '*'
   ..\..\..\PVRTGeometry.cpp(1064) : error C3861: 'min': identifier not found

   then go to

   Tools -> Options -> Projects and Solutions -> VC++ Directories

   and set **"Platform"** to **"WindowsCE 6 CEPC Default (x86)"** and **"Show directories for"** to **"Include files"**

Then move the **“WindowsCE6 CEPC Default”** directories above **“$(VCInstallDir)ce\include”**.

3. For examples that use external files (i.e. .pod, .pfx) these files need to be copied across to the root of the device using the **“file viewer”** under

   Target->Remote Tools

3.10. iPhone OS

1. Download a version of Apple’s iPhone SDK from the following location: http://developer.apple.com/iphone/. You will need to become a member of Apple’s developer programme in order to access this page. You can find details of how to join this at: http://developer.apple.com
2. Install the Apple SDK on your Mac as specified by Apple’s hardware/software requirements. This should also install Xcode and the other development tools required.
3. Expand the POWERVR iPhone SDK to a location that you have read/write access for.
4. To build the demos, training course and other projects of the SDK, find the various OGLES2XXX.xcode projects available within the SDKPackage directory and double click these to launch them in Xcode.
5. To build for an iPhone OS device you will need a valid developer certificate in your machine’s keychain. You may also have to change the Properties:Identifier property from Project:Edit Active Target… to match that which you have set up for yourself through Apple’s Program Portal.
6. If you don’t have a developer certificate from Apple then you can still build and launch applications in the iPhone Simulator. Choose this configuration from the drop-down menu in the top left and then choose “Build and Run” from the drop-down menu.

3.11. Android

The following instructions for building the SDK assume that you have already checked out and built the Android source tree.

To build individual components go to the /Build/LinuxGeneric sub-directory of the component to build and type:

```
make
```

The makefiles require several variables to either be exported or passed on the command-line. The variables are as follows.

Variable	Value
ANDROID_ROOT	The path to the root of the Android source tree.
PLATFORM	The platform you wish to target. The value of this will coincide with a folder within *<sdk root>*/Builds/*<api>*/
ANDROID_TOOLCHAIN	The path to the Android toolchain. If this is not defined then the build will assume that the toolchain is present in your PATH.
ANDROID_PRODUCT	The Android target product that the Android source tree was built for. By default this is set to ‘generic’.

TARGET_BUILD_TYPE	An optional variable that should be set to 'debug' if the Android source tree was a debug build.

3.12. Android JNI

The following instructions for building the SDK assume that you have already installed the Android SDK, NDK and Apache ant.

To build individual components go to the /Build/Android sub-directory of the component to build. On first build you will need to run

```
android update propject –p .
```

to create local.properties. To use the 'android' tool you need to have the Android SDKs tool folder in your path. After this the building of an application is done in two stages. The first stage involved compiling the C++ code into a library and the Java parts of the shell into a .jar file. This can be performed by typing

```
make
```

The makefiles require several variables to either be exported or passed on the command-line. The variables are as follows.

Variable	Value
NDK_ROOT	The path to the root of the NDK.
PLATFORM	The platform you wish to target. The value of this will coincide with a folder within *<sdk root>*/Builds/*<api>*/

The second stage compiles the remaining Java components and creates the .apk file for installing on your device. The quickest way of achieving this is to type

```
ant debug
```

which will create an .apk file in ./bin and will handle the signing of your application for you. For creating a release build of your app please see http://developer.android.com/guide/developing/other-ide.html#ReleaseMode.

3.13. Bada

The following instructions assume that you have already installed Samsung's Bada SDK and are familiar with the IDE.

To build individual components import the Bada projects located in /Build/Bada sub-directory of the component to build into your workspace. Except for a few of the training courses you will also need to import the project for the OGLES2 tools located in /Tools/OGLES2/Build/Bada. The POWERVR SDK requires a path variable defined called IMG_SDK_HOME which should point to the root of your SDK package. This variable should be added to the Linked Resources section under 'Window -> Preferences -> General -> Workspace'. As well as defining IMG_SDK_HOME you will need to set the Bada SDK root under 'Project->Properties->bada Build'.

3.14. Palm PDK

The following instructions assume that you have already installed Palm’s PDK.

3.14.1. Build and run on a Windows PC

To build and run an application on a Windows PC use the Visual Studio projects located in the /Build/PalmPDK sub-directory.

3.14.2. Build and run on the device

To build an application for the device open up a command prompt and navigate to the /Build/PalmPDK sub-directory. Then type:

```
nmake –f makefile.mak
```

This will compile the code and create the .ipk package. To run this package on the device without installing it type

```
nmake –f makefile.mak run
```

If you would like to install it on the phone type:

```
palm-install <name>.ipk
```

Note: To work around a known problem with the Palm PDK the SDK makefiles have been setup to link against libstdc++.so.6.0.9 within \Palm\PDK\device\lib. This library doesn’t come with the PDK and needs to be taken from the /usr/local/lib directory on the device.

4. Support Contact

For further support contact:

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