Outline

• Khronos Mobile Ecosystem
  - Neil Trevett (NVIDIA)

• OpenGL ES Update
  - Tom Olson (ARM)

• WebGL Update
  - Vlad Vukicevic (Mozilla)

• Member News
  - Epic Games (Josh Adams)
  - Symbio (Petri Talala)
  - Imagination Technologies (David Harold)
  - ARM (Nizar Romdhane)
Mobile OS Fragmentation

- Every handset is unique from the programmers perspective
  - Differences in OS functions, Java implementations and media functionality

Symbian 7, 8, 9, UIQ, S60
PocketPC / Windows Mobile / WinCE
Linux variants – Android, Limo, WebOS
Java MIDP-1, MIDP-2, JSR fragmentation
RTOS – Nucleus, Synergy
Brew, WIPI, iPhone OS

We need cross platform standard APIs to de-fragment access to visual computing acceleration if the market is to be fully realized

Severe platform fragmentation
ISVs need to port to and support 100s (even 1000s) of source variants of each title
The Other Needs for Mobile Acceleration

**Faster Performance at Higher Quality**
Hardware delivers smoother interaction with much better looking visuals

**Less Power!**
Hardware accelerators exploit media pipeline parallelism and caching for a x10 increase in power efficiency over software

**Better User Experience**
Small screens need advanced graphics processing per pixel

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**POWER EFFICIENCY**

<table>
<thead>
<tr>
<th></th>
<th>ARM9</th>
<th>32-Bit RISC at 400MHz</th>
<th>DSP at 175MHz</th>
<th>APA 512 MiMagic 6</th>
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<tr>
<td>Power</td>
<td>17.6</td>
<td>1.85</td>
<td>0.14</td>
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</table>

Software 3D vs. Accelerated 3D
Pervasive OpenGL ES

- OpenGL ES has become the most widely deployed 3D API
  - Smartphones, games consoles, GPS, media players, automotive, tablets...

Mobile Operating Systems that have adopted OpenGL ES as their native 3D API
OpenGL ES Market Penetration

Source: Jon Peddie Research, March 2009
OpenVG - Accelerated Vector Graphics

- OpenVG is the industry’s first native Bezier acceleration API
  - Enables a new class of hardware acceleration – Bezier primitives – not polygons
- Primarily used to accelerate higher-level engines such as SVG
  - OpenVG is an OpenGL-style, low-level API

OpenGL ES accurately represents PERSPECTIVE and LIGHTING using 3D polygons
OpenVG accurately represents SHAPE and COLOR using 2D Bezier Curves
OpenMAX IL Media Acceleration

OpenMAX IL enables diverse high-level media frameworks and applications to portably tap into silicon media acceleration.
OpenCL 1.0 Embedded Profile

- OpenCL – parallel programming of heterogeneous processors
- OpenCL 1.0 has Embedded profile - no need for a separate “ES” spec

- An always-on, connected, mobile device with multiple sensors PLUS graphics and imaging PLUS a supercomputer – all in the palm of your hand will create a new wave of application opportunities...

A concept GPS phone processes images to recognize buildings and landmarks and uses the internet to supply relevant data
EGL - Mobile API Interoperability Hub

Buffers, textures and video streams flow efficiently between any combination of client APIs

Inter-API Synchronization events enable efficient resource sharing

EGL Interoperability Conformance Tests being created to ensure that client APIs can cleanly communicate

Enabling the Khronos individual APIs to interoperate as a coherent ecosystem
Raising 2D and 3D Visual Quality

State-of-the-art APIs enable compelling consumer displays
Advanced functionality, fast interactivity and extremely high quality

High-quality 2D graphics and test using OpenVG

Video and image processing with OpenMAX IL

High-quality 3D displays using OpenGL ES

Older generation APIs
Provide rudimentary graphics functionality and quality
Mobile Application Portability

Applications are portable to Khronos-enabled platforms

Silicon independent graphics, media and compute acceleration

OS resource abstraction

Compositing User Interfaces
Games and Game Engines
Flash and SVG Players
TV and Video Stacks
Browsers

Applications are portable to Khronos-enabled platforms
OpenGL-based Wider Ecosystem

Desktop Visual Computing
OpenGL and OpenCL have direct interoperability. OpenCL objects can be created from OpenGL Textures, Buffer Objects and Renderbuffers.

Mobile Visual Computing
Compute, graphics and AV APIs interoperate through EGL.

3D Everywhere
OpenGL 4.0 and OpenGL ES 2.0 and WebGL provide streamlined APIs to deliver 3D content everywhere. Desktop, mobile and Web.
OpenGL ES Update

Tom Olson
Director, Graphics Research, ARM
OpenGL ES Working Group Chair
What is OpenGL ES?

• OpenGL for mobile devices
  - Gets rid of redundant / legacy features
  - Extensions to make it mobile-friendly
  - All the functionality of the desktop API

• Versions
  - ES 1.0 / 1.1: fixed function
  - ES 2.0: shader-based via GLSL ES

• A huge success!
  - The dominant native 3D API for mobile devices
  - Moving rapidly into other embedded markets
  - >> 200M units shipped
OpenGL ES 2.0

- The First Modern Mobile 3D API
  - Shader-based, not fixed function
  - Buffer-based, not client array
  - Clean, small, efficient API

- Advanced Feature Set
  - Vertex and Fragment Shaders
  - High level language (GLSL ES)
  - Eight attrs / varyings / samplers
  - Cube Map Textures
  - Framebuffer Objects
OpenGL ES 2.0 is here!

- Available in all the latest high-end handsets
- SDKs, books are now available

...and the fun is just starting
Working Group Activities

• Next Generation OpenGL ES
  - Working Group’s main focus since mid-2009
  - Will be released when market needs it
  - Will not disrupt the growing OpenGL ES 2.0 ecosystem

• ARB / ES Convergence Group
  - Joint subcommittee of OpenGL and OpenGL ES working groups
  - Goal is to align roadmaps and avoid unnecessary divergence
  - Currently discussing whether OpenGL ES can / should become an OpenGL profile

• Ecosystem Support
  - OpenGL ES 2.0 Reference Card
Exciting News on Texture Compression

• **OpenGL ES 2.0 has no standard texture compression formats**
  - But, almost all ES 2.0 platforms support the ETC1 format extension
  - Created by Ericsson R&D, provided royalty-free to Khronos
  - Provides 4bpp RGB compression at quality comparable to DXT1 RGB
  - Issues: RGB only, has artifacts in some cases

• **Ericsson has offered four new royalty-free formats for use in OpenGL ES**
  - ETC2 – extends ETC1 to remove artifacts, provides better quality than DXT1
  - EAC – provides high-quality 4bpp single-channel (R) compression
  - Interleaved ETC2+EAC provides 8bpp RGBA at higher quality than DXT5
  - Interleaved EAC+EAC provides 8bpp RG compressed format

• **Thanks to Ericsson for this important contribution!**
ETC2 Texture Compression is Great!
Thanks to…

• **Specification Editors**
  - ES 1.x, ES 2.0: Jon Leech (Khronos)
  - ES Next: Benj Lipchak (Apple)
  - GLSL ES: Rob Simpson (Qualcomm)

• **Conformance Test Leads**
  - ES 1.x: Tom McReynolds (NVIDIA)
  - ES 2.0: Maurice Ribble (Qualcomm)

• **...and the Working Group Regulars**
• See “Bringing UE3 to Apple’s iPhone Platform”, Josh Adams (Epic Games), GDC 2010
COMPANY VISION

PROVIDE ADVANCED PRODUCT ENGINEERING AND R&D CO-CREATION SOLUTIONS TO THE WORLD’S LEADING TECHNOLOGY INNOVATORS

GLOBAL & REGIONAL HEADQUARTERS

| Beijing, China | Tampere, Finland | San Jose, USA |

TOP 5 CLIENTS

| Ericsson | Nokia |
| IBM | PayPal |
| Microsoft |

KEY KHRONOS COMPONENTS

* OpenGL ES 1.1 or 2.0 rasterizers for platforms without graphics acceleration
* OpenVG 1.1 software rasterizer for vector graphics
* OpenMAX implementation for video
* OpenSL implementation for audio
* OpenWF implementation for windowing/composition
* OpenCL implementation for GPGPU
* Flash player modifications /proprietary extensions
Symbio OpenGL ES 2.0 Implementation

- Complete OpenGL ES 2.0 implementation for a fabless semiconductor manufacturer
  - Including GLSL shader compiler from scratch
  - Hardware design modified
- OpenGL ES 2.0 SW backend for x86
3D Graphics Engine

- Renders OpenGL ES 1.1 and OpenGL ES 2.0 content
- OS agnostic
  - Currently available various Linux ports, Symbian, WinCE, etc...
- Multi input / interactivity support

ARM Virtual Table UI Demo
-> Supports touch display and touch functionality
-> Content can be scaled to 1080p resolution
-> OGLES 2.0 shading effects such as shadows, lightning, realistic materials (wood, metal, etc...).
Thank You!

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Symbio
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www.symbio.com
Imagination News @ GDC 2010

- **250,000,000 unit installed base**
  - 97% OpenGL ES capable devices
  - Shipments switching from OpenGL ES 1.x bias to OpenGL ES 2
  - Market size is now significantly larger than the current generation handheld console market
  - Market that for applications alone will be worth more than $5 billion dollars in 2010

- **25,000 games**
  - Strongly dominated by two platforms – Apple App Store and NTT DoCoMo
  - But now more than one game in town – lots of interest in Android
  - Lots of demand for porting support

- **16,000 developers**
  - 95% OpenGL ES developers
  - Active developer community inc. online forum at powervrinsider.com

- **Over 100 SGX devices – media player, phone, netbook, tablet etc.**
  - 60% OpenGL ES 2
  - 40% OpenGL 2.0 and later

- **Over 150 MBX, many still shipping – almost all phones, media player**
IMG continued

- SGX53x shipping in volume
- SGX54x devices shipping Q2 from Samsung, TI, others to follow soon
  - 5x performance increase between OMAP 3 and OMAP 4
- SGX543MP licensed to 3x partners
- Expect 32x today’s performance and beyond with MP in ‘near’ future

- New ExtremeBall demo from
  Digital Legends on booth 705

- SDK v2.6 released at GDC 2010
  - This update includes support for Android platforms – Palm Pre and Samsung Wave (Bada) following soon
  - New PVRTrace utility for application analysis
  - Support for Blender, the open source 3D modelling package
  - SDK DVD, available free at Imagination’s booth at GDC
  - Also includes Imagination’s promotional demos showing the very best of mobile and embedded graphics capability
  - All content will also be available for download from www.powervrinsider.com

- DEVELOP NOW!
Malideveloper.com:
Developer Portal for OpenGL® ES 2.0
Game Development

Nizar Romdan – Mali Developer Community Manager
Media Processing Division
Mali Developer Center: malideveloper.com

Supporting Mali developers with a full range of resources through one, easy-access portal
# Mali GPU Developer Tools

- Rich portfolio of enabling tools for:
  - Software Development
  - Shader Authoring
  - Performance Analysis and Optimization

<table>
<thead>
<tr>
<th>Category</th>
<th>Tool</th>
<th>Version</th>
</tr>
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<tbody>
<tr>
<td><strong>Software Development</strong></td>
<td>OpenGL® ES 1.1 Emulator</td>
<td>1.0</td>
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<tr>
<td></td>
<td>OpenGL® ES 2.0 Emulator</td>
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<tr>
<td></td>
<td>Mali GPU User Interface Engine</td>
<td>2.3</td>
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<td>Mali GPU Binary Asset Exporter</td>
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<tr>
<td><strong>Shader Authoring</strong></td>
<td>Mali GPU Shader Development Studio</td>
<td>1.1</td>
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<td>Mali GPU Offline Shader Compiler</td>
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<td>Mali GPU Shader Library</td>
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<td><strong>Performance Analysis &amp; Optimization</strong></td>
<td>Mali GPU Performance Analysis Tool</td>
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<td>Mali GPU Texture Compression Tool</td>
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</table>

- Available under Windows & Redhat Linux Enterprise from [malideveloper.com](http://malideveloper.com)
- Large set of Examples
- Comprehensive Documentation

...everything you need to start developing applications for Mali
Connecting Developers to Boards

- **ST Ericsson STE MOP500**
  - CPU: ARM Dual Cortex-A9
  - GPU: Mali-400 GPU
  - Memory: 256MB
  - Reference platform for the **Symbian** foundation
  - Android & embedded Linux

- **Telechips TCC8900**
  - CPU: ARM1176JZF-S
  - GPU: Mali-200 GPU
  - Memory: 128MB up to 256MB

- **Ordering Info**
  - Under Mali Developer Centre [www.malideveloper.com](http://www.malideveloper.com)