The OpenGL Family: 3D Everywhere!

The Leading Cross-Platform API for 3D Graphics on Desktop
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Mobile-friendly OpenGL subset deployed on billions of devices
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OpenGL ES 2.0 functionality made available on the web via HTML5
Accelerating OpenGL Innovation

OpenGL 2.0  OpenGL 2.1  OpenGL 3.0
2004  2005  2006  2007  2008  2009  2010  2011

DirectX 9.0c  DirectX 10.0  DirectX 10.1  DirectX 11
OpenCL 4.2 pipeline model
Vertex Pulling

- Read vertices from memory
OpenGL 4.2 pipeline model

Vertex Shading
- Transform and Light vertices
Tessellation and Geometry Shading

- Add geometric detail

OpenGL 4.2 pipeline model
OpenGL 4.2 pipeline model

Transform Feedback
- Output geometry to memory
Rasterization

- Generate fragments

OpenGL 4.2 pipeline model
Fragment Shading

• Assign Colors to Fragments

OpenGL 4.2 pipeline model
New Functionality in OpenGL 4.2

- **ARB_texture_storage**
  - More efficient texture objects

- **ARB_shader_atomic_counters**
  - GLSL built-in functions to access atomic counters

- **ARB_shader_image_load_store**
  - Shader I/O to texture objects in memory

- **Other New Features**
  - Instanced transform feedback
  - Shading language improvements
  - BPTC texture compression
  - More efficient compressed texture upload
ARB_texture_storage

• Texture structure is immutable on creation
  - Format
  - Dimensions
  - Presence of mipmap levels

• Contents are mutable

• Always complete (!)

```c
void TexStorage{1D,2D,3D}(enum target, sizei levels,
    enum internalformat, sizei width,
    sizei height, sizei depth)
```
Image Load/Store and Atomic Counters

- **Image Load/Store**
  - Vertex or Fragment shaders can read or write locations in a texture
  - Can also perform atomic RMW operations
  - This allows memory I/O from inside the graphics pipeline
  - No guarantees on order of update

- **Atomic Counters**
  - Can increment atomic counters from inside a shader

- **These features provide simple compute capability in OpenGL**
  - Does not replace OpenCL – capability is limited
  - Does allow tightly coupled graphics/compute operations
Tightly Coupled Computing Example

- Single rendering pass Order Independent Transparency
  - Fragment shader writes to layer in 2D image Array using ARB_image_load_store
  - Which layer to write to is tracked with a 2D image updated with atomic adds
  - Result: Unordered list of fragments per pixel

- Sort and compositing pass
  - Draw full screen quad
  - Shader copies all fragments into an array
  - Sorts array back-to-front
  - Blends colors together

OpenGL ES

- **OpenGL for embedded & mobile devices**
  - Gets rid of redundant / legacy features
  - Adds mobile-friendly features

- **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
  - Widely adopted for STB, DTV, automotive,…
  - Hundreds and hundreds of millions shipped
Where OpenGL ES was in 2009:

- OpenGL ES 2.0 platforms are shipping!
  - Available in several popular handsets
  - Coming soon to set-top boxes, navigation devices, etc.
  - SDKs, books available
Where OpenGL ES was in 2010:

OpenGL ES 2.0 is everywhere!

- **On the desktop**
  - ARB_ES2_compatibility
  - ES 2.0 context creation in desktop drivers

- **In the browser**
  - WebGL

- …and, of course, on mobile devices

- Awesome content is appearing
OpenGL ES in 2011

The year of high-end content

• Game Engines modified for ES 2.0
  - UE3
  - Unigine

• Demos / Promos
  - Rage

http://www.idsoftware.com/rage-mobile/

See “Bringing UE3 to Apple’s iPhone Platform”, Josh Adams (Epic Games), GDC 2010
OpenGL ES Working Group Activities

• **Next Generation OpenGL ES**
  - Working group’s main focus since mid-2009
  - Based on Desktop OpenGL 3.3

• **ARB / ES Convergence TSG**
  - Meeting weekly to align roadmaps and minimize incompatibilities

• **Conformance Test Improvements**
  - Joint project of OpenGL ES WG and the ARB
  - Common test framework for OpenGL 4.x and next-gen OpenGL ES
ARM Mali Design for OpenGL ES

• Mali-400MP Leading Android Performance
  - High performance OpenVG and OpenGL ES 2.0
  - World’s first multi-core embedded GPU
  - Scaling to all resolutions from VGA to 1080p

• Mali-T604/T658 for Visual Computing
  - Designed to support next generation OpenGL ES
  - Support OpenCL 1.1 full profile
  - Perfect embedded high-end GPU for 4K x 2K market
OpenGL ES in 2012?

<Your Application Here!>
THANKS