Overview

- NVIDIA’s role in visual computing development
- Tegra’s architecture
- SHIELD
- Next generation
  - NVIDIA Works
- All that processing power.. What’s next?
  - Next gen apps and games
  - Being efficient
  - Shared computing & convergence (blue-sky mining)
A Tale of Convergence

- Today’s theme is “convergence”
- Today’s theme is dedicated to Grah-Grah
- It all started for me, with the *Mobiletronics Pocket Phone*
  - Not a brick
  - But still the weight of a brick
  - No backlight
  - Brilliant ☺️
NVIDIA’s Role in Development

- Content & Technology Division
  - Ex-game developers, driver engineers, hardware architects
- We assist developers and enhance content
- 15 year heritage
- Result:
  - Better quality apps
  - More efficient apps
  - Interest in mobile from developers that may have overlooked it
Developing for Android

- Setting up an Android development environment can be tricky
- Android SDK, NDK, ANT, Eclipse, adb.. Grrr!
- Native debugging.. Double grrr!
- Is that gcc configuration quite right?
Tegra Android Development Pack

- GET STARTED in minutes NOT hours
- INSTALLS all tools required for Tegra Android

- CPU DEBUGGING with Nsight Tegra
- GPU DEBUGGING with PerfHUD ES
- OPTIMIZE applications with Tegra Profiler
- REFERENCE docs, samples & tutorials

- OPTIMIZED for Tegra Android development
- FLASHES Tegra DevKit with OS Image
- CONFIGURED for debugging and profiling
- INCLUDES Kernel symbols and DS-5 support

http://developer.nvidia.com/develop4tegra
Native Code Samples

- Android lifecycle
  - Lifecycle can be tricky
  - Highly recommend using “Native Basic” as a base
- OpenGL ES
- Input device handling
  - Multitouch
    - Beware the stylus!
    - Use getToolType()
      -- see http://goo.gl/eRdIC
  - Sensors
  - Gamepad

http://developer.nvidia.com/develop4tegra
Tegra Developer Tools

Native Android Development Tools

Nsight Tegra
Visual Studio and Eclipse integrations
Full Android build management
Native Android CPU debugging
Breakpoints in both Java and Native

Tegra Profiler
Maximize multi-core CPU utilization
Quickly identify CPU “hot spots”
Identify thread contention issues

PerfHUD ES
Examine and debug OpenGL ES frames
Automated bottleneck analysis
Edit shaders at runtime

http://developer.nvidia.com/develop4tegra
TegraZone

- Around 5 million installs
- Monthly statistics:
  - Unique users ~500K/month
  - Unique pageviews ~4.5M
- 50% of TegraZone titles have over 100,000 purchases/install (25% > 500K)
Tegra’s History

- NVIDIA historically is a GPU company
- Mid 2000’s, NVIDIA started building mobile GPUs
- Purchased PortalPlayer in 2006
  - Tegra was the convergence of PortalPlayer’s SoC technology and the core NVIDIA GPU technology
- Tegra 1 & Tegra 2 were the first (amazing) steps
  - Tegra 1 first SoC for NVIDIA, Tegra 2 first dual-core CPU
  - Innovating on mobile like the desktop, workstation & supercomputer

- GOAL: Enhance every pixel!
Tegra 3 = 4 + 1

- World’s first quad-core ARM Cortex A9
- Still needed to be power efficient
- Debuted NVIDIA’s “Companion Core”
  - One CPU core in LP process
  - Quad core complex in high speed silicon
  - OS transparent switch from single to quad
Tegra 4 Family

Tegra 4 (“Wayne”)  
*World’s Fastest Mobile Processor*

- **Superphone / Tablet**
- **Quad CPU**
  - Cortex A15, 4+1
- **NVIDIA GPU**
  - 72 Core
- **LTE**
  - Optional with i500
- **Chimera***
  - ✓

Tegra 4i (“Grey”)  
*1st Integrated Tegra 4 LTE Processor*

- **Smartphone**
- **Quad CPU**
  - Cortex A9 r4, 4+1
- **NVIDIA GPU**
  - 60 Core
- **LTE**
  - Integrated i500
- **Chimera** *
  - ✓

*Chimera is NVIDIA’s Computational Photography*
Mobile Processor, Ultrabook Performance

Intel Core i3-2377m 1.5GHz, Core i3-3217U 1.8GHz & Core i5-2467m 1.6GHz, Core i5-3317U 1.7GHz all have 17W maximum TDP

Competitive data published on Geekbench website; Tegra 4 1.9GHz measured on reference platform.
# Tegra 4 vs Tegra 3 GPU stats

<table>
<thead>
<tr>
<th></th>
<th>Tegra 4/ Tegra 3</th>
</tr>
</thead>
<tbody>
<tr>
<td>Vertex Shader</td>
<td>8x</td>
</tr>
<tr>
<td>Fragment ALU</td>
<td>8x</td>
</tr>
<tr>
<td>Pixel Rate</td>
<td>2.6x</td>
</tr>
<tr>
<td>Texture Rate</td>
<td>2.6x</td>
</tr>
<tr>
<td>Memory Rate</td>
<td>2.3x</td>
</tr>
<tr>
<td>Z-Kill Rate</td>
<td>1.3x</td>
</tr>
<tr>
<td>Triangle Rate</td>
<td>1.3x</td>
</tr>
</tbody>
</table>

Tegra 4 - 72 Core GPU @ 672 MHz
4 pixel pipes * 3 ALUs/pipe * 4 MADS/ALU +
6 VPEs * 4 MADS/VPE

Tegra 3 - 12 Core GPU @ 520 MHz
2 pixel pipes * 1 ALU/pipe * 4 MADS/ALU +
1 VPE * 4 MADS/VPE
Demo: Dead Trigger 2

TEGRA 3 DEVICES

NEW NVIDIA TEGRA 4
Tegra 4 - Shadows

- Depth textures
- Percentage-closer filtering
- Soft-edged, AA shadows
- No fragment shader emulation

Unfiltered

Percentage Closer Filtered
SHIELD Features

- Tegra 4 powered
- 5 inch 720p & multitouch display
- Console grade controller
- High speed Wi-Fi
- Full connectivity (HDMI, Miracast, USB, MicroSD, headphone)
- Tuned port base reflex speakers
- Pure Android (currently Jellybean)
- 3D dashboard
SHIELD Development Considerations

- Support landscape screen orientation
  - Don’t assume device is a phone and lock to portrait based on DPI
- Don’t require touch
  - UI useable with controller
  - Highlights for UI
- Test using HDMI
  - Is everything possible without getting up?
  - How does it look on a big screen?
- Controller is King!
Looking back at SHIELD

- NVIDIA’s first large-scale consumer product
- Built with determination, sweat, tears & love
- Many lessons learned
  - Who needs a second USB port?

AVAILABLE ONLINE

AVAILABLE AT THESE STORES

Check out SHIELD at a store near you using the dropdown below.
Project Logan is coming!

- Project Logan is NVIDIA’s next generation mobile processor
- Announced at GPU Technology Conference 2013
- Desktop level GPU features come to mobile
  - First time NVIDIA’s acclaimed Kepler GPU comes to mobile
  - OpenGL 4.3 support (tessellation, GI, compute shaders)
  - CUDA compatibility
PC tech: a peak into the future of mobile
Demo: Infiltrator
Demo: FaceWorks
What’s Next?

- Great new graphical features
  - Desktop level graphical effects & post processing
  - Access to the NVIDIA Works suites
- CUDA and true compute shaders
  - Especially important for CV & AR
- Efficiency
  - Do more with less
  - Do the same with much less
  - ..let my battery last more than a day!
Future: Fun!

- Future mobile games
  - Convergence of games
    - More than just chat or auctions
  - “Tom Clancy’s: The Division” by Ubisoft includes a companion app

- CV/AR
  - Games
  - Image manipulation (hats, goofy eyes etc)
  - Beautification
The Division with Companion App
Future: Safety

- Automotive
- Training & safety (eg engine maintenance)
Future: (Actually Interesting) AR

- Augmented Reality that looks real
- Current state of the art
  - Physically based refraction
  - Refraction of real world in virtual objects
  - Anti-aliased virtual objects
  - Photon base caustics
  - Light-source estimation
  - Depth of Field

See: High-Quality Reflections, Refractions, and Caustics in Augmented Reality and their Contribution to Visual Coherence - P. Kán, H. Kaufmann (Vienna University of Technology)
Future: Shared Computing

The convergence of: wearable, mobile, personal & cloud

Examples:
- Oakley goggles / Google Glass
- Phone
- PC
- Cloud

CloudLight
- Splits lighting & shading tasks for always-connected devices
- NVIDIA spoke yesterday on CloudLight
CloudLight

The client renders direct light (~3 ms)

The server renders indirect light (~40 ms)

Compress, transmit, combine, display
What the user sees
Future: Media Convergence

- Convergence of TV/movies, mobile apps & social media
- Choose your own adventure - on a mass scale!
  - Companion app or monitor tweets
  - JIT Filming for TV series
In Closing

Questions?

Andrew Edelsten
http://developer.nvidia.com
NVIDIA Booth @ SIGGRAPH