SIGGRAPH 2013
Shaping the Future of
Visual Computing

TEGRA: Attacking Mobile Entertainment
with Sword and SHIELD
Andrew Edelsten – Manager, Tegra Developer Technologies

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
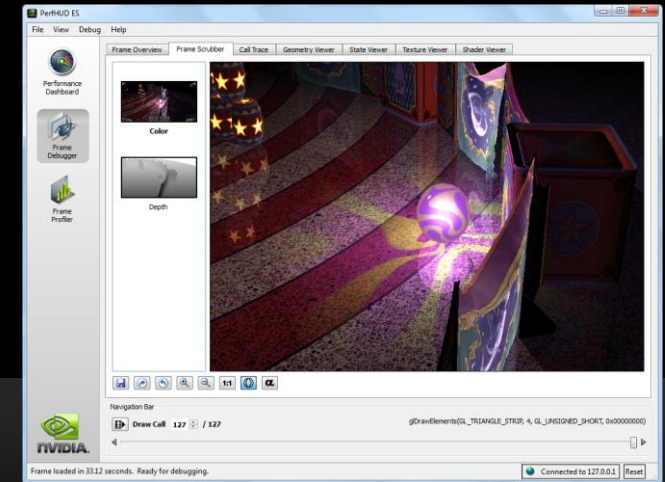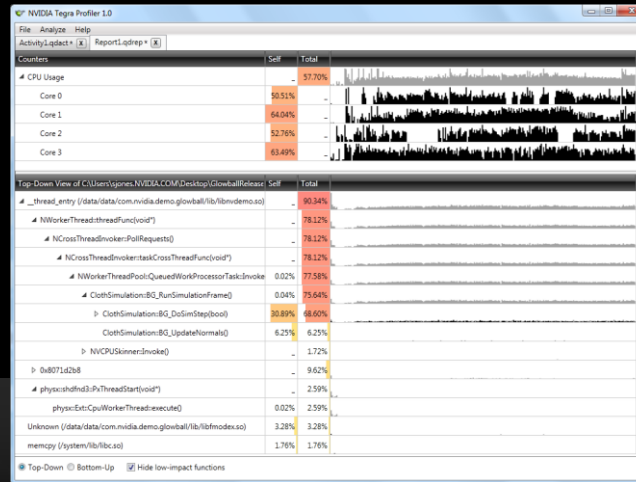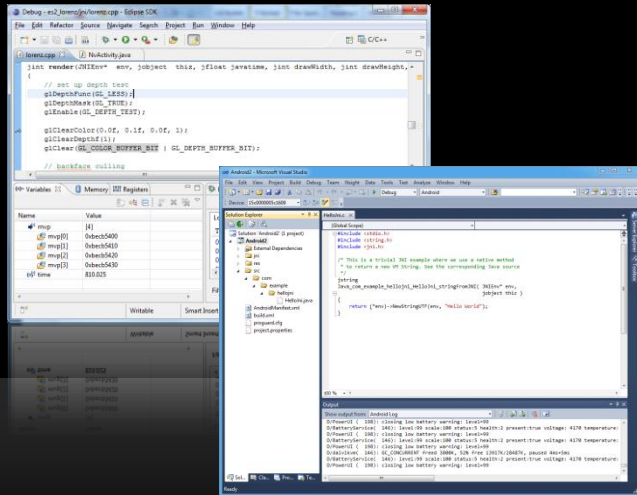
Native Code Samples

- 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
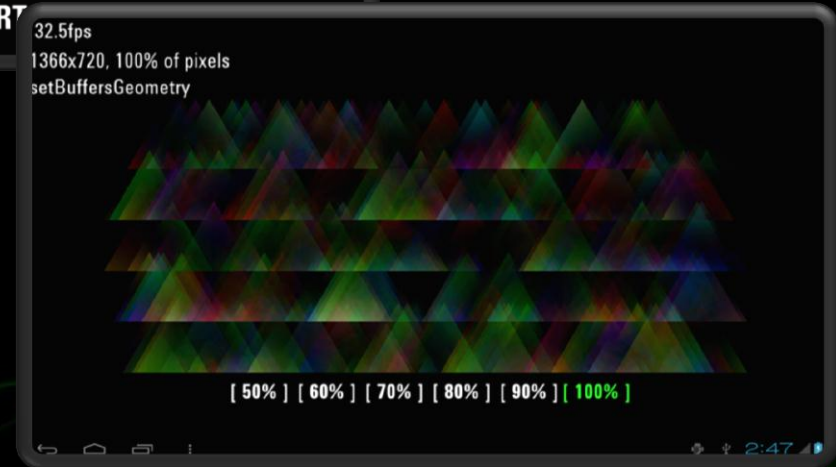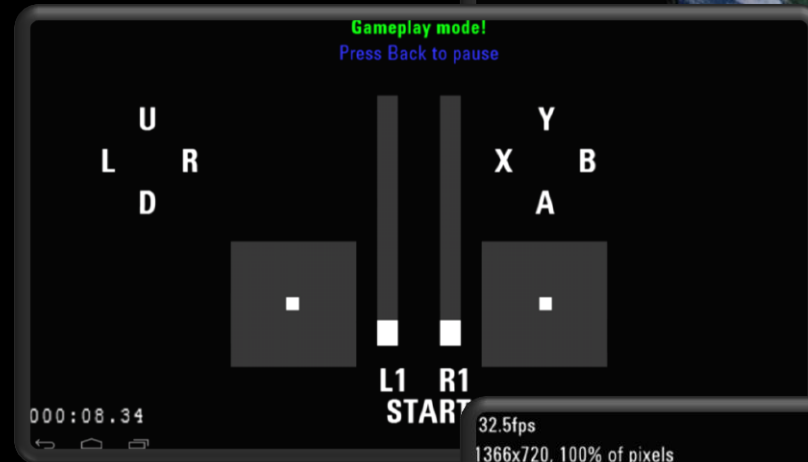
Tegra Developer Tools

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/installs (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
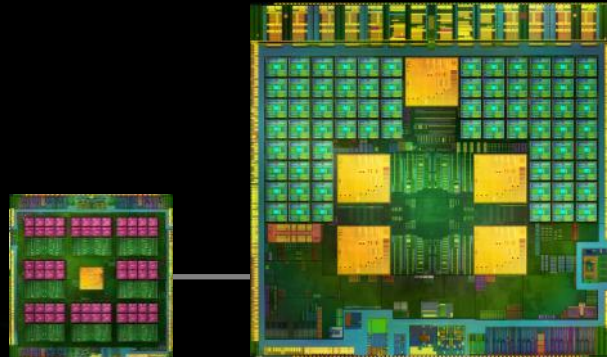 - OS transparent switch from single to quad
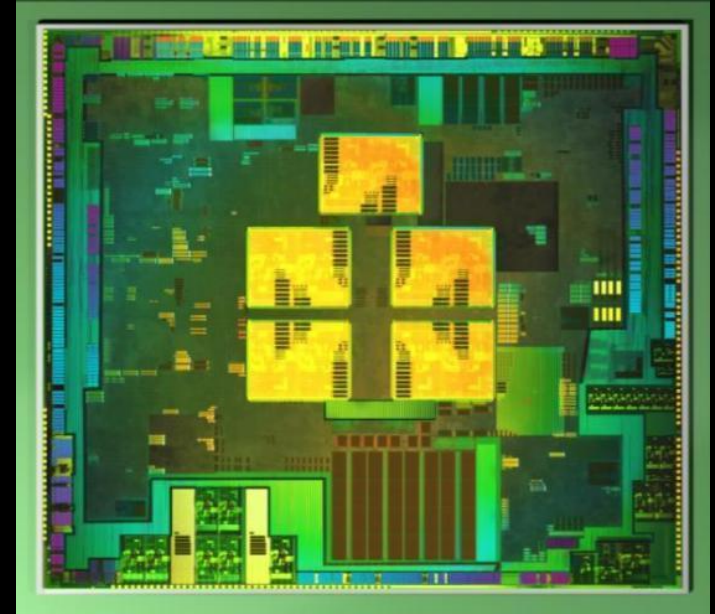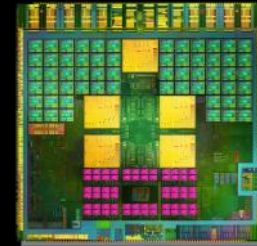
Tegra 4 Family

	Tegra 4 ("Wayne")	Tegra 4i ("Grey")
	World's Fastest Mobile Processor	*1st Integrated Tegra 4 LTE Processor*
	Superphone / Tablet	Smartphone

	Tegra 4 ("Wayne")	Tegra 4i ("Grey")
Quad CPU	Cortex A15, 4+1	Cortex A9 r4, 4+1
NVIDIA GPU	72 Core	60 Core
LTE	Optional with i500	Integrated i500
Chimera*	✓	✓

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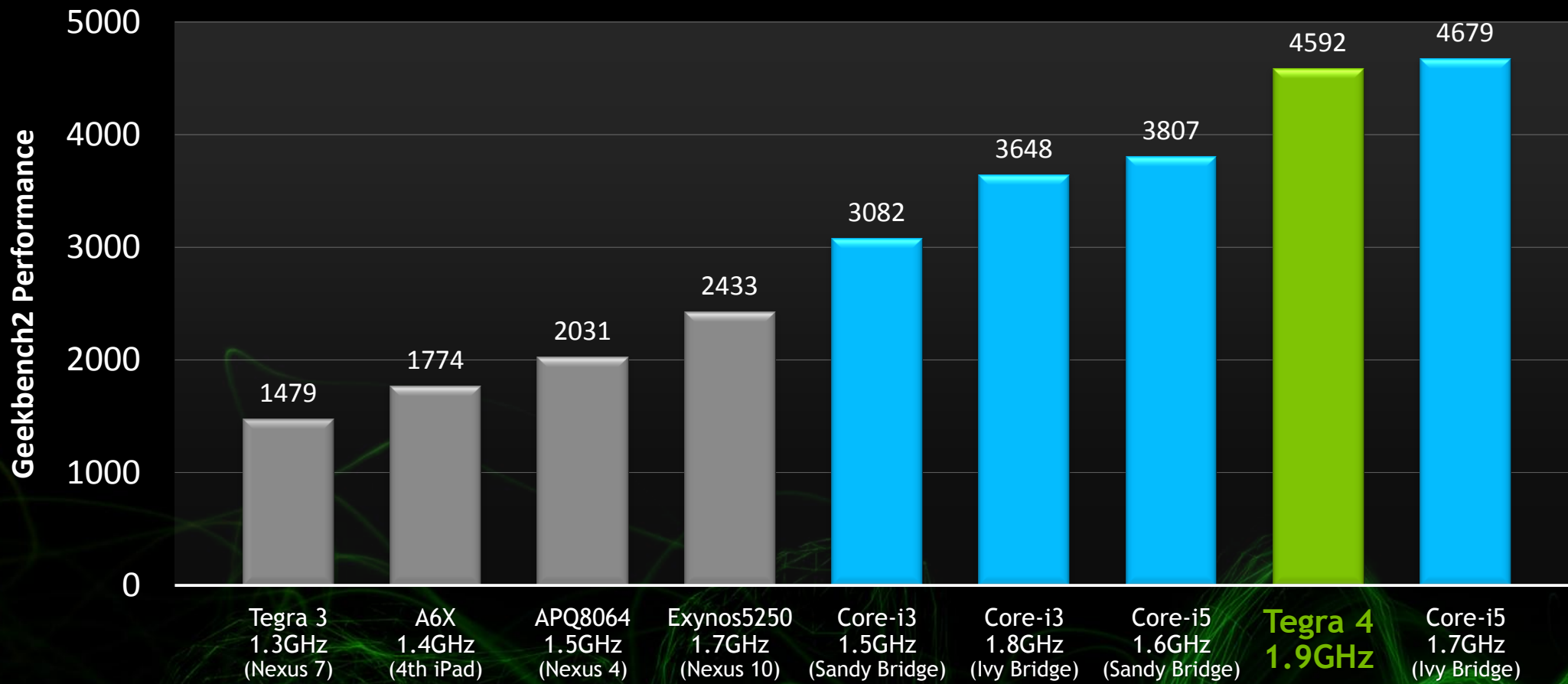
Mobile Processor, Ultrabook Performance

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

	Tegra 4/ Tegra 3
Vertex Shader	8x
Fragment ALU	8x
Pixel Rate	2.6x
Texture Rate	2.6x
Memory Rate	2.3x
Z-Kill Rate	1.3x
Triangle Rate	1.3x

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 +
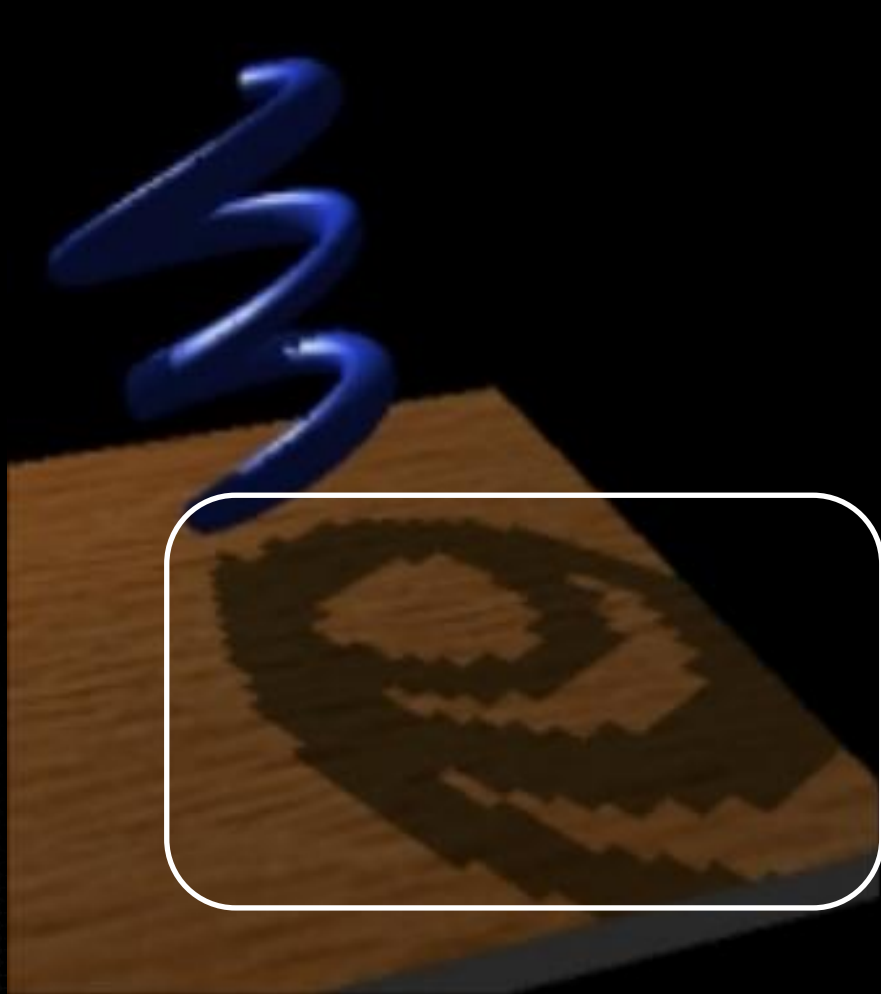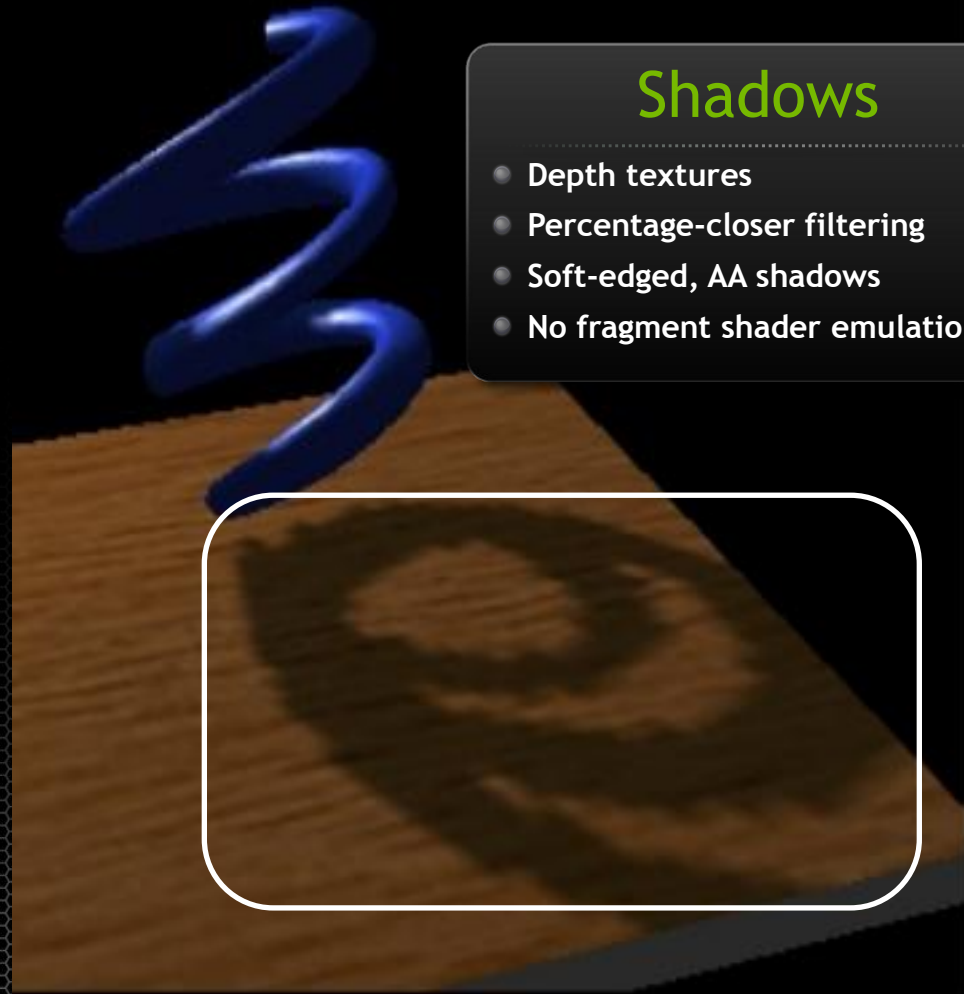1 VPE * 4 MADS/VPE

Demo: Dead Trigger 2

Tegra 4 - HDR

HDR

- FP16 Filter
- FP16 Blend
- Multiple Render Targets
- sRGB

Tegra 4 – Shadows

Shadows

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

Unfiltered

Percentage Closer Filtered

NVIDIA SHIELD

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

newegg.com NVIDIA.

AVAILABLE AT THESE STORES
Check out SHIELD at a store near you using the dropdown below.

GameStop   MICRO CENTER   Canada Computers

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

1996

2004

2013 +

100 Times

8,000 Times

Demo: Infiltrator

NVIDIA Works

FaceWorks

WaveWorks

Hair

Clothing

Particles

Turbulence

Destruction

HBAO

Ray Works

GI Works

No AA   8x MSAA   TXAA
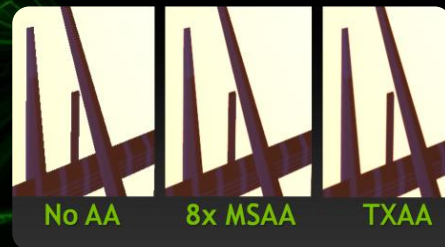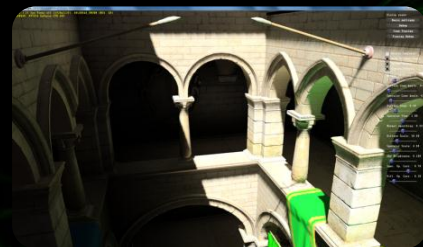
TXAA

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
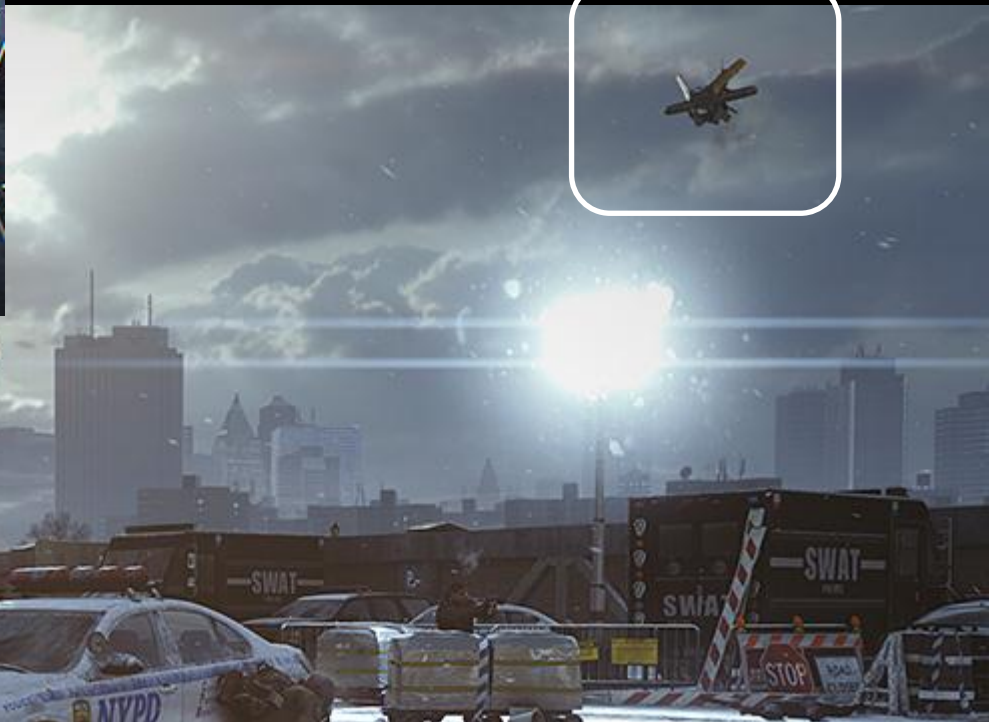
Future: Safety

- 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
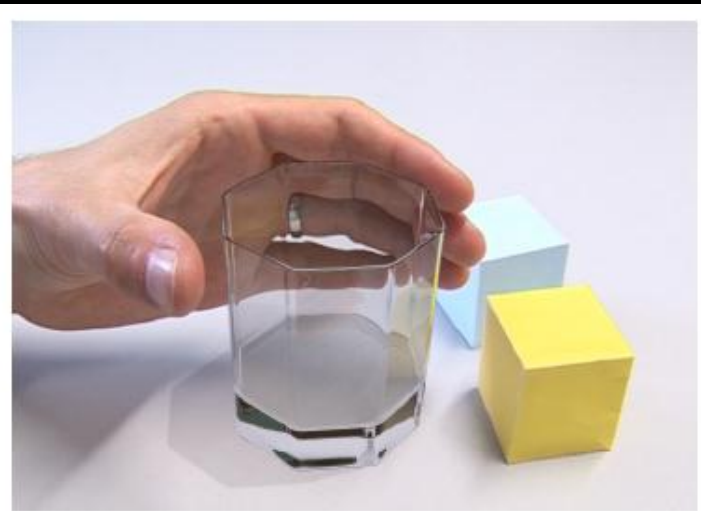- P. Kán, H. Kaufmann (Vienna
   University of Technology)

Figure 1: Refractive virtual glass surrounded by the real environment. Note the correct refraction of the hand in the glass obtained by the reprojection method.
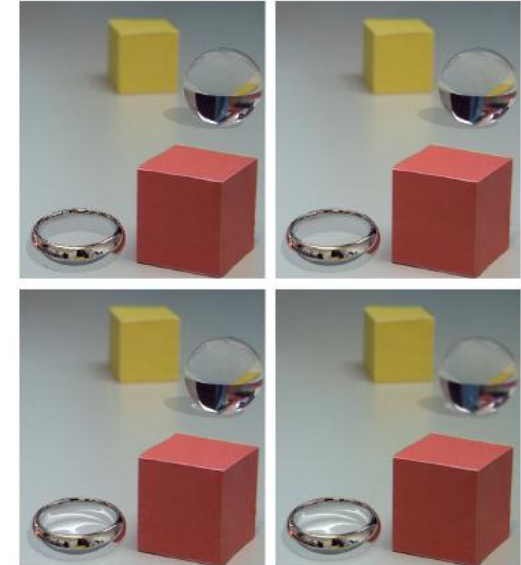

Figure 8: Comparison of rendering with different features. The scene contains a real red and yellow cube, a virtual refractive sphere and a virtual metal ring. (Top left) Rendering refraction and reflection using 1 ray per pixel and no caustic simulation at 27 fps. (Top right) Anti-aliasing added using 25 rays per pixel - 7 fps. (Bottom left) Caustics are enabled using 150K photons. Rendering speed is 3 fps. (Bottom right) Depth of Field effect is enabled. Frame rate is 2.5 fps. Differences in images can better be seen in closeup.

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 (~40ms)

Compress, transmit, combine, display

CloudLight

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