



Beyond Programmable Shading Course
ACM SIGGRAPH 2012

Beyond Programmable Shading 2012

Aaron Lefohn
Intel

Mike Houston
AMD

Welcome



- 5th consecutive year of Beyond Programmable Shading SIGGRAPH course
- This field changes quickly
 - We re-write the content of this course every year



~~Future~~ Interactive
rendering techniques
are created using an inseparable mix of
data- and task-parallel algorithms
and **graphics pipelines**

What is “Beyond Programmable Shading?”



- Real-time rendering algorithms that combine parallel CPU/GPU code with the 3D D3D/OpenGL pipeline
- Innovation directions in real-time rendering
- Understanding and pushing rendering HW and SW architectures



Beyond Programmable Shading Course
ACM SIGGRAPH 2012

COURSE HISTORY

Key Events in Course History



- 2008:
 - OpenCL and ComputeShader public sneak peek
- 2009:
 - GPU architecture details explained, revealed and compared
 - Tiled deferred rendering in ComputeShader DX11
- 2010:
 - Details of GPU 3D pipeline scheduling revealed
- 2011:
 - Introduction to power-friendly rendering and call to rethink all GPU APIs

University Curriculum



- Stanford graduate course (2010 and 2011)
 - <http://graphics.stanford.edu/wikis/cs448s-10>
 - <http://graphics.stanford.edu/wikis/cs448s-11>
- University of Washington graduate course (2011)
 - <http://www.cs.washington.edu/courses/cse558/11wi/>

Rendering Hardware Evolution



- “...the [nested parallelism] changes in [NVIDIA] GK110 were a direct result of these sorts of talks and discussions...these sorts of discussions have a direct effect on future design decisions...”
 - *Dan Wexler, The 11ers (formerly at NVIDIA), G+ conversation about Johan Andersson’s BPS 2012 talk*

Beyond Programmable Shading in 2012



- The future is now
 - In 2008, BPS rendering was “in the future”
 - In 2012, BPS rendering used in multiple leading game engines
- Power consumption
 - In 2008, fixed-function HW was declining
 - In 2012, power is king and fixed-function is critical
- Another GPU compute language for graphics
 - GL Compute in OpenGL 4.3



Beyond Programmable Shading Course
ACM SIGGRAPH 2012

BEYOND PROGRAMMABLE SHADING IN GAMES

Battlefield 3 (DICE Frostbite 2)



Need for Speed--The Run (Frostbite 2)



Frostbite 2 Use of DirectCompute



- Tiled deferred shading
 - Intersect lights with pixel tiles
 - Evaluate all lights within tile
- “Battlefield 3 spends ~15% of frame time in ComputeShader”
 - Johan Andersson, DICE

Codemasters DiRT Showdown



<http://blogs.amd.com/play/2012/07/03/dirt-showdown-amd-benchmark-guide/>

Beyond Programmable Shading, SIGGRAPH 2012

DiRT Showdown Use of DirectCompute



- Build 2D light acceleration structure for “Forward+” rendering
- VPL-based global illumination
- Ambient occlusion

- “Over the next few years, DirectCompute is likely to play a large part in the way we render our scenes...”
 - Gareth Thomas, Codemasters

<http://www.tomshardware.com/reviews/directcompute-opencl-gpu-acceleration,3146-11.html>

Epic Unreal Engine 4



Epic Unreal Engine 4



- “In the UE4 Elemental demo, the majority of the GPU’s FLOPS are going into general compute algorithms, rather than the traditional graphics pipeline...”
 - Tim Sweeney

<http://www.geforce.com/whats-new/articles/stunning-videos-show-unreal-engine-4s-next-gen-gtx-680-powered-real-time-graphics/>

Power of Rendering Platforms



- Desktop discrete GPU 200W+
- High-end laptop ~45W
- Ultrabook ~15W
- Tablet ~5W
- Phone ~1W



Beyond Programmable Shading Course
ACM SIGGRAPH 2012

Beyond Programmable Shading 2012

Beyond Programmable Shading 2012



9:00–9:15 – Aaron Lefohn, Intel

Introduction

9:15–9:45 – Johan Andersson, DICE

5 Major Challenges in Real-Time Rendering

9:45–10:15 – Andrew Lauritzen, Intel

Intersecting Lights with Pixels: Reasoning about Forward and Deferred Rendering

10:15–10:45 – Cyril Crassin, NVIDIA

Dynamic Sparse Voxel Octrees for Next-Gen Real-Time Rendering

10:45–11:15 – Maurice Ribble, Qualcomm

Power Friendly GPU Programming

Beyond Programmable Shading 2012



11:15 – 12:15

Panel: *From Publication to Product: How Recent Graphics Research has (and has not) Shaped the Industry*

Moderator:

Kayvon Fatahalian
Carnegie Mellon University (CMU)

Panelists:

David Blythe, Intel
Hao Chen, Bungie
David Luebke, NVIDIA
Mike Houston, AMD
Bill Mark, (startup)

Social and Live Course Evaluation



- We want feedback:
 - Ideas, praise, and constructive criticism
 - What (and why) did you like and not like?
 - What material do you want to see next year?
- On Twitter and Google+ at **#bps2012**



Course webpage and slides:
<http://bps12.idav.ucdavis.edu>

[#bps2012](#) (Twitter and G+)



Beyond Programmable Shading Course
ACM SIGGRAPH 2012

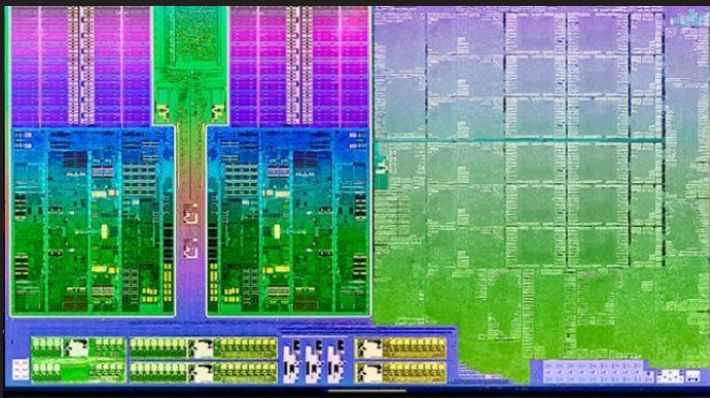
EXTRA SLIDES

What is “Beyond Programmable Shading?”

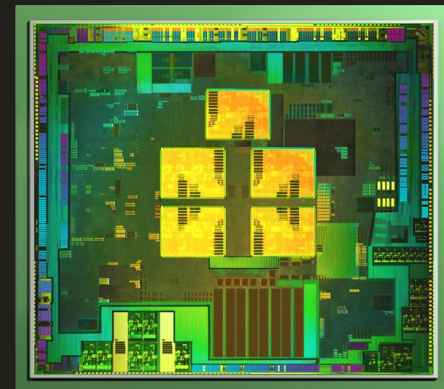


- Implementing a real-time rendering algorithm or pipeline by writing parallel CPU and/or GPU programs that are closely coupled with the 3D graphics pipeline
- Rendering innovation in software that goes beyond what is possible in the DirectX/OpenGL rendering pipeline

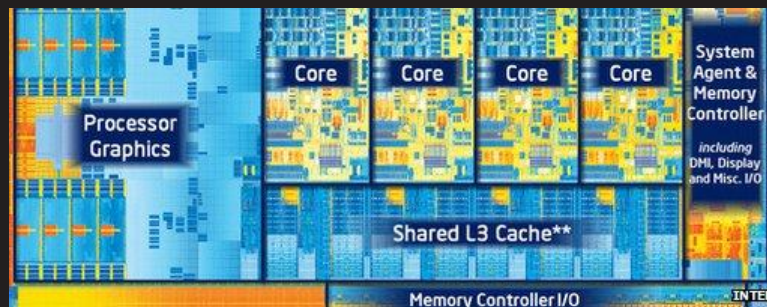
CPU-GPU Systems-On-A-Chip (SOCs)



AMD Trinity



NVIDIA Tegra 3



Intel Ivy Bridge