A look at the GPU architecture

Pre-G80: Separate vertex and fragment processors.

Hard-wired for graphics. Load balance problems.

G80: Unified architecture. More suited for GPGPU. Higher performance due to better load balancing.

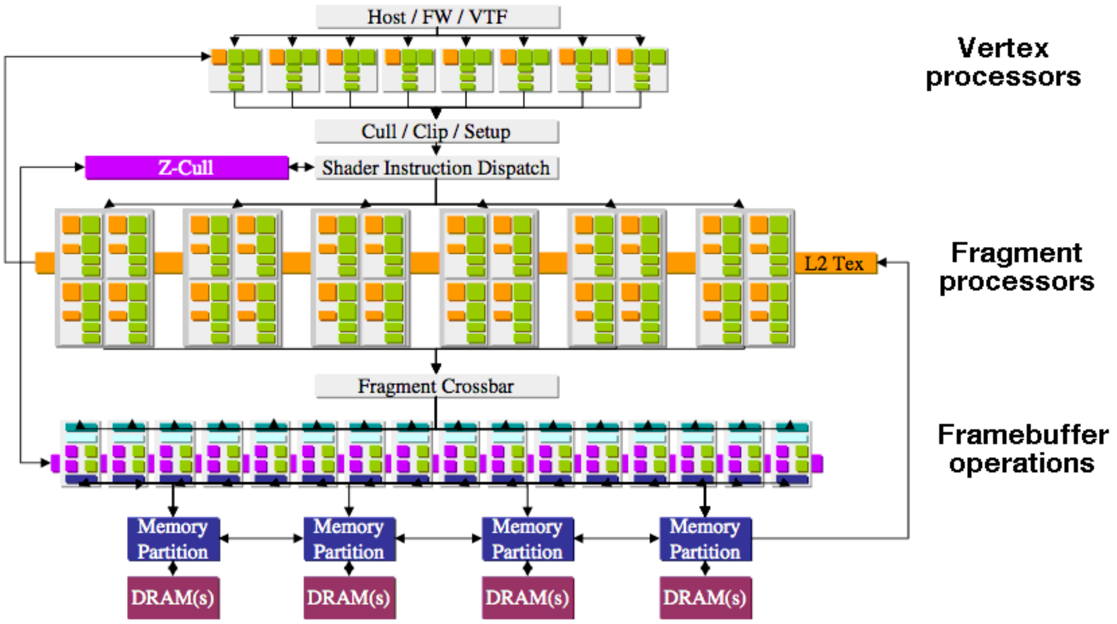
G92: Similar to G80, more cores, more cores per group.

GT100: More cores, much more double precision

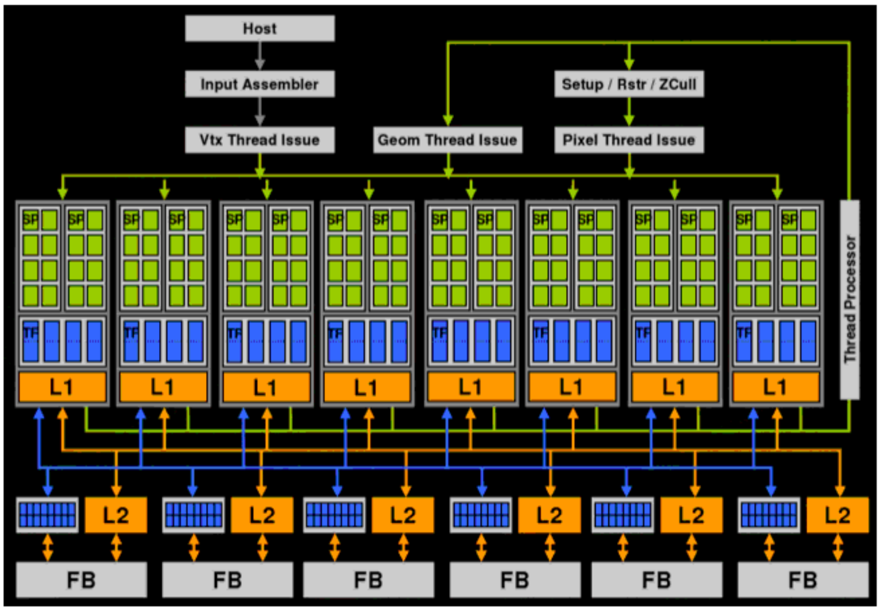
GK104: More cores, more power efficient

(Similar track for AMD)

7800: High-end GPU before G80



G80

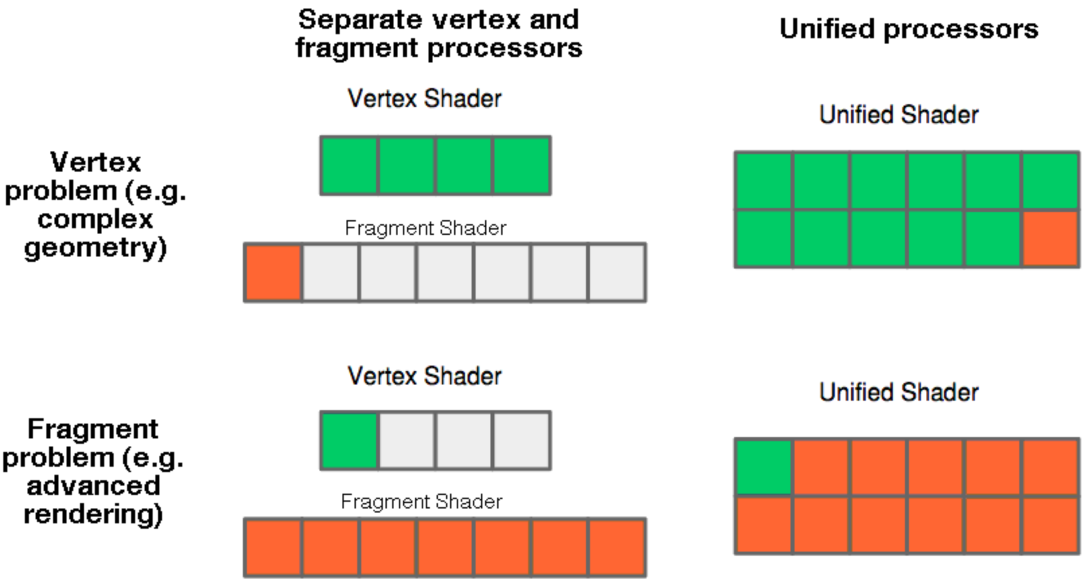


Hardware formerly between vertex and fragment processors

Unified processors

Framebuffer operations

G80: A question of *load balance*!



Separate vertex and fragment processors

Unified processors

Vertex problem (e.g. complex geometry)

Vertex Shader

Fragment Shader

Unified Shader

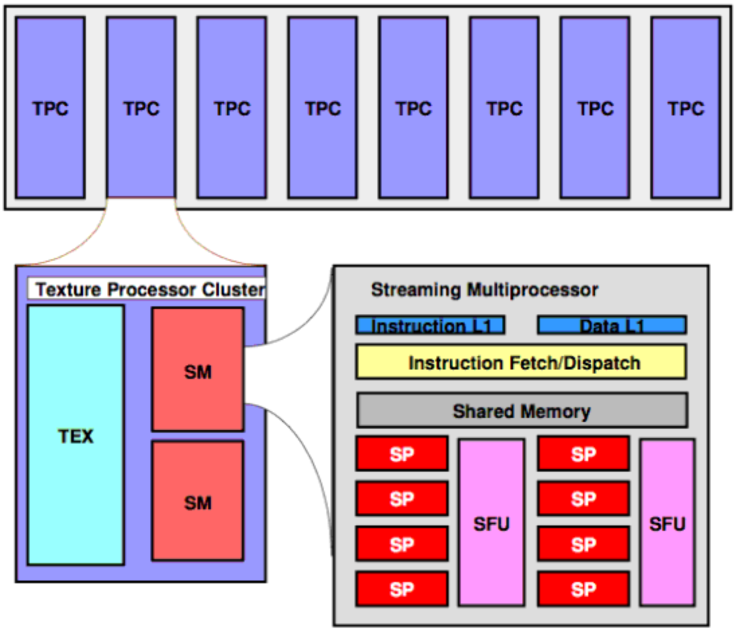
Fragment problem (e.g. advanced rendering)

Vertex Shader

Fragment Shader

Unified Shader

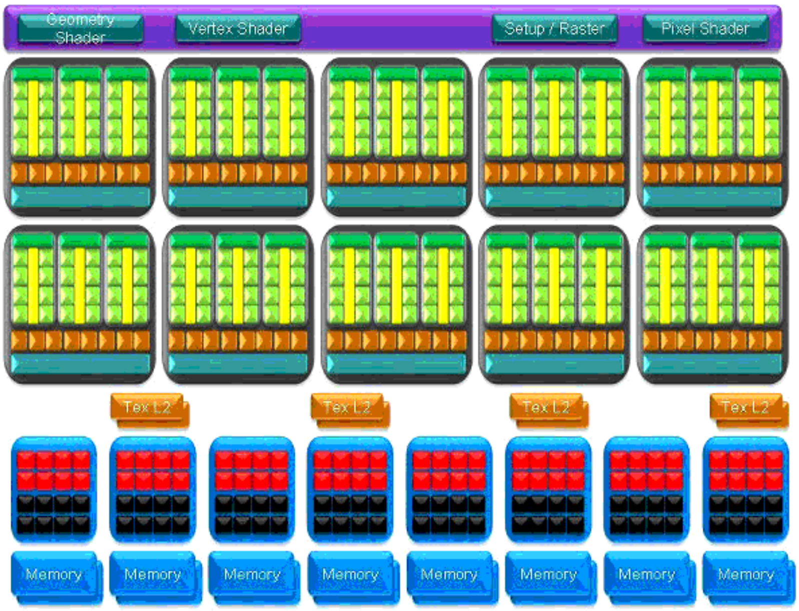
G80 processor hierarchy



8 top-level groups of TPCs

SM is a group of 8 SIMD cores

GT200

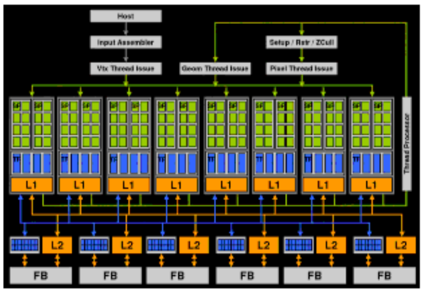


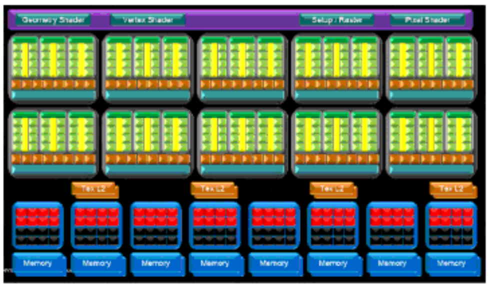
Similar but with a bit more of everything

G80 vs GT200 in numbers:

8 cores per SM
2 SMs per cluster
8 clusters

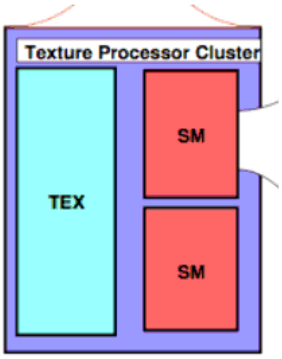
10 cores per SM
3 SMs per cluster
10 clusters





8 was *not* a magic number - more cores per SM

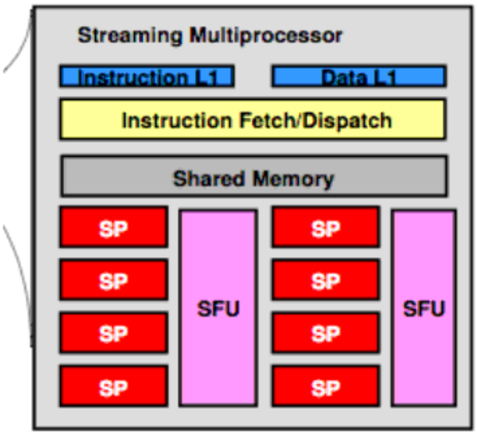
Vital components



Texture processor cluster: 2 or 3 SMs and a *texturing unit*

A texturing unit will provide texturing access with automatic interpolation - vital component for graphics

Vital components



SM: 8 cores

but also

SFU: Special functions unit

Shared memory

Register memory in each core

Instruction handling/thread management

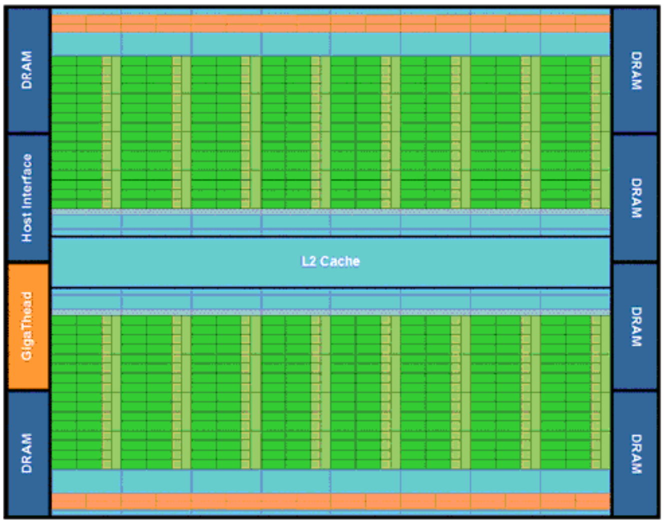
How much architecture details do we need to know?

Shaders: The architecture is mostly invisible

Cuda/OpenCL: Less so, but number of cores more or less ignored - as long as we provide more parallelism in our algorithm than the architecture has!

Memory usage is specified by the programming languages. More about that later.

2010: Fermi (GT100)



Looks like:

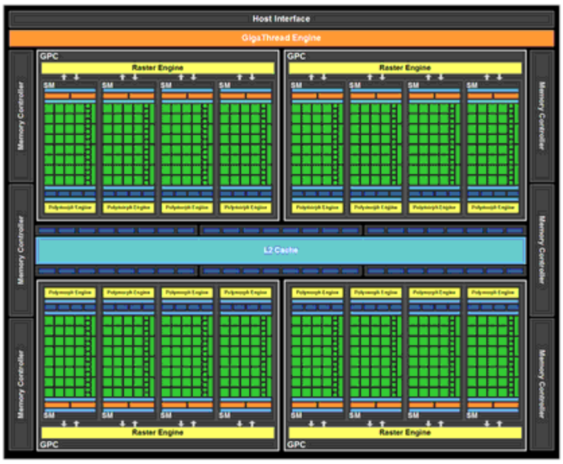
16 SMs

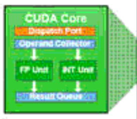
32 cores per SM

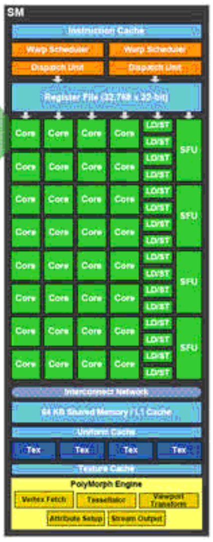
Support for 24576 threads!

Much area for L2 cache!

2010: Fermi (GT100)







Four clusters

Four SMs in each

32 cores per SM!

2010: Fermi (GT100)

Major changes in favor of general computing.

512 cores
Caching closer to the processors!
Concurrent kernels.
64-bit wide
ECC

More on Fermi

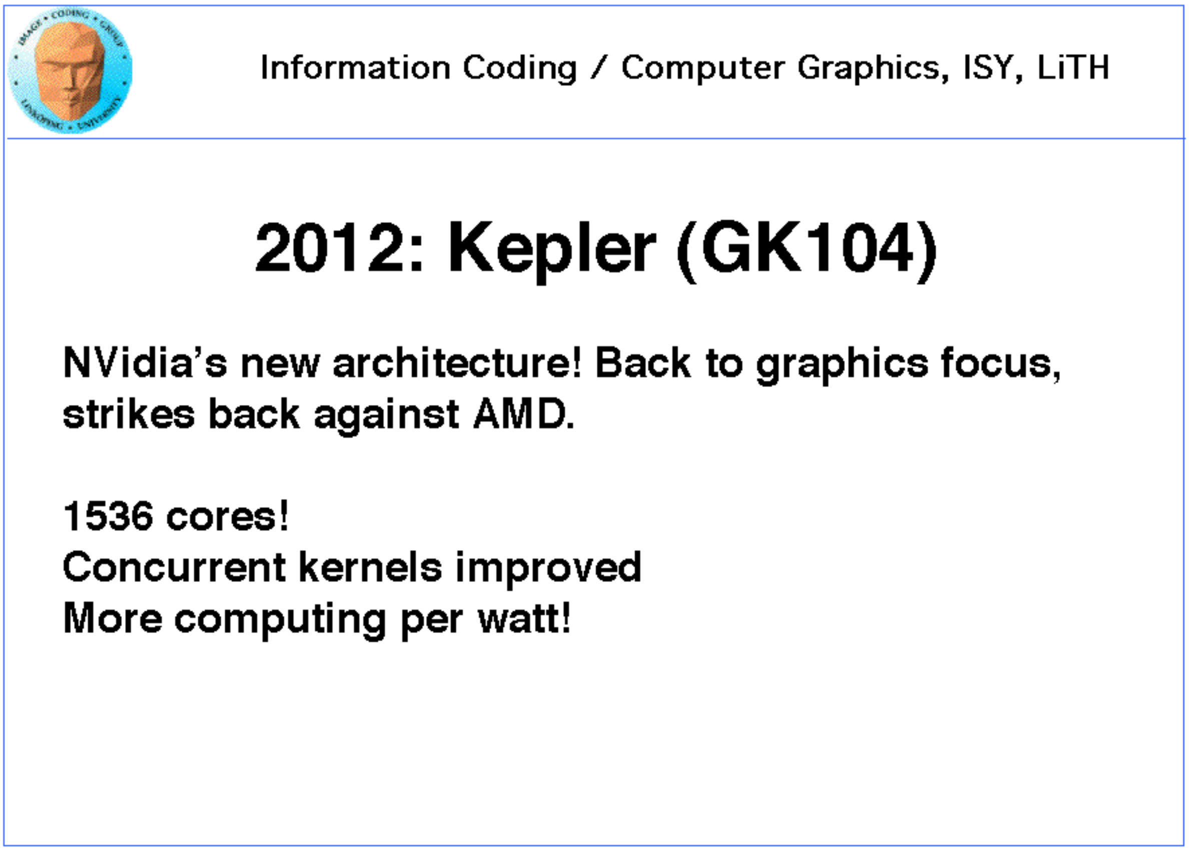
4x performance for double (64-bit FP)

More silicon space for cache! More like a CPU.

16 SMs, 512 cores (32 cores per SM)

CGPU = Computing Graphics Processing Unit

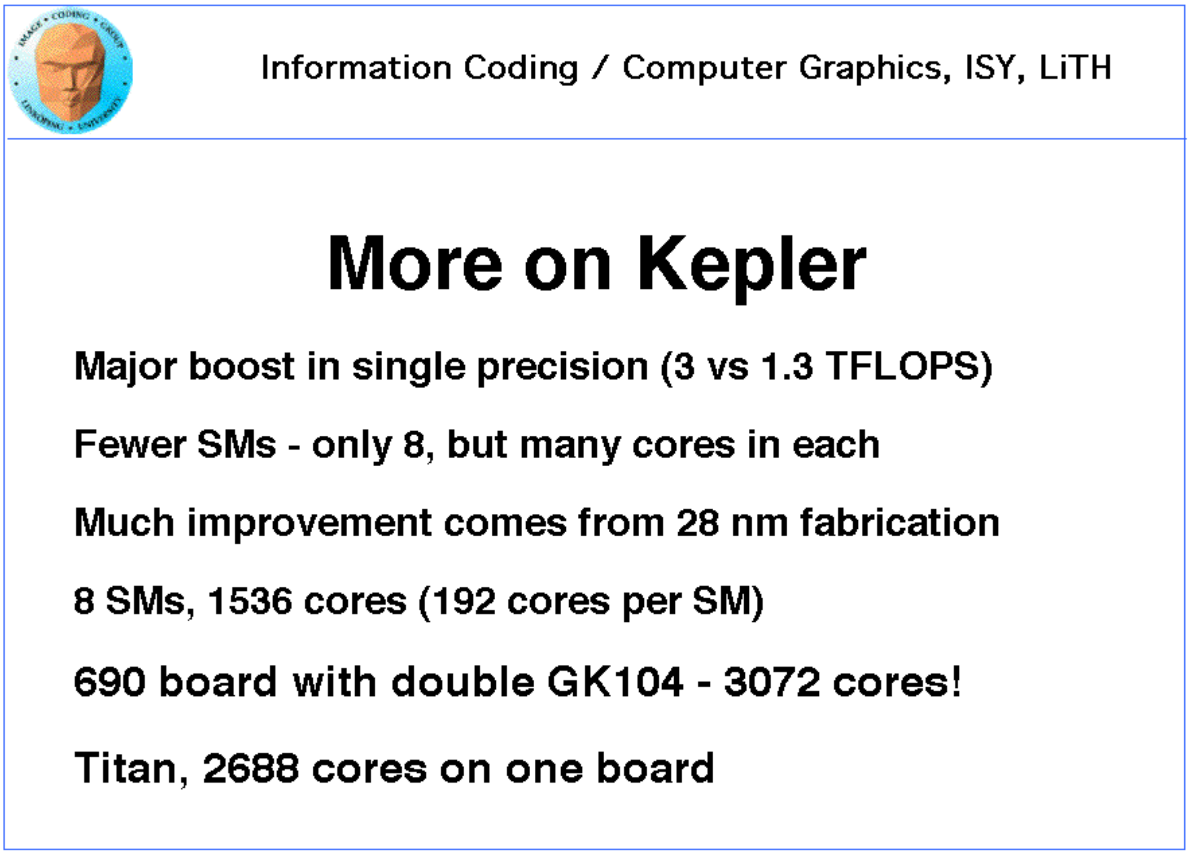
=> NVidia aims for GPGPU with Fermi!



2012: Kepler (GK104)

NVidia's new architecture! Back to graphics focus, strikes back against AMD.

1536 cores!
Concurrent kernels improved
More computing per watt!



More on Kepler

Major boost in single precision (3 vs 1.3 TFLOPS)

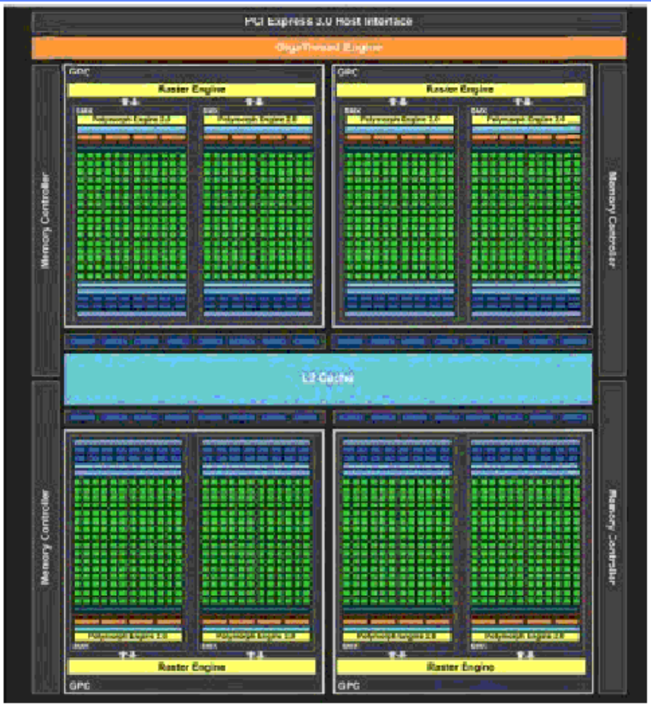
Fewer SMs - only 8, but many cores in each

Much improvement comes from 28 nm fabrication

8 SMs, 1536 cores (192 cores per SM)

690 board with double GK104 - 3072 cores!

Titan, 2688 cores on one board



GK104 Kepler

1536 cores
8 SMs
Still a lot of cache

Related parallelization efforts

IBM Cell (next generation canceled!)

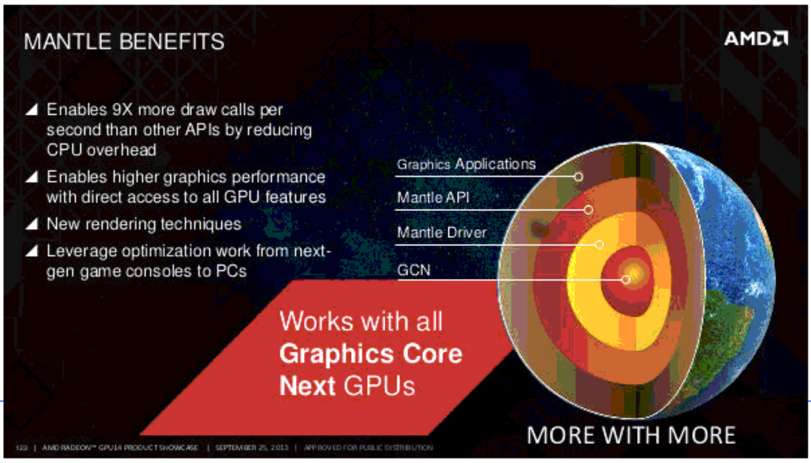
Intel Larabee (”put on ice” - dead)

GPUs are the clear winners so far!

Meanwhile, at AMD

CPU and GPU on one chip (A series)

New Mantle architecture, allows better low-level optimization



MANTLE BENEFITS

AMD

- Enables 9X more draw calls per second than other APIs by reducing CPU overhead
- Enables higher graphics performance with direct access to all GPU features
- New rendering techniques
- Leverage optimization work from next-gen game consoles to PCs

Graphics Applications
Mantle API
Mantle Driver
GCN

Works with all **Graphics Core Next** GPUs

MORE WITH MORE

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