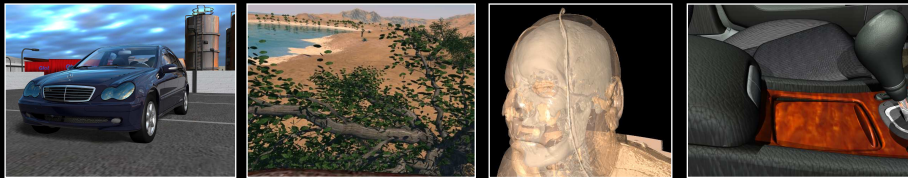
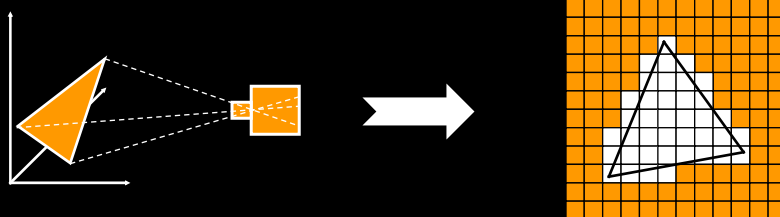

Next Generation 3D Graphics with Realtime Ray Tracing

Philipp Slusallek
Saarland University



Rasterization

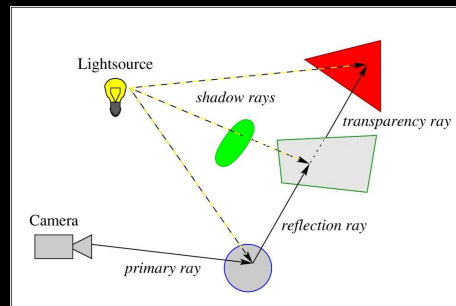


- **Fundamental Operation: Project isolated triangles**
 - No global access to the scene
- **All interesting visual effects need 2+ triangles**
 - Shadows, reflection, global illumination, ...

Ray Tracing

- **Fundamental Operation: Trace a Ray**

- Global scene access
- Individual rays in $O(\log N)$
- Flexibility in space and time
- Automatic combination of visual effects
- Demand driven
- Physical light simulation
- Embarrassingly parallel



OpenRT Project: Realtime Ray Tracing in SW

- **Results:**

- Exploit inherent coherence
- Realtime performance ($> 30x$)
- Scalability (> 80 CPUs)
- Realtime indirect lighting & caustic computation
- Large model visualization



OpenRT Project: Realtime Ray Tracing in SW

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OpenRT Project: Realtime Ray Tracing in SW

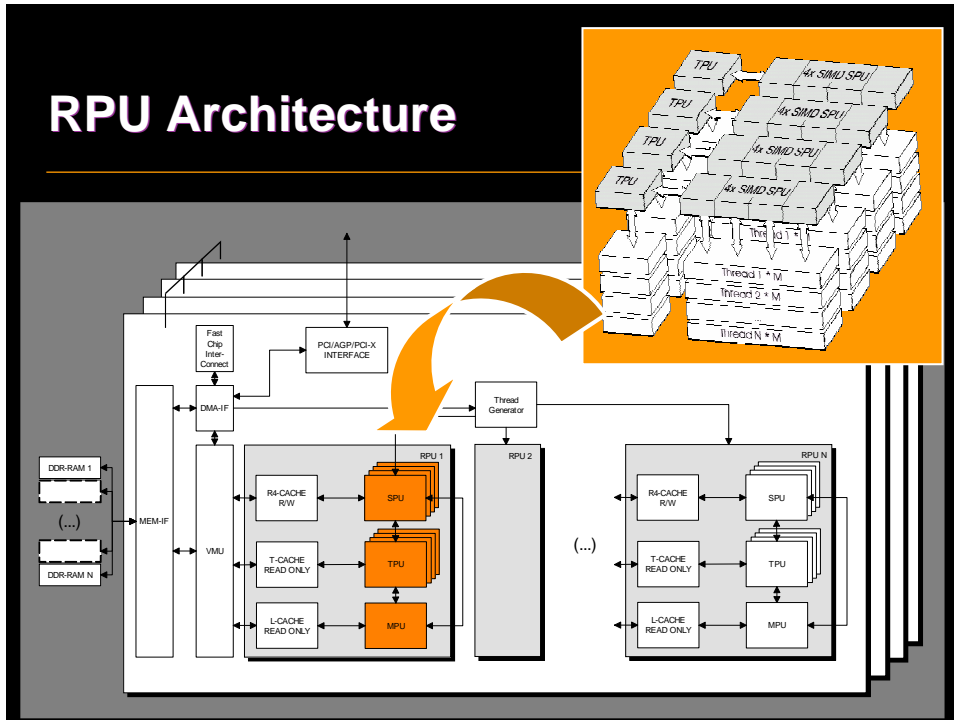
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➔ **Compact Hardware?**



RPU Architecture



FPGA prototype

- **Single FPGA at only 66 MHz**
 - 4 million rays/s
 - 20 fps @ 512x384
 - Same performance as CPU
 - 40x clock rate (2.66 GHz)
 - Running highly optimized software (OpenRT with SSE)
- **Linear scalability with HW resources**
 - Tested: 4x FPGA → 4x performance
 - Independent of scenes

FPGA prototype

- **Xilinx Virtex II 6000**
 - Usage: 99% logic, 70% on-chip memory
 - 128 MB DDR-RAM with 350 MB/s
 - 24 bit floating point
- **Configuration: Single RPU**
 - 32 threads per SPU 60% usage
 - Chunk size of 4 95% efficiency
 - 12 kB caches in total 90% hit rate



Prototype Performance

- **Technology: FPGA versus ASIC (GPU)**

RPU prototype (FPGA)	GPU (ASIC)	
4 Gflops	200 Gflops	50x
0.3 GB/s	30 GB/s	100x

- Large headroom for scaling performance



What's next

- **Handling dynamic scenes & antialiasing**
 - Many low hanging fruits
- **What to do with millions of ray per second?**
 - Highly realistic graphics with global effects
 - Many non-graphical uses
 - ...
- **New fundamental operation: Tracing a ray**
 - Basis for next generation interactive 3D graphics

Siggraph 2005: More Realtime Ray Tracing

- **RPU-Paper**
 - Monday morning, 8:30
- **Introduction to Realtime Ray Tracing**
 - Full day course: Wednesday, Petree Hall D
- **Booth 1155: Mercury Computer Systems**
 - RTRT product on PC clusters (inView)
 - RTRT on the Cell Processor
 - RTRT realtime previewing on Cinema-4D
- **Booth 1511: SGI**
 - Ray tracing massive model : Boeing 777