CS 5625
Advanced Interactive Graphics

Kavita Bala
Spring 2013

Information

- Instructor: Kavita Bala (kb@cs.cornell.edu)
- TAs:
  - Ivo Boyadhziev, John DeCorato, Sean Ryan
- AA: Randy Hess
- CS 5625 Tu/Thu:
  - 10:10-11:25 (Hollister 110)
- Office hours: Tuesday (11:30-12:30)

Why this course?

- Topics
  - Graphics pipeline
    - Though not an architecture course
  - Core algorithms and techniques
    - Those that drive interactive graphics
    - So no off-line ray tracing
    - But could be
  - Hopefully, some GPGPU

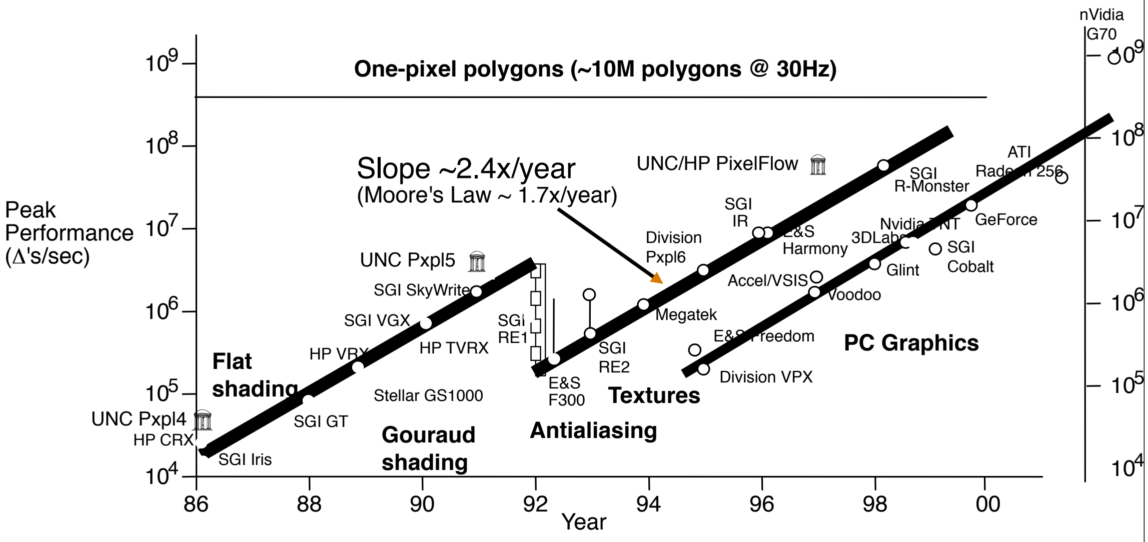
What drives this explosion?

- CPUs/GPUs
  - Graphics processing Units
- Moore's Law and Beyond
  - Parallelism

Moore’s Law

- 1965
  - number of transistors that can be integrated on a die would double every 18 to 24 months (i.e., grow exponentially with time).
- Amazingly visionary
  - 2300 transistors, 1 MHz clock (Intel 4004) - 1971
  - 16 Million transistors (Ultra Sparc III)
  - 42 Million transistors, 2 GHz clock (Intel Xeon) – 2001
  - 55 Million transistors, 3 GHz, 130nm technology, 250mm^2 die (Intel Pentium 4) – 2004
  - 290+ Million transistors, 3 GHz (Intel Core 2 Duo) – 2007

GPUs: Faster than Moore’s Law

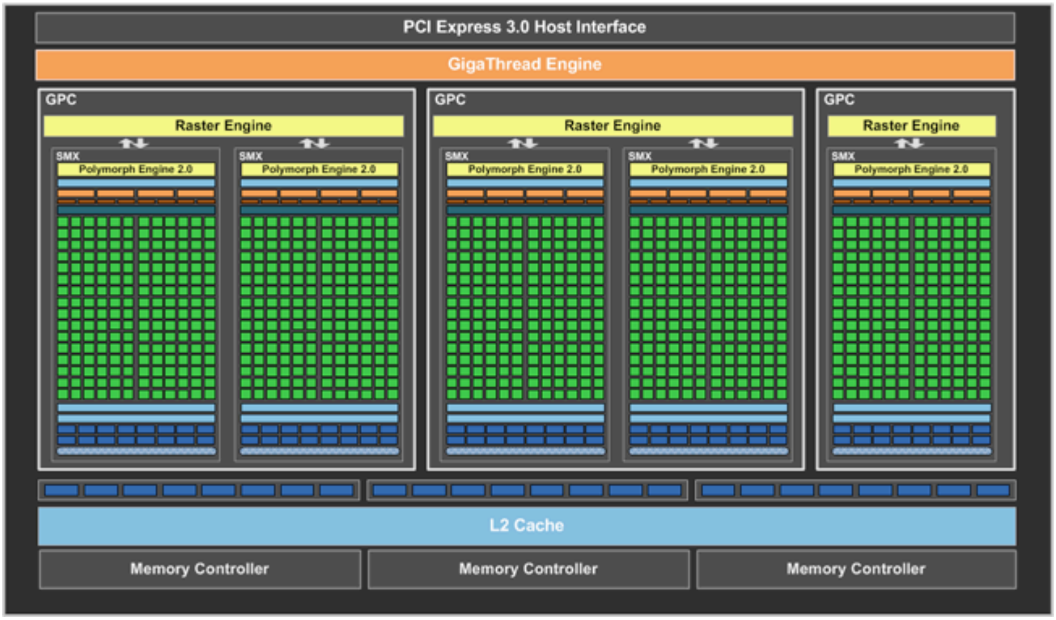


Graph courtesy of Professor John Poulton (from Eric Haines)

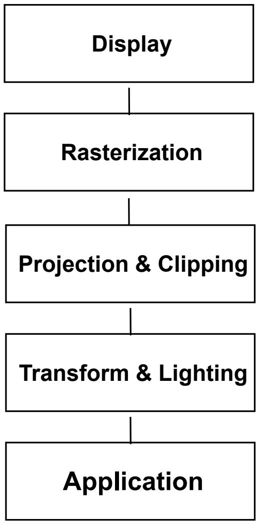
Why?

- Parallelism
- Pipelining

NVIDIA
GEFORCE
GTX
GEFORCE GTX 690


PCI Express 3.0 Host Interface
GigaThread Engine
GPC
Raster Engine
SMX
Polymorph Engine 2.0
SMX
Polymorph Engine 2.0
GPC
Raster Engine
SMX
Polymorph Engine 2.0
SMX
Polymorph Engine 2.0
GPC
Raster Engine
SMX
Polymorph Engine 2.0
L2 Cache
Memory Controller
Memory Controller
Memory Controller

Graphics Pipeline: Brief History



Display

Rasterization

Projection & Clipping

Transform & Lighting

Application

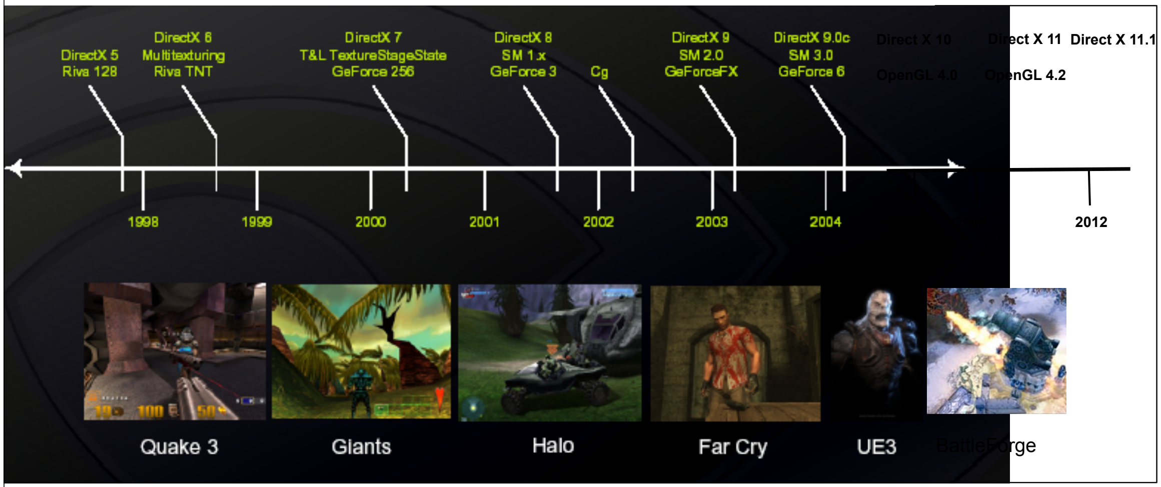
The dark ages (early-mid 1990's), when there were only frame buffers for normal PC's.

Some accelerators were no more than a simple chip that sped up linear interpolation along a single span, so increasing fill rate.

This is where pipelines start for PC commodity graphics, prior to Fall of 1999.

This part of the pipeline reaches the consumer level with the introduction of the NVIDIA GeForce256.

Hardware today is moving traditional application processing (surface generation, occlusion culling) into the graphics accelerator.


DirectX 5
Riva 128
DirectX 6
Multitexturing
Riva TNT
DirectX 7
T&L TextureStageState
GeForce 256
DirectX 8
SM 1.x
GeForce 3
Cg
DirectX 9
SM 2.0
GeForceFX
DirectX 9.0c
SM 3.0
GeForce 6
Direct X 10
OpenGL 4.0
Direct X 11
OpenGL 4.2
Direct X 11.1
1998
1999
2000
2001
2002
2003
2004
2012
Quake 3
Giants
Halo
Far Cry
UE3
BattleForge

What is Graphics

- Generating images
- Modern Graphics Pipeline
- Create them
  - Modeling
  - Animating
  - Rendering
- Manipulate them
  - Image Processing
- Focus on Interactive Graphics

Pre-requisites

- Introductory graphics course

- Or instructor permission

Information

- www.cs.cornell.edu/courses/cs5625/2013sp/
  - Tentative schedule (very tentative)
  - Homeworks, lecture notes, will be on CMS
  - Check for updates and announcements

CS 5620

- 5 HW/PA (some parts alone, some in pairs)
- 2 prelims (definitely alone)
- Final project (in pairs)
  - Project proposal
  - Mid project evaluation
  - Final project demos, presentations, writeup

Academic Integrity

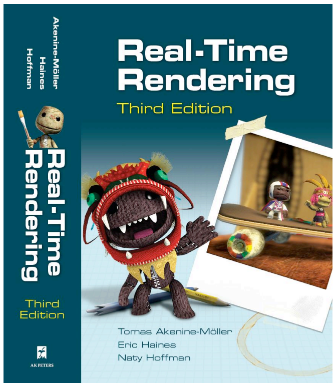
- Don’t copy from Web
- Collaboration only when projects/homeworks are with groups
- Lots of detailed discussion is not ok
  - Need to come up with answers separately
    - When individual

Programming assignments

- Some combination of these concepts:
  1. Shading
  2. Texturing
  3. Shadows and Ambient Occlusion
  4. Subdivision Surfaces
  5. GPGPU

Recommended book

- Real-time Rendering
  - Akenine-Moller, Haines, Hoffman
  - Updates will be posted
  - Not required
- Online resources
  - Lot of them!


Real-Time Rendering
Third Edition
Tomas Akenine-Möller
Eric Haines
Naty Hoffman
Akenine-Möller
Haines
Hoffman
Real-Time Rendering
Third Edition

Other Policies

- Late policy
  - 3 free late days over the semester
    - Applies to all
  - Otherwise, 10% penalty per day for 5 days
    - Then 0 on an assignment
- AI (take this very seriously)

Final Project

Administrivia

- http://www.cs.cornell.edu/courses/cs5625/2013sp
  - Updates
  - Schedule
  - Lecture notes