Lecture 3: History of Video Gaming Hardware: The 3-D Era

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Sega Saturn (1995)

- **Two** ≈29 MHz Hitachi SuperH-2 7604 32-bit
- Hitachi SuperH-1 - controller for CD-ROM
- 11.3 MHz Motorola 68EC000 sound controller
- 22.6 MHz Yamaha FH1 DSP sound processor
- 1 MB SDRAM, 1 MB DRAM
- 1.5 MB VRAM
- 4 KB VDP2 on-chip color RAM
- 512 KB audio RAM
- 512 KB CD-ROM cache
- 32 KB nonvolatile RAM
- Initial launch price $400
  - Not initially sold at a loss
- 10 million sold

Photo and info from Wikipedia
Sega Saturn - Complexity

“One very fast central processor would be preferable.

I don't think all programmers have the ability to program two CPUs — most can only get about one-and-a-half times the speed you can get from one SH-2.

I think that only one in 100 programmers are good enough to get this kind of speed [nearly double] out of the Saturn.”

- Yu Suzuki, on Saturn Virtua Fighter development
Sega Saturn - Graphics

- ≈7.1590 MHz “VDP 1” 32-bit Video Display Processor
- ≈7.1590 MHz “VDP 2” 32-bit
- Quadrilaterals - not triangles!
- No hardware decompression
Sony Playstation (1995)

- ≈34 MHz MIPS R3000A-type (R3051) 32 bit
- 2M main RAM
- 1M video RAM
- 512K sound RAM
- 32K CD-ROM Buffer
- 512K OS ROM
- 128K Memory cards
- $300 at launch
- 102 million sold
Sony Playstation - Graphics

• 24-bit color, 256x224 to 640x480 resolution
• “Geometry Transformation Engine”
  – Built into same chip with MIPS R3000A CPU
  – 66 MIPS
  – 360,000 flat-shaded polygons per second
  – 180,000 texture mapped, Gouraud shaded polygons per second
• “Data Decompression Engine”
  – 16x16 Inverse Discrete Cosine Transforms (ICDT)
  – DMA transfer of uncompressed images to GPU
Full motion cheese

Insomniac’s “Disruptor” (1996)

Excellent gameplay, but badly acted live action cutscenes

Gameplay: http://www.youtube.com/v/VdfV7BtYVFs
Cutscene: http://www.youtube.com/v/eahGUCcj6uM
Increasing trend: in-engine cutscenes

Konami’s “Metal Gear Solid” (1998)

http://www.youtube.com/v/5sny3RfMYMU

Pictures from Wikipedia
Nintendo 64 (1996)

- ≈94 MHz MIPS R4300i-type
  - 64 bit registers, instructions, internal data path
  - 32 bit external data path
- 4M RAM - unified address space
- 32K colors, 256x224 to 640x480 resolution
- $200 at launch
- 32 million sold
- SGI CPU/GPU combo design
  - SGI bought out MIPS
  - Originally for Sega, but deal fell through

Photo and info from Wikipedia
Nintendo 64 - Graphics

• ≈65 MHz “Reality Coprocessor” (RCP)
  – Designed by SGI
• “Reality Signal Processor” (RSP)
  – MIPS R4000-based 8-bit integer vector processor
  – Programmable through microcode
  – Geometry transforms, clipping, lighting
  – SGI Fast3D microcode: ~100,000 polygons per second
  – Can also handle some sound duties
  – Presages some of the programmability of modern GPUs
• “Reality Drawing Processor” (RDP)
  – Rasterizer (turns triangles into pixels)
Nintendo 64 Killer App - Rare’s “Goldeneye 007”

- 4-way split screen multiplayer
  - [http://www.youtube.com/v/7cf5kkoYexI](http://www.youtube.com/v/7cf5kkoYexI)
Nintendo 64 - Last console to use cartridges

• 4 MB to 64 MB (Resident Evil 2)
• Some cartridges have nonvolatile RAM for saved games
• Pros
  – More piracy resistant than CDs
  – Faster loading time (CD-ROMs slow at the time)
  – No lengthy load screens like on Playstation
  – More durable (important for children)
• Cons
  – Small capacity compared to CD
  – Higher manufacturing costs and lead times - turned off third-party vendors, ate into profit margins

Info from Wikipedia
Sega Dreamcast (1999)

- 200 MHz Hitachi SuperH
  - 32-bit instruction set, 128-bit FPU functions
- 16M main ram, 8M video RAM, 2M sound RAM
- Launch price: $200
- 10.6 million sold
Sega Dreamcast - Graphics

• Imagination Technologies PowerVR2
  – PowerVR series competed with Voodoo series by 3dfx
  – Both companies eventually killed by ATI & NVIDIA
• Over 5 million polygons/second (7 million peak)
• Hardware gouraud shading, z-buffering, anti-aliasing and bump mapping

Info from Wikipedia
Sega Dreamcast - Namco’s “Soul Calibur”

http://www.youtube.com/v/aRFfgdNI2F0

Screenshot from Wikipedia
Microsoft Xbox (2001)

- Sony’s success with PS1 worried Microsoft
- 32-bit 733 MHz Pentium III-based Celeron
- 64 MB main RAM
- Development very much like developing Windows PC games
  - DirectX API
  - Easy to make PC and Xbox versions
- DVD movie playback
- $300 at launch
- Killer app - Halo: Combat Evolved

Photo and info from Wikipedia
Microsoft Xbox - Graphics

- 233 MHz NVIDIA “NV2A” GPU
- Similar to GeForce 3 and GeForce 4
- 485,416 triangles per frame at 60fps
- 970,833 triangles per frame at 30fps
- Bilinear, trilinear, and anisotropic texture filtering
- Texture compression, full scene anti-aliasing
Nintendo Gamecube (2001)

- “Gekko” - 485 MHz PowerPC 750Cxe-based core
- Nonstandard, small optical disk
  - Can’t be used as a standard DVD player
  - Some protection from piracy
  - Avoid DVD Consortium licensing fees
- 24M main RAM
- 1M texture buffer
- 2M frame buffer
- 21 million sold (as of June 2007)

Photo and info from Wikipedia
Nintendo Gamecube - Graphics

- 24-bit color, 640x480 interlaced or progressive scan
- “Flipper” - 162 MHz, co-designed by Nintendo and ArtX
- TEV “Texture EnVironment” engine
  - Similar to “pixel shader”
- Fixed-function hardware transform and lighting
  - 12+ million polygons/second
- Bilinear, trilinear, and anisotropic texture filtering
- Bump mapping, reflection mapping
Sony Playstation 2

- 140 million sold as of mid-2008
- Emotion Engine:
  - 300 MHz
  - MIPS III core
  - Two “Vector Units”
  - Graphics Interface (GIF) for talking to Graphics Synthesizer (GS)
  - Image Processing Unit
    - MPEG2 decoder
    - Macroblock decoding
    - Vector quantization

Photo and info from Wikipedia
Emotion Engine

Vector Processing Units

- **VPU0**: intended for “thought simulation and physical simulation”
  - Outputs to ScratchPad RAM (SPR) for use by GS for VPU1
- **VPU1**: intended for graphics pipeline
  - Geometry transformation
  - Vertex lighting
  - Outputs triangles (display list) to Graphic Synthesizer
Graphics Synthesizer (GS)

- 16, 16-bit integer registers
- 32, 128-bit floating point registers
  - Split into 32 bit words (x,y,z,w)
- Four FMACs in one clock cycle
- Two sets of drawing environments (internal contexts)
  - GS knows which instructions came from VPU0 and VPU1
  - Merges sequences
Microsoft XBox 360 (2005)

- 3.2 GHz “Xenon” triple-core PowerPC
  - 2 hardware threads per processor
- 256 MB main RAM
- 500 MHz ATI “Xenos” GPU
- Xbox Live online service
  - “Live arcade” game distribution
- HD-DVD drive available as ad-on
- Launch price: $399 premium, $299 core (kind of useless)
- Power Mac G5 early devkits?
Sony Playstation 3 (2006)

- IBM/Toshiba/Sony Cell processor
  - PowerPC Processing Element (PPE)
  - 8 Synergistic Processing Elements (SPE)
- 256M main RAM, 256M graphics RAM
- Blu-Ray drive
  - Part of Sony’s strategy of establishing Blu-Ray movie format
- Launch price: $500 (crippled), $600 (“real” version)
- Sold at an estimated loss of around $250
- Original $600 model recently dropped to $500
- New $600 (80 gig) model released

Photo and info from Wikipedia
Sony Playstation 3 - Graphics

• 550 MHz NVIDIA RSX

• Closely related to NVIDIA 7800

• Sadly, Linux users currently do not have access to the accelerated graphics
  – Stuck using frame buffer mode
Nintendo Wii (2006)

- Not a lot of info publicly released
- “Broadway” - 729 MHz PowerPC core
- 243 MHz ATI “Hollywood” GPU
- 88 MB main RAM
- 24 MB RAM in GPU
- 64 MB external video RAM
- Regular sized DVDs
  - But original Wii won’t play DVD movies
- Bundled with Wii Sports - “killer app”
State of Mac Gaming

- PowerPC Mac OS users were lucky to get a few ports here and there
- Intel Mac OS users often boot into Windows for their gaming needs
- At MacWorld 2007, Electronic Arts Chief Creative Officer Bing Gordon announced renewed interest in supporting Mac OS X
- Latest id game engine - “id tech 5” (“Rage”) will spit out Xbox 360, PS3, Windows, and Mac OS executables in a single build

www.youtube.com/watch?v=HvuTtrkVtns