PlayStation 2 Architecture

Prof. Aaron Lanterman
School of Electrical and Computer Engineering
Georgia Institute of Technology
Why talk about the PlayStation 2?

• Previous generation:
  – Xbox: > 24 million (May 10, 2006)
  – GameCube: 21.66 million (Sept. 31, 2007)
  – PlayStation 2: 117.89 million (March 31, 2007)

• Current generation (Sept 30, 2007):
  – Xbox 360: 13.4 million
  – Wii: 13.17 million
  – PlayStation 3: 5.59 million

Info from Wikipedia
Sega pledges PS2 support until 2010

• “This generation of hardware will have longer legs than any previous generation, and that’s definitely healthy for the industry.”

• “We expect Sony to price manage the PS2’s shelf life for another two or three years at least. PS2 high profile titles, especially ‘wide market’ and licensed titles, will absolutely be part of the Sega portfolio going forwards.”

From www.maxconsole.net/?mode=news&newsid=21102
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

Emotion Engine - high-level structure (1)

Emotion Engine - high-level structure (2)

The Emotion Engine (EE)

- Memory 32mb

EE CORE

- EE: 128-bit Emotion Engine
- VU0/VU1: Vector Units
- FPU: Floating Point Unit

DMA

VU0  VU1

- GS: Graphic Synthesiser
- DMA: Direct memory access
- IPU: Image processing Unit

IOP

S. Ewen & L. Lemarie, “Console Yourself”
Special subprocessors

• IOP Input/Output Processor
  – Contains R3000 (provides PS1 compatibility)
  – 2 MB memory (same as PS1)
  – Controllers, memory cards, SPU2, DVD drive, USB, “Firewire”

• SPU2 Sound Processing Unit
  – 2 DSP cores, 48 channels
  – 2 MB sound memory

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

Vector Processing Unit 1

- VPU1
  - 16K data memory (128-bit words)
  - 16K program memory (64-bit words)
  - “Upper” and “lower” execution units
  - Special registers ACC, I, Q, R, P

Info from powerpoint presentation by H.S. Fortuna, “Video Game Programming Using The PlayStation2 Games Console,”
www.ics.heacademy.ac.uk/events/presentations/91_BCSTalk.ppt
Connection styles

Parallel Connection

Serial Connection

(c) IEEE 1999 ISSCC Slide Supplement / Copyright IEEE
Vector Unit 0

Vector Unit 1

Caches and scratchpad

- Similar to old style PC L1 cache
- PS2 has small caches, as it was felt that a lot of dynamic data would not be in the cache for any length of time

From D. Carter, “Introducing PS2 to PC Programmers,” AGDC 2002
Vector Processing Units

Intro slides for UCSD “CSE 191A: Video Game Programming Seminar” pisa.ucsd.edu/cse191/www/CSE191_01.ppt
Typical vsm assembly (dual stream)

NOP
mulax ACC, VF02, VF06x
madday ACC, VF03, VF06y
maddaz ACC, VF04, VF06z
maddw VF06, VF05, VF06w
NOP
NOP
NOP
mulaw.xyz ACC, VF01, VF00w
NOP
NOP
NOP
NOP
NOP
mulq.xyz VF06, VF06, Q
NOP
NOP
NOP
NOP
NOP
NOP
NOP
NOP

lq VF06, 7(VI02)
iaddiu VI01, VI01, 0x00000001
iaddiu VI02, VI02, 0x00000002
NOP
NOP
NOP
NOP
NOP
NOP
NOP
NOP
NOP
NOP
NOP
NOP
NOP
NOP
NOP
NOP
NOP

div Q, VF00w, VF06w
waitq
NOP
NOP
NOP
NOP
NOP
NOP
NOP

Info from powerpoint presentation by H.S. Fortuna, “Video Game Programming Using The PlayStation2 Games Console,” www.ics.heacademy.ac.uk/events/presentations/91_BCSTalk.ppt
Typical VCL (single stream)

loop:
lq                Vert, StartVert(iVertPtr)

MatrixMultiplyVertex Vert, fTransform, Vert

div                q,    vf00[w], Vert[w]
mul.xyz            Vert, Vert, q

mula.xyz           acc, fScales, vf00[w]
madd.xyz           Vert, Vert, fScales
ftoi4.xyz          Vert, Vert

Slide from powerpoint presentation by H.S. Fortuna, “Video Game Programming Using The PlayStation2 Games Console,”
www.ics.heacademy.ac.uk/events/presentations/91_BCSTalk.ppt
Graphics Synthesizer (GS)

- Receives display list of triangles from GIF
- Rasterizes triangles into frame buffer
- Handles z-buffering, alpha blending, texture mapping
- Outputs frame buffer to video

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