Xbox 360 Architecture

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Overview

- Introduction
- Hardware Overview
- CPU Architecture
- GPU Architecture
- Comparison Against Competing Technologies
- Implications of Technology
Introduction

- Robust architecture
- Xenon microprocessor
- ATI Xenos GPU
- Traditional multi-core design paradigm
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# Hardware Overview

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<th>Hardware Component</th>
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| Custom IBM PowerPC-based CPU | 3 symmetrical cores (3.2GHz)  
2 hardware threads per core  
1 VMX-128 vector unit per core  
L1 split cache (32kB/32kB)  
L2 1024 kB unified cache |
| Custom ATI GPU              | 500MHz  
10MB embedded DRAM  
48-way parallel FP shader pipelines  
Unified shader architecture |
| Memory                      | 512MB GDDR3 RAM  
700 MHz DDR  
Unified memory architecture |
| Memory Bandwidth            | 22.4 GB/s memory interface bus bandwidth  
256 GB/s memory bandwidth to EDRAM  
21.6 GB/s front-side bus |
| I/O                         | 3 USB 2.0 ports  
Wireless support |
| Mathematical performance    | 1 TFLOP (floating point performance)  
48 billion shader operations per second  
500 million triangles per second  
9 billion dot product operations per second  
16 gigasamples per second fill rate using 4x MSAA |
| Storage                     | Detachable and upgradeable hard drive  
12X dual-layer DVD-ROM |
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CPU Architecture ~ Overview

- Title: Xenon/ XGPU/ Waternoose
- Designer: International Business Machines (IBM)
- Instruction Set Architecture: Power Architecture (PowerPC-Based)
- Cores: 3 Physical Cores 3.2GHz
- Pipeline Specification: In-order execution
- Cache Configuration: L1 cache (32kB/32kB), L2 Cache (1024kB)
- Manufacturer: Globalfoundries
- Technology: 90nm(Xenon), 65nm(Opus), 45nm(Valhalla)
- Vector Unit: VMX-128 (3x), 128 VMX-128 registers/thread
Structure of PowerPC CPU core

- Wide execution
- SMT-capable clocked at 3.2GHz
- Five execution pipes (branch, load/store, fixed point, floating point, VMX)
CPU Pipeline

- Two-issue, in-order execution
- SIMD: 2x VMX128 units
- In-order execution
- Unified VMX and FPU
- LSU linked to L1 Data Cache
- Instructions fetched into unified L2 Cache
Cache Architecture

- 32kB L1 Cache 2-Way
- 32kB L1 Cache 4-Way
- Unified L2 Cache (~1MB)
  - 51.2 GB/s L2 BW
  - Lockable by GPU
  - Half CPU speed
  - 256 bit bus
- 21.6 GB/s FSB
PowerPC ISA

- RISC ISA created in 1991 (Apple-IBM-Motorola)
- Popular in embedded applications
- Based upon IBM POWER architecture
- Big Endian
- 64-bit specification (backwards compatible)
- Requires deeper pipelines
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GPU Architecture ~ Overview

- Xenos “ATI Custom R520”
- ATI (Acquired by AMD)
- Clocked @500Mhz
- Unified Shader Core
- 48 Unified Shader Pipelines (for Vertex and pixel shading)
- 16 Filtered & 16 Unfiltered Texture samples per clock
- Embedded with EDRAM
- Offers Anti-aliasing
GPU Structure

- 2 Silicon ICs
  - GPU
  - Daughter Dye
- Bandwidth saving
- CPU-GPU link
Anti-Aliasing

- Aliasing
- Daughter Dye
  - Self-processing memory controller
Unified Shader Architecture

- Shaders
  - Pixel Shaders
  - Vertex Shaders
Unified Shader Architecture (Cont.)

- Unified Shader Pipeline
  - Combining two different dedicated pipelines
  - Increased Performance
  - Texture Sampler
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CPU Performance Comparison

Xbox 360 CPU
3x 3.3Ghz Cores
Easier to develop for
Multi Platform Games advantage

PS3 CPU
1x 3.2Ghz PPE
7x 3.2Ghz SPE
Developers: full core utilization
Graphics Processing
GPU Performance Comparison

Xbox360 GPU
Unified Shader Architecture
48 Unified Pipelines
Memory: 512MB 700Mhz GDDR3

PS3 GPU
Dedicated Shader core
24 pixel pipelines
8 vertex pipelines
Transition to Unified Architecture
Memory: 256MB 700Mhz GDDR3
256MB 3.2Ghz XDR Ram
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XBOX RUL3Z
Sources

How Xbox 360 Works -Robert Valdez
http://electronics.howstuffworks.com/xbox-three-sixty.htm

Inside Microsoft's Xbox 360 -Anand Shimpi, Kristopher Kubicki & Tuan Nguyen
http://www.anandtech.com/show/1864/inside-microsoft-s-xbox-360

Microsoft's Xbox 360, Sony's PS3 - A hardware Discussion -Anand Shimpi & Derek Wilson
http://www.anandtech.com/show/1719

Details of ATI's Xbox 360 GPU Unveiled - Scott Wasson

Xbox 360 System Overview
http://www.beyond3d.com/content/articles/4/2

Microsoft CPU resources
http://arstechnica.com/features/2005/06/xbox360-2/
http://xbox.about.com/od/xbox2/a/xbox360specs.htm