NINTENDO 64 ARCHITECTURE

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AGENDA

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HISTORY

• Nintendo was founded in 1889 as a playing card company
• Nintendo 64 was Nintendo’s 3rd game console for an international market
• Released in 1996
• Nintendo’s last home console to use ROM cartridges
HISTORY OF NINTENDO

1980
The ‘Game & Watch’ systems are created, being Nintendo’s first portable video games. Each system comes with a pre-installed title, some starring Mario, Donkey Kong, and Mr. Game and Watch. The game displayed here is called ‘Mario’s Cement Factory’.

1985
After the video game ‘crash’ of 1983, Nintendo took a risk and launched their first home console, the NES, to the public in hopes of reviving the industry. It worked, and thus began the company’s road to stardom.

1995
The ‘Virtual Boy’ played games in 3 Dimensions, but one year later it was cancelled because of the poor sales.

1996
Memory cards, game discs, built-in rumble controllers, the ‘GameCube’ was turn-of-the-century technology.

2001
A true successor to the ‘GameBoy Advance’, the DS’ Dual Screen technology to the handheld family. It eventually came in three other models: the ‘Lite’, the ‘i’, and the ‘XL’.

2006
Motion controls brought families together for game night in a way that video games have never been able to do before. Coupled with online features and many other interactive media, the ‘Wii’ changed the way ‘we’ play.

2011
A more powerful DSi with glasses-free 3D, motion controls, and ‘AR’ technology. Remakes of classic titles such as ‘Zelda: Ocarina of Time’ and ‘Star Fox 64’ have debuted here.

Nintendo’s first arcade game. ‘Donkey Kong’, debut. It was a popular hit for its time. Today, you can find it on almost any Nintendo system.

This popular and well-loved handheld gave gamers a chance to play ‘on-the-go’. The games were sold separately, allowing for a large library of games on one system.

Nintendo’s second home console, the ‘Super NES’, had twice as much graphical power as the NES. The game ‘Donkey Kong Country’ helped boost sales of the system due to the game’s graphical abilities.

Simply put, the ‘GameBoy Pocket’ was a slimmed-down version of the ‘Original GameBoy’. It still played games in black and white.

Moving from 2D to 3D rendered games, the ‘Wii’ was a whole new dimension to explore. Up to four people could now play instead of the usual two.

Better graphics and two extra buttons made the ‘GameBoy Advance’ indeed advanced. It was basically a portable ‘SNES’. Two other models were later released: the ‘SP’ and the ‘Micro’. 
Main competitors at the time were the Sony Playstation and Sega Saturn.

Nintendo 64 was created in response to the competing products and a Japanese recession.

First console to truly use 64 bit processor.

With the release of the Nintendo 64, the Sega Saturn sales dropped significantly.
INTRODUCTION TO THE NINTENDO 64 ARCHITECTURE

• 64 bit RISC CPU
  – NEC VR4300
• 4 MB RDRAM
• Reality Coprocessor
  – Reality Signal Processor
  – Reality Display Processor
• 4-64 MB ROM Game Cartridges (Game Pak)
CPU

- NEC VR4300: RISC MIPS III ISA
  - Derivative of R4300i
- 64-bit processor
  - 32-bit system bus
  - 64-bit arithmetic operations
- Classic 5-stage scalar pipeline
  - Fetch, Decode, Execute, Memory, Writeback
- 93.75 MHz clock speed
- 250 MB/s max throughput
- Integrated FPU
- Shared integer-FP pipeline
- Split 24 KB L1 Cache
  - Instruction cache: 16K bytes
  - Data cache: 8K bytes
  - Parallel access
- No direct memory access
MEMORY

- 4 MB RDRAM
  - DRAM developed by Rambus, Inc.
  - Two chips of 2 MB each
- 9-bit data bus
  - Simplified circuit board design
- High bandwidth
  - 500 MB/s
- Very high random-access latency
- Expandable to 8 MB with Expansion Pak
GAME PAK

- 4-64 MB Mask ROM
  - Much less storage space than CD
- Saving capability
  - EEPROM, 4Kb to 16Kb
  - Battery-backed SRAM, 256Kb
- Data transfer 5MB/s-50MB/s
  - Faster than CD
REALITY COPROCESSOR

- Interfaces directly to CPU
- Handles most of the audio and graphics processing
- Handles timing and signals for game cartridges
- Two Processors in RCP
  - Reality Signal Processor (RSP)
  - Reality Drawing Processor (RDP)
REALITY SIGNAL PROCESSOR

• Performs all 3D manipulations and audio functions
  – Geometric Transformations
  – Clipping and Culling
  – Lighting Calculations
• Configurable using microcode which allows the system to be optimized by developers
• Altering the microcode allowed for new effects, better speed or better quality etc.
REALITY DISPLAY PROCESSOR

• Performs all pixel-level operations
  – Texture Mapping
  – Anti-Aliasing
  – Polygon Rasterization
  – Mipmapping
  – Z-Buffering

• 4kB Texture Cache

• Has four cycle modes where the individual process units are collaborating to produce pixels
  – Fill Mode
  – Copy Mode
  – One Cycle Mode
  – Two Cycle Mode
I/O

• I/O handled by RCP made up of several interfaces
  – Video Interface
  – Audio Interface
  – Parallel Interface
  – Serial Interface
WEAKNESSES

• Limited texture cache of 4 kB which could be halved if mipmapping was used
• Z-Buffering was controlled by programmer, not RDP
• 64 bit instructions were rarely used
  – 32 bit instructions faster and smaller code size
WEAKNESSES CONTINUED

• Fillrate limited, not geometry limited
• High latency Memory
• CPU doesn’t have DMA
  – Went through RCP for memory accesses
• No memory prefetch
• Game Pak had limited space compared to competing consoles with discs
END OF LIFE CYCLE

• GameCube addressed the two main limitations: small texture cache and use of Game Paks
• Discontinued in 2002-2003, following the release of the game cube in 2001
SOURCES


ANY QUESTIONS?