Hardware Overview

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Agenda

- Platform goals
- System architecture
  - CPU, GPU, memory, audio, disc
- Briefly
  - Wii Remote and Nunchuk
  - WiiConnect24
  - DS to Wii connection

Platform Goals

- Innovative Controller Interface
  - Simplified controls for mass market appeal
  - Intuitive controls such as pointing and gestures
  - Player immersion through Controls
    - Not through simulating reality
- Simplicity
  - Wireless controllers
  - Small, sleek, quiet, power-efficient console
  - No more Memory Cards
    - 512MB of internal flash memory

Platform Goals

- Compatibility
  - Fully compatible with GCN discs
    - Supports GCN controllers, Memory Cards
  - Plays many older games through Virtual Console
- Low Cost Development
  - Low cost dev kits (NDEV $1,995.00, RVT-R $595)
  - Free compiler, plus other free tools and middleware
  - Modest texture and model requirements = less development cost
    - ~$5 million vs. $10 to $20 million
- Realistic Business Model
  - Price/Performance considerations on hardware

System Architecture

- GPU: Hollywood
- CPU: Broadway
- 88MB RAM
- 512MB data storage
- External Interfaces
  - 2 USB ports
  - SD card slot
- Wireless
  - Controllers
  - Network

CPU: Broadway

- Power PC 729MHz
- Level 1 cache
  - 32KB instruction cache
  - 32KB data cache
    - 16KB can be data scratch pad
- Level 2 cache
  - 256KB
- Write-gather pipe
  - Provides high speed writes of graphics commands to memory

CPU: Broadway

- Paired single floating point
  - PPC natively works in 64-bit floating point
  - Two 32-bit floating point values stored in that space
  - One instruction operates on two 32-bit values at a time
  - SDK vector libraries are already optimized for it
    - (or copy it to your own vector libraries)
- Static and dynamic branch prediction
- Out-of-order execution
- 100% backward compatible with GCN

Hollywood

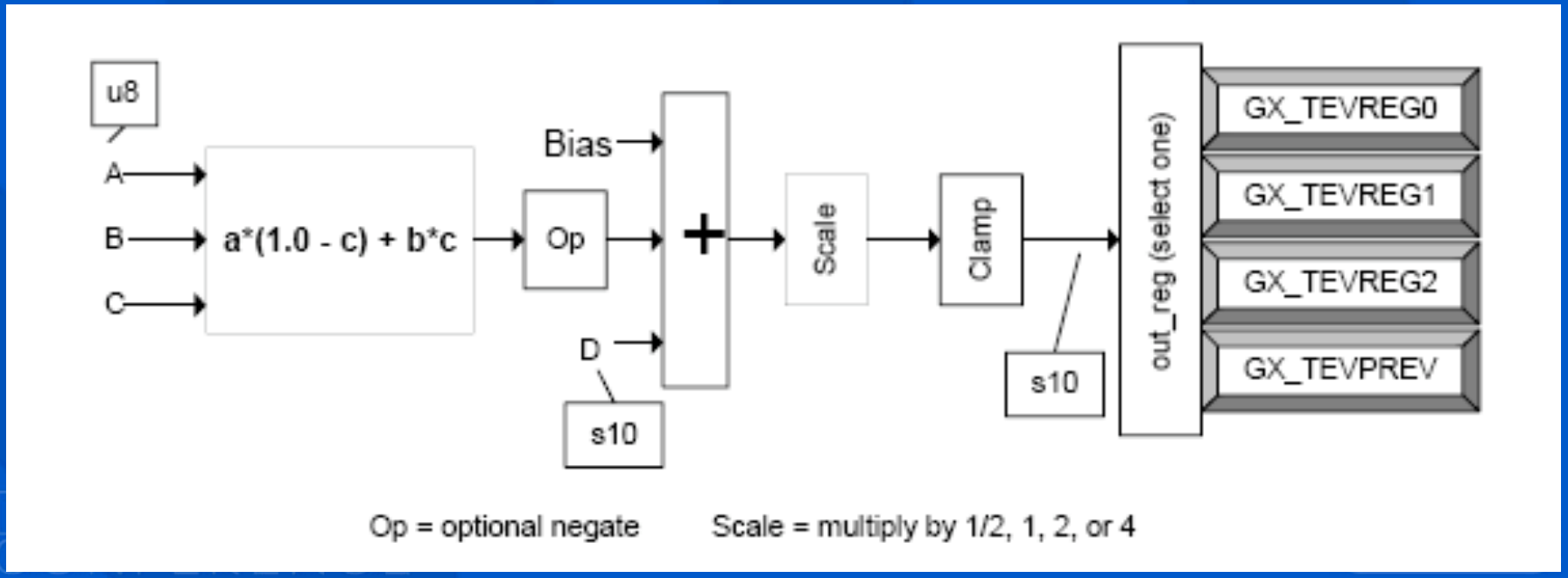
- Single chip contains
  - GPU (with 3MB graphics RAM)
  - 24MB main RAM
  - Audio DSP
  - Additional logic for I/O control
- Clocked at 1.5 times GCN
  - 243MHz vs 162MHz

GPU

- Feature set
  - Support for
    - Reflection mapping
    - Bump mapping
    - Anti-aliasing
    - Fog
  - 8 hardware lights
  - 16 TEV stages (flexible fixed pipeline)

Single TEV Stage

- Inputs A and B are linearly interpolated using C
- Bias and D are added in, then scaled and clamped
- Result can be stored in 1 of 4 registers



Multiple TEV Stages

- Multi-texturing
  - Combine multiple TEV stages
  - TEV stage output can be input for next stage
- Inputs
  - Up to 8 textures
  - Up to 8 texture coordinates

GPU Performance

- GPU Vertex Performance
  - 1 Texture no lights: 35MV/s
  - 2 Textures, 1 light: 27MV/s
- GPU Texture Performance
  - 1 Texture: ~1 billion pixels/second
  - 2 Textures: ~500 million pixels/second
- At 30fps, real world games ~200,000 polys/frame
  - Give or take 100,000 polys based on your particular design

Graphics

- What should you be targeting graphics-wise?
- Build a GCN game, add detail and extra effects
  - More textures / higher resolution textures
  - More TEV stages
  - More lights
  - More post processing
    - Blur
    - Bloom effect
    - Convolution filters

Audio

- Based on GCN AX audio engine
  - More voices than GCN
    - Mixing offloaded to DSP for up to 96 voices (112MHz DSP)
  - More effects than GCN
    - More power for reverb, delay, chorus, etc.
- Built-in Support for
  - Mono, Stereo, Surround, Dolby Pro Logic II
  - Dolby Pro Logic II is 4 discrete channels
    - Interpolated 5.1
    - If used, display Dolby logo before gameplay

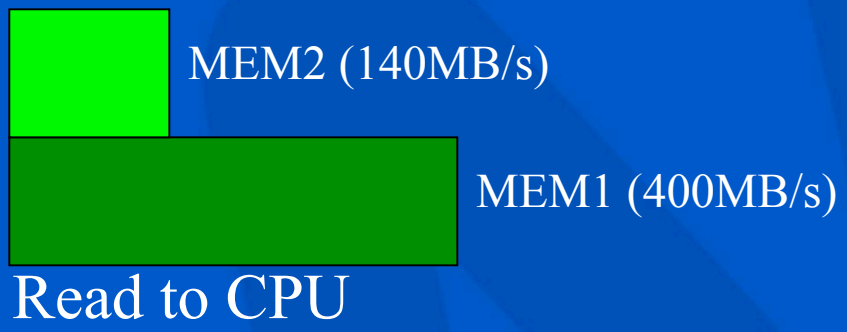
Audio

- Wii Remote Speaker
  - Used for feedback and game immersion
  - Quick simple sounds
    - Clicks, beeps, percussion, gun reload, gun firing, etc.
  - Avoid long samples
    - May break up due to wireless interference

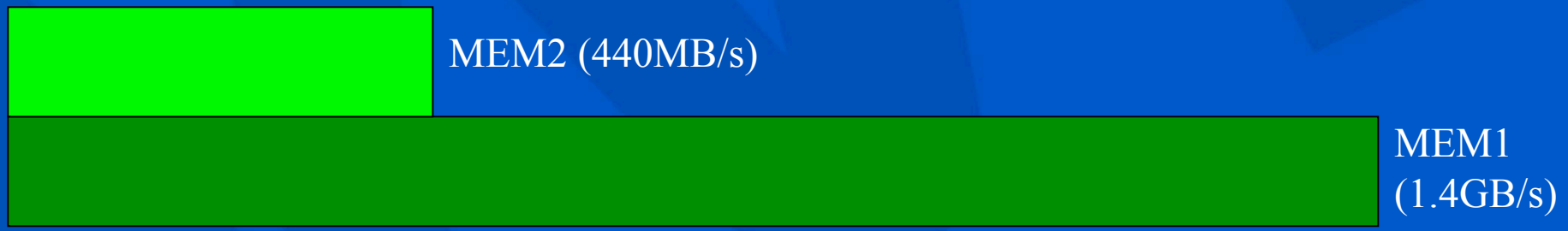
Memory

- MEM1
  - 24MB
  - Read and write speed to CPU 400MB/s
- MEM2
  - 64MB of GDDR3 (128MB on NDEV, RVT-H)
    - CPU read speed 3x slower than MEM1
    - CPU write speed identical to MEM1
      - Only if cache line already in memory
      - Or zero out cache line first (using dcbz instruction)

MEM1 vs. MEM2
Data Read Speeds

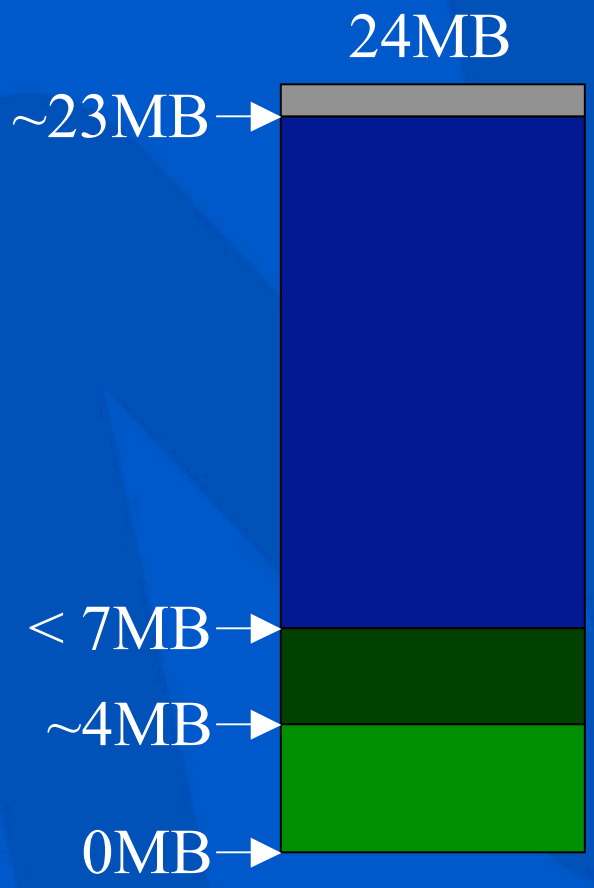


Read to CPU



Read to Locked Cache

MEM1 Layout



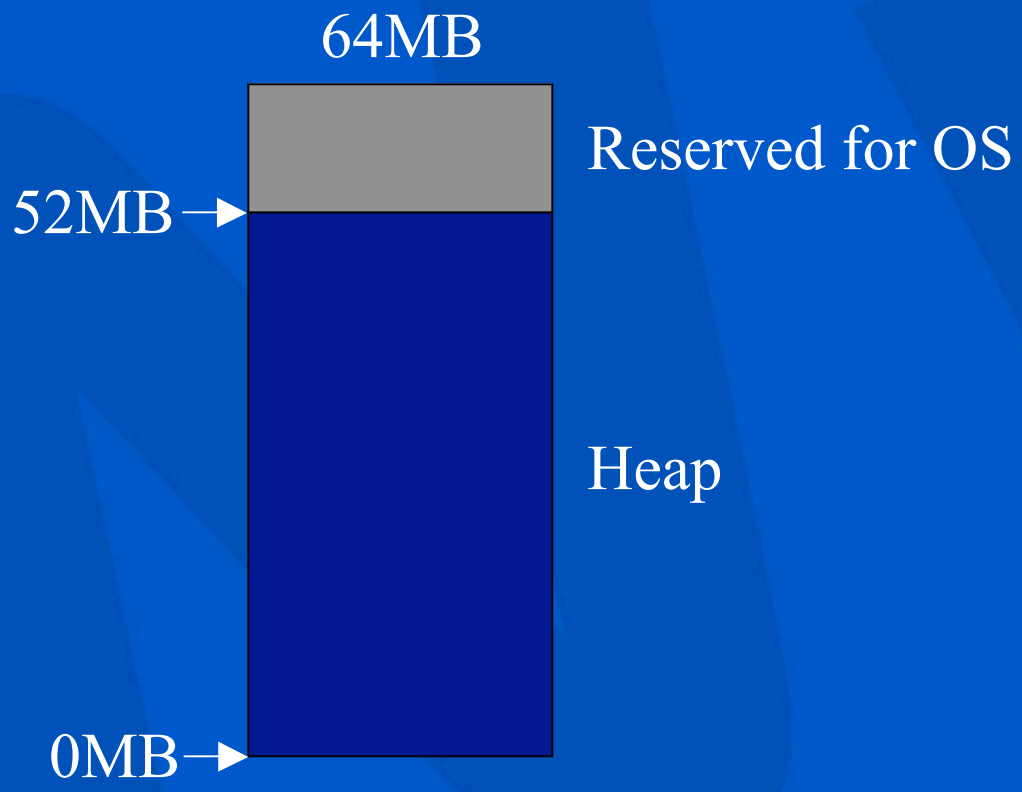
File Symbol Table (FST)

Heap

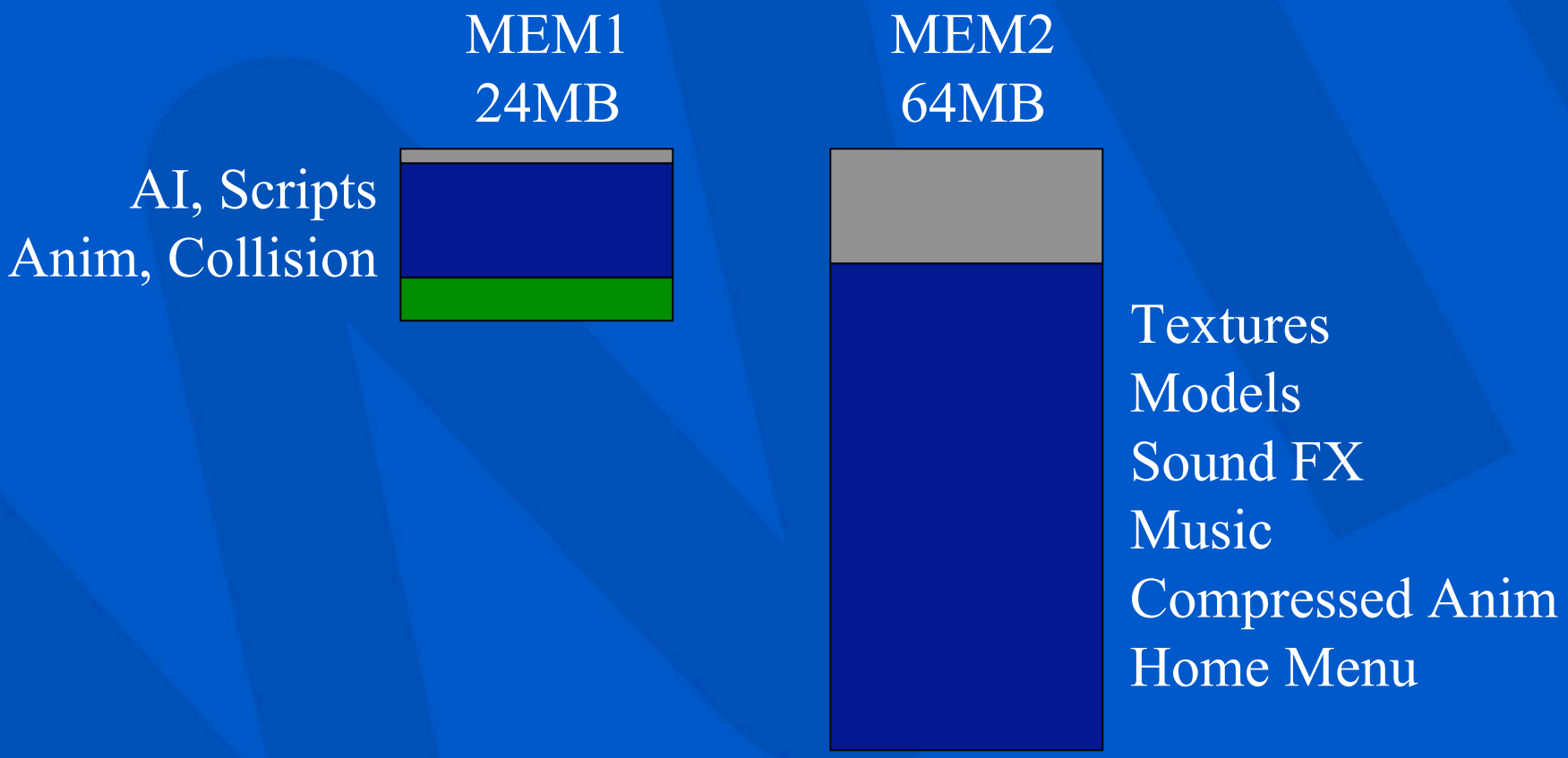
Uninitialized Data

Game Code (dol file)

MEM2 Layout



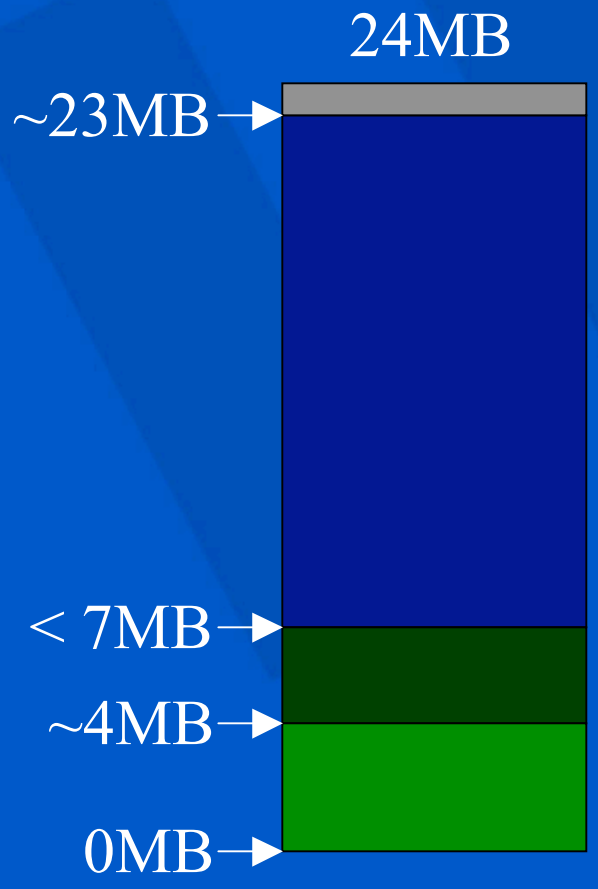
Recommended Memory Usage



MEM1 Layout

Enforced Limit:

- 7MB for game code + all data sections
  - Console boot code resides at 7MB
  - NDEV will issue warning on boot
  - Look at MAP file to verify



Engineering Around 7MB Restriction

- Option #1
  - Small boot program loads real game
  - Uses OSExec functionality
    - Results in terrible load times (8s) with black screen
    - Not recommended
- Option #2
  - Use RSO or REL functionality
    - Nintendo's version of a dll
    - RSO (Revolution Shared Object)
    - REL (Relocatable Elf)

Video

- Console settings offer 4:3 or 16:9
  - When in 16:9 mode:
    - Game renders at 16:9 aspect ratio
    - Image is stretched by TV
- Support for Progressive Scan
  - Requires component video cables

Is this a Widescreen TV?

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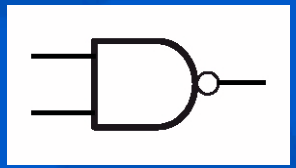
Be careful testing widescreen!
16:9 versus 16:10

Both models marketed as widescreen LCD TVs

NAND
Internal Data Storage



- Total size: 512MB
- Writing
  - Fairly slow
  - Limit writing – less than once per minute
    - Writes eventually wear out the memory
- Reading
  - Like disc access without the seek time (6MB/s)
  - Limit reading – less than once per second
    - After ~100,000 reads, memory can become corrupted

Uses for NAND

- Temporary scratch memory
  - Limited to 40MB and 64 files
  - Reset for each game
- Saved games
  - Limited to 16MB and 32 files per game
  - Three permission levels
    - Owner (single game)
    - Group (games from the same company)
    - Everyone (all games)
- Virtual Console games
- System use (reserve area for bad blocks)

Optical Disc Drive

- Size
  - 4.7GB single layer
  - 8.5GB dual layer (available in the future)
- Speed
  - 2.2MB/s at inside of disc
  - 4.6MB/s at outside of disc
- Automatically performs speculative prefetch
  - Benefit for forward linear reads
- No hardware audio streaming (unlike GCN)
  - So stream it in software

Disc Performance

- Faster reads on outside edge of disc
  - Use tools to place files by priority
- Minimize seek time
  - Place all level files linearly on disc
    - In the order they will be loaded
  - Don't store data in folders by type
    - (audio, models, textures, etc)
- Lot Check will be upset if you seek "too much"
  - Causes unnecessary drive wear
  - Especially during an attract mode

Wii Remote Features

- Pointer
  - Detects 2D screen position
  - Distance from TV
  - Rotation
- Motion sensing
  - Built into Wii Remote & Nunchuk
  - Detects 3D acceleration, including gravity
- Speaker on remote
- Rumble on remote
- Extension port for new controllers
  - Possibility for 3rd parties – talk to NOA Licensing
- 16KB Memory – you can use 4KB and store 1 file

WiiConnect24

WiiConnect24

- Concept
  - Game console that is turned on daily
    - Standby mode
      - Low power mode capable of receiving data
  - Game console that is always connected
    - Games can be updated with new info or content
- Two primary features
  - Sending/Receiving messages
  - Downloading
- To use, fill out the WiiConnect24 Design Sheet
  - On WarioWorld.com – send to support@noa.com

WiiConnect24: Sending/Receiving Messages

- Exchange messages between users
- Send event information notifications
- Restrictions on sending Wii messages
  - 200KB per day per application
  - 8 or fewer recipients per message

WiiConnect24: Sending/Receiving Examples

- Big Brain Academy
  - Sharing Student Record books with friends
- Elebits
  - Sharing custom made levels and screenshots
- Metroid Prime 3: Corruption
  - Sharing of screenshots

WiiConnect24: Downloading

- Get periodic data from some information source
- Examples:
  - Forecast Channel
  - News Channel
  - Everybody Votes Channel

DS to Wii Communication

- Download Revolution SDK Extensions 1.0
  - Must sign the Wii WiFi Connection Development Tools agreement to gain access
- MP Communication library
  - Performs DS Download Play (mpdl.a library)
    - DS doesn't need game card – download game
  - Performs DS Wireless Play (mp.a library)
    - General communication

Summary

- Nintendo Wii
  - Sleek affordable system for the masses
  - Unique and original game experiences
  - Easy and relatively cheap to develop games
  - Exciting opportunities with
    - Wii Remote
    - Wi-Fi
    - WiiConnect24
    - DS to Wii connection

Questions?

Ask me during the reception/breaks

Or e-mail support@noa.com