Xenos: XBOX360 GPU

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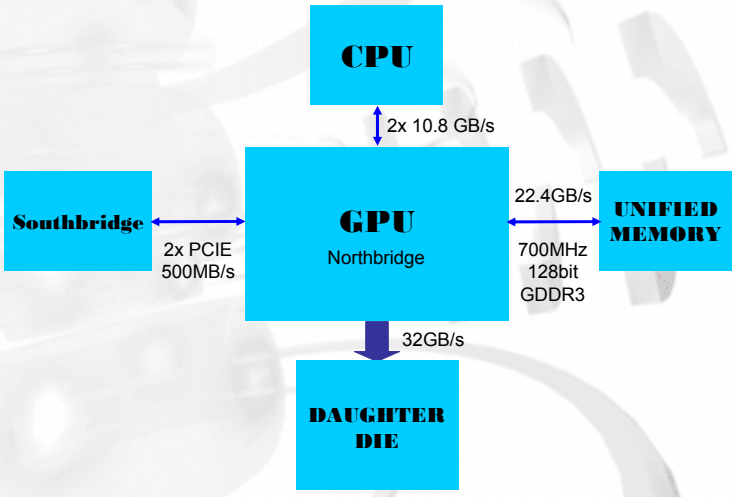
Overview

- System architecture
  - Rendering performance
  - GPU architecture
- Unified shader
- Memory Export
- Texture/Vertex Fetch
- HDR rendering
- Displaced subdivision surfaces

System architecture



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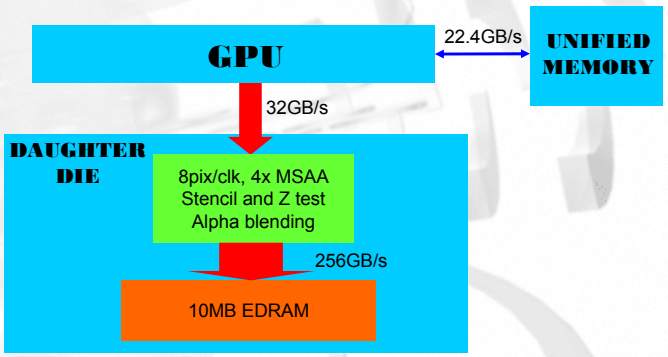
Rendering performance

- Render surface bandwidth



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Rendering performance

- GPU to Daughter Die interface
  - 8 pixels/clk
    - 32BPP color
    - 4 samples Z - Lossless compression
  - 16 pixels/clk – Double Z
    - 4 samples Z - Lossless compression
- Alpha and Z logic to EDRAM interface
  - 256GB/s
  - 32 samples x 32bit color, 24bit Z, 8bit stencil
  - Double Z
    - 64 samples x 24bit Z, 8bit stencil

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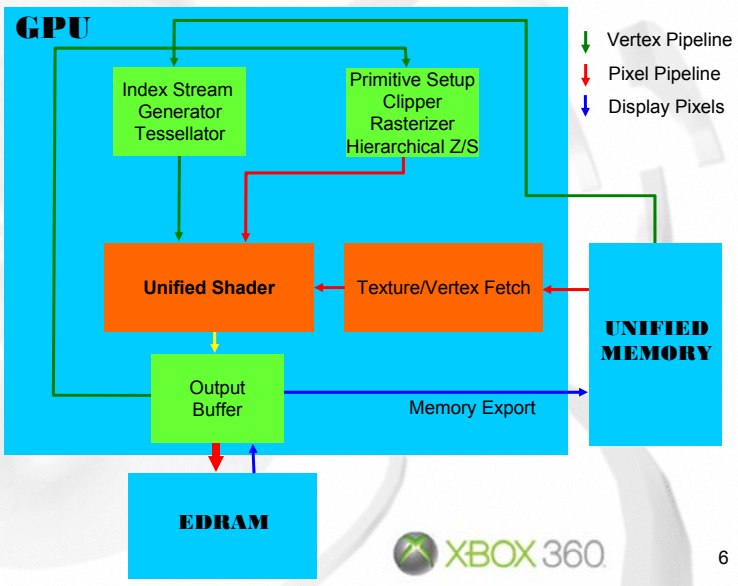
GPU architecture



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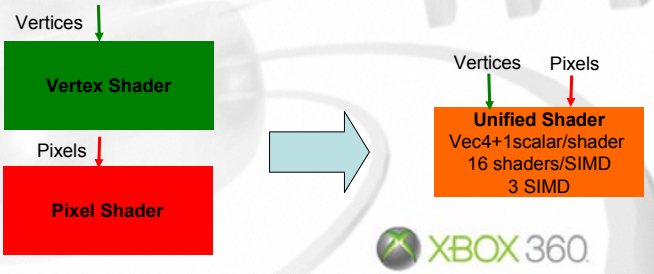
Unified Shader

- A revolutionary step in Graphics Hardware
- One hardware design that performs both Vertex and Pixel shaders
- Vertex processing power



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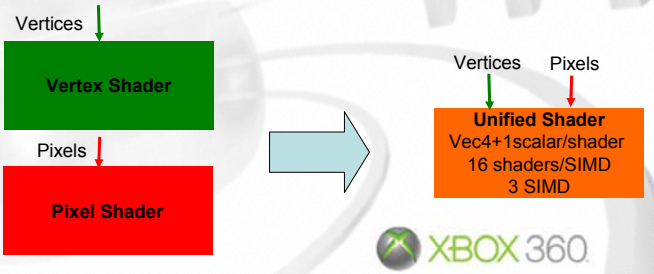
Unified Shader

- GPU based vertex and pixel load balancing
  - Better vertex and pixel resource usage
- Union of features
  - E.g. Control flow, indexable constant, …
- DX9 Shader Model 3.0+



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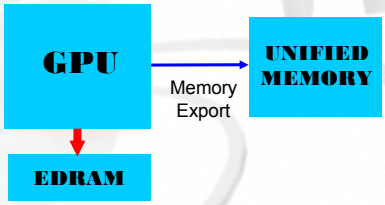
Memory Export

- Shader output to a computed address
- Virtualize shader resources - multipass
- Shader debug
- Scatter write



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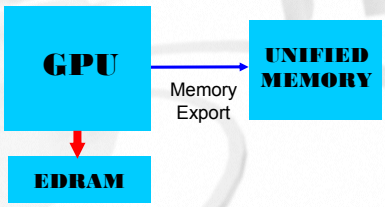
Memory Export

- Randomly update data structures from Vertex or Pixel Shader
  - Ray tracing acceleration structures
  - Physical simulation – GPGPU
- Enabling exploration for the future



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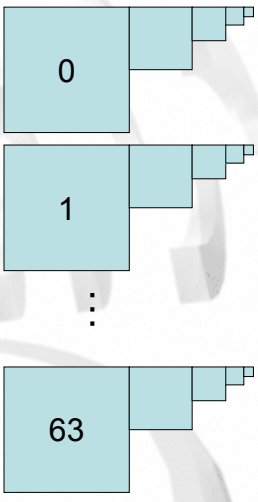
Texture/Vertex Fetch

- Shader fetch can be either:
  - Texture fetch (16 units)
    - LOD computation
    - Linear, Bi-linear, Tri-linear Filtering
    - Uses cache optimized for 2D, 3D texture data with varying pixel sizes
    - Unified texture cache
  - Vertex fetch (16 units)
    - Uses cache optimized for vertex-style data

Texture Arrays

- Generalization of 6 faced cube maps to 64 faces
- Each face is a 2D mip mapped surface
- *Not* volume texture
- Applications
  - Animation frames
  - Varying skins for instanced characters / objects
  - Character shadow texture flipbook animations



Texture array application :
Unique seeds for instanced shading

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Texture array application :
Hundreds of instanced characters

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High Dynamic Range Rendering

- Special compact HDR render target format:
  - Just 32 bits: 7e3 7e3 7e3 2
  - Compatible with multisample antialiasing
  - R, G and B are unsigned floating point numbers
    - 7 bits of mantissa
    - 3 bits of exponent
    - Range of 0..16
  - 2 bits of alpha channel
- 16-bit fixed point at half speed
  - With full blending

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Displaced subdivision surfaces

- Prototype algorithm
- Vineet Goel, ATI research Orlando

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Displaced subdivision surface algorithm

- Tessellator:
  - Generates 64 vertices for each patch that are fed into the VS.
- Vertex Shader:
  - Reads in one-ring, computes Stam's method using precomputed table lookup
  - Adds Displacement map
- Pixel Shader
  - Adds bump mapping and surface color

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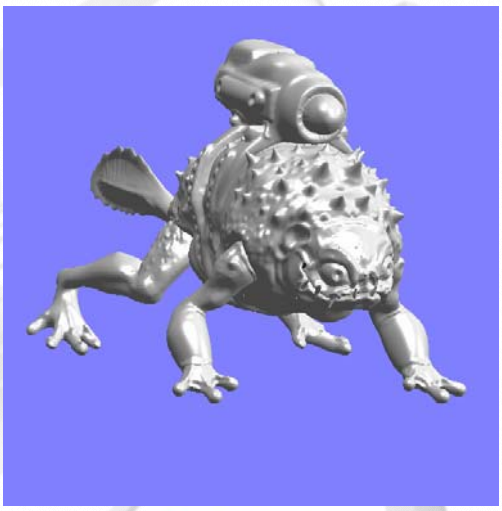
Displaced subdivision surface results



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Demo

- Ruby: The Assassin