



Xenos: XBOX360 GPU



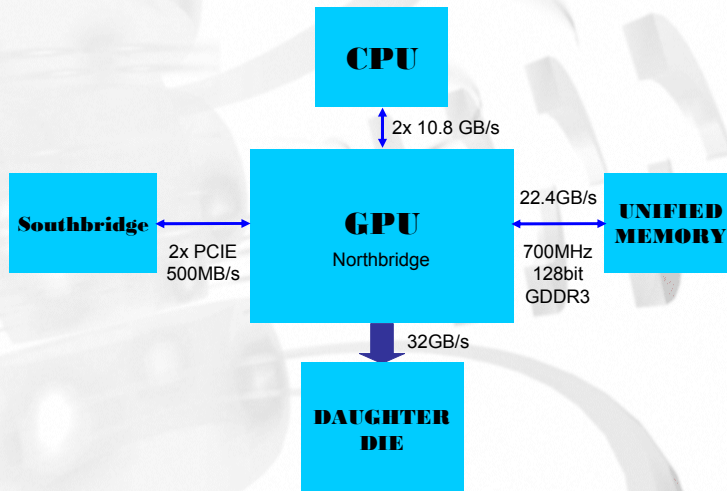
Michael Doggett
Architect
October 26, 2005

Overview

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



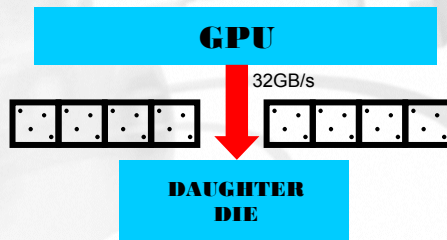
System architecture



3

Rendering performance

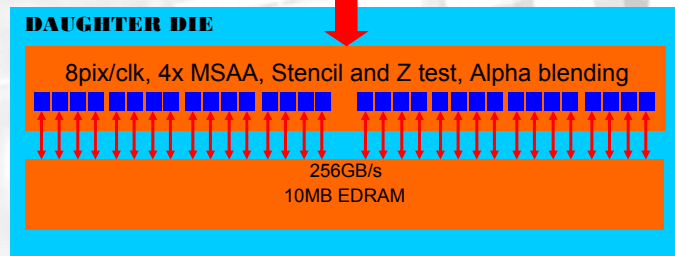
- GPU to Daughter Die interface
 - 8 pixels/clock
 - 32BPP color
 - 4 samples Z - Lossless compression
 - 16 pixels/clock - Double Z
 - 4 samples Z - Lossless compression



4

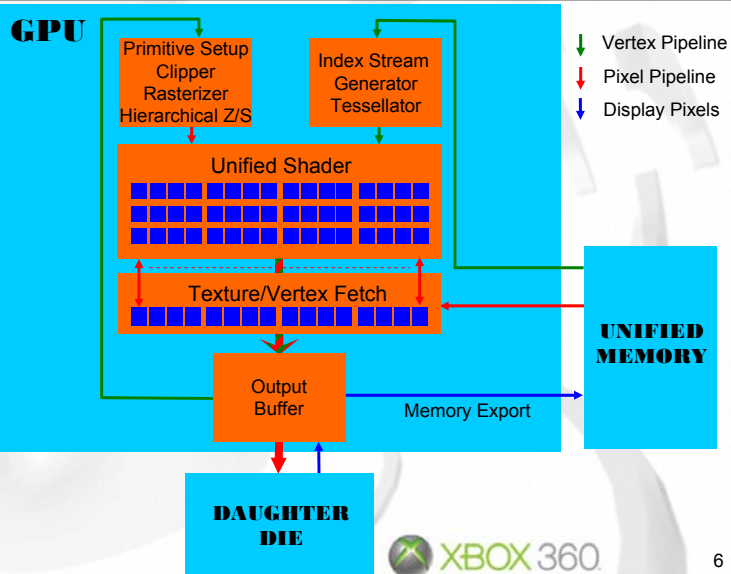
Rendering performance

- Alpha and Z logic to EDRAM interface
 - 256GB/s
 - Color and Z - 32 samples
 - 32bit color, 24bit Z, 8bit stencil
 - Double Z - 64 samples
 - 24bit Z, 8bit stencil



5

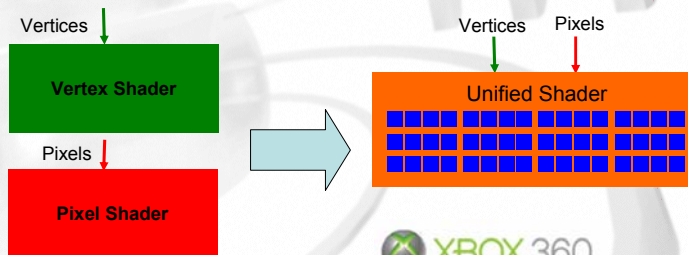
GPU architecture



6

Unified Shader

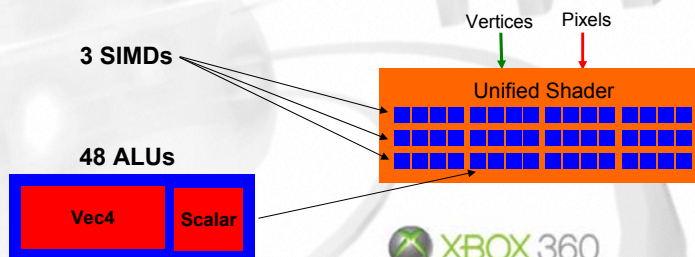
- A revolutionary step in Graphics Hardware
- One hardware design that performs both Vertex and Pixel shaders
- Vertex processing power



7

Unified Shader

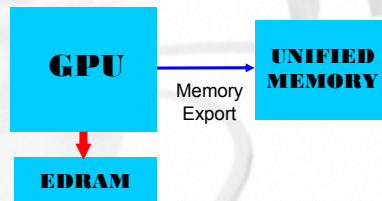
- GPU based vertex and pixel load balancing
 - Better vertex and pixel resource usage
- Union of features
 - E.g. Control flow, indexable constant, ...
- DX9 Shader Model 3.0+



8

Memory Export

- Shader output to a computed address
- Virtualize shader resources - multipass
- Shader debug
- Randomly update data structures from Vertex or Pixel Shader
- Scatter write



9

Texture/Vertex Fetch

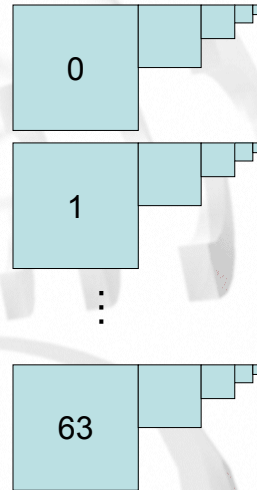
- Shader fetch can be either:
 - Texture fetch (16 units)
 - LOD computation
 - Linear, Bi-linear, Tri-linear Filtering
 - Uses cache optimized for 2D, 3D texture data with varying pixel sizes
 - Unified texture cache
 - Vertex fetch (16 units)
 - Uses cache optimized for vertex-style data



10

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



11

Texture array application : Unique seeds for instanced shading



12

Texture array application : Hundreds of instanced characters



13

Texture compression

- All of the old DXT formats
 - DXT1, DXT2/3, DXT4/5
- Several new formats (variations on above formats)
 - DXT3A
 - 4 bit scalar replicated into four channels in shader
 - DXT3A as 1111
 - 1 bit per channel pixel
 - DXT5A
 - 3bit selection between 2 8bit endpoints
 - DXN
 - 3Dc normal compression,
 - 2-channel version of DXT5A
 - CTX1
 - 2bit selection between 2 8.8bit endpoints



14

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



15

Displaced subdivision surfaces

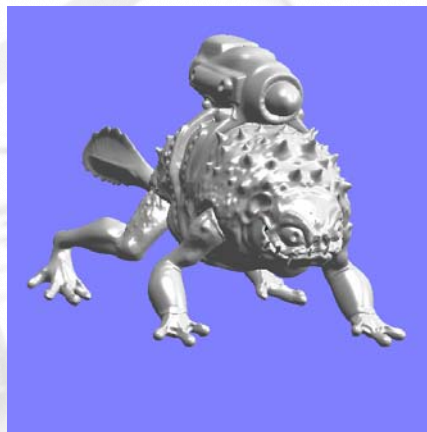


Base mesh

- Used by Tessellator to generate vertices



Subdivision surface



Displaced subdivision surface



16

Questions ?

