Advanced Rendering Technology

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The AR350

Today’s Ray Trace Rendering Processor
Hardware and software solution

Architecture overview
- AR250/350 Rendering Processor

How and why it works
- The ART Model
- Main AR250 Data Flows
- System Architecture
  - RenderDrive Network Appliance
- Software
  - Software architecture
  - Rendering core
  - RenderMan compliant interface
- Silicon roadmap

AR350 Rendering Processor

- Pipeline-parallel ray geometry engine
- Programmable shading co-processor
- Ray generation & control (CPU)
- On-chip data caches
- Host bus interface

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Problems with Parallelism

- Data distribution
- Load balancing
- Scalability of calculation
- Complexity

The ART Model

- Hardware intersection pipeline
- Ray-parallel data distribution
- Broadcast parallelism of geometry
- Hierarchical geometry
- Distributed concurrent shading
- Vector parallel programmable shading acceleration
### Main AR350 Data Flows

- **DRAM**
- Pipeline-parallel ray geometry engine (permutes multiple geometry and rays)
- Hierarchical geometry
- Programmable shading co-processor
- Ray generation & control (CPU)
- Geometry & shaders
- Pixels
- Host bus interface
- Geometry and shaders (broadcast)
- Pixels (sequential read-back)
- Additional AR350 processor cores
- Fine grain distribution of rays between AR250s for load balancing

### AR350 Statistics

- 0.22um drawn, Texas Instruments silicon process
- 1.8M gates, 110mm² die
- Custom RISC processor core
- 64, single-stage, 32 bit IEEE compatible floating-point units
- Multi-dimensional noise, square root and trig. Functions
RenderDrive Network Appliance

- 3D Workstation
  - 3D Application
  - RenderPipe
- RenderDrive
  - Flash memory
  - Boot disk
  - Embedded OS
  - RenderMan compliant renderer
  - CPU / Motherboard
  - AR350s x 40

LAN
- Internet
  - Images
    - Compressed RenderMan protocol
    - HTML job control
    - TCP / IP

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Software Architecture

- 3D Application
  - Scene
  - Texture files
- RenderPipe Plug-in
  - RenderMan function calls
    - Network layer
      - Compression
  - Network layer
  - Compression
  - AR350s
  - Shaders
    - Geometry
    - Rays
    - Render
    - Texture files, etc

TCP / IP (RM Calls + extensions)

Host

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Rendering Core

- Parallel Ray Tracer
- Regular Algorithms
- Physically Accurate
- Floating Point throughout
- Large geometry and image handling
- 9+M triangles, 16K line images
- Robust!

Rendering Core Features

- High quality lighting & anti-aliasing
- True Camera and Object Motion Blur
- True Depth of Field
- Diffuse Reflection & Refraction
- Area Lights (true soft shadows)
- Programmable Shading (RenderMan S. L.)
- Displacement Shading
- Volumes
- Camera shaders & Lens effects
**RenderMan Compliant Interface**

- Support RenderMan Shading Language
  - C like programming language
  - Total flexibility
  - Surfaces, Volumes, Lights & Cameras

- Directly support all standard geometry types
  - Polygons, Patches, NURBS, Primitives

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**Silicon Roadmap**

(Current Generation 1.8M gates at 0.22um)

- Next generation (AR450) probably at 0.13um
  - Major architectural evolution
  - Same functionality, greater performance

- IP for real time consumer
  - Silicon core and firmware components
    - Full Programmable Shading
    - Visibility Engine
  - Enabling Technologies