NVIDIA indeX™ - Leveraging GPU Compute for Interactive Large-scale Data Visualization

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NVIDIA indeX - Scalable Large-Scale Data Visualization at Interactive Frame Rates

- Distributed rendering on GPU clusters
  - Supports today’s and tomorrow’s large-scale data

- Rendering performance
  - 260 GB seismic volume
  - 14 cluster nodes
  - 4 Tesla K10 per machine
  - 13 frames per second
Visual Quality and Accuracy

- Visualization at original data resolution
- Depth-correct rendering of transparent geometry
  - Example: triangle geometry embedded into volume data
Sort-Last Approach for Scalable Rendering

- Object-space subdivision of large-scale data into smaller subcubes
- Parallel, distributed rendering on GPU cluster
Distributed Rendering Process
Performance and Scalability

**Dataset**
- 80 GB volume, top view

**Cluster**
- 4 Tesla K10 per cluster machine
NVIDIA indeX - Software Architecture

- **Extensibility**
  - User-defined components
  - Intellectual property separation

- **NVIDIA DiCE**
  - Platform for writing parallelized and distributed high-performance computing applications
  - Provides networking infrastructure (UDP, TCP, InfiniBand, RDMA)
  - Scales to large cluster sizes (GPU/CPU)
  - Next talk in this session
Interactive Attribute Generation for Instantaneous Visualization

▪ Applications
  – Weather simulations for atmospheric dynamics visualization
  – Seismic attribute generation for survey visualization

▪ Requirements
  – Raw $n$-dimensional data is huge compared to generated attributes
  – Process raw data using user-defined compute algorithms
    ▪ Plethora of possible attribute types
    ▪ Must support algorithm-specific data subdivision schemes
  – Interactive parameterization with instantaneous updates
Proxy Shapes for Attribute Generation

- Proxy shapes
  - Slices
  - Triangle surfaces
  - Volumes

- Part of the scene description

- Canvas for attribute visualization
Interface for Attribute Generation

- **User-defined attribute computation**
  - Compute jobs launched per subcube
  - Receives proxy shape intersection
  - May use algorithm-specific subdivision scheme
  - Returns attributes

- **Computed attributes are mapped when rendering proxy shapes**
  - Analogy: procedural texturing
Attribute Data Generation Process and Visualization
GPU Clusters for Combined Compute and Rendering Cycles

- Asynchronous compute maximizes performance
  - Rendering and compute process run in parallel
  - Results integrated into rendering as they become available
Additional Benefits

- Remote visualization
  - H.264 video encoding
  - Hardware-accelerated on Kepler
- Private and public clouds
  - Web-based applications
  - Thin clients (tablets)
- Multi-user support for world-wide collaboration
Demo

- GPU cluster located in Berlin, Germany
  - 8 cluster nodes, each with 2 Tesla M2090
  - 82 GB volume
  - Seismic horizon with 250 million triangles
  - H.264 video streaming
Thank you...

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