Accelerating Realism with the (NVIDIA Scene Graph)

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SIGGRAPH 2009 presentation
NVIDIA® application acceleration engines ("AXE")

**NVIDIA® SceniX™** was NVSG
The NVIDIA Scene Graph (with Cg 2.2), powering the world’s most demanding real-time applications

**NVIDIA® CompleX™** was NVScale
Making massive data sets interactive, greatly rising the ceiling for frame buffer memory

**NVIDIA® OptiX™** was NVIRT
Interactive GPU ray tracing, taking interactive realism to a new level

**NVIDIA® CgFX™**
Meta language and runtime approach, taking programmable shading and material development to the next level.

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customer examples courtesy of Autodesk Showcase, RTT, Mercedes Benz
AXE – Engine Relationships: Initial

AXE Connections

CgFX API

AXE Center

CgFX OpenGL

SceniX scene management engine

Custom Applications

AXE Reach

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AXE Connections

- CgFX API
- QB Stereo API
- 30-bit & SDI API

AXE Center

- CgFX OpenGL
- SceniX scene management engine
- Quadro HW Features
- 30-bit, SDI

AXE Reach

- Custom Applications

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AXE – Engine Relationships: Today

AXE Connections
- CgFX API
- QB Stereo API
- 30-bit & SDI API

AXE Center
- SceniX scene management engine
- CgFX OpenGL
- Quadro HW Features
- QB Stereo
- 30-bit, SDI
- OptiX Ray Tracing
- Scene Scaling Complex

AXE Flexibility
- OptiX ray tracing engine
- ComplexX scene scaling engine

AXE Reach
- Non-Graphic Applications
- Custom Applications
- Open SceneGraph
- Other Scene Graphs

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SceniX (NVIDIA Scene Graph)  
the fastest route to a high performance 3D app

Created by NVIDIA for software developers, to speed the creation of high performance 3D applications that exploit the latest GPU and OpenGL capabilities, by providing:

- A solid, free-to-use, cross-platform foundation for creating 3D App’s
- The latest CgFX support for maximum rendering options and quality
- Constant speed improvements in scene management & rendering
- Freely available for building your interactive applications
SceniX 5 - Built-in support for latest NVIDIA features and products

Cg 2.2
Superior rendering and performance

10-bit color, SDI i/o
Support for demanding color and video markets

3D Vision
High end 3D stereo support for immersive and desktop systems

MetaSL
Support for sharing mental mill® shaders between renderers & applications

CompleX and (soon) OptiX
Built-in support for massive scenes via GPU distribution and interactive GPU ray tracing (later this year)
SceniX Software Stack

Loader & Saver Plug-ins → 3D Application → SceniX → Cg/Runtime → OpenGL / Ray Tracing → GPU

CUDA → Acceleration Engines
Support of Different Render Targets

SceniX allows different render targets to achieve different effects, like:

- Framebuffer (direct output)
- FBO (e.g. Re-use the FBO for reflections or shadowmaps)
- 2D Overlay (e.g. For menus and GUI elements)
- Ray Tracing (high quality shadow, reflections and refractions)
- Broadcast Graphics Hardware (GVO / SDI)
- Transform Feedback (e.g. HW accelerated skinning)
Ray tracing render area needs to provide the output buffer for the ray tracing engine and a mechanism to present the final image on the screen.

The ray tracing traverser is responsible for sending the information contained in the scene graph to the ray tracing engine.
SceniX supports multipass rendering for a wide range of multipass algorithms such as:

- Depth of Field
- Order Independent Transparency
- FSAA
- Stereo (implementation dependent)
- And many more
Maximum FSAA Quality

MPAA: Combine HW FSAA with Software controlled FSAA to get benefits from both worlds:
maintain speed and quality
Stereo Support

SceniX offers ways to support different kinds of stereo formats:
- Active Stereo – Quad-buffered stereo
- Passive Stereo – Render left and right eye and compose final image

Support for different Stereo solutions:
- Interlaced stereo
- Red/Cyan
- Custom
Skinning Support

Usage of skinning processors
- CPU Skinning Processor
- GPU skinning Processor
  - Hardware accelerated skinning
  - Minimal requirement: Shader Model 4
- Future: CUDA skinning
Skinning Processors

- **CPU Skinning** – data needs to be moved from system memory to video memory on a frame by frame basis

- **GPU Skinning** – data can reside and manipulated on the graphics board
Shading – Cg/CgFX

Cg/CgFX developed for developers and artists to make the material definition easier and more effective. Special effects can we written in a special effect file format which directly links into the Cg runtime for easy parameter and tweakable handling.

- Cross platform and API-independent
- GPU Shading language inspired by C
- Exposing latest HW features
- Part of 3D content creation tool chains - professional apps and games

Write your shaders in Cg/CgFX and deploy them to any API or platform
Cg software stack

- Cg Compiler
- Cg Run-time API
- 3D API interface: CgGL or CgD3D
- 3D Application or Game
- OpenGL or Direct3D
- Graphics Processing Unit (GPU)
Shader Authoring Tool Integration

- Shader authoring tools
- FXComposer
- mental mill

- Visual programming
- Drag & Drop
- Debugging
MetaSL support with SceniX

- MetaSL will be translated to a valid CgFX shader
- The translated CgFX can use the whole Cg framework in SceniX
Demo – SceniX + Material

- Sample Viewer created with SceniX
- OpenGL with CgFX material handling
NVIDIA® CompleX™ scene scaling engine busting through the 4GB ceiling

CompleX makes massive scenes interactive by easily integrating with OpenGL applications for fully leveraging the memory and performance across Quadro Plex GPUs

- Automatically distributes the geometry load across GPUs and composites a seamless end result
- Can leverage up to 8 GPUs and **32 GB** of memory; using 4 Quadro Plex D2 or 2 Quadro Plex S4 systems
- Direct support for SceniX, OpenSceneGraph and (soon) Open Inventor
- CompleX SDK for custom integration with *any* OpenGL scene graph
- "Developer Mode" works with any two matching Quadro FX boards
CompleX SDK - Compositor

Image compositor for sort-first & sort-last based applications
- Screen tiling, alpha and depth based compositing approaches
- Platforms: Win 64, Linux 64
- Compositor implementation based on latest technologies, minimal migration effort for applications

Screen Tiling

Depth Compositing

Alpha Compositing
Distributed rendering with SceniX

**GLDistributedRenderArea**
- Clients must derive from this and integrate with windowing system
- Optionally select GPUs to be used
- Uses MGPUSDK for image composition

**DistributionTraverser**
- Assigns GPUs to handle scene graph objects based on distribution scheme
- Distribution scheme assigns objects to optimally balance load on GPUs

**GLDistributedTraverser**
- Multiple instances (one per GPU)
- Instances run in parallel
- Each instance only renders objects assigned to its GPU
- Triggers image composition when ready
Demo Video – SceniX & CompleX

- Massive Dataset Rendering
  - Geometry data
  - Volume data
NVIDIA® OptiX™ ray tracing engine elevating interactive realism

- Programmable GPU ray tracing via a C-based SDK, akin to a programmable graphics pipeline (e.g., OpenGL)
- Easy adoption of GPU ray tracing for Application developers
- Transparent exploitation of future GPU advances
- Easily paired with GPU raster rendering for +speed
- OptiX: interactivity physically correct: mental images
Basic Structure of a Ray Tracing Render Area in SceniX

- Render Area creates e.g. OpenGL output
- RayTracingTraverser
  - Creates an RT-Outputbuffer
  - Traverses the scene graph
  - OptiX ray traces via CUDA into the RTOutputbuffer
  - Maps to OpenGL Output
Shader Types

Shader Domain scene-wide
- RayGenerationPrograms
- ExceptionPrograms
- MissPrograms

Shader Domain local
- IntersectionPrograms
- BoundingBoxPrograms
- AnyHitPrograms
- ClosestHitPrograms
Scene Layout

nvsg::Scene

nvsg::RTFxSceneAttribute

nvsg::Group

nvsg::GeoNode

nvsg::PrimitiveSet

nvsg::StateSet

This RTFx will apply to this PrimitiveSet

RTFxSceneAttribute will apply to the entire scene.

Other StateAttributes

nvsg::RTFx
Demo Video – SceniX & OptiX

- SceniX/OptiX based Path Tracer
- Global illumination
- Progressive refinement of the final image for photo quality
- Art Path: 3ds Max & Maya – Collada – SceniX/OptiX
Thanks!