Introduction to Open Scene Graph

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What is Open Scene Graph?

- Designed for real-time scene rendering
  - Uses a scene graph to manage world database;
  - and multiprocessing to improve performance;
- Multi platform (at the moment IRIX, Linux, Windows, FreeBSD, Mac OSX, Solaris, HP-UX and even PlayStation2)
- C++ API (Java and Python bindings available too);
- Built on industry standard OpenGL library (supports direct calls to OpenGL where necessary);

What is Open Scene Graph?

- Open Source with a large and active community
- Makes Use Of STL and Design Patterns
- Easy to develop plug-ins - lots of them available, esp. loaders
- Supports modern graphic cards features through support of OpenGL Shader Language
- All information and documentation on http://www.openscenegraph.org/

A few examples

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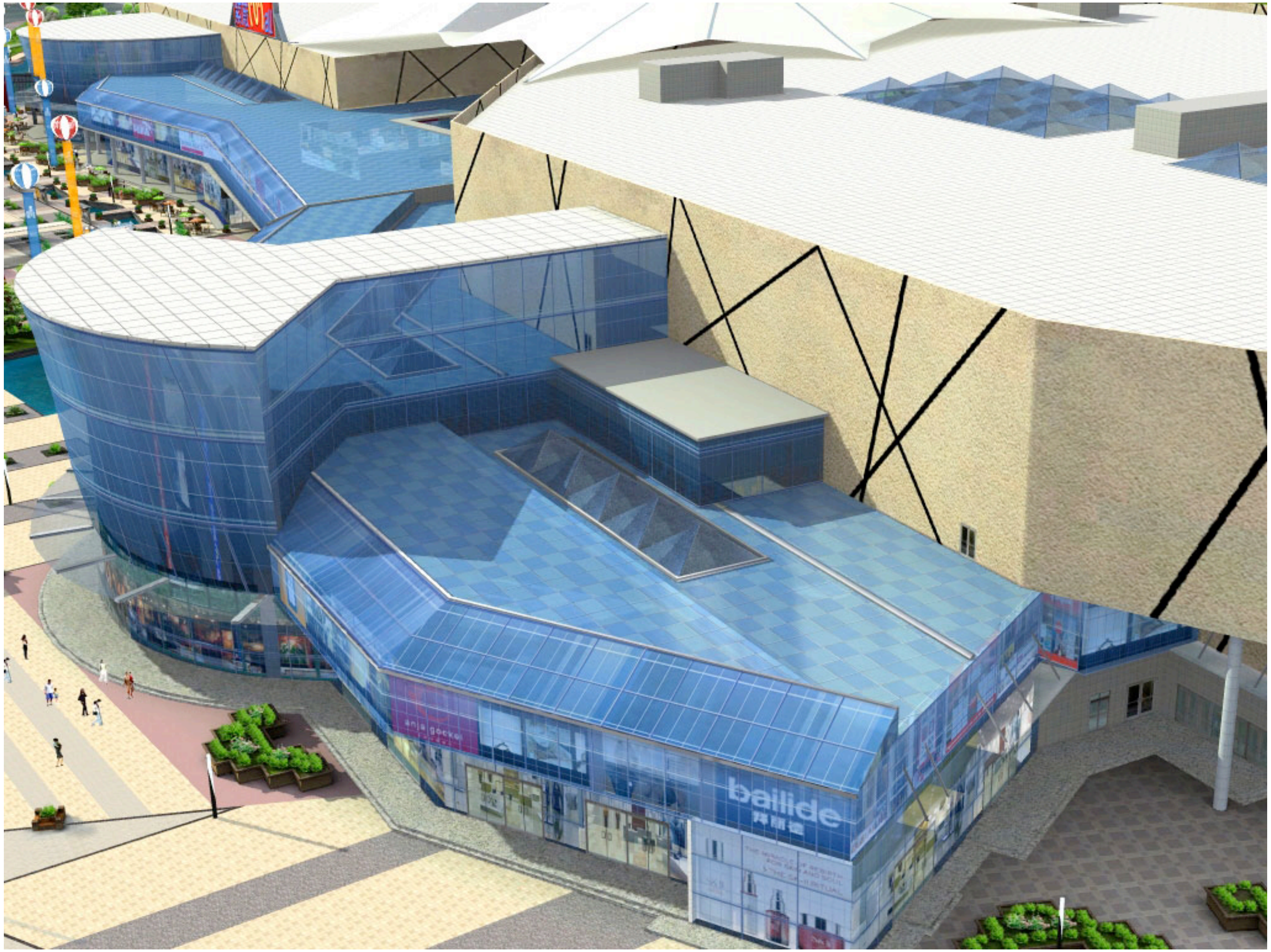


What is in it? – The libraries (1)

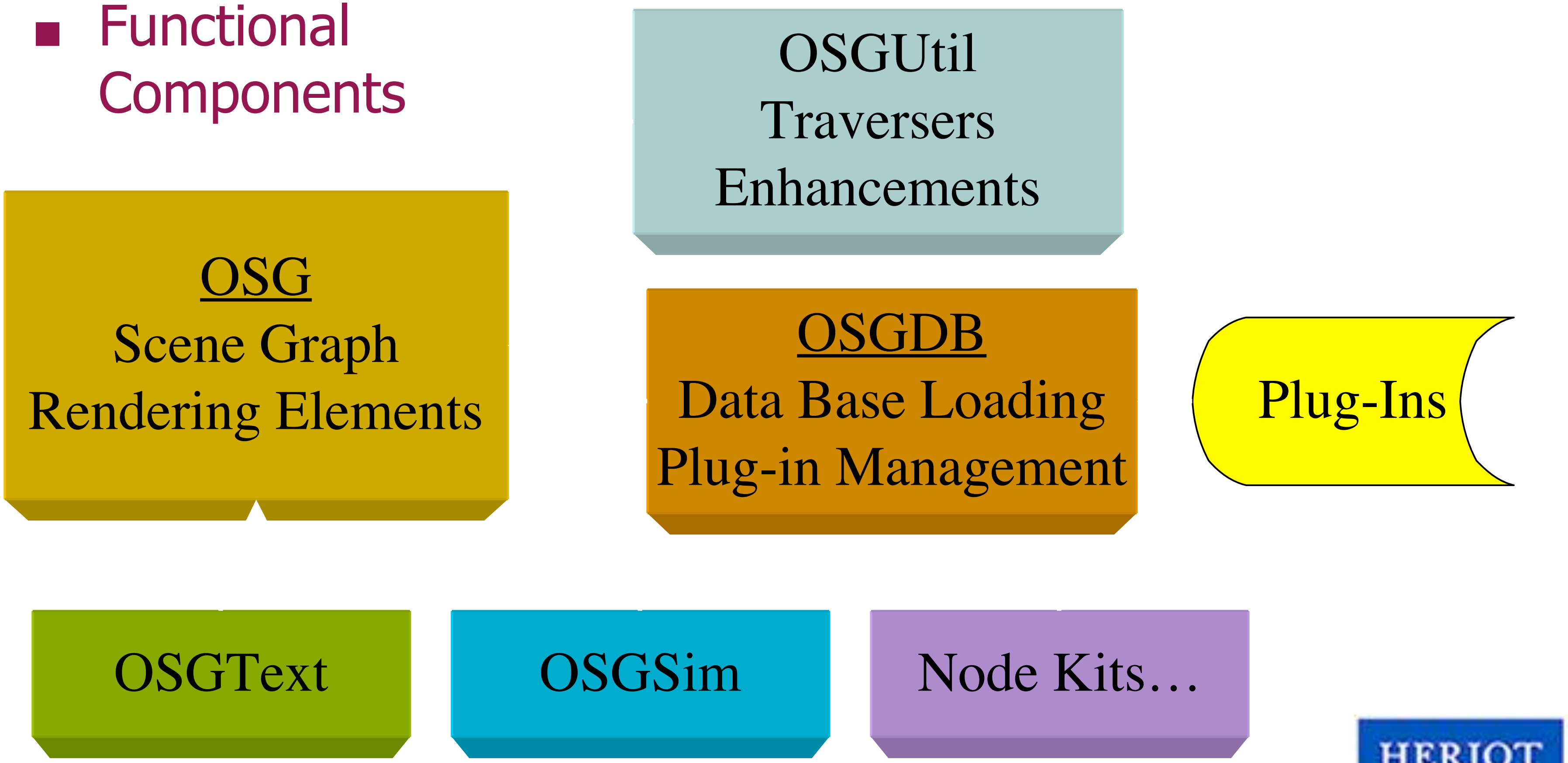
- osg - Core scene graph
- osgUtil - Utility library for useful operations and traversers
- osgDB – Database reading and writing library
- osgFX – Special effects framework Nodekit
- osgText - NodeKit which add support for TrueType text rendering

What is in it? – The libraries (2)

- osgParticle - NodeKit which adds support for particle systems
- osgTerrain – Terrain generation Nodekit
- osgSim – Visual simulation Nodekit
- osgGA - GUI abstraction library
- osgProducer - viewer library integrating OSG with producer

What is OpenSceneGraph?

- Functional Components



OSGUtil
Traversers
Enhancements

OSG
Scene Graph
Rendering Elements

OSGDB
Data Base Loading
Plug-in Management

Plug-Ins

OSGText

OSGSim

Node Kits…

Namespaces

- Every of the libraries has its own namespace (e.g. osg, osgDB, osgFX, etc.)
- Classes are either referenced including namespace (using scope operator, e.g. osg::Group)
- or without namespace, with additional “using namespace *** ” line (e.g. using namespace osg;)

Core OSG library

- Helper classes - *memory management, maths classes*
- osg::Nodes - *the internal nodes in the scene graph*
- osg::Drawables - *the leaves of the scene graph which can be drawn*
- osg::State* - *the classes which encapsulate OpenGL state*
- Traversers/visitors - *classes for traversing and operations on the scene*

The structure of a scene graph

- osg::Group at the top containing the whole graph
- osg::Groups, LOD's, Transform, Switches in the middle
- osg::Geode/Billboard Nodes are the leaf nodes, which contain:
- osg::Drawables which are leaves that contain the geometry and can be drawn.
- osg::StateSets attached to Nodes and Drawables, state inherits from parents only.

Group nodes

- osg::Group - Branch node, which may have children, also normally top-node
- osg::Transform – Transformation of children
- osg::LOD - Level-of-detail selection node
- osg::Switch - Select among children
- osg::Sequence - Sequenced animation node
- osg::CoordinateSystemNode – defines a coordinateSystem for children
- osg::LightSource – defines a light in the scene
- And many more..

Leaf nodes

- osg::Geode - "geometry node“, a leaf node on the scene graph that can have "renderable things" attached to it.
- In OSG, renderable things are represented by objects from the Drawable class
- so a Geode is a Node whose purpose is grouping Drawables
- it is however NOT a group node
- Other leaf node type osg::Billboard - derived form of osg::Geode that orients its osg::Drawable children to face the eye point.

Drawables

- osg::Drawable itself is a pure virtual class
- everything that can be rendered is implemented as a class derived from osg::Drawable
- A Drawable is NOT a node and cannot be directly added to the scene graph (always through a Geode)
- Like Nodes can be children of several parents, also Drawables can be shared between several Geodes
- the same Drawable (loaded to memory just once) can be used in different parts of the scene graph -> good for performance

Drawable Sub Classes

- osg::Geometry – drawable basic geometry
- osg::ShapeDrawable - allows to draw any type of osg::Shape
- osg::DrawPixels – single pixels
- osgParticle::ParticleSystem – allows to draw a particle system
- osgText::Text – drawable true type text

Drawing basic Geometry

- Drawable osg::Geometry allows drawing basic geometry:
- Assign to it:
  - a vertex array
  - Primitive sets
    - Can be any of the modes POINTS, LINES, LINE_STRIP, LINE_LOOP, TRIANGLES, TRIANGLE_STRIP, TRIANGLE_FAN, QUADS, QUAD_STRIP, POLYGON
    - Direct encapsulation of OpenGL primitives
    - Contains indices of vertices that form the primitive(s)
  - (optional) color, normal and texture coordinate arrays

Shapes

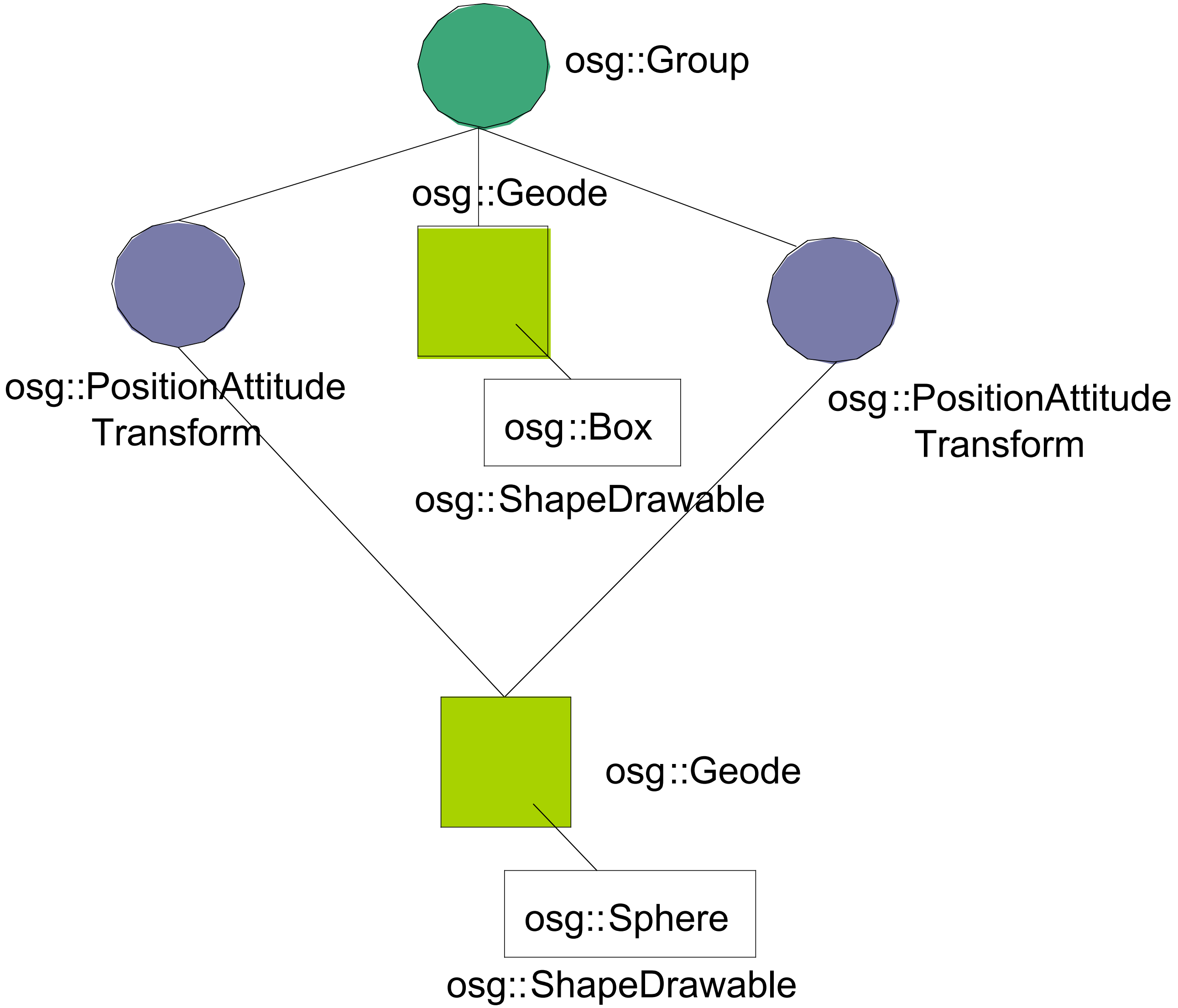
- Pure virtual base class osg::Shape
- Shapes can be used for culling, collision detection, or be drawn via osg::ShapeDrawable
- Some shape sub-classes:
  - osg::Box
  - osg::Sphere
  - osg::Cone
  - osg::Cylinder
  - osg::Capsule
  - osg::InfinitePlane
  - osg::TriangleMesh

Transformations

- Transformation = Translation, Rotatation and Scaling
- Base class osg::Transform provides basic Transformation via 4x4 Matrix
- Often better use more accessible subclasses though
- Most important sub class:
  - osg::PositionAttitudeTransform – sets the coordinate transform via a vec3 position and scale and a quaternion attitude

A simple example scene graph

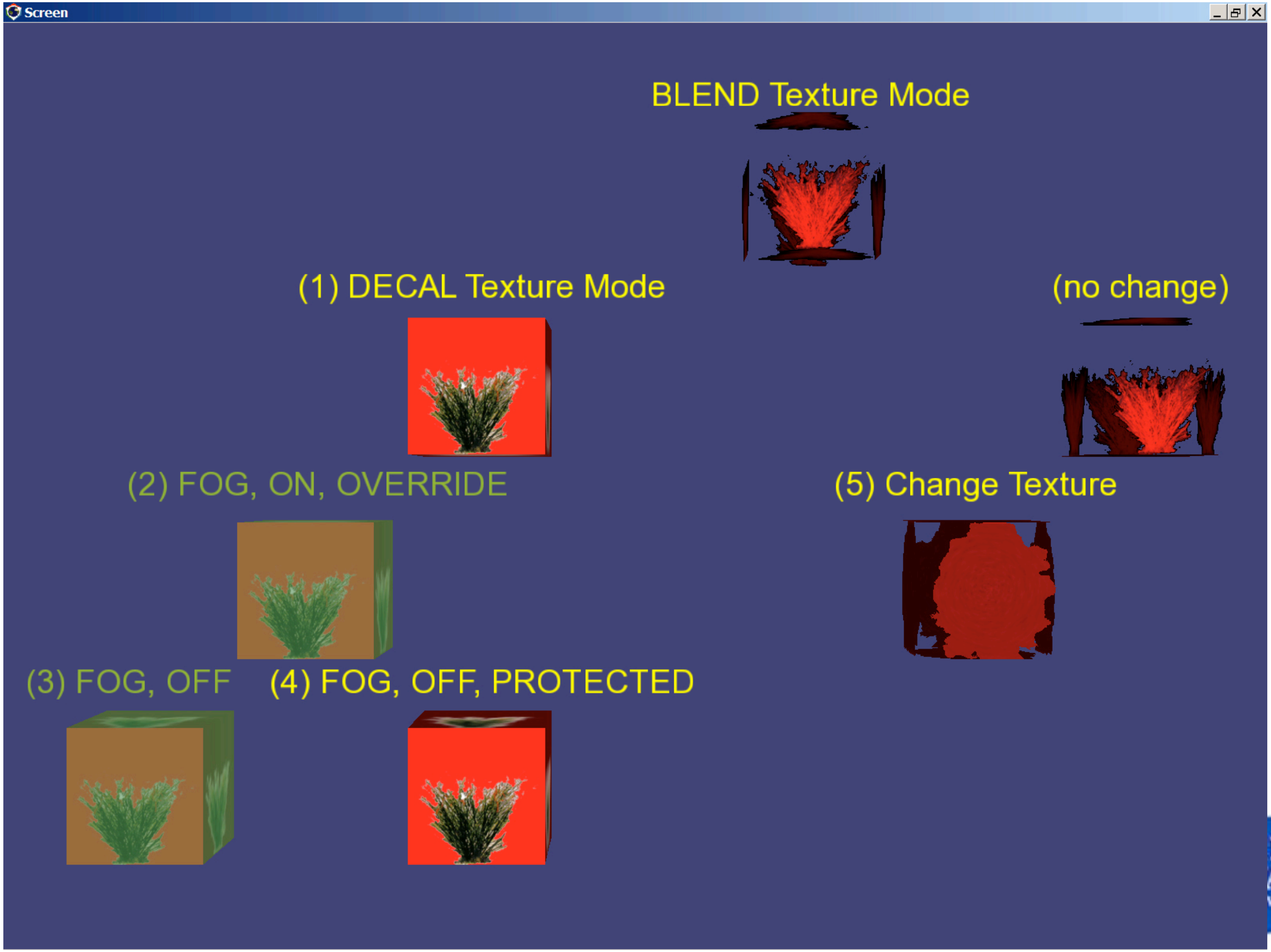
- One box and two spheres



StateSets

- Stores a set of modes and attributes which respresent a set of OpenGL state
- Can be attached to any Node or Drawable
- Defines drawing state for node and it’s subtree
- Drawing state is always inherited from parents, unless it is overridden
- State’s affect the way OpenGL renders, so the appearance of objects
- For example: textures, fog, transparency …

State Set Example



Smart Pointers

- Instead of standard pointers to osg objects, use osg::ref_ptr<> template
- Provides a smart pointer that automatically counts references
- Object is removed from memory if reference count drops to zero
- Similar to Java Garbage collection, helps keeping the memory free and simplifies programming
- Example:
  - Dumb pointer: osg::Group *group1 = new osg::Group();
  - Smart pointer osg::ref_ptr<osg::Group> group1 = new osg::Group();

Third Party Dependencies

- To support multi platform functionality, the open scene graph distribution includes 3rd party libraries:
  - Open Threads for platform independent threads
  - Producer for a platform independent viewer
  - And several file format plugins

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Standard steps

- 1. Create a Producer based viewer
- 2. configure the viewer
- 3. Load or create a scene graph, and associate its top node with the viewer
- 4. (optional) optimize the scene graph
- 5. update the scene
- 6. draw the scene
- 7. Create the simulation loop, which loops between 5. and 6.

The simulation loop

- Three main steps:
  - Update the scene, e.g location of an object
    - It may be moving
  - Update the camera, e.g. zoom in on scene
    - The position of the user for example
    - May require interaction with input devices
    - Normally just the viewer’s update method is called, standard viewer already implements basic mouse camera control
    - non-standard interaction (i.e. other input devices, 1st person cam, etc.) would ideally be implemented in a customized viewer class
  - Redraw the frame

Importing 3d-Models

- osgDB library responsible for reading/loading 3d-model-files
- File format plug-ins (loaders) are registered with osgDB
- In your application, no matter which supported file format always use the same function osgDB::readNodeFile, file extension tells osgDB, which loader to use
- Function returns an osg::Group pointer
- Best file format to use: osg’s native format *.osg
- Can quickly save any scene graph in a *.osg file with: osgDB::writeNodeFile

Importing VRML

- VRML loading is handled by Inventor plug-in
- Not part of standard Open Scene Graph distribution, need to compile and register first
- Easier way: use 3D Studio Max to convert wrl file to 3ds file
- 3ds files can be loaded by standard osg distribution
- Whichever way is used, not all VRML is imported, because not everything in a VRML file belongs in a scene graph (e.g. scripts, animations)

Optimization

- You can optimize the scene graph to improve performance
- Use osgUtil::Optimizer
- Makes especially sense for huge loaded models
- Optimization will rearrange scene graph, don't optimize parts, that you want to modify at runtime, scene graph structure might change
- How can a scene graph be optimized:
  - By removing redundant nodes
  - By minimizing state changes
  - By using more efficient geom. Primitives (e.g. tristrips)
  - …

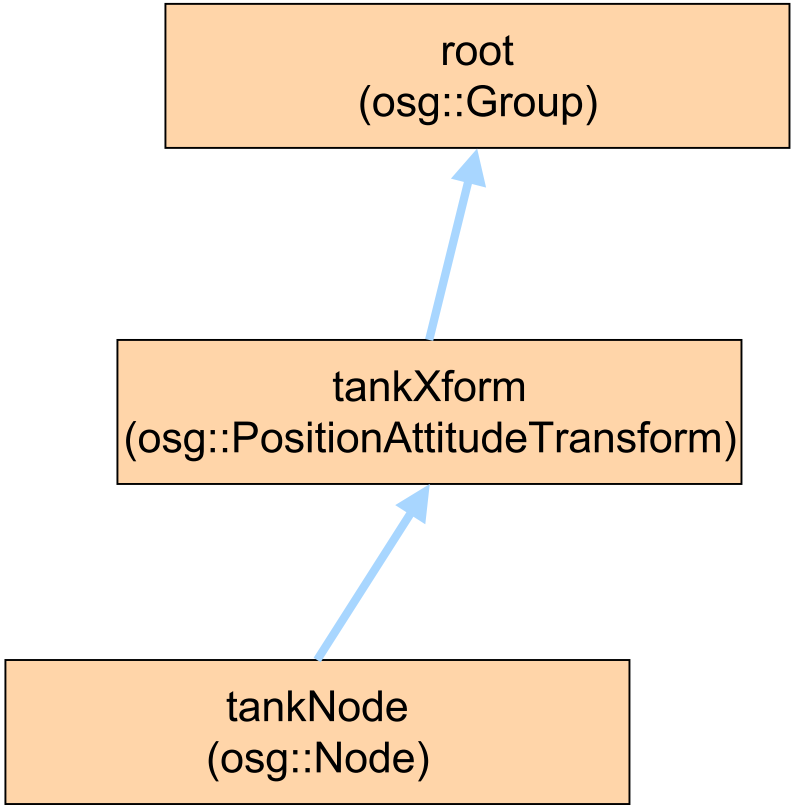
Examples

- Jason McVeigh's OpenSceneGraph Tutorial Set.
- http://openscenegraph.org/documentation/NPSTutorials/

Example 1

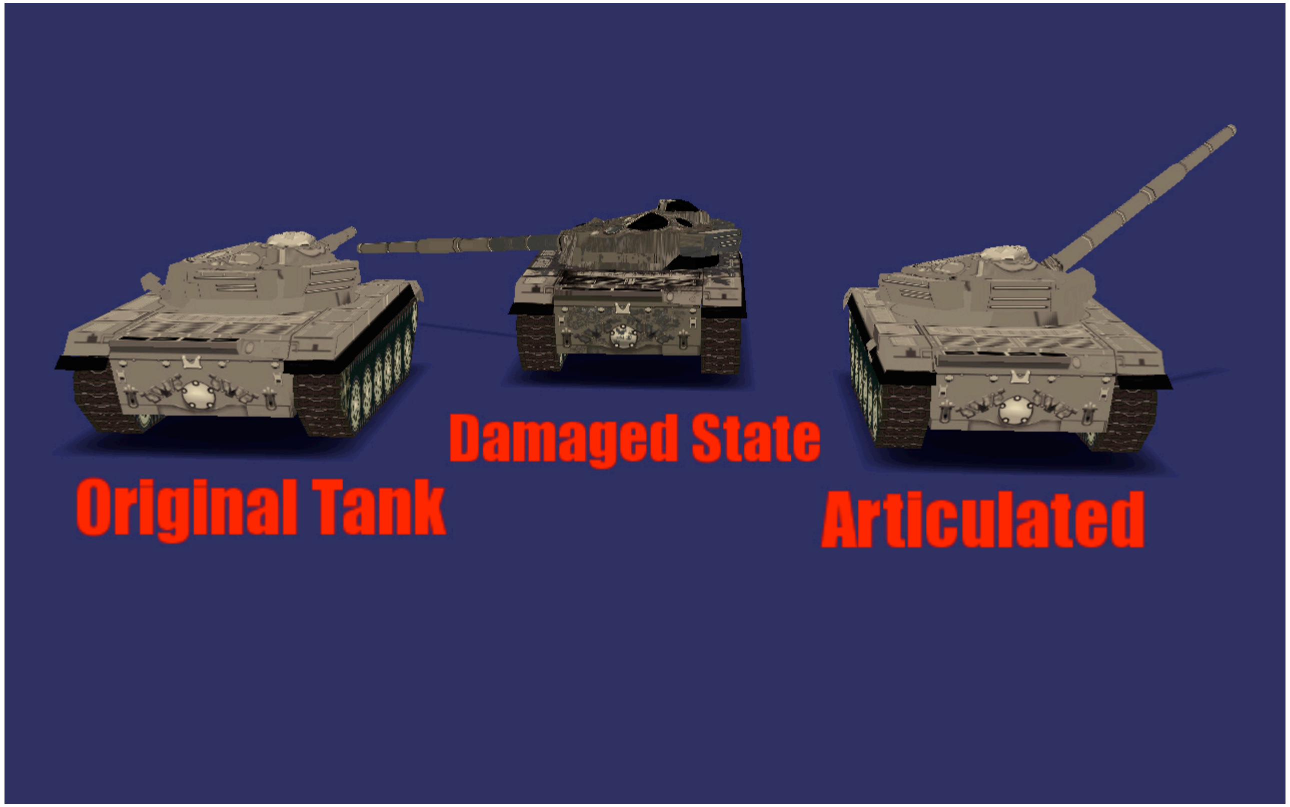
- Loading geometric models from files and positioning them in a scene

Example 1

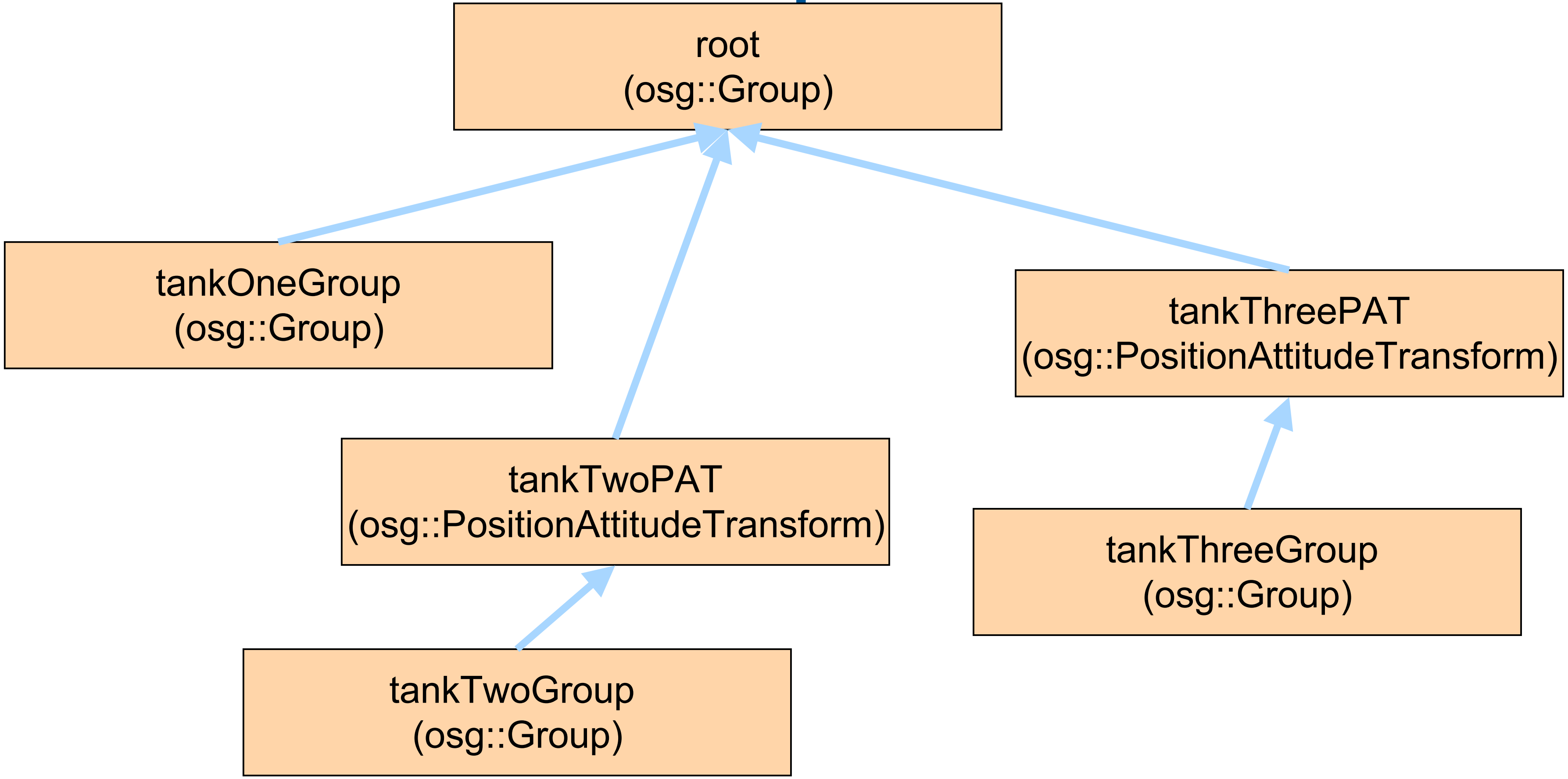

root
(osg::Group)
tankXform
(osg::PositionAttitudeTransform)
tankNode
(osg::Node)

Example 2

- Finding named nodes, updating DOF and switch nodes



Example 2



root
(osg::Group)

tankOneGroup
(osg::Group)

tankTwoPAT
(osg::PositionAttitudeTransform)

tankTwoGroup
(osg::Group)

tankThreePAT
(osg::PositionAttitudeTransform)

tankThreeGroup
(osg::Group)

Example 3

- Using an update callback to articulate a node within a scene

Articulate tank using a Callback

Example 4

- Manually positioning a camera
  1. Create and initialize a matrix with the correct world position and orientation.
  2. Get the inverse of this matrix and …
  3. Provide a world up orientation. In this case by rotating from ‘Y’ up to ‘Z’ up.

Example 5

- Using tracking devices

Available Resources

- www.openscenegraph.org
- OpenSceneGraphReferenceDocs.zip
- Tutorials
- Examples
- Source Code
- Mailing List Archives