Introduction to jMonkeyEngine

What is jMonkeyEngine?

A jME Application

Scene graphs

Coordinate systems

What is jMonkeyEngine?

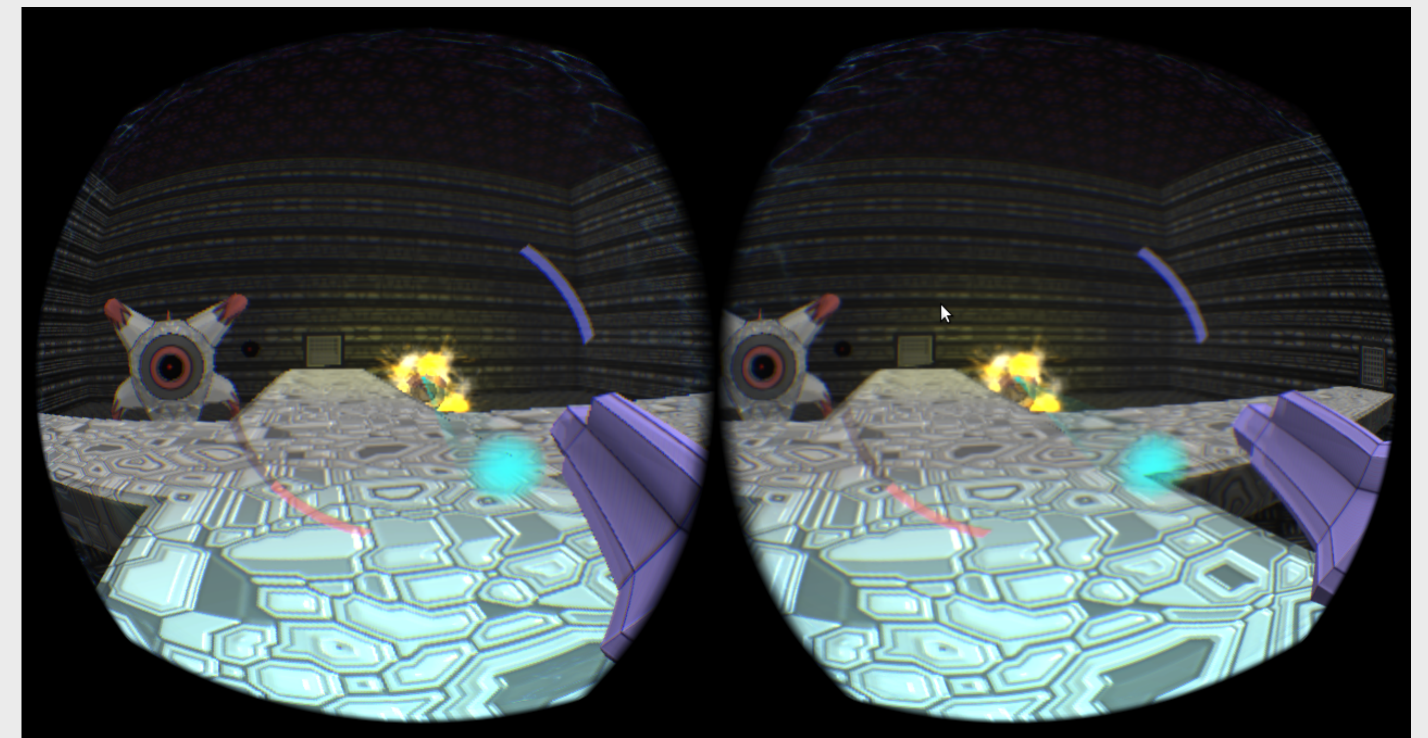
- jME is a game engine made for developers who want to create 3D games and other visualisation applications following modern technology standards
- Uses Java and is platform independent. Can deploy to Windows, Mac, Linux, Android and iOS.
- OpenSource, non-profit, New BSD License

Features of jMonkeyEngine

- Has integrated tools to make it easier to create games and applications
  - Physics integration
  - Special effects (pre/post processing, particles)
  - Terrain-, Vegetation-, Water-systems++
  - Graphical User Interface
  - Networking

Showcase

- http://www.youtube.com/watch?v=eRC9FDin5dA&feature=player_embedded
- http://jmonkeyengine.org/showcase/



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Why use a high level API?

- Faster development process
- Not necessary to reinvent the wheel
- Provides abstraction from the low level:
  - *Think Objects*…. Not vertices
  - *Think content*… not rendering process.
- Not necessary to tell when to draw, just tell what to draw
  - Retained mode
- This does not mean you do not need to understand what is going on underneath
- This is a programming course

What does jME do?

- Uses OpenGL, and features a modern shader based architecture (GLSL)
- Organises your scene with a scene graph data structure
- Transformations and mathematics
- jME performs rendering optimisations
  - View frustum culling
  - State sorting
  - Batching
- jME is single threaded
- jME is NOT thread safe. Only modify the scenegraph from the rendering thread.

Applications of jME

- Games
- Education
- Scientific visualisation
- Information visualisation
- Geographic Information Systems (GIS)
- Computer-aided design(CAD)
- Animation

Getting started

- Software:
  - Java 6 or later
  - Latest version of jME3 SDK
  - LWJGL for communicating with OpenGL
  - Latest version of graphics drivers
- Hardware:
  - Hardware-accelerated graphics card required
    - Must support OpenGL 2 or newer
    - Must support GLSL (shader)
- Note: Do not use earlier versions of jME (< 3.0)

Getting started

- Documentation:
  - Website: http://jmonkeyengine.org/
  - Wiki: http://wiki.jmonkeyengine.org/doku.php/jme3
  - Books:
    - jMonkeyEngine 3.0 Beginner’s Guide
    - jMonkeyEngine 3.0 Cookbook

Development environment

- jME SDK
  - Built on top of Netbeans IDE
  - Aims to be similar to editor environments like the UDK
- Other IDE's
  - Netbeans
  - IntelliJ
  - Eclipse
  - …
  - Text editor + command line

- Use the IDE of your choice

A jME application

SimpleApplication

- The base for most jME applications
- Gives you access to standard game features such as
  - scene graph (rootNode)
  - an asset manager
  - a user interface (guiNode)
  - input manager
  - fly-by camera

SimpleApplication

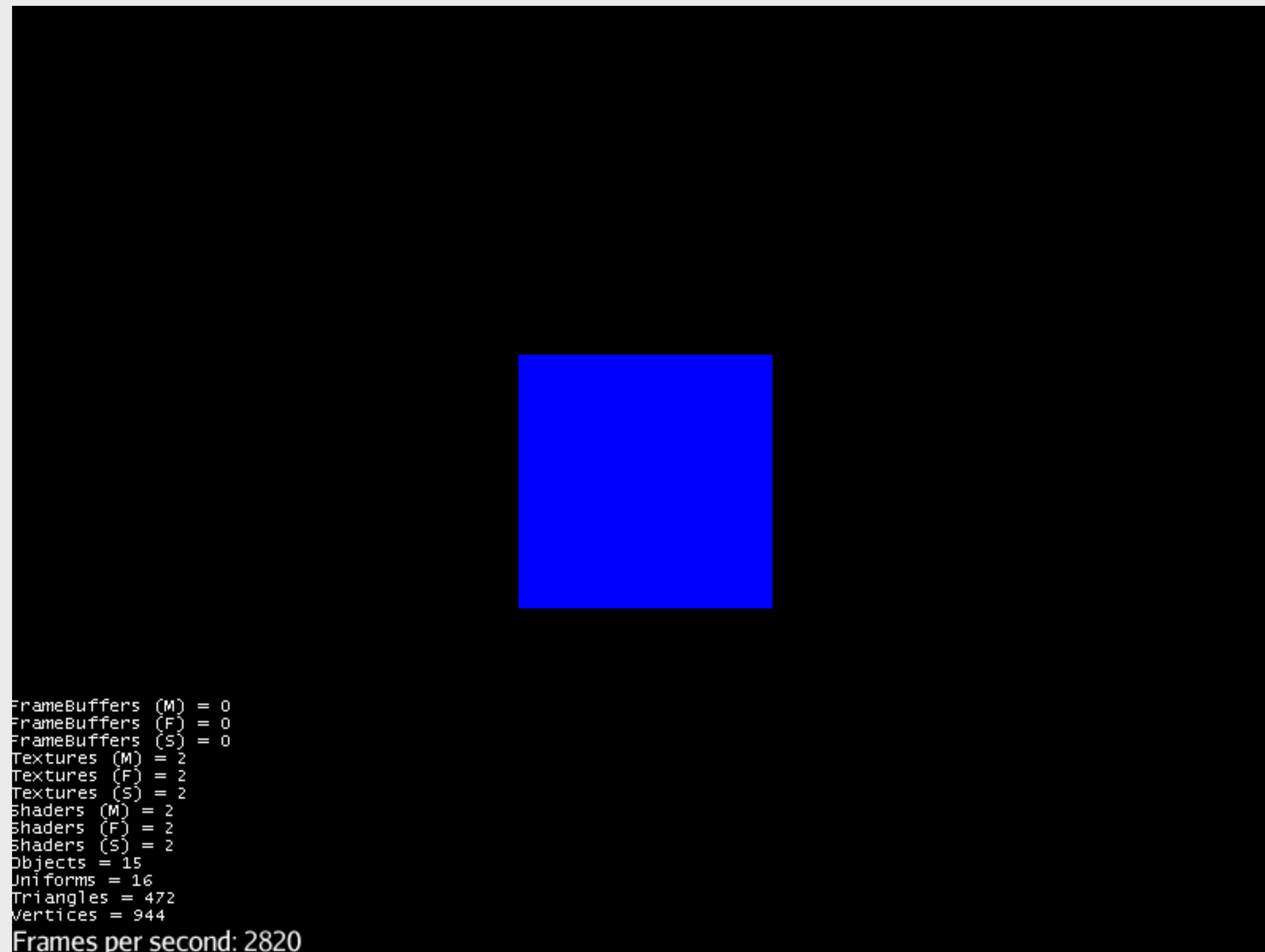
- You should inherit from SimpleApplication
- You initialise your data by overriding

```
public void simpleInitApp()
```

- You have to add your subgraph to the rootNode to make it visible
- Get a callback in the rendering thread by overriding

```
public void simpleUpdate(float tpf)
```

Hello World



Hello3D.java

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Bypassing SimpleApplication

- It is possible
- You lose functionality
- Only necessary if you have specific requirements
- You can unload everything added by SimpleApplication
- "Simple" means nothing more than necessary

Scene graphs

What is a scene graph

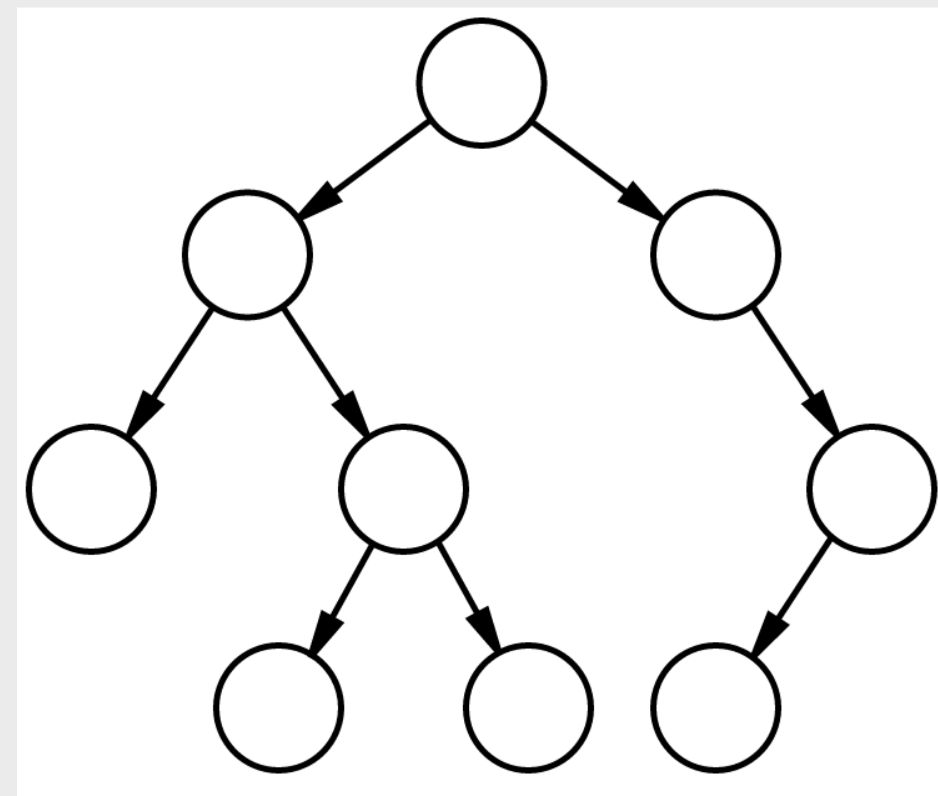
Scene graphs in jME

What is a scene graph

- A data structure containing all the data needed to render the scene
- More specifically it is a tree data structure
- Commonly used in 3D applications and vector based graphics

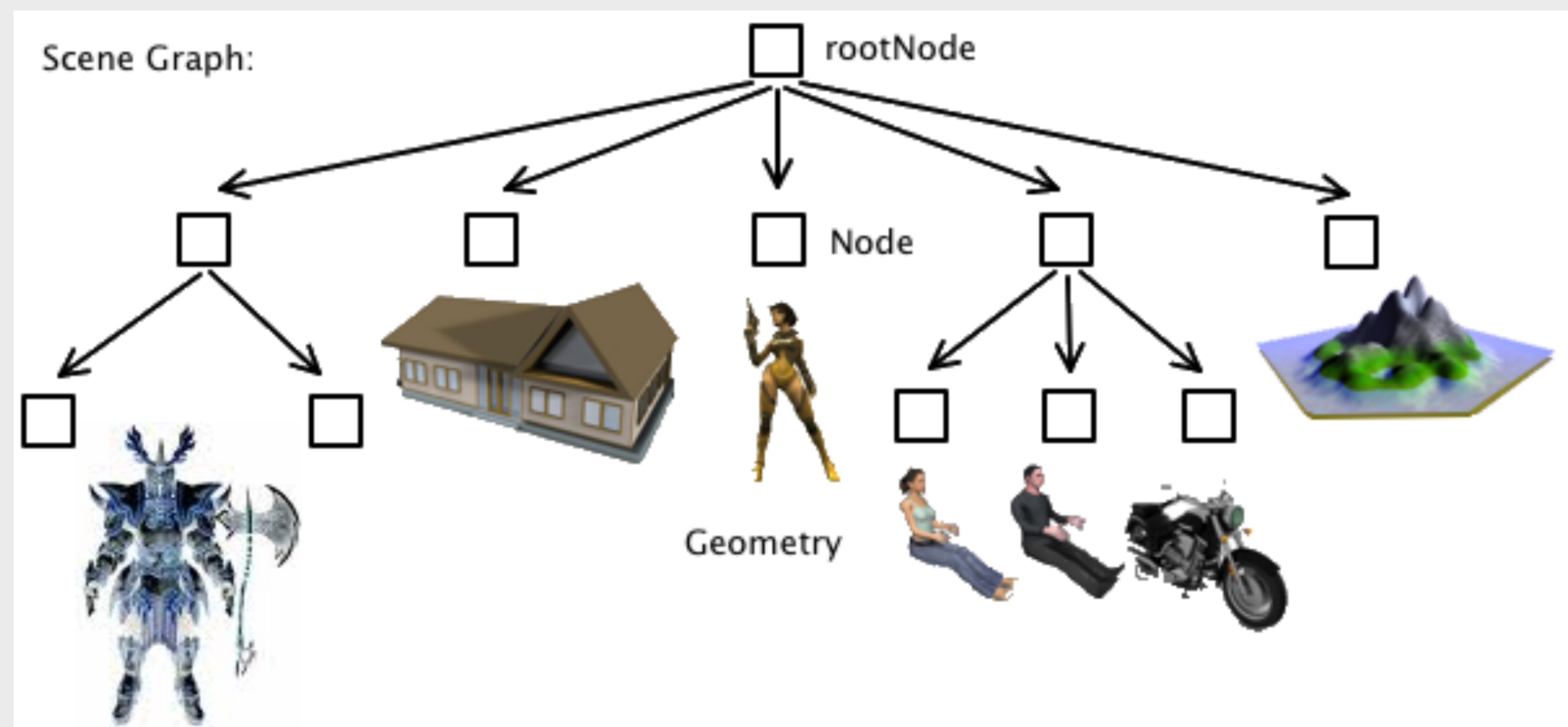
What is a scene graph

- jME renders the scene graph automatically to the screen
- If you want something visible, add it to the graph
- A scene graph is a transform hierarchy
- Two types of nodes:
  - Group nodes
  - Leaft nodes
- All nodes contains:
  - Transform
  - Parent
  - (Children)



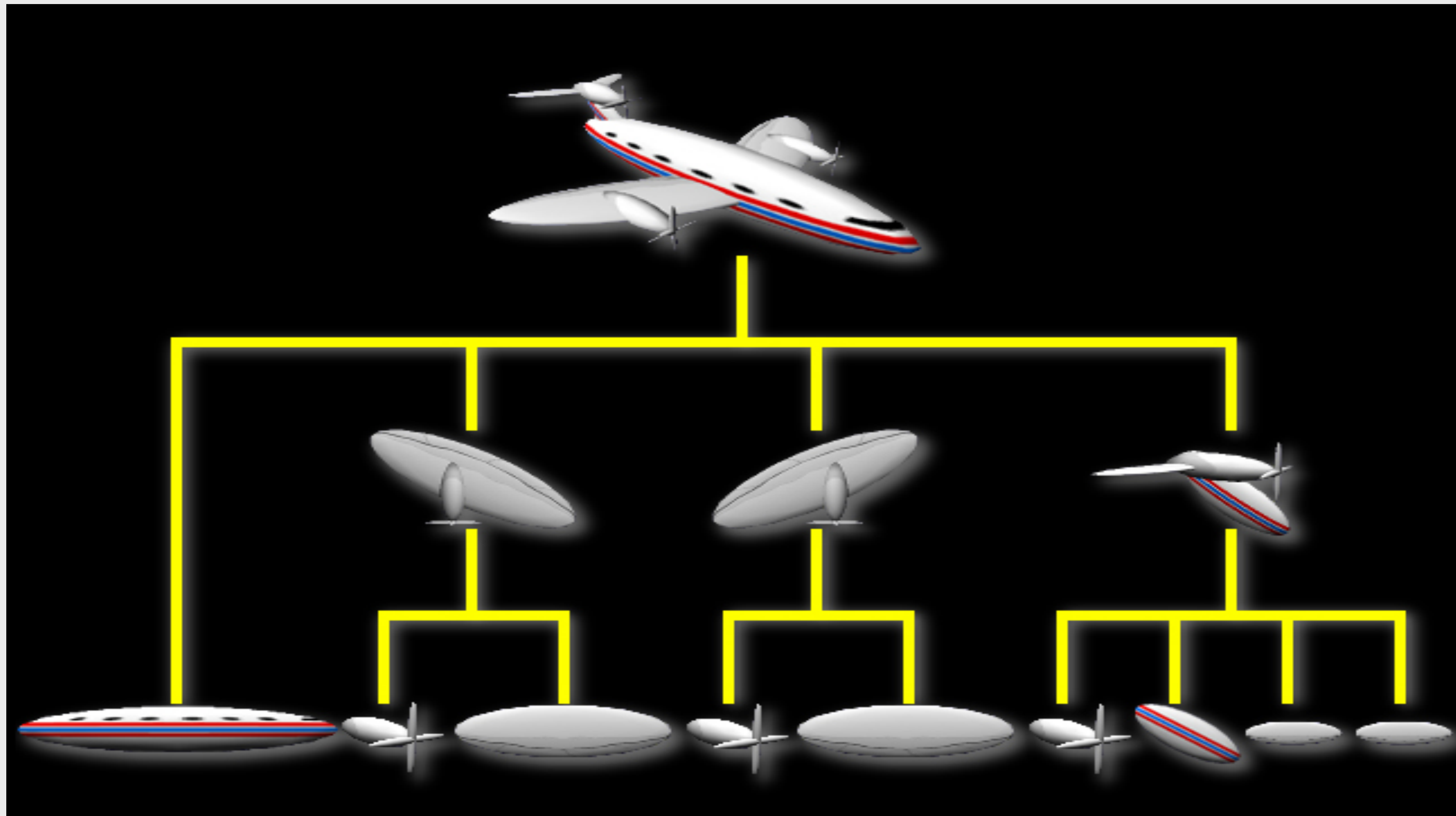
What is a scene graph

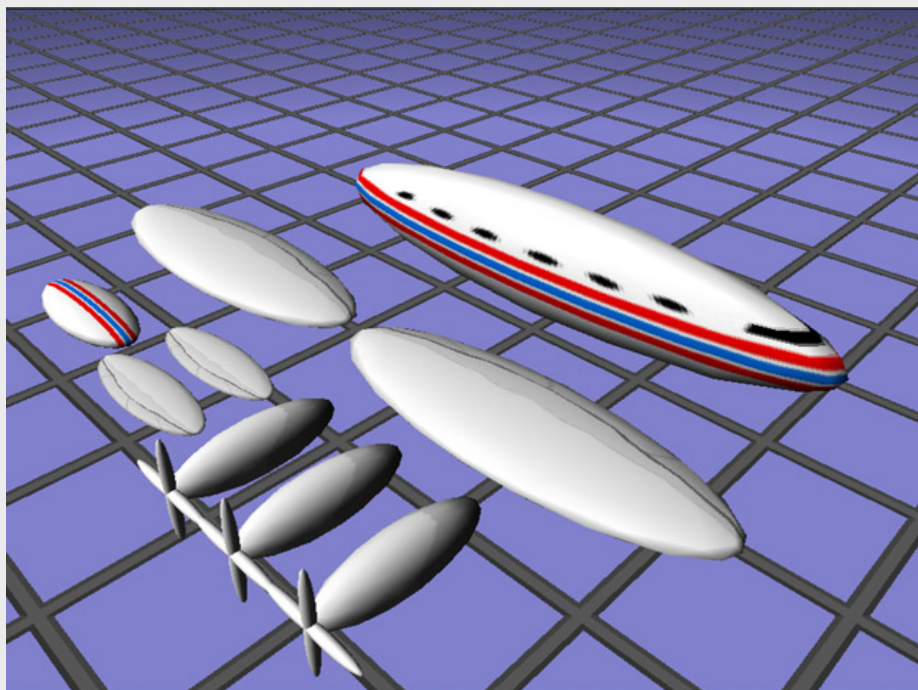
- Organize the scene logically and spatially
- Ease of operations such as transformation, visibility etc.
- Optimizations for picking, culling, etc.

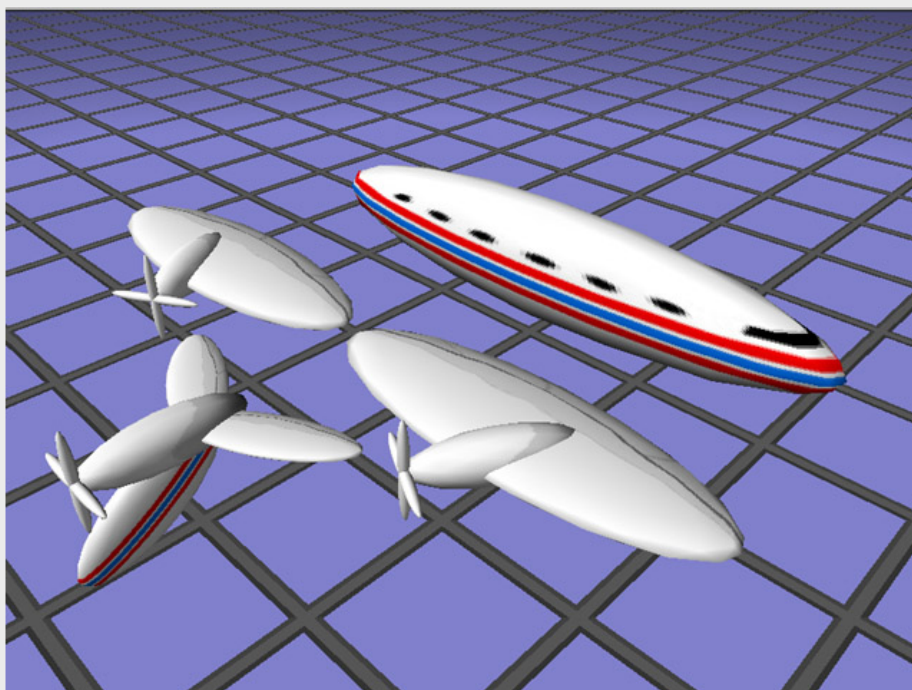


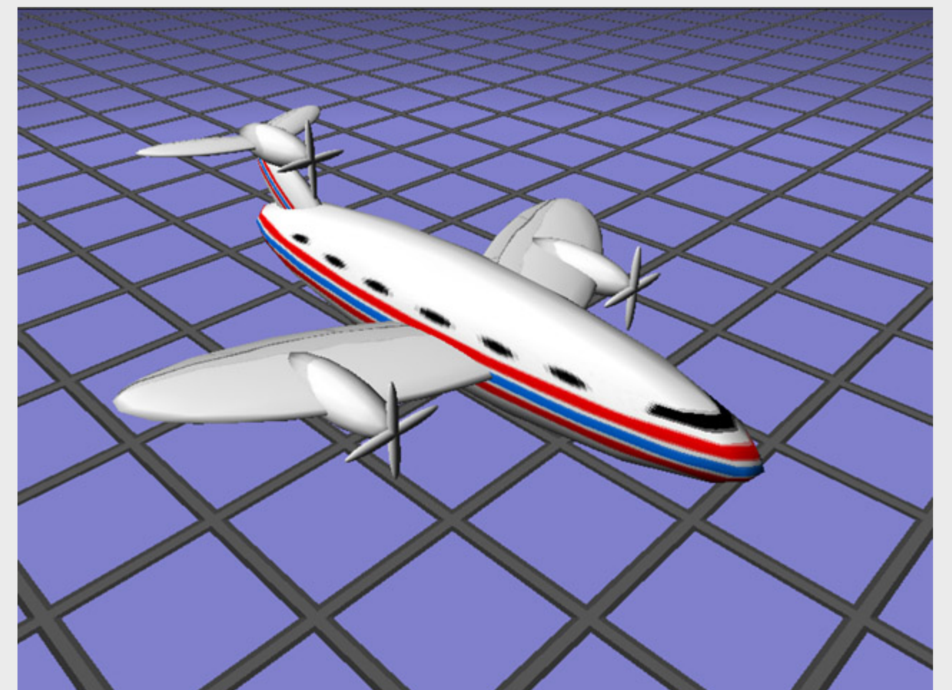
What is a scene graph

- To outline a scene graph can help to clarify a design and ease the development of software
- Better performance with good organisation









Scene graphs in jME

- Every node in jME's scene graph is a **Spatial**
- Spatial contains:
  - Transformation (more on this later)
  - Parent (Node)

Scene graphs in jME

- Spatial is an abstract class
- Two classes inherit Spatial: **Node** and **Geometry**
- Geometry represent visible objects in the scene
  - Mesh (geometry) and Material (rendering properties)
  - Can only be children and leaf nodes
- Node is an ”invisible” object, used for grouping objects
  - Children (Spatials)
  - Can be both parent and children

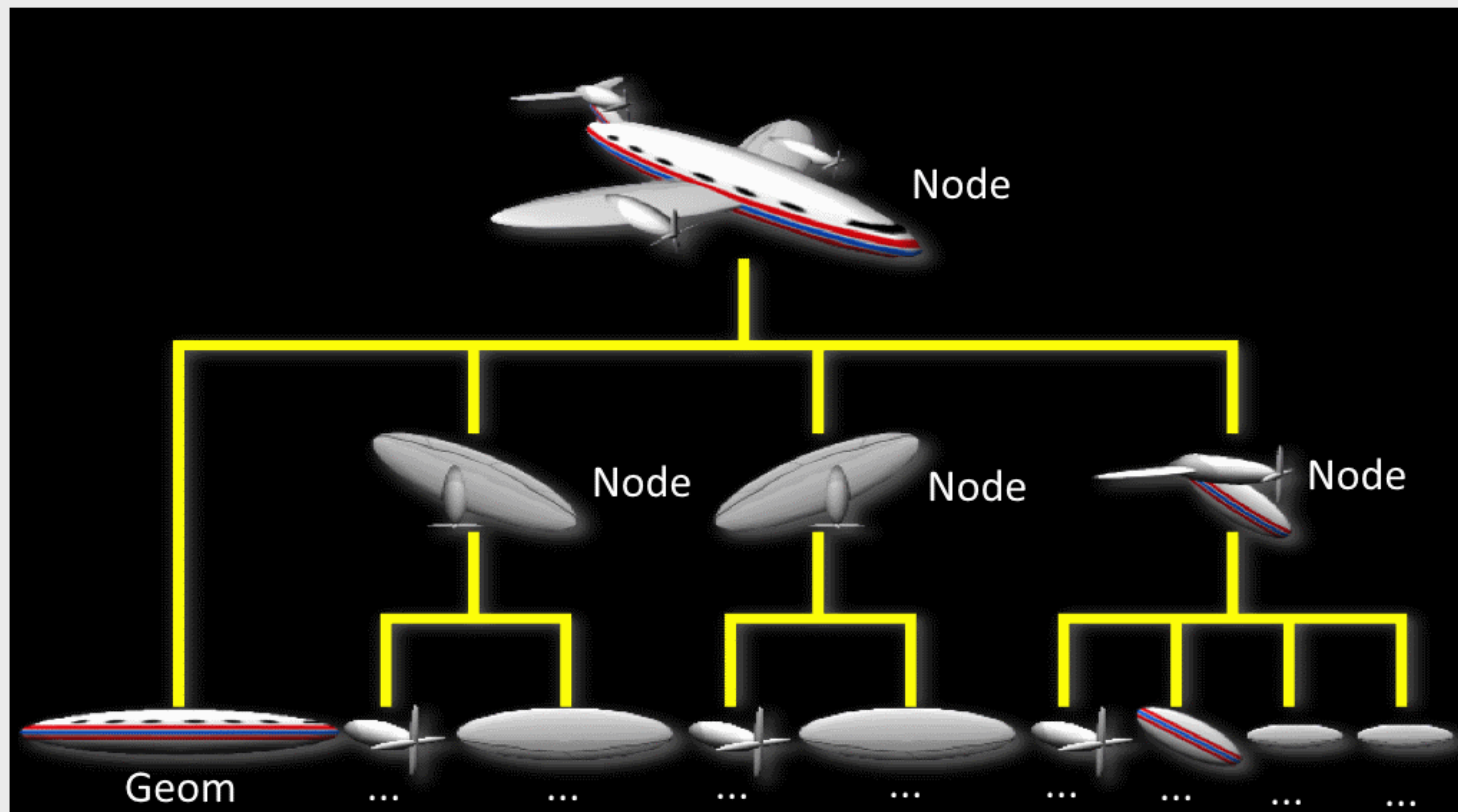
Scene graphs in jME

- Spatials also contain:
  - List of Lights
  - List of Controls (Behaviors)

- Other APIs might implement Light, Behaviors etc. as scene graph objects

Scene graphs in jME

- This is what the scene graph would look like in jME:



Scene graphs in jME

- We create nodes by instantiating jME classes

```
Geometry planeBody = new Geometry( ”planeBody",
  planeBodyMesh );
Geometry leftWing = new Geometry( ”leftWing" );
```

- We modify the nodes by using methods on an instance.

```
leftWing.setMesh( wingMesh );
```

- Build groups with nodes

```
Node plane = new Node(”plane” );
plane.attachChild( planeBody );
plane.attachChild( leftWing );
...
```

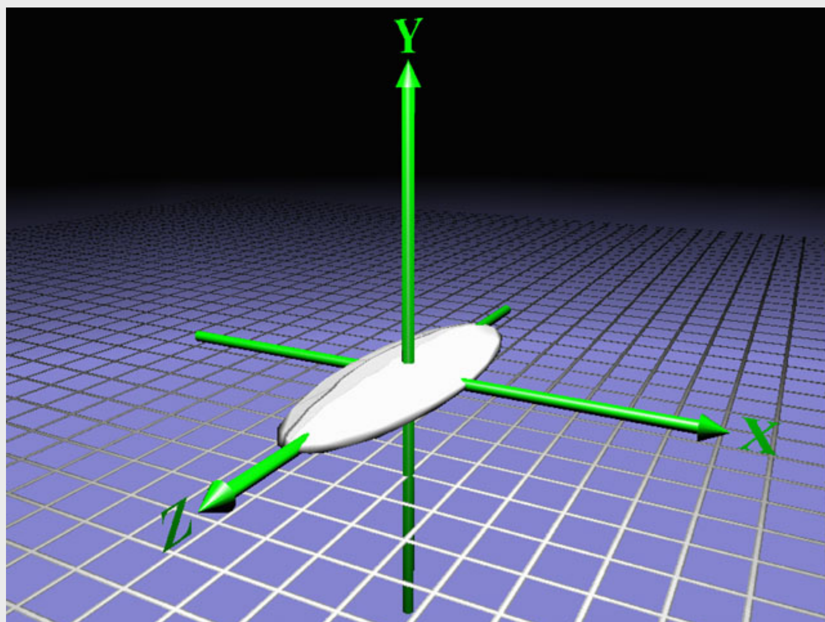
Coordinate systems and transformations

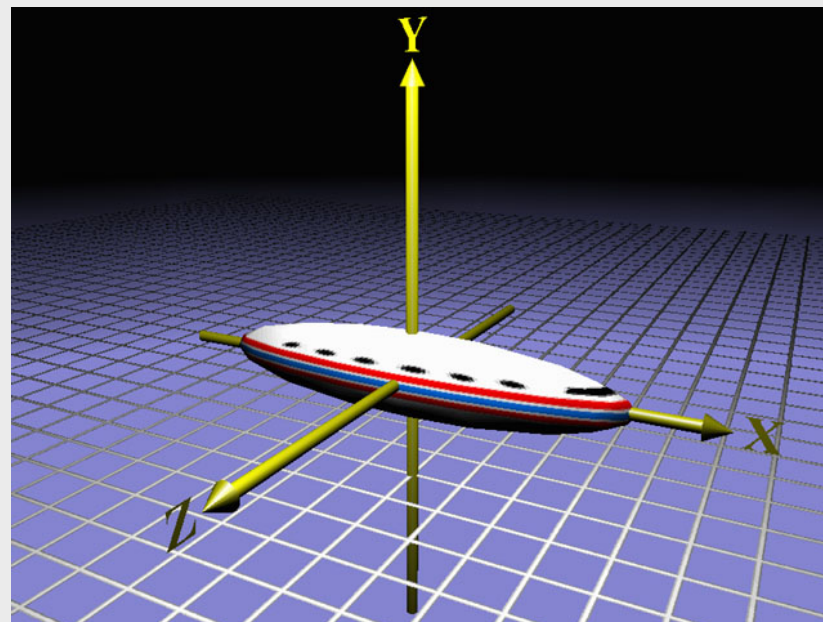
Coordinate systems

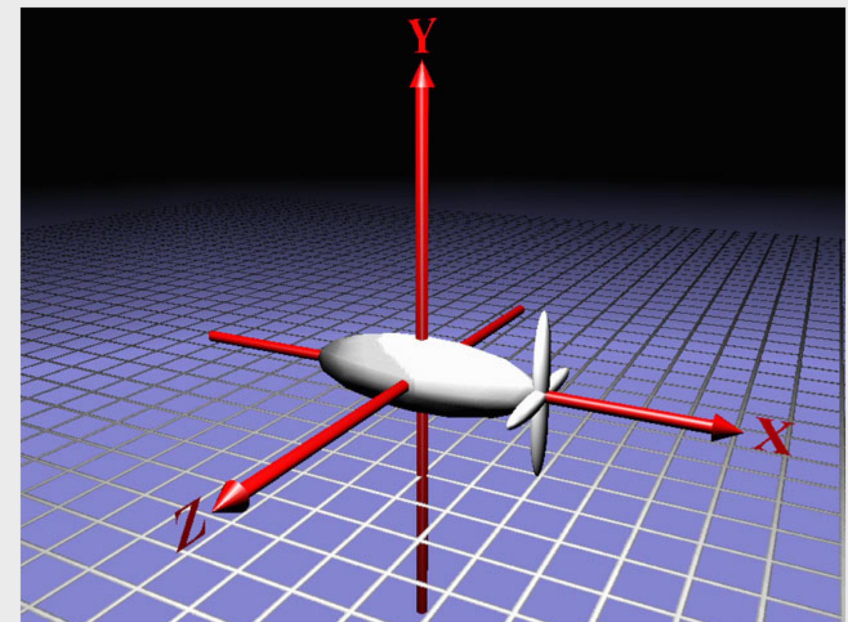
- All spatials share a common *world coordinate system*
- A Spatial creates a new local coordinate system. This is **relative** to the parent
  - Translation (position) sets the relative position
  - Rotation sets the relative rotation
  - Scale sets the relative size
- If you transform the parent system, all the children moves with it

Using the coordinate system

- Every part is built into their own local coordinate system

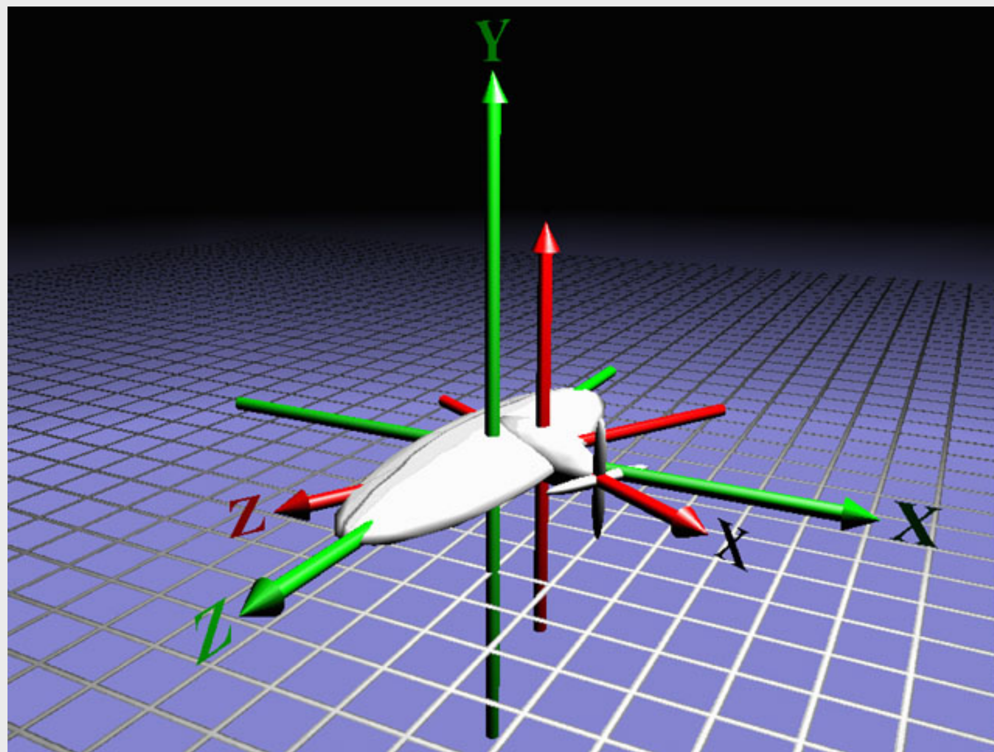


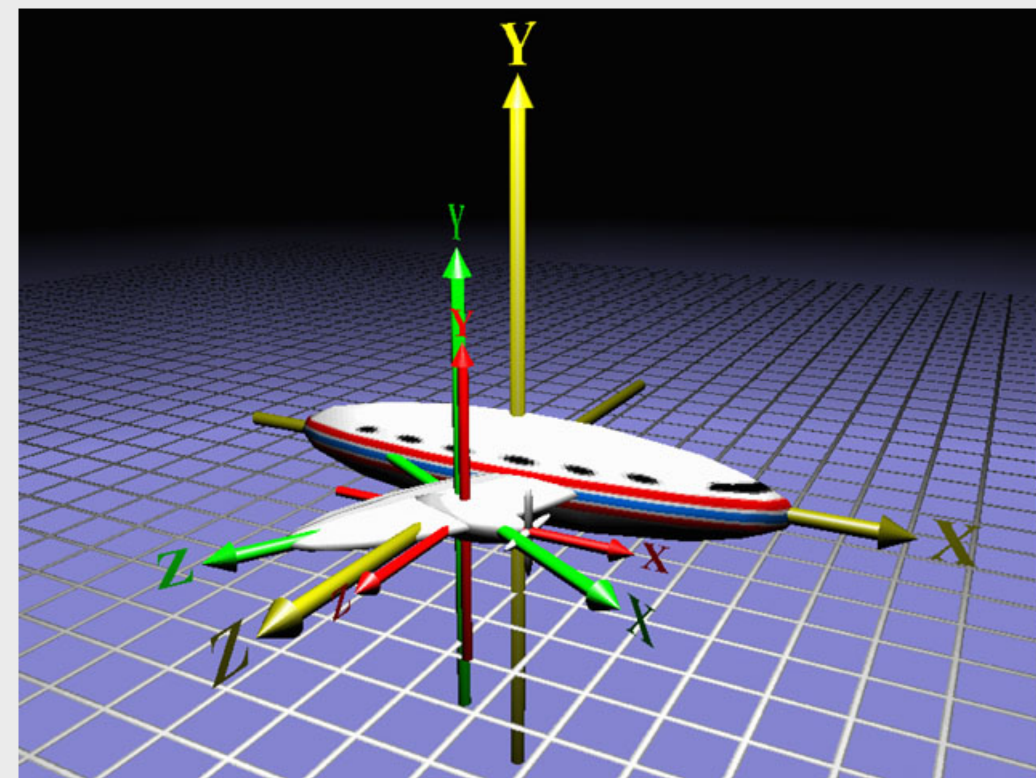




Using the coordinate system

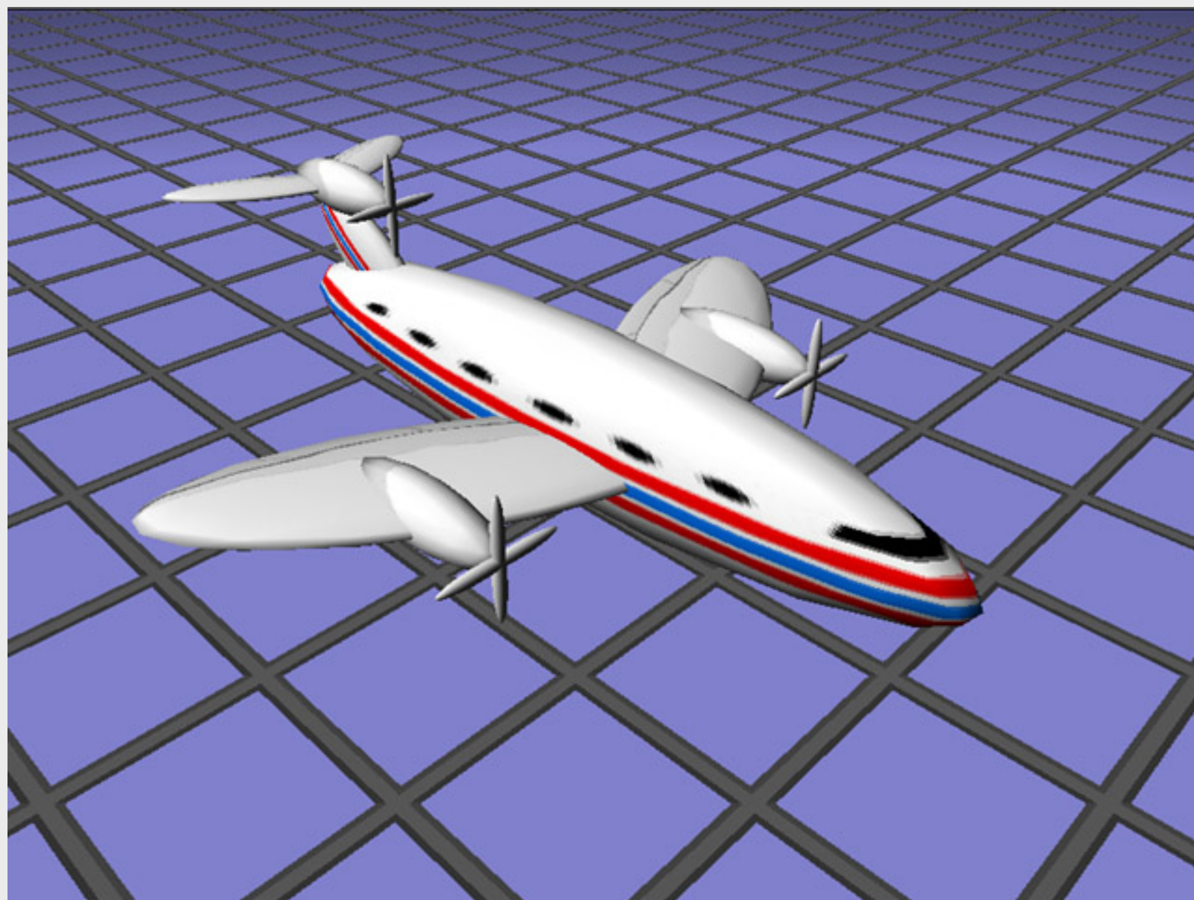
- When these parts are assembled, this transposes the childrens shapes into the parents coordinate system

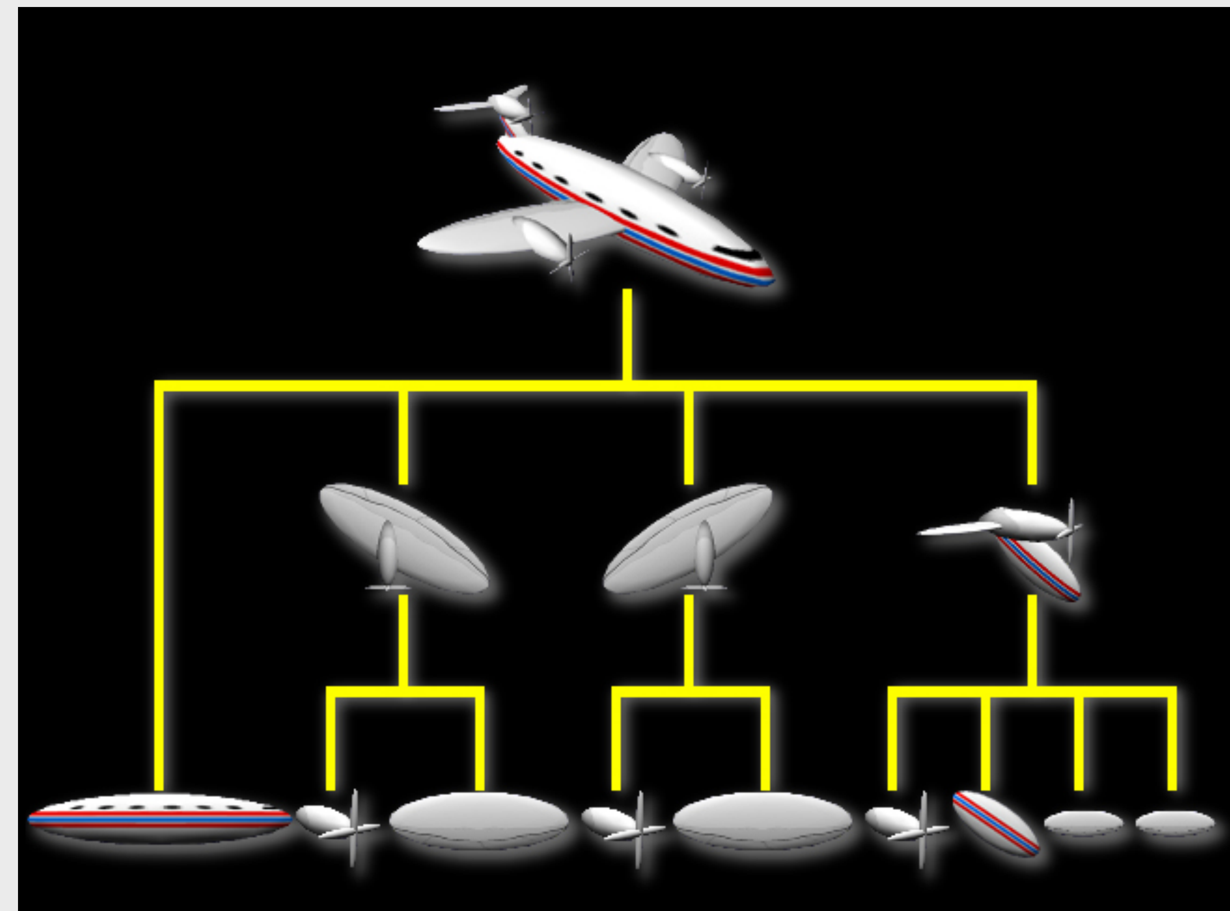




Using the coordinate system

- And so on, until we have built the plane





Transformations

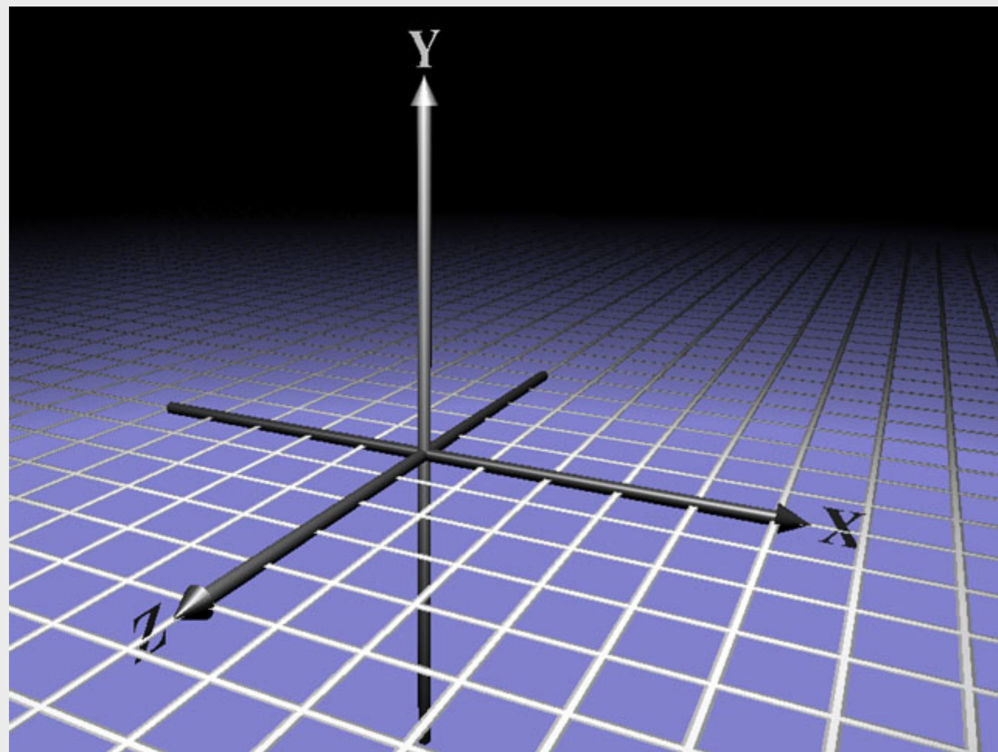
- Every spatial has a *Transform* component
- The Transform represents the *translation*, *rotation* and *scale* of the spatial

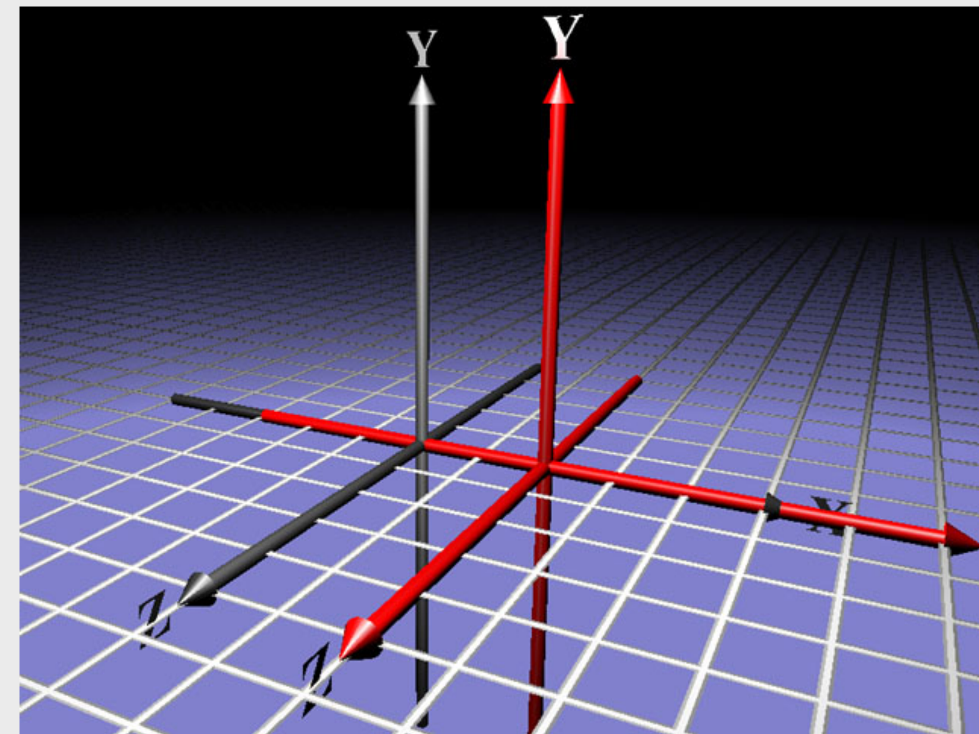
Identity

- By using the method loadIdentity(), the transform is set to Identity
  - No translation in X, Y or Z
  - No rotation
  - A scale factor of 1 on X, Y and Z

Positioning in a coordinate system

- A vector moves the coordinate system
  - Right-hand coordinate system
  - A Vector3f holds the X,Y and Z distance





Translation example code

- Build the geometry

```
Geometry geom = new Geometry("geom", mesh);
```

- To move the geometry +1.0f in the x-direction we need a Vector3f

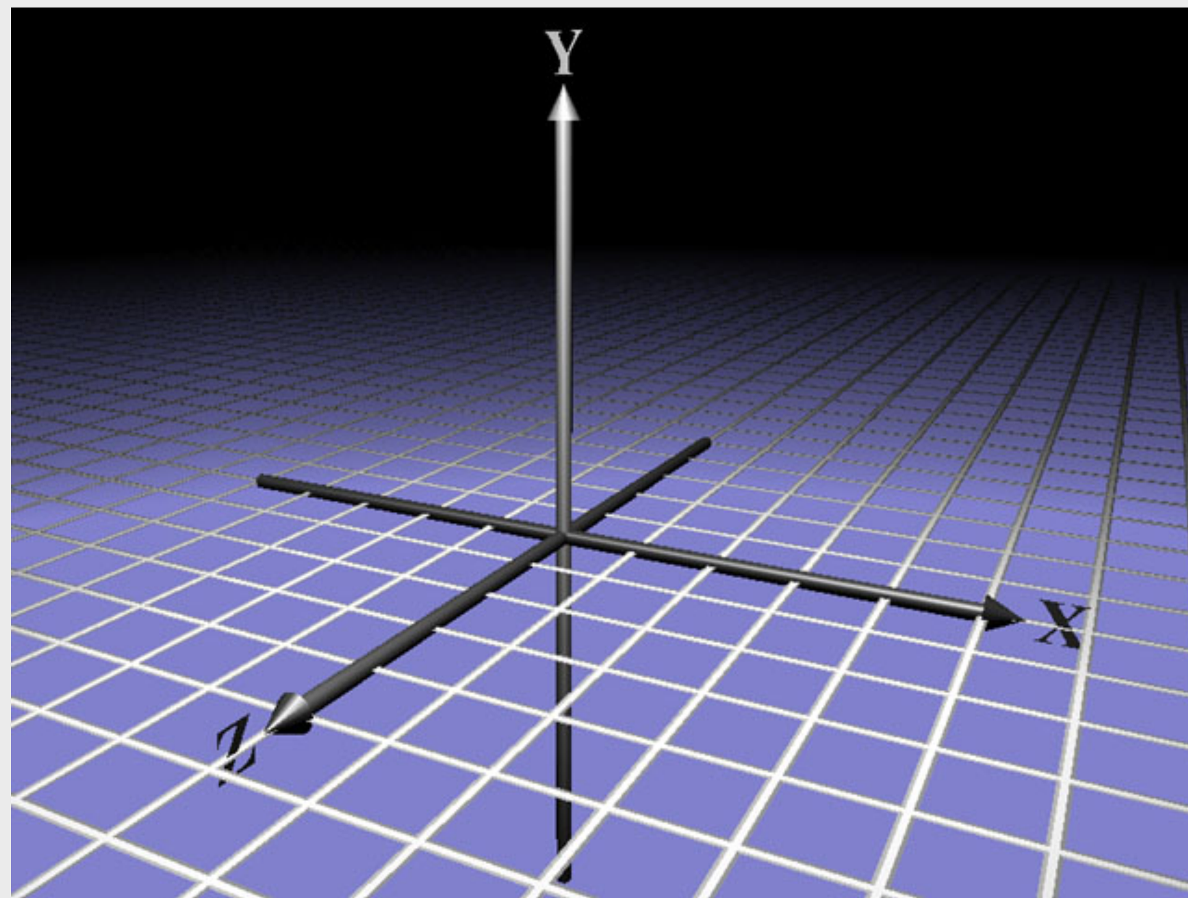
```
Vector3f trans = new Vector3f(1.0f, 0.0f,0.0f);
```

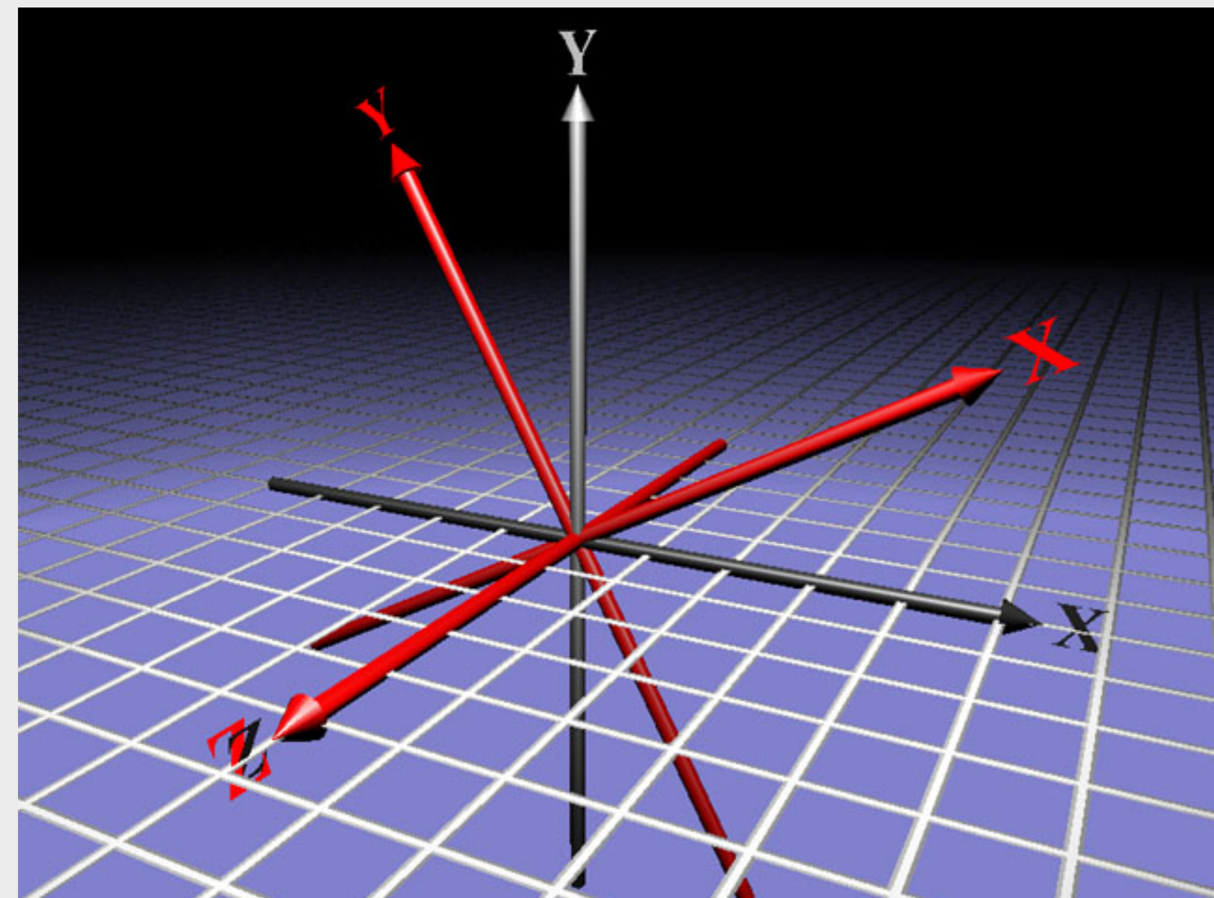
- This translation must be applied to the geometry

```
geom.setLocalTranslation(trans);
```

Rotate a coordinate system

- Rotate around x,y or z and an axis
- Rotate around axis





Rotation, simple example

- Create the geometry

```
Geometry geom = new Geometry("geom", mesh);
```

- Develop a 3D Transform for rotation around y-axis 45 degrees.

```
Quaternion quat = new Quaternion( );
quat.fromAngleNormalAxis((float)Math.PI/4,
  Vector3f.UNIT_Y);
```

- Set the rotation to the geometry

```
geom.setLocalRotation(quat);
```

Scaling a coordinate system

- By scaling we increase or decrease the size of a coordinate system and the shapes to the coordinate system
  - Normal scale is 1.0f
  - To scale equally much in x, y and z we can scale with a simple scale factor

    ```
    void setLocalScale ( float scale );
    ```

  - Or we can use individually scaling factors for each axis

    ```
    void setLocalScale (Vector3f scale);
    ```

Scaling, example code

- Create the geometry

```
Geometry geom = new Geometry("geom", mesh);
```

- Create a Vector3f to scale with different values in the x.y and z axis

```
Vector3f scale = new Vector3f(1.3f, 0.5f, 1.0f);
```

- Set the local scale for the geometry

```
geom.setLocalScale(scale);
```

Modification of parts of transform

- Modification of parts of an existing transfom
  - The other parts of the transform is untouched
  - Is used to combine translation, rotation and scaling

```
void setTranslation(float x, float y, float z);
void setTranslation(Vector3f trans);
void setRotation(Quaternion quat);
void setScale(float scale);
void setScale(Vector3f scale);
```

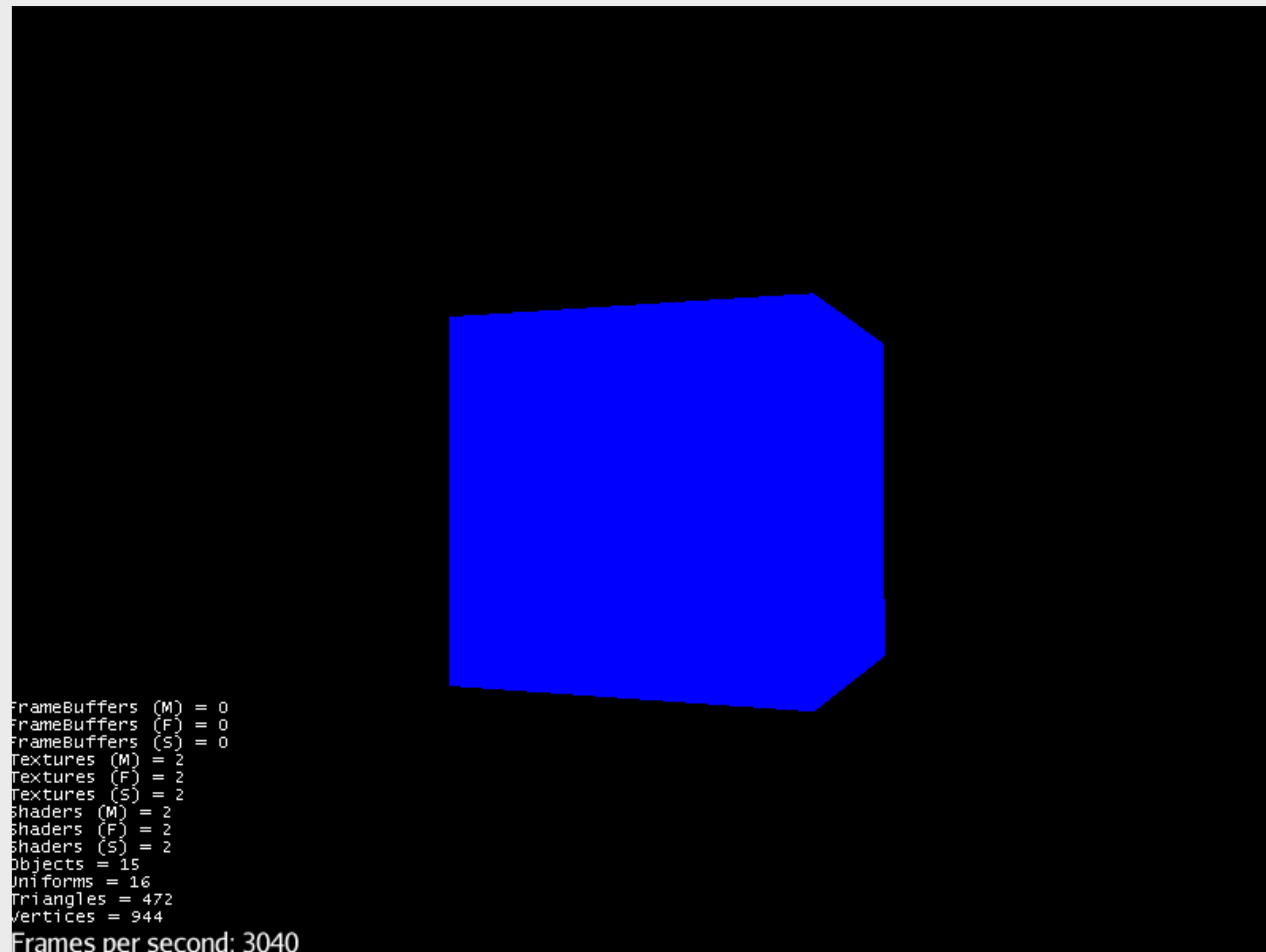
Tranform points

- It is possible to transform points from one coordinate system to another

```
      Vector3f transformVector(Vector3f in,
Vector3f store)
```

- jME uses Vector3f to represent both points and vectors.

Hello Rotation



HelloRotation.java