X3D Geospatial Component and X3D Earth

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Chapter Overview





Overview: Geospatial X3D

Geospatially referenced scenes have special requirements beyond ordinary 3D scenes

- Double-precision accuracy on floating-point displays
- Diverse yet coherent spatial reference systems
- X3D Geospatial Component nodes add necessary functionality to X3D in a consistent way
 - Goal: easy to integrate Earth with X3D scenes
- X3D Earth capabilities enable generation of local regions or full-scale globes using any data
 - Without license restrictions, openly scalable



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Concepts





History: GeoVRML

Geospatial referencing has always been a goal of X3D in order to make models most useful

The core design efforts for geospatial X3D were performed by GeoVRML working group

This design has been carefully evolved over time to match practical experience gained by producing ever-larger geospatial models



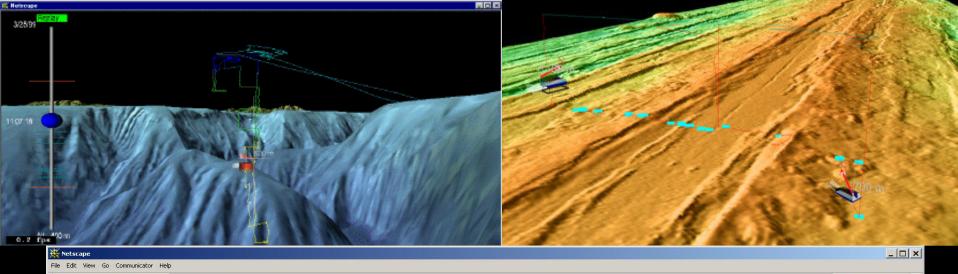


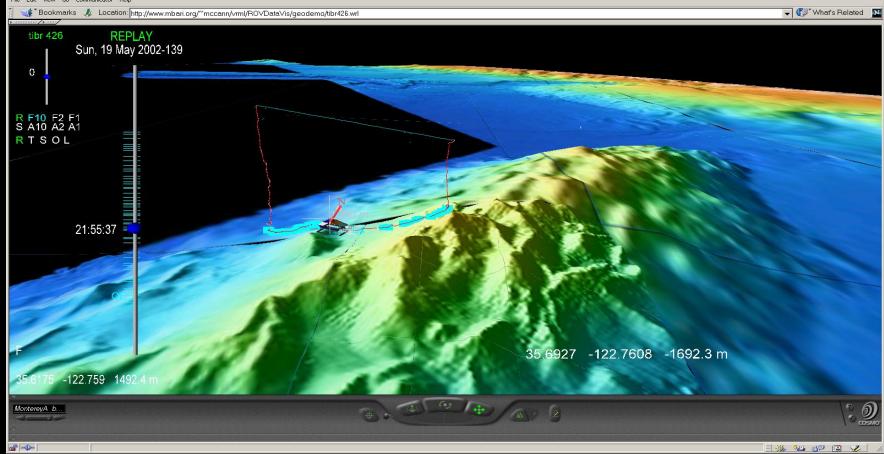
Example: Monterey Bay exploration

Mike McCann, MBARI

- Monterey Bay Aquarium Research Institute
 GeoVRML application for underwater track data
 from remotely operated vehicles (ROVs)
- Tracks converted to line sets with user interfaces for interpolator-driven playback
- Bathymetry and vessels are geolocated
- Image billboards link photography, videos Scientists can previsualize, explore missions







Double precision requirements

Geospatial position values for latitude, longitude require double precision accuracy

- Otherwise single-precision roundoff jitter equates to 3-10m of positional error
- Graphics cards only support single precision
 - Single precision 32 bit, double precision 64 bit

X3D Geospatial component reconciles this mismatch correctly and efficiently

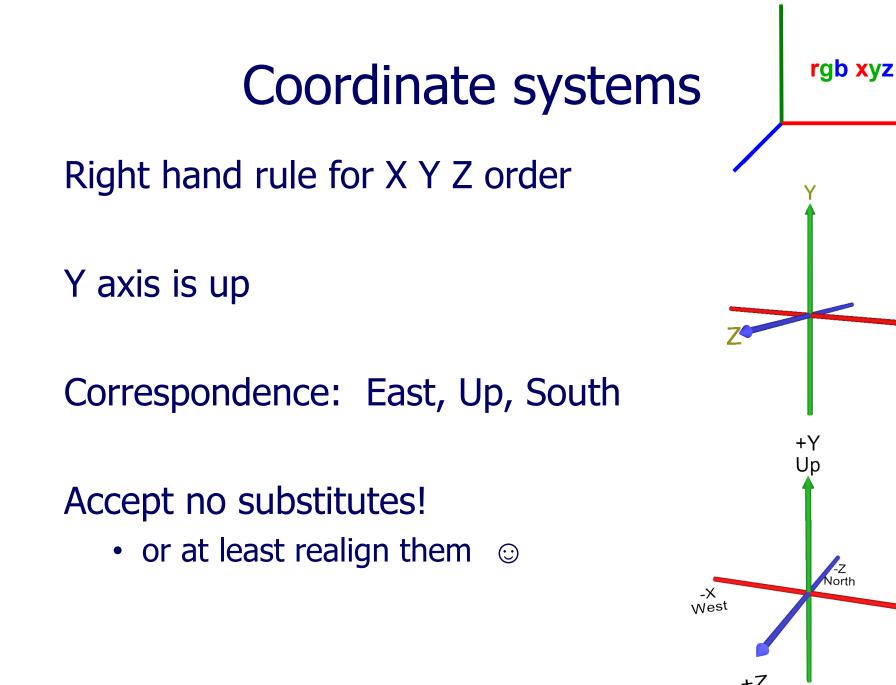




X3D types for double precision

- SFDouble single-field singleton value
- SFVec2d singleton vector of 2 values
- SFVec3d singleton vector of 3 values
- SFVec4d singleton vector of 4 values
- MFDouble multiple-field array of values
- MFVec2d vector array of 2-tuple values
- MFVec3d vector array of 3-tuple values
- MFVec4d vector array of 4-tuple values





+X East

South Down

Spatial reference frames

X3D is based on a right-handed Cartesion x,y,z coordinate system

centered at arbitrary (0,0,0)

Geospatial data can be captured in a large variety of earth-oriented coordinate sytems

- It is important to keep these different coordinate systems straight, or else objects do not appear where they are expected
- Related to ellipsoid for actual Earth shape





Spatial reference frames

Primary

- GD Geodetic spatial reference frame <latitude> <longitude> <elevation>
- GC Geocentric spatial reference frame

<x> <y> <z>

• UTM Universal Transverse Mercator <northing> <easting> <elevation>

X3D browsers transform geographic coordinates into earth-fixed geocentric coordinates





Supported earth ellipsoids

Code	Ellips oid Name	Semi-Major Axis (metres)	Inv. Flattening (F-1)
AA	Airy 1830	6377563.4	· · ·
AM	Modified Airy	6377340.19	299.32
AN	Australian National	6378160	298.25
BN	Bessel 1841 (Namibia)	6377483.87	299.15
BR	Bessel 1841 (Ethiopia Indonesia)	6377397.16	299.15
CC	Clarke 1866	6378206.4	294.98
CD	Clarke 1880	6378249.15	293.47
EA	Everest (India 1830)	6377276.35	300.8
EB	Everest (Sabah & Sarawak)	6377298.56	300.8
EC	Everest (India 1956)	6377301.24	300.8
ED	Everest (W. Malaysia 1969)	6377295.66	300.8
EE	Everest (W. Malaysia & Singapore 1948)	6377304.06	300.8

Code	Ellips oid Name	Semi-Major Axis (metres)	Inv. Flattening (F-1)
EF	Everest (Pakistan)	6377309.61	300.8
FA	Modified Fischer 1960	6378155	298.3
HE	Helmert 1906	6378200	298.3
НО	Hough 1960	6378270	297
ID	Indonesian 1974	6378160	298.25
IN	International 1924	6378388	297
KA	Krassovsky 1940	6378245	298.3
RF	Geodetic Reference System 1980 (GRS 80)	6378137	298.26
SA	South American 1969	6378160	298.25
WD	WGS 72	6378135	298.26
WE	WGS 84	6378137	298.26

Common field: geoSystem

geoSystem field indicates spatial reference frame and corresponding earth ellipsoid

• Used by X3D geospatial nodes containing position data (i.e. most of them)

geoSystem default value is ["GD" "WE"]

- "GD" means geodetic
- "WE" means WGS84 ellipsoid, i.e. the World Geodetic System of 1984 (updated 2004)





Common field: geoCenter

geoCenter field indicates geospatial position of center of the current node's coordinate frame

• Used by several X3D geospatial nodes

Values held by *geoCenter* field are determined by choice of corresponding *geoSystem* field:

- GD <latitude> <longitude> <elevation>
- GC <x> <y> <z>
- UTM <northing> <easting> <elevation>





geoSystem field editor X3D-Edit

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			default		
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GC	\bigcirc		AM Modified Airy	No.	GeoSystem
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UTM	0 70		3R Bessel 1841 (Ethiopia Indonesia)		
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	SOL	<u>1</u>	CD Clarke 1880		
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			GC 💿		
					OK Cancel
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			geoid dei		ispirere (ir enecked), deidale is northern riemspirere
				aun ault	
					eodetic System (dated 1984, revised 2004)
					OK Cancel

Common field: metadata

Each node can also contain Metadata nodes

- This is consistent throughout all X3D Metadata nodes allow authors to add pairs of names and typed values to describe content
- Possible option for annotating, augmenting content in a valid machine-readable way
- MetadataSet, MetadataString, MetadataFloat, MetadataDouble, MetadataInteger

Note that GeoMetadata node also available





X3D Geospatial Implementations

- Xj3D: open source Java
- www.xj3D.org
- FreeWrl/FreeX3D: open source C++
- http://freewrl.sourceforge.net
 BS Contact Geo commercial C++
- http://www.bitmanagement.de
 Other players to follow?
 Feature comparison:
- Player support for X3D components wiki



Geospatial navigation issues

Regular X3D navigation modes often fail when confronted with geospatial coordinates

- Reason: world coordinate frame is no longer Cartesian x,y,z but rather geospatial surface
- Typical failure that leaves user lost in space: <NavigationInfo type=' "EXAMINE" "ANY" '/>

Special implementation techniques required for X3D players to handle user navigation properly

• Velocity also should be proportional to altitude





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X3D Nodes and Examples





Obtaining example scenes

X3D Basic archives, GeoSpatial directory

- http://www.web3d.org/x3d/content/examples/Basic
- Under version control on sourceforge

X3D-Earth globe server

- http://x3d-earth.nps.edu
- A few examples are there, more to follow





Also in NPS Savage archives: specific locations available

Locations

Baltimore Maryland Dardanelles Hampton Roads Virginia

Monterey Bay California

Narragansett Bay Rhode Island Small Rio De Janeiro Singapore Straits Of Malacca Large Bosphorus Fort Lauderdale Florida

<u>Hawaii</u>

Narragansett Bay Rhode Island Bathymetry

Panama City Florida

San Francisco California Southern California Border Straits Of Malacca Small Camp Pendleton California Globe Level Oto 4 <u>Malaka</u> Narragansett Bay Rhode Island Large

Port Hueneme California

<u>Ship Island Mississippi</u> <u>Straits Of Hormuz</u> <u>Tunis Airport Tunisia</u>





GeoCoordinate node

Defines a list of coordinate values, used as *coord* field of a vertex-based geometry node

 such as IndexedFaceSet, IndexedLineSet, or PointSet node

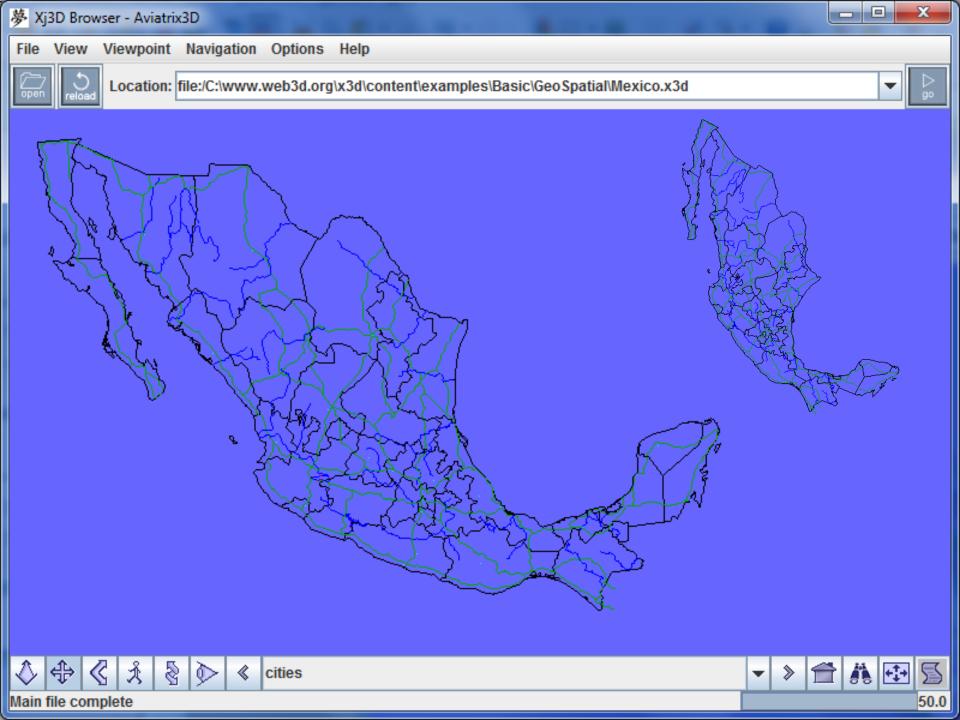
As described before, each value is defined according to specified coordinate system:

- GD <latitude> <longitude> <elevation>
- GC <x> <y> <z>
- UTM <northing> <easting> <elevation>





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3 📮 <x3d 1'="" name="Geospatial" profile="Immersive" version="3.0" xmlns:xsd="http://www.w3.org/2001/XMLSchema-instance" xsd:nonamespaceschemalocation="http://w</td><td></td></tr><tr><td>4 🗗 <head></td><td></td></tr><tr><td><pre>5 <component level="></x3d>	
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18 -	
19 - <scene></scene>	
20 <background skycolor="0.4 0.4 1.0"></background>	
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38 - <group></group>	
39 - <shape></shape>	
40 - < <u>IndexedLineSet</u> colorIndex='0 0 0 0 0 0 0 0 0 0 0 0 0 0 -1 0 0 0 0 0	0
41 <color color="0.0 0.0 0.0"></color>	
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GeoCoordinate node X3D-Edit

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GeoElevationGrid node 1

Similar to regular ElevationGrid node

- Adds geoGridOrigin, geoSystem fields
- *height* field is now a double array (not float) representing height above geoid surface
- Also includes *set_height* (inputOnly) field *Geometry of Ge*oElevationGrid *height* field itself is curved to match geospatial ellipsoid
- Curvature typically not visible for small areas
- Nevertheless holds accurate for large areas, including definition of a full globe!
 Web 3D CONSORTIUM

GeoElevationGrid node 2

geoSystem defines geospatial coordinate system

also affects units of other values

geoSystem "GD"

- *xSpacing* refers to the number of degrees of longitude between adjacent height values
- *zSpacing* refers to the number of degrees of latitude between vertical height values.

geoSystem "UTM"

- *xSpacing* refers to the number of eastings (metres) between adjacent height values
- *zSpacing* refers to the number of northings (metres) between vertical height values.

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22	This scene shows example GeoSpatial node relationships in a scene graph		
23	<background groundcolor="0.1 0.1 0.8" skycolor="0.1 0.1 0.8"></background>		
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30	<geoelevationgrid ccw="true" colorpervertex="true" creaseangle="0" geogridorigi<="" td=""><td></td><td></td></geoelevationgrid>		
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GeoLocation node

GeoLocation node provides ability to georeference any standard X3D model

- X3D model is contained as child
- Thus GeoLocation is a grouping node
- Local vertical aligned with +Y axis up geoSystem gives geospatial coordinate system geoCoords field indicates location
 - can dynamically update this geospatial location using GeoPositionInterpolator

Warning: do not nest GeoLocation nodes within each other, either directly or via Inline

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8	<meta content="Don Brutzman NPS, X3D encoding" name="creator"/>	
9	<meta content="26 June 2000" name="created"/>	
10	<meta content="4 July 2004" name="modified"/>	
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GeoLOD node

GeoLOD node provides a terrain-specialized form of the regular LOD node

- rootUrl or rootNode are used to define geometry shown at default level
- *Child1Url ... child4Url* fields define quadtree links to children subscenes
- *geoSystem* defines geospatial coordinate system

• Also includes output event for *level_changed* Wish list: children within node, vice urls web 3D

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2	<pre><!DOCTYPE X3D PUBLIC "ISO//Web3D//DTD X3D 3.0//EN" "http://www.web3d.org/specifications/x3d-3.0.dtd"> ^ []</pre>
3	
4	
5	<pre><component level="1" name="Geospatial"></component></pre>
6	<meta content="Squaw.x3d" name="title"/>
7	<meta bayarri,="" content="This model was output using the GeoVRML export capabilities of ESRI's 3D Analyst Extension for ArcView/ArcInfo 8.1 product</th></tr><tr><th>8</th><th><meta content=" esri'="" name="creator" salvador=""/>
9	<meta content="Don Brutzman" name="translator"/>
10	<meta content="22 April 2003" name="translated"/>
11	<meta content="19 July 2010" name="modified"/>
12	<pre><meta content="http://www.geovrml.org/examples" name="reference"/></pre>
13	<meta content="X3D geospatial example" name="subject"/>
14	<pre><meta content="http://www.web3d.org/x3d/content/examples/Basic/GeoSpatial/Squaw.x3d" name="identifier"/></pre>
15	<pre><meta content="Vrml97ToX3dNist, http://ovrt.nist.gov/v2_x3d.html" name="generator"/></pre>
16	<meta content="X3D-Edit 3.2, https://savage.nps.edu/X3D-Edit" name="generator"/>
17	<meta content="/license.html" name="license"/>
18	
19 -	
20	<worldinfo info='"Generated by ArcScene"' title="ArcScene Document"></worldinfo>
21	<background skycolor="1.0 1.0 1.0"></background>
22	<pre><directionallight ambientintensity="0.3" direction="0.612372 -0.612372 -0.5"></directionallight></pre>
23	<pre><directionallight ambientintensity="0.3" direction="-0.612372 0.612372 0.5"></directionallight></pre>
24	
25	<pre><geoorigin def="ORIGIN" geocoords="4342525.500000 740604.000000 0.000000" geosystem='"UTM" "Z10" "N"' rotateyup="true"></geoorigin></pre>
26 27 -	-
27 28	
20 2	
30	
31	
32	geoSystem='"UTM" "Z10" "N"' range='32266.666'>
33	
34	
35	<pre></pre> <pre> </pre> <pre> <pre> <pre> <pre> <pre> <pre> </pre></pre></pre></pre></pre></pre>
36	<pre></pre> <imagetexture url='"images/squaw000.jpg" "http://www.web3d.org/x3d/content/examples/Basic/GeoSpatial/images/squaw000.jpg"'></imagetexture>
37	-
38	
39	geoSystem='"UTM" "Z10" "N"' height='2329.3235 2313.5854 2299.391 2275.616 2256.039 2260.0962 2289.158 2271.813 223
40	solid='false' xDimension='12' xSpacing='110.727273' yScale='1.0' zDimension='16' zSpacing='107.555556'>
41	<pre><</pre>
42	<geoorigin use="ORIGIN"></geoorigin>
43	<pre></pre>
44	-
45	<geoorigin use="ORIGIN"></geoorigin>
46	- declop
47	
31 16	INS

GeoLOD node X3D-Edit

Edit GeoLO	D				×
		DEF	ca	ontainerField ~	
geoSystem	UTM Z 10 N			▼	
range	32266.66601	6			
center	4340966		738223.375	2183.5	
bboxCenter	0		0	0	
bboxSize	-1		-1	-1	
url arrays	layout diagra	am rootUrl list child 1Url lis	t child2Url list child3Url list child4	Url list	
	No	rth ► East	rootUrl or root node	2 4 1 3 Level <i>n</i> +1	root and child url arrangement
			Levern	Level n+1	
				Visualize Accept	Discard <u>H</u> elp

GeoMetadata node

Describes geospatial information of interest

- Design is similar to WorldInfo node
- Developed and approved prior to other Metadata* nodes from X3D Core Component

Note unusual syntax: writing, parsing is difficult

- "title" "name-value pairs for GeoMetadata"
- "description" "are defined as MFString string arrays"

Typically defined names of interest include:

 title, description, coordinateSystem, horizontalDatum, verticalDatum, ellipsoid, extent, resolution, originator, copyright, date, metadataFormat, dataUrl, dataFormat

Im TripsModel.x3d - Editor						
🐳 TripsModel.x3d 🛛 🗱						
1 🕼 🗟	·					
1	xml version="1.0" encoding="UTF-8"?					
2	X3D PUBLIC "ISO//Web3D//DTD X3D 3.0//EN" "http://www.web3d.org/specifications/x3d-3.0.dtd"					
3 🖯	<pre>X3D profile='Immersive' version='3.0' xmlns:xsd='http://www.w3.org/2001/XMLSchema-instance' xsd:noNamespaceSchemaLocation='http://www.taiter *</pre>					
4	<pre><head></head></pre>					
5	<component level="1" name="Geospatial"></component>					
6	<meta content="TripsModel.x3d" name="title"/>					
7	<meta content="Individual trip locations and links, integrated as Inline into TripsAroundWorld." name="description"/>					
8	<meta content="Martin Reddy, SRI" name="creator"/>					
9	<meta content="Don Brutzman" name="translator"/>					
10	<meta content="22 April 2003" name="translated"/>					
11	<meta content="30 April 2003" name="modified"/>					
12	<meta content="http://www.geovrml.org/examples" name="reference"/>					
13	<meta content="X3D geospatial example" name="subject"/>					
14	<meta content="http://www.web3d.org/x3d/content/examples/Basic/GeoSpatial/TripsModel.x3d" name="identifier"/>					
15	<meta content="Vrm197ToX3dNist, http://ovrt.nist.gov/v2 x3d.html" name="generator"/>					
16	<meta content="X3D-Edit 3.2, https://savage.nps.edu/X3D-Edit" name="generator"/>					
17	<meta content="/license.html" name="license"/>					
18	-					
19 🗄	<scene></scene>					
20	<pre><group></group></pre>					
21	<pre></pre> <pre><</pre>					
22	GeoMetadata summary='"title" "Martin's Trips" "software" "text2geovrml (C) 2000 SRI International" "models" "46"'/>					
23 🛱	<pre><geolocation geocoords="-22.9062 -43.1748 +50100" geosystem='"GD" "WE"'></geolocation></pre>					
24	Anchor description='Rio De Janeiro' parameter='"target= martinstrips"' url='"http://www.ai.sri.com/cgi-bin/show_img.pl?img=jpg					
25	<pre><transform rotation="1.0 0.0 0.0 3.14159"></transform></pre>					
26	<pre></pre>					
27 🛱	<pre><appearance></appearance></pre>					
28	<material diffusecolor="1.0 0.0 0.0"></material>					
29	-					
30	<cone bottomradius="50000.0" height="100000.0"></cone>					
31	-					
32	-					
33	-					
34	-					
35	<pre><geoviewpoint description="Model 2" geosystem='"GD" "WE"' orientation="1.0 0.0 0.0 -1.57" position="20.9458 -86.8608 +5000100"></geoviewpoint></pre>					
36 🛱	<pre><geolocation geocoords="20.9458 -86.8608 +50100" geosystem='"GD" "WE"'></geolocation></pre>					
37 🛱	<pre><anchor 0.0="" 0.0'="" 1.0="" description="Cancun" parameter='"target= martinstrips"' url='"http://www.ai.sri.com/cgi-bin/show img.pl?img=mx/mexico1.</pre></th></tr><tr><th>38 🛱</th><th></th></tr><tr><th>39 🛱</th><th><pre></pre></th></tr><tr><th>40</th><th></th></tr><tr><th>41</th><th><Material diffuseColor='></anchor></pre>					
22 7	INS					

🕎 Edit GeoMetadata	
USE O	GeoMe node X
Edit row: Copy Add Remove 👚 🖶 Edit cells: Assign cell value: 🗸 to selected cell 🗸 Apply	
summary title V Martin's Trips	metadataFormat
description	date
coordinateSystem	copyright
horizontalDatum	originator
verticalDatum	resolution
Accept Discard Help	

tadata **3D-Edit**

 Apply 		
	metadataFormat	
E	date	
	copyright	
	originator	
	resolution	
ard <u>H</u> elp	Accept Discard <u>H</u> elp	

GeoPositionInterpolator node

Similar to regular PositionInterpolator node

- Adds *geovalue_changed*, *geoSystem* fields Consistent behavior throughout
- geovalue_changed value corresponds to the world position returned by position_changed
- Output values are referenced to geospatial coordinate system defined by *geoSystem*

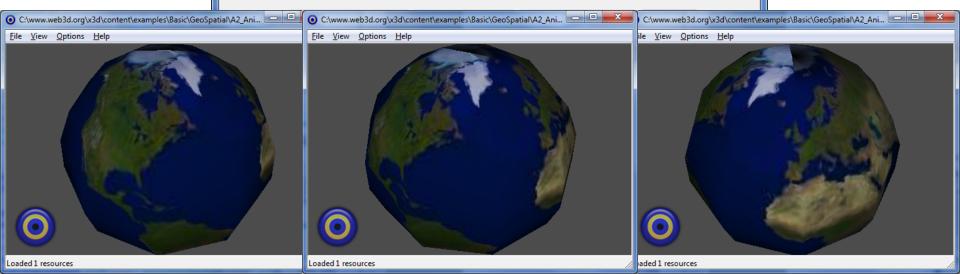




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🔆 A	2_A	nimatedGeoViewpoint.x3d	8	
I¢	Ç	• 💷 • 🔍 🔜 🖧 🖶 🕌	▶ ♣ ♣ 옆 옆 ● ■ マ ♥ ♣	
1		xml version="1.0"</th <th>encoding="UTF-8"?></th> <th><u> </u></th>	encoding="UTF-8"?>	<u> </u>
2		X3D PUBLIC</th <th>C "ISO//Web3D//DTD X3D 3.0//EN" "http://www.web3d.org/specifications/x3d-3.0.dtd"></th> <th></th>	C "ISO//Web3D//DTD X3D 3.0//EN" "http://www.web3d.org/specifications/x3d-3.0.dtd">	
		-	sive' version='3.0' xmlns:xsd='http://www.w3.org/2001/XMLSchema-instance' xsd:noNamespaceSchemaLocation=	'http://
	P	<head></head>		
5			<pre>l='1' name='Geospatial'/></pre>	
6			A2_AnimatedGeoViewpoint.x3d' name='title'/>	
7			Martin Reddy SRI, original example' name='creator'/>	
9			Don Brutzman NPS, X3D encoding' name='creator'/> 26 June 2000' name='created'/>	
10			B April 2009' name='modified'/>	
11			Specification example shows animated GeoViewpoint, using GeoPositionInterpolator between latitude/longit	ude loca
12			http://www.geovrml.org/1.0/doc/examples.html' name='reference'/>	1000
13			priginals/viewanim.wrl' name='meta'/>	
14			http://www.geovrml.org/1.0/doc/examples/viewanim.wrl' name='VRML 97 encoding'/>	
15		<meta content="h</th><th>http://www.web3d.org/x3d/content/examples/Basic/GeoSpatial/A2 AnimatedGeoViewpoint.x3d" name="identifier</th><th>·/></th></tr><tr><th>16</th><th></th><th><meta content=" th="" }<=""/> <th>X3D-Edit 3.2, https://savage.nps.edu/X3D-Edit' name='generator'/></th> <th>=</th>	X3D-Edit 3.2, https://savage.nps.edu/X3D-Edit' name='generator'/>	=
17		<meta content=".</th><th>/license.html" name="license"/>		
18				
19	白	<scene></scene>		
20	₽_	<group></group>		
21		<geoviewpoint< th=""><th>DEF='V' description='Animating GeoViewpoint' fieldOfView='0.785398' geoSystem='"GD" "WE"'</th><th></th></geoviewpoint<>	DEF='V' description='Animating GeoViewpoint' fieldOfView='0.785398' geoSystem='"GD" "WE"'	
22	LL -		headlight='true' jump='true' orientation='1 0 0 -1.57' position='51.5122 -0.065 10000000' speedFactor=':	1'/>
23		<shape></shape>		
24	딘	<appearance:< th=""><th></th><th>-+</th></appearance:<>		-+
25			diffuseColor='0.8 1.0 0.3'/>	
26			ture url='"images/earth.jpg" "http://www.web3d.org/x3d/content/examples/Basic/images/earth.jpg" "http://www.web3d.org/x3d/content/examples/Basic/images/earth.go" "http://www.web3d.org" "http://www.web3d.org" "http://www" "http://www"" "http://www"" "http://ww"" "http://ww"" "http://ww"" "http://ww"" "http://ww""" "	www.geov
27 28		<th><pre>c> onGrid ccw='true' colorPerVertex='true' creaseAngle='1.05' geoGridOrigin='-90 -180 0' geoSystem='"GD" "W</pre></th> <th></th>	<pre>c> onGrid ccw='true' colorPerVertex='true' creaseAngle='1.05' geoGridOrigin='-90 -180 0' geoSystem='"GD" "W</pre>	
29				
30		-	lPerVertex='true' solid='true' xDimension='11' xSpacing='36' vScale='1.0' zDimension='11' zSpacing='18'/	
31	╎┝╹			
32		-	nterpolator DEF='GPI' geoSystem='"GD" "WE"' key='0.0 0.1 0.55 1.0'	
33			lue='51.5122 -0.065 10000000 48.865 2.35 1000000 40.6698 -73.943849 10000000 51.5122 -0.065 10000000'/>	
34	"	<timesensor dh<="" th=""><th>EF='TS' cycleInterval='8.0' loop='true'/></th><th></th></timesensor>	EF='TS' cycleInterval='8.0' loop='true'/>	
35		<background gi<="" th=""><th>roundColor='0.3 0.3 0.3' skyColor='0.3 0.3 0.3'/></th><th></th></background>	roundColor='0.3 0.3 0.3' skyColor='0.3 0.3 0.3'/>	
36	-			
37		<route fromfield<="" th=""><th>d='fraction_changed' fromNode='TS' toField='set_fraction' toNode='GPI'/></th><th></th></route>	d='fraction_changed' fromNode='TS' toField='set_fraction' toNode='GPI'/>	
38		<route fromfield<="" th=""><th>d='geovalue_changed' fromNode='GPI' toField='set_position' toNode='V'/></th><th></th></route>	d='geovalue_changed' fromNode='GPI' toField='set_position' toNode='V'/>	
39				
40				-
				F.
33	15	INS		

GeoPositionInterpolator node X3D-Edit

Edit GeoPositionInterpolator								
DEF GPI ContainerField USE Children								
geoSystem GD WE key, keyValue arrays								
#	key	х	У	Z				
0	0	51.512199	-0.065	10000000				
1	0.1	48.865002	2.35	1000000				
2	1000000							
3 1 51.512199 -0.065 10000000								
Edit row: Copy Add Remove Append: commas, Ine breaks								



GeoProximitySensor node

Generates events when the viewer enters, exits, and moves within a box region of space

- Vertically aligned with local +Y axis up Similar to regular ProximitySensor node
- Adds *geoCenter*, *geoCoord_changed*, *geoSystem* fields

Consistent behavior throughout

- geoCoord_changed value corresponds to the world position returned by position_changed
- Output values are referenced to geospatial coordinate system defined by *geoSystem*

GeoProximitySensor example

• TODO: example needed!





GeoProximitySensor node X3D-Edit

• TODO: implementation needed!





GeoTouchSensor node

Similar to regular TouchSensor node

- Adds *hitGeoCoord_changed*, *geoSystem* fields
- Consistent behavior throughout
- hitGeoCoord_changed value replaces
 TouchSensor position_changed
- Output values are referenced to geospatial coordinate system defined by *geoSystem*





🤟 GeoTouchSensorExample.x3d - Editor	
🔆 GeoTouchSensorExample.x3d 🛛 🕿	
☞ ▶ • ▶ • • • • • • • • • • • • • • • •	
<pre>1 <?xml version="1.0" encoding="UTF-8"?></pre>	
2 X3D PUBLIC "ISO//Web3D//DTD X3D 3.0//EN" "http://www.web3d.org/specif</td <td>ications/x3d-3.0.dtd"></td>	ications/x3d-3.0.dtd">
3 - <x3d 1'="" name="Geospatial" profile="Immersive" version="3.0" xmlns:xsd="http://www.w3.org/2001/XMLSch</td><td>ema-instance" xsd:nonamespaceschemalocation="http://www.web3d</td></tr><tr><td>4 📮 <head></td><td></td></tr><tr><td><pre>5 <component level="></x3d>	
<pre>6 <meta content="GeoTouchSensorExample.x3d" name="title"/></pre>	
7 <meta brecht,="" content="This example shows the use of the GeoTouchSensor in order to</p></td><td>retrieve the geographic coordinate that the user is pointing</td></tr><tr><td><pre>8 <meta content=" international'="" john="" name="creator" sri=""/>	
<pre>9 <meta content="Don Brutzman" name="translator"/></pre>	
<pre>10 <meta content="22 April 2003" name="translated"/></pre>	=
<pre>11 <meta content="24 July 2010" name="modified"/></pre>	
12 <meta content="http://www.geovrml.org/examples" name="reference"/>	
<pre>13 <meta content="http://www.ai.sri.com/~reddy/geovrml/examples/showgdc/GTS_De</pre></td><td>mo.wrl" name="reference"/></pre>	
<pre>14 <meta content="X3D geospatial example" name="subject"/></pre>	
<pre>15 <meta content="http://www.web3d.org/x3d/content/examples/Basic/GeoSpatial/G</pre></td><td>eoTouchSensorExample.x3d" name="identifier"/></pre>	
<pre>16 <meta content="Vrml97ToX3dNist, http://ovrt.nist.gov/v2_x3d.html" name="gen</pre></td><td>erator"/></pre>	
<pre>17 <meta content="X3D-Edit 3.2, https://savage.nps.edu/X3D-Edit" name="generat</pre></td><td>.or"/></pre>	
<pre>18 <meta content="/license.html" name="license"/></pre>	
19 -	
20 - <scene></scene>	
21 <navigationinfo visibilitylimit="0"></navigationinfo>	
22 - <transform></transform>	
23 <background groundcolor="0.3 0.5 0.8" skycolor="0.3 0.5 0.8"></background>	
24 - <shape></shape>	
25 C <appearance></appearance>	
26 <material diffusecolor="0.75 0.75 0.75" emissivecolor="0.0 0.0 0.0" t<="" td=""><td></td></material>	
27 Z7 ImageTexture DEF='TEX' url='"earth.gif" "http://www.web3d.org/x3d/co	<pre>intent/examples/Basic/GeoSpatial/earth.gif"'/></pre>
28 -	
29 - <geoelevationgrid def="GEOEG" geocoords="0 0 0" geogridorigin="-90 -180 0" geosystem='"GD" "WE"' height="0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0</td></tr><tr><td>30 <GeoOrigin DEF=" origin'=""></geoelevationgrid>	
31 -	
32 -	
33 C <geotouchsensor def="GEOTOUCH" description="Select object to display posi</td><td>tion" geosystem='"GD" "WE"'></geotouchsensor>	
34 <geoorigin use="ORIGIN"></geoorigin>	
35 -	
36 /	
37 - <geoviewpoint description="Africa" geosystem='"GD" "WE"' navtype='"EXAMINE"</td><td>"ANY"' orientation="1.0 0.0 0.0 -1.57" origin'="" position="0 0 1000000</td></tr><tr><td>38 <GeoOrigin USE="></geoviewpoint>	
39	
40 <pre><geoviewpoint description="Mojave" geosystem='"GD" "WE"' navtype='"EXAMINE"</pre></td><td>"ANY"' orientation="1.0 0.0 0.0 -1.57" origin'="" position="35 -118 100</td></tr><tr><td>41 <GeoOrigin USE="></geoviewpoint></pre>	
42 /	•
	•
33 22 TNS	

GeoTouchSensorExample.x3d part 2

🚾 GeoTouchSensorExample.x3d - Editor						
😽 GeoTouchSensorExample.x3d 🛛 🛚						
Mer Rev - R						
39 -						
40 GeoViewpoint description='Mojave' geoSystem='"GD"	"WE"' navType='"EXAMINE" "ANY"' orientation='1.0 0.0 0.0 -1.57' position='35 -118 100					
41 <geoorigin use="ORIGIN"></geoorigin>						
42 -						
43 GeoLocation DEF='GEOLOC'>	🕎 Edit GeoTouchSensor					
44 - <shape></shape>						
45 - <appearance></appearance>						
46 <material diffusecolor="1.0 0.0 0.0"></material>	DEF GEOTOUCH ContainerField					
47 - 48	USE ContainerField is field-label prefix indicating relati					
49 -						
50 - <billboard axisofrotation="0.0 0.0 0.0"></billboard>						
51 - <transform translation="0.0 0.0 0.0"></transform>						
52 - <shape></shape>	geoSystem GD WE					
53 🖸 <appearance></appearance>						
54 <material diffusecolor="1.0 1.0 1.0"></material>	enabled 🔽					
55 -	description Select object to display position					
56 C <text def="TXT" string='"GeoTouchSensor"'></text>						
57 <fontstyle size="300000.0"></fontstyle>						
58 -						
59 -						
60 -	Accept Discard Help					
61 -						
62 <geoorigin use="ORIGIN"></geoorigin> 63 -						
64 - <script def="SFTOMF"></td><td></td></tr><tr><td>65 <field accessType='outputOnly' name='value change</td><td>ed' type='MFString'/></td></tr><tr><td>66 <field accessType='inputOnly' name='set value' ty</td><td></td></tr><tr><td>67 <! [CDATA[ecmascript: function set value(value)</td><td></td></tr><tr><td><pre>68</td><td>Conversion script to</td></tr><tr><td>69 $var s2 = s[2]/1000;$</td><td>edit position value for</td></tr><tr><td><pre>70 value_changed = new MFString('Lat: ' + s[0]</pre></td><td></td></tr><tr><td>71 'Lon: ' + s[1]</td><td></td></tr><tr><td>72 'Elev: ' + s2</td><td>+ ' km'); display in reactioned</td></tr><tr><td>73 }</td><td></td></tr><tr><td>74]]></td><td></td></tr><tr><td>75 - </script>						
<pre>76 <route <="" changed'="" fromfield="hitGeoCoord_changed" fromnode="SFTOMF" geocoords="" geocoords_changed'="" pre="" value=""></route></pre>	_					
79 -	correcte soring conder in //					
80						

9 53 INS

GeoTransform node

Similar to regular Transform node

- Adds *geoCenter, geoSystem* fields
- Vertically aligned with local +Y axis up
 Consistent behavior throughout
- Allows regular animation of *translation*, *rotation*, other fields in a geospatial context





GeoTransform example

• TODO: example needed!





GeoTransform node X3D-Edit

Edit GeoTransform						
DEF ()			containerF	ield		
USE 🔘			children			
geoSystem	GD WE	•	modify]		
translation	0	0	0]		
rotation	0	0	1	0		
geoCenter	0	0	0]		
scale	1	1	1]		
scaleOrientation	0	0	1	0		
bboxCenter	0	0	0]		
bboxSize	-1	-1	-1]		
	normalize rotation and scaleOrientation values					
Visualize Accept Discard Help						





GeoViewpoint node

Similar to regular Viewpoint node, but also integrates some fields from NavigationInfo

 Adds *hitGeoCoord_changed*, *geoSystem* fields

Consistent behavior throughout

- hitGeoCoord_changed value replaces
 TouchSensor position_changed
- Output values are referenced to geospatial coordinate system defined by *geoSystem*





M A1_GeoElevationGrid.x3d - Editor	
🚧 A1_GeoElevationGrid.x3d 🛛 🕺	
☞ 등 - 등 - 즉 등 등 등 상 & & 1 1 2 2 ● □ マ ♥ →	
<pre>1 <?xml version="1.0" encoding="UTF-8"?></pre>	
2 X3D PUBLIC "ISO//Web3D//DTD X3D 3.0//EN" "http://www.web3d.org/specif</td <td>ications/x3d-3.0.dtd"></td>	ications/x3d-3.0.dtd">
3 - <x3d profile="Immersive" td="" version="3.0" xmlns:xsd="http://www.w3.org/2001/XMLSch</td><td>ema-instance" xsd:nonamespaceschemalocatic<=""></x3d>	
4 🛱 <head></head>	
<pre>5 <component level="1" name="Geospatial"></component></pre>	
<pre>6 <meta content="A1_GeoElevationGrid.x3d" name="title"/></pre>	
7 <meta content="Martin Reddy SRI, original example" name="creator"/>	
8 <meta content="Don Brutzman NPS, X3D encoding" name="creator"/>	
<pre>9 <meta content="26 June 2000" name="created"/></pre>	
<pre>10 <meta content="4 July 2004" name="modified"/></pre>	
11 <pre><meta content="under revision, not matching spec example. Trying to get Bac</pre></td><td>kground aligned." name="warning"/></pre>	
12 <pre><meta content="Specification example shows the use of the GeoElevationGrid a</pre></td><td>and the GeoViewpoint nodes.</td></tr><tr><td>13 A flat grid is mapped to the full extent of Earth latitude as</td><td>nd longitude." name="description"/></pre>	
14 <meta content="http://www.geovrml.org/1.0/doc/examples.html" name="reference</td><td>e"/> =	
<pre>15 <meta content="originals/exagearth.wrl" name="reference"/></pre>	
<pre>16 <meta content="http://www.geovrml.org/1.0/doc/examples/exagearth.wrl" name="</pre"/></pre>	
17 <meta 3.2,="" content="http://www.web3d.org/x3d/content/examples/Basic/GeoSpatial/A</p></td><td></td></tr><tr><td>18 <meta content=" https:="" name="generate</p></td><td>or" savage.nps.edu="" x3d-edit="" x3d-edit'=""/>	
<pre>19 <meta content="/license.html" name="license"/></pre>	
20 -	
21 - <scene></scene>	
22 This scene shows example GeoSpatial node relationships in a scene graph</td <td>n></td>	n>
23 <background groundcolor="0.1 0.1 0.8" skycolor="0.1 0.1 0.8"></background>	
24 <pre><geoviewpoint description="Initial GeoViewpoint" fieldofview="0.785398" geo<="" pre=""></geoviewpoint></pre>	
25 jump='true' orientation='1 0 0 -1.57' position='35.0 70.0 300' 26 - <shape></shape>	00000. speedractor=.1./>
27 - <appearance></appearance>	
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GeoViewpoint node X3D-Edit

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			Visualize Accept	Discard <u>H</u> elp			

deprecated: GeoOrigin node

Originally included in GeoVRML, X3D scenes to provide shared-reference origin point

- Intended to reduce spatial roundoff errors
- Adds to scene complexity

However this scene information is duplicative

• Since latitude/longitude or UTM coordinates also provide precise location information

Thanks to research by Chris Thorne, proper player workarounds have been figured out

• Deprecated = allowed but unnecessary

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X3D Earth





Example X3D Earth globes

Multiple globes are available online, although resolution is still fairly low

- HelloEarthOpenStreetMap.x3d using OpenStreetMap
- http://x3d-earth.nps.edu/7_levels_plus/tiles/0/globe.x3d
- http://x3d-earth.nps.edu/globe/MBARI1MinuteBathy/world.x3d
- http://x3d-earth.nps.edu/globe/SRTM30Plus/world.x3d





Globe production process

Dr. Byounghyun Yoo, MIT Singapore Alliance

- Tutorial for terrain Tile Production Chain
- Terrain Tile Production Course Slideset
- Rez tiling tool
- Example X3D-Earth Globes





X3D Earth vision, mission

X3D Earth Working Group

http://www.web3d.org/x3d-earth

Vision

• Make it easier to create, use 3D spatial data

Mission

 Promote spatial data use within X3D via open architectures





X3D Earth design workshop

X3D Earth Technical Requirements Workshop

- Naval Postgraduate School, Monterey California USA, 14-15 November 2006
- Summary report available

Twenty presentations provide motivating requirements that continue to guide us today



web





Motivating goals: X3D Earth

Use the Web architecture, XML languages and open protocols

Build a standards-based X3D Earth of geospatial models

Results usable by governments, industry, scientists, academia and the general public





X3D Earth: what is it

Build a backdrop X3D model of planet Earth

- Use publicly available terrain datasets
- Use publicly available imagery
- Use X3D Geospatial Component throughout
- Provide linkable locations for any place
- Provide hooks for physical models
- Use open standards, extensions and process





Why X3D Earth is needed1

Proprietary commercial approaches are viable, but not necessarily over long term

- Many past commercial failures, shutdowns
- Even very large companies sometimes subject to economic pressures beyond their control

Government, science, research and academic needs are different than commercial needs





Why X3D Earth is needed2

Public and government assets need to be openly available over long term, indefinitely.

- Huge investment in data preparation
- Future rework/rewrite may not be possible
- Archiving, availability is essential prerequisite for many agencies
- New spatial applications become possible
 - including Semantic Web and search applications





What we are not proposing

Commercial competitor to other schemes

• They already have technologies of choice, economic imperatives and business models

Vive la difference

• Some commercial approaches may actually benefit by having an open approach widely available, providing new services & products





The key challenge is scalability

Because the only information systems capable of scalably growing to match global scope are the Internet and the World Wide Web, X3D Earth will deliberately follow the architectural principles of World Wide Web.

• Architecture of the World Wide Web, Volume One http://www.w3.org/TR/webarch





Data

3D, GIS communities have a wealth of data and imagery

- Both freely available and sustainably funded
- Significant metadata usually included
- Many different formats, not always searchable

Let's get consistent and professional about how to

- Represent, compose and harmonize such data in X3D
- Create "path of least resistance" to success
- Some converters already available (e.g. KML2X3D)
- [Insert 1 million metric tons of data resources here]



Science

Researchers model the world in detail already

• but rarely interconnect one to another

Most interesting part of "virtual reality" ?

• Reality – which means physics

Need hooks to connect physics engines, virtual sensors, propagation algorithms, live sources





Stepping up is inevitable

Long-running experience in 3D graphics has shown that each accomplishment leads to new (and sometimes unforeseen) challenges

• "Graphics Internetworking: Bottlenecks and Breakthroughs," chapter 4, *Digital Illusion*, Clark Dodsworth editor, ACM Press, Addison-Wesley, Reading Massachusetts, August 1997

X3D past, present are prelude to our next steps





Big trump cards

The hardest parts of the technical infrastructure are already proven possible

- Web3D X3D specifications
- W3C Recommendations
- OpenGIS Consortium (OGC) specifications
- Synthetic Environmental Data Representation and Interchange System (SEDRIS) specifications





Server-side 3D graphics

Our classical bias in the SIGGRAPH community is to think in terms of client-side 3D graphics

With terrain databases, imagery, cartography and worlds of related objects, the subject of attention becomes <u>server-side</u> 3D graphics

New issues of interest include preprocessing, prerendering, decimation and compression, digital signature, encryption, streaming etc.

Important work to mainstream X3D continues





Proven success story

Web3D Consortium members have the capabilities, resources and staying power to undertake this major new Web initiative.

Proof point: NPS already proposing and executing multiple ambitious projects with many Web3D members

All this work is unencumbered, repeatable





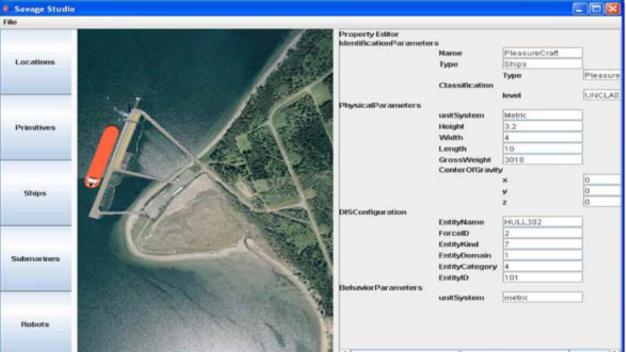






X3D-Earth









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Globe generation by supercomputer

- Obtain (usually LARGE) datasets
- Image files
- Terrain files
- Generate scripts
- process data into quad-tree pyramids

Dispatch scripts to supercomputer

- Tasks scheduled via Sun Grid Engine (SGE)
- Link top-level globe together with pyramids
- Publish to appropriate data server for access



Assets: Rez by Chris Thorne

"Open source framework and tools for translating gridded data, mainly geospatial, to different formats including images and multiresolution models for X3D or VRML web browsing"

Java program with multiple input/output plugins

Can be executed using a GUI or command line





Rez formats

Inputs

- DTED
- ASCII Grid
- XYZ
- DEM
- GeoVRML
 ElevationGrid

Outputs

- X3D
- VRML
- Contoured Jpeg
- Grey Scale Jpeg





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Continuing work





Proposed work: X3D v3.3 draft

- Maintained on member-only wiki
- Errata: fix GeoViewpoint field accessType to match Viewpoint
- Add full geospatial support to X3D nodes for Distributed Interactive Simulation (DIS) network protocol
- Need metadata linking scheme to allow rapid transition to high-resolution data, rather than forced loading of all intermediate quadtrees





Proposed: GeoTerrainLOD node

Reported in Web3D 2009 Symposium Harmonization of techniques

• backwards compatibility kept strictly separate

Is more refactoring needed?

 Overlapping functionality remains for GeoLOD, GeoTerrainLOD





Proposed: NavigationInfo accuracy field

- User navigation might be more forgiving or natural if accuracy constraints are sometimes relaxed
- Are there consistent lessons learned regarding such improvements for X3D?





Proposed: GpsSensor node

Many mobile devices include GPS capabilities

- X3D sensor types are designed to be generally extendable
- Should we provide native support in X3D so that authors can easily write GPS-aware scenes and applications?

Some overlap with Augmented Reality (AR) working group

• Needed: implementations, evaluation





Proposed: additional image formats?

Some formats commonplace for Earth imagery

- JPEG 2000
- GeoTIFF
- NITF
- TGA?

Some formats also embed information

• Such as geospatial metadata Should X3D players support them natively, rather than requiring conversion to disseminate?





Proposed: Projective Texture Mapping

PTM algorithm

- Project an image texture at some geometry
- Texture is then wrapped over that geometry

Obvious geospatial application to apply aerial imagery (or video) to terrain geometry

Requires multi-pass rendering

• Please see Korea Chapter proposal





Proposed: KML Interoperability

Multiple ways to improve interoperability between X3D and KML

- X3D embedded in KML files (allowed)
- KML embedded in X3D scenes as XML
- KML to X3D conversions (some available)
- Custom X3D nodes to represent KML data (some prototypes available)

This is an active area of current work





Testing

Need common baseline for consistent testing

- Dataset distribution of heavyweight archives? Local copies needed for consistent comparison of results
- OpenAerialMap restart a potential candidate, once ready
- Creating additional content for fly-throughs etc. using KML and conversion stylesheets





Performance measurement

Performance testing needed across X3D-Earth server, intervening network, and client display

- Collaborative partnership needed among builders of X3D-Earth software and globes
- Agreed-upon test suite
- Common reporting of results
- Hudson server-side build tests might automate the conduct of testing





Implementing experimental features

- Browser supported needed to test new fields before we can agree on new X3D capabilities or new "best practices"
- Use X3D Earth wiki to propose, record and analyze both progress and problems





Getting more people involved

- Making "wish lists" of needed activity, along with benefits to contributors and community
- Better documentation: website, wiki, code
- Video showcase?
- Reporting enterprise-wide approval, usage
- Example: Navy Marine Corps Internet (NMCI)





Siggraph 2010 Carto BOF

- Introductory Remarks (5 minutes) -Theresa-Marie Rhyne, Carto BOF Director
- X3D Update and Demonstrations -Don Brutzman & Team
- Visitcity Project using X3D & OGC technology) Peter Schickel. BitManagement
- RayGun, an iPhone and Android based Geographic Platform - David Colleen, Planet9





Siggraph 2011 Carto BOF

- Introductory Remarks (5 minutes) -Theresa-Marie Rhyne, Carto BOF Director
- BitManagement Geospatial Capabilities and Visitcity Project using X3D & OGC technology Peter Schickel, BitManagement
- 3D Portrayal Interoperability Experiment (3DPIE), Benjamin Hagerdorn, OGC
- X3D Update and Evolution, Don Brutzman



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Additional Resources





KmlToX3dViewpointTour Prototype

Input

• KML file containing placemarks

Conversion

• XSLT stylesheet

Output

- X3D scene with corresponding set of viewpoints
- plus a ViewpointTour prototype to sequence through them

web **3D** CONSORTIUM



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Chapter Summary





Chapter Summary

X3D geospatial component allows positioning objects at correct geospatial locations

X3D Earth project is building globes of interest using a variety of terrain, imagery datasets

Ongoing work to build repeatable, royalty-free results available for broad use





Suggested exercises

Map a building or object to geospatial location

- Then add Inline for an X3D-Earth globe Create a terrain tile
- Pick a location of interest
- Use GlobalMapper (or some other tool for assisted downloads) to retrieve terrain geometry and corresponding imagery
- Follow details in tutorial to accomplish this Convert GPS tracks or other data into X3D





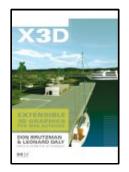
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References





X3D: Extensible 3D Graphics for Web Authors by Don Brutzman and Leonard Daly, Morgan Kaufmann Publishers, April 2007, 468 pages.



- Chapter 3, Grouping Nodes
- http://x3dGraphics.com
- http://x3dgraphics.com/examples/X3dForWebAuthors

X3D Resources

http://www.web3d.org/x3d/content/examples/X3dResources.html





X3D-Edit Authoring Tool

https://savage.nps.edu/X3D-Edit

X3D Scene Authoring Hints

• http://x3dgraphics.com/examples/X3dSceneAuthoringHints.html

X3D Graphics Specification

- http://www.web3d.org/x3d/specifications
- Also available as help pages within X3D-Edit





TODO

- Martin Reddy book
- Chris Thorne disseration
- Mike McCann papers, site, GeoVRML
- Craig Anslow thesis





TODO

- GeoVRML, X3D geospatial papers
- NPS thesis list





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http://faculty.nps.edu/brutzman

Code USW/Br, Naval Postgraduate School Monterey California 93943-5000 USA 1.831.656.2149 voice





CGEMS, SIGGRAPH, Eurographics

The Computer Graphics Educational Materials Source(CGEMS) site is designed for educators

- to provide a source of refereed high-quality content
- as a service to the Computer Graphics community
- freely available, directly prepared for classroom use
- http://cgems.inesc.pt

X3D for Web Authors recognized by CGEMS! ③

- Book materials: X3D-Edit tool, examples, slidesets
- Received jury award for Best Submission 2008

CGEMS supported by SIGGRAPH, Eurographics







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'our fair dealing and other rights are in no way affected by the above

web|3

Open-source license for X3D-Edit software and X3D example scenes

http://www.web3d.org/x3d/content/examples/license.html

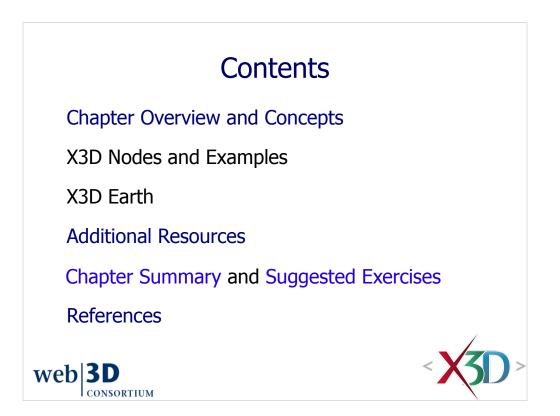
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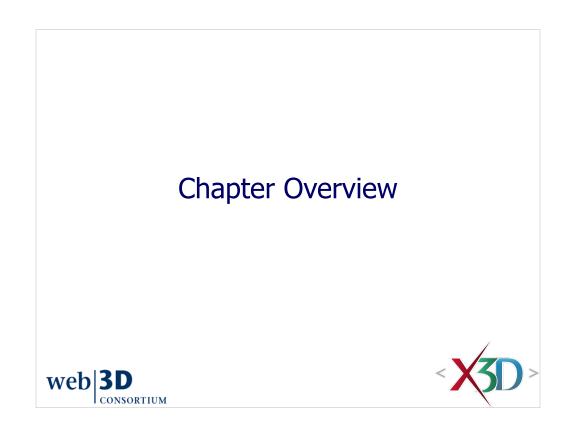
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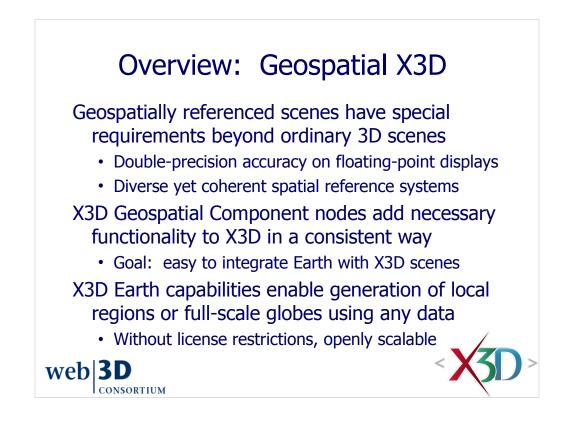
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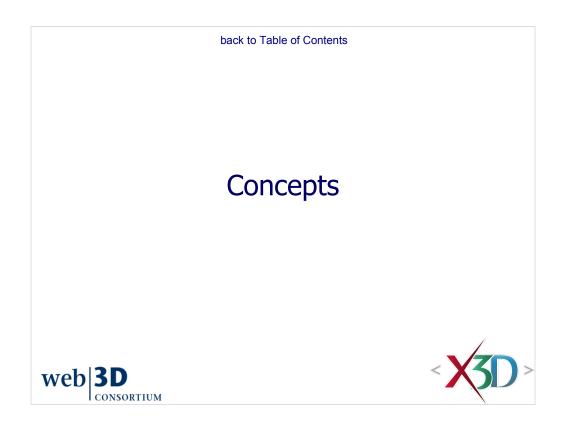
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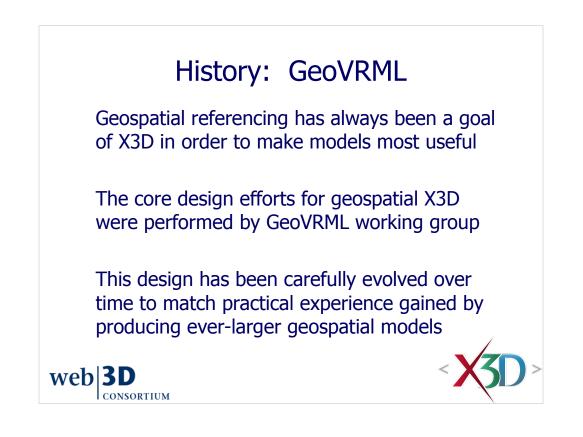


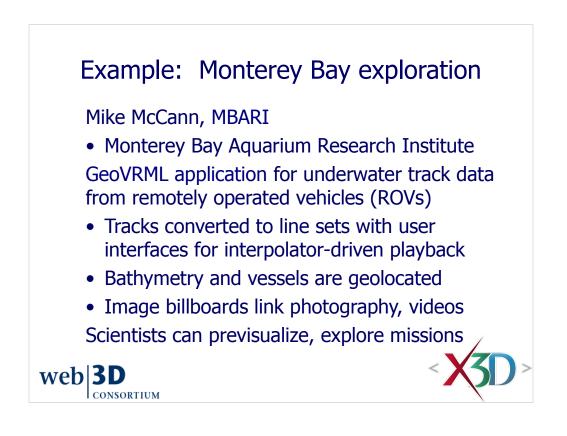


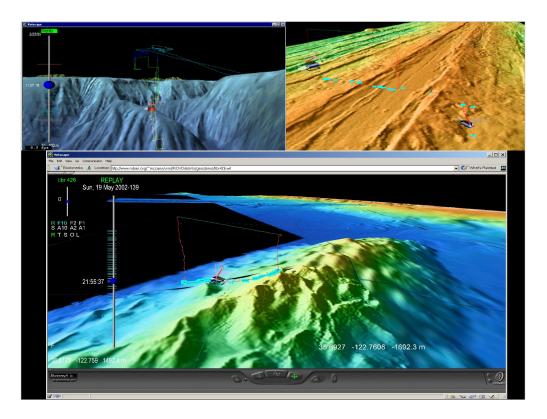












MBARI Web3D Applications

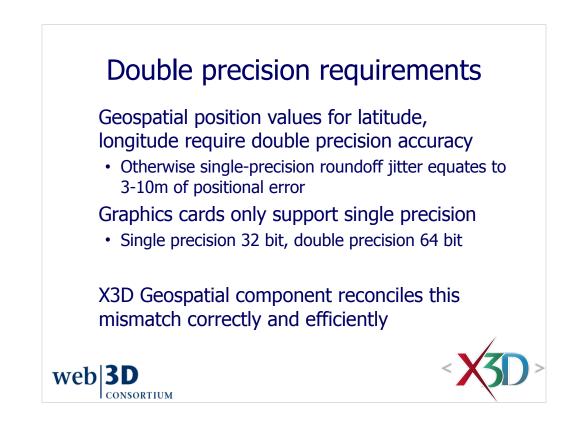
http://www.mbari.org/staff/mccann/vrml/ROVDataVis

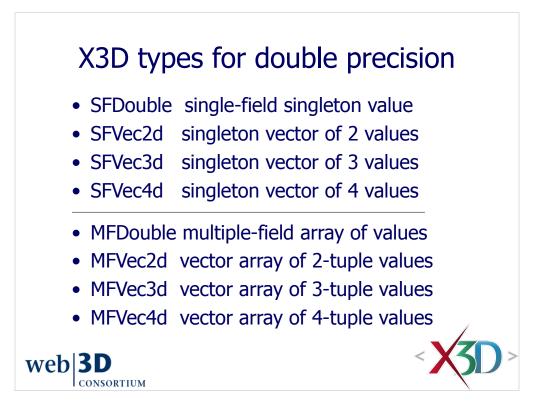
MBARI Web3D Applications: 3D Replay requirements and FAQ

http://www.mbari.org/staff/mccann/vrml/ROVDataVis/geodemo/geoVRMLreqts.html

Michael P. McCann, "Creating 3D Oceanographic Data Visualizations for the Web," Web3D 2002 Sympsium. ACM SIGGRAPH.

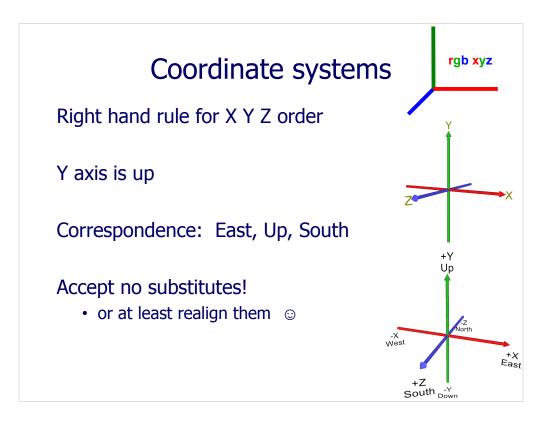
• http://www.mbari.org/staff/mccann/vrml/ROVDataVis/papers/w3ds2002Paper.pdf





X3D Specification: field types reference

• http://www.web3d.org/x3d/specifications/ISO-IEC-19775-1.2-X3D-AbstractSpecification/Part01/fieldsDef.html



See Figures 3.1 and 3.1, page 68, X3D for Web Authors

There are a total of eight different Euler angle systems, each with different relative orientations for the X, Y and Z axes.

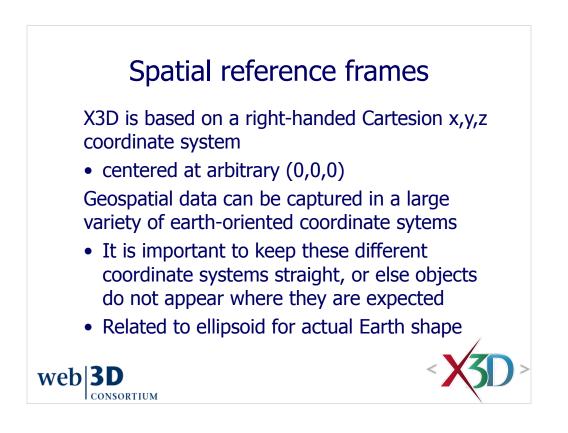
Half of these follow a left-hand rule, rather than a right-hand rule. Occasionally a graphics book comes out that presents mathematical equations using a left-hand rule. Immediately throw such books in the fire so that further pain and suffering is prevented!

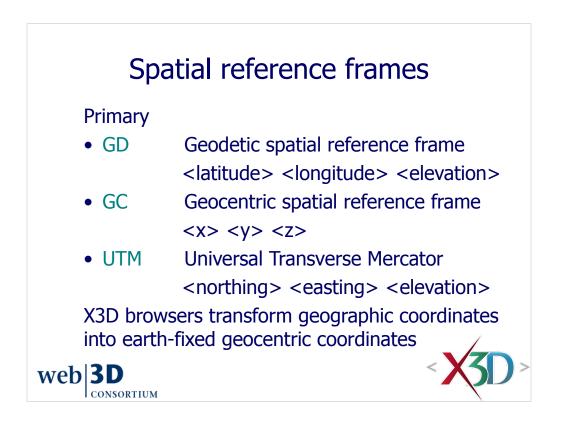
The second and third displayed examples are

http://www.x3dbook.com/examples/X3dForWebAuthors/Chapter03-Grouping/CoordinateAxesNSEW.x3d

http://X3dGraphics.com/examples/X3dForWebAuthors/Chapter03-Grouping/CoordinateAxes.x3d http://X3dGraphics.com/examples/X3dForWebAuthors/Chapter03-Grouping/CoordinateAxesInlineExample.x3d

Ordinarily we ignore correspondences with geographic North, South, East and West, since regular X3D coordinates are single-precision floating point, while the Geospatial nodes use double-precision floating-point values in order to capture latitude and longitude coordinates with sufficient accuracy.

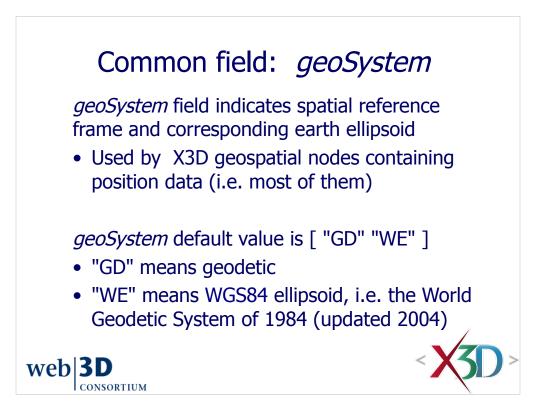




Supported	earth	ellipsoids
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Code	Ellipsoid Name	Semi-Major Axis (metres)	Inv. Flattening (F-1)
AA	Airy 1830	6377563.4	
AM	Modified Airy	6377340.19	299.32
AN	Australian National	6378160	298.25
BN	Bessel 1841 (Namibia)	6377483.87	299.15
BR	Bessel 1841 (Ethiopia Indonesia)	6377397.16	299.15
сс	Clarke 1866	6378206.4	294.98
CD	Clarke 1880	6378249.15	293.47
EA	Everest (India 1830)	6377276.35	300.8
EB	Everest (Sabah & Sarawak)	6377298.56	300.8
EC	Everest (India 1956)	6377301.24	300.8
ED	Everest (W. Malaysia 1969)	6377295.66	300.8
EE	Everest (W. Malaysia & Singapore 1948)	6377304.06	300.8

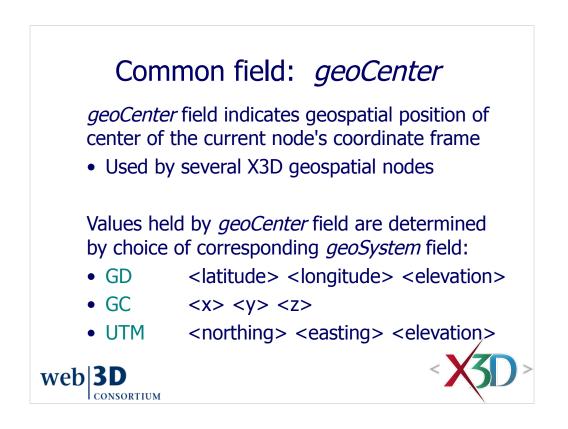
Code	Ellipsoid Name	Semi-Major Axis (metres)	Inv. Flattening (F-1)
EF	Everest	6377309.61	300.8
	(Pakistan)		
FA	Modified	6378155	298.3
	Fischer 1960		
HE	Helmert 1906	6378200	298.3
но	Hough 1960	6378270	297
ID	Indonesian 1974	6378160	298.25
IN	International 1924	6378388	297
KA	Krassovsky 1940	6378245	298.3
RF	Geodetic Reference System 1980 (GRS 80)	6378137	298.26
SA	South American 1969	6378160	298.25
WD	WGS 72	6378135	298.26
WE	WGS 84	6378137	298.26



World Geodetic System, http://en.wikipedia.org/wiki/WGS84 From Wikipedia, the free encyclopedia (Redirected from WGS84)

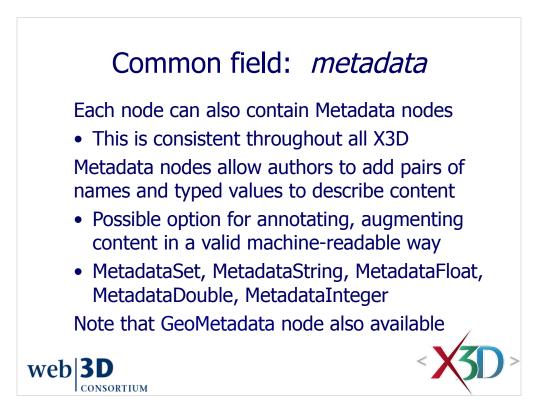
> The World Geodetic System is a standard for use in cartography, geodesy, and navigation. It comprises a standard coordinate frame for the Earth, a standard spheroidal reference surface (the datum or reference ellipsoid) for raw altitude data, and a gravitational equipotential surface (the geoid) that defines the nominal sea level.

The latest revision is WGS 84 (dating from 1984 and last revised in 2004), which will be valid up to about 2010. Earlier schemes included WGS 72, WGS 66, and WGS 60. WGS 84 is the reference coordinate system used by the Global Positioning System.



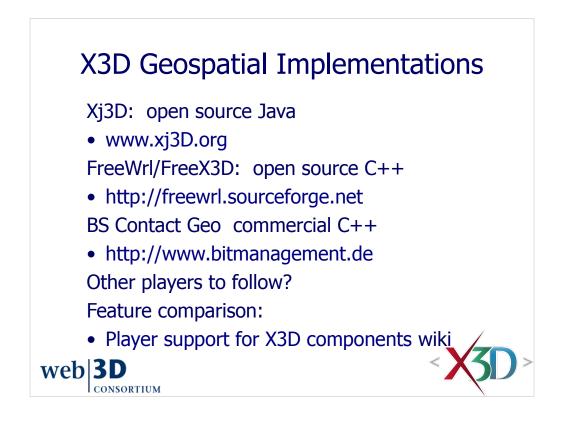
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	GC C Cancel
	geoid default default WGS84 World Geodetic System (dated 1984, revised 2004) WGS84 World Geodetic System (dated 1984, revised 2004) OK Cancel

TODO: GC tooltip

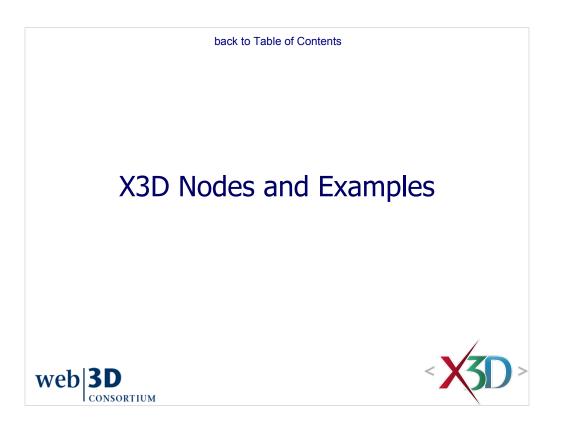


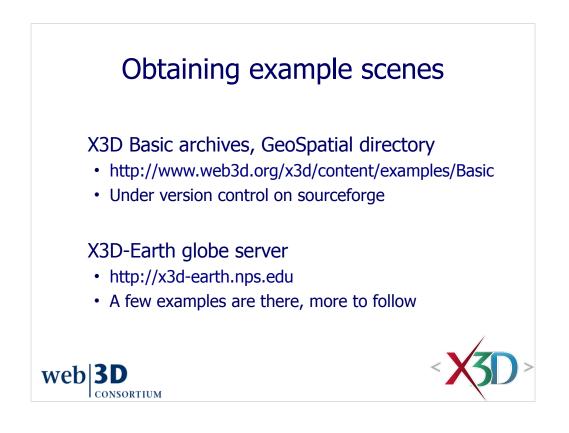
See X3D Abstract Specification Core Componentfor Metadata node definitions

X3D for Web Authors textbook includes a free online Metadata chapter









Also in NPS Savage archives: specific locations available

2	ocations
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Baltimore Maryland
Dardanelles
Hampton Roads Virginia

Monterey Bay California

Narragansett Bay Rhode Island Small Rio De Janeiro Singapore Straits Of Malacca Large Bosphorus Fort Lauderdale Florida Hawaii Narragansett Bay Rhode Island Bathymetry

Panama City Florida

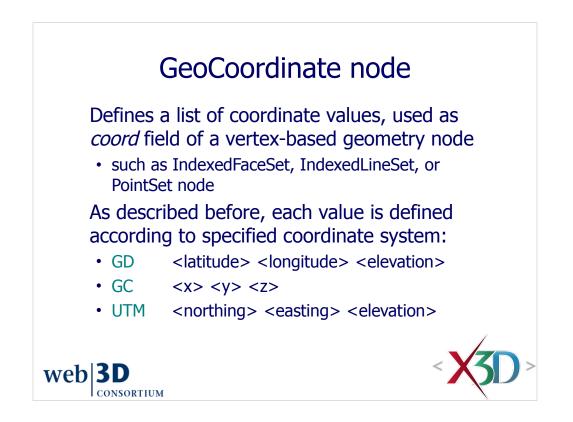
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Port Hueneme California

<u>Ship Island Mississippi</u> <u>Straits Of Hormuz</u> <u>Tunis Airport Tunisia</u>

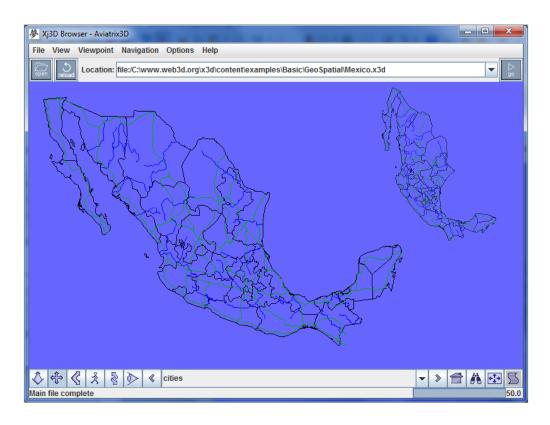






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http://www.web3d.org/x3d/content/examples/Basic/GeoSpatial/Mexico.x3d

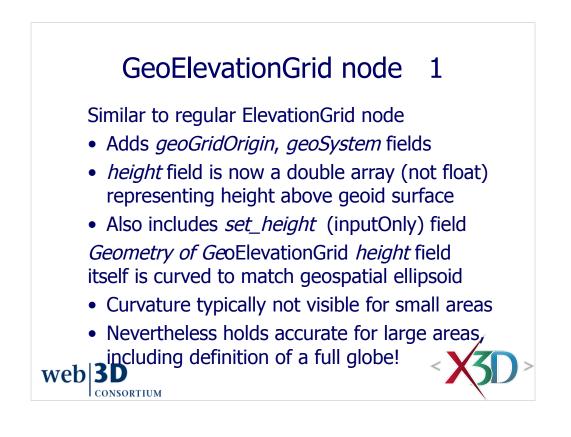


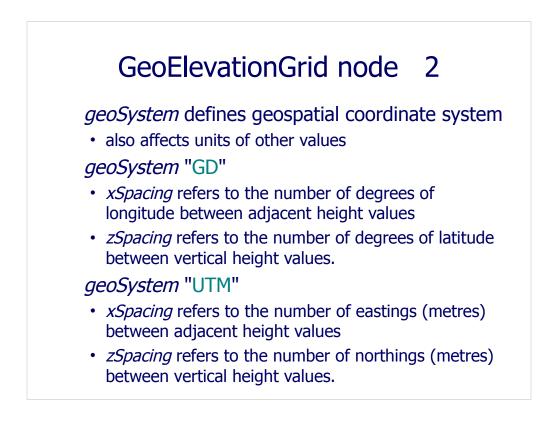
http://www.web3d.org/x3d/content/examples/Basic/GeoSpatial/Mexico.x3d

This is an interesting model of Mexico's major roads and rivers. Upon initial viewing, it simply looks like any other map of Mexico. Upon rotating the scene, however, it immediately becomes evident that the curvature of the Earth's surface is quite significant even at this scale.

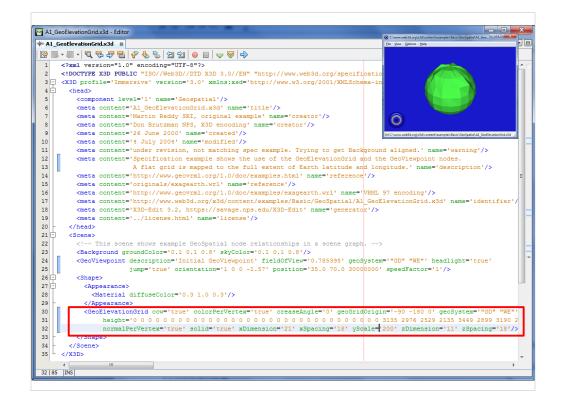
One might conclude that we are so used to flat projections of curved Earth surfaces that we really do not have a good intuitive feel of their actual shape.

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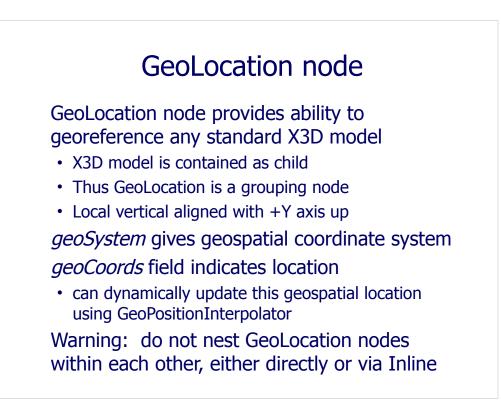


geoSystem "GC" is geocentric and so xSpacing, zSpacing units remain in meters.



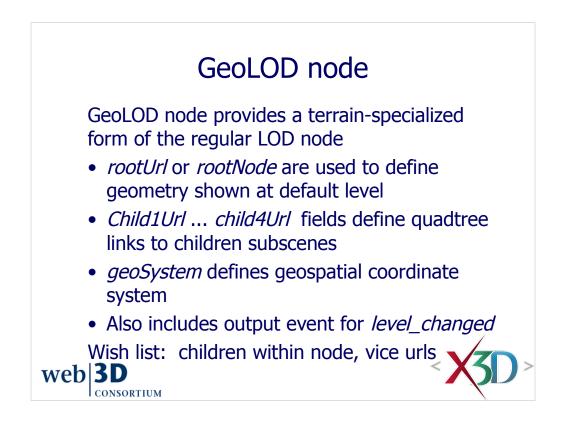
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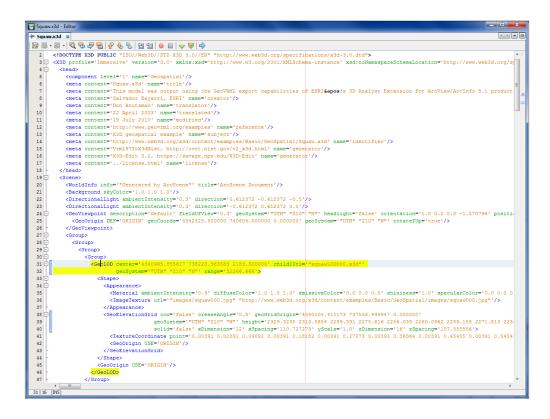
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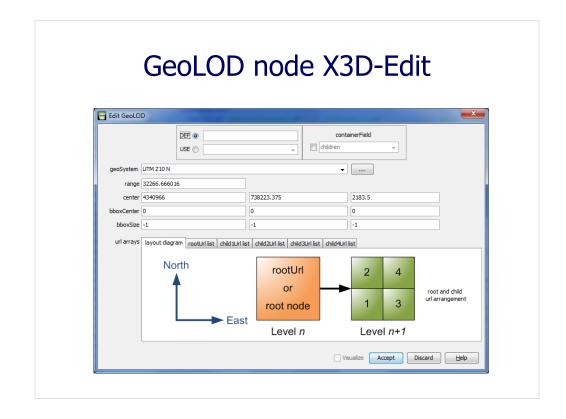
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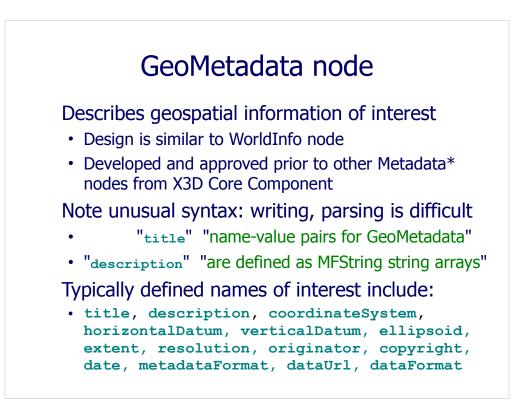
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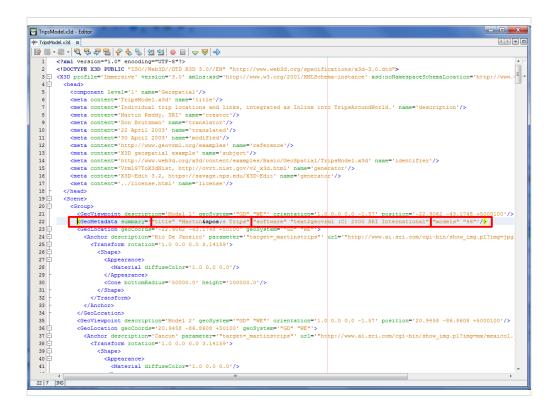




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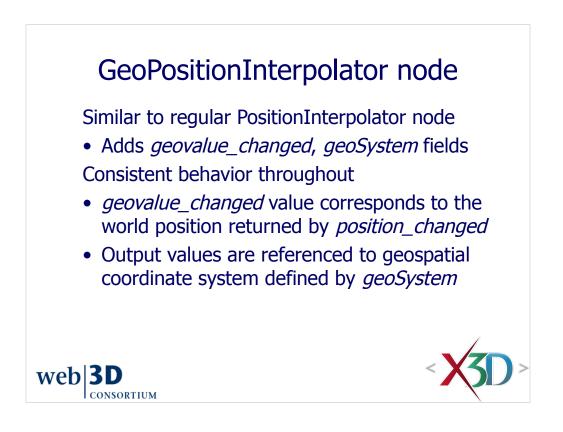


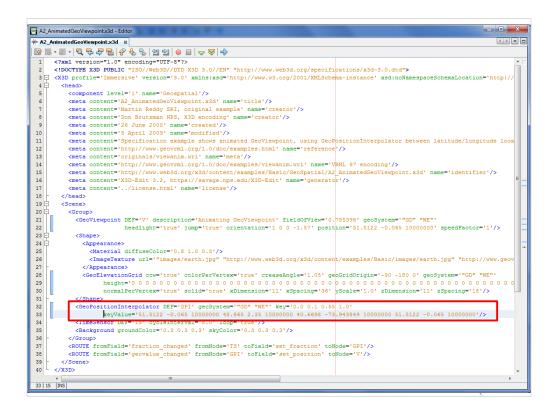




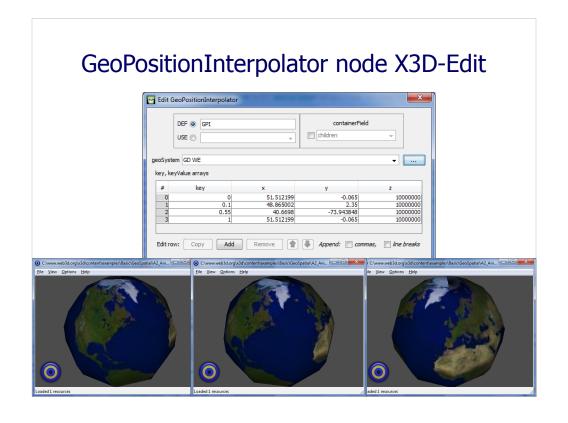
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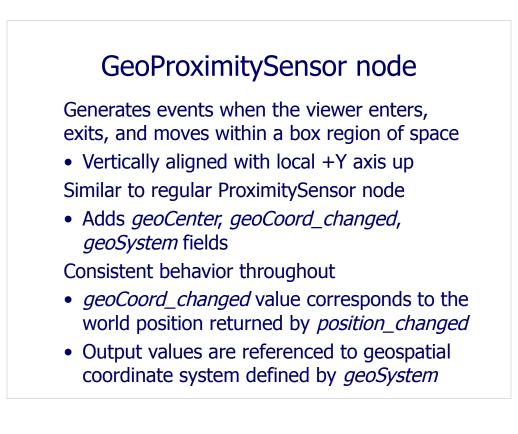
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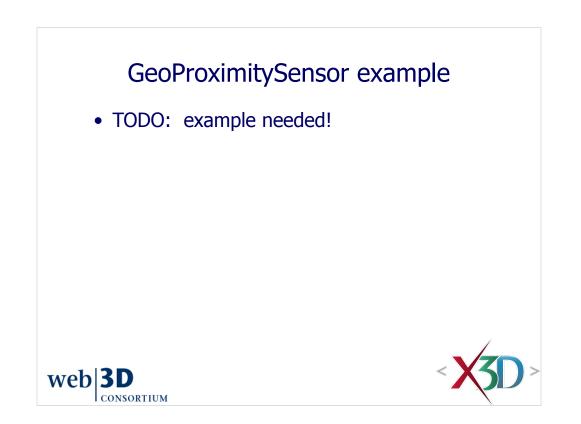


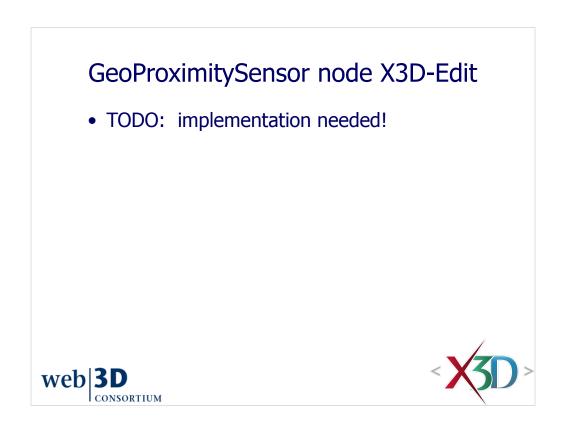


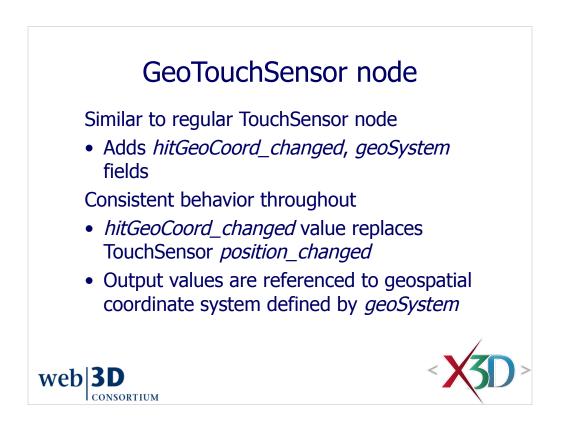
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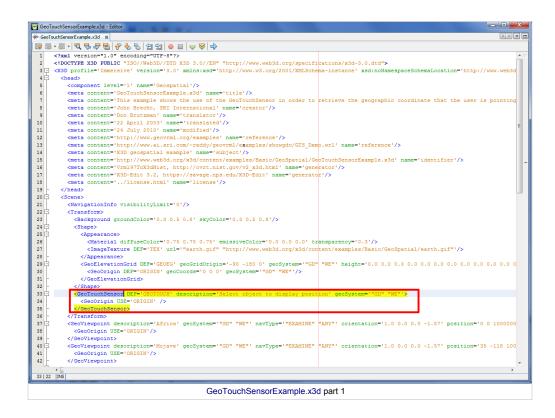








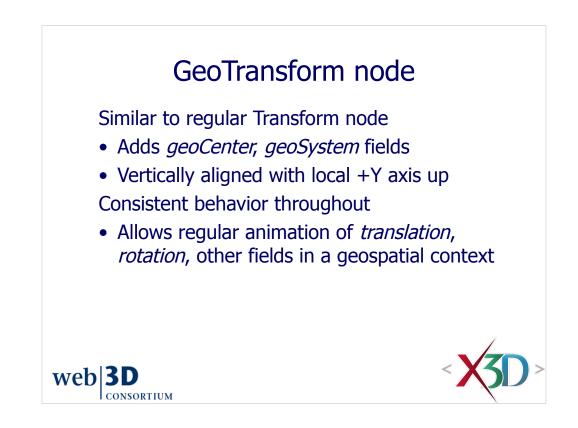


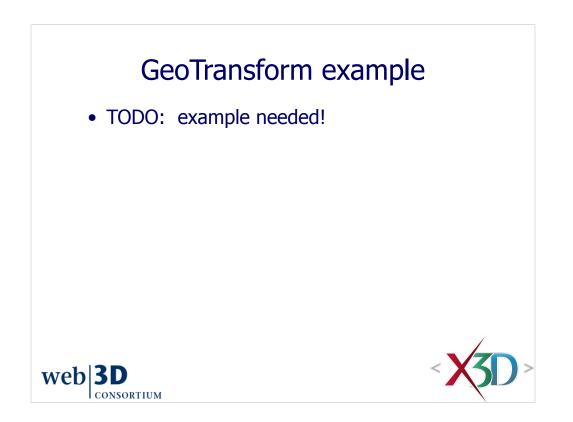


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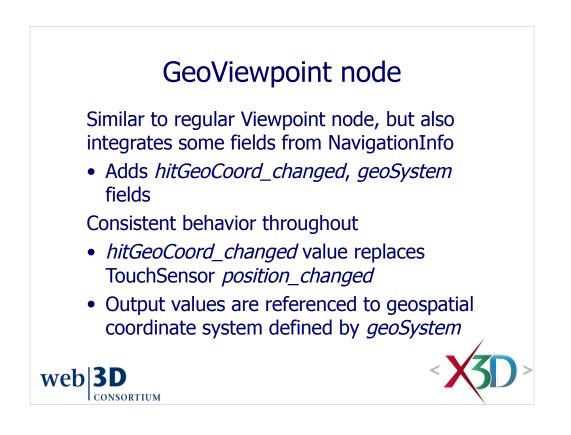
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<pre>Stol: <billboard axisofrotation="0.0 0.0 0.0"></billboard></pre>							
51 C							
52 G <shape> geoSystem GD WE</shape>							
53 C <appearance></appearance>							
54 <material diffusecolor="1.0 1.0 1.0"></material> enabled ♥							
55 - description Select object to display position							
se Kiext DEF='IXI' string='"Geolouchsensor"'>							
57 <fontstyle size="300000.0"></fontstyle>							
58 -							
So							
Ci - Accept Discard Help							
62 <geoorigin use="ORIGIN"></geoorigin>							
63 -							
64 CScript DEF='SFTOMF'>							
65 <field accesstype="outputOnly" name="value_changed" type="MFString"></field>							
<pre>66 <field accesstype="inputOnly" name="set_value" type="SFString"></field></pre>							
<pre>67 <!--(COATA[emasoript: function set_value(value) {</th--></pre>							
edit position value for							
¹¹ ¹² ¹ Lev; + s(1) + ¹ , display in Text node							
74 11>							
75 -							
76 <route fromfield="hitGeoCoord_changed" fromnode="GEOTOUCH" tofield="set_geoCoords" tonode="GEOLOC"></route>							
<pre>77 <route fromfield="geoCoords_changed" fromnode="GEOLOC" tofield="set_value" tonode="SFIOMF"></route></pre>							
78 <route fromfield="value_changed" fromnode="SFTOMF" tofield="string" tonode="TXT"></route>							
79 -							
80 L							
4 () 9 53 165							
- 2100 [mm]							

http://www.web3d.org/x3d/content/examples/Basic/GeoSpatial/GeoTouchSensorExample.x3d





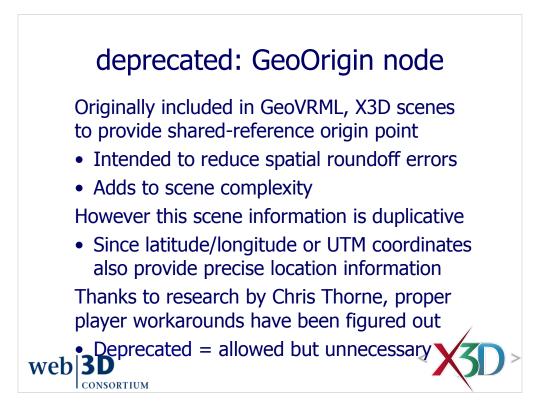
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1 xml version="1.0" encoding="UTF-8"?	*
2 X3D PUBLIC "ISO//Web3D//DTD X3D 3.0//EN" "http://www.web3d.org/specifications/x3d-3.0.dtd"	
3 - <x3d profile="Immersive" th="" version="3.0" xmlns:xsd="http://www.w3.org/2001/XMLSchema-instance" xsd:nonamespacesch<=""><th>hemaLocatic</th></x3d>	hemaLocatic
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8 <meta content="Don Brutzman NPS, X3D encoding" name="creator"/>	
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10 <meta content="4 July 2004" name="modified"/>	
11 <pre><meta <="" content="under revision, not matching spec example. Trying to get Background aligned." name="warning" pre=""/></pre>	·/>
12 <meta content="Specification example shows the use of the GeoElevationGrid and the GeoViewpoint nodes.</th><th></th></tr><tr><th>13 A flat grid is mapped to the full extent of Earth latitude and longitude." name="description</th><th>a"/>	
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15 <meta content="originals/exagearth.wrl" name="reference"/>	
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18 <meta content="X3D-Edit 3.2, https://savage.nps.edu/X3D-Edit" name="generator"/>	
19 <meta content="/license.html" name="license"/>	
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22 This scene shows example GeoSpatial node relationships in a scene graph	
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24 <geoviewpoint <="" description="Initial GeoViewpoint" fieldofview="0.785398" geosystem='"GD" "WE"' headlight="tr</td><td>rue" td=""></geoviewpoint>	
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26 C <shape></shape>	
27 - <appearance></appearance>	
28 <material diffusecolor="0.3 1.0 0.3"></material> 0 CumanblogiddocumetampularComp	fishA1_Geo_
29 -	
30 <geoelevationgrid ccw="true" colorpervertex="true" creaseangle="0" geogridorigin="</th"><th></th></geoelevationgrid>	
31 height='0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0	
32 normalPerVertex='true' solid='true' xDimension='21' xSpacing='18' yScale='20 33 -	
34 - 35 -	
U/I C/www.web3dorg/338.content/examples/Basic/GeoSpat	tial\A1_GeoElevationGrid.x3d 🥢

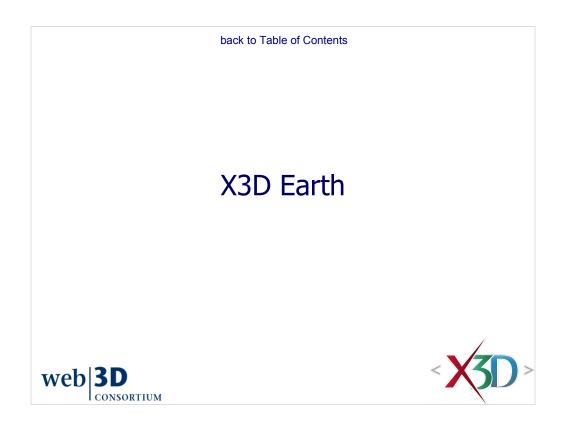
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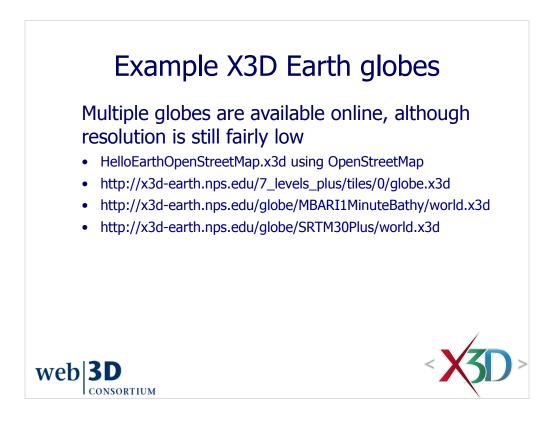
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			Visualize Accept	Discard Help



Deprecated means

Obsolescent; said of a construct in a computing language considered obsolete but still available for use, though planned to be phased out.

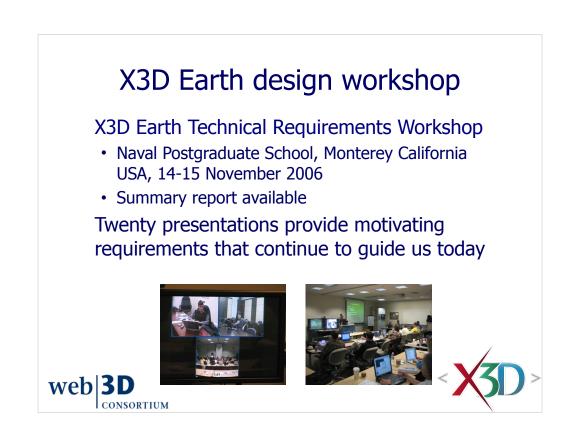




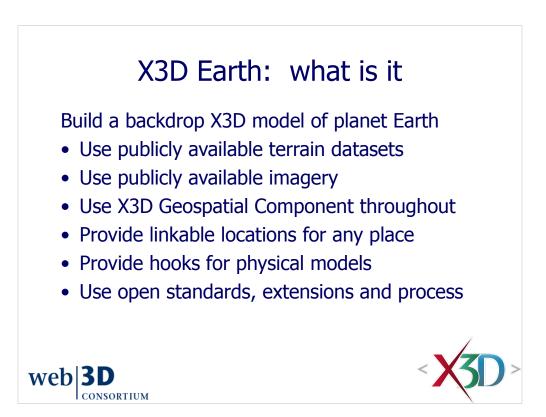
TODO linked images



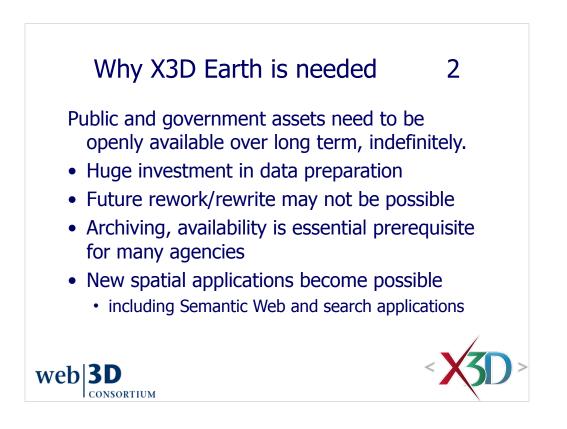


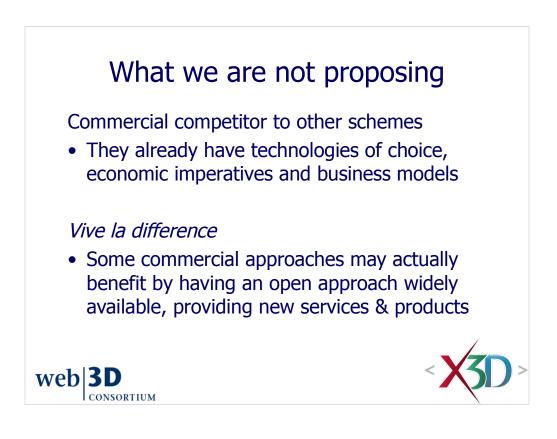




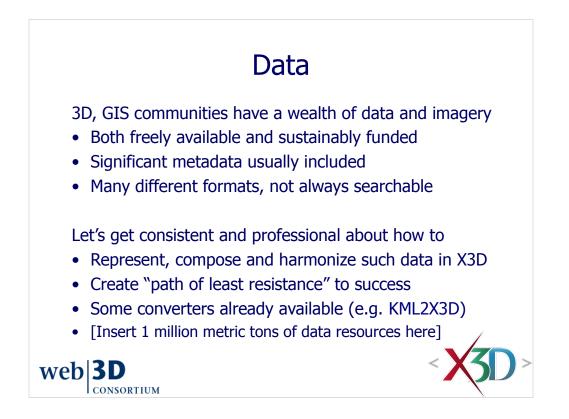


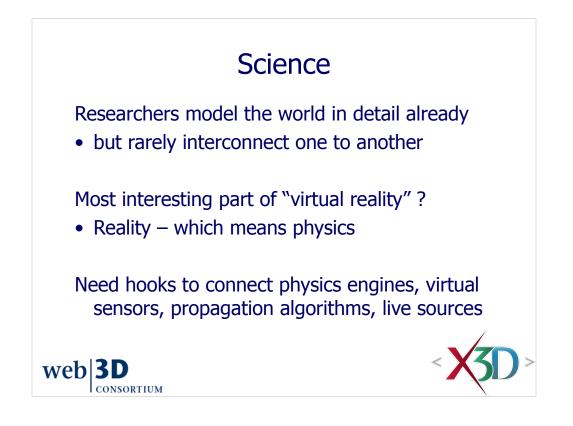


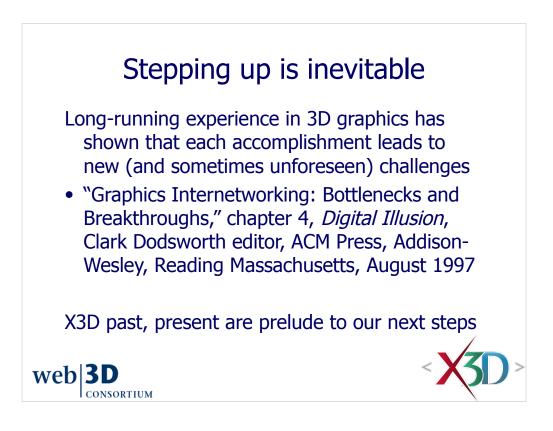


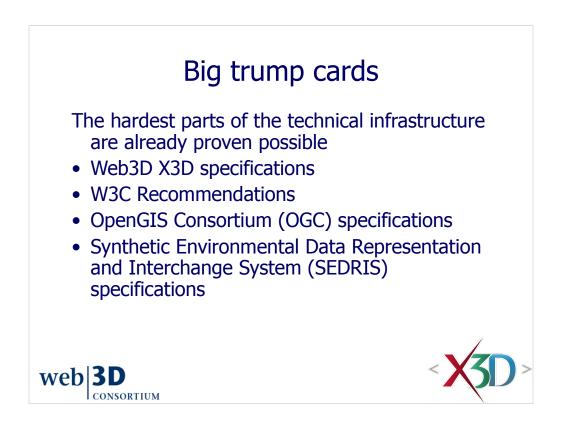


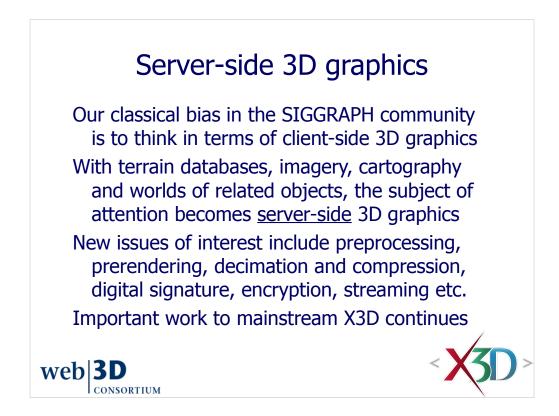


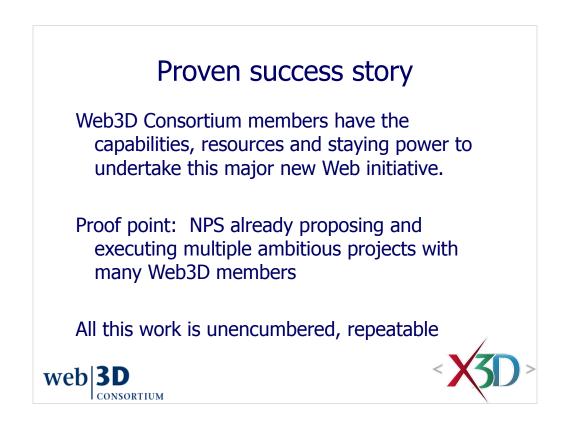




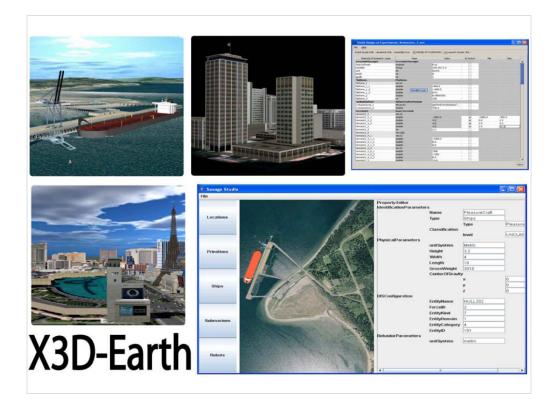




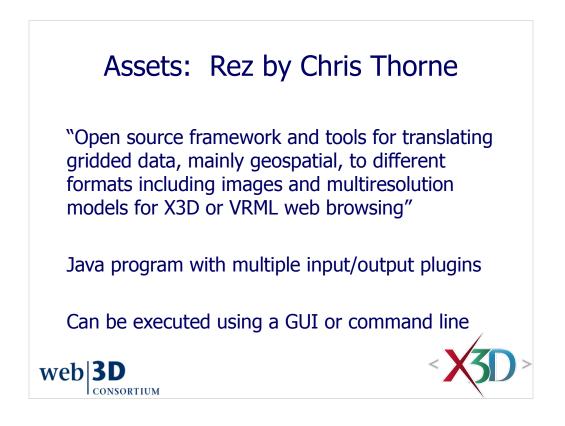


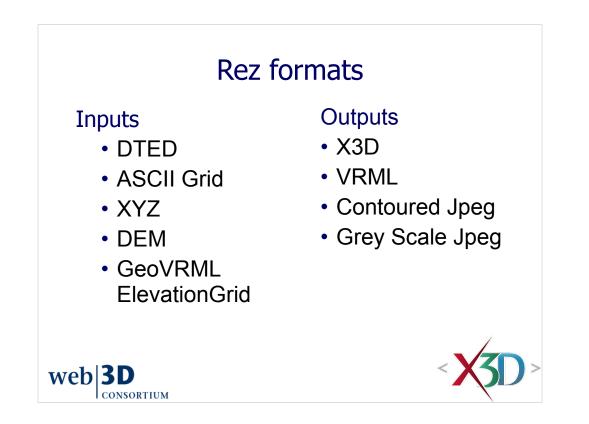


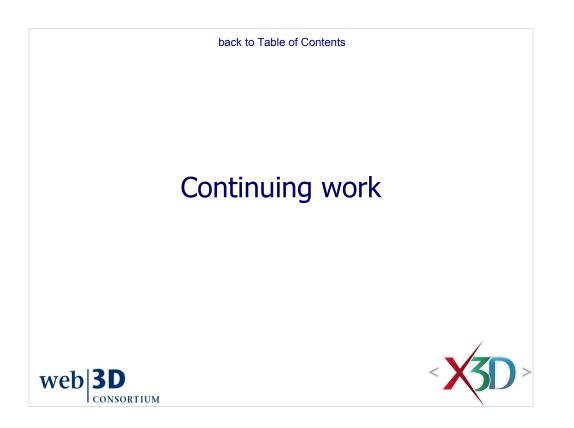


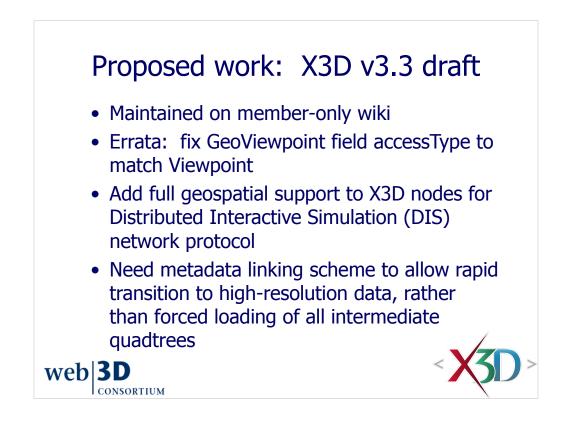


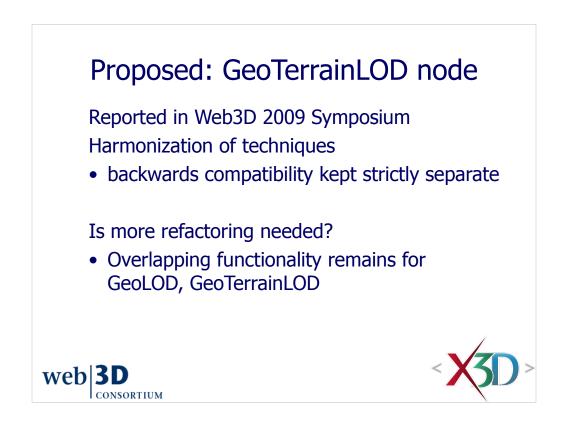


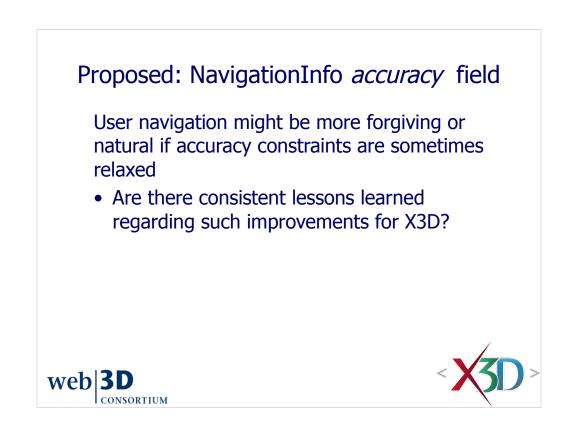


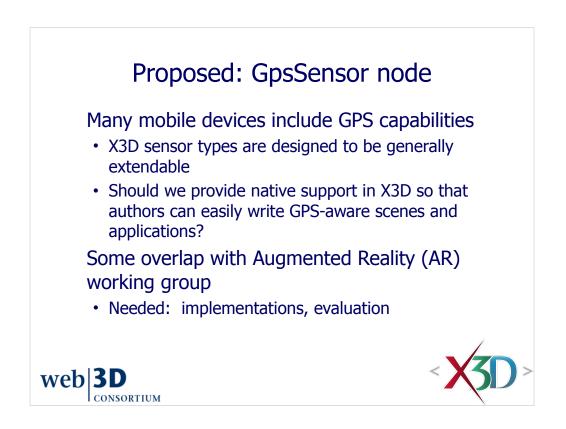


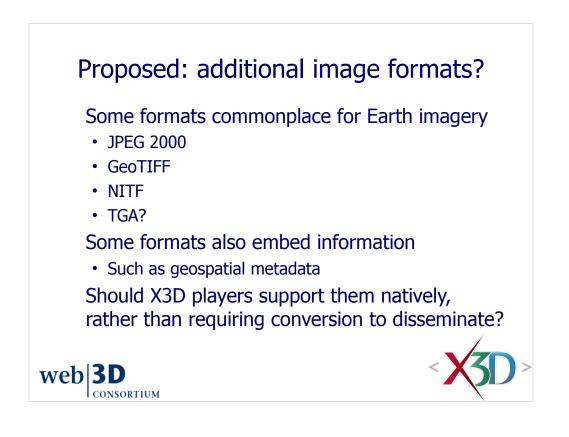


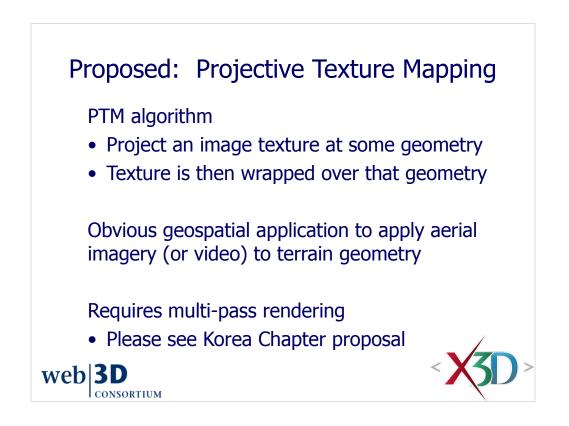


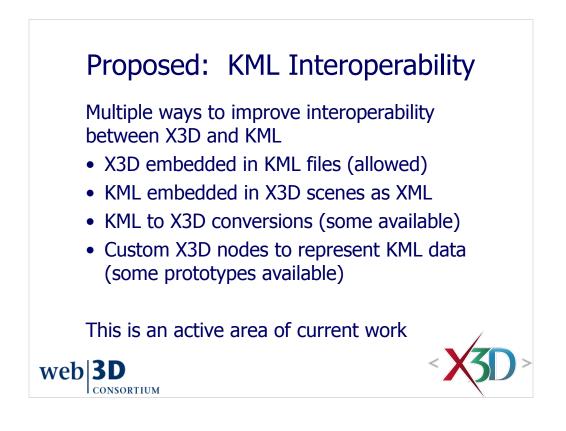


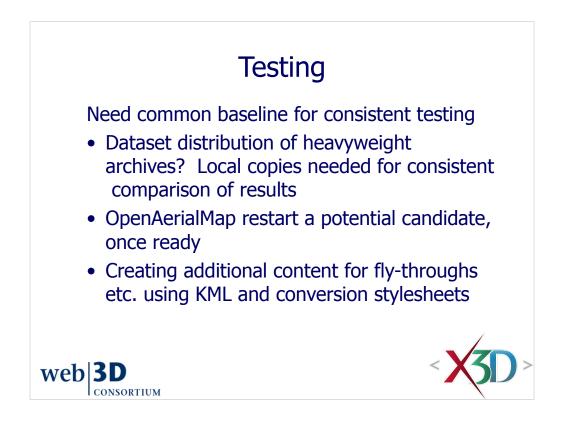


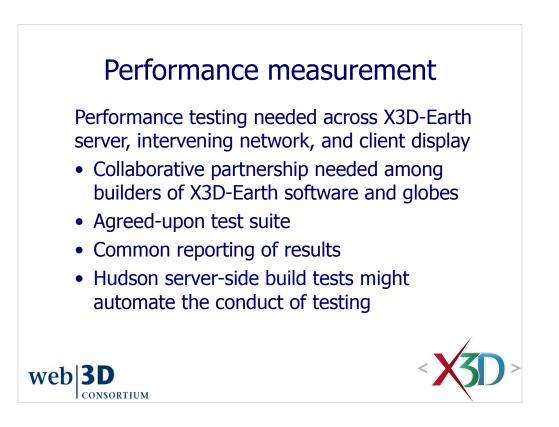


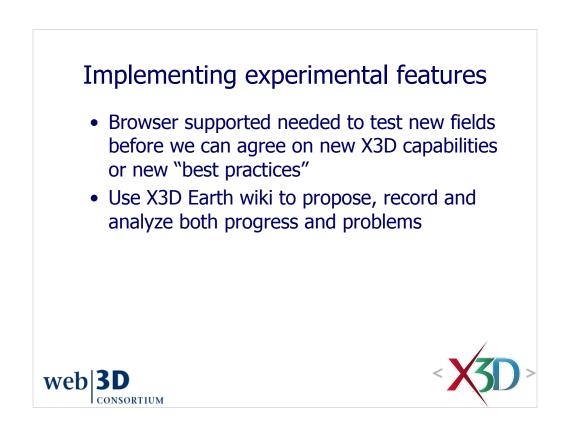


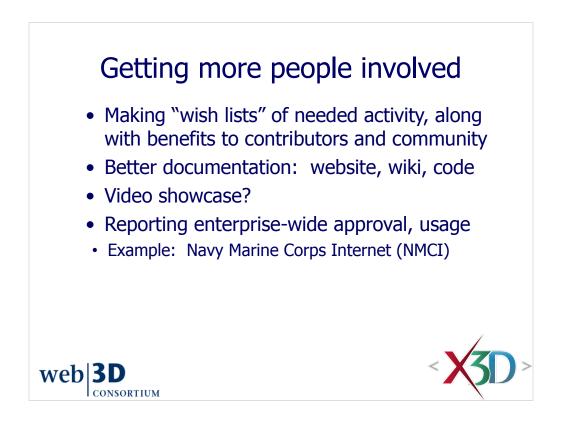




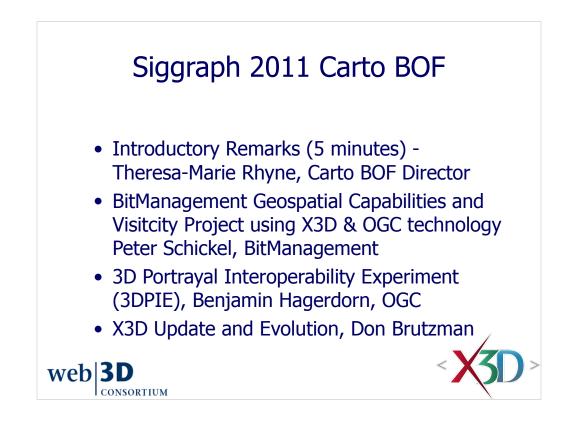


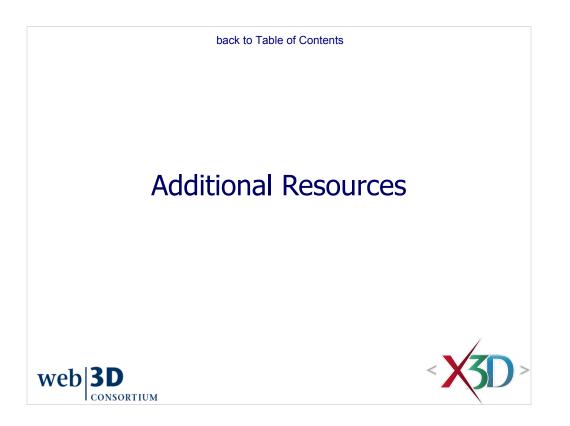


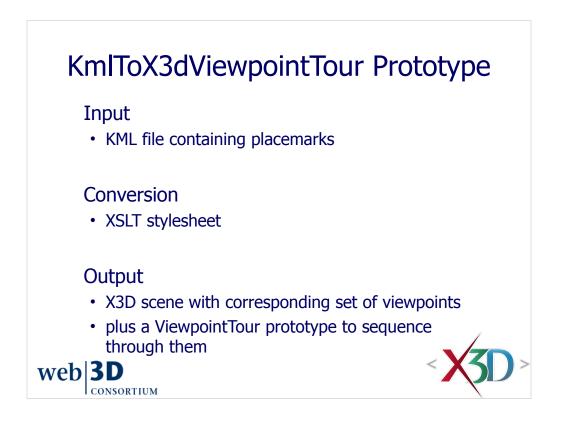


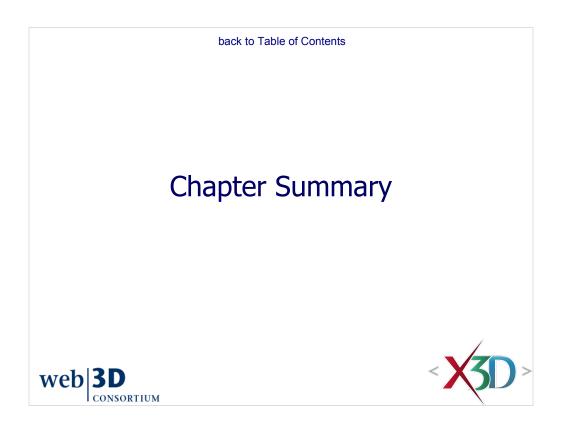


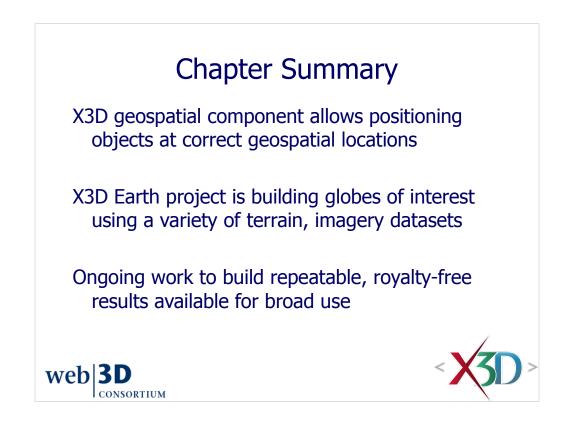


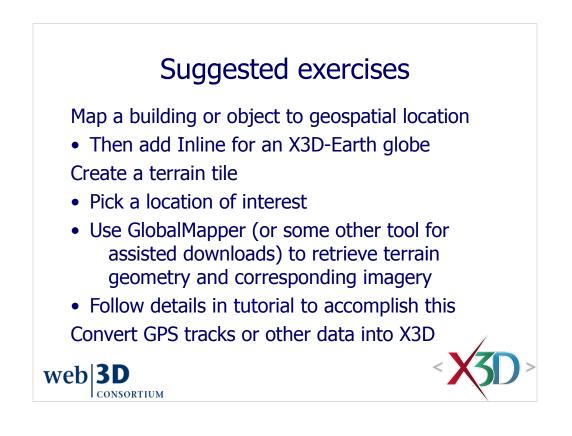


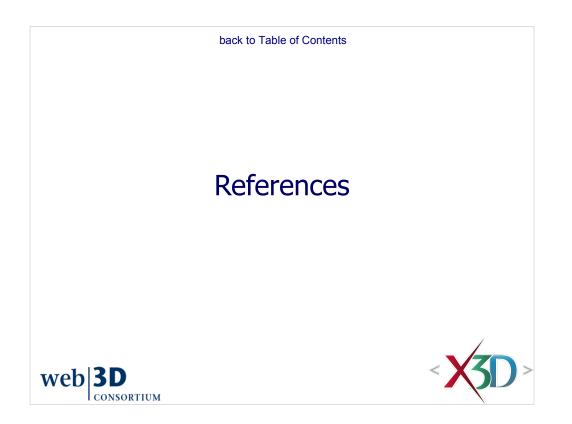


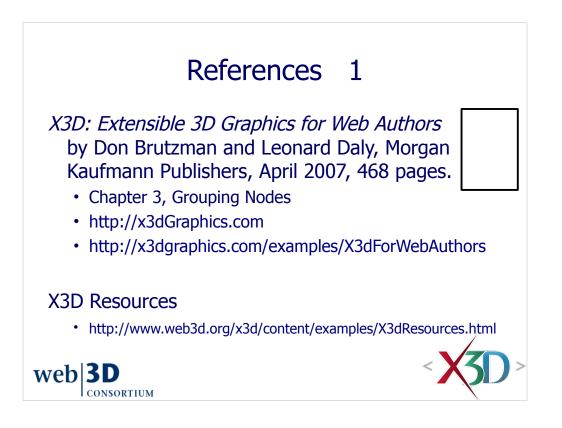


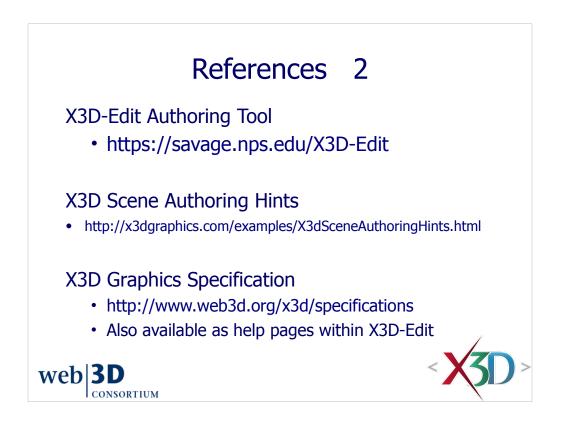


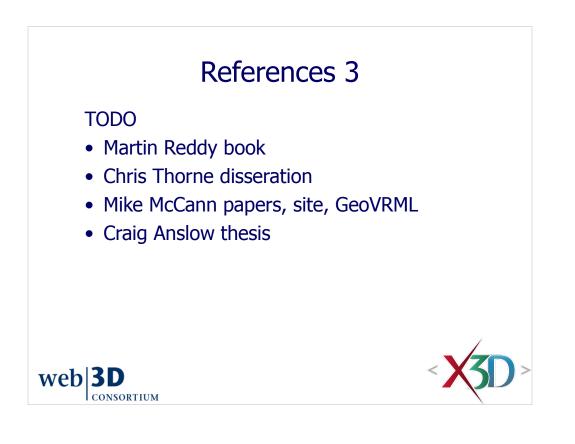


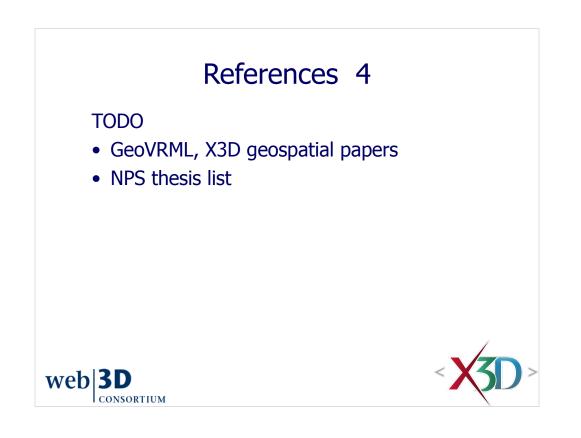
















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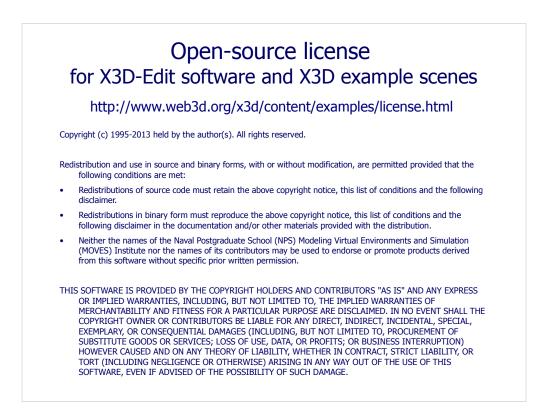
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Herz, J. C., Mark Lucas, John Scott, *Open Technology Development: Roadmap Plan*, Deputy Under Secretary of Defense for Advanced Systems and Concepts, Washington DC, April 2006. http://handle.dtic.mil/100.2/ADA450769





