GIS & 3D are Advancing

Buildings (BIM)

Facilities / Indoors

Plants / Structures

Networks

Utilities / Telecom

Pipelines

Roads and Highways

Cities

Smart City

Planning

Landscaipes

Environment

Topographic

Oceans

Geospatial Infrastructure

Digital Twin
3D Capabilities Are Integrated Across the ArcGIS System

Supporting Multiple 3D Workflows... A Complete 3D System of Record

... A Living Digital Twin
Indexed 3D Scene Layers (I3S)

I3S is an OGC Community Standard
http://www.opengeospatial.org/standards/i3s

The open community GitHub version of this Standard:
https://github.com/Esri/i3s-spec
I3S | Indexed 3D Scene Layer

Supports multiple Profiles and Layer Types

3D Objects
• 3D Shapes
• Trees
• Buildings
• Infrastructure

Point Scene Layer
• Point locations
• Symbolize with 3D Object Styling
• Can visualize attributes by size and color

Integrated Mesh Scene Layer
• Skin of the Earth
• Textured with imagery
• Captured by Drone2Map or other methods

Point Cloud Scene Layer
• LiDAR
• Photogrammetric points
• Style by elevation, color, classification

Building Scene Layer
• Detailed building models
• Read directly from Revit
• Filter categories and floors
3D Web GIS | Full 3D Visual Experience on the Web

3D Features
Database Driven

3D Mesh
Reality Capture
3D Web GIS | Line of Sight + Shadow Analysis
3D Web GIS | 3D City Visualization

Realistic

Schematic

Hand-drawn

The same I3S 3D Object Layer dynamically stylized
Climate Change & Disaster Response
Flood simulation
BIM Data in Geo Context

e.g. for visualization or facility management
glTF helps to Address

Consistency of assets between ArcGIS & 3rd-party applications.

Materials from 3rd Party tools (i.e. Sketchup, Blender, etc.) import into ArcGIS with inconsistencies (aesthetically look different).

Consistency of assets between ArcGIS & 3rd-party marketplaces.

Models from popular 3D marketplaces (i.e. Sketchfab) import into ArcGIS with inconsistencies (aesthetically look different).

Consistency of AutoCAD 3D models between ArcGIS & 3rd-party applications.

3D AutoCAD assets import into ArcGIS with inconsistencies (aesthetically look different).
gltf & 3D GIS | Servers as a glue

General Workflow

1. Model
   - glTF
   - OBJ
   - FBX
   - DWG

2. 3rd-party apps
   - Unreal
   - Twin Motion
   - Unity
   - Lumion
   - Lumion RT
   - Rhino 3D
   - Maya
   - 3D Max
   - Sketchup
   - Blender
   - Sim Scale
   - Real Flow
   - ArchiCAD
   - Flow3D
   - Infraworks

ArcGIS
- ArcGIS Pro
- ArcGIS Urban / CityEngine
- ArcGIS Online / Enterprise
- ArcGIS Earth / Runtime

Model
1. Analyst exports building footprint out of ArcGIS as gltF
2. Modeler imports building footprint into Maya
3. Modeler builds detailed building model on top of building footprint with Maya and Substance Designer
4. Modeler exports detailed building model out of Maya (i.e. glTF)
5. Analyst consumes detailed building model into ArcGIS as glTF
6. Analyst views detailed building model in ArcGIS Online or Earth/Runtime/Maps SDK
gltF & 3D GIS | Retain Consistency on the Web all platforms

Industries | Sectors

- GIS
- DoD
- Science, Research, & Education
- 3D & Game Development
- AEC
- 3D Modeler

Roles:
- 3D GIS Specialist
- City Planner (Graphics staff)
- Data Visualization Specialist
- Urban Designer
- GIS Technologist
- Architectural Designer
- Game Developer
- Visual Database Engineer
- Modeling / Simulation Analyst
- Research Scientist (CFD)
- GeoSpatial Intelligence Analyst
- 3D Modeler
- GIS Developer
- Architectural 3D Modeler
- Game Artist
- Modeling/Simulation Developer
- Synthetic Environment Designer
- Transportation Modeler
- 3D Artist
- Cartographer
- Civil Engineer
- Environmental Planner
- DoD Analyst
- Thermal Researcher
- Traffic Engineer
- GIS Analyst
- Plant Designer
- BIM Specialist
- Army GeoSpatial Engineer
- Flood Modeler
- Traffic Simulation Specialist
gltF in ArcGIS | Supported ‘Everywhere’

- **ArcGIS API for JavaScript** can load and place glTF and .glb - Supports Metallic-Roughness

- Scene Viewer supports a configurable authoring experience with hosted glTF webstyles

- **ArcGIS Pro** can use glTF as Marker Symbols

- ArcGIS Pro **Geprocessing** tools can import and manipulate the glTF format

- **ArcGIS CityEngine** can import glTF or export entire procedurally-generated cities as glTF

- Work in progress to support it pervasively in all other ArcGIS suite of 3D Products
Citizen Engagement
Collaborative planning
Esri-Binomial collaborate to improve Basis/KTX2 encoding by ~4X

- Reduce the encoding and supercompressing speed of the binomial library
- Create a ready to use web/c++ API to output and consume basis in Ktx2 format

Basis encoding Version 1.12 compared to Version 1.13: Plots Quality (measured as a function of Y-PSNR (db)), Encoding times (seconds) and Bits Per Texel (basis file size in bits/Texel Count*Num Channels) – where Texel count is texture.width*texture.height for each of the 7 use cases and the basis encoder setting for quality was set to 128 and compression level to 1. Note the difference between Basis Ver. 1.12 Encoding Time (in seconds – orange bars) vs Basis Ver. 1.13 Encoding Time using the Optimized code base Version 1.13 (In seconds – yellow bars).
I3S | Esri-Binomial Collaboration

- Basis/KTX2 Encoding speed has been improved by ~4X

<table>
<thead>
<tr>
<th>Image_name</th>
<th>Encoding Time (Secs)</th>
<th>Encoding Time (Secs)</th>
<th>Encoding Time (Secs)</th>
<th>Improvement Factor (Using Comp_level_1)</th>
<th>Improvement Factor (Using Comp_level_0)</th>
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<tr>
<td>IM_Frankfurt_4K</td>
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</table>

Compares the Encoding Optimization gained for various I3S datasets: Basis 1.13 added a new geospatial focused compression level 0.
Slpk size is ~42% less in size

1.8 SLPK Version compared to I3S 1.7:
- 42.3% (10.7GB!) smaller than equivalent 1.7 version (with DDS & Jpg textures)
- Would be 57.35% (14.5GB) smaller than equivalent 1.7 version if we drop Jpeg

### Encoding from Jpg to DDS/KTX2

<table>
<thead>
<tr>
<th>Munich_Mesh_SURE-4-3 I3S Input SLPK (in 1.7 format)</th>
<th>Slpk with jpg + DDS (1.8 format)</th>
<th>Slpk with jpg + ktx2 (1.8 format)</th>
<th>Slpk with ktx2 only (1.8 format)</th>
<th>Slpk with Jpeg only (1.8 format)</th>
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</thead>
<tbody>
<tr>
<td>Slpk file Size (in KB)</td>
<td>26,410,747</td>
<td>15,204,071</td>
<td>11,262,152</td>
<td>10,930,345</td>
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<td>Encoding Time (hr:min:sec)</td>
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<td>0:14:15</td>
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</tbody>
</table>
I3S | Esri-Binomial Collaboration

- Encoding speed has been improved by ~4X

ArcGIS Maps SDK  Use game engines to enable immersive geospatial experiences

- Delivered as plugins
  - ArcGIS Maps SDK for Unity
  - ArcGIS Maps SDK for Unreal Engine
- UI and APIs to access ArcGIS services and local data
- Supports local and global 3D experiences

Public beta program:
esriurl.com/a4ge
Interoperability: Transcoding Support via tileconveter

• A loaders.gl based converter between I3S and 3D tiles tilesets

• Supports the following types of conversion (2-way)
  • 3DTiles Batched3DModel ⇔ I3S IntegratedMesh Scene Layer
  • 3DTiles Batched3DModel + Hierarchy extension ⇔ I3S 3D Object Scene Layer

• Ability to batch convert a 3D Tiles content to Scene Layer Package (SLPK) and Indexed 3D Scene Layer REST (i3sREST)
  • Directly from cesium ion - via its REST api
  • From a file-based 3D Tiles content
Interoperability: Transcoding Support via tileconveter

• Ability to batch convert an I3S 1.7 in Scene Layer Package (SLPK) and Indexed 3D Scene Layer REST (i3sREST) format to 3D Tiles

• Support for: 3DTiles version 1.0, embedded glTF version 2.0
  • Has experimental support for glTF 1.0 as it still seems prevalent in the marketplace

• Coordinates: supports WGS84 as that’s the only supported 3D Tiles CRS

• Handles correct gravity models by converting between orthometric (i3s preferred height model) to ellipsoidal (cesium preferred)
Interoperability: Transcoding Support via tileconveter

- Released under MIT umbrella license - a permissive open-source license compatible with Apache 2.0

```
node converter.min.js --input-type 3dtiles --tileset ../Frankfurt-3d-tiles/cesiumJpg/tileset.json --name Frankfurt_completed_bundle --output data --max-depth 6 --slpk --egm /home/user/pgm/egm2008-5/geoids/egm2008-5.pgm

node converter.min.js --input-type 3dtiles --tileset https://assets.cesium.com/29328/tileset.json --name CairoLayer --egm /home/user/pgm/egm2008-5/geoids/egm2008-5.pgm --slpk

node converter.min.js --input-type i3s --tileset https://tiles.arcgis.com/tiles/z2tnIkrLQ2BRzr6P/arcgis/rest/services/Rancho_Mesh_mesh_v17_1/SceneServer/layers/0 --name Rancho --max-depth 4 --egm /home/user/pgm/egm2008-5/geoids/egm2008-5.pgm
```
3D Web GIS | Summary

- The current trend is pointing for 3D Web GIS to become the primary interface for most geospatial users.

- A good out of the box functionality (no code) as well as robust API for JavaScript and a configurable authoring experience is essential.

- Geospatial users expect consistency of experience, data and quality between Web, desktop and mobile experiences – glTF is uniquely positioned to serve that purpose.

- Fragmentation of features between various browsers is still a risk for further wider adoption.