I3S: Enabling 3D GIS Everywhere

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GIS & 3D are Advancing

... but what is the underlying technology, what are the use cases, and what are the trends
3D Capabilities Are Integrated Across the ArcGIS System

Enriching All User Experiences

Desktop
- Pro
- CityEngine
  (Procedural Modeling)
- 3D Visualization and Analytics

Mobile
- Earth
- Runtime
- Web Scenes

Web
- Experience Builder
- Indoors
- Scene Viewer

Supporting Multiple 3D Workflows
... A Complete 3D System of Record
... A Living Digital Twin
I3S | Indexed 3D Scene Layer  Supports multiple Profiles and Layer Types

<table>
<thead>
<tr>
<th>Layer Type</th>
<th>Profile</th>
<th>Attributes</th>
</tr>
</thead>
<tbody>
<tr>
<td>3D Object</td>
<td>Mesh Pyramids</td>
<td>Yes</td>
</tr>
<tr>
<td>Integrated Mesh</td>
<td>Mesh Pyramids</td>
<td>Triangle attributes</td>
</tr>
<tr>
<td>Point</td>
<td>Point</td>
<td>Yes</td>
</tr>
<tr>
<td>Point Cloud</td>
<td>PointCloud</td>
<td>Yes</td>
</tr>
<tr>
<td>Building</td>
<td>Building</td>
<td>Yes</td>
</tr>
</tbody>
</table>

- The format is extensible with new layer types and/or profiles following the same design principles
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
Point Cloud Scene Layer (PCSL) adopted by OGC as I3S 1.1 Community Standard in Feb. 2020

I3S 1.2 currently under adoption process by OGC to incorporate new features:

- Better material support – gltf feature compatible
- Paged Node access pattern – reduces client-server traffic
- More compact Geometry – supports Draco compression
- More optimal Selection Strategy - standardizes on OBBs
- Ktx2 (basis) compressed texture support
I3S: AI and Deep Learning friendly format...

I3S - well suited for AI and Deep Learning manipulation:

- Automatic mesh segmentation of an Integrated Mesh
- Point cloud classification
- In March 2020, the arcgis.learn module added PointCNN, to efficiently classify and segment points from a point cloud dataset
- In May 2021, ArcGIS Pro 2.8 added functionalities to export training data, train and classify point cloud datasets
3D Web GIS | Full 3D Visual Experience on the Web

3D Features
Database Driven

3D Mesh
Reality Capture
3D Web GIS | 3D City Visualization

Realistic

Schematic

Hand-drawn

The same I3S 3D Object
Layer dynamically stylized
BIM Data in Geo Context
e.g. for visualization or facility management
Visual Inconsistencies

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

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

Model
- dae
- fbx
- obj
- glTF
- glb
- dwg
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 | Build onto Georeferenced Model**
glTF & 3D GIS | Retain Consistency on the Web all platforms

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### Industries | Sectors

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

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**GIS Specialist**
- City Planner (Graphics staff)
- Urban Designer

**Data Visualization Specialist**

**GIS Technologist**
- Architectural Designer
- Game Developer
- Visual Database Engineer
- Modeling / Simulation Analyst
- Research Scientist (CFD)
- GeoSpatial Intelligence Analyst

**GIS Developer**
- Architectural 3D Modeler
- Game Artist
- Modeling/Simulation Developer
- Synthetic Environment Designer
- Transportation Modeler
- 3D Modeler

**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
ArcGIS Maps SDK
Use game engines to enable immersive geospatial experiences.

Geospatial Data
- Imagery and Terrain
- 3D Objects
- Features

Developer Tools
- Unreal Engine
- Unity

Effects
- Atmosphere
- Renderers

Analysis
- Simulation
- Measurement

XR
- Virtual Reality
- Augmented Reality
- Mixed Reality
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
The Vis.gl open framework now has support for I3S consumption (IM & 3D Object layers) using deck.gl & loaders.gl modules.

https://loaders.gl/examples/i3s
An I3S 1.7 IntegratedMesh Scene Layer loaded in cesium.js

- Supports IntegratedMesh and 3D Object Scene Layers in OGC I3S 1.2 standard
- Modeled after ArcGISTiledElevationTerrainProvider module that consumes arcgis tiled elevation layers
- Pull request under review: https://github.com/CesiumGS/cesium/pull/9634
I3S | Import/Export

- 3DTiles ⇔ I3S Conversion

- 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 (from cesium ion or file based) to Scene Layer Package (SLPK) and Indexed 3D Scene Layer REST (i3sREST)

- Handles correct gravity models by converting between orthometric (i3s preferred height model) to ellipsoidal (cesium preferred)
PCSL to LAS conversion using pdal.io

- A capability within pdal.io for converting an I3S PointCloud Scene Layer (PCSL) to various LAS formats

```json
{
  "type": "readers.i3s",
  "filename": "https://tiles.arcgis.com/tiles/8cv2FuXuWSIf0nbL/arcgis/rest/services/AUTZEN_LiDAR/SceneServer",
  "bounds": "([-123.075542,-123.06196],[44.049719,44.06278])"
}
```

```bash
pdal translate i3s://https://tiles.arcgis.com/tiles/8cv2FuXuWSIf0nbL/arcgis/rest/services/AUTZEN_LiDAR/SceneServer\autzen.las \--readers.i3s.threads=64 \--readers.i3s.bounds="([-123.075542,-123.06196],[44.049719,44.06278]
```

readers.i3s is now streamable