Sharing 3D Content

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- Joined Esri in 2000
- Primary focus areas
  - 3D Services
  - Indexed 3D Scene Layer Specification (I3S)
  - 3D across the ArcGIS platform
Speaker

- **Sean Morrish**
  - 3D Product Engineer
  - 15 years AEC experience
  - 4 years with Esri as product engineer in 3D
  - Primary Focus areas
    - 3D Scene Layer Services
    - Data prep and processing (3D Objects, Points, Mesh, Point Cloud)
    - Testing and implementation of i3S Scene Layers across the platform
Agenda

3D Scenes Layers Across the Platform
Sharing Scenes
Best Practices
What is *Shareable* 3D Content?

- Elevation
- Draped/Extruded 2D Feature Layers
- 3D Symbols
- Indexed 3D Scene Layers (I3S)
Indexed 3D Scene Layers

ArcGIS Scene Layers

• 3D Object Scene Layer
• 3D Point Scene Layer
  - Preset Point Symbols (Trees...etc)
  - User Defined 3D Symbols
• 3D Integrated Mesh Layer
• 3D Point Cloud Scene Layer
Indexed 3D Scene Layers are supported across the ArcGIS platform

- ArcGIS Enterprise
- ArcGIS Online
- Drone2Map for ArcGIS
- Esri CityEngine
- ArcGIS Pro
- Publishing/Sharing
- Consuming
  - Web
  - Gallery
  - Desktop
  - Mobile
Publishing Web Scenes
To Enterprise and ArcGIS Online
Indexed 3D Scene Layers (I3S) – What is it?

- Open standard for storage and transmission of large, heterogeneous 3D geospatial data sets

- Cloud, Web and Mobile friendly based on JSON, REST and modern web standards

- Support 3D geospatial content, various coordinate systems along with a rich set of layer types

- An I3S data set, referred to as a Scene Layer is:
  - a container for arbitrarily large amounts of heterogeneously distributed 3D geographic data
Indexed 3D Scene Layers (I3S) – What is it?

- I3S is an OGC community standard

- The standard includes specification for Scene Layer Package (SLPK):
  - A single file that packages the complete node tree and its resources into an archive that supports direct access to the individual nodes and resources within it

- I3S can serve as a common tool to package and disseminate, a variety of GIS content

- Both I3S and SLPK are licensed under Creative Commons

- Available @ https://github.com/Esri/i3s-spec
### Indexed 3D Scene Layers (I3S) – What is it?

- **I3S Design Principals for a 3D GIS visualization format**

<table>
<thead>
<tr>
<th>Principal</th>
<th>Description</th>
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<tbody>
<tr>
<td><strong>1. Web friendly:</strong></td>
<td>JSON + Typed Arrays</td>
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<td><strong>2. Mobile friendly:</strong></td>
<td>Works good with varying bandwidth</td>
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<td><strong>3. Extensible:</strong></td>
<td>Support different types of content</td>
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<td><strong>4. Declarative:</strong></td>
<td>Reduce required implicit knowledge</td>
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<td><strong>5. Efficient:</strong></td>
<td>Use spatial indexing for quick delivery</td>
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<td><strong>6. Scalable:</strong></td>
<td>Provide Level of Detail Support</td>
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<td><strong>7. Protected:</strong></td>
<td>Ensure that content is protected</td>
</tr>
<tr>
<td><strong>8. Open:</strong></td>
<td>Full Specification publicly accessible</td>
</tr>
</tbody>
</table>

[https://github.com/Esri/i3s-spec](https://github.com/Esri/i3s-spec)
Scene Layer types and profiles

- Support different geometry types
  - 3D Objects
  - Integrated Meshes
  - Points
  - Point Clouds
Indexed 3D Scene Layers (I3S)

- **3D Objects**
  - Example: Building Exteriors
  - Sources: Derived from GIS Data, as well as 3D models in various formats
Indexed 3D Scene Layers (I3S)

- **Integrated Meshes**
  - Examples: Mesh surface representing the skin of the Earth, including vegetation, buildings and roads
  - Sources: Derived from satellite, aerial or drone imagery via dense matching photogrammetry, or calculated
Indexed 3D Scene Layers (I3S)

- Points
  - Examples: Hospitals, schools, trees, cars
  - Sources: Feature locations combined with Instanced 3D models generated by hand
Indexed 3D Scene Layers (I3S)

- **Point Clouds**
  - Example: LiDAR data sets
  - Sources: Typically sensor-collected or Photogrammetrically derived
I3S: Organization and structure

- Organizes geospatial data using a hierarchical, node-based spatial index structure
**I3S: Organization and structure**

The physical organization of information within node:
• I3S promotes the concept of discrete levels of details with multiple discrete representations of features and nodes.

• An example lod selection metric is *the maximum screen size* that the node may occupy before it must be replaced with data from more detailed nodes.

• This model of discrete LOD rendering is referred to in I3S as *node switching.*
I3S: Consumption

- As a service (via a REST API) or locally as a file system (SLPK)

  - As RESTful interfaces/services:
    - Via a RESTful interface that exposes the scene layer, its nodes and their associated resources (geometries, attributes, textures) as web addressable resources.
      - I3S resources are designed for direct access (via a unique key) from key value based cloud blob stores such as Windows Azure Blob Storage or Amazon Simple Storage (S3) using built in REST APIs of such infrastructures
    - As a single large Scene Layer Package (SLPK):
      - A single file that packages the complete node tree and its resources into an archive that supports direct access to the individual nodes and resources within it.
I3S: Flexibility

Examples of I3S flexibility:

Minimum Bounding Volume (MBV):
- Minimum Bounding Sphere (MBS)
- Oriented Bounding Box (OBB)

The node structure may be
- "expanded" – with complete meta-information about node’s position and BVH topology
- "fixed-size" – in support of "paged" access pattern
I3S: Flexibility (cont’d)

• Nodes may have “embedded” vs “binary” geometry/attribute content format
  - Embedded geometry: as JSON in-lined with additional metadata
  - Binary format: as typed array buffer views

• LOD Selection based on different metricTypes:
  - maxScreenThreshold – LOD switching based on screen ‘size’ of the node’s MBV
  - screenSpaceRelative – LOD switching based on screen ‘scale’ of the node’s MBV
  - distancRangeFromDefaultCamera – LOD switching based on normalized distance of the node’s MBV from the camera
  - effectiveDensity – estimation of the point density covered by the node
Scene Layer Package (SLPK) and Scene Service REST API

- **Archive.slpk**
  - metadata.json
  - 3dScenelayer.json.gz

- /nodes/
  - /nodes/root/
    - 3dNodeIndexDocument.json.gz
  - /nodes/1-4-2-0/
    - 3dNodeIndexDocument.json

- geometries/*
- textures/*
- shared/*
- features/*
- attributes/*

- Zip64 container
- gzip'ed resources
Viewing and Consuming Scene Layers
In Browser, ArcGIS Pro, Earth, App or mobile
Best Practices when working with I3S content

• An Open Specification for the Community

• Use Sharing tool in ArcGIS Pro to upload large Packages (2GB +)
• Try to organize content via layers (don’t mix large scale with small scale data in the same layer)
• Use hardware compressed textures whenever possible
• Pre-cache attribute driven symbolization
• Scene Layer Package tool is handy to create I3S content offline and upload the content to your portal or online

• ....
Road Ahead

- Adoption of I3S as OGC community standard
  - Provide I3S utility tools including (validation (Available with ArcGIS Pro 2.0), re-projection, optimization)
  
- Support additional compressed texture formats (optimized for mobile)

- Caching Performance Improvement

- Detailed specification of point cloud layer type

- Areas of active R&D:
  - Enhanced support for BIM data types
  - Partial Updates of Scene Layers
  - Support paged node index access for all layer types
  - Support more use case for Integrated Mesh layer types (attribution, use as surface etc...)
  - Mesh Compression
  - ....
Consuming Scene Layers In Mobile

In Browser, ArcGIS Pro, Earth, App or mobile