Indexed 3D Scene (I3S) Layers Specification

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con•terra
Agenda

- ArcGIS 3D Platform
- Authoring 3D Scene Layers
- Indexed 3D Scene Layer
Indexed 3D Scene Layers (i3s)

1) Overview
2) Downloads
3) Official Schemas
4) Related News

1) Overview
A single i3S data set, referred to as a Scene Layer, is a container for arbitrarily large amounts of heterogeneously distributed 3D geographic data. Scene Layers are designed to be used in mobile, desktop, and server-based workflows and can be accessed over the web or as local files.

The delivery format and persistence model for Scene Layers, referred to as Indexed 3D Scene Layer (i3S) and Scene Layer Package (SLPK) respectively, are specified in detail in this OGC Community Standard. Both formats are encoded using JSON and binary ArrayBuffer (ECMAScript 2015). i3S is designed to be cloud, web and mobile friendly. i3S is based on JSON, REST and modern web standards and is easy to handle, efficiently parse and render by Web and Mobile Clients. i3S is designed to stream large 3D datasets and is designed for performance and scalability. i3S is designed to support 3D geospatial content and supports the requisite coordinate reference systems and height models in conjunction with a rich set of layer types.
ArcGIS 3D Platform
ArcGIS 3D helps users

Create and Manage

Quickly and easily extract value from 2D and 3D data

Visualize and Analyze

Understand and experience events and change

Design and Simulate

Manage the designed environment
3D GIS across industries

- Transportation
- Environmental assessment
- Land Management
- Facilities Management
- Mining
- Scientific Visualization
- City monitoring and planning
- Developing Energy resources
- Utilities and Telecommunications
- Infrastructure
Authoring 3D Scene Layers
Scene Layers supported across the ArcGIS platform

*Web and Desktop Clients!*
ArcGIS 3D Scene Layers

- 3D Objects Scene Layer
- 3D Point Scene Layer
- 3D Integrated Mesh Layer
- 3D Point Cloud Scene Layer

Future: Line, Polygon..
# I3S Support in ArcGIS Platform

*Scene layer types and product versions supporting Scene Layers*

<table>
<thead>
<tr>
<th>ArcGIS Software</th>
<th>Scene Layer Types</th>
<th>Publishing</th>
<th>Consuming</th>
</tr>
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<tbody>
<tr>
<td></td>
<td>3D Object</td>
<td></td>
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<tr>
<td>ArcGIS Online</td>
<td>Current</td>
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<td>Yes</td>
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<tr>
<td>ArcGIS Enterprise</td>
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<tr>
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<tr>
<td>ArcGIS Earth</td>
<td>1.2</td>
<td>-</td>
<td>Yes</td>
</tr>
<tr>
<td>Esri CityEngine</td>
<td>2016</td>
<td>Yes (.slpk)</td>
<td>-</td>
</tr>
<tr>
<td>Drone2Map</td>
<td>-</td>
<td>Yes (.slpk)</td>
<td>-</td>
</tr>
</tbody>
</table>

**Focused Solutions!**
Demo
Authoring and publishing 3D Scene Layers in ArcGIS Platform
I3S - Sharing

3D Model in a Geodatabase → Processing with ArcGIS Pro → SLPK – local I3S Format for native apps → GDB (zipped) → ArcGIS Online → ArcGIS Enterprise (Portal) → I3S – REST Interface for Web → 3D Web Scene / 3D Web App as Client

SLPK for native apps

3D Desktop-/Mobile-Software as Client
Publishing Hosted 3D Scene Layers in ArcGIS Online

Two ways of hosting 3D Scene Layers in ArcGIS Online

1. Create cache in ArcGIS Pro as SLPK and upload
2. Or cook the cache in ArcGIS Online –
   - Allows cache update
   - Costs credits
   - 1 cr. per 1000 textured multipatch
   - 1 cr. per 5000 untextured multipatch
   - 1 cr. per 5000 features in feature layer

More Details:
- [https://blogs.esri.com/esri/arcgis/2017/01/03/72321/](https://blogs.esri.com/esri/arcgis/2017/01/03/72321/)
Indexed 3D Scene Layer
Open 3D Service Format
Indexed 3D Scene Layer – I3S

- **I3S layer specification**
  - Open specification for 3D layers
  - Shared under Creative Commons licensing
  - Already an OGC Community Standard!
  - Describes a scalable scene cache with attributes and indexing
  - Multiple levels of detail
  - Can be streamed over the internet/intranet
  - Can be used locally on disk as “a scene layer package”
  - Opportunity for future profiles to accommodate new data types
  - Open for feedback and modification
3rd party adoption of I3S

- **Integrated mesh**
  - VRICON, Pix4D, and Bentley sharing packages or services in I3S format
  - Supports Drone2Map

<table>
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<tr>
<th>Vendor</th>
<th>Product/URL</th>
<th>Scene Layer Type</th>
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<tr>
<td>Bentley</td>
<td>ContextCapture</td>
<td>Integrated Mesh</td>
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<tr>
<td>Vricon</td>
<td>Vricon</td>
<td>Integrated Mesh</td>
</tr>
<tr>
<td>Pix4D</td>
<td>Pix4D</td>
<td>Integrated Mesh</td>
</tr>
</tbody>
</table>

- **More partners coming soon…**
Esri Indexed 3d Scene (*.i3s) and Scene Layer Package (*.slpk) formats
Requirements for a 3D GIS visualization format

1. **Web friendly:** JSON + Typed Arrays
2. **Mobile friendly:** Works good with varying bandwidth
3. **Extensible:** Support different types of content
4. **Declarative:** Reduce required implicit knowledge
5. **Efficient:** Use spatial indexing for quick delivery (nodes!)
6. **Scalable:** Provide Level of Detail Support
7. **Protected:** Ensure that content is protected
8. **Open:** Full Specification publicly accessible

Now available @ https://github.com/Esri/i3s-spec
The Key to Scalability: Indexing

- Adapt Index type to data
  - R-Tree
  - Quadtree, Octtree
  - Standard Tiling Scheme

- Load-Balanced
  - Clustering based on content distribution
  - Near-Constant Data Volume per Node
Scene Services Resources & REST API

- **Service**
  - **Layer**
    - **Symbols**
    - **Node**
      - **Features**
      - **Geometry**
      - **Texture**
      - **Shared Resource**
      - **Attributes**

1 Node Index Document
- **1 Feature Data**
- **1..* Geometry Files**
- **0..* Texture Files**
- **1 Shared Resource**

- **SceneServiceInfo.json**
- **3dSceneLayer.json**
- **FeatureData.json**
- **NodeIndexDocument.json**
- **Geometry Typed Array**
- **Image with Texture LoD**
- **sharedResource.json**
- **attribute Typed Array**
Declarative: Geometry buffer metadata

```
"defaultGeometrySchema": { // geometry resource layout for nodes that declare the use of defaultGeometrySchema in the node index.
  "header": [ // header fields that precede the vertex data
    {
      "property": "vertexCount", // vertex count
      "type": "UInt32"
    }
  ],
  "topology": "PerAttributeArray", // one of ["PerAttributeArray", "InterleavedArray", "Indexed"]. When "Indexed", the indices must also be declared in the geometry.
  "vertexAttributeOrder": ["position", "normal", "uv0", "region"], // provides the order of the keys in vertexAttributes.
  "vertexAttributes": { // the vertex attributes must appear in the order that they are declared here.
    "position": { // the name of the vertex attribute; here: vertex positions
      "valueType": "Float32", // the element type, either UInt8, UInt16, UInt32, Int16, Int32, Int64 or *Float32*, Float64
      "valuesPerElement": 3 // number of (Float32) values need to make a valid element (here a xyz position)
    },
    "normal": { // the name of the vertex attribute; here: vertex normals
      "valueType": "Float32"
    }
  }
},
```

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<th>Body</th>
<th>featureAttributes</th>
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</thead>
<tbody>
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</tbody>
</table>
Demo

Debugging an I3S service
i3s persistence options

Storing and serving i3s resources
1. File System Folder Layout

Direct mapping of the REST API

- All resources reside in the file system as individual files.
- These files are organized in folders in the following schema:

  /3dSceneLayer.json
  /nodes/<node-id>/3dNodeIndexDocument.json
  /nodes/<node-id>/features/0.json ...n.json
  /nodes/<node-id>/geometries/0.bin ...n.bin
  /nodes/<node-id>/shared/SharedResource.json
  /nodes/<node-id>/textures/0_0.bin ...n_m.bin
  /nodes/<node-id>/attributes/0.bin ...n.bin
3. Scene Layer Package *.slpk – the i3s package format

Best for single-file exchange and portability of i3s stores

**Archive.slpk**

- **metadata.json**
- **3dScenelayer.json**

- **/nodes/**
  - **/nodes/root/**
    - **3dNodeIndexDocument.json**
    - **features/**
    - **geometries/**
    - **textures/**
    - **shared/**
    - **attributes/**

- **/nodes/1-4-2-0/**
  - **3dNodeIndexDocument.json**
  - **features/**
  - **geometries/**
  - **textures/**
  - **shared/**
  - **attributes/**

**Zip64 container**

**gzip’ed resources**
Become a part of the community!
Get Involved with I3S!

- Now available @ https://github.com/Esri/i3s-spec
- Shared under Creative Commons licensing
- Toolkit License: Apache 2.0
- Implement Encoders, Services, Clients!
Thanks!

Questions?
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Scroll down to the “Feedback” section

Complete Answers, add a Comment, and Select “Submit”