Sharing 3D Content With Scene Layers

Chris Andrews, Tamrat Belayneh
3D across ArcGIS

- GIS is 3D
- Web GIS services-based architecture
- New clients and experiences
- Workflow modernization
- Story-based product and tech concepts
What are the opportunities for developers with 3D?

- Content creation with Esri standards
- Content conversion (BIM/lidar)
- 3D content management
- Mobile/AR/VR workflows/apps
- Dashboards/web app integration
- Embedded GIS
- Extending 2D workflows into 3D
- Enterprise integration

Content examples from Vricon, PLW Modelworks
Web Scenes, Scene Layers

• Web Scene
  - Collection of layers, environment settings, slides, animation
  - Essential for 3D apps on any platform or experience

• Mobile Scene Package *(planned for 2018)*
  - Transportable, large 3D content packages
  - Used for mobile and publishing workflows

• Scene Layer
  - Scalable cache of graphics, styles, and attributes
  - 3D Objects, 3D Points, Integrated Meshes, Point clouds
Open Software, Standards and Data enable organizational resiliency

- Ensure access to data
- Guarantee interoperability
- Enable innovation
- Encourage usage and adoption

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<th>I3S</th>
<th>Scalable 3D scene content for visualization and distribution</th>
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<td>Raster (imagery and elevation) compression technology for 2D and 2.5D</td>
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<td>3D compression technology used for point clouds and other 3D rasterized data</td>
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<td>GeoREST</td>
<td>Esri open REST APIs for access to any kind of GIS content and services</td>
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ArcGIS Pro

Powerful 2D/3D desktop authoring and data management
• Rich spatial analysis for advanced 3D workflows
• Interactive 3D analytics and animation
• 2D to 3D procedural modeling engine
• LiDAR classification, feature extraction and mesh generation
• BIM (IFC) and KML (KMZ) interoperability support
• ArcGIS Pro SDK for Microsoft .NET to extend workflows

CityEngine

Advanced authoring tool for Urban Design
• 3D in-memory local scenes
• Interactive design/modeling tools
• Procedural rule authoring
• Dynamic 3D streets and blocks
• Virtual reality with ArcGIS 360 VR

ArcGIS Extensions
- 3D Analyst
- Spatial Analyst
- Network Analyst
- Tracking Analyst
- Data Interoperability

2018 Esri Developer Summit | Palm Springs, CA
ArcGIS Earth

Easy-to-use 3D data exploration for Enterprise users

Drone2Map

Streamline the creation of professional imagery products from drones

Web Scene Viewer

View 3D maps in any standard web browser

Web AppBuilder

Build powerful 3D GIS apps without writing a single line of code

Story Maps

Combine 3D maps with narrative text, images, and multimedia content
Enterprise data and services

- **Web Scene**
  - Vehicle for cross-platform 3D capability
  - Collection of layers, environment settings, slides, animation
  - Essential for 3D apps on any platform or experience
- **Scene Layer**
  - Scalable cache of graphics, styles, and attributes
  - 3D Objects, 3D Points, Integrated Meshes, Point clouds

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<th>ArcGIS Online</th>
<th>Content and services for sharing ideas in 2D and 3D</th>
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<td>ArcGIS Server</td>
<td>Scalable 2D/3D enterprise content distribution and geoprocessing</td>
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<td>GeoEvent Server</td>
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Content

Esri and 3rd Party Partner Content

Ready-to-Use Maps and Data
- Global Coverage
- Compiled from Best Available Sources
  - Basemaps
  - Imagery
  - Demographics
  - Landscape
- Tens of Thousands of Open Datasets

ArcGIS Marketplace
3rd party geospatial apps and data from Esri’s global Partner Network

Living Atlas
3D and 2D content for use throughout mapping applications
Developer Tools

Development and Scripting Tools For Extending/Customizing

- 2D and 3D native iOS, Android, Windows solutions
- Building and extending 2D and 3D web apps

ArcGIS Runtime SDKs: Developer tools for 2D and 3D native iOS, Android, Windows solutions
ArcGIS JavaScript API: Developer toolkit for building and extending 2D and 3D web apps

Reduce Development Costs
- 3D Everywhere
- Leverage User Roles
- ArcGIS layers
- Smart Mapping
- Data Flows Between Apps
What's new in ArcGIS 3D in 2017… tons!

- Core information model changes to support 3D data
  - Vertical Coordinate Systems
- Interactive editing and analysis tools in Pro, CityEngine, and Runtime
- Smart Mapping in the Scene Viewer
- Usability and platform integration with CityEngine
- 3D in the Runtime 100

Point Cloud Scene Layer with Cyclomedia data
What is *Shareable* 3D Content?

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

Feature Service Layers
Scene Layers (I3S)
Your Local Imagery
Your Local Terrain
Desktop
Web
Device
Server
Online Content and Services
Draped Imagery
Terrain
ArcGIS Online
ArcGIS Online

2D Layers
Draped or Absolute*

3D Layers
(Absolute Z')

ArcGIS Online
Feature Service Layers
Scene Layers (I3S)
Scene Layers supported across the ArcGIS platform

Publishing/Sharing

ArcGIS Enterprise
ArcGIS Online
Drone2Map for ArcGIS
Esri CityEngine
ArcGIS Pro

Consuming

Web
Gallery
Desktop
Mobile
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 now an OGC community Standard for Streaming 3D content

• 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

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
6. Scalable: Provide Level of Detail Support
7. Protected: Ensure that content is protected
8. Open: Full Specification publicly accessible

https://github.com/Esri/i3s-spec
Scene Layer types and profiles
Support different geometry types

- 3D Objects
- Points
- Integrated Meshes
- 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: LoD Models, Selection Metrics

- 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/*`
What’s New

ArcGIS Pro 2.1/ArcGIS Enterprise 10.6/ArcGIS Online

• Create Scene Layer Package Tool
  - Support for file or folder for LAZ, LAS and ZLAS data as input sources for PCL

• Validate Scene Layer Package Tool
  - Supports all scene layer types (3D Object, Integrated Mesh, Point, Point Cloud)

• Consumption in ArcGIS Pro
  - Users can select scene layer objects and ‘hide selection’ and ‘show selection’ in the data tab > exclusion group
  - Users can set definition queries on scene layers
  - Users can adjust point display limit and point density for point cloud scene layers
What’s New

ArcGIS Pro 2.1/ArcGIS Enterprise 10.6/ArcGIS Online

• Symbology
  - Unique Value symbology support for point and 3D object scene layers
  - Unclassed colors symbology support for point and 3D object scene layers
  - Transparency attribute driven symbology support for 3D object scene layers
  - Transparency, rotation, and size attribute driven symbology support for point scene layers

• Sharing
  - Scene layers can be shared directly to ArcGIS Online
  - When publishing web scene layers can be cached locally to ArcGIS Online and ArcGIS Enterprise 10.5.1 and later
  - Web scene layers can reference registered enterprise geodatabase data to ArcGIS Enterprise 10.6
  - Custom styles with 3D model markers can be shared to ArcGIS Online and Enterprise 10.6. These can be used to symbolize layers in scene viewer
What's New
Web Scene Viewer (ArcGIS Online/Enterprise)

• Point Scene Layer Visualization Enhancements
  - Relative to Scene Elevation Mode
  - Callouts
  - Labeling
  - Declutter
  - Improved depth perception of Icons

• Smart Mapping
  - Improved Types Style for Points, 3D Object and Point Cloud Layers
  - New 3D Symbols / Support for Custom 3D Symbols

• Measure Tools
Demo
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
What are we working on …

- Enhanced support for BIM data types
- Partial Updates of Scene Layers
- Direct importing of non-ArcGIS data sources as Scene Layer
- Support additional compressed texture formats (optimized for mobile)
- Caching Performance Improvement
- Detailed specification of point cloud layer Released Today!!
- 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
- Continuous loading: loading during navigation for all scene layer types (mesh, pointcloud, points)
What are we working on …

• Memory reduction: more aggressive culling with obbs, vertex buffer compression etc.
• Memory controller: global limit, reduce quality when limit is exceeded
• Edge rendering: 3d object scene layers can be rendered with visible edges