



Working with Oriented Imagery

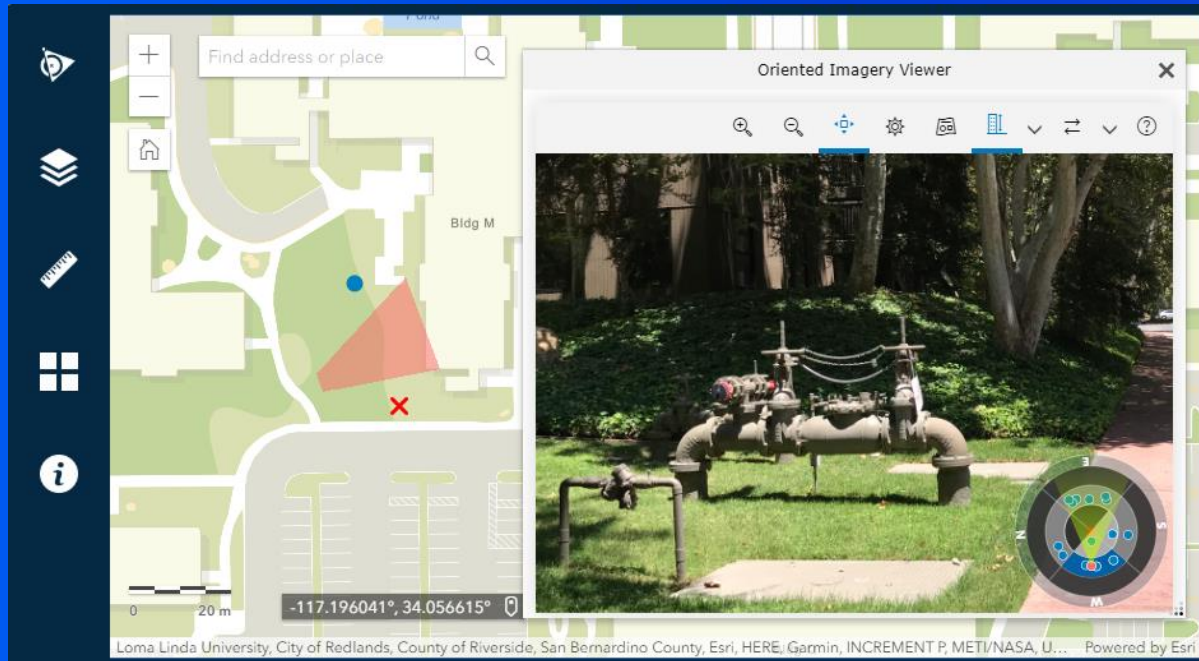
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Vijay Pawar



SEE
WHAT
OTHERS
CAN'T





Esri Campus

Example of user facing 2D app

<https://oidev.geocloud.com/app/index.html>

Terminology

Image geometry & metadata

- **Geotagged**
 - An image with metadata re: XY(Z) location of the camera
- **Oriented**
 - An image with location and defined field of view (Direction + other camera parameters)
- **Georeferenced**
 - An image with pixels mapped onto the ground (not necessarily accurate)
- **Orthorectified**
 - An image that is accurately georeferenced using a terrain surface



Oriented Imagery

Access imagery at any angle for any location

- Pick location and find best available imagery
- Fast, intuitive access and navigation
- Measurement (if suitable metadata available)
- **Lightweight Feature Service** - Stores image and ground locations
- For many modes of imagery
 - Oblique, 360, Streetview, Inspection, Handheld, Panoramic, Video...
- Your own source data, or from many partners & services



WideAngle / FishEye



Panorama



3rd Party



Pinhole / frame



Video



Drone close
range inspection

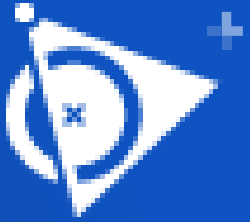


6 Separate Images

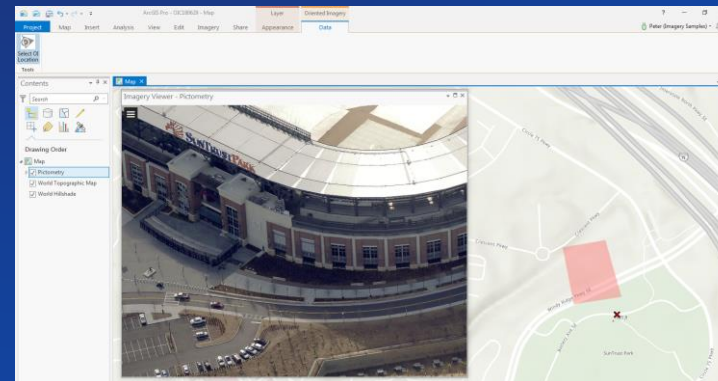
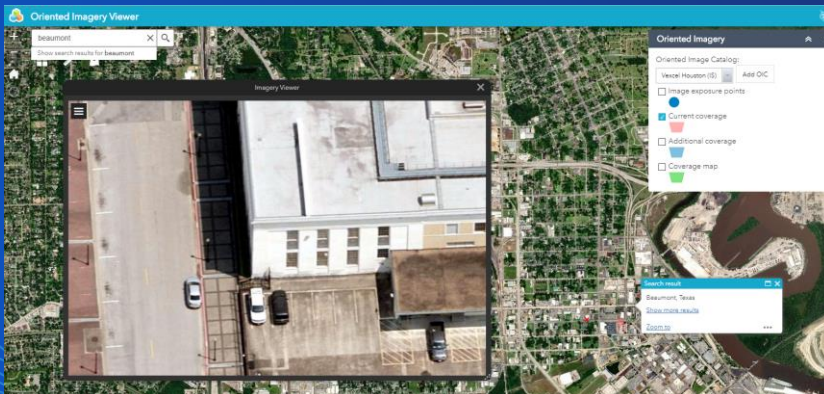
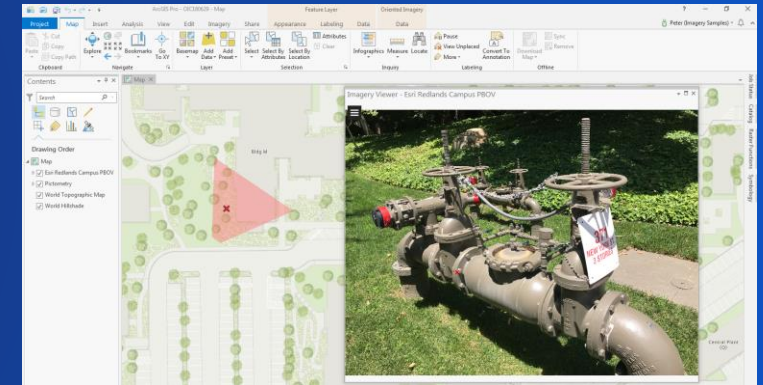


Stitched Image

Oriented Imagery is for:



- **Anyone who...**
 - ... manages physical infrastructure
 - ... wants to visualize, locate, inspect, or measure their assets
 - ... needs situational awareness
- **Industries:**
 - State and Local Government, Public Safety, Commercial
 - Utilities, Petroleum, Transportation, Nat Resources



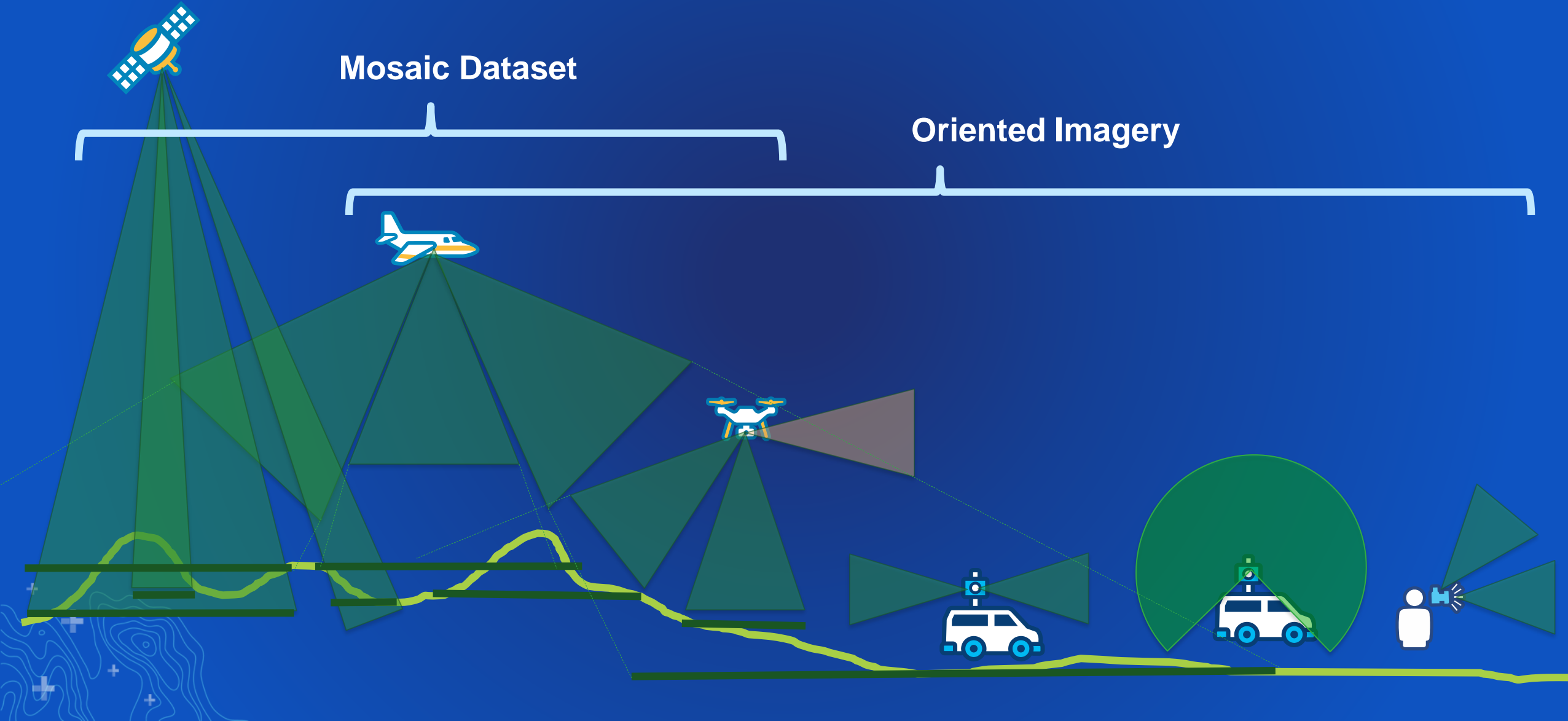


Use Cases

- “Can we display 360 imagery in ArcGIS Pro? ArcGIS Online?”
- “How can I work with ROV imagery of my pipeline?”
- “How can I record the location of all assets in streetside imagery?”
- “I need to work with oblique imagery for property evaluations”
- “How can I record details in my inspection imagery?”
- “I need to see assets up close, from multiple directions”
- “I need immediate access to today’s drone imagery”



Extending Imagery Sources





Key differentiators

Oriented Imagery vs. Mosaic Datasets / Image Services

Beyond traditional mapping

- Mosaic dataset is a powerful data model for imagery, but does not support images aimed partially above the horizon

Lightweight data model for agile requirements

- Easily work with ArcGIS Online, Cloud, Web, Mobile
- Basis for creation of many solutions (Partners)
- Rapidly expand deep learning to different image modalities
- **Provide interoperable solutions across the platform:**
 - Manage the vast collections - (System of Record)
 - Integrated into applications - (System of Engagement)
 - Extract information - (System of Insights)





Demo

3D app

<https://oidev.geocloud.com/app3D/index.html>

Oriented Imagery - Components



Components

<https://www.esriurl.com/OrientedImageryDownload>

- **Authoring tools**

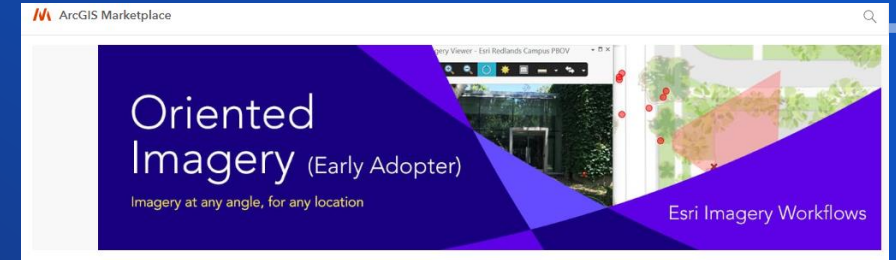
- **Create Oriented Image Catalogs from many sources**
 - EXIF, Drone2Map, tabular
 - Customizable to any source that provides orientation metadata
- **Upload images to cloud storage or use existing services**
- **Publish Oriented Image Catalogs to ArcGIS Online / ArcGIS Enterprise Portal**

- **Client Tools**

- **ArcGIS Pro Add-In – From Market Place**
- **2D Sample WebApp**
 - <https://oi.geocloud.com/app/index.html>
- **3D Sample WebApp**
 - <https://oi.geocloud.com/app3D/index.html>

- **Developer Tools**

- **2D widgets (for JS API 3.x)**
- **API (for 2D and 3D apps) - Github**



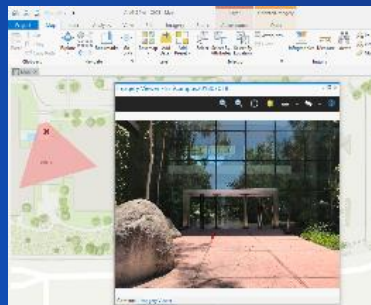
Available from the Esri Marketplace

Oriented Imagery API 2.0

Find and display all the images that contains the asset being inspected

V1

- Simple to integrate into applications
- Uses: JavaScript, WebGL, HTML5 and CSS3
- External Libraries:
 - JavaScript API for ArcGIS and Pannellum
- Creates coverage polygons of images
- Provides Ground2Image and Image2Ground transforms
- Provides feature collection Interface
- Enables 3rd party viewer integration



In ArcGIS Pro

V2

- Superimpose features into image view
- Feature collection of Points, Lines, Polygons and Labels, with attributes and simple renderers
- Multiple view support
- Web Scene Support, with frustum
- Drive camera to view and drive view to camera
- Integrate Camera view into scene
- Improved styling



In WebApps

4 Side Viewer

Example customized App





Demo

Authoring an oriented image catalog

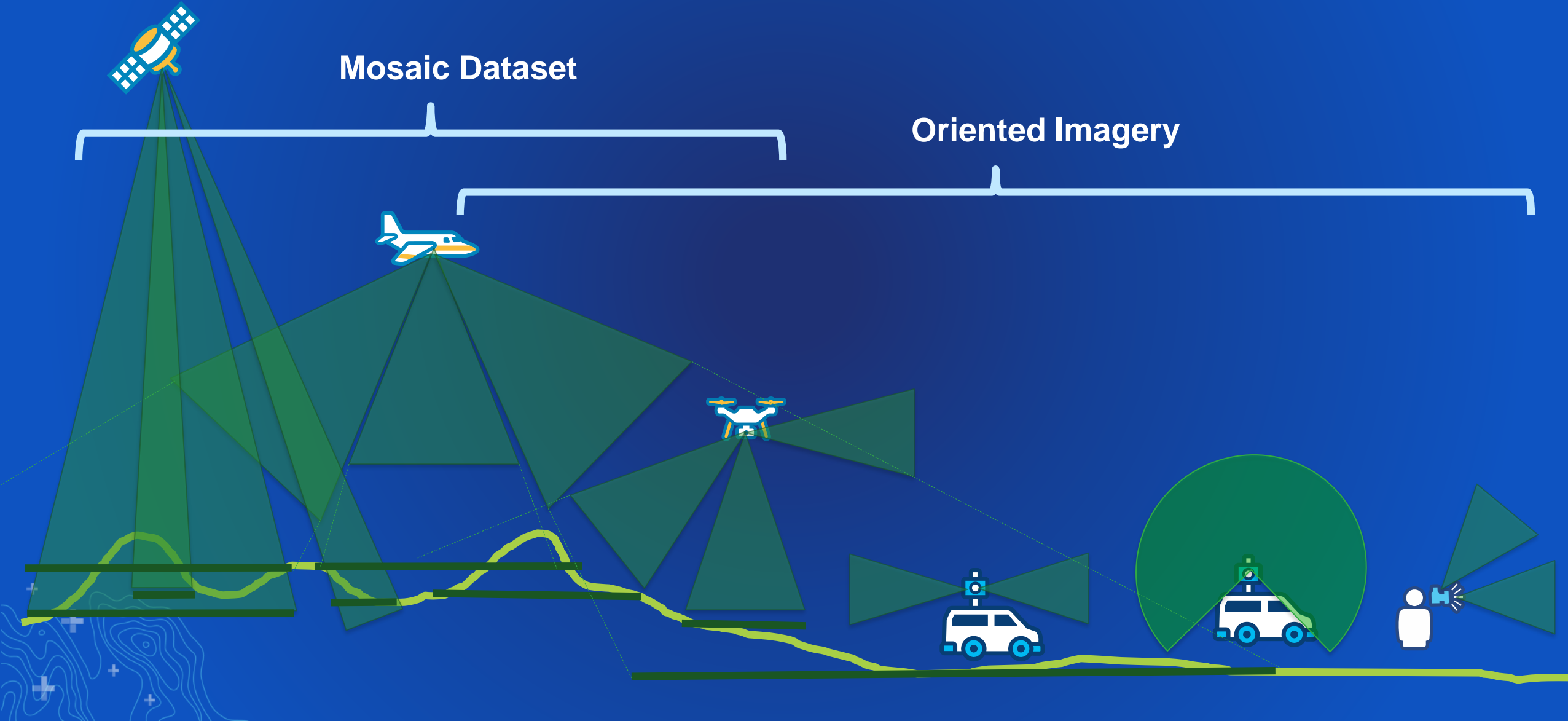


Technical details/discussion

For the developer / data manager



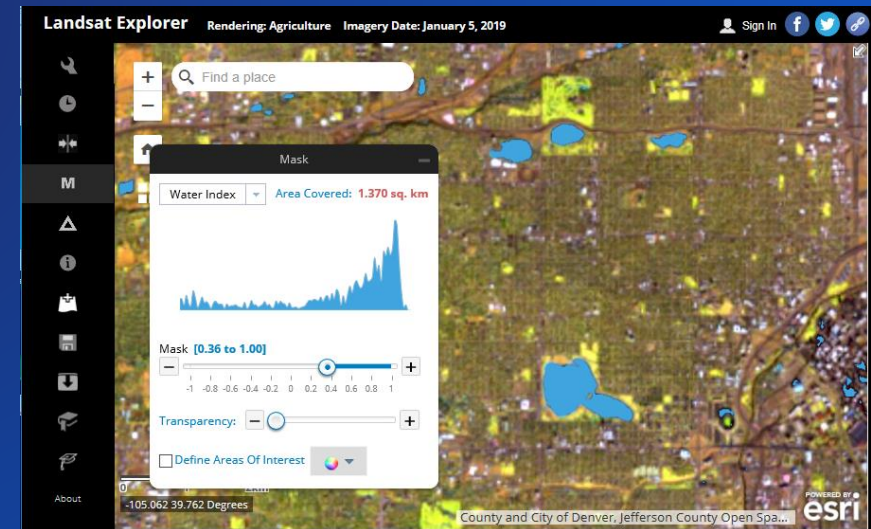
Extending Imagery Sources



Mosaic Dataset

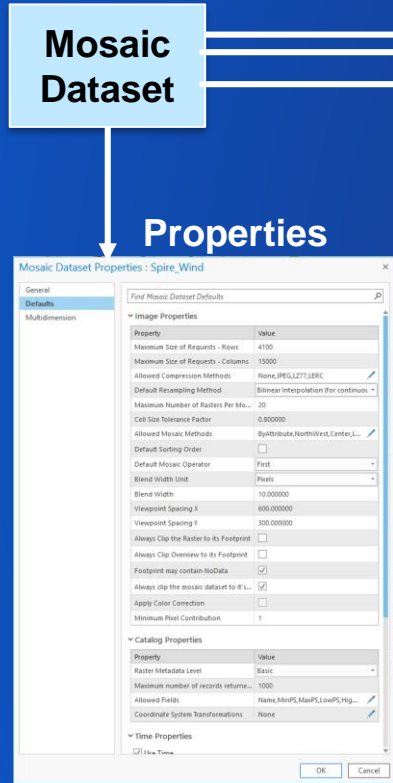
Optimized model for image management and serving of orthorectified imagery

- **References: Source Imagery/Rasters**
- **Defines: Metadata, Processing**
- **Flexible – Different types of data**
- **Author and Direct use in: ArcGIS Desktop Pro, Python Scripting**
- **Basis for:**
 - **Dynamic Image Services**
 - **Raster Analytics**
 - **OrthoMapping**



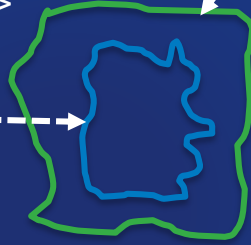
<http://www.esriurl.com/landsatonaws>

Mosaic Dataset - Schema



Seamline Table <1 record per item>

Field	Description
ObjectID	UniqueID
Shape	PolygonGeometry
RasterID	Link to footprint
BlendWidth	Width of Blend
BlendType	Across, Inside, Outside
BlendWithUnits	Pixels or Map



Stereo Table

Field	Description
...	...

Raster Type Table

Field	Description
...	...

Levels Table

Field	Description
...	...

Logs Table

Field	Description
...	...



Raster Item

Function Chain

Metadata

Properties

Property	Value
Columns	512
Rows	512
Number of Bands	1
Uncompressed Size	8527.936
Format	AR3
Raster Type	Quadlet
Pixel Type	Unsigned char
Pixel Depth	8 Bit

Footprint Table (1 record per item/scene)

Field	Description
ObjectID	Unique ID
Shape	Polygon Geometry
Raster	Item Object
Name	Readable Name
MinPS	MaxScale to display image (in screen pixels)
MaxPS	MinScale to display image (in screen pixels)
LowPS	Highest resolution data
HighPS	Lowest resolution data
Category	Primary, Overview
Tag	Link similar Items
GroupName	Used to group items together
ProductName	Product level from Vendor
CenterX	Center of image for display optimization
CenterY	Center of image for display optimization
ZOrder	Force Order of display
Raster Type ID	Source Identifier, used for synchronization
PerspectiveX	Aerial Frame Camera location
PerspectiveY	Aerial Frame Camera location
SensorAzimuth	Azimuth from center to sensor
SensorElevation	Azimuth from center to sensor
AcquisitionDate	Acquisition Date and time
CloudCover	CloudCover
...	...
CameraID	Camera ID for aerial
Variable	For Multidimensional data
Dimension	Dimension of Variable
ProjectID	Project Identifier
Year	Year of acquisition
DayOfYear	Day of Year
Best	Ordering
...	...

Required

Sensor Optional

User Optional

Mosaic Dataset

Advantage

- **Flexible sources**
 - PreProcessed Orthos
 - Satellite Scenes, Frame Camera
 - Scanned Maps, Categorical Data
 - Multidimensional Data, Data Cubes / ARD
 - Hyperspectral/Multispectral/Radar/Lidar
 - ...more
- **Scalable to 10's millions of scenes**
- **Advanced tools to create from any source. Highly automated**
- **Serve as Image Services**
 - Accessible as ImageServices, WMS, WCS, WMTS, KML, ...

Disadvantage

- **Does not handle imagery that does not fully intersect the ground**
- **Relatively heavy / Relational database**





Oriented Imagery

Access imagery at any angle, for any location

- Support many imagery sources/cameras
- Requires catalog:
 - Supports non-ground-intersecting imagery
 - Light weight
 - Different types of imagery
 - Different sources (Direct to cloud, Tile handlers)
 - Support many security models



Frame Camera



WideAngle



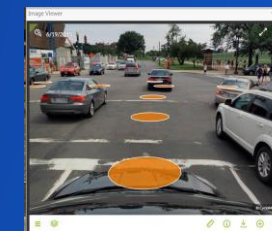
Video



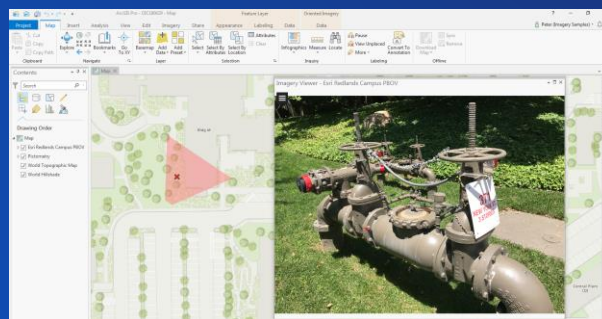
Panorama



6 Separate Images



3rd Party



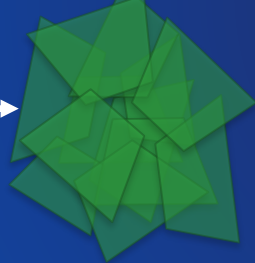
Oriented Imagery - Schema

Oriented Imagery Catalog
JSON
Name
Description
Tags
ServiceURL
OverviewURL
DefaultAttributes
CamHeading
CamPitch
CamRoll
HFOV
VFOV
...
MaxDistance
ImageField
ImagePrefix
VideoPrefix
DepthImagePrefix
DEMPrefix
SourceImagePrefix
MeasurementUnit
Variables
Filters

Variables used to declare repeated values

Overview Map

(VectorTiles, MapService, WMS)



Exposure Table (Feature Service)

Field	Description
Shape	Point geometry. XY or XYZ
Image	Link to Image – JPEG, MRF, TileHandler
Name	Visible Name
ExposureID	UniqueID
CamHeading	Heading of Camera – 0 North CW
CamPitch	Pitch of Camera – 0 Down, 90 Horizon
CamRoll	Roll of Camera - CW
ImgRot	Rotation of image in relation to camera
OIType	Oriented Imagery Type
HFOV	Horizontal Field of View
VFOV	Vertical Field of View
NearDist	Nearest useful distance
FarDist	Furthest useful distance
AvHtAG	Average Height Above Ground
CamOri	Camera Orientation - String
Accuracy	Accuracy of each parameter
CamOffset	Camera Offset - Optimization
ImgPyramid	Link to Image Pyramid if separate
DEM	Link to DEM – MRF, TileHandler
DepthImage	Link to Depth Image – MRF, TileHandler
Video	Link to Video
OffsetFromStrat	Offset(s) from start of Video
ExternalViewer	External Viewer to use
SortOrder	Order to sort records in gallery, Next, Previous
ExposureStationID	Group multiple image to same location
AcquisitionDate	Acquisition Date Time
...	Any user definable attributes



JPEG, MRF TileHandlers

Oblique
Inspection
Terrestrial
Bubble
Separate
Multiframe
Panorama
Video
ImageService

Optional



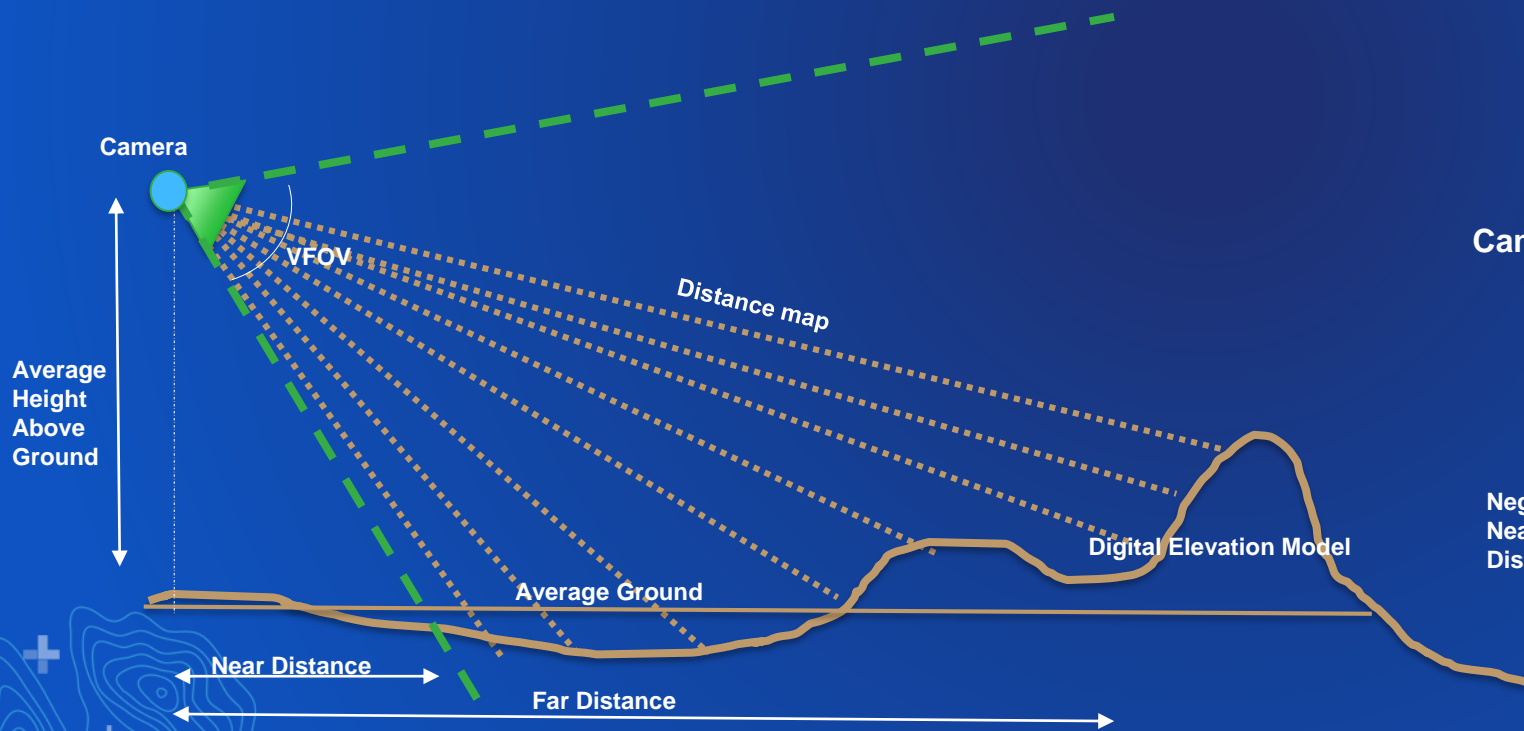
JPEG, MRF TileHandlers

Can be very compact & efficient

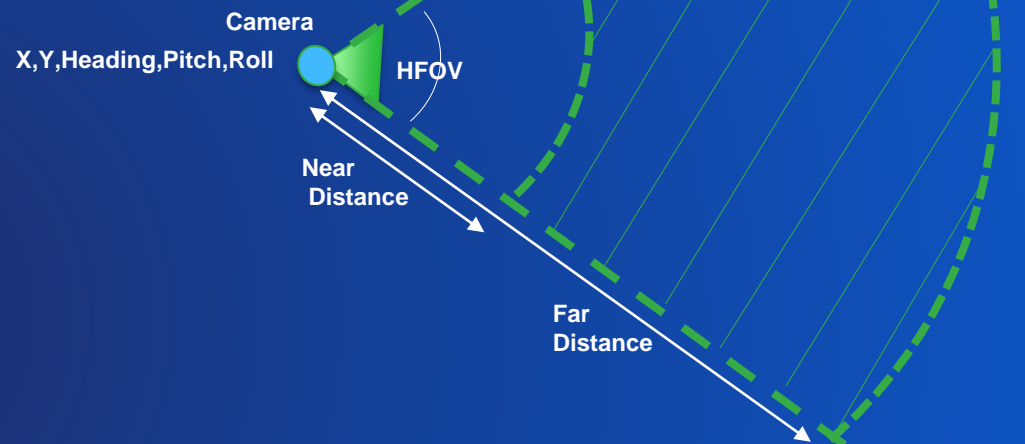
Generic Model

Used for Search and Non-Precise Viewing

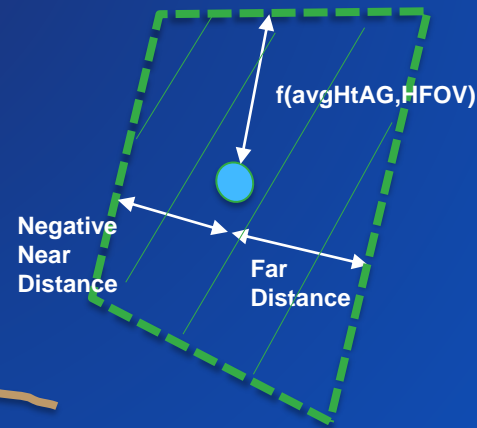
Profile View



Overhead (Planimetric) View



Camera Near Vertical



CamOri String

Defines accurate camera orientation – Enables precise measurement

- Type 1 - Heading, Pitch, Roll
- Value ordering: 1|WKID_H|WKID_V|X|Y|Z|H|P|R|A0|A1|A2|B0|B1|B2|FL|PPX|PPY|K1|K2|K3
 - WKID_H - WKID for Horizontal coordinate system
 - WKID_V - WKID for Vertical coordinate system. Can be undefined, but must be same unit as the WKID_H.
 - X,Y,Z - Camera center coordinate (Perspective point)
 - H,P,R – Heading pitch roll – Define as in key attributes
 - A0 A1 A2 B0 B1 B2 Affine transformation parameters to camera center in the ground to image direction. (IE A0 and B0 are offsets in cols and rows and A1,B2|A2,B1 are 1/pixelsize in microns)
 - FL - FocalLength in mm
 - PPX,PPY - PrincipleX,PrincipleX - Principal Point offset in X and Y from camera center in mm
 - K1,K2,K3 - Konrady distortion coefficients in mm
- Type 2 – Omega, Phi, Kappa
- Value ordering: 2|WKID_H|WKID_V|X|Y|Z|O|P|K|A0|A1|A2|B0|B1|B2|FL|PPX|PPY|K1|K2|K3
 - WKID_H - WKID for Horizontal coordinate system of the point
 - WKID_V - WKID for Vertical coordinate system of the point
 - X,Y,Z - Camera center coordinate (Perspective point)
 - O,P,K – Omega, Phi, Kappa
 - A0 A1 A2 B0 B1 B2 Affine transformation parameters to camera center (IE A0 and B0 are offsets in cols and rows and A1,B2|A2,B1 are 1/pixelsize in microns)
 - FL - FocalLength in mm
 - PPAX,PPAY - Principal Point offset in X and Y from camera center in mm
 - K1,K2,K3 - Konrady distortion coefficients in micron

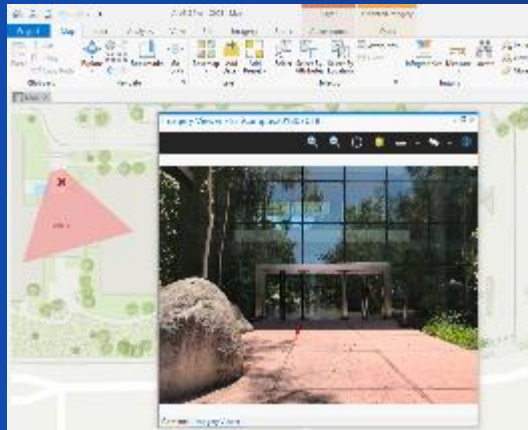
Expandable to different sensor models

3rd Dimension defined by DEM or Depth Image



Oriented Imagery

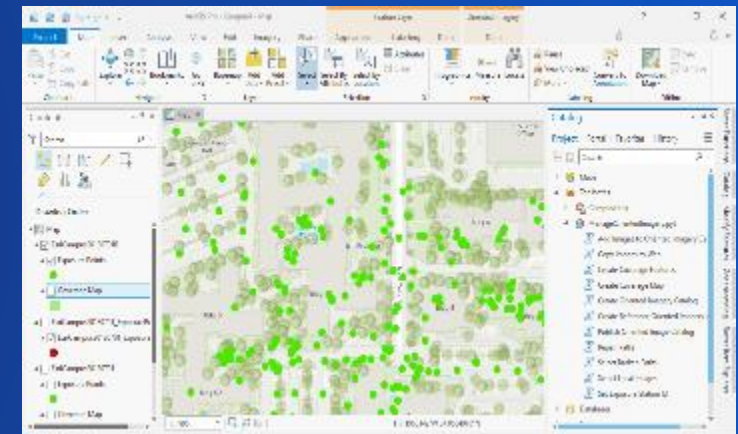
Access imagery at any angle, for any location



Pro Add In



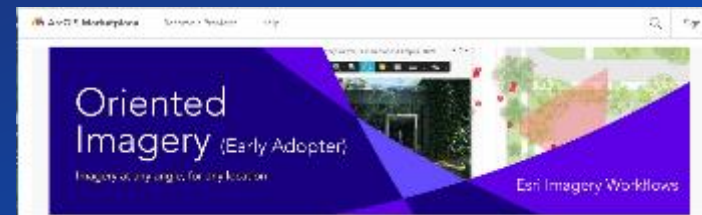
Web App Widget



Management and Publishing Tools



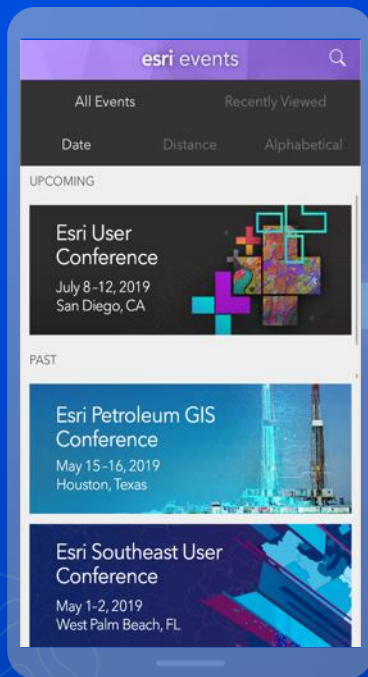
Integration with Content Providers



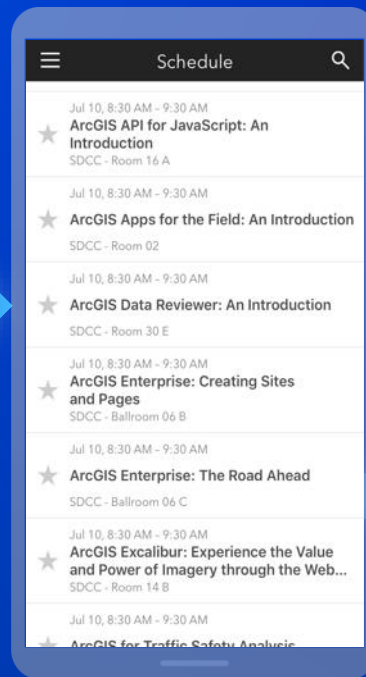
Available from the ArcGIS Marketplace, free
<http://esriurl.com/OrientedImagery>

Please Share Your Feedback in the App

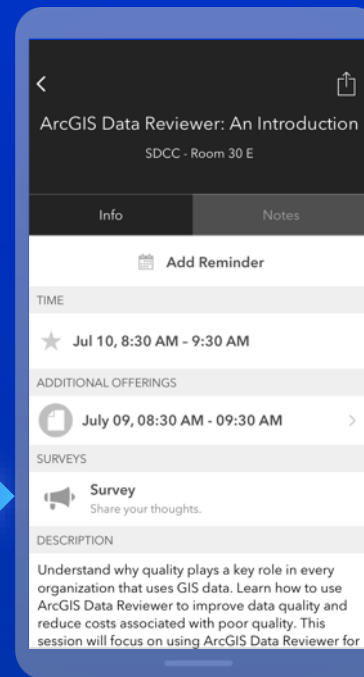
Download the Esri Events app and find your event



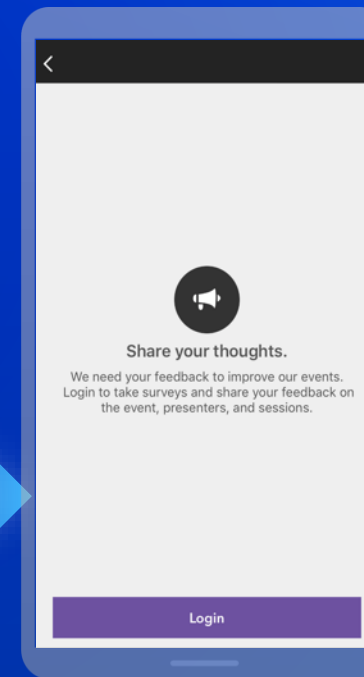
Select the session you attended



Scroll down to "Survey"



Log in to access the survey



Complete the survey and select "Submit"

