

Orthorectification of 1968 aerial photography covering Glacier National Park

Montana Imagery Summit
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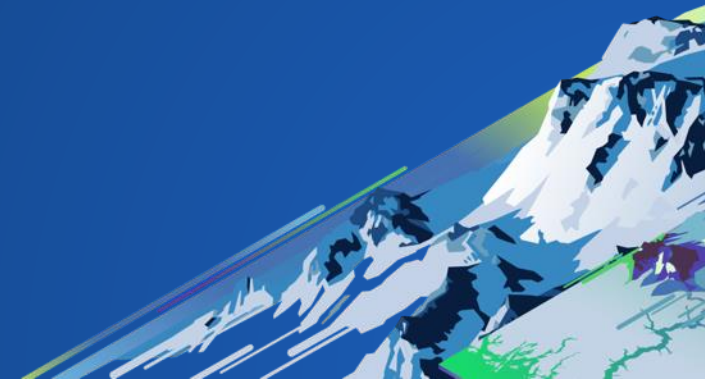
nbp104@psu.edu

Richard Menicke, National Park Service

Richard_Menicke@nps.gov

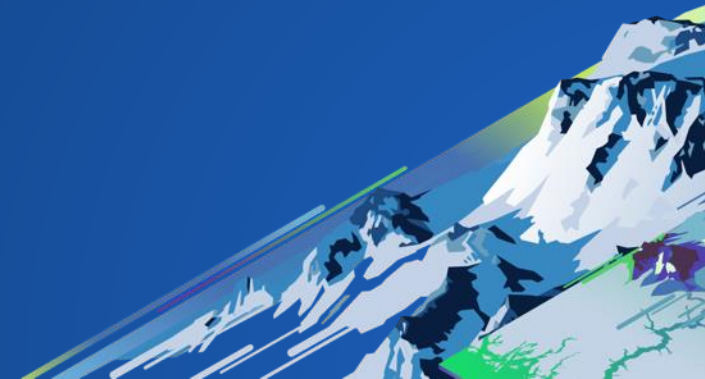
OUTLINE

- BACKGROUND
- OBJECTIVES
 - Ortho mapping project
 - Applications for the results
- WORKFLOW in ArcGIS
- RESULTS (work in progress)
- FUTURE WORK



Background

- Collaboration between Penn State and National Park Service (NPS)
- Approximately 1400 air photos (9x9) 1968
- Hardcopy prints - film not accessible
- Scan by hand
- Process in ArcGIS Pro Ortho Mapping



Applications enabled by orthophotos from 1968

- Quantify climate-related landscape change 1968 - 2019
 - Upslope movement of vegetation communities in alpine habitats (emphasis on Whitebark Pine)
 - Encroachment of conifer species into lower-elevation sage and native grasslands
 - (North Fork of the Flathead River watershed - an impact of fire suppression)
 - Avalanche chute patterns and extents
 - Stream / river main channel location (surrogate for spring high water impact)
 - Lake status (extent, succession to wet marsh) due to changing hydrology
 - Improving historical maps of wildfire extents
- Use 1968 orthomosaic as reference base for 1945 photos



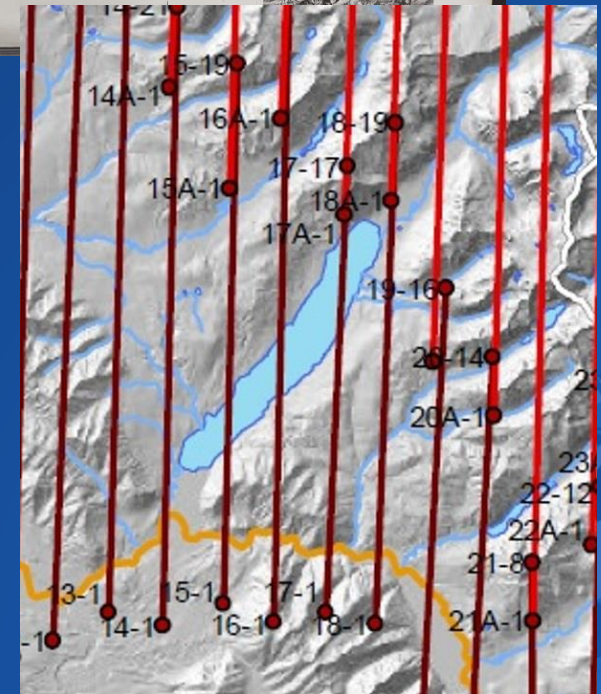
Workflow in ArcGIS Pro Ortho Mapping

- Exterior orientation – estimated from photo index plot
- Interior orientation
 - CFL from film
 - No camera calibration report
 - Ambiguous fiducials, no principal point or distortion figures
- Extract ad hoc control
 - (x,y) from ArcGIS Online Imagery basemap; (z) from USGS NED
- Aerotriangulation & Block adjustment → Self calibration for camera parameters
- Apply DEM - world terrain from ArcGIS Online (USGS NED)
- Access dynamic mosaic in ArcGIS Pro
- Color correction & seamlines → optional orthomosaic (publish & share)



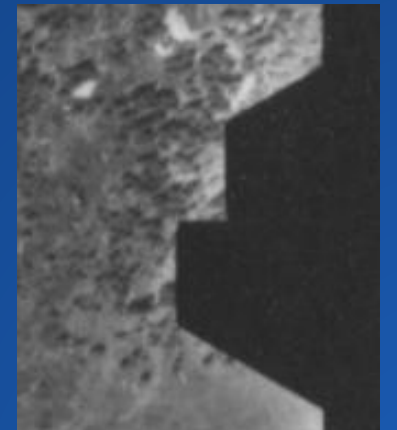
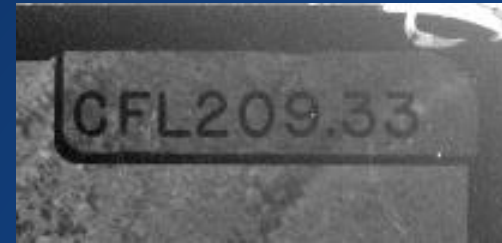
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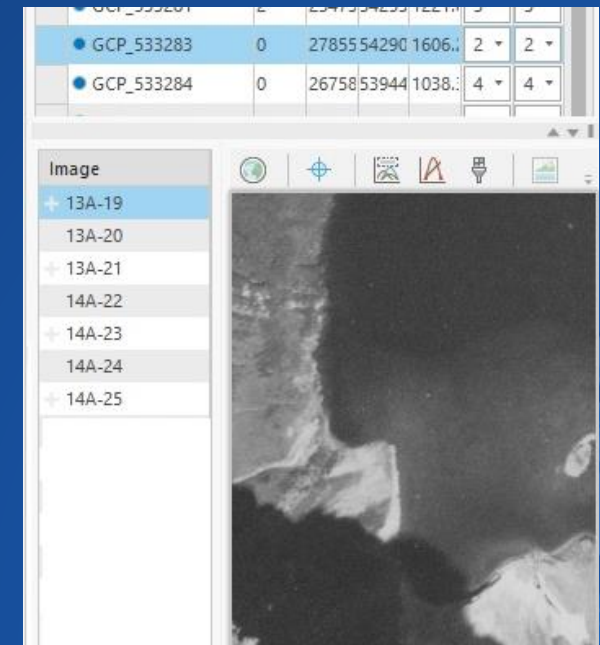
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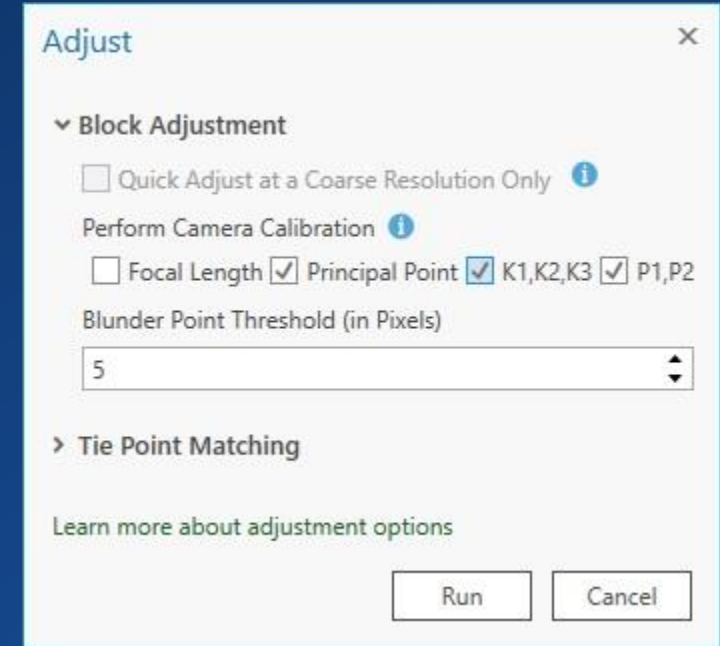


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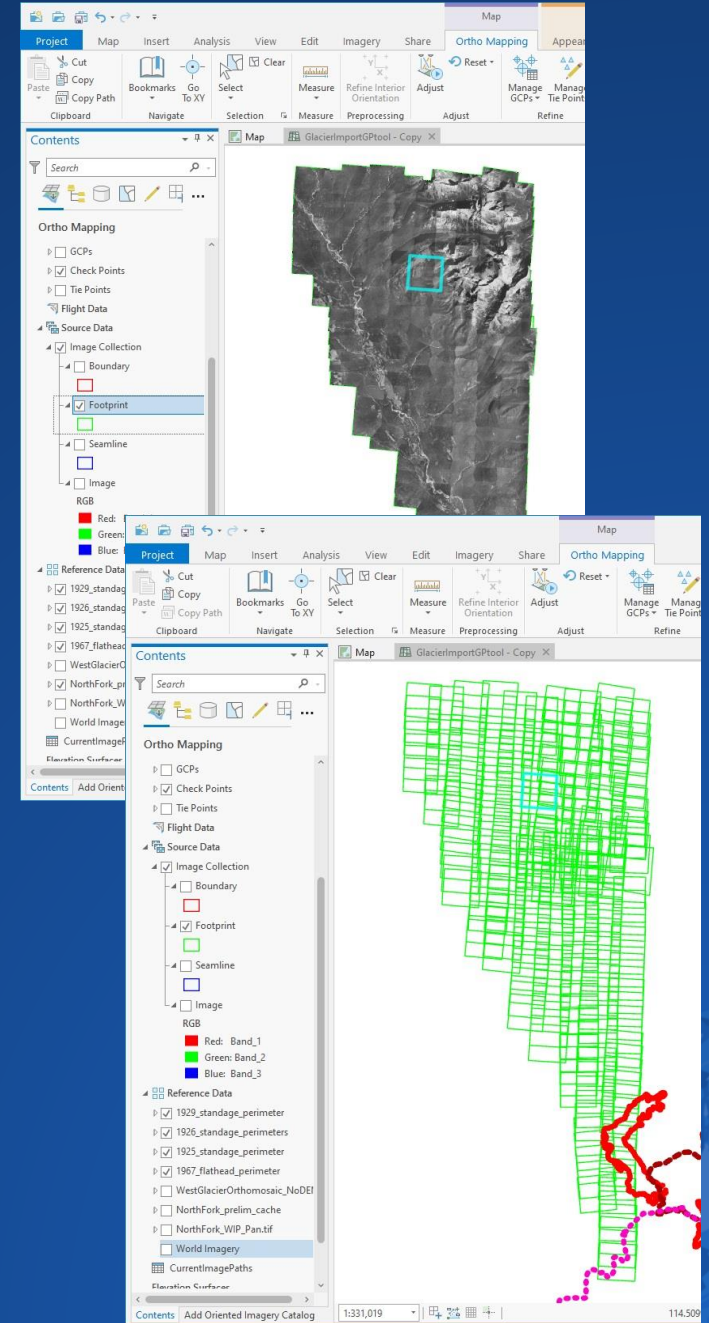
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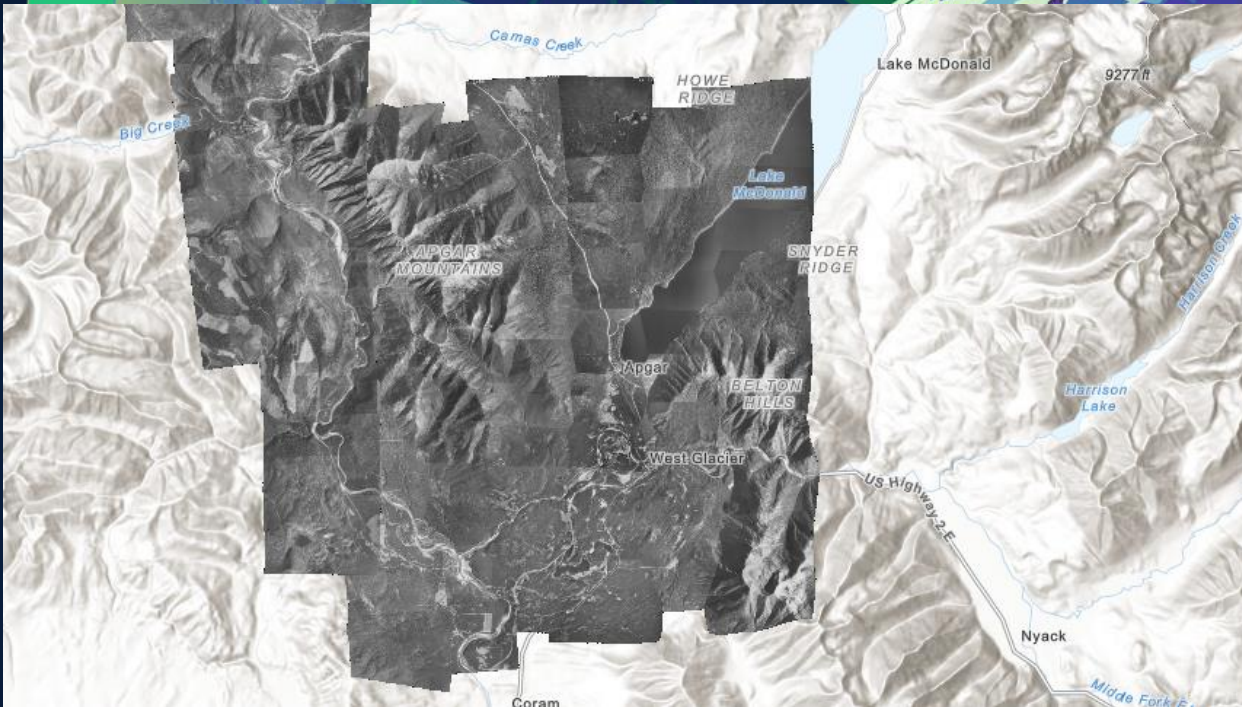
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Challenges

- Manual scanning
 - Time consuming, manual orientation & file naming, 8 vs. 16 bit dynamic range, apply compression & tonal adjustments, non-photogrammetric scanners (2 scanners used @ NPS & PSU)
- Image content
 - High contrast shadows/snow fields; some fiducials “lost”; extreme terrain (scale changes); annotations on prints; but few clouds!
- Repeated images (half flightlines re-flown)
- Fiducial measurement
- Estimating accuracy





Web map shared in ArcGIS Online

Work in progress

<https://esriurl.com/Glacier1968>

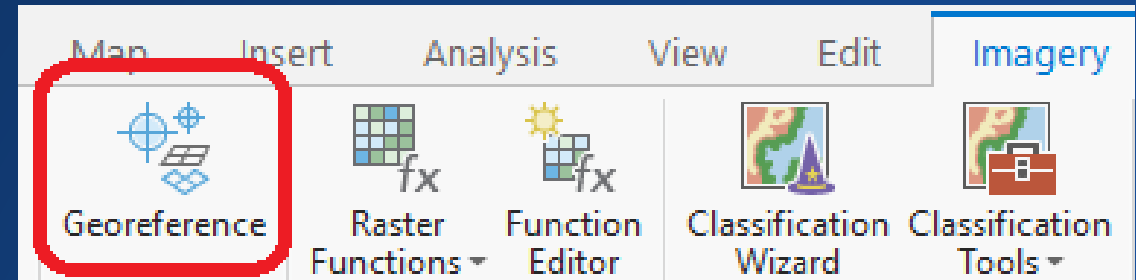
Next steps

- Complete western half of Glacier National Park (North Fork watershed)
- Prove viability of applications for historical imagery
- Test extraction of 1968 DEM
- Complete eastern half of Glacier National Park
- Test project with 1945 air photos (2 cameras)
- Funding proposal to scan original film rolls
 - Scan at NE Document Conservation Center (NEDCC); aim to begin early 2023
 - Replace image files, rebuild interior orientation, re-run block adjustment



Limited/No orientation data: Consider the *Georeferencing* tools

- If number of images is small, attempting photogrammetric processing may be overkill; georeferencing tools may be fastest and easiest solution



- If high accuracy is not required,
 - Manage using mosaic dataset with *Raster Dataset* Raster Type
 - Use directly in ArcGIS Pro
 - (and/or) Publish as raster tile cache (ArcGIS Online) or Image Service (Image Server)
- If you're seeking to generate orthorectified images or extract a historical DEM, proceed into Ortho Mapping

Summary – Open for questions

Web map at <https://esriurl.com/Glacier1968>

Information on Ortho Mapping @ <https://esriurl.com/OrthoMapping>

General resource for imagery in ArcGIS @ <https://esriurl.com/ImageryWorkflows>

Contact info cbenkelman@esri.com



Bonus material (if time permits)

- Oriented Imagery
 - Supporting non-mapping imagery in ArcGIS
- Remote inspection of assets using imagery

*Please take our survey
regarding INSPECTION
requirements*





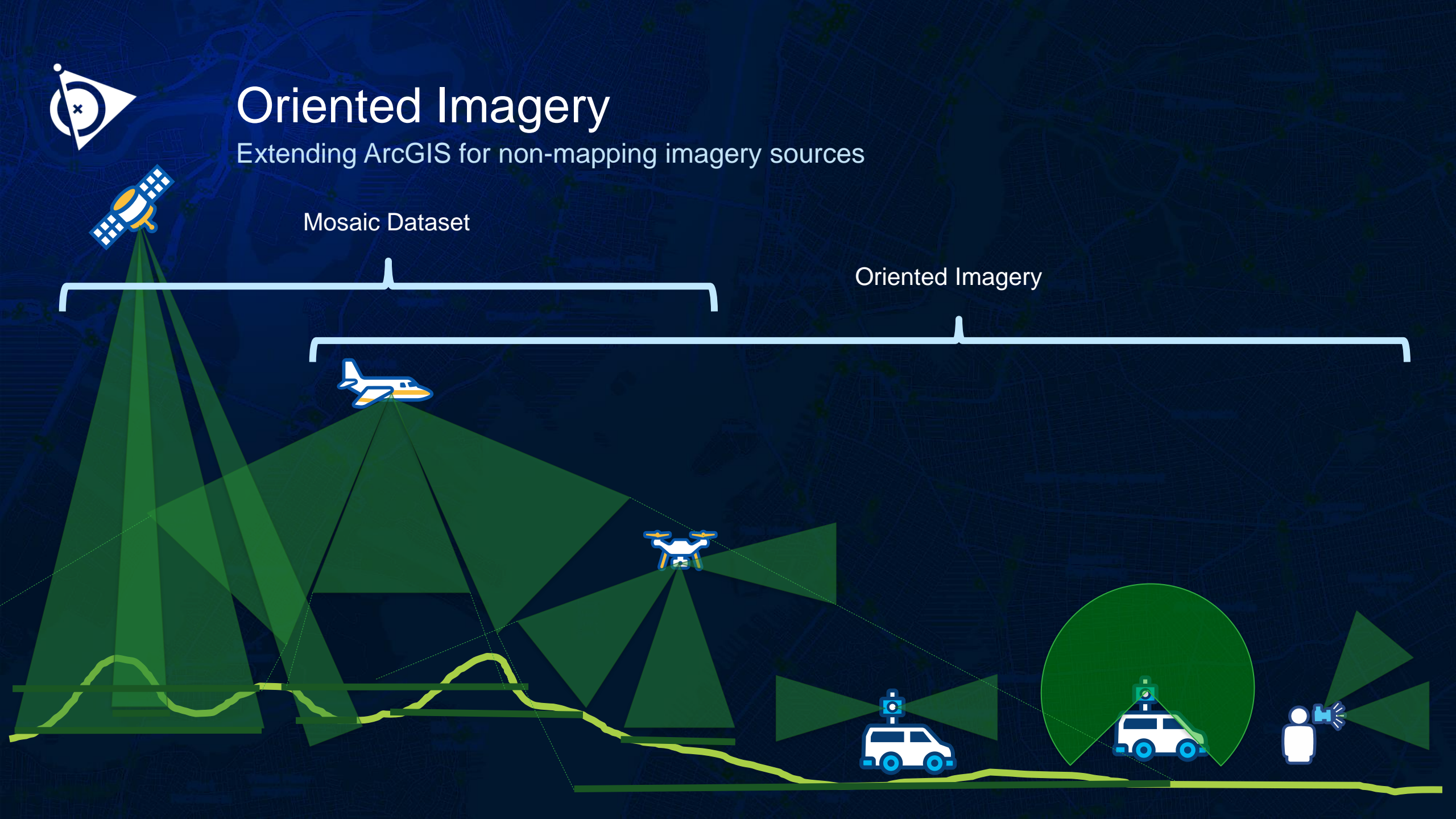
Oriented Imagery

Extending ArcGIS for non-mapping imagery sources



Mosaic Dataset

Oriented Imagery





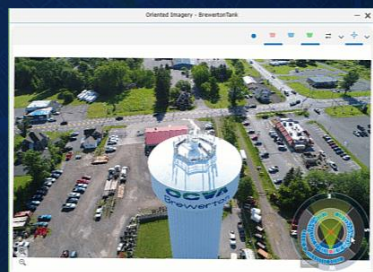
Oriented Imagery – example use cases

Access imagery at any angle for any location

Desktop, Web, Mobile



ArcGIS Pro



View assets from multiple directions



Time Selector



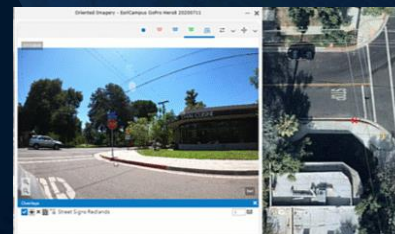
3D Superimpose view



Web Apps

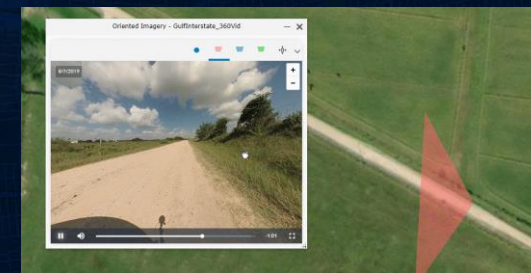


Measurement



Feature and Label collection

Geospatial Video Image type



360-degree video

Oriented Imagery Catalog Data Model

- Simple, Highly scalable
- Focused on non nadir imagery:
 - Obliques, Terrestrial, StreetSide, 360, Video
 - Also able to support nadir mapping imagery



QuickCapture
Integration

Sample web apps at <https://esriurl.com/Olgallery>

Using Imagery for Remote Inspection of Assets

High level workflow

Plan → Capture Images → Manage & Share → Access images for inspection

Discrete sites vs.
general area

Specific photos vs.
broad coverage



Systematic
vs. Ad Hoc

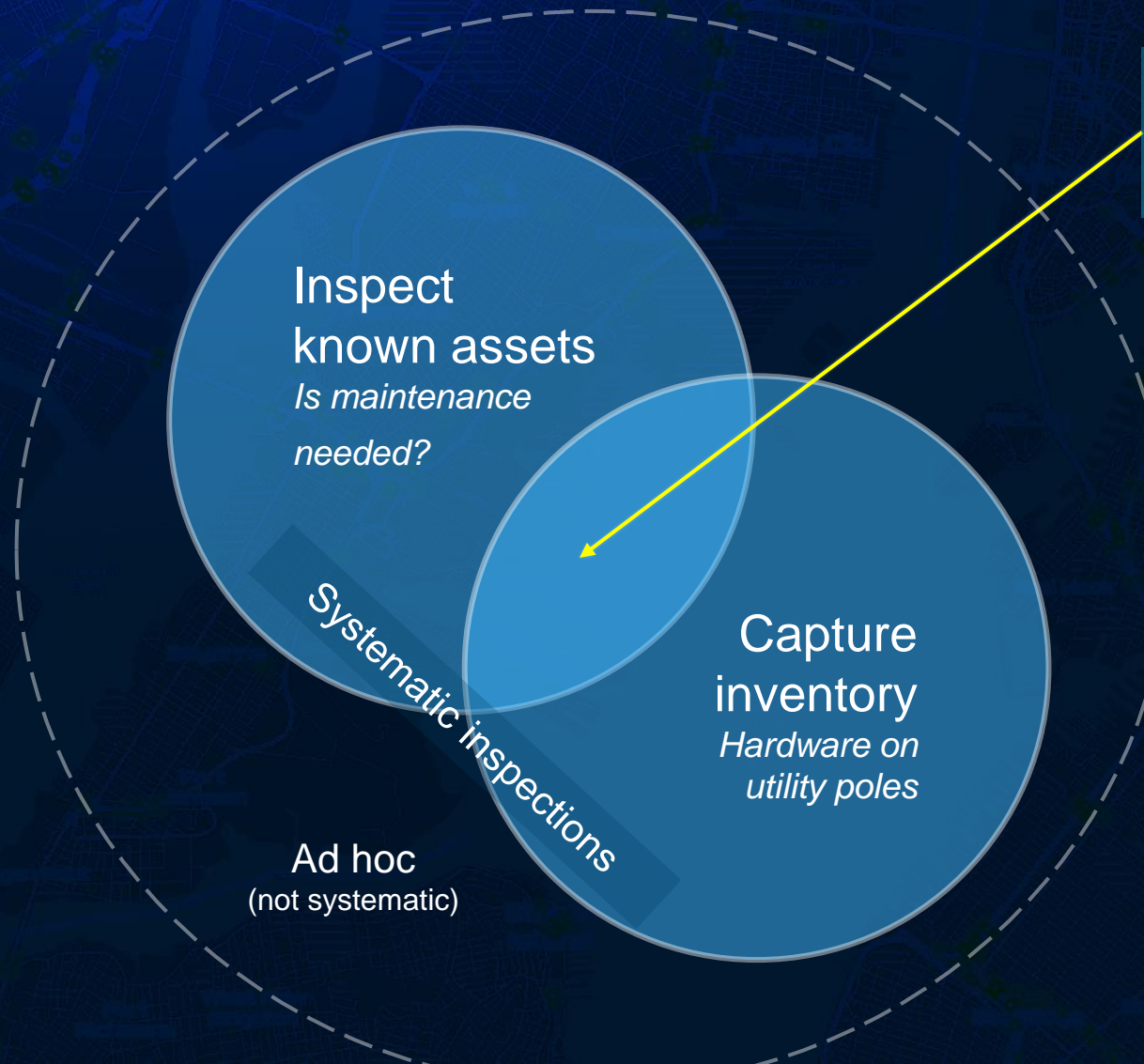
Manual
vs. AI/ML

Local vs.
Web

Record
in GIS

*Training for
AI/ML/DL*

Requirements for remote asset inspection using imagery



Requirements and workflows common to (nearly) all use cases

Systematic inspection sequence driven by:

- Assets
- (or) Images
- (or) Labels

Please take our survey





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