

Drone Imagery: Creating Orthomosaics, DEMs, and 3D Mesh

Cody Benkelman, Nico Bonnafoux, Mark Buie,
Mark Barker, & Chris Patterson



2021 ESRI USER CONFERENCE

Imagery & Remote Sensing Capabilities

Comprehensive Imagery System



Imagery & Remote Sensing Capabilities

Comprehensive Imagery System



Image Mapping in ArcGIS

From sensor to accurate derived products

Data Capture

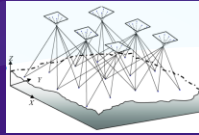


Processing

Block Adjustment

Aerial Triangulation

Ground Control



Orthophotos

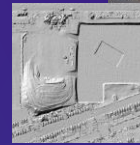
Ortho mosaics

DTM

DSM

3D Point Clouds

Output Products



Feature Extraction & Editing

Stereo Feature Capture



Point Cloud Classification



Automated Feature Extraction

Point Cloud Editing

Pixel Editing

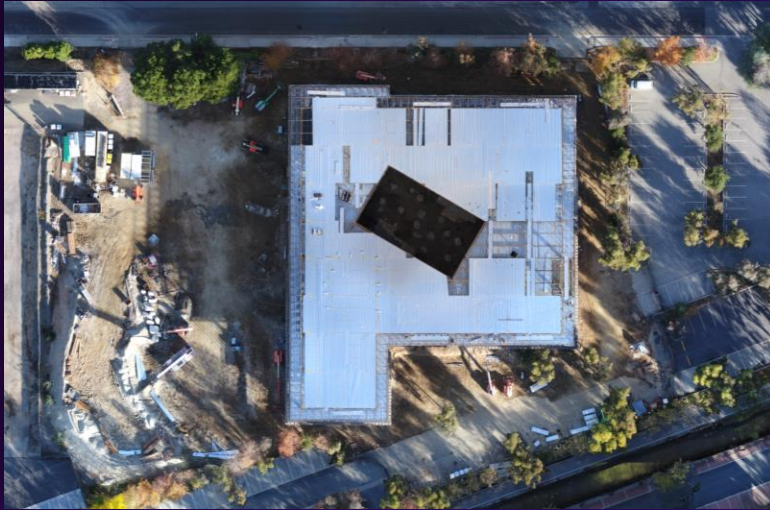
Image Mapping in ArcGIS

From sensor to accurate derived products



Digitize your world with ArcGIS

From sensor to accurate derived products



Orthomosaics



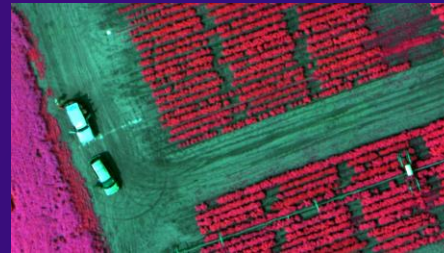
Digital Surface Models



Thermal Orthomosaics



Dynamic Orthomosaics



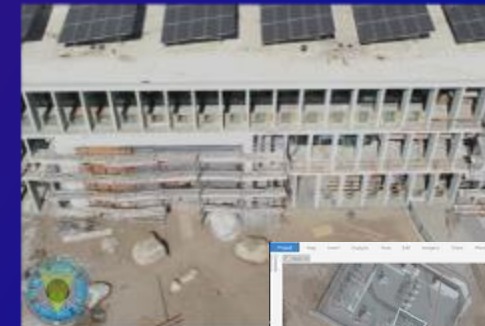
Multispectral Orthomosaics



360° Panoramas



3D Point Clouds & Meshes



Inspection with Video (FMV)
& Oriented Imagery

Drone processing options in ArcGIS

	Site Scan	Drone2Map	ArcGIS Pro * (Ortho Mapping)	Enterprise + Image Server (Ortho Maker)
Processing Environment	Web / Cloud	Desktop (office/field)	Desktop	Web (ArcGIS Enterprise)
Drone Flight app included	Site Scan Flight	Site Scan LE	Site Scan LE	Site Scan LE
Input data	Drone	Drone	Drone, Satellite, Scanned Film, Digital Camera	Drone
Data Products				
2D (orthomosaic, DSM, DTM)	✓	✓	✓	✓
3D (point cloud, mesh)	✓	✓		
Cloud connection from flight app	✓			
Drone Fleet Management	✓			
Analysis Capabilities	Some focused tools; Connect with ArcGIS for advanced analysis		Extensive (part of ArcGIS Pro)	Some focused tools + ArcGIS Enterprise

* Advanced license



Drone flight planning and execution

Nico Bonnafoux
Site Scan Flight for ArcGIS



Badouzi Port, Taiwan

Credits and thanks to



&



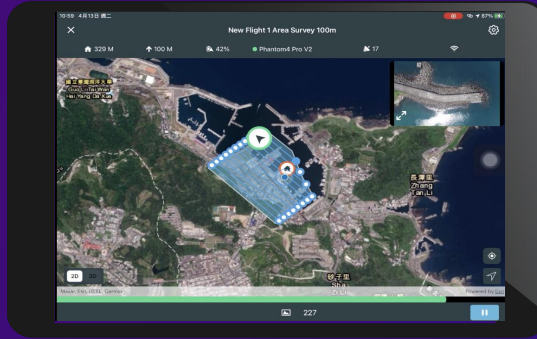
Site Scan Flight for ArcGIS



Site Scan Flight for ArcGIS

Cloud-connected flight planning and execution, automated fleet management

Requires a Site Scan license



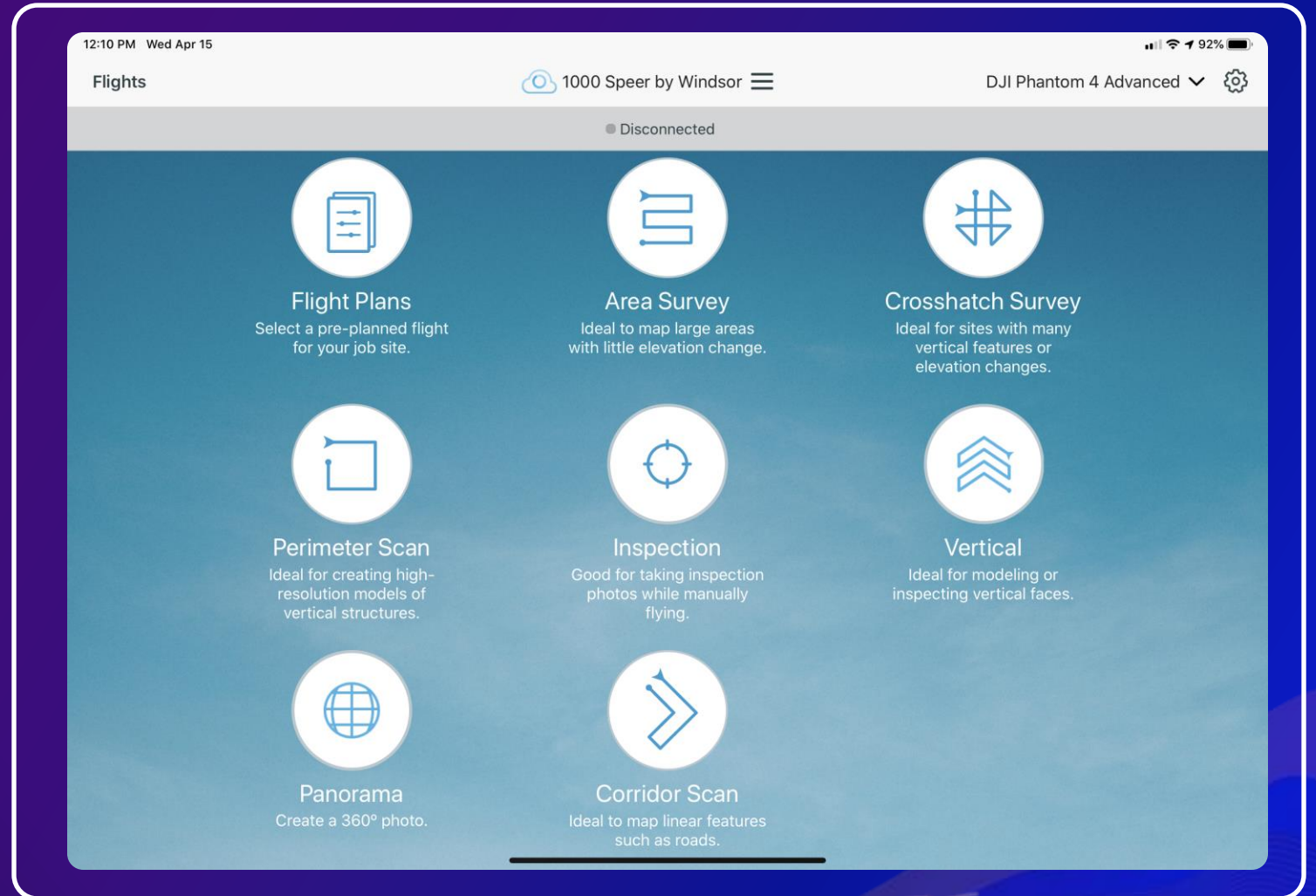
Site Scan LE (Limited Edition)

Disconnected flight planning and execution

Available to all ArcGIS users for free

Site Scan Flight and LE

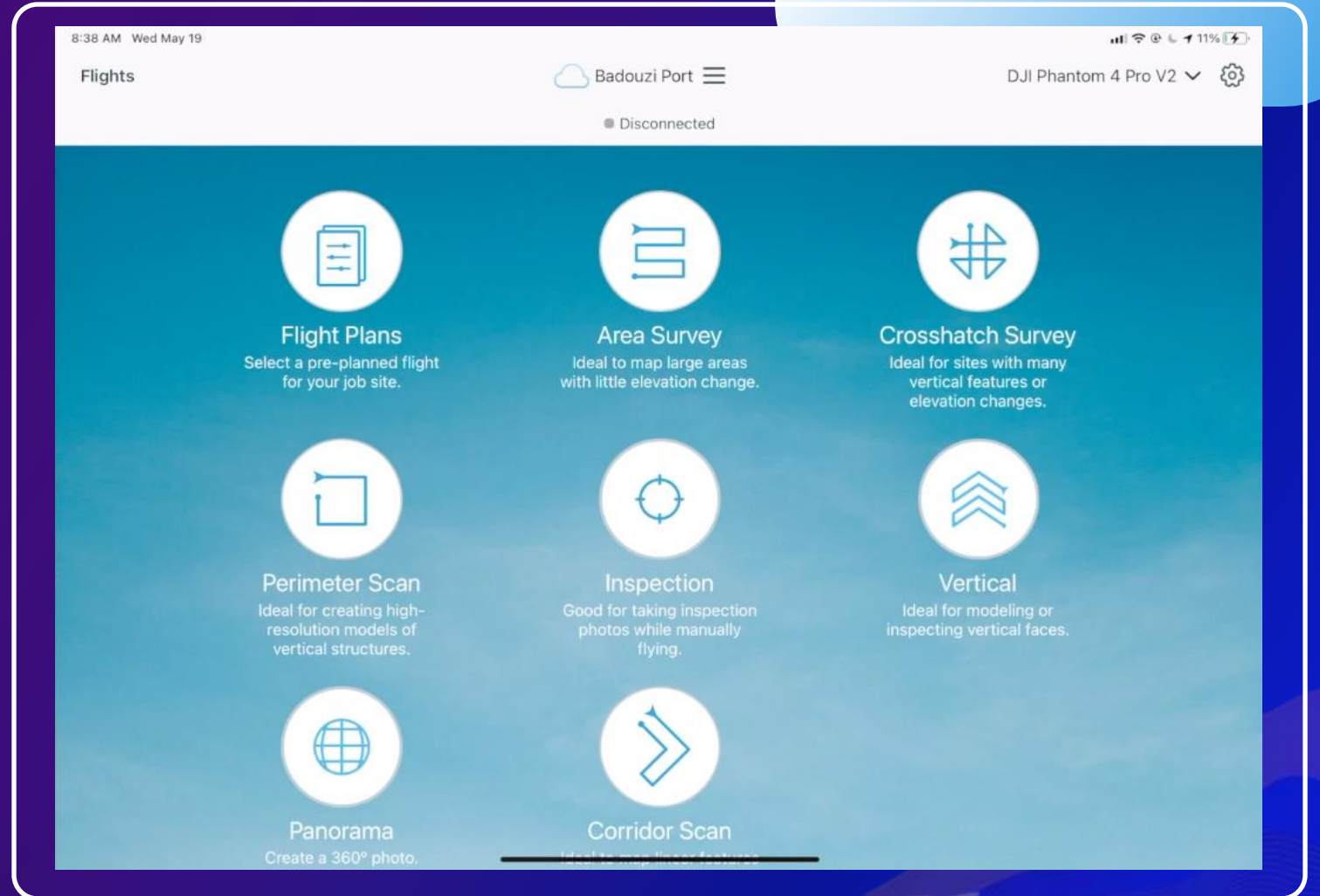
- ✧ iPadOS application
- ✧ Plan automated mapping & inspection flights in 2D & 3D
- ✧ Geospatial Video Log recording
- ✧ Terrain Follow capability
- ✧ Offline basemap download
- ✧ Display 2D & 3D data from ArcGIS Online or Enterprise
- ✧ QuickMap offline photo-mosaic stitching
- ✧ Field data management



Site Scan Flight for ArcGIS

- Cloud connected functionalities requiring a Site Scan license:

- Saving and **sharing of flight plans** between users
- Display of previously processed flight data
- Automated Fleet management**
- Organization-mandated **custom preflight checklist** forms
- Field-to-Cloud imagery upload**



8:38 AM Wed May 19

11%

Flights

Badouzi Port

DJI Phantom 4 Pro V2

Disconnected



Flight Plans

Select a pre-planned flight for your job site.



Area Survey

Ideal to map large areas with little elevation change.



Crosshatch Survey

Ideal for sites with many vertical features or elevation changes.



Perimeter Scan

Ideal for creating high-resolution models of vertical structures.



Inspection

Good for taking inspection photos while manually flying.



Vertical

Ideal for modeling or inspecting vertical faces.



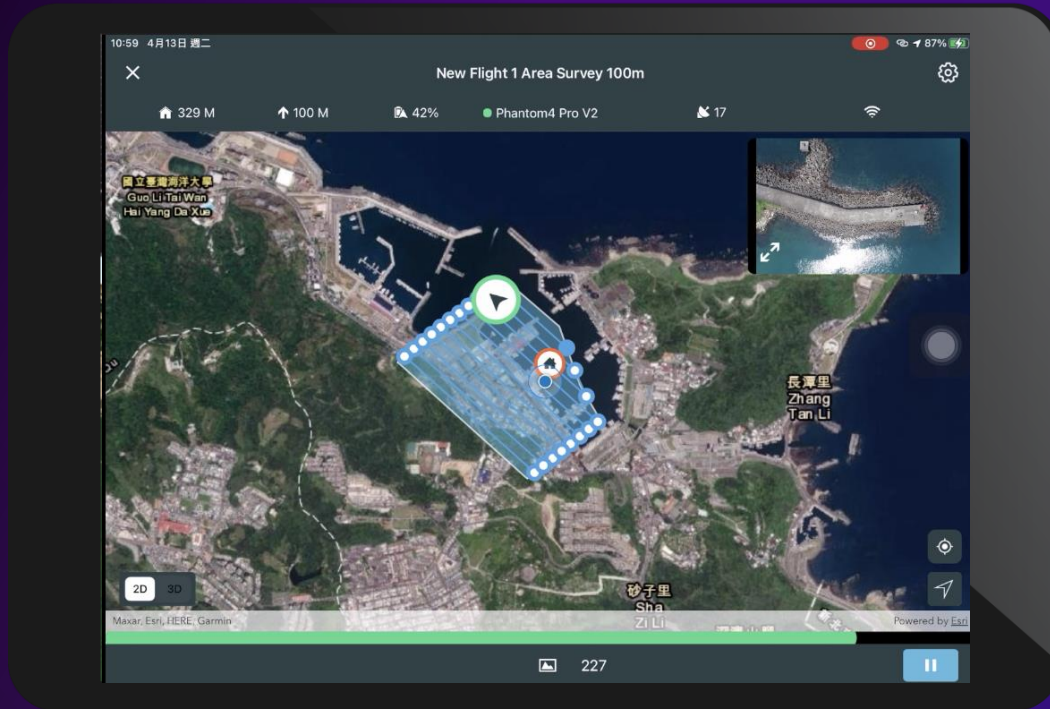
Panorama

Create a 360° photo.



Corridor Scan

Ideal to map linear features.

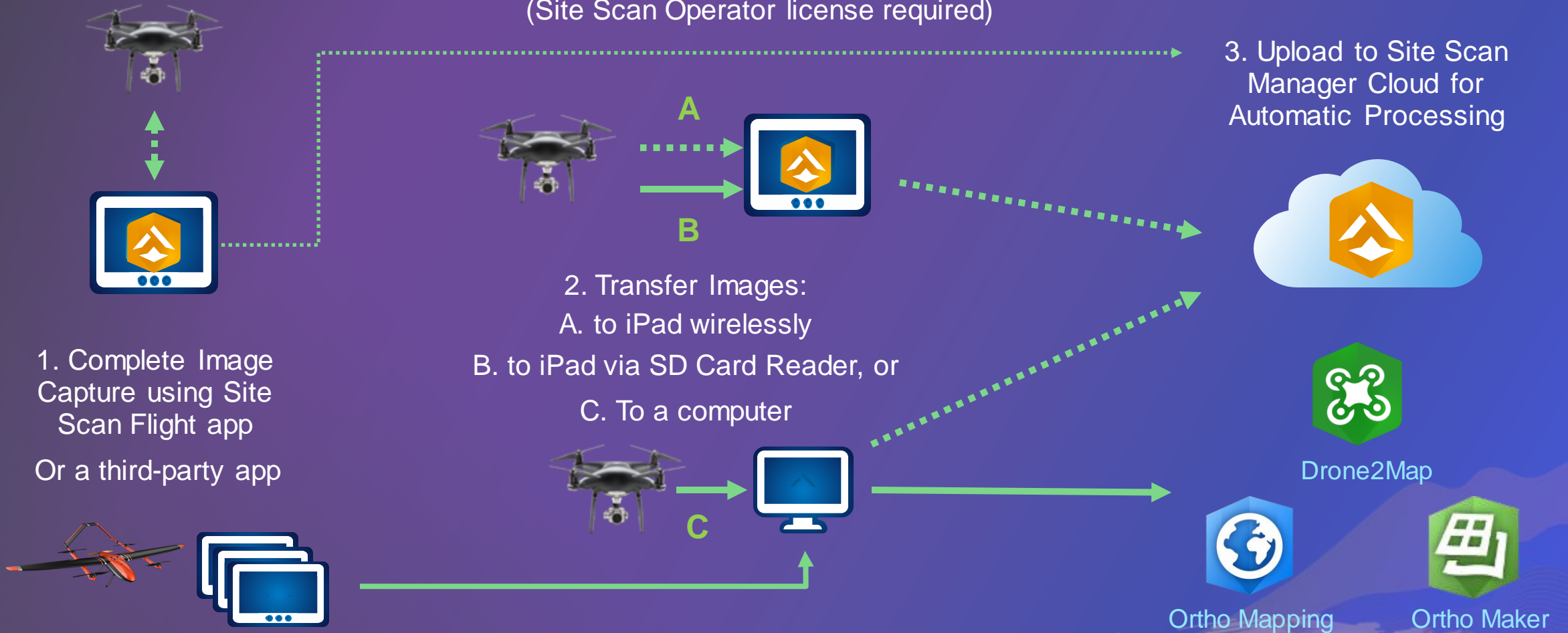


Site Scan Flight Execution

Post-Flight

- Uploading Images and Fleet Management Data

Fleet Management and Checklist data: sync to Site Scan Cloud
(Site Scan Operator license required)



Drone Data Processing

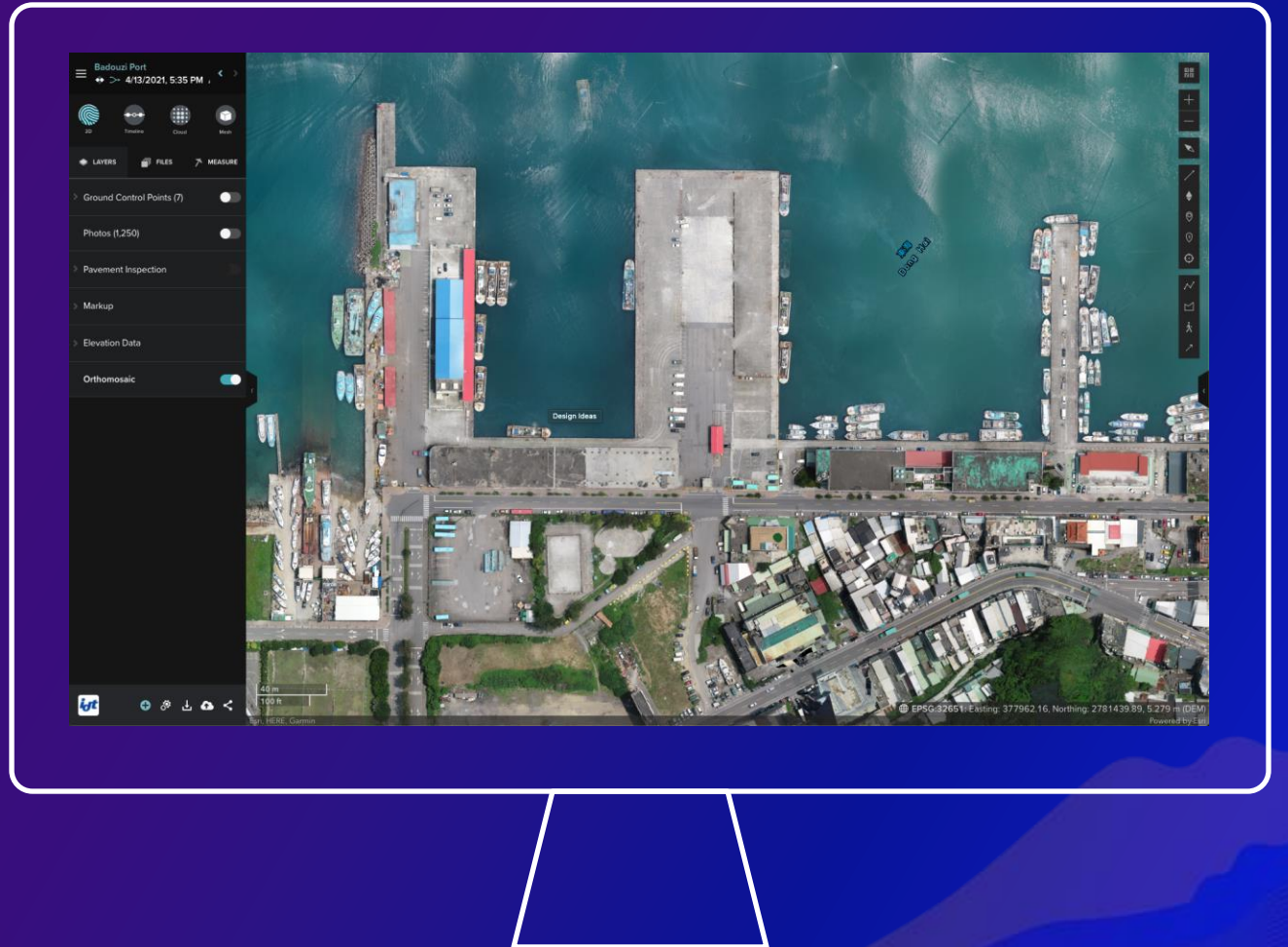
The background is a vibrant, abstract composition. It features large, flowing shapes in shades of purple, magenta, and pink. On the right side, there is a stylized, high-contrast illustration of a mountain range in orange and yellow tones. A thin, curved yellow line arches across the right side of the image, adding a sense of motion or a path.

Site Scan Manager for ArcGIS



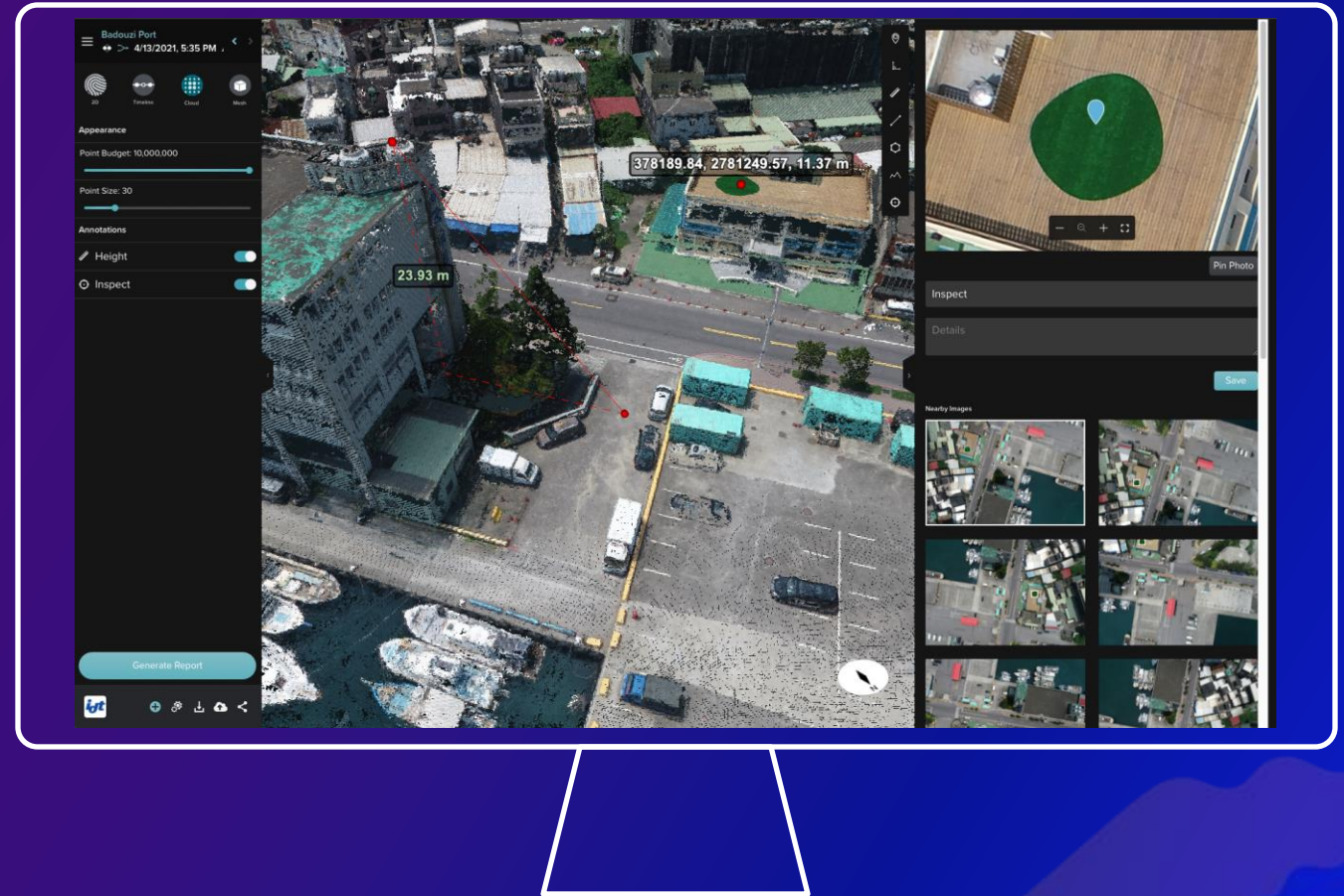
Site Scan Manager for ArcGIS

- Web application
- Unlimited cloud processing of drone imagery
- Secure hosting in the U.S. or E.U.
- Visualization, first-phase analysis and collaboration tool
- Publishing of processed outputs into ArcGIS Online or ArcGIS Enterprise
- Local export and sharing functionalities



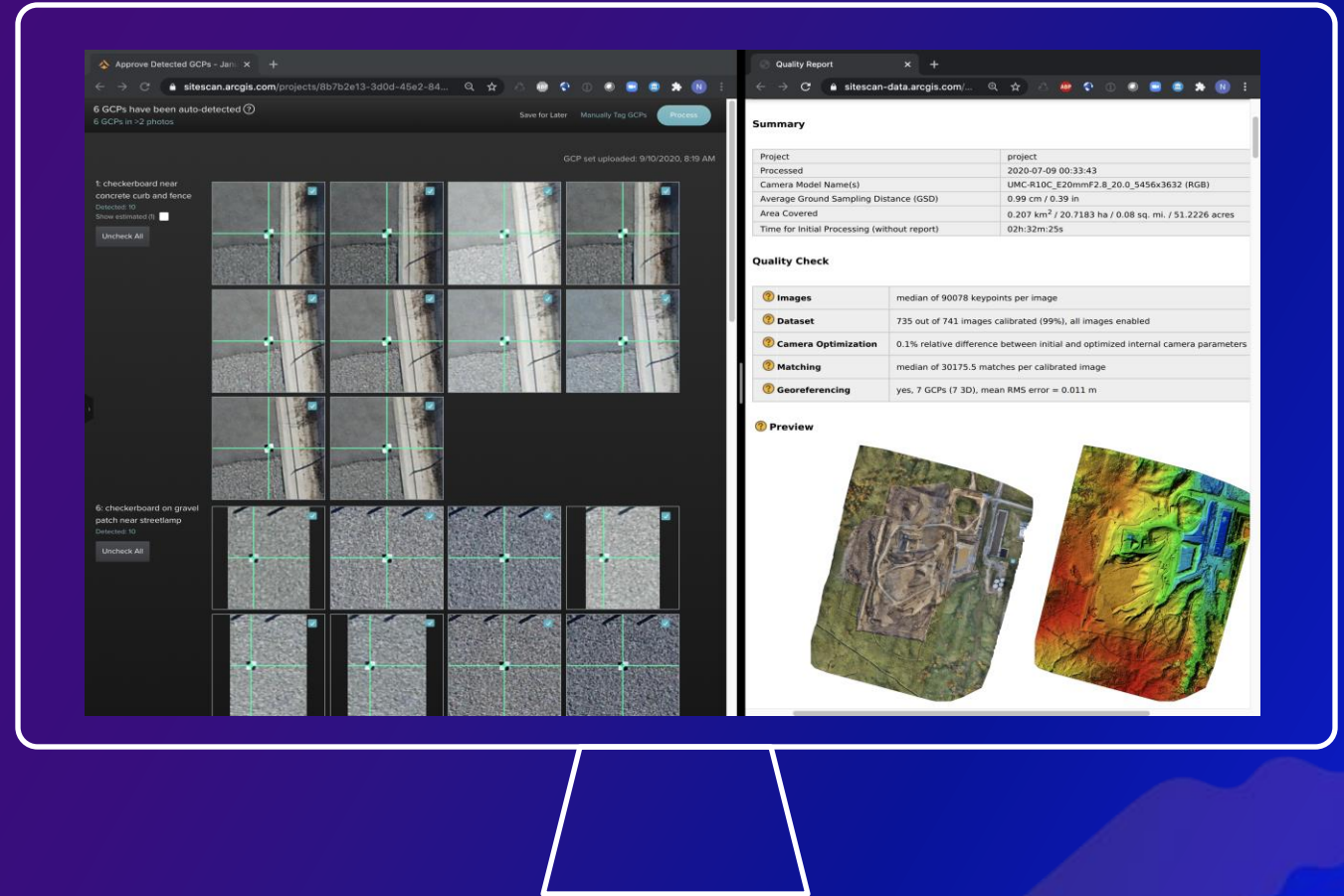
Site Scan Manager

- Perform linear, volumetric and cut/fill analysis with one click
- Display CAD and PDF overlays to perform Quality Control
- Generate inspection reports as PDF documents
- Navigate through inspection photos in 3D using the point cloud
- Easily share 2D & 3D Data outputs, or 360° Panorama photos with project teams and collaborators



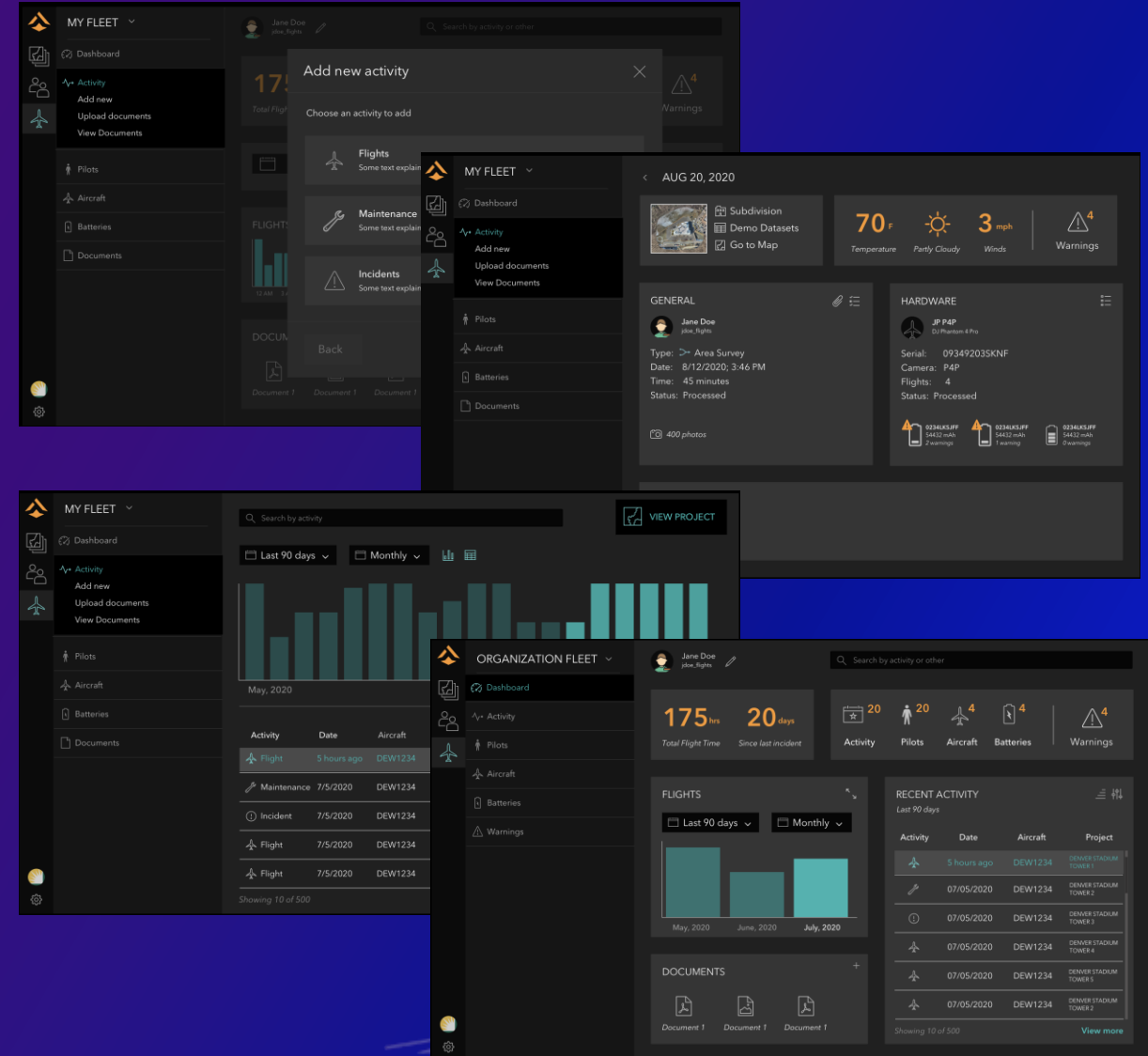
Site Scan Manager

- Computer vision Ground Control Point detection
- Accuracy validation through checkpoints
- Processing & accuracy reports
- RTK and PPK support

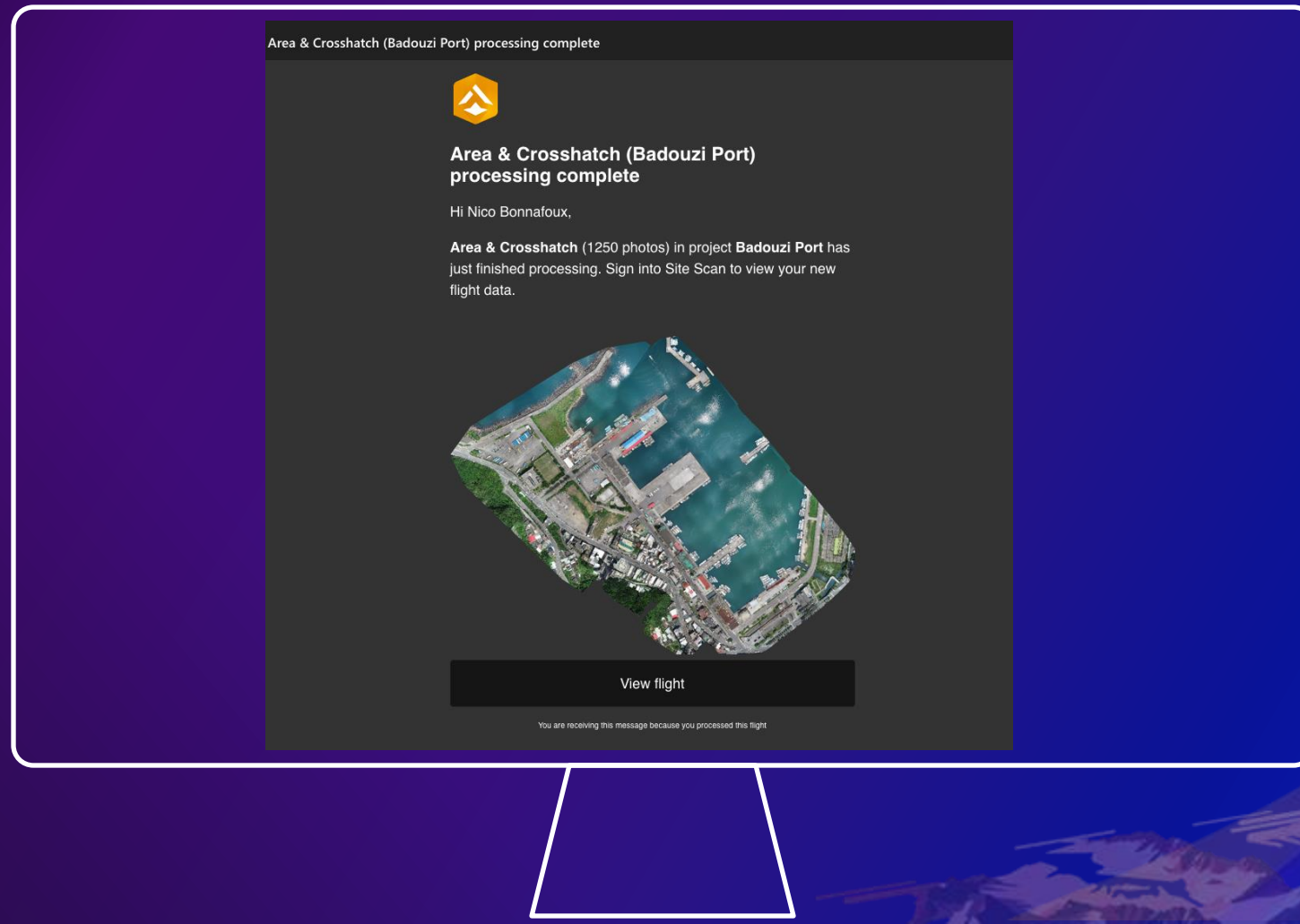


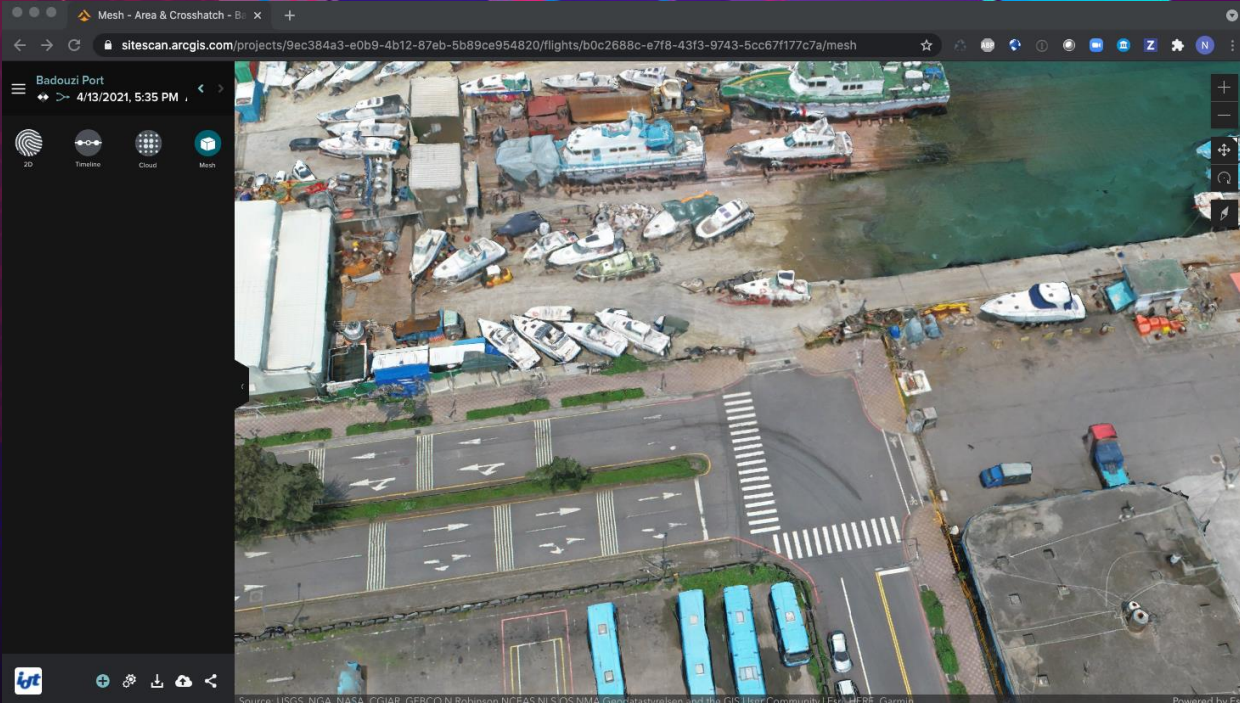
Site Scan Manager - Fleet Management

- Automatic recording of all flights conducted with the Site Scan Flight app & manual flight logging:
 - Pilot
 - Aircraft
 - Batteries
 - Weather...
- Dynamic operations dashboard
- Maintenance scheduling and tracking
- Data exports for reporting
- Pilot certificate and aircraft document tracking
- Incident tracking and administrator notifications



Site Scan Manager: Processing Complete Email Notification





Processing in the cloud

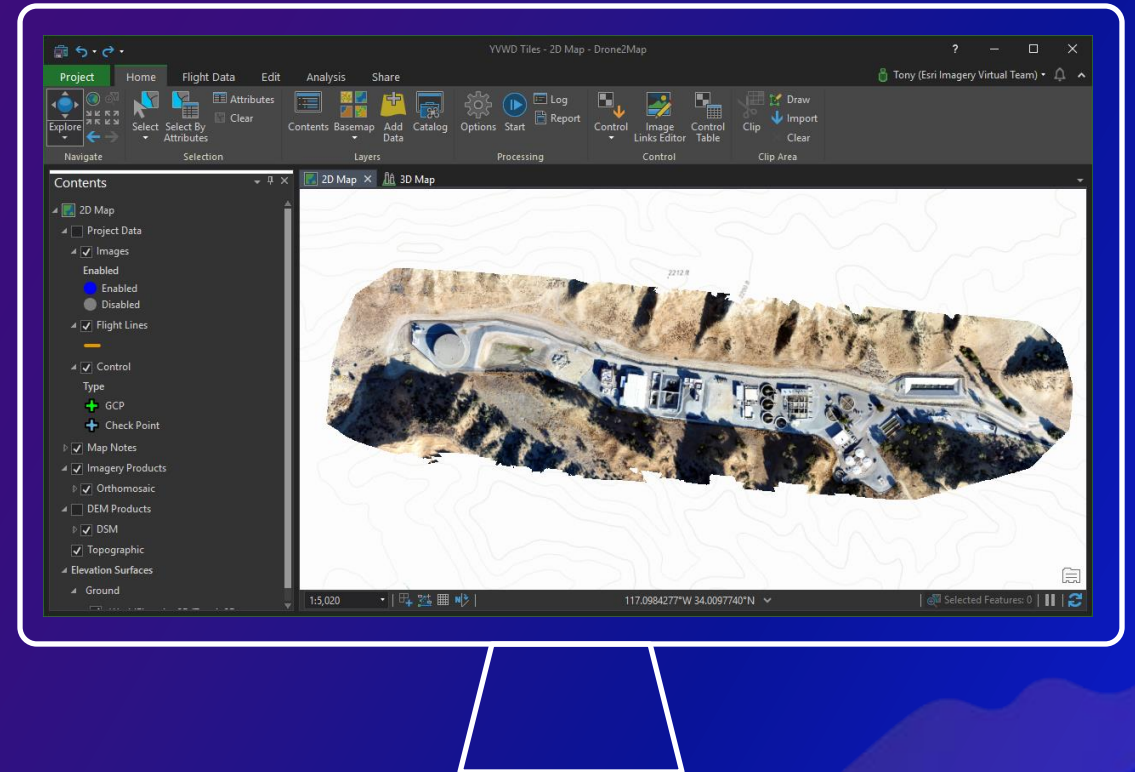
Nico Bonnafoux
Site Scan Manager for ArcGIS

ArcGIS Drone2Map

Mark Buie

ArcGIS Drone2Map

- Standalone Desktop Application
 - Does not require ArcGIS Pro
 - Licensed with Creator Users Type
 - Open projects in ArcGIS Pro for advanced analysis
- Accurate high-resolution 2D & 3D products
 - Ground Control Points, Manual Tie Points, Check Points
 - RTK/PPK
- Secure local processing
- Import and publish data from ArcGIS Online or ArcGIS Enterprise



ArcGIS Drone2Map

Compatible with the drone that fits your needs and budget

- Low operation cost
 - Compatible with entry-level and professional mapping drones
- Supports multiple payloads
 - RGB Cameras (<55 MP)
 - Multispectral Cameras
 - Calibrated Cameras
 - RTK/PPK
 - Integrated or external module



ArcGIS Drone2Map

Process geolocated images from any source



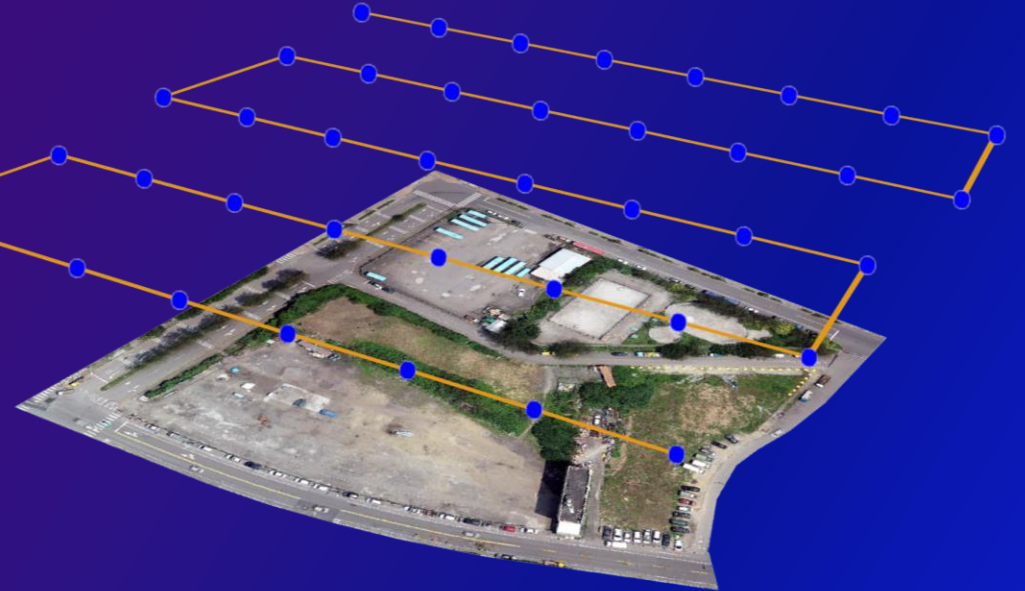
Optimized for Site Scan LE



Compatible with third-party
flight planning apps

$$\begin{bmatrix} X \\ Y \\ Z \end{bmatrix}$$

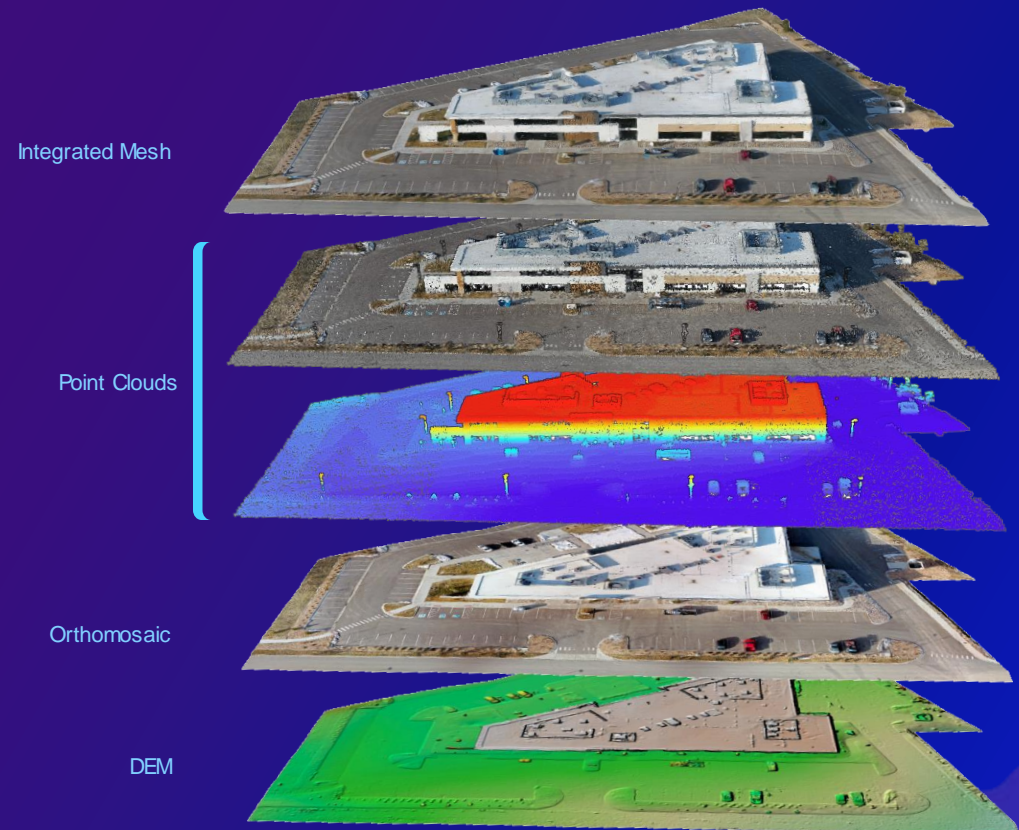
- Image Metadata
- Geolocation File

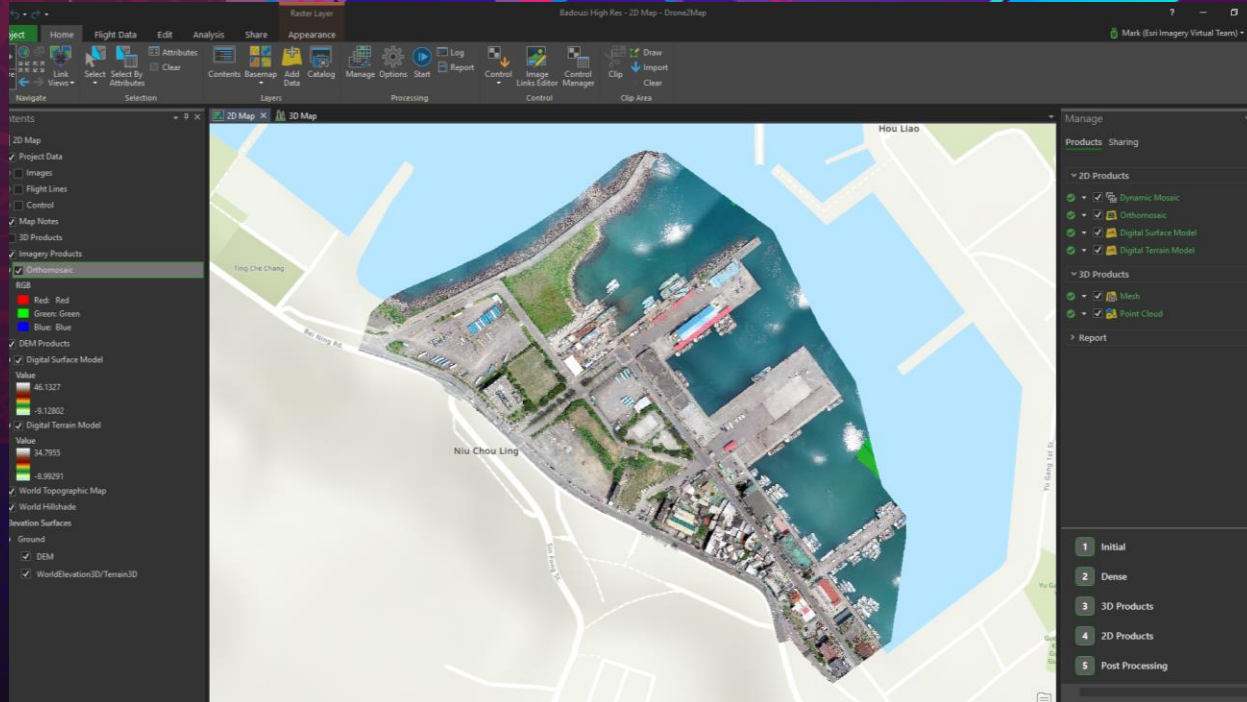


ArcGIS Drone2Map

Accurate high-resolution products

- 2D Products
 - Orthomosaics
 - Digital Elevation Models (DSM & DTM)
 - Contours
- 3D Products
 - Point Clouds
 - Integrated Mesh
- Save products locally or share to ArcGIS Online and ArcGIS Enterprise





Processing on Desktop & In the Field

Mark Buie
ArcGIS Drone2Map



ArcGIS Pro Advanced

Chris Patterson & Cody Benkelman

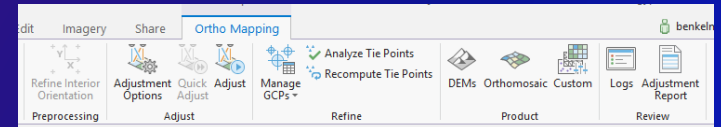
Ortho Mapping in ArcGIS Pro

Optional Ortho Maker in ArcGIS Enterprise with Image Server



Ortho Mapping

- **Ortho Mapping is a capability built into ArcGIS Pro (Advanced license required)**
 - Create Orthomosaics & DEMs from Satellite, Aerial (digital & film) & Drone Imagery
 - **Mosaic dataset of source images, orthorectified on-the-fly based on DTM**
 - Enables multiple views from different perspectives, Stereo models for Image Analyst
 - **Fine-grained control over output products (seamline & pixel editing)**
 - **Geoprocessing (GP) tools for process automation**



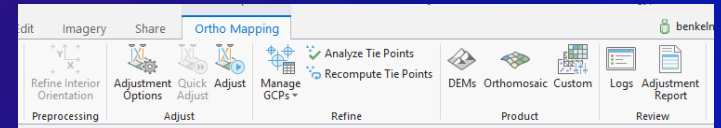
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Ortho Maker

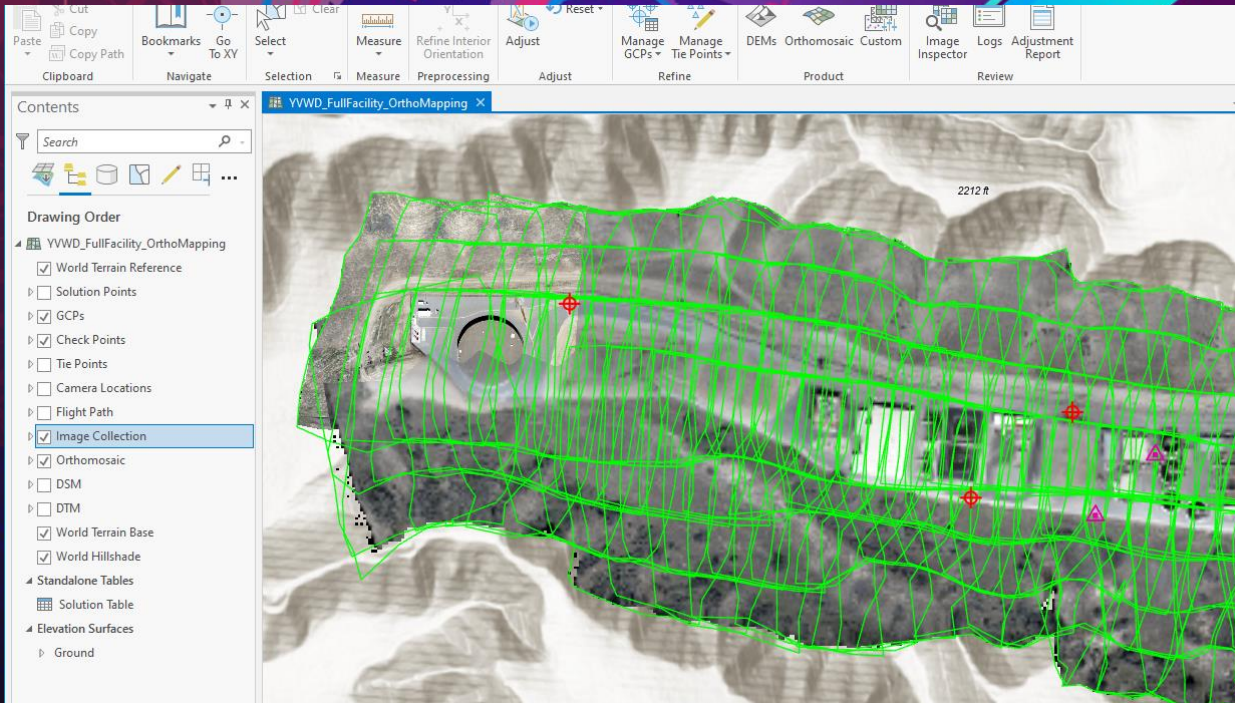
- **Ortho Maker is a web-based user interface for uploading and processing drone imagery through Ortho Mapping on Enterprise with Image Server**
 - Output data products appear as web layers



ArcGIS
Enterprise



ArcGIS
Image Server



Processing in ArcGIS Pro

Chris Patterson
Ortho Mapping in ArcGIS Pro

Image Mapping options in ArcGIS

	Site Scan	Drone2Map	ArcGIS Pro (Ortho Mapping)	Enterprise + Image Server (Ortho Maker)
Processing Environment	Web / Cloud	Desktop (office/field)	Desktop	Web (ArcGIS Enterprise)
Drone Flight app included	Site Scan Flight	Site Scan LE	Site Scan LE	Site Scan LE
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Data Products				
2D (orthomosaic, DSM, DTM)	✓	✓	✓	✓
3D (point cloud, mesh)	✓	✓		
Cloud connection from flight app	✓			
Drone Fleet Management	✓			
Analysis Capabilities	Some focused tools; Connect with ArcGIS for advanced analysis		Extensive (part of ArcGIS Pro)	Some focused tools + ArcGIS Enterprise

Summary - Esri software for Image Mapping

- **Output data products**
 - 2D orthomosaics, 3D point clouds & meshes, Inspection images
- **Operational environments**
 - Field, Desktop, Enterprise, Cloud, Web
- **Key considerations**
 - Scalability
 - Automation
 - Drone fleet management
 - Drone based sensors
 - RGB, Thermal, Multispectral, Video



Site Scan



Drone2Map



Ortho Mapping



Ortho Maker





We want your feedback

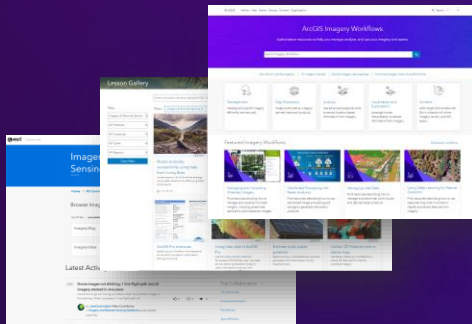
Click on the [Session Survey link](#)
below this video window

Learn more

Find resources about this topic



go.esri.com/UC2021_ImageryResources



Imagery Tech Sessions

MONDAY

Getting Started with Imagery (12:30 – 1:30 PM)

ArcGIS Image for ArcGIS Online: An Introduction (1:45 – 2:45 PM)

ArcGIS Image Analyst: An Introduction (3:00 – 4:00 PM)

TUESDAY

ArcGIS Image Server: Image Management & Analysis at Scale (7:15 – 8:15 AM)

Imagery in ArcGIS: What's New (11:45 AM – 12:45 PM)

Living Atlas: Imagery and Elevation (11:45 AM – 12:45 PM)

Imagery in ArcGIS: Working with Time Series Data (2:15 – 3:15 PM)

WEDNESDAY

Drone Imagery: Creating Orthomosaics, DEMs & 3D Mesh (10:00 – 11:00 AM)

ArcGIS: Introduction to Deep Learning (7:30 – 8:30 AM)

Geospatial Deep Learning Using the ArcGIS API for Python (1:45 – 2:45 PM)



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