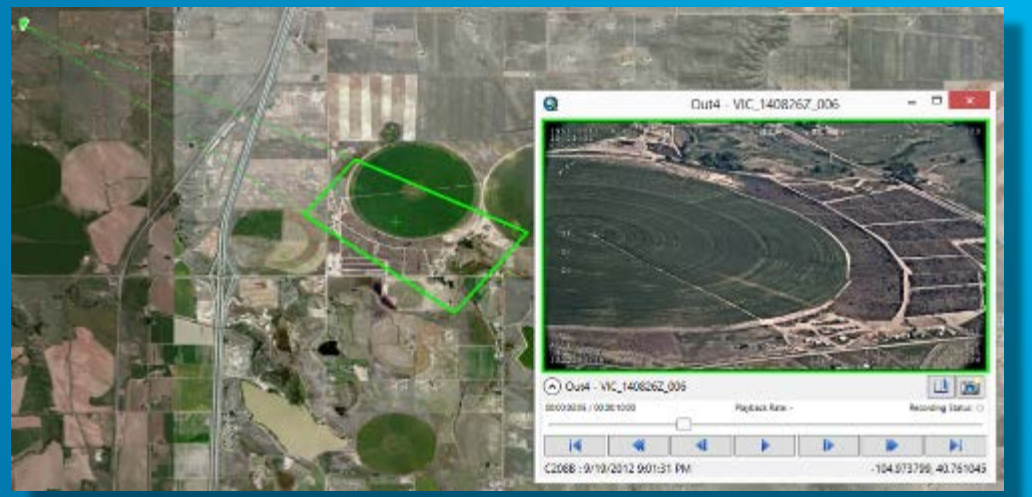
Drones in ArcGIS Workshop

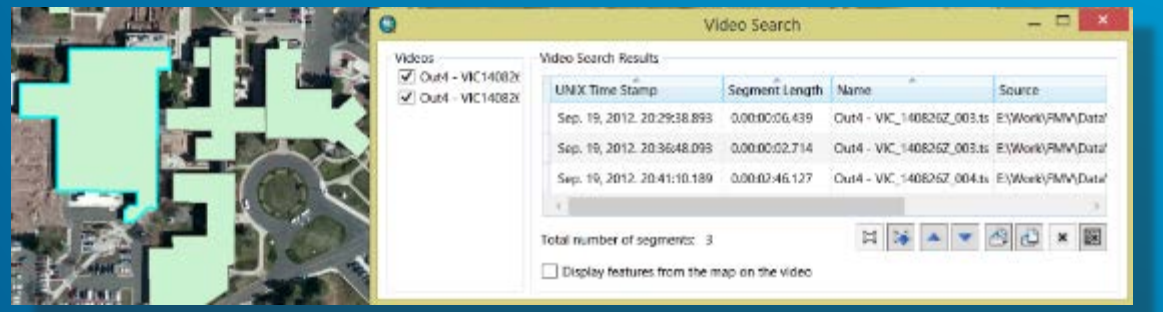
Jeff Liedtke, Alex Muleh, Doug Ridenour, Jim Michel Esri

Jeff Safran, BLM

Drones in ArcGIS Workshop Agenda

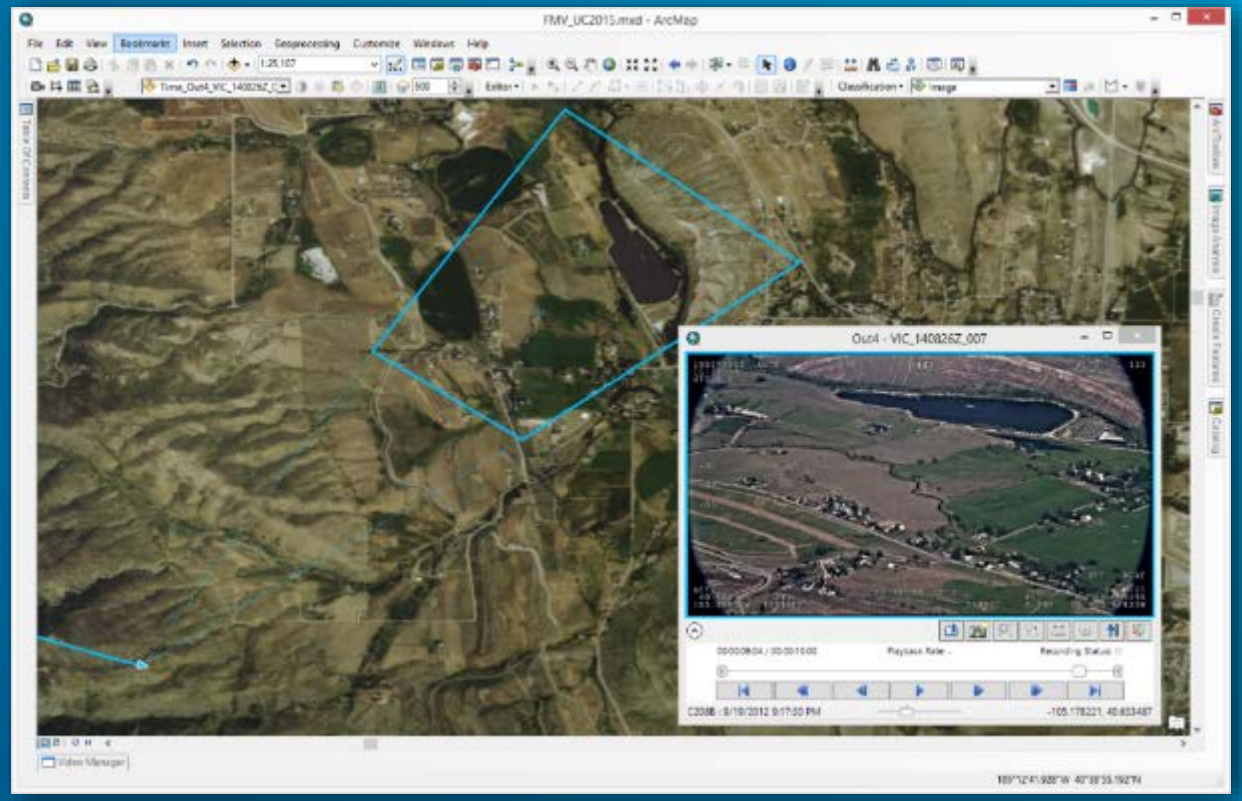


- Introduction and Background
- Key Concepts
- DEMO: The Video Player – Operation and Visual Analysis
- Important FMV Components that support Concepts above
- DEMO: Searching Video Archives
- DEMO: Sharing
- Video Multiplexer
  - Introduction and Key Concepts
  - DEMO: From drone data to displaying a video footprint on the ground in ArcMap
- Report from the Field – Lessons Learned
- Summary



ArcGIS Full Motion Video Overview

- What is Full Motion Video (FMV)?
- Who uses it?
- Esri FMV product features
- Demos



What is FMV?

- FMV is a term primarily used by the Defense and Emergency Management industries
- Refers to a video stream merged with metadata about the video data
  - Sensor and platform position and attitude is captured as metadata (GPS and IMU)
- FMV is an Add-In for Desktop 10.x and in Desktop Pro slated for early 2017.
- The Add-In provides ArcMap tools for the playback and analysis of Video Files

Who Uses FMV

Situation Awareness

- Anyone who needs to monitor remote or dangerous locations
- Public Safety and Emergency Management
- Defense ISR
- Oil Companies
- Local and Federal Governments
- Border Patrol
- Utilities

ArcGIS Full Motion Video

Where does FMV data come from?

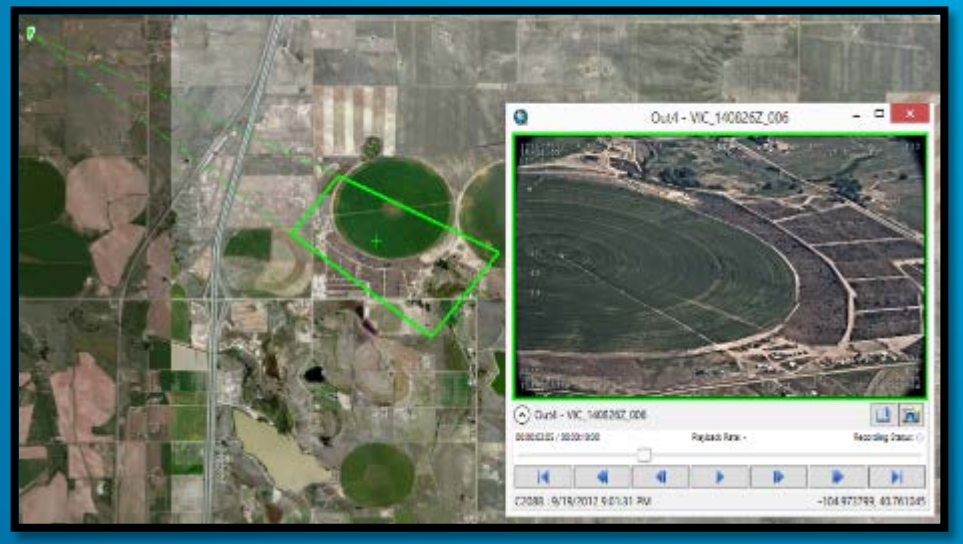
- Unmanned Aerial Vehicles (UAV’s; UAS’s, RPV’s, drones)
- Fixed Wing and Helicopter
- Orbital sensors (overhead sensors)
- Vehicle mounted cameras
- Hand-held mobile devices and cameras
- Stationary (persistent surveillance)

What is the FMV Add – In for ArcGIS?

Now that we have collected FMV, how do we get this on to the map?

By using the FMV add-in, you can register your videos and begin to do GIS analysis on the map.

FMV Add - In

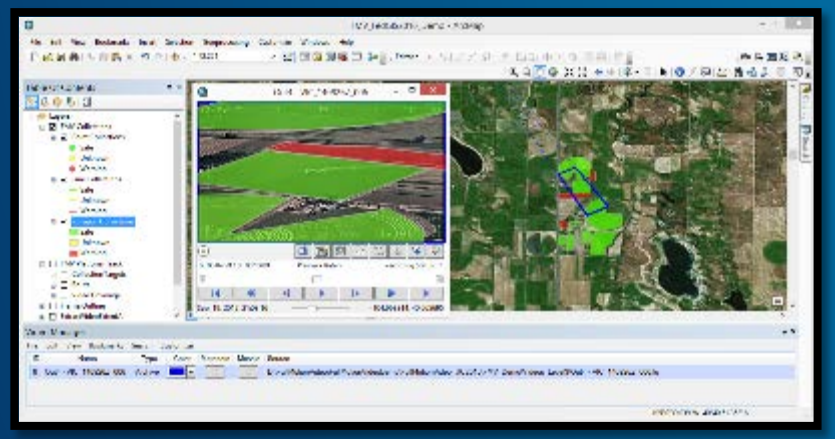


Video Metadata (Non – MISB and MISB Compliant)

- **Desktop Add – in**
  - **ArcMap (10.0 – 10.4.1)**
- **Geoprocessing Tools**
- **Documentation**

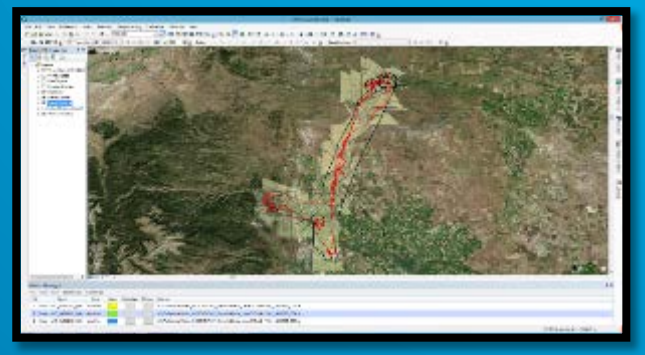
ArcGIS Full Motion Video Feature and Capabilities

Capture Features on the Video

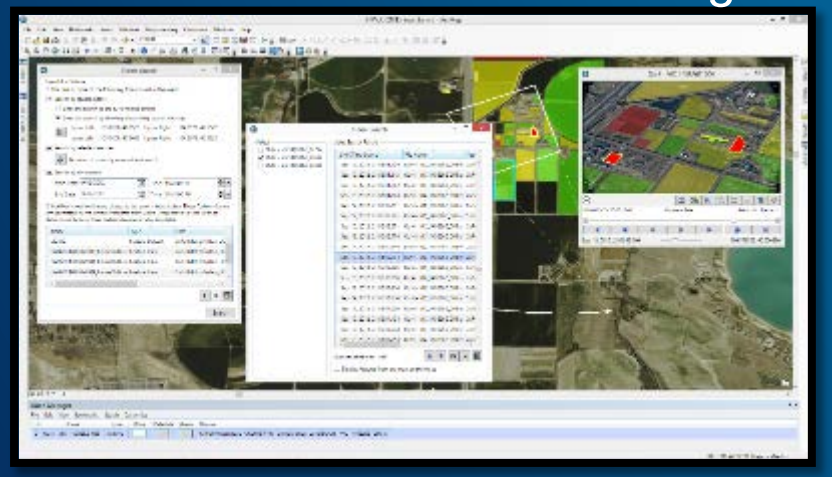


Extract Video Extent

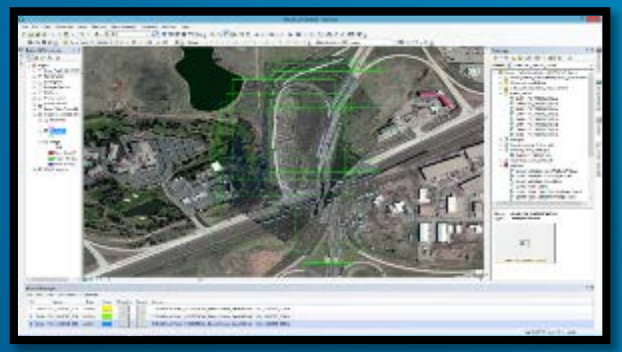
Extract Metadata from Video



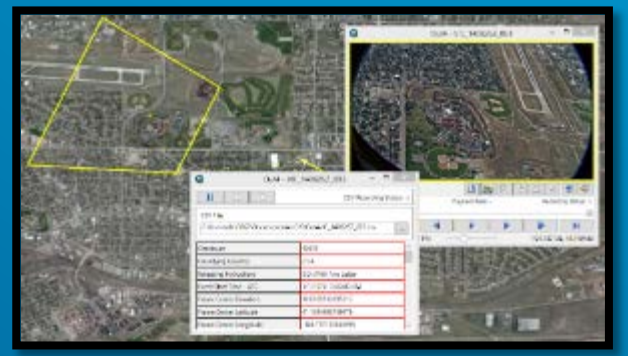
Search Archives for Video Segments



Mosaic Videos a Video Frames

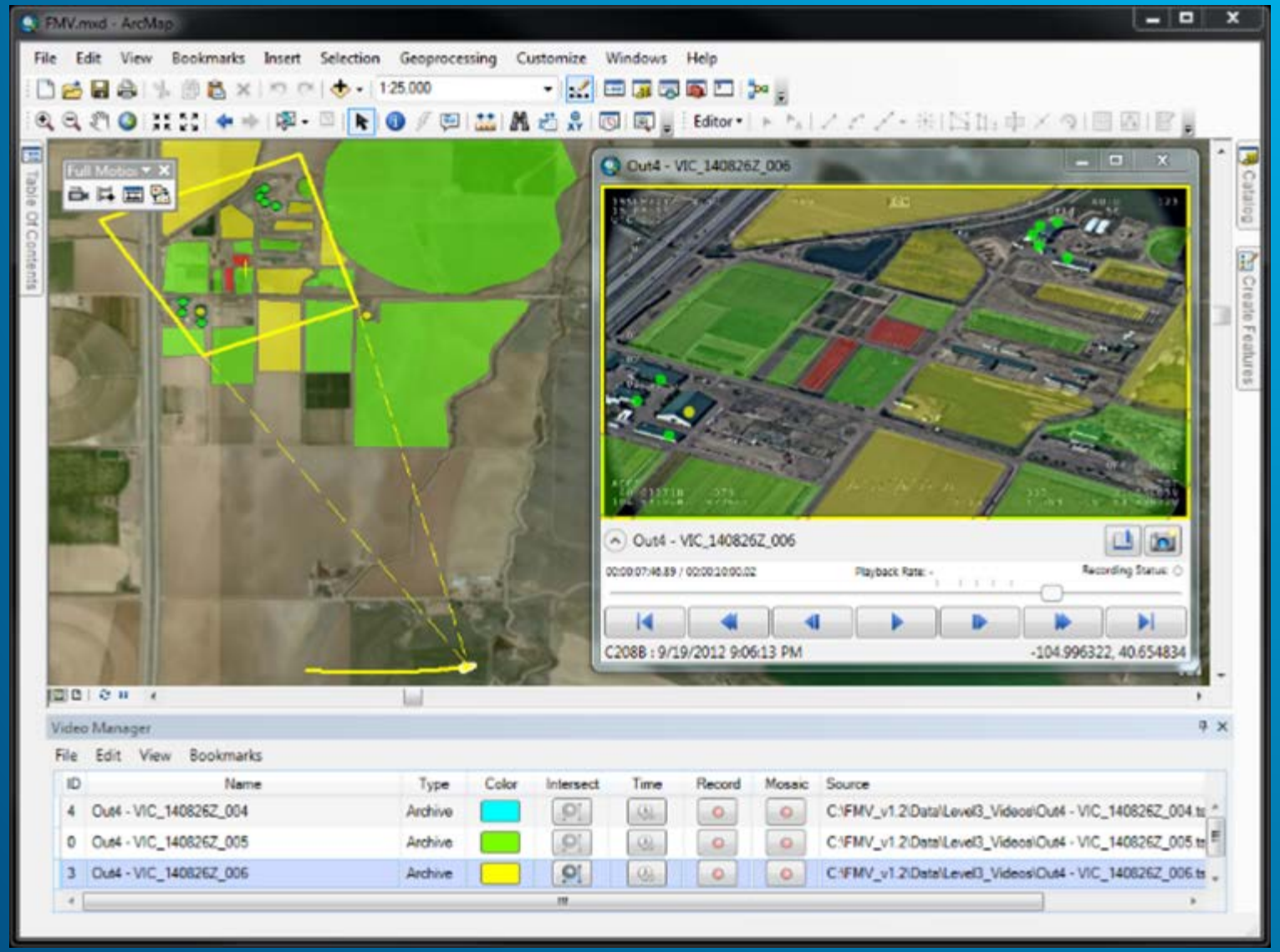


Multiplexer



What is Full Motion Video, and How Does It Help Me?

- Components of FMV
  - Video Player
  - Analysis/management tools
  - GP Tools
- How does it support Operational Workflows?
- Find, Analyze and Share relevant information

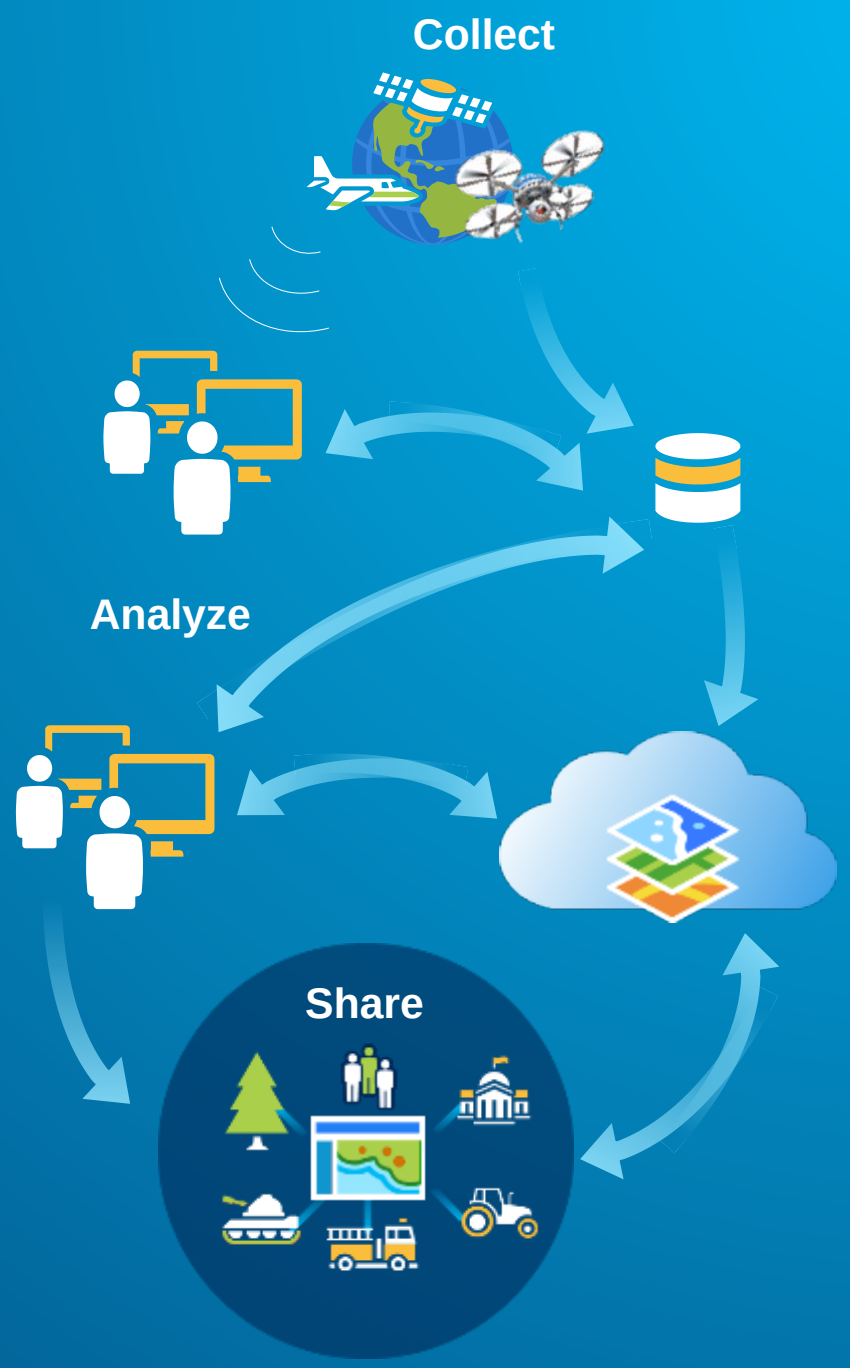


ArcGIS Full Motion Video

Support Operational Workflows

Find, Analyze and Share video information

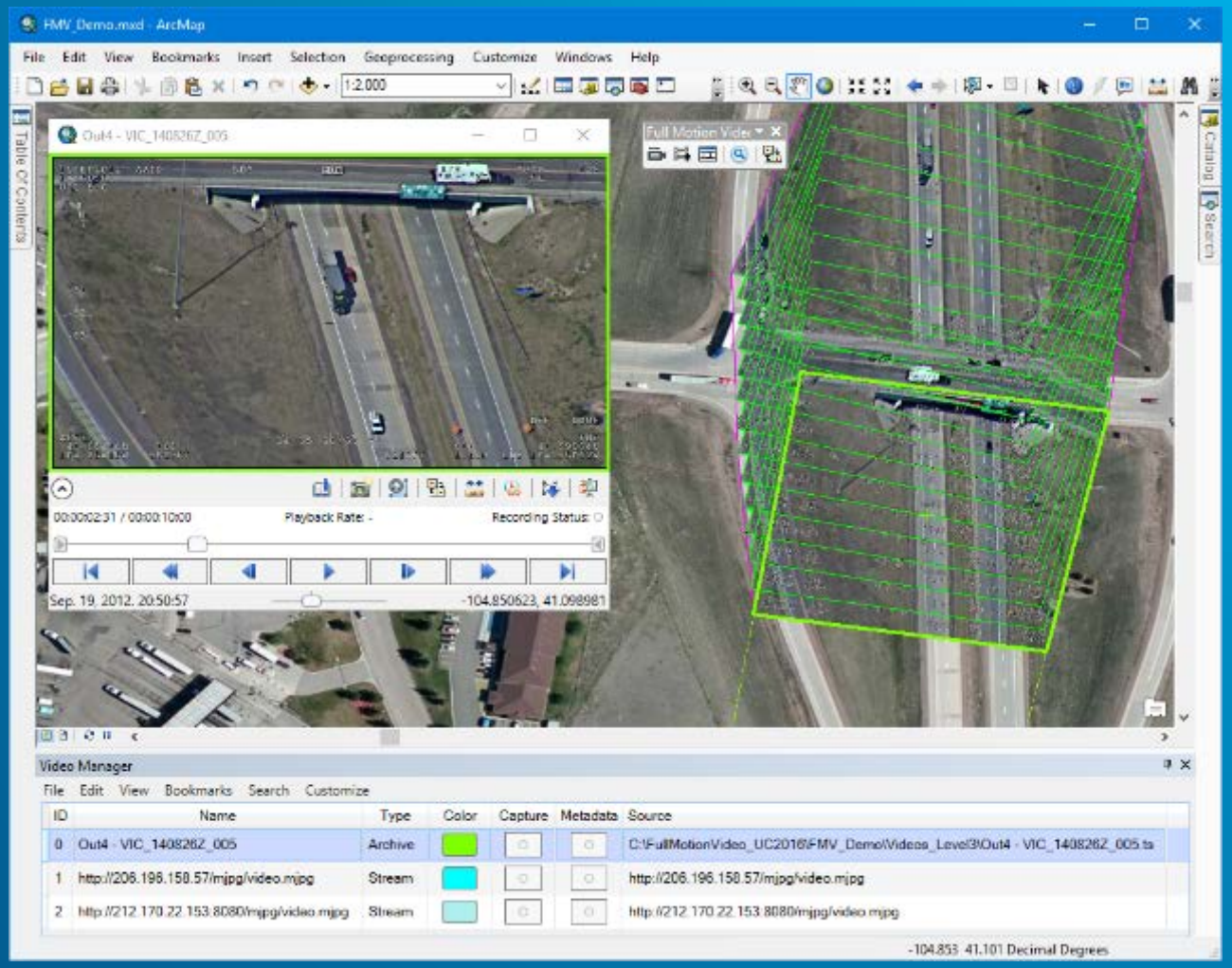
- Connect
- Search
- Analyze
- Share



Full Motion Video

Easy to use.

- Video and Map Integration
- Video Search - ***Easy*** and ***Fast***
- Live Video Streaming
- One-Click Reporting
- FMV Geoprocessing Tools

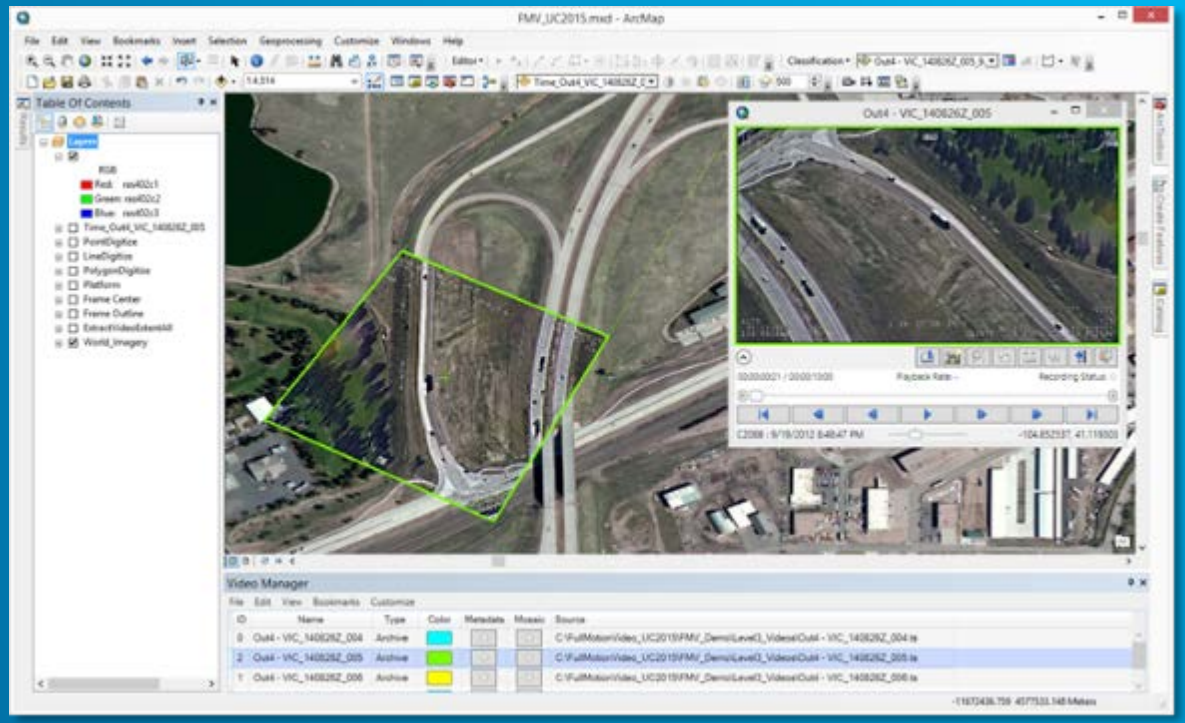


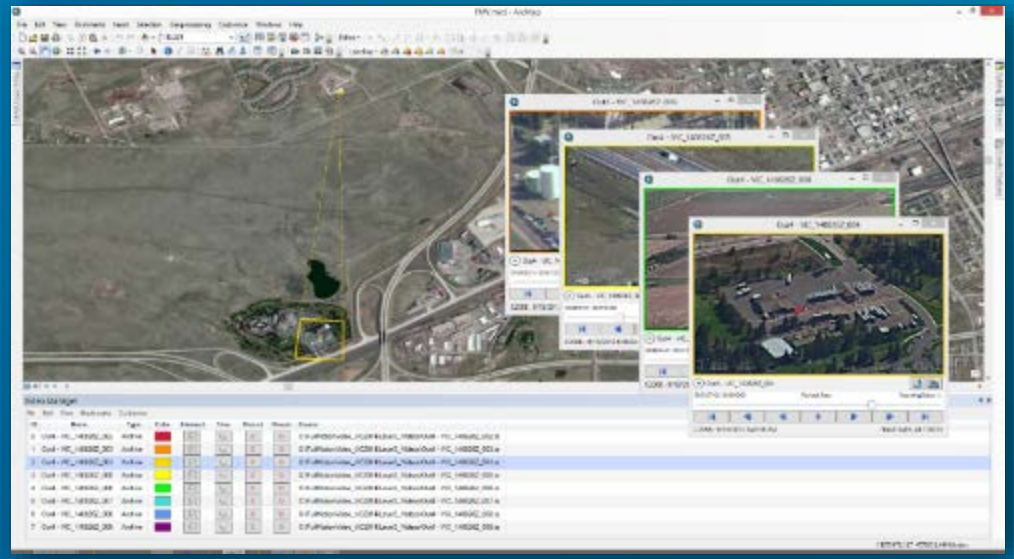
www.esri.com/fmv

ArcGIS FMV Features and DEMO

The Video Player

- Overlay video frames on the map display
- Pan and Zoom for live streams and archived videos
- Slow & fast motion playback
- Display metadata in real time
- Create and manage bookmarks
- Mark locations/phenomena of interest
- Easily capture and export video frames and video clips
- Automatic report generation
- Live stream Recording

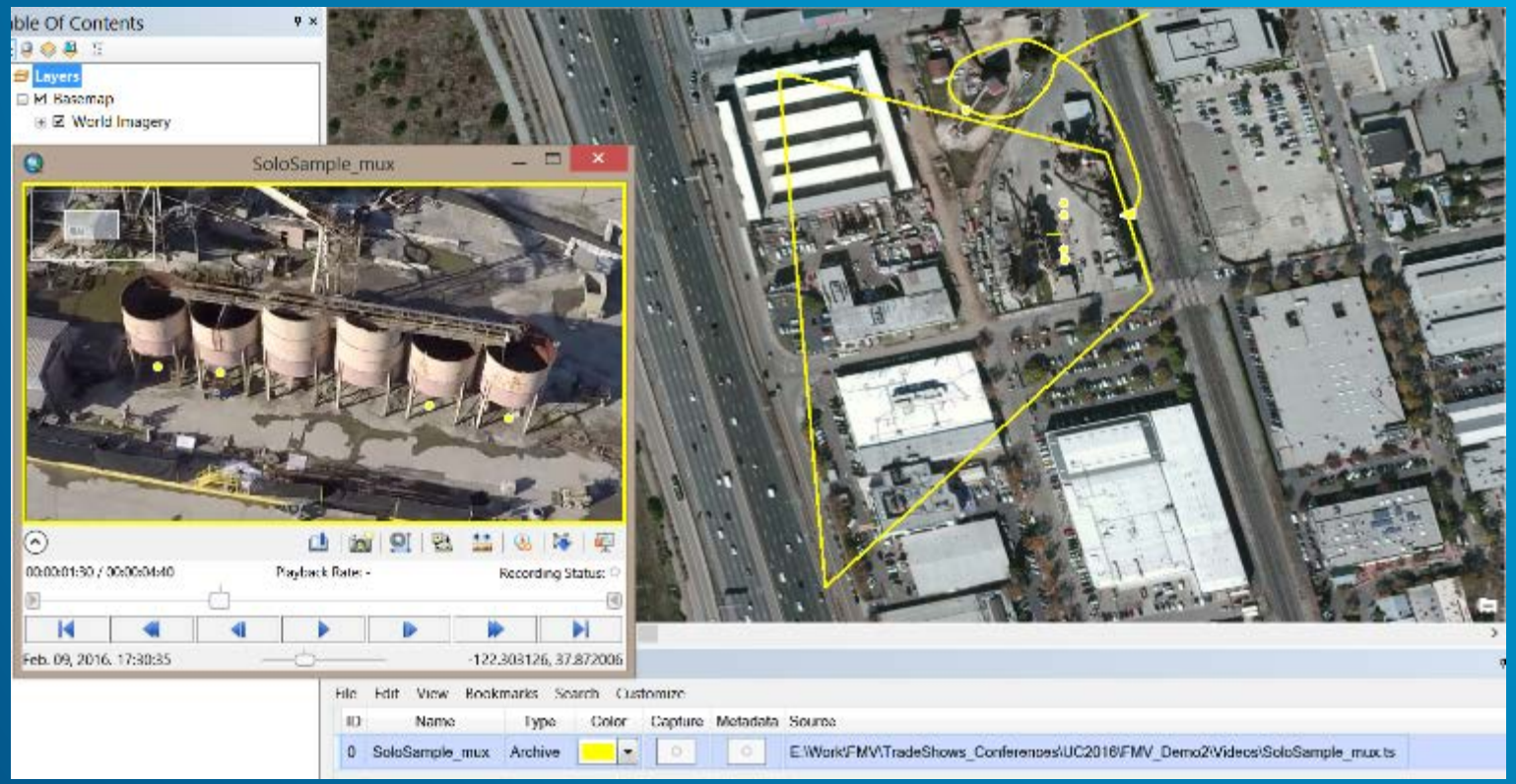




Demo: FMV Video Player

- FMV Demo using 3D Robitics UAS
- Sensor – GoPro
- Using 3DR Flash logs
- Video and metadata combined using

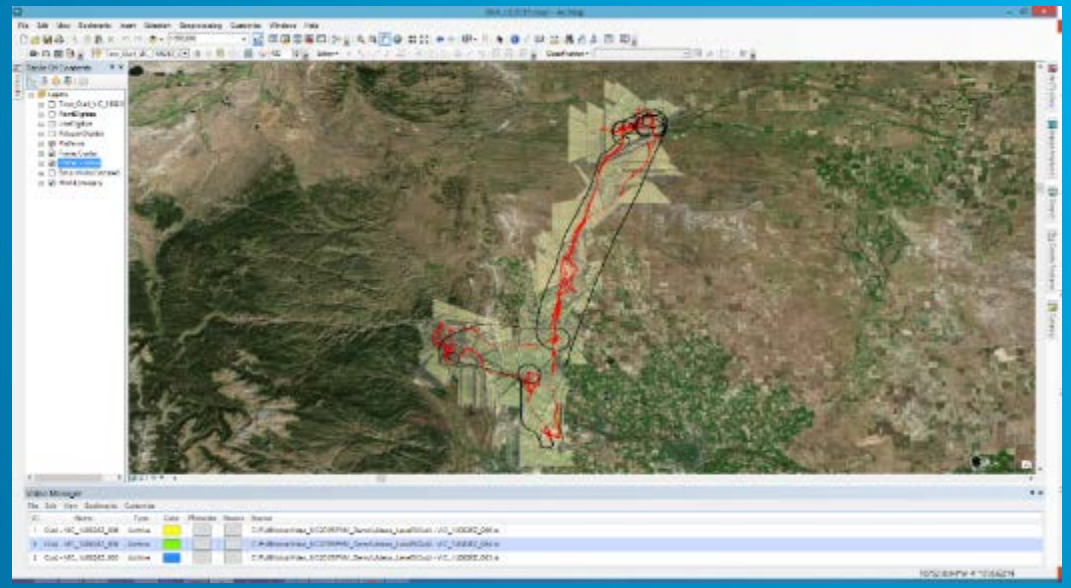
  FMV Video Multiplexer tool

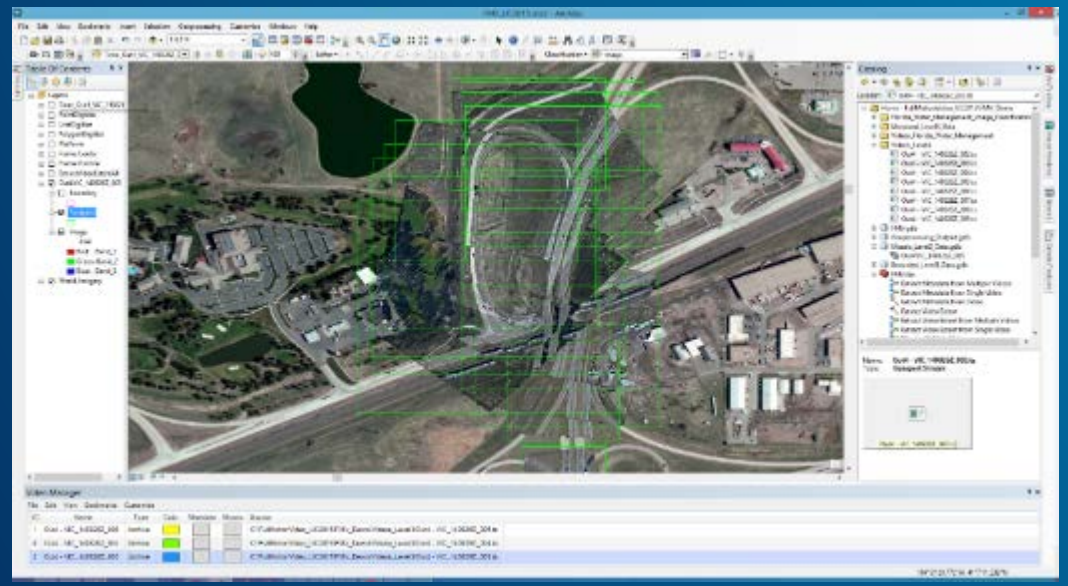


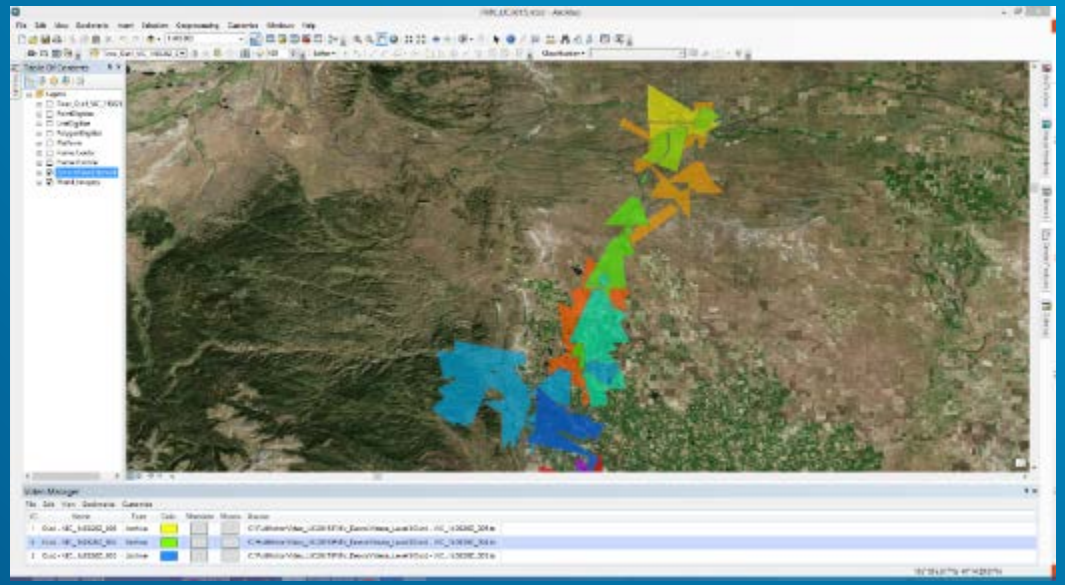
ArcGIS Full Motion Video

FMV Management and Analysis Tools

- Search Video Libraries and Archives
- Extract Metadata from Video
- Extract Video Extent
- Mosaic Video
- Mosaic Video Frames
- Video Multiplexer





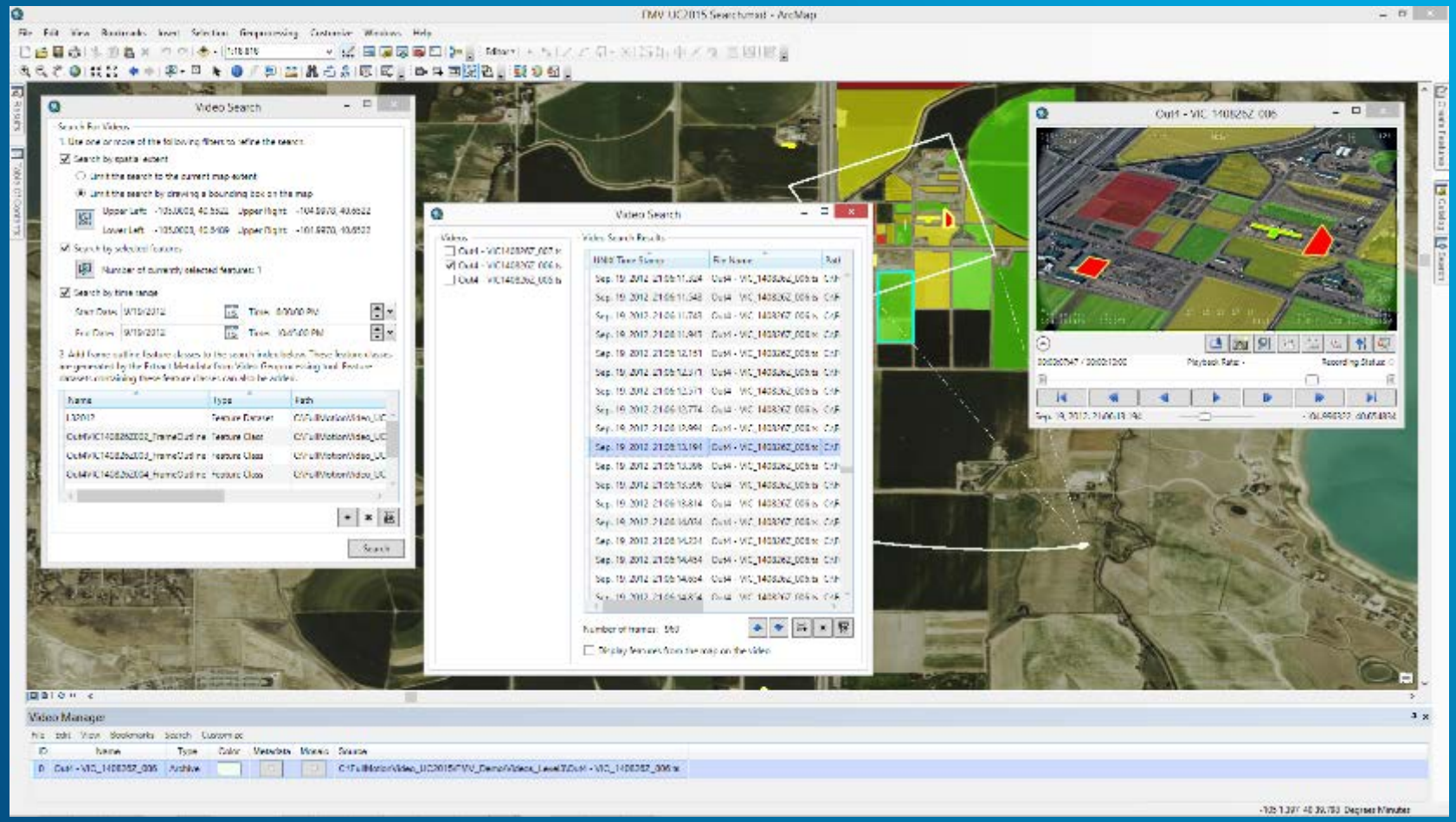


What is Video Search?

Easy to use and focused on performance!

1. Select search criteria
2. Load search indexes
3. Run the search!

Non-blocking. Keep working while you search.



www.esri.com/fmv

What is MISB-Compliant Data and Why is it Important?

Preparing your videos and metadata for the ArcGIS Full Motion Video Add-in

Alex Muleh and Doug Ridenour, Esri

Video Multiplexer GP Tool

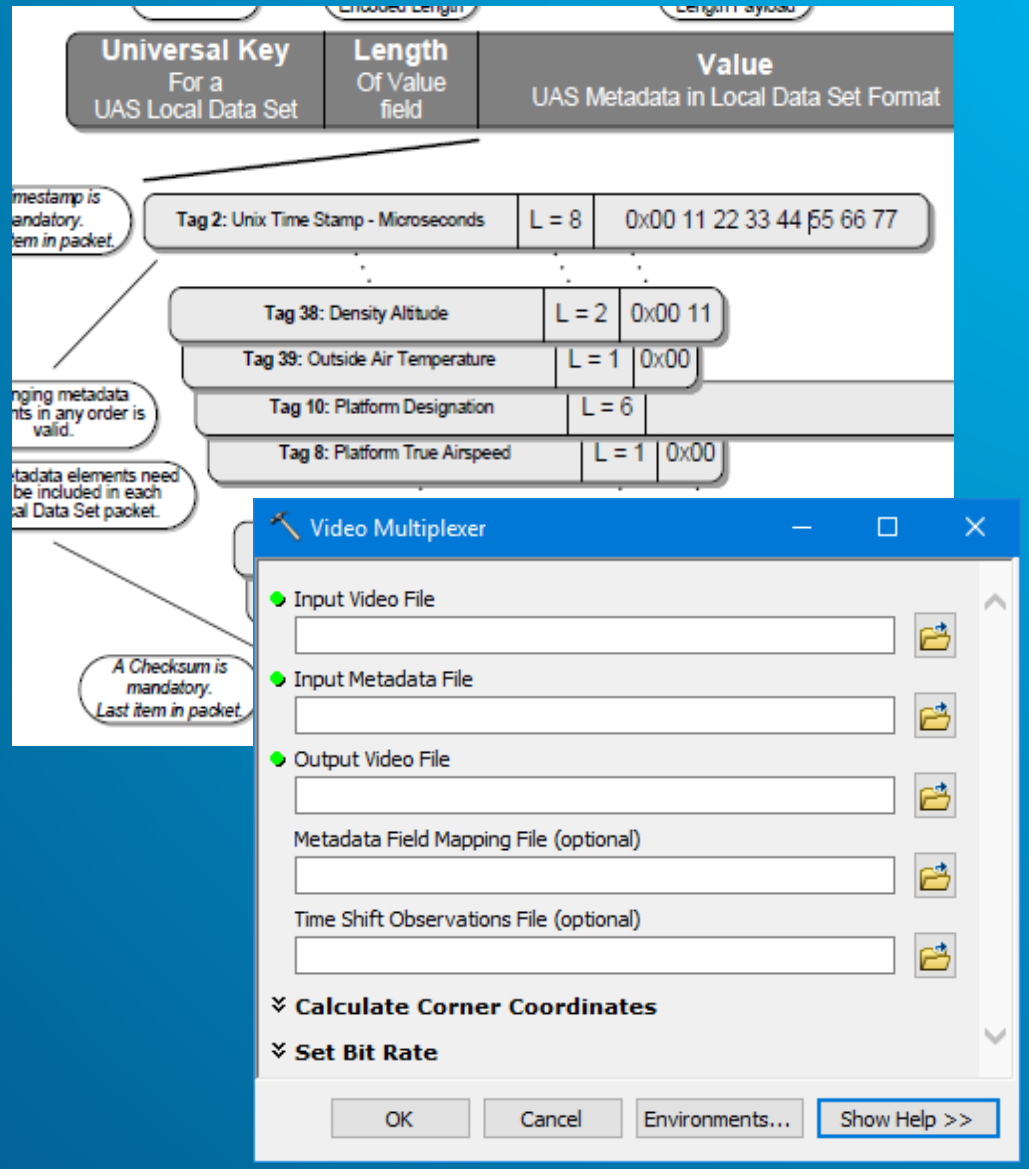
Metadata Standards

- **Combine video and metadata into a single MISB compliant file.**

- **Why?**
  - **Motion Industry Standards Board (MISB)**
  - **"For a reliable, bandwidth-efficient exchange of metadata among digital Motion Imagery systems."**

    MISB ST 0601.9. N.p.: Motion Industry Standards Board, n.d. PDF.

http://www.gwg.nga.mil/misb

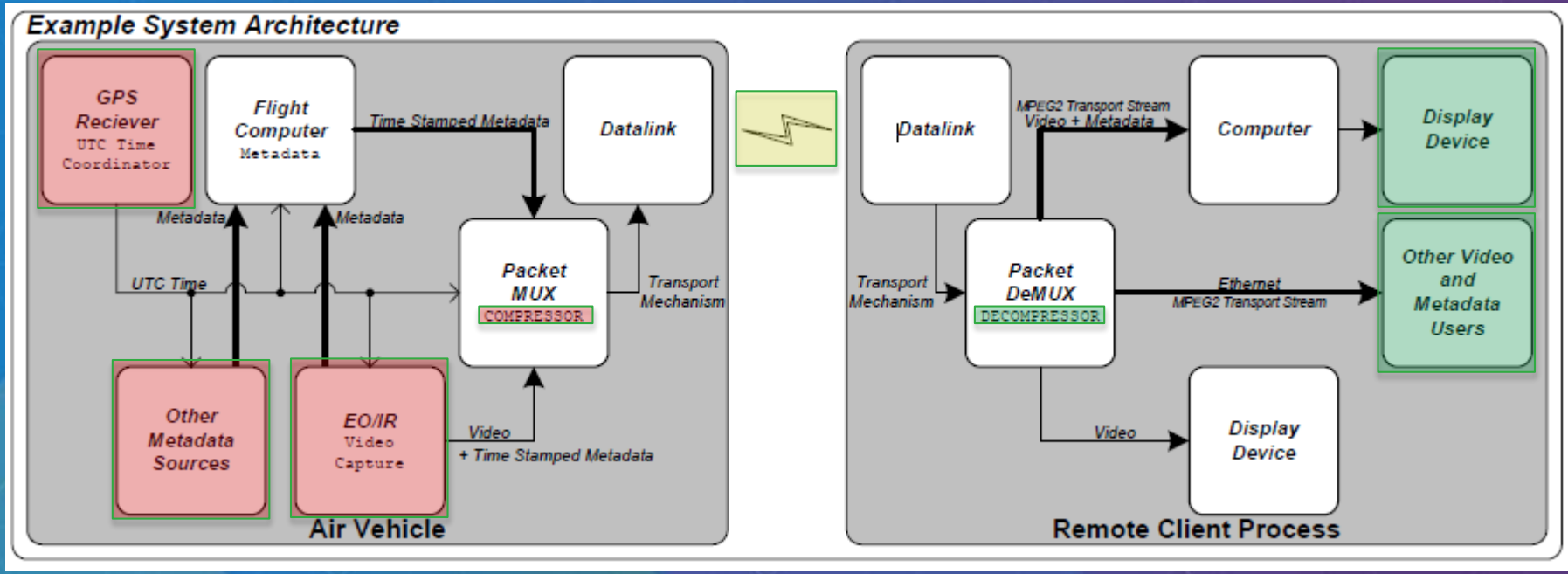


www.esri.com/fmv

Motion Industry Standards Board (MISB)

Data Collection and Dissemination

- “Metadata is collected, processed, and then distributed to a flight computer through the most appropriate interface.” – Standard060105.pdf



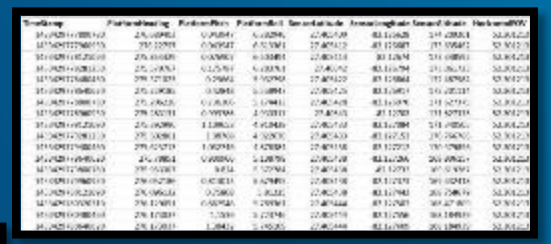
Courtesy of http://www.gwg.nga.mil/misb

Video Multiplexer

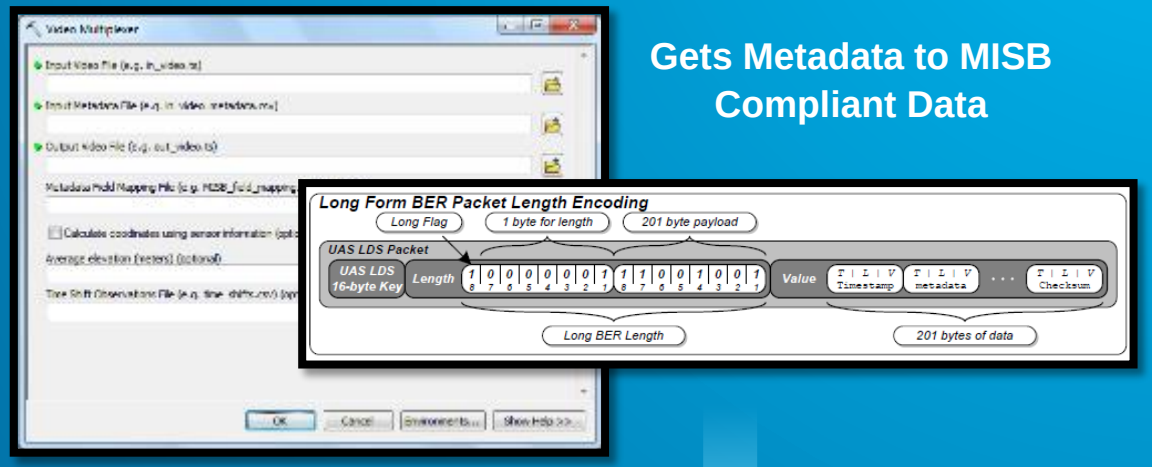
- **Non-MISB Metadata Support**
  - Works with non-MISB metadata to make your videos MISB-compliant (Ready for the FMV Add-in)
  - Calculates frame center and corner data automatically

Collect Video

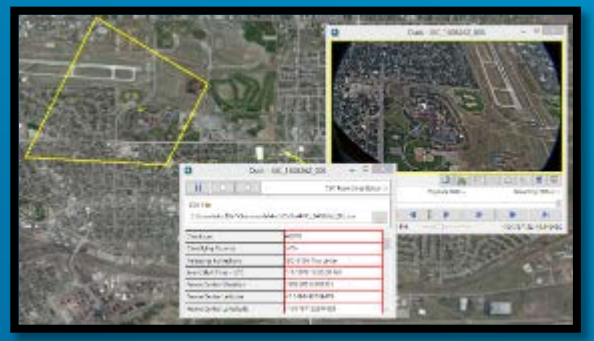
Supply Positional Metadata w/ Multiplexer Template



Use Multiplexer GP Tool



Gets Metadata to MISB Compliant Data



Video Data Now MISB Compliant and on the Map

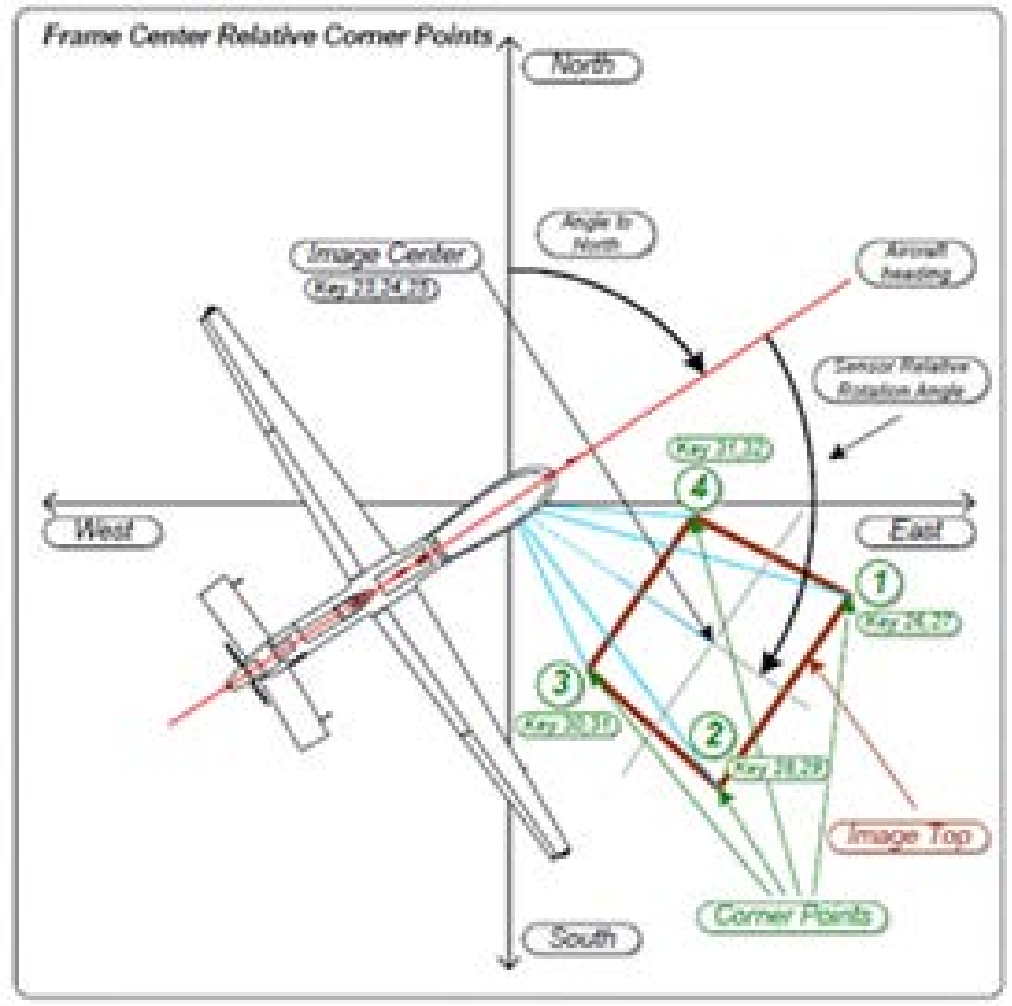
Minimum Requirements to Create Video Footprints

From a GPS
UNIX Time Stamp
SensorLatitude,
SensorLongitude
SensorAltitude
PlatformHeading

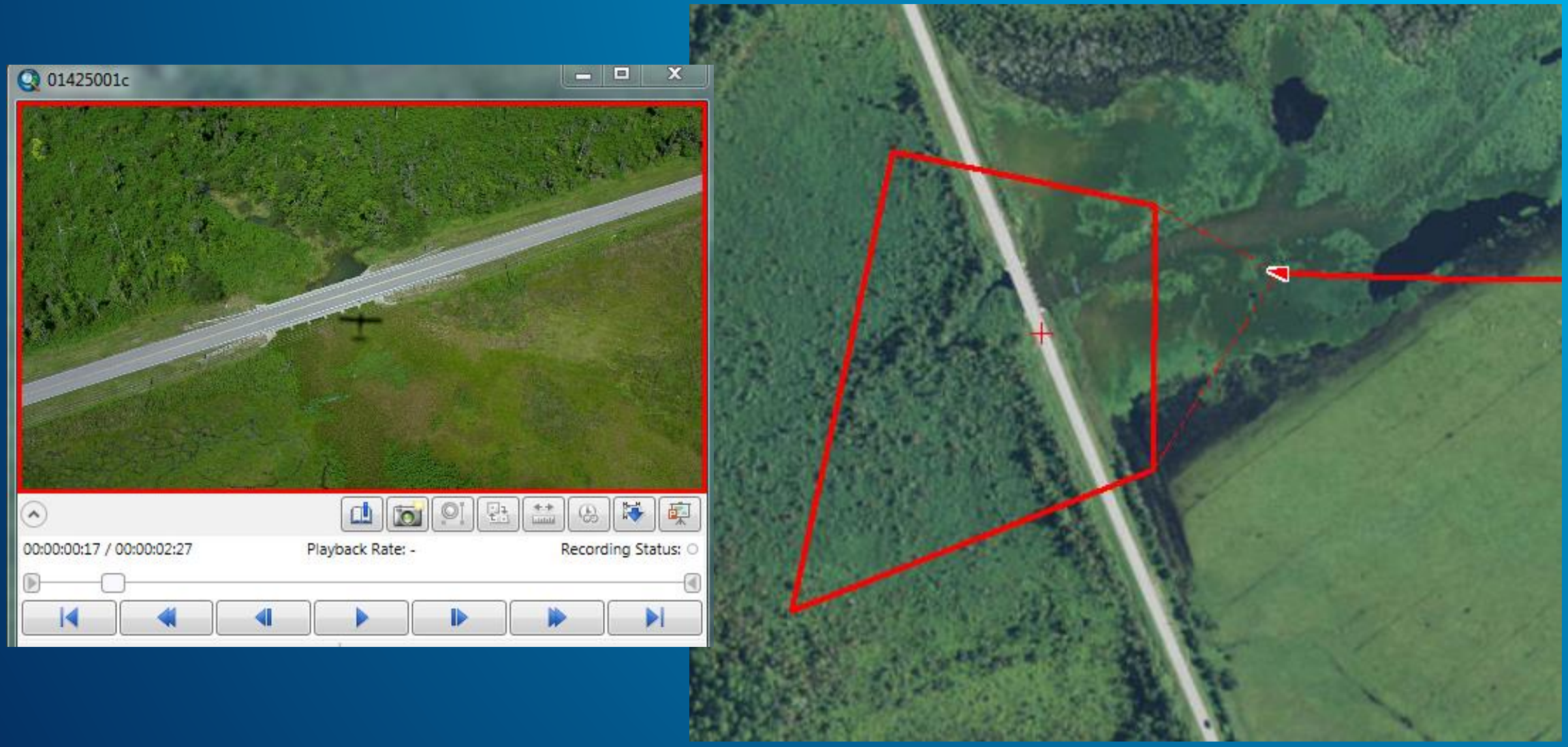
From a gimbal
SensorRelativeAzimuth
SensorRelativeElevation
SensorRelativeRoll

From Inertial Measurement Unit (IMU)
PlatformPitch
PlatformRoll

Static value from a camera
HorizontalFOV



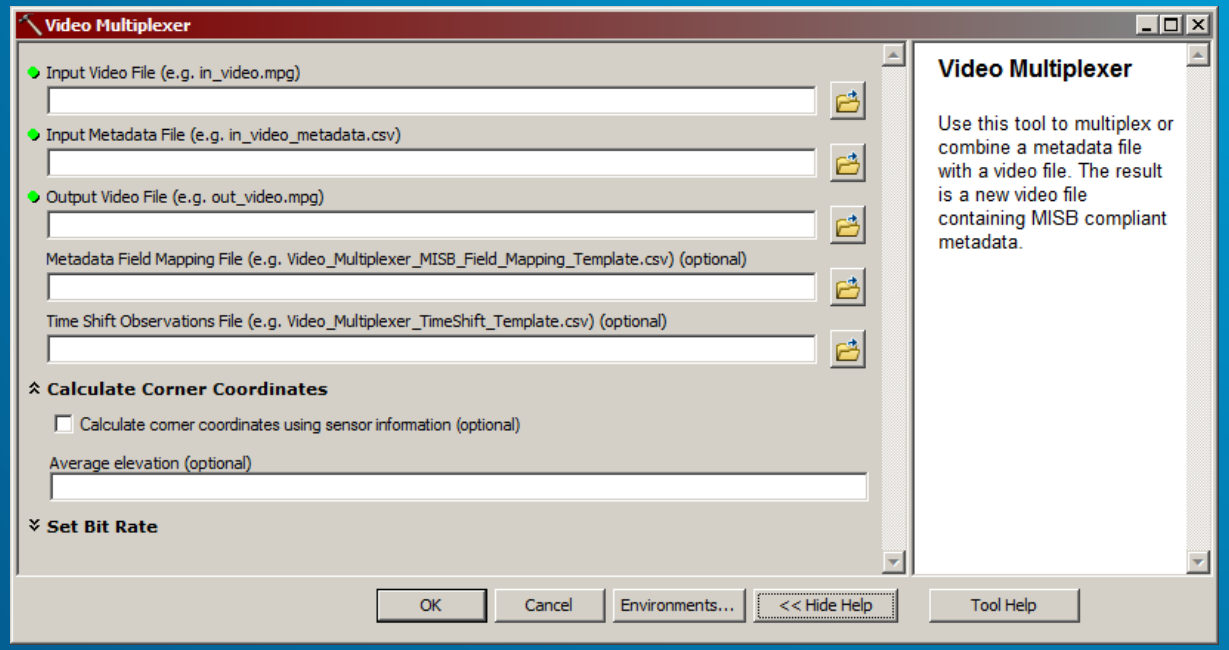
FMV Video Multiplexer Demo – Doug Ridenour, Esri



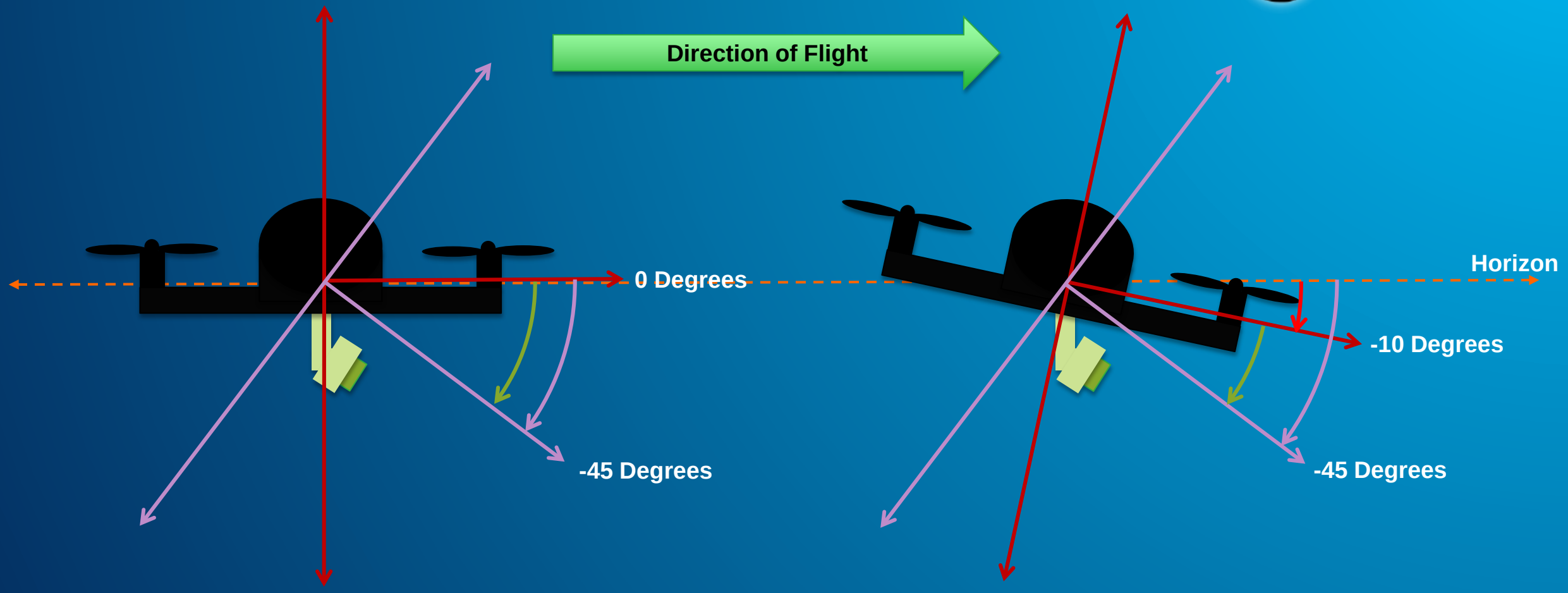
Multiplexing Video with MISB Metadata

- Pixhawk autopilot telemetry logs are easily converted to a MISB compliant format
- Dataflash Log – AHRS2, ATT, and/or GPS lines (Firmware version dependent)
- ESRI FMV Multiplexer GeoProcessing Tool

  - UNIX Time Stamp
  - Platform Heading Angle
  - Platform Pitch Angle (Full)
  - Platform Roll Angle (Roll)
  - Sensor Latitude
  - Sensor Longitude
  - Sensor True Altitude
  - Sensor Horizontal Field of View
  - Sensor Vertical Field of View
  - Sensor Relative Azimuth Angle
  - Sensor Relative Elevation Angle
  - Sensor Relative Roll Angle

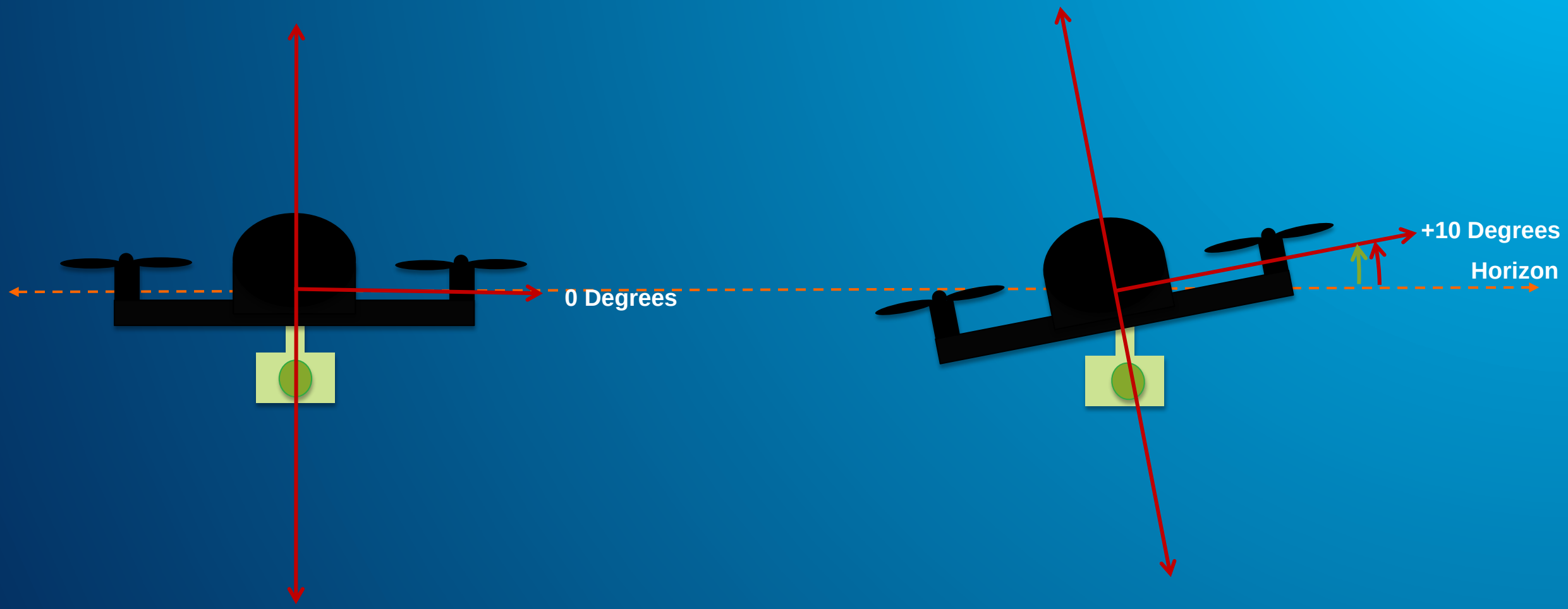


Calculating Sensor Relative Pitch



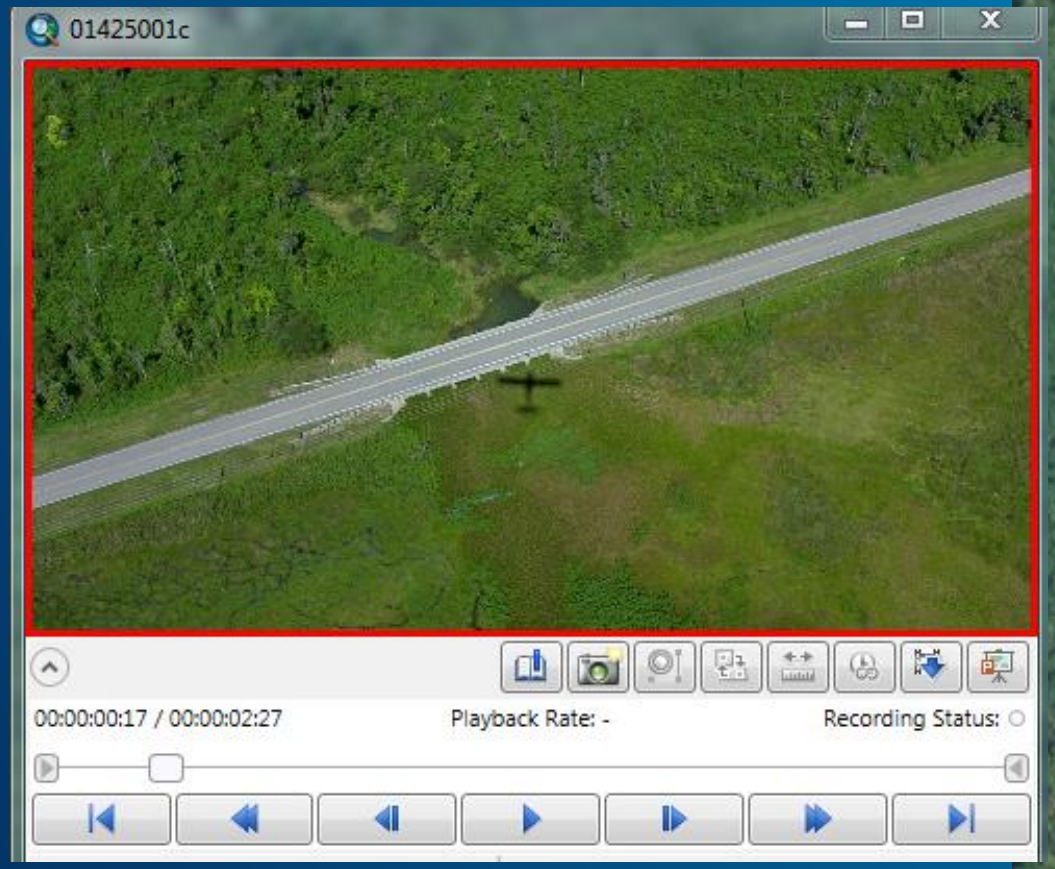
Sensor Relative Pitch = Sensor Pitch – Platform Pitch

Calculating Sensor Relative Roll



Sensor Relative Roll = Platform Roll

FMV Deployed in Operational Projects – Jeff Safran, BLM



What is the Bureau of Land Management?

The Bureau of Land Management (BLM) may best be described as a small agency with a big mission: To sustain the health, diversity, and productivity of America's public lands for the use and enjoyment of present and future generations. It administers more public land – over 245 million surface acres – than any other Federal agency in the United States. Most of this land is located in the 12 Western states, including Alaska

Current BLM UAS Organization and Staff

- UAS Program Manager
  - BLM National Aviation Office, Boise, ID
- UAS Operations Manager (Acting)
  - BLM National Operations Center, Portland, OR
- UAS Operators – Denver, CO (1), Portland, OR (2), Boise, ID (3), Salt Lake City, UT (1)
- 2 operators are FAA Licensed Pilots
- All training and “carding” is managed by the Department of Interior Office of Aviation Services. The FAA has accepted the DOI training program to satisfy all aviation training requirements of the Private Pilot Written Exam

Current BLM UAS Fleet

Falcon Fixed Wing

- Modular interchangeable payloads
- Sony A5100
- Ricoh GR2
- Canon S100
- FLIR Tau 2
- Pixhawk Autopilot
- Mission Planner GCS
- 1 Hour flight endurance
- Catapult Launch
- Parachute Recovery

Falcon Hover

- Modular interchangeable payloads
- Sony A5100
- Ricoh GR2
- Canon S100
- FLIR Tau 2
- Pixhawk Autopilot
- Mission Planner GCS
- 20-30 minute flight duration
- Vertical Takeoff and Landing

MLB Superbat

- Each airframe configured for specific mission
- Nikon D750 Aerial photography
- Cloudcap Tase 150 LWIR
- Cloudcap Tase 200 EO/LWIR
- Cloucap Piccolo Flight control system
- 6-8 hour flight endurance
- Catapult Launch
- Landing skids

Imagery and Video Acquisition with a sUAS

- Camera Selection
  - Use the appropriate camera for your needs
  - Rolling Shutter
  - Image Compression
  - Fisheye Lens
- Camera Settings
  - High shutter speed, but as low as you can get away with
  - Shutter Priority
  - Appropriate ISO Range (lighting dependent)
  - Appropriate F-Stop (lighting dependent)
- Flight Planning
  - 60% Forward, 30% side overlap.
  - A least a few perpendicular transects
  - An appropriate altitude for the desired resolution

Paradise Fire

Background

This series of tests examined the ability of a small UAS (sUAS) to be employed from within a TFR in the intelligence, surveillance, and reconnaissance role, while being safely flown BVLOS and segregated from manned aircraft.

Paradise Fire

Objectives

1. Examine the ability to deploy and operate an sUAS completely within an established TFR.

2. Establish procedures for notification and deconfliction procedures for potential non-participating aircraft with access to the TFR (e.g. law enforcement, emergency medical aircraft, etc.).

3. Develop and employ airspace segregation protocols for separating manned and unmanned aircraft operating over the fire during the same time period.

4. Assess the ability of the sUAS to be operated BVLOS in the fire environment. OAS V1.0 Page 2 of 4 8-30-15

5. Evaluate the ability of sUAS hotspot detection through dense smoke.

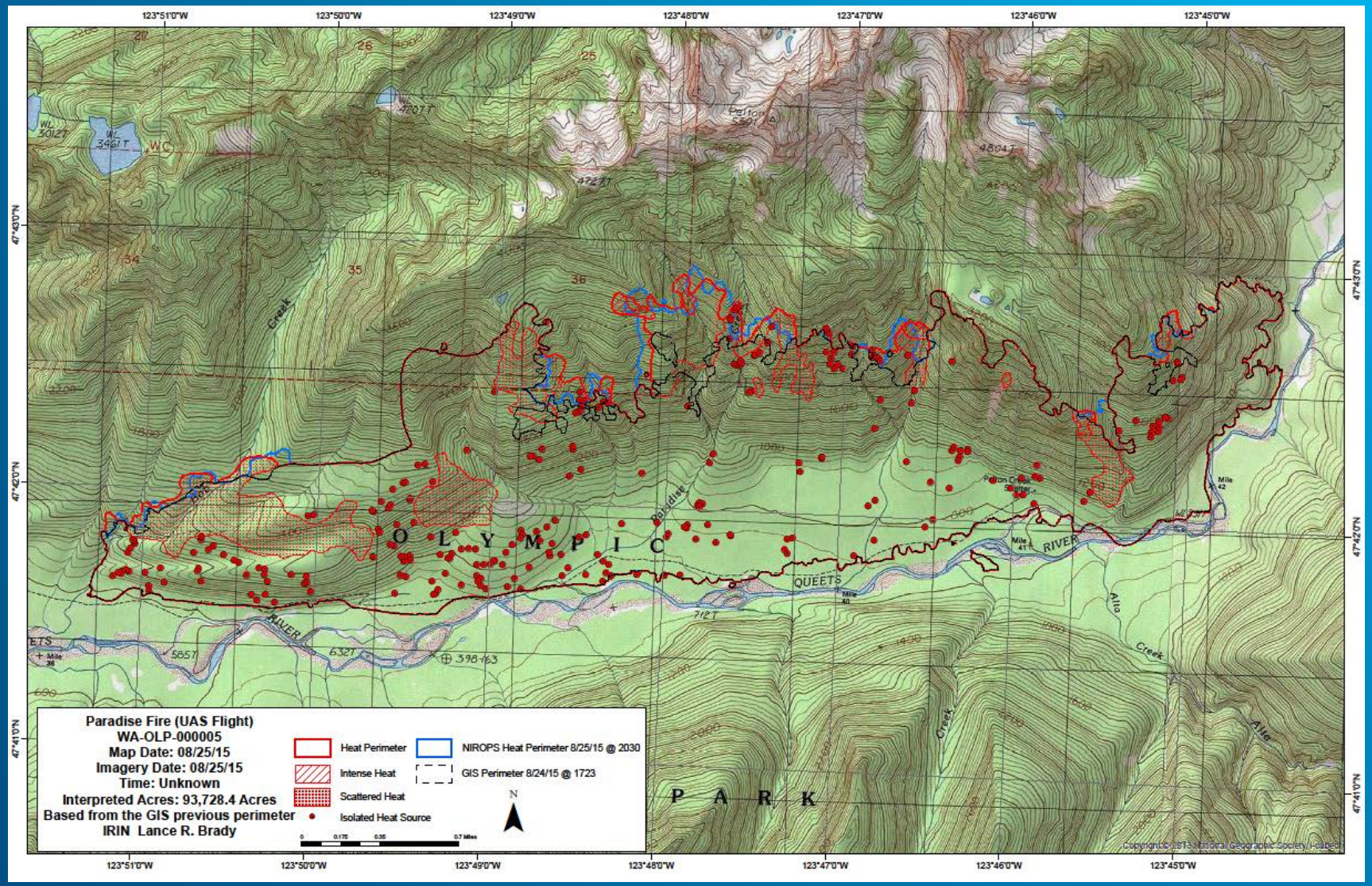
6. Gauge the ability of the sUAS to provide outcome effectiveness assessments of manned aircraft suppression/retardant drops.

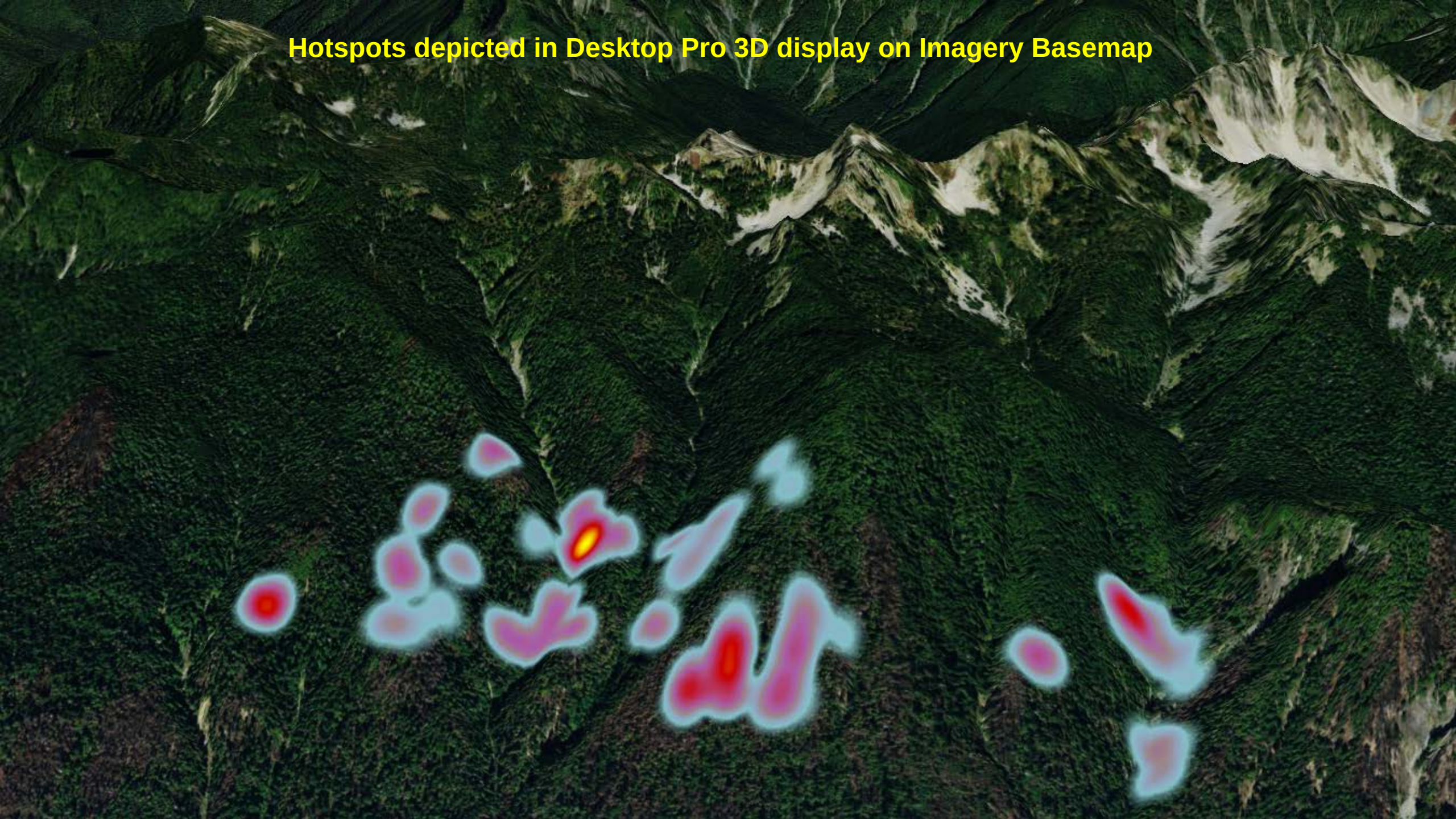
7. Evaluate the utility of sUAS developed precision map products for near-real time incident command and field use.

Paradise and North Fires - FMV Demo

Paradise Fire

NIROPS heat perimeter map showing both Aircraft and UAS derived products, interpreted by a trained IRIN.

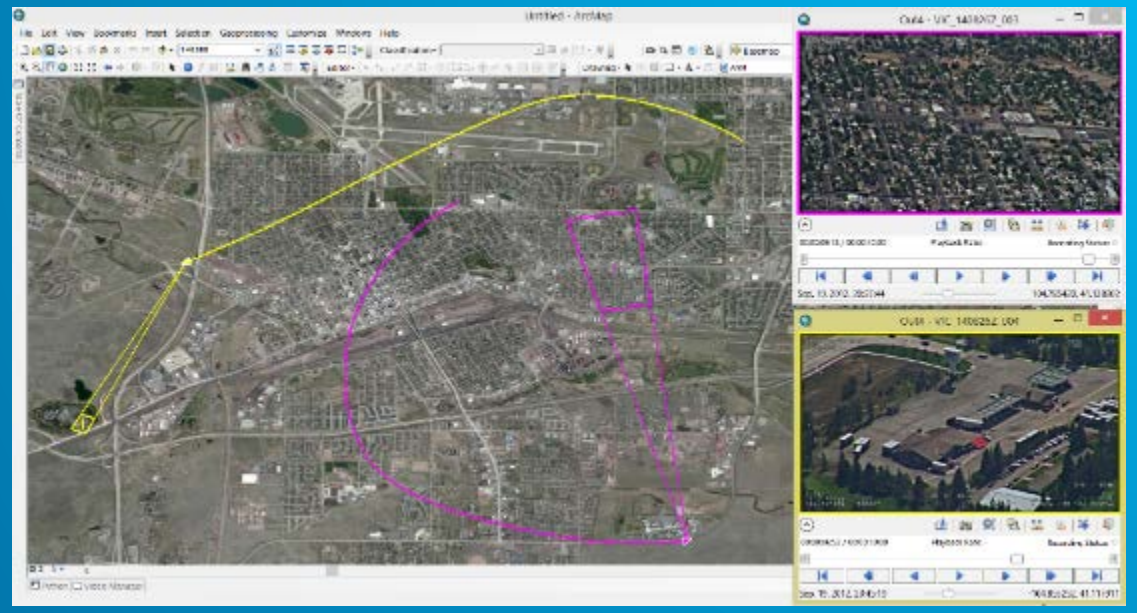



Hotspots depicted in Desktop Pro 3D display on Imagery Basemap

Lessons learned working with video as a spatial dataset

- Very few, if any, sUAS class aircraft are collecting video data natively to the MISB standard.
  - Multiplexing the video with the telemetry is very important
- Gimbal telemetry data is not as easily deciphered as the aircraft Pitch, Roll, Yaw from the Pixhawk and Mission planner
- We did not save telemetry logs from past projects as the FMV technology did not yet exist. In hindsight, I wish we had saved all telemetry files for future use.
- Meticulous record keeping of flight and video start/end times is critical for matching telemetry log files to videos
- The payload (Gimbal) operator needs to have a thorough understanding of how the data will be used.

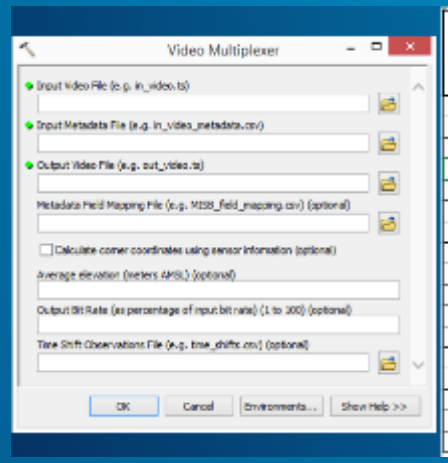
Summary of Popular Capabilities



1. **<u>Map your Video</u>** – display of the video footprint, sensor ground track , sensor pointing direction on the map

2. **<u>Bi-directional feature mapping</u>** between image space an map space. Allows creation and editing of features either in the video player or the map.

3. **<u>Video Search</u>** – search thru video archives to identify video files and segments based on geolocation, specific features and timeframe



UnixTimeStamp	Platform Heading	Platform Pitch	Platform Roll	Sensor Longitude	Sensor Latitude	Sensor Altitude	Horizontal FOV	Sensor Relative Azimuth	Sensor Relative Elevation	Sensor Relative Roll
1411141140000000	153	1.4	0.9	-73.9129819	37.89008	-1093.8	100	0	0	0
1411141140000000	153.1	1.4	0.9	-73.9129819	37.89008	-1093.8	100	0	0	0
1411141140000000	153.1	1.4	0.9	-73.9129819	37.89008	-1093.8	100	0	0	0
1411141140000000	153.1	1.5	0.9	-73.9129819	37.89008	-1093.8	100	0	0	0
1411141140000000	153.1	1.5	0.9	-73.9129819	37.89008	-1093.8	100	0	0	0
1411141141000000	153.1	1.5	0.9	-73.9129818	37.89008	-1093.8	100	0	0	0
1411141141000000	153.1	1.5	0.9	-73.9129818	37.89008	-1093.8	100	0	0	0
1411141141000000	153.1	1.6	1	-73.9129818	37.89008	-1093.8	100	0	0	0
1411141141000000	153.1	1.6	1	-73.9129818	37.89008	-1093.8	100	0	0	0
1411141141000000	153	1.6	1	-73.9129818	37.89008	-1093.8	100	0	0	0
1411141142000000	153	1.6	1	-73.9129818	37.89008	-1093.8	100	0	0	0
1411141142000000	152.9	1.7	1.1	-73.9129818	37.89008	-1093.8	100	0	0	0
1411141142000000	152.9	1.7	1.1	-73.9129818	37.89008	-1093.8	100	0	0	0
1411141142000000	152.8	1.7	1.1	-73.9129818	37.89008	-1093.8	100	0	0	0
1411141142000000	152.7	1.6	1.1	-73.9129818	37.89008	-1093.8	100	0	0	0
1411141143000000	152.7	1.6	1.1	-73.9129817	37.89008	-1093.8	100	0	0	0
1411141143000000	152.6	1.6	1.1	-73.9129817	37.89008	-1093.8	100	0	0	0

3. **<u>Video Multiplexer</u>** – Combine standard video streams and associated metadata into a single MISB-compliant video file.

5. **<u>Support and handling of live video streams</u>**

Full Motion Video Landing Page

Easy access to additional information…

- Order the FMV add-in and GP tools
- Customer service information
- Get tutorials and free data
- Presentations
- FAQ's
- Blogs
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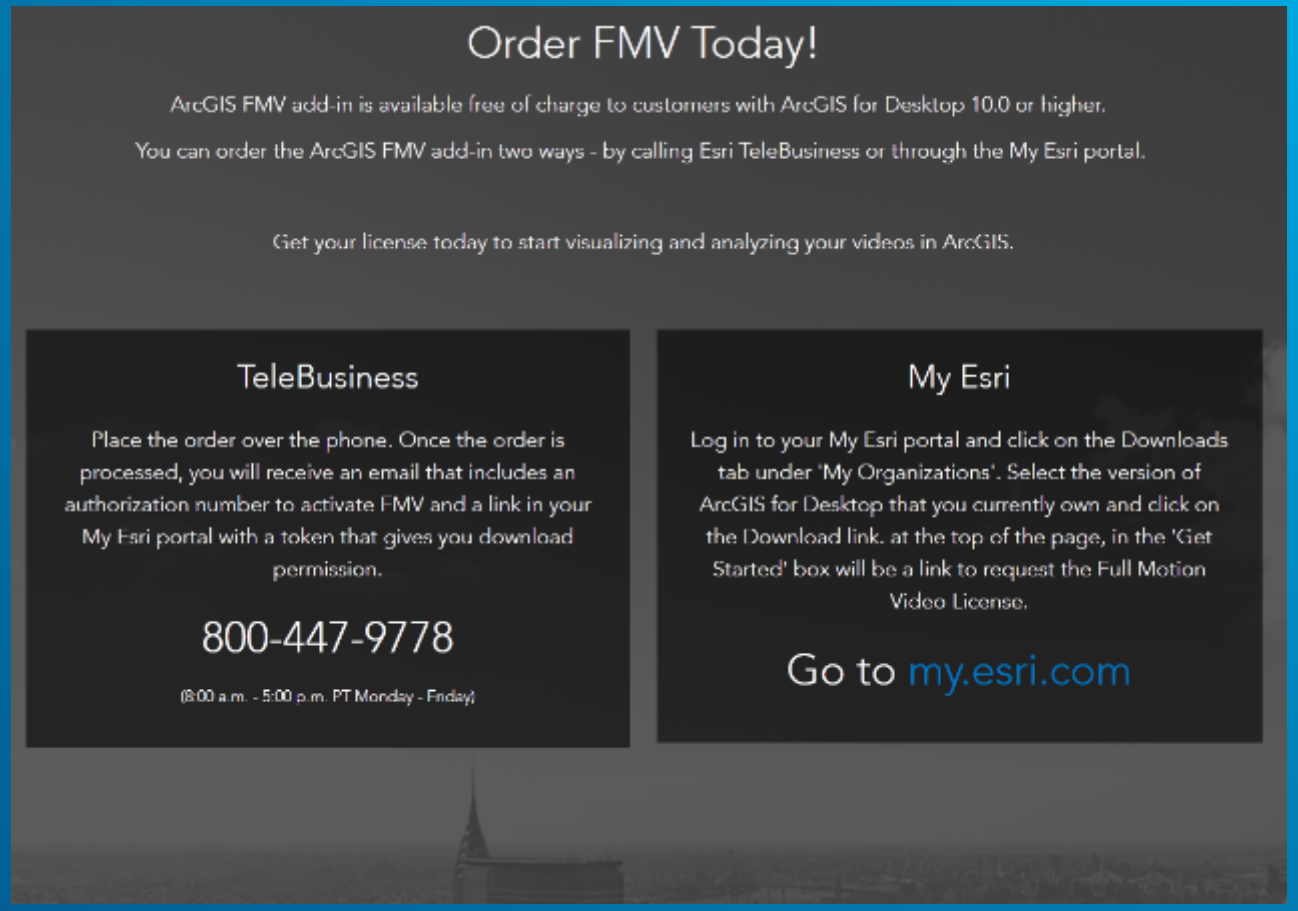
- And more!

www.esri.com/fmv



Thank You

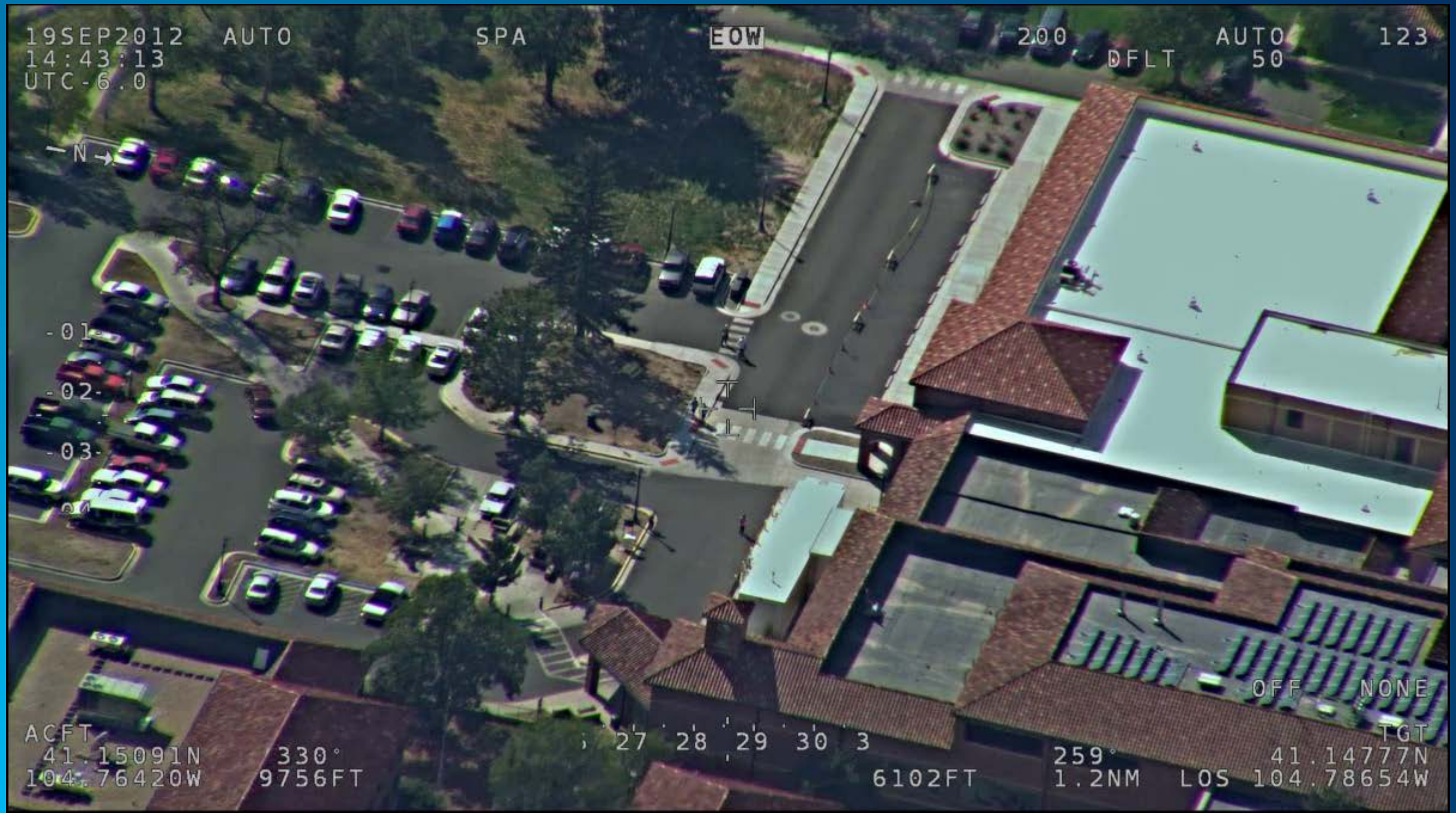
Engage in Question and Answer Follow UP

esri

Understanding our world.

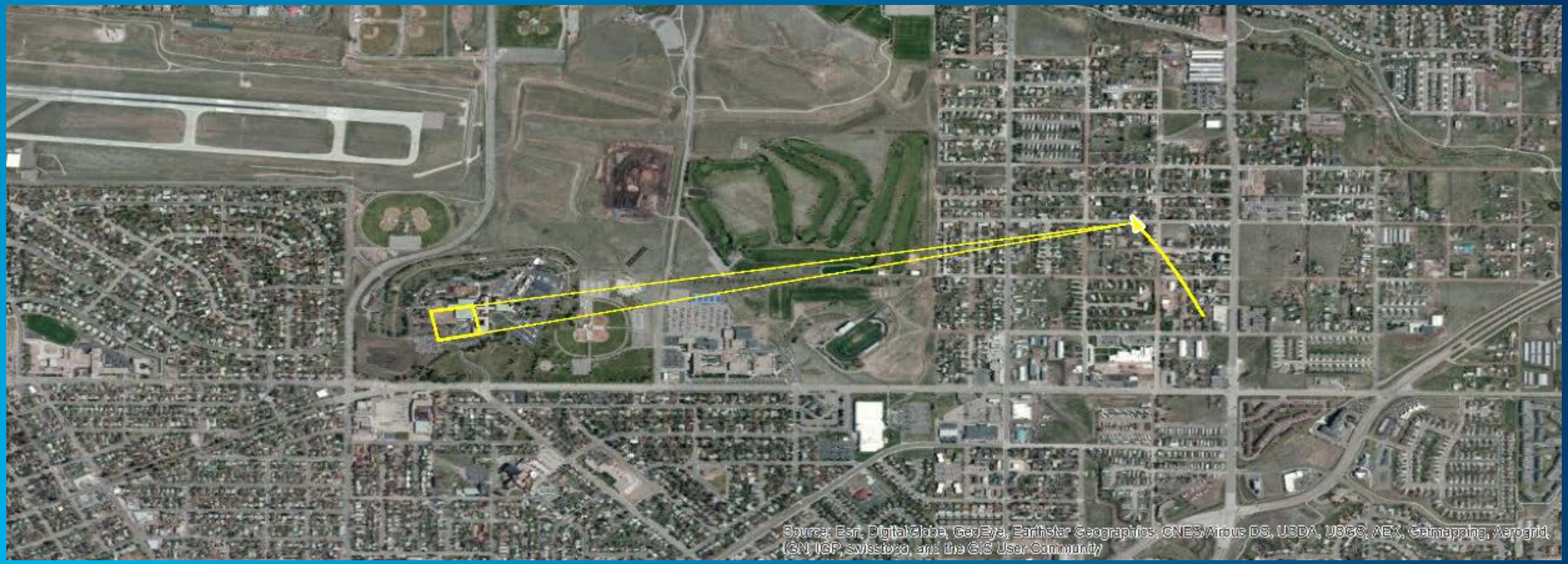
ArcGIS Full Motion Video
Automatic Powerpoint Report

The Video Frame



The Zoomed View in the Video Player

The Video Frame Footprint Displayed on the Map

Context of Video Frame

- Platform Ground Track
- Platform Heading
- Sensor pointing direction
- Video footprint