# Full Motion Video Add-In for ArcGIS 10.x
# Frequently Asked Questions

**2018 February 12** **See http://esriurl.com/FMVFAQ for most current version**

***Scroll to the bottom to see the newest entries***

**What is FMV?**
Full Motion Video (FMV) is an Add-In to ArcGIS Desktop 10.x. It enables you to view and analyze video data within your ArcGIS environment. The FMV Add-In is comprised of the Video Player, Video Manager and associated GP Tools.

**How do I get FMV?**
Please go to the Full Motion Video product page http://www.esri.com/fmv and scroll to the bottom for full licensing instructions. The FMV landing page outlines two ways to license the product. The first is via TeleBusiness, which lets you place your order via phone. Once the phone order is processed, you will receive an email that includes an authorization number to activate FMV and a link in your My Esri portal with a token that gives you download permission. You can call (800)447-9778 between 8am – 5pm PT Monday – Friday. The second method is through your My Esri account. Log in to your My Esri portal (my.esri.com) and click on the Downloads tab under 'My Organizations'. Select the version of ArcGIS for Desktop that you currently own and click on the Download link at the top of the page, in the 'Get Started' box will be a link to request the Full Motion Video License.

**How much does FMV cost?**
The FMV add-in and GP tools are free if you're current on maintenance for ArcGIS Desktop. Otherwise, there is a one-time licensing fee of $19.99. Once registered, you can use as many instances of the FMV add-in and GP tools as you want under the licensed account. Your order can include more than one license for the same fee.

**What are the system requirements to support the FMV Add-In?**
FMV requires an ArcGIS 10.x Basic, Standard, or Advanced license. All functionality is open to all license levels, except a standard or advanced license is required to use the FMV Mosaic Video and Mosaic Video Frames geoprocessing tools.

**When will Full Motion Video be available for ArcGIS Pro?**
FMV for ArcGIS Pro 2.2 is planned for release in early or mid 2018.

**Can I use FMV in a web map/web app?**
No, not at this time. We are currently evaluating requirements for deploying FMV capability in a web app.

**Can I use FMV in ArcGIS Runtime?**
Not at this time.

**What video formats are supported?**
The FMV add-in will play video from any camera that records any of 7 common file formats including MPEG, MPEG-2, MPEG-4, MPEG-2 Program Stream (PS), MPEG-2 Transport Stream (TS), H264 and ESD (VOB). 4K x 4K format video is also supported.

Also **note that *.mov format video files are typically (but not always) H264 format,** so if you have *.mov files, make a copy of a test file and rename the extension to *.h264, then try playing it in FMV. If it works, you can proceed to the next step of multiplexing to add location and orientation metadata into the video file.

**Is there a maximum file size for videos?**
No, there is no maximum file size.

**Can FMV display real-time video feeds from surveillance cameras, or a realtime downlink from an aircraft?**
FMV currently supports direct connection to live video streams such as Internet Protocol version 4 (IPv4) addresses and both the User Datagram Protocol (UDP) and the Real Time Streaming Protocol (RTSP). MPEG TS streams can be broadcast as UDP unicast or multicast and can include MPEG-1, MPEG-2, and H.264 video decoding, and KLV metadata parsing. RTSP playback is supported for live RTSP streams that use any of the following video codecs: MPEG-1 Video, MPEG-2 Video, H.264, and MJPEG.

Entire videos or partial segments can be recorded and stored to disk in real time from the live video feed. Viewing is supported, but more importantly virtually all video functions are supported including marking, measuring, bookmarking, mosaicking, digitizing features, and more, all in real-time during the live video feed, assuming the live stream is MISB-compliant. This capability is important for real-time situation awareness, ISR (Intelligence, Surveillance and Reconnaissance) and emergency management operations.

**What are the minimum metadata requirements?**
The minimum geospatial metadata includes the latitude, longitude and height (i.e., GPS location) of the camera, orientation angles for where the camera is pointing known at tip, tilt and heading (from the Inertial Measurement Unit (IMU)), and sensor field of view. In photogrammetry, these parameters are known as x, y, z, omega, phi, kappa and FoV. These parameters are described in more detail at the end of this FAQ.

This metadata is encoded into the video stream to produce a MISB-compliant video. If your sensor system produces the video and metadata as separate files, the Esri Video Multiplexer tool will combine them into a MISB-compliant video.

If the minimum required metadata described above is provided, FMV provides a moving footprint of the video on the map, as well as a dynamic path of the aircraft presuming the video was captured from the air. GIS feature data (points, lines, polygons) can also be projected into the video as graphic overlays.

If your metadata is limited, for example [x,y,z] location of the camera from GPS is recorded but no sensor orientation information is available, some functionality of FMV will be limited.

| GIS and Mapping Support | Video with MISB compliant metadata | Video with GPS only |
|---|---|---|
| Video footprint on map | yes | no |
| GIS features displayed in video | yes | no |
| Aircraft flight path shown on map | yes | yes |
| Measure features in the video | yes | no |

| | | |
|---|---|---|
| Digitize/edit features in the video | yes | no |
| Mark features in the video | yes | no |
| Save video frame as an image | yes | yes |
| Export video clip | yes | yes |
| Create Powerpoint report | yes | no |
| Collect / label / save Bookmarks | yes | yes |
| Play video controls (pause, FF, etc) | yes | yes |

**Does video data need to be MISB-compliant to work in the FMV Add-In?**
Not necessarily. Any video in the formats listed above can be played and viewed (pan and zoom) in the FMV video player. However, videos need to be in a MISB-compliant format to be able to see the sensor ground track, video frame displayed on the map, and to seamlessly map features bidirectionally in the video player and the ArcMap display. See table above.

**What is the MISB standard, and why is it important?**
The Motion Imagery Standards Board defined the MISB standard for encoding various metadata parameters into the video stream. The metadata enables advanced FMV applications such as locating the video frame on a map, locating and mapping features within the video frame, viewing the sensor ground track and pointing direction, and multicast broadcasting.

Support of the MISB standard is important for interoperability between the FMV Add-In, ArcGIS and other applications and systems related to defense ISR, situation awareness, emergency management, monitoring and mapping.

**How do you integrate the metadata with the video file in FMV?**
Depending on the source, the MISB metadata may already be embedded in the video stream. If not, and you have separate files for video, position, and orientation metadata, use the Video Multiplexer GP tool (in the FMV toolbox). It requires 2 main inputs: the video file and the metadata in a csv file. This is described in the FMV User's Manual and multiplexer templates available when you download the FMV Add-In. If you collect the minimum metadata listed above in a csv file, the FMV Video Multiplexer GP Tool will calculate the video frame corners, and thus the size, shape, and position of the video frame outline and display it on the map. This type of information is usually readily available from commercial IMU (Inertial motion unit) and GPS units. Please note that without all of this data there will be no way to calculate a frame outline.

A multiplexer template is provided (Video_Multiplexer_MISB_Field_Mapping_Template.xls) which maps the field names in your metadata csv file to the MISB field names. Another template is provided to accommodate any time offsets in your data, for example if your video recorder was turned on before your metadata instruments (i.e., GPS and IMU) were turned on.

**Can the GPS data come from a *.gpx file?**
Yes. GPS and IMU metadata can be recorded in GPX format, which is easily imported into a spreadsheet as XML format (change the *.gpx extension to .xml). This file is then written as a CSV (comma separated values) file which is input into the Video Multiplexer tool along with the video file to create a MISB-compliant video file suitable for the FMV add-in.

**How is a video archive created and indexed for searching?**
The metadata must first be extracted from the video stream, then used in the search. The 4 corners of the video frames and timestamp are extracted and stored in a GDB. The extent of

these footprints is searched for intersection with the search criteria defined: selected features, and/or display or clipped display extent, and/or time. The metadata can be extracted in 2 different but related workflows, either via the Extract Metadata GP tool, or via the Video Search tool dialog which guides you through the process. You can specify the metadata extraction rate and video playback rate which results in faster performance of both the metadata extraction process and the time searching.

**Can you recommend the best drone and sensor systems to purchase for FMV?**
Esri is drone and sensor agnostic, i.e., the FMV Add-In will work with data collected from any platform and sensor as long as it meets minimum requirements addressed above. Generally speaking, the higher quality the sensor system, the more accurate the results will be.

A sensor system with high quality airborne GPS and IMU and on-board computers with built-in multiplexer is ideal, but can be expensive. Conversely, you can buy a more basic pre-built or custom quadcopter or fixed wing platform with camera and IMU for a reasonably low price. There is some info in the blogs posted on https://blogs.esri.com/esri/arcgis/2015/03/02/arcgis-full-motion-video-1-2-1-for-arcgis-10-2-and-10-3. There are any number of drone platforms and video cameras that are adequate. In addition, you will need a GPS and IMU (Inertial Motion Unit) which usually include a software application that records the info from these instruments. Some video cameras include GPS and IMU information such as the Garmin Virb, for example. And flight planning software is useful. You can get all this for about $3,000. Other commercial/consumer drone systems include everything (drone, camera, GPS, IMU, data logging and flight software) in one system.

The Video Multiplexer tool will combine the video and metadata from the instruments into a MISB-compliant video data stream suitable for mapping information in both the FMV player and ArcMap display.

**How do you associate the metadata and video data with the FMV Add-In?**
Metadata is collected concurrently with the video data and is either multiplexed together with an onboard computer in real-time (expensive/sophisticated sensor system), or recorded in a separate file (less expensive consumer-oriented system). Assuming the latter, the metadata - in CSV format - is combined with the video data with the Esri Video Multiplexer tool to create a MISB-compliant video.

**Can videos be stored within a geodatabase?**
The video files are not managed in the geodatabase, but the metadata about the video can and should be managed in a geodatabase, then can reference the source video files on disk or in the cloud. This is the gateway into the powerful Video Search capability of FMV, where the video metadata is searched according to location of the map, features and/or time in ArcMap. The search tools find the appropriate video files and position of the appropriate segment in the video file in the results. Simply click on the search results and the video file is loaded and begins playing the correct segment containing your feature, location or timeframe of interest.

**Can you measure object heights in the video player?**
The current version of FMV Add-in does not support measurements in 3D (height of features). Only 2D linear measurements are currently supported.

**Can Full Motion Video be used with video of underground utilities?**

Yes, FMV can be used with video of underground utilities. If the location of the sensor is also recorded (latitude and longitude), along with time stamp, the ground track of the sensor will also be displayed on the map in ArcMap.

**Does FMV work with mobile video (e.g. law enforcement dash cam)?**
Yes, FMV will work with mobile video if the video is collected in, or converted to, one of the supported video types, and has metadata (a minimum of Latitude, Longitude, and Unix Time Stamp), and each set of video and metadata are multiplexed together. One consideration with dash cams is the angle at which they film. Because the angle will often include the area above the horizon it makes it difficult to calculate the frame footprints; however, if you're just interested in seeing the latitude and longitude of the sensor, a dash camera could be a great solution.

**What happens in FMV if the camera is aimed at or above the horizon?**
If the camera is aimed above the horizon the metadata will contain values that can't be resolved in the context of placing a video footprint on the ground. As a result, you'll often see oddly shaped polygons or no frame data at all on the map. In this mode, it is recommended to disable the display of the Frame Center and Frame Outline, and use only the Field of View and Platform displayed on screen to provide context.

**Which specific UAV models are MISB compliant?**
Esri does not maintain a list of MISB compliant cameras or UAVs. MISB compliant systems are not very common and are relatively expensive, typically deployed on high performance drone or aircraft platforms that require onboard computers to multiplex the data in real time. Esri prefers to be sensor-agnostic, and can support virtually any video camera/sensor system as long as the required metadata is collected in an easy to read format such as CSV or GPX file. The metadata is provided by instruments onboard the drone/imaging platform, and in some cases completed with values that are estimated based on the camera and platform. The GPS provides UNIX Time Stamp, SensorLatitude, SensorLongitude, SensorAltitude, and PlatformHeading. The IMU (Inertial Measurement Unit) or gimbal data encoder, if available, provides platform and sensor Pitch, Roll and Yaw. The camera manufacturer provides the field of view for the camera. This metadata is common to many drone setups, and is combined with the video data using the Video Multiplexer GP tool.

**What are the minimum metadata requirements to enable mapping between the video player and the ArcMap display?**

The MISB standard is very robust and covers many aspects related to the physical and environmental conditions of data collection. However, only a subset of the metadata parameters are needed for the FMV Add-In to compute the 4 corners of the video frame on the map and enable mapping on the video player and map. Essentially, all you need for a given point in time is the location of the imaging platform determined by GPS (x, y and z), and orientation or attitude of the sensor commonly expressed as Tip, Tilt and Yaw (or Heading, Pitch, and Roll), as well as the field of view of the sensor.

Thus, in order for FMV to project the 4 corners of the video frame on the reference map in ArcGIS, the following 8 parameters need to be collected at a minimum:

From the GPS:

- UNIX Time Stamp: Coordinated Universal Time (UTC) represented in the number of **microseconds** elapsed since midnight (00:00:00), January 1, 1970. Derived from the POSIX IEEE 1003.1 standard. Resolution: 1 microsecond.
- Sensor Latitude: The latitudinal position of the sensor aboard the imaging platform. Based on WGS84 ellipsoid.
- Sensor Longitude: The longitudinal position of the sensor aboard the sensor platform. Based on WGS84 ellipsoid.
- SensorAltitude: The height above or below mean sea level of the sensor aboard the sensor platform.

These parameters enable display of the sensor ground track on the map.

From the IMU:

- Platform Heading: Aircraft (or vehicle) heading angle, in degrees. Measured from forward longitudinal axis relative to True North in the horizontal plane, positive clockwise. (0…360, where “due East” would be 90).
- Platform Pitch: Aircraft pitch angle determined by the rotation around the side-to-side axis of the collection platform, also described as nose up or nose down, measured positive upward. (0…+/-20). Note that Pitch = 0 means the platform is aimed toward the forward horizon, so for a sensor aimed at nadir (straight down), the SensorRelativeElevation (see below) would be approximately -90.
- Platform Roll: Aircraft roll angle determined by the rotation around the front-to-back axis, measured positive clockwise when viewed from behind. 0 means level flight, +10 degrees means airplane right wing is lower than left wing.

From the Camera manufacturer, and sensor internal electronics:

- Horizontal FOV: Horizontal field of view of selected imaging sensor, in decimal degrees. For a sensor with variable zoom, note that this value may vary as a function of time.

Presuming the sensor is not aimed straight forward (may be a fixed mount, or mounted on a gimbal), 3 additional measurements are needed:

- Sensor Relative Azimuth: Relative rotation angle of the sensor relative to the aircraft longitudinal axis. Rotation angle between platform longitudinal axis and camera pointing direction as seen from above the platform, measured positive clockwise in degrees.
- Sensor Relative Elevation: Relative pitch angle of the sensor to the aircraft longitudinal-transverse plane, measured in degrees positive upward. A camera aimed toward the direction of flight would show SensorRelativeElevation = 0, whereas a camera aimed out of the floor of the aircraft would show -90.
- Sensor Relative Roll: Relative roll angle of the sensor relative to the airdraft. Rotational angle of the camera about its lens axis. Top of image is zero degrees. Positive angles are clockwise when looking from behind the camera.

The parameters above are well described in the MISB standards document.

Go to http://www.gwg.nga.mil/misb/zip_pubs.html and download the zip file titled 'MISP-2016.1'. Unzip the file and look for a folder called 'MISP-2016.1CompositeDocuments'. Open the folder and look for a pdf called 'ST0601.9.pdf'. This pdf contains a reference to all of the MISB fields supported by the FMV tool set. It also includes descriptions of the parameters and useful diagrams.

**Is possible to measure any feature accurately?**
This will depend on the accuracy and frequency of the metadata, the off-nadir view angle and distance from the features of interest. Measurements can be accurate, but for best accuracy, it is recommended to use a nadir or near-nadir viewing angle. Long oblique view angles will naturally lead to less accurate measurements.

**Can we extract frames from FMV to create a DSM?**
Video frames and georeferencing information can be exported as GeoTiff, NTF and JP2000 format. These video frames can be input to another software application such as Drone2Map to generate a DSM (assuming proper stereo overlap, etc) and/or orthomosaic. Note that, for this use case, a nadir or near-nadir camera orientation is required.

**Where can I find for detailed information about the Esri Full Motion Video Add-In?**
Links to information about FMV are available on the FMV homepage www.esri.com/FMV
The Full Motion Video category on GeoNet is the best place to find lots of info about FMV. Information includes the FAQ, links to blogs, Training Exercises including sample data, webinars and Live Training Seminars and more.
https://geonet.esri.com/community/gis/imagery-and-remote-sensing/content?filterID=contentstatus%5Bpublished%5D~category%5Bfull-motion-video%5D

**Does the Esri Full Motion Video Add-In support audio (sound)?**
No, not at this time.

**I have multiple videos – can FMV work with more than one at the same time?**
Yes, it is common to open and review multiple videos simultaneously.

**When I am playing multiple videos, if they were captured at the same time, can FMV synchronize the video playback?**
No, this is not possible in the current version.

**Does the (Sensor True Altitude) field support continuous data values?**
Generally yes, although the values are quantized to approximately 1/3 meter. Sensor altitude is stored and displayed as a floating point value, but the precision is limited by this data quantization.

**I am capturing single frames from the video, but some of the frames are PNG format and not georeferenced. What is causing that?**

As noted in the Properties menu/Imagery tab for the video window, if metadata is not available for a section of the video, images from that clip cannot be georeferenced. If this is a video you have processed with the multiplexer, there are likely to be temporal gaps in your metadata file. You may need to reprocess the metadata, and fill in any missing time stamps, then interpolate (X,Y,Z) and Heading, Pitch, and Roll across those new times. This data may not be highly accurate, but will enable ArcGIS to generate approximately georeferenced frames.

**Where can I get more information about the Full Motion Video Add-In?**
Esri FMV Product Page: http://www.esri.com/FMV
GeoNet: https://geonet.esri.com/search.jspa?q=fmv