LVSD

What is Large Volume Streaming Data (LVSD)?

LVSD is a NATO designation for a certain class of motion imagery sensors. In the U.S., the terms WALF (Wide Area Large Format), WAMI (Wide Area Motion Imagery), WAPS (Wide Area Persistent Surveillance) and WAAS (Wide Area Aerial Surveillance) are frequently used. All of these acronyms are used to describe essentially the same systems, so don't let the various terms confuse you. LVSD systems typically collect very large frame imagery (100 Mpixels to a 10 Gpixels per frame) using arrays of smaller cameras or multiple focal plane sensors which are then processed to form a large single image mosaic. The large image frames are collected at rates of 1 Hz or faster, therefore we treat them as motion imagery.

LVSD systems may incorporate more than one sensor modality. For example, an HD FMV (i.e. 24 - 60 Hz frame rate) camera might be present in addition to the large image array. LVSD systems typically collect very large volumes of data (terabytes to petabytes during a collection) and may provide motion imagery streaming services off of the platform during data collects. The MISB is currently working with systems under development and our NATO partners to define appropriate compression and metadata recommendations for these systems.

What standards are available for LVSD systems?

LVSD systems will need to employ several different standards to fully realize their potential. LVSD systems that employ HD or SD FMV cameras should make use of H.264 and MPEG-2 TS for compression and formats for these sensors. The *MISB EG 0601* and *Standard 0102* data sets should be used for metadata. Implementers may also need to consider *MISB EG 0801: Profile 1: Photogrammetry Metadata Set for Digital Motion Imagery*. The MISB is currently working on a metadata set for LVSD systems; see *MISB EG 0810: Profile 2: KLV for LVSD Applications*. The proper choice of metadata set is really a function of system CONOPS. Implementers and system designers are strongly encouraged to think beyond the current limited use of their LVSD data. Other people will find new and interesting ways to exploit this motion imagery and appropriate metadata will be a necessity.

The large image frames generated by LVSD camera arrays are currently compressed on a frame by frame basis. All known systems are either using JPEG 2000 or plan to migrate to it. The MISB has developed a JPEG 2000 compression profile, *MISB RP 0705: LVSD Compression Profile* and a JPIP (JPEG 2000 Interactive Protocol) profile, *MISB RP 0811: JPIP Profile (Client/Server Functions)*. JPIP is a client/server interactive streaming protocol for delivery of JPEG 2000 compressed imagery.

The MISB is also developing file formats for LVSD systems. LVSD systems comprise large volumes of motion imagery data, metadata and may contain multiple sensor types. Most file formats are not flexible enough to serve as an LVSD container. The commercial video industry has very similar problems at the studio level. The need to contain metadata and video from disparate sources and maintain an accurate temporal relationship between all of the data lead to the development of the AAF and MXF (Material eXchange Format) standards. MXF is a SMPTE standard (see SMPTE 377M) and the AAF standard is maintained by the Advanced Media Workflow Association (see http://www.aafassociation.org/). The MISB has developed an AAF profile that is appropriate for LVSD the relevant document is *MISB RP 0301.3a: MISB Profile for Aerial Surveillance and Photogrammetry Applications (ASPA)*.

As new sensor modalities are added to LVSD systems and LVSD system CONOPS change, new standards, recommended practices and engineering guidelines will need to be developed. The MISB is seeking active participation from all programs and implementers in this area.

Wait a minute; you said that JPEG 2000 compression was not as good as MPEG-2 or H.264 for motion imagery. Why are you using it for LVSD?

The reasons for this choice are many. JPEG 2000 provides a multi-resolution representation of the compressed image. This is very important when dealing with 100 Mpixel - 10 Gpixel images where it is impossible to view the full image at full resolution. When dealing with imagery of this size you typically look at the full image at reduced resolution and zoom in to increased resolutions as you define your areas of interest. JPEG 2000 excels at this. It is trivial to extract reduced resolution data sets (RRDS) from a JPEG 2000 compressed image. JPEG 2000 also provides easy region of interest access and decoding and the ability to adjust decoded/transmitted image quality on the fly. This allows users to select a desired spatial region of interest in a large image and even control the visual quality received.

Furthermore, JPEG 2000 allows for images with bit depths up to 32 bits/pixel/color component and it allows up to 16,000 color components, so it is suited for multi-spectral image compression. JPEG 2000 can even compress an image losslessly when needed and extract from the losslessly compressed image a reduced quality version to save on transmission bandwidth. The JPIP protocol allows for very efficient transmission of portions of large compressed images over modest bandwidth links. Most of these features are simply not available within the MPEG-2 and H.264 standards.

The MISB recognizes that increasing the compression efficiency of JPEG 2000 by adding temporal compression capability to the standard would be advantageous for LVSD applications. We are currently examining the feasibility of doing this with our academic and government partners.