DISCOVERING THE POWER OF METADATA

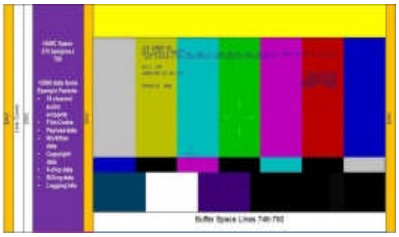
Exactly what you have always wanted

Dive in to learn how video recording and metadata can work simultaneously to organize and create an all-encompassing representation of reality. Metadata delivers a means to capture a record that permanently ties physical response of objects to the stimulus that drives them.

Everything we perceive has a behavior. Modeling behavior is an activity of scientists and engineers that has been ongoing for millennia. To model behavior we need to understand responses to a variety of stimuli. How a rock behaves when thrown through the air in response to the push by the thrower, gravity, air density, humidity wind speed and direction relative to the flight of the rock. To study a behavior it very meaningful to capture pictures of the flight while recording the entirety of external stimulus at the onset and throughout the flight.

Correlating stimuli with images is an essential element of behavior studies and modeling. Many methods have been used over the years to do so. In modern times collecting data with timestamps and collecting images (film, analog video and now digital video) with timestamps provided a means to later correlate data with images. This can be a lengthy and arduous task. Thankfully, ITS has released tools to provide the data you need, in real time. First, let's understand how it all works.

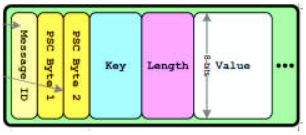
When the Society of Motion Picture and Television Engineers (SMPTE) designed the structure for 720 and 1080 high definition images, spaces were integrated into each frame that were intended to hold data related to but not actual elements of the picture. These ancillary spaces, vertical and horizontal; HANC (purple) and VANC (yellow), can old blocks of data of various structures. In general these data are referred to as metadata. Every digital video we see contains metadata that is the audio content, closed captioning, alternate language. It also contains data that we don't know about such as parental controls, copyright protection, and descriptors of what the format is and many other elements of data. SMPTE keeps a registry of metadata structures and has formally assigned numbers to each. The numbers (key) are used by encoders and decoders to understand what to do to put information in a metadata structure or extract it.



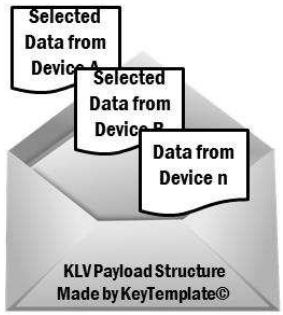
SMPTE also defined how to serialize digital video so that it can be transported. Studio uncompressed transport is handled with coax for distances up to 125 meters. Serialization of video data is referred to as SDI. HD-SDI is the serialization of either 720 or 1080 video. It is uncompressed and contains all of the image information that the camera delivered. Many professional HD cameras deliver video via the SDI transport stream. Uncompressed imagery delivers the same quality you paid for when you purchased the high resolution camera and companion lens.

The HANC and VANC space offer a real opportunity to embed information into video in real time. This is a widely held objective in investigative and testing environments. Envision a system where measurements may be taken in synchronism with each image frame captured by a

camera. The result is a record of stimuli and response of an object in real time that can be studied, modeled and evaluated. Undoubtedly, the ability to capture data samples permanently attached to a subject images is a valuable property that should be fully exploited. Uncompressed images high definition images matched to handpicked data capture delivers the most accurate portrayal of the behavior.



Now the question becomes, how does on hand pick the data and sample it with video image frames? Flowing through the SMPTE specifications there are structures defined to transport information of various types within the video frames. These structures are envelopes that serve a similar purpose to Ethernet packets on a network. There are several envelope types indicating that the information within is payload information, audio information, and unspecified information among others. Within each envelope there are tables that define the specific format of the message within. A general purpose envelope is the KLV (key-length-value) envelope or packet. The KLV structure is made up of a data type table (key) where each data type is identified in the lookup by a number. The payload, V, is the data itself where the length of the message is specified by the L. The KLV structure then offers the opportunity to define payloads containing many elements of data each having their own data type (numbers, letters, codes). Literally any structure of data can appear in this envelope. It is up to the designer to determine. The KLV structure is widely used and is commonly employed to transport information to instruct playout devices, closed captioning, timing amongst a list of several thousand registered keys. Registered keys are those that SMPTE have approved for standardization and listed in the RP210 (recommended practice) list. This list defines the internal structures so that products can be designed to embed such information in the SDI stream or detect KLV envelops and know how to read and interpret the message within.



Similar to Ethernet, if the message key doesn't mean anything to you (not your equipment address) you usually discarded the message. KLV envelopes containing unregistered keys will simply pass through any system without side effects.

The flexibility using the KLV envelope designed in by SMPTE offers the engineering and test community the opportunity to create KLV messages that contain the unique information that each individual environment needs to match stimuli to response.

While the ability to accomplish matching data to images is built into the SMPTE frame, the devil is in the details. How does one collect data from a multiplicity of sensors, organize it and cause it to be inserted in an organized manner in KLV envelops as a camera takes pictures?

Harnessing KLV Metadata

ITS has developed equipment and a suite of software accessories to enable and simplify use KLV metadata features of SDI video.

Our line of 6055C-nGHD multi-channel and 6041G-HD/6980G-HD HD-SDI inserters can build KLV envelopes and place in them the payload data (V) as video passes through. The insertion process behaves as though asynchronous data from sensors are coming into the inserter and

a set of such data is sampled at the start of each frame, encapsulated in the KLV envelope and inserted in the VANC metadata space of the same incoming video frame.

If the KLV envelopes are there, our inserters can detect them, find keys of interest extract the messages and send them to a file for later use. If our equipment is told about the structure of the message (V), it can read the message and display all or a part of the content in the video frame in which it is received.

So tools exist to insert, extract and overlay KLV payload content in real time as video passes though. The next step is building a message in real time that has some relationship the pictures being captured by a camera.

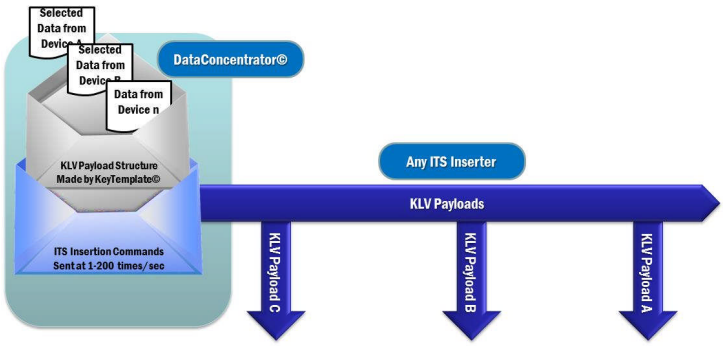
ITS has two accessories to its HD-SDI inserter line to help achieve this goal. First a hardware upgrade called Camera Sync (CS) can phase lock picture taking of a camera to a time standard such as GPS, network time or range time. This is especially helpful if two or more cameras are viewing the same object from different perspectives. Behavior snapshots from each such position then are synchronized so that each picture represents behavior at the same point in time. Equally important is to collect stimulus data at the same instance. The CS option also generates a digital signal aligned to the camera sync signal to tell a sensor, data acquisition or other measurement device when to capture or latch data. This can cause the data collection to be precisely aligned with the image capture in the video stream in real time.

The CS upgrade also has features to adjust the timing of the latching digital signal to happen before or after the camera sync signal in fine increments. This feature assures that data capture and insertion into the video stream can be matched in real time as it happens.

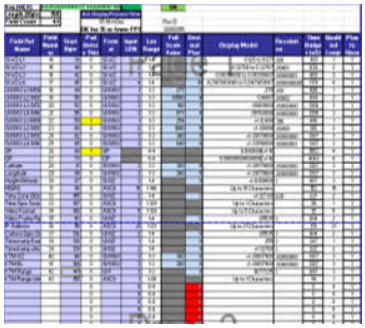
With an inserter and CS, one can embed and extract KLV metadata messages in real time.

Real Time Data Collection

The next detail is how to get the payload information to the inserters. ITS has an accessory software tool that facilitates collecting measurements from a variety of sensors connected to a PC, populate the structure of payload (V) and send those messages to an inserter for embedding HD-SDI video stream. The DataConcentrator© software does this without you having to know anything about how to enclose the messages in commands needed by the inserter. It also can do this without doing any programming to collect the data from sensors and populating the payload message structures. The data population interval, an aggregate sampling rate, can be set by the user from 1 per second to 200 times per second. If you know how the information is formatted from each sensor and what port (IP address, com port, USB port, etc.) the data comes from, you can setup the DataConcentrator© to accomplish this in less than an hour.



Carrying the ITS toolset one step deeper into the details, for any one set of measurements or test scenarios, you can use the ITS KeyTemplate©, a template created with Excel, to build a KLV message structure. With the KeyTemplate© a structure with up to 64 different elements of



information can be formed. Each element can be any one of an array of data types such as text, integers and floating point numbers. When it comes to numbers, integers can be specified to 8 digits with a decimal point anywhere in the range. It is a lot of resolution.

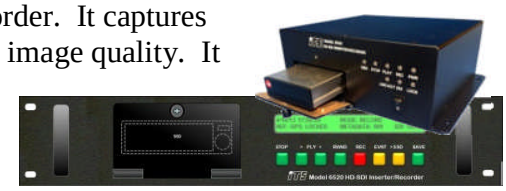
Our HD Inserters support two independent KLV messages. In total up to 128 different fields of data can be sampled on each video frame and embedded in the VANC space. That is a lot of measurements. The inserter samples the incoming messages at the video frame rate. At present the ITS inserters support frame rates of up to 60 per second. So the entire system can support over 7,600 measurements per second.

The real time data could be used for control. Information in payloads could be used as feedback to a control mechanism, input to display status and alarms, or information used by an operator. There are countless applications for use.

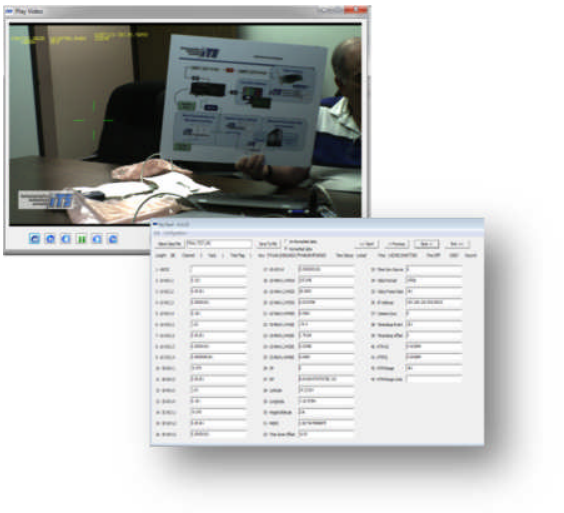
In test and modeling scenarios, recording video and data is commonly needed. When dealing with HD-SDI video, recording devices, how and what they record vary widely. Recording HD video requires lots of storage space. A SMPTE 274 frame (1080) requires more than 6 MB of storage to hold the image, HANC and VANC data. Recording 60 frame/sec video consumes 36 MB/second of storage. For this another reasons, image compression has been used as a tool to reduce frame sequence data sizes so that meaningful length video can fit in practical storage equipment.

The objective of such compression is to reduce the amount of data stored without giving up too much in image quality. Every bit counts. . Even before image compression itself, only those elements of the HANC and VANC space that are essential to reproduce the essence of video material (image and sound) are kept by an encoder. Most commercial recorders use compression and do in fact strip off the VANC space and many elements of the HANC data as well.

As part of the end-to-end metadata solution ITS offers the Fusion (6520) Video Recording Instrument (VRI). This unit is an uncompressed HD recorder. It captures all of the video without any compression compromises in image quality. It captures all of the HANC and VANC data with each image. That means that any information that was embedded in the SMPTE frame in either ancillary space (HANC, VANC) is captured and preserved. The Fusion VRI also has an embed HD-SDI inserter. Therefore it can embed KLV payloads received into the incoming video as it records. In this way, images and corresponding data are recorded and preserved. During playback the Fusion VRI will output the HD-SDI video just as though it was coming from the camera that captured it. The HANC and VANC information is there too. The Fusion VRI playback channel can also detect, extract, display and output a data stream during playback that permits one to see the KLV messages (or parts thereof) during playback. Playback may be slow, even single stepped frame by frame. When doing so, the data is also slow or single step in lockstep with the video playback. These Fusion VRI features form a powerful observation and analysis tool set. Uncompromised unmodified images may is critical to evidence, observation and archive. Related data sampled on each picture provides the precise data details need to fully understand what is being obvserved.



Painless PC Data Analysis



ITS offers the DownloadVideo© software tool. This software simplifies and quickly tackles the task of analysis and archive on a PC. This software can receive a previously recorded video clip from a Fusion VRI and process it to be encapsulated in an AVI format. The video remains uncompressed so except for what the host PC may do to adjust the video to be compatible with its local display, the images are those delivered by the camera. DownloadVideo© can also process the audio and the KLV data embedded by our system. When playing the video/audio can be observed on the host PC. DownloadVideo© will also open an independent form that will display all of the KLV messages frame-to-frame formatted in accordance with the structure you created with the KeyTemplate©. In this way you can watch the video, single step the video and see the related data. DownloadVideo© also offers the ability to select a field of data and search on some criteria you set to help you quickly find an image where an event of interest happened. DownloadVideo© can export the KLV message sets structured in accordance with the messages created with KeyTemplate© to a comma separated value (CSV) file. A CSV file can be used by Excel or many other programs to chart and analyze data.

Combined these tools enable you to spend less time aggregating and organizing data, thereby increasing productivity and focus on results. The power of metadata can empower your team and empower your mission.

But wait there's more!

These descriptions just scratch the surface of what can be done with this unique and market leading metadata toolset. As a bundle this toolset is flexible and simple enough to use for adhoc research and experimentation and robust enough to use as a standard test environment.

For more information about how you can take full advantage of the video/data capabilities designed into the SMPTE HD-SDI video system, go to our website, www.ITSamerica.com, contact us, sales@ITSamerica.com or call our offices at (818) 886-2034.

ITS is a small business located in California. All of our products are designed, manufactured and delivered from our headquarters in NW Los Angeles, USA.