# FMX

## Fast Metadata Express

*VidTrans 2019*

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*for*
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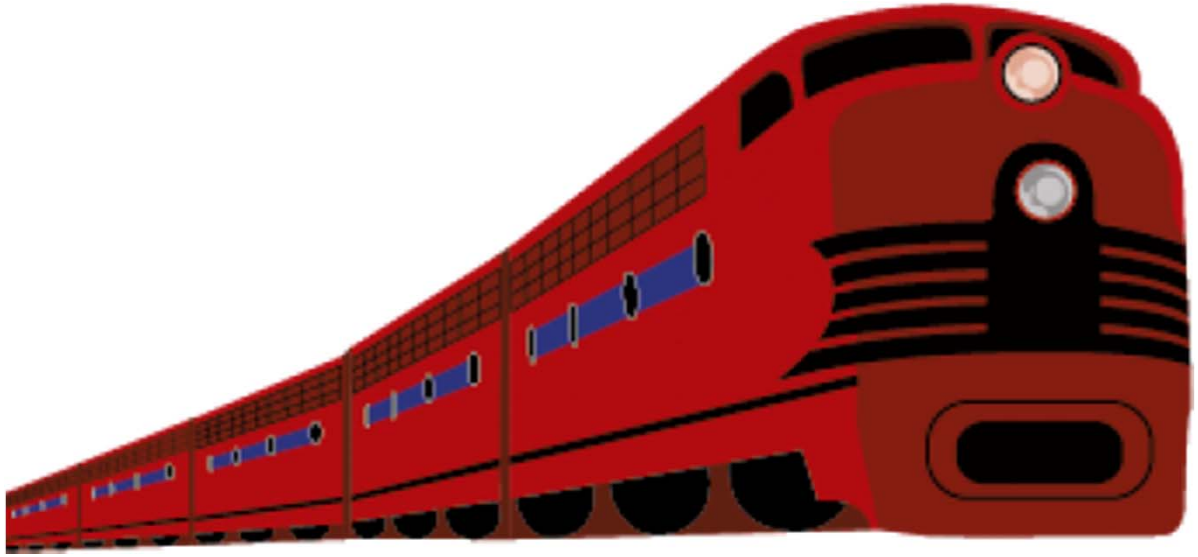


# What is FMX?

**F**ast - rapid time-aware delivery

**M**etadata - arbitrary metadata

e**X**tensible - can be extended into future applications

# What is FMX?

Fast - rapid time-aware delivery

Metadata - arbitrary metadata

eXpress - see “Fast”

# A note of Caution

This is active SMPTE project work in 32NF-60 DG SVIP

*SMPTE work is confidential*

Can’t disclose the details of the activity

*Can* disclose the ‘what’ and discuss the ideas that are input to the process

# What is Metadata?

"Data that provides information about about some other data"

*- Webster's*

In our industries, that "other data" is usually video and audio.

Some metadata is necessary in order to use the data – at all even

Other metadata is 'nice to have' information – optional use

Some metadata is static / persistent (never changes / always there)

Other metadata is dynamic - may change, may come and go

Some other metadata is actually essence:

e.g. Closed Captioning and Haptic / Tactile are media essence masquerading as metadata just because it's the easiest way to move and store it.

*Metadata is important*

# Characteristics of Video Metadata

- Temporally bound to the video essence – frame accurately
- Added at the sender, used selectively by receivers
  - Use what you want, ignore the rest
- There are many applications
  - Some intended for ‘internal use’ within production workflow (e.g. timecode)
  - Some intended to propagate to point of consumption (e.g. Closed Captions)
  - Some come and go throughout the production workflow
  - Some get lost
- Managing metadata in a facility is a challenge.

# How about new Metadata?

- Legacy metadata is simple
  - Sufficient for applications in SDI era
    - Non-interactive
    - Simple use contexts
- 2110 metadata will become rich
  - Interactive environment in IP
  - Technology has evolved
  - Opportunity to do more things with 2110
  - Far more than today's SDI applications to consider

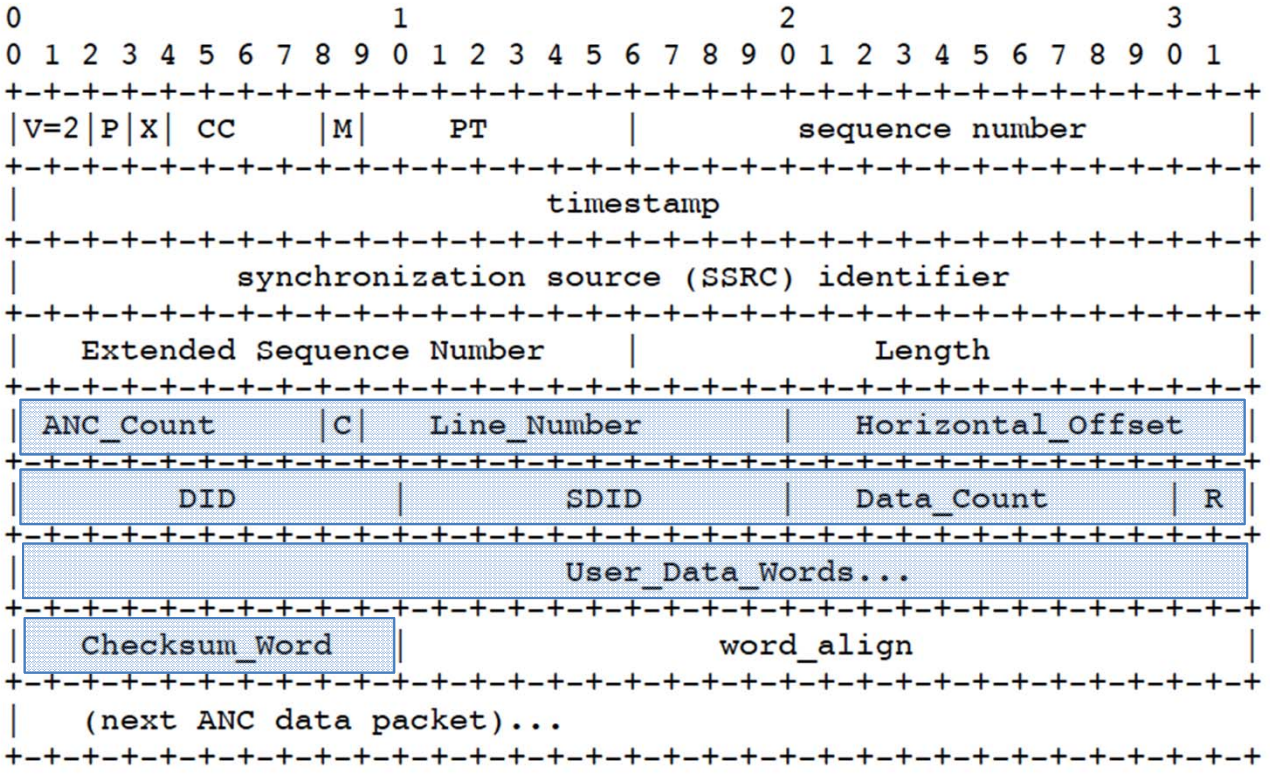
# Problem to be Solved

- The ST 2110 suite does not include a method for time-aware (i.e. synchronized with some essence) transport of non-ST 291 metadata
- The existing ST 291 metadata standards are:
  a) intended for use with SDI transports
  b) insufficient for applications requiring significant amounts of metadata
- Many current and future 2110 applications would benefit from a new metadata transport that:
  - was not constrained to limitations of ST 291
  - supports rich and arbitrary metadata payloads
  - offers time-aware native transport using the ST 2110-10 model.

# Metadata in ST 2110 SVIP today

- ST-2110-40 transports SDI metadata using ST 291 formatting
  - Sender prepares an SDI ANC-compliant ST291 payload
  - Sender wraps entire ANC payload in IP for transport
  - Transmits ANC packets on one or more unique IP addresses
    - May use one address per service
    - May group services on one IP address
  - Synchronization to a given video frame is through 2110 / 2059 mechanisms
  - Receiver unwraps the IP container, then unwraps the SDI container to get to the payload to use it, or places it back into SDI in the SDI container.
    - Two-step abstraction
  - Supports all known ST-291 metadata
  - Good evolutionary bridge method
  - Limited by ST-291 capacity and capabilities

# ST 291 over ST 2110-40 (RFC8331)



# Challenges with ST 2110-40

- Works fine for SDI ANC, but there are potential interop issues
  - 2110-40 allows one or more ANC payloads per -40 packet – “no rules”
    - Do you put one service per -41 stream? That’s IP-address-hungry
    - Do you group services in one or more -41 stream(s)?
      - Now they’re glued together, how do you add / remove one (like SDI ANC)?
        - » No “Marked for deletion” service
- SDI + ANC technology horizon is in view
    - Not all future metadata needs to be backwards compatible with SDI ANC.
- Inefficient / unclean
    - Wrapping up an already-wrapped entity
    - This is why we use AES67 as 2110-30 rather than AES3 over 2110-31
- Only supports ST-291 SDI ANC services
- Consumes one or more IP addresses

# New 2110-specific Metadata?

- Today we get there via SDI ANC
  - Define an ST291 application
  - Register it? Maybe – no intent to use on SDI
  - Wrap / unwrap into / out of 2110-40
- Does it fit the constraints of 291? How to adapt?
- Is funny business required to accommodate?
- Why are we doing this?
  - Natural first step, hybrid systems with SDI

# The Fast Metadata Proposal

- Rapid, time-aware delivery of arbitrary metadata streams in concert with a media stream – or not
- Standardized encoding method for transport
- Extensible and consistent data structure
- Does not consume additional IP addresses
- Payload agnostic – transport any arbitrary data
- Can be synchronized with the media stream (2110-10 + 2059)
- Can support legacy ST 291 SDI ANC metadata (if we want)
- Media-stream agnostic – any time-aware stream can use it
- Can be an independent data channel – doesn't need to be stream-associated
- No changes to other 2110 documents

# Project Statement

Problem to be solved:: In the ST 2110 suite, there is provision for carriage of legacy ST 291 ANC metadata. This legacy SDI-centric method is described in ST 2110-40 and provides an excellent bridge to IP for SDI services. In the IP-centric future, there will undoubtedly be new metadata requirements which will have no relevance or application in the SDI domain and additionally may not be appropriate for efficiently wrapping in legacy ST 291 SDI ANC packets for IP transport with 2110-40. This project will create a new transport method for arbitrary metadata using RTP packets in the same manner as the other 2110 standards. This method will not be strictly tied to any type or form of metadata. Use of the 2110 synchronization mechanism will permit transmission in association with a 2110 essence stream, for example transmitting the packet at the video Alignment Point. It is proposed that the SMPTE ST291 RA be used to index payload types for use in this Standard using a new RA Data Type and the existing DID / SDID addressing scheme. Two initial applications are proposed: carriage of a 2110 sender SDP record using a TLV structure (separate Project) and carriage of the (in-process) SMPTE TLX Time Label (SMPTE liaison). Proponent will offer an initial presentation at the first DG meeting.

Project scope:: Develop a Standard to enable arbitrary data to be transmitted and synchronized with another RTP stream in an ST 2110 environment.

Specific tasks:: Establish detailed design goals Look at IETF for existing RFCs that could be used research / establish exact method for transport and data formatting Investigate / establish use of SMPTE RA or other

# What it Does

- Uses a consistent data structure (such as a KLV-type structure)
  - Well-known representation
  - Extensible – beyond foreseeable needs
  - Optionable / scalable
  - Easily parseable
- Carries the naked metadata – no unnecessary wrappers
- Delivers at a specific time
  - In concert with (or before) the first packet of video
    - Real (or predicted) timestamp
    - Early delivery means early processing
      - Could deliver immediately after last packet (M bit packet) of prior frame
- Can also be used on its own with no associated stream
  - Arbitrary data transport
  - System-level or other bulletins sent periodically (like ATIS)

# What Would it Enable?

Carriage of new payload types

- Standardized data structure can carry other specific structures
  - XML, JSON, etc.

- Carriage of arbitrary metadata for any time-aware RTP stream
  - Metadata we haven't dreamed up yet
- Address conservation
- A cleaner way to carry today's ANC services
  - Overcomes limitations of 2110-40
  - Could still use existing registry and DID / SDIDs
  - Metadata payload would be identical – just not wrapped for SDI

# High-level Proposed Methodology

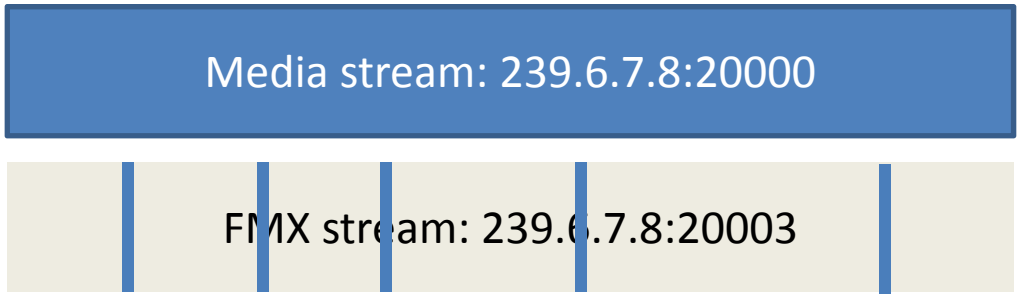
- Transport
  - Directly associated with a 2110-xx stream
    - Use same IP address as stream
    - Use “UDP port number + offset” enumeration to differentiate metadata stream
    - Use same associated stream’s RTP timestamp clock rate and time value
      - RTP Timestamp can be altered for early delivery
- Wrapping
  - Use a generic TLV- / KLV-type structure
    - Payload agnostic
    - Well-known and widely used format

# A Blob in a BLob

- Two KLV-like protocols are used
  - Outer protocol is the boxcar that 2110 carries
  - Can carry one or more outer protocol boxcars
  - Each can contain one or more inner protocols
  - Inner protocol(s) contain the actual metadata
  - Designed specifically for the application(s)

# Yet Another RTP Stream

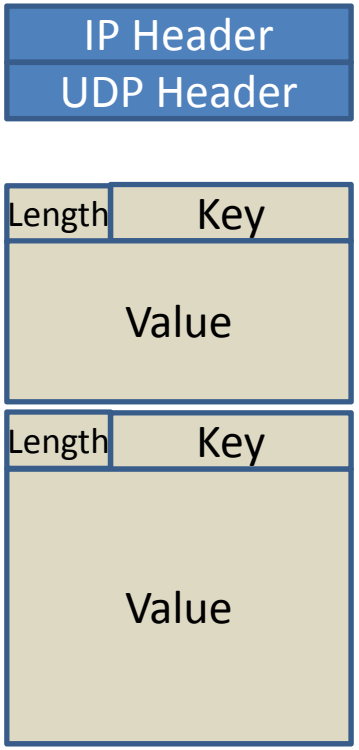
- Rides on the same multicast as the related media
  - It uses another port number
  - Similar to the approach used for FEC




- The FMX packets have RTP timestamps in the same units as the media stream
  - If the metadata has a time relationship to the media, then the timestamp indicates how it relates
- FMX packets are in the outer protocol format

# FMX Packets: A familiar design (RTP)

- Use Standard RTP
  - 16-bit sequence number is plenty
  - RTP-TS in units of related media
- KLV-type structure allows extensibility
  - Defined namespace structure for keys to allow experimental and user-private keys in addition to standardized, registered keys
  - KLV blobs fit inside a packet. Any fragmentation logic is the responsibility of the inner protocol.
  - KLV blobs are 32-bit aligned. Any required padding to achieve alignment is the responsibility of the inner protocol
  - Length = 10 bits = # of 32 bit words that follow



# Things to look at

- Existing standards we can use “out of the box”
  - RFC6597
    - Transport of SMTPE ST 336 KLV data over IP
      - 336 requires use of ST 298, ST335, RP 210 (SMPTE ULs)
    - May contain useful elements we can use directly with constraints
  - AES-x242
    - Transport of audio (only) metadata associated with AES67 Streams
    - SMPTE Liaison underway
  - ST 2109
    - KLV framework for Audio Metadata
- Others?

# Topics for Discussion

- Use of SMPTE RA for FMX
  - Agreeable extension?
- Port + offset concept
  - What offset(s) / range to use?
- Rules for grouping metadata
  - Could help -40 as well – maybe an RP
- Rules for synchronization
- Rules for arbitrary transmission
- SDP

# The Collateral Project – 2110-42

- "SDP over FMX"
  - Not really the entire SDP
  - Essential stream-descriptive elements only
    - *Plus*
  - Other non-SDP stream-descriptive metadata

This is intended to *augment* the IS-04 service

# First Application for FMX – 2110-42

"Formatting of the relevant elements of a 2110 sender's SDP Object and other relevant descriptive data for FMX transport"

The goal is to enable a stream to be self-describing

- Present systems use IS-04 to convey SDP objects from senders to receivers
- SDP objects enable the receiver to understand and use the sender's stream

- Applications:
  - Direct connections (e.g. camera to monitor on the bench)
  - Source without IS-04 (e.g. some routed remote stream)
  - Non-NMOS control applications

# Project Statement – 2110-42

Problem to be solved:: The SDP object of an ST 2110 sender is conveyed via the mechanisms of AMWA NMOS IS-04, requiring use of a Registration and Discovery server, or through a vendor-proprietary control system mechanism, requiring that one of these be present in the system. This project proposes an alternative delivery method for the essential descriptive SDP items of the device. If the SDP object were associated with and transmitted along with an essence stream, it could be delivered directly to the receiver in a timely fashion, such as in concert with the first packet of a video frame. This could enable SDP-serverless systems to operate effectively, would deliver on-the-fly operational parameter changes of the sender to be delivered to the receiver as quickly as possible, and offer benefits to switching applications.
Project scope: Develop a Standard to specify the packing of specific syntax elements of the ST 2110 sender's SDP object for transport with the (proposed) SMPTE Fast Metadata (FMX) Standard. Other operational parameters may be considered for inclusion as part of this work. Possibly provide informative guidance to its use; if extensive, then an EG may be warranted. This in no way precludes the additional use of IS-04 or elements thereof, and it is intended that NMOS SDP objects and the data carried by FMX be harmonized.

Specific tasks:: Establish: - list of SDP parameters for carriage - list of any other parameters to be carried - data structure, syntax, enumeration

# Does this replace NMOS IS-04?

- No. Not the intent at all
- IS-04 is a discovery and registration service, period.
  - Good for startup of the system / device, does not serve dynamics
- IS-04 has operational limitations
  - Response time
  - Realtime accuracy ( currency of data)
- 2110-42 is an augmentative service for IS-04
  - Enables realtime data updates
  - Data is as fresh as it gets
    - Sender sets it, -42 sends it. SDP reconciliation may come later
    - SDP parameters may not be sufficient to fully describe the stream
  - Can send -42 metadata any time wrt the essence, not just at the -40 alignment

# The Story so Far

- Conceived in discussion with numerous 2110 –type colleagues, users and vendors
- Proposed as ideas at last VidTrans
  - Positive support and useful input was received from VSF members
- Presented to AIMS for input
  - More positive support and ideas, several proponents for SMPTE drafting work raised their hands
- Presented to SMPTE as a project proposal
  - Passed Project Reviews unscathed
  - Drafting project approved, work started in DG

# Applications for FMX

- ST 291 SDI ANC data
- TLX – new time label
- Frame-by-Frame dynamic metadata
  - HDR metadata
  - PTZ+
  - Geolocation
  - Prompter text
  - Staging / lighting cues, other metadata
- A two-way data channel between participants?

# SDI ANC Transport

- Current method of 2110-40 works fine
  - Completely SDI-centric, good for hybrid systems
  - Has operational challenges
    - One or more ANC per IP packet?
    - How to handle “marked for deletion”
    - Still contains SDI source line / pixel information
  - No reason to change at this point
  - Can carry those payloads in -41 as an inner type

# TLX New Time Label

- A new technology looking for a transport
  - TLX structures can be mapped to FMX
  - FMX transport offers another temporal reference
- Various TLX structures may exist
  - FMX doesn’t care
  - Can be delivered variably wrt the essence.

# Camera Metadata

- Pan / Tilt / Zoom // Focus / Iris
- Dolly X / Y, Ped up / down (Z)
- 3-D xyz orientation in space (real or virtual)
- GPS geolocation: lat, long, alt, speed, direction
- Variable framerate timestamp

- *Frame by frame*

# 2110 and DICOM

*Digital Imaging and Communications in Medicine*

- All about medical imaging
  - 2110 is an ideal candidate for this application
  - FMX is a good candidate for associated metadata
    - See Phillippe Lemonnier's presentation tomorrow

# Data Indexing Proposal

- SMPTE RA offers an existing register for metadata services
- 2110-41 can transport native ST 291 ANC
- Presently constrained to ST 291 metadata, but could be extended
- RA has plenty of open space
  - 65536 slots (8-bit DID and SDID in ST291)
  - 80 are in use
    - ST 291 likely won't use too many more

| | | | |
|---|---|---|---|
| 08h | 0Ch | In Force | S353 |
| 40h | 01h | In Force | S305 |

- Add a new data type
  - Already have Types 1 and 2, add Type 3 for -41
- Rename RA to include -41-based services

# Next Steps

- More research
- Draft -41 document first – outer protocol
- Investigate use of SMPTE-RA as index
- Build list of candidate elements for -42
- Work with TLX to ensure their needs are met

# FMX

## Fast Metadata Express

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*for*
Evertz Microsystems

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