IP Showcase ST 2110 LaunchPad

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IP SHOWCASE™

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Audio Engineering Society

AIMS
Alliance for IP Media Solutions

AMWA
Networked Media. Working.

EBU

SMPTE

VSF
VIDEO SERVICES FORUM

Key Requirements for IP Video Systems

Function	Description	Standards
Encapsulation	Put media data into IP packets	Video: ST 2110-20 Audio: ST 2110-30 & AES67 Ancillary Data: ST 2110-40

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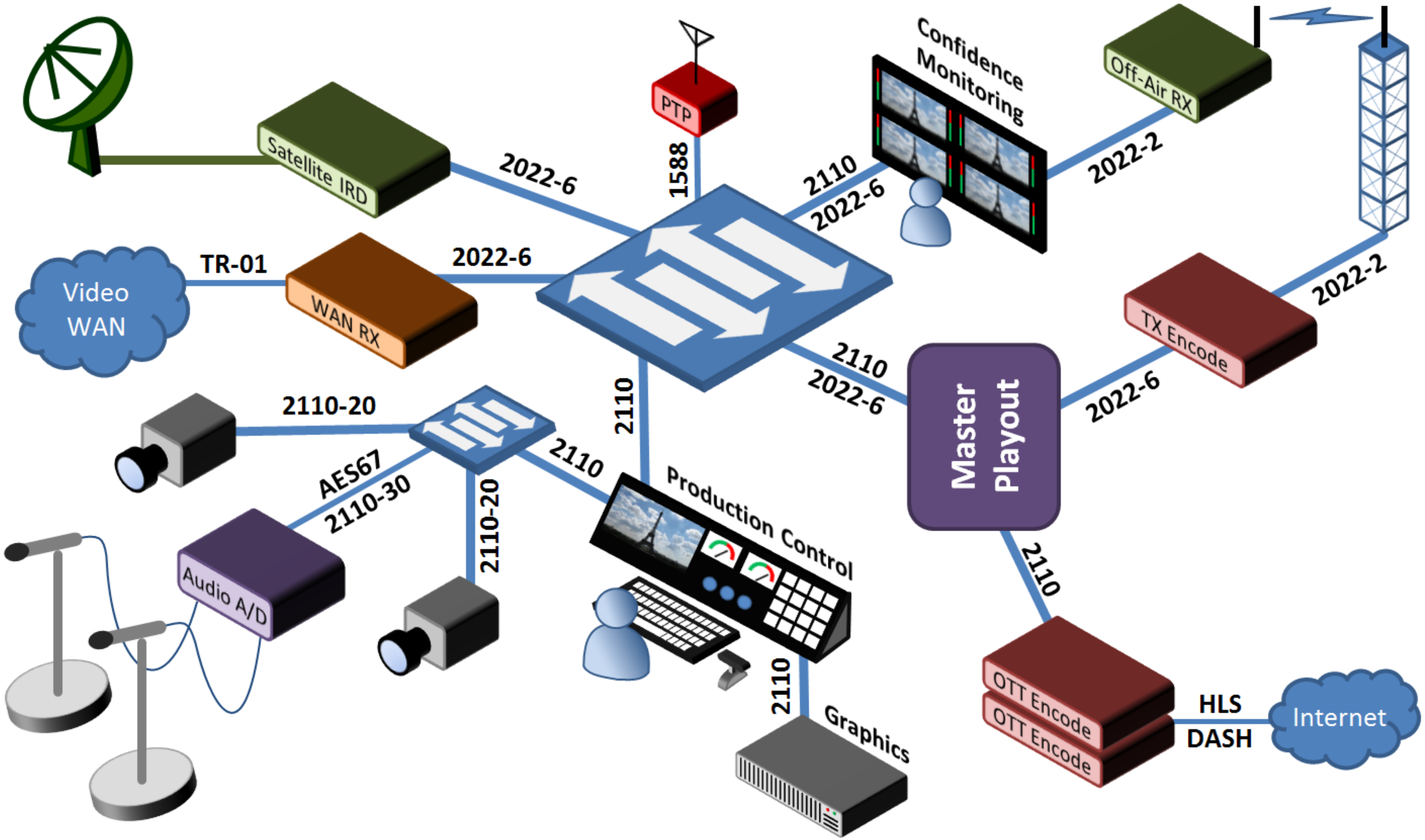
Connection Management	Route signals from sources to destinations	SDP – Session Description Protocol NMOS IS-05

Media Transport over IP

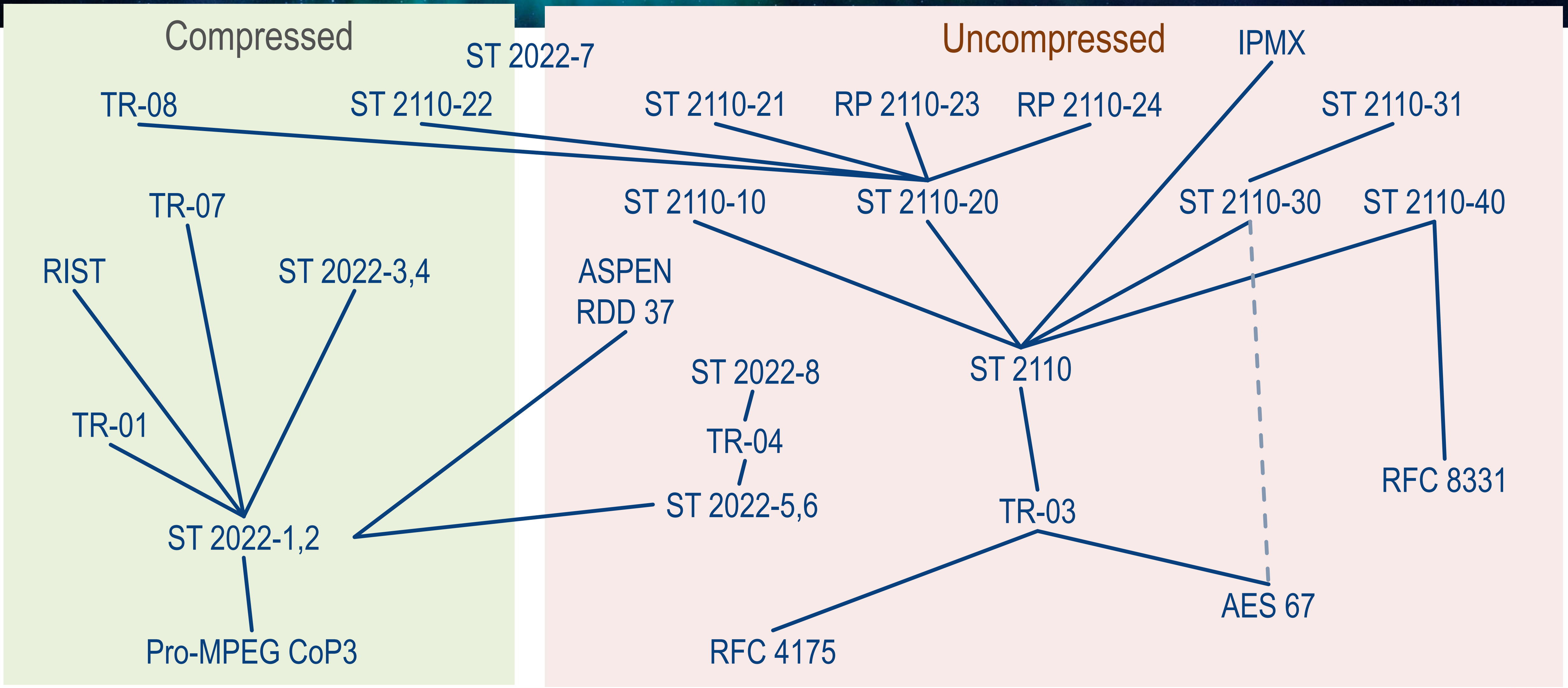
SMPTE ST 2022-6

SMPTE ST 2110

The IP Video Ecosystem



IP Media Evolutionary Tree



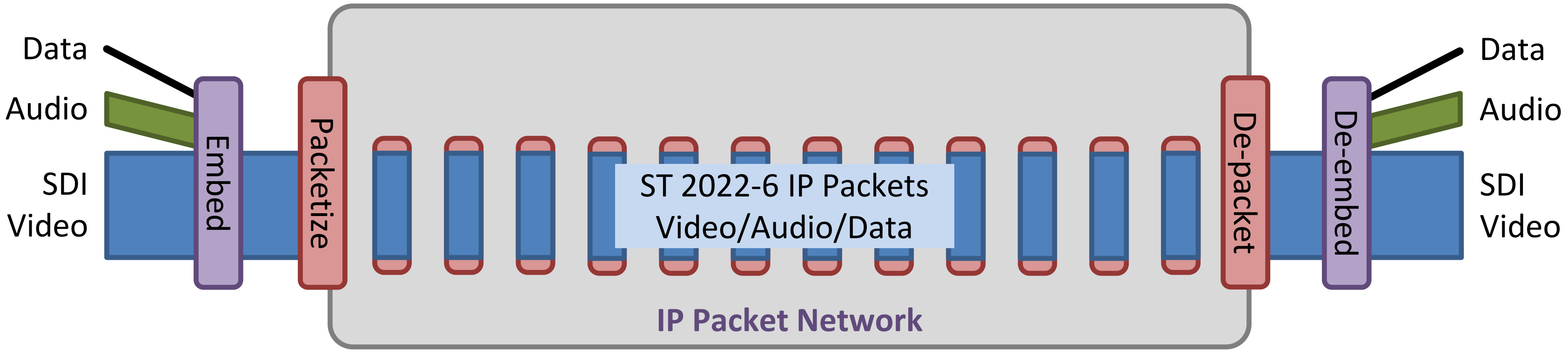
>> Note that ALL these signals could co-exist on the SAME IP network <<

SMPTE ST 2022-6

- Specifically designed for transporting SDI signals over IP
  - 270 Mbit/s, 1.485 Gbit/s and 2.97 Gbit/s
- Carries entire SDI signal intact
  - Video, embedded audio, ancillary data, HANC, VANC and all other bits
  - Permits bit-for-bit copy of signal to be transported across IP network
- Works with ST 2022-5 Forward Error Correction
  - Row/Column FEC handles lost RTP datagrams
  - Separate UDP ports used for transmission of SDI and FEC

Media Transport over IP: SMPTE ST 2022-6

- Take entire SDI signal and encapsulate into one IP stream
  - Includes audio and embedded data signals
- Easy to maintain audio/video synchronization
  - Hard to process just one part of a stream

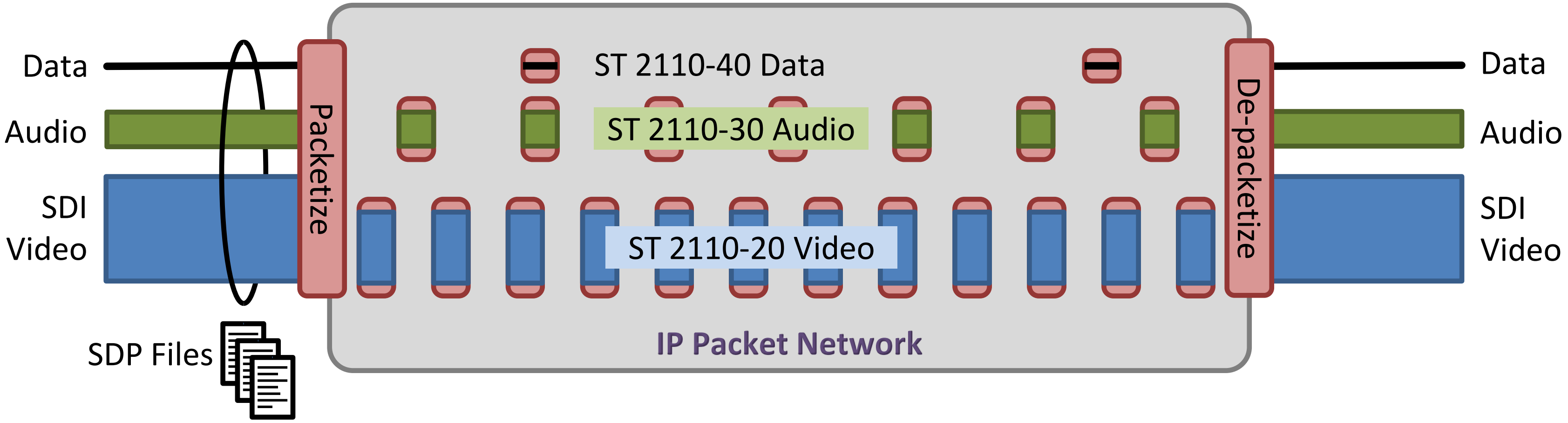


SMPTE ST 2110

- General-purpose media transport over IP
  - Standards for video, audio, synchronized metadata
- Carries each media element as a separate stream
  - Video in one stream, one or more audio channels in another, metadata in another
- Capable of handling wide variety of formats
  - Video from SD all the way up to 8K HDR and beyond
  - Compressed and uncompressed video at any frame rate
  - Multi-channel audio at multiple sampling rates
  - Many different categories of metadata

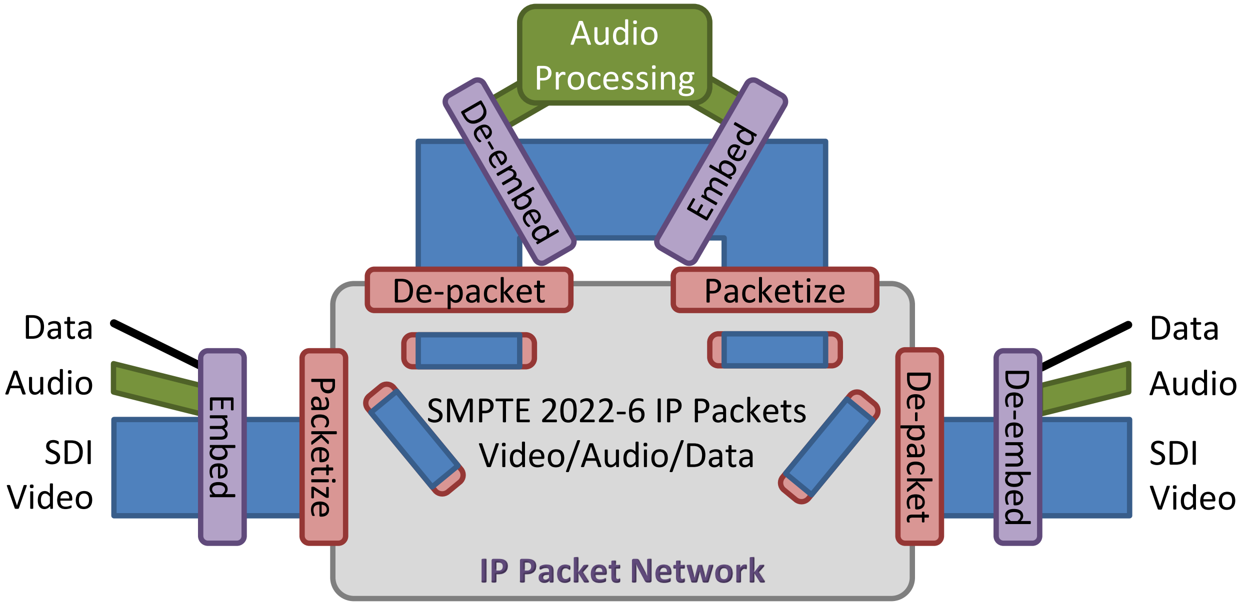
Media Transport over IP: SMPTE ST 2110

- Each media type in a separate packet stream
  - Easy to process individual components
  - Signals need to be resynchronized after processing
- PTP (Precision Time Protocol) used for packet timestamping
- SDP Files used to describe each packet stream

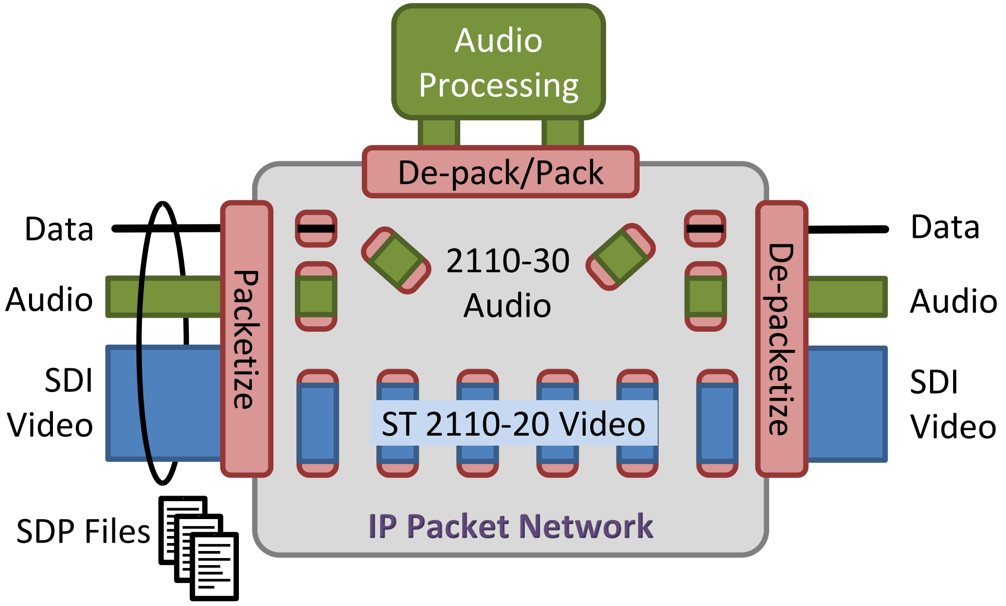


ST 2022-6 / ST 2110
Audio Processing Packet Flow

Using SDI/ST 2022-6



Using ST 2110



SMPTE ST 2110 – Released Standards

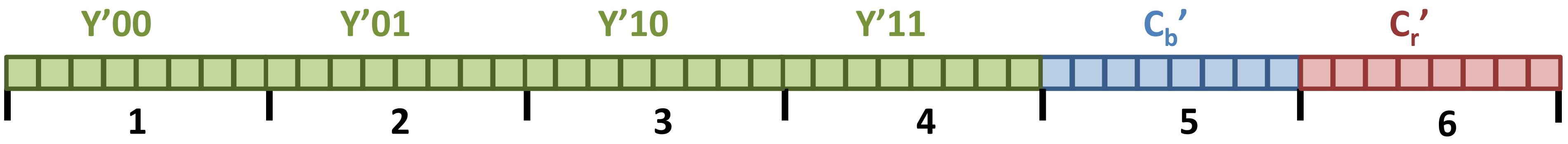
- OV 2110-0 Roadmap for the 2110 Document Suite
- ST 2110-10 System Timing and Definitions
- ST 2110-20 Uncompressed Active Video
- ST 2110-21 Traffic Shaping and Delivery Timing for Video
- ST 2110-22 Constant Bit-Rate Compressed Video
- ST 2110-30 PCM Digital Audio (uncompressed)
- ST 2110-31 AES3 Transparent Transport (for non-PCM audio)
- ST 2110-40 SMPTE ST 291-1 Ancillary Data
- ST 2110-43 TTML for Captions and Subtitles

ST 2110-20 Video Encapsulation

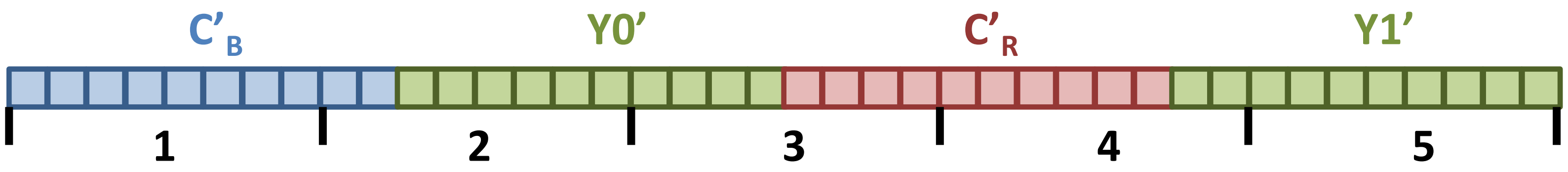
- Multiple video pixel groups (pgroups)
- RTP Payload Header applied (unique to each media type)
- Inserted into an RTP packet
- Placed into UDP packet
- IP packet header attached
- Wrapped into Ethernet Frame

ST 2110-20 Pixel Groups

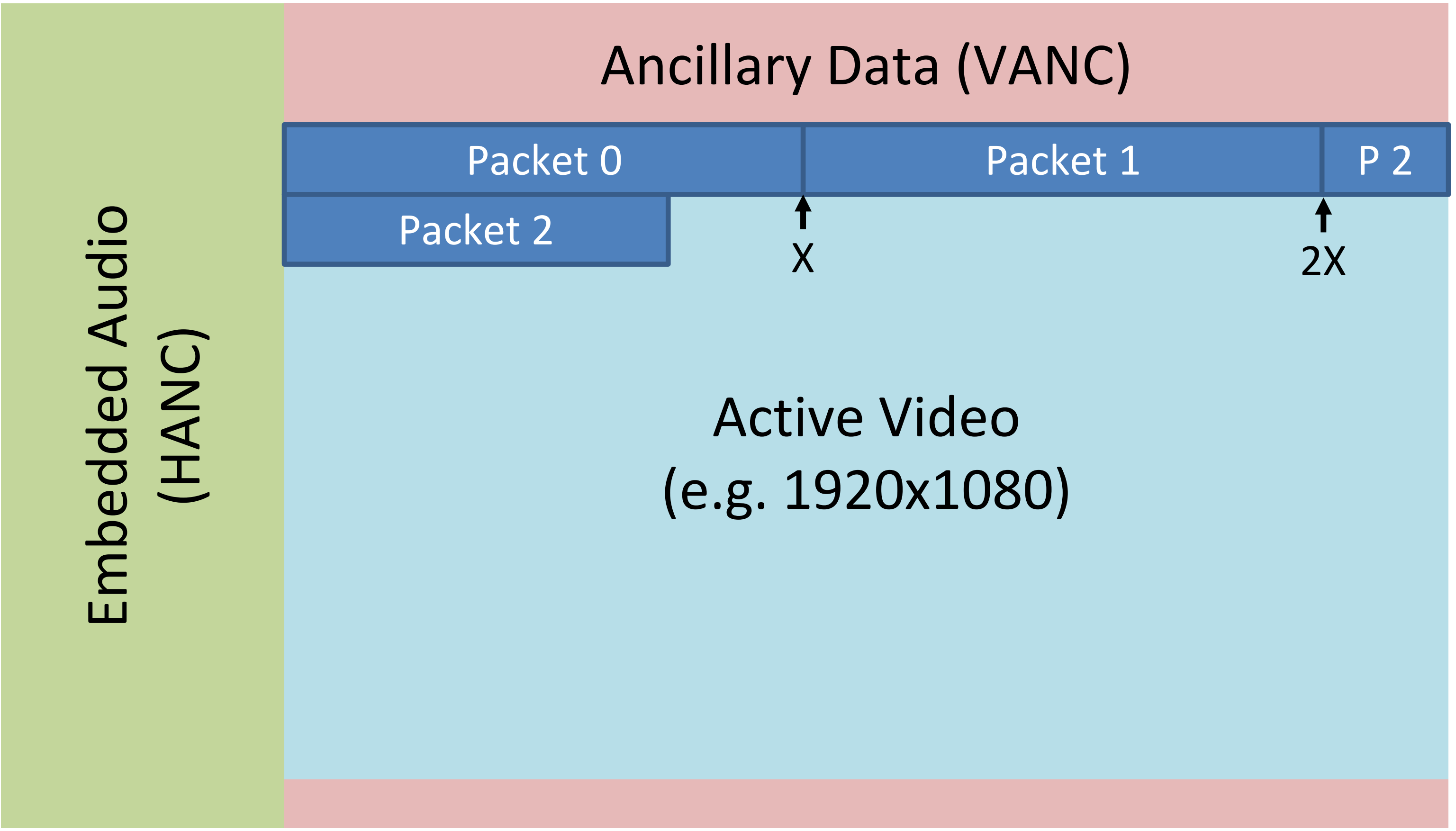
- Pixels formed into pgroups
  - pgroup size depends on sampling format
  - Must be integer number of octets
  - Pixels that share samples must be in the same pgroup
- Example: 4:2:0 8-bit groups 4 pixels into 6 octets



- Example: 4:2:2 10-bit groups 2 pixels into 5 octets



ST 2110-20 Sample Row Data



- Packet 0
- Packet 1
- Packet 2

Lossless Compression

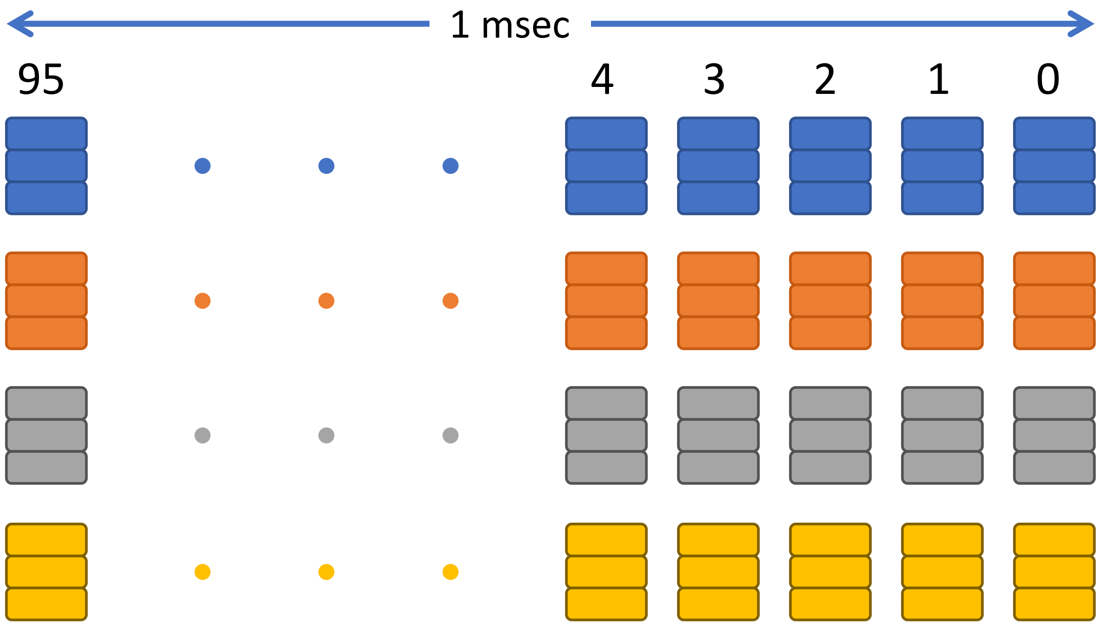
- Visually lossless compression cannot be seen by observer
  - Some data must always be removed
  - Done so as to be invisible to human viewer
  - Can have very low latency (~1 millisecond or less, encode + decode)
- Popular codecs available
  - JPEG XS – RTP Encapsulation – RFC 9134
  - Also VC-2 DIRAC from BBC – RFC 8450
- 2:1 to 8:1 compression ratio
  - 3Gbit/s SDI compressed to 1.5 to 0.5 Gbit/s

Compressed Video Signal Rates

- Often measured in bpp (bits per pixel)
- Uncompressed SDI used 4:2:2 10-bit video
  - Works out to 20 bits/pixel
  - Note that SDI also has HANC and VANC occupying significant bandwidth

Video Format	Pixels/frame	Pixels/second	"SDI" bit rate	1 bpp	3 bpp	6 bpp
720p60	921,600	55,296,000	1.485 Gbit/s	70 Mbit/s	195 Mbit/s	390 Mbit/s
1080i60	2,073,600	62,208,000	1.485 Gbit/s	70 Mbit/s	195 Mbit/s	390 Mbit/s
1080p60	2,073,600	124,416,000	2.97 Gbit/s	150 Mbit/s	390 Mbit/s	780 Mbit/s
4K 2160p60	8,294,400	497,664,000	11.88 Gbit/s	500 Mbit/s	1.4 Gbit/s	2.8 Gbit/s
8K 4320p60	33,177,600	1,990,656,000	47.53 Gbit/s	2 Gbit/s	5.6 Gbit/s	11.2 Gbit/s

ST 2110-30 Audio Encapsulation



4 channels of 96 kHz 24-bit audio

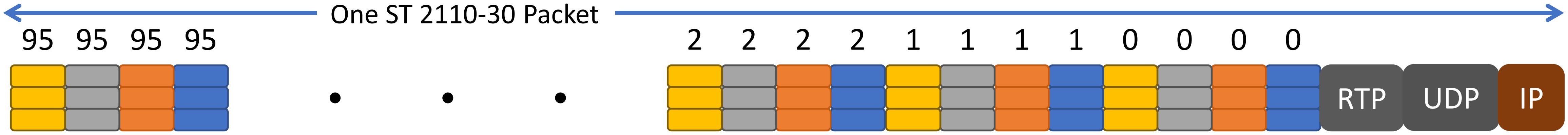
96 ea. 24 bit Samples (3 bytes) @ 96 kHz

Each Channel has 3 x 96 = 288 bytes per packet

4 Channels have 4 x 288 = 1,152 bytes

All channels in one IP Packet

Maximum theoretical capacity – 5 channels, 1440 bytes



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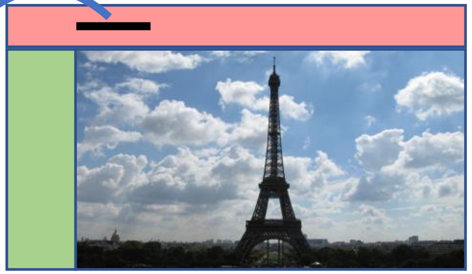
2110-40 Ancillary Data

- Extract ancillary ST 291 data packets from VANC or HANC
  - Captions, time code, ad triggers, etc.
  - Place them into RTP packets with custom header
- Line numbers are based on SDI line numbering
  - Don't match 2110-20 line numbers



Ancillary Flag	DID	SDID	DC	User Data	CS	
000 3FF 3FF	41	07	xx	SCTE 104	zz	ANC Data Packet

RTP Header	Payload Hdr.	Anc. Packet Header	DID	SDID	DC	User Data	CS	
Seq. #, SSRC	01	Line #, Offset	41	07	xx	SCTE 104	zz	RTP Datagram

IP Transport

RTP Encapsulation

Timing

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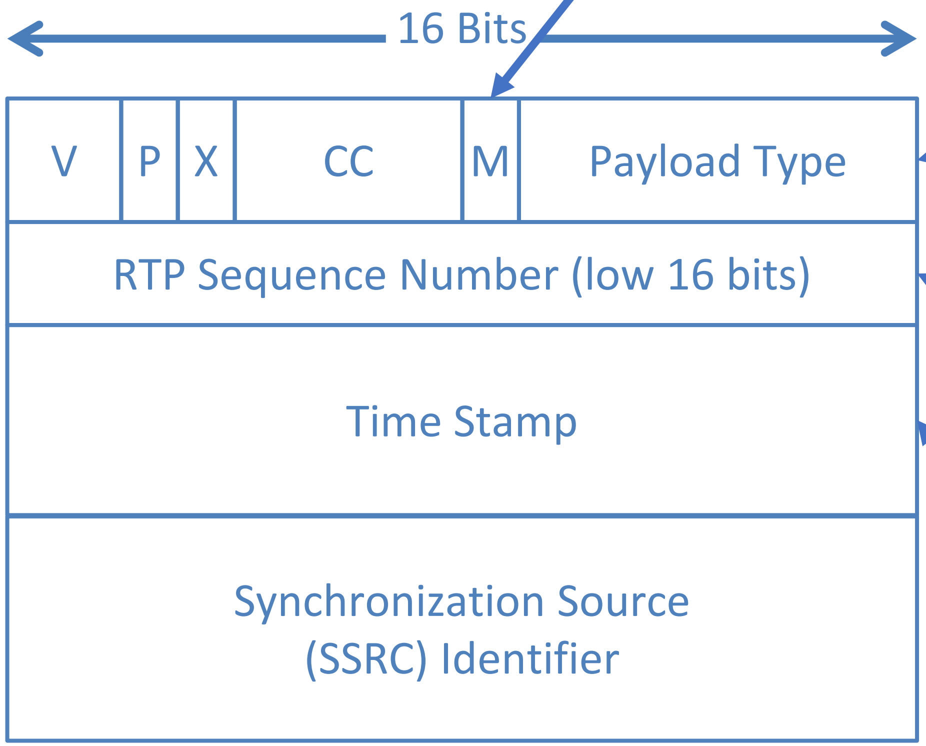
RTP Packet Features

M-Bit – Media-specific indicator flag
In ST 2110 video, indicates last packet of video frame

RTP Header



Payload Type
Indicates type of media in packet (video/audio/etc.)

Sequence number
- Each packet in a stream has a unique number
- Permits packets to be put into correct sequence
- Allows missing packets to be detected

Timestamp
- Indicates when media content was created
- Multiple packets may share one timestamp

All Signals in Phase at SMPTE Epoch

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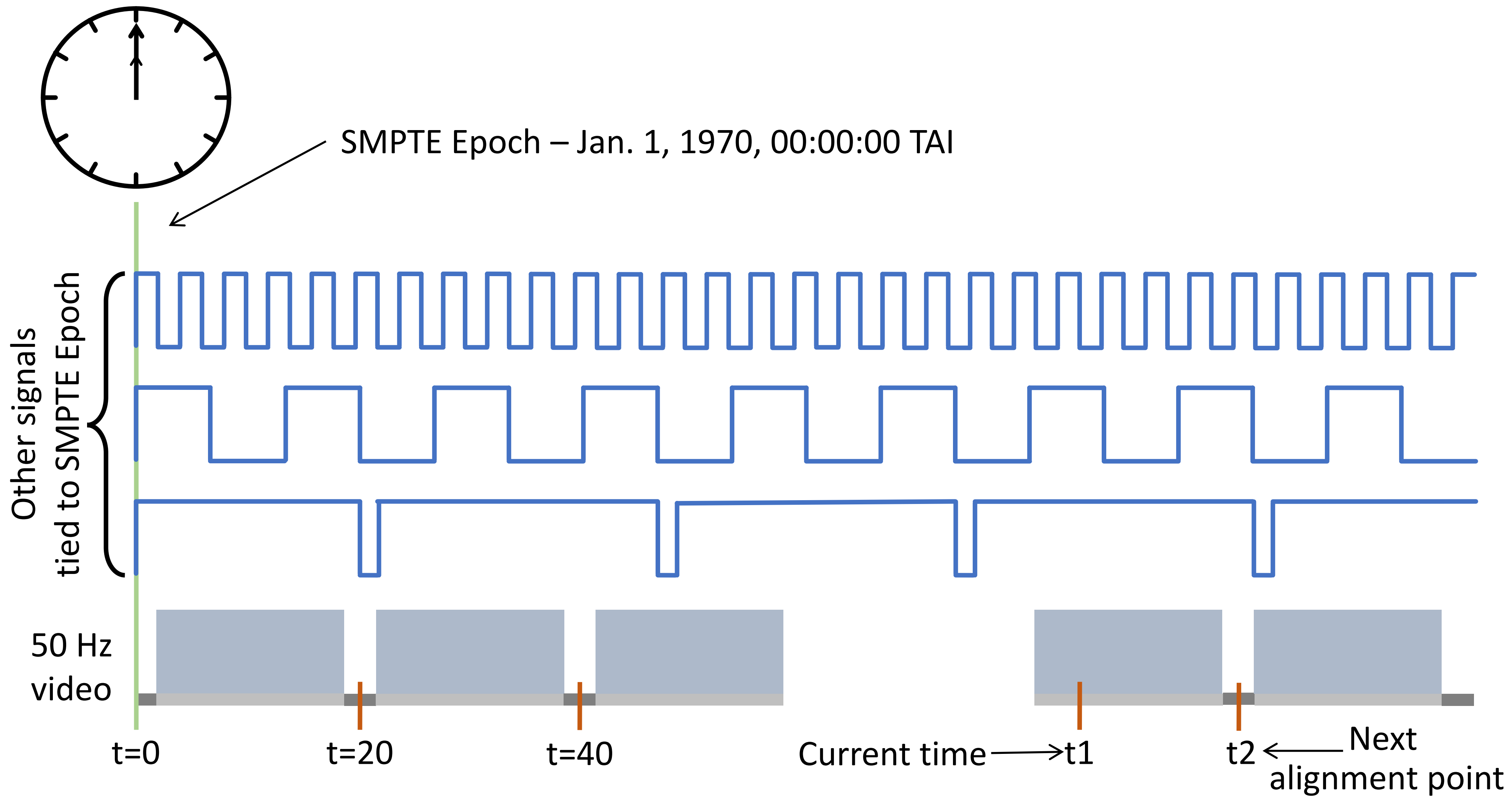
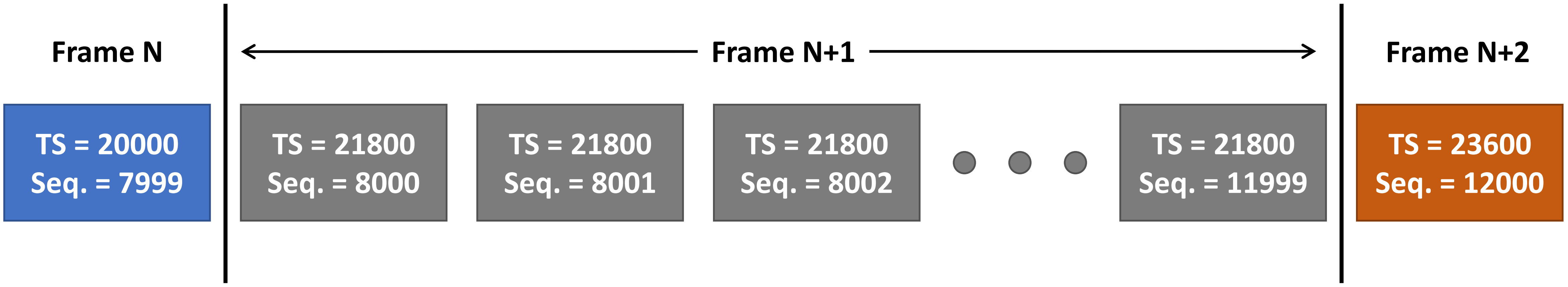
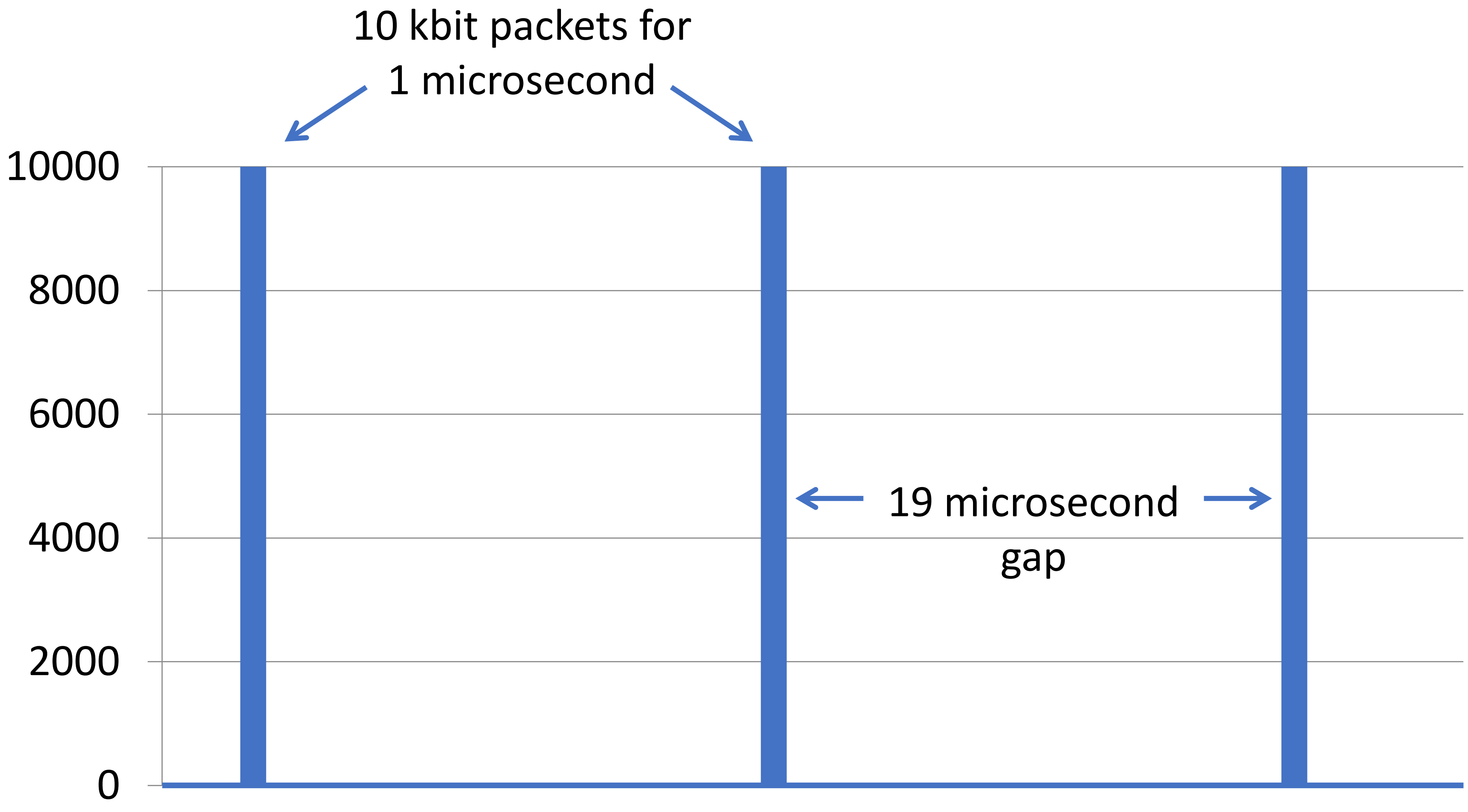


ST 2110-20 RTP Timestamps and Sequence Numbers

- All packets from one video frame will have the same RTP timestamp
  - However, RTP Sequence number is always incremented by one for each packet
  - For interlaced video, the packets for each field will have the same timestamp
- Timestamp will jump for each frame of video
  - By a count equal to the clock rate (90 kHz) divided by the video frame/field rate



500 Mbps Signal on a 10 Gbps Link



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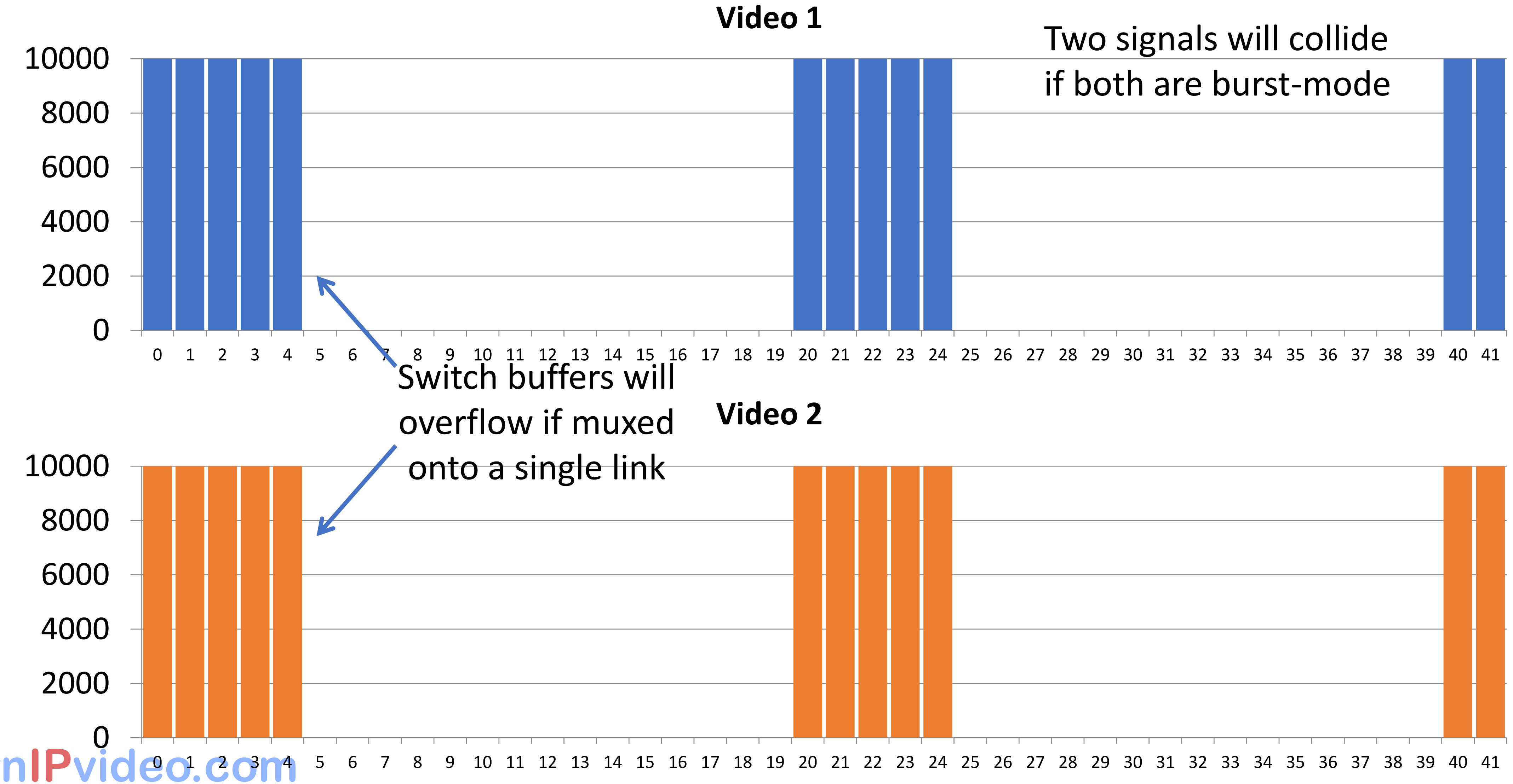
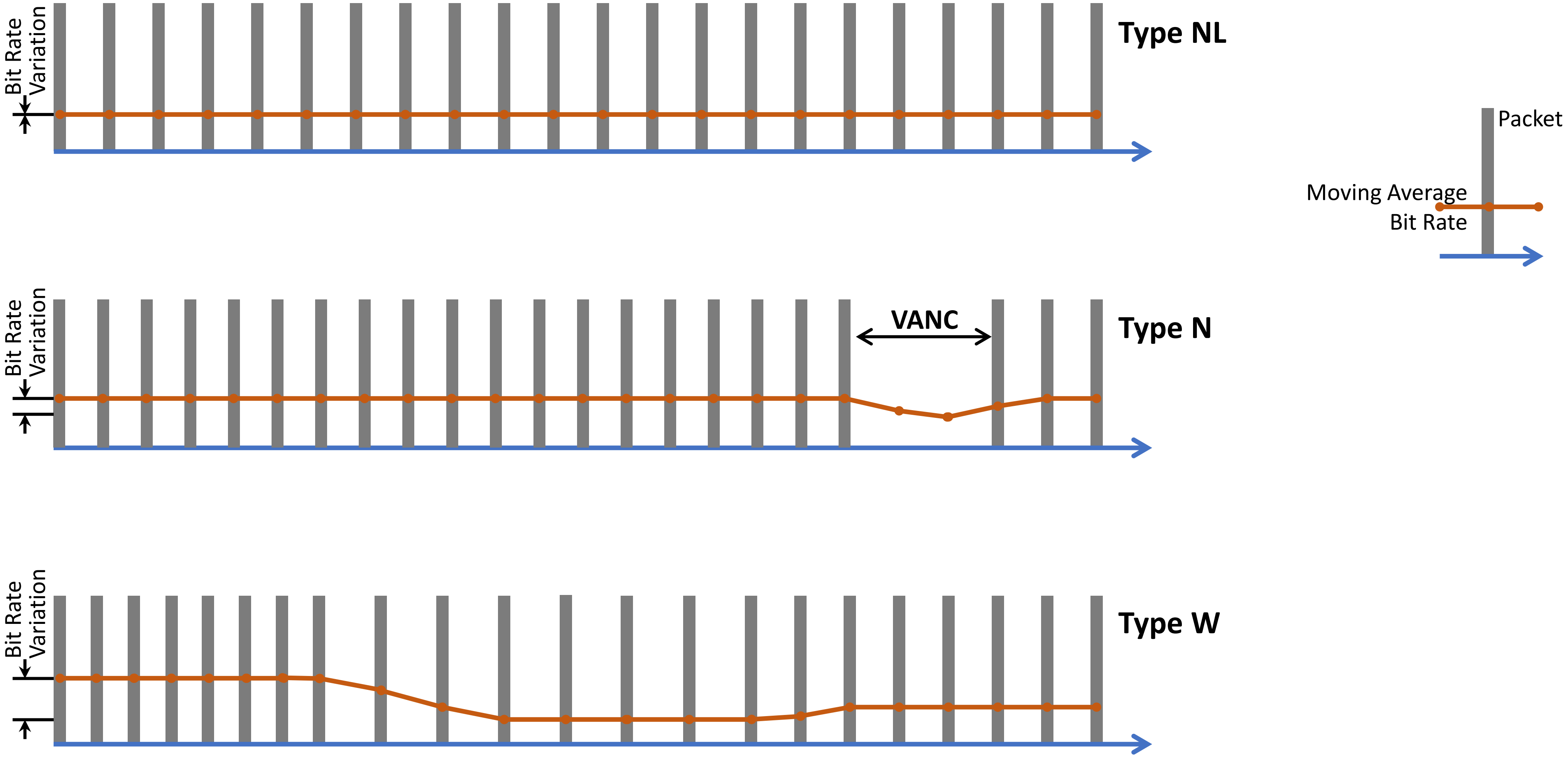
Two 2.5 Gbit/s Signals on Two 10 Gbps Links

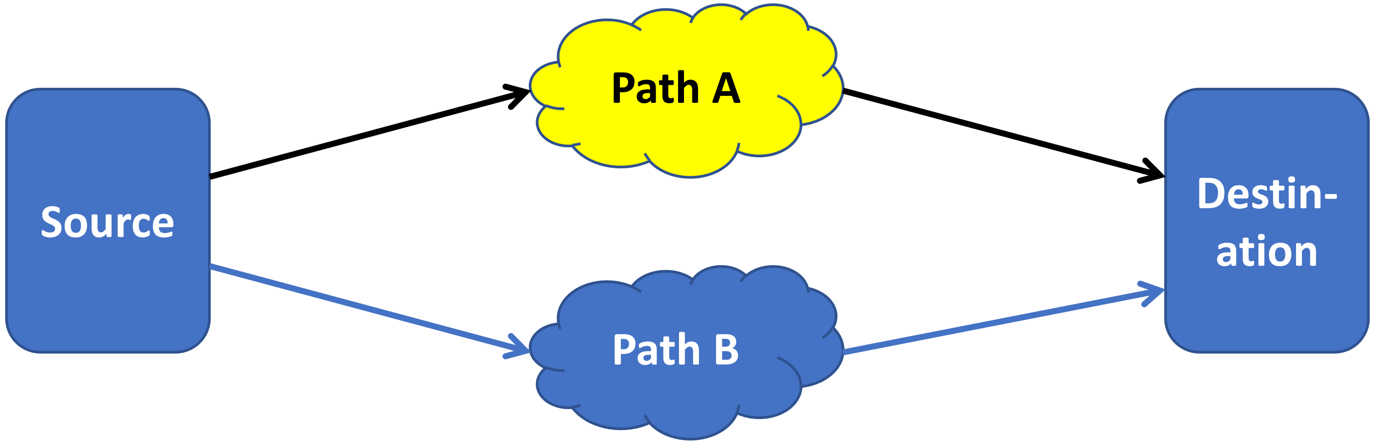


Type N, NL and W Packet Pacing



ST 2022-7 Hitless Protection Switching

- Send identical signal on two separate paths
  - Identical RTP packet timestamps, RTP sequence numbers
  - Receiver aligns packets using buffer
  - Transit time equal to delay of longest path
- SMPTE ST 2022-7 Standard
  - “Seamless Protection Switching of RTP Datagrams”
  - Published in 2019



SDP Example for 1080i 29.97Hz Video

```
v=0

o=wes 203763372 89 IN IP4 10.201.33.19

s=Example of a 1080i29.97 video signal

t=0 0

m=video 31008 RTP/AVP 101

c=IN IP4 232.201.33.11/32

a=source-filter: incl IN IP4 232.201.33.11 10.201.33.19

a=rtpmap:101 raw/90000

a=fmtp:101 sampling=YCbCr-4:2:2; width=1920; height=1080; interlace;
exactframerate=30000/1001; depth=10; TCS=SDR; colorimetry=BT709;
PM=2110GPM; SSN=ST2110-20:2017

a=ts-refclk:ptp=IEEE1588-2008:39-A7-94-FF-FE-07-CB-D0:42

a=mediaclk:direct=0
```

Multicast Stream Dynamics

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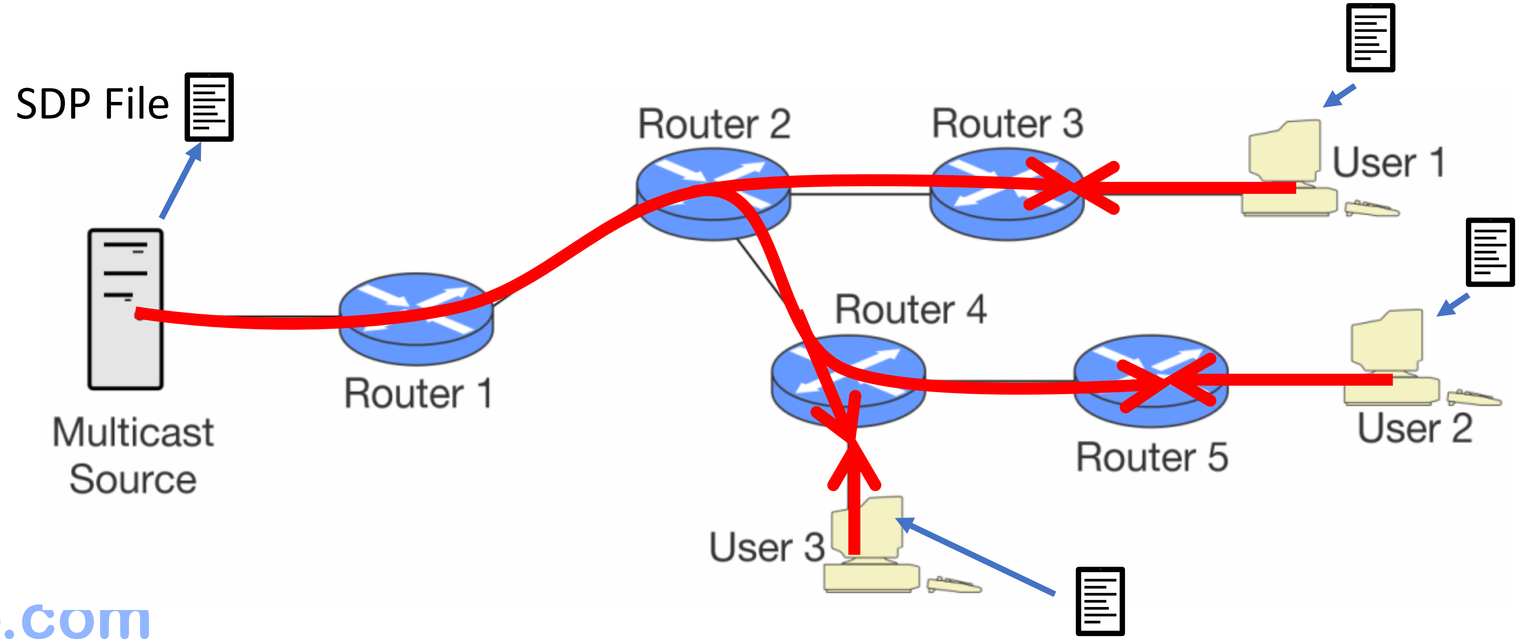
- Source offers stream via multicast addresses listed in SDP
  - Destination devices get SDP via NMOS or other means
- Receivers generate requests to join multicasts using IGMPv3
- Network determines best way to deliver streams



ProAV Format Comparison

Capability/Feature	IPMX	ST 2110	SDVoE	HDBaseT
Uncompressed 4K60p Video	Yes	Yes	No	No
Visually Lossless Compression	Yes	Yes	Yes	No
Network-based Precision Clock (PTP)	Optional	Required	No	No
Open Standard	In process	Yes	No	No
HDCP Support	Yes	No	Yes	Yes
ST 2110 Compatibility	Yes	Yes	No	No
IR Control Link	No	No	No	Yes
PoE (Power over Ethernet)	Possible	No	No	Yes
PoH (Power over HDBaseT) (100W)	No	No	No	Yes
Data Channel*	Not Required	Not Required	Up to 1 Gbit/s	Up to 100 Mbit/s

*IPMX and ST 2110 work over standard IP/Ethernet infrastructure. As such, other IP and Ethernet data flows can easily be transported over the same networks.

So, Why ST 2110?

- Futureproof
  - Can handle any video format: 8K, HDR, 3D, and beyond
- Cloud-Friendly
  - IP signals travel easily to and from public and private clouds
- Flexible
  - Common network backbone handles SD, HD, UHD, SDR, HDR, multiple frame rates, compressed/uncompressed, streaming, file transport and much more

Emmy-award Winning Technology

Any Questions?

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