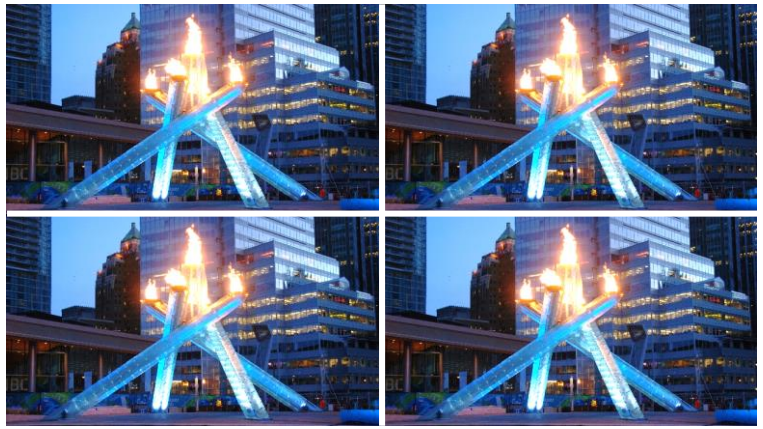
UHD/HDR Infrastructure

Lots of ways to do it
- Choose Wisely

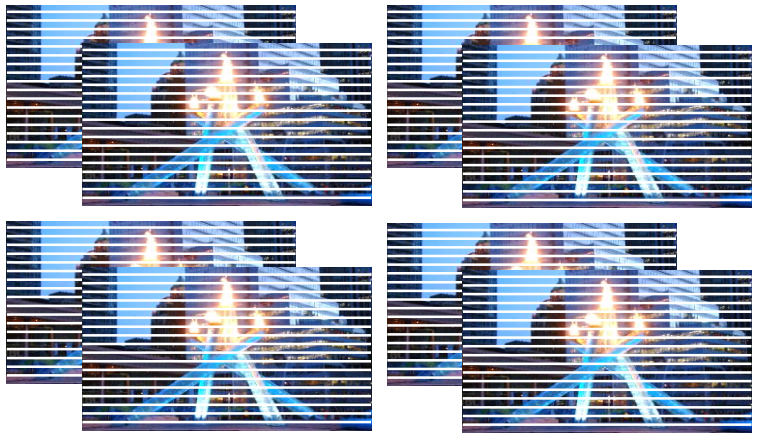
imagine COMMUNICATIONS

UHD is so easy – just bigger pictures, right?

- Just 4 x HD ?
  - No, its 4x 1080P



- Its 8x HD !!!



At least its still on SDI, right? (SQD)

- Any new technology, our industry seems to invent and then fix.
  UHD on SDI is this way

- First, there was “Square Division Multiplexing”
  - Seemed so easy – just four of everything, tweaked a bit
  - This let us use legacy gear that didn’t understand UHD, and mostly worked
  - Except for the problems…

✘ This method is obvious, but not written down

✘ Asynchronous Handoffs (frame syncs) ??

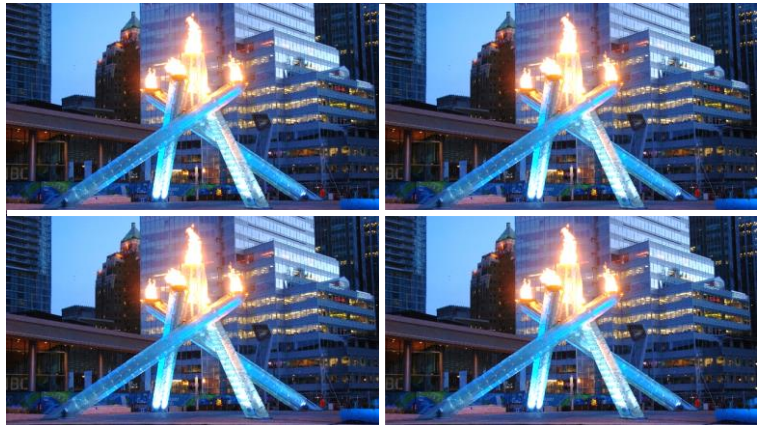
✘ It adds a half-frame of latency every time

✘ Four Wires – but no signaling about UHD

✓ But its easy to tell which one goes where

At least its still on SDI, right? (2SI)

- SMPTE Saves the Day with “Two Sample Interleave”
  - Still 4 wires, but now its written down properly
- How close do the 4 wires need to be matched ?
  - Very Very close
  - 400ns
- The signals are all labeled on the wire, correctly?



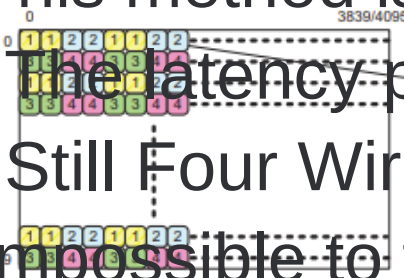
✘ This method is written down, but not obvious

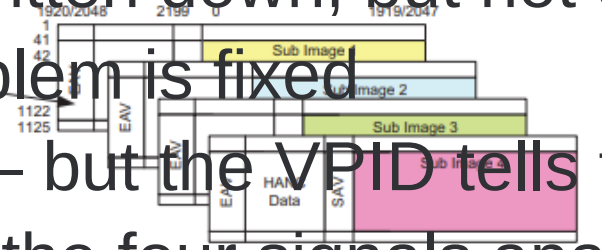
✓ The latency problem is fixed

✓ Still Four Wires – but the VPID tells the story

✘ Impossible to tell the four signals apart visually

✘ Asynchronous Handoffs are even harder





What is this VPID thing anyway? Does it Matter?

- SD-SDI was simple enough
- HD-SDI was just faster bits
- SMPTE ST 425-1 defined VPID first, but only for 3G
- SMPTE ST 352:2013 generalized it for SD & HD
- 425-1 revised twice since
- 425-5 defines it for UHD
  - In 2014
  - Then again in 2015
  - Then perfectly in 2019

✘ Not Every Piece of Equipment kept up

Bits	Byte 2	Byte 3	Byte 4
Bit 7	Interlaced (0) or Progressive (1) transport	Aspect ratio 16:9 (1), unknown (0)	Reserve
Bit 6	Interlaced Progressiv		
Bit 5	Reserved		

1:2011

Bits	Byte 2
Bit 7	Interlaced (0) or Progressive (1) transport
Bit 6	Interlaced (0) or Progressive (1) picture
Bit 5	Transfer characteristics
Bit 4	SDR-TV (0h) HLG (1h) PQ (2h) Unspecified (3h)
Bit 3	Picture Rate (Refer to SMPTE ST 352 Table 2)
Bit 2	
Bit 1	
Bit 0	

*1 Rec 709 indicates Conventional Sys and referenced in SMPTE ST 274.

*2 UHDTV indicates Recommendatio referenced in Recommendation ITU-

SMPTE S

Bits	Byte 1	Byte 2	Byte 3	Byte 4
Bit 7	1	Progressive transport (1)	Aspect Ratio 16:9 (1) or Unknown (0)	Link assignment 3G-SDI Link 1(0h) 3G-SDI Link 2 (1h) 3G-SDI Link 3 (2h) 3G-SDI Link 4 (3h)
Bit 6	0	Progressive picture (1)	Horizontal sampling 1920 (0) or 2048 (1)	
Bit 5	0	Transfer characteristics SDR-TV (0h) HLG (1h) PQ (2h) Unspecified (3h)	Colorimetry Rec 709*1 (0) Color VANC Packet (1) UHDTV*2 (2) Unknown (3)	Reserved (0)
Bit 4	1			Luminance and color difference signal YCBCR (0) ICTCP (1)
Bit 3	0	Picture rate (as per Table 2 of SMPTE ST 352)	Sampling structure (as per Table 6a)	Reserved (0)
Bit 2	1			Audio – 3G-SDI Link 2 to Link 4, 3G-SDI Link 2 to Link 4 carry additional channels or audio not present (0) 3G-SDI Link 2 to Link 4carry a copy of 3G-SDI Link 1 audio (1)
Bit 1	1			Bit depth 10-bit Full Range (0h) 10-bit (1h) 12-bit (2h) 12-bit Full Range (3h)
Bit 0	1			

Notes:

*1 Rec 709 indicates ITU-R BT.709 colorimetry and is equivalent to SMPTE ST 2036-1 Conventional System Colorimetry.

*2 UHDTV indicates SMPTE ST 2036-1 UHDTV colorimetry and is equivalent to ITU-R BT.2020 colorimetry.

SMPTE ST 0425-5:2019

Bits	Byte 2	Byte 3	Byte 4
Bit 7	Interlaced (0) or Progressive (1) transport	Aspect ratio 16:9 (1), unknown (0)	Reserve
Bit 6	Interlaced Progressiv		
Bit 5	Reserved		

Bits	Byte 2
Bit 7	Interlaced (0) or Progressive (1) transport
Bit 6	Interlaced (0) or Progressive (1) picture
Bit 5	Transfer characteristics
Bit 4	SDR-TV (0h) HLG (1h) PQ (2h) Unspecified (3h)
Bit 3	Picture Rate (Refer to SMPTE ST 352 Table 2)
Bit 2	
Bit 1	
Bit 0	

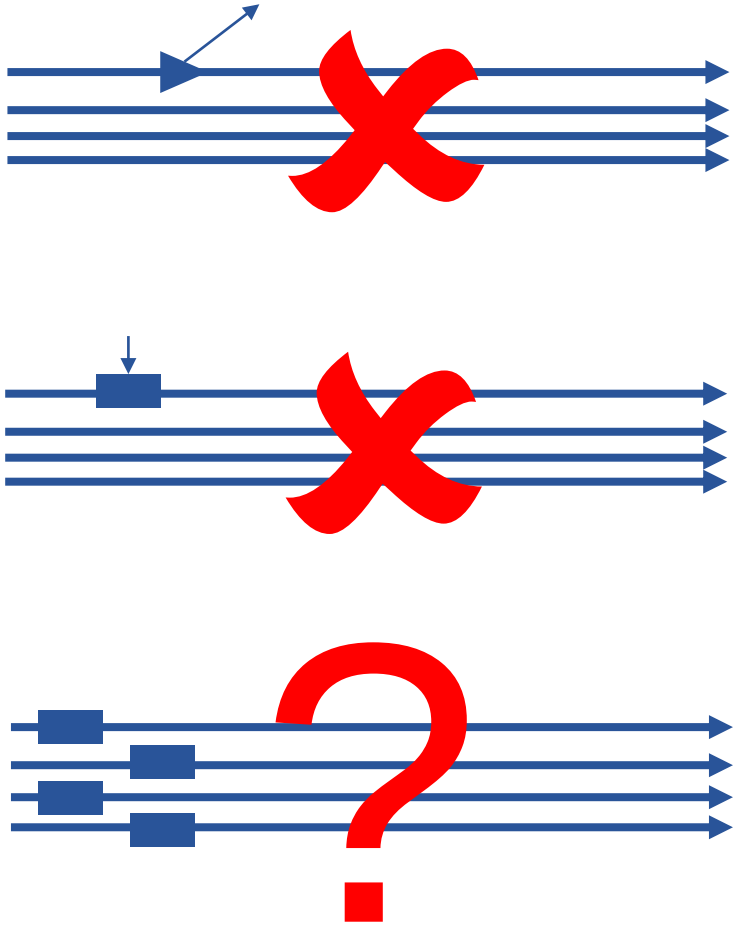
*1 Rec 709 indicates Conventional Sys and referenced in SMPTE ST 274.

*2 UHDTV indicates Recommendatio referenced in Recommendation ITU-

Bit 0	1		
Bit 2			
Bit 1			
Bit 0	1		10-bit (1h) 12-bit (2h) Other values are Reserved

Who wants 4 wires anyway?

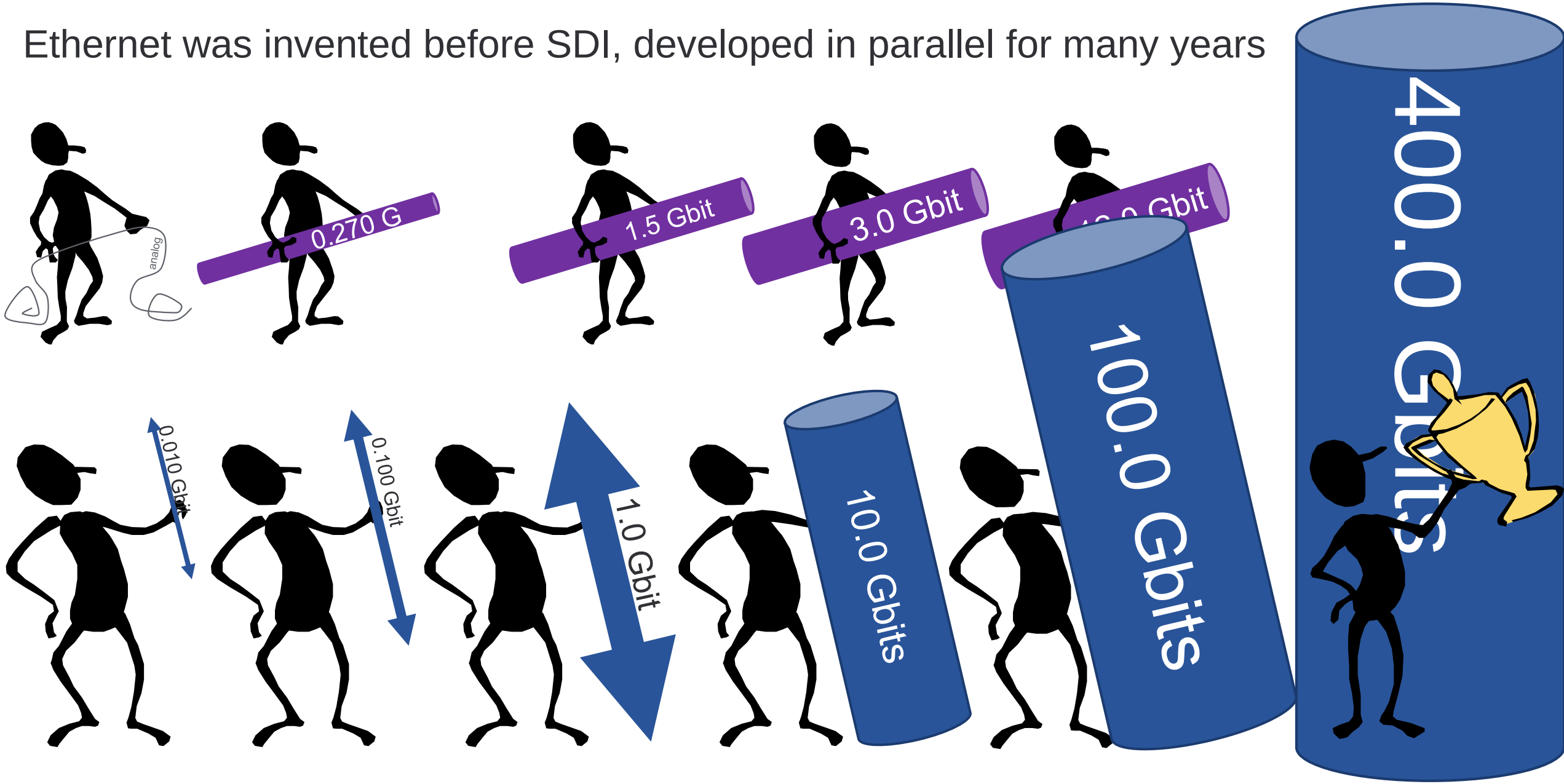
- The 400ns spec is a bit hard to meet
  - A re-clocking DA can take longer
  - An audio embedder certainly takes longer
- Switching 4-wire signals inside SDI routers, all on the same vertical, reliably, works perfectly every time…?
- Non-UHD Frame Syncs on each wire can skip/repeat at different times
- 4x the fun – reminds you of analog component days



How about 12G SDI? Down to one wire at last

- Works Great within its reach
  - Cable reach on really good coax is ok
  - Equipment is new enough to get VPID right
  - Equalizer chips and Re-Clockers are coming down in cost and working better every year
  - Does Pathological Performance matter anymore?
- Optical 12G also can work well
  - Still one signal per fiber, though
  - And a bit more expensive than 3G on fiber
- 12G SDI is a great solution for short-reach and point-to-point UHD signals

Ethernet was invented before SDI, developed in parallel for many years



Is IP the Universal Answer for UHD & HDR? (YES)

- Why not just 2022-6 for 12GSDI ?
  - Today only defined for SD, HD, and 3G
  - Can only signal what the VPID can signal
  - Obvious how to extend to 12G, but…

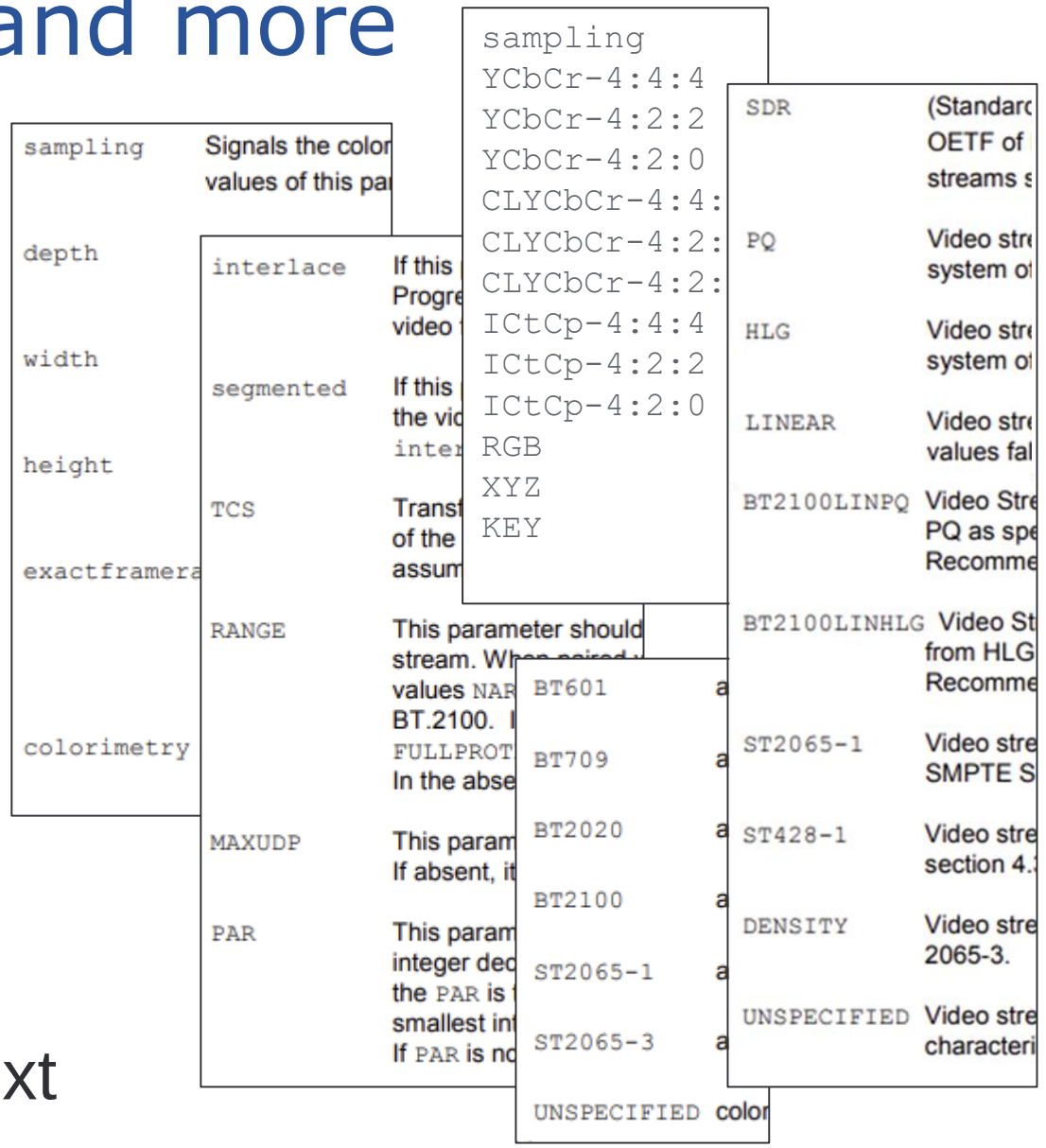
- UHD over 2022-6 as 4x3G streams in IP ?
  - All the headaches of 4 wires plus IP
  - Switching Four Streams at the same time?

- UHD is one essence stream on the network
  - Correct signaling for all the ways people use it
  - Easy path to new HDR systems, new colorimetry, and more

SMPTE 2110 for UHD, HDR, and more

- 2110-20 – Uncompressed UHD single-stream
  - 9.2 Gbits/sec for 2160p50
  - 11.2 Gbits/sec for 2160p59
- 2110-22 – Compressed UHD in 2110
  - ~1.5..2.0 Gbits/sec for UHD
  - Requires codec on both ends

- Switches and routes as one video signal
- Full “Vocabulary” for describing the signal
- Harmonizes signals from DCI, Post, Film, and other disciplines, not just “television”
- Can GROW with us into whatever is next



Is UHD-2110-Single-Stream working in Reality?

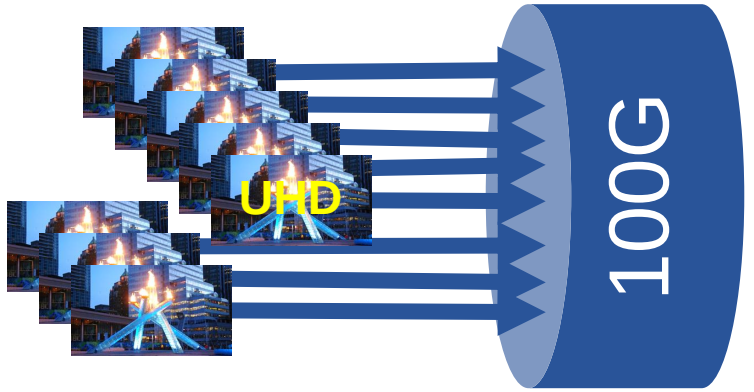
To Sum Up

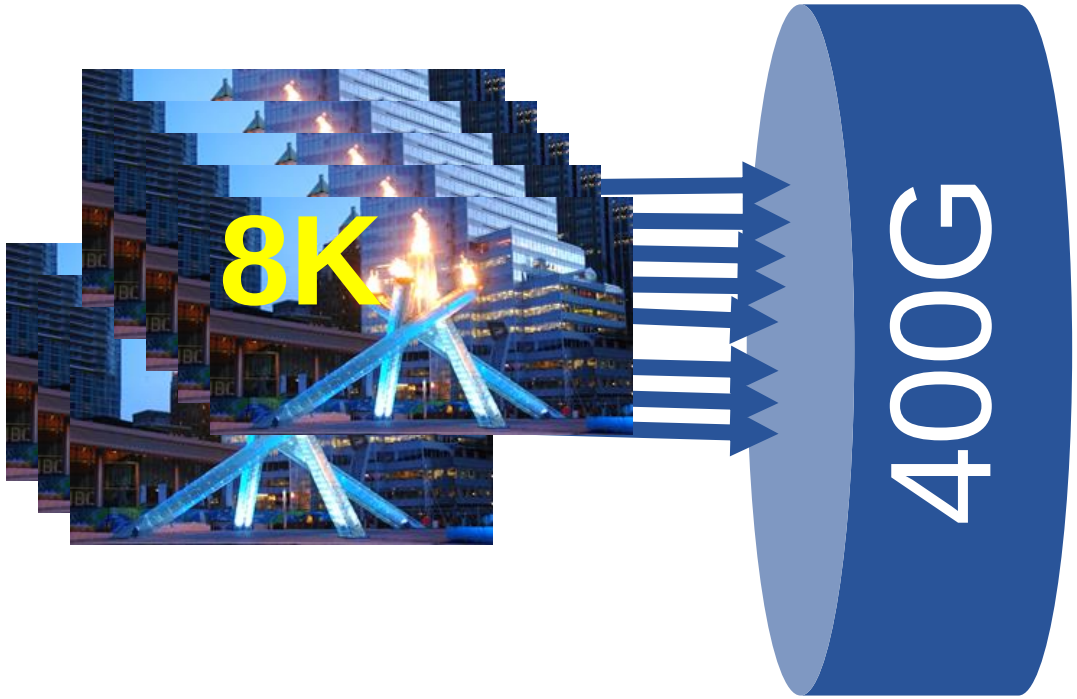
- UHD over SDI – 3 different ways

- UHD over IP – **ST 2110 is clearly the winner**
  - Very Flexible for any type of color, sampling, bits, frame-rates, HDR
  - Can easily extend to new tools
  - Enough bandwidth for 8k and more

- **100GBE** is now mainstream technology
  - 8 x UHD => 100GBE
- **400GBE** is shipping in volume also
  - 32 x UHD => 400GBE
  - 8 x 8k => 400GBE

8xUHD (59.94) → 100GBE no problem





8xUHD-2 (8k) (59.94) → 400GBE no problem

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