Packetized Professional Video

Let’s move hundreds of multicast streams at precisely 1.5 Gbps each and never drop an Ethernet frame…

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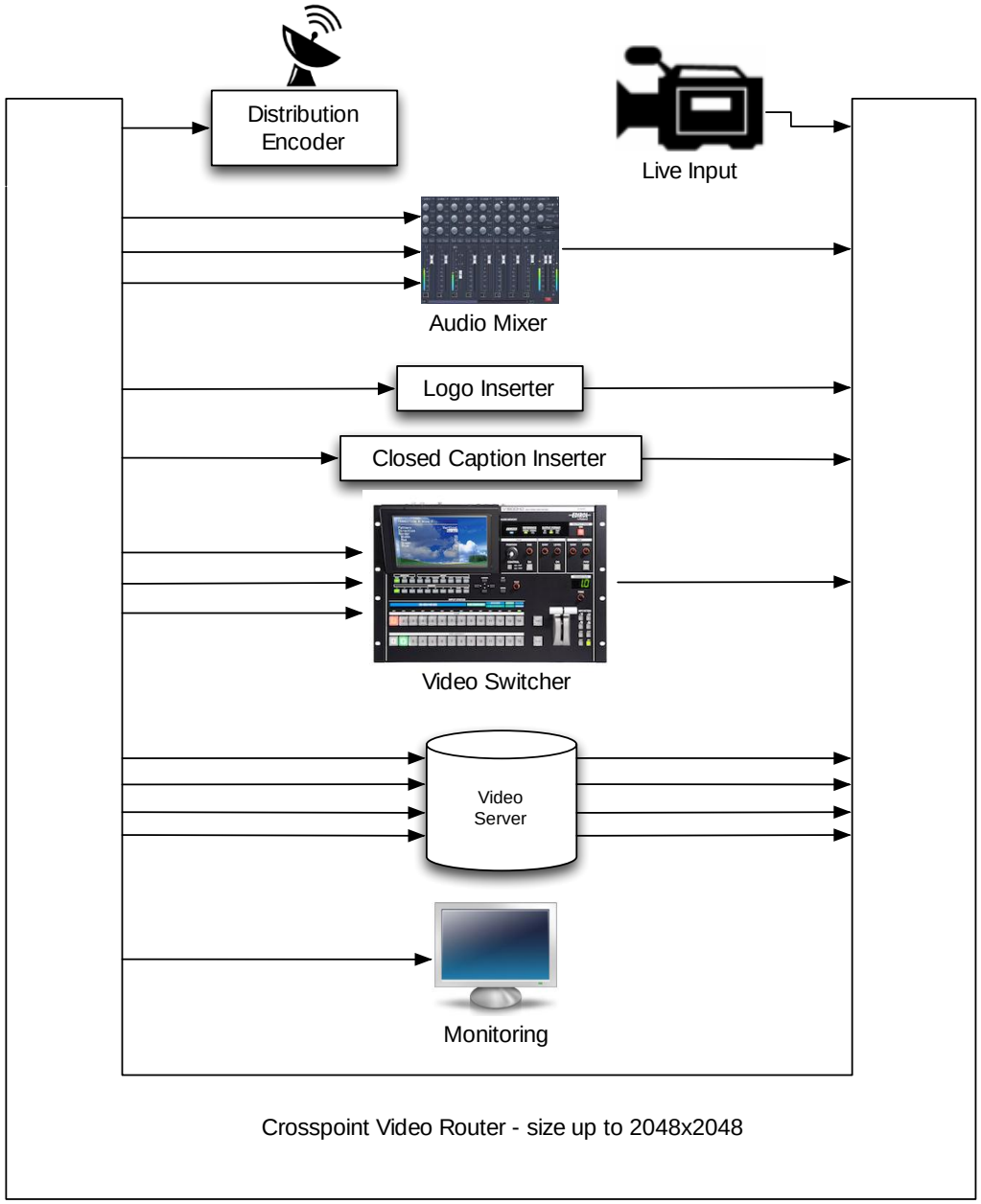
Today's Broadcast Plant



HD-SDI: 1.485 Gbps*, Uncompressed HD serial digital video & audio on 75Ω coaxial cables

Huge crosspoint switches ("routers"), connects output of every device with input of every device

Devices to cut between or mix video streams ("switchers")

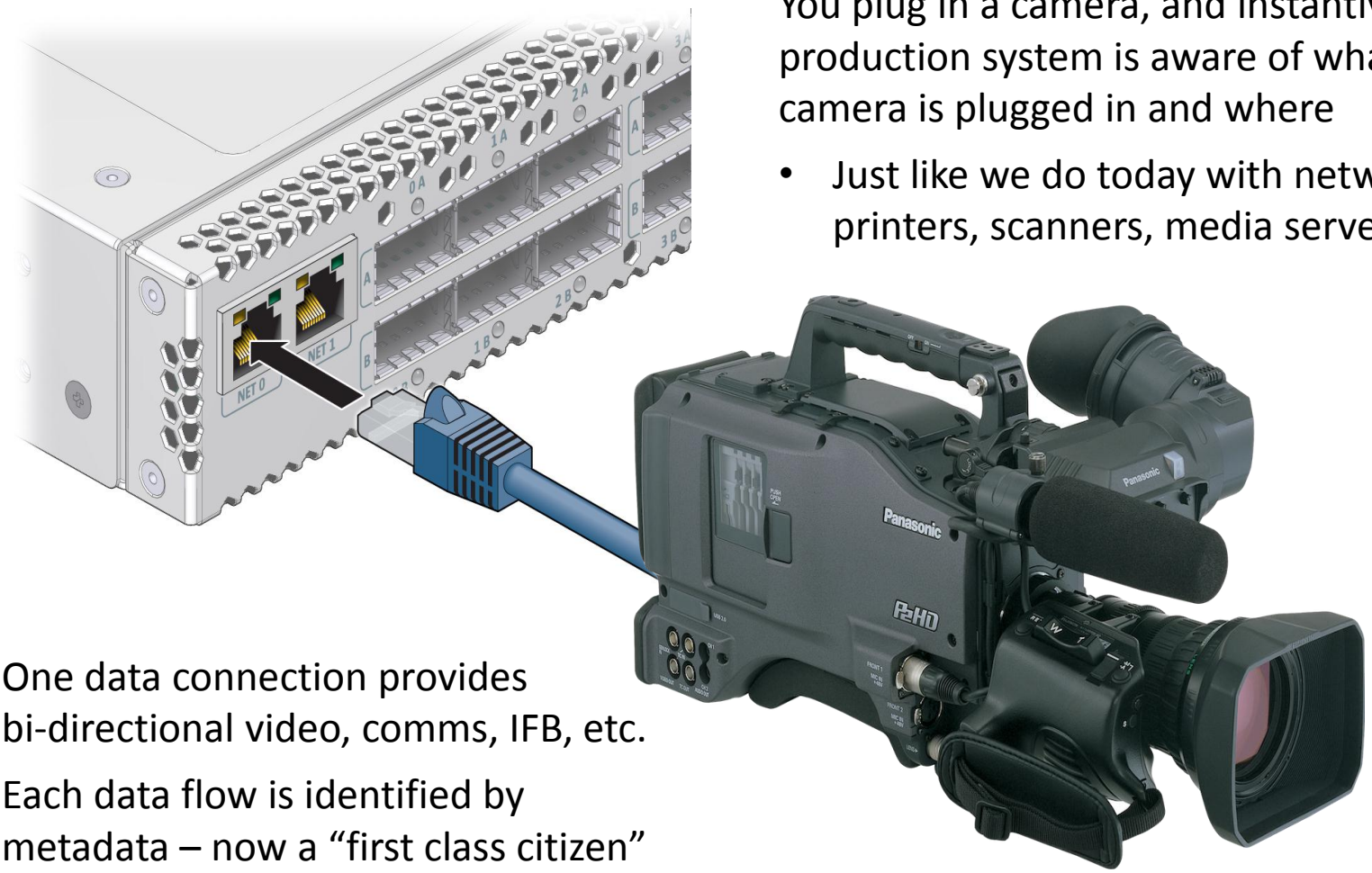
[not shown] separate analog composite "black" signal for synchronization

* 3G-SDI at 2.97 Gbps (1080p) is in limited but increasing use

Why Professional Networked Video?

- Enhance flexibility & agility
  - Pooled, virtualized resources
  - Leverage private/public cloud infrastructure
  - Distribute workflows on demand
  - Automatic discovery and registration of devices
- One cable for video/metadata/control/sync and perhaps power for some devices
- Mix audio, MPEG-2, H.264, J2K, AVC-I, uncompressed SD, HD, 4K, perhaps 8K on the same network fabric,
- *Convergence:* Traditional IT data rides on the same network without interfering with critical media streams/data

Auto-Discovery



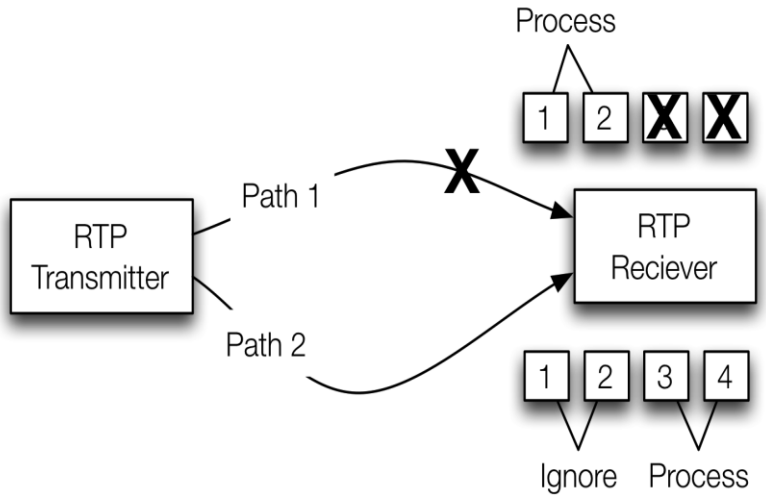
You plug in a camera, and instantly the production system is aware of what camera is plugged in and where

- Just like we do today with networked printers, scanners, media servers, etc.

- One data connection provides bi-directional video, comms, IFB, etc.
- Each data flow is identified by metadata – now a “first class citizen”
- Media does not flow (and consume bandwidth) until a receiver asks for it.

“Seamless” Protection using Redundant Streams

- Send two copies of every media packet along separate paths
- If one path is down, accept packet from other path
- VSF work now in SMPTE (2022-7) using RTP streams
- Another scheme: IETF draft-ietf-avtext-rtp-duplication
- In broadcast contribution use today with J2K/IP



Why else?

- Economies of Scale
  - Huge IT market (~$3.6 trillion)
    - Broadcast equipment market ~$24 billion
  - COTS hardware + software defined (and upgradeable) functionality
  - Every business of any size on the planet uses Ethernet
  - We already have big Enterprise routers moving files
  - Ethernet keeps getting faster: 10G, 40G, 100G, …
- Enlarged Talent Pool
  - SMPTE: 6000
  - CCIE: 26,000
  - Any Cisco Cert: 1.9 million
  - Today's youngsters are growing up in a networked world, gaining IT knowledge by osmosis

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Cable Aggregation

vs.

Cable Aggregation

Ethernet Type	JPEG 2000 HD Streams @ 150 Mbps*	Uncompressed HD streams @ 1.5 Gbps
1 GbE	6	N/A
10 GbE	66	6
40 GbE	266	26
100 GbE	666	66

Stream counts are per direction, and SDI links are unidirectional, so in many cases these numbers can be doubled!

*JPEG 2000 @ 150 Mbps – “Visually lossless” to pro eyes at generation 5
Vendors have announced encode/decode latencies of 10ms

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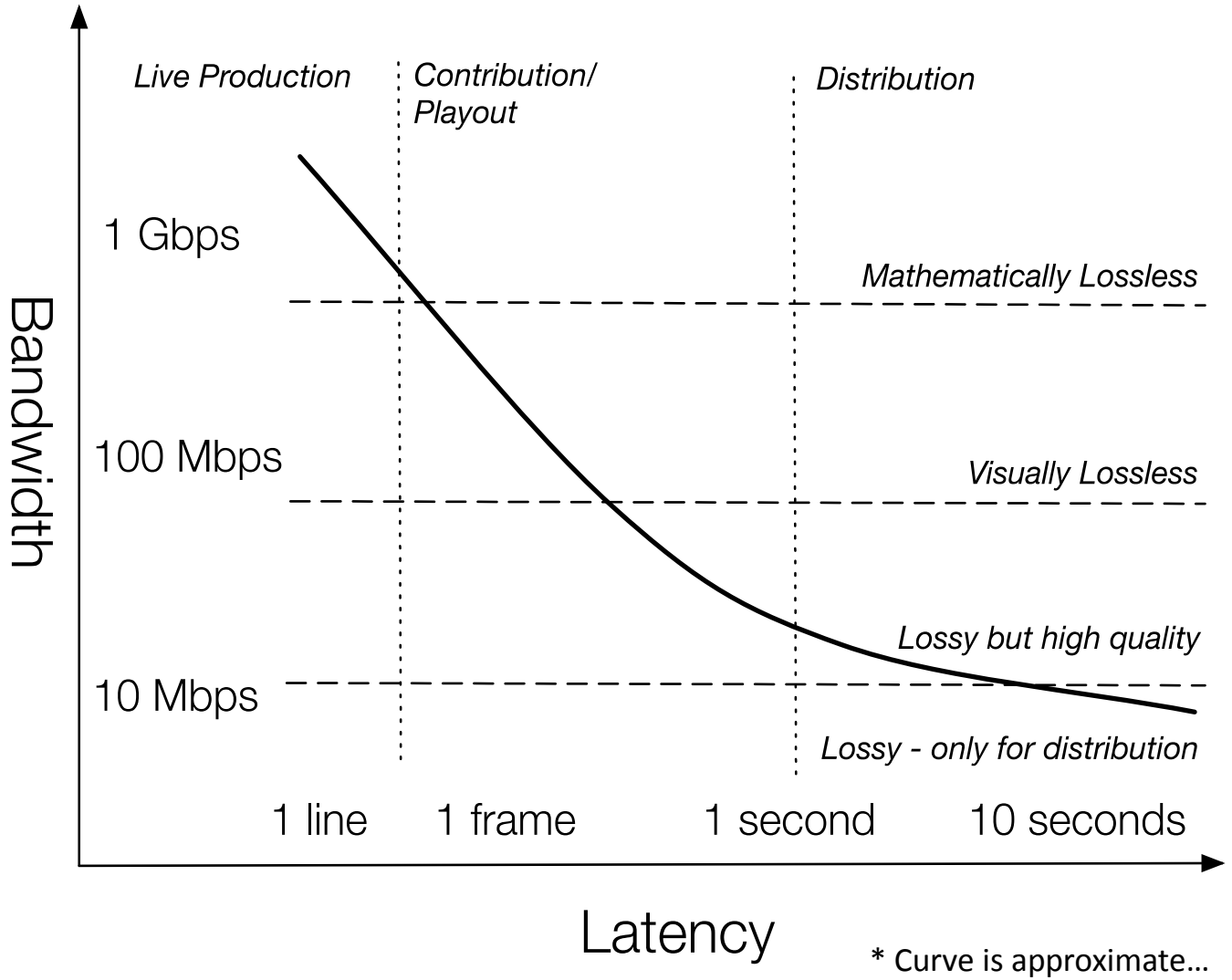
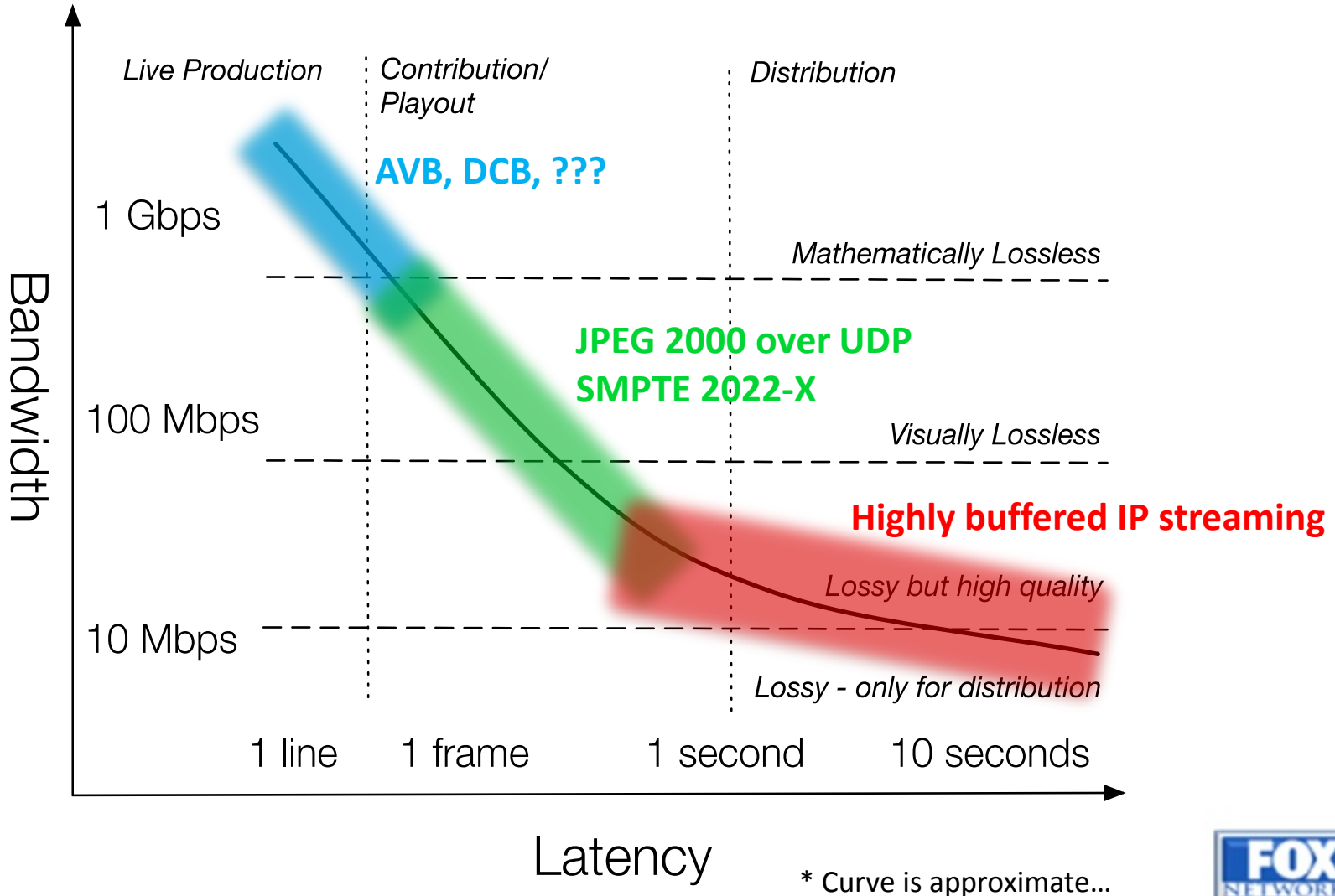
Compression, Bandwidth, Latency



* Curve is approximate…

Compression, Bandwidth, Latency



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How Fast is Uncompressed HD?

- For 720p59.94 in SMPTE 2022-6:
  - SDI bit rate is 1.485 Gbps
  - HD Video Frame size ~3.1 MB
  - 2249 packets per frame
  - ~135,000 packets per second
  - ~3 packets per line
  - One packet every ~7.4µs
  - @10 Gbps, packet transmission time is ~1.2µs

    => 5 to 6 streams can fit on a 10G link

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UHD data rates get astronomical
(for uncompressed formats)

Samples per Line	Lines	fps	10-bit 4:2:2 Gbps	10-bit 4:4:4 Gbps	12-bit 4:4:4 Gbps
3840	2160	50	8.3	12.4	14.9
3840	2160	59.94	9.9	14.9	17.9
3840	2160	120	19.9	29.9	35.8
7680	4320	50	33.2	49.8	59.7
7680	4320	59.94	39.8	59.7	71.6
7680	4320	120	79.6	119.4	143.3

(Video Only)

Ethernet Type:	10 GbE	40 GbE	100 GbE	250 or 400 GbE?

106 Million People have already seen Uncompressed HD-SDI over IP…

"For true technical geeks, one of the highlights was a Super Bowl first as CBS Sports used an uncompressed feed as the backbone of its telecast with Level 3 backhauling an uncompressed signal at 1.5 Gbps to the CBS broadcast center in New York City via dark fiber and Cisco gear…" [SVG, Feb. 9, **2010**]

Why is SDI so Awesome?

1. Makes beautiful pictures
   - Uncompressed & never drops a frame
2. Low-latency
   - On the order of nanoseconds
   - Routers have frame-accurate switching while imposing < 10usec latency
3. Open, non-proprietary
4. “Lingua Franca”
   - Often compressed systems interface to each other using uncompressed SDI, just to leverage the infrastructure

An Ethernet solution may need to match all of these qualities!

Decisions Need to be Made…

1) Will audio/video transport be just L2 or also L3?

2) What QoS schemes are required? (DCB, AVB, DiffServ)

3) Should compression be used for HD? 4K? 8K? (latency/bandwidth/computation tradeoffs)

4) How will A/V payload be formatted into packets, with what metadata (line#, timestamps), and will audio and video be in different streams? Should we abandon "SDI" bit stream for more generic image representation?

5) What IEEE 1588 profile will be used for timing? (e.g. AVB, X192, SMPTE) …And once timing is established, should sync points be calculated by individual nodes or distributed via the network?

6) Can we use commodity network equipment (e.g. Ethernet switches) to replace the synchronous switching functionality of SDI routers?

Based on business requirements, the industry is trying to make these decisions

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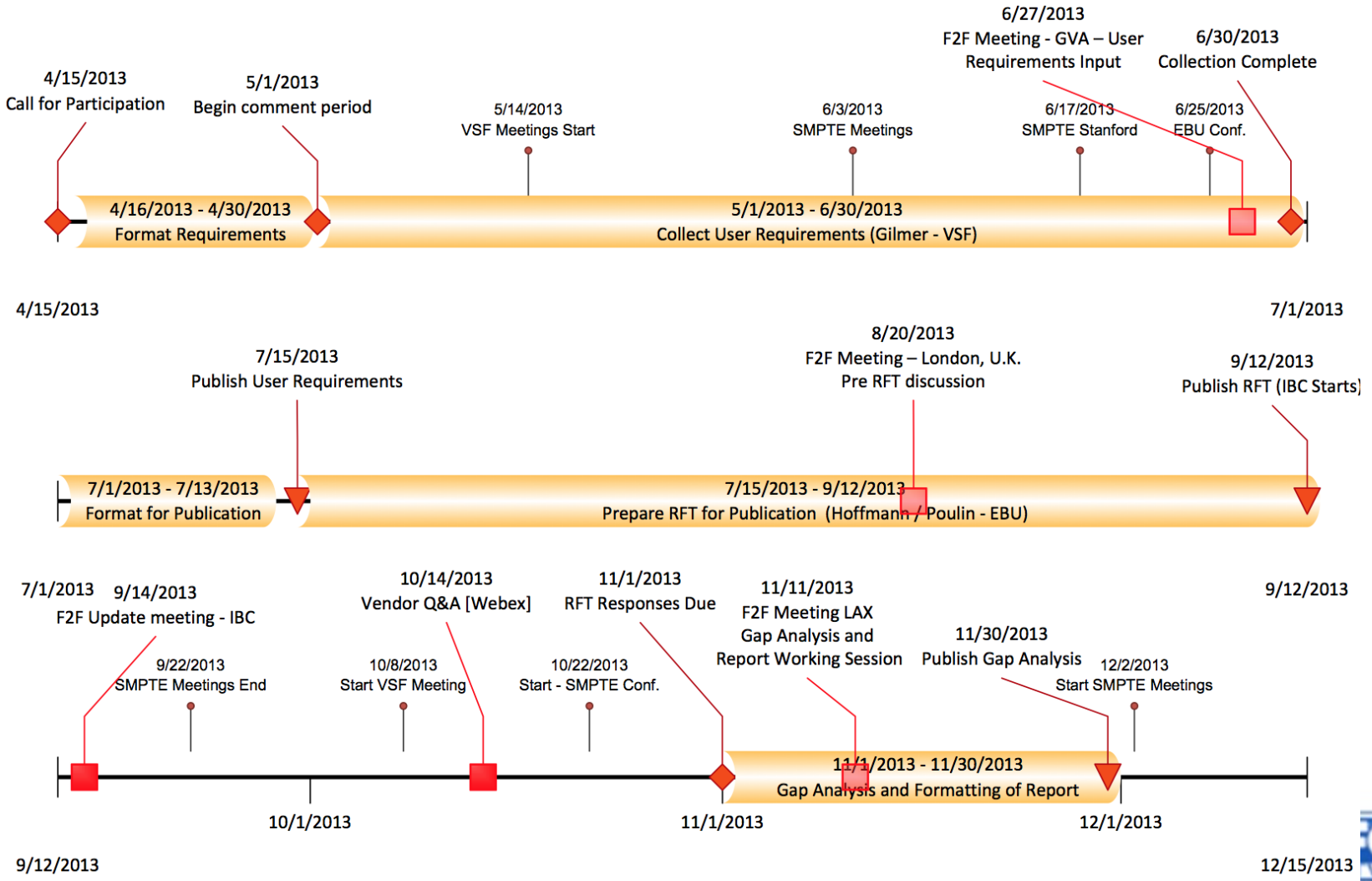
Developing an Industry Strategy

8 Apr. 2013 - Joint Task Force on Networked Media (JT-NM) define a strategy to develop a packet-based network infrastructure for the professional media industry



Questions?