TOWARDS ALL-IP STUDIO
IS THIS THE END OF SDI?

FÉLIX POULIN – POULIN@EBU.CH
19 NOVEMBER 2013 – SMPTE MONTRÉAL
THE EUROPEAN BROADCASTING UNION

Alliance of
74 Members in 56 Countries
35 Associate Members in 21 Countries

Mission:
“defend the interests of public service media and to promote their indispensable contribution to modern society.”

Based in Geneva, Switzerland
THE EUROPEAN BROADCASTING UNION

Services:
- Rights acquisition
- Market Intelligence
- Live Event (e.g., Song Contest)
- Training
- Network Transmissions
- Programme Exchange
- Co-Productions
- Lobbying
- Legal Support
- Technical Expertise

GLOBAL CONNECTIVITY

EBU
OPERATING EUROVISION AND EURORADIO
EBU TECHNOLOGY & INNOVATION

Activities:
• Recommendations
• Tech Specifications
• Project Groups
• Seminars
• Workshops
• Webinars
• Etc.

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THE POINTS

1. Concept and opportunities
2. The challenges ahead
3. Candidate technologies
4. Ongoing activities
THE CONCEPT AND THE OPPORTUNITIES
THE ALL-IP STUDIO... OVERSIMPLIFIED

- Professional studio interfaces/signals and equipment
  - SDI, AES, MADI
  - Black Burst/Tri-Level
  - LTC, Serial control, etc.
  - Cross point router

- Replaced by generic IT
  - Packetized networks: Ethernet, IP, etc.
  - COTS switches, CPU, Storage
SDI: WHY SOMEONE WANTS TO CHANGE THIS?

- Open and widely adopted Standards
- Plug & Play - Simple
- Bit perfect pictures
- High Availability (BER 10E-14)
- Low latency (ns)
- Reserved constant bandwith
- SD@270 Mbit/s, HD@1.5 Gbit/s, 3G@ 3 Gbit/s

-New Standards in preparation to support UHD formats (6G, 12G, 24G)

The same for AES3, MADI, etc.
TWO DIFFERENT APPROACHES

<table>
<thead>
<tr>
<th>SDI</th>
<th>Packet Networks</th>
</tr>
</thead>
<tbody>
<tr>
<td>Deterministic</td>
<td>Probabilistic</td>
</tr>
<tr>
<td>Guaranteed bandwidth</td>
<td>Best effort / Priorization</td>
</tr>
<tr>
<td>Circuit connections / Static</td>
<td>Routed / Dynamic</td>
</tr>
<tr>
<td>1 cable = 1 signal</td>
<td>1 cable = many signals</td>
</tr>
<tr>
<td>Synchronous</td>
<td>Asynchronous</td>
</tr>
<tr>
<td>Real-time (on time, in order, low latency)</td>
<td>Non-real time (Latency vs jitter and reordering)</td>
</tr>
<tr>
<td>Zero errors</td>
<td>Error management: Retransmission, FEC, etc.</td>
</tr>
<tr>
<td>Point to point</td>
<td>Any to any</td>
</tr>
</tbody>
</table>
+ UNIFIED AUDIO/VIDEO/METADATA/CONTROL
## SIGNAL AGGREGATION

### 1080i59

<table>
<thead>
<tr>
<th>Ethernet</th>
<th>AVC-I @ 100 Mbit/s</th>
<th>JP2K @ 150 Mbit/s</th>
<th>Uncomp @ 1.5 Gbit/s</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 GigE</td>
<td>10</td>
<td>6</td>
<td>N/A</td>
</tr>
<tr>
<td>10 GigE</td>
<td>100</td>
<td>66</td>
<td>6</td>
</tr>
<tr>
<td>40 GigE</td>
<td>400</td>
<td>266</td>
<td>26</td>
</tr>
<tr>
<td>100 GigE</td>
<td>1000</td>
<td>666</td>
<td>33</td>
</tr>
</tbody>
</table>

### 2160p120

<table>
<thead>
<tr>
<th>Ethernet</th>
<th>HEVC-I @ 400 Mbit/s</th>
<th>10:1 @ 2.4 Gbit/s</th>
<th>Uncomp @ 24 Gbit/s</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 GigE</td>
<td>2</td>
<td>N/A</td>
<td>N/A</td>
</tr>
<tr>
<td>10 GigE</td>
<td>25</td>
<td>4</td>
<td>N/A</td>
</tr>
<tr>
<td>40 GigE</td>
<td>100</td>
<td>16</td>
<td>1</td>
</tr>
<tr>
<td>100 GigE</td>
<td>250</td>
<td>41</td>
<td>4</td>
</tr>
</tbody>
</table>
+ NEW WORKFLOWS

- Collaborative
- Distributed
- Remote
- Flexible / Reconfigurable
- New User Interface
- New type of content
- Viewer driven content
+ ON-DEMAND RESOURCES

- CPU / GPU
- Network
- Storage
- Memory
OH WOW! PARADIGM SHIFT!
COTS = COST CUTS
MAYBE NOT: JEVONS’ PARADOX

Improved technology doubles the amount of Work produced with a given amount of Fuel.

Demand for Fuel rises.

Costs fall by half.


Inspired by a presentation from Al Kovalick.
BUT...

MANY CHALLENGES REMAIN TO BE ADDRESSED
**WHAT WE ARE AFRAID TO LOSE IN THE CHANGE?**

<table>
<thead>
<tr>
<th>Reliability and technology maturity</th>
<th>Ease of monitoring the signal and visibility in the system</th>
<th>Relative simplicity and high level of control</th>
</tr>
</thead>
<tbody>
<tr>
<td>Quickness to troubleshoot and resolve problems</td>
<td>Sub video frame latency</td>
<td>No longer the only domain of broadcast engineers!</td>
</tr>
</tbody>
</table>

“What important functionalities of the current production control room would be lost or negatively impacted when relying on IT/IP infrastructure instead of SDI/AES?” – Survey to EBU Member, January 2013
INTEROPERABILITY

- Open Standards
- Be able to mix and match products from different vendors
CANDIDATE TECHNOLOGIES
10 GigE Playing Near You

10 GigE NICs <$500

Ethernet Switch Attach Rate on Servers

Source: Dell’Oro Group Ethernet Switch July 2012 Forecast

Slide inspired by Thomas Edwards, FOX
10 GIGE FORMATS

- SFP+
  - Optical Fiber (MMF 400m, SMF 80km)
  - Direct-Attach Copper (8.5m)
  - Latency 0.3 μs
- 10GBASE-T
  - 10 Gbps over Cat 6A or Cat 7 cable (100m)
  - Latency 2.4 μs
  - Likely to become less expensive
- 10GBASE-KX4/KR
  - Blade backplane Ethernet

Slide inspired by Thomas Edwards, FOX
BANDWIDTH VS LATENCY

Slide inspired by Thomas Edwards, FOX
ETHERNET AVB – THE STANDARDS

• IEEE Audio/Video Bridging Task Group
• 802.1Qav: Queuing and forwarding of time-sensitive streams
  – AVB frames are forwarded with precedence over Best Effort traffic
  – Credit-based shaping of AVB traffic
• 802.1Qat “Stream Reservation Protocol”
  – End-to-End Registration/Reservation of time-sensitive streams
• 802.1AS: IEEE 1588 (Precision Time Protocol) Profile
  – Layer 2 profile of 1588
  – Synchronization to 1μs over 7 switch hops
• 802.1BA: Overall AVB system architecture
  – 2ms bounded latency through 7 switches

Slide inspired by Thomas Edwards, FOX
AVB “DOMAINS”

Diagram Credit: Michael Johannes Teener
USING AVB

Now shipping:
- Switch Extreme Networks “enable avb”
- Audio devices AVB (Riedel, Meyer Sound, BSS Soundweb, etc.)
- Apple MacBooks “avbdeviced –enable-interface en0”

Upcoming:
- Video device AVB: Axon in 2014
- Broadcom Chipset

Very early experimentations for broadcast
ETHERNET DCB

- Problem – Ethernet is “best efforts” transport
- Packets can – and will – be dropped if buffers over run
- Fibre Channel uses “credit-based” solution – never over runs buffers
- When you put Fibre Channel on Ethernet, a “no-drop” service needs to be established

- IEEE Data Center Bridging (DCB) Task Group
- Is shipping today on enterprise switches
- 802.1Qbb: Priority Flow Control (PFC)
  - Existing 802.1Q priority code point (8 values) sets CoS
  - When buffers fill up, recipient can “pause” one of the CoS
  - Other CoS can continue (possibly leading to packet drops)
  - “Paused” CoS restarted when buffers clear

Slide inspired by Thomas Edwards, FOX
DCB – PRIORITY FLOW CONTROL

Slide inspired by Thomas Edwards, FOX
DCB – ENHANCED TRANSMISSION SELECTION

- 802.1Qaz: Enhanced Transmission Selection (ETS)
  - Dynamic bandwidth allocation for CoS
  - Weights selection of packets into output queues based on CoS
  - Lower priority CoS packets start to get dropped when bandwidth becomes scarce
DCB – CONGESTION NOTIFICATION

- 802.1Qau – end to end congestion notification
- Server 1 sending traffic to Server 2
- Server 3 sending traffic to Server 4 (same CoS)
- Server 1 congests Server 2
  - Server 2 PFC pauses Switch B
  - B buffers run out and PFC pauses Switch A
  - Now Server 3 can’t send to Server 4 even though that path is not congested
- Instead, CN message sent all the way to Server 1 to SLOW DOWN!

Slide inspired by Thomas Edwards, FOX
SDN – SOFTWARE DEFINED NETWORKING

• Separation of the control plane from the data plane

• Allow “intelligent” and content aware routing

• Open Flow / Open Networking Foundation

• Proprietary

• Suitable for broadcasters? BBC is testing.
PTP - IEEE 1588V2

• Synchronize high precision clocks to a master

• Over Ethernet and IP

• Accuracy: < 1µs (compliant networks)

Used by
• SMPTE 33TS
• AVB
• AES67
• But with slight different profiles...
SDI OVER RTP/UDP/IP

- Newer: SMPTE 2022-6 – SD/HD/3G-SDI over RTP/UDP/IP
- SMPTE 2022-5 FEC
$ AES67$

• Interoperability mode for transport of professional audio over networks based on the Internet Protocol

• Linear PCM coding

• <10 milliseconds latency

• Synchronization, media clock identification, network transport, encoding and streaming, session description and connection management.

• The new AES3/MADI over network?
REMAINING QUESTIONS

• Ethernet AVB, IP + SDN, New protocols or all of them?
• Why “SDI” over IP?
• How to switch cleanly between 2 video streams, is the network switch the right place?
• Can we get the reliability we need using networks?
• How to monitor to get the visibility of the signal flow?
• Will PTP be appropriate for professional media?
• Uncompressed or low latency mezzanine compression?
• Is it better to train a broadcast engineer/technician for IT or an IT specialist for media applications? Where to recruit the media/IT expert?
• What should I install in my new facility? Coax, Cat6/7 or fiber?
• Will this work in practice? Will this meet the expectations?
• Why get rid of SDI? It is working!
WORK IN PROGRESS!
“A problem can never be solved on the same level of thinking that identified it.”

Albert E.
JOINT TASK FORCE ON NETWORKED MEDIA

“… help manage the transition from specialty broadcast equipment and interfaces (SDI, AES, etc.) to IT-based packet networks (Ethernet, IP, etc.)”

1. Business-driven User Requirement
   136 in 16 categories

2. Request for Technology
   26 Responses
   66 Technologies

3. Gap Analysis
   Report due: 30 Nov

Next steps: TBC. Standardization, PoC, Interop Tests, ...

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EBU  SMPTE  VSF
- 32NF-net Study Group on Media Production System Network Architecture
  - Report in 2014 – recommendations for standard activities

- 33TS.20 Time Synchronization
  - Draft ST 2059-1 Epoch definition
  - Draft ST 2059-2: IEEE 1588 PTP profile for professional media

- 33TS.10 Time Labelling
  - New “Time Label”
  - To replace famous SMPTE 12M timecode
  - Higher frame rates, network and file-friendly
- FNS: Future Networks  
  - Workshops  
  - Briefings to broadcasters  
  - VCIP Group: Video Contribution over IP  
  - ACIP Group: Audio Contribution over IP  
  - SLA Group: Service Level Agreement for media transport  
  - FSS Group: Future Storage  
  - NTS: Network Technology Seminar, yearly in June in Geneva
THANKS

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