From SDI to IP
Moving to IP

• You will listen a lot of people saying that it is the time to move.
• IP is the future
• IP is better
• IP is cheaper
• IP is more simple
• You need to move now.
• But it is true?
IP main Challenges

- Standards
- Router
- Inputs
- Outputs.
• SDI is a point to point connection using a coaxial or fiber cable
• IP is a packet network where multiple video coexist in the same stream
• SDI video is a continuous stream
• IP the video is divided in packets and each packet run by itself.
Ethernet
Discovered
• Ethernet: It is a LAN protocol that is used in Bus and Star topologies and implements CSMA/CD as the medium access method

• Original (traditional) Ethernet developed in 1980 by three companies: Digital, Intel, Xerox (DIX).

• In 1985, the Computer Society of the IEEE started a project, called Project 802, to set standards to enable intercommunication among equipment from a variety of manufacturers.
  – Current version is called IEEE Ethernet
### Ethernet Frame format

<table>
<thead>
<tr>
<th>Bytes</th>
<th>8</th>
<th>6</th>
<th>6</th>
<th>2</th>
<th>0-1500</th>
<th>0-46</th>
<th>4</th>
</tr>
</thead>
<tbody>
<tr>
<td>(a)</td>
<td>Preamble</td>
<td>Destination address</td>
<td>Source address</td>
<td>Type</td>
<td>Data</td>
<td>Pad</td>
<td>FCS</td>
</tr>
<tr>
<td>(b)</td>
<td>Preamble</td>
<td>Destination address</td>
<td>Source address</td>
<td>Length</td>
<td>Data</td>
<td>Pad</td>
<td>FCS</td>
</tr>
</tbody>
</table>

Frame formats. (a) DIX Ethernet, (b) IEEE 802.3.
**Preamble**: 56 bits of alternating 1s and 0s.

**SFD**: Start frame delimiter, flag (10101011)

<table>
<thead>
<tr>
<th>Preamble</th>
<th>SFD</th>
<th>Destination address</th>
<th>Source address</th>
<th>Length or type</th>
<th>Data and padding</th>
<th>CRC</th>
</tr>
</thead>
<tbody>
<tr>
<td>7 bytes</td>
<td>1 byte</td>
<td>6 bytes</td>
<td>6 bytes</td>
<td>2 bytes</td>
<td></td>
<td>4 bytes</td>
</tr>
</tbody>
</table>

Physical layer header
– Ethernet data link layer protocol provides connectionless service to the network layer
  • No handshaking between sending and receiving adapter.
– Ethernet protocol provides Unreliable service to the network layer:
  • Receiving adapter doesn’t send ACK or NAK to sending adapter
  • This means stream of datagram's passed to network layer can have gaps (missing data)
    – Gaps will be filled if application is using reliable transport layer protocol
      » Otherwise, application will see the gaps
Frames size

<table>
<thead>
<tr>
<th>Destination address</th>
<th>Source address</th>
<th>Length PDU</th>
<th>Data and padding</th>
<th>CRC</th>
</tr>
</thead>
<tbody>
<tr>
<td>6 bytes</td>
<td>6 bytes</td>
<td>2 bytes</td>
<td></td>
<td>4 bytes</td>
</tr>
</tbody>
</table>

Minimum payload length: 46 bytes
Maximum payload length: 1500 bytes

Minimum frame length: 512 bits or 64 bytes
Maximum frame length: 12,144 bits or 1518 bytes
Ethernet evolution

- Standard Ethernet: 10 Mbps
- Fast Ethernet: 100 Mbps
- Gigabit Ethernet: 1 Gbps
- Ten-Gigabit Ethernet: 10 Gbps
Full Duplex

• Traditional Ethernet is half duplex
  – Either transmit or receive but not both simultaneously
• With full-duplex, station can transmit and receive data simultaneously
• With full duplex, Throughput (actual transmission rate) is doubled.
  – 10-Mbps Ethernet in full-duplex mode, theoretical transfer rate becomes 20 Mbps
  – 100-Mbps Ethernet in full-duplex mode, theoretical transfer rate becomes 200 Mbps
• Changes that should be made with any computer in order to operate in Full-Duplex Mode
  – Attached stations must have full-duplex NIC cards
  – Must use two pairs of wire one pair for transmitting from host to switch (inbound) and the other pair for transmitting from switch to host (outbound)
  – Must use a switch as a central device not a hub
  – Devices must be connected point-to-point (dedicated) to the switch
  – Each station constitutes separate collision domain
    • CSMA/CD algorithm no longer needed (no collision)
    • No limit on the segment length
    • Same 802.3 MAC frame format used
Switched Ethernet
Gigabit Ethernet

- Speed 1Gpbs
- Minimum frame length is 512 bytes
- Operates in full/half duplex modes mostly full duplex

<table>
<thead>
<tr>
<th>Name</th>
<th>Cable</th>
<th>Max. segment</th>
</tr>
</thead>
<tbody>
<tr>
<td>1000Base-SX</td>
<td>Fiber optics</td>
<td>550 m</td>
</tr>
<tr>
<td>1000Base-LX</td>
<td>Fiber optics</td>
<td>5000 m</td>
</tr>
<tr>
<td>1000Base-CX</td>
<td>2 Pairs of STP</td>
<td>25 m</td>
</tr>
<tr>
<td>1000Base-T</td>
<td>4 Pairs of UTP</td>
<td>100 m</td>
</tr>
</tbody>
</table>
• Maximum link distances cover up to 40 km
• Full-duplex mode only
• No CSMA/CD
• Use as media
  – Singlemode fiber Optical
  – Multimode fiber Optical
  – Cat6 cables (Up to 100m) 10GBASE-T
• 10GBASE-T arrives in 2006!
• Support MAC data rate of 400 Gbit/s
• Preserve the Ethernet frame format utilizing the Ethernet MAC
• Preserve minimum and maximum frame size of current Ethernet standard
• Define physical layer specifications that support link distances of:
  – at least 100 m over multi-mode fiber (400GBASE-SR16)[12]
  – at least 500 m over single-mode fiber (400GBASE-DR4)[13]
  – at least 2 km over single-mode fiber (400GBASE-FR8)[14][15]
  – at least 10 km over single-mode fiber (400GBASE-LR8)[16]
• Support a bit error ratio (BER) of 10-13, which is an improvement over the 10-12 BER that was specified for 10GbE, 40GbE, and 100GbE.
• Support for OTN (transport of Ethernet across optical transport networks), and optional support for Energy-Efficient Ethernet (EEE).
Back to Video over IP
• IP transfer has many standards
• SMPTE 2022 is one but it has more than 6 substandard, still new, it defines the different transport schemas and error corrections.
• The challenge is how to deliver video with UDP assuring quality.
• But as usually the world is more simple
• Most of the systems today use a Transport stream with a compressed payload, without error correction, as subset of SMPTE 2022
• Easy simple working.
• Uncompressed video is about 1.5Gb/seconds this is more that the standard gigabit connection.
• You need multiple gigabit cards or expensive 10Gb connections
• If you deliver a transport stream bandwidth is less about 24Mb/second using H264
• But encode and decode and H264 is resources intensive and limits the concurrent streams produced.
• A more common 100Mb/sec MPG2 will deliver a good quality and will have a low CPU requirement.
The router challenge

• In SDI a router simply connect one point with another point
• It is like to use a patch panel but more efficient
• In IP every packet has a source and a destination
• The routing is done by the switch reading source and destination address.
• So.
• To choose the monitor where view a signal you must go in the camera and add an address to the destination!
• Not very comfortable, and there is no standard.
• SDN (software defined network) is how to configure your network switches.
• SDN was born in 1995 mainly to be used inside telecom companies.
• Only in 2001 the SDN start to be inside a commercial product.
• The switch will address the packet not according the IP address but using the SDN.
• It will act as a router.
• Easy? Simple? Inexpensive?
• Not really.
Os for networks

Control Programs

Network Operating System

Specialized Packet Forwarding Hardware

Operating System

Specialized Packet Forwarding Hardware

Operating System

Specialized Packet Forwarding Hardware

Operating System

Specialized Packet Forwarding Hardware

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Specialized Packet Forwarding Hardware

Operating System

Specialized Packet Forwarding Hardware
Global Network View

Control Programs

Network Operating System

Control via open forwarding interface

Protocols

Packet forwarding

Protocols
Separate control and data plane; abstract control plane of many devices to one
Deliver open programmable interfaces to automate orchestration of network services
Open standard-based programmatic access to infrastructure

SDN structure

SDN Architecture

Application Layer

Control Layer

Infrastructure Layer

Network Device

Network Device

Network Device

Business Applications

Cloud Orchestration

SDN Applications

Programmable Open APIs

Control & Data Plane Programmable Interface (e.g., OpenFlow)
• IP in is true only if you have a live transmission
• All other cases today is simply file in, this is already IP is working it is cheap and do not need to be changed.
• You do not need a VTR and a router id your input is a file.
• So on IP world your router is smaller.
• Still only to transmitters or streamers.
• All others are file out, already easy to do.
• Monitoring for live this can be TS or uncompressed.
• Note that most of the delivery schema is File deliver.
Why move to IP

- IP cabling is less expensive.
  - Today this is true for a bitrates of less than 1G, otherwise you need to go to 10G

- Router can be expanded with a network switch
  - This is true but you need an hi class Switch plus a SDN controller, probably this combination is more expensive than the traditional router.

- You have more bandwidth to run 4K and 8k
  - Today only using FIBER connection fiber will give you bandwidth even with SDI

- More easy to connect and operate
  - Today there is no standard for IP connection, SMPTE 2022 (6 standard is not really so common)
It is time to move to IP

- As any other engineering process there is no exact answer.
- Move today can be better in some scenarios but not in others.
- Move to IP too early could be simple expensive.
- Today IP technology can become obsolete in a short time.
When it's better to Move to IP

- Playout from CIB to Encoder
  - All the signal is generated inside the CIB
  - Fixed monitoring
  - Transport using compressed TS <1Gb
  - Gigabit connection
  - No SDN

- This scenario is typical of movie channels
When it is better not to move

- SD or HD facility with a lot of routing.
- No plan to go more than HD (4k or 8k)
- Most of the delivers are already SDI and delivers also SDI
- You have a limited budget.
Example of a good move

- You have a multiple movie channel
- You have an IP ready CIB that is able to deliver video and graphics.
- Your software can run in a blade server.
- With a simple 5 RU system you run 10 channels
- Another 5 RU for the backup
- Instead of 5 racks you have 10RU
- A big advantage for power consumption, spares, simplicity.
Conclusion

• As it happens the new is not always better
• Probably a more practical solution than SDN will make the move.
• Also in about 3 years 10Gb switch will be used in the homes, this will make the technology cheaper even 10 times.
Thank You

Fabio Gattari
Software architect