Solutions for the optimal integration of broadcast cameras in IP infrastructures

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Agenda

○ Camera Signal Transmission History
  • Cable and connectors
  • Transmitted signals

○ Camera Signal Transmission over IP
  • Why IP
  • Current solutions using IP

○ Optimized camera integration in IP infrastructures
  • NativeIP
  • Additional features

○ Summary
Camera signal transmission history

Cable and connectors
Transmitted signals
The first electronic cameras for live broadcast applications required most of the processing to be done inside the camera control unit (CCU).

The interconnection between the camera head and the CCU was done via a multicore cable.

- All signals that needed to be sent had their own respective wire connected on a separate pin on the multicore connector.
Camera Signal Transmission History – Cable and connectors

- Around 1970, the Philips LDK 5 introduced a new transmission solution based on multiplexing all the signals onto a single wire
  - This Triax cable camera technology, a joint development between CBS Laboratories and Philips, was awarded a Technical Emmy® in 1991

![Triax connector diagram](image)

<table>
<thead>
<tr>
<th>Pin</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Centre pin: Power and signals</td>
</tr>
<tr>
<td>2</td>
<td>Inner shield: Return</td>
</tr>
<tr>
<td>3</td>
<td>Outer shield: housing</td>
</tr>
</tbody>
</table>
Camera Signal Transmission History – Cable and connectors

- Requirements for HD high speed & UHD cameras made hybrid fiber cables following SMPTE ST 311 the de-facto standard
Camera Signal Transmission History – Transmitted signals

- Multicore solutions used analog baseband connection
  - One wire for every individual signal

- Earlier Triax solutions used analog signals for transmission
  - Bandwidth requirements increased over time which required to move carriers up
  - Max. cable length became reduced to critical levels
Camera Signal Transmission History – Transmitted signals

- Triax solutions moved to digital signals for transmission
  - 2nd generation digital Triax solution became introduced in 2011
    - Based on COFDM encoding and QAM in combination with low latency wavelet compression
  - Transmitting digital HD signals with reduced bandwidth requirements over Triax
  - Achieving a max. cable length exceeding SD digital Triax by at least three times
Camera signal transmission over IP

Why IP

Current solutions using IP
Camera Signal Transmission over IP – Why IP

- SDI video has served the broadcast market well for many years
  - But limitations are visible and beyond single-speed UHD bandwidth requirements require a more flexible and future-proof solution

- IP technology developments far outperform broadcast video
  - IP cost per Gb is typically halved every 14 months
  - In serial digital video it stands still at best

- Flexible UHD, HFR, and high-speed operations are addressed much better with format-independent IP solutions
  - It is not a question of whether IP will replace SDI video in broadcast applications, but rather when it will happen
Camera Signal Transmission over IP – Current solutions using IP

- Cradle concept support base band as well as hybrid and full IP solutions
  - Additional camera base stations can be installed in seconds
  - Memory in the cradle will automatically load the settings from the environment
Camera Signal Transmission over IP – Current solutions using IP

- XCU UXF - ALL signals available in baseband and IP

  4x 10Gb/s IP Connections
  - 2x main + 2x redundant
  - Supporting 2022-6 and SMPTE 2110
  - Supporting 4K, 3G, HD, HDR, returns, monitoring, reference (PTP), prompter, audio and I-Com (AES67)

  Baseband Connections
  - Supporting 4K, 3G, HD, HDR, returns, monitoring, reference, prompter
  - Supporting Audio (Analog / SDI / AES/EBU)
  - Supporting I-Com (2-wire / 4-wire)
  - Supporting Tally, camera control (C2IP)
Camera Signal Transmission over IP – Current solutions using IP

- In 2014, for high speed HD operation, DirectIP the first IP-based fiber transmission solution became introduced.

  - The use of standard IP technology allowed the use of IP infrastructures interconnecting camera heads and base stations.
Camera Signal Transmission over IP – Current solutions using IP

- **DirectIP operation**
  - Fully uncompromised connection between camera head and base station
  - Over any distance and without any latency (other than network latency)
  - Many use cases around the world
Optimized camera integration in IP infrastructures

NativeIP
Optimized camera integration in IP infrastructures

- Next steps of broadcast camera integration into full IP infrastructures
  - In a full IP broadcast infrastructure, baseband signals are typically not required
  - If baseband signals are required they can be generated using IP gateways
  - The power can be inserted into the camera cable by a local power supply
  - So why still use a camera base station or any other hardware to convert signals from the camera to the required IP standards?
    - Why not connect the camera heads directly to the IP infrastructure via commercial-off-the-shelf (COTS) IP hardware?
Optimized camera integration in IP infrastructures

We’ve reinvented transmission a number of times...

1968
Triax Transmission
Replacing multi-core cables by Triax, boosting large distance productions while dramatically increasing robustness

2001
HD Triax
Introducing HD transmission over Triax, enabling the HD-transition in sports while using precabled venues

2011
3G Transmission
Merging the worlds of Triax and Fiber with cross-conversion and a single power-scheme, to benefit and stimulate the transition to Fiber

2013
XCU and Cradle
Addressing the reality of broadcast’s logistical challenges, enabling seamless transitions going forward

2016
DirectIP
Enabling Centralized and REMI productions, by using the power of IP

2018
DirectIP+
Enabling compressed REMI productions, by adding compression to the DirectIP scheme

And we’re doing it again...
Optimized camera integration in IP infrastructures - NativeIP

The camera-chain no longer is an end-point at the far boundary of your topology, but becomes a vivid, versatile and active node in your distributed network.

The fact that the camera itself integrates all functions historically done by Transmission and Base Unit, we call:

NativeIP
Optimized camera integration in IP infrastructures - NativeIP

- NativeIP stands for a camera that doesn’t rely on a base unit to manage the communications
  - Instead, the camera itself is the active high-performance player in the network
- This means...
  - SMPTE ST.2110-10 PTP – PTP straight to the camera, locking the camera at the heart of the image
  - SMPTE ST.2110-20 and -30 – Video and audio as essence streams to any destination, nearby and far away simultaneously
  - AMWA-NMOS-04/-05/-07 – Discovery, connection and events all managed elegantly and direct
NativeIP must support a wide range of bandwidths

- To enable not only single-speed HD & UHD but also Hi-Speed UHD straight from the camera
- 10Gbps, 25Gbps, dual 25Gbps and even 100Gbps, straight from the camera
What is NativeIP

- **Choice in SFP** – The ability to change the SFP/ QSFP modules in the field, to match the speed, wavelength and redundancy straight from the camera requirements. Crucial for future-proofing your solution, as developments will continue at an ever increasing pace.

**Various configurations supported:**
- Single 10/25Gbps SFP
- Two bidirectional 25Gbps SFPs
- Single 100Gbps QSFP
Optimized camera integration in IP infrastructures - NativeIP

- A solution delivering power in a reliable way has to be provided
  - A compact, efficient and even redundant power supply
  - Combining the fiber for the IP signals with the camera power onto one hybrid fiber cable
  - Offering a robust and dependable link in the field

- To be format agnostic there
  must be no active components
  in the optical path
Optimized camera integration in IP infrastructures - NativeIP

- NativeIP operation
  - Fully uncompromised connection between camera head and IP infrastructure
  - Support of any production format from single speed HD to triple speed UHD
Optimized camera integration in IP infrastructures - NativeIP

- Minimum deployment on the venue site
- Worlds only solution that offer full functionality and format support w.o. a camera base station

Without any latency other than network latency

But it requires between 1.1 and 44 Gbps per camera! What if the bandwidth is not available?
Optimized camera integration in IP infrastructures - NativeIP

Minimum deployment on the venue site

JPEG XS compression with 8:1 to 20:1 ratio for HD and UHD in single speed and high speed

Hardly any latency other than network latency

JPEG XS = Software Option

Future development!
Optimized camera integration in IP infrastructures - NativeIP

- Transmission options

**XCU Universe UXF**
- Workflows up to single-speed UHD
- Seamless transition from baseband to IP
- Supports DirectIP and DirectIP+
- Operational excellence with XCU and Cradle

**NativeIP**
- Workflows including triple-speed UHD
- Unique topology flexibility with NativeIP
- Freedom in SFP / QSFP choice
Optimized camera integration in IP infrastructures

Additional features
Optimized camera integration in IP infrastructures - Additional features

- Built-in GPS – Know where the camera is based on GPS information
  - Rather than deriving its location from an IP address

- Built-in NFC – Load Options into the equipment even without powering-up the camera
  - Check IP settings
  - Read-out usage information on check-out/check-in
  - Enabling far smoother logistics than ever experienced
Optimized camera integration in IP infrastructures - Additional features

- It’s key that the Camera Operator has full insight and control...
  - Instant Diagnostics
    - Six LEDs on the back of the camera instantly indicate the status of all critical IP connections
    - When everything is OK, they’re dimmed unless you press the ‘information’-button
  - More detailed information’s are simultaneously provided in the camera viewfinder
Optimized camera integration in IP infrastructures - Additional features

- Creative Grading is the powerful tool to unleash all the creativity provided by the new platform
  - Ultra-fast
  - Self-explaining
  - Educative
  - Creative
Creative Grading is the powerful tool to unleash all the creativity provided by the new platform.
- Ultra-fast
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- Educative
- Creative
- With the GPS option show the physical location of the camera
Summary

- It’s an ongoing evolution in the way how cameras are connected
  - Multicore has been replaced by Triax
  - Triax has been replaced by hybrid fiber

- The signals transmitted over the cable have changed over time
  - Analog video has been replaced by digital video
  - Digital video has been replaced by IP

- A camera system with NativeIP integration offer a future-proof solution
  - Use off the shelf IT hardware
  - Fully format agnostic
  - Offer more operational flexibility
Thanks for listening &
Time for questions

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