



# 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



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# Camera signal transmission history

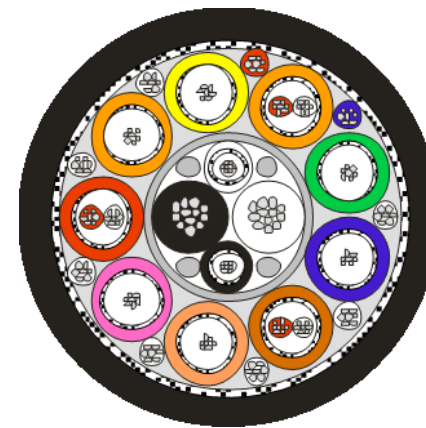
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Cable and connectors

Transmitted signals

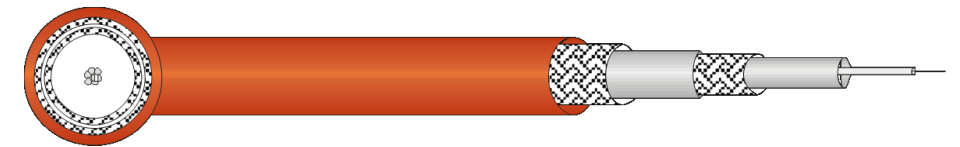
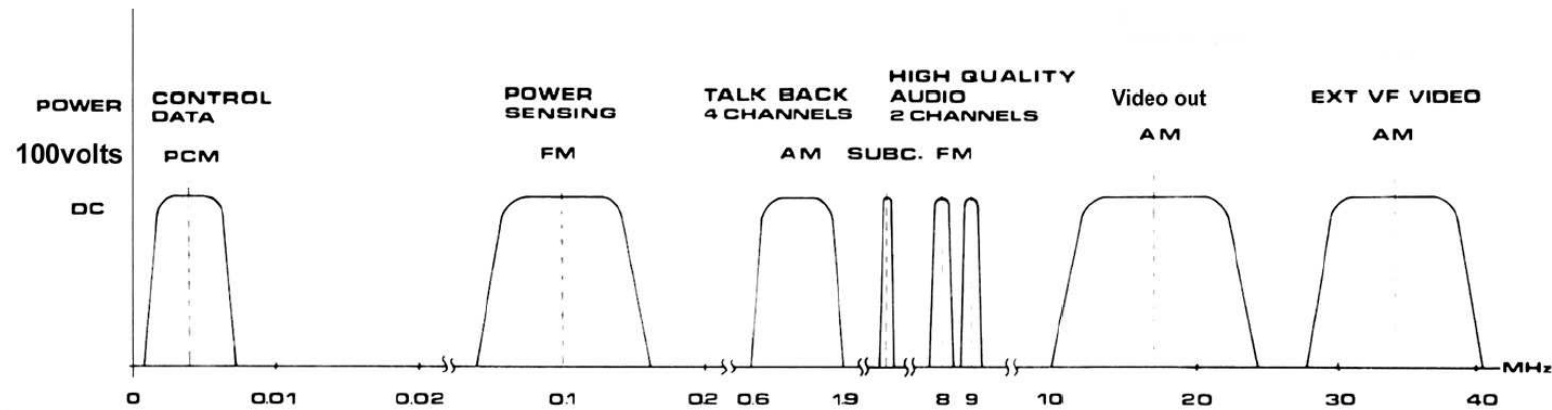
# Camera Signal Transmission History – Cable and connectors

- 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

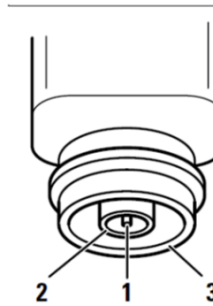


# Camera Signal Transmission History – Cable and connectors

- 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



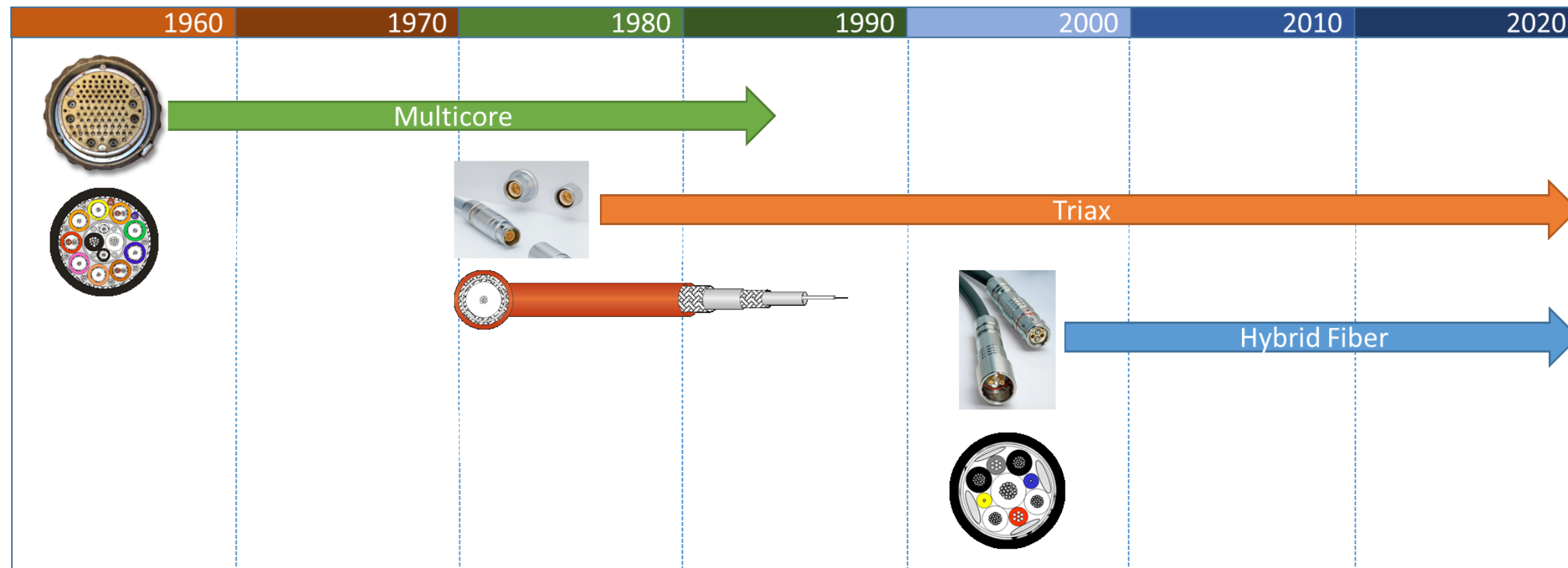
Triax connector



| Pin | Description                   |
|-----|-------------------------------|
| 1   | Centre pin: Power and signals |
| 2   | Inner shield: Return          |
| 3   | Outer shield: housing         |

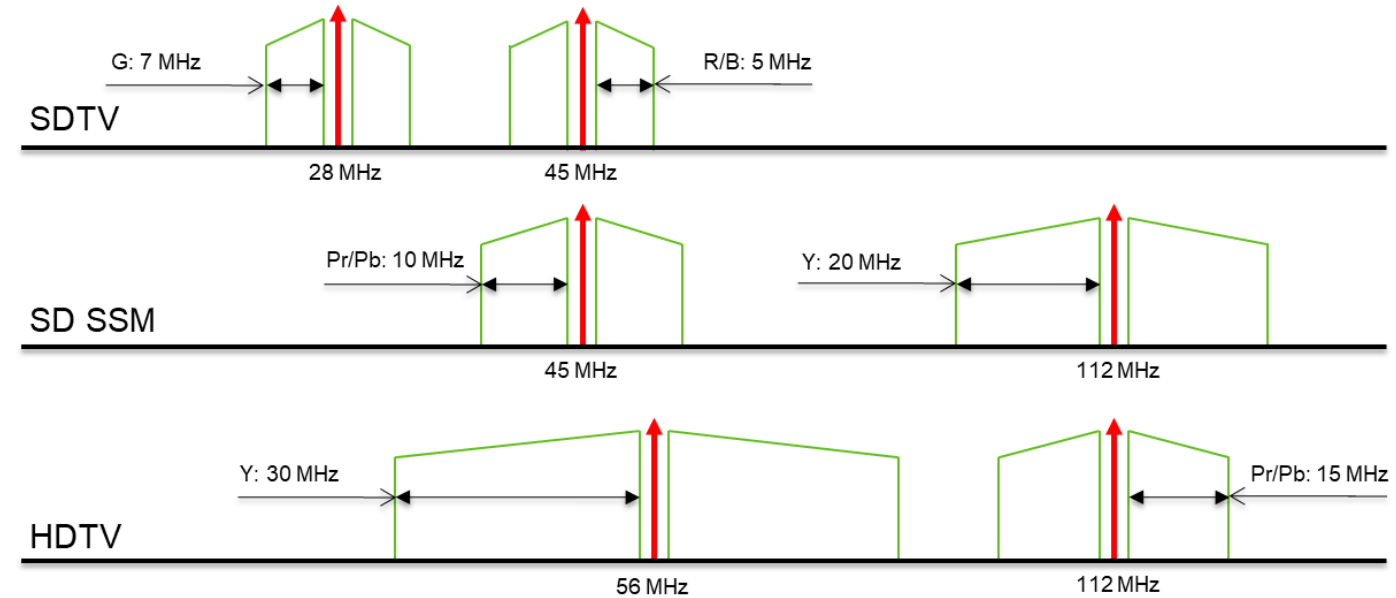
# Camera Signal Transmission History – Cable and connectors

- Requirements for HD high speed & UHD cameras made hybrid fiber cables following SMPTE ST 311 the de-facto standard



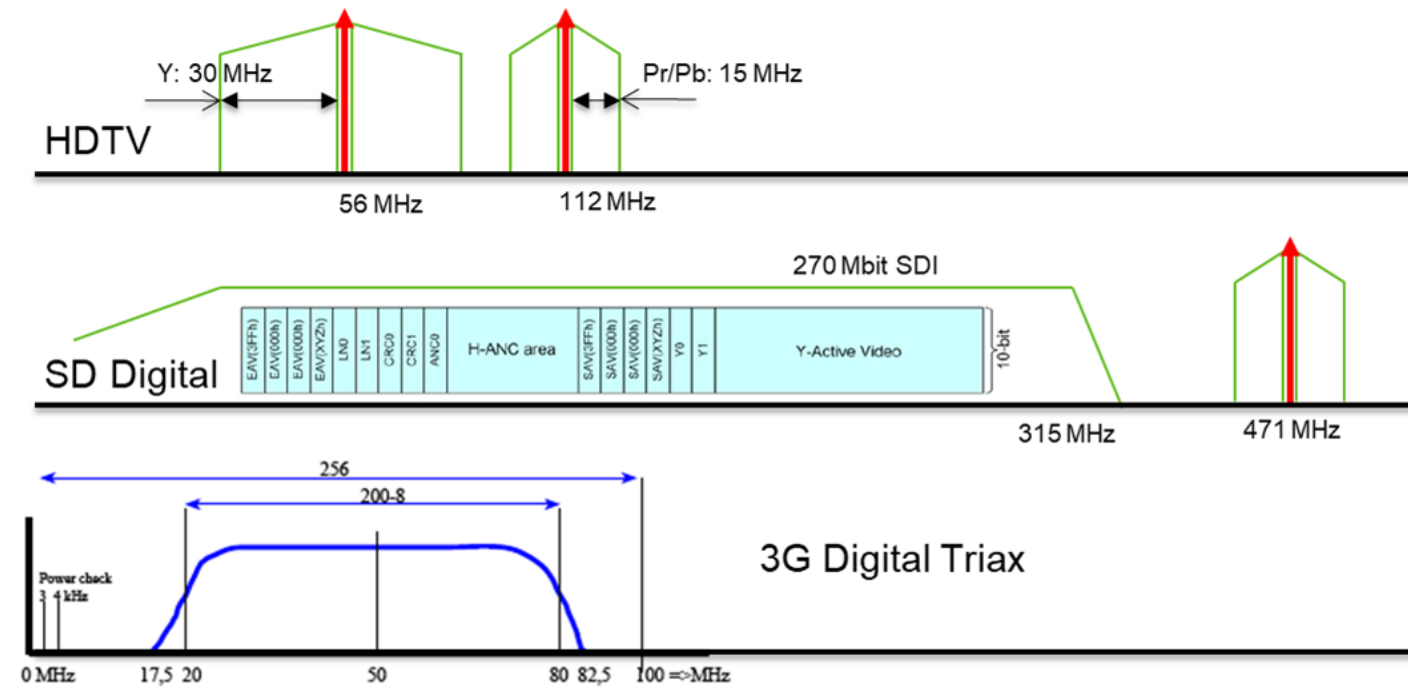
# Camera Signal Transmission History – Transmitted signals

- 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
  - 2<sup>nd</sup> 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

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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

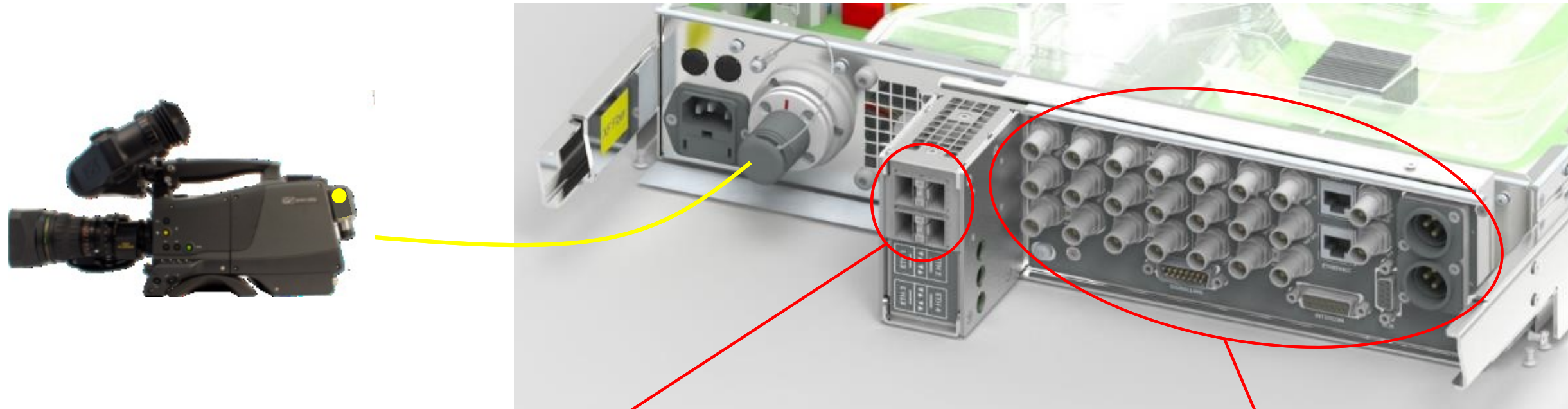
# Camera Signal Transmission over IP – Current solutions using IP

- 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)

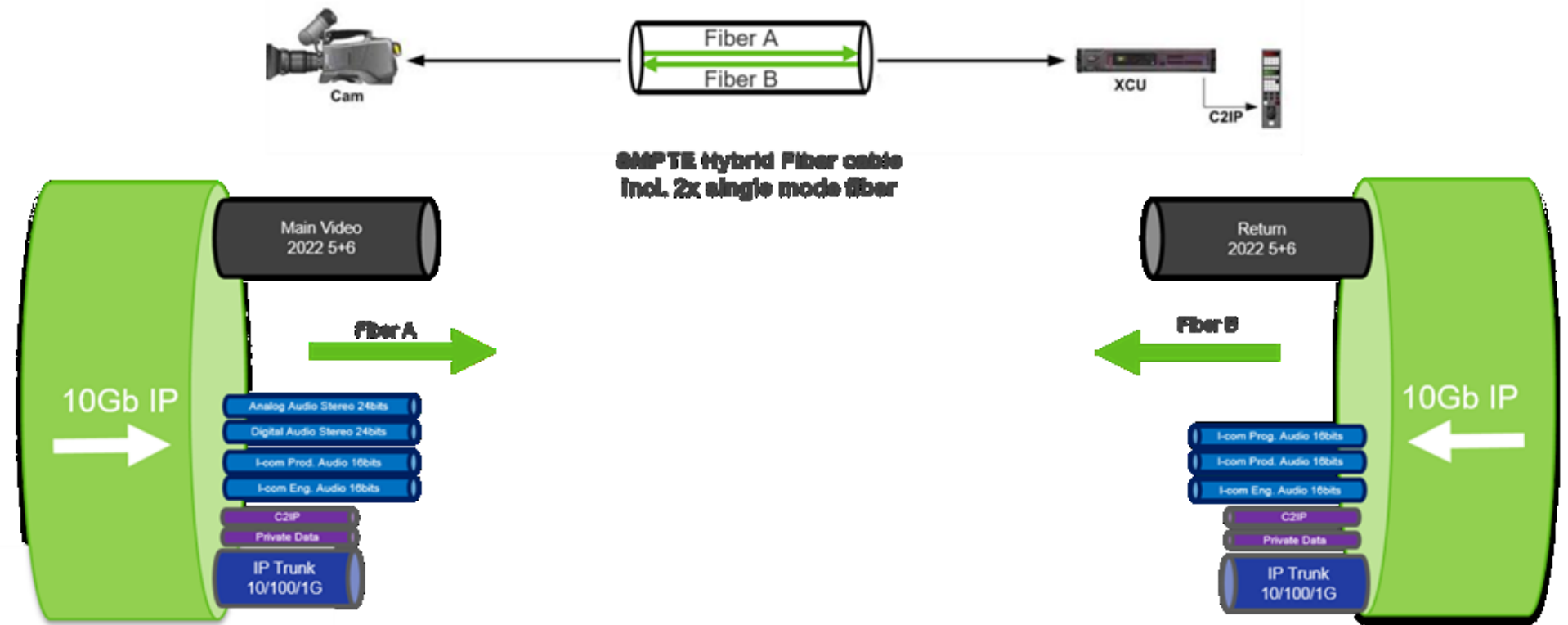
## Baseband Connections

- 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

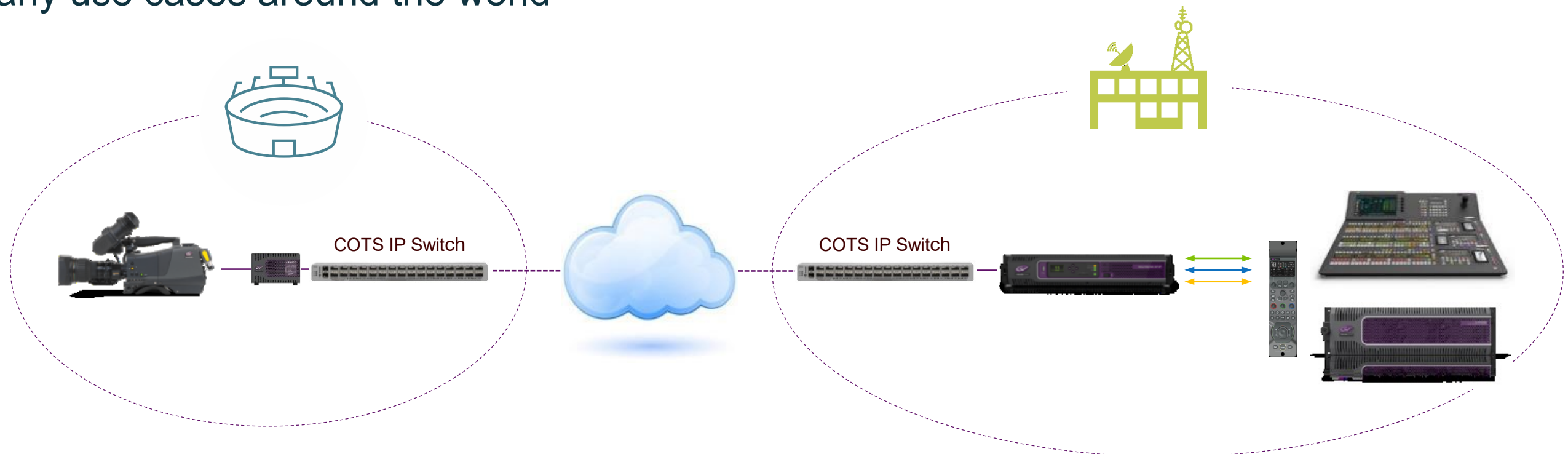
- The use of standard IP technology allowed the use of IP infrastructures interconnecting camera heads and base stations



# 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





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# Optimized camera integration in IP infrastructures

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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...



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

Introducing HD transmission over Triax, enabling the HD-transition in sports while using pre-cabled venues

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

Addressing the reality of broadcast's logistical challenges, enabling seamless transitions going forward

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

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

# Optimized camera integration in IP infrastructures - NativeIP

- 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

| NATIVE IP |           | 59,94Hz |     | Streams |              |     | Speed |  |  | SFP modules  |      |    |
|-----------|-----------|---------|-----|---------|--------------|-----|-------|--|--|--------------|------|----|
|           |           |         |     |         |              |     |       |  |  | uncompressed | 2110 | 10 |
| HD (1)    | 10G SFP   | HD      | 1.3 | 1       | 1            | 1.3 |       |  |  |              |      |    |
| 3G (1)    |           | 3G      | 2.7 | 1       | 1            | 2.7 |       |  |  |              |      |    |
| 4K (1)    | 25G SFP   | 4K      | 11  | 1       | 1            | 11  |       |  |  |              |      |    |
| 4K (3)    | 100G QSFP | 4K      | 11  | 4       | 3 + combined | 44  |       |  |  |              |      |    |

## 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.

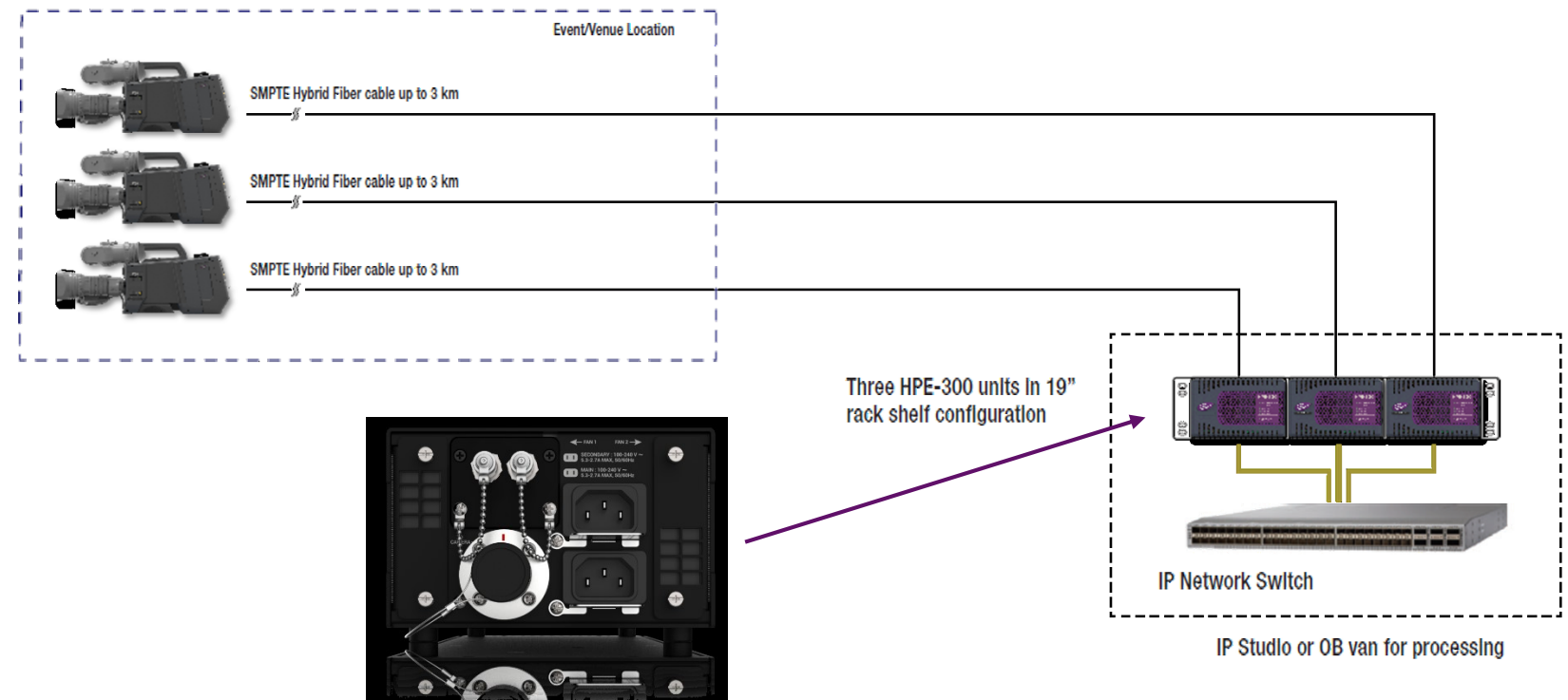
### Various configurations supported:

- Single 10/25Gbps SFP
- Two bidirectional 25Gbps SFPs
- Single 100Gbps QSFP



# Optimized camera integration in IP infrastructures - NativeIP

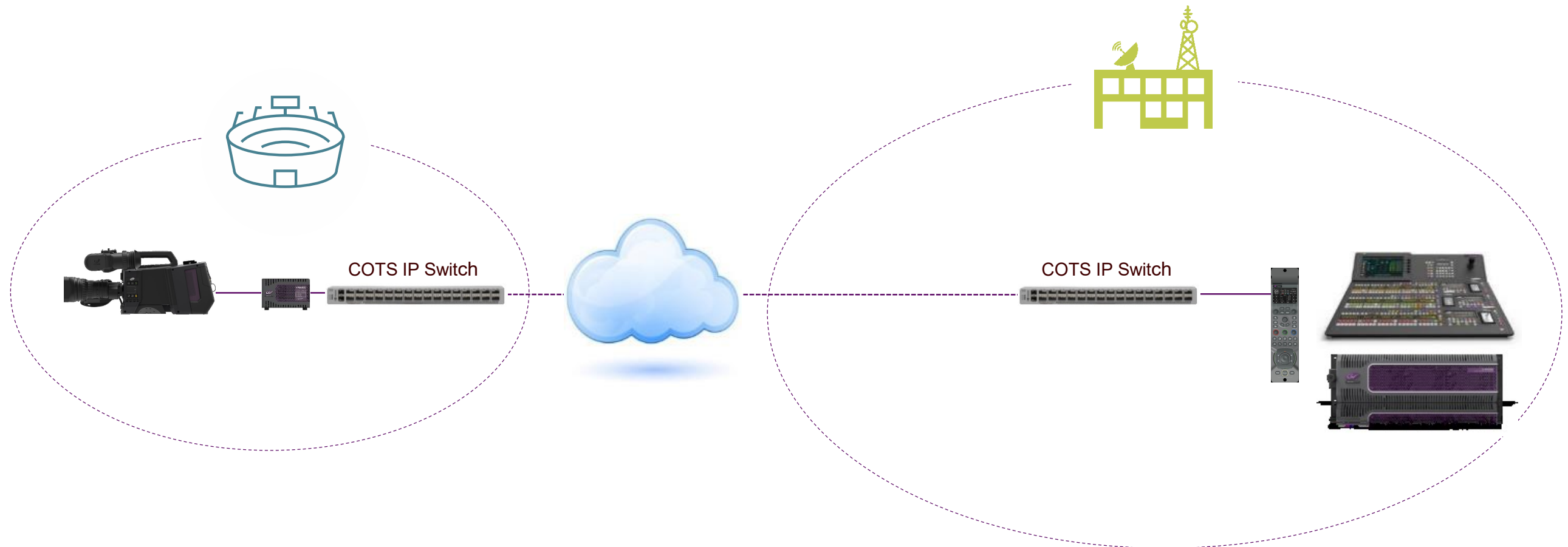
- A solution delivering power in a reliable way has to be provided
  - A compact, efficient and even redundant power supply
  - Combining the fiber for the IP signals with the camera power onto one hybrid fiber cable
  - Offering a robust and dependable link in the field
- To be format agnostic there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



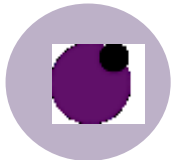
# Optimized camera integration in IP infrastructures - NativeIP



Minimum deployment on the venue site



Without any latency other than network latency



Worlds only solution that offer full functionality and format support w.o. a camera base station



But it requires between 1.1 and 44 Gbps per camera!  
What if the bandwidth is not available?



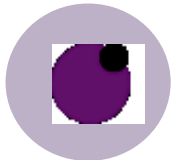
# Optimized camera integration in IP infrastructures - NativeIP



Minimum deployment on the venue site



Hardly any latency other than network latency

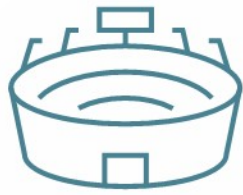


JPEG XS compression with 8:1 to 20:1 ratio for HD and UHD in single speed and high speed



Remote

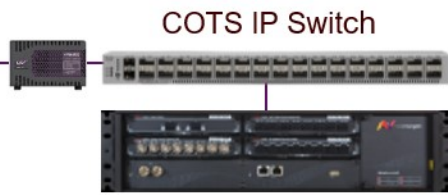
LDX 8X and LDX 100 Series



DirectIP



DirectIP+



NativeIP (JPEG XS)



LDX 100 Series



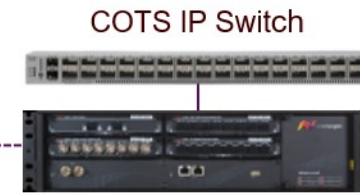
COTS IP Switch



Baseband and SMPTE 2022 or 2110



COTS IP Switch



Baseband and SMPTE 2022 or 2110



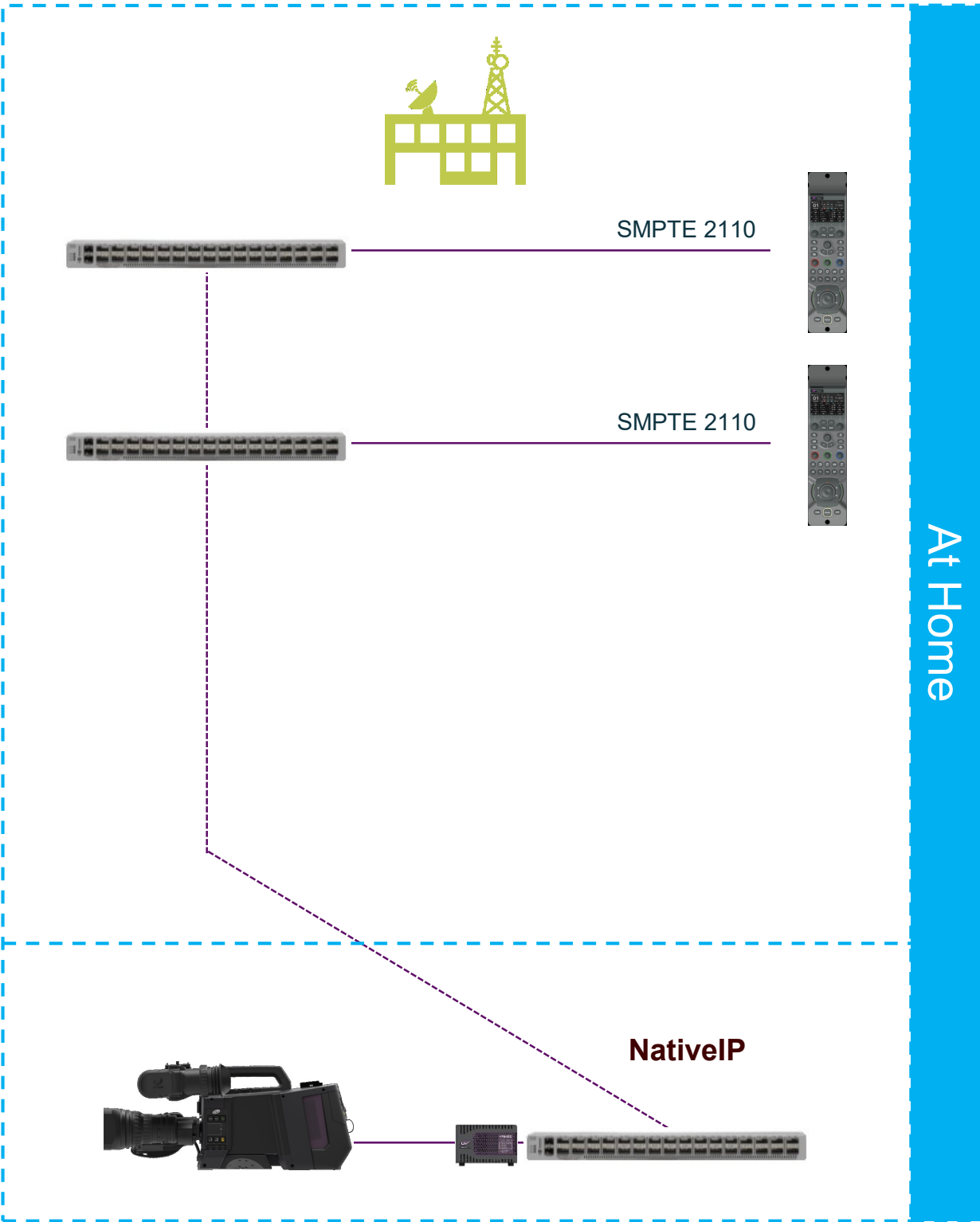
COTS IP Switch



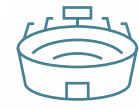
SMPTE 2110



At Home



Remote Sites



Venue A

NativeIP (JPEG XS)



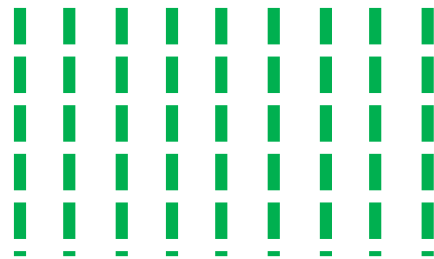
Venue B

NativeIP (JPEG XS)



Regional studio

NativeIP (JPEG XS)



SMPTE 2110



SMPTE 2110



NativeIP



At Home

# 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



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# Optimized camera integration in IP infrastructures

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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



# 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
  - 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 offers 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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Principal Camera Solutions & Technology