



# Agenda

## **PART 1**

Terminology & Standards

ST 2022-6 – The Beginning

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## **PART 2**

Benefits of ST 2110

ST 2110 Suite of Standards

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## **PART 3**

IP Networks

PTP and SDP

Standards Organizations

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## **PART 4**

The Devil in the Details



# HITACHI

Broadcast and Professional Cameras

## *Intro to IP Networks*

# *ST 2110*







# Analog → Digital → Data

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For traditional engineering & production-types...

***Welcome to the world of computer networks***

...it isn't going to be easy...

*“It will be more difficult than the transition from analog to digital.”*



# ST 2110 is **NOT**

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- Internet?** Not WAN or Internet. Intra-facility
- Network Type?** Not WiFi or small ethernet network
- Small Switch?** 10 Gbps for HD. 25 Gbps for 4K/UHD
- Switch or Router?** IT switches are like a video router



# New Terminology

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**AIMS** -This trade group that grew out of the Video Services Forum (see VSF) for a video over IP standard. Promoting the VSF TR03 and TR04 “protocols”.

**ASPEN** Originated with Evertz and their IP initiative and others who wanted compatibility with the Evertz product line.

**VSF** - Video Services Forum. This group originated in the Telco industry looking at video transport over telephone. VSF technical proposal TR03 & TR04.

**NDI** – (Network Device Interface). NewTek has tossed its hat in the IP Standards ring for interoperability consideration.

**NMI** – (Network Management Interface). This is a Sony technology that includes both a protocol and hardware (chip) device. A compression technology. Sony has been using their own LLVC (Low Latency Video Codec) codec embedded in their products for quite a while. Promoting NMI as a standard.

**FIMS** – Framework for Interoperable Media Solutions, by EBU. File based transport over networks, so end devices knew what to do with the file.

**AVB** - Audio Video Bridging also known as IEEE 802.1BA, 802.1Qat, 802.1Qav and 802.1AS..

**TICO** - The TICO Alliance is focused on UHD and higher resolution imagery that all need compression to fit in the pipe.

**JT-NM** - Joint Task Force on Networked Media. This was created by the EBU, SMPTE and VSF to support the transition to IP.

**RTSP** – Real Time Streaming Protocol falls under Internet Streaming and being adopted for real time streaming over networks.

**IETF** - Internet Engineering Task Force. Professional video is transported over the same networks as internet traffic, They are contributing standards & protocols.

**DANTE** - (Digital Audio Network Through Ethernet). It is being proposed as an Audio over IP Standard, not to be confused with AES67 or SMPTE ST302



# New Standards

**SMPTE 2110** – This is the SMPTE designation assigned to the VSF TR03 & TR04 submittal as the Standard to transport audio and video over IP networks

**SMPTE 2022 – 5,6,7** – These are the three (currently popular) of the seven part SMPTE 2022 Standard that describes how to send digital video over IP networks. Most of the standards proponents accept SMPTE 2022 as video and then use different encapsulating schemas.

**SMPTE 2059 Parts 1 and 2** - These are the timing and synchronizing standards. This is based on the IEEE 1588 Precision Time Protocol (PTP) standard.

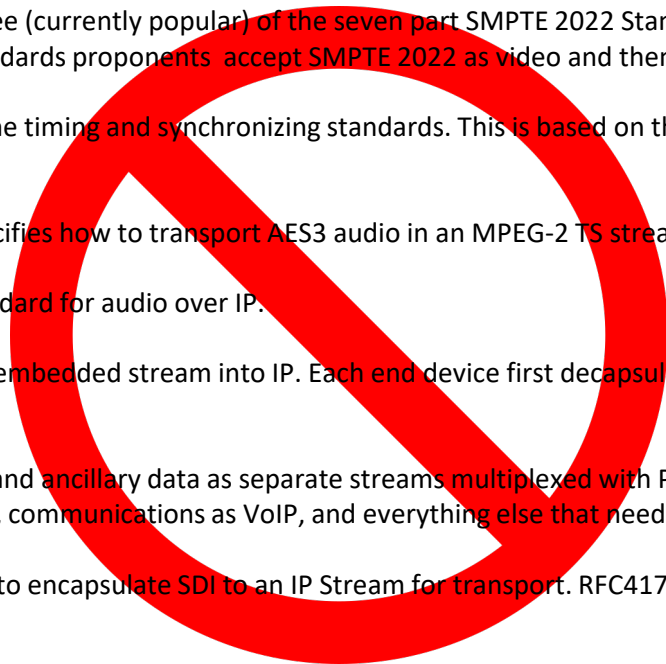
**SMPTE ST 302** - This audio standard specifies how to transport AES3 audio in an MPEG-2 TS stream.

**AES67** – This is the mostly accepted standard for audio over IP.

**VSF TR04** –This is encapsulating the SDI embedded stream into IP. Each end device first decapsulates and then debeds audio and video plus any ancillary data.

**VSF TR03** – This is keeping audio, video and ancillary data as separate streams multiplexed with PTP to keep them in sync (remember analog) then multiplexing command and control, communications as VoIP, and everything else that needs to be transported as part of the stream.

**IETF RFC4175** – This is the IETF protocol to encapsulate SDI to an IP Stream for transport. RFC4175 is only the encapsulating technology not the transport protocol.





# Basic Terminology

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**IP** Internet Protocol – It's how the Internet works

**Router** **Directs** traffic functions on the Internet

**Switch** **Connects** network devices by using packet switching



# Serial Digital Interface

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SMPTE Standardized SDI in **1989**

12G (4K) SDI standardized in 2015

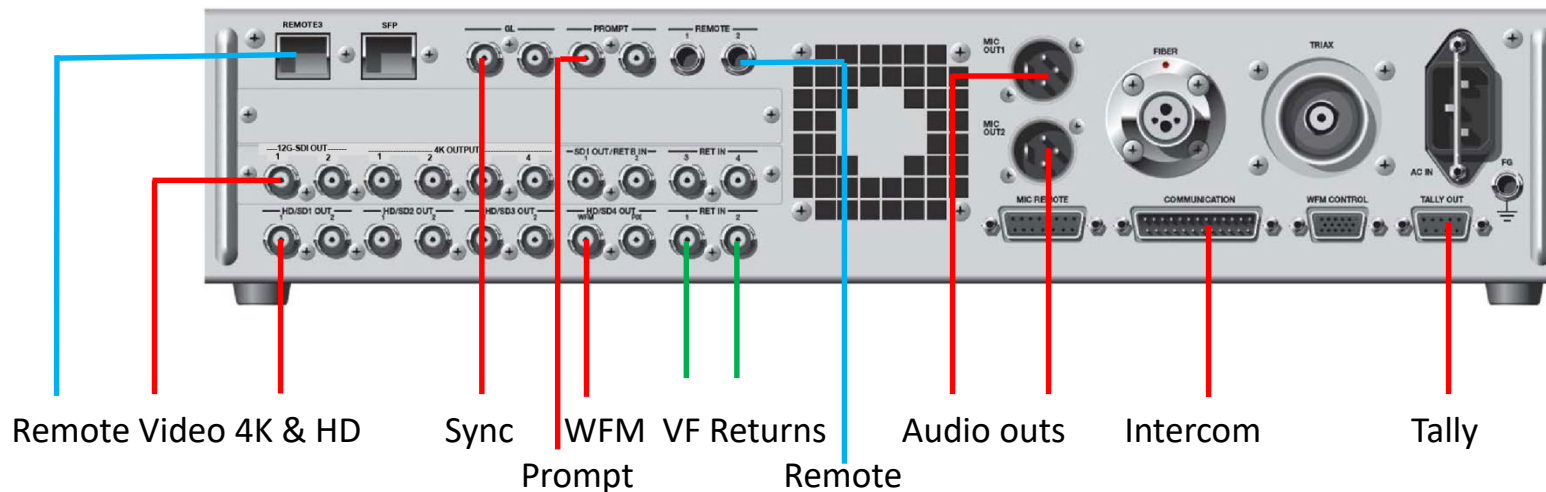
BNC connector was patented in **1951**.



***SDI Drawback: send or receive a single signal.***

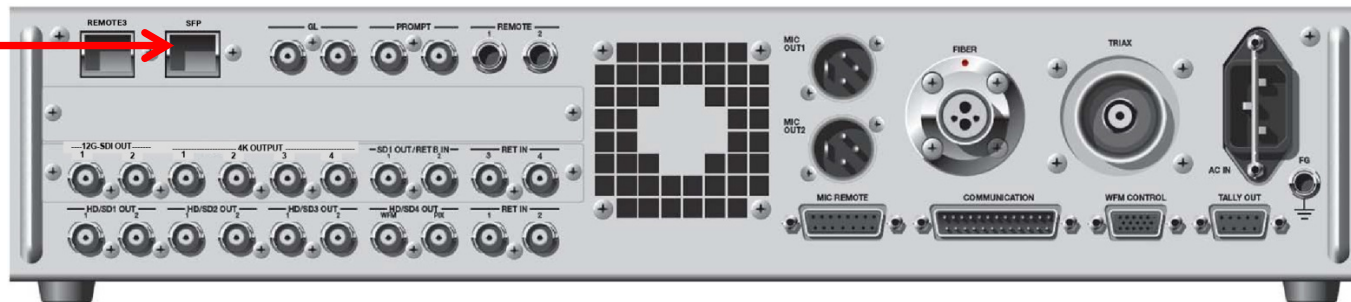


# Today - CU-HD1300 CCU





# Tomorrow - CCU



Video 4K & HD, Sync, PIX/WFM, Prompter, VF Returns, Remote, Audio out, Intercom, Tally

**ST 2110**

# The Beginning... ST 2022

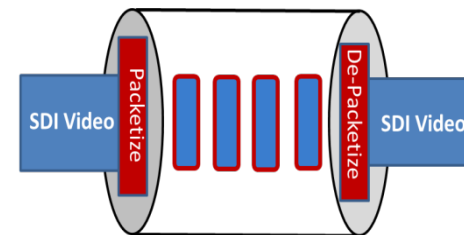
ST 2022 Packetizes SDI data into 1 stream

Easy conversion from SDI

Typically MPEG-2 compressed

Requires SDI to be reconstructed/de-embedded

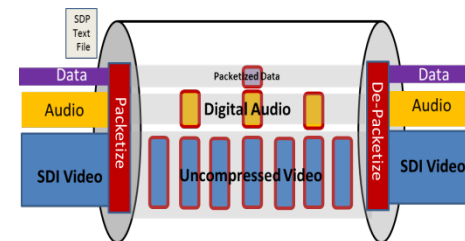
ST 2022-6



ST 2110 supported by Hitachi because

it is uncompressed with separate streams

ST 2110





# ***Benefits of ST 2110***



# ST 2110 Benefits

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- ✓ Separate A/V/Data Flows = Bandwidth efficiency
- ✓ Uses COTS equipment
- ✓ Un-Compressed
- ✓ Redundant system architecture: Fail-over without interruption
- ✓ Highly Accurate Synchronization
- ✓ Uses Existing & Industry Standards



# Bandwidth Efficiency

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**Separate Audio, Video & Metadata = Bandwidth efficiency**

4K video using ST 2110-20 fits in a 10 Gb link = Lower link cost

No embedding and de-embedding



# Characteristics of using IP

## Massive Bandwidth:

1.5/3 Gbps for HD.

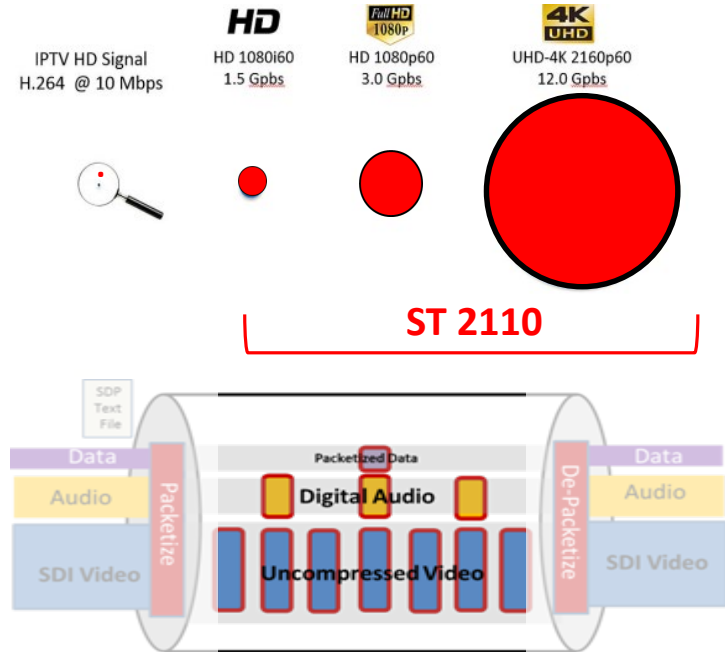
12 Gbps for UHD/4K.

## Tight Packet Pacing:

Very rigid pacing of packet transmission.

Required for low-latency.

Very small tolerances for variance.







# Additional Benefits

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- ✓ Flexibility
- ✓ Availability
- ✓ Scalability
- ✓ Cost Reduction
- ✓ Infrastructure Reduction



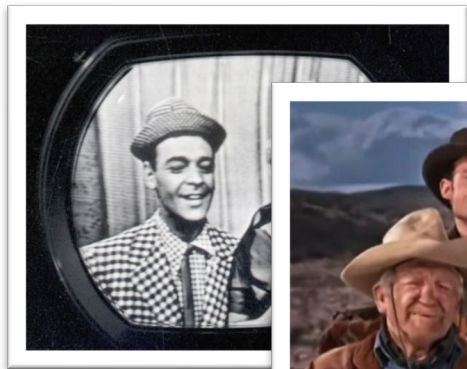
# Flexibility

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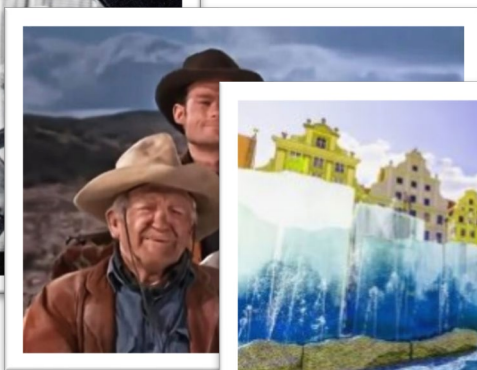
## **Only the professional TV Industry uses SDI.**

- All OTT and on-demand systems use IP for delivery.
- Most use IP networks for Production
- Most production workstations and storage systems are dependent on high-speed IP Ethernet connectivity.

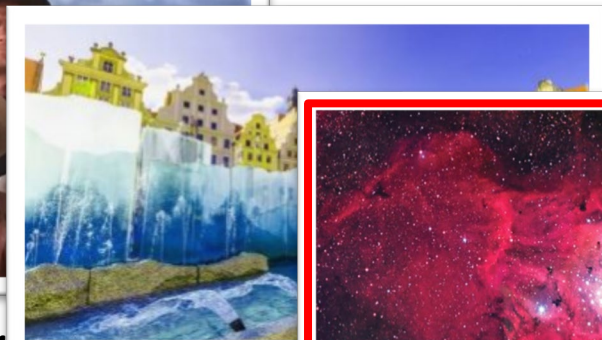
# Flexibility



**NTSC B&W 525**  
**Analog NTSC**



**NTSC Color**  
**Analog NTSC**



**ATSC HDTV**  
**SDI Digital**



**ATSC 3.0 UHD-TV**  
**IP Data**

*“Fork-lift” upgrades are NOT required for new capabilities*



# Availability

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Every smartphone user carries an IP send/receive device in their pocket.

Netflix, Hulu, YouTube and Amazon all use IP networks to deliver content.

ATSC 3.0 broadcast uses IP technology.





# Scalability

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Major sports events use:

50 cameras

4 TV mobile units and 4 ops trailers.

400 staff



# Scalability

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Extremely large “routing” possible. 5,000 X 5,000 switch

The Evertz EXE “video router” is a non-blocking, managed switch. It has 46Tb of switching capacity.

With **2,304 10Gb ports**. Supports up to 13,800 uncompressed HD-SDI signals.





# Scalability

Small desktop



\$1K - \$4K



Managed switch, 1Gb, X 48

Medium business

\$4K - \$20K



Smart Switch, non-blocking  
up to 40Gb X 48 ports

Large Network

\$260K - \$500K 432 X 100Gb  
ports.

Fully Managed, **Layer 2- Layer  
3 switches**. Up to 100+Tb  
Fabric





# Cost - COTS

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## Common Off The Shelf (COTS)

*Cost advantage for large systems is questionable, at this time*

Cost reduction by reducing unique “**heavy iron**” TV equipment.

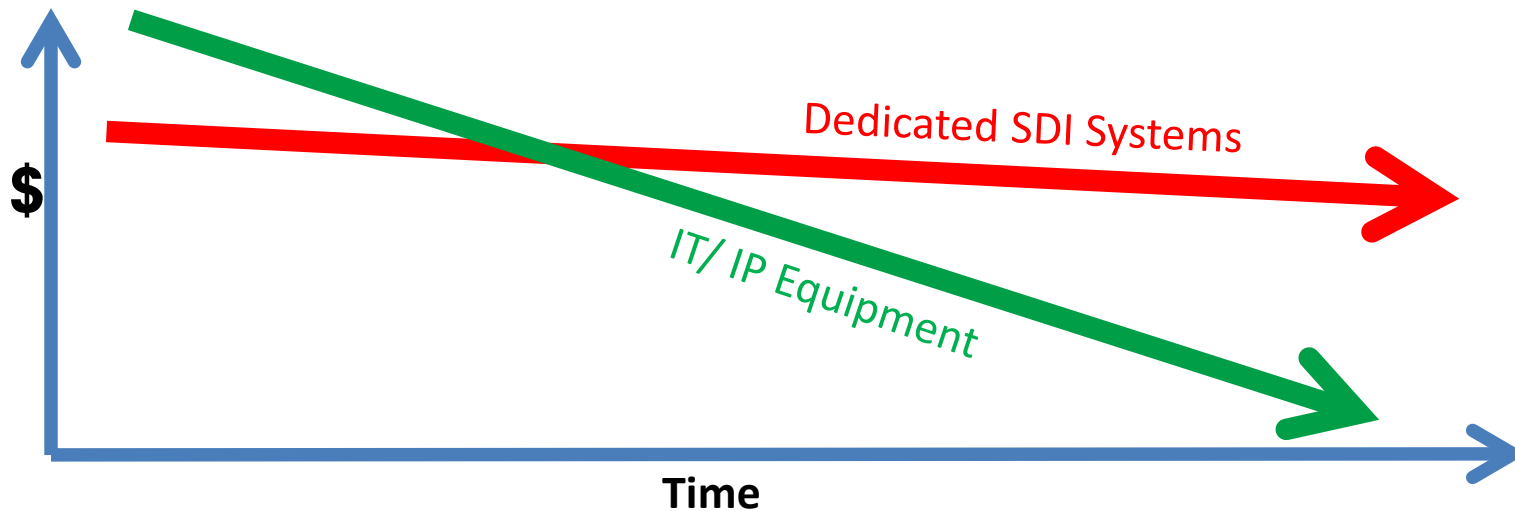
Computer IP equipment and circuits have been dropping in price rapidly.





# Cost of Equipment

*IT & Computer industry spends 1,000 more \$ than the TV industry*





# Software – It's Different

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Software is easy to change and adds capabilities

Software is always changing. Updates, etc.

Software Subscription support from manufacturers is usually required.



# Infrastructure Reduction

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A BNC/coax cable carries 1 signal  
...in one direction.

A single IP connection can support  
multiple uncompressed UHD & HD  
video and hundreds of  
uncompressed audio and data  
signals, traveling in both directions  
simultaneously.



# NEW Infrastructure

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NEP's new CBS sports truck looks more like a data center.

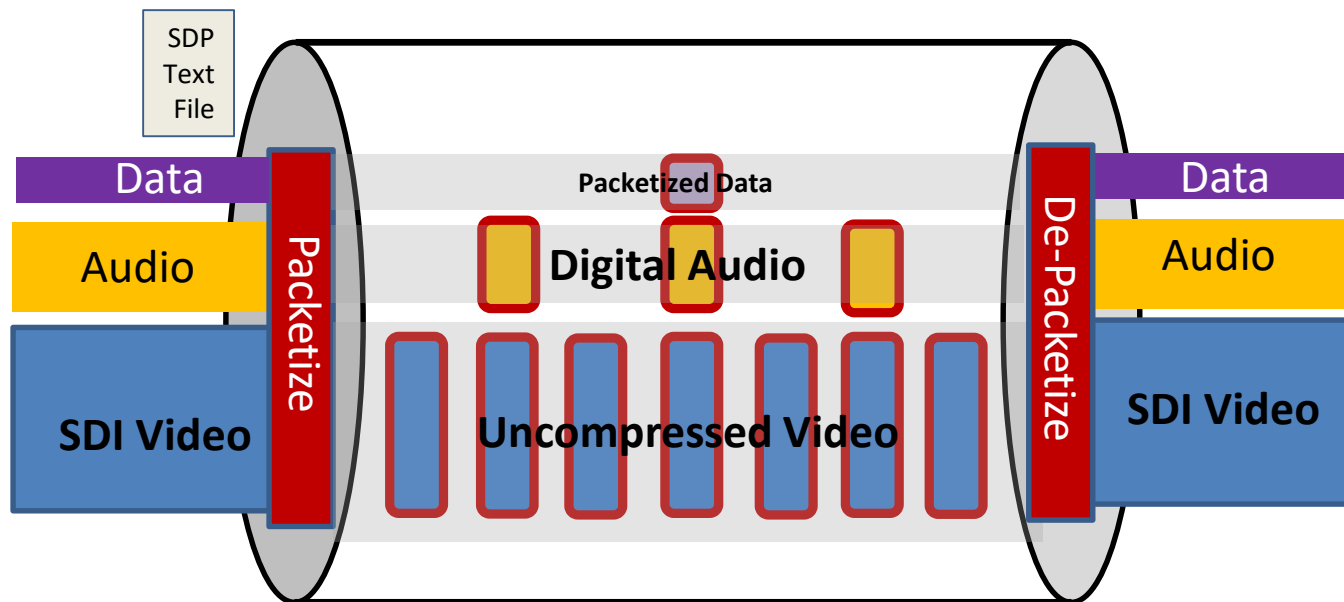
These are the Lawo V-Matrix low-latency converters for ST 2110 to SDI I/O.





# ***IP Media Networks***

# ST 2110 IP Packets



ST 2110 Media is packetized separately for IP transport across a standard IP network.



# Delivery Terminology

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**Multicast** SMPTE ST 2110 uses “one to many” connections

**RTP** (Real-time Transport Protocol)

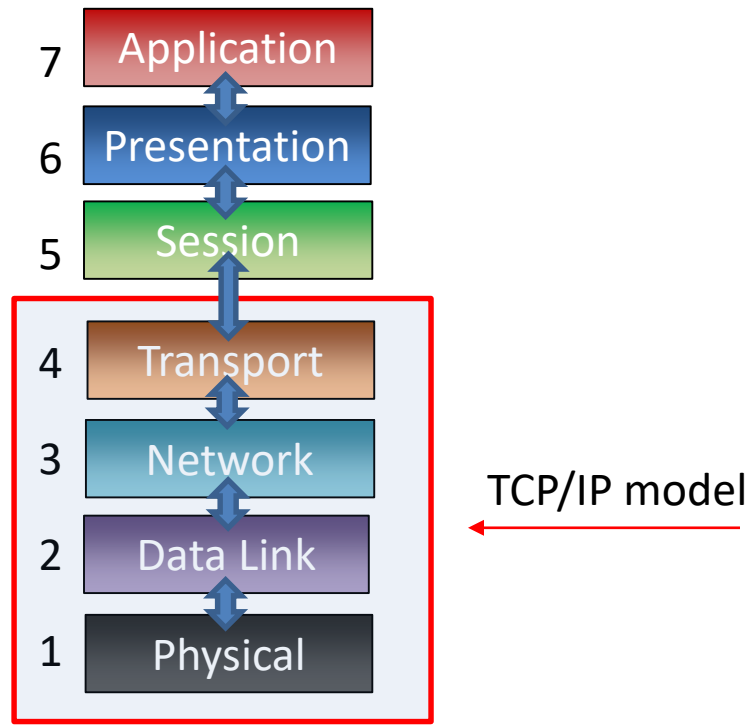
**UDP** (User Datagram Protocol)

**TCP** (Transport Control Protocol) / **IP** (Internet Protocol)

**Flow** (Data Flow) The transfer of information from one system to another

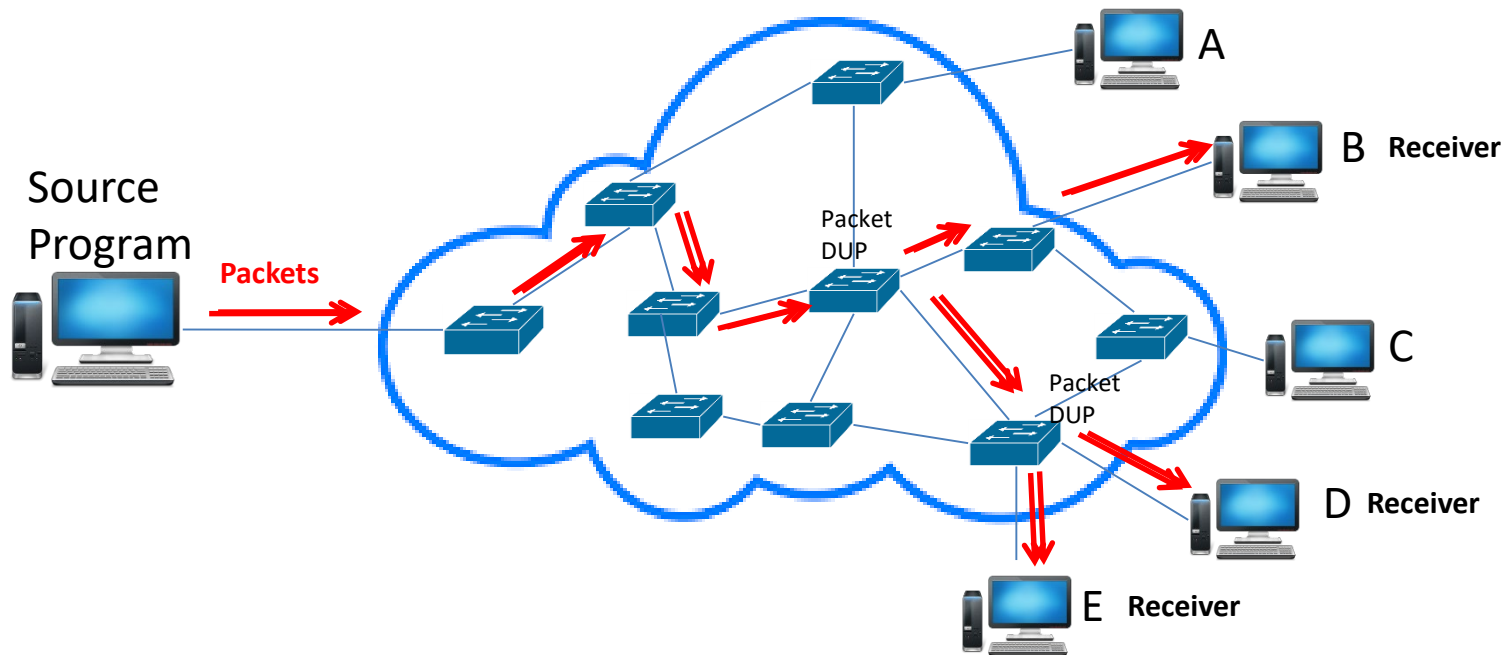


# OSI Layers & TCP/IP

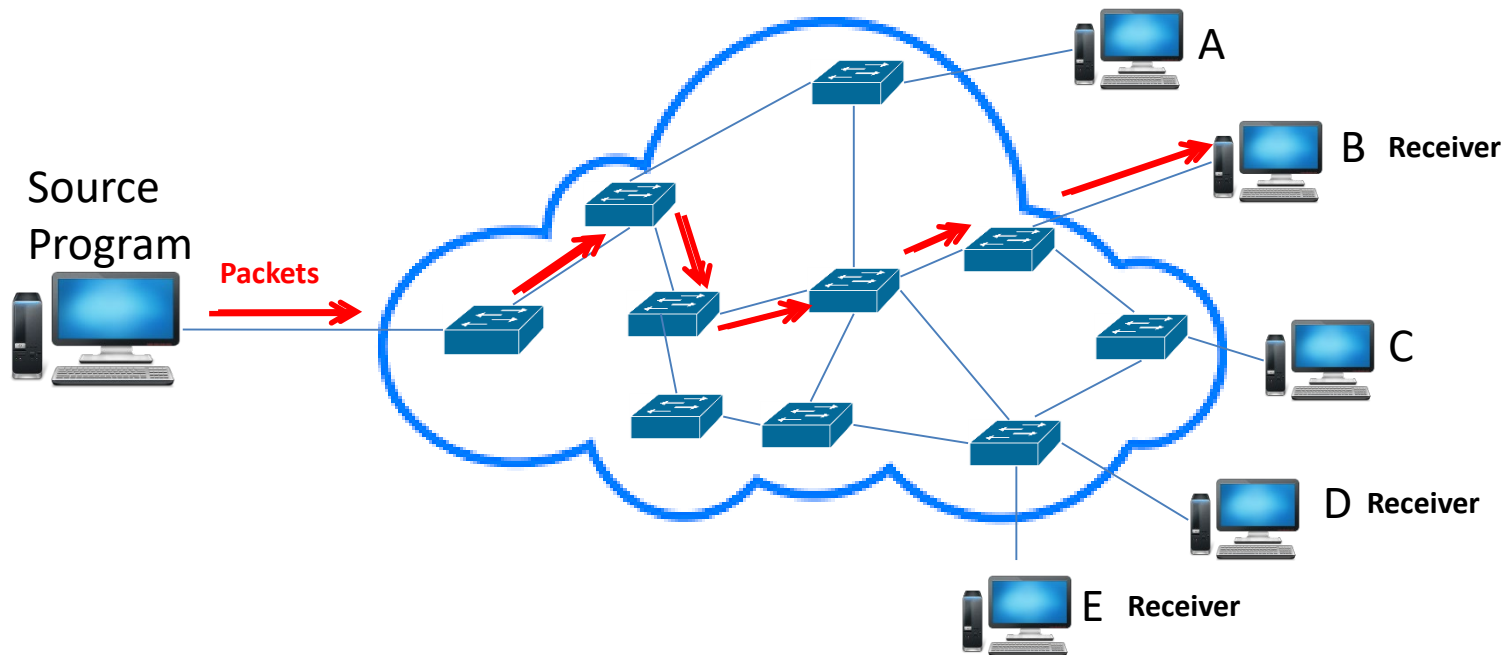




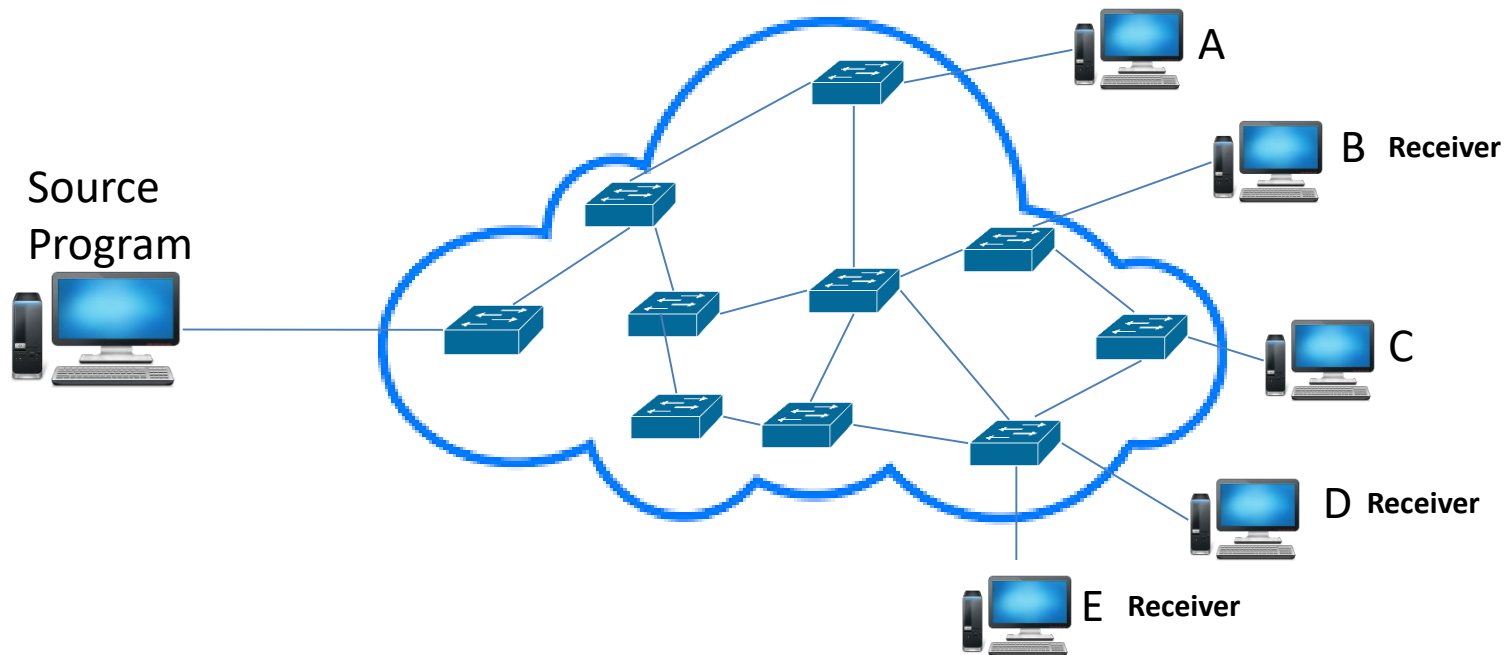
# Multicast routing



# Multicast routing



# Multicast routing





# Video Services Forum

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Reliable Internet Stream Transport (RIST) is a protocol for low-latency MPEG2 compressed streams over the internet.

ST 2110 over Wide Area Networks (WAN) deals with numerous challenges that occur when long distances separate remote video sources from production facilities.

JPEG Ultra-Low Latency (ULL) extends the specification for latencies below 1 frame, important for (REMI) applications.



# ST 2110 Suite of Standards

Standard / Specification	Description	Status
SMPTE ST 2110-10	Timing and definitions – SMPTE ST 2059 aka PTP	Published
SMPTE ST 2110-20	Uncompressed active video - RFC-4175 transport of video	Published
SMPTE ST 2110-30	Uncompressed PCM audio - AES-67 transport of audio	Published
SMPTE ST 2110-40	Ancillary data - IETF ANC 291	Published
SMPTE ST 2110-21	Video Sender Traffic Shaping for uncompressed video	Published
SMPTE ST 2110-22	Carriage for compressed video over IP	Published
SMPTE ST 2110-31	Full AES3 transport	Published
SMPTE ST 2022-6	SDI over IP – Video, audio and data interleaved	Published
AES67	High-performance streaming audio-over-IP interoperability	Published
AMWA IS-04	Discovery and registration of media flows	V1.3 approved
AMWA IS-05	APIs for managing connection between compatible flows	V1.1 approved



# Professional Groups

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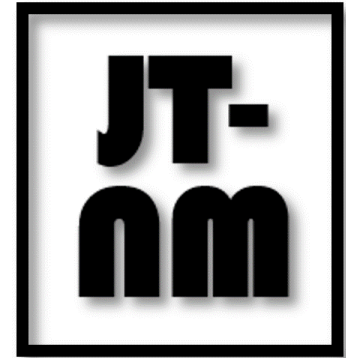




# Joint Task Force on Networked Media

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The goal is to enable the creation of networks where an end-user can take new equipment, connect it to their network, and configure it for use, with a minimum amount of human interaction.



Technical configuration regarding timing, signal transport, and routing interactions is automated by the management systems in this recommendation.



# EBU Technology Pyramid

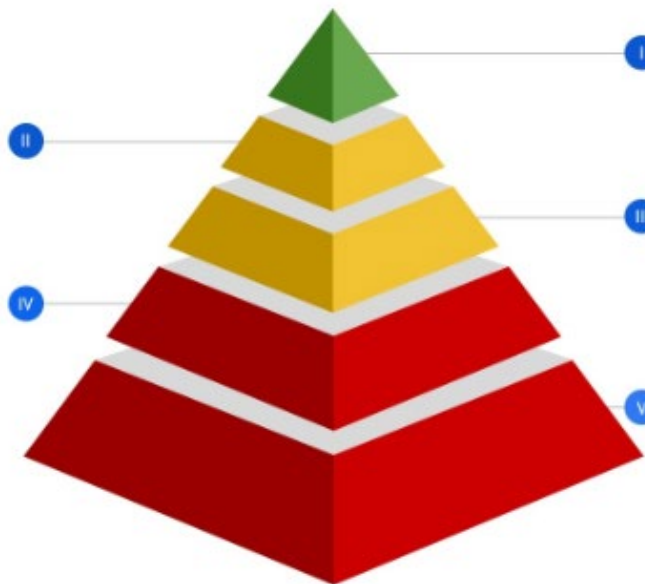
## Minimum User Requirements to Build and Manage an IP-Based Media Facility

### Time and Sync

- PTPv2 configurable within SMPTE and AES profiles
- Multi-interface PTP redundancy
- Synchronisation of audio, video and data essences

### Configuration and Monitoring

- IP assignment: DHCP
- Open configuration management - e.g., API, config file, SSH CLI, etc.
- Open monitoring protocol - e.g., syslog, agent, SNMPv3, etc.



### Media Transport

- Single link video SMPTE ST 2110-20
- Software-friendly SMPTE ST 2110-21 Wide video receivers
- Universal, multichannel and low latency audio SMPTE ST 2110-30 Level C
- Stream protection with SMPTE ST 2022-7

### Discovery and Connection

- Discovery and Registration: AMWA IS-04
- Connection Management: AMWA IS-05
- Audio channel mapping: AMWA IS-08 (in dev.)
- Topology discovery: LLDP

### Security

- EBU R 148 Security Tests
- EBU R 143 Security Safeguards
- Secure HTTPS API calls





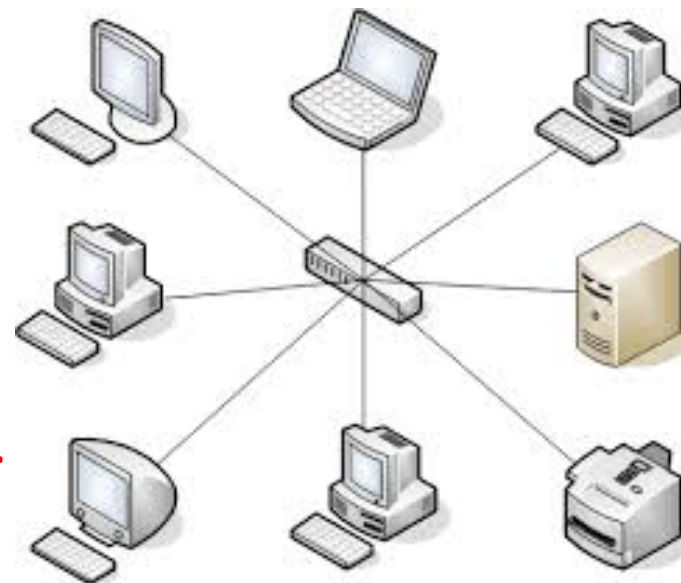
# IP Network Star Topology

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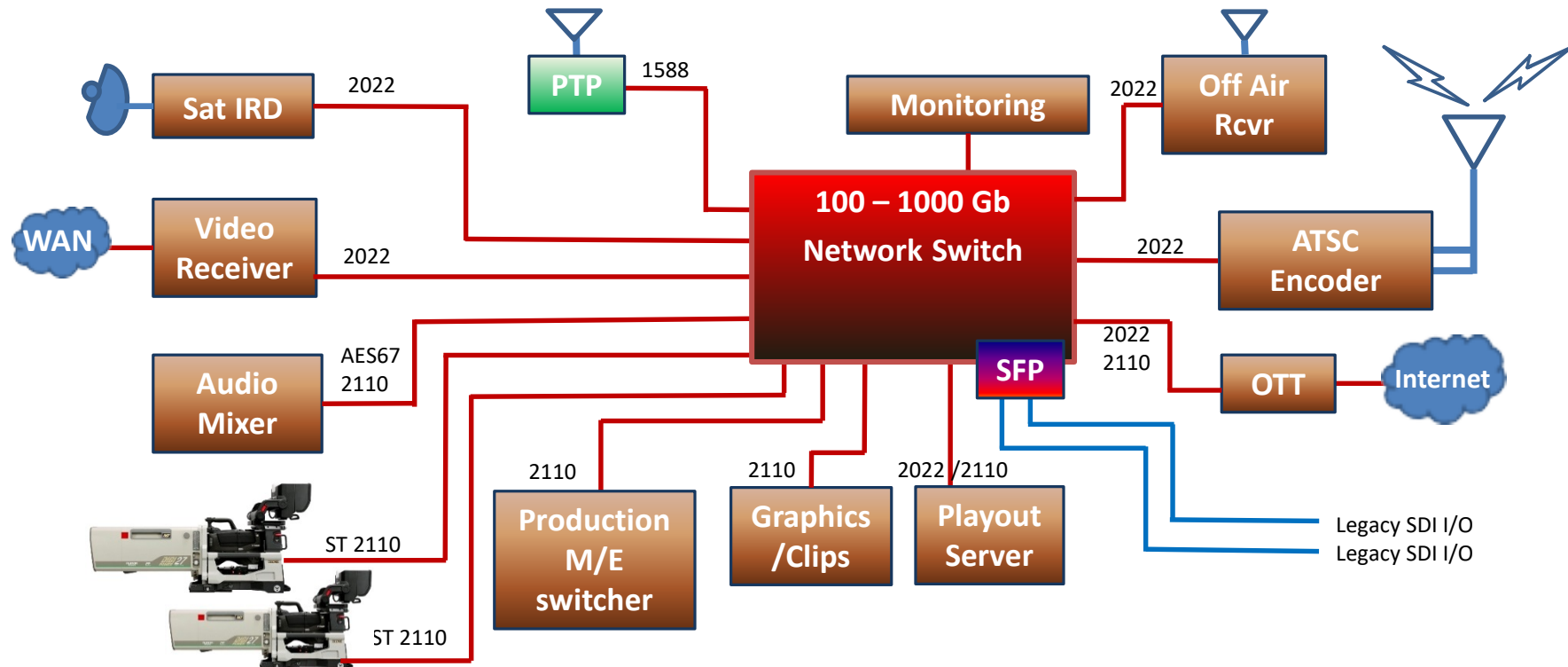
In a star network every host (source or destination) is connected to the central switch.

The transmission lines between them, form a star.

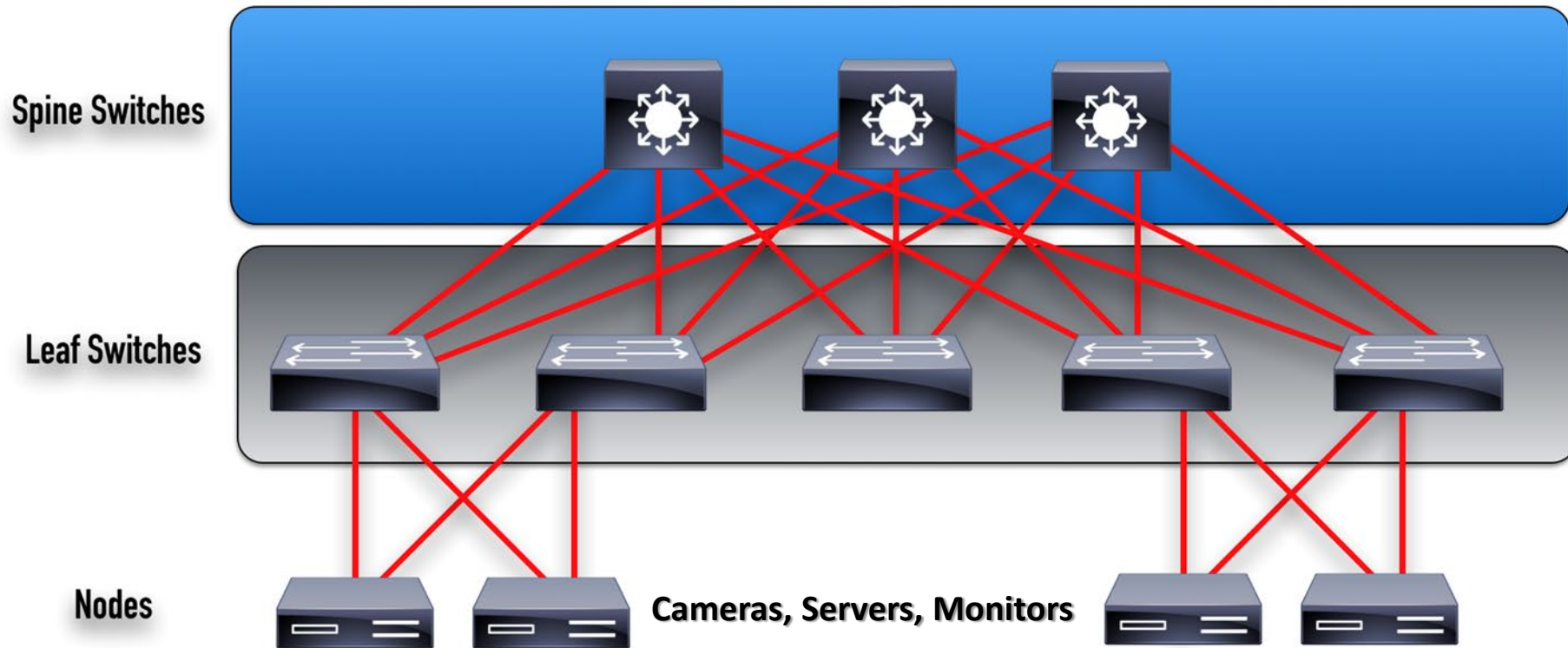
All data passes through a central switch.



# Video - IP Network Star

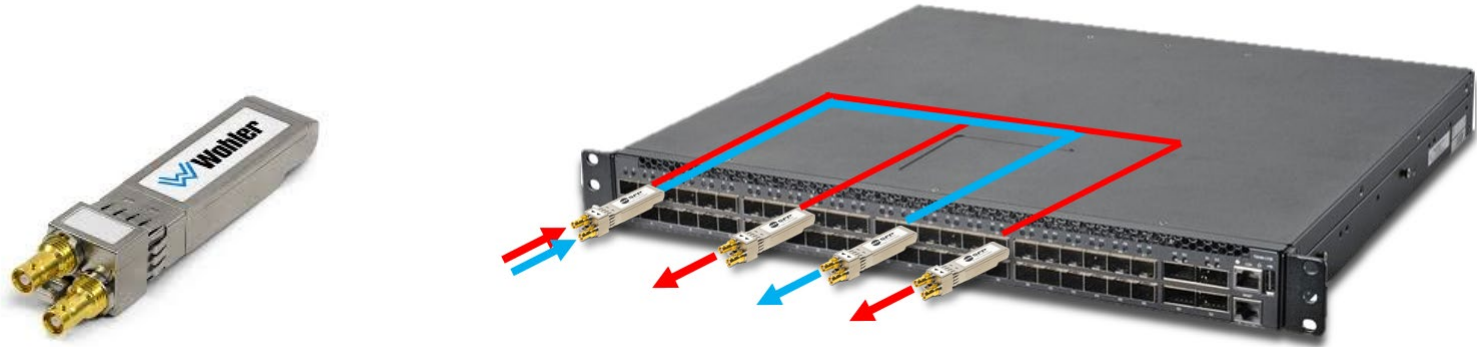


# Leaf & Spine Topology





# Hybrid SDI/IP Gateway



## Small Form Factor Pluggable (SFP)

Converts SDI inputs and/or outputs to ST 2110

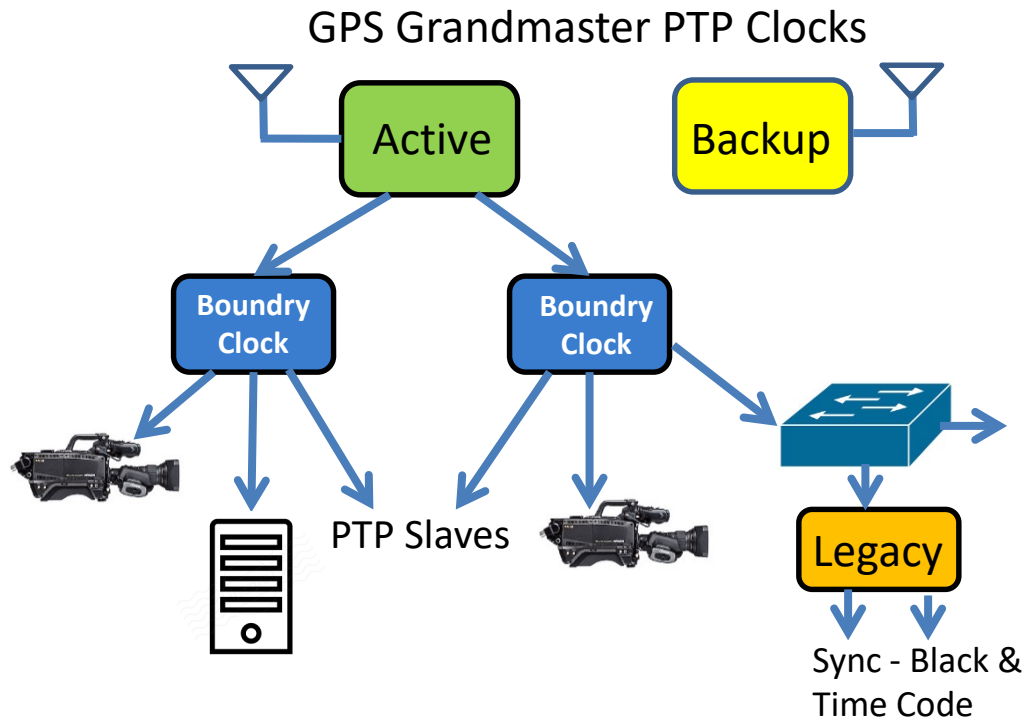
Plugs into Switch SFP ports. Currently 1Gb, 10Gb and 25Gb

# Precision Time Protocol

**SMPTE ST 2059 / IEEE 1588**

No need for separate signal paths for sync

PTP will allow devices to be precision slaved to a common master clock



# Standards Groups

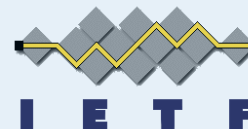
**SMPTE ST 2110**  
**SMPTE ST 2022**  
**AES67**



IETF RFC 4566 (SDP)

IETF RFC 791 (IPv4), RFC 2460/8200 (IPv6)

IETF RFC 793 (TCP), RFC 768 (UDP), RFC 3550 (RTP), RFC 2236/3376 (IGMP Multicasting)



IEEE 802.3 (Ethernet), 802.11 (WiFi), IEEE 1588 (PTP)

Cat 5 ANSI/TIA, ISO/IEC 11801 (Copper/Fiber)

ITU-T G.651.1 (Fiber), IEEE 802.11 (WiFi)



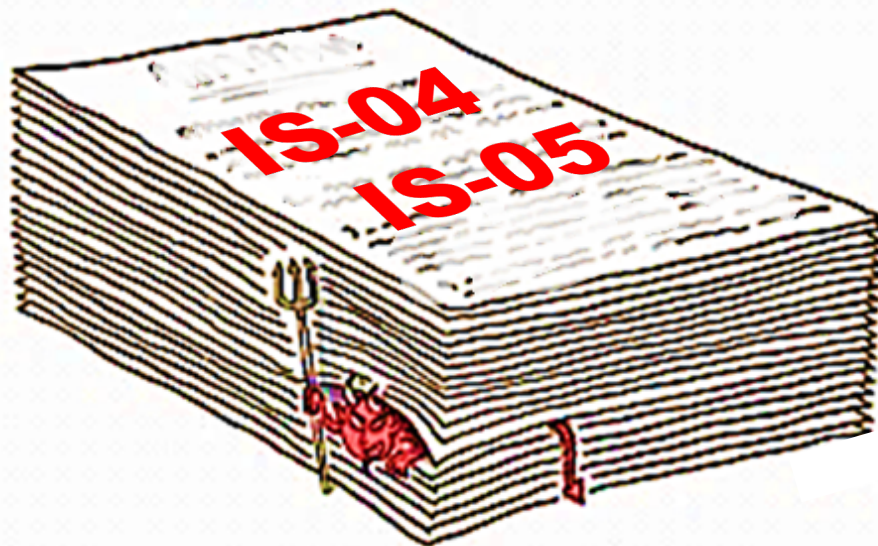


# ***NMOS***



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Advanced Media Workflow Association  
Networked Media **Open** Specifications







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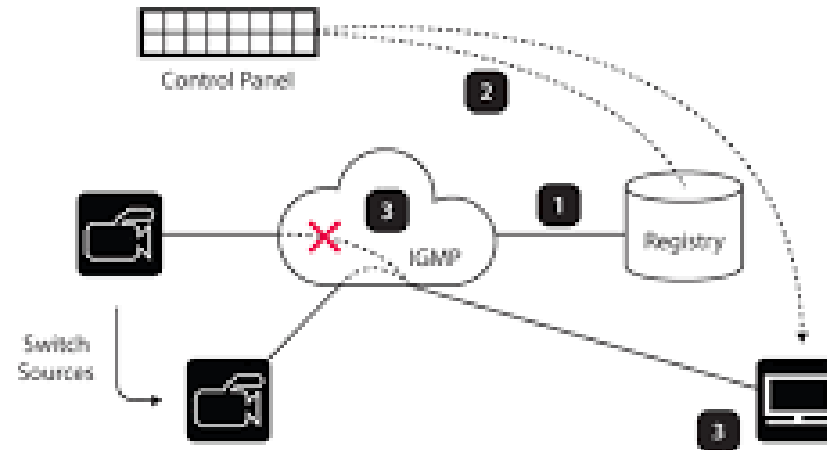
Requiring television engineers and production people to know all the configurations for connecting IT devices is impractical.

ST 2110 was supposed to be **PLUGANDPLAY**

**OPEN** Protocols are critical for further deployment of ST 2110.



NMOS specifies **OPEN** protocols for discovery, registration and connection management based on ST-2110.



- 1 Sources automatically register with RDS
- 2 Control Panel gets list of devices from RDS
- 1 Upon button press, control system commands receiver to join the new multicast stream and leave the previous one



Systems need to have a common way for that device to describe all of the things it is capable of doing. (Like a USB device)

AMWA's protocol for Registration & Discovery will not be part of the SMPTE 2110 standard.

But, NMOS must be part of the overall solution for managed IP netw





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ST 2110 defines devices on the network that send & receive  
It does not deal with control or applications.

NMOS is part of the overall solution for managed IP networks.

Network Security is a big potential issue.






# NMOS Specifications

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IS-04	Discovery & Registration
IS-05	Media Device Connection
IS-06	Network Control
IS-08	Audio Channel Mapping
IS-09	System Discovery
BCP-003	Security
IS-10	Authorization API





# Other Proposed Protocols

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**NewTek NDI: *Network Device Interface*.** NewTek has put forth an alternative **compressed** IP Standard for interoperability consideration.

**Sony NMI: *Networked Media Interface*.** Sony protocol being phased out. Compression called LLVC (Low Latency Video Codec) will be retained.

**IPMX: *Open Standard for Pro AV*.**



# NMOS

(cont.)

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Most of the work towards open deployment of discovery and registration protocols are being developed by AMWA

The disconnect between standards organizations (SMPTE) and technical recommendations organizations (AMWA) is slowing the process of setting standards.



# HITACHI

Broadcast and Professional Cameras  
Hitachi Kokusai Electric America

**Hitachi website Video Gallery**

**<https://www.hitachikokusai.com/AboutHitachiKokusai/VideoGallery/>**

**Email Address**

**[John.Humphrey@HitachiKokusai.us](mailto:John.Humphrey@HitachiKokusai.us)**