

When a Network is No Longer Just a Network

Merging AV and Network
Infrastructure

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**2018 BICSI WINTER
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Orlando, FL | February 4-8

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Agenda

- Networks
 - Supporting the Enterprise with Network Cable
 - Compression vs Uncompressed
- Video Signals
 - HDMI
 - USB 3.1 Type C
 - EDID
 - HDCP
 - IP Control
- CAT Cable for Video Over Twisted Pair
 - Shielded Cable
- Streaming Video
- Designs

Networks



What can you use a network for?

- Audio Signals
- VOIP
- Video
- Data
- Lighting
- VTC
- Control
- Multiple devices on a single network



VoIP

- VOIP – Voice over Internet Protocol is the delivery of voice communications over the Internet
- Public Switched Telephone Network (PSTN) is the worldwide topology that connects all telephones
- PSTN today is 99% digital with the Plain Old Telephone System (POTS) the only analog component remaining

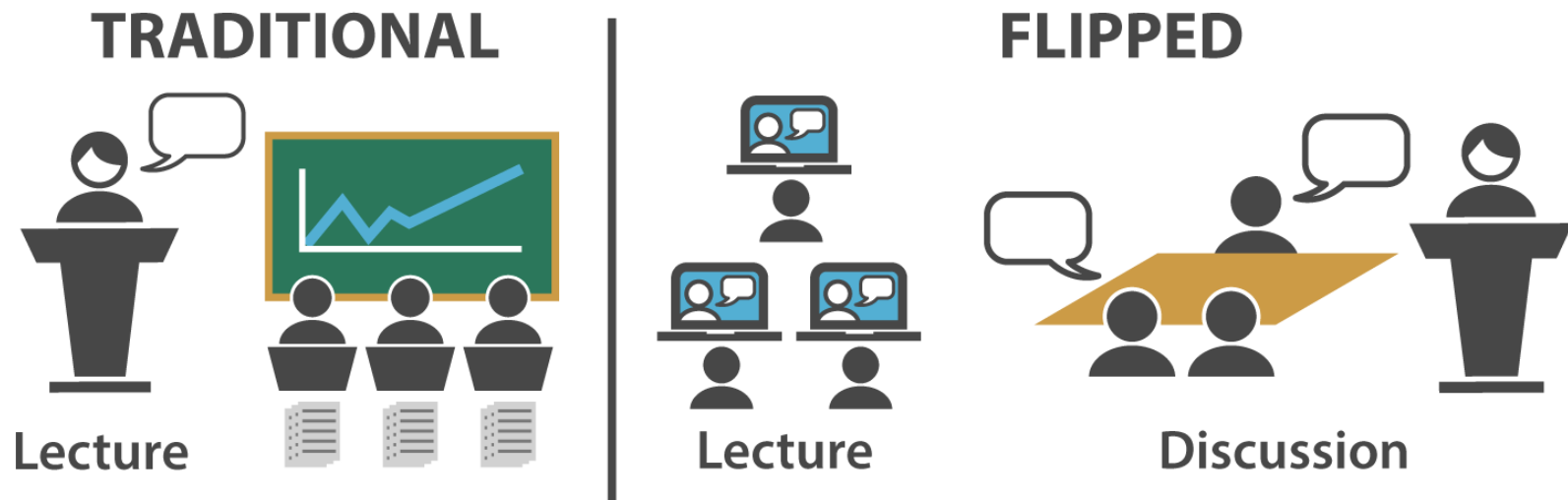


Streaming Video

- Streaming is becoming more and more popular
- Movies, Concerts, Educational Lectures, Video Conferencing, and Events are becoming more common via Streaming Video
- It is easily accessible and a common method for content delivery with a variety of different devices



Recording and the “Flip Classroom”



Data

- Access to files, folders, and content allows for greater collaboration and requires a secure network connection
- Live information and mission critical applications demand up to the second statistics and video data

A flight information board displaying flight details for various airlines and destinations.

Flight		
QF	085	HONG KONG
NZ	008	AUCKLAND
CX	104	HONG KONG
MH	148	KUALA LUMPUR
	1121	KUALA LUMPUR



Control

- More and more devices are capable of being controlled remotely over network connections
- Computers, Thermostats, Displays, Lights, Room Schedulers, Sound Systems, and Security Systems comprise the most commonly connected network devices and are used in a variety of applications



Audio

- Audio expansion now occurs using network cables
- Signals are sent over the network to different devices with almost zero latency
- Dante enabled devices can send audio signals over CAT5e, CAT6, or fiber optic cables



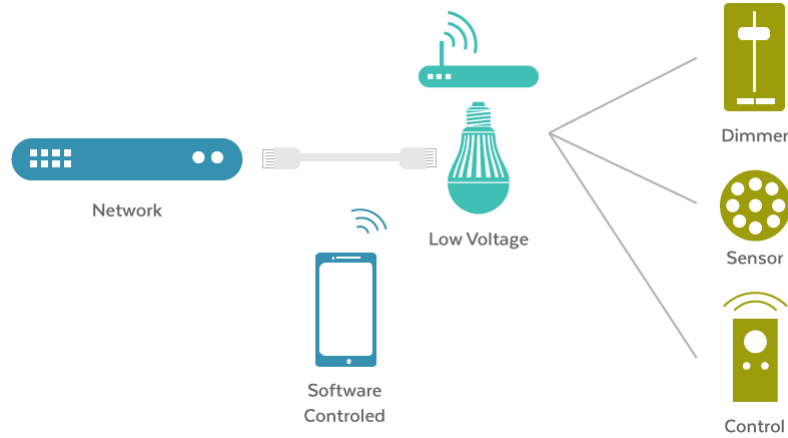
Multiple Types of Devices

- Networks need to be capable of handling multiple types of devices and environments where BYOD is common



LED Lighting

- Control and power lighting fixtures via POE
- Energy efficient LEDs provide cost savings, easy installation, and enhanced flexibility with projects of all sizes



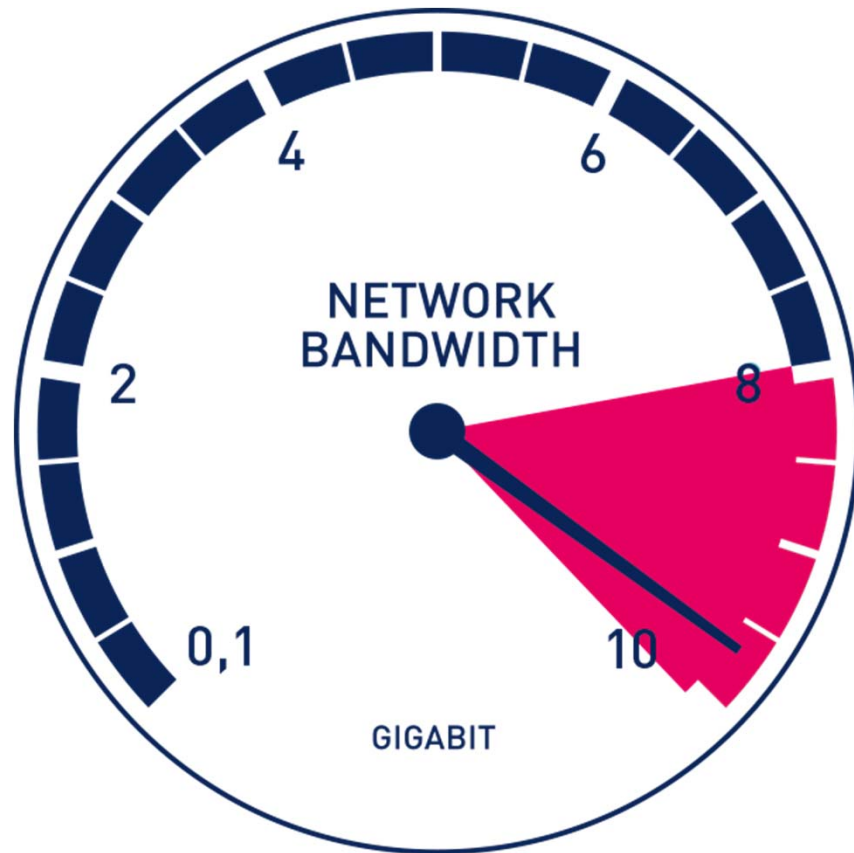
Wireless

- Devices that don't have physical connections rely on wireless connectivity to send and receive Audio Visual data



The Biggest Question

- Bandwidth and Data Rate
- 1Gigabit E
- 10 Gigabit E
- 40 Gigabit E



Video Signals



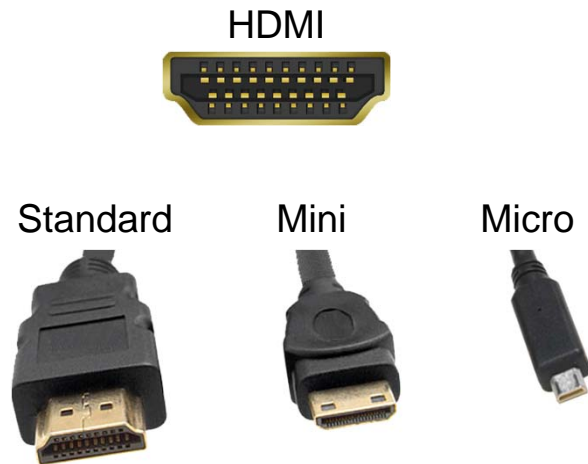
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Digital Signals – HDMI

- HDMI is an uncompressed digital video signal
 - Designed for the consumer market
- Adds support for:
 - Audio – stereo and surround formats (PCM, Dolby, DTS)
 - YCbCr color space – optional
 - HDCP – optional but recommended
 - CEC – Consumer Electronic Control – optional
 - InfoFrames



HDMI – Connectors, Distance, Communication



Mini

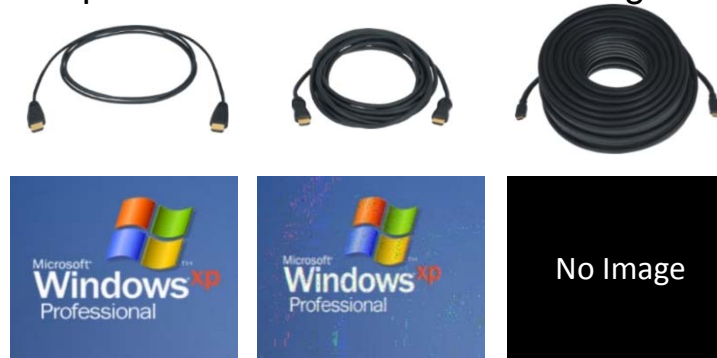
- Added in HDMI version 1.3

Micro

- Max resolution 1080p

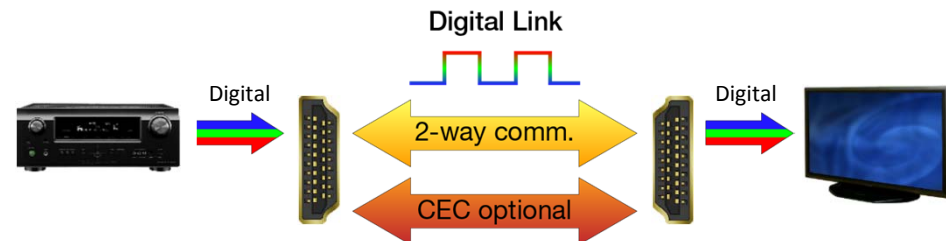
HDMI specification does not define transmission distance

- Cable performance has a direct bearing on distance



EDID information is sent from the display to the source

- Required by HDMI specifications

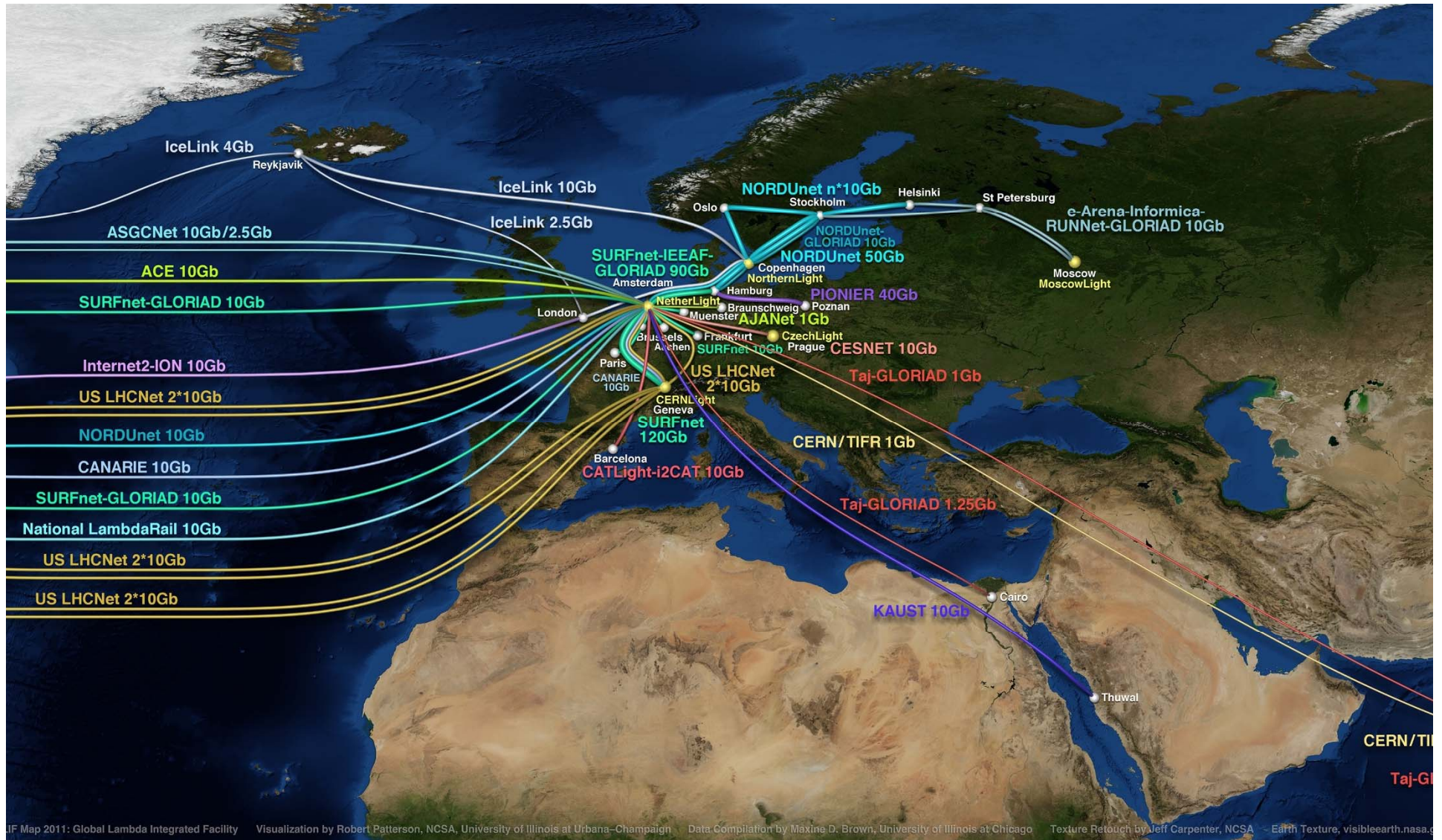


Resolutions

- Old Resolutions
- New standard 1080p
- Headed to 4K/UHD and 8K





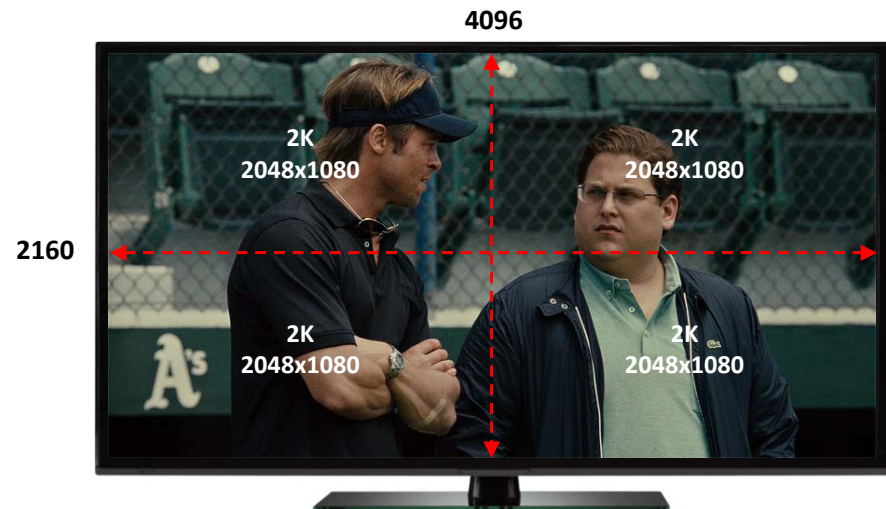
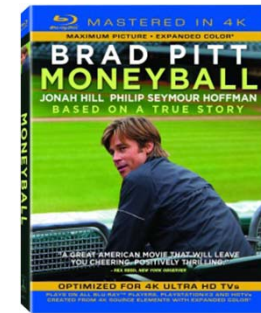


IF Map 2011: Global Lambda Integrated Facility Visualization by Robert Patterson, NCSA, University of Illinois at Urbana-Champaign Data Compilation by Maxine D. Brown, University of Illinois at Chicago Texture Retouch by Jeff Carpenter, NCSA Earth Texture, visibleearth.nasa.gov



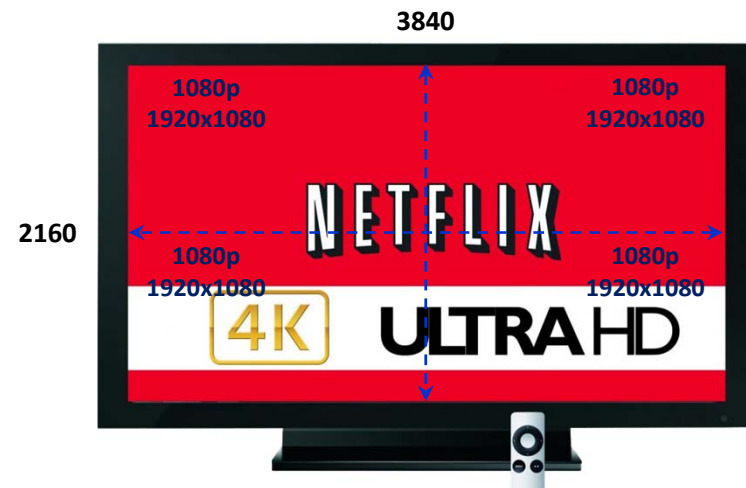
4K Signal Parameters

- 4K DCI is 4096x2160
 - Four times the resolution of 2K DCI
 - Targeted towards digital cinema
- 4K refresh rates
 - Varies – 24 Hz up to 60 Hz
- Color bit depth
 - 8-Bit, 10-bit, and 12-bit
- Aspect Ratio
 - 17:9 – same as 2K

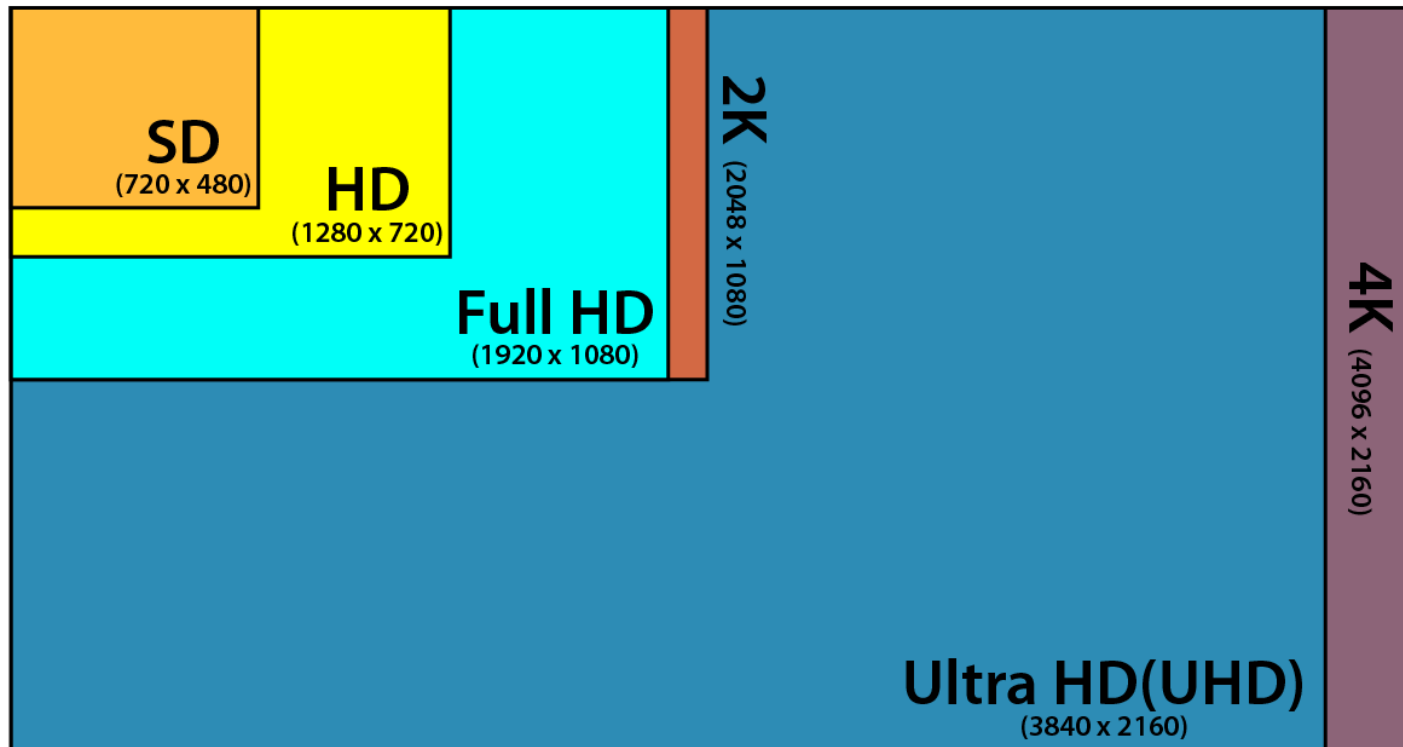


Ultra HD Video Signal Parameters

- Ultra HD is 3840x2160
 - Four times the resolution of 1080p
 - Targeted towards consumer and broadcast markets
- Ultra HD refresh rates
 - Varies – 24 Hz up to 60 Hz
- Color bit depth
 - 8-Bit, 10-bit, and 12-bit
- Aspect Ratio
 - 16:9 – same as 1080p



4K and Ultra HD Resolution Comparison



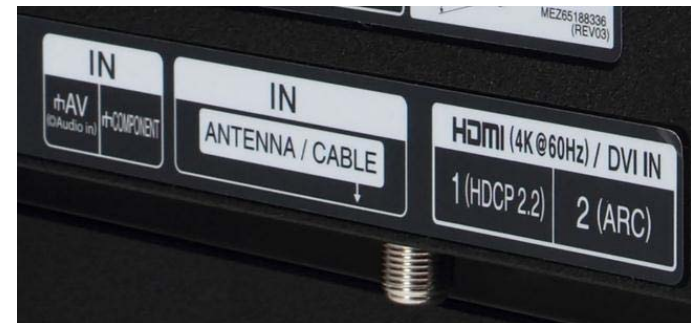
8K Ultra HD Video Signal Parameters

- 8K Ultra HD Super Hi-Vision is 7680x4320
 - 16 times the resolution of 1080p
 - Designed to be superior to the human visual system
 - Shoots at 2x the rate of normal video so movement is smooth and realistic
- Aspect Ratio
 - 16:9
- 8K refresh rates
 - Varies – up to 120 Hz
- Color bit depth
 - 8-bit, 10-bit, and 12-bit
- Chroma sampling
 - 4:4:4, 4:2:2, or 4:2:0



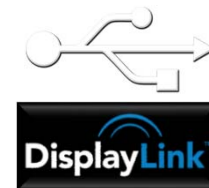
HDMI 2.0 and HDMI 2.1

- **New functionality includes**
 - Enables transmission of HDR – High Dynamic Range video
 - Signaling speed to 18 Gbps
 - 4K@50Hz/60Hz, (2160p)
 - 4 times the clarity of 1080p/60 video resolution
 - Up to 32 audio channels with up to 1536 kHz audio sample frequency
 - 32 channels @ 48kHz each
 - Dual video streams on same screen, 4 audio streams
 - Support widescreen 21:9 format
 - Dynamic sync of audio/video
 - CEC extensions with expanded control via single point
- **Backwards compatible**



Digital Signals – USB

- Over the years speeds have increased and USB supports video and audio transfer
 - USB 2.0 - 480 Mbps
 - USB 3.0 - 5 Gbps
 - USB 3.1 -10 Gbps
- Providing additional options for transporting video and audio



USB Type-C

- Send Data, Video, Audio, and Power
- Latest, high speed, reversible USB
- 10Gbps data rate (V3.1), V3.0 = 5Gbps
- Deliver up to 100 watts! Devices negotiate...
- Supports “alternate modes” ... like DisplayPort
- “...beyond 20 Gbps in the future.”
 - Pres. USB-IF

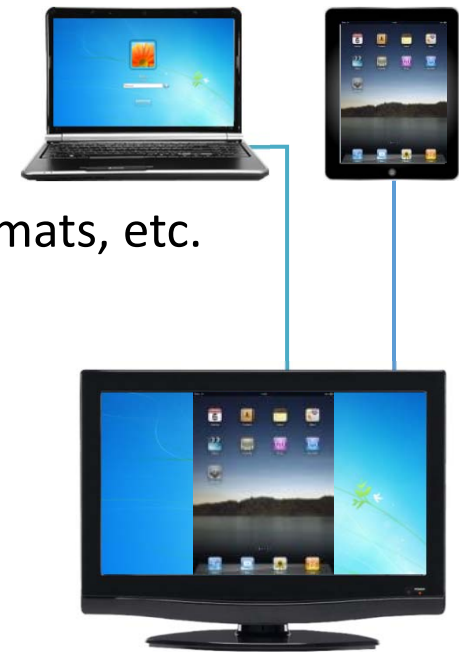


TYPE-C PLUG & CABLE



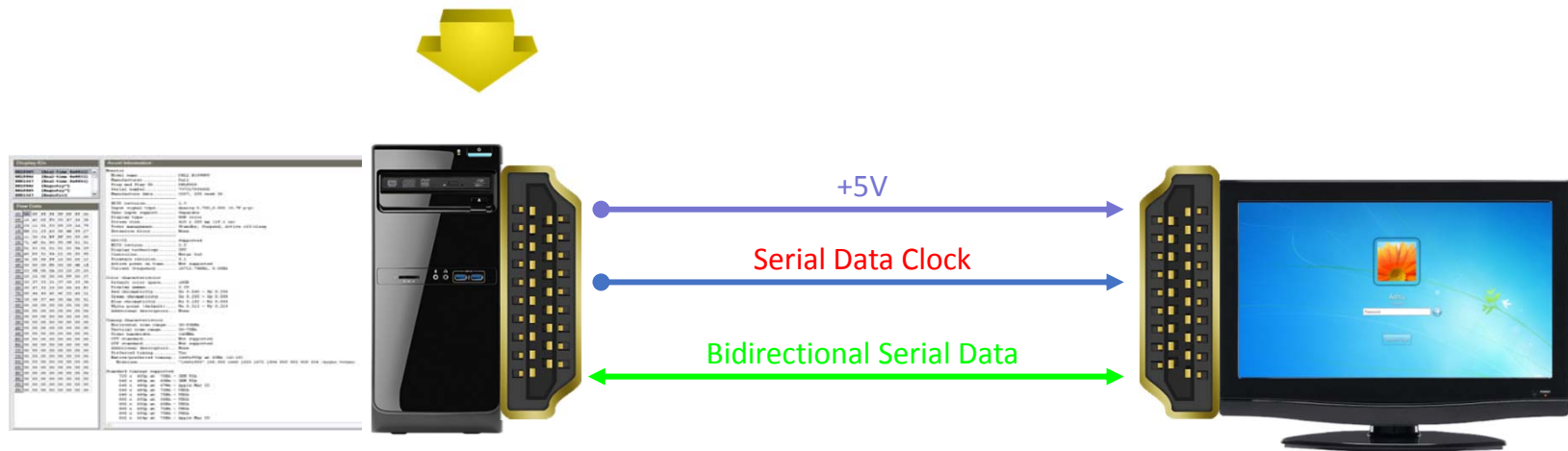
EDID – Extended Display Identification Data

- EDID contains the following information:
 - Sink identity – device type, model number, etc.
 - Sink capability – video/audio
 - Video timing parameters, color space, audio formats, etc.
- EDID also defines the data structure
 - Block 0 – 128 byte of hexadecimal data
 - Block 1 – additional 128 byte of hexadecimal data
 - Block 1 was added in version 1.3



EDID – Sequence

1. Power on PC or activate external graphics card
2. Computer requests EDID data from display
3. Display sends EDID data to computer
4. Computer attempts to match display parameters



HDCP – High-bandwidth Digital Content Protection

- HDCP protocol is a 3-phase process
 - Authentication
 - Content encryption
 - Renewability
- This can take a few moments depending on the number of downstream devices



DVD Player

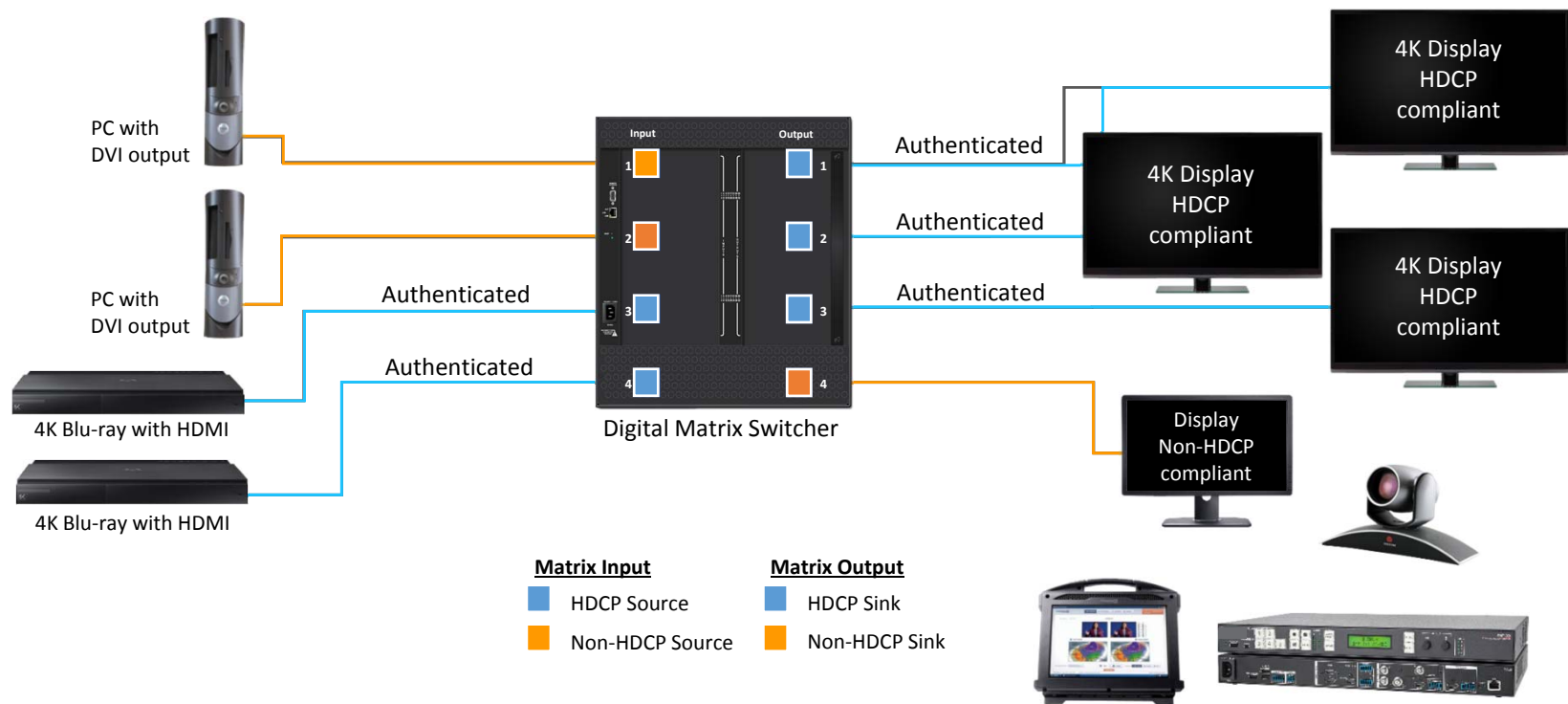


Blu-ray with HDMI



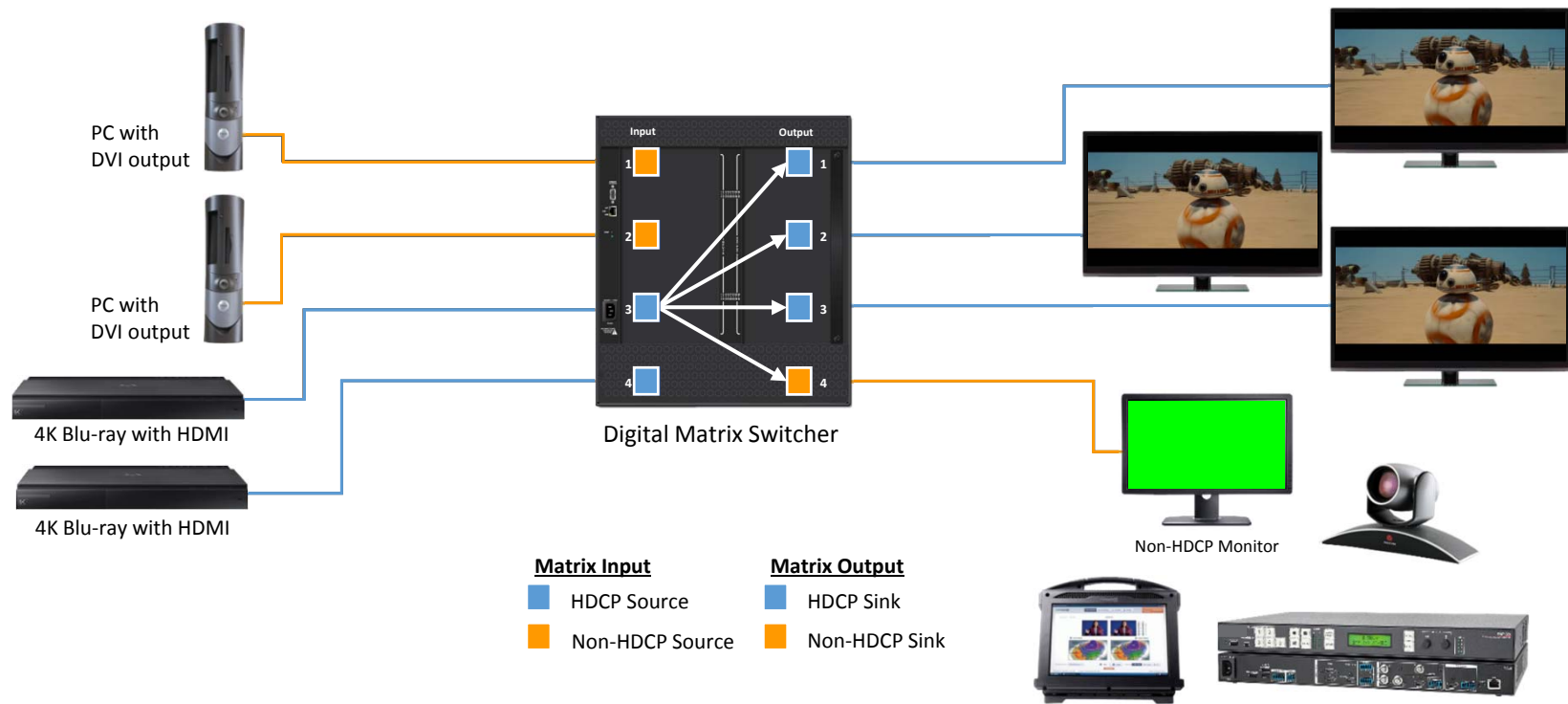
HDCP Handshakes

- I/O authentication



HDCP Handshakes With Products That Are Not HDCP Compliant

- Visual confirmation



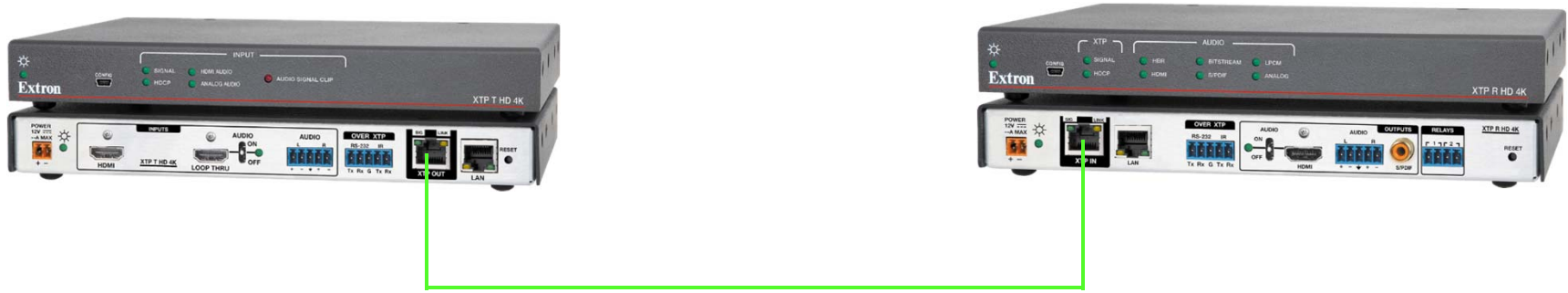
Uncompressed Video Over Twisted Pair



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Twisted Pair Transmission

- Distance
 - 328 feet (100 meters) between endpoints

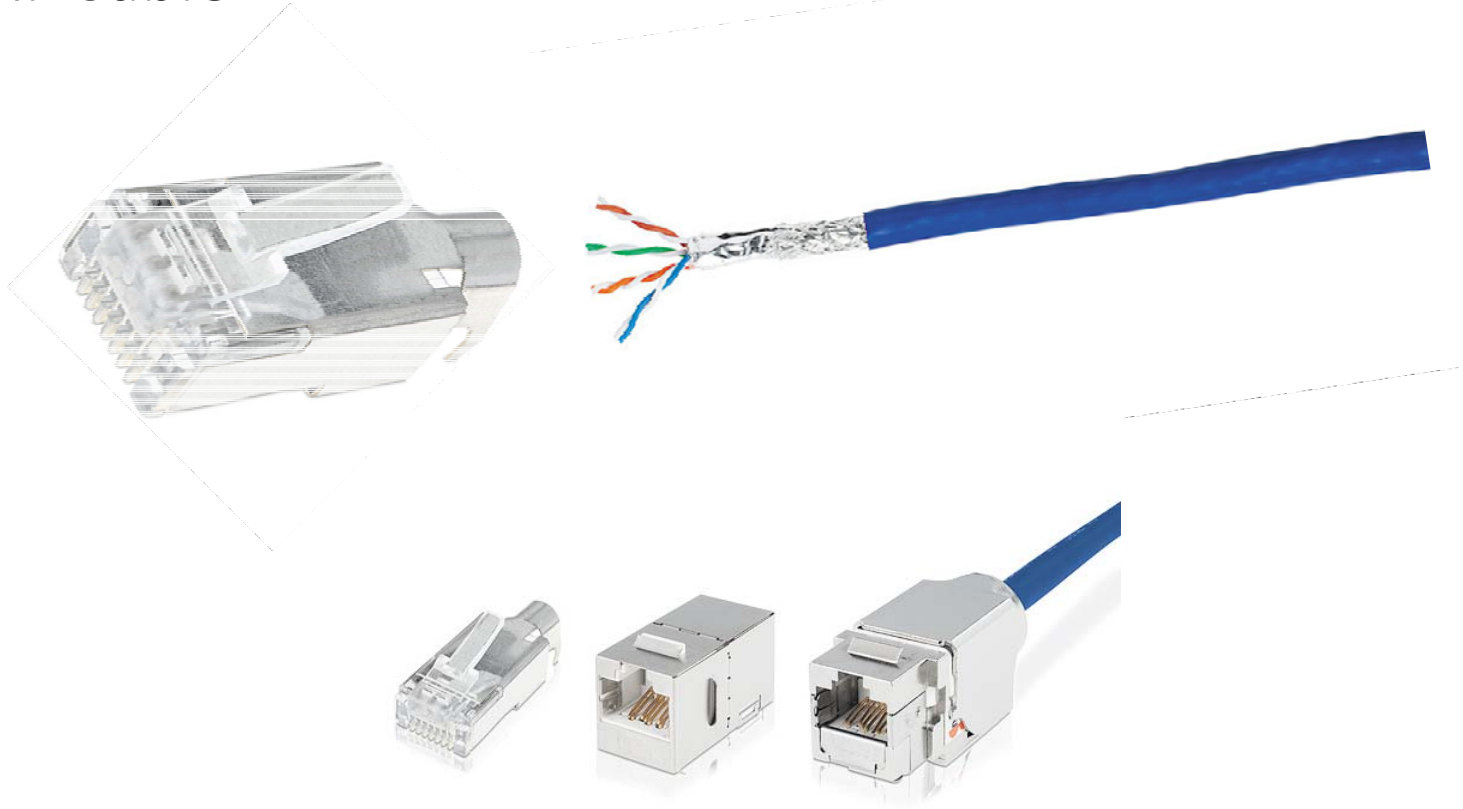


Why Use Twisted Pair?

- One twisted pair cable can carry multiple signals
 - Video
 - Audio
 - Bidirectional RS-232 control and IR
 - Ethernet
 - Remote Power



CAT Cable



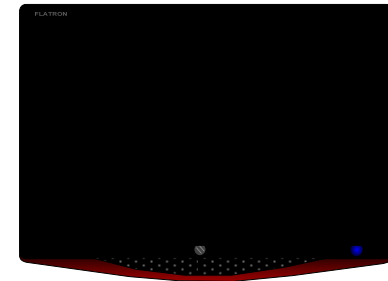
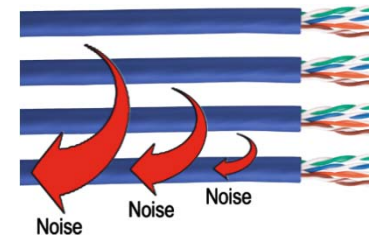
Twisted Pair Transmission

- Cable
 - Supports CATx cable
 - Solid conductor, shielded twisted pair cable with shielded connectors should always be used
 - Skew-free cable **should not** be used with XTP Systems



Twisted Pair Signal Transmission

- Shielded cable protects against outside interference from:
 - Air conditioning units
 - Power from adjacent cabling
 - Crosstalk from other cables or within the same cable
 - Radio interference from walkie-talkies
- Symptoms of noisy environments
 - Image drop-out or flashing
 - No image at all

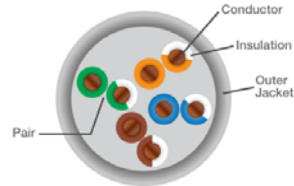


Twisted Pair Shielding

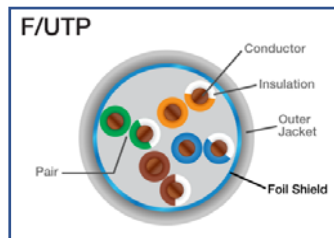
- Different types of twisted pair shielding

Cable Name	Outer Shielding	Individual Pair Shielding
U/UTP	None	None
F/UTP	Foil	None
U/FTP	None	Foil
S/FTP	Braided	Foil
SF/UTP	Braided & Foil	None

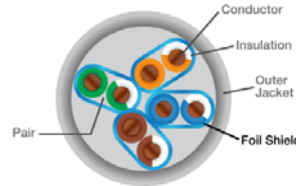
U/UTP



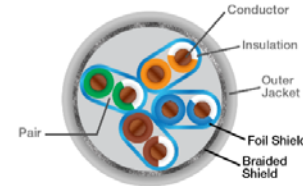
F/UTP



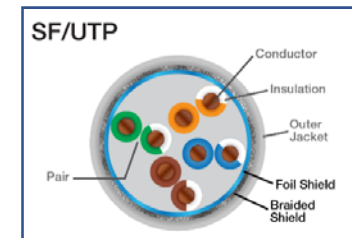
U/FTP



S/FTP



SF/UTP



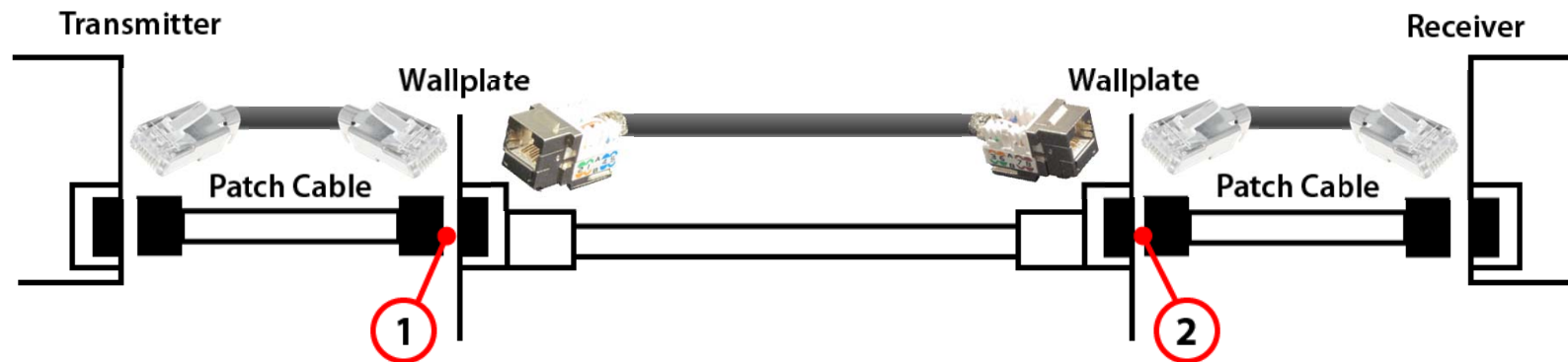
Twisted Pair Signal Transmission

- Types of Category cable

Cable	Gauge	Conductor	Outer Shield	Pair Shielding	Required Bandwidth	Crosstalk Loss
CAT 5e (U/UTP)	24	Solid	None	None	100 MHz	~27dB
CAT 5e (F/UTP)	24	Solid	Foil	None	100 MHz	~27dB
CAT 6 (U/UTP)	24-23	Solid	None	None	250 MHz	~37dB
CAT 6 (STP)	24-23	Solid	Foil	None	250 MHz	~37dB
CAT 6a (U/UTP)	24-23	Solid	None	None	500 MHz	~37dB
CAT 6a (F/UTP)	24-23	Solid	Foil	None	500 MHz	~37dB
CAT 6a (U/FTP)	24-23	Solid	None	Foil	500 MHz	~37dB
CAT 6a (SF/UTP)	24	Solid	Braid and Foil	None	500 MHz	~37dB
CAT 7 (S/FTP)	24	Solid	Braid and Foil	Foil	600 MHz	~60dB
CAT 7a (S/FTP)	24	Solid	Braid and Foil	Foil	1 GHz	~60dB

Twisted Pair Installation

- Cable infrastructure and patch points
 - Up to 2 patch points recommended



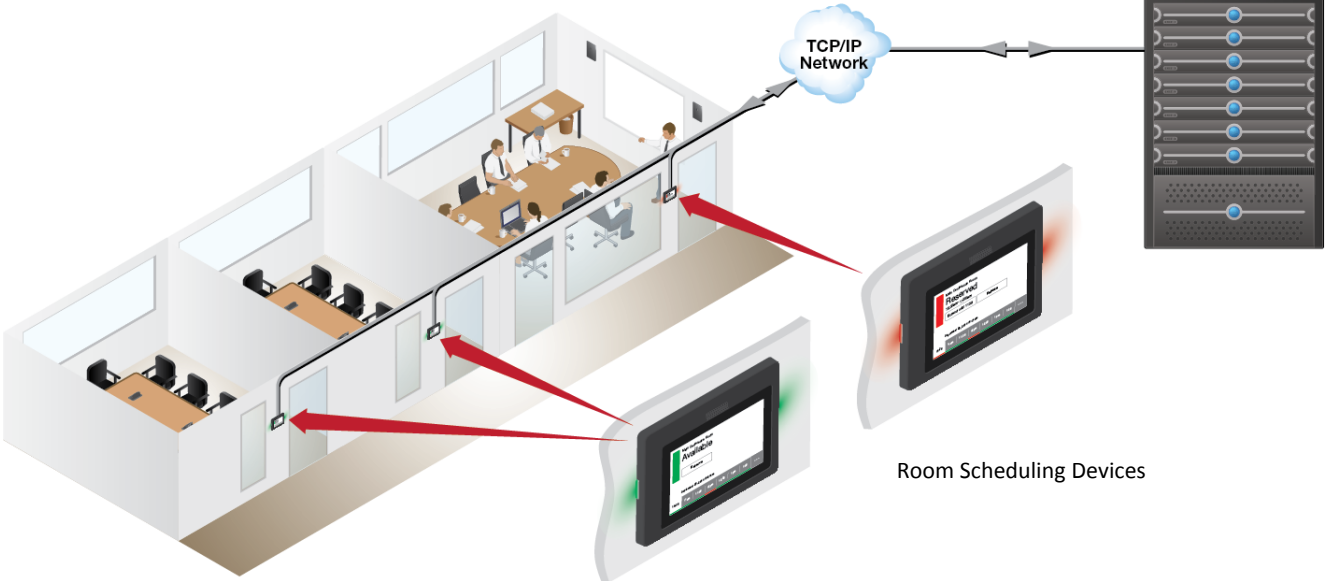
Typical scenario for AV connectivity

IP Control

- Devices on the Network are capable of communication, configuration, and control
- Devices will often have internal webpages for configuration



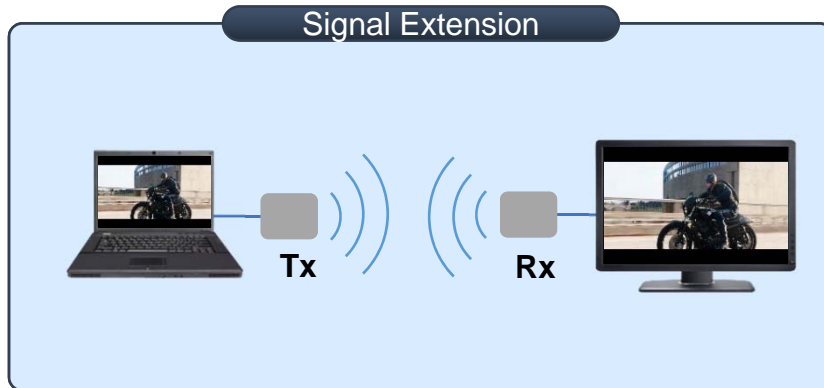
Room Scheduling



Room Management



Wireless Video Applications

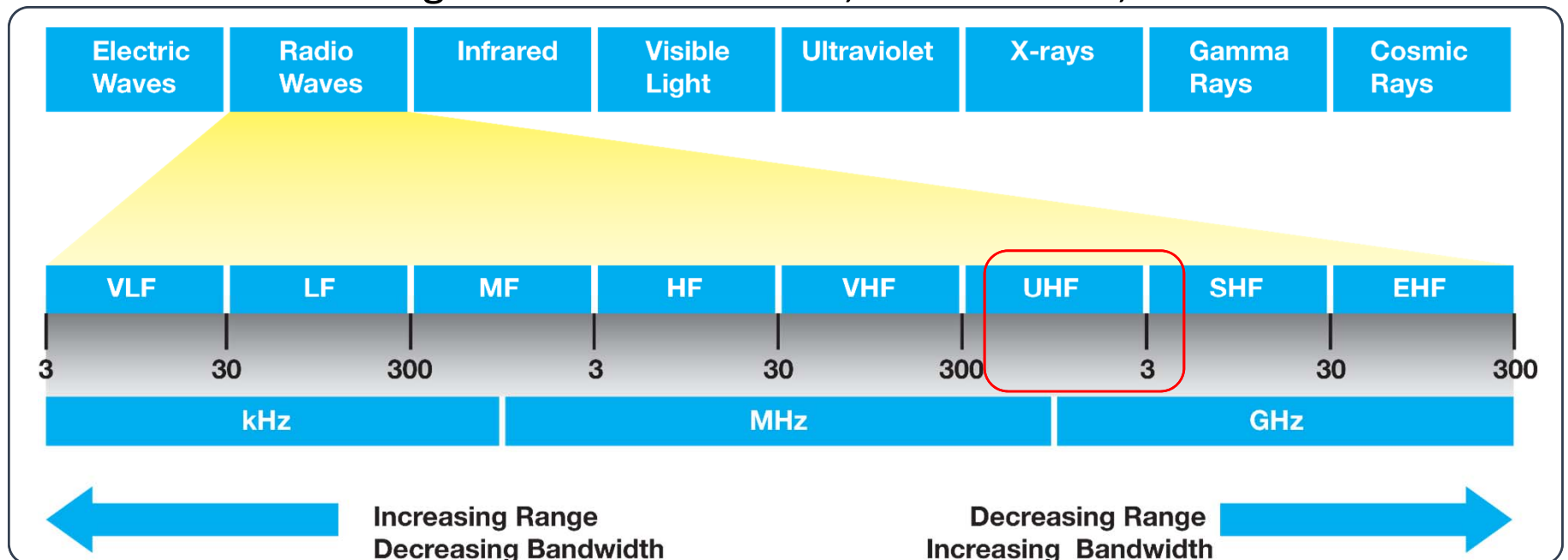


- Point-to-point applications where source video signal is converted to a modulated RF signal for wireless transmission to a receiver connected to a display

- BYOD applications where computing device encodes and transmits video content over a Wi-Fi network to a receiver connected to a display

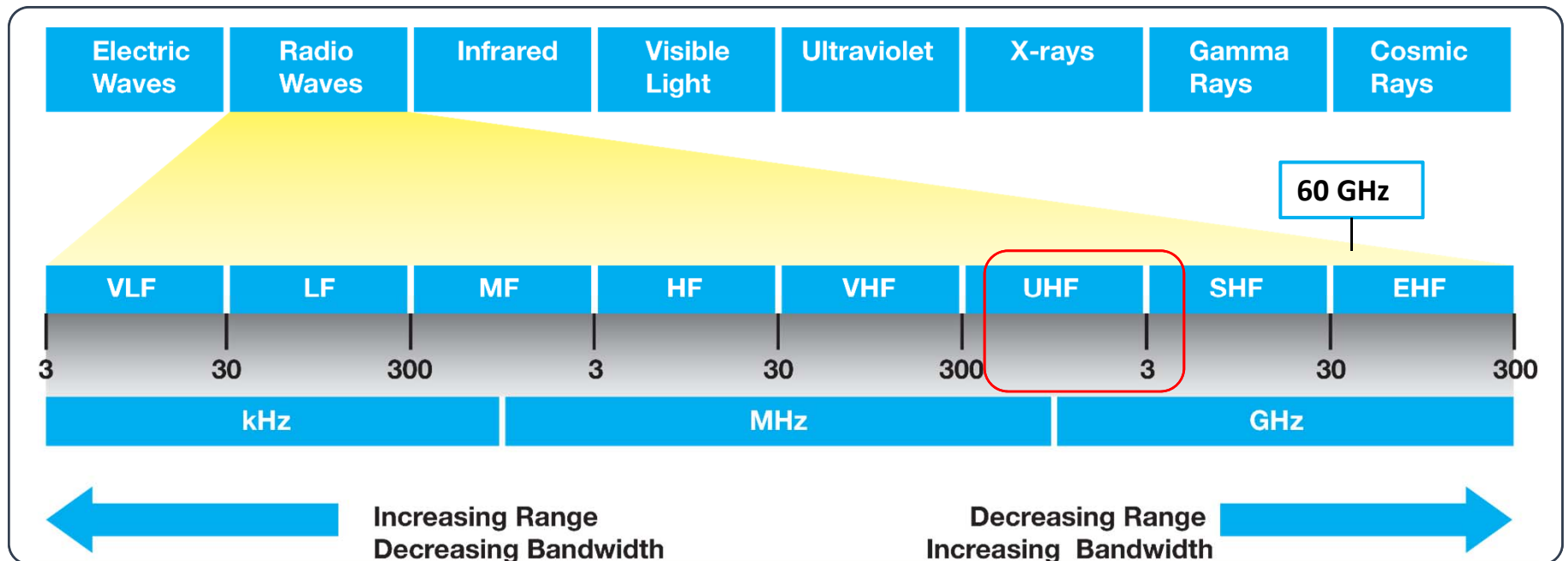
Radio Frequency Spectrum

- 500MHz to 5GHz balances capacity and range
- Transmits through common obstacles, such as walls, with low to



Radio Frequency Spectrum

- 60 GHz used for higher data carrying capacity
 - Cannot penetrate solid objects



Wireless Technologies

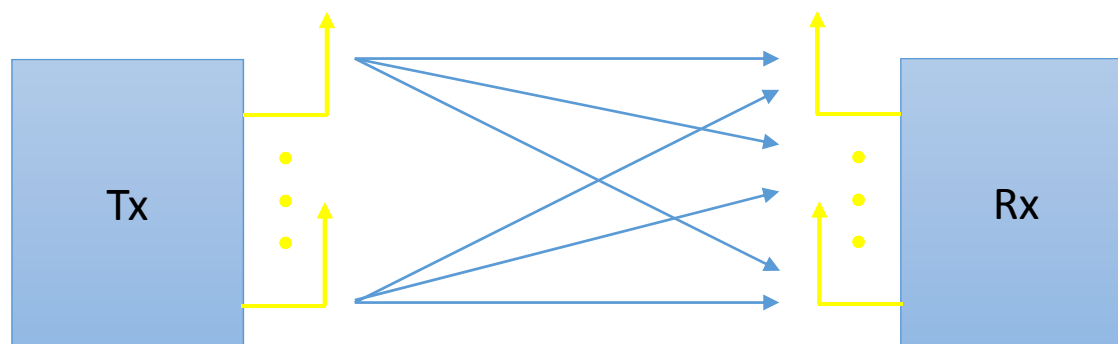
Compressed and Uncompressed



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MIMO – Multiple-input, Multiple-output

- Smart antenna technology using multiple antennas on both transmitter and receiver to improve performance
 - Spatial multiplexing
 - Same frequency, different information on each antenna
 - Each signal travels multiple paths from Tx to Rx
 - DSP – Digital Signal Processor in receiver separates the signals into parallel paths and restores the original signal

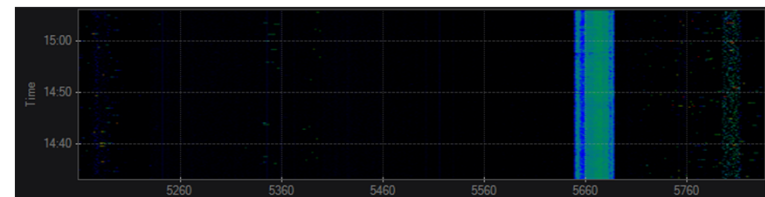
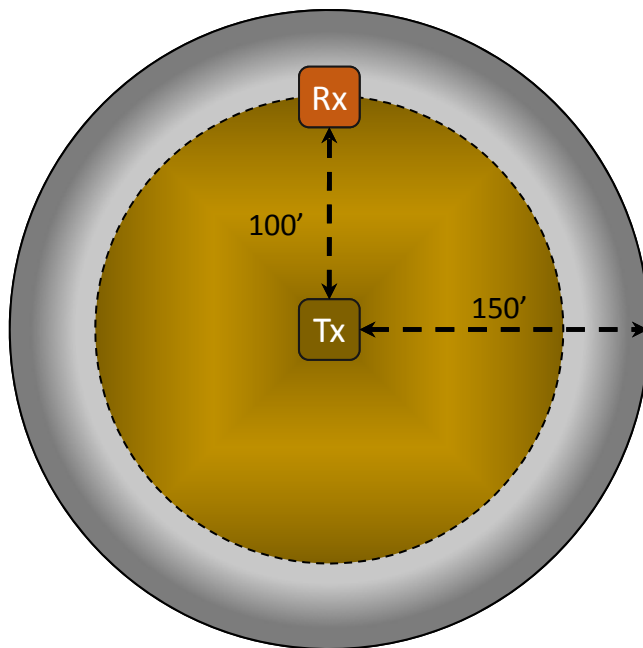


Proprietary Wireless Protocols

Wireless Interface	Frequency Band	Computing Hardware Required	Uncompressed Video
AirPlay	Wi-Fi	Apple Products	No
Chromecast	Wi-Fi	PC, tablet, smartphone	No
Miracast	Wi-Fi	PC, tablet, smartphone	No
WiDi	Wi-Fi	Intel Products	Yes
WiGig	Wi-Fi, 60 GHz	PC, tablet, smartphone	Yes
UWB	3.1 – 10.6 GHz	None	Yes
WHDI	5 GHz	None	Yes
WirelessHD	60 GHz	None	Yes

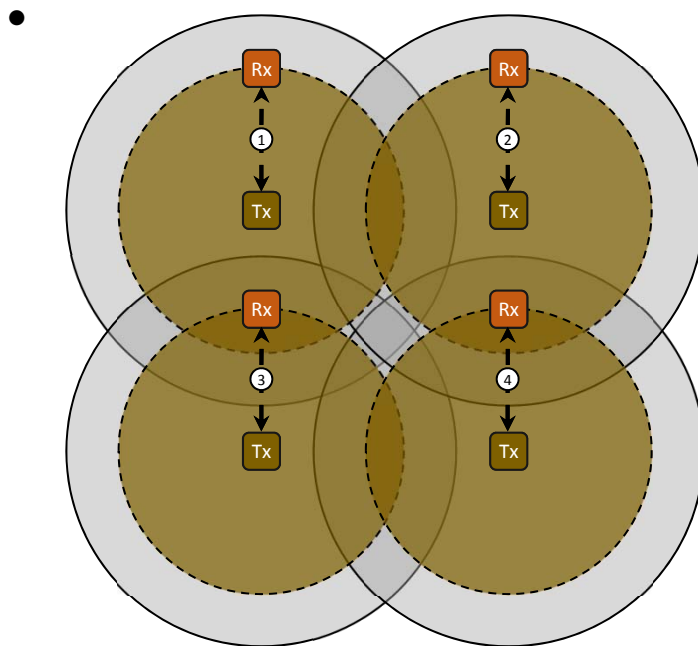
eLink 100 – 1 to 1 Link

- eLink supports robust wireless extension up to 100 feet (30m)
- Includes normally anticipated obstructions – walls, furniture

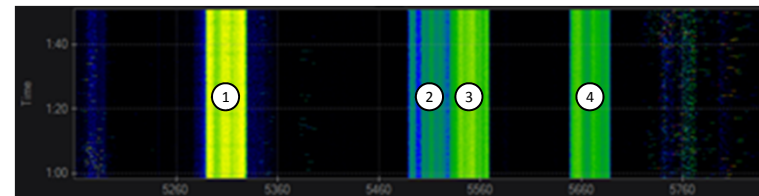


eLink 100 – Channel Use

- Multiple eLink systems can operate within same 150 foot (45m) radius



ns overlap



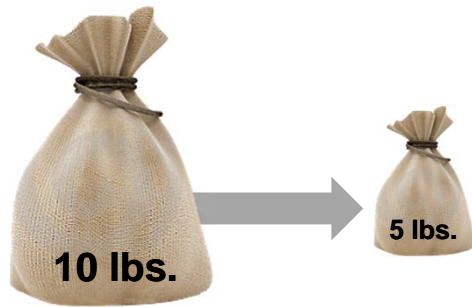
Streaming Video



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Why Streaming?

- Uncompressed content is too large to send over a network



Signal	Sampling	Bits per Color	Horizontal Pixels	Vertical Lines	Frames per Second	Approx. Data Rate
NTSC	(4:2:2)	8	720	486	30	126 Mbps
ATSC 720p	(4:2:2)	10	1280	720	60	1.5 Gbps
ATSC 1080p	(4:2:2)	10	1920	1080	60	2.97 Gbps
XGA	(4:4:4)	8	1024	768	60	1.1 Gbps
SXGA+	(4:4:4)	8	1400	1050	60	2.1 Gbps
WUXGA	(4:4:4)	8	1920	1200	60	3.3 Gbps



126 Mbps



100 BaseT Ethernet

100 BaseT Networks do not support streaming uncompressed NTSC video



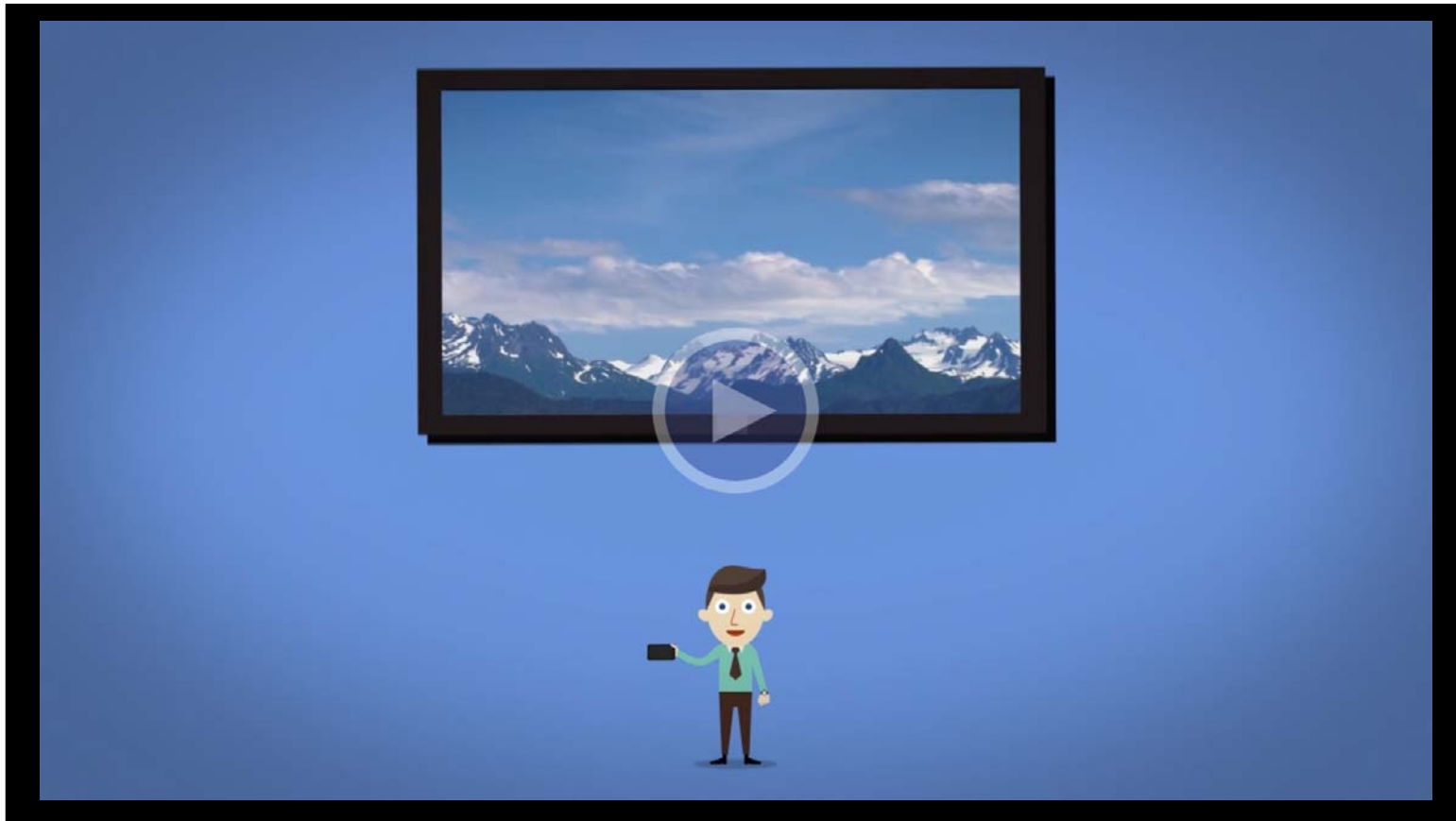
3.3 Gbps



Gigabit Ethernet

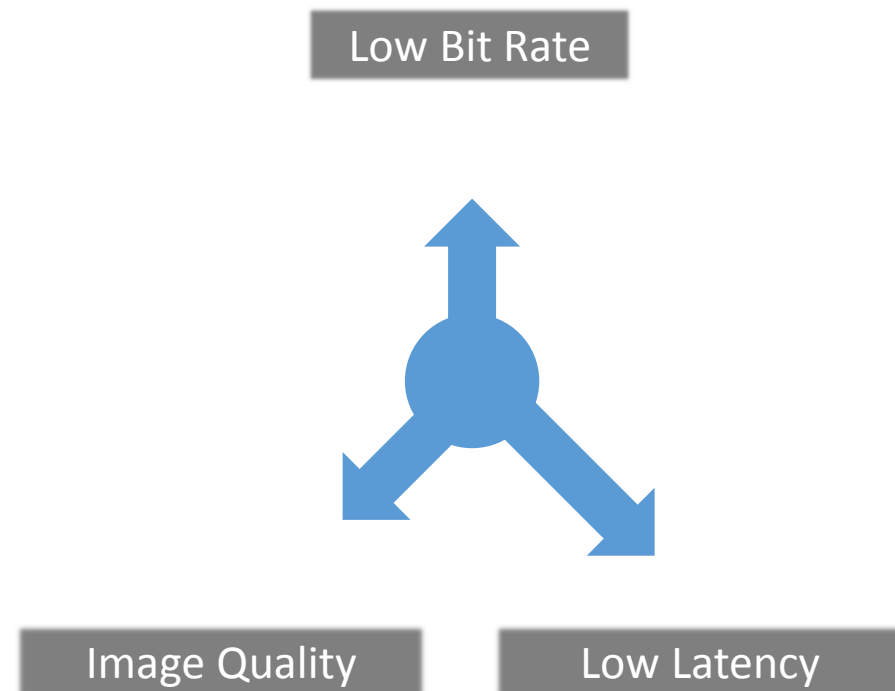
Gigabit Networks do not support streaming uncompressed computer graphics

Streaming Video



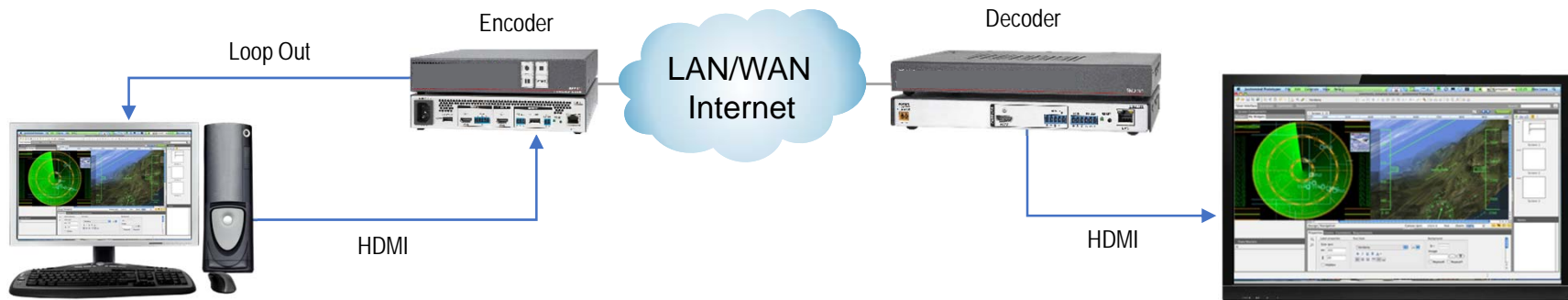
Application Focus – Compression

- Design focus on core application requirements
 - Viewing expectations
 - Connection bandwidth
 - Interaction or workflow
- Select components
- Focus on one or two performance areas

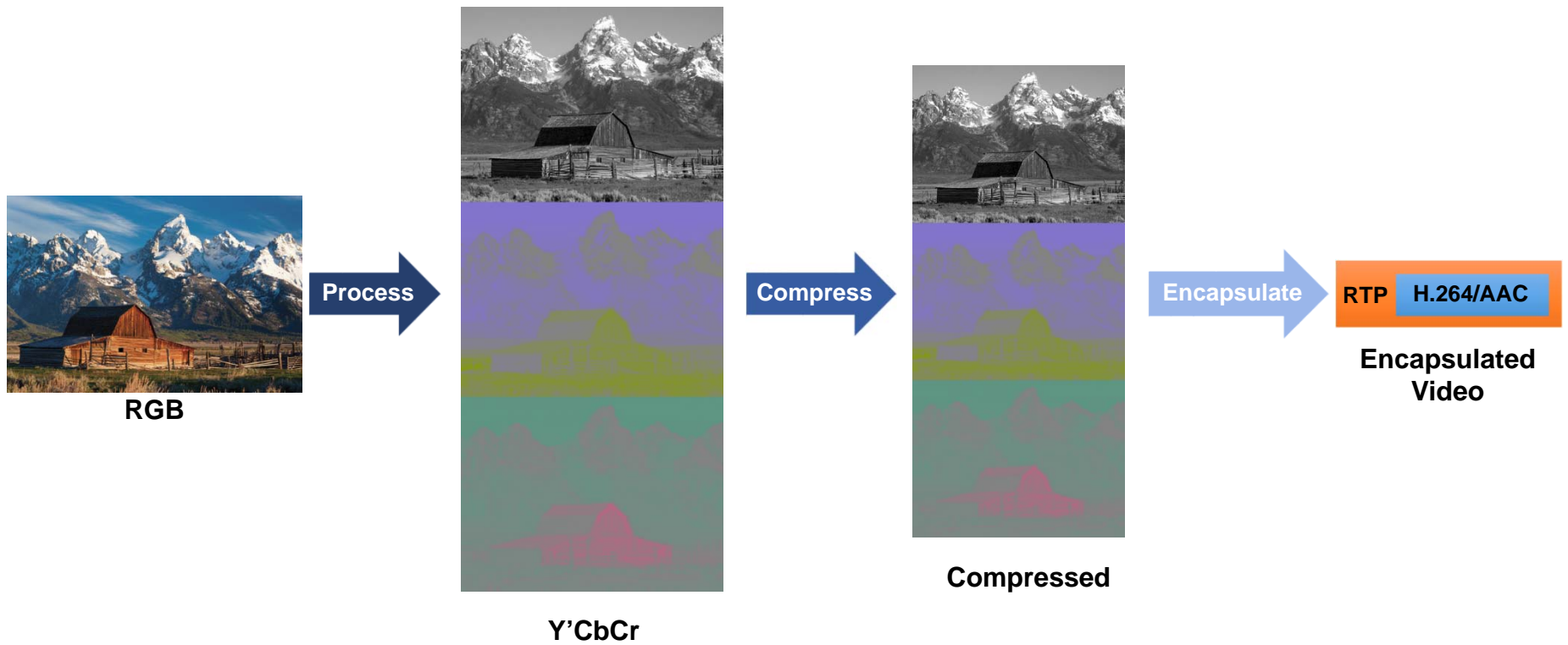


Steps in Streaming Media

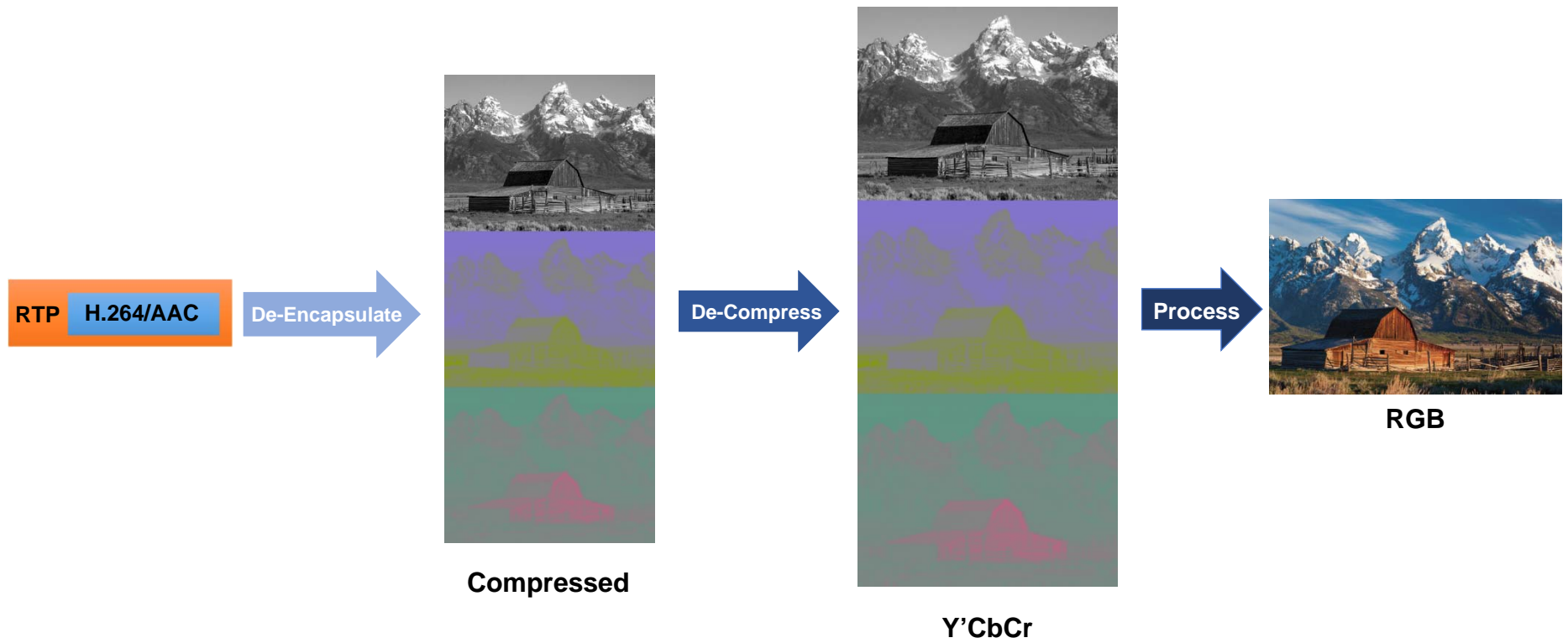
- Encode
- Transport
- Decode



Encoding Process



Decoding Process



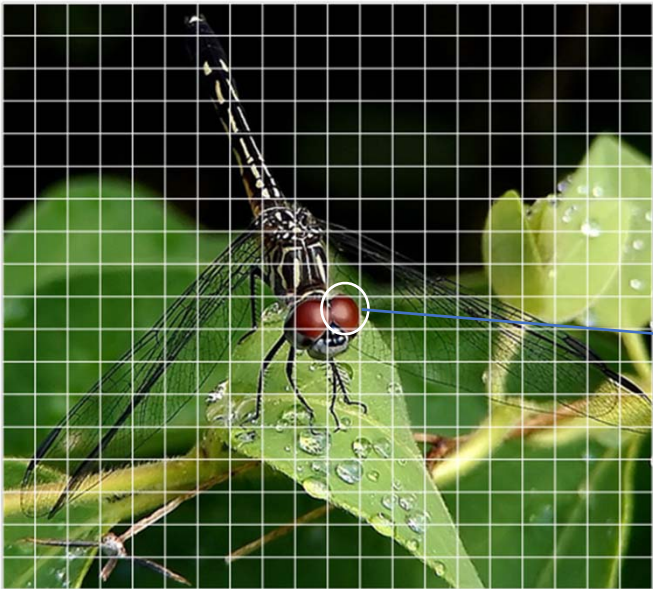
Encoding Considerations

- Sampling
- Color space conversion RGB to Y'CbCr
- Chrominance subsampling
- Bit depth

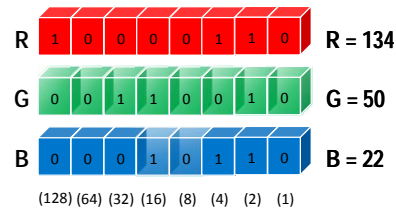
Encoding processes affect quality

Color Bit Depth

- 24-bit color allocates 8 bits per channel for both RGB and Y'CbCr color space
 - $8 \times 3 = 24$ -bit color



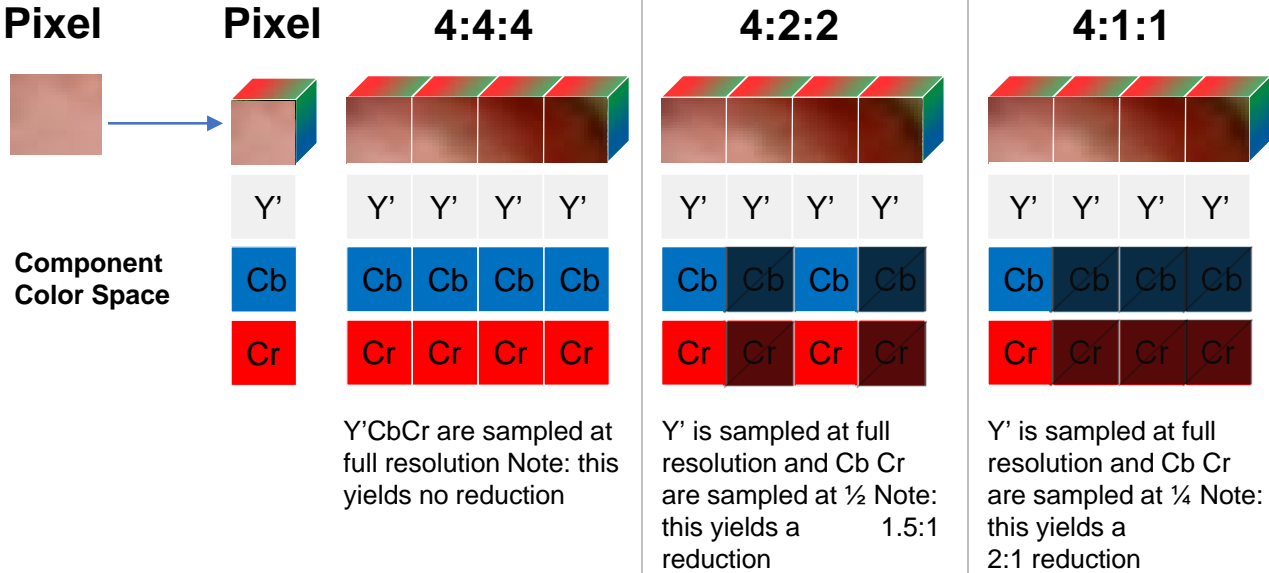
Range for each color = 0-255 or 256



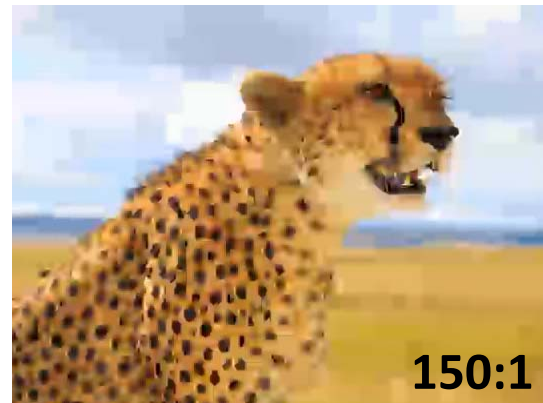
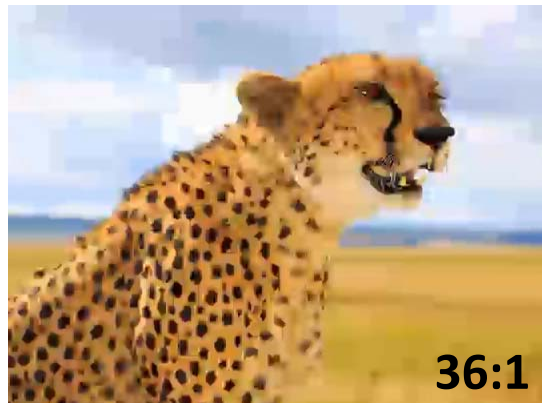
Counting in Binary

- Each pixel is represented by 3 groups of 8 bits, for a total of 24 bits
- Each group can represent up to 256 colors
- The sum of all 3 groups (colors) are able to represent 256^3 or 16,777,216 colors

Example Chrominance Subsampling



Compression Artifacts



Compression Codecs

- Why are there so many different compression codecs?
 - They are developed for a variety of reasons
 - Commercial
 - Technical
 - Political



Many Considerations for Codec Selection

- Image Quality
- Streaming Latency
- Scalability Requirements – number of endpoints
- Network
 - Bandwidth Availability
 - Network QoS
- Compatibility
- Which requirements are more important?
- What is good enough?

Image Quality – Considerations

- Viewing device – screen size
- Uninterrupted quality – error concealment
- Resolution – maintain native or reduced
- Production environment – editing, broadcast, studio



Non-critical



Critical

Latency



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Latency – Considerations

- The amount of delay can vary based on:
 - Compression and encoding method
 - Network environment: Private, Public
- Delay can be important or unimportant to the application

Low Latency “Interaction”	High Latency “Accessibility, One-way”
<ul style="list-style-type: none">• Interactive:<ul style="list-style-type: none">• Real-time communication• Collaboration• Control equipment remotely• Mission critical and Life safety	<ul style="list-style-type: none">• Availability:<ul style="list-style-type: none">• Broad range of users• Across the Internet• Variety of endpoints – PCs, Mobile devices• Immediacy or “on demand”

Network Paths

Identifying the Operating Boundries



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What Kind of Network Will I Be Streaming On?

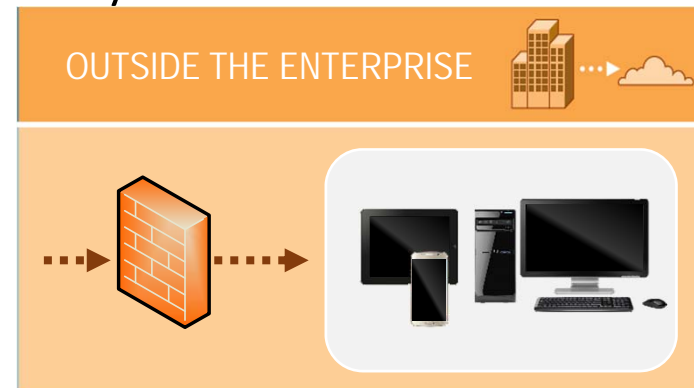
Enterprise Streaming

- Streaming is co-mingled with data and voice traffic
- Building or campus LAN
- Streaming occurs inside the Enterprise



Public Networks

- Streaming is delivered outside the firewall
- Internet or public network provider is used
- VPN – Virtual Private Network may be used



CDN Providers

Amazon barges into the content delivery network business

September 18, 2008 | Dean Takahashi

[Add a Comment](#)



When you've got computing infrastructure like Amazon does, it's a competitive weapon. Amazon is proving that today by using its infrastructure to **launch a new business in content delivery**. In doing so, it is aiming squarely at rivals such as **Akamai Technologies** and **Limelight Networks**.

Content delivery networks set up servers across geographies that can deliver network-clogging data such as videos. They prevent Internet traffic jams by positioning the video servers closer to consumers who are doing the downloading.



Previously, Seattle-based Amazon showed how it could use its data centers — built to serve the mainstay Amazon.com e-commerce business — to launch Amazon Web Services, which hosts sites for other companies. Its S3 storage service and EC2 on-demand computing services can help start-ups get off the ground by outsourcing the web hosting and storage chores that small businesses don't want to deal with.

Amazon said the service will be available later this year in North America, Europe and Asia. Smaller web sites that use lots of voice, video or graphics could tap Amazon to ensure that they can deliver high-quality



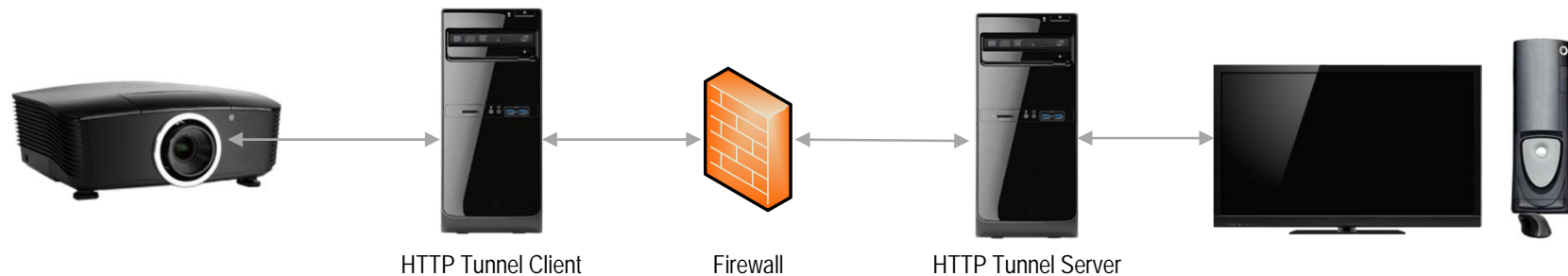
Common Transport Protocols



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What is HTTP Tunneling Streaming?

- HTTP tunneling is the process in which communications are encapsulated by using HTTP protocol
- An HTTP tunnel is often used for network locations which have restricted connectivity or are behind firewalls or proxy servers



What is RTSP Streaming

- Real Time Streaming Protocol (RTSP) is a network control protocol designed for use in entertainment and communications systems to control streaming media servers
- It works like a remote control for media streaming



Data Rate?



Resolution?



Audio?




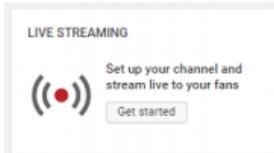
RTMP Push Streaming and its benefits

- RTMP Push Streaming allows content to be pushed to a CDN (Content Delivery Network) to wait for a client to request it
- This uses 0 bandwidth until it is requested
- This allows content to pass through the local firewall and remain available until it is requested

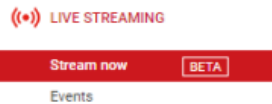


Streaming to YouTube Live

1. Go to www.youtube.com and log in to your account.
2. Click on the  **Upload** button on the top right corner
3. Click on the **Get started** button of Live Streaming

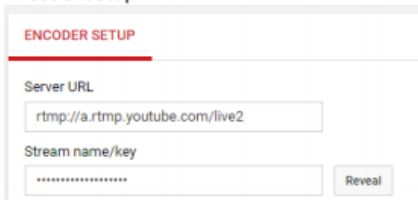


4. There are two options for live streaming:



- A. **Stream now** - for instant live streaming – see step 5
- B. **Events** - to scheduled live events – see step 12

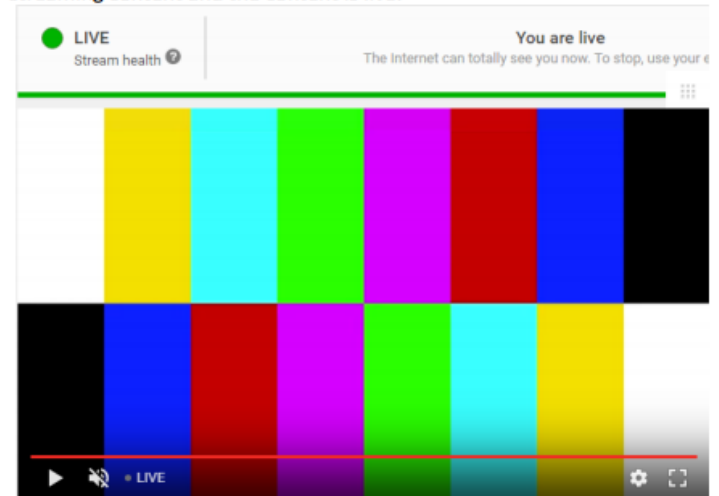
- A. For **Stream Now** page, enter basic information about the live stream, and scroll down to the Encoder Setup:

A screenshot of the YouTube Encoder Setup form. It has a title "ENCODER SETUP" and two input fields: "Server URL" with the value "rtmp://a.rtmp.youtube.com/live2" and "Stream name/key" with a "Reveal" button.

1. Copy and paste the **Server URL** and **Stream Name/key** to the SMP Streaming data fields, then **Click Apply**.
2. On the SMP Streaming, click "Start RTMP stream" button to activate the stream.
3. After a few seconds, the button will change to red and indicate the RTMP stream is now live.



4. Back on the YouTube live dashboard page, you should now see the display of the SMP streaming content and the content is live.



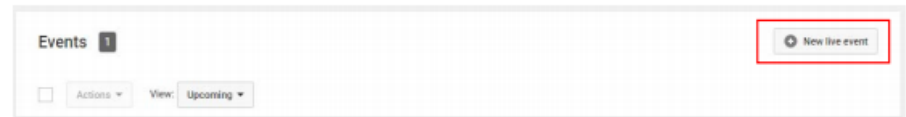
5. The live stream will be available on YouTube until it is stopped from the SMP streaming page or SIS command.



Note: YouTube does not require Username and Password for Live Stream. YouTube uses port 1935 for streaming. This port must be open for network access.

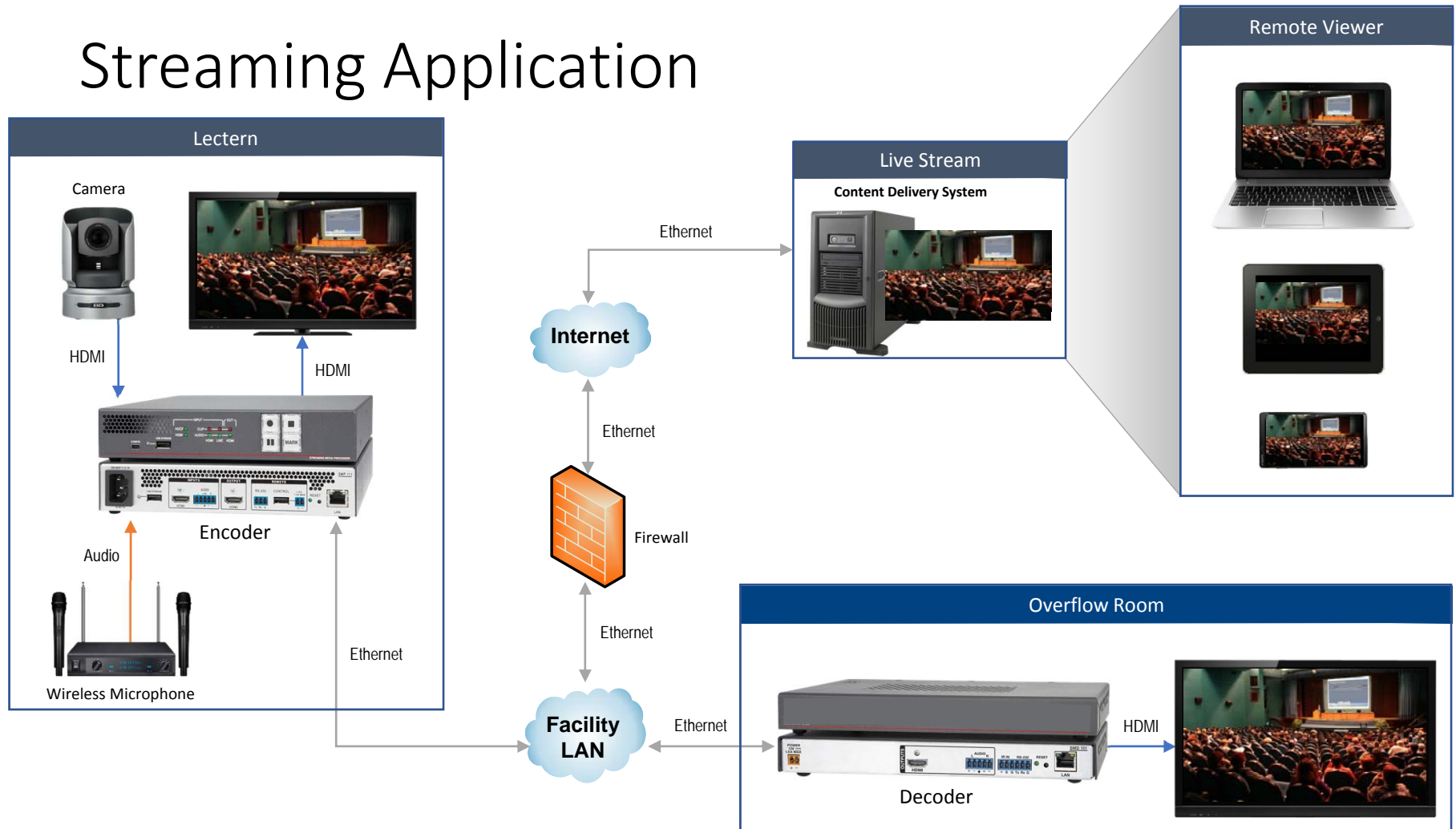
- B. For **Events** workflow on the Youtube page:

1. Click **New live event** to start a new event



2. Enter the event **Title**, **Start Date/Time**, and a **Description**.
3. Click **Create Event**

Streaming Application



Designs



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Small Meeting Room



AV Requirements

- AV Sources
 - Multiple Laptops
- Output Devices
 - 4K Display

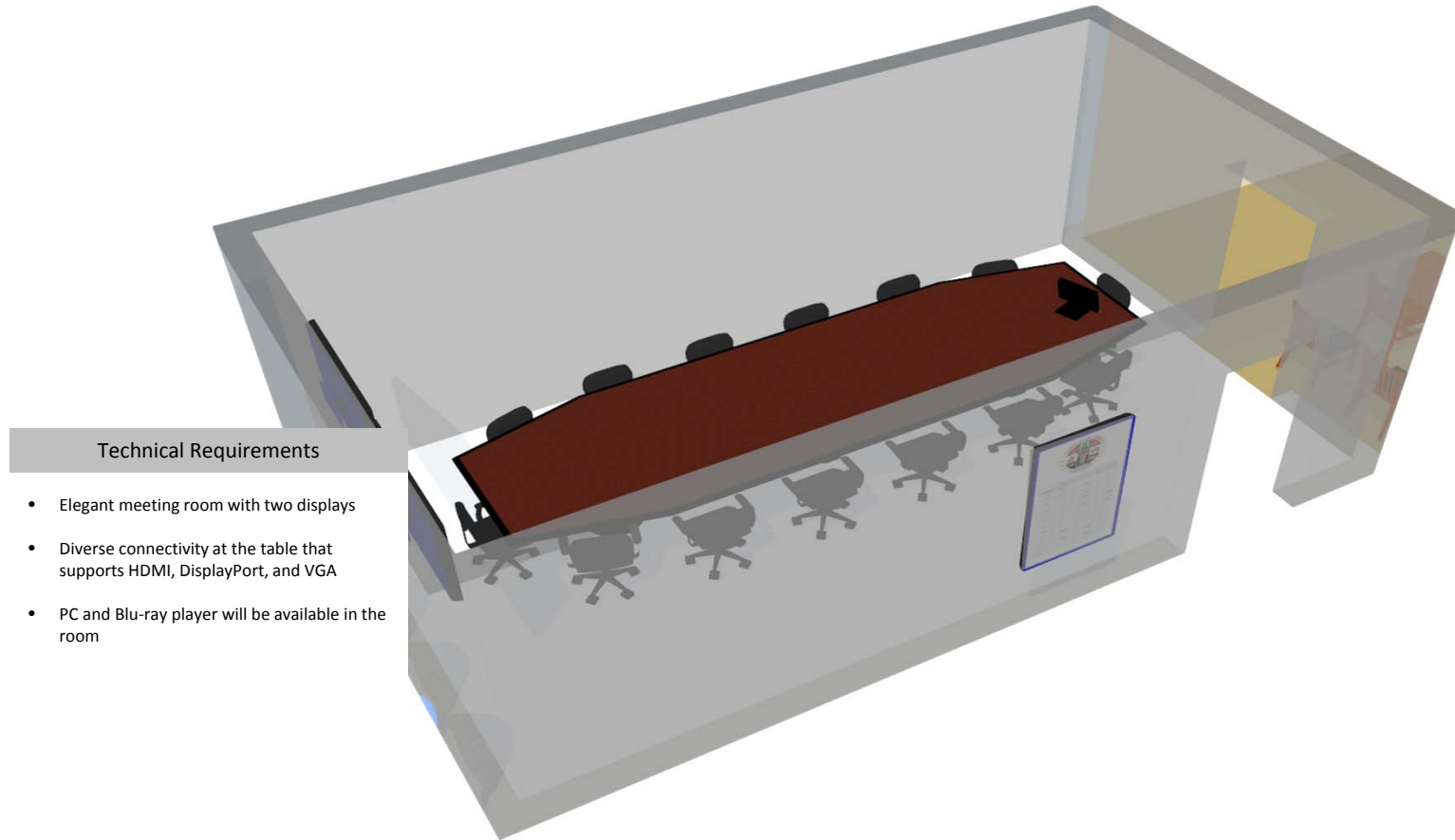
Technical Requirements

- Users will have ability to connect to system with laptops using HDMI, DisplayPort, or VGA
- Auto-switching between inputs
- System will use internal speakers of display for Audio support

Small Meeting Room



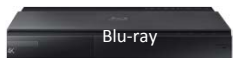
Executive Meeting Room



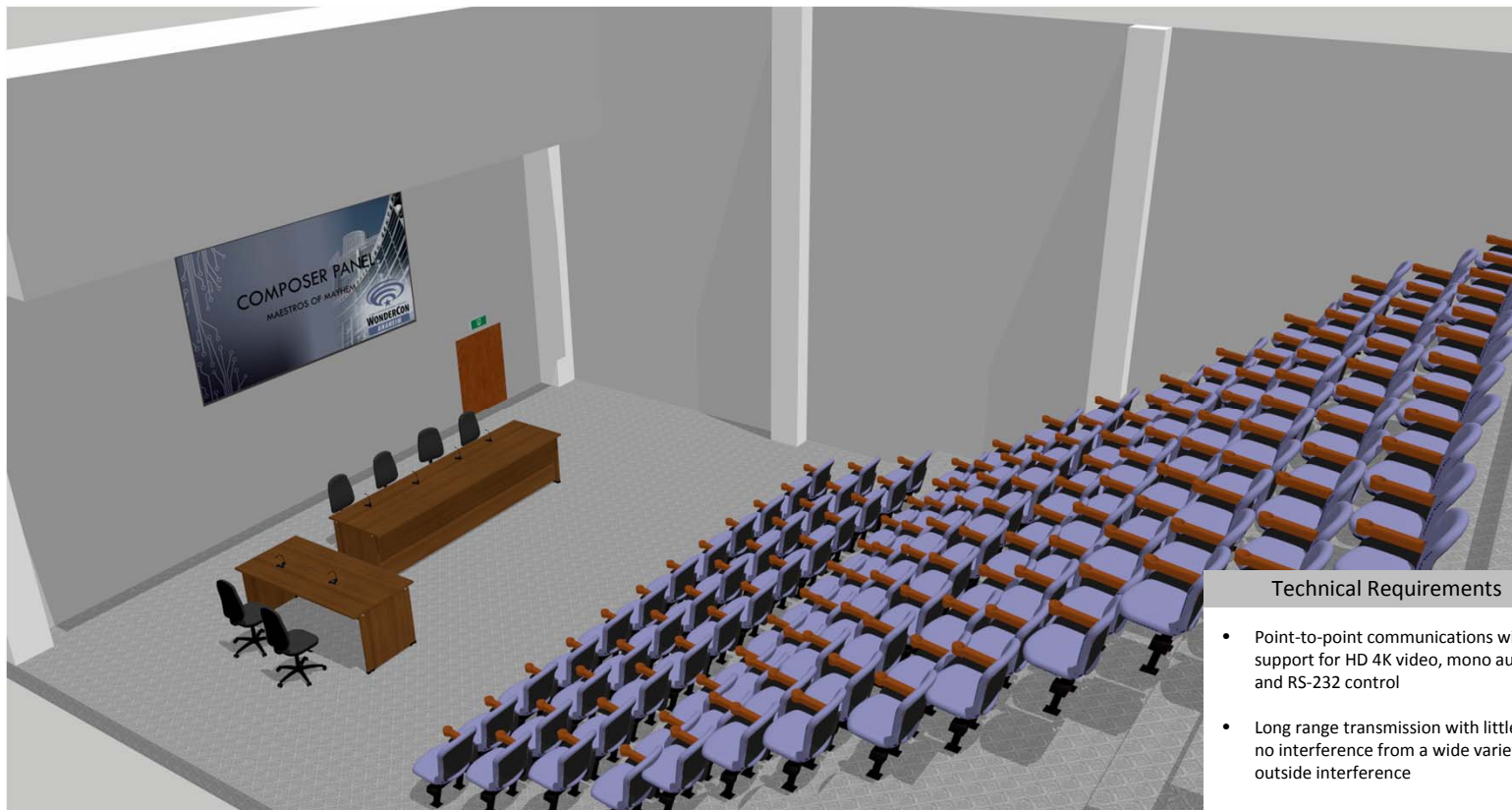
Technical Requirements

- Elegant meeting room with two displays
- Diverse connectivity at the table that supports HDMI, DisplayPort, and VGA
- PC and Blu-ray player will be available in the room

Executive Meeting Room



Lecture Hall



Technical Requirements

- Point-to-point communications with support for HD 4K video, mono audio, and RS-232 control
- Long range transmission with little or no interference from a wide variety outside interference

Lecture Hall



Desktop



Apple TV



Blu-ray



MacBook



Laptop



Laptop



MacBook



iPad



Microphone



Microphone



Wireless Rx

Projector - 1920x1200



Motorized Screen



Display - 1080p

Church Streaming



Technical Requirements

- Audio and Video recording with displays used for presentation, information, and digital signage
- Streaming capabilities with live content sent to a lobby display, internal and external streaming servers

Church Streaming



Laptop



Camera



Microphone



Microphone



Wireless Rx



Lobby Display – 1080p



Main Displays – 1080p



When a Network is No Longer Just a Network

Merging AV and Network
Infrastructure



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