Digital Video for BICSI Folks

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Bicsi

Agenda

- Digital Video Signal Characteristics
  - EDID and HDCP
- Digital Signal Types
  - USB and HDMI
- Resolution and Color
- Transmission Methods
- Designs and Real World Applications

Digital Video Signal Characteristics

Introduction

- Technology is constantly evolving
  - Video formats
  - Communication
  - Collaboration
  - Mobile/wireless

- This evolution creates AV system design challenges

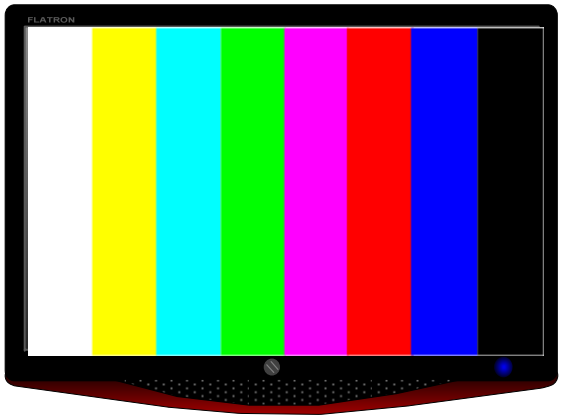
Signal Integrity

- Distance and quality – how far is too far?
- Cable quality – are all cables the same?
- Cables or electronics?
- Connections – how many connection points?

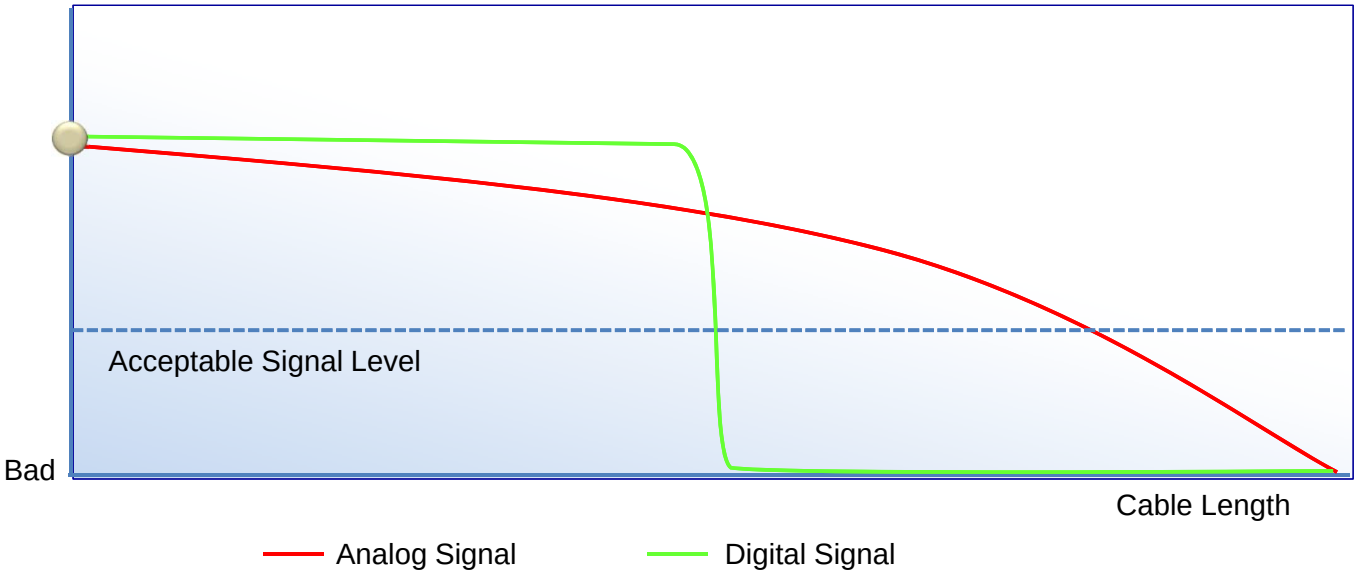
?

Signal Integrity

- Digital video signal loss – cliff effect

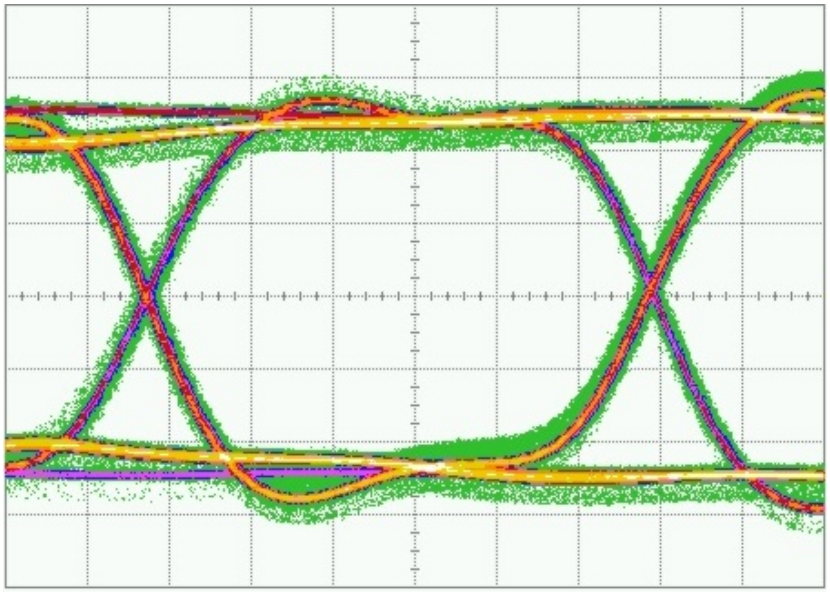


LCD Monitor



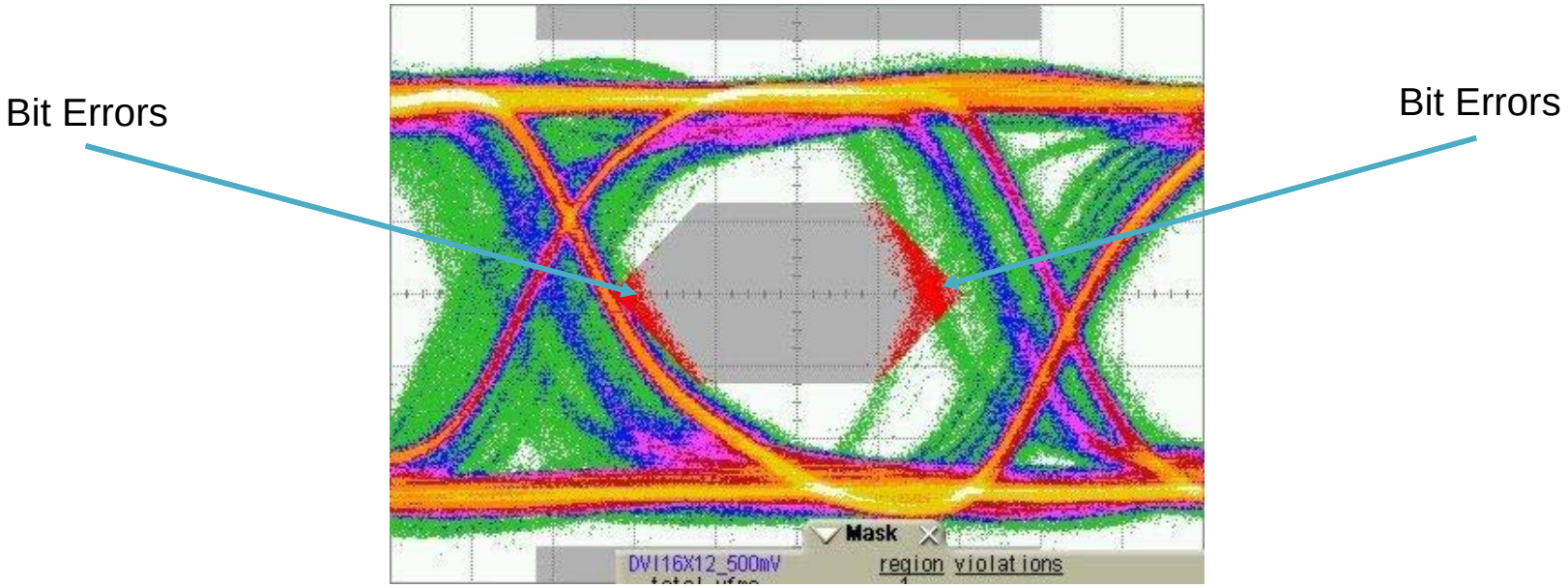
Digital Video Characteristics – Eye Diagram

- An Eye Diagram is formed by repeated sampling of a digital signal
  - The eye pattern is a useful tool in measuring overall signal quality



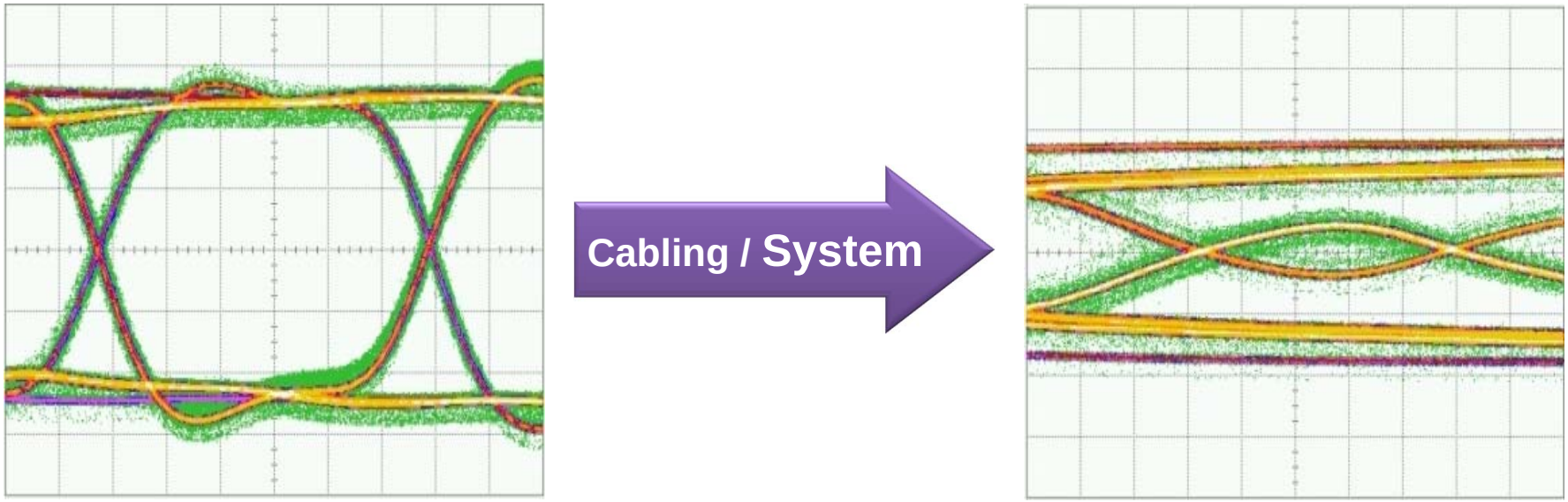
Digital Video Characteristics – Bit Errors

- The mask allows you to identify when bit errors occur
- The signal touching the mask is an indication of a bit error

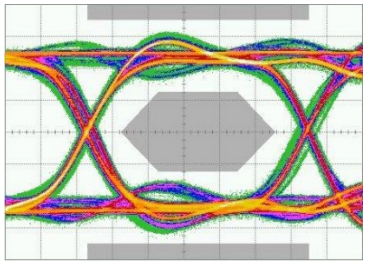


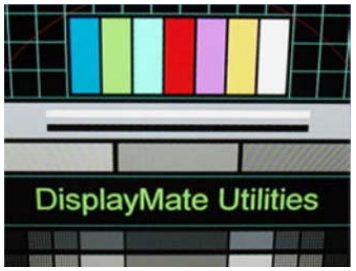
Digital Video Characteristics – Loss

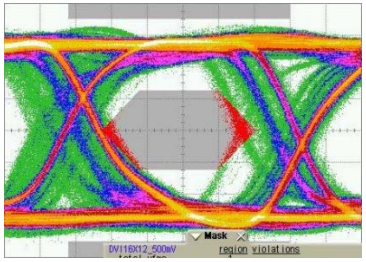
- Digital video signals consist of high speed transitions
- Very susceptible to degradation from:

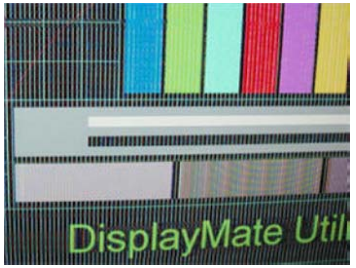


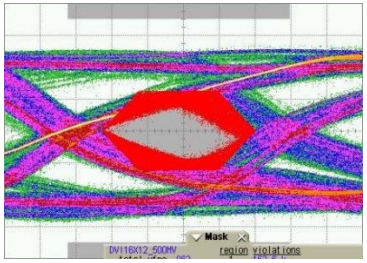
Digital Video Characteristics – Loss

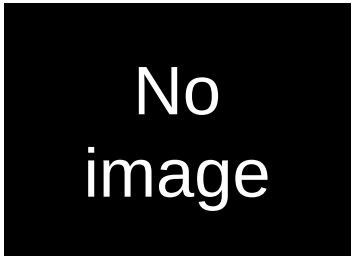






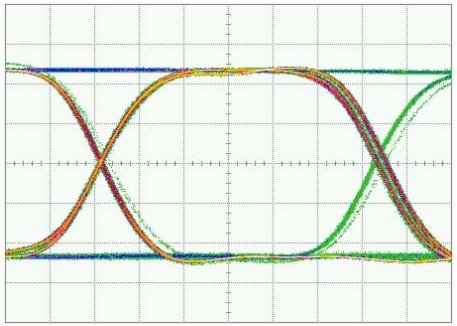


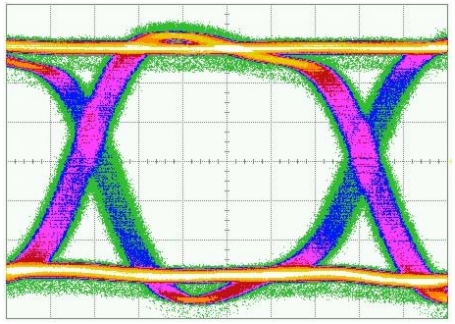




Digital Video Characteristics – Variables

- What is the quality of the signal from the source?
  - This information is not listed in the product's specifications



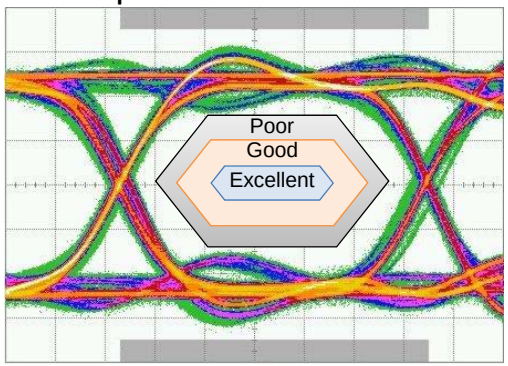


Digital Video Characteristics – Variables

- Cables can vary widely in performance
  - Adapters are useful but may affect signal quality

Digital Video Characteristics – Variables

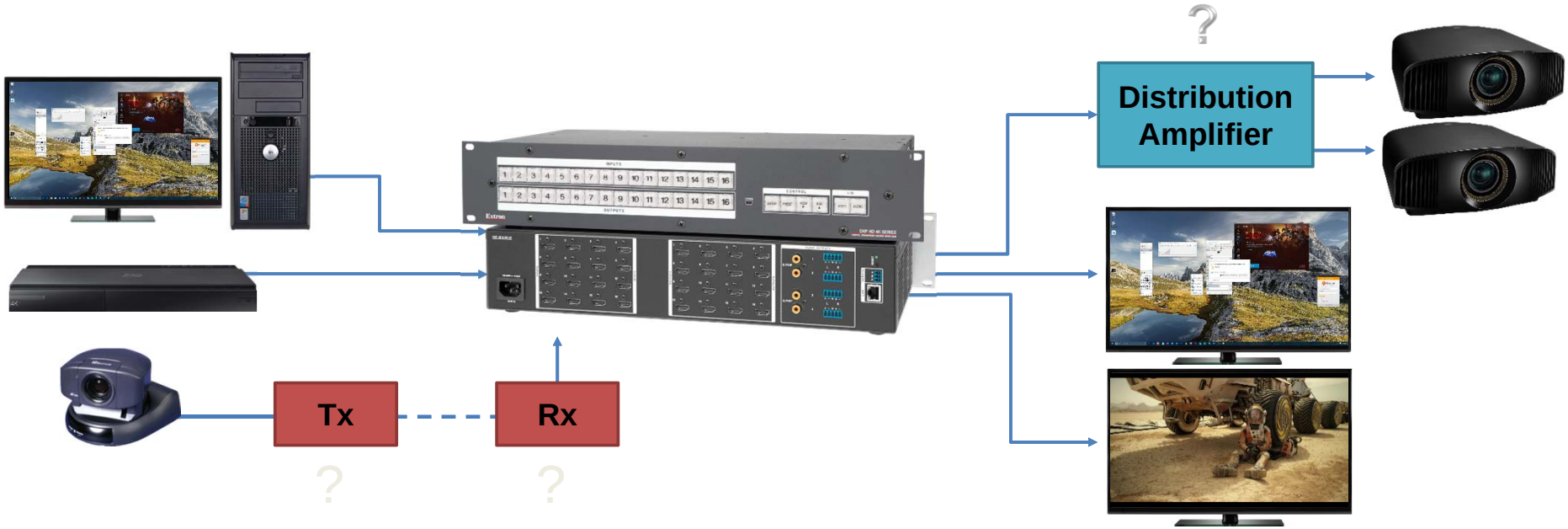
- What is the sensitivity of the receiving device?
  - This information is not listed in the product's specifications



My Documents
WordPad
My Computer
HHHHHHHH...
Recycle Bin
DTD Calculator
Internet Explorer
ELDIM - EDIDViewer
Adobe Reader 8
MonInfo
EDID Editor
EDID
Media Player Classic
softMCCS
VLC media player
chris
Video Card Drivers
CCleaner
EI2007Temp
Microsoft Windows xp Professional
start
1:14 PM

Product Interoperability

- The emphasis going forward is to build products that establish the best in interoperability
  - Working with equipment that might not meet the specifications



EDID

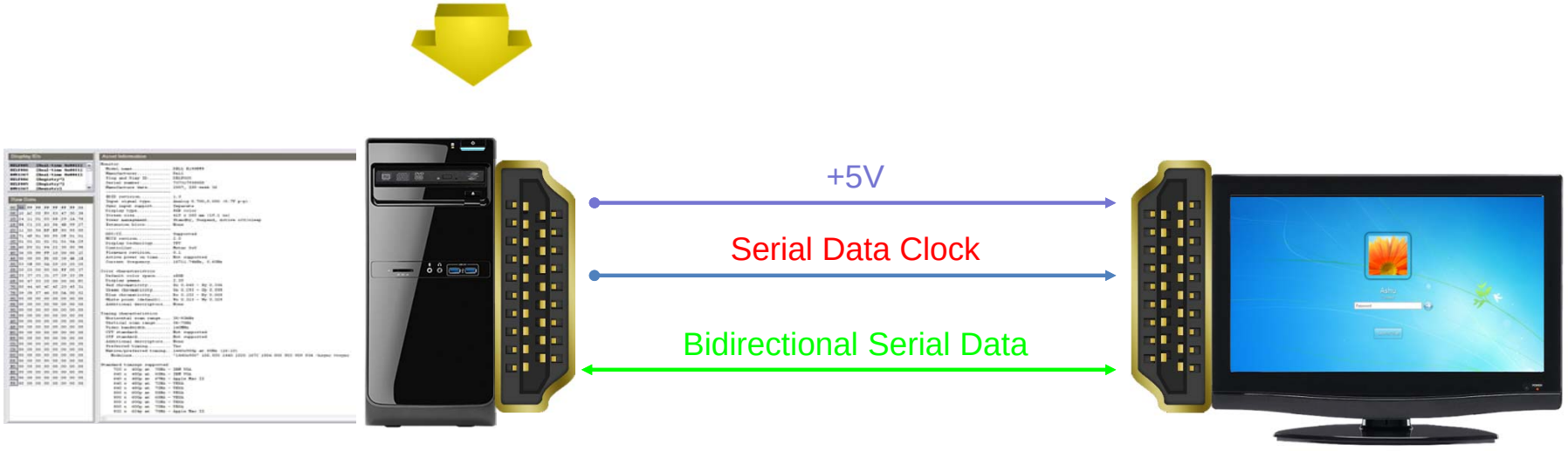
Extended Display Identification Data

EDID – Data

- EDID contains the following information:
  - Sink identity – device type, model number, etc.
  - Sink capability – video/audio

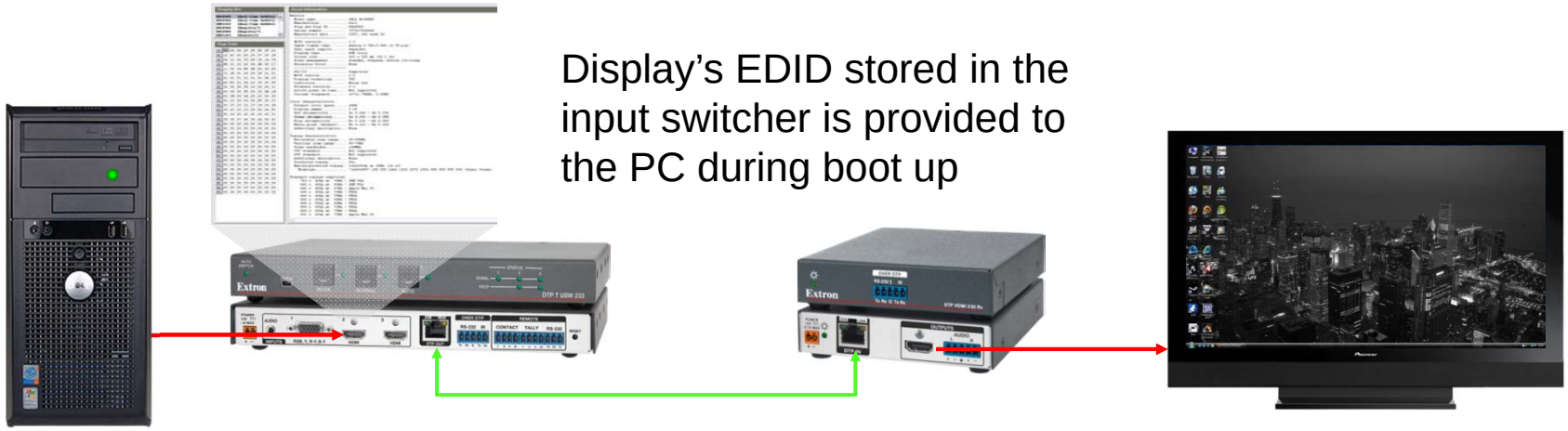
EDID – Sequence

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



EDID Minder

- Provides communication to the connected source to ensure it boots up using the correct video/audio output parameters



Scaler Solution

- BYOD equipment with Scaler/EDID Minder
  - Resolution management

EDID to 720p

HDCP-Compliant Video Scalar

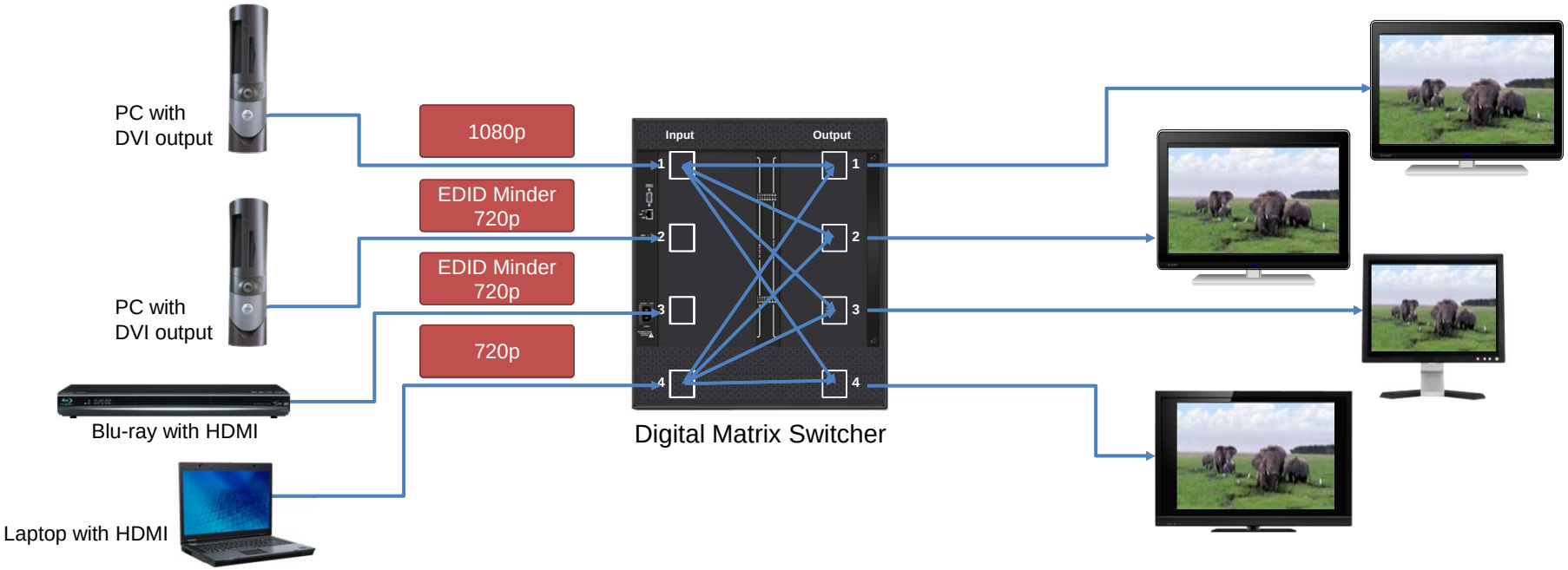
Output to 1080p

- Reformats signal for system requirements
- Delivers consistent resolution to endpoints

EDID Management and Switching

EDID Minder

- Displays have different native resolutions
  - Most ideal EDID configuration depends on requirements
  - Advisable to select EDID from pre-stored settings for each source



EDID Strategy

EDID Strategy

Project: **Date:**

System Description

Sources	**Format**	**Resolution**	**Refresh**	**ColorSpace**	**Audio**	**HDCP**	**Location**	**Notes**
1 Lectern Laptop								
2 Lectern PC								
3 DocCam								
4 Tuner								
5 BluRay Deck								
6 Codec Feed								
7 Camera 1								
8 Room 201 Feed								

Destinations	**Format**	**Resolution**	**Refresh**	**ColorSpace**	**Audio**	**HDCP**	**Location**	**Notes**
1 Left Display								
2 Right Display								
3 Projector								
4 Codec Send								

EDID Strategy

HDCP

High-bandwidth Digital Content Protection

HDCP – Protocol

- 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

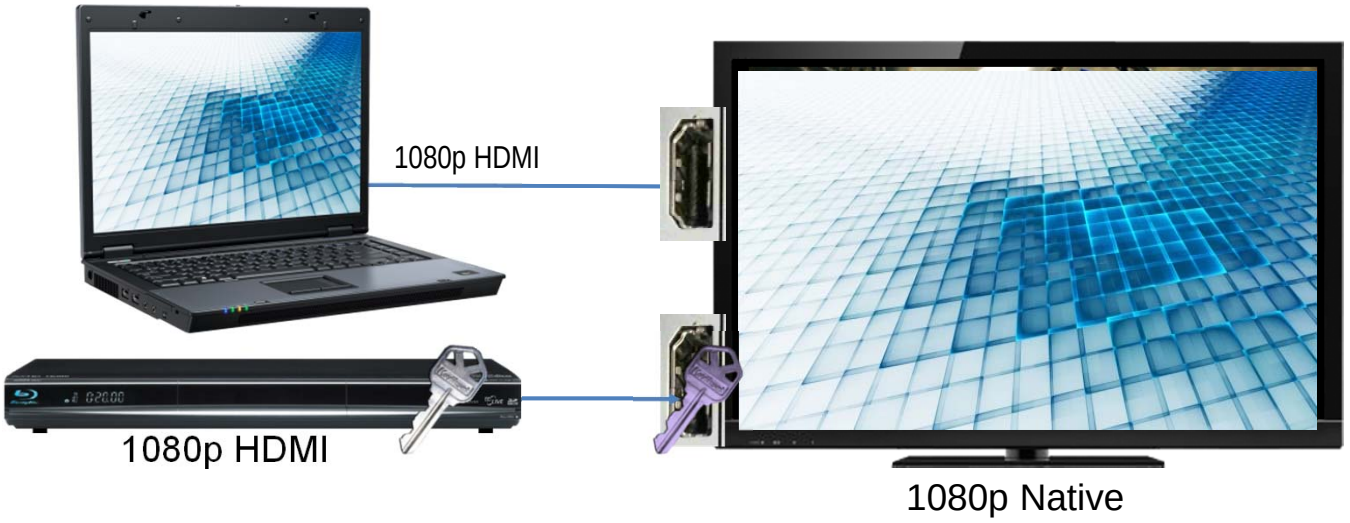
Blu-ray with HDMI

Challenges: HDCP

- Many sources encrypt playback of high value content
- Content encrypted with HDCP
- Typical sources are:
  - Blu-ray players
  - Cable/satellite receivers
  - PC, Mac and iOS devices
- HDCP can negatively affect switching performance
- Some devices unnecessarily encrypt output

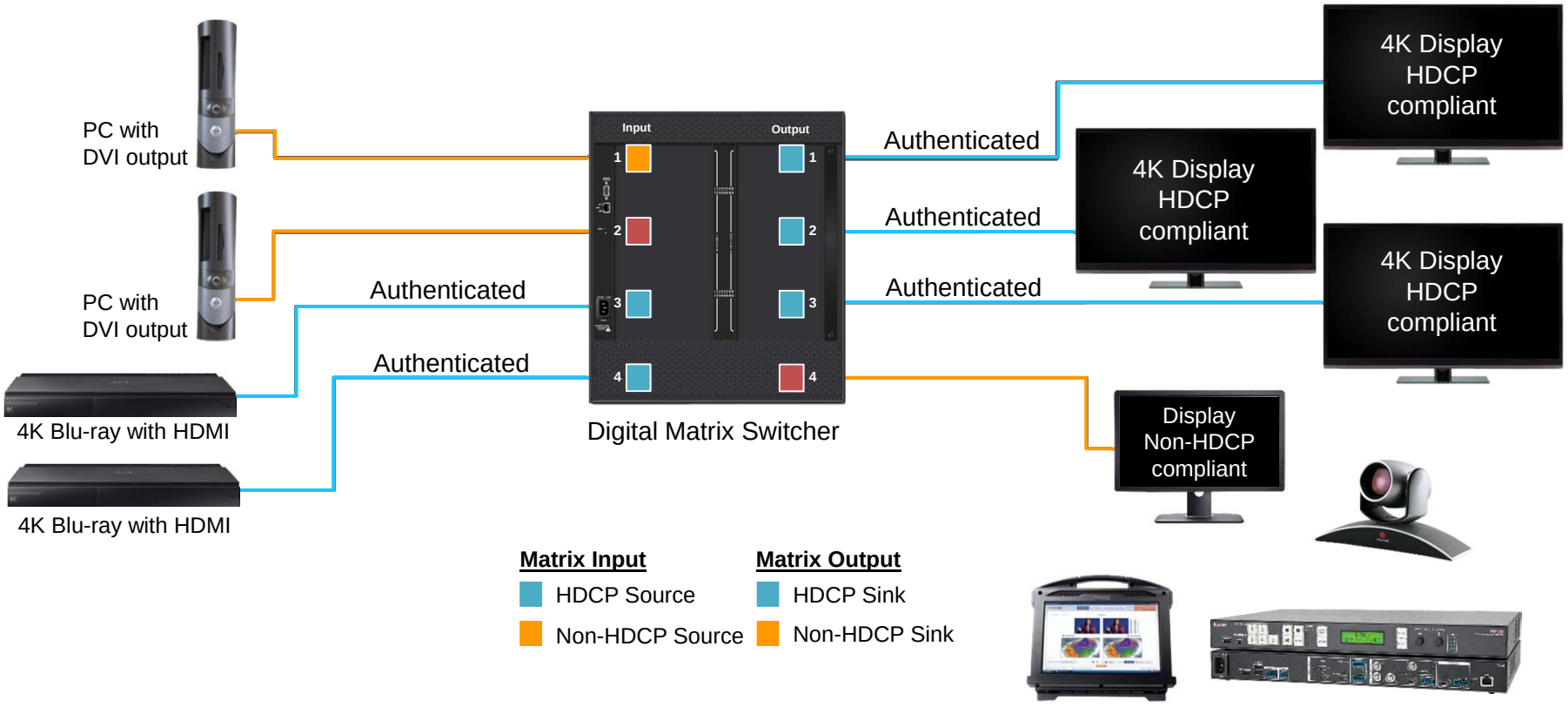
What If You Get It Wrong?

- Slow source switching
- Streamed content may not work as expected
- System may fail to display an image



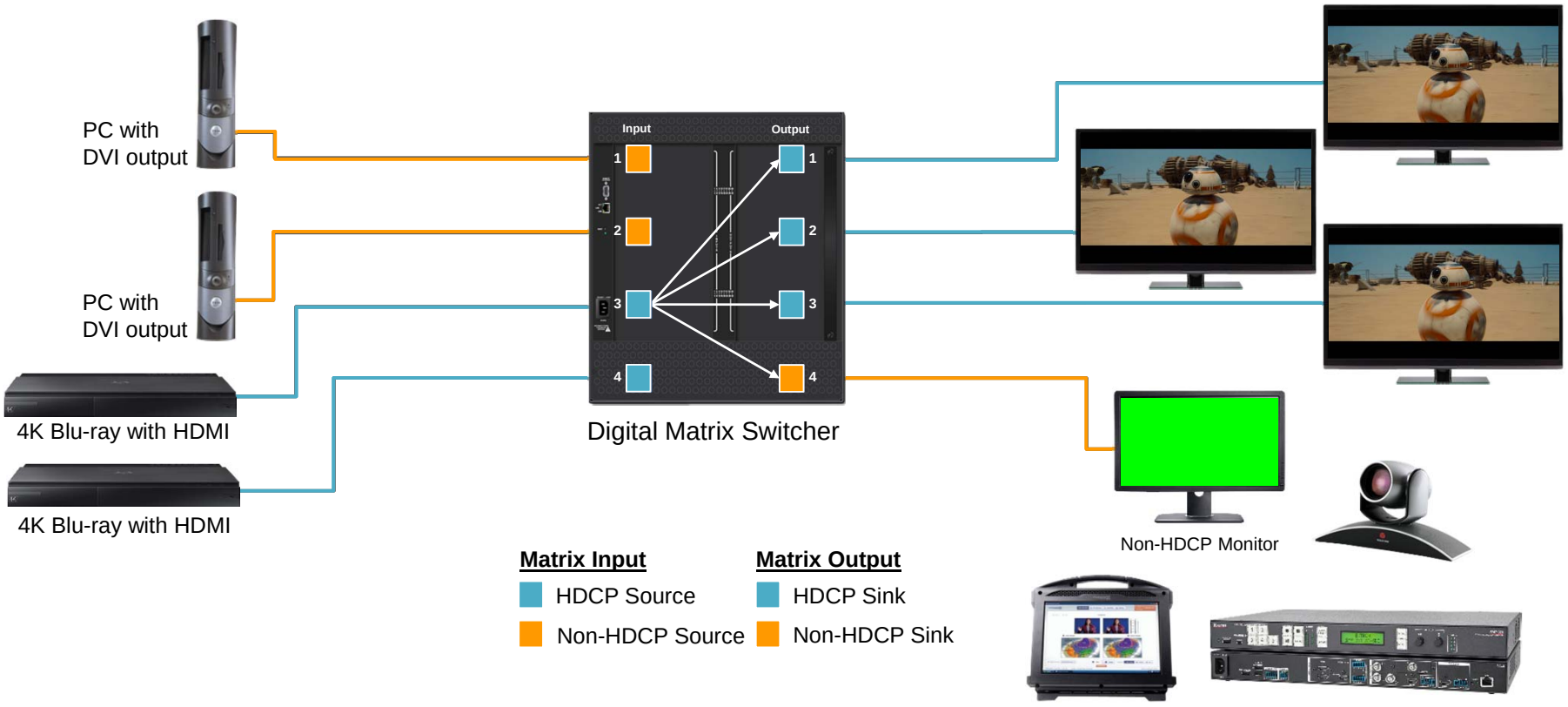
HDCP Handshakes

- I/O authentication



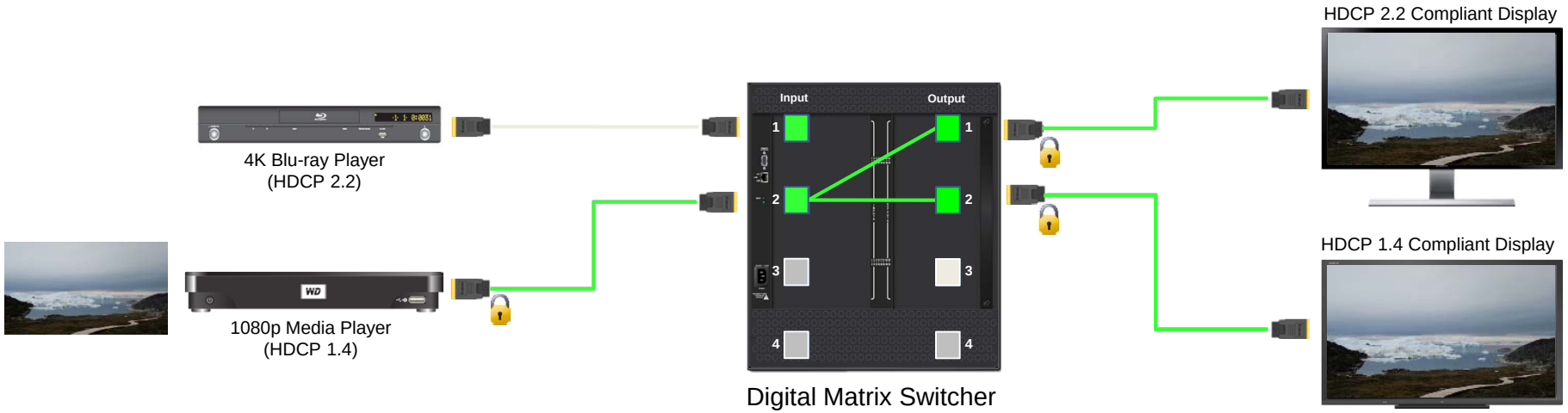
HCDP Handshakes With Products That Are Not HDCP Compliant

- Visual confirmation



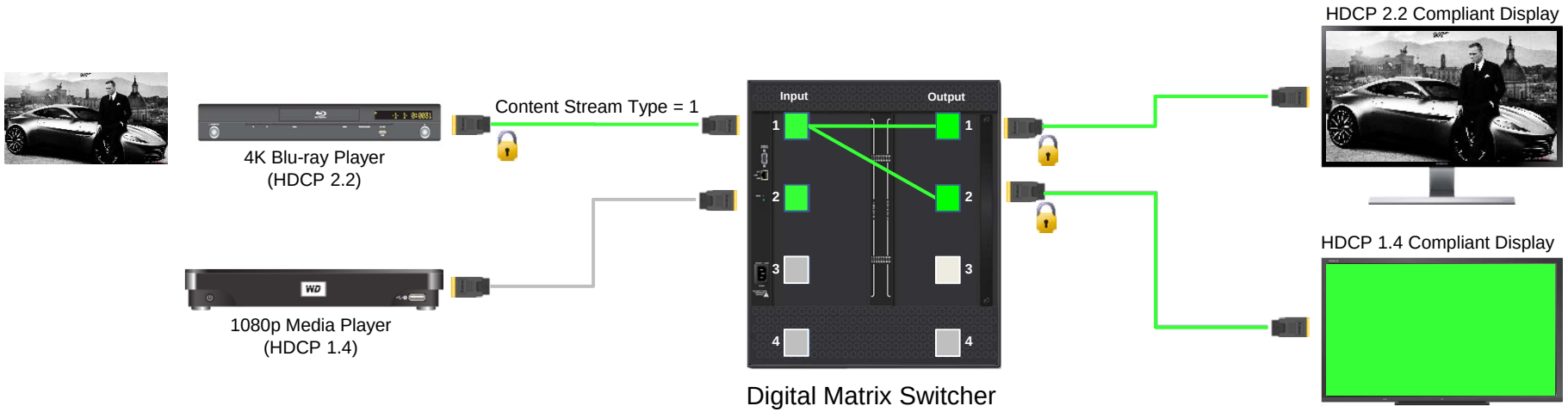
Backward Compatibility With HDCP 1.x

- HDCP 1.x source to HDCP 2.2 displays
  - Most HDCP 2.2 displays accept HDCP 1.x encrypted content



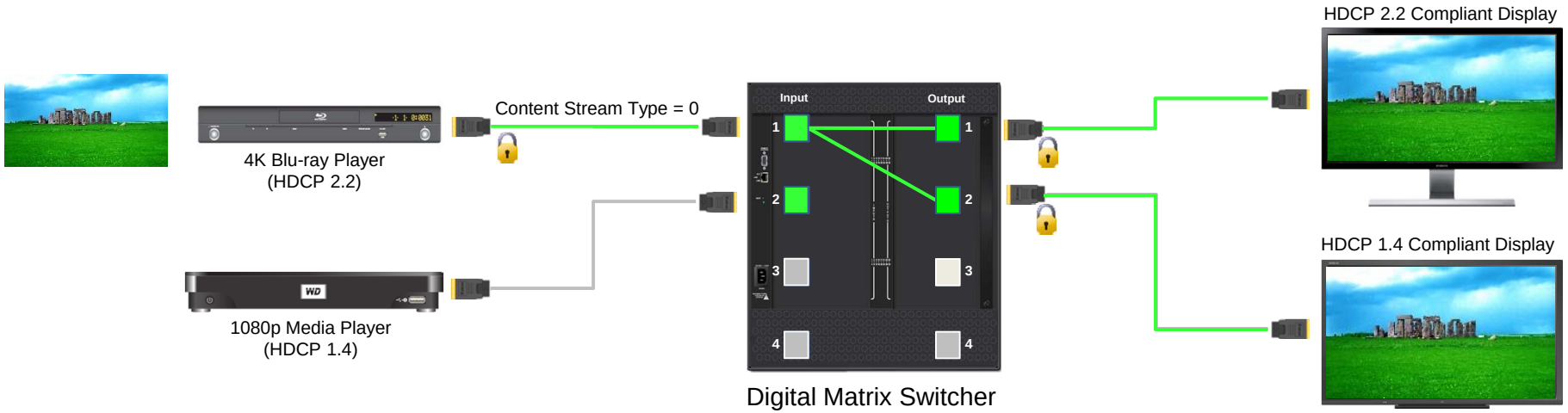
Backward Compatibility With HDCP 1.x

- HDCP 2.2 source to HDCP 1.x displays – content marked “High Value”
  - An HDCP 2.2 compliant source will not transmit high value protected content to HDCP 1.x displays



Backward Compatibility With HDCP 1.x

- HDCP 2.2 source to HDCP 1.x displays – content not marked “High Value”



Digital Signal Types

USB and HDMI

Digital Signals – USB

- A standard for communication protocols that includes cables and connectors
- Historically used for attaching peripheral devices to computers

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
- Providing additional options for transporting video and audio

DisplayLink™

USB Type-C

- 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

USB 3.1 Types-C hub

Type-C
Supply Power to Laptop

MacBook

Chromebook

Type-C

Projector

Display Monitor

HD TV

HDMI

Keyboard/Mouse

USB Drive

Phone

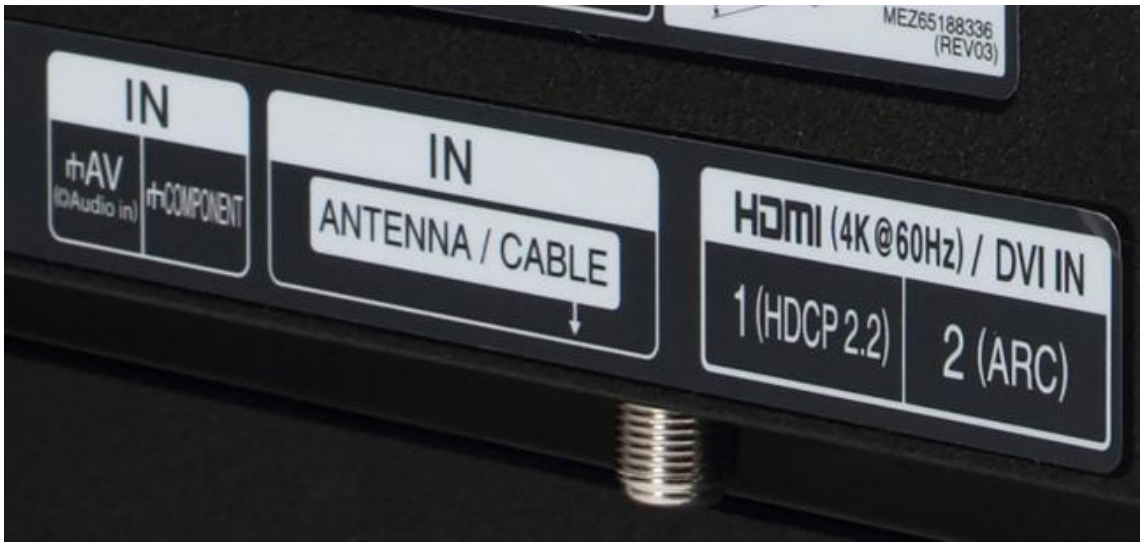
USB 3.1

Digital Video 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 2.0 and HDCP 2.2

- 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

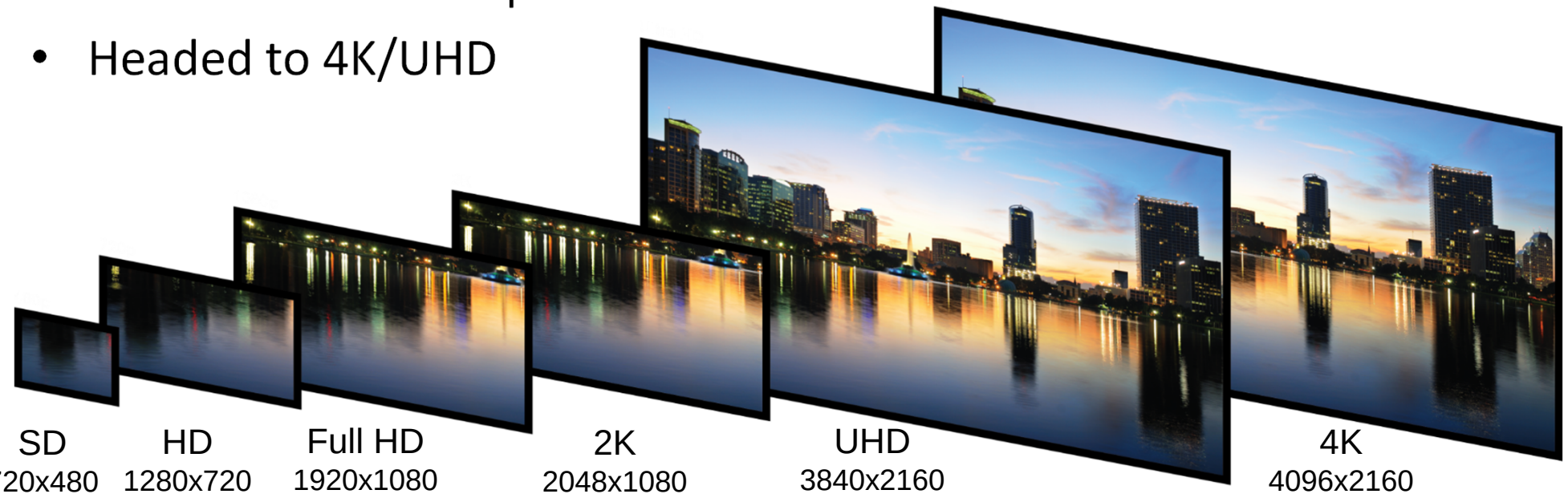


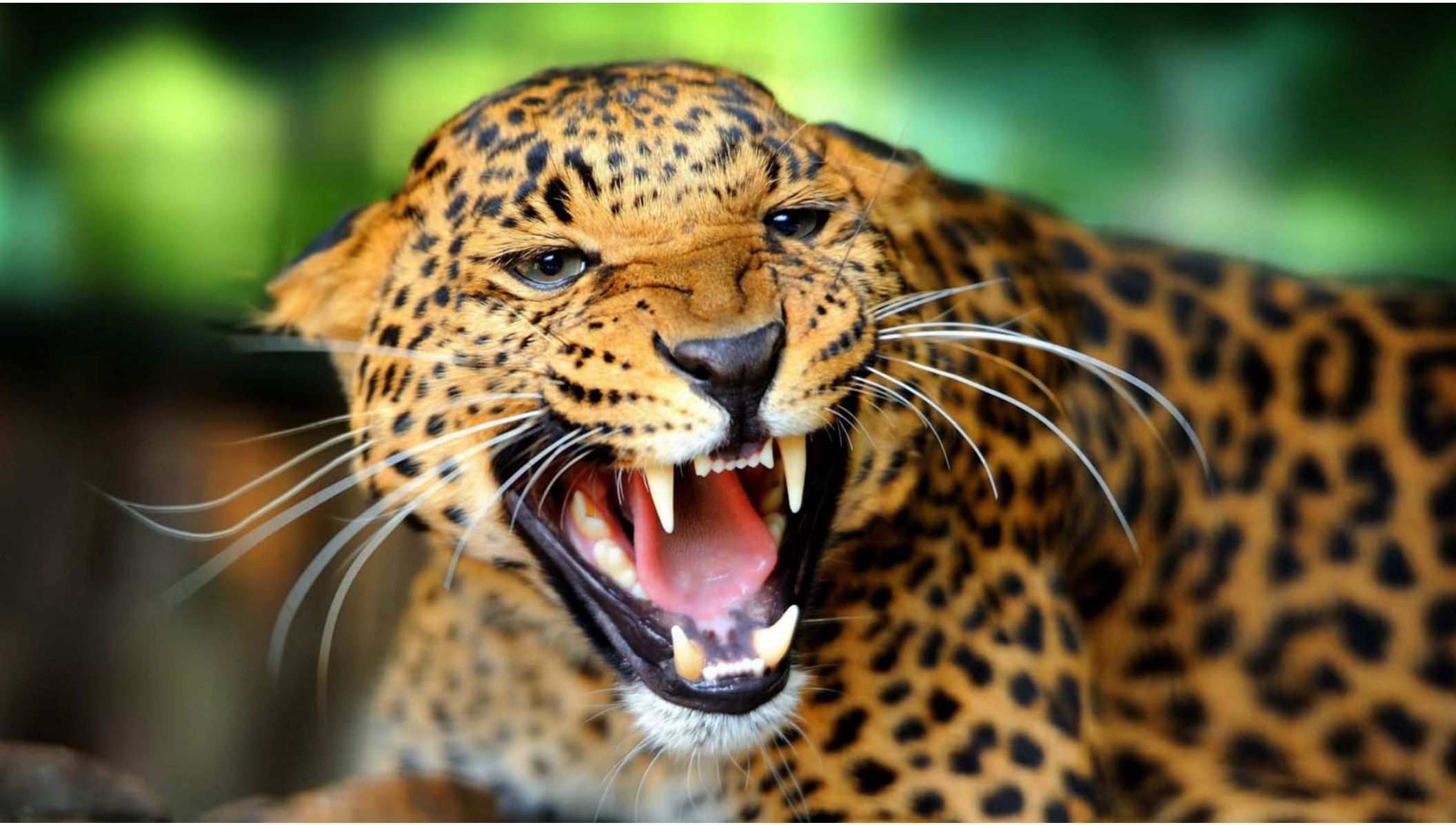
Resolution

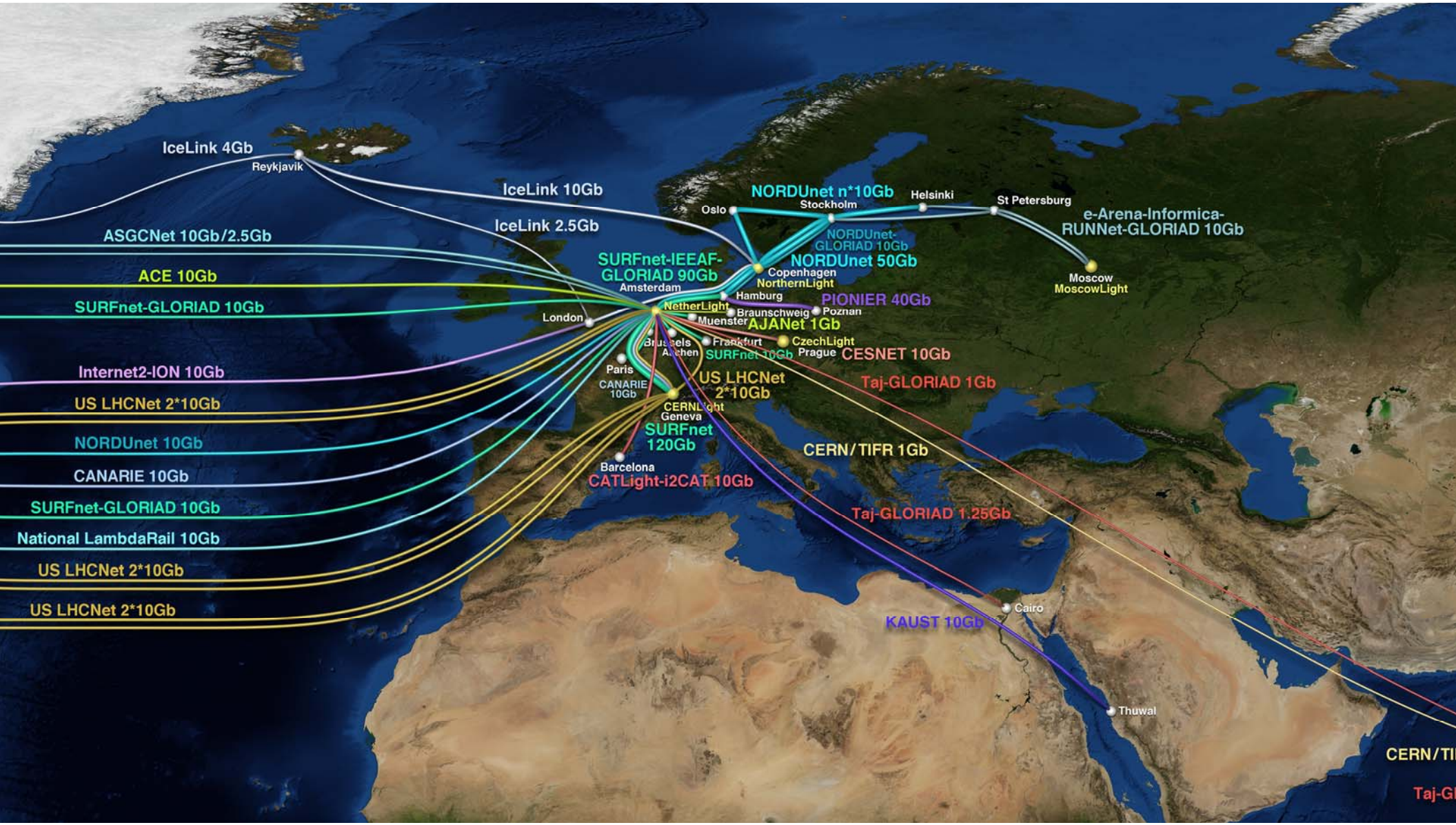
4K / UHD and 1080p Video Signals

Resolutions

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






IceLink 4Gb
Reykjavik
IceLink 10Gb
IceLink 2.5Gb
ASGCNet 10Gb/2.5Gb
ACE 10Gb
SURFnet-GLORIAD 10Gb
Internet2-ION 10Gb
US LHCNet 2*10Gb
NORDUnet 10Gb
CANARIE 10Gb
SURFnet-GLORIAD 10Gb
National LambdaRail 10Gb
US LHCNet 2*10Gb
US LHCNet 2*10Gb
NORDUnet n*10Gb
Oslo
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Helsinki
St Petersburg
e-Arena-Informica-
RUNNet-GLORIAD 10Gb
NORDUnet-
GLORIAD 10Gb
NORDUnet 50Gb
SURFnet-IEEAF-
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Copenhagen
NorthernLight
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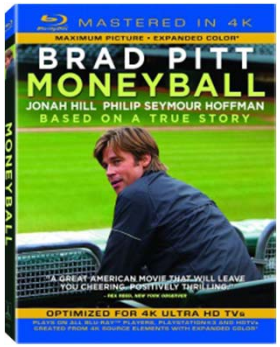
PIONIER 40Gb
NetherLight
Braunschweig
Poznan
London
Muenster
AJANet 1Gb
Frankfurt
CzechLight
Prague
CESNET 10Gb
SURFnet 10Gb
Paris
CANARIE
10Gb
US LHCNet
2*10Gb
Taj-GLORIAD 1Gb
CERN Light
Geneva
SURFnet
120Gb
CERN/TIFR 1Gb
Barcelona
CATLight-i2CAT 10Gb
Taj-GLORIAD 1.25Gb
Cairo
KAUST 10Gb
Thuwal
CERN/TI
Taj-G

DUNLOP
Red Bull
MOTOREX
Red Bull
9
MOTOREX

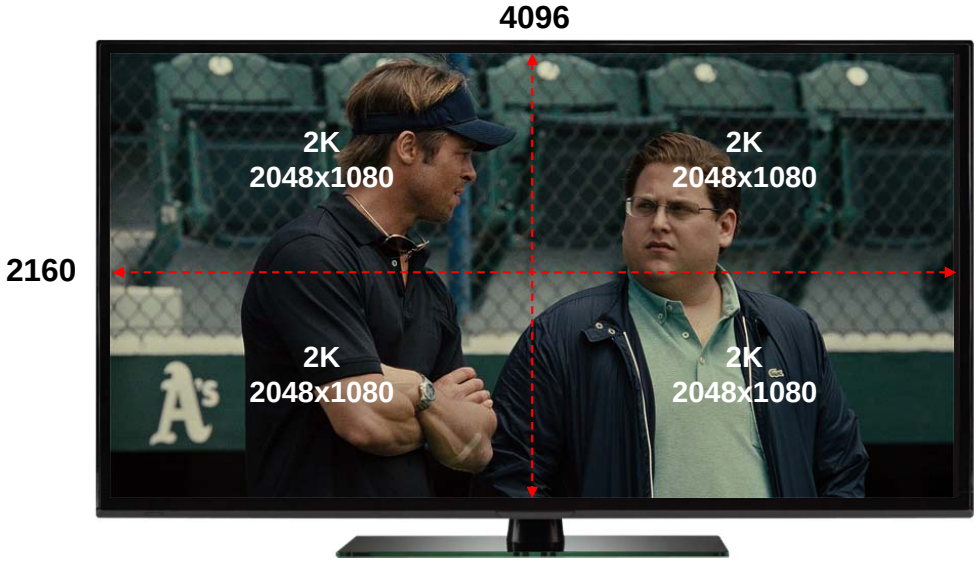
4K Video Signal – What You Need to Know

- Data rate requirements determined by
  - Resolution
  - Refresh rate
  - Chroma sampling
  - Color bit depth
  - Maximum supported data rate

4K Signal Parameters

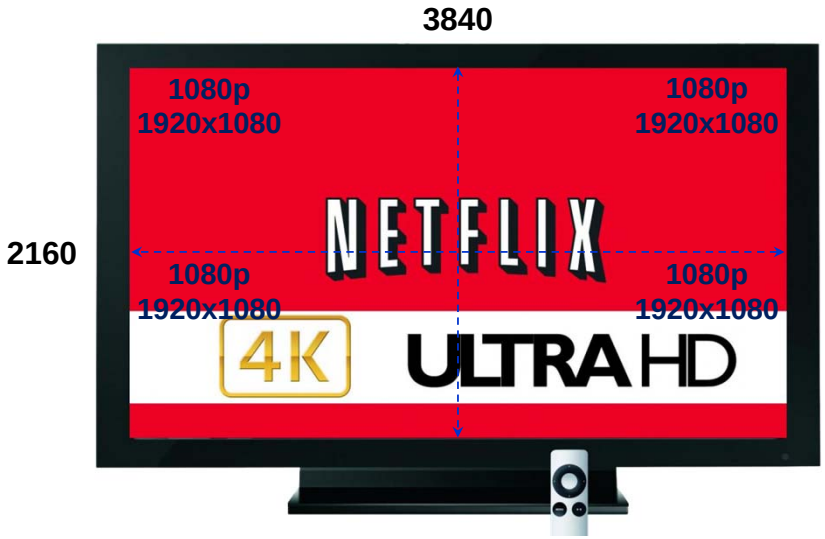


- 4K DCI is 4096x2160
  - Four times the resolution of 2K DCI
  - Targeted towards digital cinema
- 4K refresh rates
  - Varies – 24 Hz up to 60 Hz
- Color bit depth
  - 8-Bit, 10-bit, and 12-bit
- Aspect Ratio
  - 17:9 – same as 2K

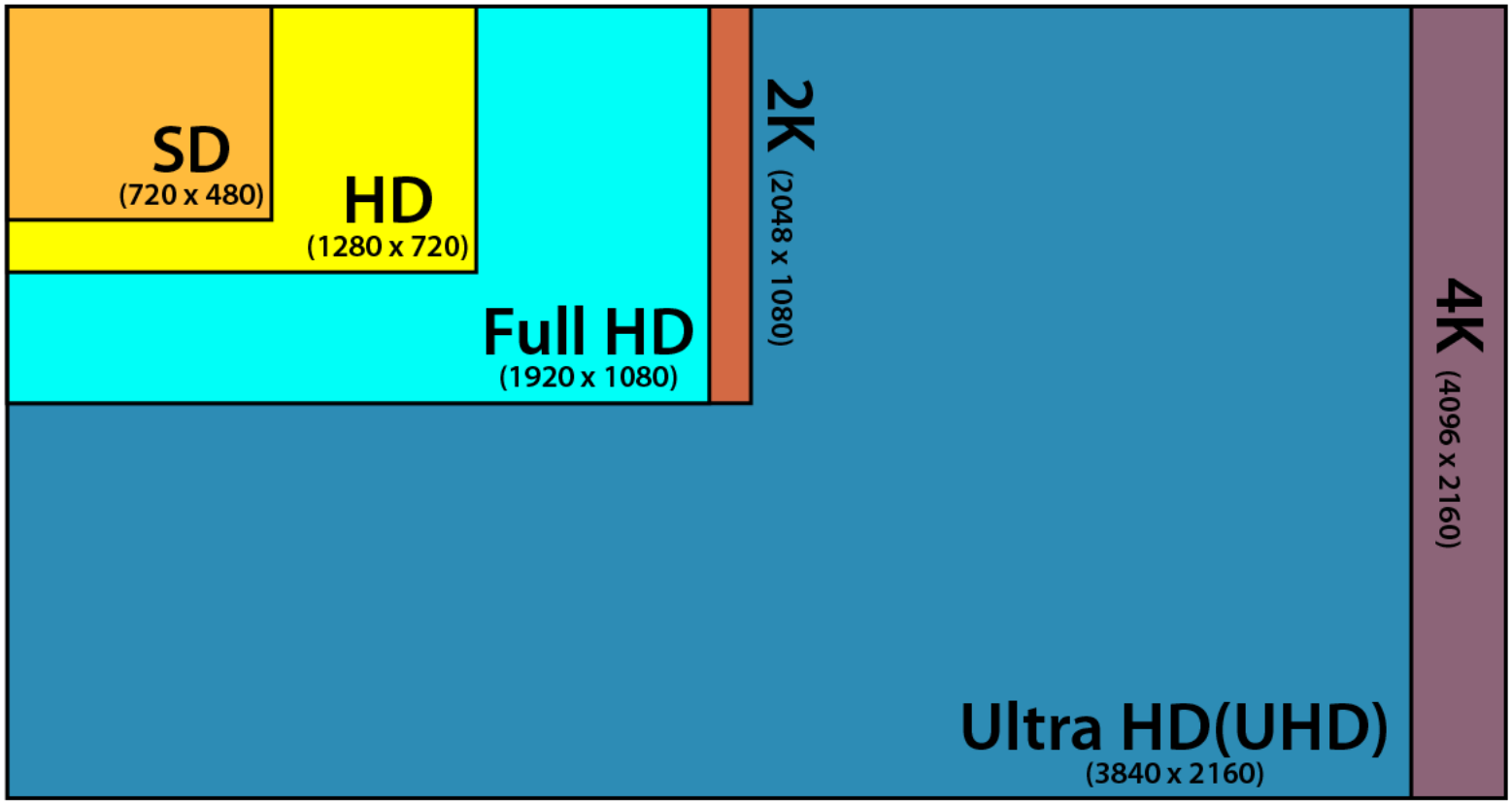


Ultra HD Video Signal Parameters

- 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

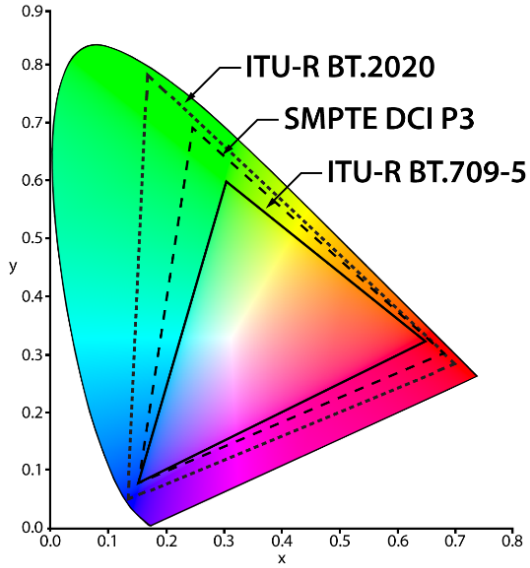


4K and Ultra HD Resolution Comparison



Wide Color Gamut

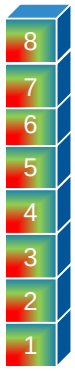
- UHD proposes a significantly broader color space standard
  - Rec. 2020 supports a very wide color gamut



CIE 1931 chromaticity diagram

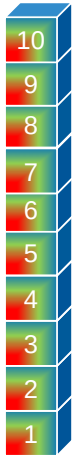
Ultra HD Color Bit Depth

- For UHD to achieve the full color spectrum of REC-2020, greater color bit depth is required



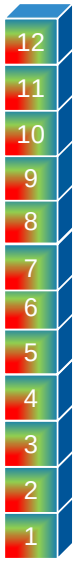
- 256 shades for each color
- 256^3 = 16 million colors

8-bit



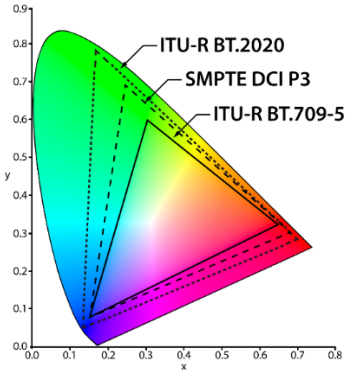
- 1024 shades for each color
- 1024^3 = 1 billion colors

10-bit



- 4096 shades for each color
- 4096^3 = 68 billion colors

12-bit

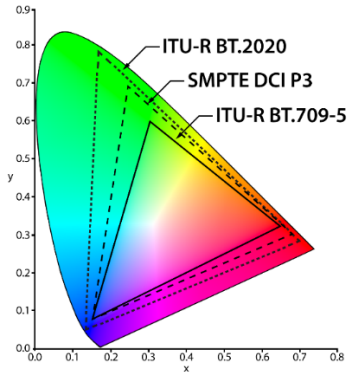


HDR – High Dynamic Range

- Produces video with a greater contrast range closer to what the human eye perceives
  - Color gamut is technically not part of HDR but goes hand in hand since greater contrast and brightness will display more colors

Standard Dynamic Range

High Dynamic Range



UHD Alliance Premium Certified

- Rating applied to displays that meet or exceed certain performance minimums for Ultra High Definition displays
  - Specs include High Dynamic Range and Wide Color Gamut, brightness and more
    - Resolution: 3840x2160 pixels
    - Color depth: 10-bit
    - Color gamut: Wide, including the ability to show at least 90% of the P3 color gamut

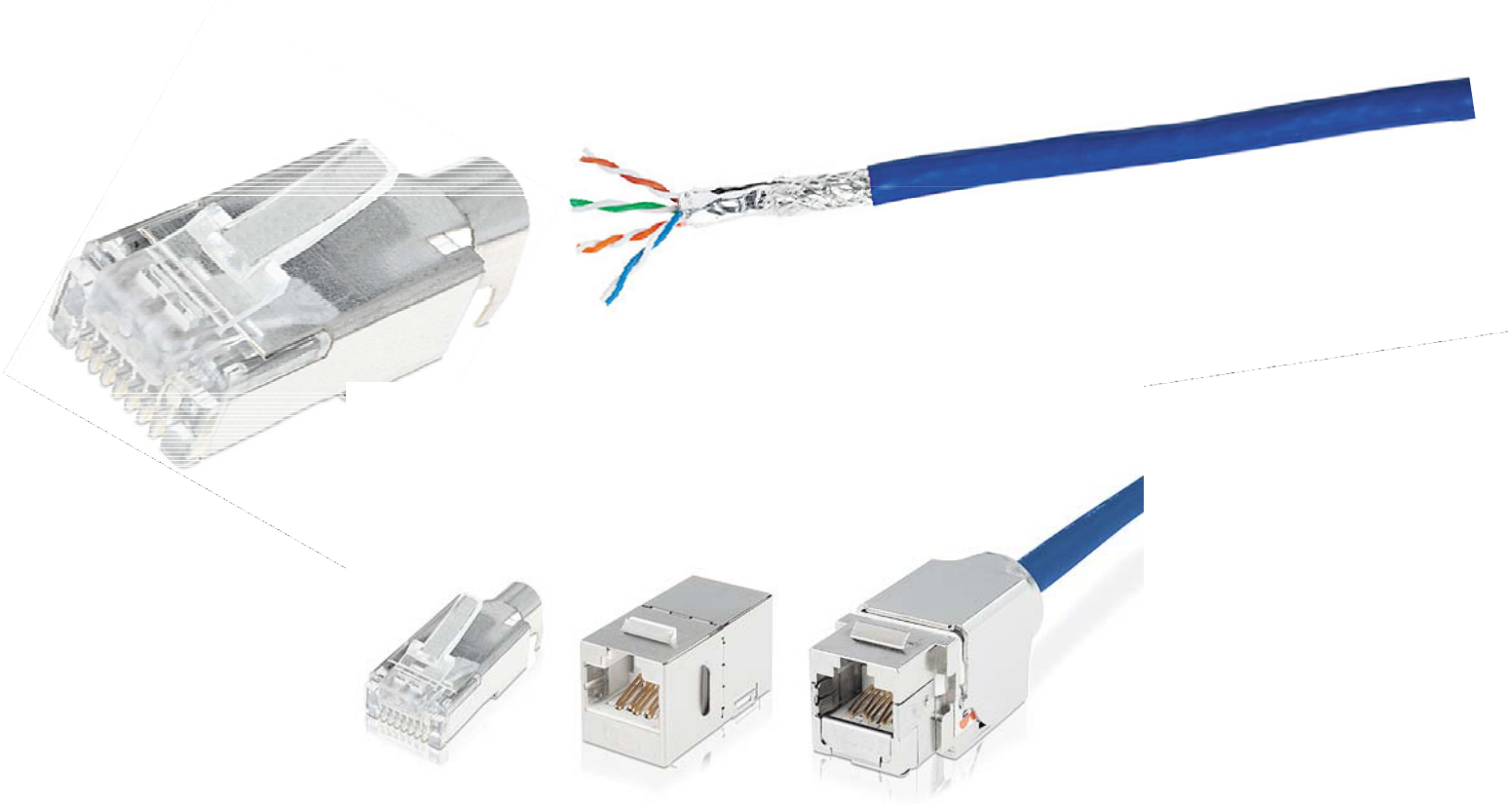
4K Applications with HDMI

- Optimal 4K parameters depend on the application

4K Applications with HDMI: Requirements and Compromises						
Application	Refresh Rate	Color Bit Depth	Sub-sampling	Color Space Version	HDMI Version	Comments
Consumer/Residential	60Hz	8-bit	4:2:0	BT.709	1.4	Single Cable
Digital Signage	60Hz	8-bit	4:2:0	BT.709	1.4	Dynamic Content – Single Cable
	30Hz	10-bit	4:4:4	BT.2020	2.0	Static Content – Single Cable
Corporate Presentation	30 Hz	8-bit	4:4:4	BT.709	1.4	Single Cable
Graphic Workstations	30Hz	8/10/12bit	4:4:4	BT.709/ BT.2020	1.4/2.0	Single Cable
Special Applications (Medical/VR/Military)	High Frame Rate (>60Hz)	12/16bit	4:4:4	BT.2020	2.0	Multi-Lane signal paths

Transmission Methods

CAT Cable and HDBaseT

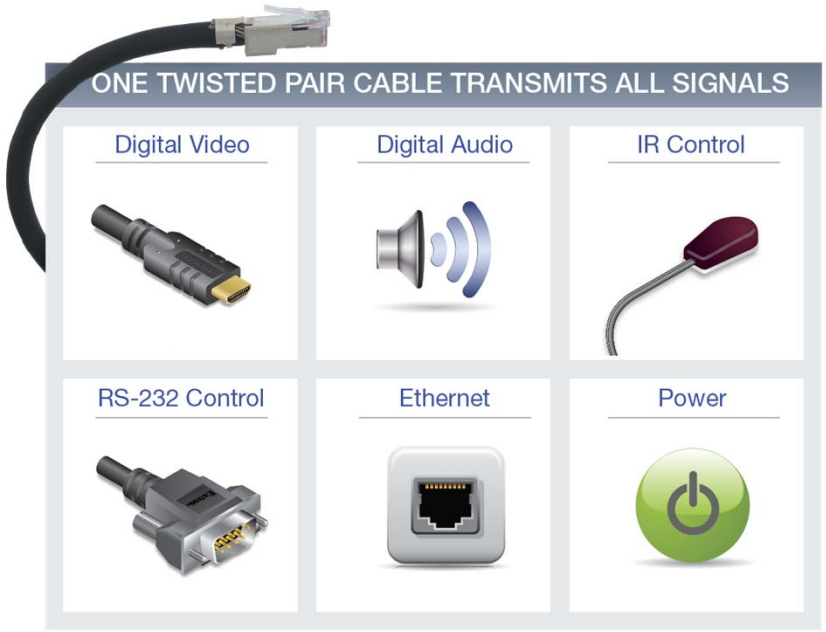


HDBaseT

- A Valens technology that enables the transport of multiple signals over a single twisted pair cable
- HDBaseT 5Play
  - Signal support – Video, Audio, Control, Power, Ethernet
  - Distance capabilities – 100m (328 feet)
  - Cable type – Shielded Twisted Pair
- Different implementations using HDBaseT (Valens)
  - 2-3-4Play – something less than all five signals

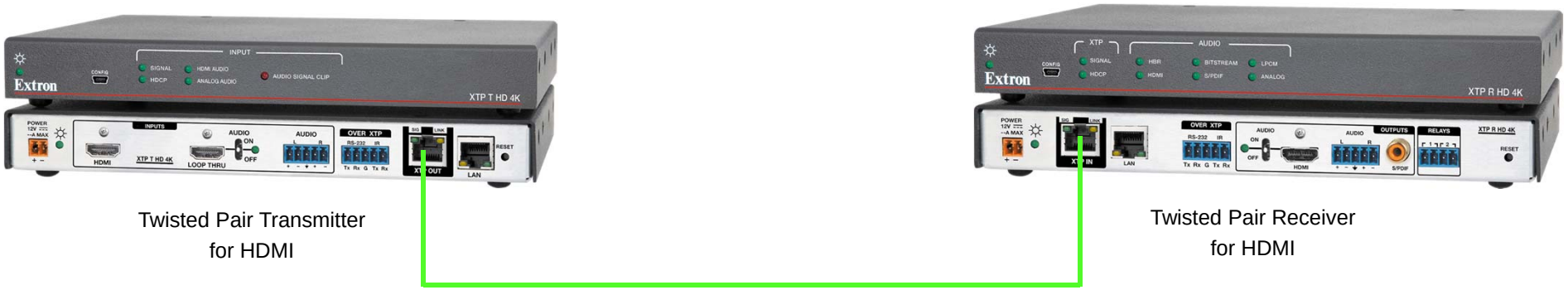
Why Use Twisted Pair?

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



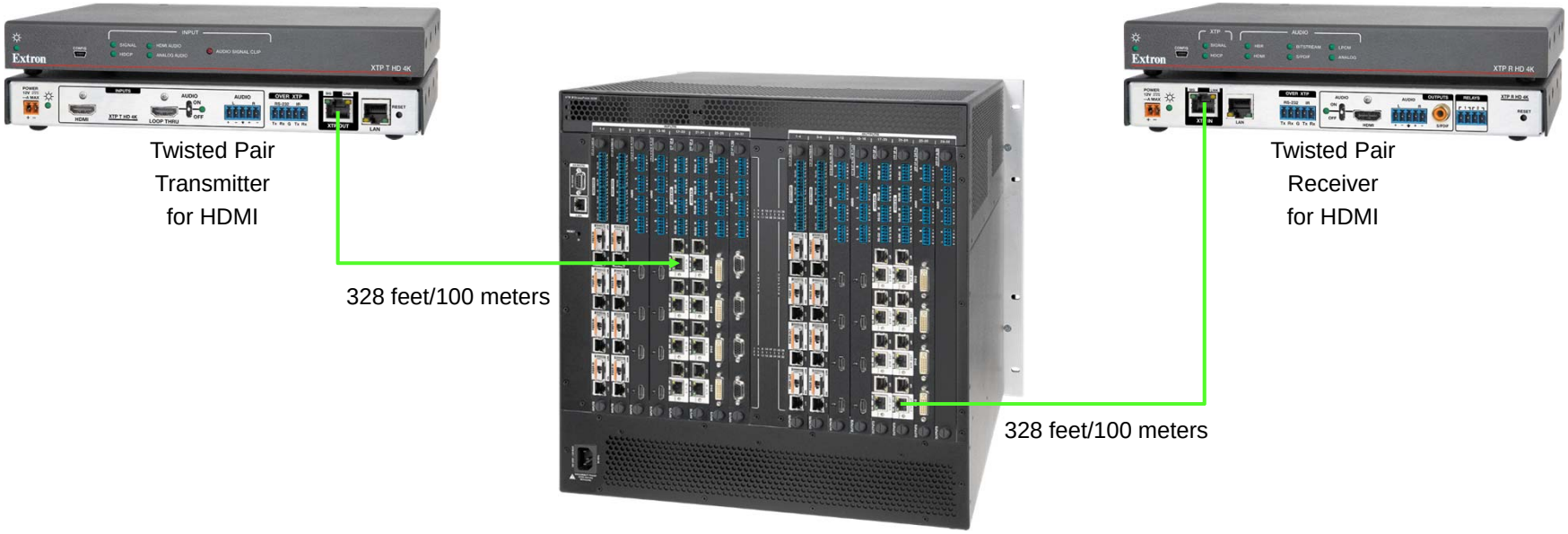
Twisted Pair Transmission

- Distance
  - 328 feet (100 meters) between endpoints



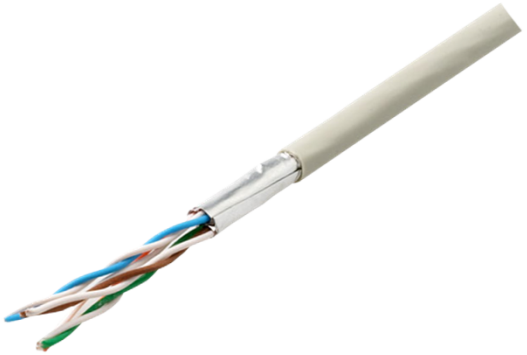
XTP Twisted Pair Transmission

- Distance
  - 328 feet (100 meters) between devices



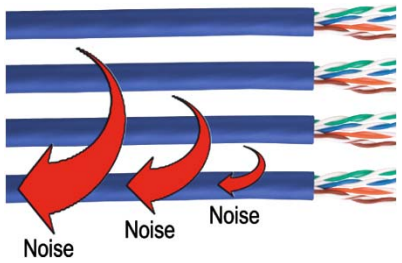
Twisted Pair Transmission

- 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

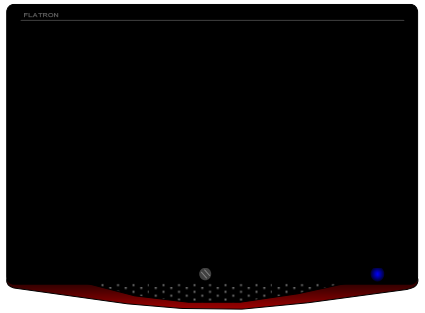


Twisted Pair Signal Transmission

- 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



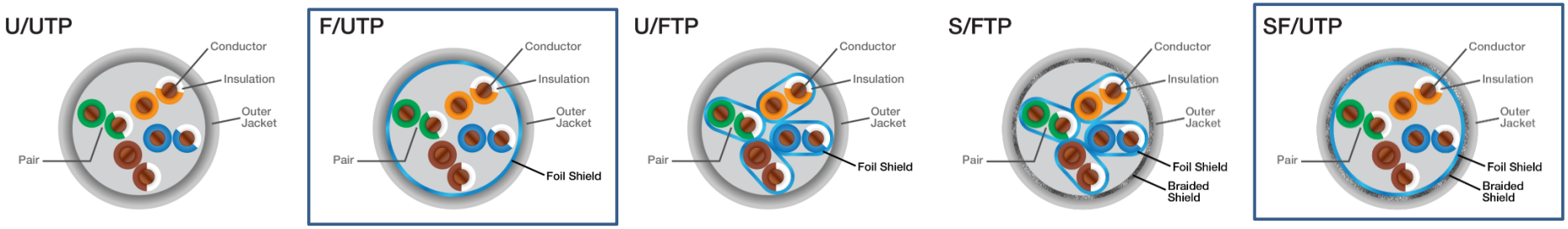
- Symptoms of noisy environments
  - Image drop-out or flashing
  - No image at all



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



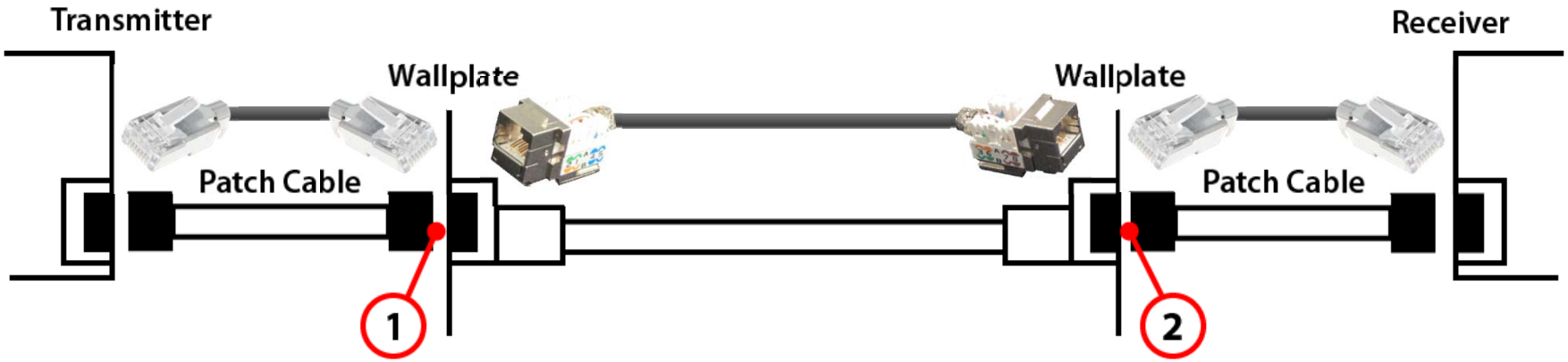
Twisted Pair Signal Transmission

- 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

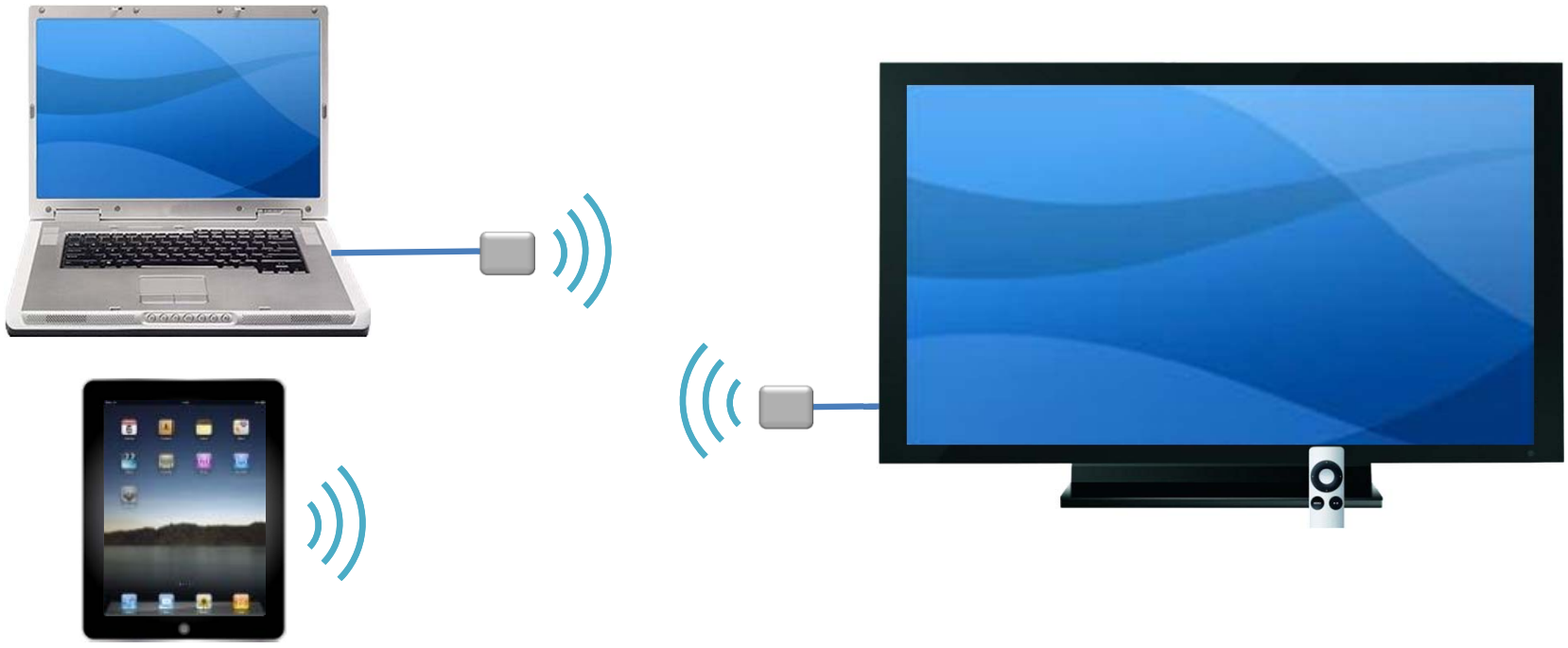
Twisted Pair Installation

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

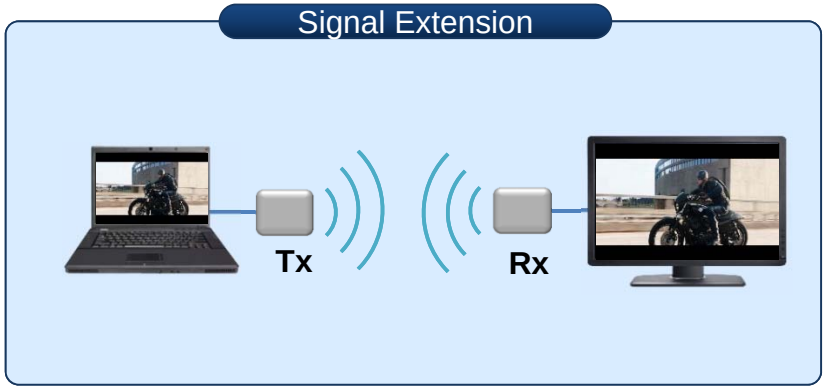


Typical scenario for AV connectivity

Wireless

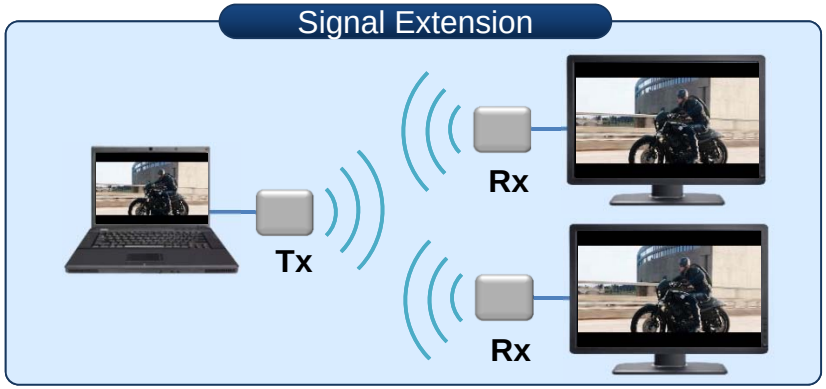


Wireless Video Applications



- 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

Wireless Video Applications

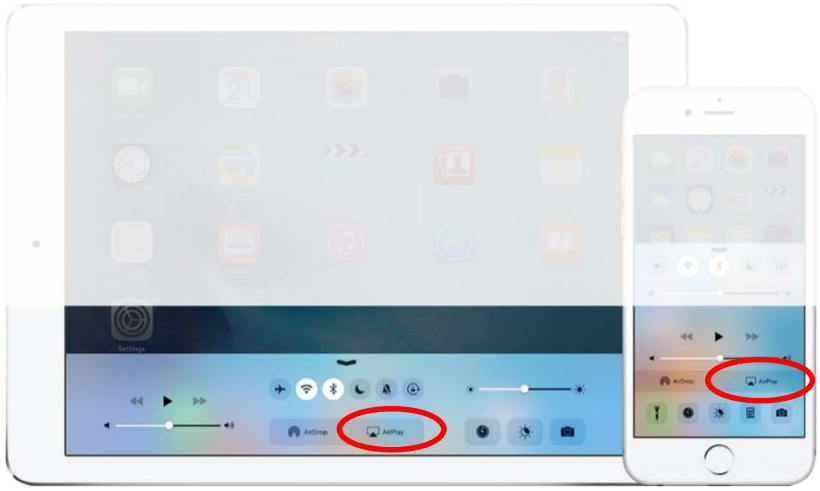


- No computing device required – simple signal extension
  - Real-time performance – extremely low latency
  - High video quality – maintains resolution, refresh rate, color depth
  - Works with more types of video sources
  - Entire bandwidth is dedicated to video

- Wide availability of networking and compression technologies
  - Receiver is the only hardware required
  - BYOD devices already have Wi-Fi built-in
  - Loaded software can perform video compression
  - Mobile device acts as transmitter

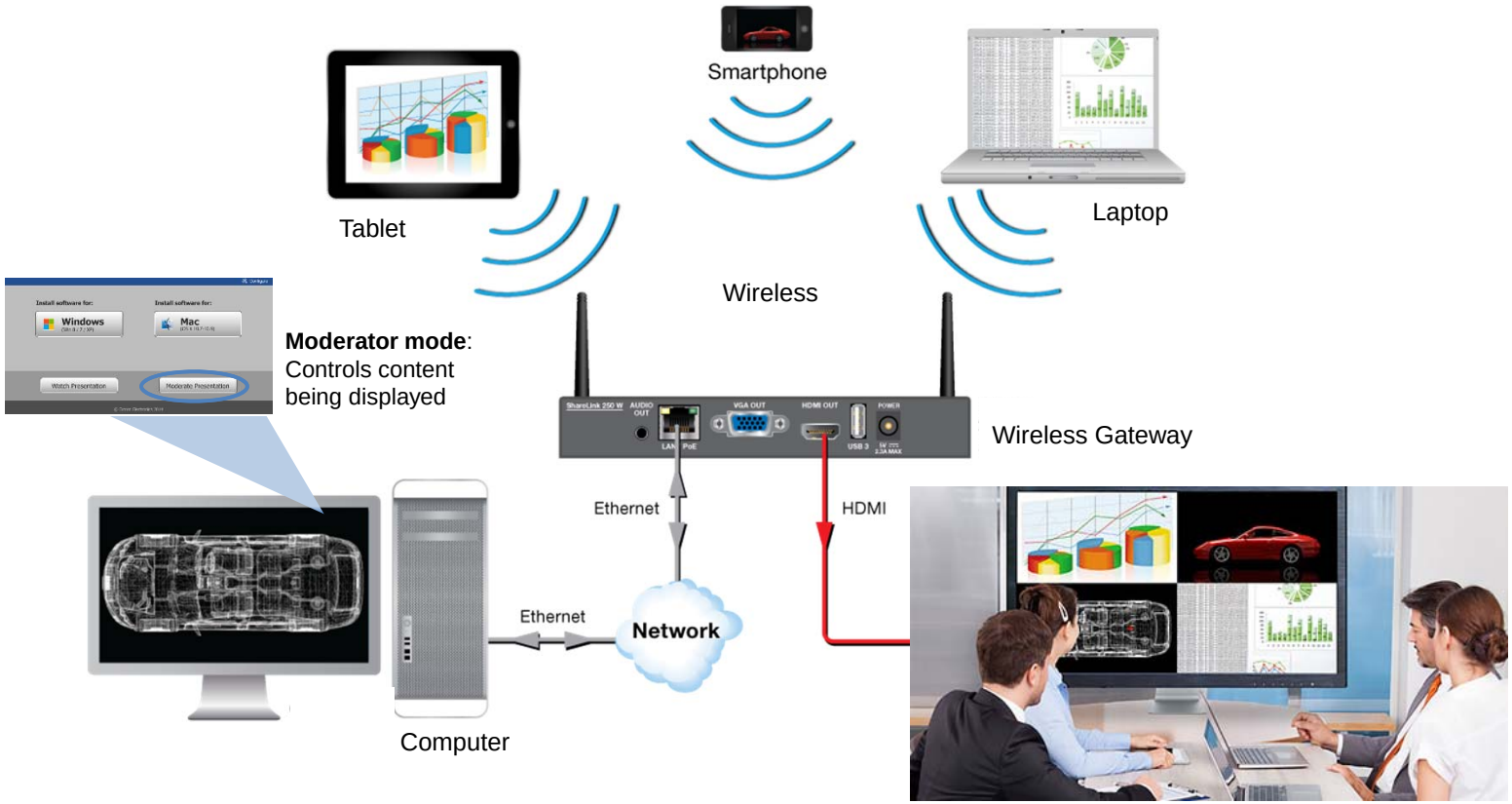
Mirroring iOS Devices

- Works for Apple iPads and iPhones
- Use Control Center on your iOS device
  - Swipe ‘up’ for Control Center
  - Select ShareLink from Airplay Device List
  - Disconnect when done



Wireless Collaboration

- Simultaneously share up to 4 different devices



Design Exercises

Small Meeting Room

AV Requirements

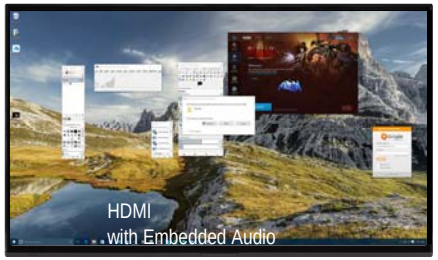
AV Sources
- Multiple Laptops

Output Devices
- 4K Display

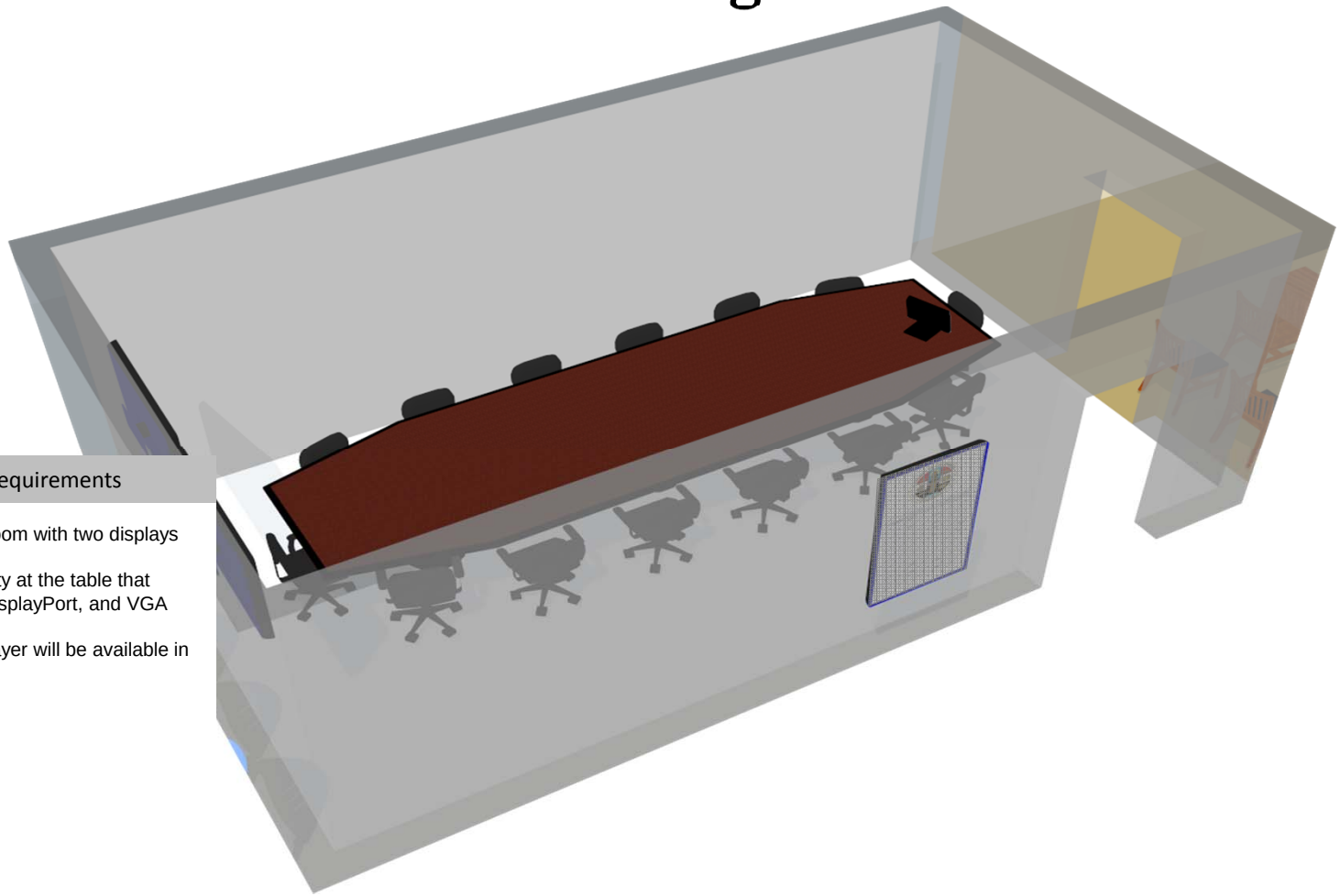
Technical Requirements

- 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

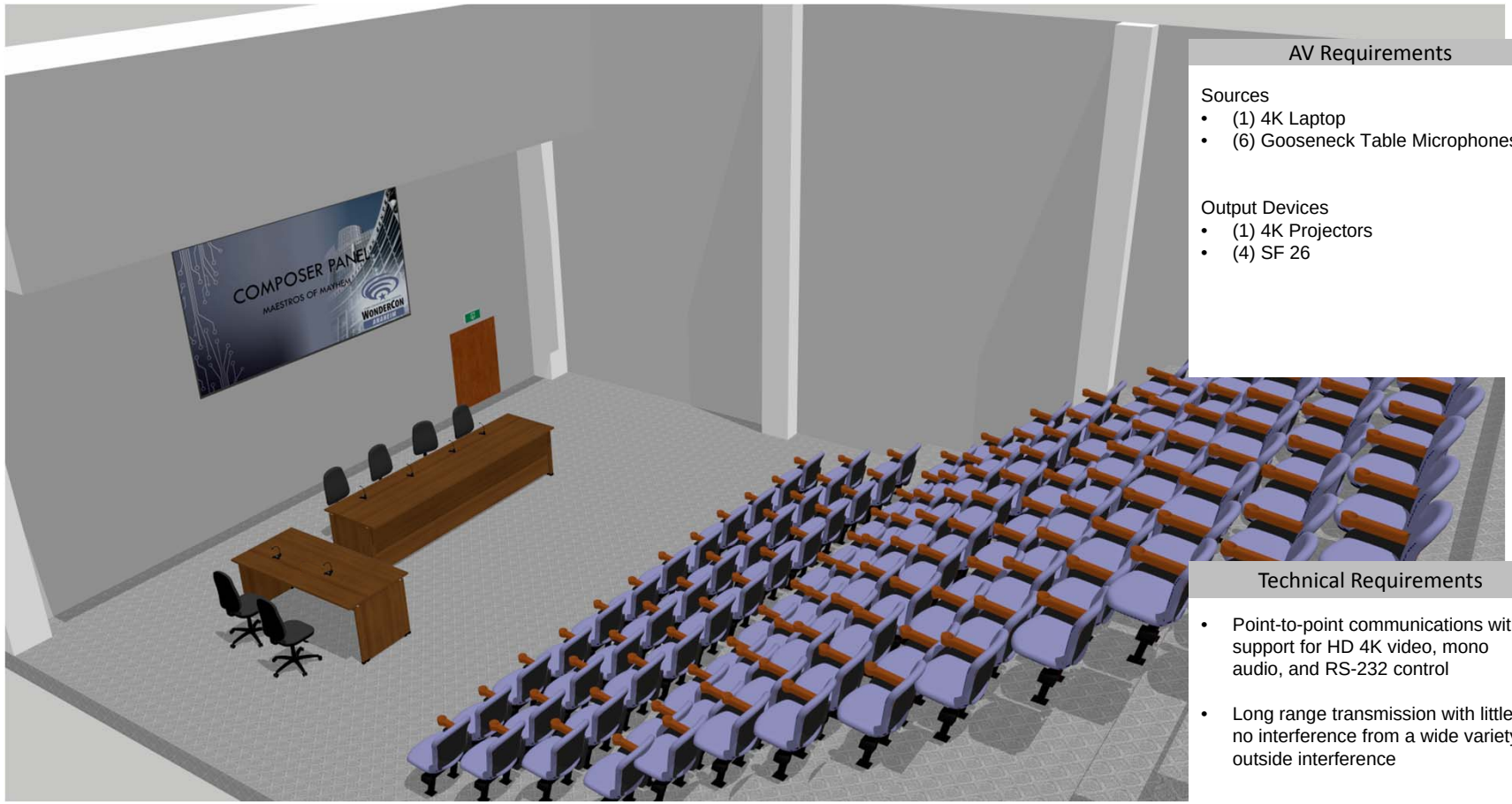


Technical Requirements

- 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



AV Requirements

Sources
- (1) 4K Laptop
- (6) Gooseneck Table Microphones

Output Devices
- (1) 4K Projectors
- (4) SF 26

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

Digital Video for BICSI Folks

Karl Rosenberg, Regional Applications Specialist
Extron Electronics