Designing and Implementing HDMI Distribution

The History of VANCO

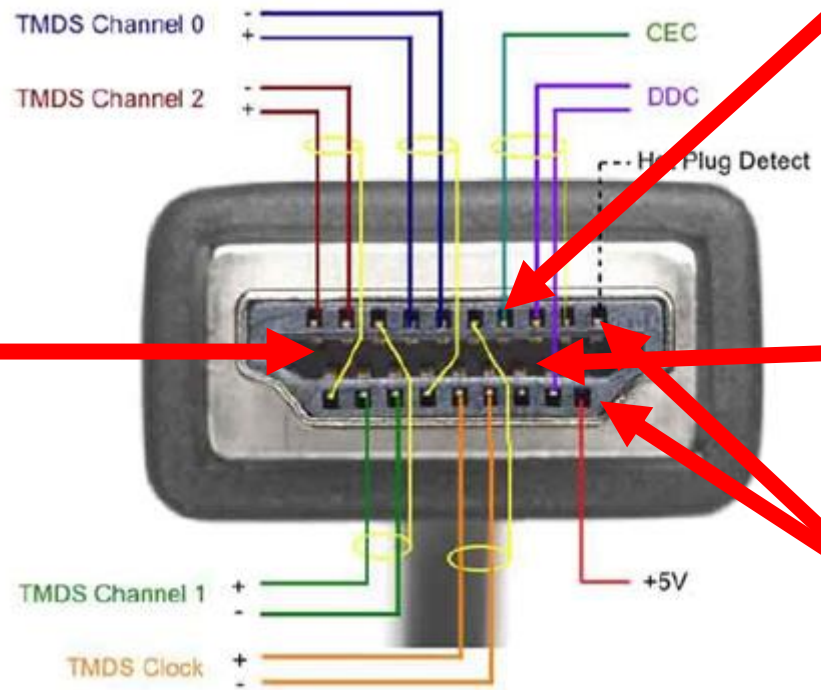
- Vanco founded in Illinois in 1957
- Short for “Van Company”
- Committed to high quality Customer Service
- Lifetime warranty on all cables
- QC active product 100%, twice

Presentation Outline

- HDMI
  - Structure and Terminology
  - Why HDMI?
  - Past, present, and future
  - 4K/HDMI 2.0/HDCP 2.2
  - 8K resolution
  - Specifications and Bandwidth
- Different ways HDMI is transmitted (Coax, Cat, Fiber, etc.)
  - HDBaseT, Redmere, and new 4K active cables
- Design and Installation
  - Extender vs HDMI
  - Splitter vs Switch vs Matrix
- Design Ideas and examples
  - Keep it simple but don't be afraid to think outside the box
  - Everywhere you see a TV or Monitor is a potential job
- Good Practices
  - Running cables
  - Type of cabling
  - Terminations
  - Testing
  - Cabling before installation
  - Products before on site
- Troubleshooting Checklist
- Q&A

The HDMI Connector

- TMDS (Transition-Minimized Differential Signaling) Channels
  - Audio and Video data (pins 1-9)



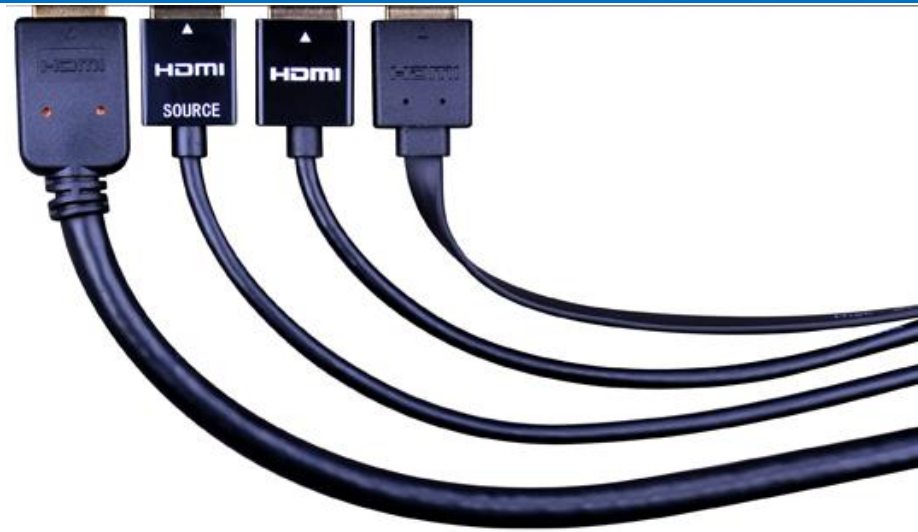
- CEC (Consumer Electronic Control)/ARC (Audio Return Channel
  - Control source from TV remote
- DDC (Display Data Channel)
  - Transfers EDID info
- Hot Plug Detect
- 5V of power running through

HDMI Cables aren't Created Equal

- Braid coverage
- 360 degree metal case around connector
- 100% Foil coverage reduces interference
- Gel molding = connectors won't fall off
- Triple Shielding = Braid, individually insulate wires, insulated ends

HDMI Terminology

- “The Handshake”
  - The communication and exchange of data between the source and sink
- EDID (Extended Display Identification Data)
  - The capabilities of the display or sink
- HDCP (High-bandwidth Digital Content Protection)
  - Protection of digital (entertainment) content
- Keys
  - The amount of allowed devices a source can be connected to (127 keys)



EDID (Extended Display Identification Data)

The HDMI Handshake

-Occurs every 2-3 seconds

Why Do We Use HDMI?

- Established 2002 as a 1-cable solution for High Definition Audio and Video
  - Best Quality of Audio and Video TODAY
  - Access to Content
  - Carries HDCP
  - Single connection
  - Backwards compatible

Classifications of HDMI Cables

- STANDARD: Designed to handle typical home use
  - recommended for STB's, DVD/Media Players
- STANDARD with Ethernet: Same as Standard HDMI, but with a dedicated data channel for device networking
- STANDARD AUTO: Same as Standard HDMI but with a stronger signal
- HIGH SPEED: Tested to handle 1080p resolutions and beyond
  - 4K, 3D, Deep Color
- HIGH SPEED with Ethernet: Same as High Speed HDMI but with a dedicated data channel for device networking

HDMI Versions 1-3

- HDMI 1.0/1.1 (2002-2004)
  - Support for DVD Audio on 1.1
- HDMI 1.2 (2005)
  - Increased resolution support for PCs with HDMI outputs
  - 1.2a introduced CEC
- HDMI 1.3/1.3a (2006-2008)
  - Increased speed (10.2 Gbps) to support higher resolutions and higher frame rates
  - Deep Color introduced
  - New Mini connector introduced for small portable devices such has HD Camcorders and Cameras
  - Dolby TrueHD and DTS-HD Master Audio

HDMI Version 1.4

- HDMI 1.4/1.4a (2009-2013)
  - Addition of Ethernet Channel
  - Audio Return Channel (ARC)
  - 3D
  - 4K/24Hz Support
  - Better and Deeper Color
  - Micro HDMI for mobile phones, tablets, etc.
  - Automotive Connection System (Type E)

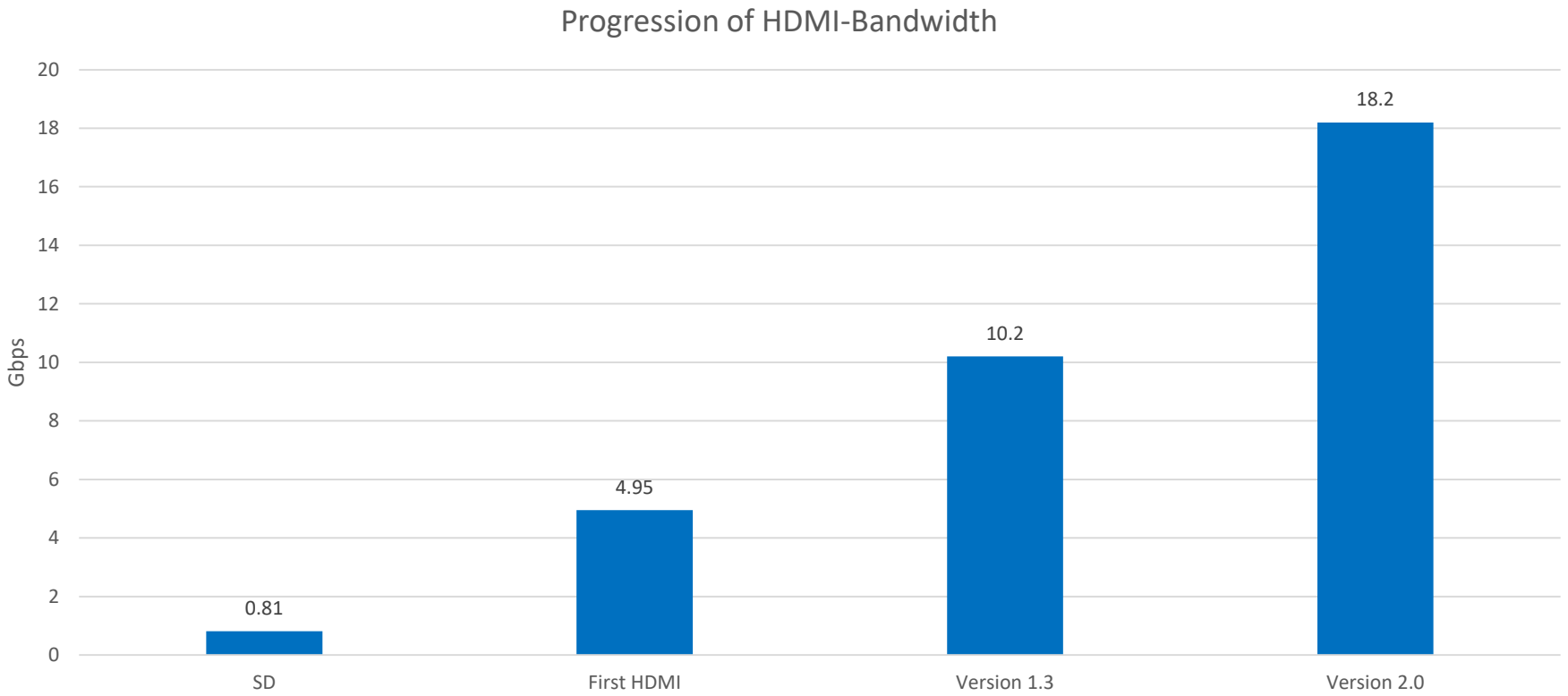
HDMI Version 2.0

- HDMI 2.0 (2013-2015)
  - 1.4 cable compatible with 2.0 source and 2.0 display
  - Increased speed to 18 Gbps (using HDMI Certified Cable)
  - Dual View using 3D technology
  - Ability to handle up to 32 channels of audio (ie Dolby Atmos)
  - Wider viewing format – 21:9
- HDMI 2.0a/b (2015-Present)
  - High Dynamic Range (HDR) Video
    - HDR10 and Dolby Vision capable
  - 4K at 50/60 frames per second

Vanco Premium HDMI Certified Cables

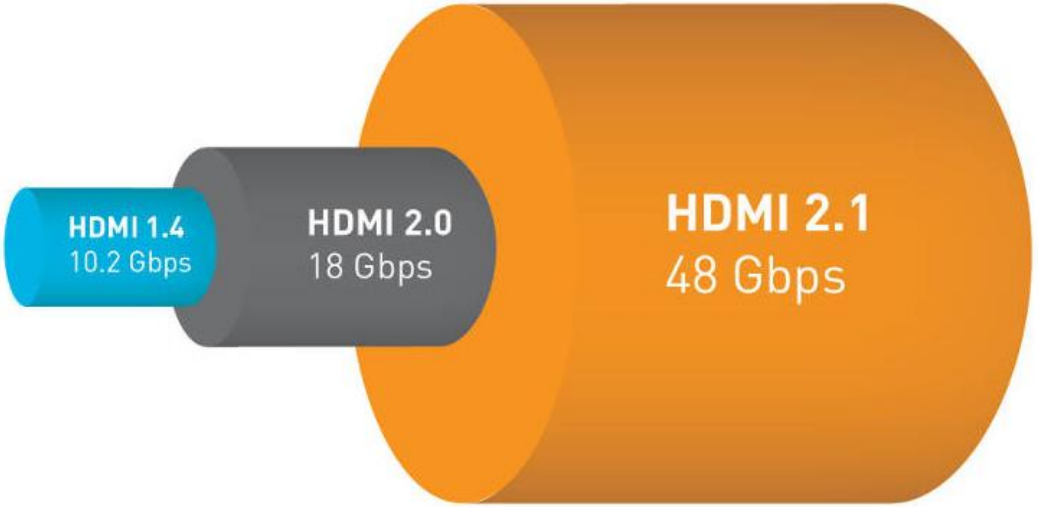
- Premium High Speed HDMI Cables testing
- Ensures 18 Gbps and HDR for HDMI 2.0 and 2.0a up to 25ft
- Advanced EMI testing
- Notes if cable is capable of 4k @ 60Hz, BT .2020, HDR (High Dynamic Range), etc.
- Packaging would be labeled Premium High Speed
- Part #s begin with HDMICP

HDMI and Bandwidth



HDMI Version 2.1

- HDMI 2.1 (2017)
  - 8K/60Hz and 4K/120Hz
  - HDR
  - 48Gbps
  - Backwards compatible



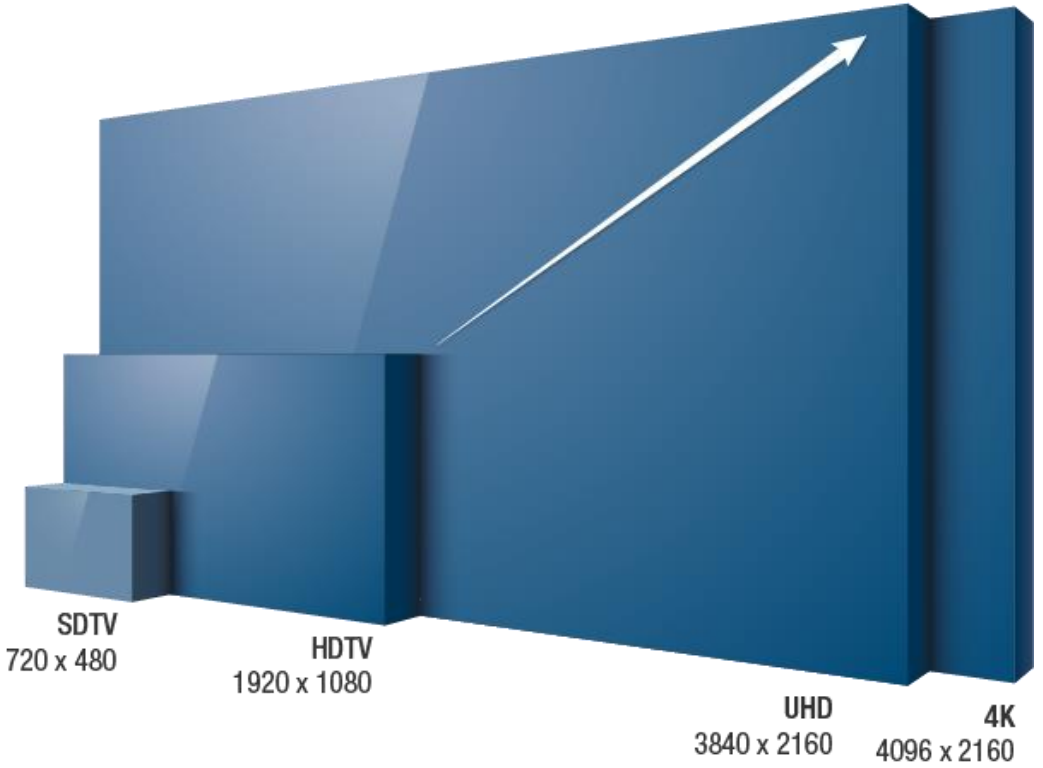
4K Resolution

What is 4K?

- 4K is a resolution standard that has improved upon 1080p, the next resolution standard (8K is the next standard above 4K)
- Many different names including 4K, 4K2K, Ultra HD, UHD, etc.
  - 4K nomenclature is a professional production and cinema standard
  - UHD (Ultra High Definition) nomenclature is a consumer display and broadcast standard
- 4K2K =
  - 4K: 4 times the pixel count of 1080p
  - 2K: 2 times the resolution of 1080p (2160p)
- Why not 2160p?
  - Presumably for marketing reasons, the 4K nomenclature is being used for consumer products

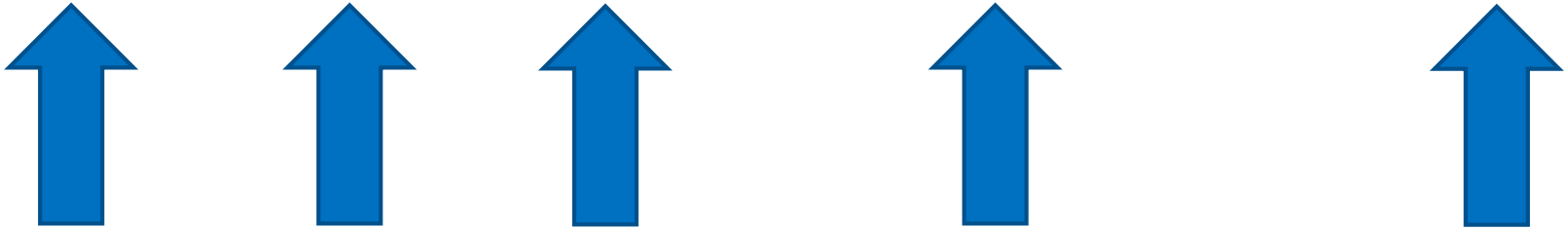
4K vs UHD: Resolution Confusion

- Technically Full 4K is 4096x2160p, however most if not all consumer “4K” displays can only handle 3840x2160p
- What’s the difference?
  - UHD 3840x2160 (see illustration) is literally double the resolution of 1080p (1920x1080), however technically is a less resolution than 4K
  - 4K 4096x2160 (see illustration) is a better resolution with more pixel count than “UHD”
    - 4K represents the 4096 number, which is the horizontal resolution
    - 3840 been rounded up to “4” for marketing purposes



What makes up a 4K Specification?

4K @ 60Hz, 4:4:4, 12 Bit Color with HDR



Resolution

Refresh Rate

Chroma Subsampling

Color Depth

High Dynamic Range

Refresh Rates

- 4K/30 vs 4K/60 Hz Refresh Rates
  - Refresh rate refers to the number of times per second that a video screen is updated
  - Video with lots of movement (Sports), need higher refresh rates
  - The higher the refresh rate, the movement becomes more “natural-looking” (to a point)

Chroma Subsampling

- 4:2:0 vs 4:4:4
  - These numbers are a ratio of luminance and chrominance in a pixel
  - The better the chroma subsampling (4:4:4), the brighter and more vivid in color the pixels are
  - In a lower chroma subsampling (4:2:0), pixels will have multiple colors combined resulting in a picture that is less sharp and not as vivid in color

4:2:0

4:4:4

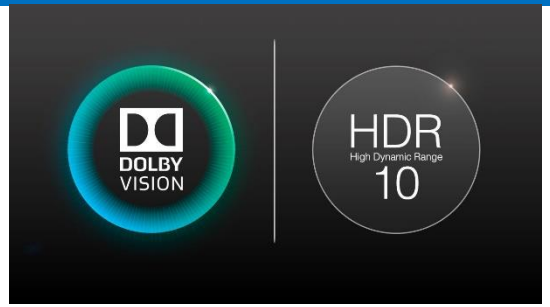
What is HDR?

- HDR is short for “High Dynamic Range”
- Originally introduced in digital imaging (iPhone cameras), later moved into digital video
- HDR combines multiple exposures of the same video (or photo) to provide more vivid colors and darker images at the same time
- Creates a more realistic or lifelike image

What is HDR?

What is HDR?

Types of HDR



- **Dolby Vision**
  - 12 bit
  - 68.7 billion colors
  - Tones masters past displays range are mapped use Dolby Chip
  - Asks for dynamic metadata
  - More proprietary
  - Less sources, content, and displays found currently in the market

- **HDR10**
  - 10 Bit
  - 1.07 billion colors
  - Tones mastered past display's range are mapped using PQ transfer method
  - Asks only for static metadata
  - More current displays and devices available in the market

HDCP 2.2

- HDCP in general creates a secure connection between a source and display to keep from unauthorized recording or copying
- HDCP 2.2 is the next generation copy protection for the 4K era
- So what's new with HDCP 2.2?
  - The encryption is more advanced than the previous versions, which makes the connection much more secure and more difficult to break
  - New feature called "locality check", in which the source sends a signal to the display (sink), and if that signal isn't received by the display within 20ms, the source kills the connection
  - Copy protection for 4K

HDCP™
HIGH-BANDWIDTH DIGITAL CONTENT PROTECTION

HDCP Conflict

4K HDCP 2.2 Bluray Player

4K TV
HDCP 1.4
display

4K HDCP 2.2 Bluray Player

4K TV
HDCP 2.2
display

4K HDMI Conditioner

- Allows for High-definition HDMI transmission and HDCP conversion for legacy 4K TV's and projectors
- Solution for any compatibility issues between HDCP 2.2 sources and HDCP 1.4 displays
- HDMI Input supports HDMI 2.0 with HDCP 2.2 and is backwards compatible with lower HDMI standards
- HDMI Output supports HDMI 1.4 & HDCP 1.4 and is compliant with lower HDMI standards
- Transmits 4Kx2K @ 60Hz (max) signal up to 49 feet/15m
- EDID bypass function ensures the best resolution
- Part # HDVC1

Alternative Ways of Transmitting HDMI

Thinner, *Faster*, *More Flexible*

- 25% the size of standard HDMI cables
- Active amplification
- 1080p, 3D (shorter lengths may be able to pass 4K depending on equipment connected)
- 100 Mb/s Ethernet Channel
- Audio return channel
- 12ft to 100ft

Full 4K Active Cables

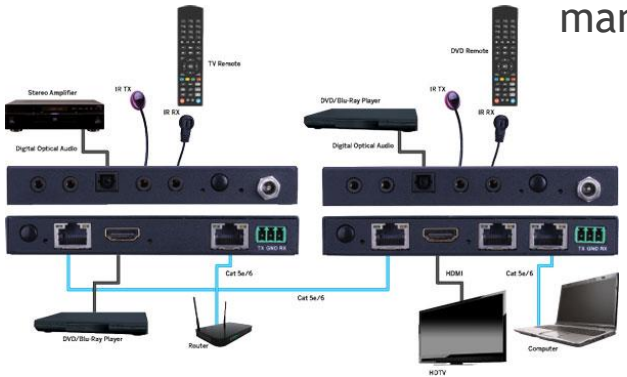
- Full 4K up to 50ft
- Active amplification
- 4K/60Hz, 4:4:4, and HDR
- 18Gbps
- 12ft to 50ft
- Part #s begin with “HDAC”

What is the purpose of an HDMI Extender?

- HDMI Cable limitation is length
- Extenders will extend HDMI signal further than HDMI cable can
- Category cables are a cheaper option, easier to replace
- Carries audio, video, IR, and even power over a single Cat5e/6

HDMI Extension over Category Cable

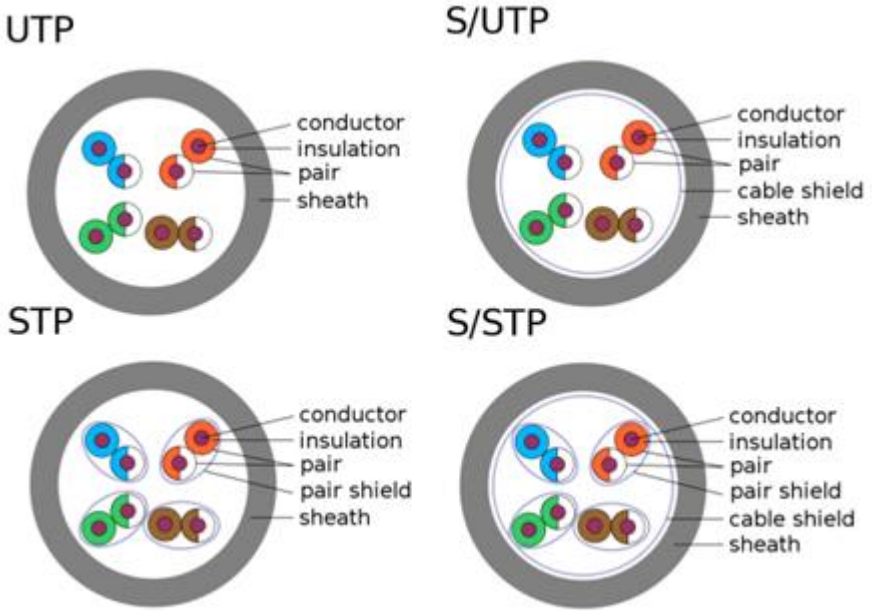
- PRO's:
  - Relatively inexpensive
  - Easy to replace or re-terminate
  - Variety of solutions depending on you what is needed for the job
  - Audio, video, and control over 1 or 2 category cables.
  - Able to withstand long distance cable runs
- CON's:
  - Cable/Extender type and conditions greatly affect the overall outcome
  - Environmental issues such as EMI or other types of interference can hinder the overall performance
  - Some products are dependent on knowledge of HDMI and the adjustment of manual settings.



Part # EVEXHDARC shown

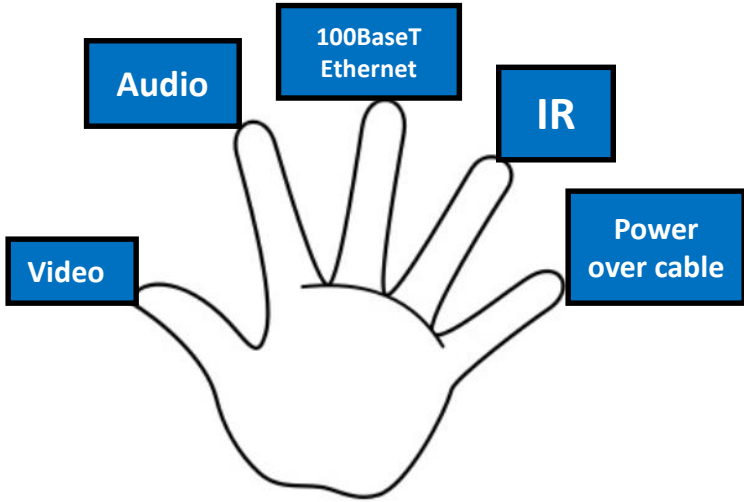
Unshielded vs. Shielded Cat Cables

- Residential or Commercial applications
  - Lots of equipment, machinery, electrical lines, etc.
- Applications where you are looking to reduce electrical noise
- STP= Shielded Twisted Pair
- UTP= Unshielded Twisted Pair
- S/= Screened



HDBT® and 5-Play

- Newest HDMI signal transfer technology uses proprietary transmit and receive chips
- HDBaseT Technology transmits uncompressed full HD digital video, audio, 100BaseT Ethernet, various control signals including IR, and power over cable
- Single Category cable, 330ft
- UTP connection supports HDMI, 3D, IR and 100 Mb/s Ethernet
- Offers possibility of daisy chaining devices

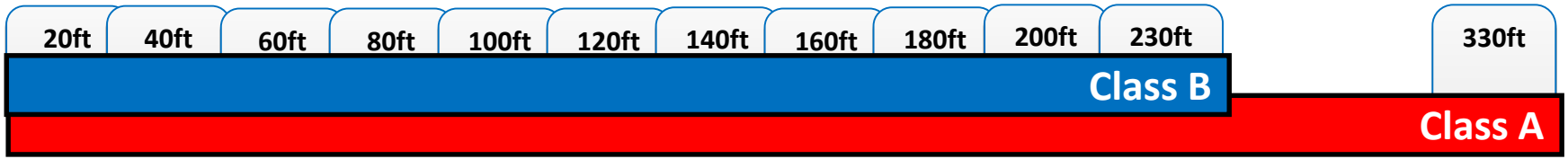


5 play system

20ft | 40ft | 60ft | 80ft | 100ft | 120ft | 140ft | 160ft | 180ft | 200ft | 230ft | 330ft

HDBT® Versions

- Class A Chipset
  - 330ft/100m transmission range
  - Serial control pass through
  - Bidirectional IR
  - Uncompressed high quality audio
  - Uncompressed high quality video (4K/UHD)
  - Ethernet (100Mbps)
  - Power (PoE, PoC, PoH)
- Class B Chipset
  - 230ft/70m transmission range
  - Serial control pass through
  - Bidirectional IR
  - Uncompressed high quality audio
  - Uncompressed high quality video (4K/UHD)
  - Some circumstances power(PoE, PoC, PoH)

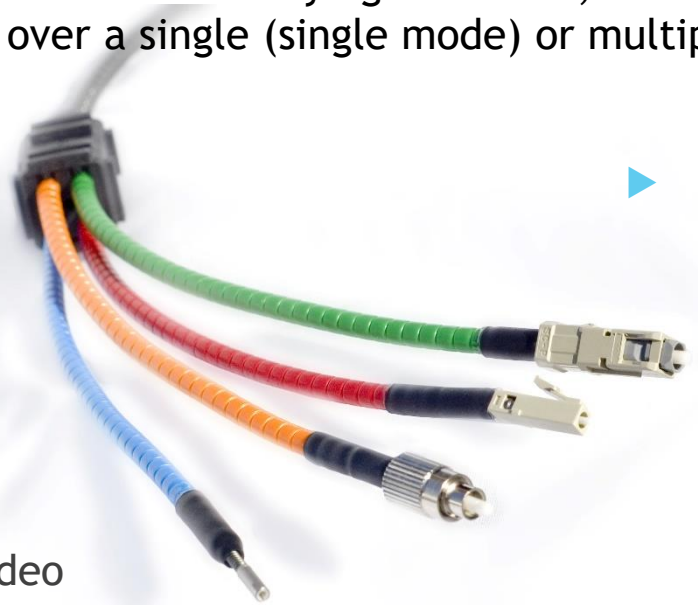


HDMI Extension over Coax Cables

- PRO's:
  - Able to maintain 1080p/60Hz at long distances
  - Utilizes a single RG6 to provide audio, video and control.
  - Easy to terminate/re-terminate as needed
- CON's:
  - More compatibility issues than Cat extenders
  - Not able to handle certain audio formats

HDMI Extension over Fiber Optics

HDMI over Fiber has been available for half a decade but due to the high costs of high cost involved, it has not taken off as much in the US as it has elsewhere. Using fiber optics to transmit HDMI has the main benefit of carrying HD video, audio, and in some circumstances control up to several miles over a single (single mode) or multiple (multi mode) fiber optics (s) cable.



- PRO's
  - Able to obtain MUCH greater distances (miles…not meters)
  - Capable of higher bandwidth
  - Uncompressed HD video resolutions
- CON's
  - Overall cost of system
  - Fragile and lengthy termination process
  - Extenders are often limited in spec's and capabilities and often are without control

HDMI over IP

- PRO's
  - Flexibility in design can allow for a single point to point solution, or a audio video matrix solution incorporating hundreds or even thousands of devices
  - Easy to allow for growth within the system
  - Cost effective solution for larger installations
- CON's
  - Unlike the previously mentioned methods of alternatively transmitting HDMI, HDMI over IP is usually a compressed signal
  - Limited in the type or brands of switches that can be used
  - Interruption and/or audio lag

System Design and Choosing the Right Product

When to use an HDMI Splitter

- Takes the same signal and distributes it the same way to multiple outputs
- Best used if only 1 or 2 inputs needs to be shared on numerous outputs

Part # 280704 shown

- Look for splitters with EDID management
- HDMI, Cat5e/6, or HDBaseT outputs

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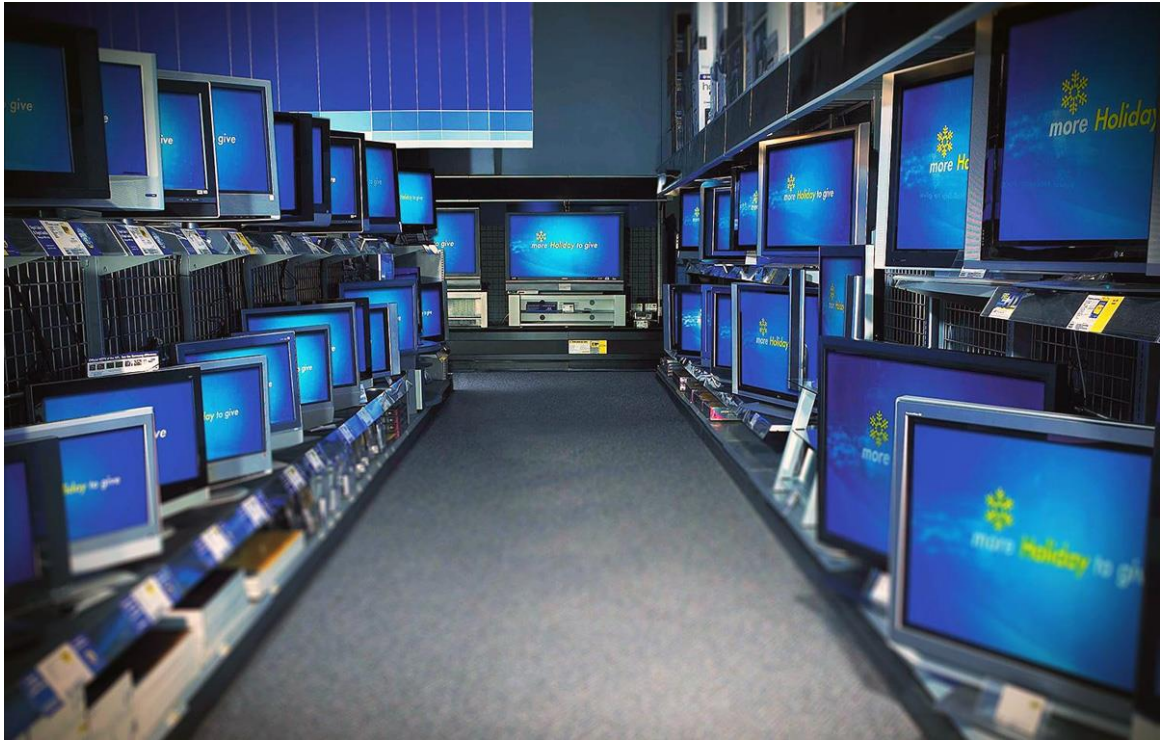
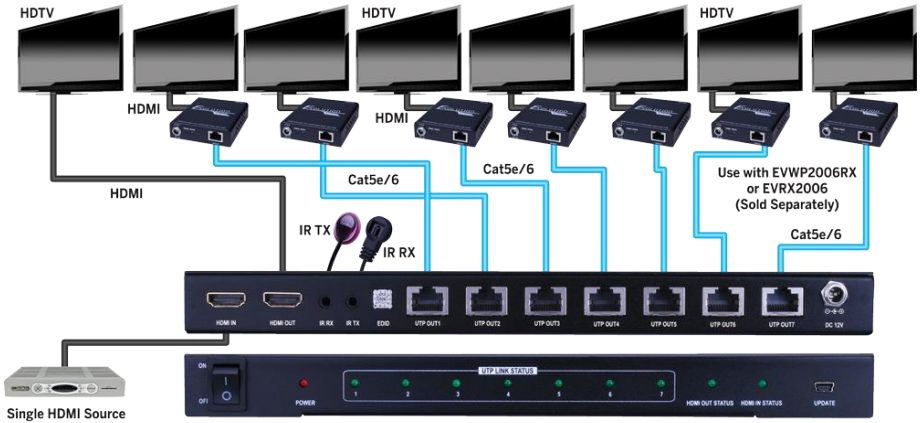


Example of Splitting HDMI

This installation required 8 satellite boxes to be distributed to 32 TV's. The TV's were numbered 1-8 around the perimeter of the restaurant/bar. One splitter was needed for each satellite box, and one receiver was needed for each TV.



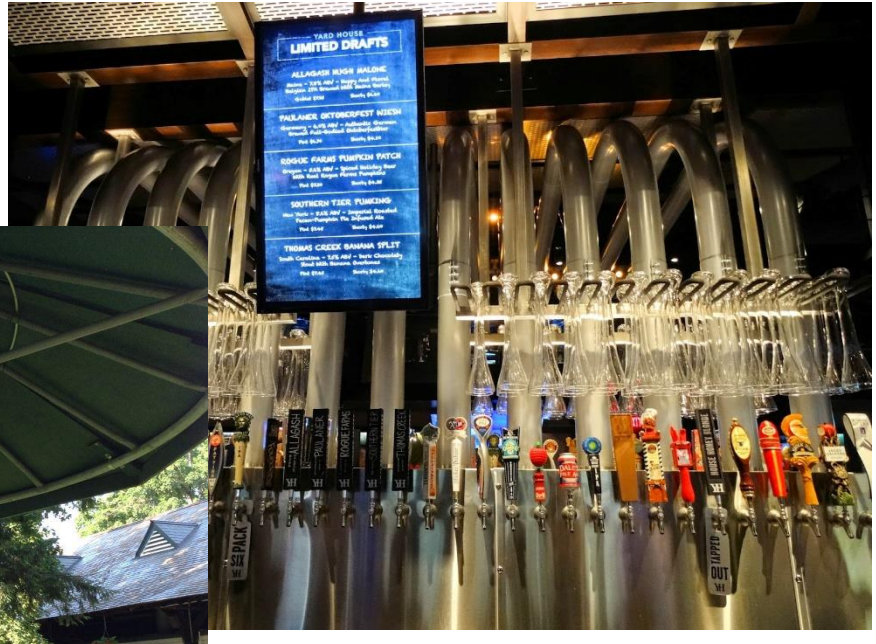
Part # EVSP1017 shown

Other Examples of HDMI Splitters

DEPARTURE	CARRIER - FLIGHT- PARTNER	GATE	TIME	STATUS
Albany	UNITED UA 7472 QR 5605	A2	5:23P	On Time
Albuquerque	UNITED UA 783 BD 4046	D18	5:34P	On Time
Allentown	UNITED UA 6861	A6	5:35P	On Time
Altoona, PA	UNITED UA 6937	A5	5:32P	On Time
Amsterdam	UNITED UA 946 LO 4601	C14	5:59P	On Time
Atlanta	DELTA DL 915	B76	2:35P	On Time
Atlanta	DELTA DL 1449	B76	4:06P	On Time
Atlanta	UNITED UA 7269 BD 4018	D12	4:46P	On Time
Atlanta	DELTA DL 1409	B76	5:25P	On Time
Austin	UNITED UA 7281 QR 5611	C18	5:40P	On Time
Binghamton	UNITED UA 6942	A5	5:34P	On Time
Boston	UNITED UA 7157 NH 7100	A5	2:21P	Now 4:00P
Boston	Blue B6 1256	B70	4:18P	On Time
Boston	UNITED UA 822 LH 9352	D10	4:59P	On Time
Brussels	UNITED UA 950 LO 4611	C27	5:57P	On Time
Buffalo	UNITED UA 7089 BD 4656	C24R	1:02P	Departed
Buffalo	UNITED UA 7832 QR 5629	A5	5:35P	On Time
Burlington	UNITED UA 8021 BD 4650	C22	5:09P	On Time
Charleston	UNITED UA 7982 OS 7845	C20R	4:55P	On Time
Charleston,	UNITED UA 6885	A6	5:38P	On Time
Charlotte, NC	US AIRWAYS EXPRESS USE	Z8	3:47P	On Time
Charlotte, NC	UNITED UA 7189 NH 7152	C24	5:20P	On Time
Charlotte, NC	US AIRWAYS US 2643	Z7	6:06P	On Time
Charlottesville	UNITED UA 6879	A4	5:55P	On Time
Chicago-	SOUTHWEST WN 456	B50	1:50P	
Chicago-	SOUTHWEST WN 2683	B50	5:40P	On Time
Chicago-	UNITED UA 395 JJ 7351	D11	2:32P	On Time
Chicago-	UNITED UA 951 OS 7915	C5	5:14P	On Time
Cincinnati	DELTA DL 6134	B78	5:00P	On Time
Cincinnati	UNITED UA 7885 AC 4783	A4	5:09P	On Time
Cleveland	UNITED UA 7135 NH 7126	A2	4:50P	On Time
Cleveland	Continental CO 8647	B31	5:35P	On Time
Columbia	UNITED UA 7279 OS 7811	A6	5:28P	On Time
Columbus, OH	UNITED UA 7844 SK 8885	A4	5:09P	On Time
Dakar, Senegal	South African SA 208 UA 9818	B14	5:40P	On Time
Dallas /Ft	QANTAS QF 4514	B73	2:20P	On Time
Dallas /Ft	American AA 601	B73	2:20P	On Time

TUESDAY NOVEMBER 17, 2009 1:53P

DEPARTURE	CARRIER - FLIGHT- PARTNER	GATE	TIME	STATUS
Dallas /Ft	American AA 1783	B71	4:30P	On Time
Dallas /Ft	QANTAS QF 4594	B71	4:30P	On Time
Dallas /Ft	UNITED UA 7681 US 7619	A2G	4:50P	On Time
Dayton	UNITED UA 7989 QR 5649	C26	5:30P	On Time
Daytona Beach	DELTA DL 1449	B76	4:06P	On Time
Denver	UNITED UA 517 US 6257	C23	2:40P	On Time
Denver	UNITED UA 903 US 6259	C19	4:22P	On Time
Denver	UNITED UA 937 LH 9058	C4	5:28P	On Time
Denver	SOUTHWEST WN 2683	B50	5:40P	On Time
Detroit	NORTHWEST AIRLINES NW 3721	B72	4:45P	On Time
Detroit	UNITED UA 7348 US 7608	A3	5:09P	On Time
Frankfurt	UNITED UA 916 LH 9051	D3	5:26P	On Time
Frankfurt	Lufthansa LH 419 UA 8832	B49	5:50P	On Time



When to Use an HDMI Switcher

- Switchers distribute multiple inputs to 1 or 2 or even more outputs

- Typically used if there are limited HDMI inputs available or if there are multiple formats of video that need to be converted and switched via HDMI

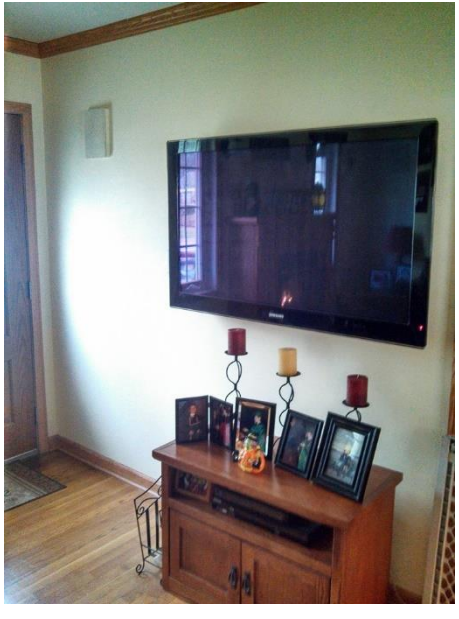
Part # 280711 shown

Examples of HDMI Switchers in Commercial Applications

Both examples below are great ways to utilize a multiple format switcher. These allow you to use numerous types of inputs (HDMI, VGA, Component, Composite) and output them via 1 or several HDMI outputs. Typically this type of product can also scale the input so that there is no messing around with additional settings on the source. This is helpful when using multiple computers and video cards.

Examples of HDMI Switchers in Residential Applications

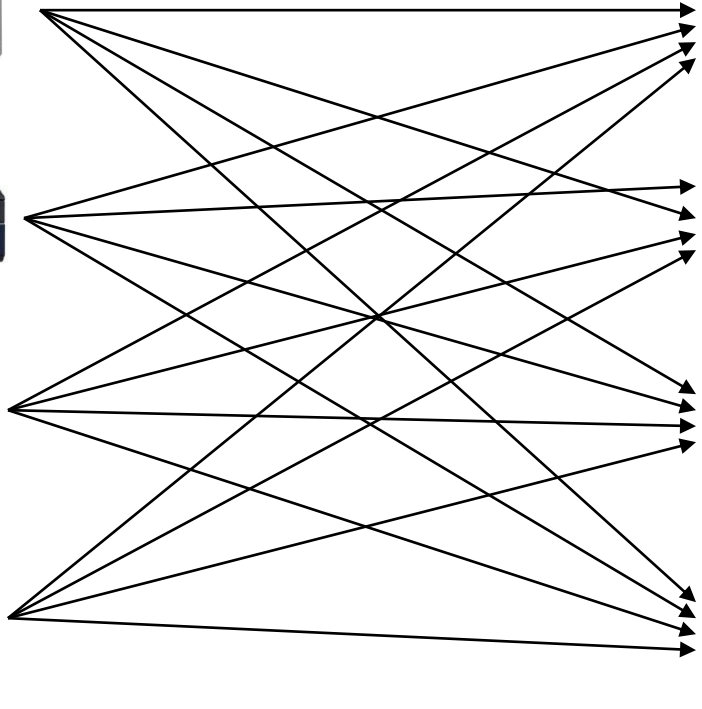
The example below is a typical residential installation where the TV is mounted and all of the components are connected to a single switched rather than having multiple HDMI cables behind the wall to the display. This also allows the smart TV to have audio from it's apps to be played through the sound system due to ARC. Any hidden components are also controlled through the IR routing feature also found on the switch.



Part # EVSW1041 shown

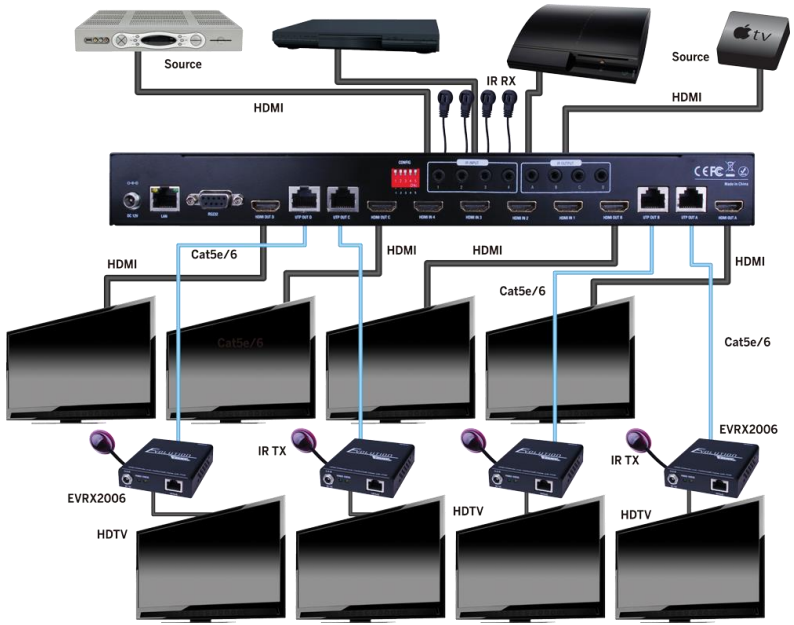
When to Use an HDMI Matrix

- A matrix is comprised of multiple inputs and outputs
- Allows any input to be independently selected on any output without disrupting the rest of the system
- EDID management is important for all components within the system to play nicely together
- Advanced features such as constant HDCP and Key management allows for faster and uninterrupted switching



Matrix Example – Small Scale

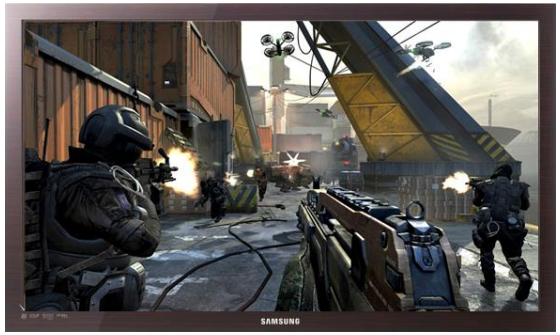
This was a basic installation which benefitted greatly by having a 4x4 matrix. TV's were in the Living Room, Bedroom, and Playroom with a projector in the basement. The entire system was located out of the reach of little hands in a closet.

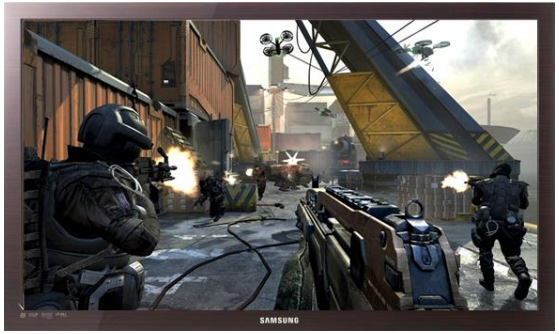


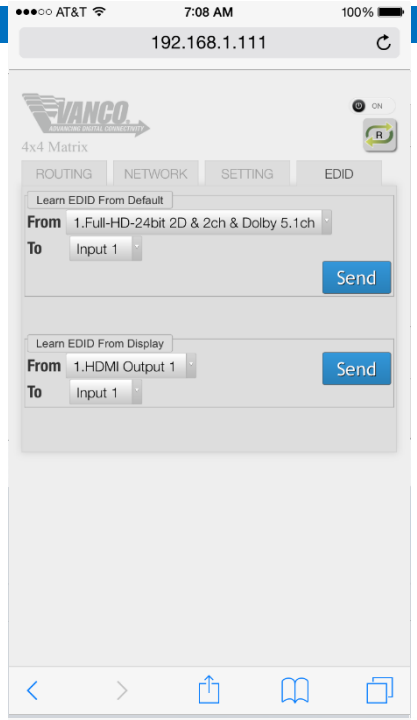
Part # EVMX44QI shown

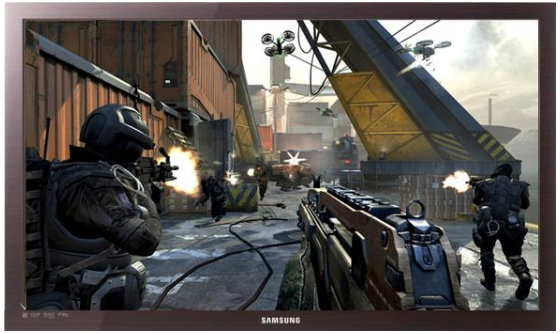
Web/IP Control

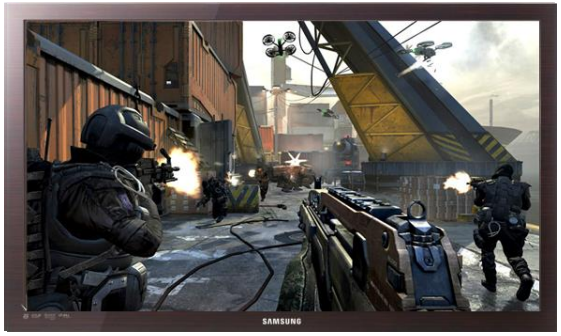
Control matrix switching from your mobile phone or tablet





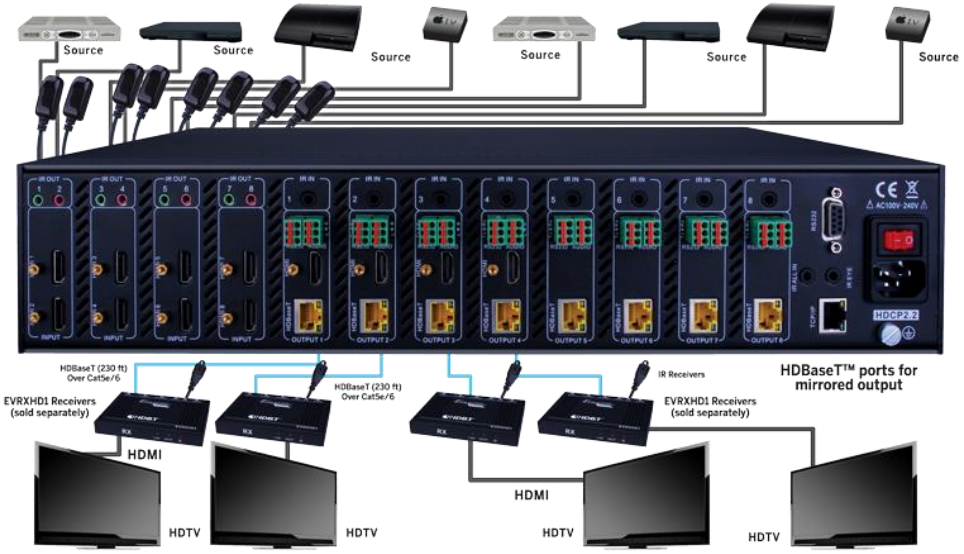






Matrix Example – Large Scale

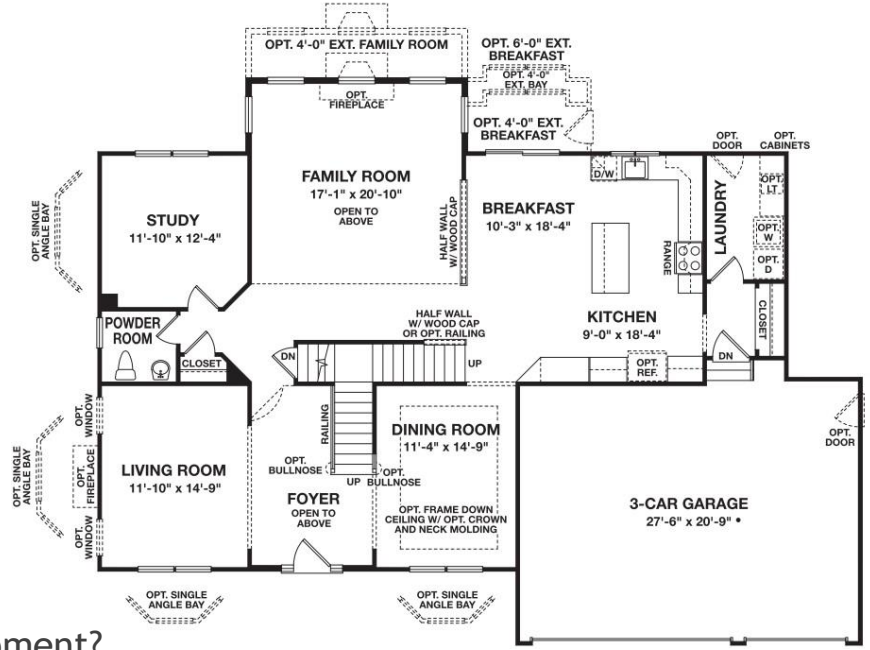
This installation was in a sports bar. Simply had 8-satellite boxes to be ready for all of the games on Sunday and actually had 12 displays coming out of an 8x8 matrix by utilizing both the HDMI and Cat5e outputs.



Part # EVMX4K08 shown

Fundamental Design Questions

- How many rooms or displays will require A/V?
- How many sources/inputs will there be in total?
- How will each component within the system be controlled?
- Where will the equipment be located?
- How far are the displays and rooms from the equipment?
- Is there room for growth or future technologies?



When HDMI Goes Bad….

EDID and “The Handshake”

- HDMI source outputs +5V power toward HDMI sink
- Source waits for hot plug detect to be asserted
- Source reads the EDID sent from the sink.
- Source identifies audio and video formats and outputs unencrypted audio/video content & metadata.
- HDCP authentication is conducted by the source (refreshes every 2 seconds)
- Sink uses metadata to get the picture and sound correct.

Symptoms of a Bad “Handshake”

- No picture or losing picture after a short period of time
  - HDCP

- Improper audio or video information
  - EDID
- No picture after long periods of time or switching sources
  - Hot Plug

Common EDID Conflict

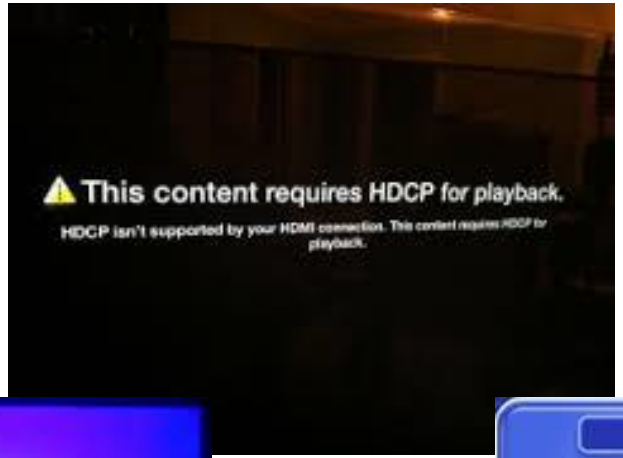
- A source is connected to a splitter. The splitter then feeds audio and video to 2-different displays, a 1080p display and a 720p display
  - Output the higher resolution
    - Resolved by EDID settings on the splitter or by changing settings within the source.

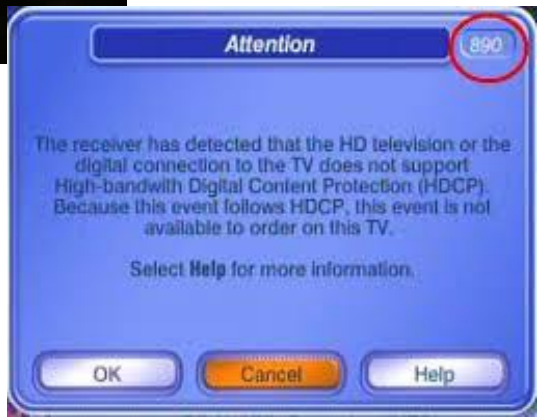
Part # 280702 shown

1080p

720p

What Happens When the Source does not Recognize what it is being Connected to?





Good HDMI Practices

- Choose your cabling carefully
- Be mindful of where your cables are running and how long they are
- Run more than 1 category, HDMI, or coax cable to account for variables outside your control
- Allow for a 10% in maximum cable distances to account for variables such as wall plates, patch panels, etc.
- Terminate the cabling to the recommendations of the manufacturer
- **TEST, TEST, TEST, then TEST again!!!**
  - Bench test products before they go out on the job or if they are new to you
  - After a pre-wire, schedule a visit before the installation of the components to ensure all cabling is still intact
  - Test signal generator and monitor can save hours in troubleshooting and identifying issues.
- Always be able to think outside of the box but keep the design simple and work within the specifications of the products you are working with
- Be in control of your system. Don't rely on "AUTO" settings
- Install for now, but plan for tomorrow

Troubleshooting

Installers cheat sheet to troubleshooting audio/video for HDMI and HDMI related products

- Are the HDMI cables securely connected?
- **Are the HDMI cables connected in the right direction?**
- Does the HDMI have any excessively sharp bends or kinks in the cable run?
- **Have you tried changing the resolution of the source?**
- **Have you tried a different source with the same HDMI/equipment?**
- **Have you tried connecting to a different display using the same cabling and equipment?**
- **Have you tried different cabling with the same equipment?**
- **If there are dip switches or dials on the device, are they set correctly?**
- **Does the length of the HDMI/Cat5e exceed the equipment's limits?**
- Are the status/link lights on?
- Was the HDMI/Cat5e ran with electrical wire, stapled, or nicked?
- **What standard was the Cat5e/6 terminated to, 568A or 568B?**
- Is each Cat5e/6 labeled to ensure they go to their corresponding ports (EX: Port 1->Port 1, Port 2->Port 2)?
- Were the devices hot plugged before the product was properly connected?
- Did you try removing the Cat5e/Coax products and connecting the source straight into a known working display with an HDMI?
- Are the transmitters and receivers in the correct order?
- **Are there any wall plates or patch panels within the line of communication?**

The End. Q&A time