

### **Designing and Implementing HDMI Distribution**



- ✤ 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







#### 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)





## 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)



Log-out E Sorting Edit D Setting

### The HDMI Handshake Hello Source, nice to meet you, I'm a 1080p, -Occurs every 2-3 seconds 3D TV and am able to do 120Hz.... Hi TV, I'm a source, here is the video and audio that you SMART HUB need.... -0 - 98 0- -

## Why Do We Use HDMI?



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

## TM HIGH DEFINITION MULTIMEDIA INTERFACE 1110111 HOMI HOMI SOURCE

## **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)



### 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)

HDMI 2.0 (2013-2015)

>

- > High Dynamic Range (HDR) Video
  - > HDR10 and Dolby Vision capable
- > 4K at 50/60 frames per second

### VANCO INTERNATIONAL LLC CONFIDENTIAL





## HDMI Version 2.0

## Vanco Premium HDMI Certified Cables



## Premium HDMI<sup>®</sup> Cable Certification Program

REMIUN

Tested for Ultra-reliable 4K/Ultra HD Performance

VANCO INTERNATIONAL LLC CONFIDENTIAL



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- 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**



### Progression of HDMI-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





ULTRAHD



## 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?





### **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





FEATURES

BRIGHTER, DEEPER, MORE LIFELIKE

COLORS



**4KHDR** 

RANGE

DYNAMIC

HIGH

## 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 Conflict



## **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

- 25% the size of standard HDM 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



## Red Mere IS HERE!



## 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

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Cat 5a/6

Carborn



### 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:

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- 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.

## **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



## **CHDB**, 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



## 



### 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)

### 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





## 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



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



## **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**



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LIMITED DRAFT

## When to Use an HDMI Switcher





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

![](_page_47_Picture_2.jpeg)

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.

![](_page_47_Picture_4.jpeg)

![](_page_47_Picture_5.jpeg)

## When to Use an HDMI Matrix

![](_page_48_Picture_1.jpeg)

- 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

![](_page_48_Picture_6.jpeg)

## Matrix Example – Small Scale

![](_page_49_Picture_2.jpeg)

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.

![](_page_49_Picture_4.jpeg)

![](_page_49_Picture_5.jpeg)

Part # EVMX44QI shown

### Web/IP Control Control matrix switching from your mobile phone or tablet

![](_page_50_Picture_1.jpeg)

![](_page_50_Picture_2.jpeg)

![](_page_50_Picture_3.jpeg)

![](_page_50_Picture_4.jpeg)

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![](_page_50_Picture_6.jpeg)

![](_page_50_Picture_7.jpeg)

![](_page_50_Picture_8.jpeg)

![](_page_50_Picture_9.jpeg)

## Matrix Example – Large Scale

![](_page_51_Picture_1.jpeg)

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.

![](_page_51_Picture_3.jpeg)

#### Part # EVMX4K08 shown

## **Fundamental Design Questions**

![](_page_52_Picture_1.jpeg)

OPT. OPT. DOOB CABINETS

- □ 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?

FAMILY ROOM AUNDRY 17'-1" x 20'-10" OPT. SINGLE ANGLE BAY BREAKFAST OPEN TO STUDY ABOVE 10'-3" x 18'-4" OPT. 11'-10" x 12'-4" HALE WAL KITCHEN POWDER W/ WOOD CAP 9'-0" x 18'-4" ROOM OPT. REF. CLOSE DINING ROOM OPT. 11'-4" x 14'-9" OPT. SINGLE ANGLE BAY OPT. BULLNOSE LIVING ROOM OPT UP BULLNOSE 11'-10" x 14'-9" FOYER 3-CAR GARAGE OPT. FRAME DOWN CEILING W/ OPT. CROWN AND NECK MOLDING OPEN TO 27'-6" x 20'-9" ABOVE OPT. SINGLE OPT. SINGLE Conserve /

OPT. 6'-0" EXT BREAKFAST

OPT. 4'-0" EXT BREAKFAST

OPT. 4'-0" EXT. FAMILY ROOM

OPT.

- □ How far are the displays and rooms from the equipment?
- □ Is there room for growth or future technologies?

### When HDMI Goes Bad....

![](_page_53_Picture_1.jpeg)

### EDID and "The Handshake"

![](_page_54_Picture_1.jpeg)

- > 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.

![](_page_54_Picture_8.jpeg)

### Symptoms of a Bad "Handshake"

![](_page_55_Picture_2.jpeg)

- No picture or losing picture after a short period of time
  - HDCP
- Improper audio or video information
   EDID

![](_page_55_Picture_6.jpeg)

- No picture after long periods of time or switching sources
  - Hot Plug

![](_page_55_Picture_9.jpeg)

## **Common EDID Conflict**

![](_page_56_Picture_2.jpeg)

720p

- 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.

![](_page_56_Picture_6.jpeg)

![](_page_56_Picture_7.jpeg)

![](_page_56_Picture_8.jpeg)

Part # 280702 shown

![](_page_56_Picture_10.jpeg)

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

![](_page_57_Picture_2.jpeg)

![](_page_57_Picture_3.jpeg)

## **Good HDMI Practices**

![](_page_58_Picture_1.jpeg)

- 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?

![](_page_59_Picture_20.jpeg)

### The End. Q&A time

![](_page_60_Picture_1.jpeg)