HDBaseT INSTALLER EXPERT PROGRAM

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HDBaseT Alliance

2018 BICSI WINTER
CONFERENCE & EXHIBITION
Orlando, FL | February 4-8

HDBaseT Installer Expert Program

Agenda

- Inside HDBaseT Technology
- 5Play Elements
- Installation Practices
- Troubleshooting
- Installer Zone
- HDBaseT Demonstration
- Use-Cases

Course Accreditation

Participants in this Installer Expert Program receive the following accreditations

- InfoComm – 3 CTS RUs, 3 CTS-D RUs and 3 CTS-I Rus
- CEDIA – 1.5 CEU credits

CEDIA TRAINING

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HDBaseT Alliance

Inside HDBaseT Technology

- Why HDBaseT?
- HDBaseT Link Characteristics
- Classes and Media
- HDBaseT 5Play Elements
  - Audio/Video
  - Power
  - Controls
  - Ethernet
  - USB

HDBaseT Technology

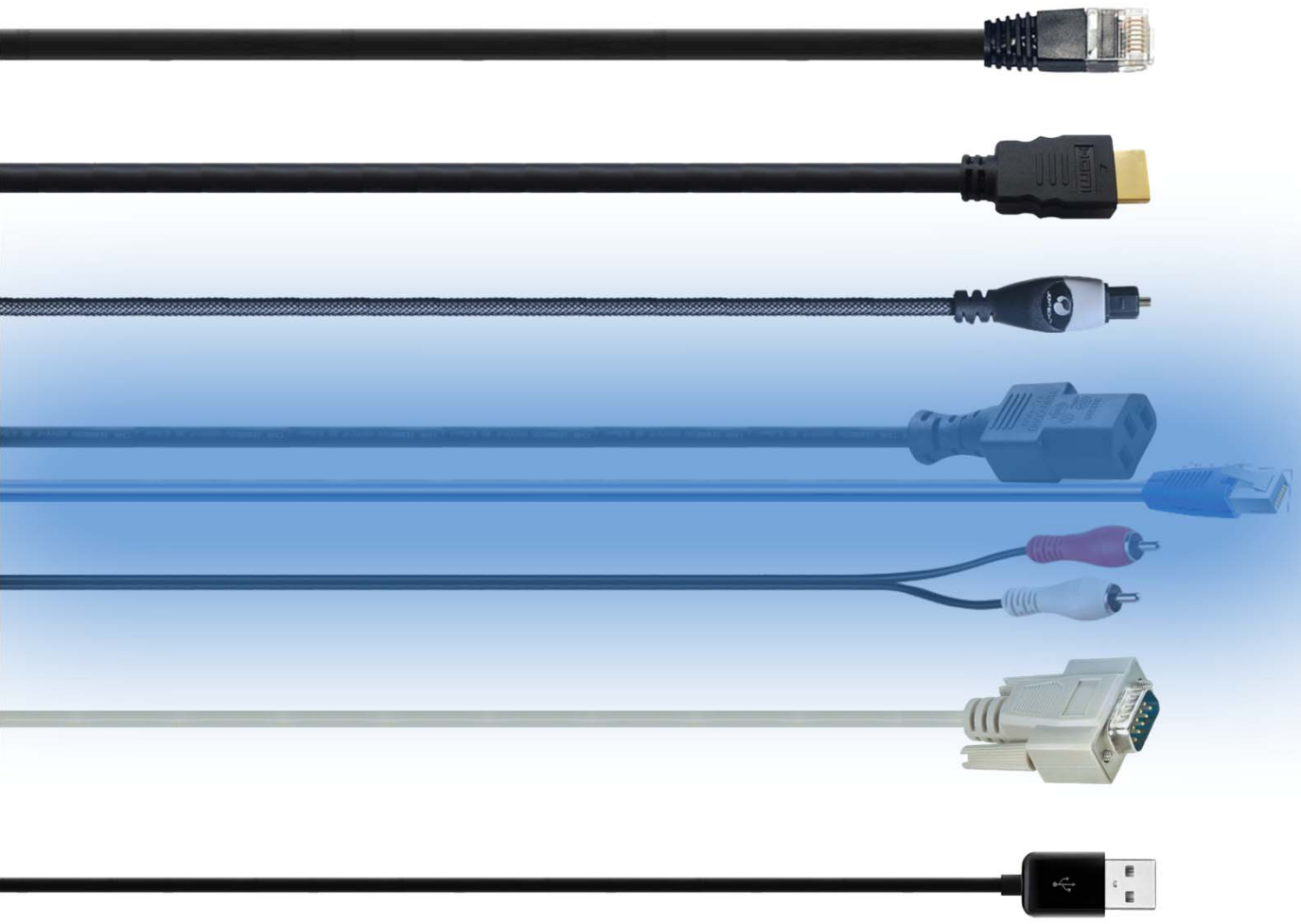
Inside HDBaseT

HDMI

S/PDIF
Optical Audio

RCA
AUDIO

RS 232
485



The Ultimate Standard of

Over a **Single Cable**

Digital Connectivity

Maximum Cable Lengths

How Long Can They Go?

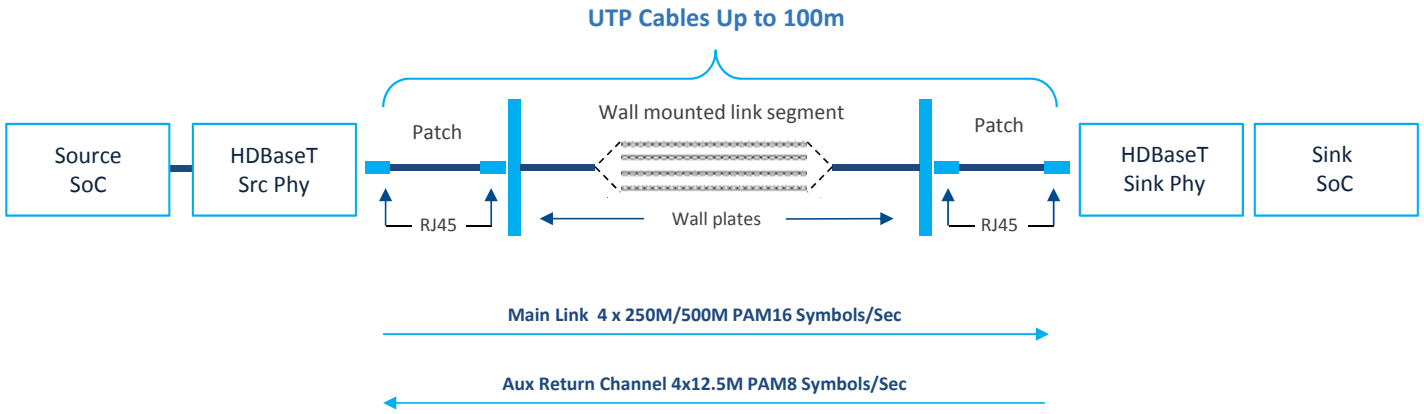
HDBaseT is not just about reducing the number of cables – it's also about extending their range

Cable Type	Maximum Range
HDMI	15m (in practice)
USB 2.0	5m (by spec)
RS-232	15m (by spec)
I^2C	1m @100Kbps (in practice)
IR	>30m (in practice)

Structured Link/Full Duplex Asymmetric System

Asymmetric Full-Duplex Operation - **HDBaseT 1.0**

Main Link transmits at 250M/500M from Source to Sink over the 4-pairs while at the same time the Aux Return Channel transmits at **12.5M** from Sink to Source

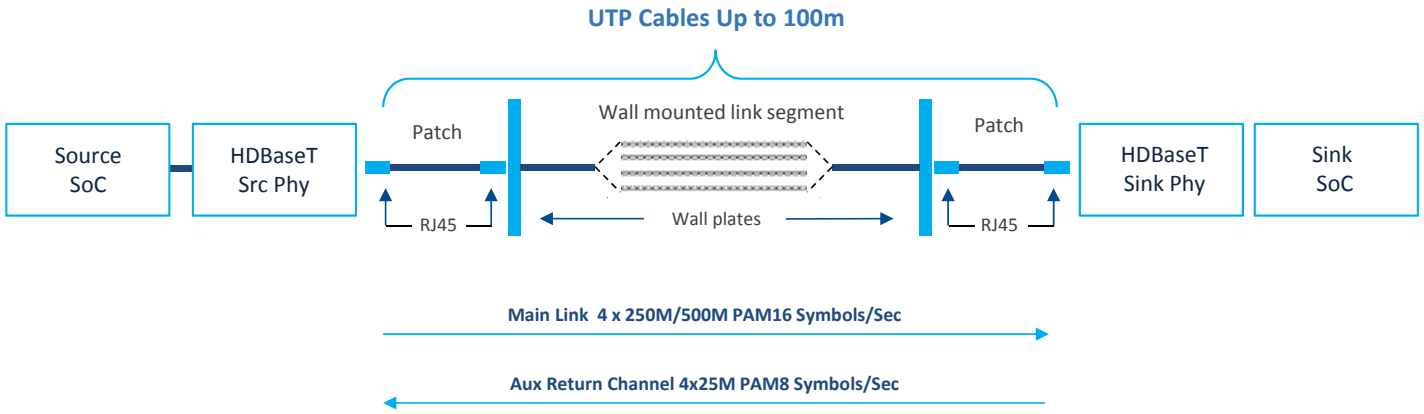


Less sensitive to errors caused by electrical wire effects → **optimal bandwidth**

Structured Link/Full Duplex Asymmetric System

Asymmetric Full-Duplex Operation - **HDBaseT 2.0**

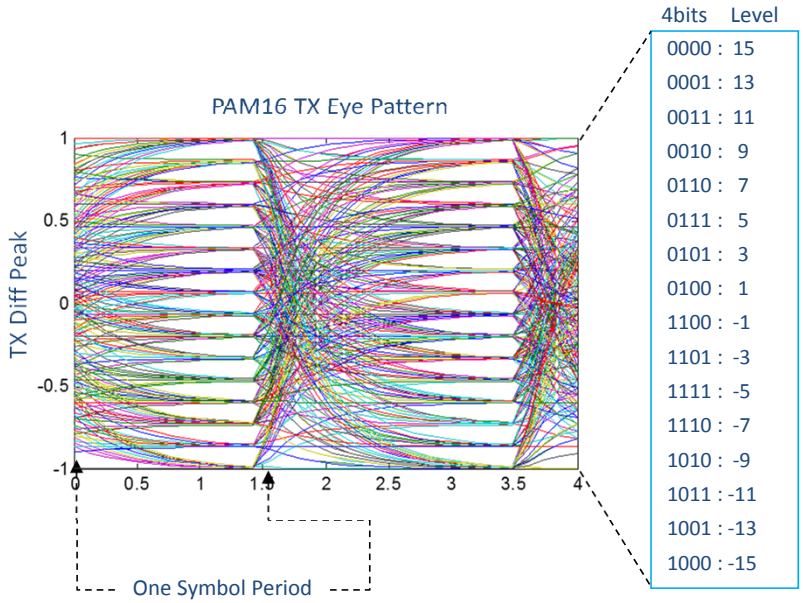
Main Link transmits at 250M/500M from Source to Sink over the 4-pairs while at the same time the Aux Return Channel transmits at **25M** from Sink to Source



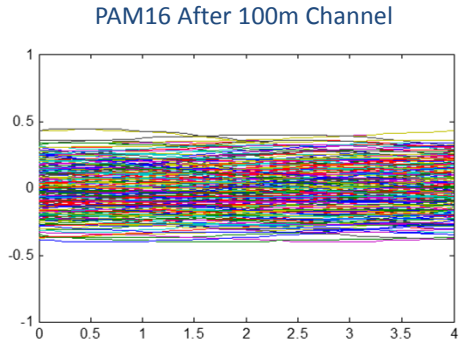
Improved error correction mechanism

Pulse Amplitude Modulation

HDBaseT uses PAM16 symbols. Each symbol is transmitted using 1 of 16 discrete, differential voltage levels, each representing 4 bits of data



4bits	Level
0000 :	15
0001 :	13
0011 :	11
0010 :	9
0110 :	7
0111 :	5
0101 :	3
0100 :	1
1100 :	-1
1101 :	-3
1111 :	-5
1110 :	-7
1010 :	-9
1011 :	-11
1001 :	-13
1000 :	-15



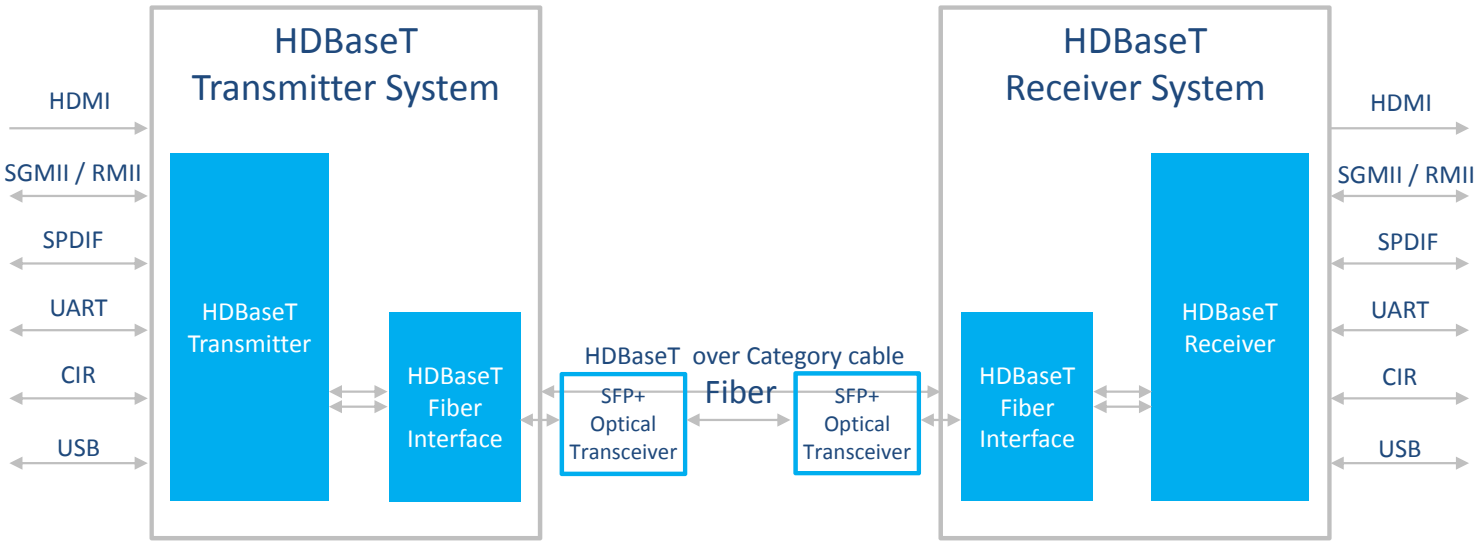
HDBaseT 2.0/1.0 Classes

Class	HDBaseT spec	Media	Max Resolution	Supported max Cable length	Cable category
Class A	1.0	Copper	1080p 4K	100m 70m	Cat5e Cat5e
Class B	1.0	Copper	1080p 4K	70m 35m	Cat6a Cat5e
Class C	2.0	Copper	1080p 4K 4K	100m 90m 100m	Cat5e Cat5e Cat6a
Class D	2.0	Copper	1080p	30m	Cat6a
Class E	2.0	Fiber	4K	SM: 10s of Km MM: >800m	

- HDBaseT is driven by pixel clock rate and not by resolution
- HDBaseT 2.0/1.0 support up to 340MHz Pixel clock

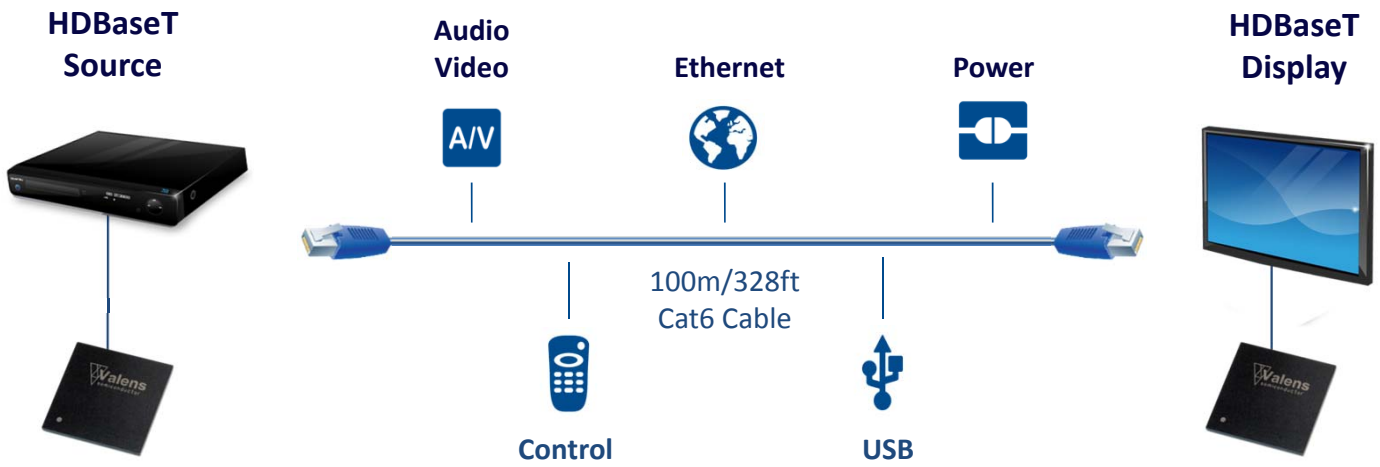
HDBaseT Functional Description

HDBaseT 2.0



HDBaseT 5Play

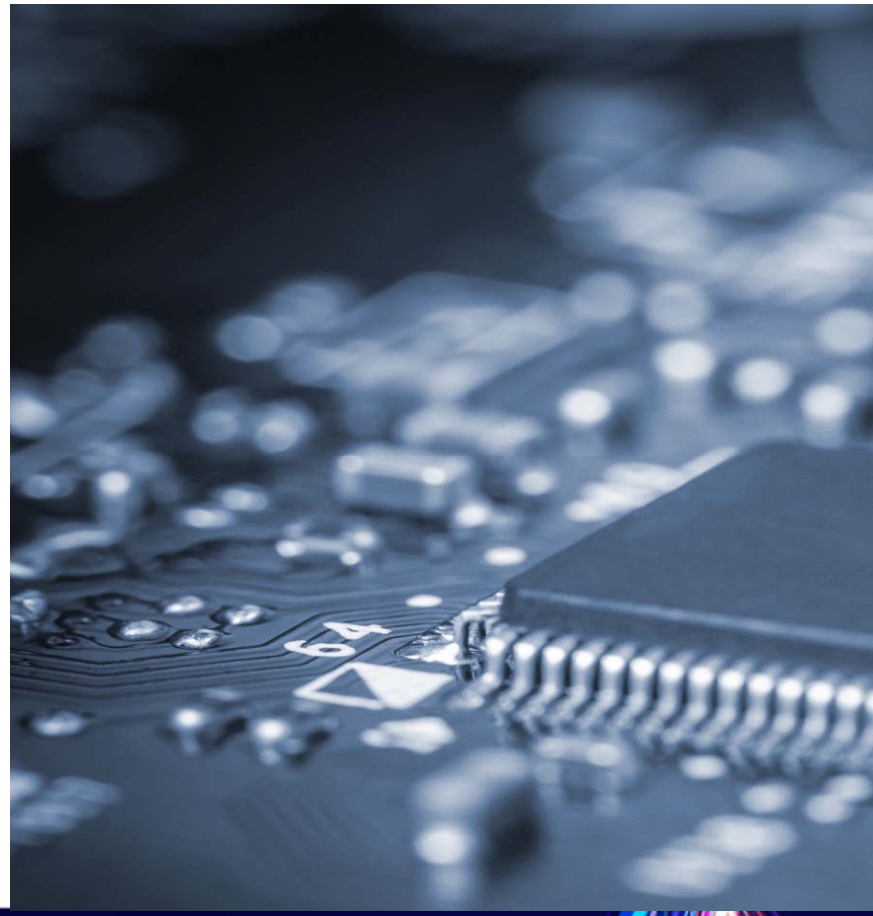
HDBaseT: 5Play Convergence on a Single Cable



- Uncompressed ultra-HD video & audio
- 100BaseT Ethernet
- USB 2.0
- Control signals (IR, CEC, RS232)
- Power over HDBaseT (up to 100W)

Audio/Video

- A/V over HDBaseT
- What A/V can HDBaseT support?
- Can my resolution fit HDBaseT?
- HDBaseT 2.0 enhanced audio channels



Audio/Video

HDBaseT is:

- A bit exact pass-through channel for the video and audio
- Does not interfere with the DDC line
  - Does not terminate the HDCP (High-Bandwidth Digital Content Protection)
  - Transparent for EDID, no manipulation over the HDBaseT

Audio/Video

Video

- Full HD/3D and 2K/4K uncompressed video
- HDMI 1.4 (HDMI 2.0 compatible)
- Multi-streaming capability
- CEC, EDID, HDCP supported
- Highest video quality with zero latency

Audio

- Digital Audio is passed-through directly from the HDMI chipset
- All standard formats supported, e.g. Dolby Digital, DTS, Dolby TrueHD, DTS HD-Master Audio, Dolby Pro Logic IIz 7.1 & 9.1 and more

Audio/Video - Pixel Clock Calculation

Can my resolution fit HDBaseT 2.0?

- HDBaseT is driven by pixel clock rate and not by resolution
- The table shows commonly used video formats and their attributes
  - Some of the data was taken from the CEA-861-E standard
- How to calculate pixel clock rate:

$$BW = (H_{active} + H_{Blank}) \times (V_{Active} + V_{Blank}) \times \text{Color Depth} \times 3 \times f_{refresh-rate} \times \frac{10}{8}$$

$$f_{pixelclock} = f_{refresh-rate} \times (H_{active} + H_{Blank}) \times (V_{Active} + V_{Blank})$$

- Example: 1080p/60Hz/8bit

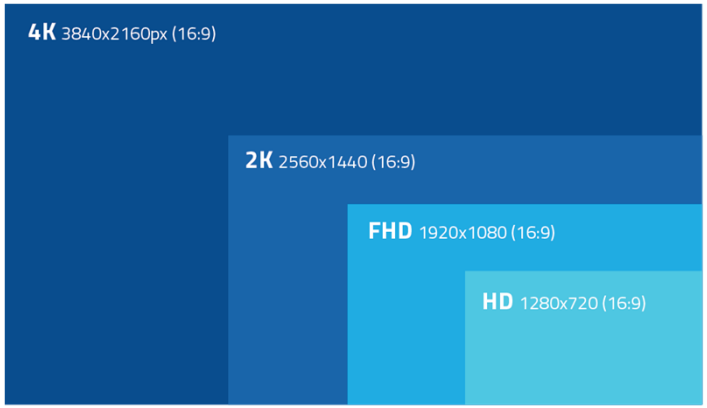
  BW=(1920+280)x (1080+45)x8x3x60x10/8 = **4.455Gbps**

  f=60x(1920+280)x(1080+45)= **148.5MHz**

Rate (fps)	Hactive	Vactive	Color Depth	Prog/ Inter	Htotal	Hblank	Vtotal	Vblank	Rate (Gbps)	Pixel Freq. (MHz)
50	1440	576	24	I	1728	288	625	49	0.6	27
50	1440	288	24	P	1728	288	312	24	0.6	27
50	1440	288	24	P	1728	288	313	25	0.6	27
50	1440	288	24	P	1728	288	314	26	0.7	27
50	2880	576	24	I	3456	576	625	49	1.3	54
50	2880	288	24	P	3456	576	312	24	1.3	54
50	2880	288	24	P	3456	576	313	25	1.3	54
50	2880	288	24	P	3456	576	314	26	1.3	54
50	1440	576	24	P	1728	288	625	49	1.3	54
50	1920	1080	24	P	2640	720	1125	45	3.6	149
50	2880	576	24	P	3456	576	625	49	2.6	108
50	1920	1080	24	I	2304	384	1250	170	1.7	72
60	640	480	24	P	800	160	525	45	0.6	25
60	720	480	24	P	858	138	525	45	0.6	27
60	1280	720	24	P	1650	370	750	30	1.8	74
60	1920	1080	24	I	2200	280	1125	45	1.8	74
60	1440	480	24	I	1716	276	525	45	0.6	27
60	1440	240	24	P	1716	276	262	22	0.6	27
60	1440	240	24	P	1716	276	263	23	0.6	27
60	2880	480	24	I	3432	552	525	45	1.3	54
60	1920	1080	24	P	2200	280	1125	45	3.6	149
60	2880	480	24	P	3432	552	525	45	2.6	108
100	1920	1080	24	I	2640	720	1125	45	3.6	149
100	1280	720	24	P	1980	700	750	30	3.6	149
100	720	576	24	P	864	144	625	49	1.3	54
100	1440	576	24	I	1728	288	625	49	1.3	54
100	1920	1080	24	P	2640	720	1125	45	7.1	297
120	1920	1080	24	I	2200	280	1125	45	3.6	149
120	1280	720	24	P	1650	370	750	30	3.6	149

HDMI 2.0 – Video Support

- Current versions of the HDBaseT specification support pixel clock speeds up to 340MHz
- This translates to maximum uncompressed HDMI video format of 4K/30Hz/4:4:4 or 4K/60Hz/4:2:0
- HDMI 2.0 defines video formats with pixel clock speeds up to 594MHz including 4K/60Hz/4:4:4
- These exceed the available HDBaseT bandwidth

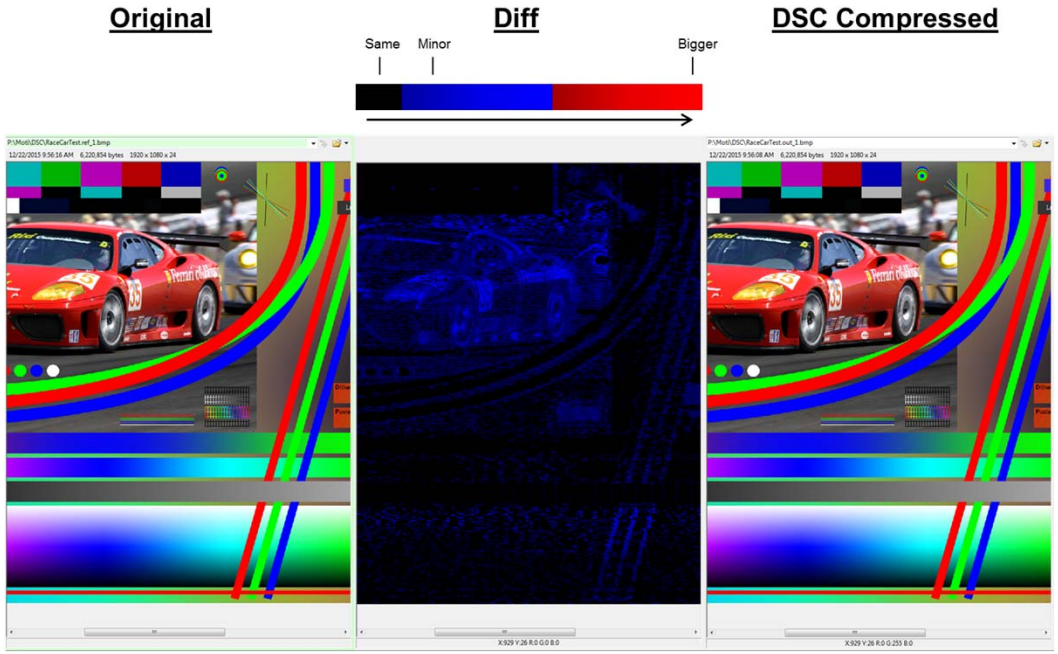


Beyond 4K/30/4:4:4 – Visually-Lossless Compression

- Future versions of the HDBaseT specification will increase the bandwidth of the link
- Until then, interim solutions based on visually-lossless compression (VLC) are proposed
- Uses algorithm from DSC – Display Stream Compression
  - VESA standard for visually-lossless compression
  - Video is compressed line by line, meaning very low latency (few µs)
  - Very light compression ratio of 2:1 or 3:1

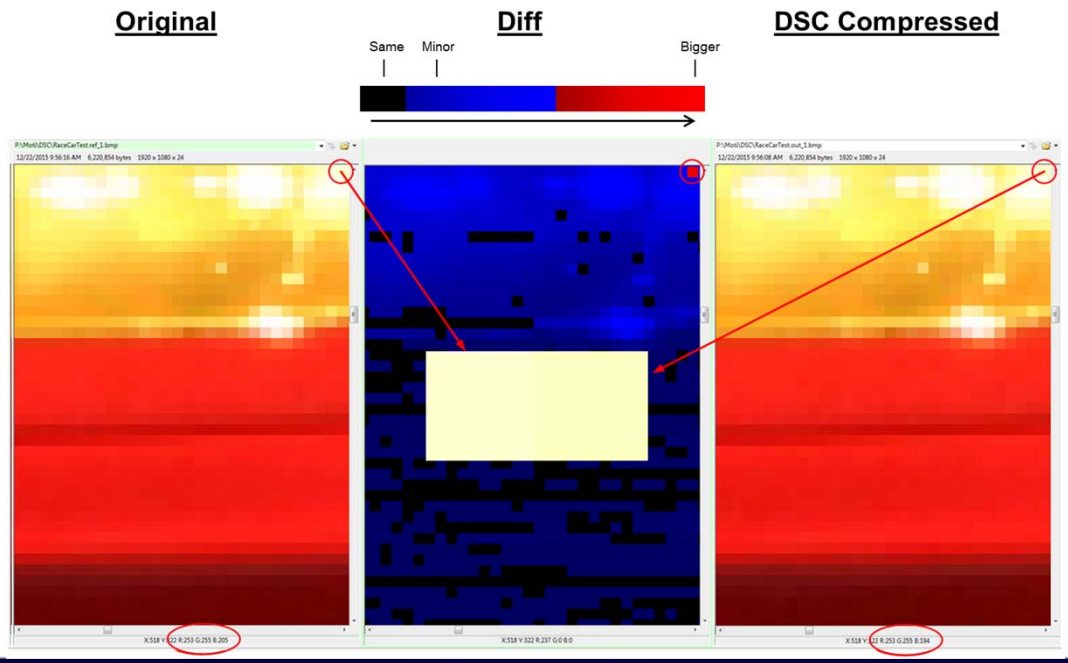
Visually-Lossless Compression

Mathematical difference between every pixel in original and compressed images

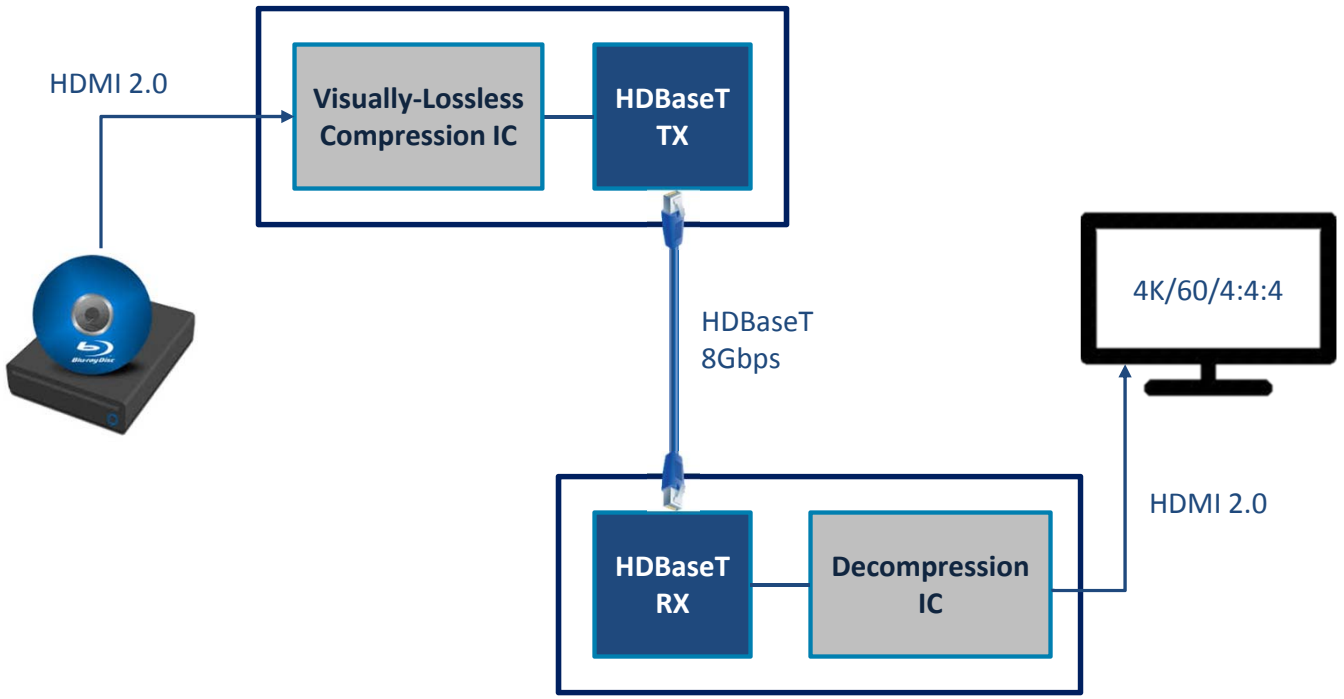


Visually-Lossless Compression

Comparison of worst-case pixel with largest difference



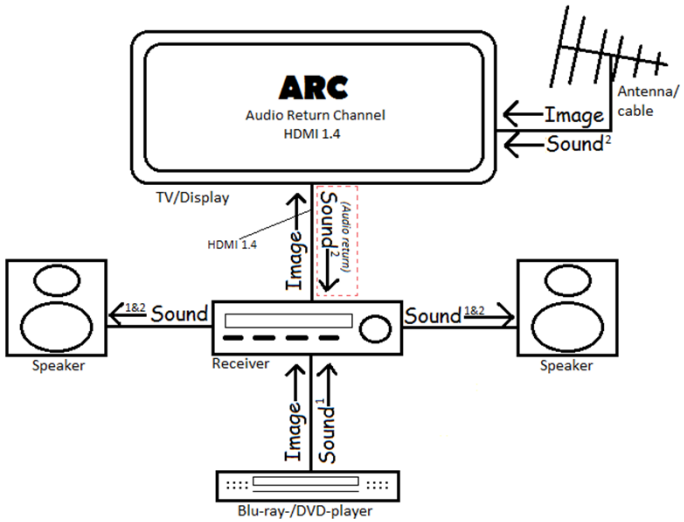
Visually-Lossless Compression - System Solution



Audio - Supported Formats

HDBaseT 2.0 Native Audio

- HDBaseT 2.0 introduced support for 2 native audio interfaces
  - S/PDIF - Sony/Philips Digital Interface Format
  - I^2S
- These are in addition to the audio embedded in the HDMI stream
- Supports the use of the HDMI Audio Return Channel (ARC)



Audio/Video - SPDIF

HDBaseT 2.0 supports S/PDIF

- S/PDIF is a digital audio format used in consumer audio equipment
- S/PDIF implementation can transfer audio with sample rates up to 192KHz (vendor dependent)
- Commonly two channels are contained in a data stream, but the protocol does not define a specific number of audio channels within the data stream

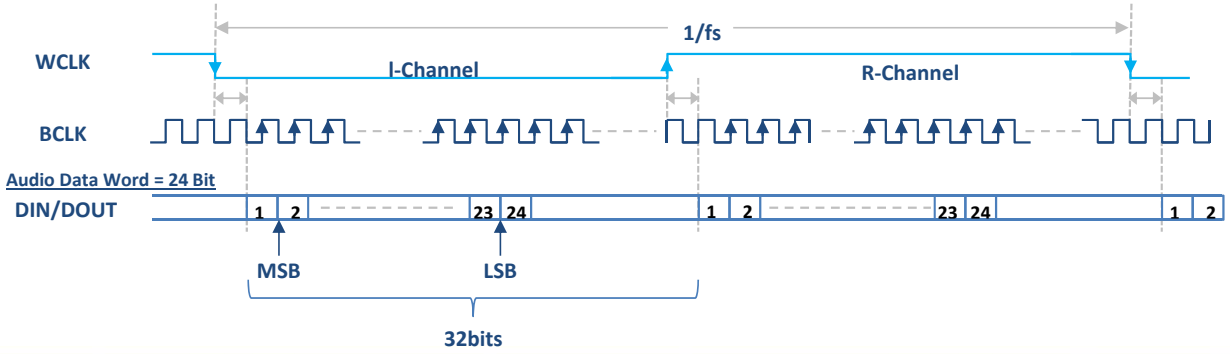
S/PDIF	
Cabling	75-ohm coaxial or fiber
Connector	RCA or TOSLINK
Output level	0.5–0.6 V peak to peak
Min. input level	0.2 V
Max. distance	10 m
Modulation	Biphase mark code
Subcode information	SCMS copy protection info.
Max. resolution	20 bits (24 bits optional)

Audio/Video – I²S

HDBaseT 2.0 supports I²S

- Inter-IC Sound (I²S) is another serial bus interface used for digital audio connectivity, serving mainly headsets and microphones
- The specification was first released by Philips in 1986, and revised 10 years later

- The I2S bus has 3 serial lines
  - Serial data (DIN/DOUT)
  - Word select (WCLK): 0 = left channel, 1 = right channel
  - A continuous serial clock (BCLK)
- HDBaseT 2.0 limits the maximum BCLK rate to 5MHz



Audio/Video

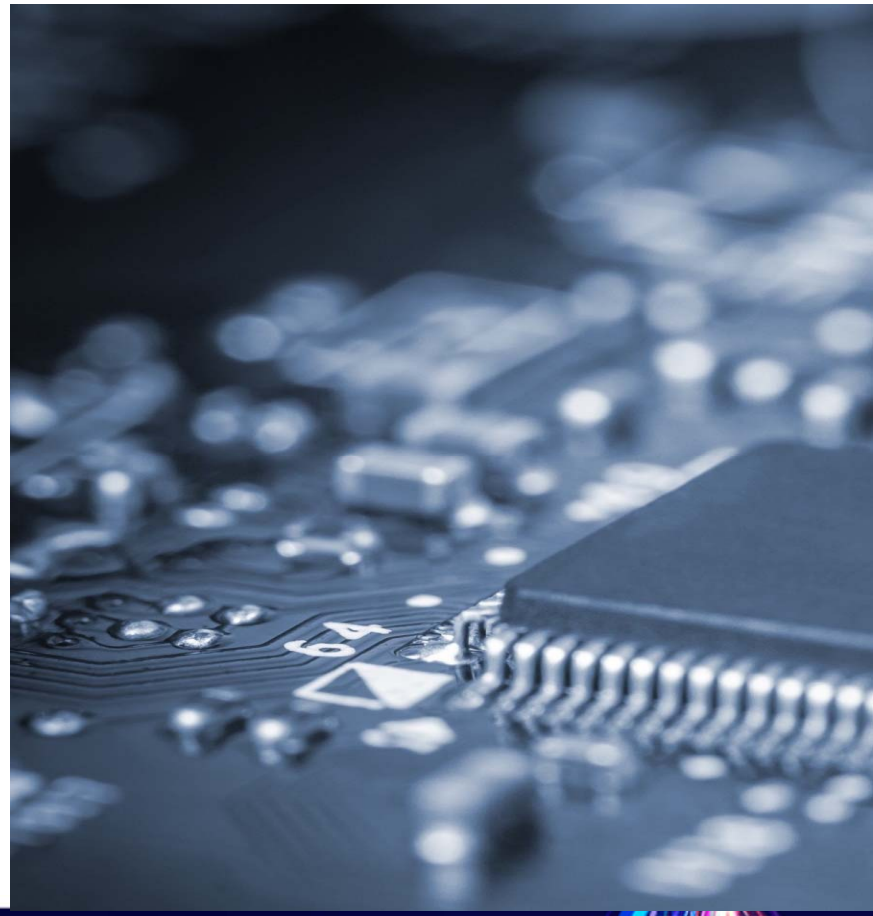
Summary – Key Points to Remember About A/V Over HDBaseT

- HDBaseT 1.0 + HDBaseT 2.0
  - TMDS data over HDBaseT is bit exact, no manipulation, no compression
  - When we think of HDBaseT as resolutions → we need to calculate pixel clock rate

- HDBaseT 2.0 offers enhanced audio channels
  - S/PDIF is capable of transferring audio with sample rates up to 192KHz
  - I^2S can support a maximum BCLK rate of 5MHz
  - Support for ARC

PoH – Power Over HDBaseT

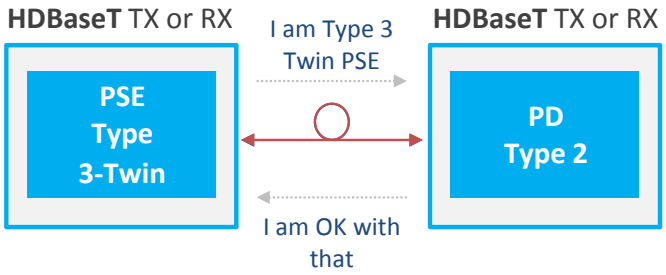
- HDBaseT Power Definition – PoH
- Terminology
- Certification and Interoperability



PoH – Power Over HDBaseT

HDBaseT Power Definition

- Compatible with IEEE 802.3at and standard IEEE 802.3af
  - Input power 44-57v DC
  - Max current per 2 pairs – 1A
- Delivery of up to 100 watts
- Uses all 4 pairs in the HDBaseT cable
- PoH is fully interoperable with POE
  - Power will be driven on the twisted pair only after negotiation
  - Power level is based on the highest mutually supported
- Meets electrical power safety regulation



PoH – Power Over HDBaseT Terminology

Power Sourcing Equipment (PSE)

- Any device that wishes to be stated as an HDBaseT PoH PSE should be classified according to the types shown in the table below
- An HDBaseT PSE will have to declare its type and will have to meet the max power requirements of the spec

PSE Type	Max power supplied	Notes
Type 1	15.4W	based on IEEE 802.3af / 802.3at-type1
Type 2	30W	based on IEEE 802.3at-type2
TWIN MP PSE (Type2-Twin)	30W x2	based on IEEE 802.3at-type2 (two power interfaces) but only defined in HDBaseT specification
Type 3	47.5W	Defined in HDBaseT specification
TWIN HP PSE (Type 3 Twin)	47.5W x2	

PoH – Power Over HDBaseT Terminology

Powered Device (PD)

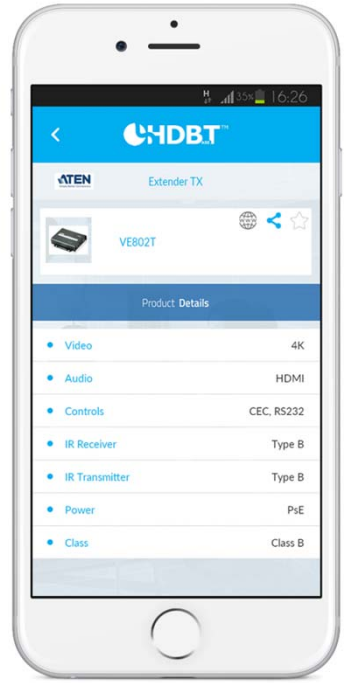
- A PD device has to confirm the PSE type it requires to work with, while keeping the HDBaseT link performance and conforming to the defined protocol (# of events, etc)

PD Type	Max power consumed	Notes
Type 1	13W	
Type 2	25.5W	
TWIN MP PSE (Type2-Twin)	25.5Wx2	
Type 3	36.2W	When Cable Power loss info **is not** known or fixed
TWIN HP PSE (Type 3 Twin)	36.2W x2	
Type 3	47.5W-Cable loss	When Cable Power loss info **is** known and fixed
TWIN HP PSE (Type 3 Twin)	(47.5W-Cable loss) x2	

PoH – Power Over HDBaseT

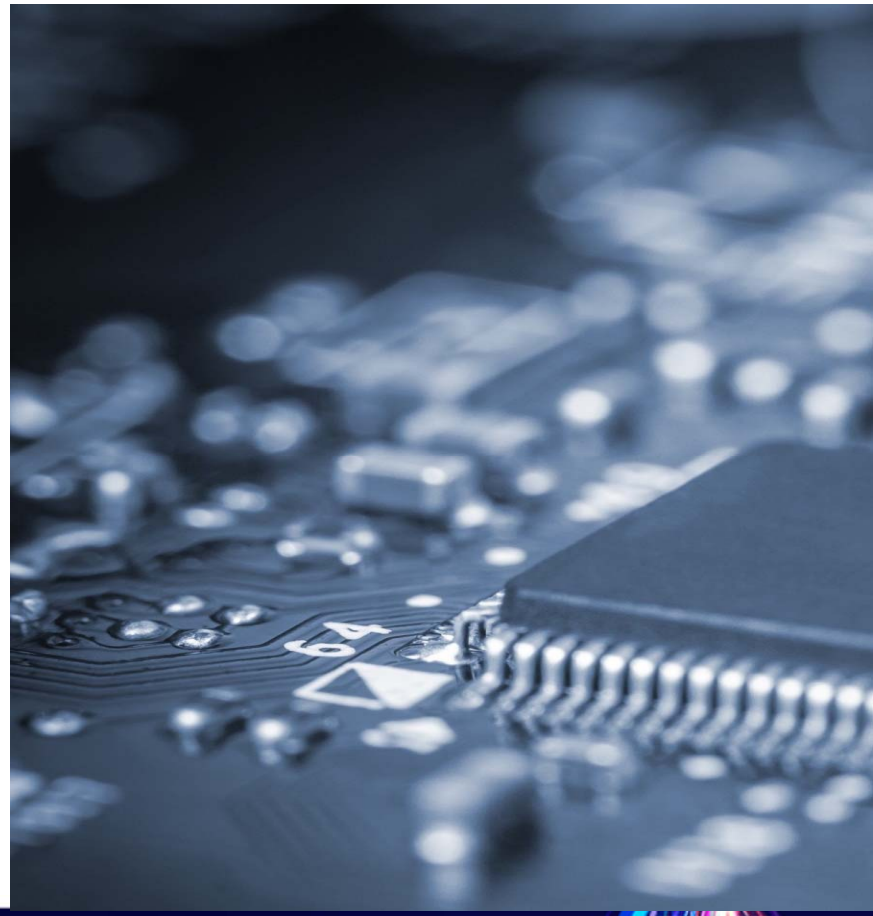
Certification and Interoperability

- Power driven on the category cable which does not comply with the IEEE PoE or HDBaseT PoH requirements is a violation of the HDBaseT spec, and products using such techniques will not pass compliance testing
- It is the users responsibility to verify the HDBaseT certified features
- The HDBaseT Alliance mobile App for Android and iOS provides this information, as does the listing of certified products on the Alliance web-site
- Products supporting PoH are listed as PSE or PD
- User MUST cross-check the product certification spec with the manufacturer product spec in order to determine which Type is supported



Controls

- RS232
- Consumer Infrared (CIR) – Type A/B
- Consumer Electronic Controls (CEC)



HDBaseT Control

RS232

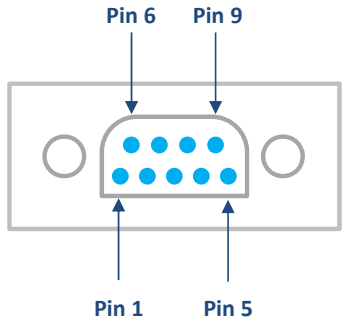
HDBaseT Control – RS232

What is RS232?

- RS-232 is a standard for serial communication transmission of data
- The maximum cable length for RS-232 is 15m/50ft
  - In practice it depends on baud rate, cable-specific capacitance and ambient noise

Pin 1	DCD
Pin 2	RXD
Pin 3	TXD
Pin 4	DTR
Pin 5	GND
Pin 6	DSR
Pin 7	RTS
Pin 8	CTS
Pin 9	RI

RS232 Pinout (9 Pin Male)

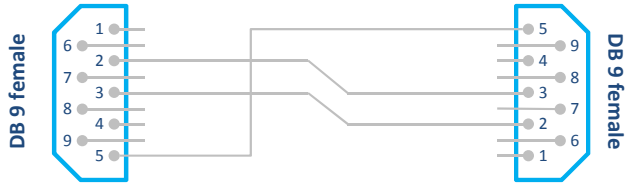


HDBaseT Control – RS232

RS232 over HDBaseT

HDBaseT supports a cable with only three pins connected (TD, RD and GND)

- Pin 2, Received Data (RD)
- Pin 3, Transmit Data (TD)
- Pin 5, Ground (GND)



HDBaseT RS232 Interoperability

- HDBaseT does not support Flow control
  - Flow control must be set to 'none' in the COM port setup on both ends (Windows Control Panel)
- The HDBaseT specification does not refer to RS232 physical layer (12v) but as TTL level (5V)
- RS232 can be terminated internally (within the unit) using a microprocessor

HDBaseT Control – RS232

HDBaseT 1.0 vs. 2.0

HDBaseT 1.0 RS232

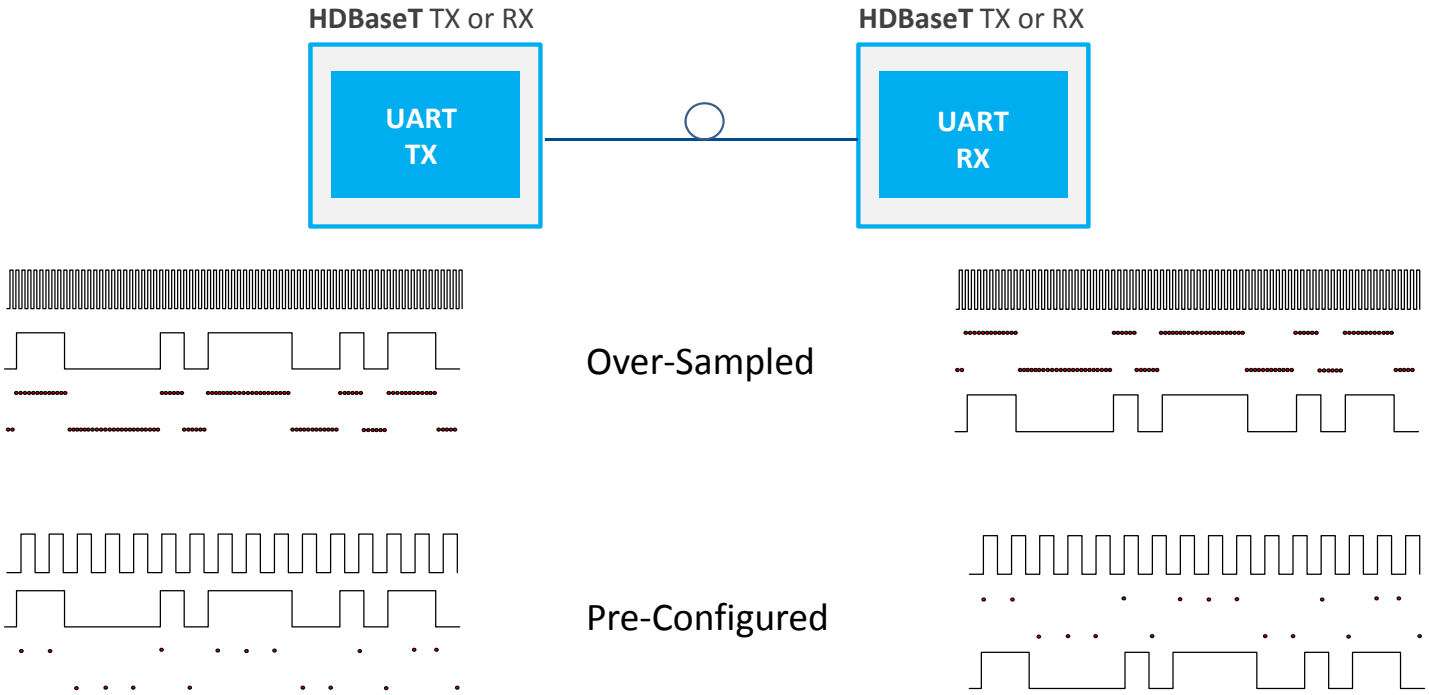
- RS232 is a passthrough over-sampled channel
- All baud rates up to 115Kbps are supported
- Limited in HDBaseT low-power modes to a maximum baud rate of 9.6Kbps

HDBaseT 2.0 RS232

- RS232 support 2 modes of operations
  - Passthrough over-sampled channel
  - Pre-configured mode
    - Allows pre-configuration of the UART baud rate – up to 115Kbps – for optimal data transfer
    - Pre-configured baud-rate is available also in HDBaseT low power modes (up to 115Kbps)

HDBaseT Control – RS232

HDBaseT 2.0



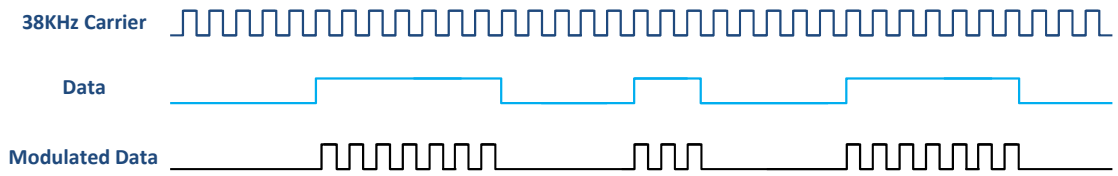
HDBaseT Control

Consumer Infra Red - CIR

Consumer IR (CIR)

What is Infra Red (IR) Signal?

- Carrier – clock frequency in the range of ~38KHz and higher
- Data – low frequency signal up to ~10KHz
  - "1" – represented by carrier clock
  - "0" – represented by no signal



Consumer IR (CIR)

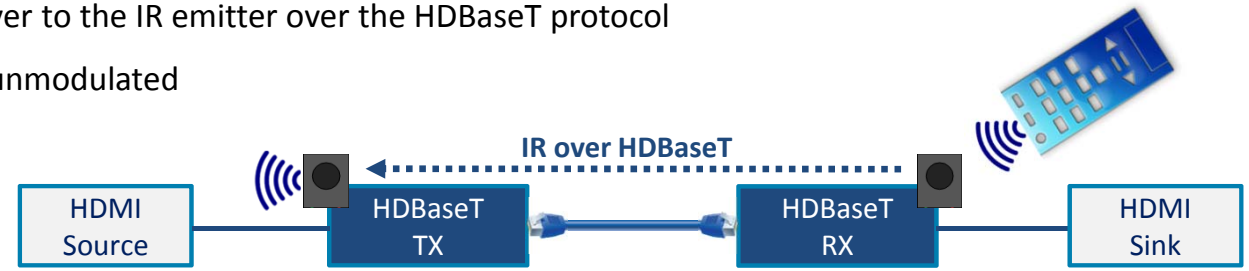
IR Terminology

CIR “over the air”

- Infra Red Transmission between IR emitter to IR receiver
- This signal must be modulated
- Carrier frequency range is mostly in the range of 38KHz

CIR “over HDBaseT”

- Infrared transmission from the IR receiver to the IR emitter over the HDBaseT protocol
- The signal can be either modulated or unmodulated

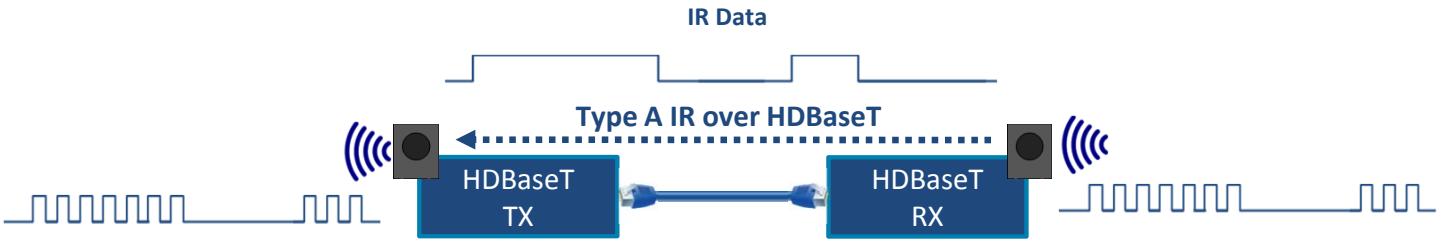


Control

CIR Type A

Type A – IR data is passed over the HDBaseT (carrier is filtered)

- Supports 38KHz CIR
- IR receiver demodulates the signal (removes the 38 KHz carrier signal)
- Signal is passed unmodulated over HDBaseT (IR receiver → IR emitter)
- IR emitter must add 38KHz carrier modulation to the CIR signal before transmitting out of blaster emitter diode ("over the air")

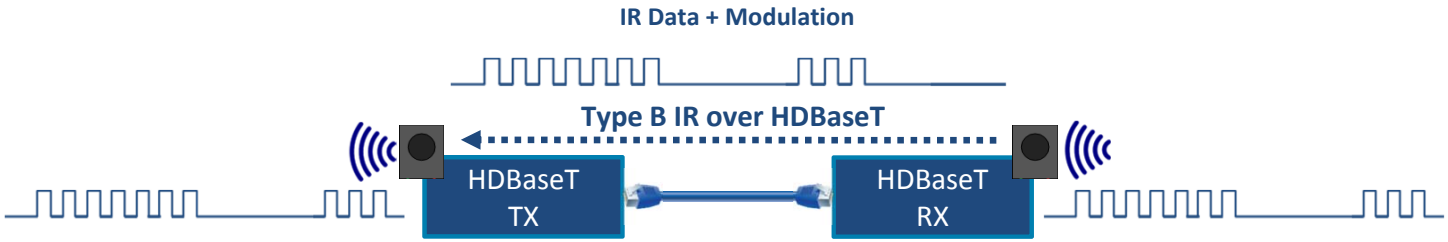


Control

CIR Type B

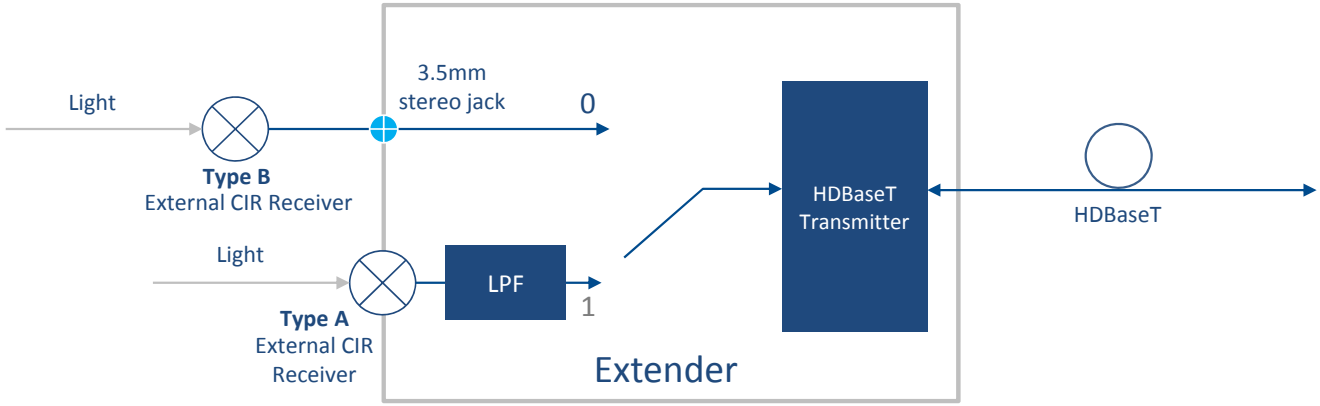
Type B – Carrier + Data are passed over the HDBaseT link

- Supports up to 60KHz IR signal carrier
- IR receiver delivers the signal to the HDBaseT link including the modulation
- IR light emitter gets the signal from the HDBaseT link including the modulation



CIR Receiver

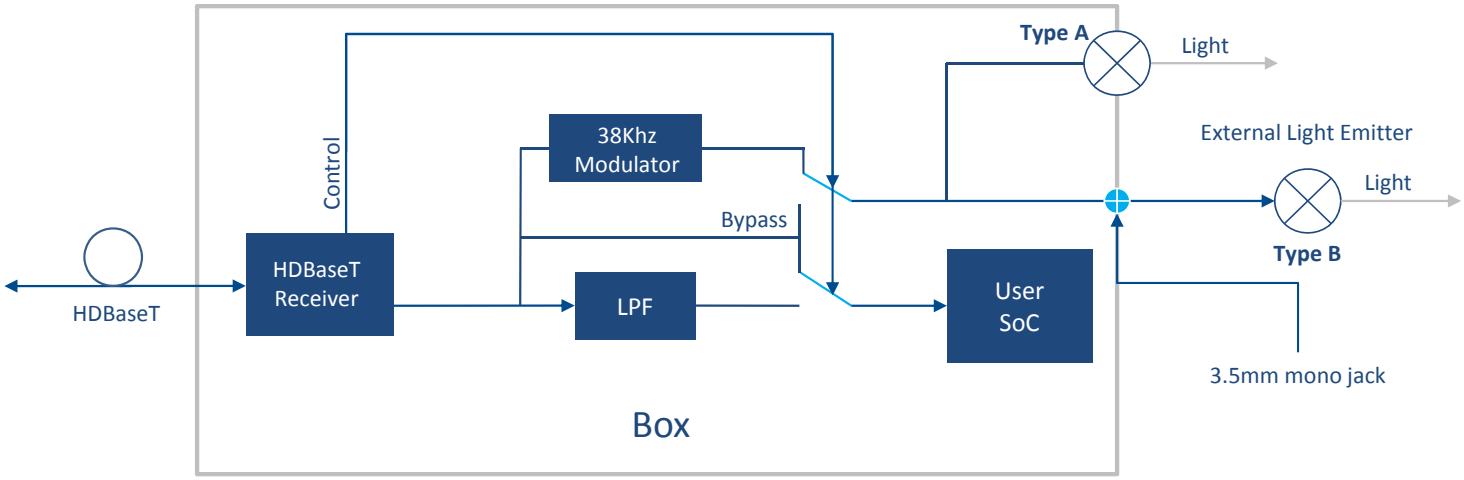
CIR Receivers - Both Internal and External



CIR Transmitter

Internal / External / Modulation / Passthrough

- Control=0: LPF is bypassed and modulation is enabled, suits baseband input signal (Type A)
- Control=1: LPF is enabled, and modulation is bypassed, suits modulated signal (Type B)

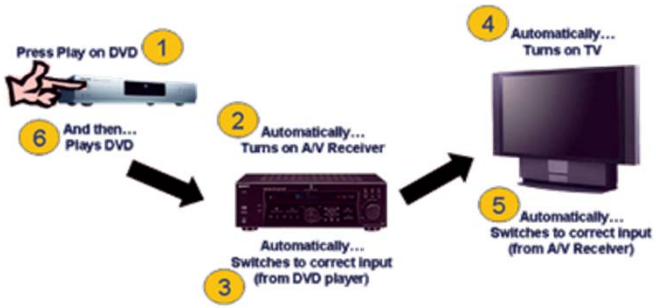


HDBaseT Control

Consumer Electronics Control

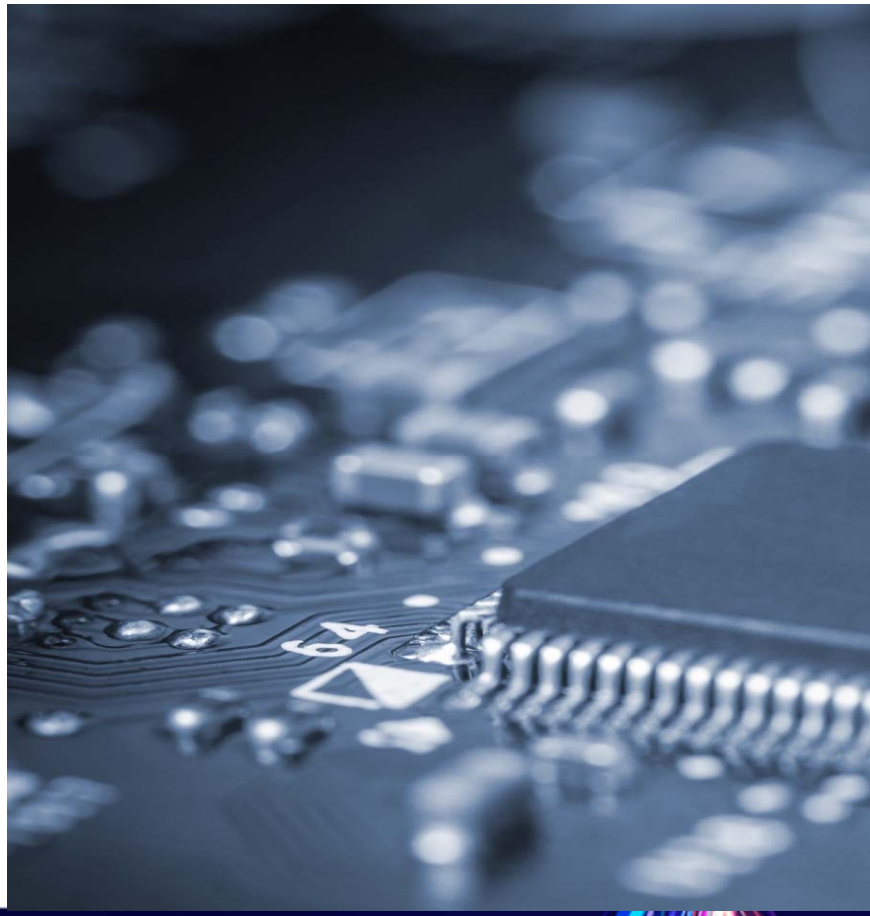
Control - CEC

- HDMI CEC (Consumer Electronic Control) is a one-wire bidirectional serial communication used by the industry-standard AV
- It can be considered the HDMI control protocol
- Allows the user to command and control up to ten CEC-enabled devices
- For example, HDMI-CEC commands
  - System On/Standby: switches all connected devices to on/standby with single press
  - OSD Display: use the OSD of the TV set to display text
  - System Information: checks all components for bus addresses and configuration
- HDBaseT treats CEC data as passthrough



Ethernet

- Standard 100BaseT Ethernet
- Fallback

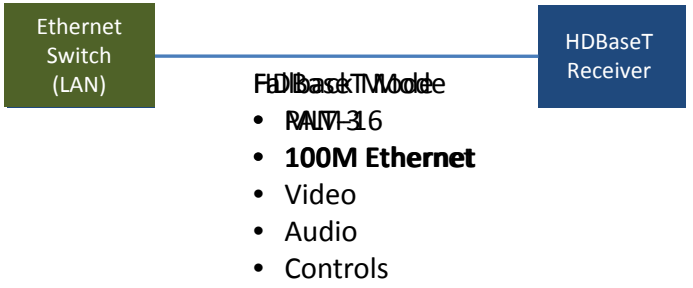


Ethernet

HDBaseT Definition of Ethernet

HDBaseT Ethernet configuration for both HDBaseT and Fallback

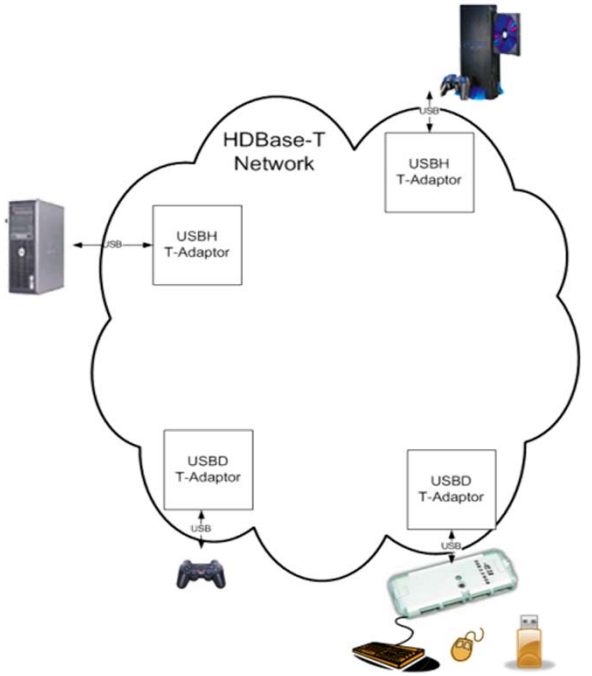
- RMII
- Full Duplex
- 100Mbit
- FB (Fallback) = connecting LAN to the HDBaseT RJ45 connector



USB 2.0

USB over HDBaseT

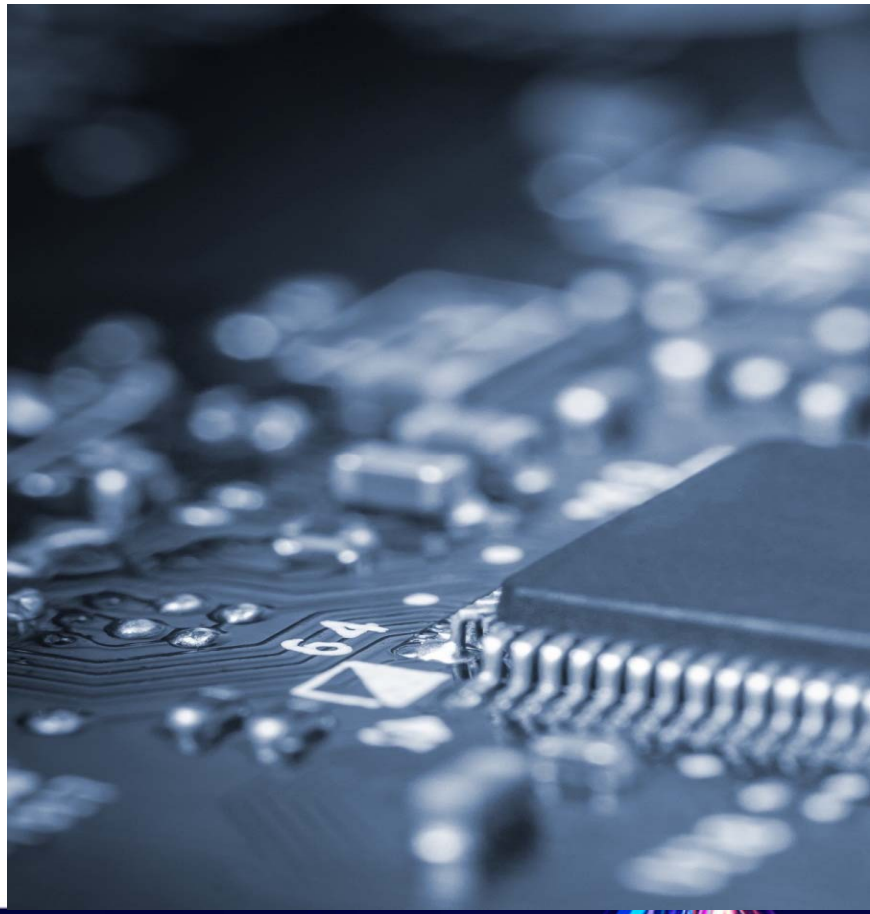
- Compliant with USB 2.0 specification
- Supports all types of USB transfers
  - Isochronous – e.g. web cameras, audio devices
  - Bulk – e.g. disk drives
  - Interrupt – e.g. keyboard, mouse
  - Control (all devices)
- Supports maximum 7 devices
- Bandwidth up to 190Mb/s (for Isochronous transfers)



HDBaseT Installation Practices

Interoperability

- Cabling
  - Cable terminations
  - Power and cable shielding
  - Bundling
- CIR – Consumer Infra Red
- HDMI and HDBaseT Transmitter – Stretching
- Control Capabilities – UART Extension



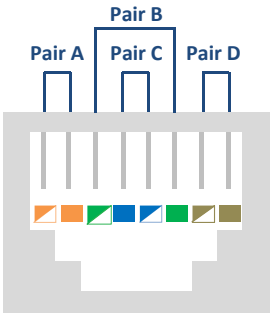
Interoperability - Cabling

HDBaseT Cable Termination

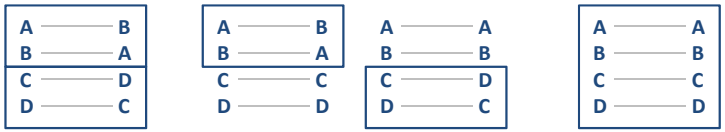
HDBaseT Cable Diagram

- Supports different cable topologies
  - “Crossover”
  - “Semi-Crossover”
  - “Straight”
- HDBaseT automatically resolves all cross types in the cable

HDBaseT Wiring



“T568B”

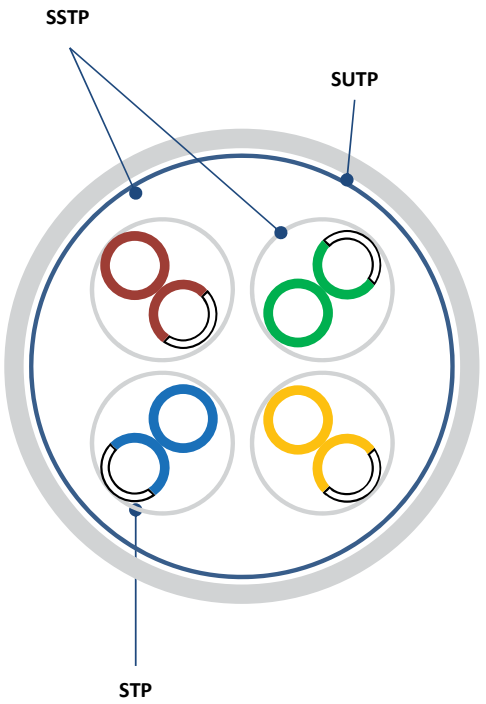


Crossover | Semi-Crossover | Straight

HDBaseT Category Cable

Cable Recommendations

- HDBaseT defines the link as
  - 90 meter infrastructure cable
  - 2 x 5m (max) patch cable, one on each side
- Infrastructure cable should be 24 AWG or better
- The minimum requirement for the cable is Cat5e or better
- Any of the following cables will fit
  - UTP
  - STP - individual shields for each twisted-pair
  - S/UTP - an overall cable shield
  - S/STP - both an overall cable shield as well as individual shields for each twisted-pair

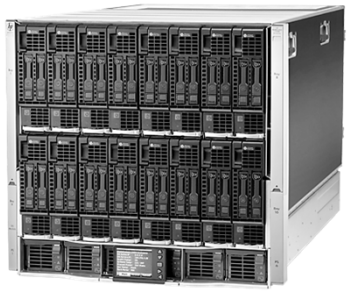


HDBaseT Cable Termination

Category Cable Shield Termination

3 common use-cases to deal with when connecting HDBaseT transmitter and receiver

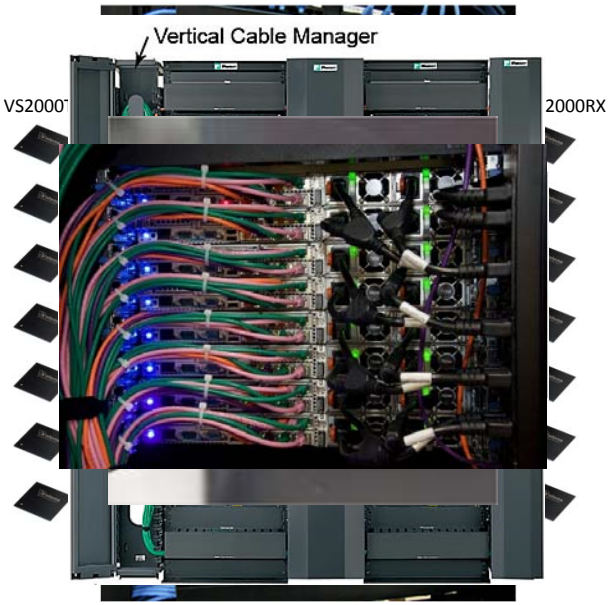
- Floating power supplies
  - Connect the cable shield on one end of the cable (due to high differential voltage developed between the Tx and Rx)
- PoH implementation
  - Connect the shield on both ends of the cable
- Chassis grounded system
  - If both sides are chassis grounded, terminate the shield on both ends
  - If one side is chassis grounded and the other is floating, connect the shield on the chassis terminated side



HDBaseT Cable Bundling – Recommendations

- The installation practices can positively impact alien crosstalk headroom when using Cat5e/6 cables
- For the first 20 meters
  - Do not “comb” or “pinstripe” cables
  - Separate path and equipment cords
  - Avoid tie-wraps
  - Use horizontal wire management techniques (e.g. route odd ports to upper management and even ports to lower management)
  - Loosely place cables in vertical wire management
  - Reduce maximum conduit fill density to 40% (but never exceed local regulations)

- Implementation of these practices is not required for any augmented Cat6a F/UTP (sometimes referred to as ScTp) or Cat7 S/FTP (fully shielded) cabling systems.



HDBaseT Cable Bundling – Recommendations (cont.)

Media	Augmented Category 6 UTP	Augmented Category 6A F/UTP	Category 7/Class F S/FTP
Cable Construction			
Alien crosstalk	Exhibits compliant alien crosstalk due to core separation design	Exhibits virtually zero alien crosstalk due to overall foil construction	Exhibits virtually zero alien crosstalk due to fully shielded constuction
Installation Notes	Larger overall diameter must be taken into consideration when calculating conduit and pathway fill	Grounding of the foil in one location from the patch panel in the telecommunications closet to the TGB is required	Grounding of the shield in one location from the patch panel in the telecommunications closet to the TGB is required
Work Area Interface	Standard 8-position Modular (RJ-45 style)	Standard 8-position Modular (RJ-45 style)	Quadrant-Pair Isolated Connector (non RJ-45 style)
Maximum Recommended Conduit Fill (never exceed local regulations)	60%	60%	60%

The above cable types are recommended to support the bundling of HDBaseT over several cables

PoH – UL Cable Certification Program

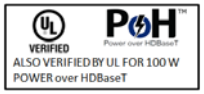
Introducing the UL Program for PoH Cable Certification

- UL has worked with the HDBaseT Alliance to develop a dedicated certification program for PoH cables
- The requirements are based on the HDBaseT compliance test specification for the HDBaseT Alliance Recommended Cables program, and a safety and performance test under heating conditions developed by UL
- The cables are tested in a specified bundle at 100 Watts and the HDBaseT parameters are verified at the temperature measured during operation

PoH – UL Cable Certification Program

Introducing the UL Program for PoH Cable Certification

- Cables are distinguished with an industry recognized UL certification Mark and a holographic sticker
- UL's Follow-up Program covers factory inspection and market surveillance to ensure ongoing compliance
- PoH certified cables are listed separately on the HDBaseT Alliance website
- UL are also a Recognized Test Facility for the HDBaseT Recommended Cables program



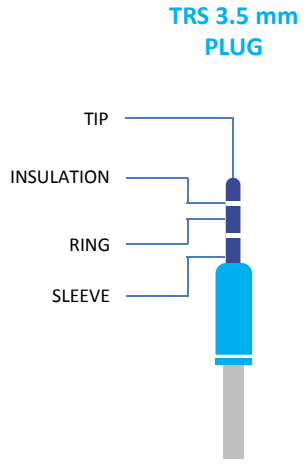
Interoperability - CIR

Infra Red (IR) Extension

Things To Pay Attention To

- IR Type B interface
  - 3.5mm stereo jack is common also for audio
  - You should not connect audio to the IR interface as it might damage your equipment

- IR Diodes in the market
  - There are several types of IR blasters in the market
  - 12v and 5v are the most common
  - For each system use the IR equipment provided by the manufacturer



	Type	Tip	Ring	Sleeve
IR Transmitter	Mono	Signal Input	GND	-
IR Transmitter	Stereo	Signal Input	GND	GND
IR Receiver 12V	Stereo	Signal Output	GND	12V
IR Receiver 5V	Stereo	5V	Signal Output	GND

Interoperability – RS232

RS232 Control Interoperability

- HDBaseT 1.0
  - Single operating mode: over-sampled channel
  - During low-power modes supports maximum 9.6Kbps data rate

- HDBaseT 2.0
  - Supports two operating modes: over-sampled and preconfigured
  - Over-sampled mode works identically to HDBaseT 1.0 definitions and limitations
  - Preconfigured mode works as a native interface – only data is passing on HDBaseT
    data is extracted on one side, reconstruct and transmitted again at the remote side

Chipsets Interoperability	Operating Mode
HDBaseT 1.0(over-sampled) + HDBaseT 2.0 (pre-configured)	Over-Sampled
HDBaseT 2.0 (over-sampled) + HDBaseT 2.0 (pre-configured)	Preconfigured
HDBaseT 2.0 (Pre-configured) + HDBaseT 2.0 (pre-configured)	Preconfigured *

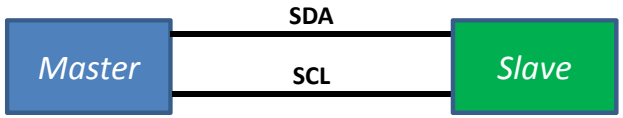
* If there is a difference in baud rate settings
then there will not be a communication channel

HDMI and HDBaseT Interoperability – DDC Clock Stretching

HDMI and HDBaseT Interoperability

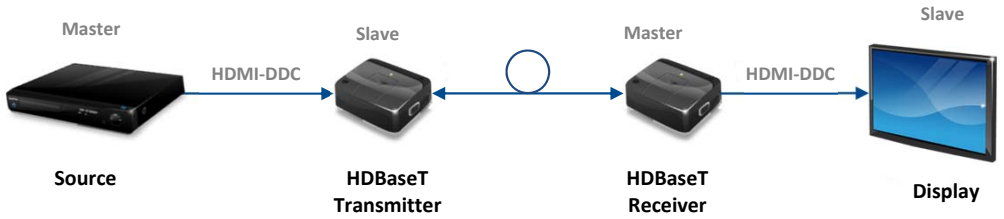
What is stretching?

- HDMI DDC (Display Data Channel) is an I^2C serial communication channel used for EDID and HDCP
- In I^2C serial communications, the Master device determines the clock speed
- There are situations where an I^2C Slave is not able to co-operate with the clock speed set by the Master and needs to slow things down a little
- The Slave is allowed to hold down the clock in order to reduce the bus speed
- This mechanism is known as clock stretching, and was defined in HDMI 1.3



HDMI and HDBaseT Interoperability

- The HDBaseT Transmitter (HDMI Receiver) act as slave on the DDC lines – the video source is the Master
- The HDBaseT Receiver (HDMI Transmitter) act as a Master on the DDC lines – the display (sink) is the Slave
- When HDBaseT is connected between source and sink, there is a propagation delay over 100m
  - HDBaseT defines maximum latency of 10µs from source → sink, and 10 µs from sink → source, resulting in a 20µsec roundtrip
  - 20µs == 50Khz clock
- Theoretically, if the source device DDC clock is above 50KHz, there is a probability that the HDBaseT TX can not fetch the sink data, and it will need to "request" the source device (DDC Master) to stop toggling the DDC clock by performing stretching as per the HDMI standard

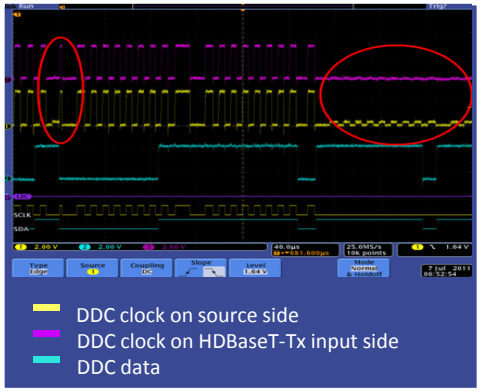


HDMI and HDBaseT Interoperability

How to Test & How to Solve

Test setup

- Cut the DDC clock line and insert 10Ω serial resistor
- Checking the clock signal on the source side

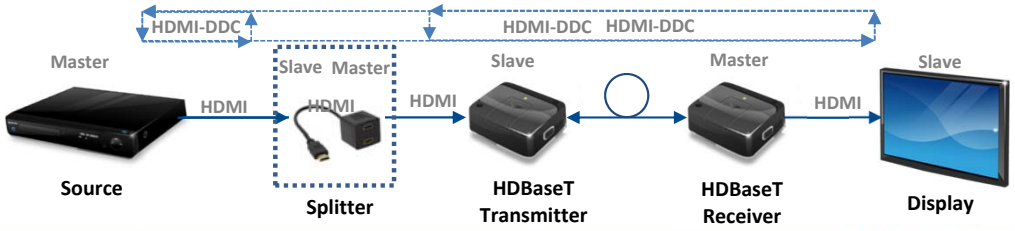


How to recognize it in the field?

- You see colored snow
- Intermittent video drop

Solution

- Common solution is to use an HDMI splitter 1:2 between the source and the HDBaseT TX



Troubleshooting

What To Do When Things Go Wrong

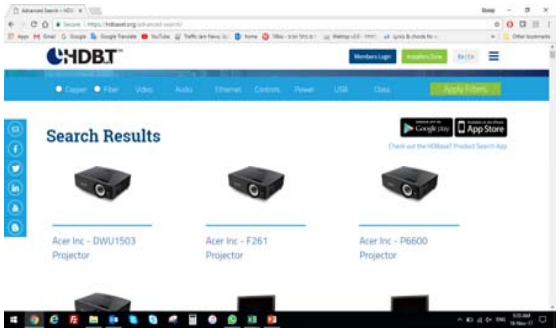
- HDBaseT has become the de-facto standard in AV interconnectivity
- Installers tell us that they enjoy using HDBaseT because of its reliability and ease of use
  - “It just works”
  - “True plug-and-play”
- Despite this, issues may still arise that need to be debugged
- We shall explore methods for troubleshooting HDBaseT installations

Source/Sink Equipment Compatibility

- Before dismantling any installed equipment, it is worth double-checking compatibility of the Source and Sink equipment
- Read the product documentation to make sure of interop compatibility
  - For example, do not expect an HDR TV to work if the video Source does not support it
- Try to eliminate HDBaseT as the cause of the issue
  - Directly connect the Source to the Sink to be sure they work together
  - Not all HDMI ports support all features (e.g. HDMI 2.0 may only be on certain ports)

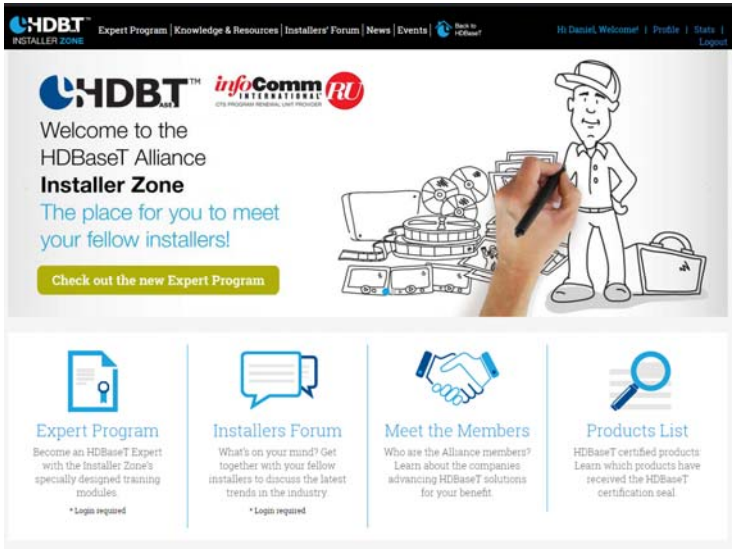
HDBaseT Equipment Interoperability

- As discussed, not all HDBaseT products include the full 5Play functionality
- And as we know, “common” HDBaseT functions may differ from one product to another
  - CIR
  - UART
  - Cable reach (different classes)
- Refer to the list of approved products on the HDBaseT website to make sure the HDBaseT TX and RX equipment is compatible
- Use the HDBaseT App to check compatibility of the different products



Check HDBaseT Installer Zone

- The HDBaseT Alliance Installer Zone contains a wealth of information related to HDBaseT products
- Check the Installer Forum to see if any of your peers have experienced similar issues and may have the solution already
- Start a new thread on the Forum explaining the issues to see if anyone can help you

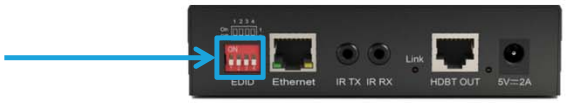


Check Cabling

- The HDBaseT cable is an essential part in the system
- How is the shield connected?
- Are the connectors correctly wired and properly crimped?
- How are the cables routed?
  - What other cables run nearby?
  - Are there any “noise” sources close to the cable (e.g. aircon units, fluorescent lights)?
- Try replacing the cable
  - Try using a shorter cable length to see if the issues are related to link performance
- Make sure the HDMI cable is suitable for its intended use
  - For example, HDMI Premium High-Speed Cable for 4K/60/4:4:4 and HDR setups

Checking the HDMI Interface

- Replace the Source and Sink products with HDMI generators and analyzers (if available)
- Check to see if the issue is related to specific formats
  - Could the HDBaseT link bandwidth be exceeded?
  - Try running with lower video formats
- Check that 5V and HPD signals are reaching their destinations
  - Without them, EDID and HDCP transactions can not be completed
  - Use simple HDMI breakout boards
- Some products have manual EDID settings
  - Make sure they are compatible with the HDMI Source and Sink



Checking the HDMI Interface

- As discussed, IR can be complicated due to different configurations of receivers and blasters
  - Some remove the modulation – other pass it through (Type A or Type B)
  - Any IR over-the-air must be modulated
- Always use the IR receivers/blasters provided by the equipment vendor
- Again, refer to the list of approved products on the HDBaseT website to confirm the IR type of the equipment

Atlona - AT-UHD-EX-70-KIT

Extender

TX

Controls	CEC
IR Transmitter	Type B
IR Receiver	Type B
Class	Class B
Video	4K
Audio	HDMI
Power	PoE

General Issues

- Status Indicators
  - LEDs can provide an indication as to the operating mode and status of the link
  - Are we in HDBaseT mode, Low Power Mode or Fallback mode? Check the Link LED
  - Is there video, and is it HDCP encrypted? Check the Video LED
- Power
  - If using PoE, make sure that there is 1 PSE and 1 PD per link
  - Check vendor documentation for the PoE class and compatibility
  - Ensure that the cable shield is grounded correctly according to the power scheme
- UART
  - If the equipment runs in pre-configured mode on both sides of the link, double-check that the configurations are identical

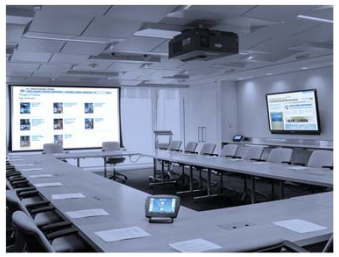

HDBaseT-IP
2018 BICSI WINTER
CONFERENCE & EXHIBITION
Orlando, FL | February 4-8

Expanding HDBaseT Capabilities

- Since the release of the first chipset, HDBaseT has become the de-facto standard for high-definition wired connectivity in different AV Markets
- The technology provides a convergence of multiple interfaces over a single cable, and significantly extends their reach (up to and above 100m/328ft)
- As a result, HDBaseT has become the ultimate solution for replacing multiple cables and protocols with a single category cable
- HDBaseT is ideally suited for installations up to 100m radius – for example, in-room and cross-floor systems
- However, existing HDBaseT is less well suited for cross-campus topologies

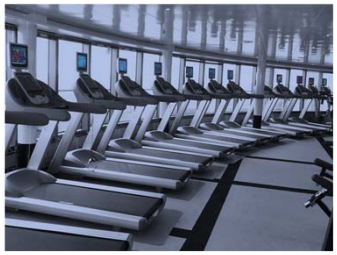
Typical HDBaseT Scope

In-Room


100m

Cross-Floor



Going Cross-Campus?

Limitations of Today's IP Solutions

- Existing HDBaseT is not well suited for cross-campus topologies
- While other IP solutions are currently available for such topologies, they have a number of limitations

No interoperability in eco-system	• Each vendor implements proprietary solution • No interoperability across vendors
Not standardized	• Not standard at Application layer • Creates interoperability issues
Incompatible with non-IP install base	• Non-compliant with existing non-IP equipment • Need to replace install base
Not Pro-AV grade	• Not up to the demands of Pro-AV grade • HDCP does not meet DCP LLC requirements

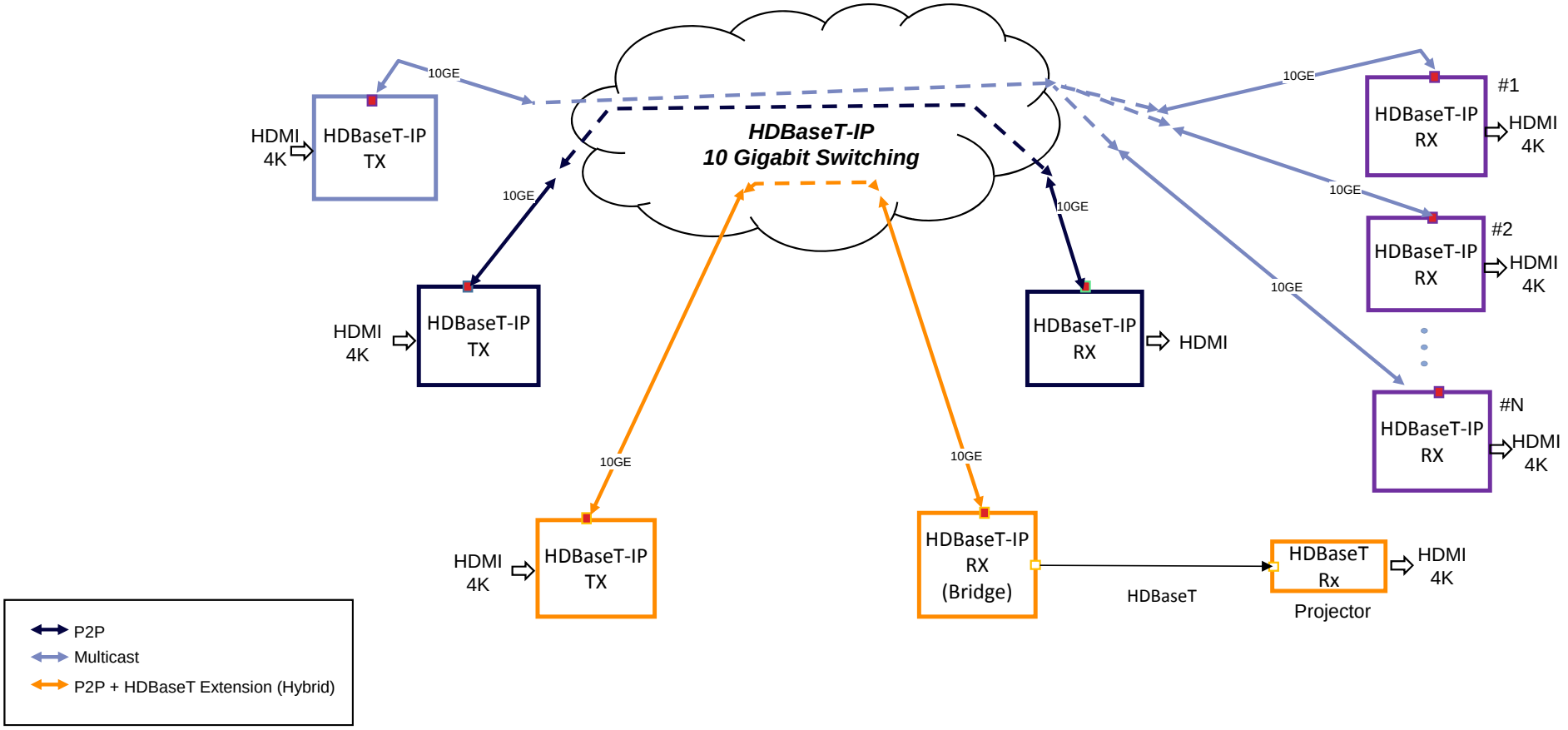
HDBaseT-IP - Motivation

- Leverage the **in-room** solution to a **cross-campus/cross-organization** solution, with Application level interoperability
- Flexible configuration of the number of sources and sinks
- Support for ultra-large scale installations

HDBaseT-IP – Key Benefits

- Building upon a **proven standard technology** with a thriving eco-system
- Integration and scalability with existing HDBaseT products - **expanding the scope of HDBaseT**
- Unified management - **end-to-end HDBaseT**
- HDBaseT 5Play **convergence** – full **interoperability** up to the Application level
- Utilization of both **copper and fiber** interfaces
- Use of standard **10G switches and future support for lower speed rates**
  - Cost-effective quality – use the best infrastructure that meets the cost restrictions
- A true ProAV-grade solution
  - **Time-sensitive:** Zero Frame Latency, Low Latency Variation

HDBaseT-IP – Use-Cases



The HDBaseT Alliance

HDBaseT Alliance Goal

To **promote and standardize HDBaseT™** technology for **whole-home** distribution of **uncompressed HD** multimedia content

HDBaseT Alliance Reaches 190 Members Milestone

HDBaseT Certification Program

The Path To HDBaseT Interoperability in an Imperfect World

- Not all HDBaseT products support the full 5Play feature set
- Some features may be supported but not HDBaseT certified, so interoperability may not be achieved
- Only HDBaseT interoperability, not full product interoperability, is being tested, so check the fine print for proprietary features that may make the product interoperable in general!

HDBaseT Certification Program

Formal framework to ensure **compliance & interoperability** in the HDBaseT **ecosystem**

HDBaseT Compliance Test Specification

Logo Guidelines

HDBaseT Recognized Test Facility

Your Guide to HDBaseT Interoperability

Logo

- Only certified products may carry the HDBaseT logo
- Increased enforcement by the Alliance

The Certified Product List

- The list is constantly updated as more and more products receive certification
- You can check by manufacturer, product category, resolution, class, and specific HDBaseT features

Manufacturers' Collaterals

- Check for the 'fine print' or contact manufacturer to verify any specific features that may cause the product not to be interoperable

HDBaseT Alliance Website – Installer Zone

HDBaseT Alliance Installer Zone

www.hdbaset.org

- Who are the Alliance members? Learn about the companies advancing HDBaseT solutions for your benefit
- HDBaseT certified products: Learn which products have received the HDBaseT certification seal
- Become an HDBaseT Expert with the Installer Zone's specially designed training modules
- What's on your mind? Get together with your fellow installers to discuss the latest trends in the industry on the Installers Forum

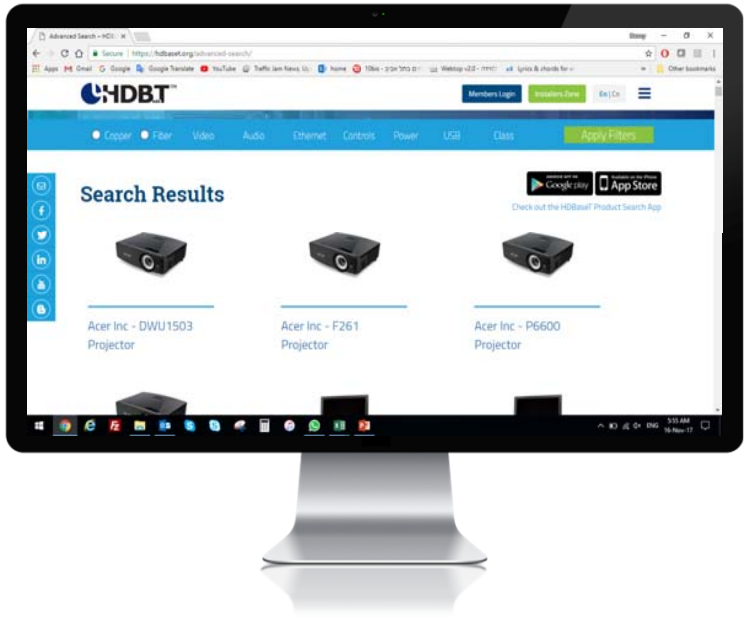
Meet the Members

Product List

Expert Program

Installers Forum

HDBaseT Certified Product List



ANDROID APP ON Google play

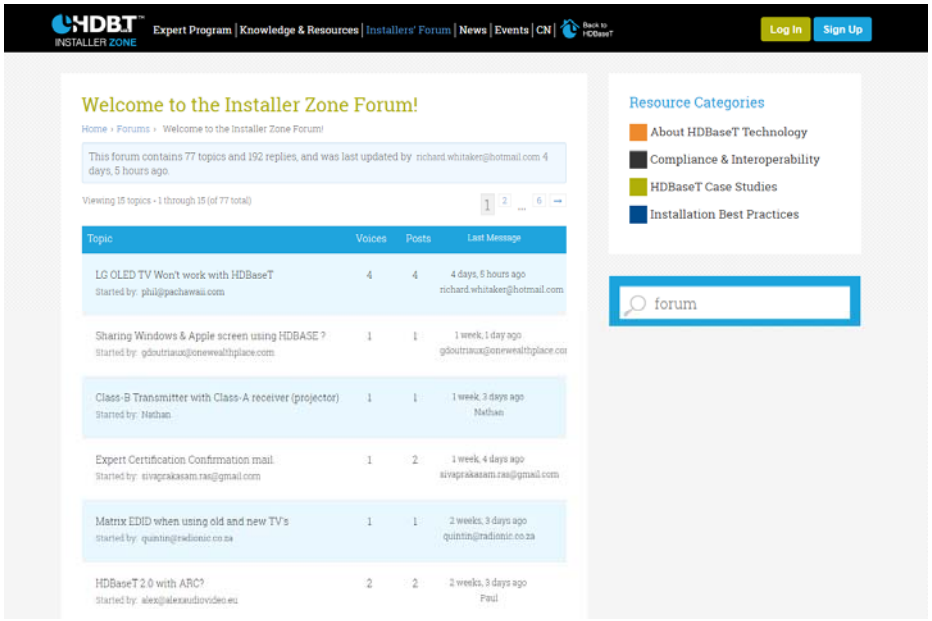
Available on the App Store

- Over 1700 Certified Products
- Rapid annual growth
- Enforcement program - every HDBaseT product MUST be certified

Online Installer Expert Program

- Comprises nine lessons
- Users that pass the training receive
  - HDBaseT expert certification, email and printed
  - HDBaseT T-shirt
  - Submit the certificate to InfoComm to receive 1 RU (Renewal Unit) accreditation

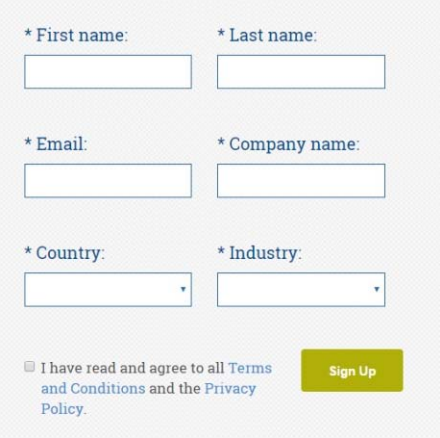
Installer Zone Forum



- Registration is required (free of charge)
- Users can submit HDBaseT queries to be answered by the Alliance or other forum participants
- Users can open discussions and share their experience

HDBaseT

Installers Zone Registration



How to …?

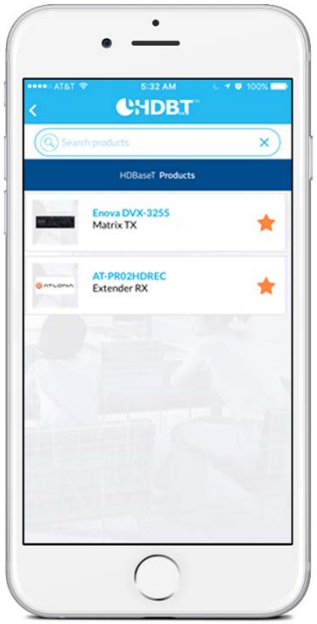
3 simple steps to join the HDBaseT installer forum

- On the main page select the “Installers Forum”
- Press the Sign-Up button
- Fill in your details and click “Sign Up”

HDBaseT App

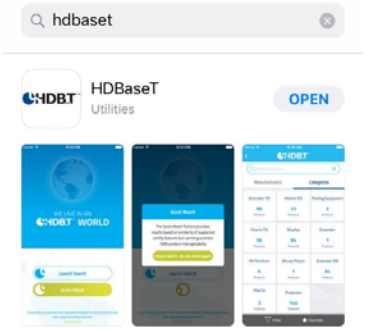
Check for product certification on-the-go

- Make informed decisions
- Compare different vendors and products
- Research product interoperability
- Check for mix & match



ANDROID APP ON Google play

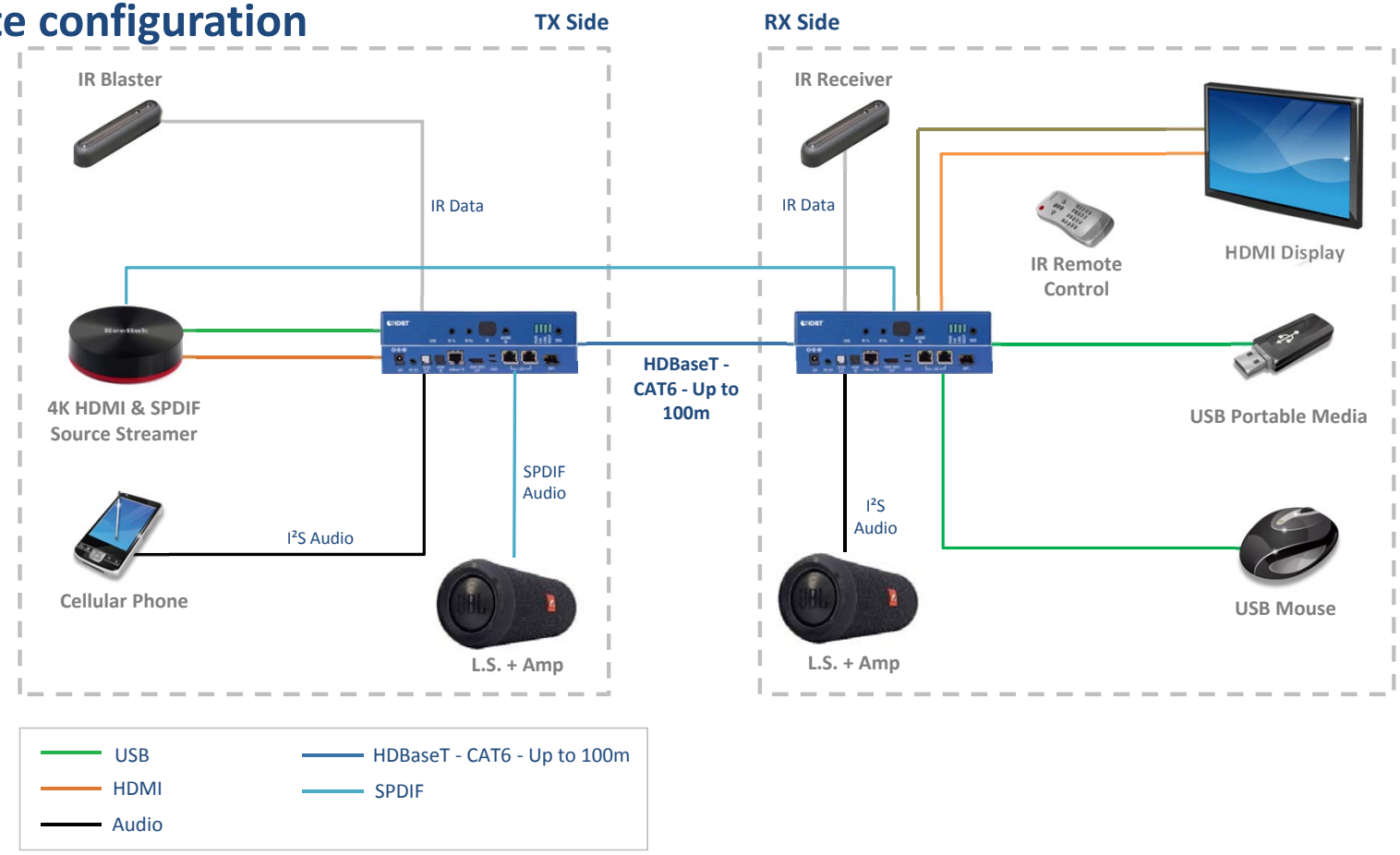
Available on the App Store



HDBaseT 2.0 – Demo

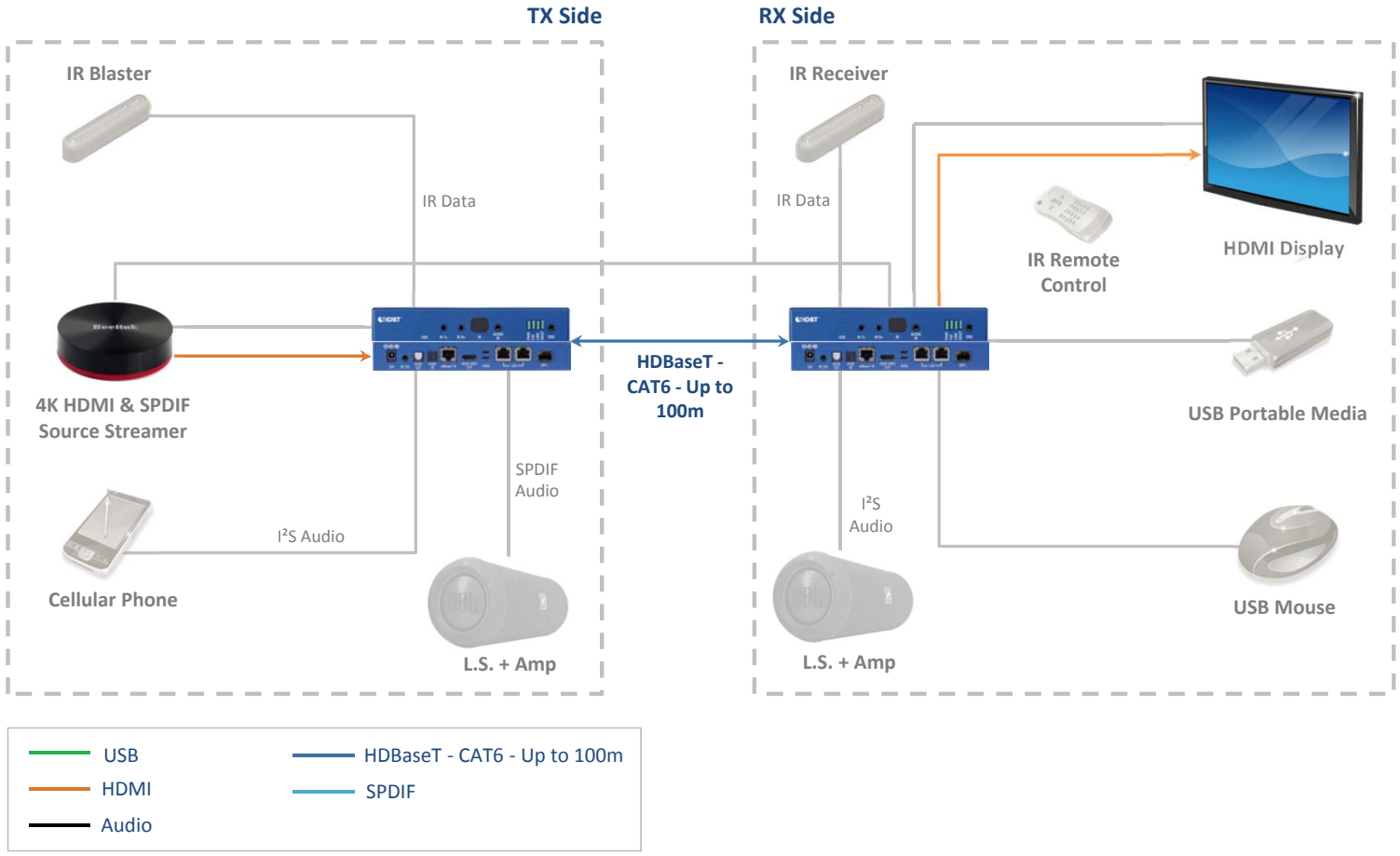
HDBaseT 2.0 Demo

Complete configuration



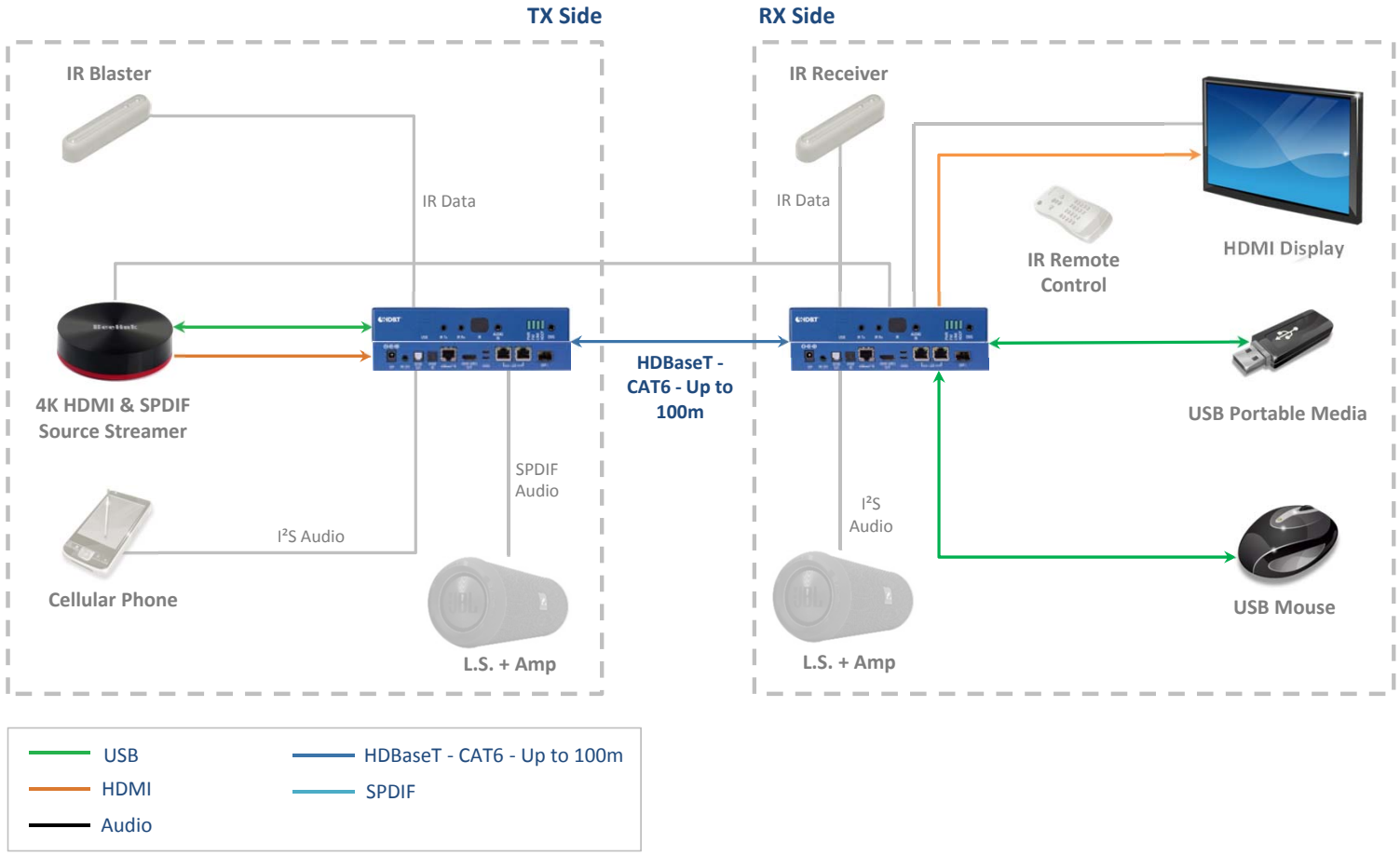
HDBaseT 2.0 Demo

HDMI



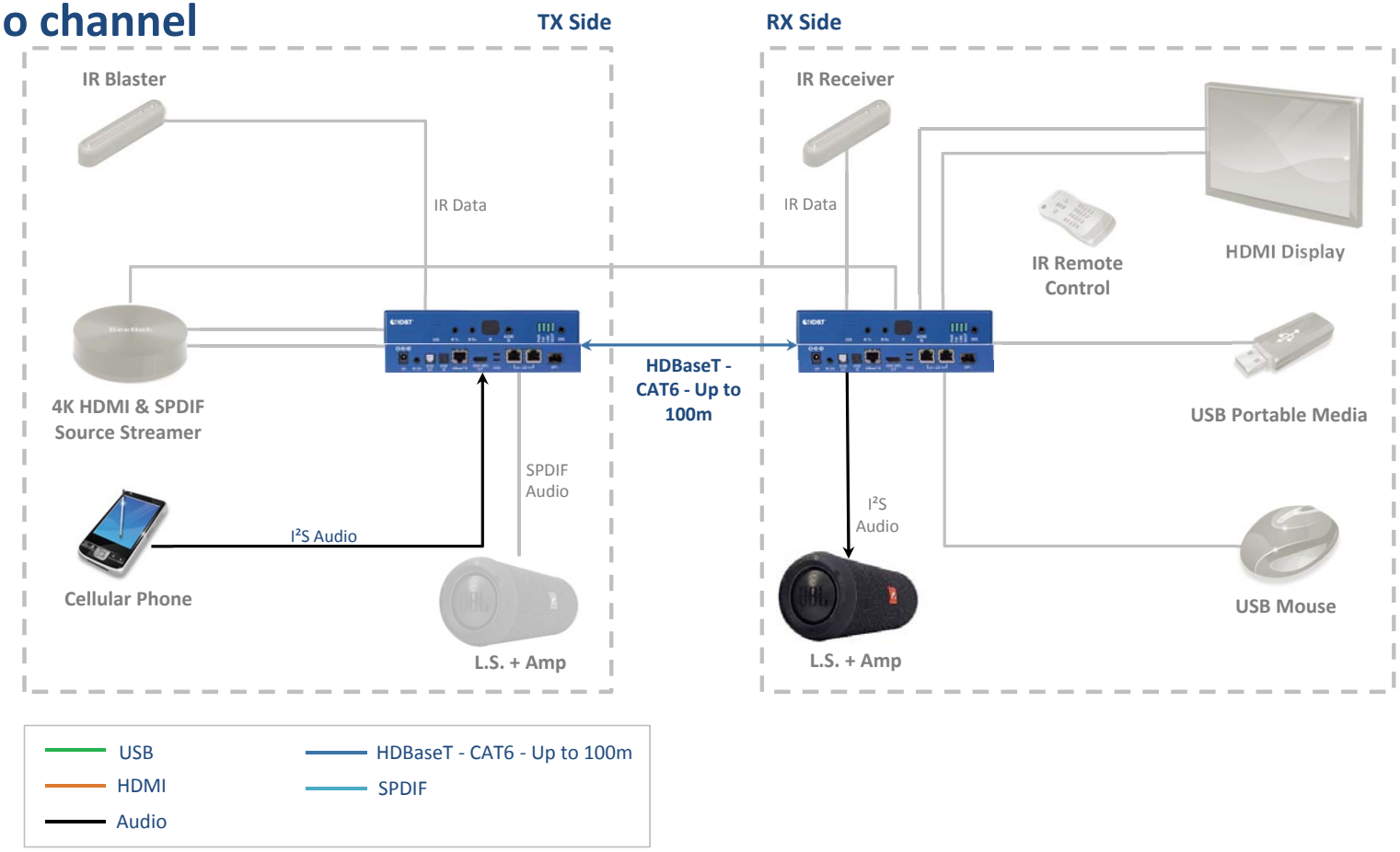
HDBaseT 2.0 Demo

USB 2.0



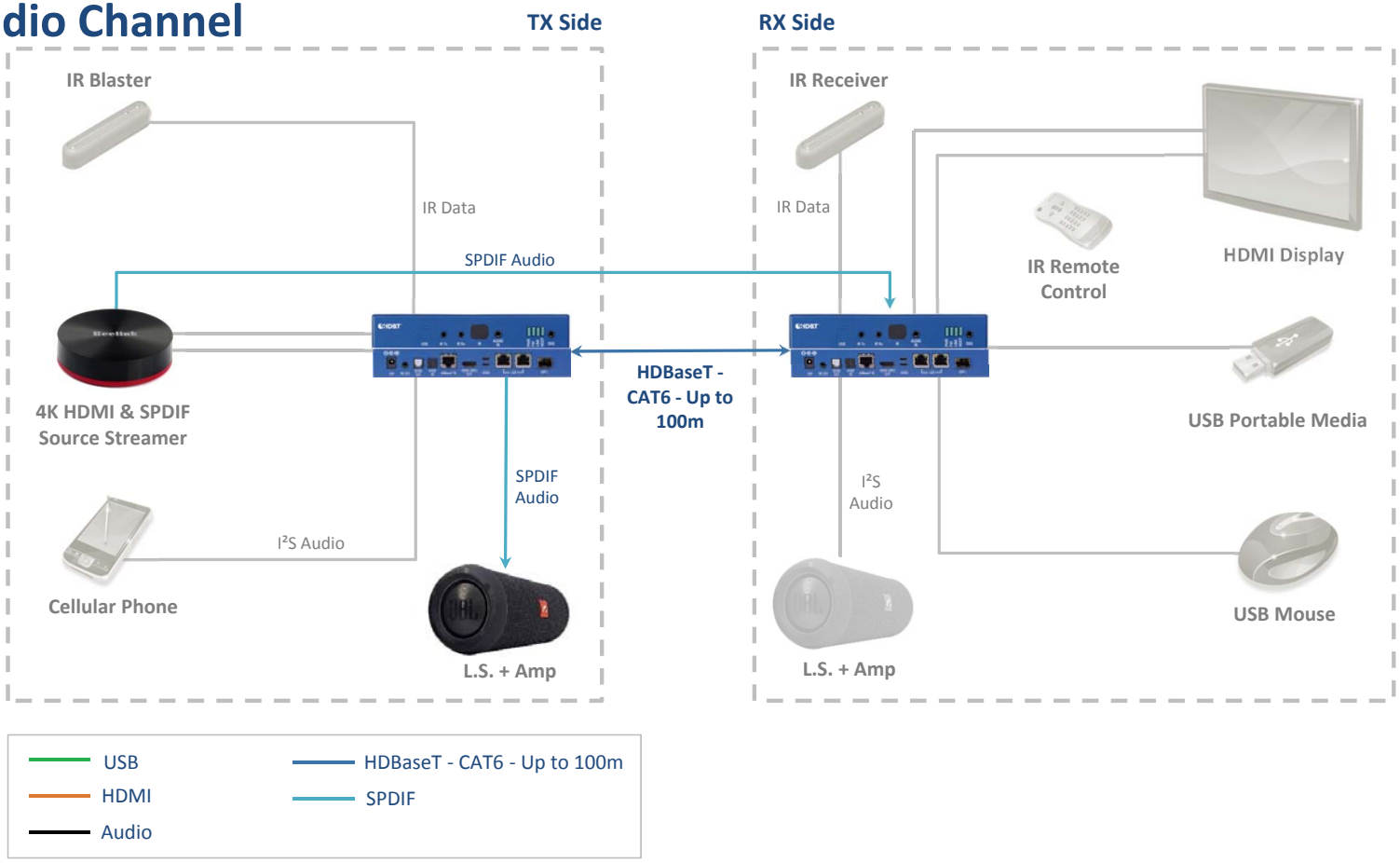
HDBaseT 2.0 Demo

I2S Audio channel



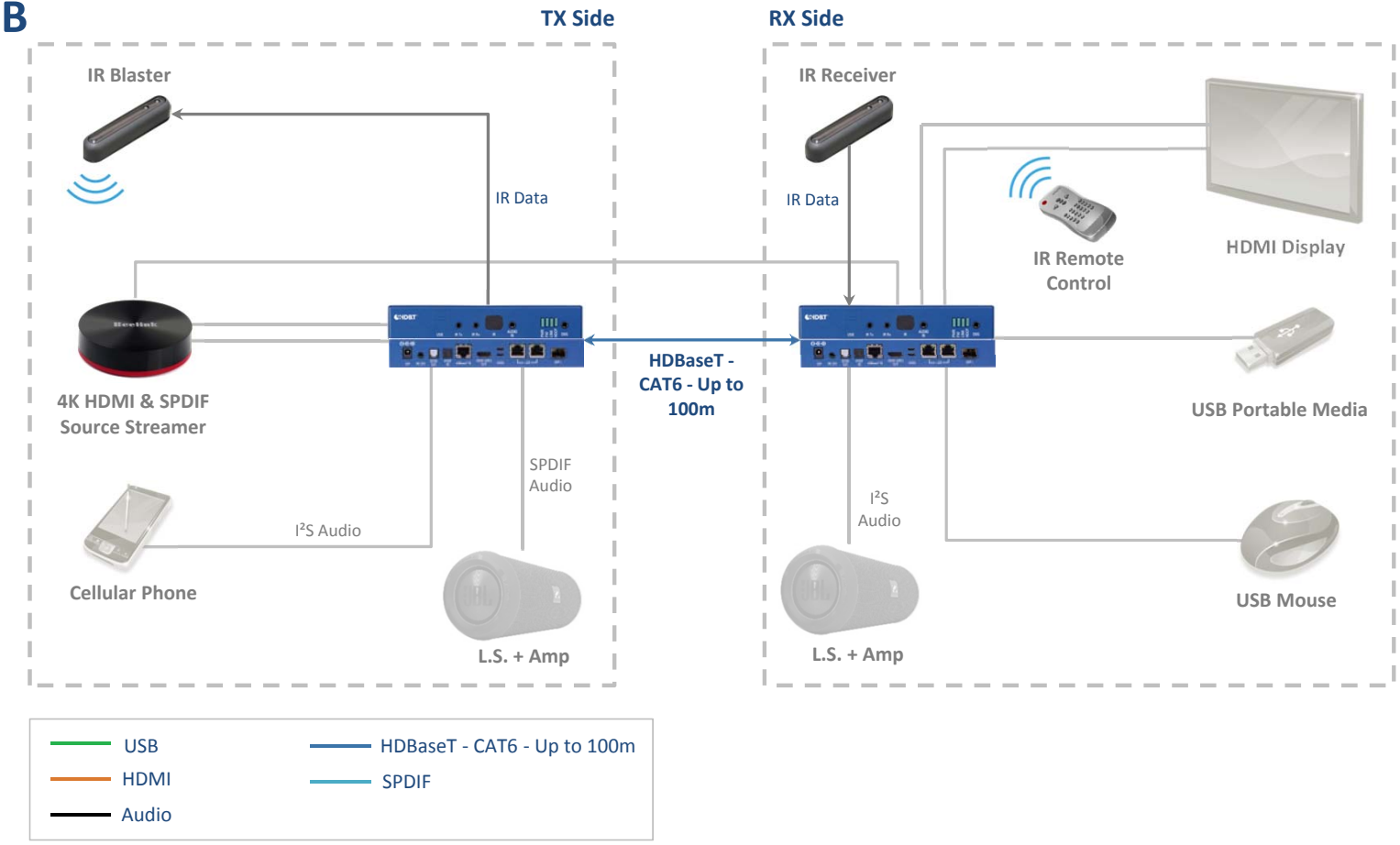
HDBaseT 2.0 Demo

SPDIF Audio Channel



HDBaseT 2.0 Demo

IR Type B



HDBaseT Use-Cases

HDBaseT Major Applications

Home

Custom Installations

Digital Signage

Projection


Consumer Electronics
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Whole Home Networking Application

HDBaseT Switch for

Complete Home Networking

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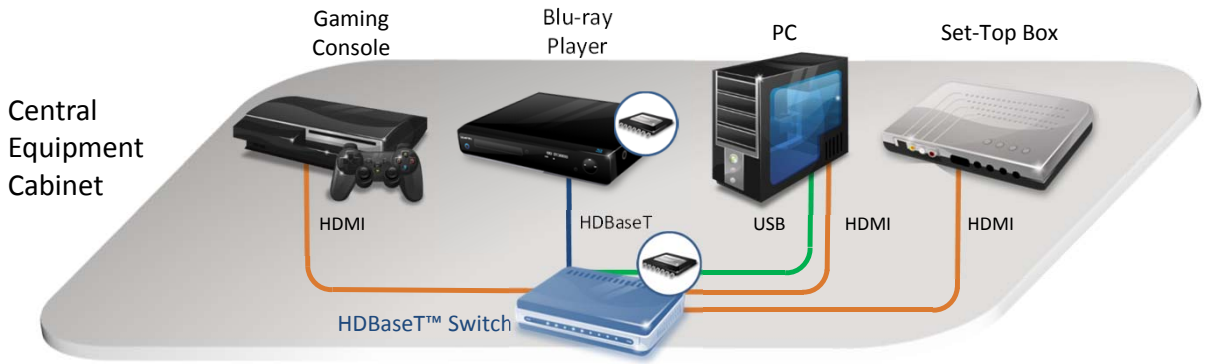
Whole Home Networking Application

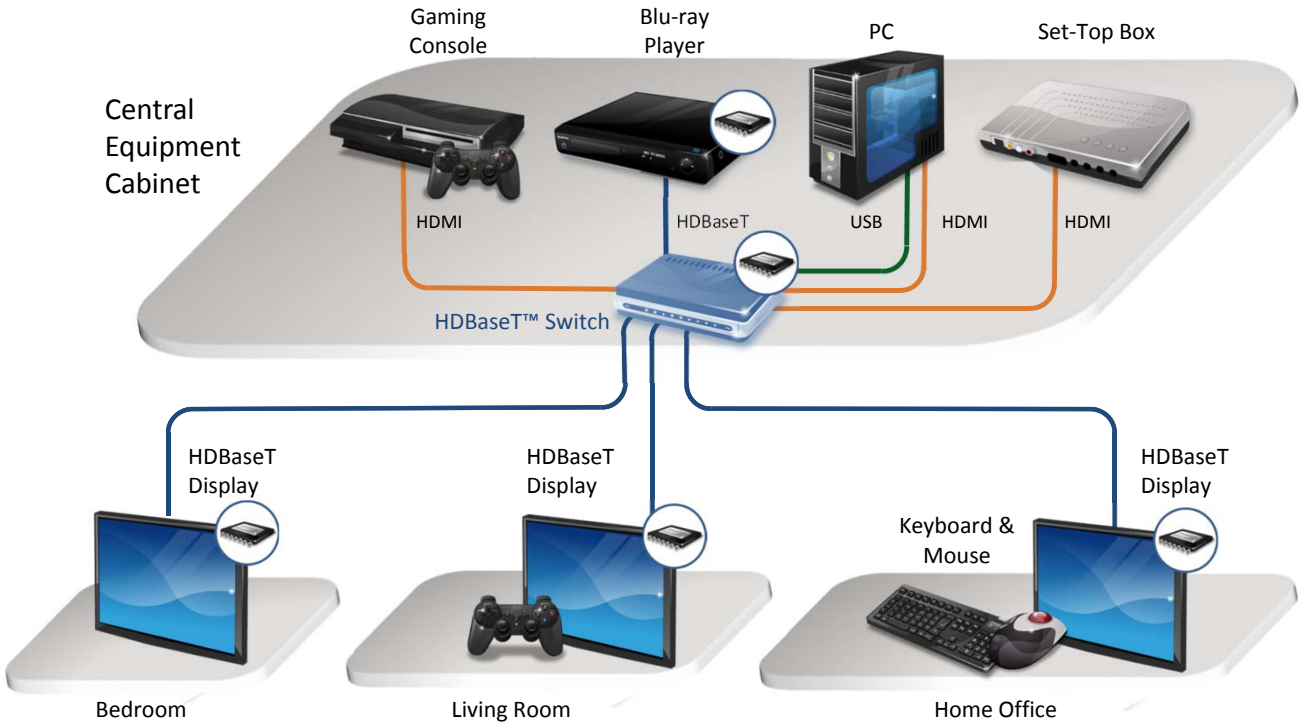


All AV Devices are Placed in a Central Location

HDBaseT Switch Terminates the Sources

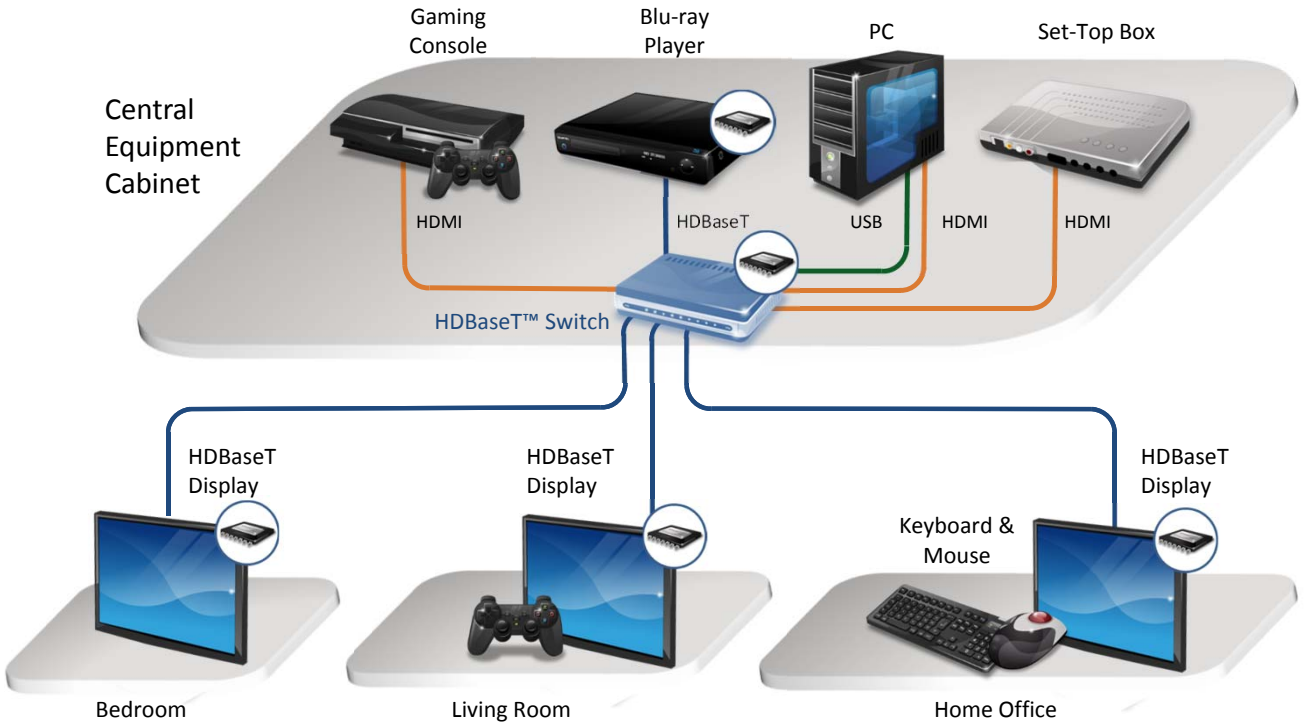
Legacy Connectivity is Supported

Whole Home Networking Application



Standard LAN Cable – Existing Infrastructure Can Be Used

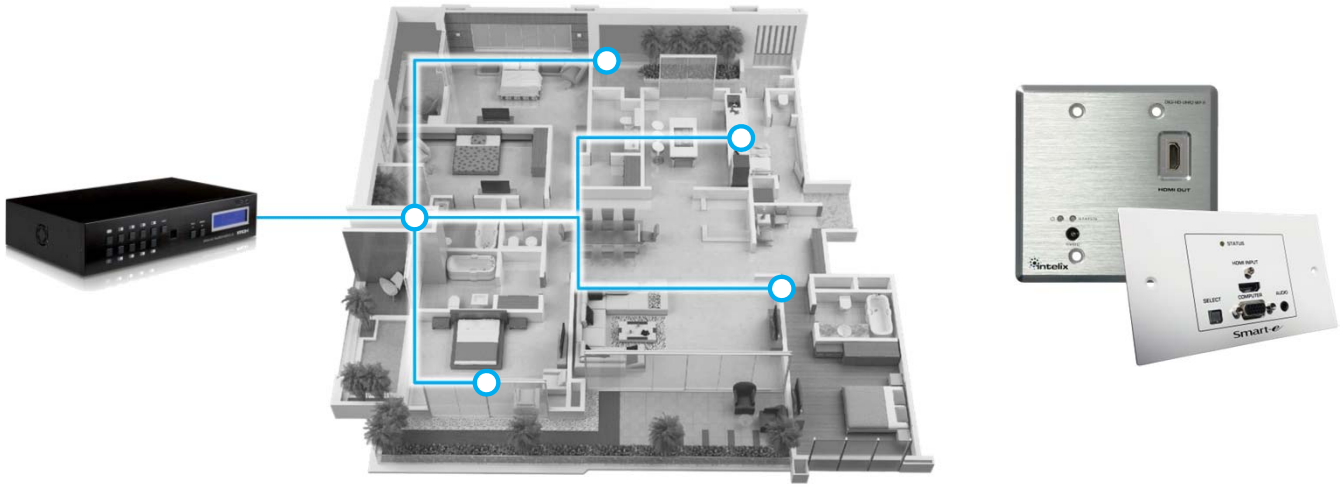
Whole Home Networking Application



Tablet or Smartphone for Remote Control over HDBaseT™ Switch

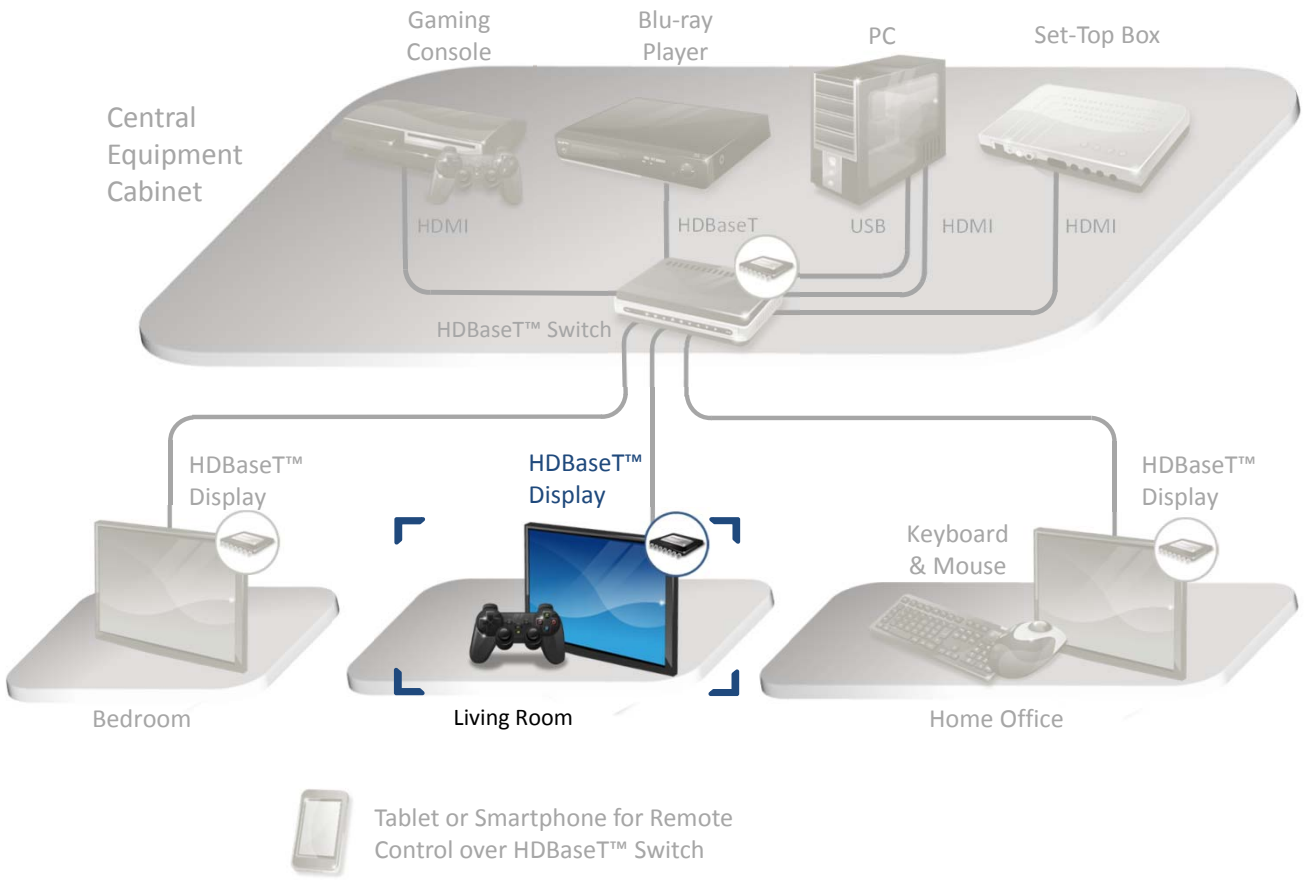
HDBaseT™ Connected Home Topology

The **HDBaseT™ Switch** connected using standard **CAT5e/6 cabling** and various Wall-Mount Adapter plates



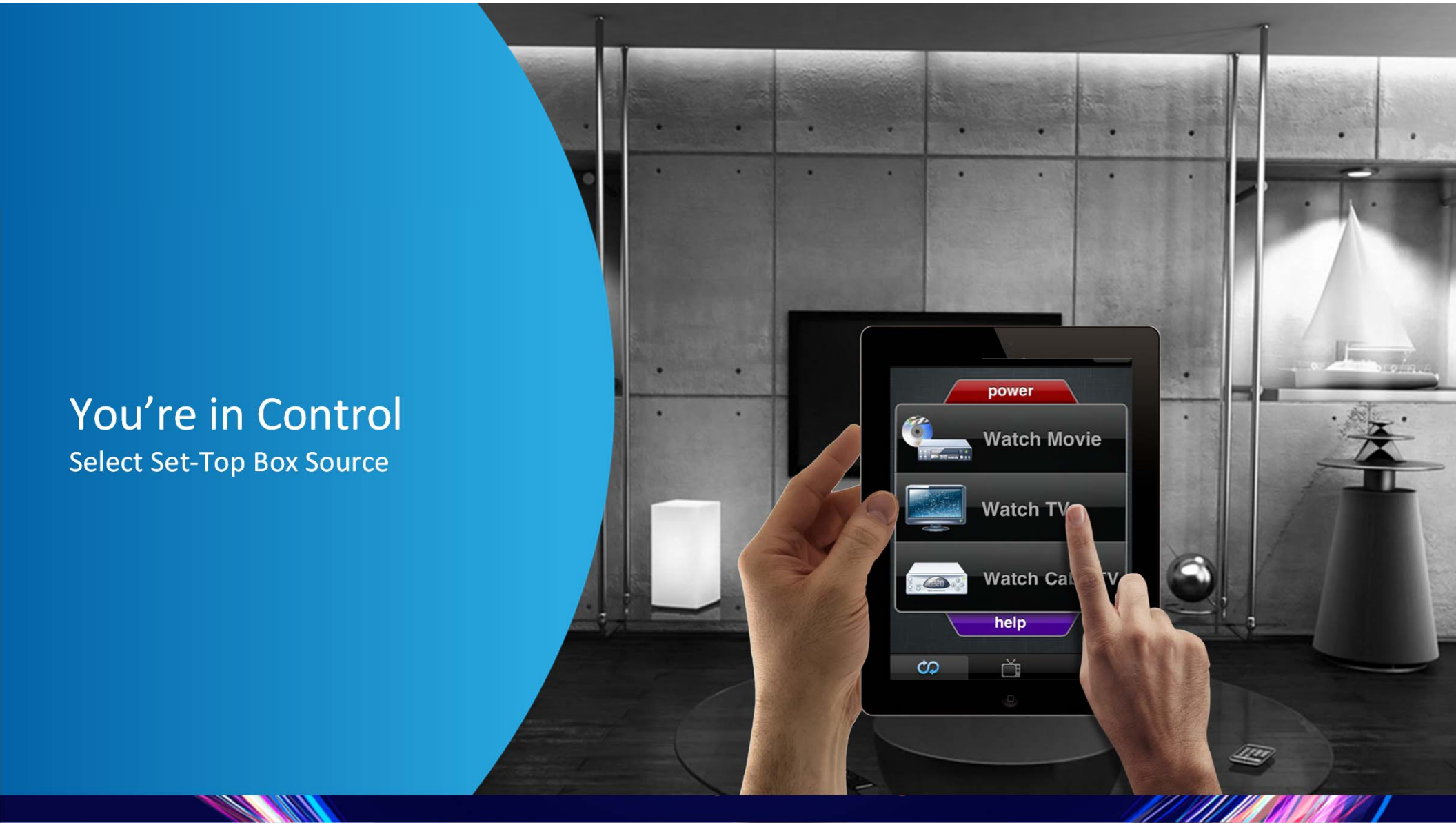
HDBaseT™ wall plates supports legacy connectivity, e.g. HDMI, Ethernet ports and various controls

Whole Home Networking Application

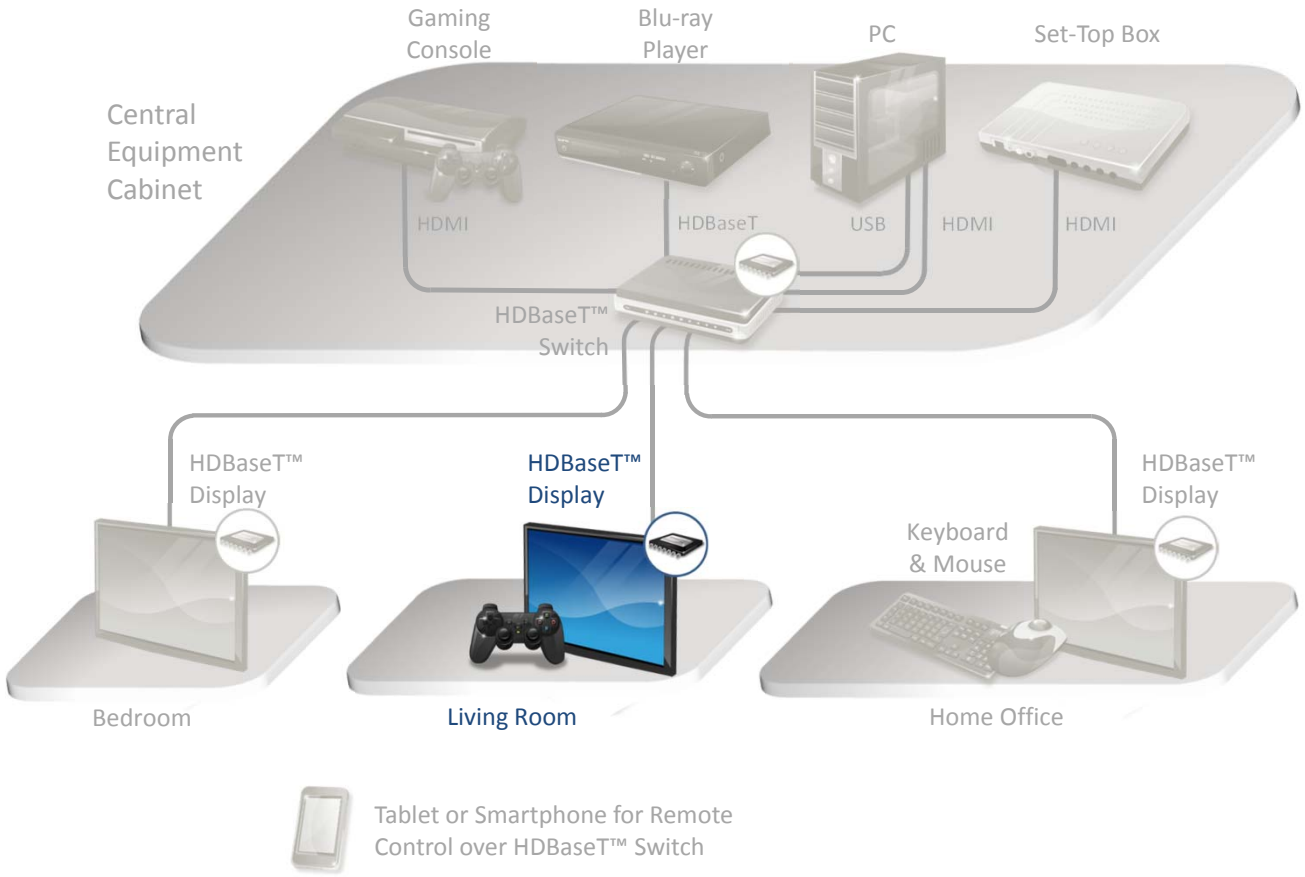


You’re in Control

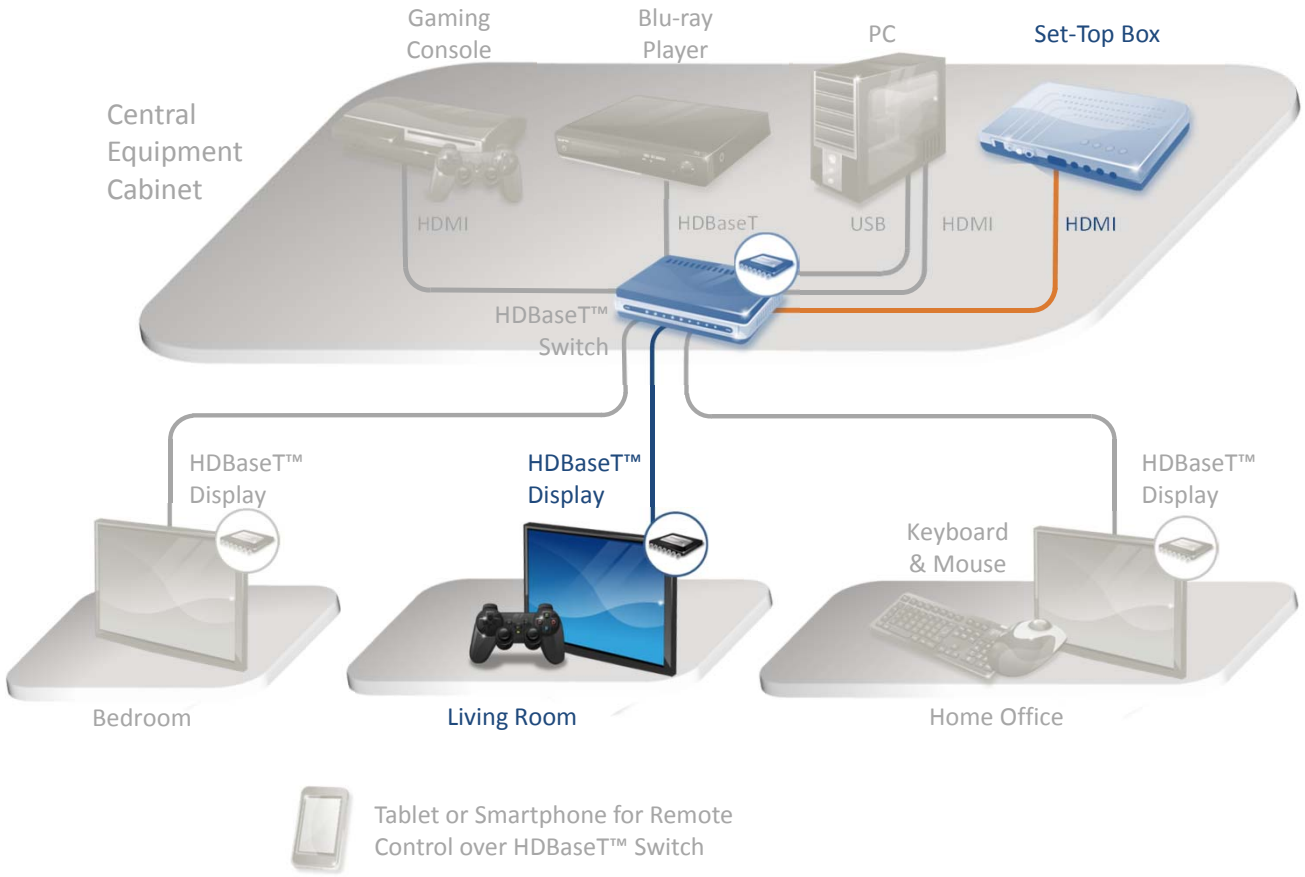
Select Set-Top Box Source



Whole Home Networking Application

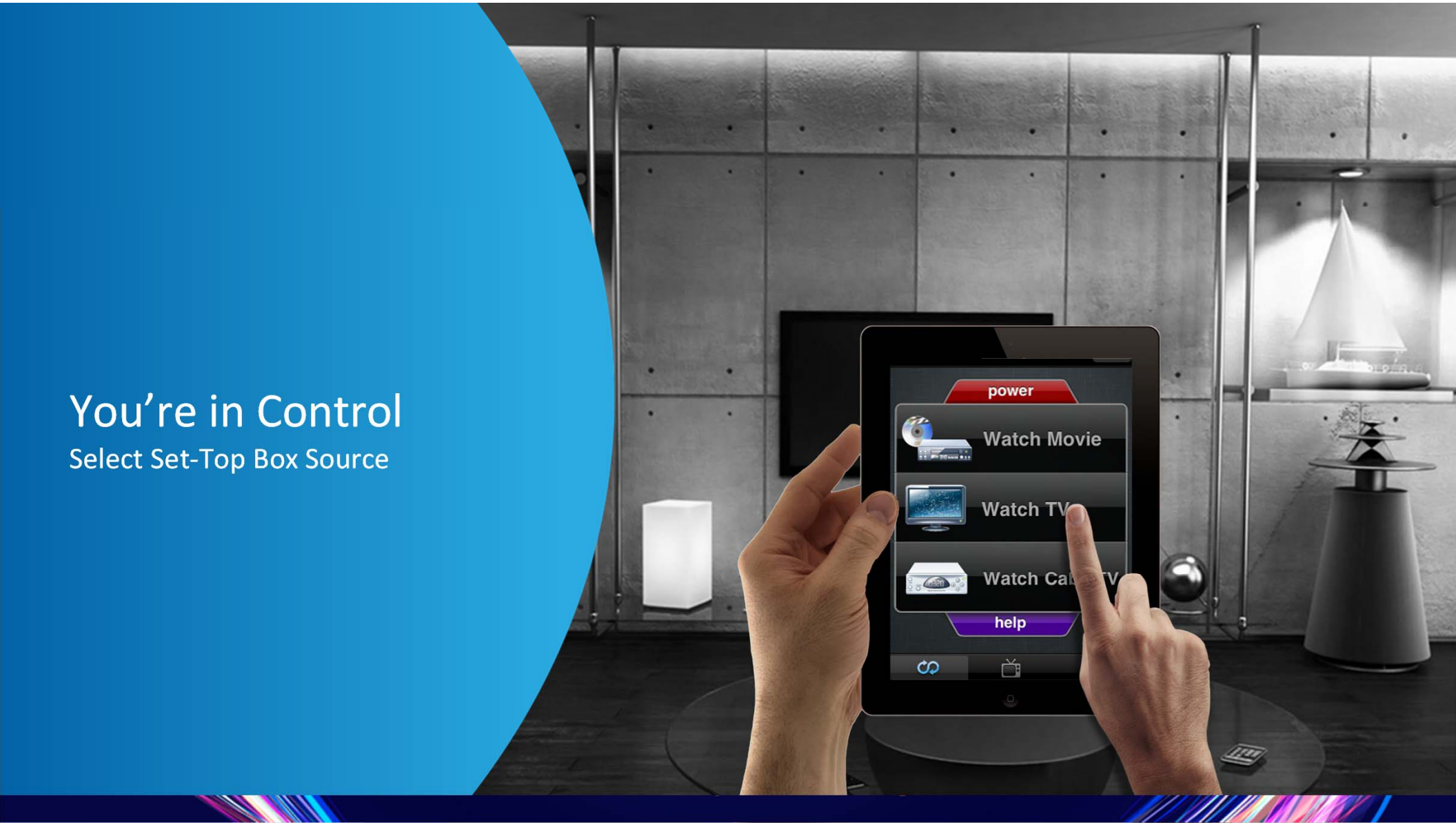


Whole Home Networking Application



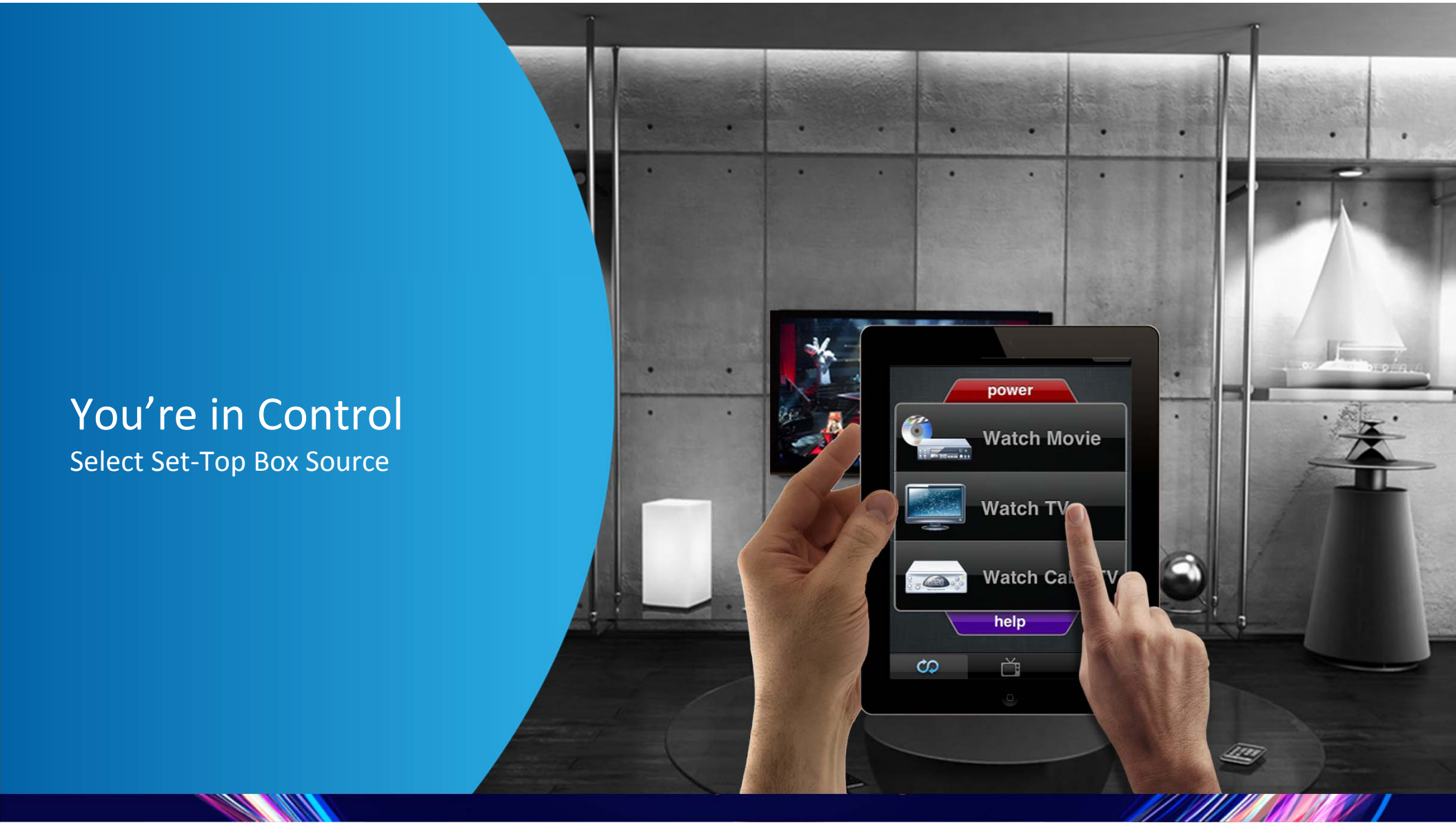
You’re in Control

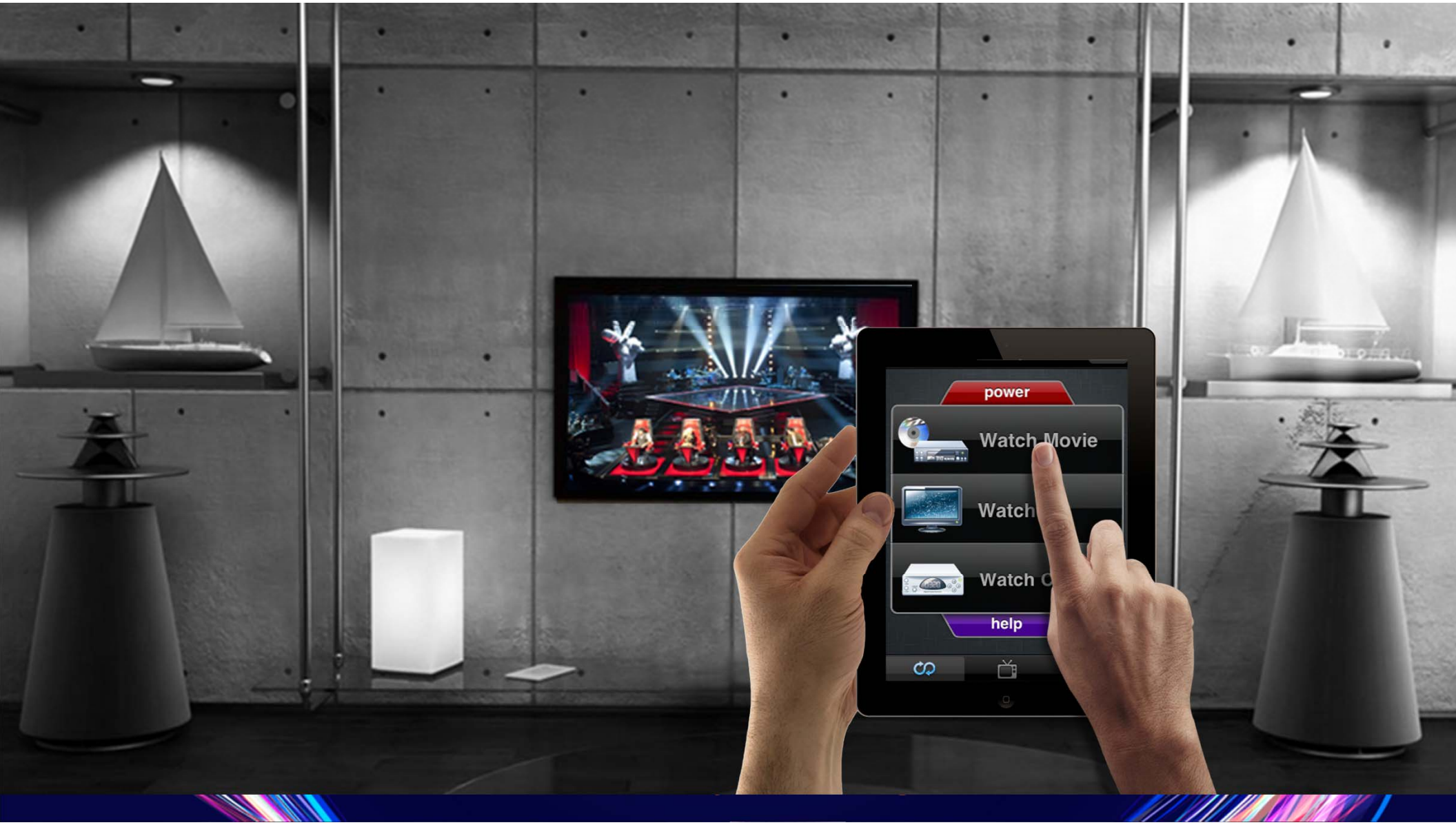
Select Set-Top Box Source



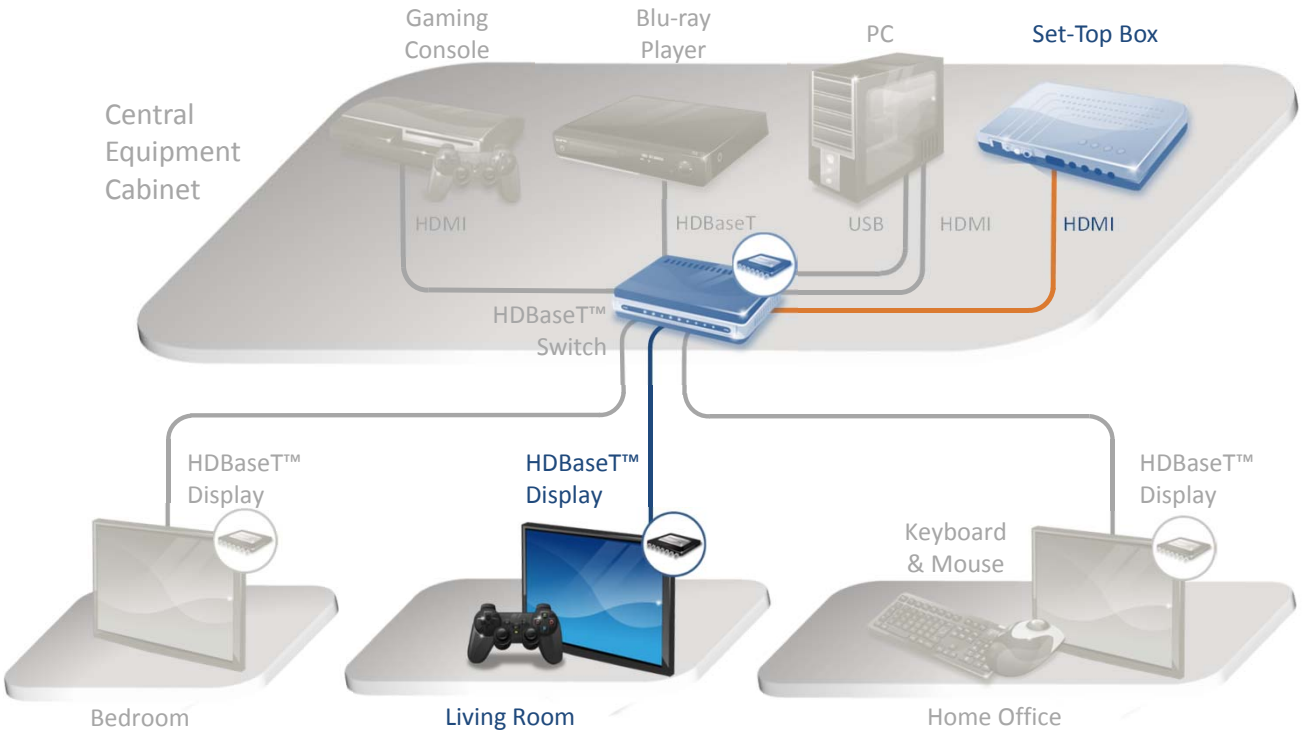
You’re in Control

Select Set-Top Box Source



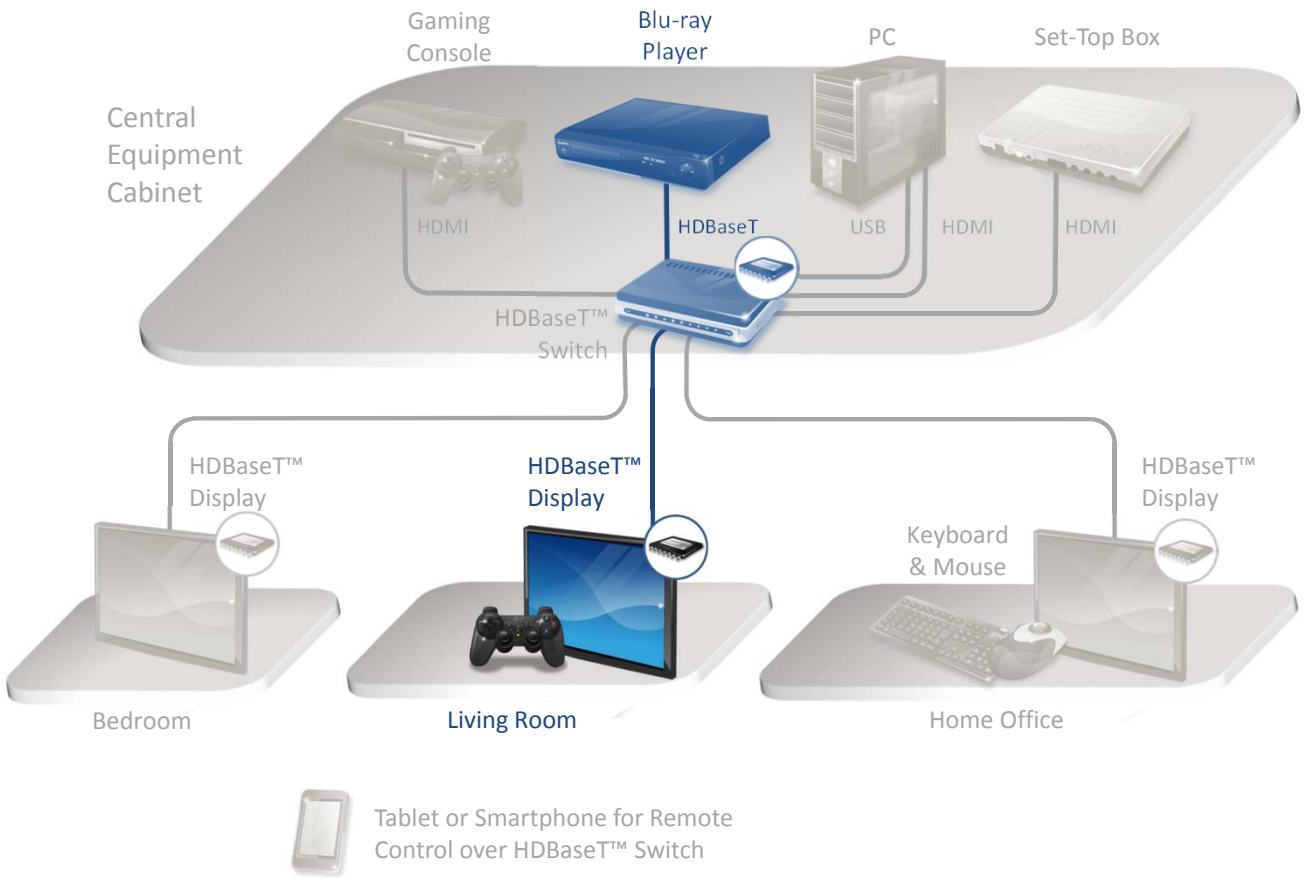

power
Watch Movie
Watch
Watch C
help

Whole Home Networking Application



Tablet or Smartphone for Remote Control over HDBaseT™ Switch

Whole Home Networking Application

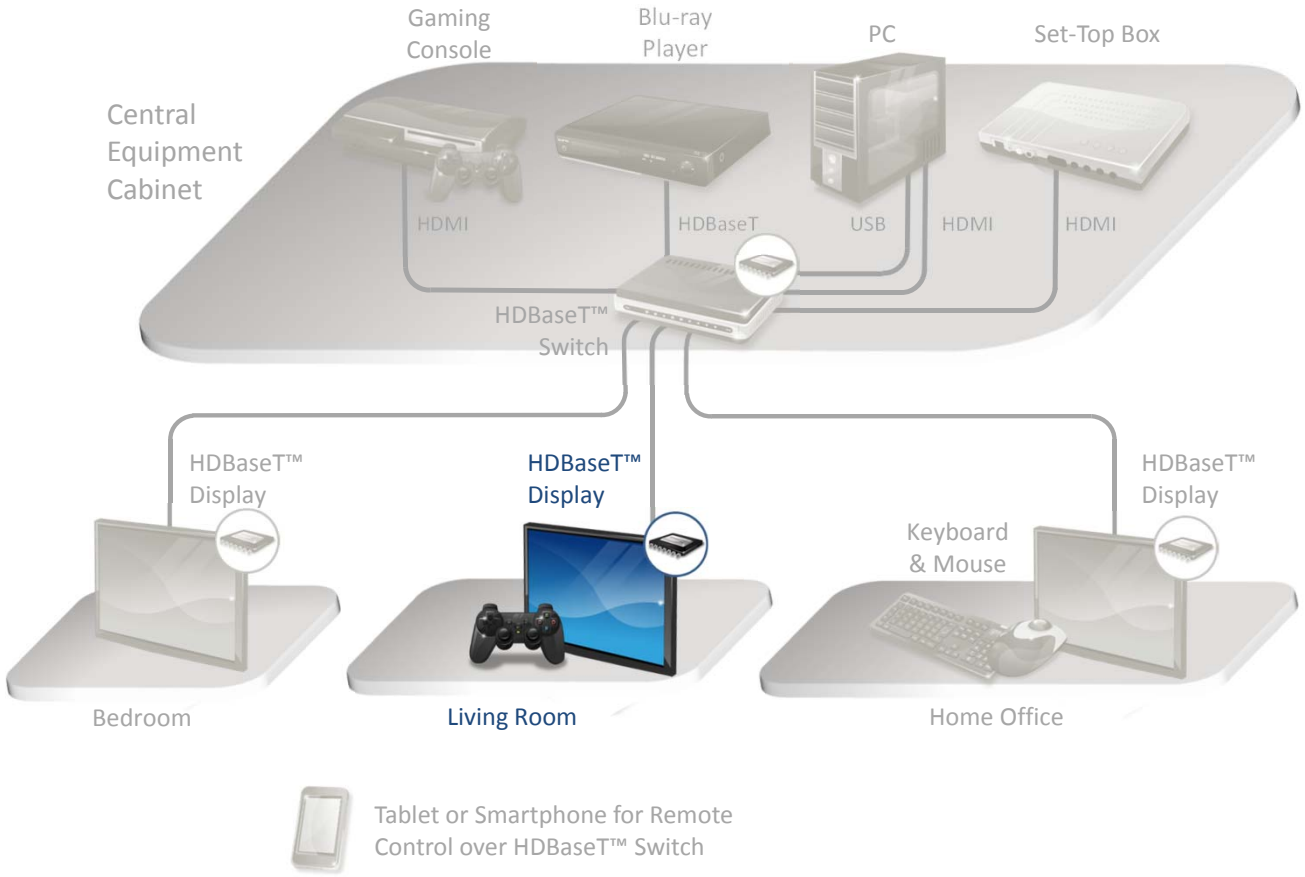


You’re in Control

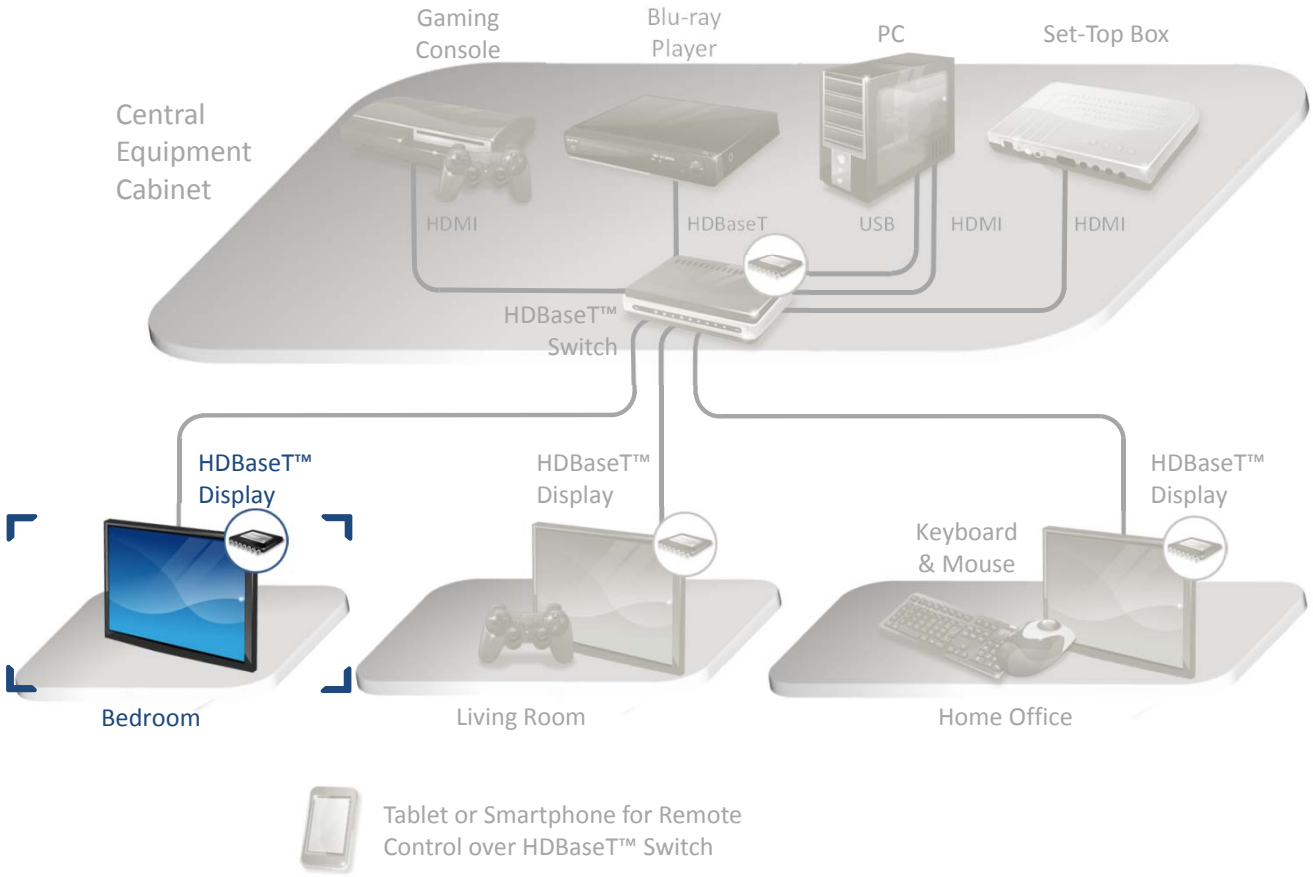
Select Blu-Ray


power
Watch Movie
Watch T
Watch Cab
help

Whole Home Networking Application

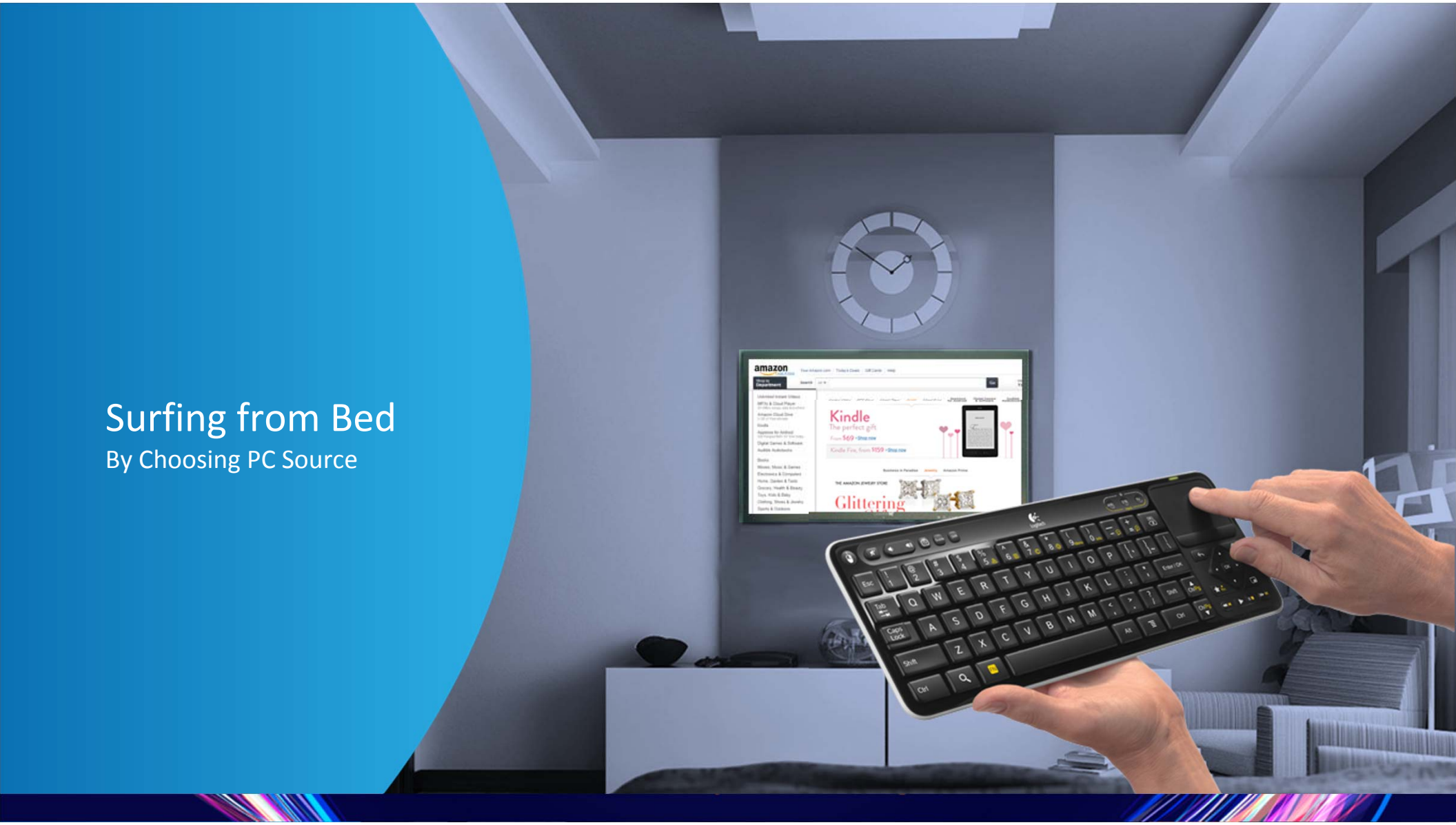


Whole Home Networking Application

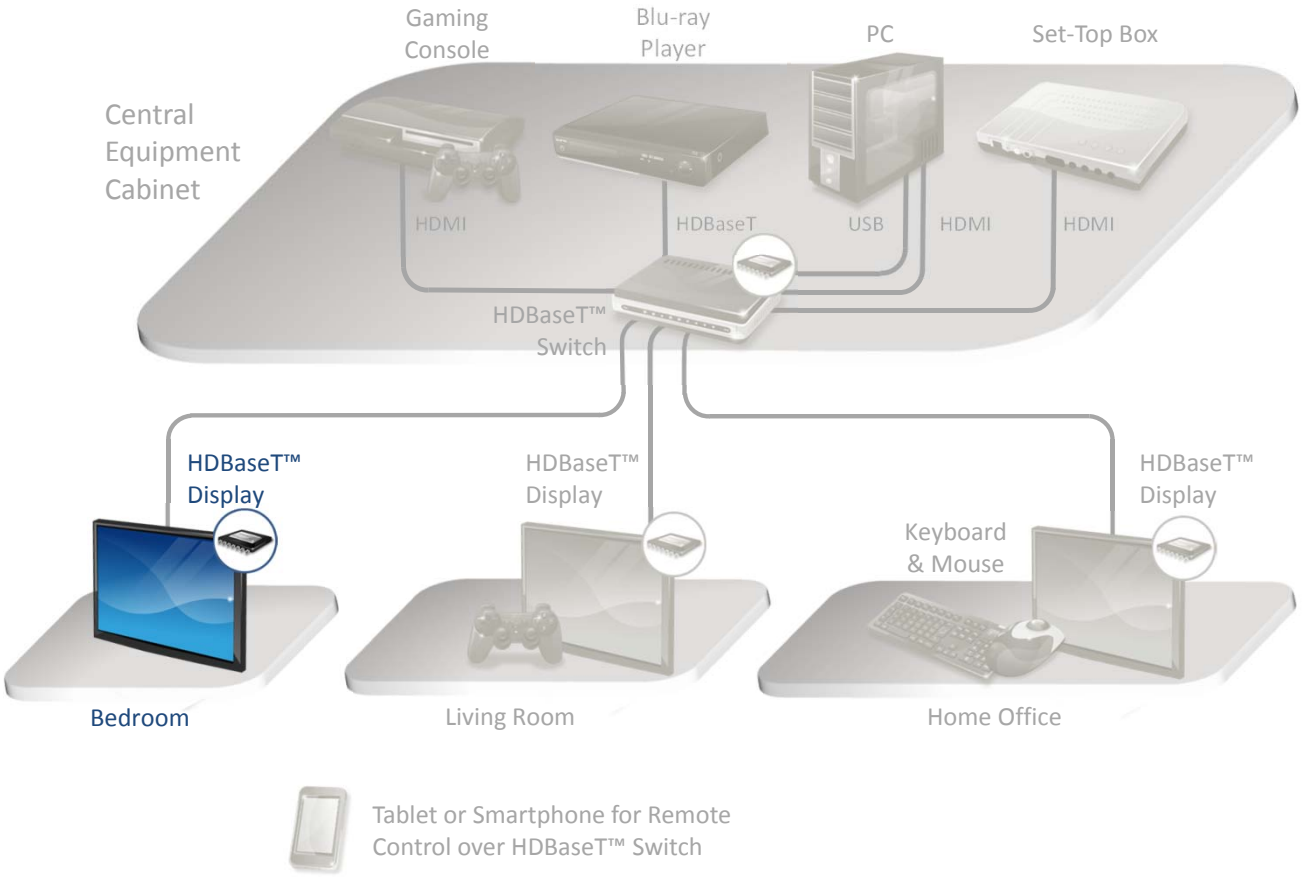


Surfing from Bed

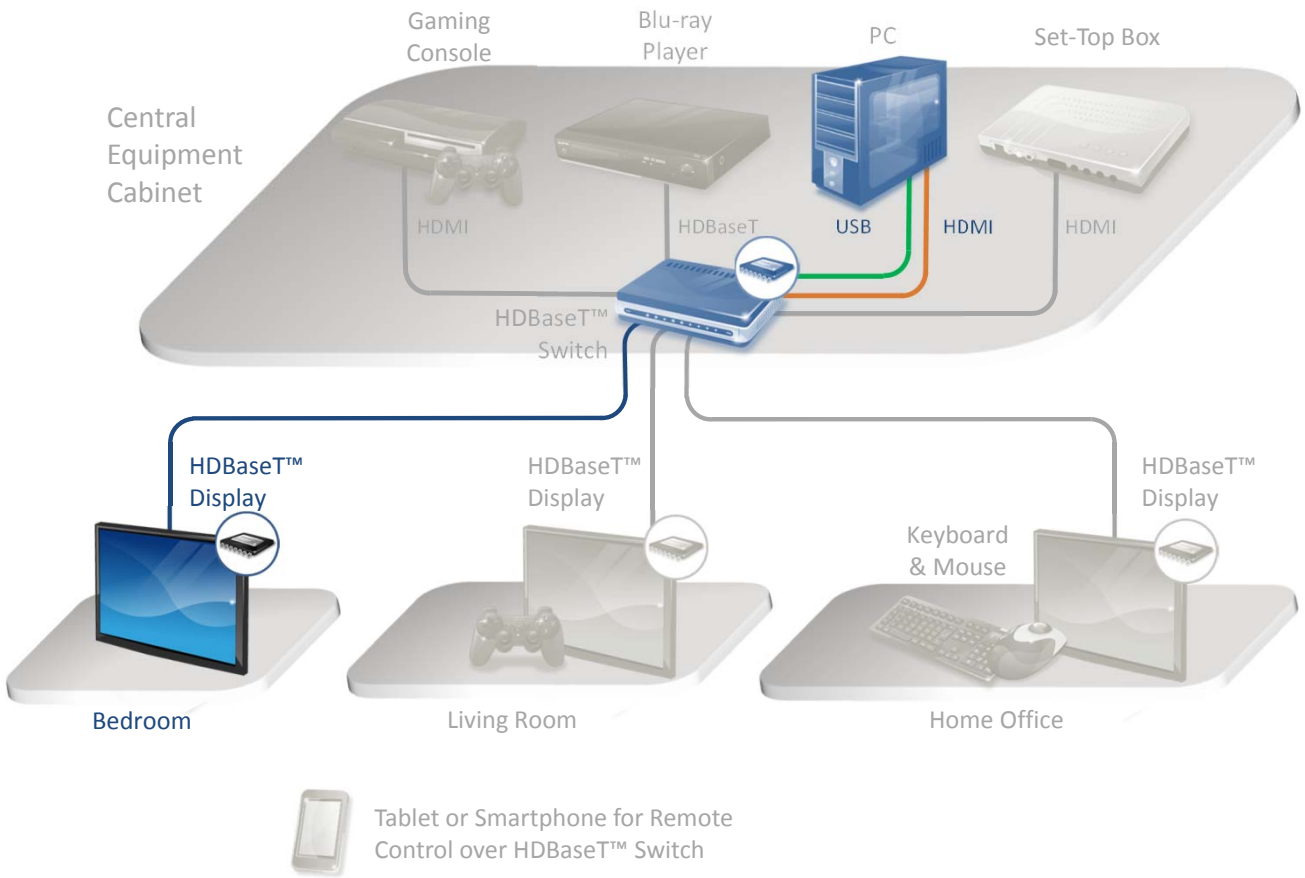
By Choosing PC Source



Whole Home Networking Application

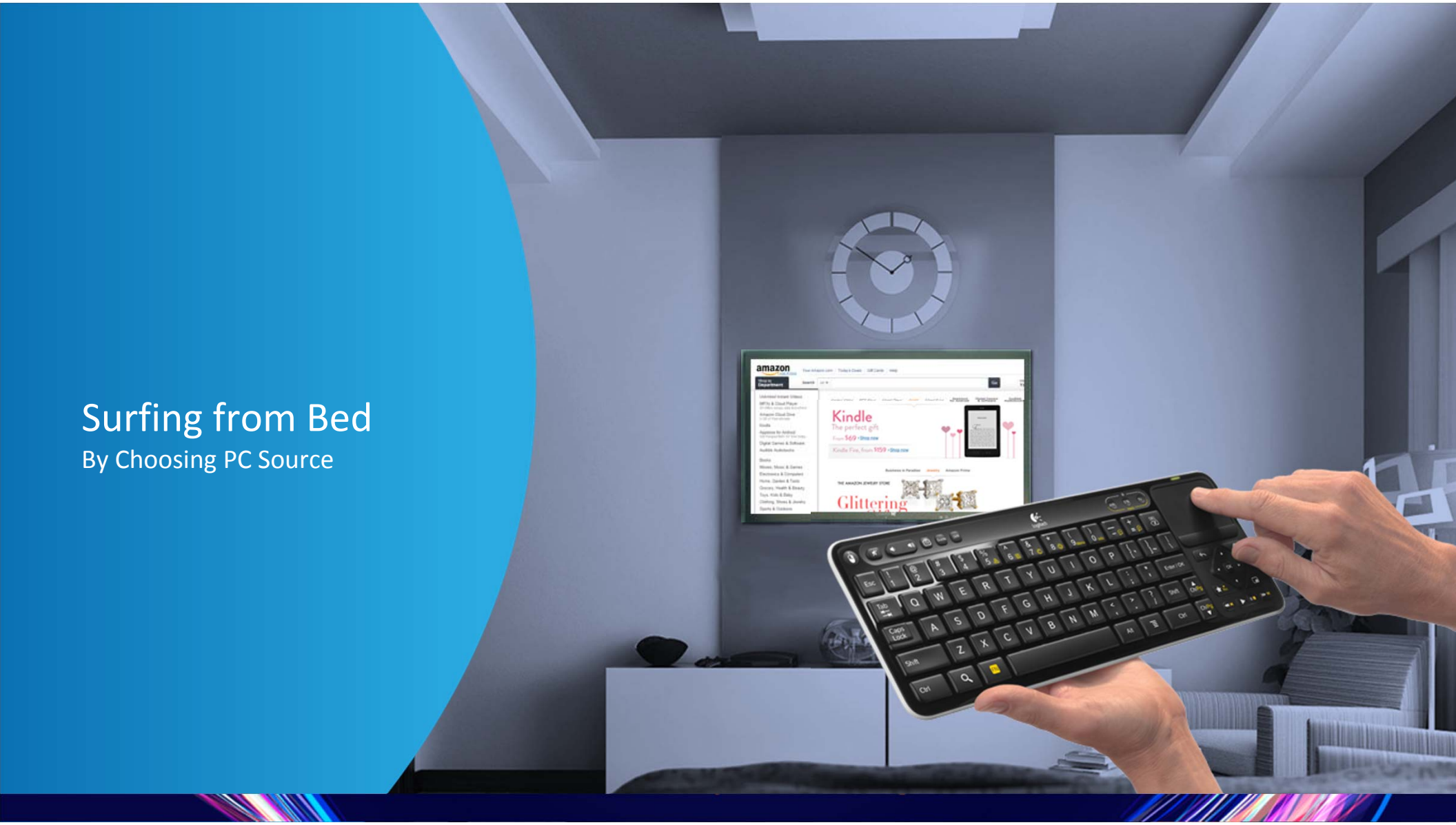


Whole Home Networking Application



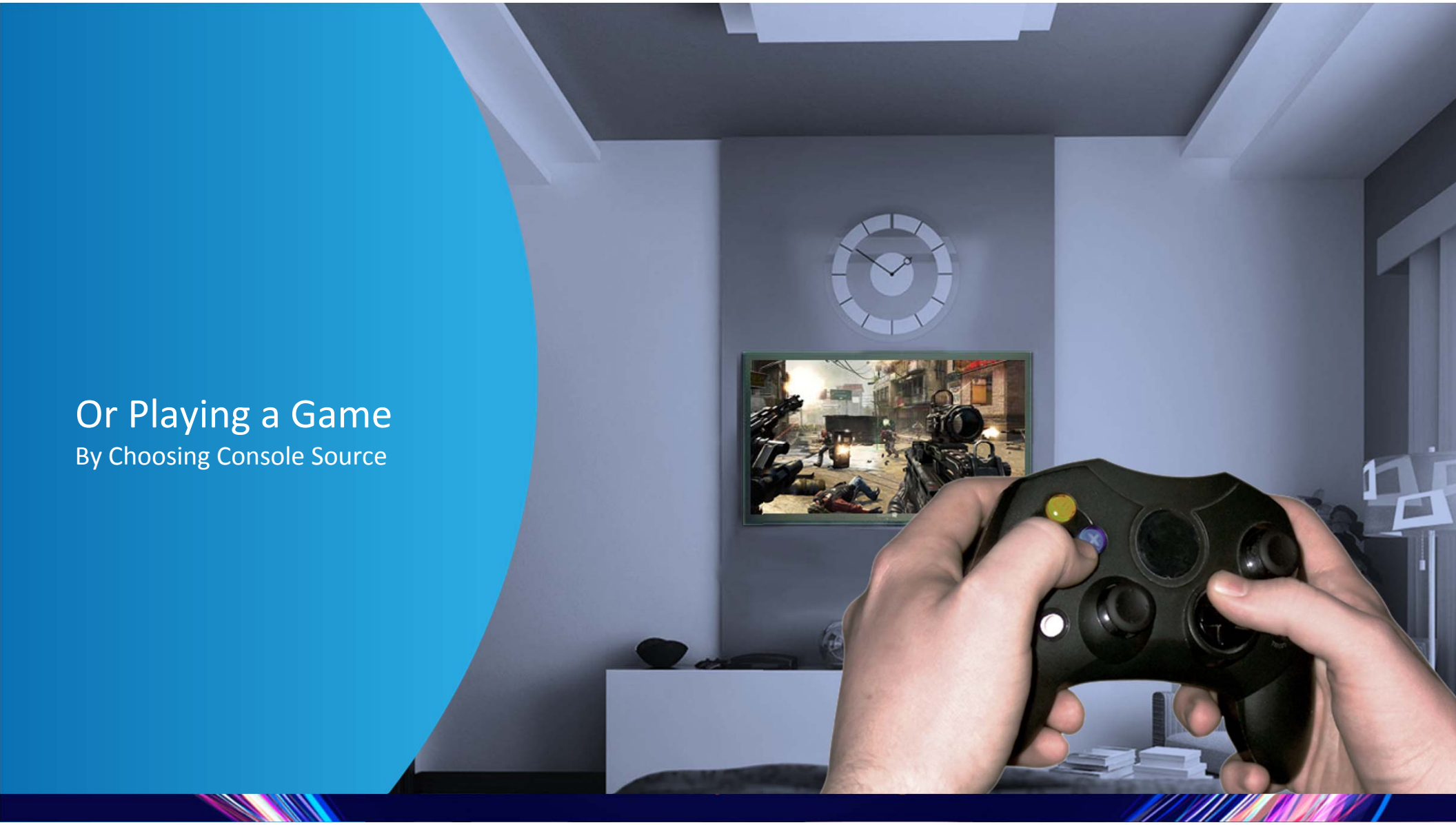
Surfing from Bed

By Choosing PC Source

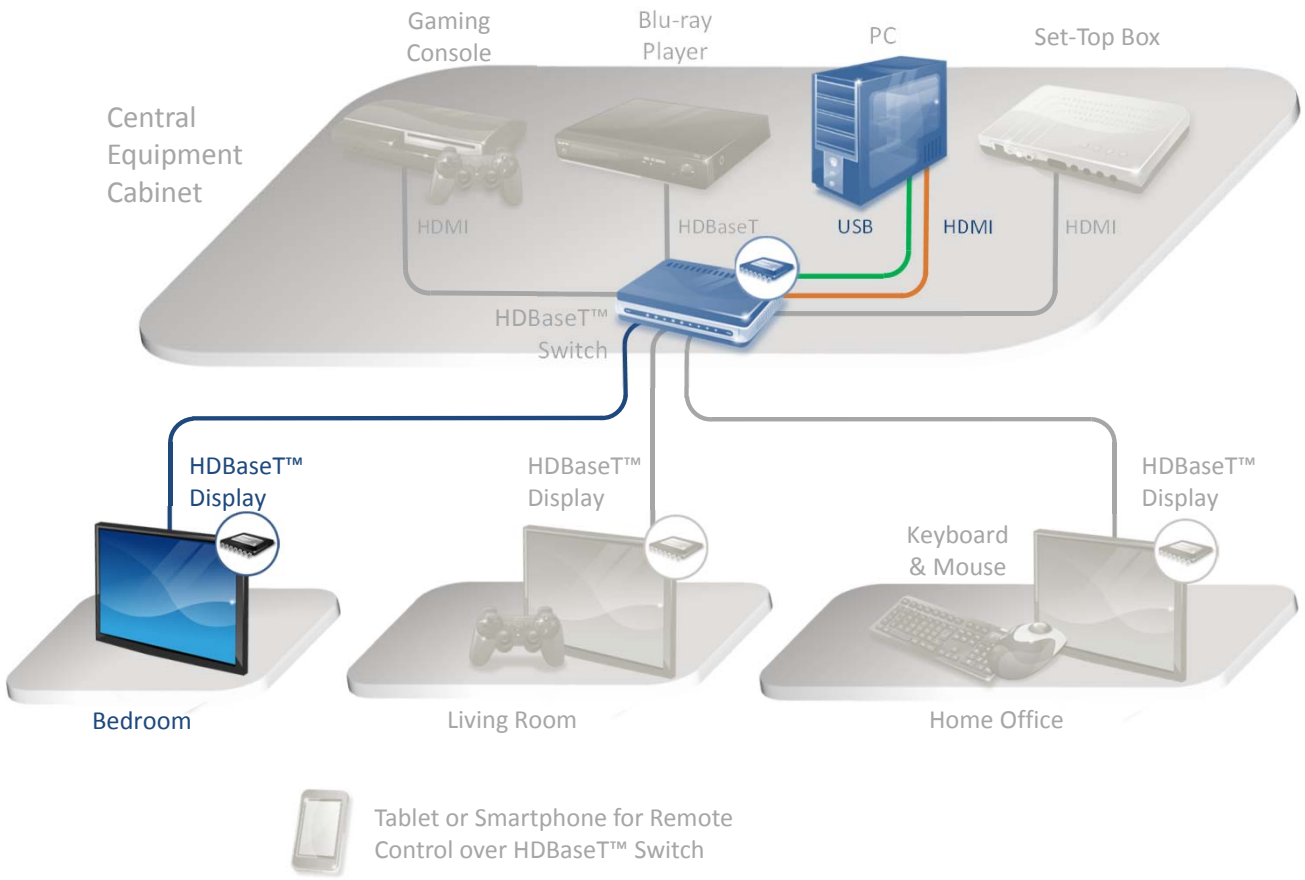


Or Playing a Game

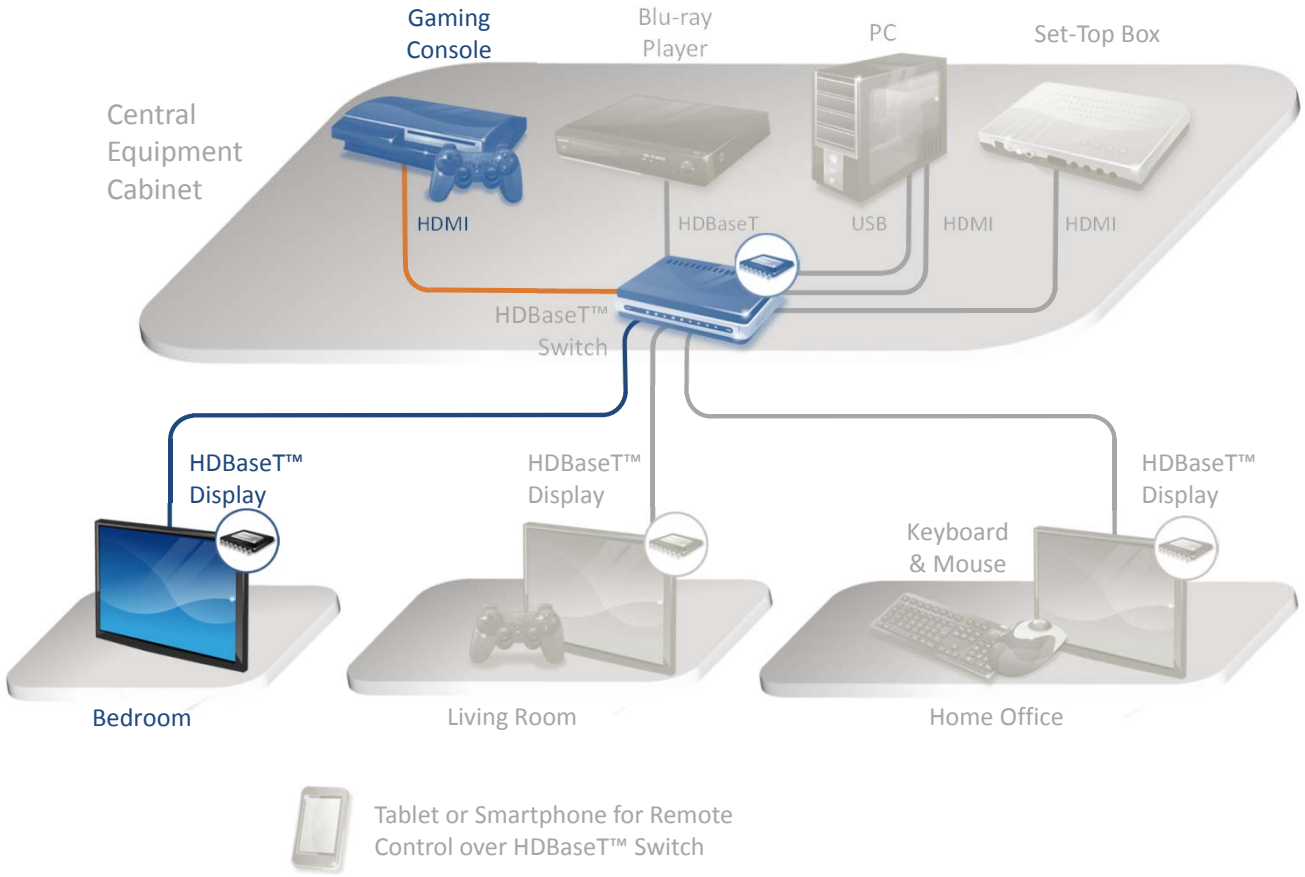
By Choosing Console Source



Whole Home Networking Application

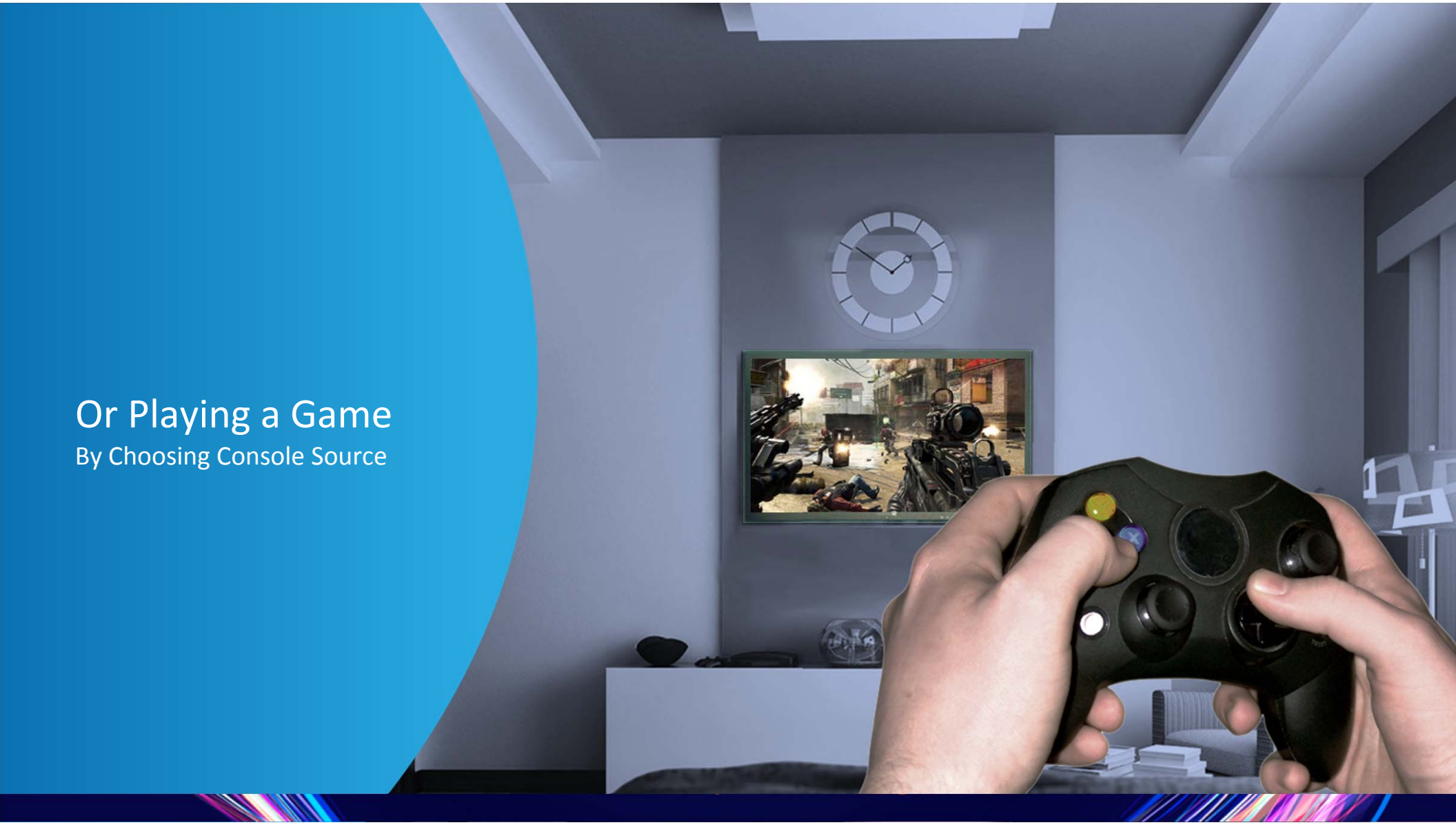


Whole Home Networking Application

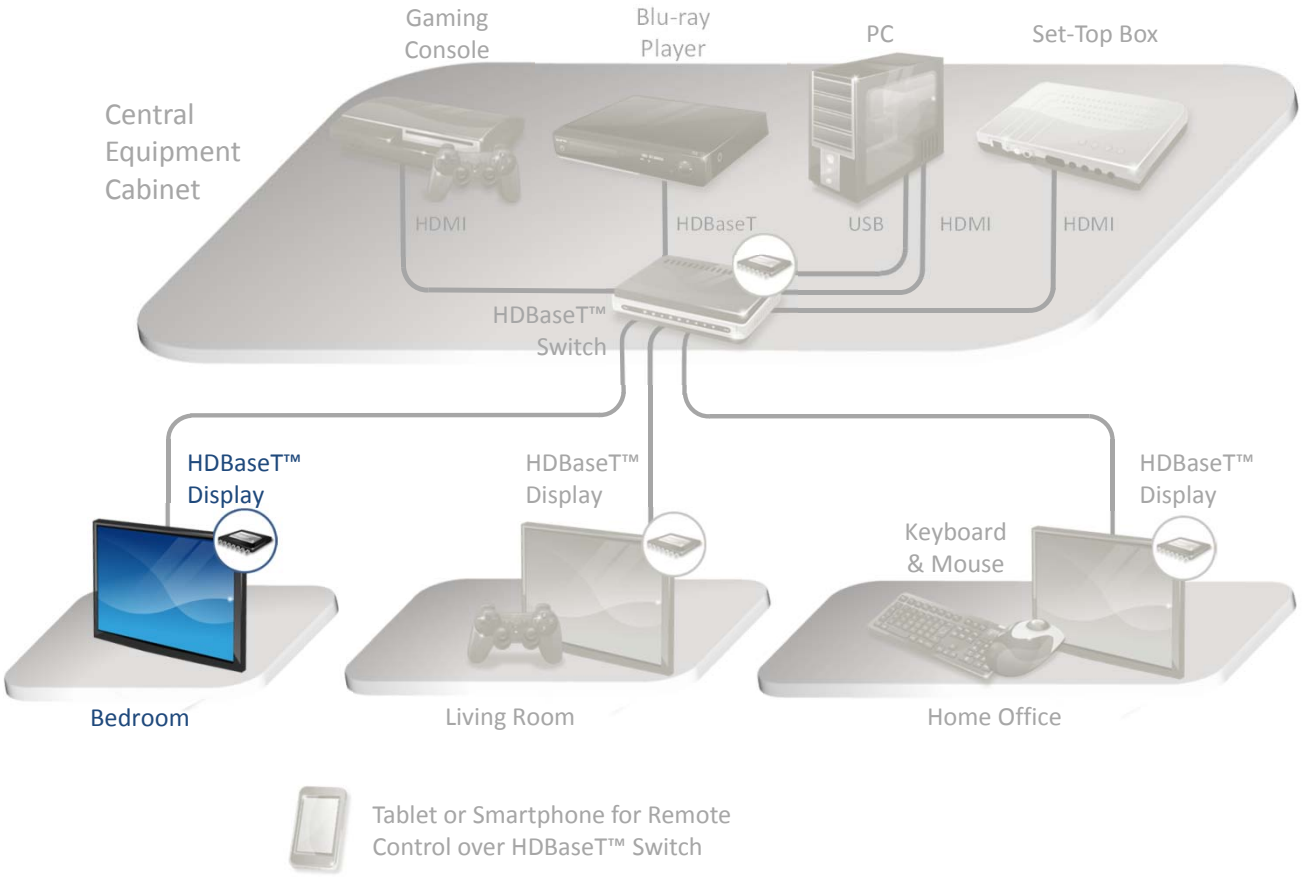


Or Playing a Game

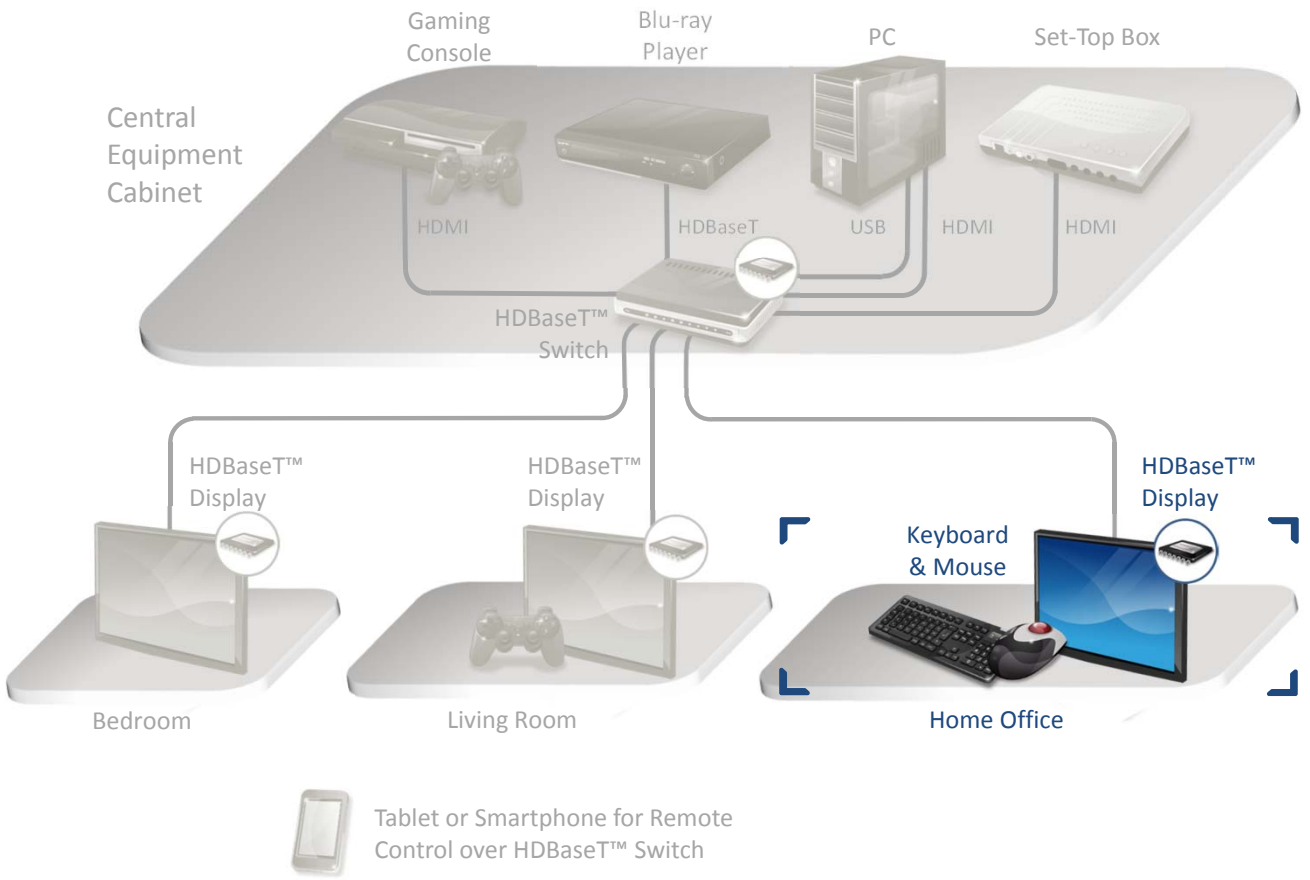
By Choosing Console Source



Whole Home Networking Application



Whole Home Networking Application



Work on Your PC

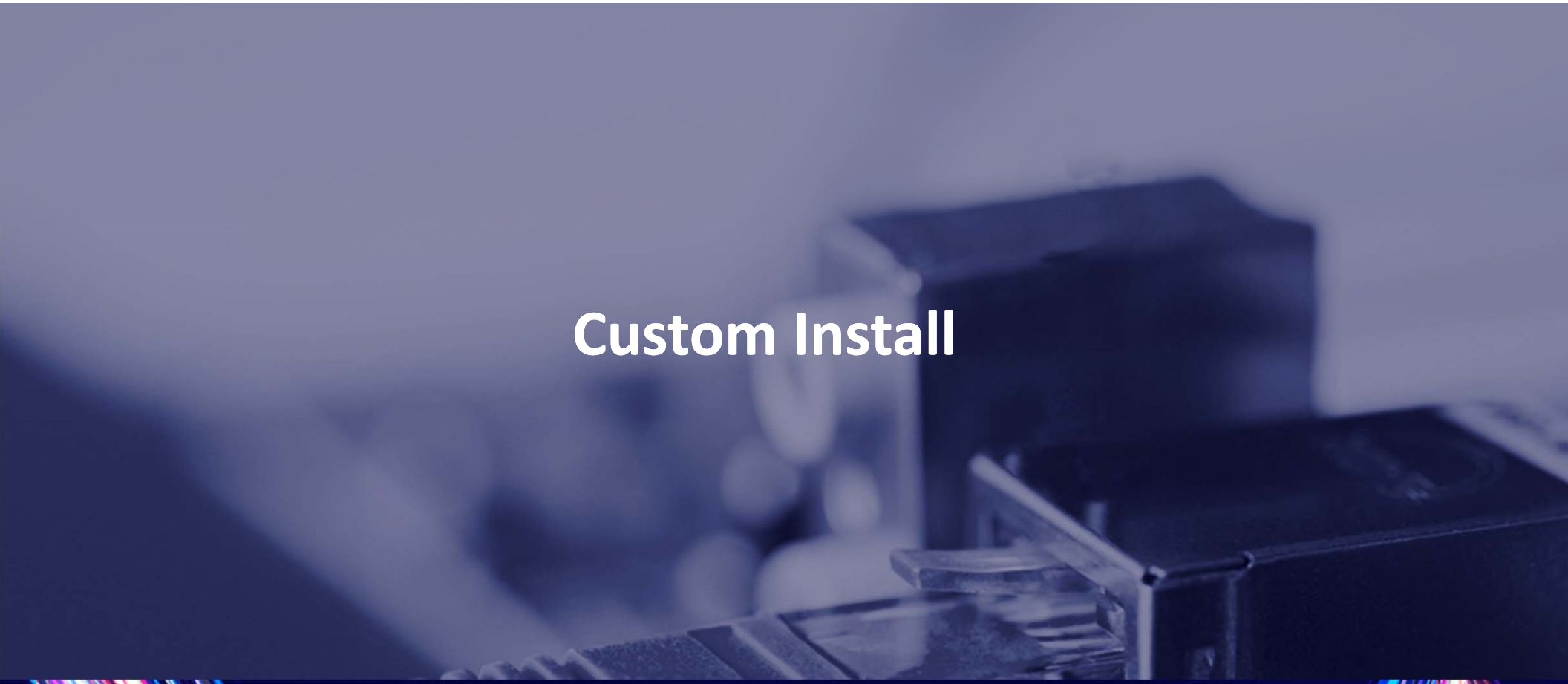
By Choosing PC Source

Or Monitor CCTV

By Choosing CCTV Source

HDBaseT™ Home Network Benefits

Total Control	Connect any Video or Data source to any display Control sources using tablet or smartphone app
Elegance	True single cable solution eliminating cable clutter
Distance	Connect display devices up to 100m away from the switch
Simplicity	Plug and Play Rely on existing Cat5e/6/7 Cabling infrastructure
Quality	Support all resolutions up to 4K UltraHD / 3D video



Custom Install

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All Professional Needs On a Single Cable

- Unmatched solution for professional integrators
- Eliminates current transmission distance limitations
- Simple, reliable and low-cost installation without compromising on quality
- Popular applications: AV switching matrix adaptors

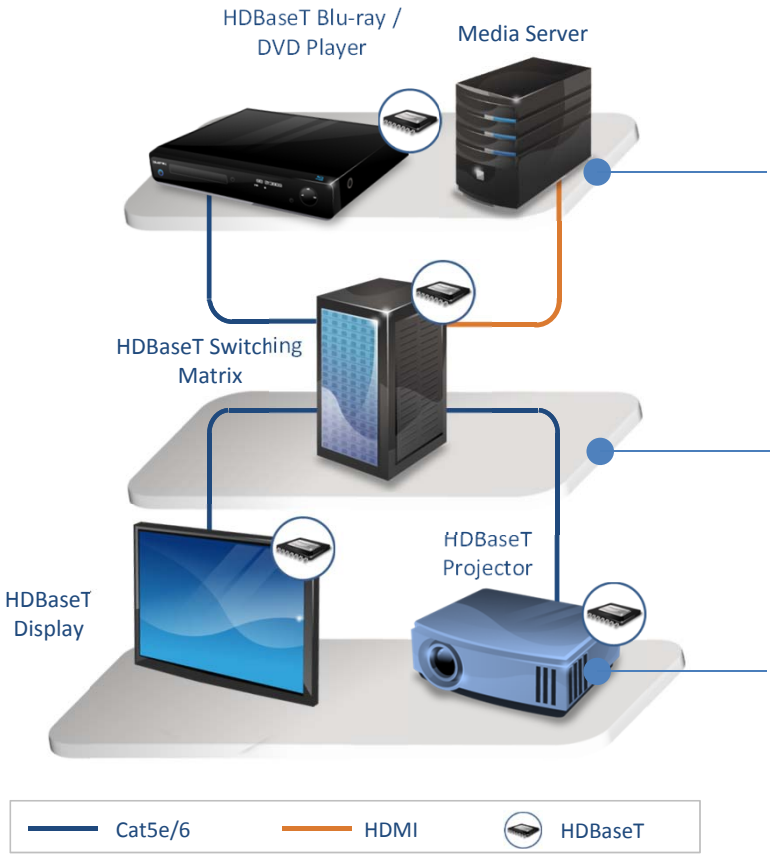
Popular Pro-AV HDBaseT Applications

Switching Matrix

HDBaseT Adaptor

Up to **100m** (Single Hop) of **Point-to-Point/Multi-Point** HD Connectivity

HDBaseT Switching Matrix

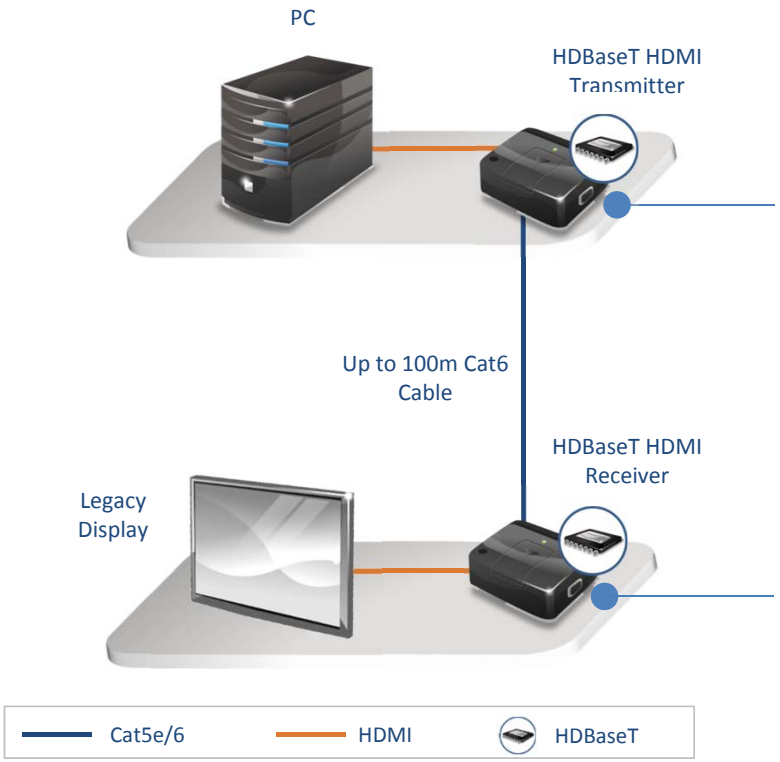


HD sources are placed in a central location. **Legacy cabling** can be used

HDBaseT switching matrix **terminates sources** and **delivers 5Play feature set** to remote devices

HD Devices can be placed up to **~1Km** (8 hops) from Switching Matrix

HDBaseT Adaptor



HDBaseT transmitter is used to deliver legacy input up to **100m away**

Bidirectional **RS232** and **USB** supported

HDBaseT receiver terminates cable and connects to remote displays

Corporate Enterprise

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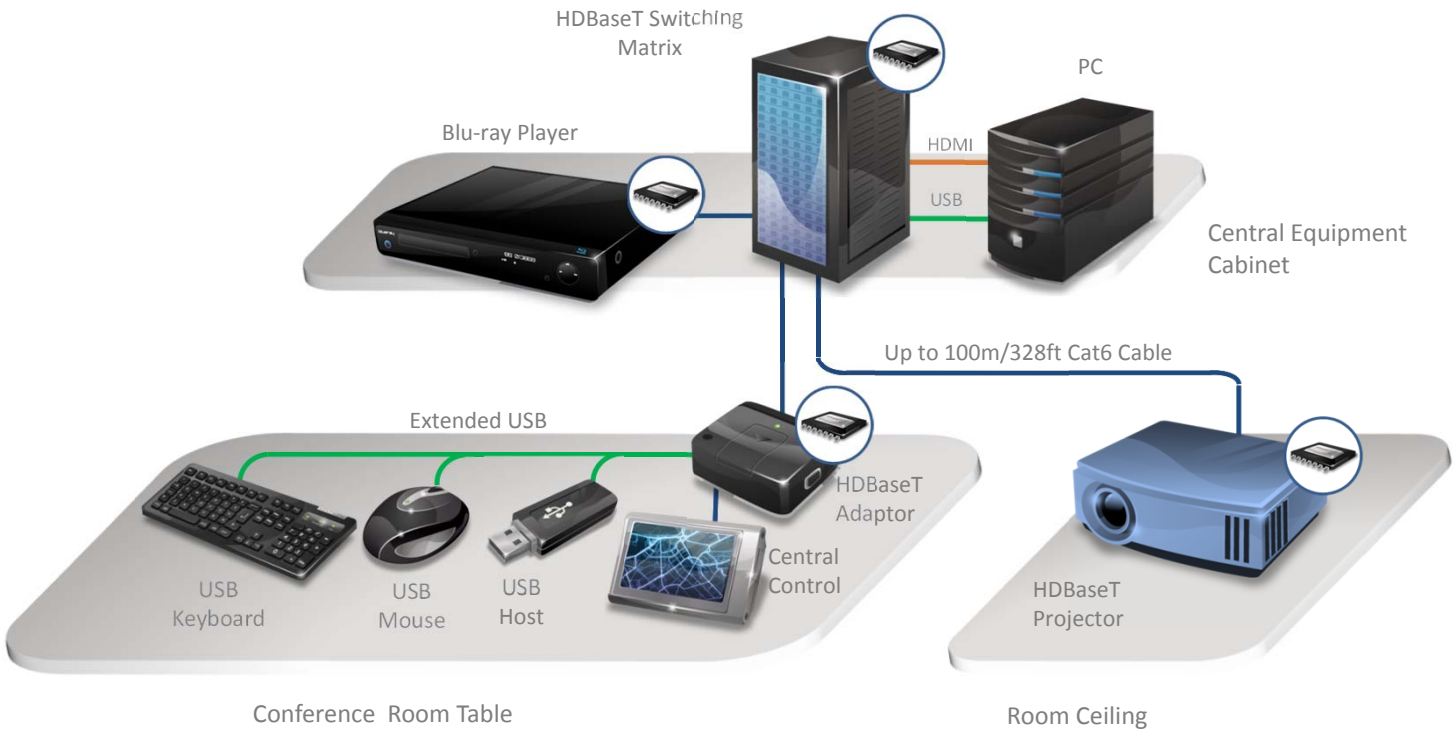
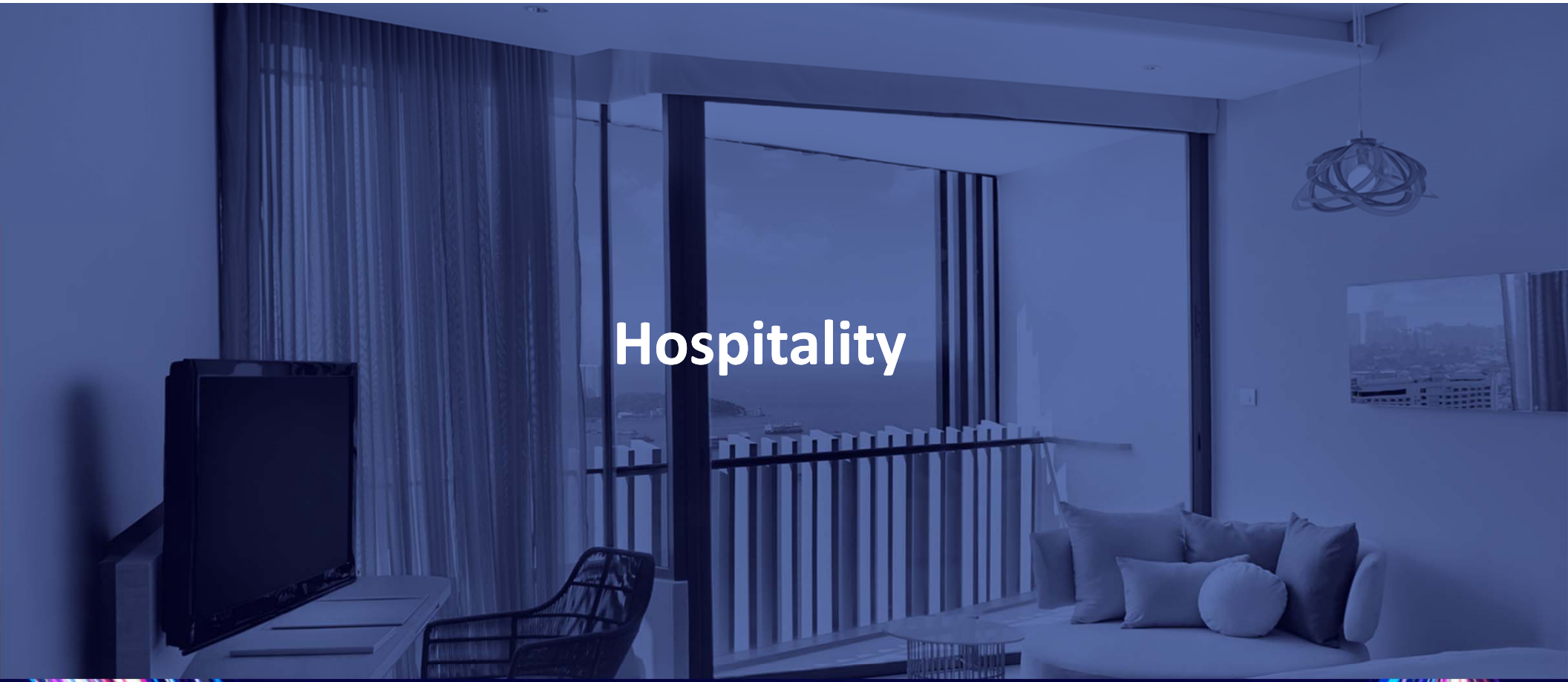
Corporate Enterprise Application



HDBaseT Switching Matrix Facilitates Full Multimedia Capabilities



Hospitality

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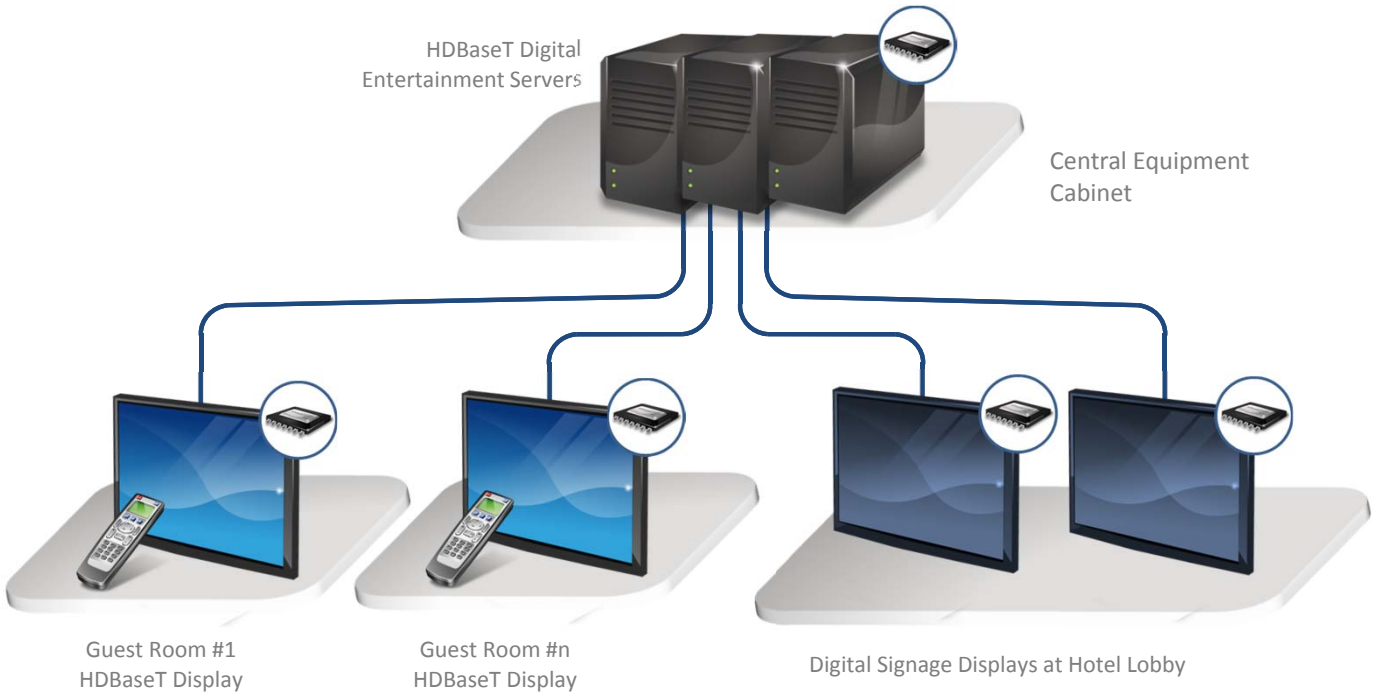
Hospitality Application



HDBaseT Facilitates In-Room Entertainment System & Signage

Projectors

In Projection,

Distance

is Always a Challenge

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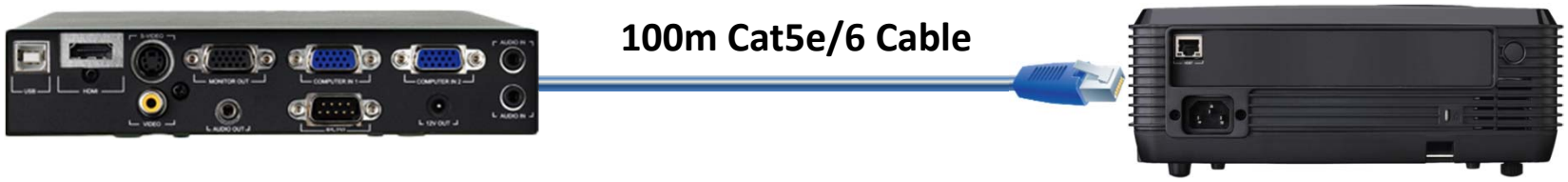
HDBaseT Projector

HDBaseT Projector

2-Box Projector

Elegance and **Practicality**



PC KVM Extension

Industrial PCs
Internet Cafés

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HDBaseT Industrial

The Ultimate Cable that Carries All Your Industrial Computing

- Video, USB, Control and Power over standard Cat6 cable
- Powers up remote displays
- Up to 100m IPC-to-monitor
- Plug-and-play installation

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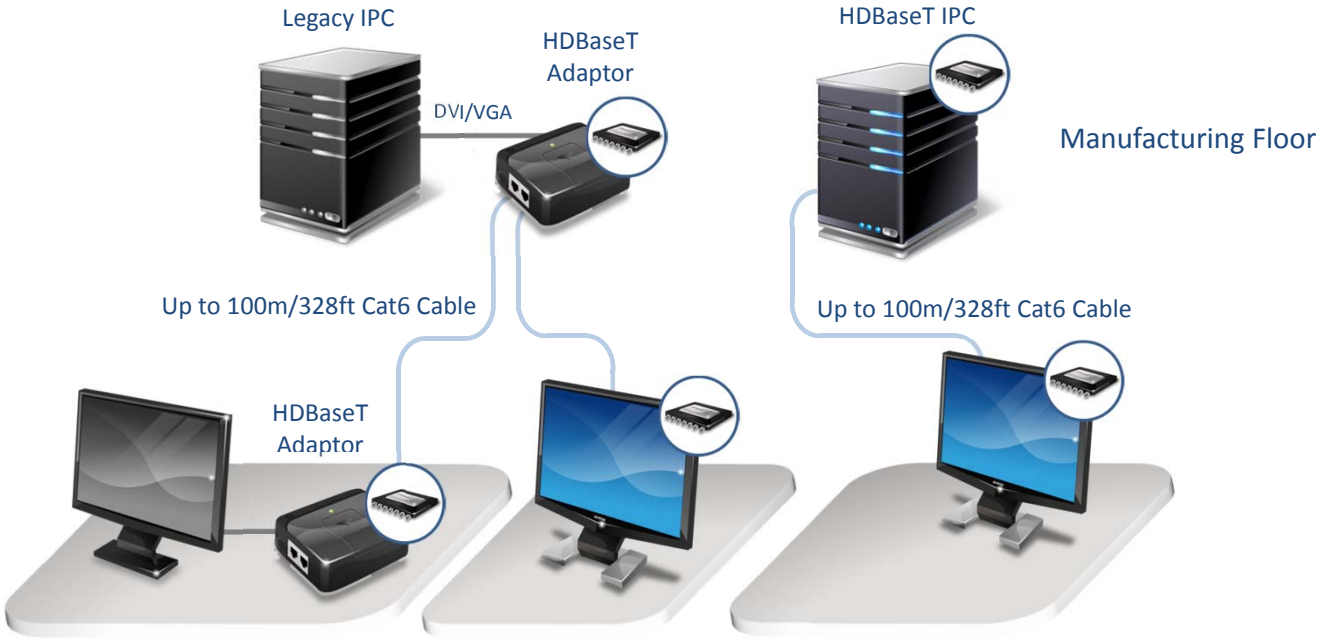
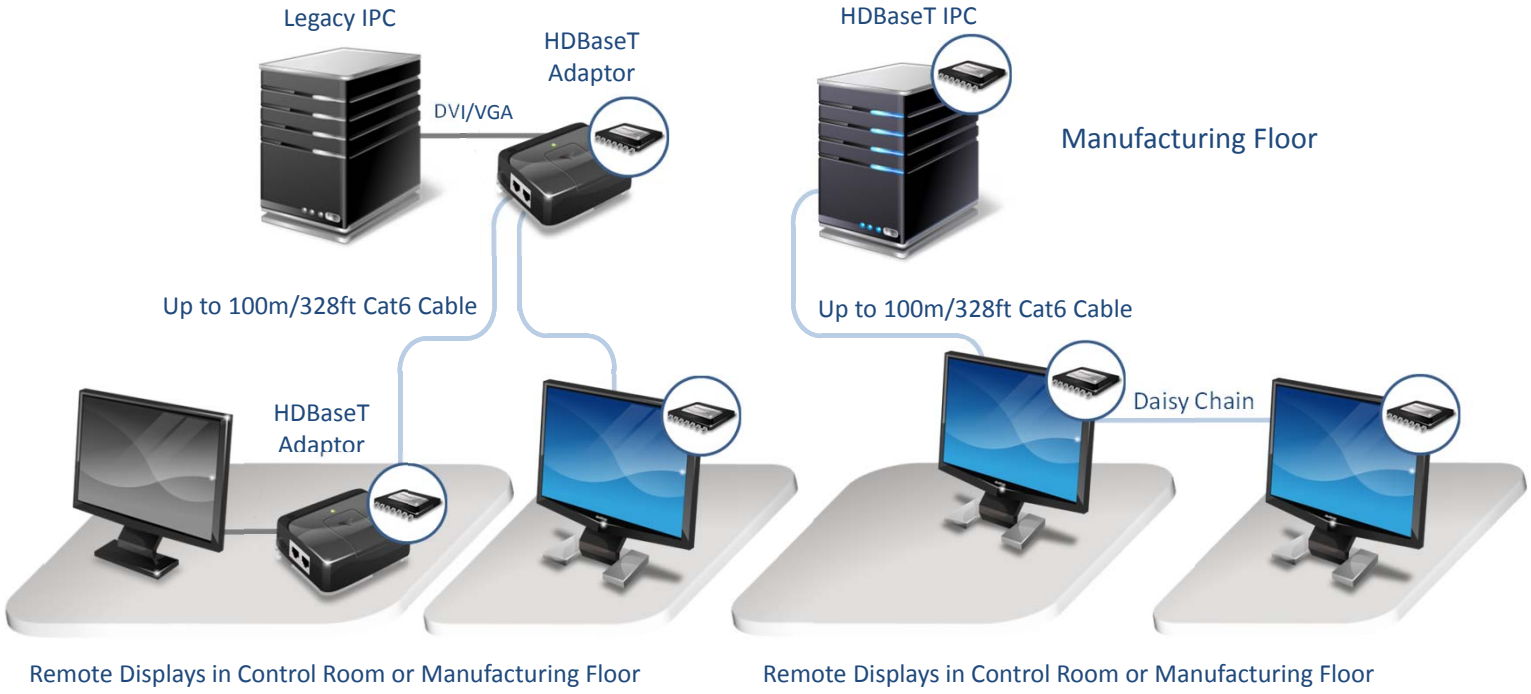
HDBaseT IPC Installation



Native HDBaseT Deployments

HDBaseT IPC Installation



Daisy-Chain Support for IPC to Multi-Display Implementation

HDBaseT IPC Installation

Bi-directional USB channel for keyboard, mouse, touchscreen, USB drive and more

Internet Café

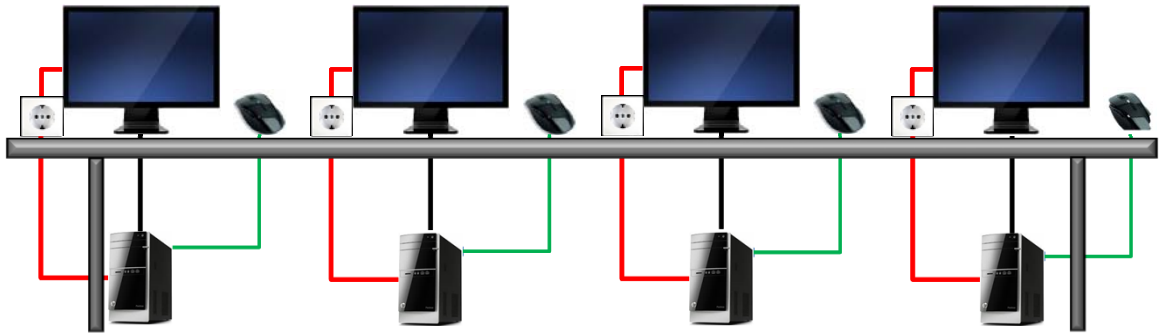
India

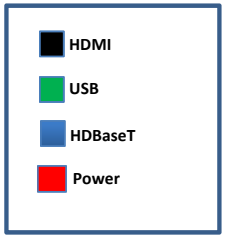
China

Korea

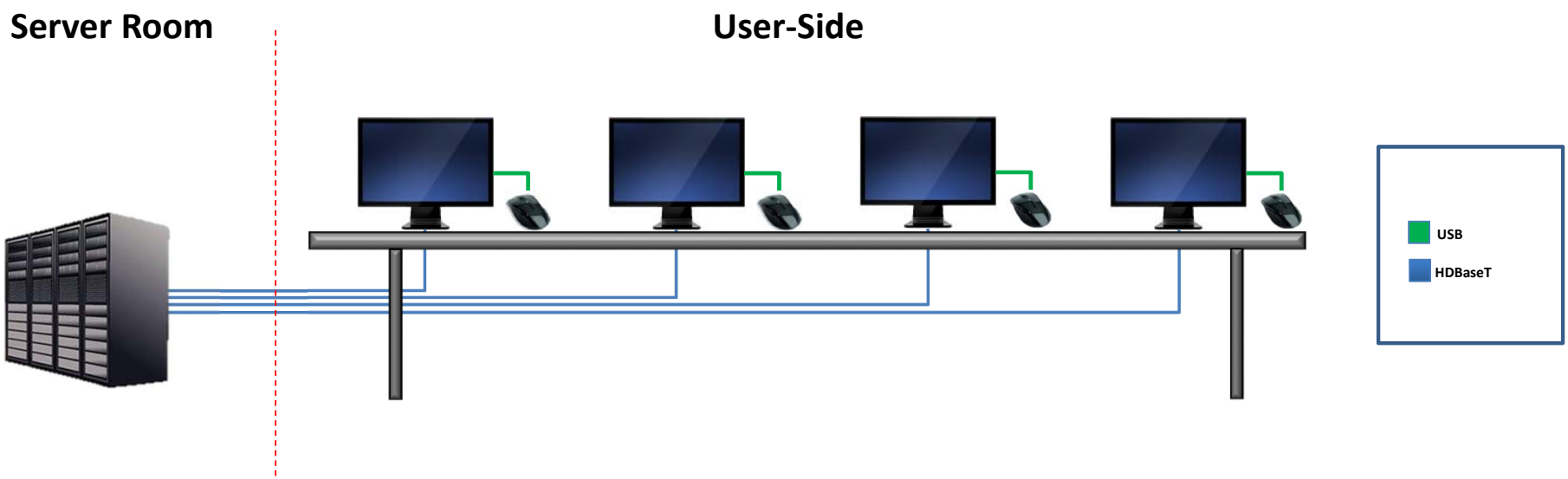
Japan

Standard Internet Café



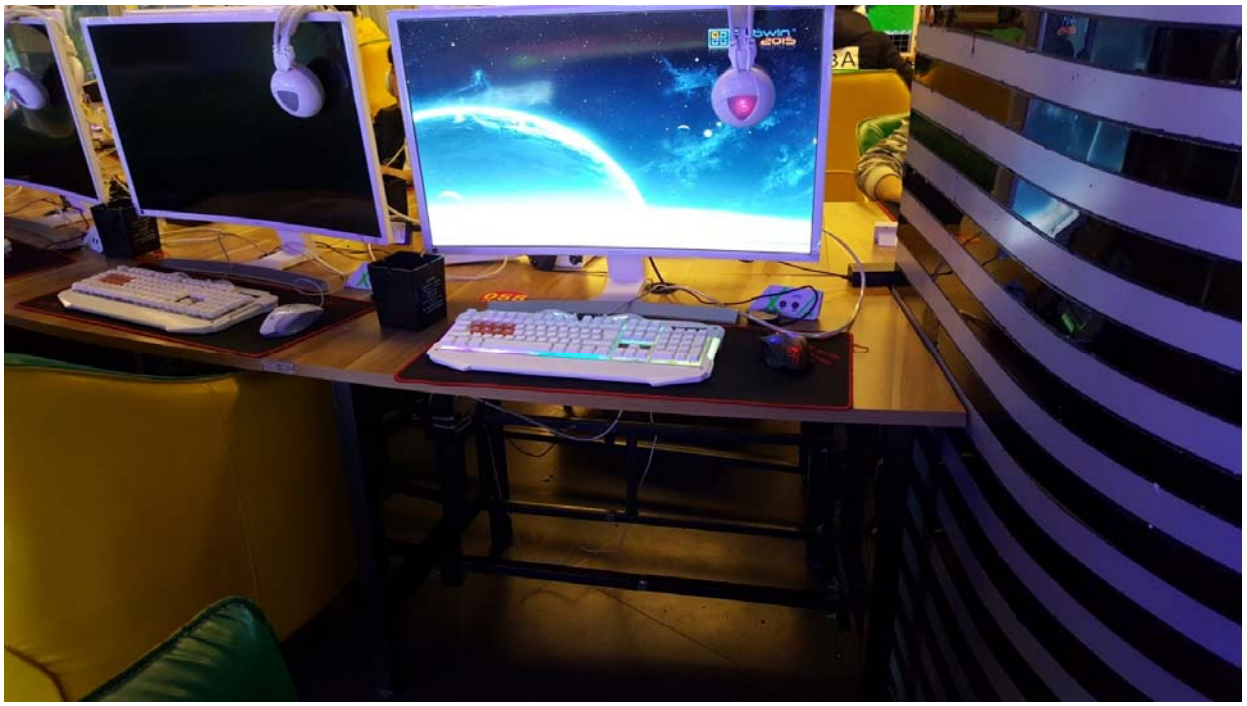


HDBaseT Internet Café



HDBaseT Internet Café – Server Rooms

HDBaseT Internet Café – “Zero-Client”




Digital Signage
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HDBaseT – Digital Signage Made Simple

- Supports daisy-chaining and multi-streaming
- Simple, low-cost and standard implementation
- 4K ultra-high-definition video
- Popular applications: HDBaseT digital signage displays, AV switching matrix, adaptors

HDBaseT Building Blocks for Digital Signage

HDBaseT Server

HDBaseT Digital Signage Display

HDBaseT Adaptor

Up to **100m** (single hop) of **point-to-point/multi-point** ultra-HD connectivity

HDBaseT Daisy Chaining

HDBaseT supports

Daisy-chain architecture

Perfectly suits

digital signage installations

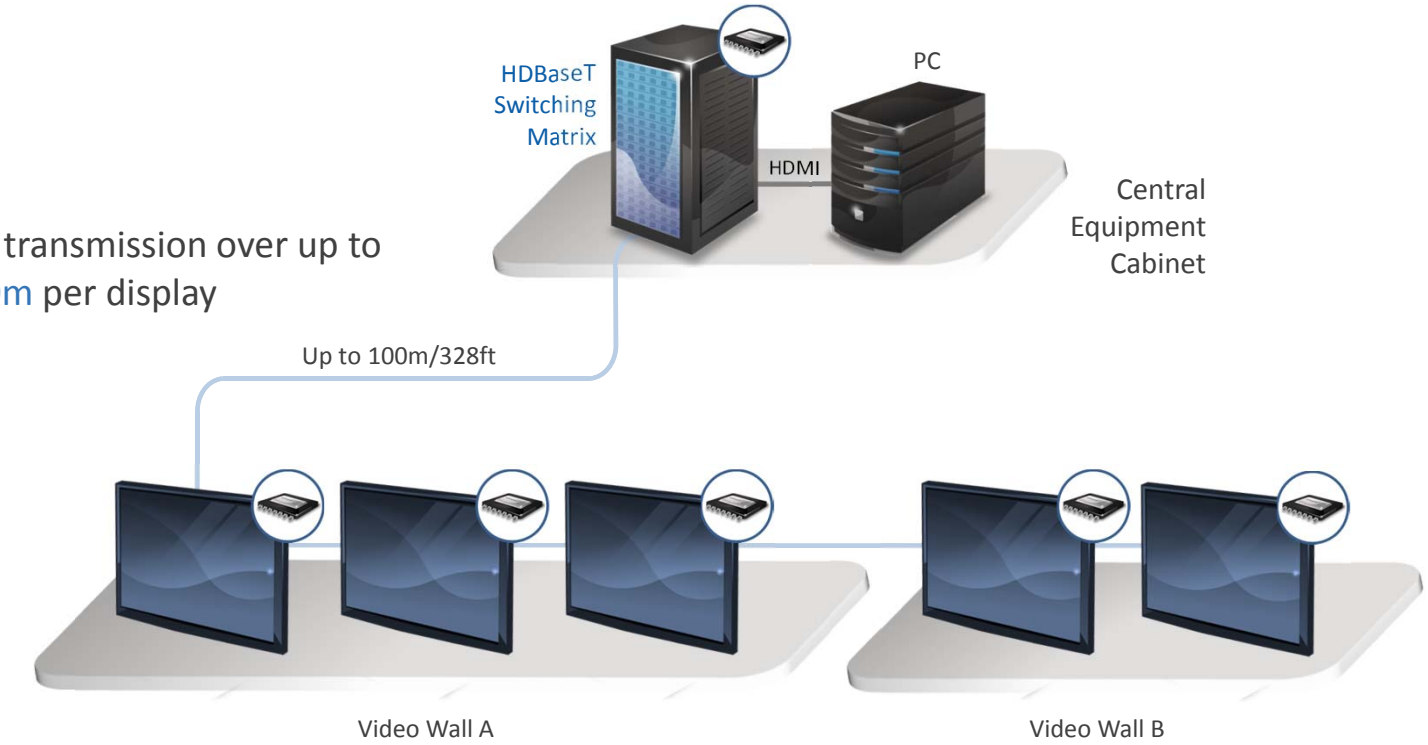
Video Wall Application

2018 BICSI WINTER CONFERENCE & EXHIBITION

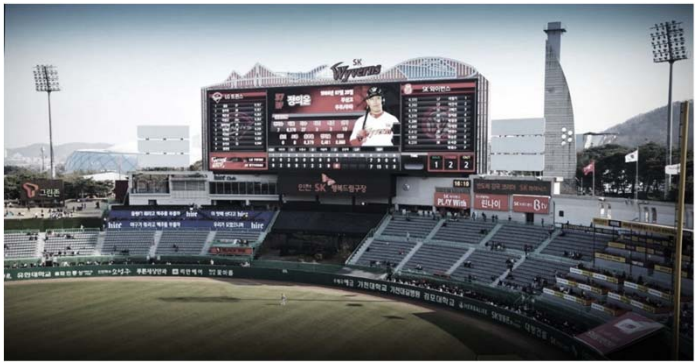
Orlando, FL | February 4-8

Point to Multi-Point HDBaseT

Simultaneous transmission over up to 100m per display



HDBaseT Video Wall Installations




We live in an
HDBaseT world
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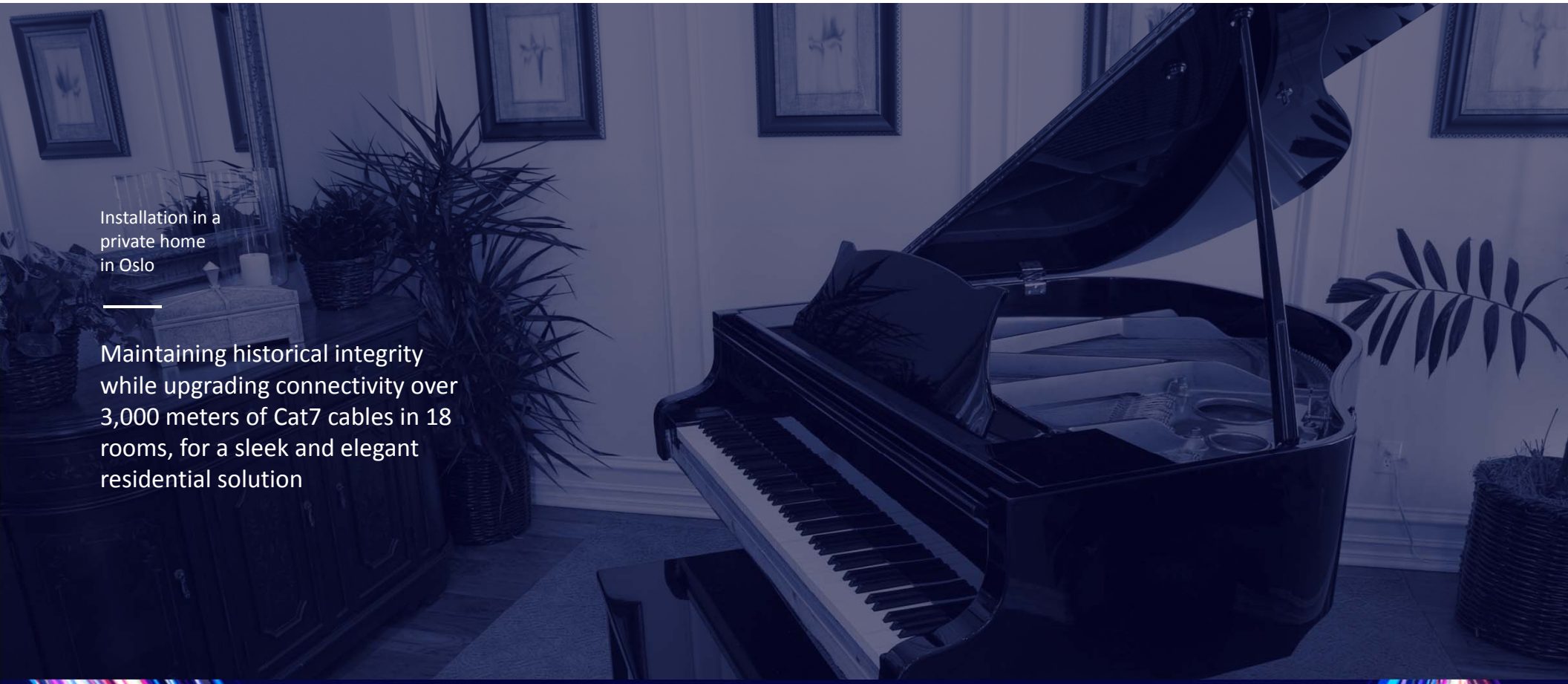

Installation in a private home in Oslo

Maintaining historical integrity while upgrading connectivity over 3,000 meters of Cat7 cables in 18 rooms, for a sleek and elegant residential solution

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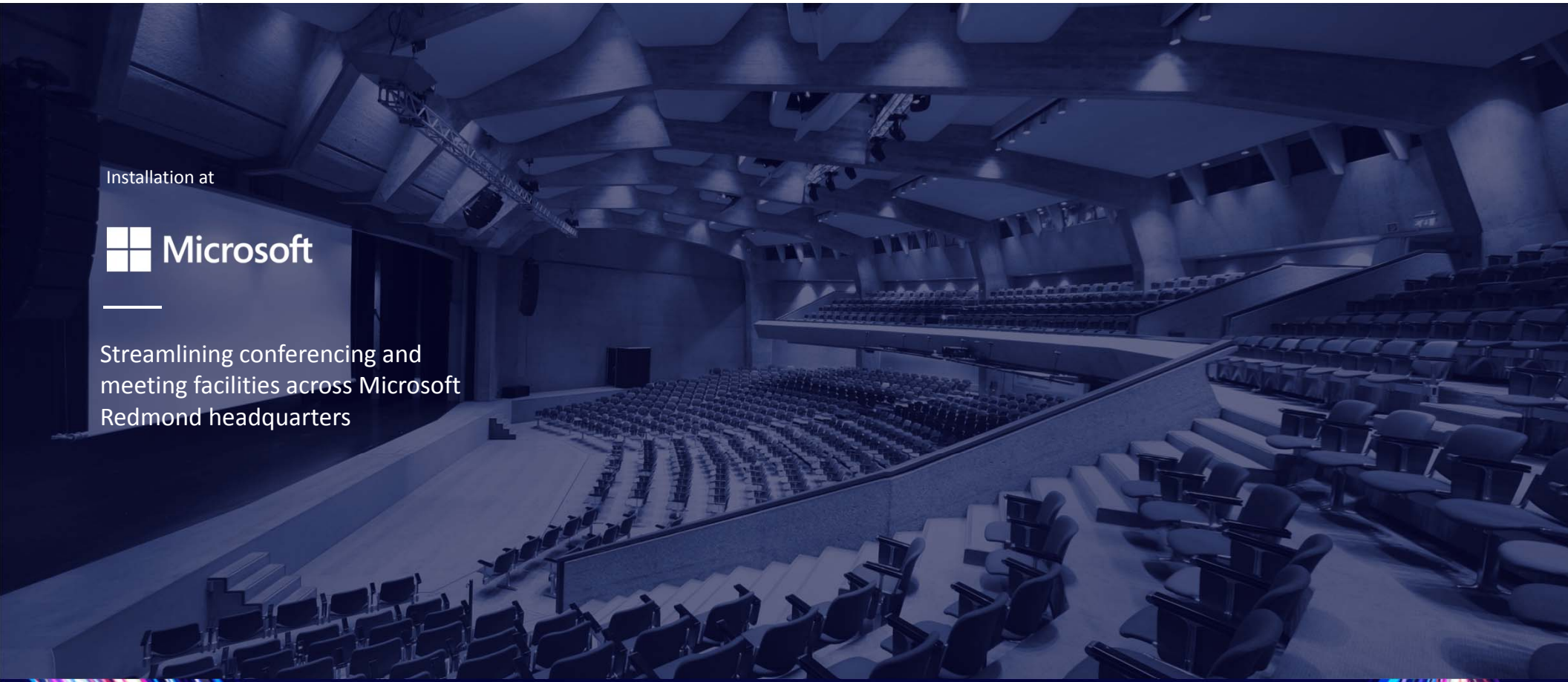

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Installation at
QUT
Queensland University of Technology
Brisbane Australia
Educating the next-generation through an interactive, 48-multi-touch video wall across two floors, connected over 8km of Cat6 cables
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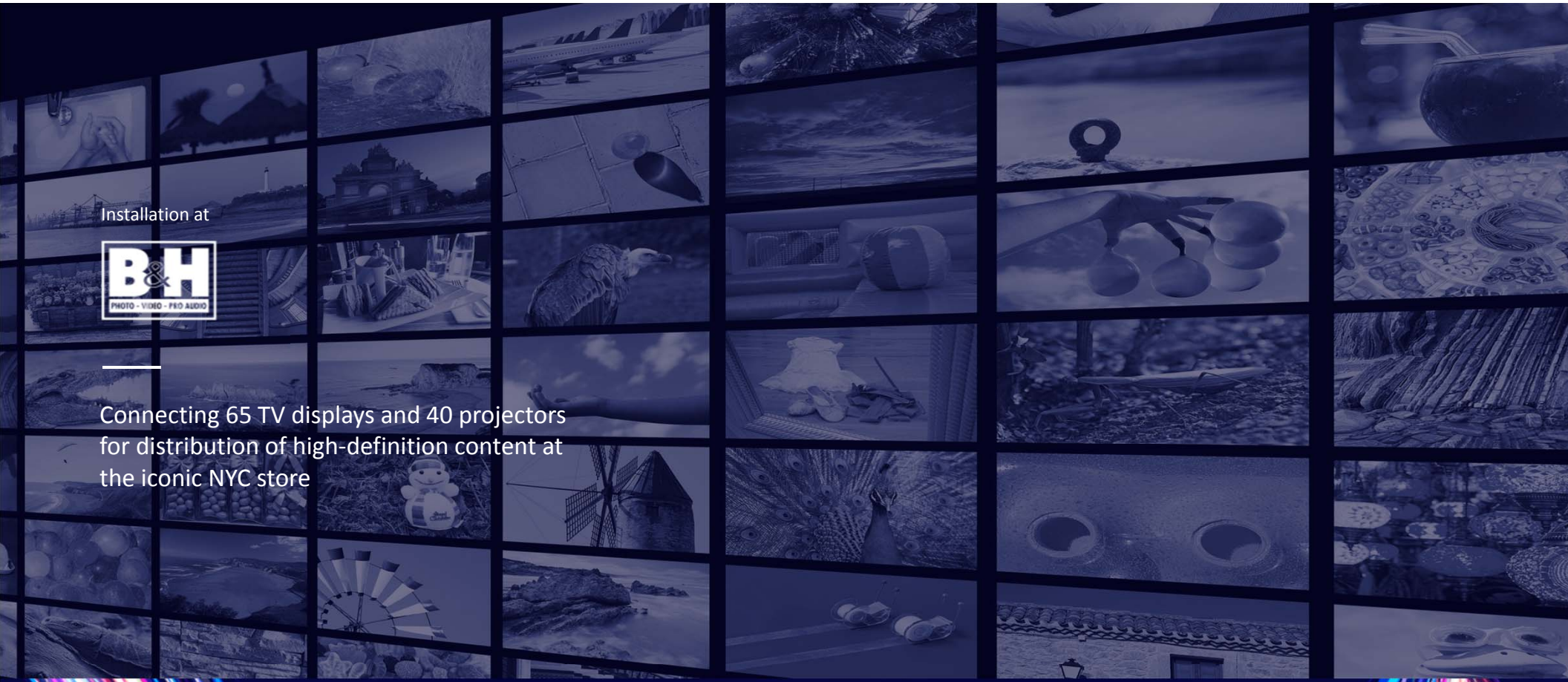

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Real Life Installations - BMW Showroom (USA)

The Solution

- HDBaseT switching matrix was used to transmit video to the screens over existing CAT5e cables (from original installation/infrastructure) and newly installed CAT6a cables.
- Daisy-chain over HDBaseT was used – it was the only way to cover the large building under the design limitation.
- HDBaseT was the only solution that was able to cope with the high electric emissions caused by challenging environment (all other technologies were tested and failed).

Real Life Installations - Empire Cinema Complex in London

- Empire Cinemas are operating 17 modern multiplex cinemas throughout the U.K.
- Replacing all 35mm projectors with digital projectors, which provide a much sharper picture and supports 7.1 surround sound.
- Using HDBaseT-enabled Wyrestorm extender sets to future-proof the new equipment. The extenders are capable of transmitting full 4k resolution, 48bit color HD video and high quality HD audio with bidirectional control of source and display from either location to multiple screens throughout theatres distances up to 100m/328ft

"I chose Wyrestorm HDBaseT equipment due to the speed and ease of installation we enjoy, combined with an excellent compatibility with our audio and projection equipment"

Andre Mort, Technical Director for Empire Cinemas.

Real Life Installations – Vertex Pharmaceuticals HQ (NY)

- Vertex is a large pharmaceuticals company
- Chose HDBaseT for 2x8 video wall made up of 55-inch Prime view Ultra Narrow Bezel HDBaseT displays
- The displays are daisy chained with HDBaseT

"From an installation perspective, HDBaseT just made wiring these displays that much easier, We only needed to run four category cables, one to each of the 2x2 arrays from our AV closet that's about 100 feet away. The category cable terminated at the Prime view monitor with the embedded HDBaseT receiver. The other monitors in each of the 2x2 arrays were then simply daisy-chained with DVI-D cables. The installation process was simple and we did not have to waste time troubleshooting multiple cables to find areas for potential failure."

Peter Thompson, a principal at ACT Associates.

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