AV, Data, and Power: Untangling USB-C Integration in Today's Education Spaces

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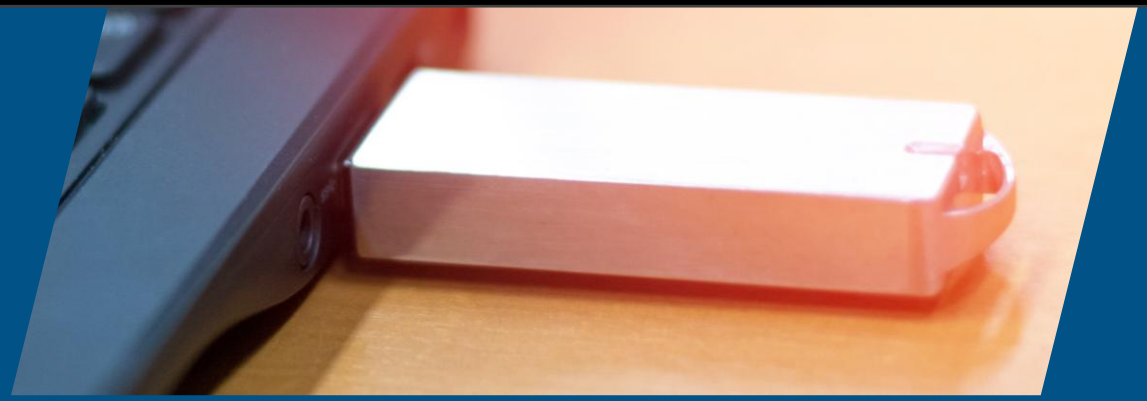
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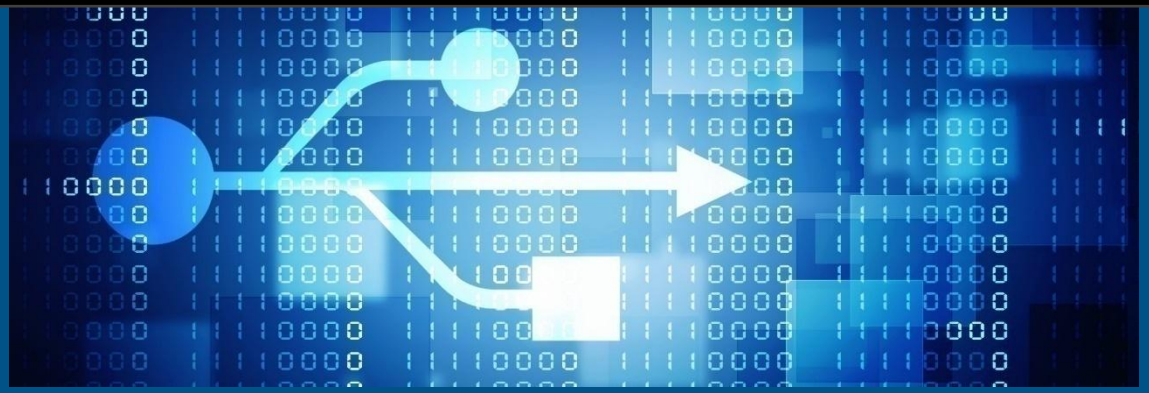
One Connector to Rule Them All



USB Communication

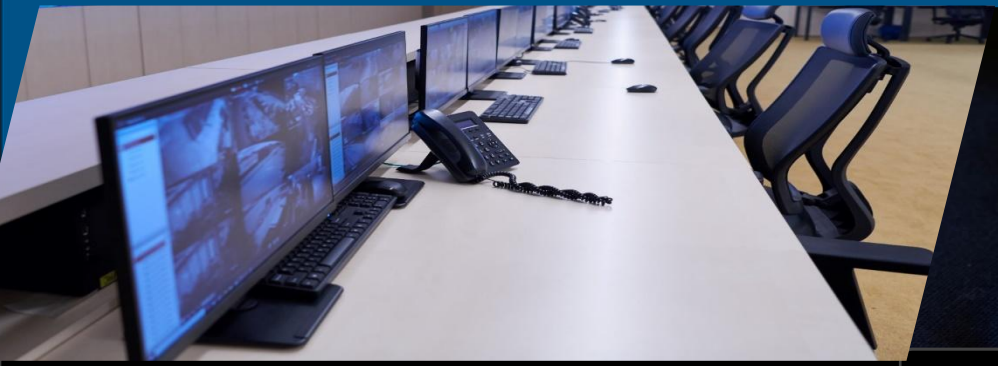
Peripheral Device **Host Device**





Originally developed to connect peripheral devices to computers

USB now supports high speed communication for many devices







Video & Audio **Power Delivery** **Data**

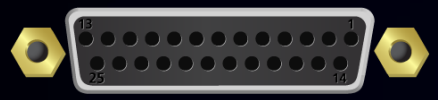
Interface of the Future

Versatility | Speed | Reversible Connector | Power Delivery | Small Form Factor

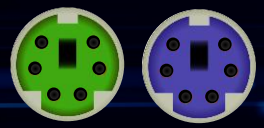
Replaced by USB



Serial Port



Parallel Port



PS/2 Port



Games Port

STANDARD



Type A



Type B

MINI



Type A



Type B

MICRO



Type A



Type B

USB 3.0 STANDARD



Standard-A



Standard-B

USB 3.0 MICRO



Micro-B

USB 3.1



USB-C

Considerations for USB-C Integration

- Lane Usage
- E-Marker
- Compatibility
- Lane 2 or 4
- Cascading Hub Limit
- SOP (Start Of Packet)
- Cable Length Requirements
- Power Delivery Variability
- Avoid Potential Data Bottlenecks
- Adapter

Multi-Use Technology



Connecting Peripherals

 Keyboards and Mice:	USB is the standard interface for connecting these input devices to computers.
 Printers, Scanners, and Cameras:	These devices connect to computers via USB for data transfer and operation.
 External Hard Drives and Storage:	USB enables easy connection and transfer of data between computers and external hard drives or storage devices.
 Game Consoles and Accessories:	USB is used to connect game controllers, joysticks, and other accessories to gaming consoles.

Bicsi CALA

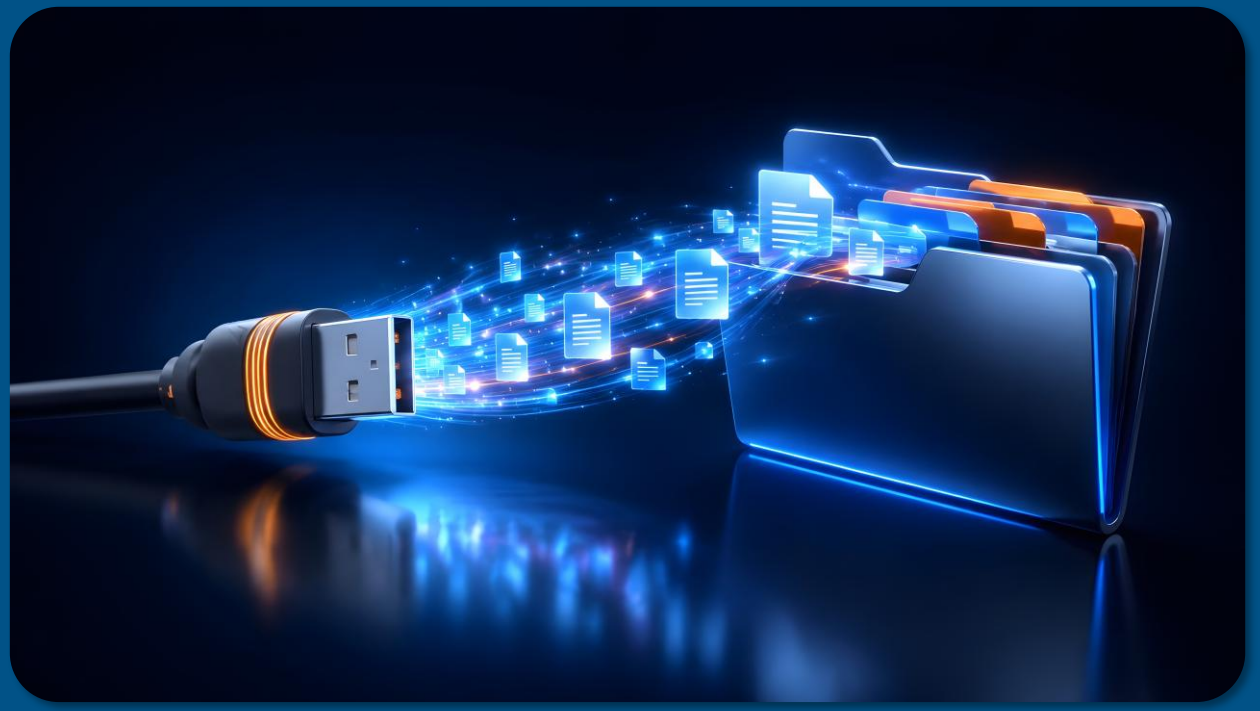
2. Charging Portable Devices:

- Smartphones and Tablets:
  - USB-A and USB-C ports are commonly used to charge these devices, with USB-C becoming more prevalent.
- Laptops:
  - USB-C ports on laptops often support power delivery and charging of other devices.



3. Data Transfer and Storage

- USB Flash Drives:
  - These portable storage devices are widely used for transferring files, backing up data, and storing documents.
- External Hard Drives:
  - USB enables easy connection and transfer of large files to and from external hard drives.
- Digital Cameras:
  - USB is used to transfer images and videos from digital cameras to computers.



4. Other Applications:

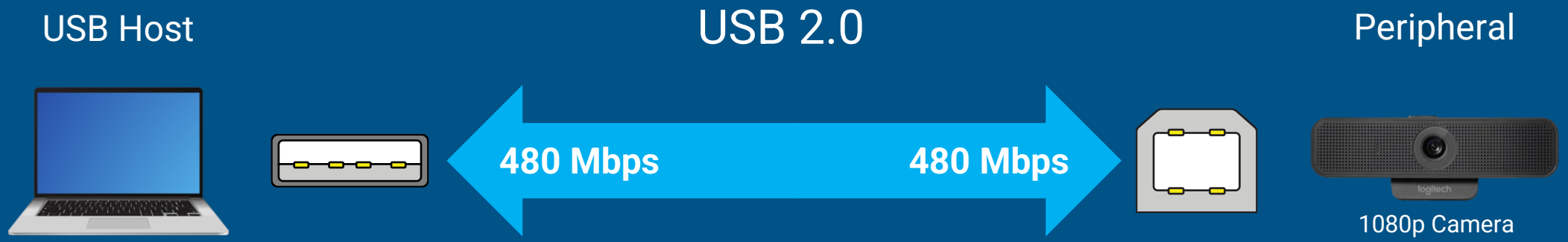
- Networking: USB can be used for network adapters and other networking peripherals.
- Industrial Automation: USB is used in industrial automation systems for connecting sensors, actuators, and other equipment.
- Audio and Video: USB can be used for connecting audio and video devices, such as microphones and webcams, to computers.
- Power Delivery: USB-C, in particular, is widely used for powering devices and charging them simultaneously.
- Display Connectivity: USB-C can also be used to connect displays and monitors to computers.



Understanding HOST & Peripheral



Host vs Peripheral



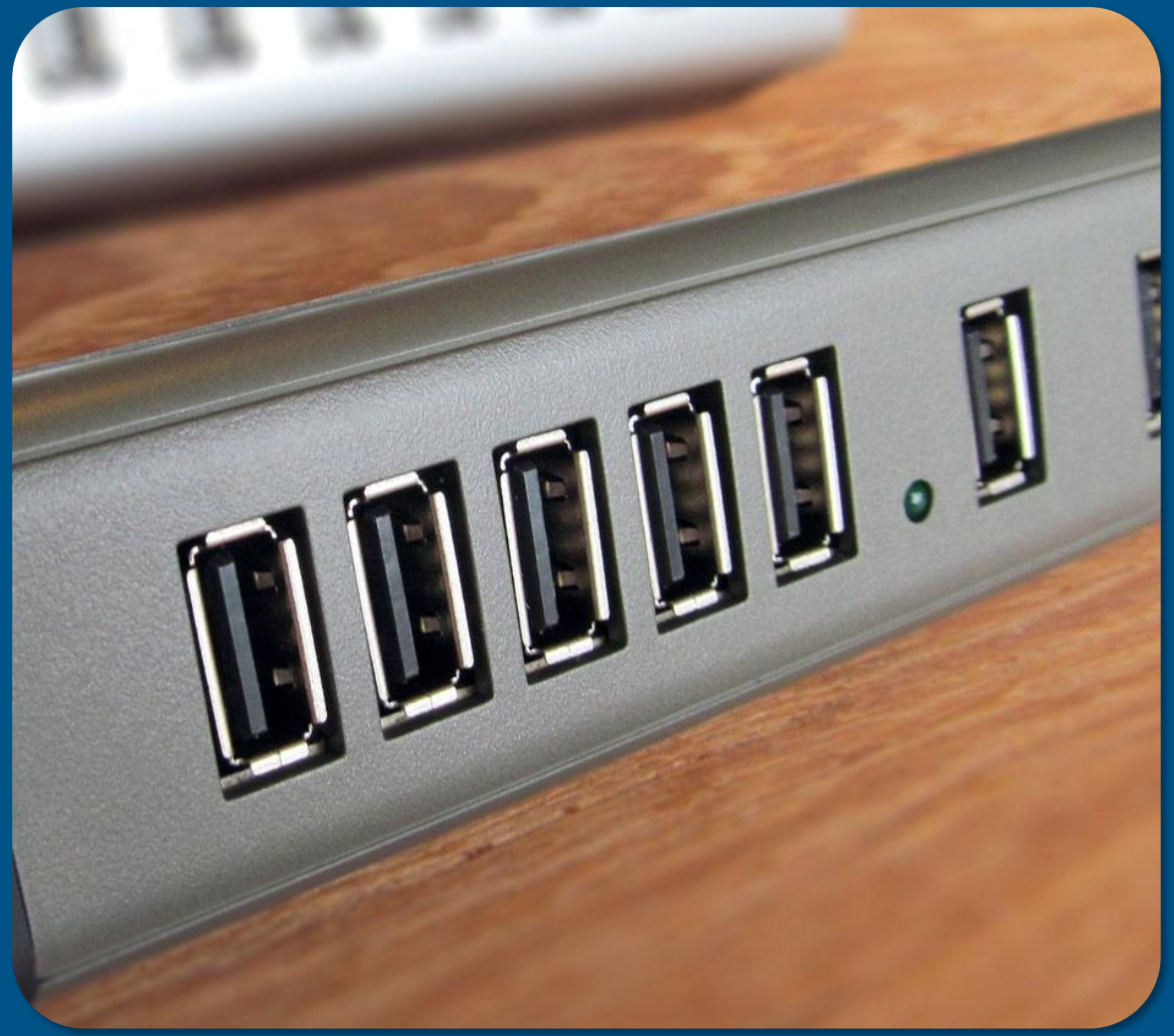
Compressed Video

MJPEG – up to 1080p/24

H.264 – up to 4K/30

What is a USB HUB?

- A USB hub is a device that expands the number of USB ports available on a computer or other device
- It connects all the peripherals



3 Main Themes Today

1. USB can do 3 things
   - Power(watts)
   - Alt Mode
   - Data
2. Understand your HOST & Peripheral
3. HUB Count

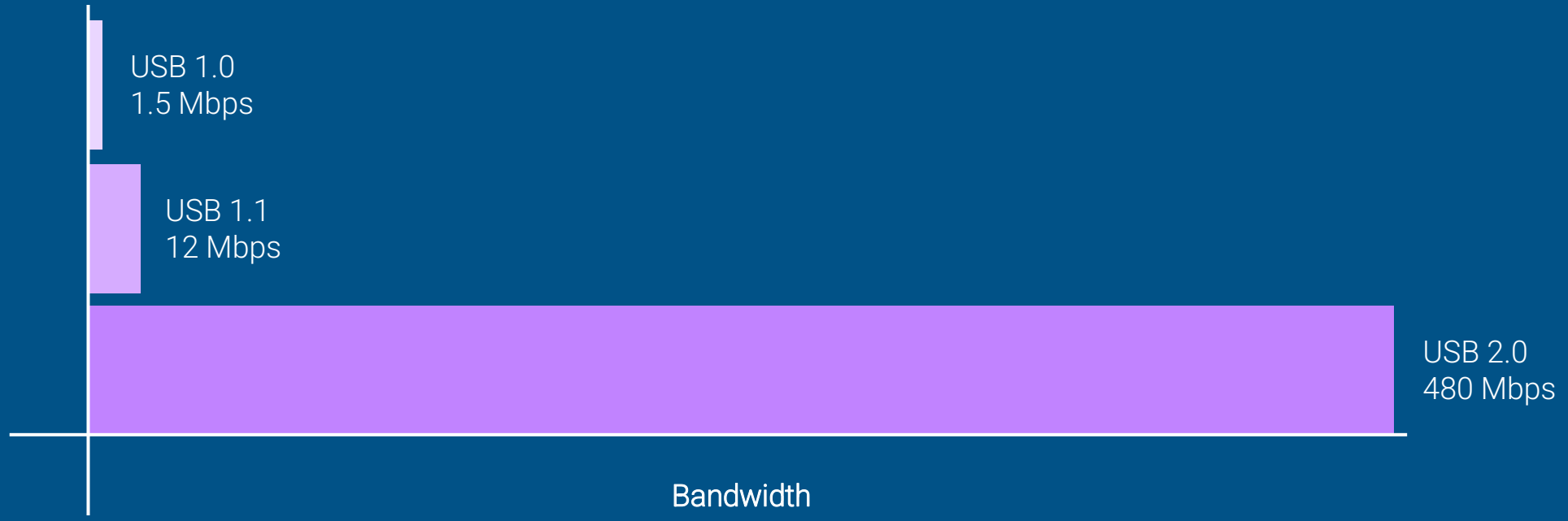
Types of USB

And their features



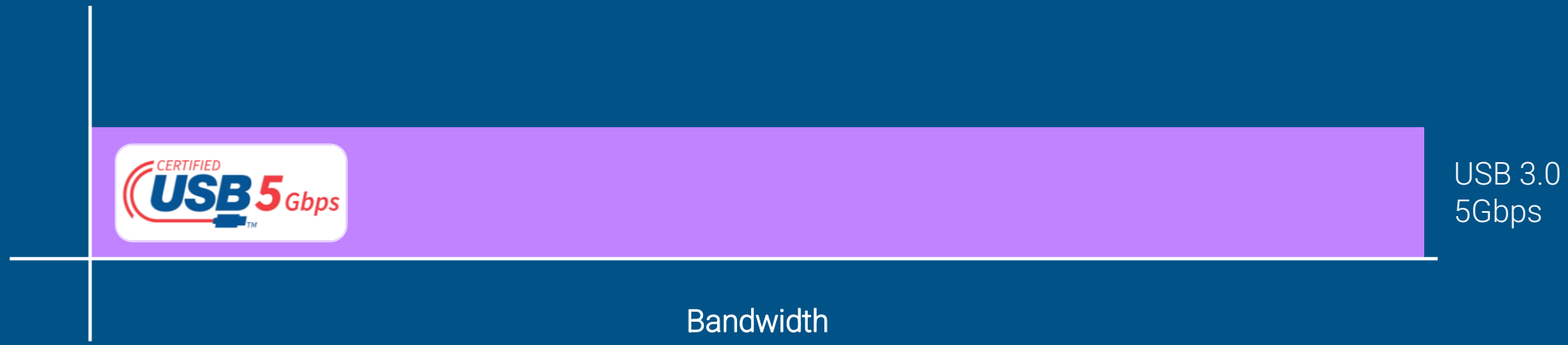
USB 2.0 Bandwidth

Specification	Data Rate	Bandwidth	Connectors
USB 1.0	Low Speed	1.5 Mbps	USB A, B
USB 1.1	Full Speed	12 Mbps	USB A, B
USB 2.0	High Speed	480 Mbps	USB A, B, Mini, Micro



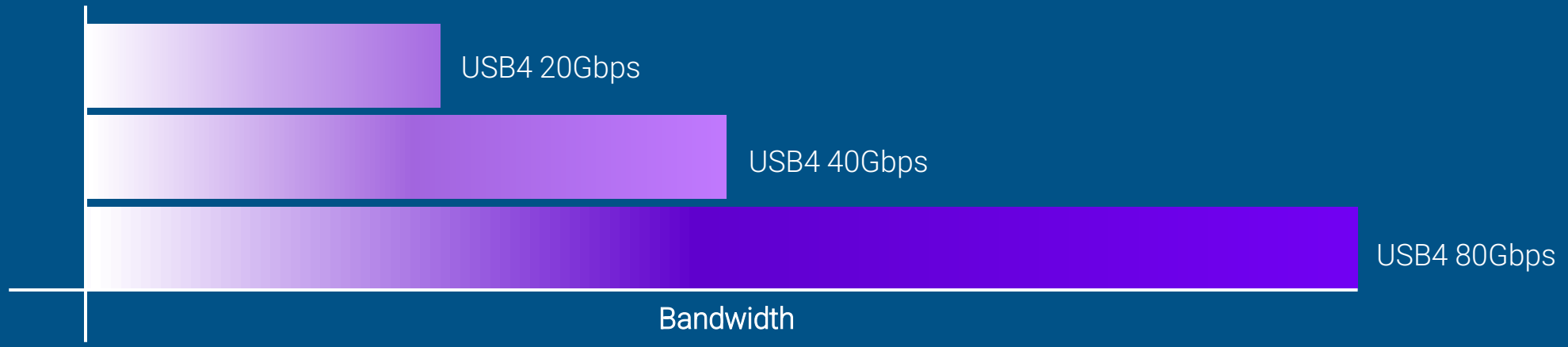
USB 3.0 Bandwidth

Specification	Data Rate	Bandwidth	Connectors
USB 3.0	SuperSpeed	5Gbps	Standard-A Standard-B Micro-B



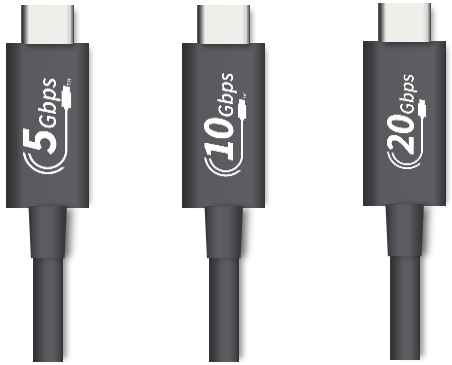
USB4 Bandwidth

Specification - Data Rate	Data Lanes	Mode Name
USB4 20Gbps	1 or 2	USB4 Gen 2 x 2 or USB4 Gen 3 x 1
USB4 40Gbps	2	USB4 Gen 3 x 2
USB4 80 Gbps	2	USB4 Gen 4



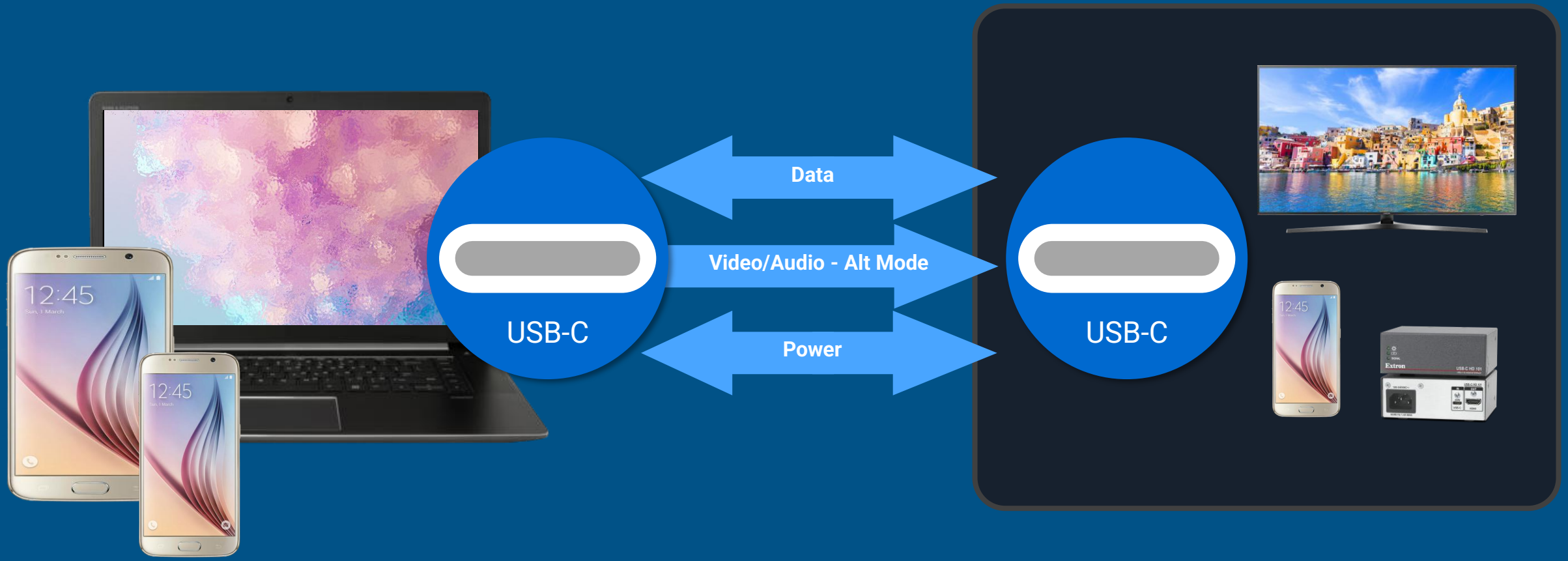
Backwards compatible with legacy USB devices

Port and Cable Markings

Label Type	USB 2.0	USB 3.x	USB4	Thunderbolt
Data Speed				
USB PD Charging and Data Speed				
Cable Marking	 USB 2.0	 USB 5Gbps USB 10Gbps USB 20Gbps	 USB4 20Gbps USB4 40Gbps	 Thunderbolt 4
Phone Fast Charge (2.1A)	✓	✓	✓	✓

Compatibility and Lane Usage

One Connector, Diverse Functionality



USB-C Connector



Small form factor
(8.3 mm x 2.5 mm)

24-pin receptacle

Compatible with existing USB Devices

Primary reference specs:

- USB 2.0
- USB 3.2
- USB4
- Alternate Mode
- Power Delivery

Reversible Plug Orientation



Reversible connector design improves user experience

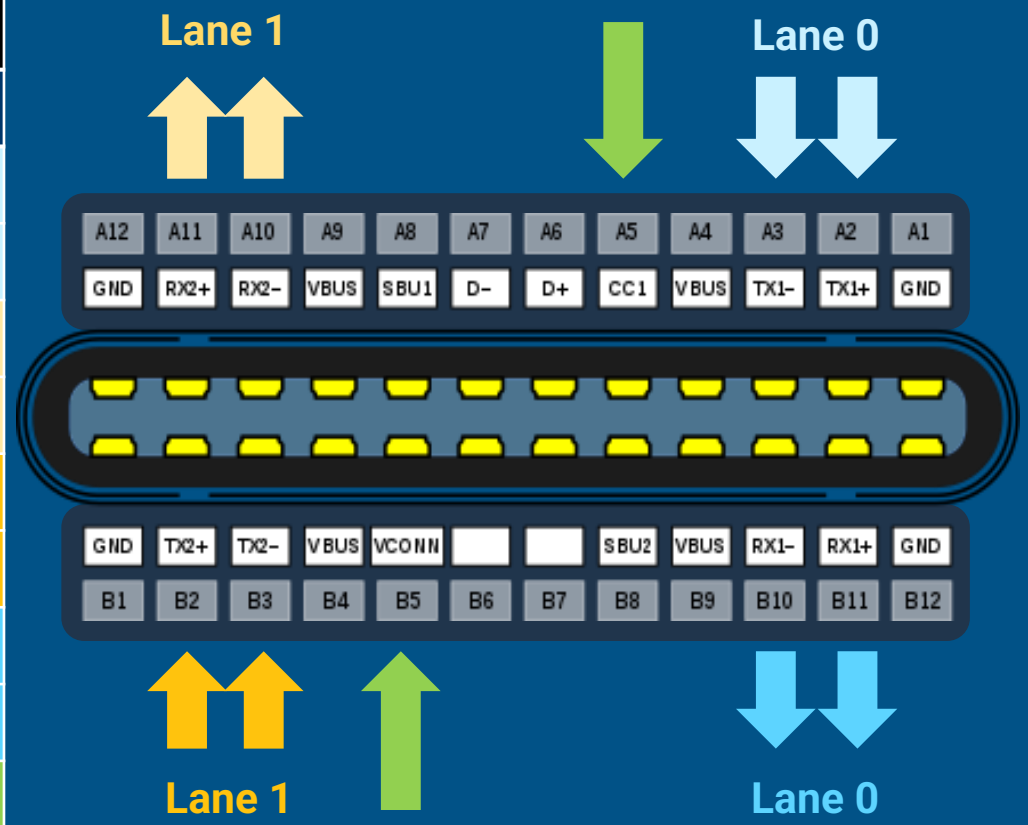
E-Marker



Cable Ref	Plug 1	Plug 2	USB Version	Cable Length[2]	Current Rating	USB Power Delivery	USB Type-C Electronically Marked
CC2-3	C	C	USB 2.0	≤ 4 m	3 A	Supported (SPR Only)	Optional
CC2-5[1]					5 A		Required
CC2-5E					5 A	Supported (SPR & EPR)	Required
CC3G1-3	C	C	USB 3.2 Gen1 and USB4 Gen2	≤ 2 m	3 A	Supported (SPR Only)	Required
CC3G1-5[1]					5 A		
CC3G1-5E					5 A	Supported (SPR & EPR)	Required
CC3G2-3	C	C	USB 3.2 Gen2 and USB4 Gen2	≤ 1 m	3 A	Supported (SPR Only)	Required
CC3G2-5[1]					5 A		
CC3G2-5E					5 A	Supported (SPR & EPR)	Required
CC4G3-3	C	C	USB4 Gen3 and USB4 Gen4[3]	≤ 0.8 m	3 A	Supported (SPR Only)	Required
CC4G3-5[1]					5 A		
CC4G3-5E					5 A	Supported (SPR & EPR)	Required

Alternate Mode – Reconfigurable Lanes

Lane Configurations		
Pin	Name	Description
A2	TX1+	Reconfigurable Lane 0 +
A3	TX1-	Reconfigurable Lane 0 -
A10	RX2-	Reconfigurable Lane 1 -
A11	RX2+	Reconfigurable Lane 1 +
B2	TX2+	Reconfigurable Lane 1+
B3	TX2-	Reconfigurable Lane 1 -
B10	RX1-	Reconfigurable Lane 0 -
B11	RX1+	Reconfigurable Lane 0 +
A5	CC1	Lane Negotiation
B5	VCONN	Lane Negotiation

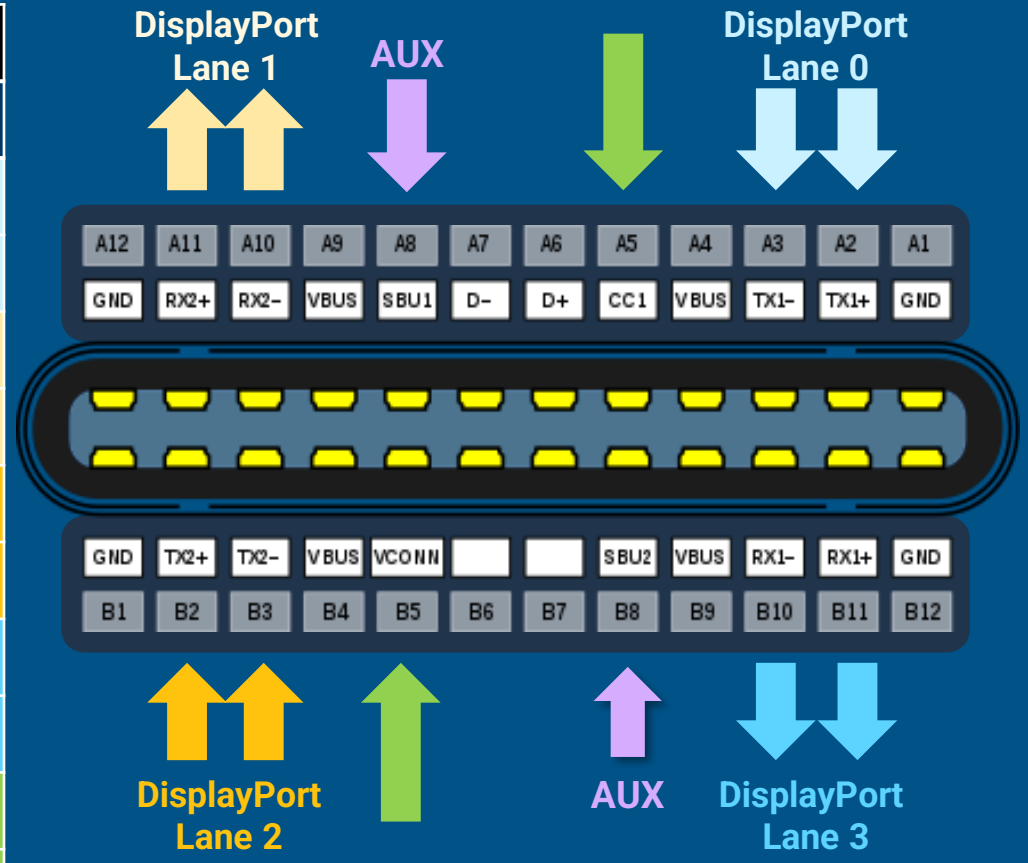




Four reconfigurable lanes carry different types of bidirectional data

Alternate Mode – DisplayPort

Lane Configurations		
Pin	Name	Description
A2	TX1+	Reconfigurable Lane 0 +
A3	TX1-	Reconfigurable Lane 0 -
A10	RX2-	Reconfigurable Lane 1 -
A11	RX2+	Reconfigurable Lane 1 +
B2	TX2+	Reconfigurable Lane 1+
B3	TX2-	Reconfigurable Lane 1 -
B10	RX1-	Reconfigurable Lane 0 -
B11	RX1+	Reconfigurable Lane 0 +
A5	CC1	Lane Negotiation
B5	VCONN	Lane Negotiation



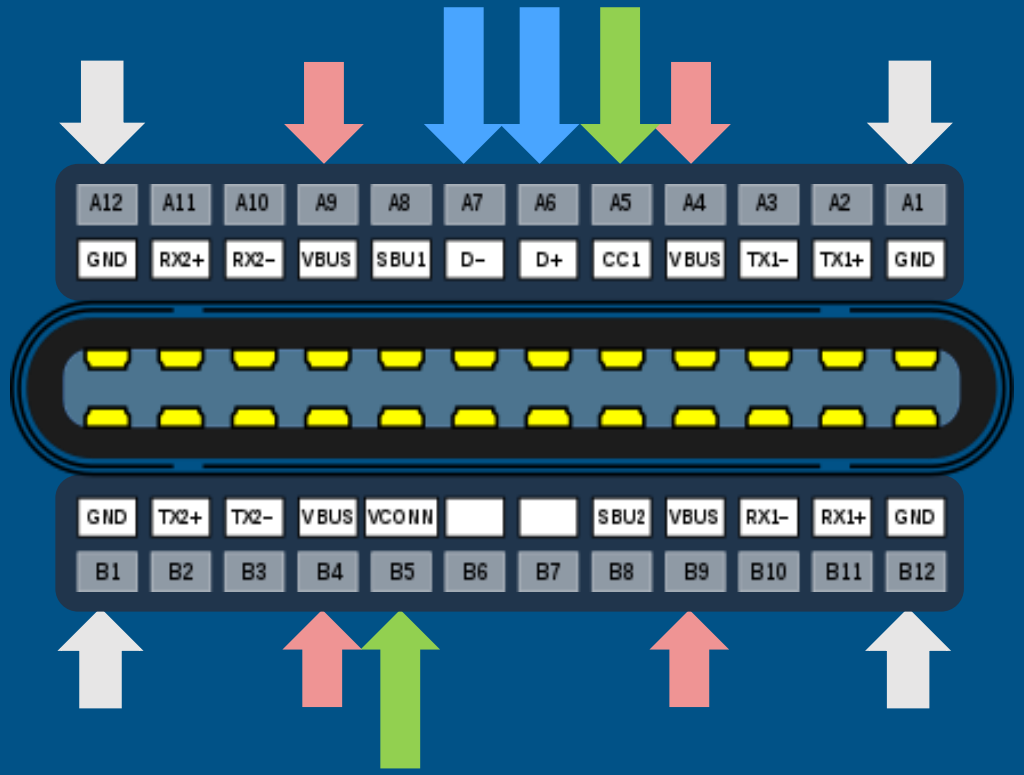


Four DisplayPort lanes plus AUX channel over Secondary Bus (SBU) for EDID, etc.

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USB-C Power Contacts

USB-C Power Contacts		
Pin	Name	Description
A1	GND	Ground
A4	VBUS	5 – 48 VDC
A9	VBUS	5 – 48 VDC
A12	GND	Ground
B1	GND	Ground
B4	VBUS	5 – 48 VDC
B9	VBUS	5 – 48 VDC
B12	GND	Ground
A5	CC1	USB PD Negotiation
B5	VCONN	USB PD Negotiation



USB 2.0 Data Contacts		
Pin	Name	Description
A6	D+	Data +
A7	D-	Data -

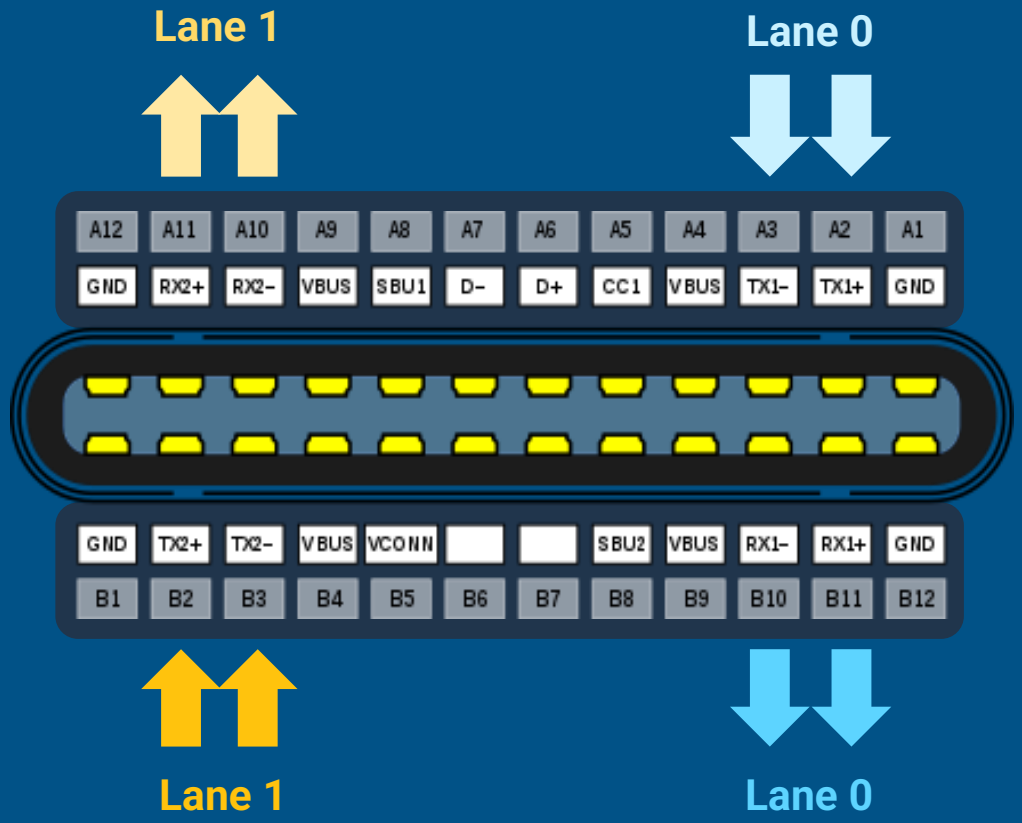


Supports USB 2.0, USB 3.2, USB4, Power, DisplayPort Alt Mode, and Thunderbolt

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USB-C Data Contacts

USB 3.2 Data Contacts		
Pin	Name	Description
A2	TX1+	SuperSpeed Lane 0 TX +
A3	TX1-	SuperSpeed Lane 0 TX -
A10	RX2-	SuperSpeed Lane 1 RX -
A11	RX2+	SuperSpeed Lane 1 RX +
B2	TX2+	SuperSpeed Lane 1 TX +
B3	TX2-	SuperSpeed Lane 1 TX -
B10	RX1-	SuperSpeed Lane 0 RX -
B11	RX1+	SuperSpeed Lane 0 RX +

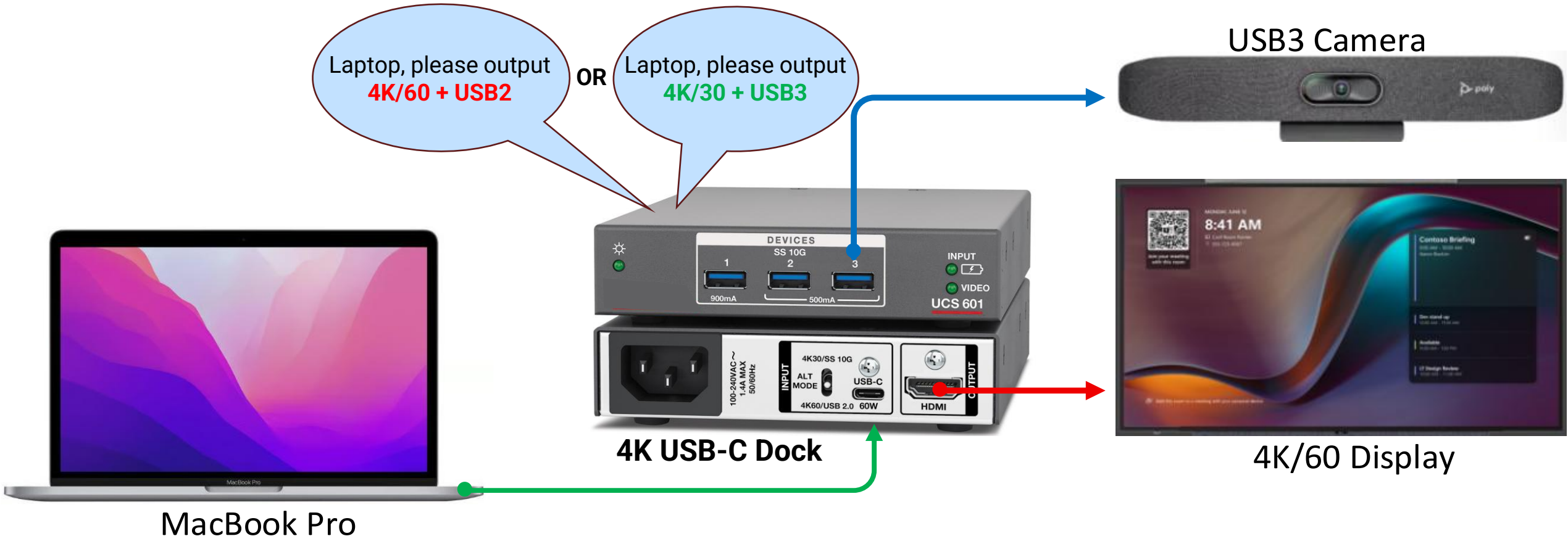




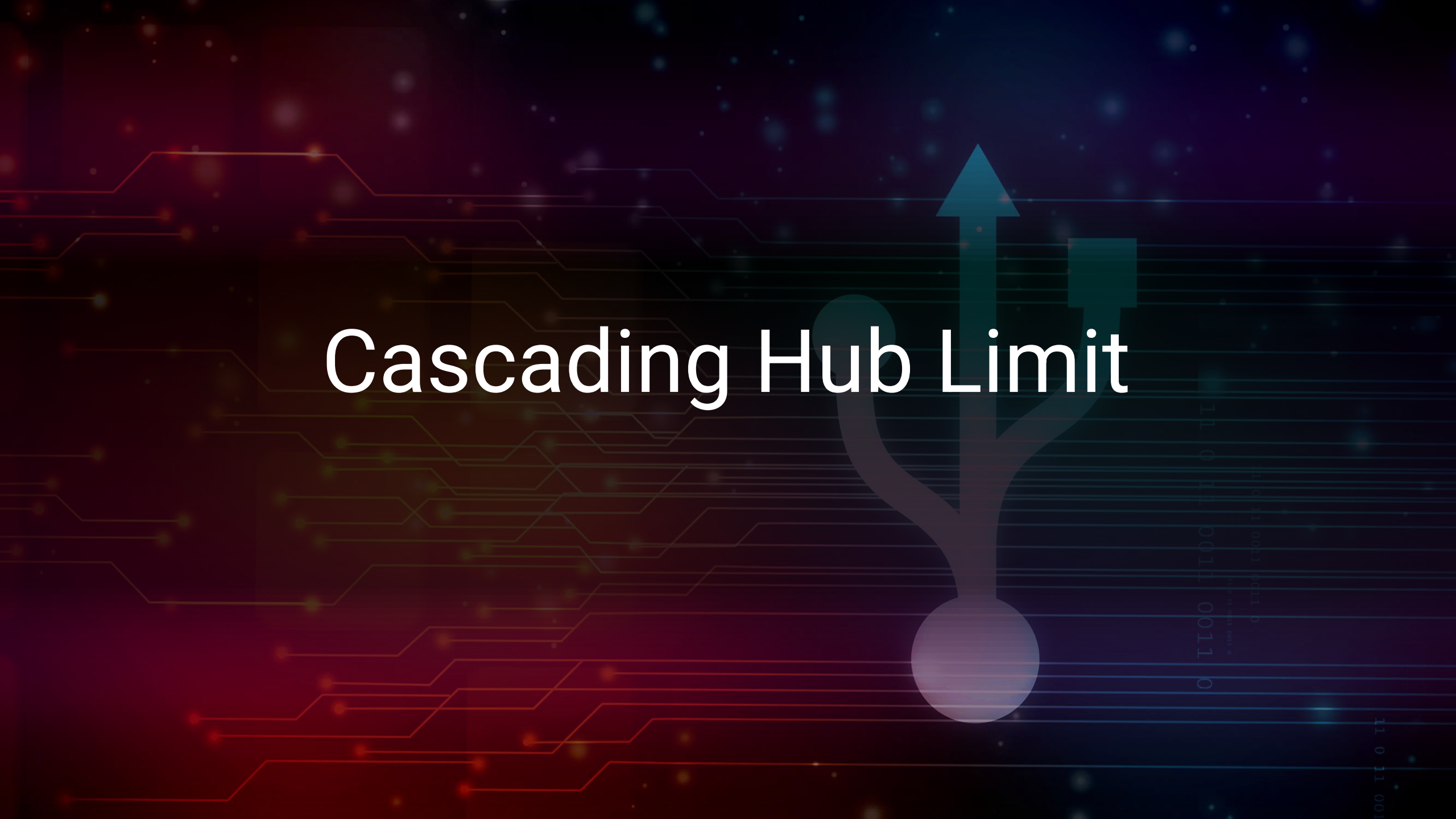
Reconfigurable Lanes – Higher Data Speeds
USB 3.2 20 Gbps – 2 x 10 Gbps bidirectional lanes

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Compatibility



Cascading Hub Limit



Device Communication



Plug in device to host



Detect device to provide power or receive power



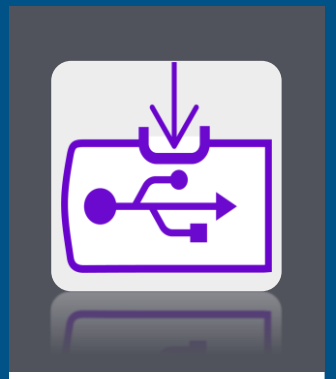
Reset device signal



Identify speed of device and supported data rate



Assign numerical address



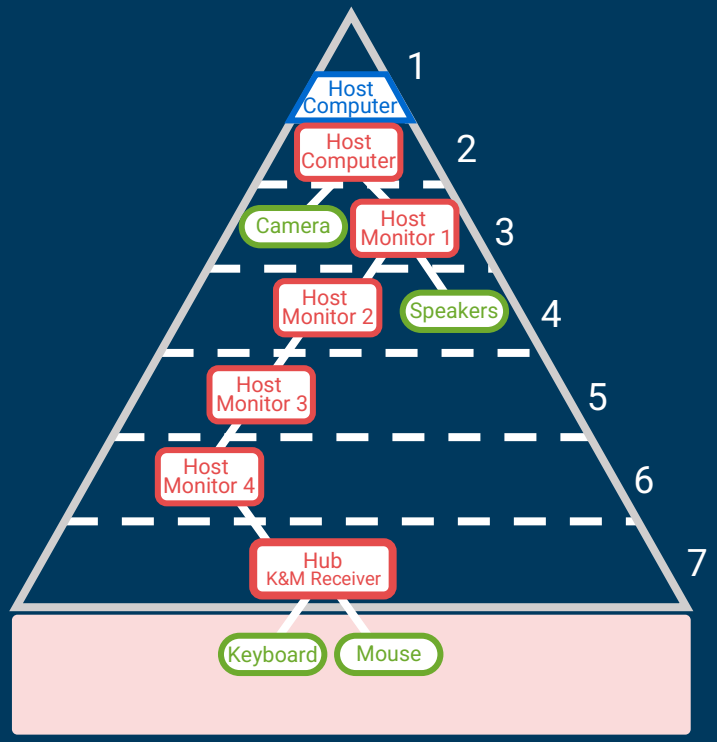
Load device drivers



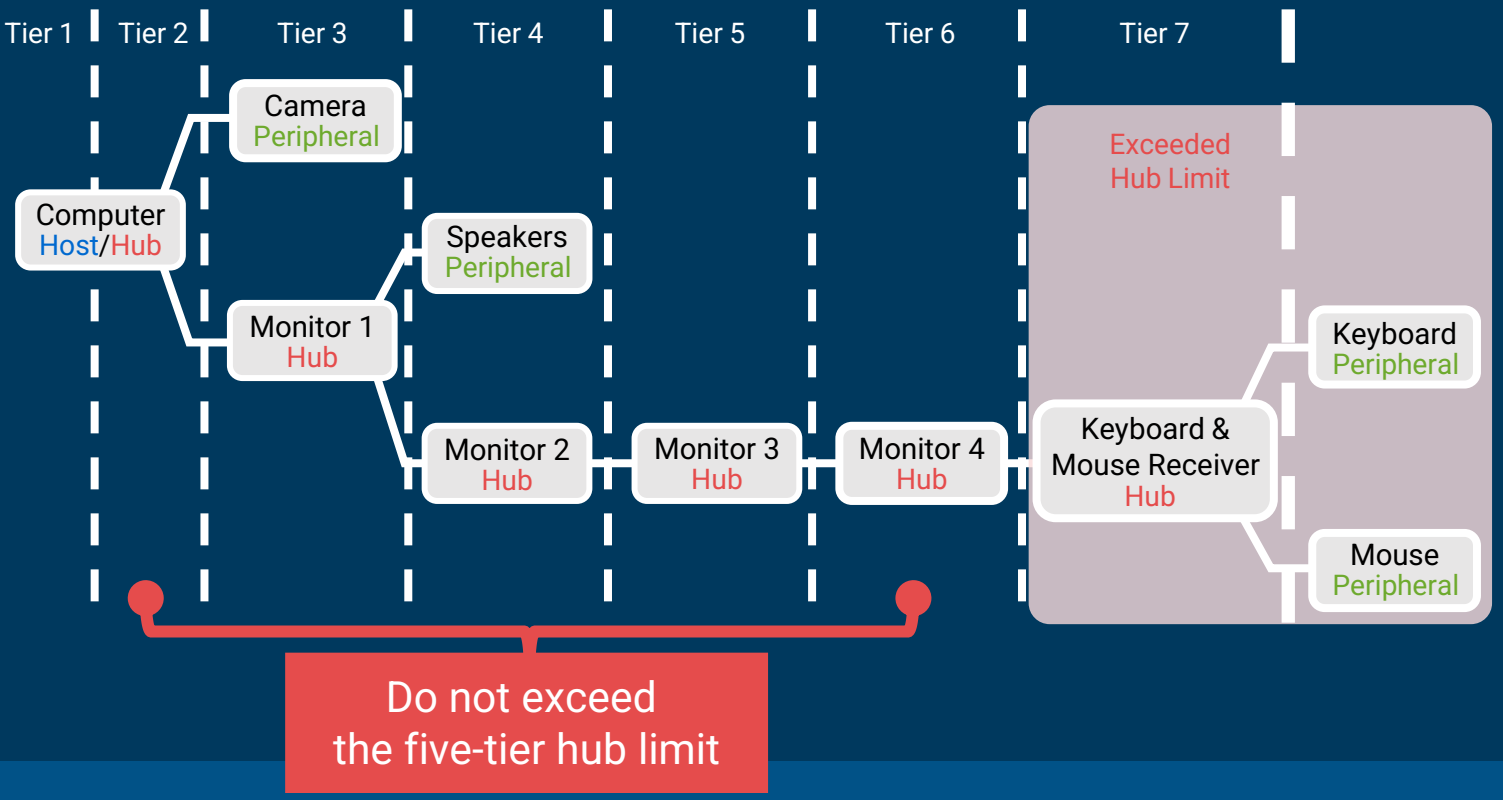
Set to a configured state

Host and device begin data flow

Hub Limitation

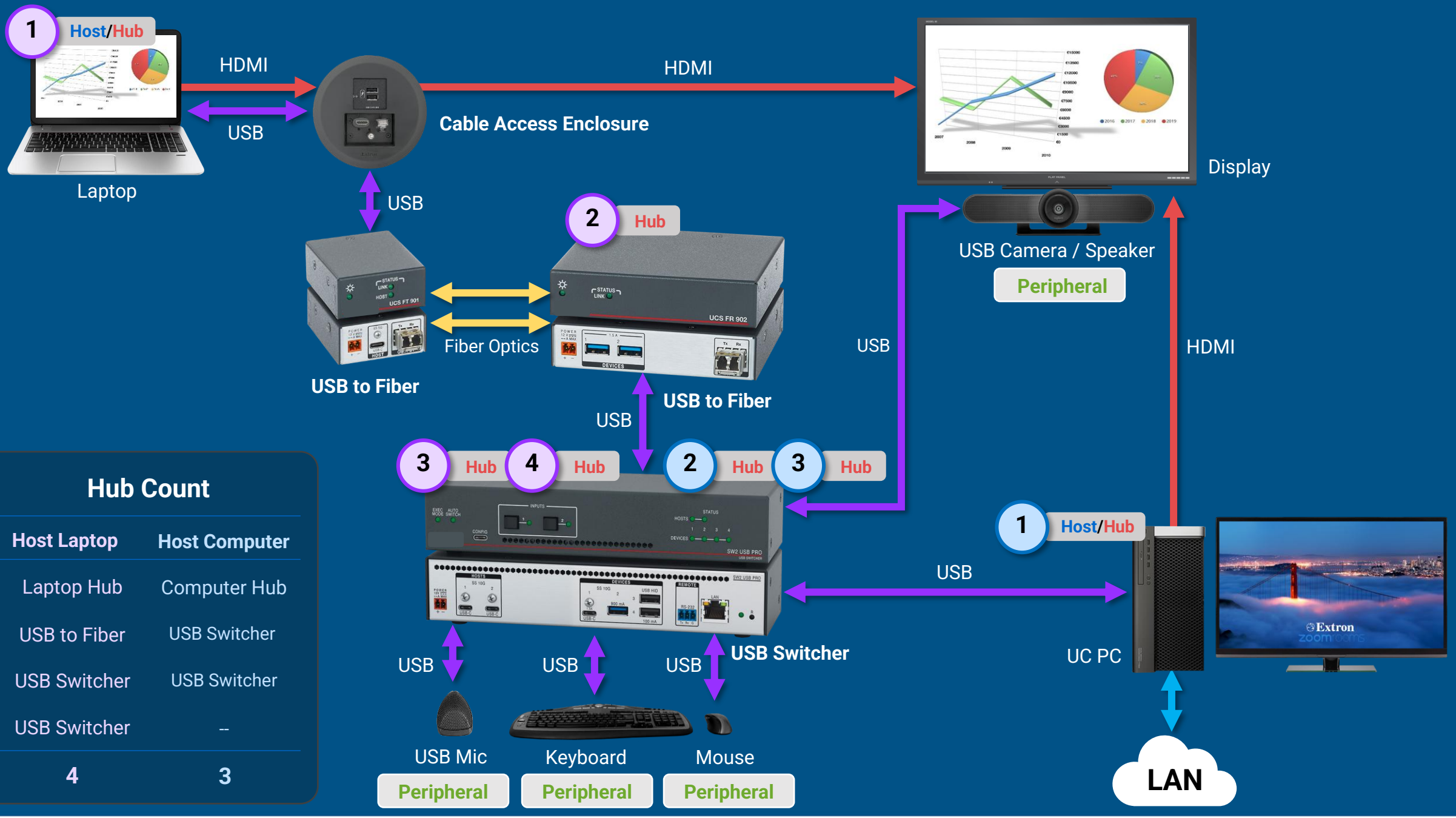


Total number of hubs



Bus supports all connected peripherals

USB Hub Count



Hub Count

Host Laptop	Host Computer
Laptop Hub	Computer Hub
USB to Fiber	USB Switcher
USB Switcher	USB Switcher
USB Switcher	--
4	3

Cable Length Requirements

Source



Laptop
BYOM



USBC Cable

4K/30 DisplayPort Video
(16.2 Gbps)

Lane 1 (8.1 Gbps)

Lane 2 (8.1 Gbps)

USB 5 Gbps Camera

5 Gbps 5 Gbps

USB 2.0
Touchback / Mic

480 Mbps 480 Mbps

60 W Power

12’ (3.6 m)

Destination



Collaboration Display

USB-C Connection
4K video laptop image
4K/30 USB camera
60 W USB Power Delivery
6 element microphone array
USB touchback

Source



Laptop
BYOM



USBC ProMax Series

8K/30 DisplayPort Video
(32.4 Gbps)

Lane 1 (8.1 Gbps)
Lane 2 (8.1 Gbps)
Lane 3 (8.1 Gbps)
Lane 4 (8.1 Gbps)

High-Speed (USB 2.0)
Keyboard & Mouse

480 Mbps 480 Mbps

100 W Power

15’ (4.5 m) | 25’ (7.6 m) | 30’ (9.1 m)

Destination





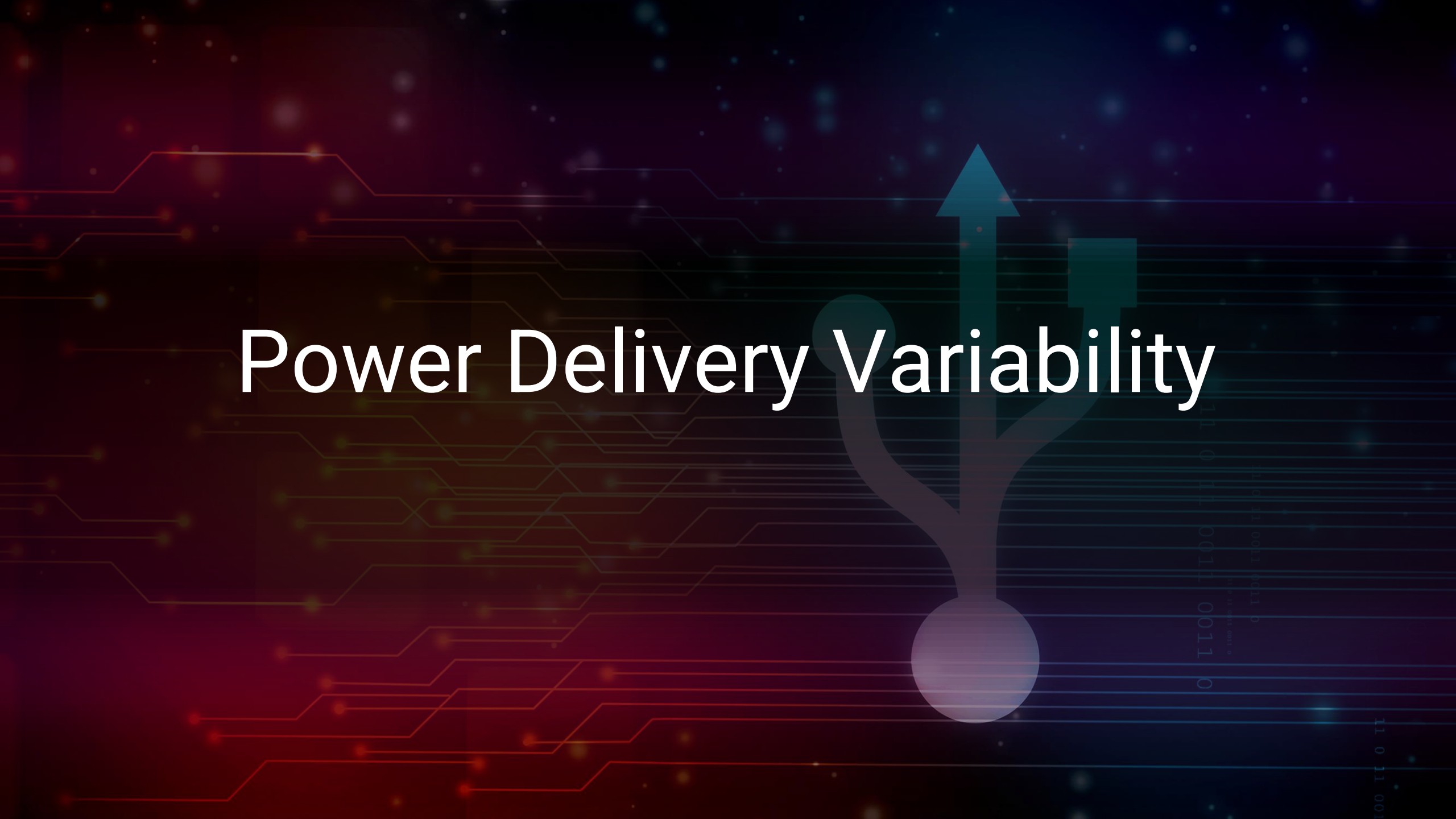
Keyboard Mouse

Collaboration Display

USB-C Connection
8K/30 DisplayPort Video & Audio
USB 2.0 – Keyboard & Mouse
Bidirectional power flow – 100 W

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Power Delivery Variability

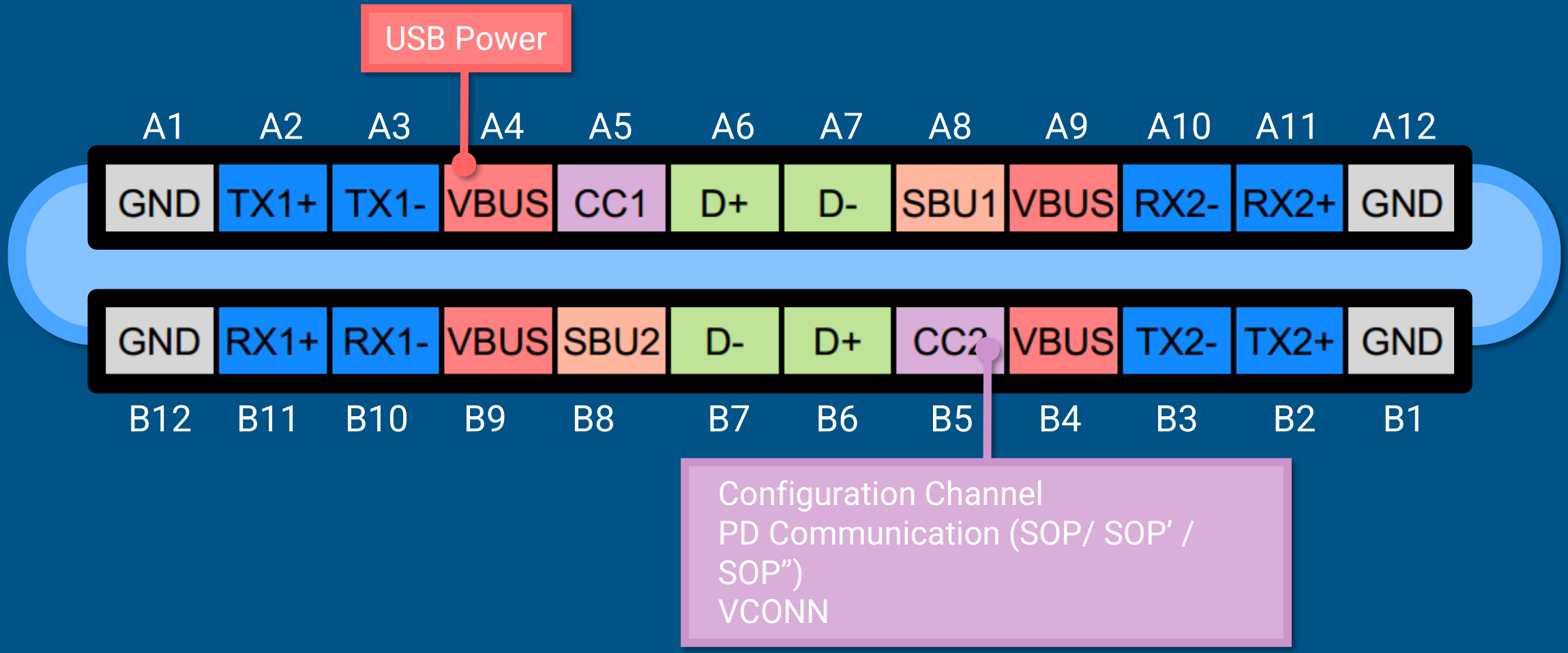


USB-C Power Capability

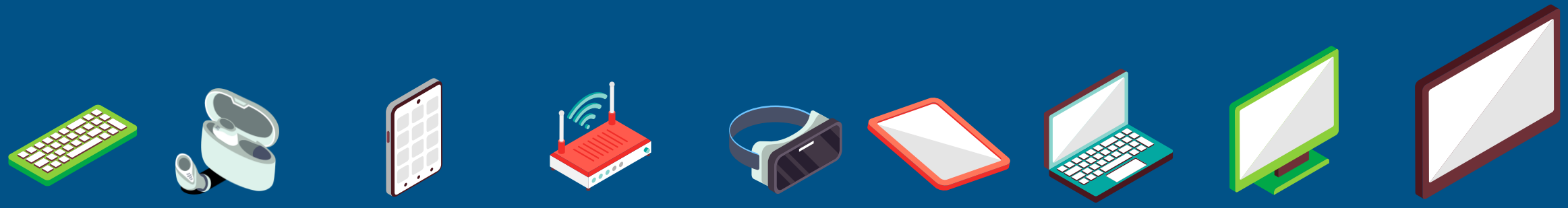


Specification	Current	Voltage	Max Power
USB-C 1.0	3 A	5 V	15 W
Power Delivery 2.0/3.0 Type-C	5 A	20 V	100 W
Power Delivery 3.1 Type-C	5 A	48 V	240 W

USB-C Connector



USB-C Power Requirements



0.5W | 3W | 5W | 7.5W | 10W | 45W | 65W | 100W | 240W

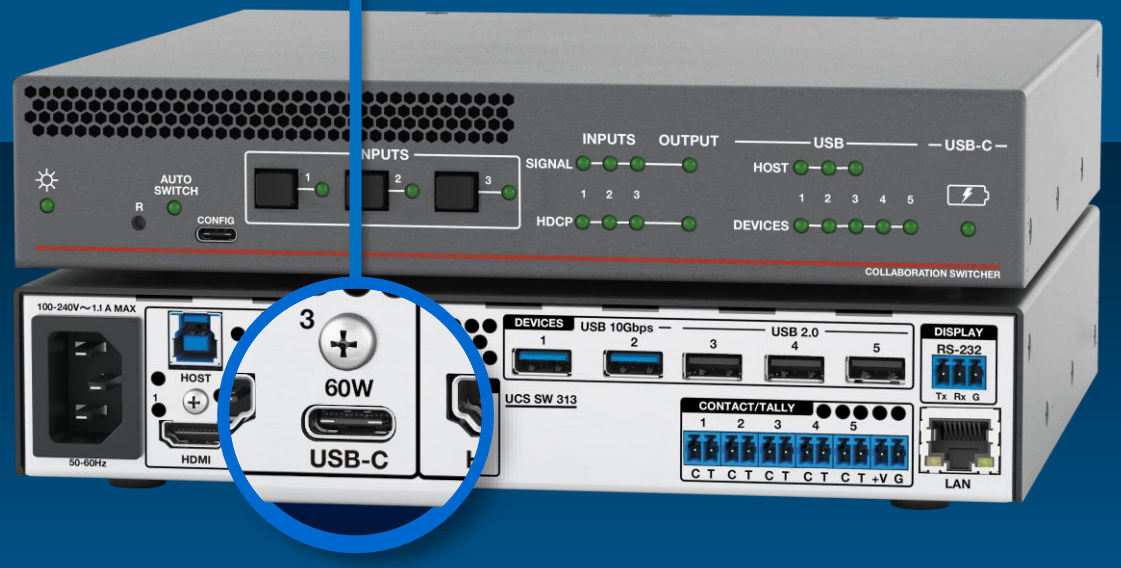
Standard Power Range - SPR

Extended Power Range - EPR

General

USB-C power delivery

Up to 60 watts power delivery at the following power profiles:
5 VDC @ up to 3 A
9 VDC @ up to 3 A
12 VDC @ up to 3 A
15 VDC @ up to 3 A
20 VDC @ up to 3 A





Strategies to Implement USB-C for AV Design

Integrated Presentation Systems and Collaboration Spaces

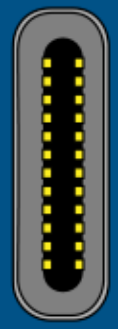


Alternate Mode Application

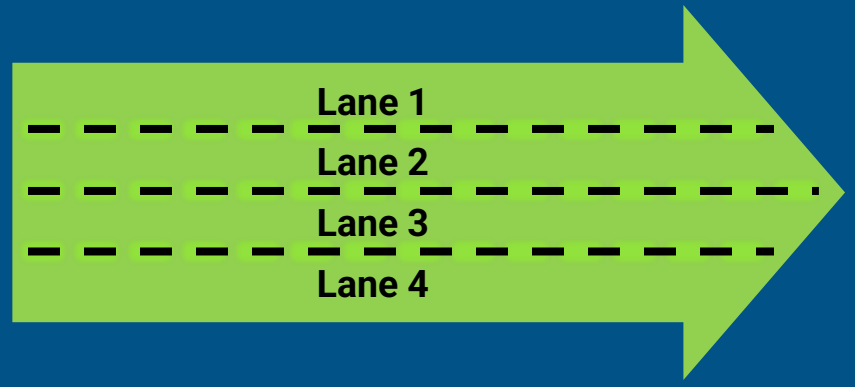


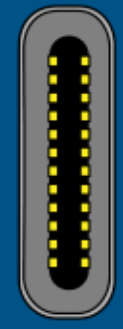


USB Host



USB 3.2 Alt Mode







HDMI

Four lanes carry native DisplayPort video

AV System to Work with Any UC



BYOM – Compute Module

USB

Cable Access Enclosure



USB

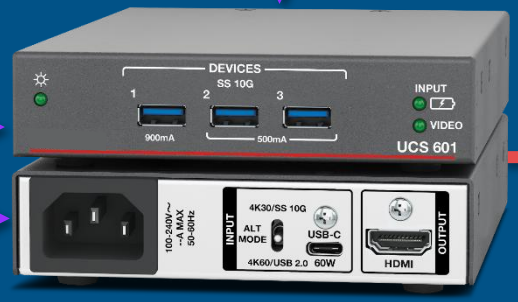
Display





USB

USB

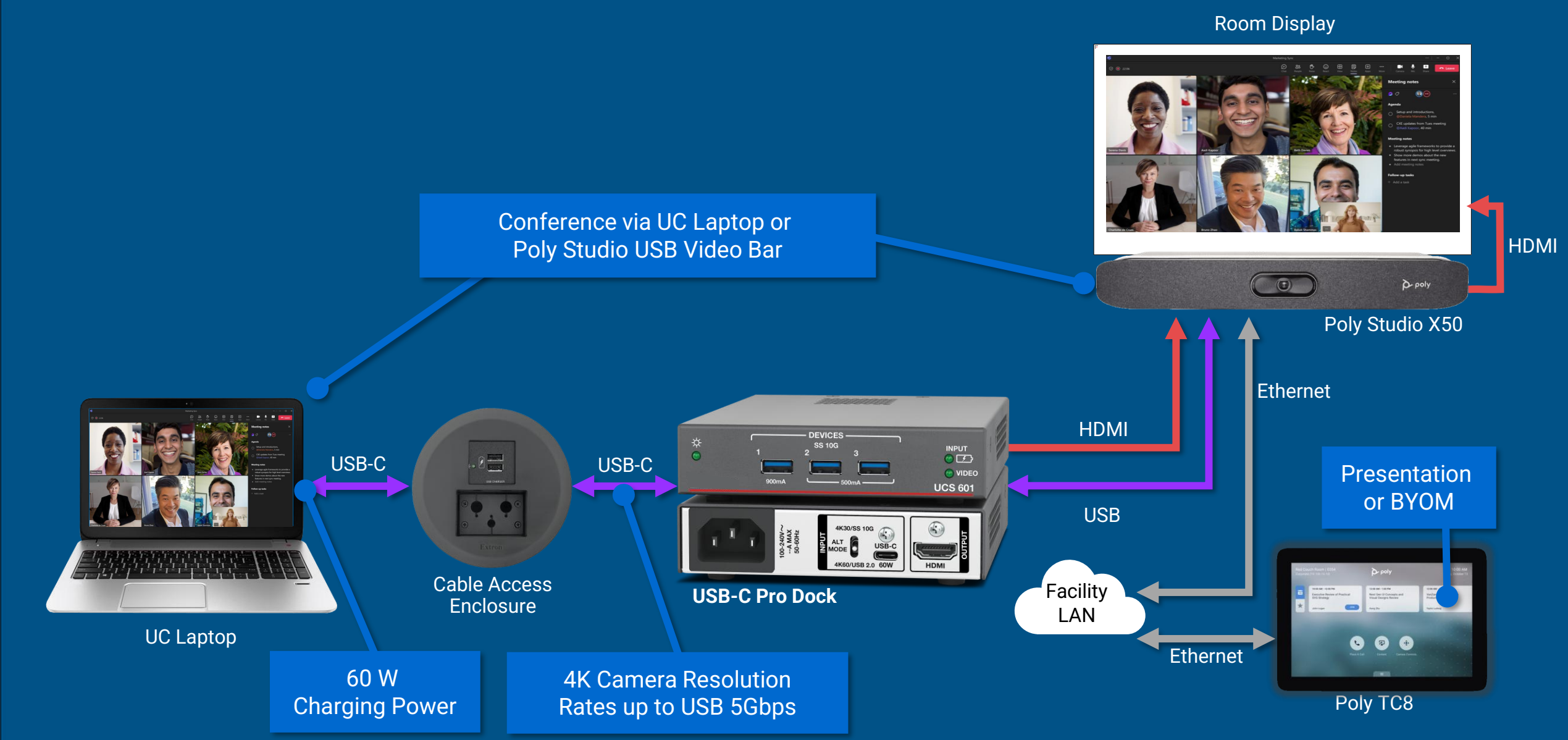


HDMI

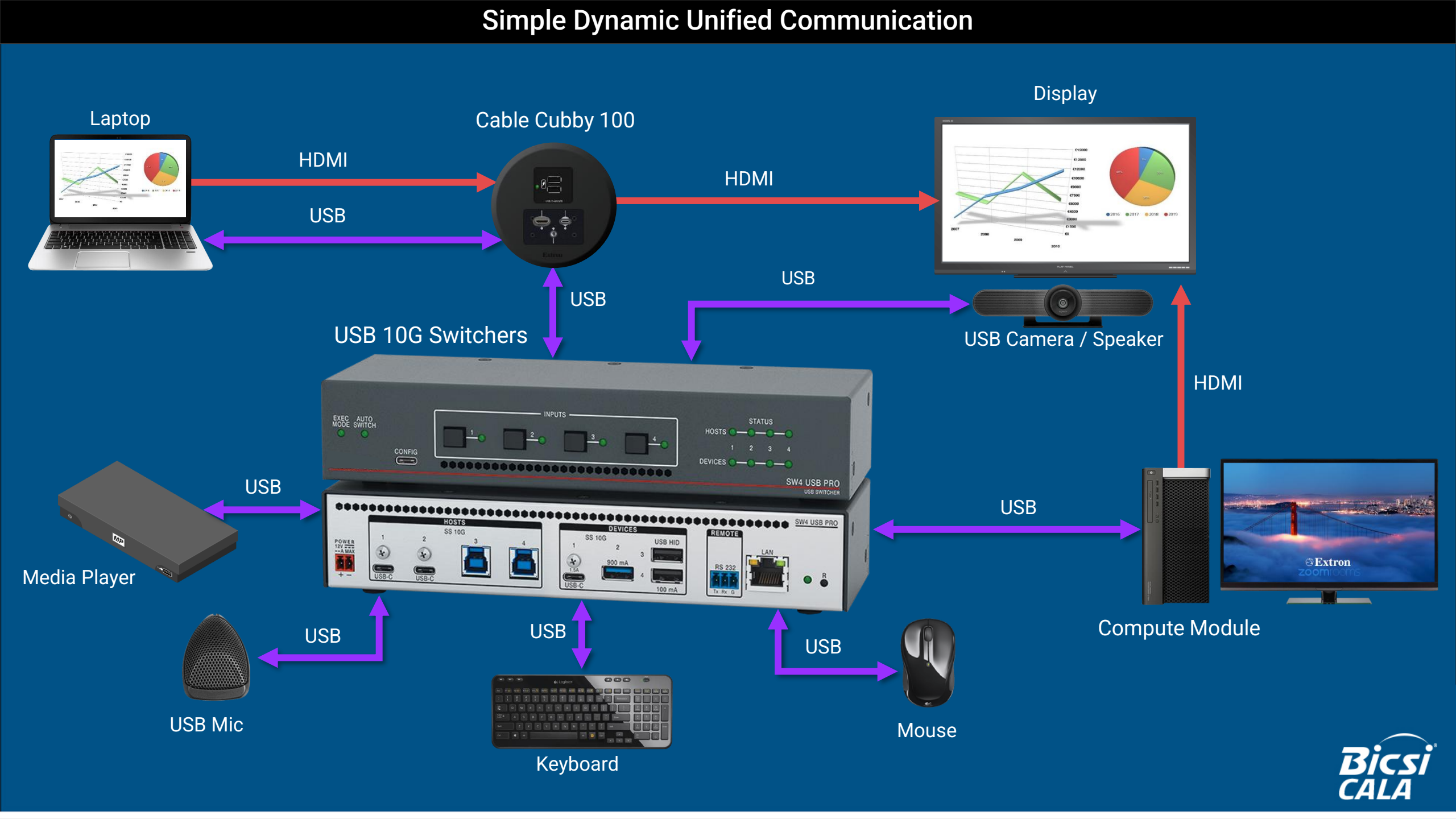
Pro 4K USB-C 10G Dock



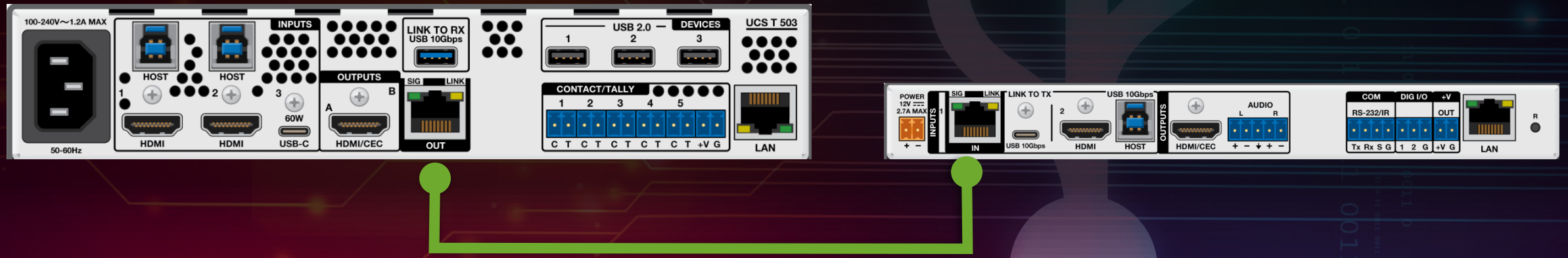
Simple USB Presentation System with UC



Simple Dynamic Unified Communication



USB Transmitter / Receiver



Large Meeting Room – Extension over CATx using USB Switcher

Meeting Room



Laptop

USB-C
(Video/Audio, Data, Power)



Laptop

USB

HDMI

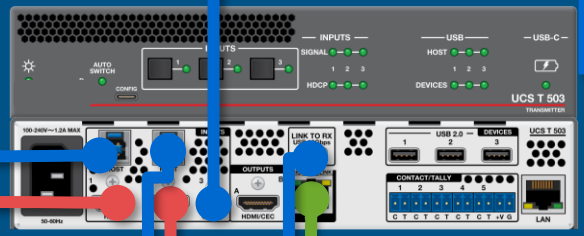


Room PC



USB

HDMI



Extend to 100m

CATx

USBA-C cable

Optional USB
10Gbps Link

On Wall

Display

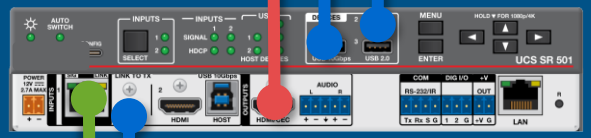


USB 2.3
Videobar

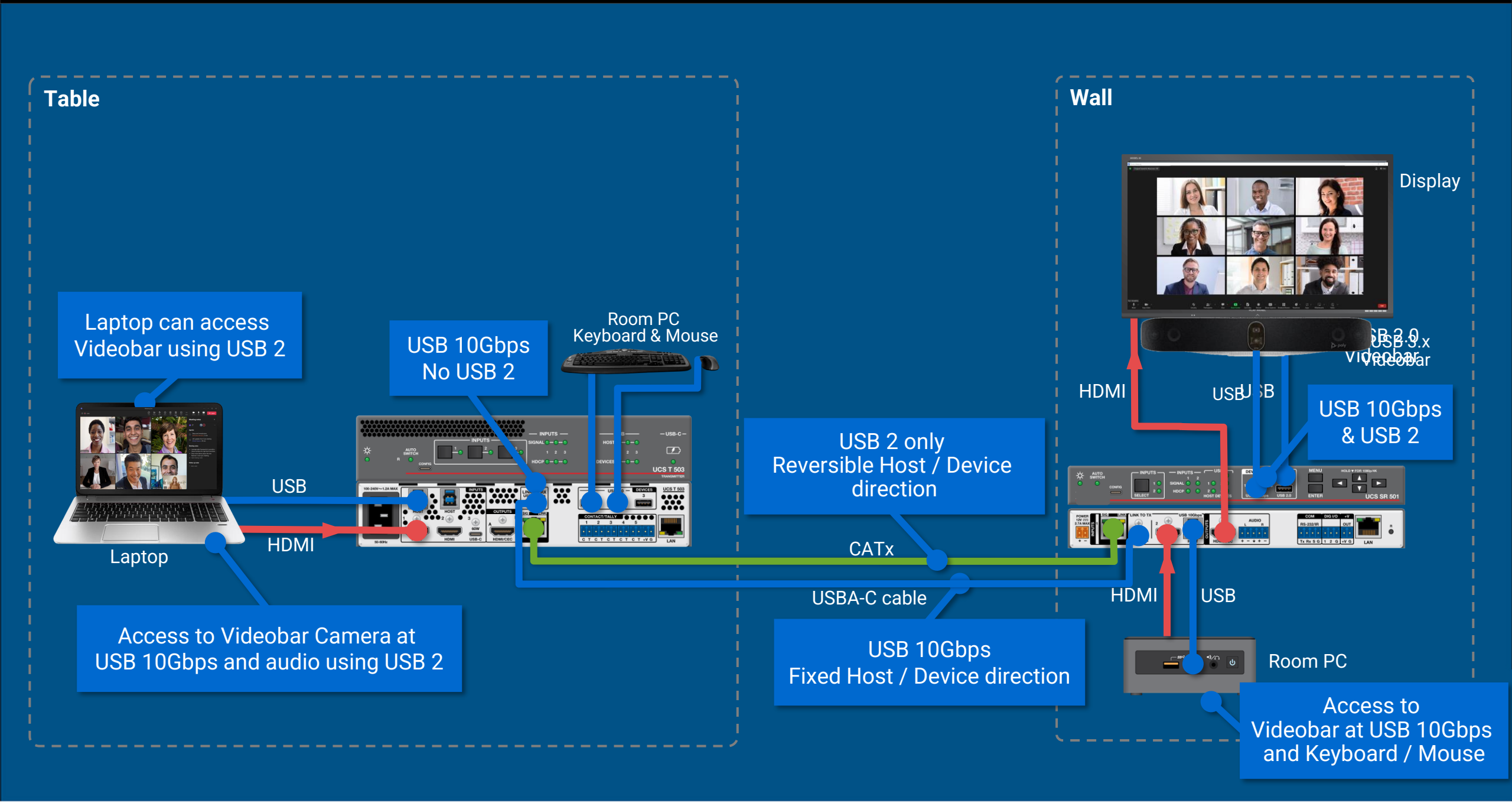
HDMI

USB

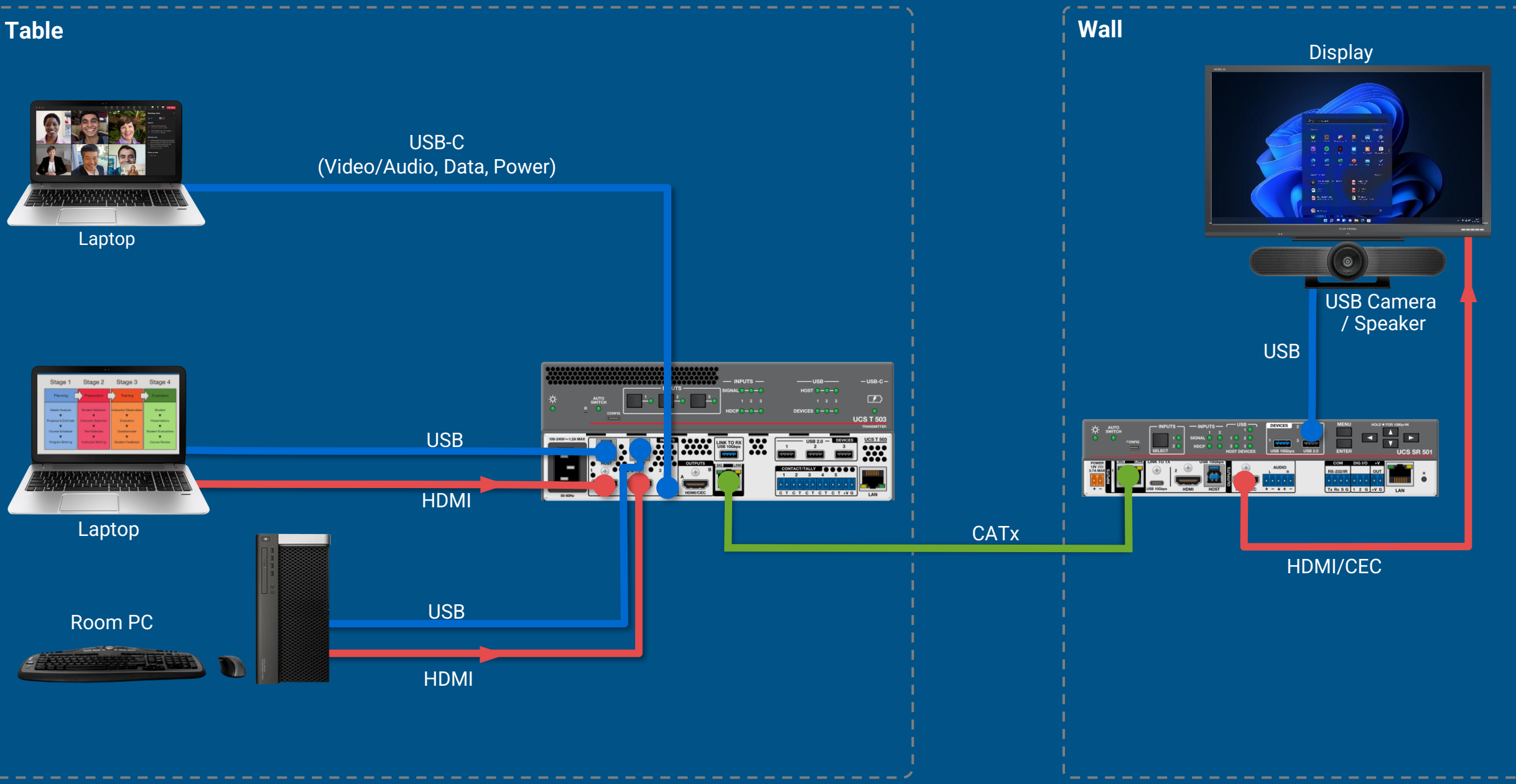
USB



USB Capabilities



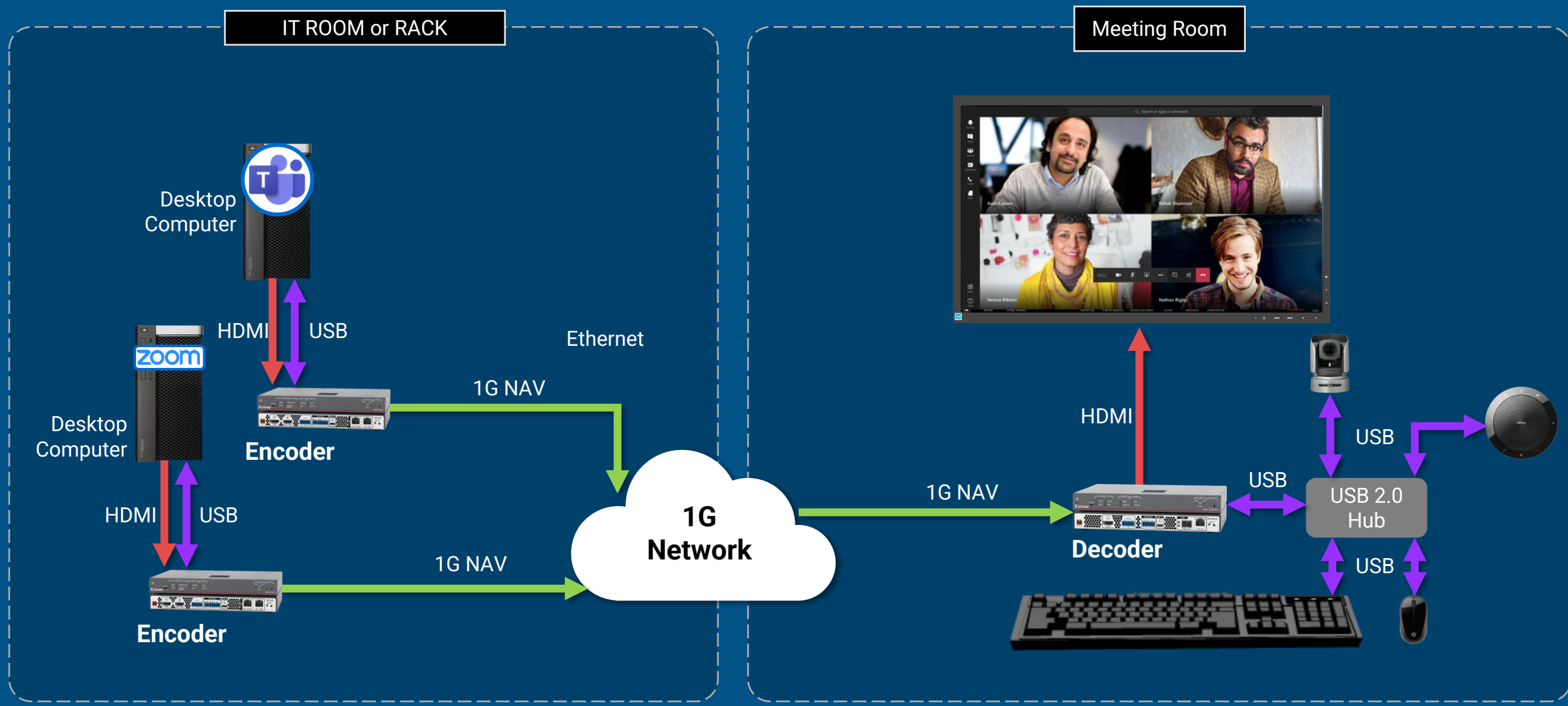
Meeting Room with Room PC – Automation



AV over IP with USB



Collaboration System Using USB and AV over IP



3 Main Themes Today

1. USB can do 3 things
   - Power(watts)
   - Alt Mode
   - Data
2. Understand your HOST & Peripheral
3. HUB Count



AV, Data, and Power: Untangling USB-C Integration in Today's Education Spaces

Joseph Frotton
Extron
Regional Applications Specialist

BICSI CALA