SUPERSPEED USB EXTENSION OVER HDBASET

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INTRODUCTION

The ability to extend USB over long distances with ultra-dependable HDBaseT technology is not new; it was introduced as part of the HDBaseT 2.0 standard in 2013. But that was USB 2.0, and being ancillary to the main HDMI transmission it was used mainly for keyboard, mouse, and other relatively slow speed peripheral applications.

In more recent years, applications have evolved and so too has USB. The rise of remote and hybrid workplaces and meeting spaces has seen a growing need for versatile videoconferencing technologies for greater meeting equity; the industrial sector is revolutionizing machine vision technologies for greater accuracy and productivity with lower waste; medical settings are transitioning to digital augmentation with the need for ultra-reliable high-resolution video and control with zero latency. Meanwhile, the USB interface has upsized its capabilities with “SuperSpeed” USB 3.2 protocols, and downsized the connector with the more versatile and user-friendly USB Type-C.

The applications for USB are now more varied and demanding than ever, but cable lengths are a limiting factor and extension solutions generally exhibit application, performance and/or cost barriers. HDBaseT has risen to the challenge with very high performance, professional grade SuperSpeed USB 3.2 extension with optional power delivery up to 100m (328ft) over standard category cable.

However, USB can still be somewhat confusing with so many connectors, protocols, and speeds in play. This paper serves to clarify the USB ecosystem and scope of applications, how HDBaseT solves the extension challenge, and installation recommendations for high-performance deployments.

USB OVERVIEW

Universal Serial Bus (USB) was first released in 1996 as a faster, unified alternative to Universal Asynchronous Transmitter/Receiver (UART) interfaces. Since then, the USB Implementers Forum, Inc (USB-IF) have developed evolving iterations of the specification with higher speeds and greater diversity in capabilities, connectors, and applications.

It is important to understand the differentiation and relationship between the USB protocols and the USB connectors through which they operate, as described below.

USB Protocol

The USB protocol defines the data transfer structure and feature set that operates over a USB interface. It describes how all the connected devices in the USB system will communicate and how data is exchanged, including system hierarchy, data packet structure, and transfer rates (speeds).

System Hierarchy

The USB Specification describes the USB Host, Device, and hubs:

- **Host -** Every USB system has just one Host, most commonly a PC or similar. The Host controller manages the USB system, controls the bus, initiates communications, and schedules bandwidth
- **Device** - A peripheral that connects to a USB system; sometimes referred to as a USB client. e.g., keyboards, mice, external HDD/SSDs, cameras, microphone arrays, etc.
- **Hub** - Device that expands a single upstream bus into several downstream, enabling more ports to which to connect Devices
- **Root Hub** - a pseudo device that sits at the "root" (Tier 1) of the USB topology and controls the bus. This is most commonly embedded with the Host controller but can also be externalized

Each of these may interconnect in a tier-based hierarchy with up to seven levels from Host ("root hub") to Devices, with up to five cascading hub tiers in-between. While Devices can be connected at any tier beyond the Host, branching into another tier requires a hub. Theoretically, up to 127 devices can be connected to a USB system but this may vary depending on individual Hosts/systems.

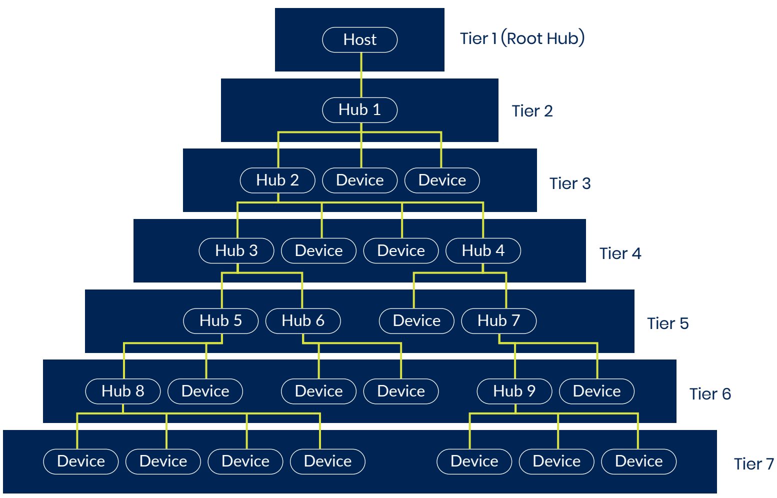

Figure 1 Example of a USB 7-tier hierarchal architecture

Types of Transfers

Data transfers can be one of four types, categorized as periodic or non-periodic:

- **Periodic repeats itself with a timing pattern, typically with very low latency. Two types:**
    1. Isochronous — devices operating at the same time as others, typically with a continuous stream without error checking. For example, web cameras and audio devices that need to prioritize continuity over occasional errors
    2. Interrupt — typically "consists of event notifications, characters, or coordinates from a pointing device."[1] For example, keyboard and mouse
- **Non-periodic are irregular and not time sensitive. Two types:**
    3. Bulk — for transferring large amounts of data without bandwidth allocation, meaning transfer speeds can fluctuate with variable latency. For example, external HDD/SSD file transfers
    4. Control — bi-directional request-response communications, typically used to set up USB Devices. Used by all device types along with any of the above transfers.

USB Versions and Speeds

Since its inception USB has evolved with four major version releases, as listed in Table 1. Key among the changes was the data transfer rate, colloquially known as "speed," and the labelling scheme, particularly with USB 3.x.

The evolution of USB 3.x can be summarized as follows:

- USB 3.0 was released in 2008 with 5Gbps data rate. Products and cables were widely marketed at the time simply as "USB 3.0" or "SuperSpeed" (SS)
- USB 3.1 later supplanted version 3.0, retaining the 5Gbps speed but also adding 10Gbps SuperSpeed+. This led to the two speeds being called Gen 1 (5Gbps) and Gen 2 (10Gbps)
- In turn, USB 3.2 replaced USB 3.1. The main change was the introduction of second Tx/Rx pair for dual-lane operation, with Gen 1 and Gen 2 now being suffixed by "x1" or "x2" to denote single- or dual-lane operating mode:
    - Single lane: **Gen 1x1** (5Gbps), **Gen 2x1** (10Gbps)
    - Dual lane: **Gen 1x2** (5Gbps x2 = 10Gbps), **Gen 2x2** (10Gbps x2 = 20Gbps)

[1] *Interrupt Transfers*
Keil.com
www.keil.com/pack/doc/mw/USB/html/_u_s_b__interrupt__transfers.html

Table 1 USB versions and associated labels and branding

Version	Label	Encompassing	Speed	Operating mode
USB 2.0	USB 2.0	USB 1.0/1.1	1.5 Mbps (Low Speed) 12 Mbps (Full Speed) 480 Mbps (High Speed)	USB 2.0 half-duplex
USB 3.2	USB 3.2 Gen 1x1	USB 3.0, USB 3.1 Gen1	5 Gbps SuperSpeed	Single lane (x1) Tx/Rx
	USB 3.2 Gen 2x1	USB 3.1 Gen 2	10 Gbps SuperSpeed+	Single lane (x1) Tx/Rx
	USB 3.2 Gen 1x2	-	10 Gbps dual lane SuperSpeed	Dual lane (x2) Tx1/Rx1/Tx2/Rx2
	USB 3.2 Gen 2x2	-	20 Gbps dual lane SuperSpeed+	Dual lane (x2) Tx1/Rx1/Tx2/Rx2
USB4® v2.0	USB4®	-	20Gbps 40Gbps 80Gbps (future) 120Gbps (future)	Dual lane (x2) Tx1/Rx1/Tx2/Rx2

The resulting architectures can be described with a simple road analogy. USB 2.0 can be likened to a narrow single lane bridge wherein traffic from each direction must take turns to cross. That slows things down. USB 3.x left the old narrow bridge intact (for backward compatibility) but built a new divided road beside it for improved traffic flow with reduced delays. Running one lane in each direction suffices most of the time, but in some circumstances an extra lane each way can also be available to double the traffic flow.

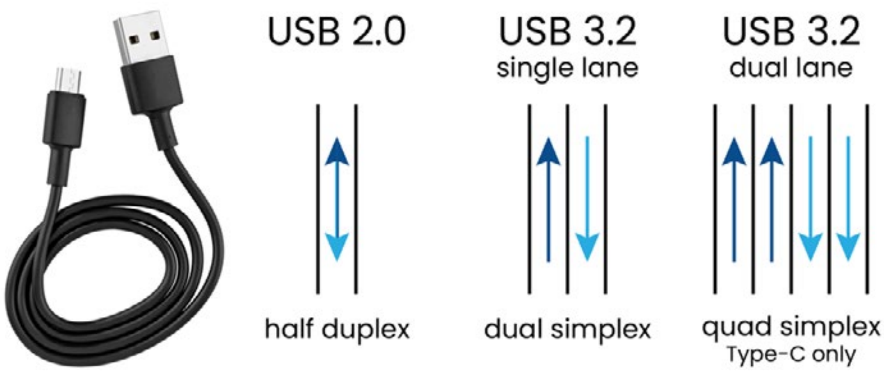

Table 2 Traffic flow configurations showing shared (USB 2.0) vs dedicated lanes (USB 3.2)

The industry has seen exponential growth in professional grade AV and interactive products utilizing 5Gbps USB 3.2 that can benefit from longer cable installations. Applications demanding higher than 5Gbps are more commonly synonymous with short length connectivity, including connection of monitors using ThunderboltTM (if supported) or DisplayPort alt mode over the USB cable, or for direct connection of HDD/SSD mass storage devices. As such, USB 3.2 Gen 1x1 is the focus of HDBaseT technology and of this paper hereon.

USB Data Packets

The USB protocol specifies "the format and structure of each packet, including the number bits in each field, the order in which the fields appear, and the correct values used to identify each type of packet."[2] Crucially, a portion of the data being transferred is dedicated to signal structure and integrity and not the payload itself. This includes protocol headers (token packets), acknowledgement packets (ACK) to ensure arrival, and cyclic redundancy check (CRC) for data integrity.

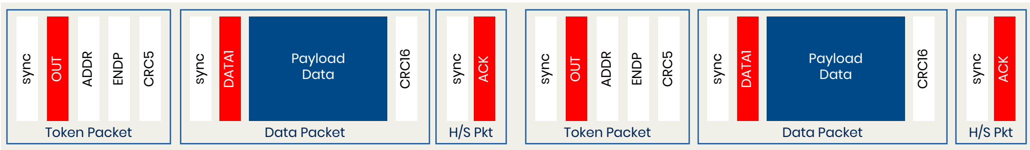

Figure 3 *Simplified depiction of USB packet structure*

The presence of this additional data means that the actual payload transfer rate is less than the maximum as stated for each USB version.

Link vs Payload Transfer Rates

USB transfer rates can be considered in three communication layers:

1. **Physical transfer rate** - the raw data rate going through the interface. e.g., 5Gbps for USB 3.2 Gen 1x1
2. **Link level rate** - a portion of the total data being transferred is overhead, a result of the encoding process that requires balancing the signal voltage (+/-) to ensure it works over a length of cable. For instance, USB 2.0 uses an encoding method called "Non-Return to Zero Inversion" (NRZI) which accounts for up to 14% overhead, whereas USB 3.2 Gen 1x1 uses 8b/10b encoding with a 20% overhead. The link level rate is the net data transfer rate with this overhead removed
3. **Payload data rate** - this is the link level rate less all the non-payload data, such as token, sync and acknowledgement packets. In the case of USB 2.0, the real-world payload rate is further reduced due to it being half-duplex, wherein downstream transfers are delayed during upstream acknowledgement and control packet transfers

Table 2 *Physical vs link level vs payload data transfer speeds*

USB version	Max. data rate	Link level rate	Payload rate
USB 2.0	480Mbps	~ 412Mbps	~ 320Mbps
USB 3.2 Gen 1x1	5Gbps	4Gbps	3.812Gbps

Note that applications that are used to measure USB transfer rates usually measure the payload data transfer rate. Furthermore, off-the-shelf USB hubs typically also add some latency, being one of many reasons why the real-world transfer rates are typically lower than the maximums stated. HDBaseT symmetric link technology fully conforms to the USB 3.2 specification, optimizing the USB link for reliable transfer rates with zero latency.

[2] *What are USB Packets?*
USB Makers
www.usbmakers.com/usb-data-packets-explained#:~:text=The%20USB%20protocol%20specifies%20the,identify%20each%20type%20of%20packet

USB Connectors

There have been several different USB connectors over the years, the different form factors and configurations of which have enabled a great range of applications and support for the evolving protocols. The main connectors are shown in figure 4, with those labelled in blue compatible with USB 3.2 SuperSpeed.

Figure 4 Predominant USB connector types (male plug shown, not to scale)

For the purposes of this paper, the USB-A SuperSpeed and USB Type-C (hereon referred to as USB-C) are the most current and relevant connectors in commercial extension settings.

USB-A SuperSpeed

USB-A SuperSpeed was introduced in 2008 to coincide with the release of USB 3.0. It retained the same USB-A form factor and pin configuration (data +/-, V, Gnd) to ensure backward compatibility, but added five extra pins for the new USB 3.0 dual-simplex Tx/Rx lane plus ground. Users can easily distinguish SuperSpeed connectors by the blue tab inside (as opposed to the original white), making them compatible with both USB 2.0 and the single-lane operating mode of USB 3.2. note that this connector **cannot** support dual lane modes.

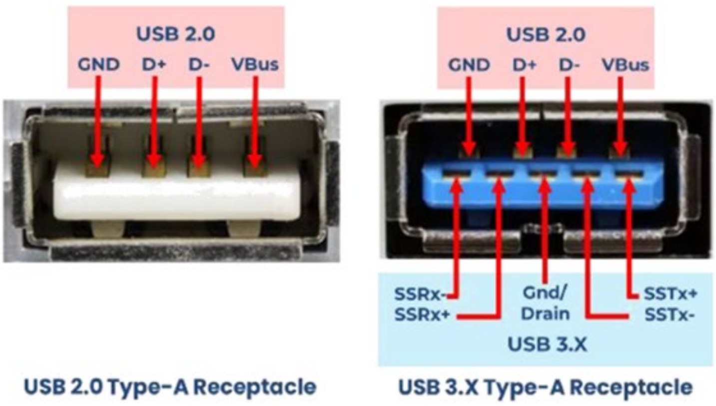

Figure 5 USB-A receptacles: up to USB 2.0 (left) and USB 3.x Superspeed with backward compatibility (right)

USB Type-C

The USB-C connector was introduced in 2014. Small and elegant, a key design point is its reversible orientation for user-friendliness. Its layout of two symmetric rows of twelve pins each includes channel configuration (CC) pins to establish the connected configuration depending on which way around the connector is inserted (shown in green in figure 5). Other features include:

USB-C retains backward compatibility pins for interfacing with USB 2.0 (A or B row used depending on inserted orientation) and two pairs of Tx/Rx pins for one- or two-lane modes of USB 3.2 and USB4. Only USB-C is equipped with the second data lane (Tx2/Rx2), making it the only connector that can be used with dual lane USB modes.

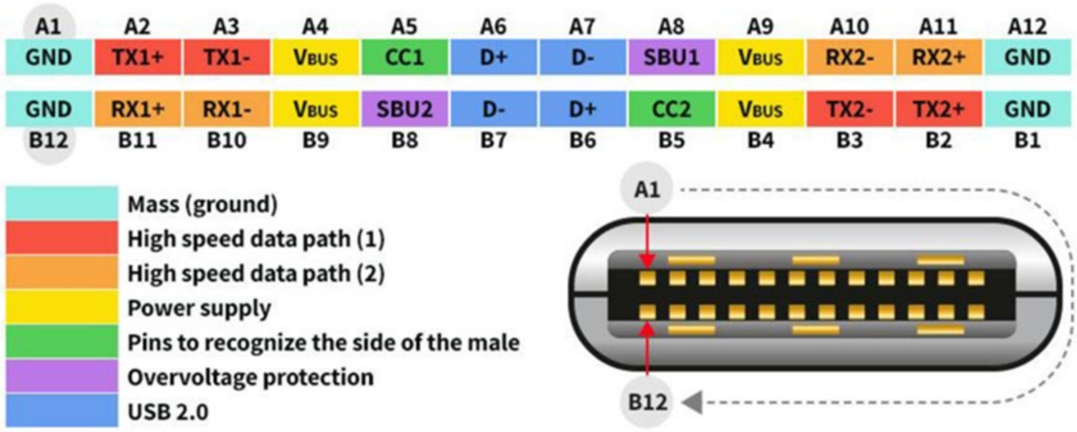

Figure 6 *USB Type C connector configuration with row B being the mirror of row A for reversible orientation. USB 2.0 contacts can interface with any USB-A (with appropriate cable), while Tx/Rx contacts are for use with USB 3.2*

Moving forward, USB-C is transitioning to become the main USB connector, initially driven by portable devices but expanding across fixed-install devices too. In 2022 the European Council, Commission and Parliament announced: "By the end of 2024, all mobile phones, tablets and cameras sold in the EU will have to be equipped with a USB Type-C charging port. From spring 2026, the obligation will extend to laptops."[3] While this proclamation was about device charging, many devices also share the same socket for data transfer. As such, unifying to a common connector makes sense, although some confusion may ensue when it comes to selecting suitable cables for a given application — see the section: Cable Recommendations.

[3] *Long-awaited common charger for mobile devices will be a reality in 2024*
www.europarl.europa.eu/news/en/press-room/20220930IPR41928/long-awaited-common-charger-for-mobile-devices-will-be-a-reality-in-2024

USB 3.2 EXTENSION OVER HDBASET

As capable and versatile as USB is, a major drawback is the limitation in native cable lengths. With passive cables, USB 2.0 is limited in practice to around 5 m (16 ft) while USB 3.2 (5Gbps and higher) is typically limited to only around 3 m (9 ft), especially with the smaller USB-C connector limiting the cable diameter. There are some extension solutions available such as active cables and optical fiber modules, but each has a unique set of pros and cons.

- Active cables are based on the premise of signal recovery with equalization, usually at the receiver (Rx) end. Lengths can be as long as 40m (130 ft) but they're typically bulky and can't be field terminated. They are generally not recommended for applications where maximum performance and uptime is required.
- Optical fiber extenders usually comprise an active module/dongle at each end interfacing with standard fiber connectors or SFP transceivers. They can offer very long length potential with bit-exact transmission and EMI immunity but may require specialist tools and skills for field termination. However, the main downside of fiber extension, other than high cost, is that it can't transmit power, meaning that remote power availability will be needed for both the Rx unit and the USB device to which it's connected.

HDBaseT introduces professional grade USB 3.2 extension up to 100 m (328 ft) over industry standard category cable. That greatly simplifies the pulling and field terminating of cables and optionally supports HDBaseT and/or USB compliant power over the link (depending on the product).

The Single-chip ASIC

At the heart of the HDBaseT solution is the Valens VS6320 chipset. This is the only solution that exists on the market that offers a high level of integration, complete USB 3.2 and separate USB 2.0 layer, plus control signals in a single-chip application-specific integrated circuit (ASIC) with integrated physical layer (PHY). The importance of a single ASIC is reflected both in terms of design simplicity, product size and lower power consumption of only about 2.5W.

By comparison, compared alternative solutions require several components for implementing the USB 2.0 and USB 3.2 layers plus PHY and logic. This can mean three or more chips instead of just one at each side of the system, significantly affecting the form factor and power consumption (typically 3x or more that of Valens).

How it Works: Features and Capabilities

According to Yaki Sfadya, Director of Product Management at Valens, "The VS6320 is represented as a Hub to the USB system. Its architecture allows the transfer of all USB 3.2 signals while meeting the strict timing requirements of 5Gbps SuperSpeed USB and with minimal latency to enable high-performance USB transfer, similar to a direct connection between a USB Host and Devices."

The system works by creating a 6Gbps symmetric link over the length of category cable for the tunnelling of bi-directional USB-native multimedia content and control. Features include:

- Concurrent extension of USB 2.0 with rates up to 480Mbps and USB 3.2 Gen 1x1 with rates up to 5Gbps. USB 2.0 and 3.2 are each handled differently, as follows:
  - USB 2.0 — both ends of the HDBaseT system combine to appear to the Host as a single virtual USB Hub with 7 ports. However, the HDBaseT system serves as a root hub, meaning the hub and device topology beyond the HDBaseT system are not visible to the USB Host
  - USB 3.2 — the HDBaseT system presents as a single USB hub with one upstream port and one downstream port (to which a hub can be connected), with the full hub and device topology visible to the USB Host. That is, the Host can access the entire tree of connected USB Hubs and Devices
  - Support all 7 tiers of the USB hierarchy
- Support for all types of USB transfers with hardware acceleration integrated for Isochronous In and Bulk In transfers
  - Maximum measured rate: 3.96Gbps Isochronous and 3.92Gbps Bulk
- Maintains USB 3.2 protocol timing requirements for optimal interoperability and low latency
- Concurrent control and frame synchronization signal extension via tunnelling of UART, 4x Multi-Standard In/Out (MSIO), and frame sync General Purpose In/Out (GPIO)

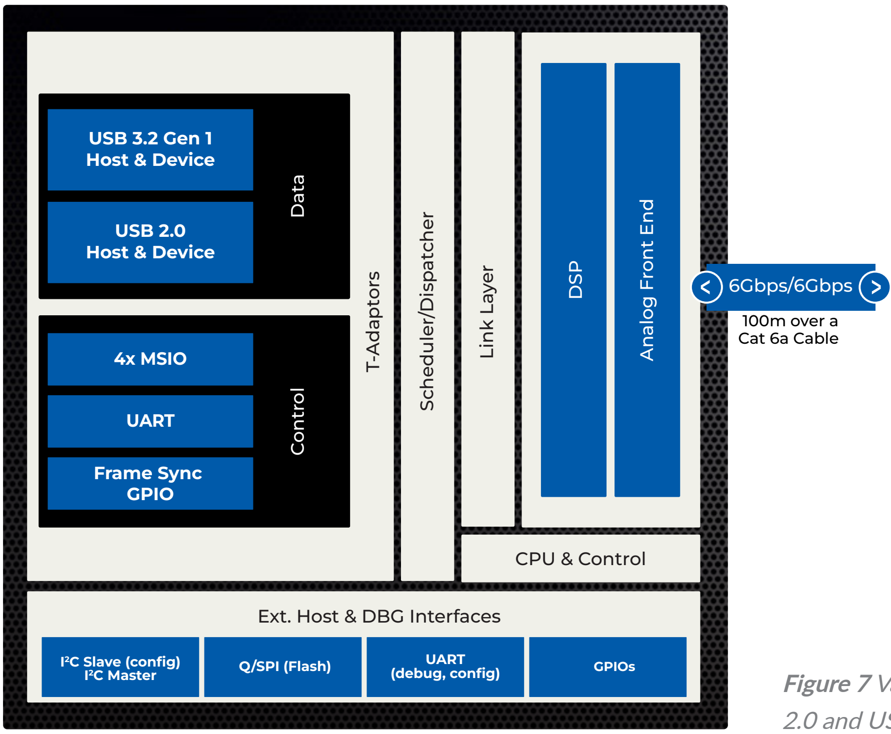

Figure 7 *Valens VS6320 block diagram showing separate USB 2.0 and USB 3.2 interfaces along with UART, GPIO, and MSIO*

Although the VS6320 harnesses the same base technology as previous HDBaseT solutions including the USB specifications of HDBaseT 2.0 and HDBaseT 3.0 for 5Play extension with HDMI® and the VA6000 family, it is not backward compatible. That means a VS6320-enabled Host side extender can't directly interface with a VS2000 or VS3000 series receiver's USB 2.0 capability, and vice versa. This is primarily due to the VS6320 producing a symmetric link for 6Gbps upstream and 6Gbps downstream, whereas other solutions are asymmetric with mostly downstream bandwidth.

Power Delivery

A dominant feature of HDBaseT since its inception in 2010 has been the ability to provide power over the link. This is not a direct feature of the Valens IC, rather a parallel supported capability most commonly utilizing industry standard Power-over-Ethernet (PoE) Power Sourcing Equipment (PSE) and Powered Device (PD) modules integrated into extension products.

This capability is continued in conjunction with professional grade USB 3.2 extension over HDBaseT. Yaki Sfadya advises: "The power, as in other HDBaseT product families, is managed and provided by external components/circuit, including the PoE/Power-over-Cable (POC)."
This includes the ability to interface the USB Host and/or Devices according to the USB power protocol. For example, a Host-side HDBaseT transceiver may be enabled to negotiate power delivery from the USB Host instead of requiring an external power supply for its operating power. This is at the discretion and innovation of product manufacturers but is supported in-principle by HDBaseT.

APPLICATIONS

Applications for SuperSpeed USB has grown significantly in scale and diversity. Where once the main use was for connecting an external HDD to a desktop or laptop computer, only requiring very short cable lengths, now applications have expanded into many commercial, industrial and medical settings with a need for longer lengths and connection of multiple devices. The transition from USB 2.0 to USB 3.2 is driven mainly by higher resolution cameras with interactive capabilities. Stable and dependable performance is essential.

USB 3.2 applications include but are not limited to the following:

- High-resolution, high frame rate imaging in real time
- Transfer of uncompressed video for additional processing such as for AI-powered subject tracking/ management
- Corporate meeting rooms, hybrid work, and educational spaces to deliver effective meeting equity. This can require setting up multiple cameras and microphones to see different angles or focus points to ensure that all participants can be clearly seen and heard for optimal participation. SuperSpeed USB unifies connectivity for video and control through one cable for use with:
  - Video bars
  - 360° cameras
  - PTZ cameras
  - Interactive whiteboard connectivity
- Unified communications and video-as-a-service (VaaS) — low-latency or real-time video for interactive live streaming services
- BYOD connectivity and screen sharing
- In-room touchscreen panels
- Industrial cameras for machine vision and customized integration
- Industrial PC control
- Medical real-time monitoring and video recording

Figure 8 Application examples: conferencing cameras and peripherals, interactive education, industrial machine vision, medical precision and diagnostics

The true power of SuperSpeed USB extension over HDBaseT is its function as a USB hub. Unlike HDBaseT versions 2.0 and 3.0 that dedicated a majority of bandwidth to a single HDMI stream, USB 3.2 extension enables connection of multiple USB devices that can operate concurrently.

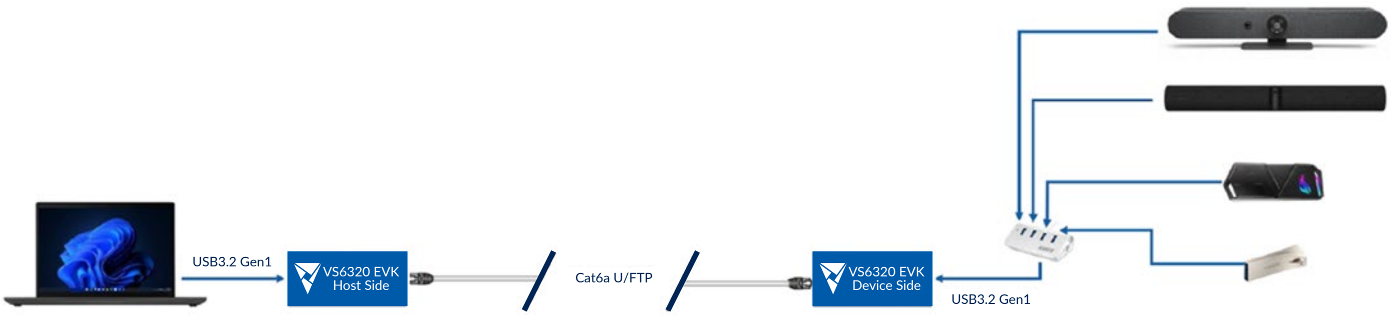

Figure 9 The true power of SuperSpeed USB extension over HDBaseT is its function as a USB hub. Unlike HDBaseT versions 2.0 and 3.0 that dedicated a majority of bandwidth to a single HDMI stream, USB 3.2 extension enables connection of multiple USB devices that can operate concurrently.

Another important consideration is green field versus retrofit installation demands, including access for cabling and availability of power at required locations. Installing new technologies should not be a predictive art, rather planned in infrastructure. The use of industry standard category cable for HDBaseT extension, particularly with versatile Power-over-HDBaseT (PoH) options offers the greatest flexibility and upgrade path.

CABLE RECOMMENDATIONS

HDBaseT Link — Category Cable

The HDBaseT Alliance recommends Cat 6A U/FTP cable for use with USB 3.2 SuperSpeed extension. That is, high bandwidth foiled twisted pairs without overall shielding with rating for 10Gbps to 100m. The superior bandwidth (500MHz) of Cat 6A matched with appropriately terminated connectors is necessary for maintaining the integrity of the high performance HDBaseT signal, while the individually shielded pairs are sufficient in protecting the signals from electromagnetic interference (EMI) and both inter-pair and alien crosstalk.

Individually shielded pairs also enables a skewless cable geometry, meaning each pair can maintain the same twist rate for better tolerances, as opposed to different twist rates for crosstalk mitigation in unshielded cables.

Some installation companies and/or sites may standardize the use of Cat 7 cable, which is also compatible. The specified 600MHz bandwidth of Cat 7 is based on termination with GG45 or TERA connectors; if terminated with RJ45 connectors, Cat 7 may produce equivalent bandwidth to the later Cat 6A specification, meaning both may perform similarly for HDBaseT applications. Ease of handling and cost are then choices for the installer. Cat 7A (essentially obsolete) and Cat 8, while both higher bandwidth again, offer no functional advantage for HDBaseT extension and may further increase handling complexity.

USB Cables

Not all USB cables are created equal. Cables can and do vary and it's important to use the right specification and quality of cable for the intended application. For example, some cables are intended for charging applications only, without support for data. System specifiers are advised to ensure that any candidate USB cables should be qualified for the intended application, as follows:

- **USB-A** — Ensure the cable has the extra contacts to support USB 3.2. This is standardized with the presence of a blue (instead of white) internal tab, but some manufacturer may deviate from this and provide another means of indication. For example, use of the official labels from USB-IF indicating a certified cable, as shown in figure 7

- **USB-C**
  - These cables have even more capabilities, and therefore are available in a bigger variety of configurations
  - Any USB-C cable will generally support DC power at least to a basic level, but everything else is optional
  - A USB-C cable that specifies support for 480Mbps can be assumed as having the USB 2.0 pins terminated but not the SuperSpeed lane. Such cables are unsuitable for USB 3.2 applications
  - Cables labelled ThunderboltTM will be compatible even if USB speed is not indicated
  - Important note: Never assume that because a cable has USB-C connectors at both ends then it must support all capabilities of USB-C

Figure 10 USB SuperSpeed logos for packaging (left) and on the cable (right)

Derek Wiley from Sound & Video Contractor reported on some of the different permutations, including a scan of four terminated USB-C cable connectors to show the vast differences, as shown in figure 8.

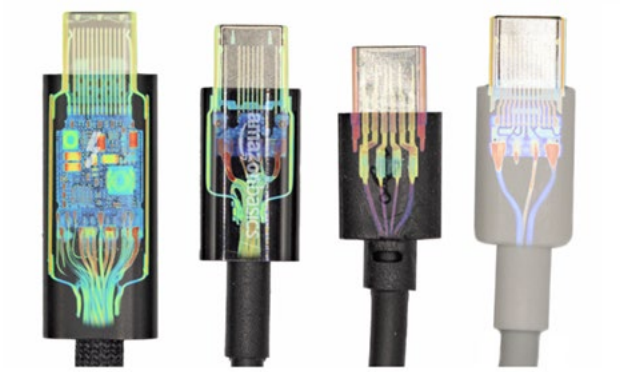

Figure 11 USB-C cable x-ray CT scans revealing internal configurations for different applications. #1 with internal PCB with full USB 3.2 Gen 2x2 support; #2 is USB 2.0 only (480 Mbps); #3 is a more basic version for USB 2.0; #4 is very low end with what appears to be power only for charging portable devices.[4]

Furthermore, even with the appropriate minimum specification of cable selected, it is also advisable to verify the integrity of the manufactured cable prior to or at time of installation. Testing to ensure the cable can operate as expected can mitigate valuable troubleshooting time and maximize the performance and reliability of installations.

USB-C Cable Testing

Verification of expected performance of cabling and subsystems is a fundamental and important step in the completion of any commercial, industrial, or medical installation. This has been well understood and practised when it comes to ensuring that terminated category cables are fit for purpose for Ethernet and HDBaseT applications, but what about USB-C cables?

Fortunately, field testing devices are commercially available to check the configuration and connectivity of USB-C cables, including power and sweep tests to check for USB protocol suitability and bandwidth. While faulty cables are relatively rare, such tests can also reveal if any pins that are meant to be connected are in fact nonoperational either from damage or manufacturing defect. Figure 10 shows a basic test interface to list supported features for a cable under test, while figure 11 shows sweep test results for three different cables.

[4] *CT scans of USB-C cables reveals the difference an extra $120 makes*
Derek Wiley, Sound & Video Contractor
www.svconline.com/proav-today/ct-scans-usb-c-cables

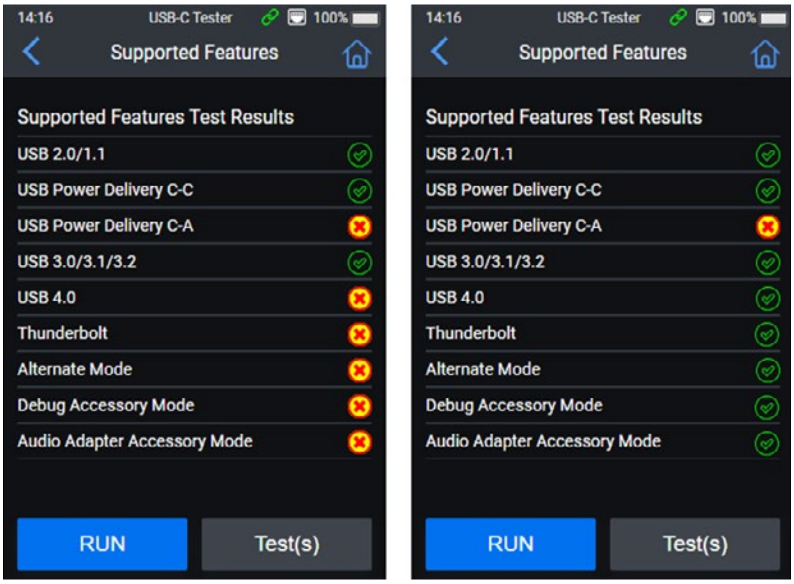

Figure 12 *MSolutions Supported Feature test comparing 2 cables: standard support for USB 3.2 (left) and a fully-featured dual-lane cable (right). Both are compatible USB 3.2 extension over HDBaseT*

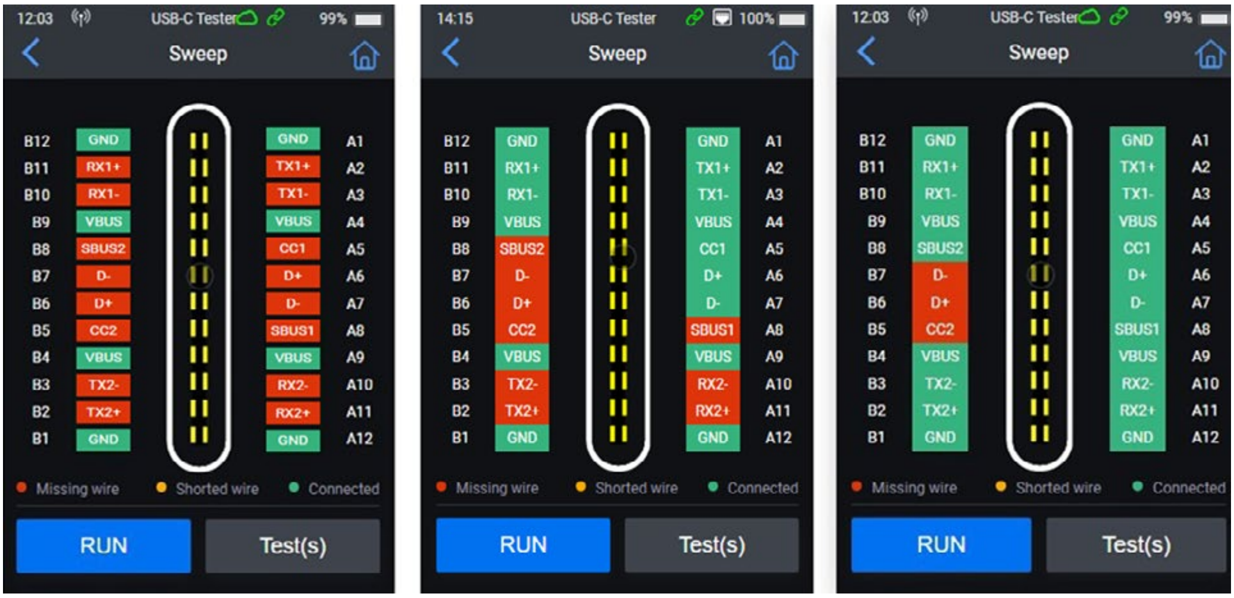

Figure 13 *MSolutions Sweep test comparing 3 different cables: power only without data support (left), single lane USB 3.2 + power (middle), dual lane USB 3.2/4 + power (right)*

SUMMARY

The applications for SuperSpeed USB continue to evolve. Systems based on HDMI® for AV with parallel USB for control are giving way to unified connectivity with SuperSpeed USB to empower immersion, interactivity and automation. But restrictions in cable length and/or performance can inhibit the user experience potential in commercial, industrial and medical settings where demands for versatility and performance are paramount. Only with USB extension and Hub virtualization can the potential be fully realized.

Based on HDBaseT standards and technology, the Valens VS6320 does just that. It is the only ASIC solution that exists on the market today that allows extension of standard USB 3.2 (alongside USB 2.0 and control signals) with professional grade performance up to 100 meters over category cable. The VS6320 allows maximum transfer rates similar to a direct connection between USB host and device, while offering all the additional advantages of using HDBaseT technology.

While implementations of USB extension over HDBaseT can unlock a plethora of professional capabilities, it remains important to also ensure the integrity of the physical layer — the cables. That goes for USB cables, particularly the build and configuration of USB Type-C, but also the category cable that makes the HDBaseT link. For this, Cat 6A U/FTP is recommended to achieve the maximum performance and reach potential.

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