APPLICATION BRIEF

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High Definition AudioVisuals over Structured Cabling ›

An introduction to HD Base-T and SDVoE

A converged networking infrastructure, supporting a range IoT devices, VoIP, Intelligent Lighting, HVAC, Building Access Systems etc., underpinned by category cable is now the new normal. As more and more technologies have transitioned from dedicated infrastructures to adopting the internet protocol (IP), so has the Audio Visual (A/V) world.

But as always, with new cutting edge technologies come new challenges. Today it is common to find increasingly large digital displays installed in classrooms, hospitals, hotels, and other types of commercial building. This creates the need for higher-definition video and image, moving beyond the high-resolution of 1080p "Full HD" to UHD.

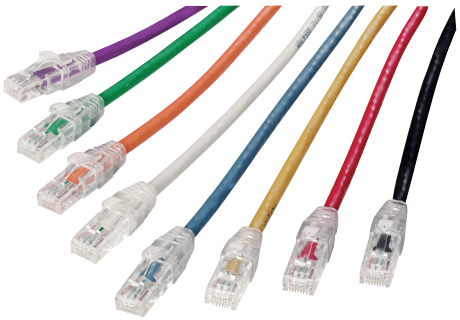
What we call UHD (Ultra-High-Definition) video with 4K (and even 8K) resolution is now considered to be the next standard. The digital High Definition AV signals of these displays will demand more and more bandwidth as the definition (number of pixels) increases.

Anticipating future needs and transmission speed of frame rates is essential. A/V systems are now consuming more and more bandwidth and their transmission speed rates are constantly increasing.

Why not HDMI?

Before we start, it's important to realize that HD Base-T, SDVoE and AVoIP in general all work with and support HDMI. These technologies are HDMI compliant and not a replacement for HDMI.

However, HDMI cabling has some serious limitations. Due to attenuation, HDMI cables are limited in length to around 10m. They are heavy and very difficult to pull through conduits since the connectors are usually overmolded. High quality cables can also be expensive.



Ethernet twisted-pair cable (top) and HDMI cable (below)

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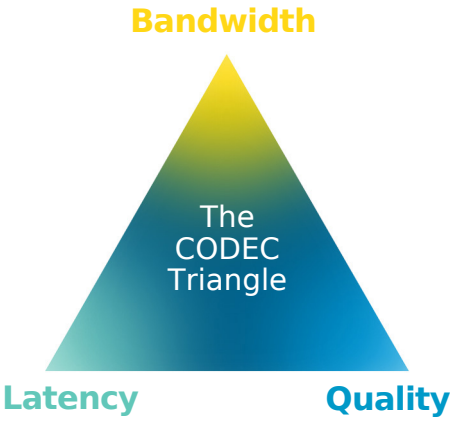
The CODEC Triangle

When transmitting video, an essential piece of metadata is the CODEC, which is a mix of the words Coder, and Decoder, or Compression and Decompression. The video compression of a CODEC seeks to balance bandwidth, latency, and image quality in a way that is best suited for the particular application. It's simply not possible to optimize a video for all 3, so there is always a tradeoff in video compression.

Unlike traditional CODECs which use intraframe or interframe CODECs, SDVoE and HD Base-T use line-by-line compressions to optimize for low latency and high quality.



HD Base-T : Main Principles

HD Base-T comes from the HD Base-T Alliance, which promotes, advances and standardizes HD Base-T technology. It also promotes the adoption of HD Base-T as the global standard for HD video and digital connectivity.

HD Base-T is a standard for the transmission of HD and UHD (Ultra High Definition) video and audio, Ethernet, controls, USB, and up to 100W of power over a single cable for up to 100m/328ft on copper, and several kilometers on fiber optic.

Put differently, HD Base-T is a connectivity standard for residential and commercial distribution of uncompressed ultra-high-definition multimedia content. It allows HDMI signals to be transmitted over balanced twisted-pair cabling and fiber optics.

The cornerstone of HD Base-T is "5Play", which is a multi-feature set that converges uncompressed full ultra-high definition 4K video, audio, Ethernet, and others, through a single copper cable or fiber. HD Base-T also supports PoH (Power over HD Base-T), enabling safe delivery up to 100 watts over 4-pair balanced twisted pair cables.

We are now on the 3rd Generation of HD Base-T (HD Base-T Spec 3.0). It's important to realize that HD Base T Spec 1.0 and 2.0 are not based on IP Packets. HD Base-T is NOT Ethernet. Although HD Base-T uses RJ45 connectors and uses coding technology and the physical medium used by IP, it is not IP. HD Base-T uses T-packets, a different packetization protocol. Spec 3.0 added support for a new physical layer (PHY) based on Ethernet/IP, but HD Base-T signals cannot be passed over a standard Ethernet network.

However, HD Base-T supports Ethernet Fallback mode, which means the HD Base-T device can be plugged into an Ethernet-only infrastructure. The device will sense it, and will enable only the Ethernet capabilities of the connection. Since an HD Base-T port is identical to an Ethernet port, users can connect to it and have fully functioning Ethernet, but no HD Base-T functionality.

It is also worth noting that OEMs do not need to design a device with a separate HD Base-T vs Ethernet port - it can be the same port that can be used for either HD Base-T (including Ethernet) or Ethernet only connectivity.

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HD Base-T Classes

HD Base-T Class A is the traditional HD Base-T product, supporting all 5Play features and able to be transmitted up to 100m/328ft. It was the first to be introduced when HD Base-T was created, but very quickly the HD Base-T Alliance recognized the need for different classes.

HD Base-T Class B is a more cost-effective solution for certain applications. It supports distances of only up to 70m/230ft, and does not support Ethernet functionality. Long-reach mode allows for long-reach connectivity on copper- up to 150m – for lower resolutions of up to 720pp.

Class C brought support for 1080p and 4K up to 100meters (with the correct category of balanced twisted pair cable), thanks to the introduction of an enhanced error correction mechanism.

Class D is used by specific markets such as Education which do not require long distances. It is more cost-effective but does not benefit from all the HD Base-T features.

Finally, Class E was introduced. It supports the same features as Class C, but over much longer distances.

SDVoE : Main Principles

SDVoE comes from the SDVoE Alliance which was founded in 2017. Its members share the objective of speeding up the replacement of point-to-point A/V connectivity and the Matrix Switch with Ethernet based transport systems.

With SDVoE, an API drives Software-Defined Video across a 10 Gigabit Ethernet Network. SDVoE is the API that will control all these A/V solutions, making sure they will work and interoperate.

An essential element of SDVoE is the 7-layer OSI model.

The OSI model is a way of sub-dividing a communications system into smaller parts, called layers. Similar communication functions are grouped into logical layers. Each layer provides services to the layer above while receiving services from the layer below. Each Host or Network Node has an OSI built into it. Control is based on software, hence the name “Software Defined Video over Ethernet”. Put simply, the SDVoE will tell the Transmitters and Receivers what they should do or which rules to follow.

In a link between two devices, information from the SDVoE Encoder or Transmitter (also called the Host, or Node) will start in the Application layer.

The data from this application is then broken down as it “travels” down the OSI layers, then a physical link will allow data to transmit from the Host computer to a Client, the SDVoE Decoder, or Receiver.

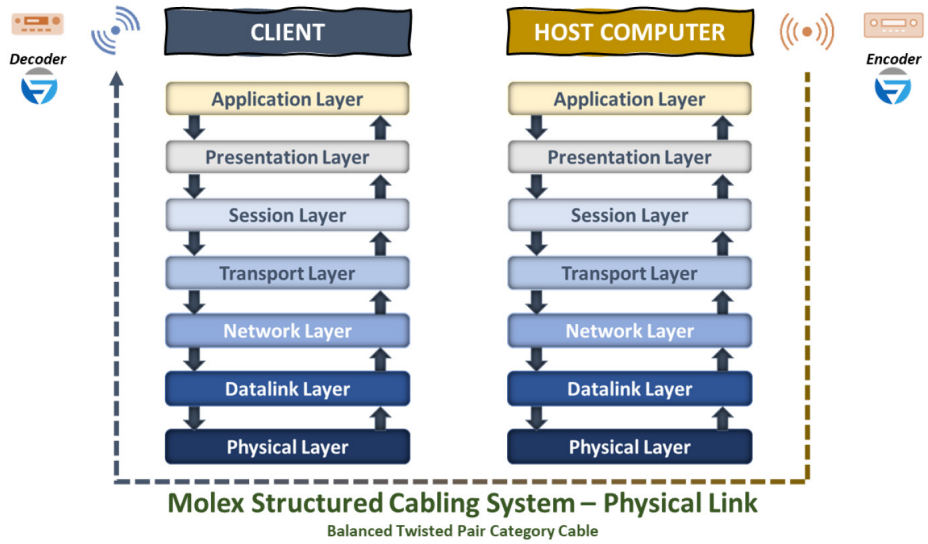
Once the data is transmitted, it is built back up as it returns up to the Application layer for the user.

SDVoE has some unique characteristics that enable it to transform video distribution.

Frame Rate Conversion

A frame which is buffered may be packed up at one speed (called the Video Clock Rate, or VCR) but then unpacked at another speed. Frame Rate Conversion allows for full scaling flexibility. No matter which resolution goes into the Encoder, it will be adjusted by the Decoder to the resolution the display is capable of.

The difference between the input and output clock may add between 1 or 2 frames of latency, which equals to max 10ms, which is far below the 50ms that the human eye can notice. But it will clearly allow for multiple video sources to be synchronized.



Video Mode Options for the receiver

Once the image or the video has been sent by the Transmitter, the Receiver may behave differently depending on which Video Mode has been set on the Receiver. It's important to note that 2 receivers may be set independently in different Video Modes, even if they receive identical information from the same Encoder.

The Gen Lock Mode ensures that the source connected to the SDVoE Encoder will output the exact resolution to the decoder connected to the Display. This is particularly important for mission critical applications, such as operating rooms for example.

Gen Lock Mode introduces a latency less than 100µs, which once again, is far below the 50ms that the human eye may notice. Additionally, the Gen Lock Mode may be set as an option to "Gen Lock Scaling" which will enable the scaling of the stream so that is perfectly matches the resolution of the display. Only a negligible amount of additional latency will be introduced.

The downside of Gen Lock Scaling is that it will introduce a brief blank screen when switch from one source to another, because the display is precisely synchronized with the source. This means Gen Lock Scaling is not ideal for applications that demand fast switching.

Another available mode is Fast Switching, which is of particular interest for applications where the switch of courses happens frequently, such as for a Police Command Center. Introducing a blank screen when switching from one camera to another would be totally unacceptable, so this mode allows for an instant switch between sources.

In Video Wall Mode Frame Buffering is leveraged along with Gen Locking. This will perfectly align objects when moving from one screen to another. Bezel correction is also used to reproduce a perfect and continuous video.

Lastly, the Multi-View mode will enable the streaming of different videos on a single display. This mode will simply adjust and scale the different source signals. This implies very stringent management of the bandwidth, both at the Transmitter and at the Receiver.

Multicasting in SDVoE

In the networking world, a broadcast address is used as a destination address for data. The source of this data will broadcast the message to all hosts within that network, whether these network nodes want it or not. This is bad for video distribution on Ethernet, because it will quickly saturate the Network.

On the other hand, a multicast address is a logical identifier for a group of hosts within a computer network. These hosts are available to process data packets or frames intended to be Multicast for a designated service. Multicast is used to forward the intended messages to only a certain group of hosts. As a result Multicasting can prevent wasted network bandwidth.

SDVoE leverages Multicasting, which is set at the Layer 3 of the OSI model, using IGMP (Internet Group Management Protocol). Multicasting also allows for an SDVoE Decoder to receive video from one transmitter and audio from another. It also allows receipt of multiple video signals from different transmitters, which eventually enables Multi-Viewing on the same display.

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Summary: HD Base-T versus SDVoE

HD Base-T and SDVoE are different technologies that work in fundamentally different ways. There is no “better” or “worse”. The following tables summarize some of the key differences and intended uses.

	HDBT™	SDVoE® ALLIANCE
Video Technology	Hardware Defined	Software Defined
Latency (Advertised)	<10µs	20 to 100µs
Ethernet Link	1Gb/s	1Gb/s
Port Duality	Yes	By design
Video Walls	Yes	Yes
HDCP	2.3	2.2
Daisy Chaining	Yes	No
Interoperability	Limited	Yes
RS-232	Yes	Yes
IR		
KVM		
USB 2.0		
1G Base-T support IToAV		
Power	100W PoH	90W PoE
Architecture	Dedicated	Shared
DIstance	100m Copper and Long-Reach	100m Copper
Copper Cabling	Cat6A	Cat6A mandatory
Scale	Small to Medium	Medium to Large
HDMI 2.0	Yes	Yes
HDMI 2.1	No	No
Dolby Vision / Dolby Atmos	Yes	Yes
4K 60fps		
Industry Applications		
Medical / Healthcare	Yes	Yes
Consumer		No
Hospitality		
Education		
Government		Yes
Retail		
Enterprise		
Automotive	Yes - HD Base-T Automotive	No
Industrial	Yes	Yes

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Cabling Requirements and Recommendations

The Molex Connected Enterprise Solutions Power over Ethernet Implementation Guide contains full guidance for both SDVoE and HB Base-T. This guide is part of the PoE Calculator, which can be downloaded from the Customer Support Portal (CSP). Log in or register for access here.

A summary of our recommendations is provided below:

- For PoE type 3 / Class 5 and above, we recommend (and for warranty purposes, require) Cat 6A cabling. This covers IEEE 802.3bt, HD-BaseT-3 (PoH), UPoE and SDVoE.
- Shielded cables and connectors are recommended. Ensure end-to-end shield continuity for shielded cabling systems.
- For requirements for higher resolution video or images, higher grade shielded cable should be used in order to prevent errors caused by EMI.
- Ensure less than 6mm of pair untwist at each end of a transmission channel.
- As per international cabling Standards, cable bundles should not contain more than 24 cables. Again, if the application in PoE Type 3 / Class 5, this is a requirement for eligibility for a Molex warranty.
- As per ISO/IEC TS 29125:2017, the maximum temperature rise for a cable bundle must be no more than 10°C / 50°F.
- When conduits are used, a maximum fill rate of 40% is recommended, as opposed to the standard 60% where PoE applications are not considered.
- It is highly recommended that each cable bundle be horizontally spaced to allow cooling by convection.
- Molex 28AWG 6A patch cords support high-speed 10GBase-T networks and offer a 20% space saving over standard 26AWG patch cords. However, additional measures must be taken to minimize heat build-up. For more information, consult the full lecture or White Paper (available on the CSP), or consult TIA TSB-184-A-1.

MORE INFORMATION

This article is an excerpt from a lecture first delivered in March 2021, titled “Safe and Easy Ways to Support the Latest A/V Technologies over Structured Cabling Systems”. The lecture is available to view on-demand or as a downloadable pdf, with accompanying FAQs. CSP users should log in and click “Lecture Series” to view. To log in or register for access to the CSP, click here.

For details of our range of shielded and unshielded Cat6A products, click here.

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