# The Best Route to Extending HD & UHD Over Long Distances

By AV Technology Staff

What's the best route to extending HD and UHD (Ultra-High Definition) 4K video over long distances? There's good news and bad news. Bad news first: There's no one definitive path. That's also the good news: You have options.

Until the past year or so, the best way to extend today's HD and 4K UHD content over long distances had been fairly cut-and-dry, with a few variations. Today, claims such as "zero latency" are bandied about, the cost of fiber-optic cabling is coming down, and the development of advanced compression technologies offer more than a few ways to navigate this milieu and still arrive within the range of acceptable delay.

This guide presents several ways to get you and your video signals there, three case studies from those who have arrived, and more than 40 products to help you decide which routes to travel.

## THE BIG DEAL WITH UHD

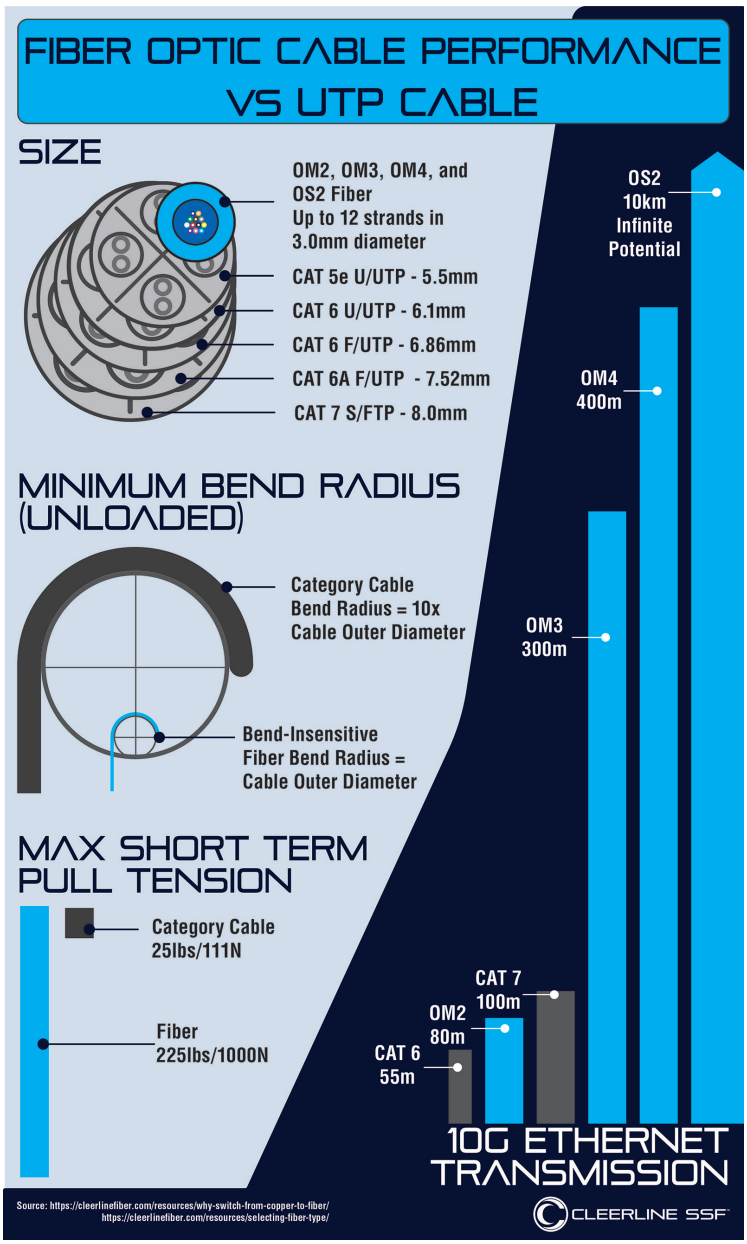
What's the big deal with UHD 4K and upcoming 8K video, anyway? UHD 4K is spreading fast and is set to become the preferred resolution for close-up viewing, especially in kiosks and video walls. The 3840 x 2160 resolution of 4K displays four times the pixels than today's standard 1920 x 1080 "Full HD," or 1080p. That's nearly 8.3 megapixels versus about 2.1.

That's a lot of data to move down a wire—and 8K will up the ante to 7680 × 4320 (33.2 megapixels).

You can get by with sending 4K content at 24 or 30 frames per second—also known as 24-30 Hz or 24p-30p, 4Kp30, etc.—using most of today's standard wiring and distribution technologies. That means HDMI and HDBaseT over Category 6 and 7 Ethernet cabling. But if you want smoother 4K resolutions at 60Hz (60p or 60 fps), you are best advised to seek other solutions, especially if you're routing that data over the distances required of many commercial buildings. Fiber-optic cabling and new schemes to send AV over IP may be the ticket.

Add to that new features like High Dynamic Range (HDR), which extends the contrast, from the darkest blacks to whitest whites by increasing the data from 24 bits per pixel (bpp) to 30 bpp—and you get the very big picture. Hopefully it arrives at your displays in its full, or shall we say 'ultra' resolutions.

UHD 4K at 60p with HDR 4:4:4 (no chroma subsampling) is the current



This sports bar application features Altinex.

gold standard for video. You don't have to transmit that, but networks today should capable of it. And don't forget: 8K is coming right up behind it.

## A MATTER OF MATH

Most of today's popular cabling and distribution methods have a numbers problem. That can translate into signal problems, compression problems, latency problems, HDCP (High-bandwidth Digital Content Protection) interoperability problems, you name it problems. Terrifying blue screen, anyone?

Traditional copper wiring such at Category cables are limited in bandwidth to 10 gigabits per second, and uncompressed 4K requires about 18Gps at 60 Hz and 11Gps at 30 Hz. Try sending those signals long distances, and you get signal loss and degradation.

Paul Zielie, manager of Enterprise Solutions for Harman Professional said, "10Gps is the practical limitation of data transfer across copper without getting into either expensive methods, or methods that involve more cables, meaning I could do 40-gigabit but it's using four [cables] instead of one [cable]."

"Pushing the ever-increasing video signal bandwidth through a fixed cable medium becomes a significant engineering challenge," echoed Jack Gershfeld, president of Altinex.

## WHY UHD EXTENSION

HD is sufficient for almost all desktop conferencing applications, says Chris Fitzsimmons, Video Products Manager for Biamp Systems. "However, once we move into the realm of conferencing on much larger displays, then UHD resolutions make more sense. UHD is best used on large displays with short working distances, such as interactive surfaces where users will truly appreciate the smaller pixel size.

Without an extension technology, HD and UHD 4K signals can only travel up to 49 feet (15 meters) with an HDMI cable and meet performance specifications. In commercial environments, signals need to be transmitted farther. HDBaseT has been the de facto way to extend HD and UHD 4K, but in the past couple of years has seen some competition with fiber coming down in prices, as well as new technologies. Last year HDBaseT Alliance announced HDBaseT-IP,

which will go head-to-head with the new SDVoE (Software Defined Video over Ethernet).

## THREE WAYS TO EXTEND UHD

Harman's Zielie identified three ways to extend UHD:

- Synchronous, such as HDMI over fiber.
- Isochronous, a space now dominated by HDBaseT technology.
- AV over IP, with solutions such as fiber-optic cabling and the new SDVoE.

"Method number one would be just to extend those signals, which are synchronous, meaning there is a clock going across and the two sides are synchronizing across the distance. This could be done by providing line drivers or, for that matter, cable with low losses. It could be done over fiber with multiple fibers—one for each signal type—or it could be done with some level of multiplexing," said Zielie.

The synchronous form used predominately by the AV industry, especially in homes, is HDMI. The connections are on laptops, projectors, you name it. But the distance HDMI can carry a video signal is only 15 meters, or about 49 feet depending on cable quality. Then it needs to be repeated, and these short distances just don't work for most commercial buildings.

The new HDMI 2.1 spec promises 48Gps for 8K/60p or 4K/120p, but the distance factor will still be limited to approximately five feet long, making it inappropriate for most commercial applications.

HDMI may be best perceived as a short-run solution, with the content and distribution paths limited to one room or space.

## ALL HAIL HDBASET?

Few had heard of HDBaseT when it debuted in 2010 as a way to send audio, video and 100 watts of power over common Category Ethernet cabling. Today HDBaseT is found in extenders, AV receivers, switches and matrixes, projectors, displays, presentation switchers, and more. HDBaseT can transmit audio and video, Ethernet, controls, USB and power for up to 330 ft. (100m) over a single category cable.

"HDBaseT as a technology is an extender," says Zielie. "It breaks data into packets that go across a medium. So, it's shared within the stream, but it's multiplex and packet-based, which means it's isochronous, or "clock-like." So, you have synchronous, which says, "I'm using the same clock on both sides," and then you have isochronous, which is deriving a clock on both sides but they're independent, in packets, going across it. HDBaseT and its various iterations enjoy the biggest market share of this technique.

Long-distance runs with HDBaseT remain an issue, but it's one that can be overcome with extension hops. "For longer distances, the solution is to use a fiber infrastructure which allows for tens of kilometers/feet transmission (without power). The transmission over long distances is done without any deterioration in quality or performance, and near-zero latency," said Daniel Shwartzberg, director for Customer Experience at the HDBaseT Alliance.

"The higher the video [resolution], the more the bandwidth it requires. To enable this, HDBaseT will transmit 4K (UHD) video using PAM16 signaling, but 1080p (HD) video can be transmitted using PAM8—a "long reach" option available in some chip classes. The additional system margins when using PAM8 mean that 150m is possible, compared to 100m when running 4K video," he added.

HDBaseT-IP enables the transmission of signals cross-campus or between buildings, while maintaining interoperability with in-building/in-room HDBaseT installations.

Workarounds for distributing UHD with HDBaseT are becoming more common.

"HDBaseT is using the same techniques as 10-gigabit Ethernet, as well as in the case of things like fiber transports," said Zielie. "We are typically using even point-to-point fiber and not IP, as there are a lot of HDBaseT-like devices that aren't actually HDBaseT but they're going over fiber with that conversion, where they're using SFPs (Small Form Pluggable). It's just a standard way of taking an electrical signal in a standardized package and turning it into fiber optic transmit-and-receive. SFP is a standard, and they'll plug in and work, so they're all going to have very similar transports.

"One of the interesting things we're seeing now, and that we're starting to use at AMX in some new products [such as the company's Incite line], is HDBaseT Lite, [a reduced chip set technology for uncompressed **HD video**, **audio** and **control signals**, without Ethernet or power-over-cable, and to only 60 meters]. It was originally built for the consumer market but fits in very well into these smaller spaces where you don't need so much control and distribution. … With a combination of some compression and decompression and HDBaseT, we're sending 4Kp60 over an HDBaseT connection. That can either go directly from our transmitter and receiver or through the small switches that support this protocol."

"We use [HDBaseT] technology and will continue to do so for point-to-point applications as well as matrix applications with I/O counts up to 16 x 16," said Garth Lobban, director of Marketing for Atlona. "But traditional, circuit-based distribution and switching can only take us so far. A technology manager needs to have in her quiver the ability to go beyond the HDBaseT-spec distance of 70m/230 ft. This is where packet-based (IP) distribution and switching comes into play.

## Best Practices From AV Experts

What's Your Latency Tolerance? Ask yourself what you have available for networks and what is your latency tolerance. If your extension is to a place where you're not seeing or interacting with the source and sync at the same time, such as sending out digital signage or TV or a number of monitors—you may have a high latency tolerance and don't need to use real-time techniques.

Is the Compression Good Enough? In addition to dealing with latency, different types of compression exhibit different types of artifacts. If you're doing 4Kp30, you don't need to compress it to go across 10 gigabits. If you're doing 4Kp60 across gigabit Ethernet, you have to compress it. Any time you're dealing with compression you have to determine, "Is that video good enough for my purposes?"

"People working on the science in compression and transmission are solving those problems—there's just a lag behind it. So, this is going to continue to evolve," said Harman's Zielie.

Beware of Encoding Challenges: "Be aware of the encoding challenges as the next standard approaches," says Ron Berty, business development manager, Matrox Graphics. "Can my stream/record system support HD and/or 4K, can it support multiple streams for simultaneous on-premises and internet consumption, can I address all levels of quality with a single device, is it interoperable with current technologies, can I integrate into my current network topology even at 1G Ethernet infrastructure?"

### AV-OVER-IP SOLUTIONS

The third method, as identified by Zielie, is true network transport. "While HDBaseT uses the same physical infrastructure of Ethernet, they are only using the physical Ethernet and not the addressing layers, so it's a point-to-point protocol," he said.

"It makes sense to harness IP technology to carry AV signals like any other kind of data across an existing Gigabit network," added Atlona's Lobban. This is where packet-based (IP) distribution and switching comes into play. Atlona's OmniStream Pro can transport 4K video, audio, and control over a standard Gigabit network with virtually unlimited scalability, low latency and forward error correction.

"When you move into a true network transport, you are using the addressing portions of the Ethernet stack, either on Layer 2 or Layer 3, so even if you can't go through a router, there are still addressing portions of the stack that goes through," explained Zielie. "Just Add Power is working on a Layer 2 using the MAC addressing, and something like [AMX's] SVSI is working on Layer 3. That is packetizing in the same way HDBaseT is, but they are not using fixed, point-to-point addressing. They are using addressing that can then be distributed over a network in various ways.

"The thing about Ethernet and distance is that Ethernet has a good regeneration feature that's inexpensive—it's called a switch," said Zielie. "If I put a switch every 90-meters, then I potentially can extend it further by using a switch to regenerate the signal.

"I think you will see more things converting to an Ethernet-type transport just because of the versatility, as well as the potential of having a source and receiver 200 meters apart because it's 100 meters to a switch, and then another 100 meters to the receiver," he added.

The new SDVoE (Software Defined Video over Ethernet) has taken a video signal up to 4Kp60. SDVoE is a chipset sold by AptoVision, which was recently purchased by SDI broadcast video market leader Semtech. SDVoE claims end-to-end transport latency under 100 microseconds (under 1/150th of a video frame), and fully uncompressed transmission for all HD and 4K30 signals, with artifact-free transmission of true 4K60 (4:4:4).

"SDVoE and AMX's SVSI IP-based products and are low-latency and very much emulate a wire because the speed is so fast that it might as well be a wire. So, it's under the 13 milliseconds perceived by the brain," said Zielie.

AptoVision's Blue River technology lightly compresses 4Kp60 to use over a 10Gps network with an Ethernet stream and RS-232 control. "They are partnering with a company called Icron and tunneling USB across it and various other things that can go across that link," Zielie added.

"The key to AV over IP is to accept [that] all standards have a purpose and to utilize the benefits of these standards to create the best possible solutions," said Paul Harris CEO/CTO of Aurora Multimedia.

Although several technologies are poised to address the difficulty of UHD video distribution, "the ultimate solution will rely on a fiber-optic infrastructure to address the delivery of HD and UHD signals over a long distance," Altinex' Gershfeld. The winner in this race will provide a solution that is easy to install and easy to use."

Robert D'Addario, president and managing director of fiber-optic manufacturer Cleerline Technology Group said, "Copper has reached its bandwidth ceiling in relation to the current HDMI 2.0 specification, be it that Category cable Cat6a specifically can only handle 10Gps and Cat8 has a limitation of 40Gps at 30m. The reality is that current HDMI 2.0 spec calls for 18.2Gps for uncompressed 4k 60 444 HDR, and the forthcoming spec for 2.1 is going to require 48Gps. Copper has reached its point of obsolescence with regards to new infrastructure." Technologies will be developed to compress HDMI video down to pass over existing infrastructure, he acknowledged, but new infrastructure fiber should be seen as a need for future-proofing.

"The stress on a signal for distance is much greater than it has been in the recent past," said Todd Mares, director of Emerging Technologies at Peerless-AV. "My advice to all integrators out there: Learn how to polish glass, as fiber is set to be the de facto medium for high-bandwidth over great distances."

"We will see the first two types of video distribution go away or become increasingly niche," predicted Zielie. "Just as [HDMI] ruled the world because it was the only thing you could do until HDBaseT came on, you're starting to see the rise of these IP-based solutions. And because there are lots of applications for compressing and moving video, this is moving into the real world. If they get adopted into the consumer world, those prices will come down and they'll push out things like HDBaseT."

## HDCP Compatibility Issues?

HDCP (High-bandwidth Digital Copyright Protection) ensures pristine digital copies of works such as movies and TV shows aren't distributed illegally. HDCP encrypts the data and allows an authorized receiver with the right HDCP to be able to decrypt it. "If I'm renegotiating HDCP every time on something like a switcher on the input, then that's going to increase my switching time," said Paul Zielie of Harman International. "What a lot of companies have done with their extensions is put an HDCP receiver and transmitter in the receiver, so both sides are emulating HDCP and it doesn't have to do that key exchange with every switch."

HDCP 2.2 is not backwards compatible with the 1-series HDCP, so there are some questions around having to use two different inputs on a display, and how that affects trying to mix content in paths, added Zielie. "There is still a huge amount of HDCP 1-series out there that's going to have to be supported."

## The Problem with EDID

EDID (Extended Display Identification Data) is a standardized way digital displays describe their capabilities to video sources to enable connections. "For the most part, it works really well up through 1080p because there are what are called standard timings and standardized blanking intervals," said Paul Zielie of Harman International. "There is one slot within EDID which allows for a custom resolution and everybody just stuck the 4K in that custom resolution. That works as long as your one custom resolution is 4Kp30, but now as we get to multiple larger resolutions, we have to look at how EDID extensions are standardized and supported."

"We see potential for a lot of EDID problems as these high-resolution standards proliferate," Zielie said.