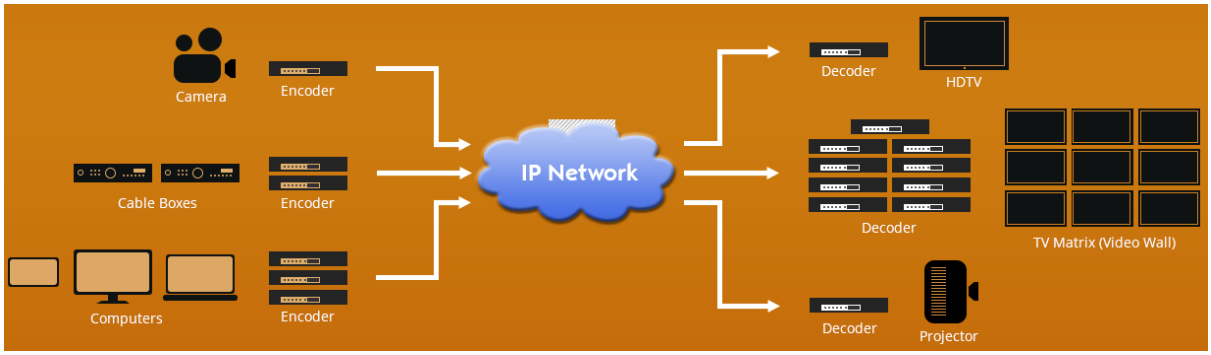
AV Over IP

The phrase “AV over IP” has become very popular of late and it is an abbreviation of “Audio and Video over Internet Protocol” but what does it really mean in practical AV terms?

Put simply, AV Over IP is about sending audio and video signals though standard networks. This process uses devices called encoders to convert analogue or digital audio and video into data that can be sent (streamed) across a standard Ethernet network to a decoder device that converts the received data back to audio and video signals.



AV Over IP solutions for audio and video have been around for many years but only recently has the latest hurdle of flawless 4K/UHD video been surmounted.

This makes possible products that are capable of high quality video distribution between rooms, buildings, or even further just as freely as computer data, but what are the practical, technical and economic considerations?

What are the benefits of AV Over IP?

It’s the scalability
Since networks can be any size we like, any number of encoders and decoders can be made to work together to allow one-to-one, one-to-many or many-to-many AV connections. In effect a standard Ethernet switch replaces a conventional AV matrix switch but without the usual constraints of a fixed size. This means that AV over IP systems have the big advantage of being expandable. New sources and displays can be added with ease.

It’s the cabling
Only one network cable needs to be installed, minimising cost and the complexity of dedicated cable runs for AV signals. And because networked AV signals are data packets just like other network traffic, they are not as susceptible to interference on the line caused by nearby power or other cables.

It's the longer distances
Ethernet networks are more readily extendable than circuit-switched AV or HDBaseT connections and can exceed 100m, with all of the same management tools, permissions for stream access, and security protocols as computer data.

It's the future
It is inevitable that the current generation of smartphone users will come to expect a level of video connectivity that is wireless (already some devices don't have video output ports) even though that is difficult to imagine with the limited speeds of today's Wi-Fi connected IP networks.

The technical challenges

HDMI is probably the most common form of digital video connection in use today and it continues to evolve to provide ever higher resolutions and picture quality. Users now expect to be able to send HD & 4K/UHD video content wherever they please but retaining the image quality expected of a HDMI or HDBaseT video system. For example, from a laptop to a projector in the boardroom, or from a Set Top Box in the lounge to a bedroom TV. With the advent of 4K/UHD HDR TV (the biggest upgrade to TV in 50 years) now delivering best ever picture quality, the HDMI bandwidth has increased to 18Gbps to support it.

Challenge #1: Compression

The two most commonly deployed network types are 1Gb and 10Gb Ethernet. (The latter is more expensive and is typically implemented with copper, or increasingly with fibre optic cables, but costs are falling). Unfortunately, both of these network types have insufficient bandwidth for a 4K/UHD HDR video stream since that needs 18Gbps. So, all current AV Over IP solutions must compress the quantity of data to be streamed, to fit the bandwidth available (with the encoder), and then expand it back at the receiving end (with the decoder).

Any video compression method (codec) requires some processing time to do this, so may noticeably delay the video (latency) and can either be lossless (zero degradation of the image) or lossy (introduces visual artefacts). Humans are very sensitive to video delays with respect to audio, so even small amounts of video latency can be problematic.

Generally heavy compression reduces data to the smallest possible bandwidth but has the lowest picture quality and the longest latency.

Light compression doesn't reduce bandwidth quite so effectively but can produce better picture quality and offers minimal latency.

Lossy compression is therefore best used where latency and image quality are not the highest priority, such as standard video, and not for high resolution text and computer displays.

Clearly AV Over IP systems that use 1Gb Ethernet networks must use heavy (lossy) compression for 4K/UHD video, resulting in lower picture quality and longer latency. Although for many applications this will be perfectly acceptable, for the highest possible picture quality a 10GB Ethernet network with light (lossless) compression is to be preferred.

There are many codecs available but in Pro AV applications the main compression technologies are; H.264, H.265 (also known as HEVC), JPEG 2000 and AptoVision BlueRiver. All can deliver high-quality 4K/UHD images, but H.264 optimizes for bandwidth, the newer H.265 is twice as efficient as H.264, while JPEG 2000 optimizes for latency.

AptoVision BlueRiver is the technology that underpins the recently formed Software Defined Video Over Ethernet Alliance and is a propriety codec for lossless, zero-latency 4K/UHD AV Over IP with support for HDMI 2.0a, HDR, high-quality video scaling, windowing and audio down-mixing.

	Lossy Codecs High Latency	**Lossless Codecs** Low Latency	**4K/UHD HDR 18 Gbps Lossless** Low Latency
1 Gigabit Ethernet	✓		
10 Gigabit Ethernet	✓	✓	✓

Challenge #2: HDMI compatibility

Which Version?

Since most HDMI sources and displays currently use either v1.x or v2.0 connections it is important that any video distribution system be compatible with them. The main difference between HDMI versions is bandwidth; version 1.x is up to 10.2Gbps while version 2.0 (which is backwards compatible) is up to 18Gbps. This means that both versions are capable of HD and 4K/UHD “lite” video but only version 2.x can handle full 4K/UHD HDR.

Copy Protection

HDMI has a built-in content copy protection scheme called HDCP, either v1.4 for HDMI 1.x or v2.2 for HDMI 2.0. For copy protected video content (Ultra HD Blu-ray Discs, Apple devices, etc.) not to be blocked, every link in the HDMI chain must have matching HDCP version support.

Although the HDBaseT standard does support HDCP 2.2 it does not officially support 18Gbps, and as there are very few matrix switches that can either, then AV Over IP

technology (if HDMI 2.0 and HDCP 2.2 capable) has the advantage that it can offer a complete 4K/UHD HDR 18Gbps distribution solution.

Challenge #3: Network considerations

Network speed

AV Over IP systems generally use either 1Gb Ethernet or 10Gb Ethernet. When planning an install, one of the most important decisions is the selection of the managed gigabit Ethernet switch that is the heart of the system. Which should you choose?

1Gb Ethernet

Suitable for HD or 4K/UHD "lite" video using lossy compression codecs.
Low-bandwidth H.264, H.265, VC-2 or similar work well in most 1Gb Ethernet environments, allowing many streams per link. Latency can easily reach half a second of delay making it great for long-distance applications but not so good for in-room applications. (E.g. a computer connected to a projector in a meeting room, where mouse and keyboard lag could be jarring). Not so good with small text or fine detail.

10Gb Ethernet

Suitable for 4K/UHD HDR video using lossless compression codecs. Good with fine detail so ideal for pro AV applications.

High bandwidth JPEG 2000 or similar streams work well in most 10Gb Ethernet environments. Low latency is great for either in-room or long distance applications.

Twisted-pair copper cabling for 10Gb Ethernet (10GBase-T) is now a mature and rapidly growing technology in IT environments. But for longer distances, up to 300m or more, fibre-optic cables are to be preferred.

Up to ten, or maybe more, low-bandwidth H.264, H.265, VC-2 or similar streams can be used per 10 Gb link between networks, ensuring much greater flexibility and scalability for distributing AV.

Managed switch requirements

Most AV Over IP systems require a managed switch to connect all the encoders and decoders together typically with these requirements:

- Full layer 2 and 3
- Fully non-blocking – backplane bandwidth greater than ports times 2.
- Must support IGMP Version 2 snooping
- Enable FASTLEAVE for 4K seamless switching
- Filter/Drop unregistered Multicast traffic
- Enable IGMP Queries

A switch will, by default, flood multicast traffic to all the ports and this can cause unnecessary load on network devices by requiring them to process packets they have not requested. So, IGMP snooping is designed to prevent devices on a local network from

receiving traffic for a multicast group they have not explicitly joined. It is therefore especially useful for bandwidth intensive dynamic multicast applications such as AV over IP.

Port Density

When designing AV racks space is always at a premium, so consideration must be given to how much space is needed for AV switching and distribution equipment.

Any Ethernet switch clearly beats HDBaseT switches for pure port density. A 48-port Ethernet switch can be had in a single rack unit. Unfortunately, by the time in-rack HDMI encoders and decoders are added, much of this benefit is lost. Only circuit-switched HDMI switches can beat the port density of network switches.

The costs

Currently with traditional circuit-switched HDMI and HDBaseT video distribution solutions the cost per port on an AV matrix switch can be up to 10X the cost of a similar 10Gb Ethernet switch from Cisco or Netgear, etc.

However, since the cost of AV Over IP encoders and decoders are still significantly more expensive than comparable HDBaseT transmitters and receivers, simple point-to-point video extension with HDBaseT and switching with HDMI remains the more cost-effective option for smaller systems. Similarly multiple in-rack sources can take advantage of the relatively low-cost of HDMI inputs on matrix switches.

But for many larger installations, especially those that require transmission over distances longer than 100m, with source devices that are remote from the AV rack as well as remote displays, then a networked AV Over IP installation can be more cost effective and conveniently avoids the cost of installing a second cable infrastructure.

Conclusion

IP offers a standardized infrastructure, that until recently could accommodate HD but not the growing customer requirements for 4K/UHD video. However, today there are an expanding number of AV over IP video technologies that can deliver high quality audio and video.

Low-bandwidth lossy H.264 or H.265 that suits HD or 4K/UHD “lite” video is already common and can use low cost 1Gb Ethernet networks. High-bandwidth lossless codecs like those used by BlueRiver with 10Gb Ethernet networks, can handle the full 18Gbps bandwidth of 4K/UHD HDR video and are more “future ready”.

	AV-over-IP	HDBaseT
Cabling	CAT 6a ,Fibre	CAT6 (shielded)
Network	10 Gb Ethernet	Dedicated cable runs
Multi-cast	Yes	No
Video signal	Lossless compression	Uncompressed
Bandwidth	18 Gbps	10 Gbps
Distance	Unlimited*	330 ft.
Number of displays	Unlimited	Depending on number of ports on transmitter

For smaller systems and latency-sensitive in-room applications, HDBaseT will probably remain the preferred choice for now.

For larger systems that require higher bandwidth, longer distances, future expansion and use a standard network infrastructure then AV Over IP is a better solution and there can be no doubt that it is the future.

AV Over IP Products Available From RGB

We offer a range of products to suit many different applications including:

OmniStream™ by Atlona

Distributing 4K/UHD video, audio, and control over a standard 1 Gigabit network using VC-2 compression. It delivers the performance and dependability of traditional AV distribution, with the virtually unlimited scalability, and cost efficiency of integrating over IP networks.

TechLogix - IPFO system

Leverages Aptovision BlueRiver technology to transmit zero-latency 4K@60 4:4:4 HDMI up to 300m (1,000 ft.) over fibre optic cabling using a 10 Gigabit network. Multiple encoders and decoders can be blended into a seamless, any-input-to-any-output system using TechLogix TLXpress software.

Any questions?

Why not give us a call today on 01488 73366 to discuss your application.

Glossary

4K/UHD	4096x2160 or 3840x2160 resolution
4K/UHD HDR	4K or UHD resolution with High Dynamic Range that needs a bandwidth of up to 18Gbps
4K/UHD “lite”	4K or UHD resolution that needs a total bandwidth up to 10.2Gbps
10GBase-T	Twisted-pair copper cabling, usually Cat6A or higher, for 10Gb Ethernet
AptoVision BlueRiver	Technology that underpins the recently formed Software Defined Video Over Ethernet Alliance. It is used in many products including the new TechLogix IPFO series.
AV Over IP	Audio and Video Over Internet Protocol. Not the same as Audio over IP (AoIP) or Audio over Ethernet (AoE)
Bandwidth	Synonym for data transfer rate. Usually expressed in bits per second (bps), Mbps (megabits per second) or Gbps (gigabits per second)
Circuit-switched	Communications in which a dedicated channel (or circuit) is established for the duration of a transmission
Codec	Coder/Decoder used to compress/expand the quantity of data representing audio or video signals. Can be hardware or software based
Decoder	Device that accepts data packets on an Ethernet network and uses a codec to convert them to audio and video signals (analogue or digital)
Dynamic Multicasting	Determines when switch ports join and leave multicast groups, and dynamically forward the traffic to only the ports participating in the group
Encoder	Device that accepts audio and video signals (analogue or digital) and uses a codec to convert them to data packets on an Ethernet network
Ethernet	Most commonly used LAN (Local Area Network) of computers that covers a small area like a room, an office, a building or a campus
fps	Frames per second. Also known as video refresh rate
H.264	(MPEG-4) is used in Blu-ray discs, internet videos sources like YouTube and iTunes Store and also HDTV broadcasts. It supports up to 4K/UHD and up to 60 fps.
H.265	(HEVC) identical video quality to H.264 but uses half the bit rate. It supports up to 8K and up to 300 fps.
HD	High Definition 1920 x 1080 resolution
HDBaseT™	Connectivity standard for transmission of uncompressed digital video (HD/UHD), audio, power, Ethernet, USB, and some control signals, over a common category cable (Cat6A or above recommended for 4K/UHD)
HDCP	High-bandwidth Digital Copy Protection
HDMI	High Definition Multimedia Interface
HEVC	High Efficiency Video Codec. Also, known as H.265
IGMP	Internet Group Management Protocol Internet is a standard protocol used by the TCP/IP protocol suite to achieve dynamic multicasting. It

	allows a device to advertise its multicast group membership to neighbouring switches and routers
JPEG 2000	Uses a higher bandwidth than H.264 or H.265 but delivers much lower latency (though still a greater video delay than uncompressed). Generally, requires a dedicated 1GB Ethernet network cable per run
Latency	Delay between an input and an output
Lossless	Mathematically perfect communication
Lossy	Communication with some information lost
Multicasting	A type of network transmission that allows for communication from one source to a selected group of destinations. For example, when streaming a Blu-ray player to many TVs
Streaming	A technology for transferring data in a steady stream. For example listening to music or watching video in 'real time', instead of downloading a file to play later
VC-2	Developed by the BBC for critical quality broadcast applications. Low compression (the lowest of any compression technology in the pro AV industry) suits high-motion video and graphics at 4:4:4 colour and is used by Atlona in their OmniStream products.

Ends.