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OmniStream:

Truly Converged, Networked AV

Table of Contents

OmniStream™

by Atlona

Introduction

Distribution of audio and video signals over data networks (also known as **AV over IP** or **networked AV**) offers potentially significant benefits for pro AV system integrators and end users. Compared to traditional systems for AV distribution, networked AV systems can be designed with virtually unrestricted scalability and flexibility, in addition to the convenience and cost efficiency of standard data networks. The benefits of AV over IP can especially be realized in large installations for enterprises and other organizations.

Networked AV solutions have been available for over a decade, but industry adoption is still evolving. This is due to several inherent challenges relating to cost, security, the need to conform to IT-specific requirements, and the fact that many AV-over-IP technologies are not capable of fully replacing traditional video distribution. OmniStream™ is a new technology platform from Atlona that specifically addresses these and other challenges, while delivering immediate and long-term ROI to enterprise end users of AV systems.

The Case for AV Over IP

In the commercial AV industry, there is a general consensus that video and audio signal distribution will eventually migrate from circuit-based AV switching to packet-based data networks. There are four primary factors driving this transition, as presented in Table 1.

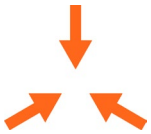	Convergence	IP is the de-facto signal infrastructure for most forms of AV communication, including audio, teleconferencing, and telephony. The final hurdle is HD and 4K video. Enterprises and IT operations are looking forward to a single medium for all communications, without the need to manage separate data and AV infrastructures.
	Scalability	Traditional circuit-based AV distribution requires hardware with fixed input and output port configurations that dictate system capacity, routing capability, and upgradeability. With networked AV, there is far greater flexibility in distributing signals, and upgrading is simply a matter of adding as many endpoints and network ports as desired. This makes it very agile for expanding system capacity.
	Distance	AV systems are usually designed with signal transmission distances in mind, due to inherent limitations in how far signals can be extended over cable. On the other hand, with networking there are few restrictions in how far IP packets can be distributed. In fact, data can theoretically be sent over networks to anywhere worldwide.
	CAPEX (Capital expenditure)	A new AV system installation requires an AV-specific infrastructure investment in specialized distribution equipment, plus cabling, equipment rack space, and power. With AV over IP, enterprises and IT operations can significantly lower their capex by using the network infrastructure already planned or installed at the facility.

Table 1. The primary motivating factors for AV distribution over IP networks.

Virtual Matrix

A networked AV system can bring together numerous sources and destinations from many different locations, and distribute content between them in ways that would not be possible with traditional AV matrix switching and distribution. For example, a corporate campus-wide, networked AV system can be configured for just about any AV presentation scenario, from an in-room presentation, to interdepartmental meetings between colleagues in several buildings, and even a company-wide presentation by the CEO. See Figure 1. This “virtual matrix” capability is enabled by the flexibility and agility of integrating AV over networks.

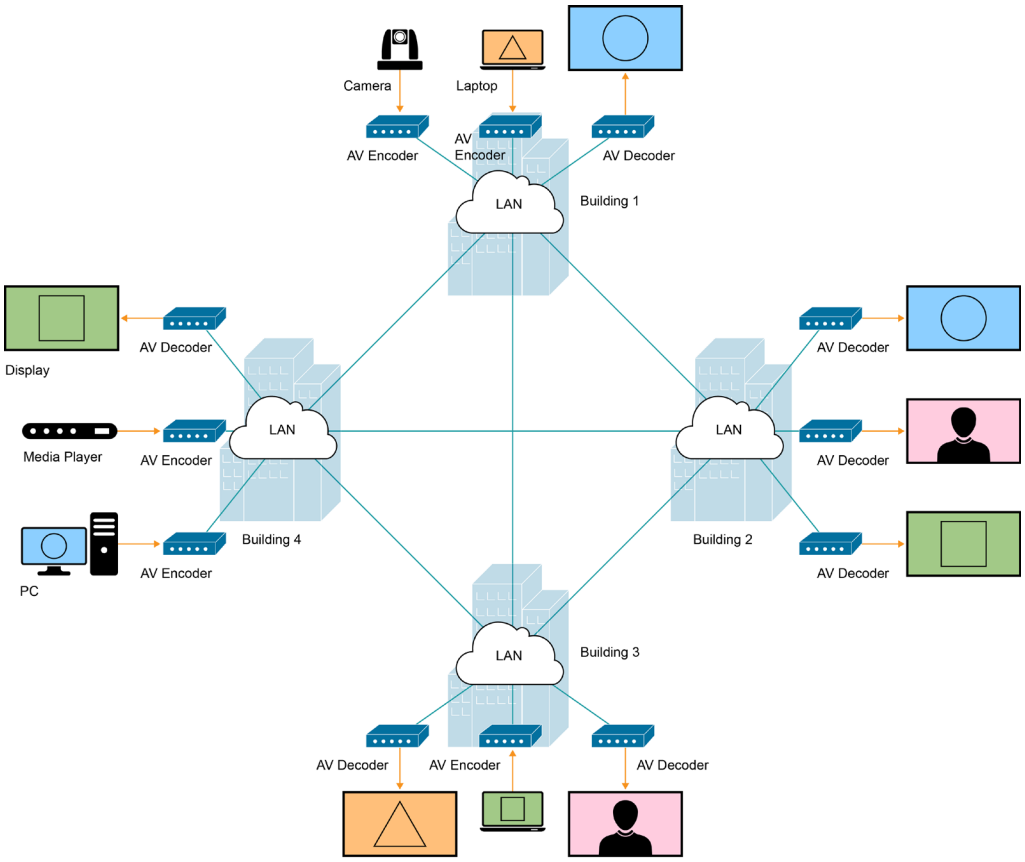

Figure 1. A networked AV system allows unprecedented flexibility in distributing AV between remote endpoints.

Atlona OmniStream

OmniStream integrates and distributes video, audio, and control signals over a standard data network. It was engineered from the ground up at Atlona with specific features and capabilities that make it ideal as the AV signal infrastructure for interconnected rooms, multiple floors, an entire building, a corporate or university campus, and beyond. OmniStream is distinguished from other networked AV platforms on the market which may be better suited for complementing traditional AV systems rather than replacing them, due to tradeoffs in performance, cost, image quality, and other factors.

The following diagram and table summarize the essential attributes of OmniStream, including their key benefits for AV and IT integrators, system designers, consultants, tech managers, and executives planning for facility-wide AV system integration.

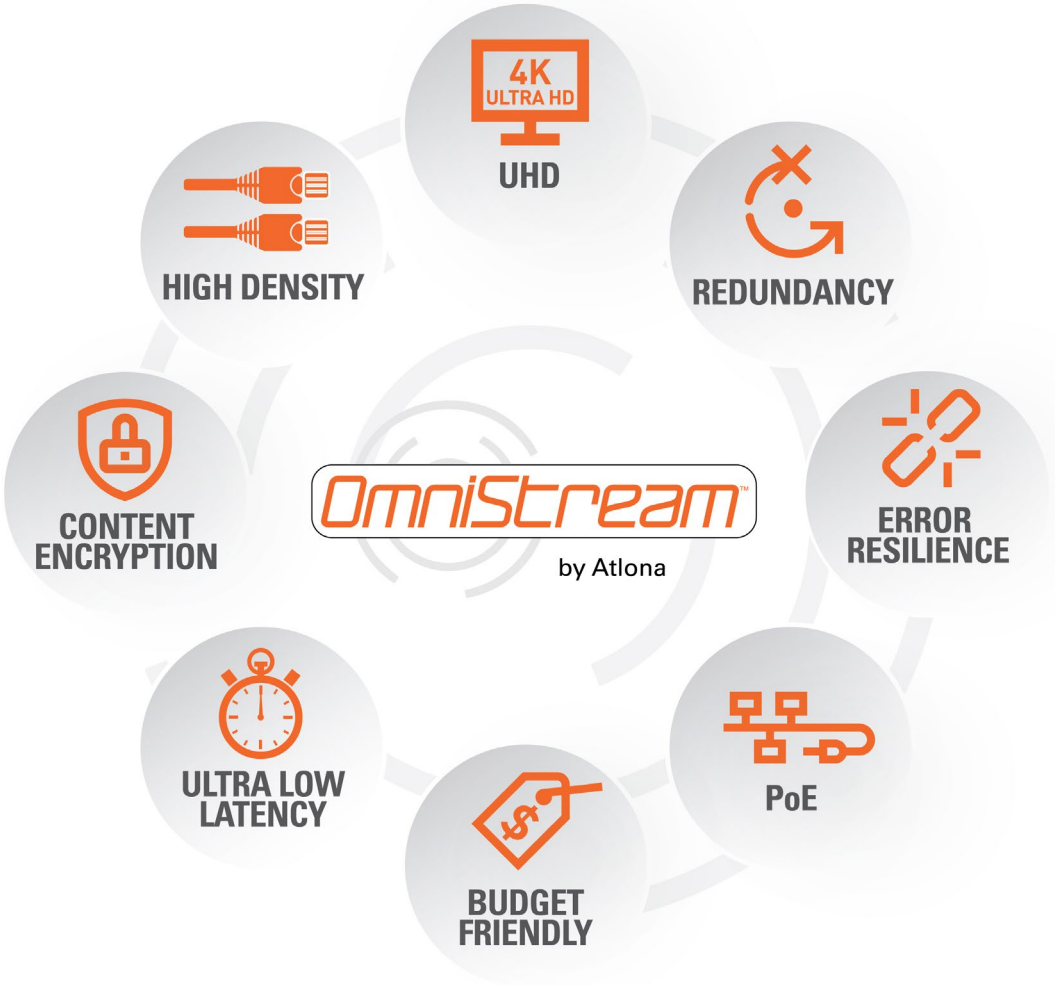

Figure 2. Primary features of Atlona OmniStream.

	Support for 4K/Ultra HD video resolutions Designing enterprise AV systems that can handle 4K video is a must. End users are aware of 4K and are requesting it from integrators, while new and interesting use cases continue to emerge for 4K in pro AV applications. The OmniStream product line supports 4K/UHD at 30 Hz with 4:4:4 color, as well as 60 Hz with 4:2:0 chroma subsampling.
	High density video-over IP integration OmniStream endpoint devices (also known as encoders and decoders) can process two independent video channels up to 4K/UHD in a single box, with dedicated processing for each channel. See Figure 3. Competitive products are of similar size, but with only one channel of video encoding or decoding. Based on pricing per video channel, OmniStream dual-channel encoders and decoders offer a significant cost advantage, along with lower box count for installation, reduced wire clutter, and more streamlined system management. These benefits can especially be realized for facility or enterprise-wide installations.
	System redundancy and failover IT operations require redundancy and failover measures for key components of their data center infrastructure to maximize system uptime. With IT increasingly managing AV operations, networked AV systems are expected to meet similar requirements. Atlona designed OmniStream with features for establishing primary and redundant networks, as well as delivering primary and redundant AV streams.
	Secure content distribution With networked AV systems as part of the IT infrastructure, security is another key consideration. For government, military, and enterprise applications, protecting sensitive information is absolutely essential, including content shared in AV presentations. OmniStream features AES-128, the same standards-based encryption technology adopted for government, financial, and other applications.
	Highly robust and reliable over networks In any network application, there is a small possibility of lost or damaged packets, especially for large systems spanning multiple networks. OmniStream employs SMPTE 2022 forward error correction, an industry-standard technology that fully compensates for any network errors while delivering artifact-free, uninterrupted real-time video. This ensures the reliability and dependability of a traditional AV signal routing platform.

Continued...

	Low latency AV content delivery Video signals are highly bandwidth-intensive. Video compression is a necessity to reduce AV signal data rates to within the throughput capacity of a network. However, compression also introduces some latency which may not be suitable for certain AV applications. OmniStream features a light compression algorithm with absolutely minimal encode-to-decode latency of less than one frame.
	Power over Ethernet Power over Ethernet (PoE) is essential for convenient installation and powering of Wi-Fi access points, IP cameras, VoIP phones, and many other devices at the edge of an enterprise network. OmniStream devices are PoE-capable as well, making it convenient and cost-effective to place them wherever AV sources and displays may be located. PoE also allows centralized power monitoring and management of endpoints.
	Cost and value benefits For facility-wide AV distribution requiring a capacity of 32 inputs and 32 outputs, an OmniStream networked AV system can deliver more appealing value compared to traditional AV technology. However, when it comes to larger system designs, the value and cost benefits increase dramatically, since there is no need to upgrade to a larger AV matrix switcher to scale up I/O capacity.

Table 2. Essential features and benefits of Atlona OmniStream.

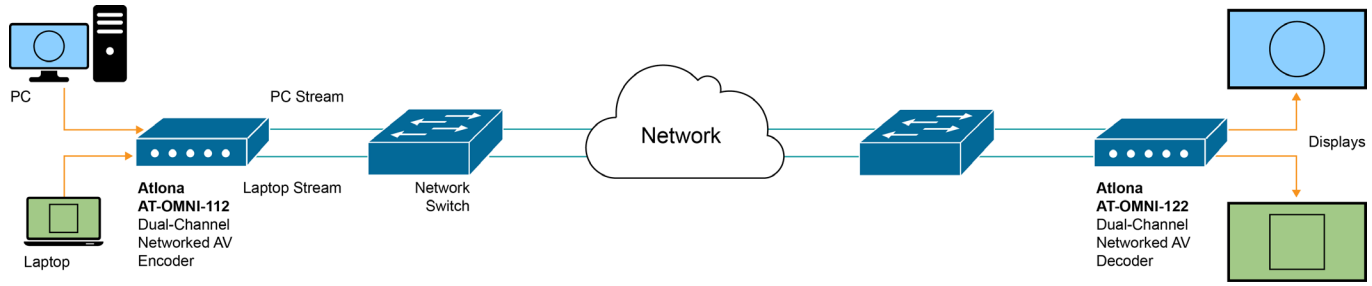

Figure 3. OmniStream enables high-density streaming with two independent channels of video processing in one box.

High Quality AV over Gigabit Ethernet

Some competitive networked AV platforms are based on 10 Gigabit Ethernet (GbE) to avoid the need for compressing video signals, including 4K/UHD video at data rates below 10 Gbps. The problem is that 10 GbE is still expensive and not widely implemented for switches or endpoints at the edge of an enterprise network. Additionally, PoE is not available with 10 GbE. On the other hand, OmniStream runs over 1 GbE, which is easily accessible, widely deployed throughout enterprises, allows PoE for powering AV encoders and decoders, and is cost-friendly.

OmniStream also delivers inherently greater scalability. Networked AV platforms over 10 GbE are limited to a single AV stream over a network link. When multiple 10 GbE switches are connected, IP port capacity increases but signal distribution capability is limited to a single AV stream in the uplink between the switches. On the other hand, Gigabit networking offers greater expandability since a 10 GbE uplink can be used to transport several AV streams between two Gigabit switches. With OmniStream, eight or more 4K streams are possible over a 10 GbE network segment. See Figure 4.

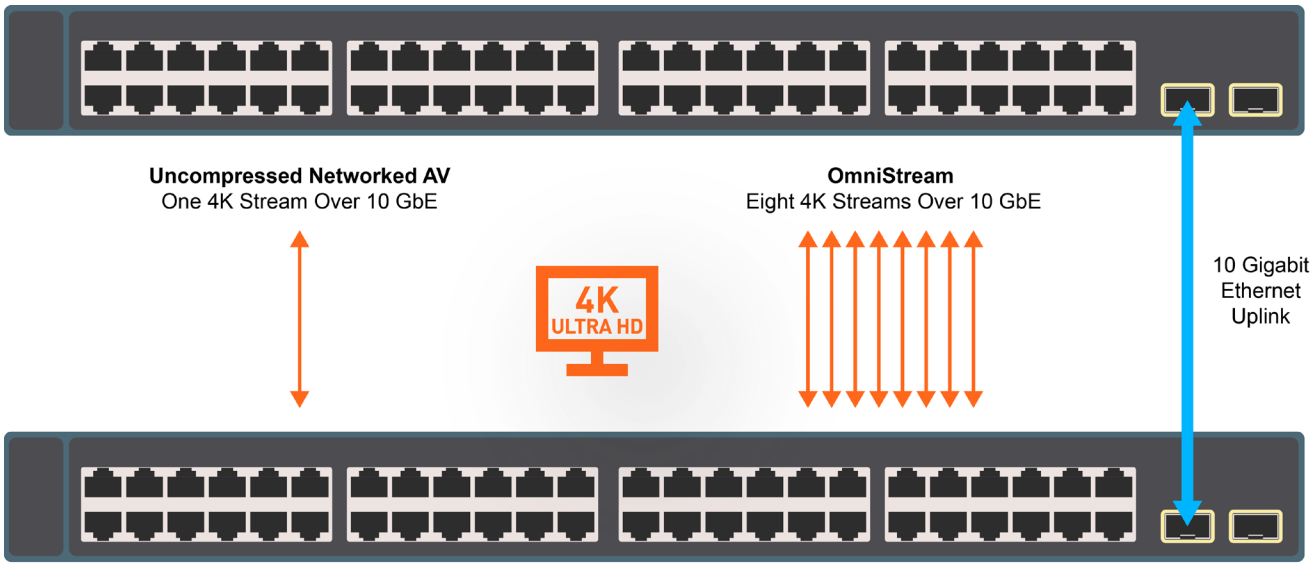

Figure 4. OmniStream offers considerable scalability with 1 GbE switches interconnected by 10 GbE uplinks.

OmniStream: A Closer Look at the Technology

With an overview of the essential features and benefits, let's explore in greater depth the key technologies engineered or adapted for use in OmniStream, and the ways in which they contribute to a networked AV product line ideal for system integration with very high image quality, operational performance, and reliability.

Professional broadcast-grade video compression

An enterprise-wide pro AV implementation should be capable of delivering nothing less than professional-quality video presentations. Visual details should be faithfully reproduced from the original source content to ensure the highest image quality. For pro AV, this is particularly important as the typical presentation material is computer-generated RGB video, which often necessitates accuracy for fine text and graphic details.

Popular video compression technologies such as H.264 are geared toward full-motion video content for consumer applications, as well as some commercial applications such as videoconferencing. However, they're usually targeted for bandwidth-constrained content delivery, or to meet specific file size and data storage requirements. This necessitates a

deliberate balance between data rate consumption, screen size, and video quality. The tradeoffs in image quality generally are not suitable for rendering professional-quality computer graphics at full fidelity.

Atlona has adopted a video compression technology developed for critical-quality image viewing in broadcast and production video applications, known as SMPTE **VC-2**, or **Dirac Pro** by the BBC, its original inventor. VC-2 addresses the challenge of transporting multi-gigabit video content over networks through a light compression algorithm that delivers visually lossless, pristine-quality representation of the master source video for post-production and archiving. VC-2 is standardized by the Society of Motion Picture and Television Engineers as SMPTE 2042.

There are several important attributes for VC-2 that make it ideal for pro AV applications. It employs wavelet-based video compression, which professional video experts generally favor when preserving image quality is important. VC-2 also compresses video content within individual video frames, which is ideal for high-motion video. Additionally, VC-2 can encode RGB video at full 4:4:4 color, which is vital for accurately rendering single pixel-width computer video graphics and text, as well as color resolution beyond 8-bit.

With VC-2, OmniStream is optimized for distributing computer-generated imagery without compromising image quality, while reducing 4K/60 4:2:0 or 4K/30 4:4:4 video to facilitate transport over 1 GbE. (Two 1080p/60 signals can be transported over 1 GbE as well.) The VC-2 algorithm is low in computational complexity, which translates to very minimal encode and decode latency. In fact, the implementation of VC-2 in OmniStream yields less than one frame of end-to-end latency, or less than 17 ms for 60 Hz video, which is significantly lower than the JPEG2000 or H.264 codecs commonly used in the pro AV industry. This allows OmniStream to be implemented for just about any AV application without the limitations normally associated with encode-decode delay.

A summary of the features and benefits of VC-2 is presented in Table 3. In short, Atlona adopted VC-2 for OmniStream to deliver the same expectations for video performance as with a traditional, uncompressed HDMI or HDBaseT™ system.

SMPTE VC-2 Video Compression	
Feature	**Benefit**
Visually lossless, light compression	Image quality visually indistinguishable from the original source
Encodes RGB video at 4:4:4	Fully preserves visual detail in PC-generated imagery
Intra-frame encoding	Ideal for high-motion video content
Compatible for color depths beyond 8-bit	Ideal for video and graphics with Deep Color
Allows 4K video over 1 GbE network infrastructure	Optimal CAPEX with widely deployed networking equipment at a lower cost per port than 10 GbE, while also supporting PoE
Encode-to-decode latency < 1 frame	Significantly lower than JPEG2000 or H.264; ideal for applications which require interactivity

Table 3. Features and benefits of SMPTE VC-2 compression for pro AV applications.

Resilience to network errors

Network errors in the form of lost or damaged packets may be a reality depending on the size and scope of the data network. For small, localized networks, network errors should not be a concern. However, for enterprise-wide implementations spanning connections between several networks, the probability of packet-related losses may increase, depending on the design, installation, and integrity of the network infrastructure.

For most network applications, including Web, e-mail, and online video streaming, packet errors are mitigated through the use of TCP (Transmission Control Protocol) which incorporates error-checking to ensure reliable delivery of all packets. If any errors are detected, replacement packets are resent to the destination node.

While TCP guarantees reliable network communication, it also may introduce latency associated with retransmitting packets, and disrupt the flow of real-time data such as video. For this reason, UDP (User Datagram Protocol) is used in time-sensitive network applications such as live video transmission. With UDP, packets are delivered to the destination as a continuous, uninterrupted stream. However, UDP does not check or correct for packet losses, which if significant, can result in visible video artifacts and possibly disruptions in image display.

To address this challenge, OmniStream employs **Forward Error Correction (FEC)** as part of SMPTE standard 2022. This standard was created specifically to allow real-time network transmission of broadcast video with a built-in mechanism to correct for network errors. With FEC, redundant data is transmitted along with the primary AV data streams. FEC works in conjunction with **RTP (Real-time Transport Protocol)** and **RTCP (Real-time Transport Control Protocol)** to track packet delivery and detect errors. Lost or corrupt packets can be replaced through FEC.

In the context of real-time video transmission, FEC enables consistent, reliable performance free of artifacts or interruptions in image display. For OmniStream, the crucial benefit is that it allows a very large-scale, enterprise-wide networked AV system implementation with uncompromised dependability.

Networked AV redundancy

Maximizing system uptime is an important requirement for IT investment and technology planning, and an integral aspect of meeting the mission-critical requirements of a company or organization. IT data centers typically are designed with backup resources and failover mechanisms for storage, WAN and Internet access, servers, IP telephony, disaster recovery, and more. AV systems over data networks should not be an exception when an IT department assumes responsibility for procuring and managing AV technology.

OmniStream offers redundancy and failover capabilities that are unique in the commercial AV industry. The AT-OMNI-112 dual-channel AV encoder, and AT-OMNI-122 dual-channel AV decoder can process two independent streams, as illustrated earlier in Figure 3. They can be configured for redundant, dual-network operation. An example of a configuration for 1080p/60 video is shown in Figure 5. Each network path can accommodate 1080p/60 streams from both the PC and laptop – OmniStream allows two 1080p/60 streams over a single GbE network connection.

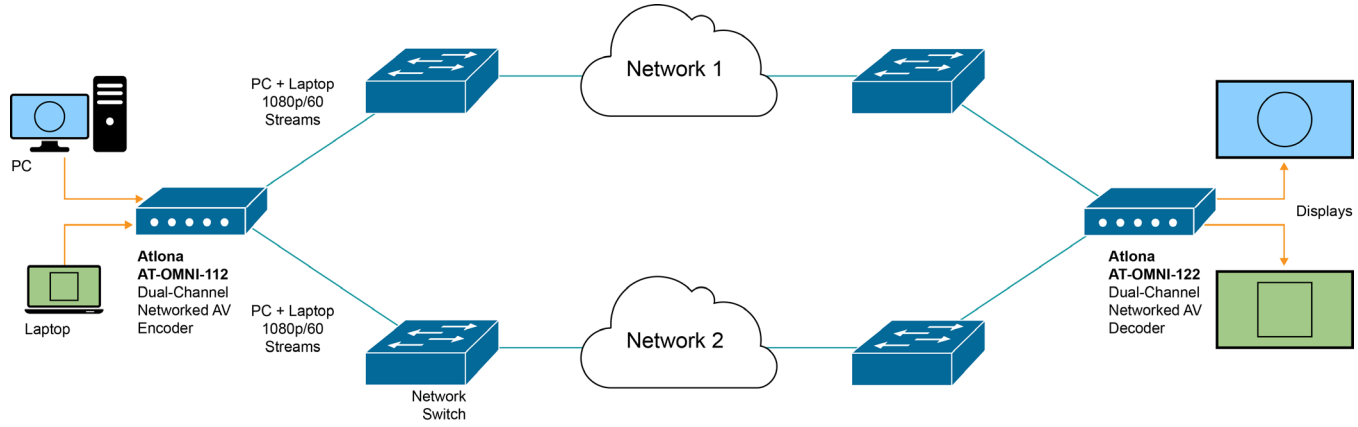

Figure 5. Dual-network system configuration for 1080p/60 sources.

An AT-OMNI-122 can continually monitor network connection integrity. If a signal loss is detected, such as from a network cable disconnection, the AT-OMNI-122 will then automatically switch over to the other network connection, and deliver AV output with minimal interruption in system operation. See Figure 6. No user intervention is necessary.

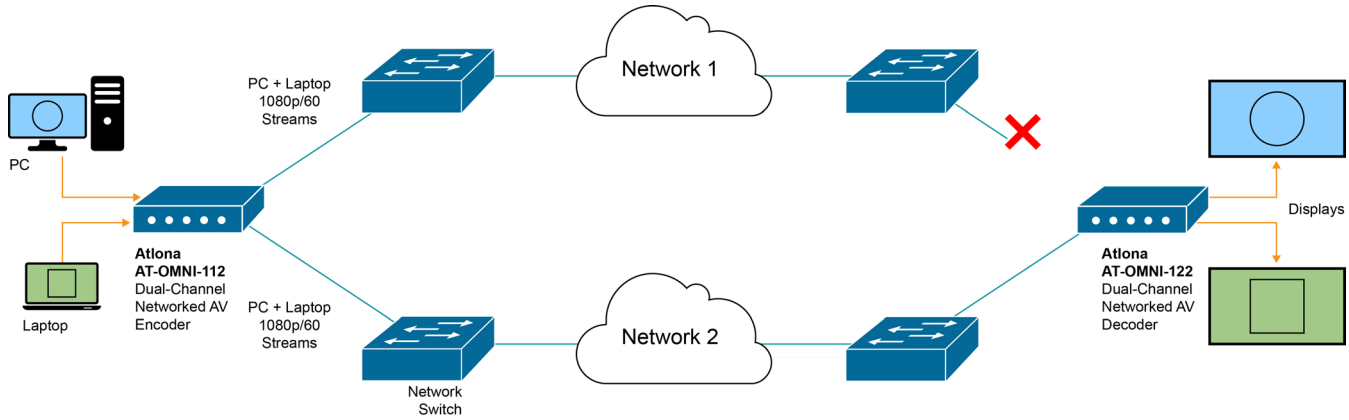

Figure 6. In the event of a lost network connection, the AT-OMNI-122 can fail over to its other Ethernet port.

The AT-OMNI-122 can also monitor for disruption of an AV stream – see Figure 7. Several configuration options are available to specify redundancy, failover, and recovery modes of operation, depending on the topology of the network, the AV system design, and the specific needs of the AV application.

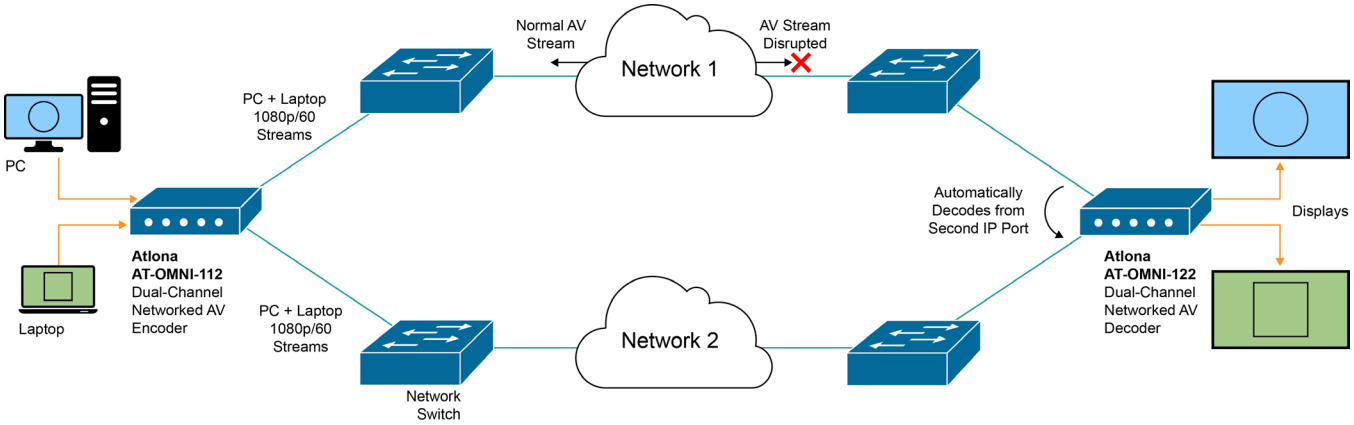

Figure 7. The AT-OMNI-122 can detect loss of an AV stream, even with a normal network connection.

To provision full network and streaming redundancy for 4K video, an AT-OMNI-112 dual-channel encoder would be required for each 4K source. An example of an OmniStream system configuration for 4K is illustrated in Figure 8.

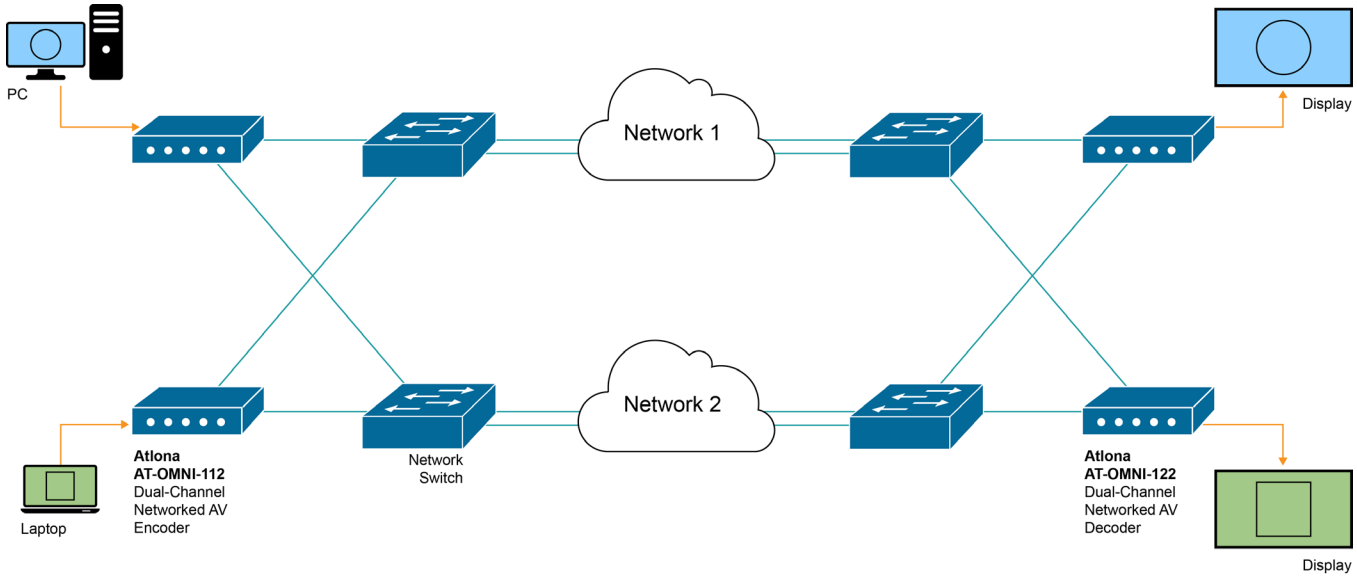

Figure 8. Dual-network system configuration for 4K sources.

Audio system integration with Dante™

Audio and video are usually separate system designs with separate signal paths and equipment. For large-scale AV implementations, separate audio and video systems can be expensive to integrate and complex to manage. Additionally, many AV-over-IP platforms are not compatible with the audio-over-IP technologies that have become very popular in modern audio system designs. For meetings, videoconferencing, and other applications, quality audio goes hand-in-hand with video presentations.

OmniStream meets this challenge with AT-OMNI-232 Dante Networked Audio Interface. It allows microphones, PC audio, amplifiers, and more to be integrated over the same network alongside OmniStream AV encoders and decoders. The AT-OMNI-232 utilizes Audinate Dante, an audio-over-IP technology very widely adopted in the commercial AV and pro audio industries. It can transmit and receive two audio channels over the network.

Figure 9 illustrates an OmniStream system for a meeting room. The AT-OMNI-232 is used to incorporate conference table microphones onto the network. The mics can then be processed by a Dante-enabled DSP (digital signal processor) to optimize audio quality. Another AT-OMNI-232 is installed at the AT-OMNI-122 decoder. It can deliver de-embedded audio to the DSP for processing, and also send audio from the DSP to the AT-OMNI-122 for embedding and playback through the display.

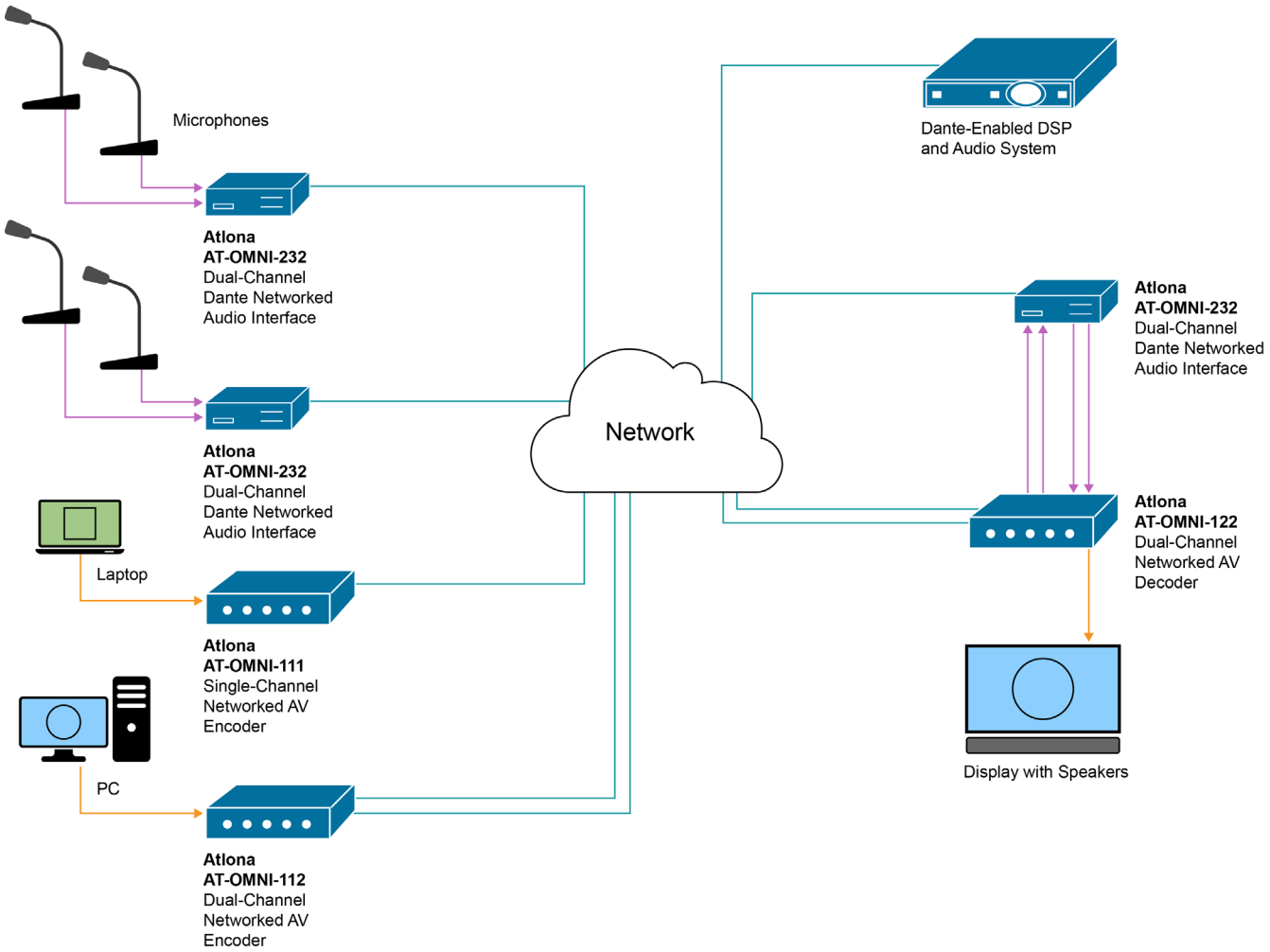

Figure 9. OmniStream enables Dante audio network integration.

Summary

OmniStream is a new technology platform from Atlona, designed for AV system integration over networks with the performance and expectations of traditional circuit-based AV signal distribution. OmniStream was developed and engineered with specific features and technologies to address the many challenges with successfully implementing networked AV systems.

With other forms of AV already IP-based, high resolution 4K video is the final step toward a fully converged data and communications medium for enterprises and other organizations. OmniStream delivers the essentials for IT and AV integrators to work with their clients in planning for a future with AV interconnected everywhere, with unprecedented flexibility and agility.