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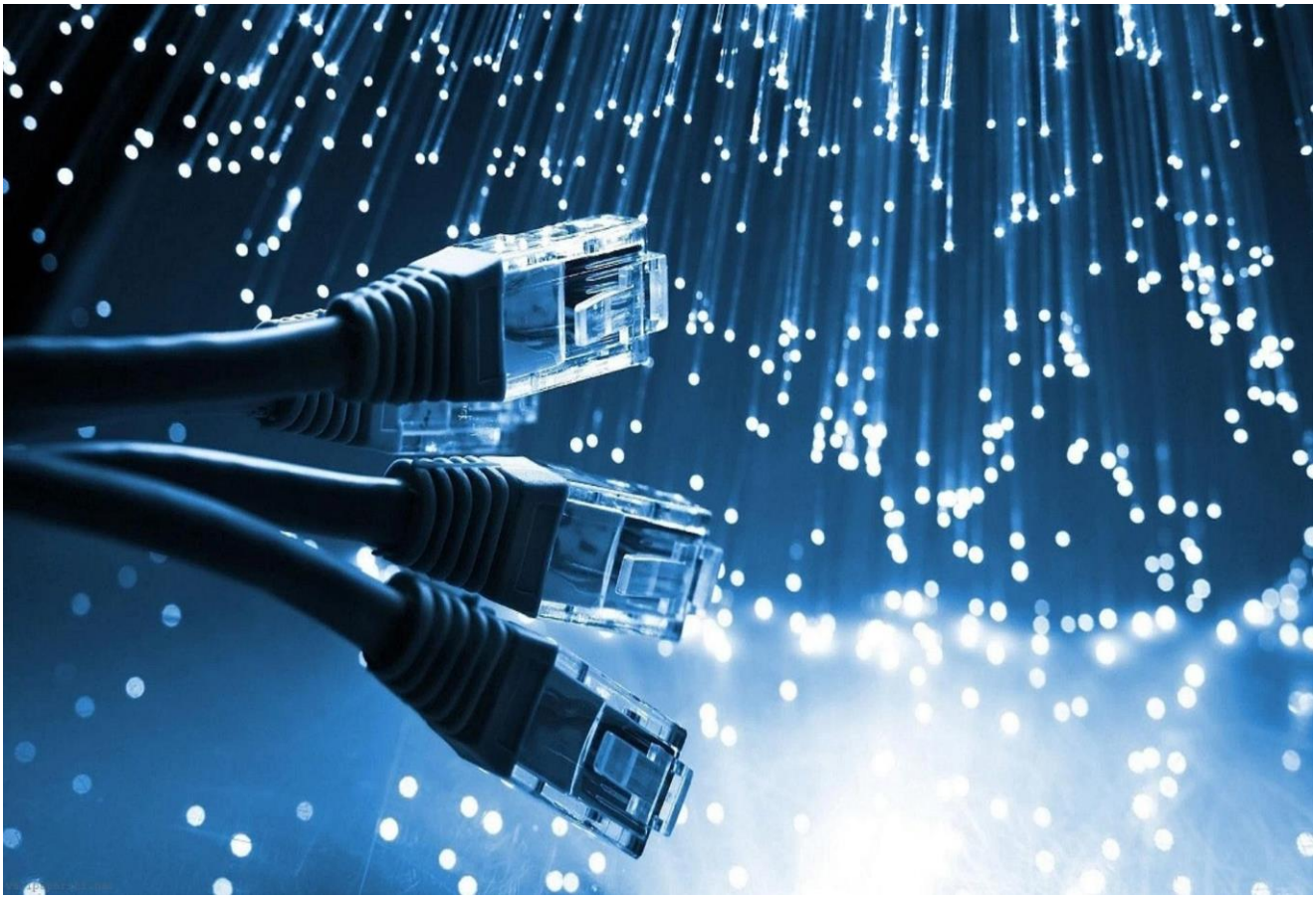

Unlocking the potential of ProAV: the advantages of IPMX over proprietary AVoIP solutions

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Introduction

In the evolving audio/visual (AV) landscape, traditionally, all AV equipment in a location has been managed through dedicated cabling run point-to-point from the device to an AV switch within each area or room. The latest trend, and one that is rapidly gaining steam, is to manage all AV devices over the data network. This approach is called AV over IP (AVoIP or AV/IP) and stands for "Audiovisual over Internet Protocol."

The benefits of AV over IP include

1. **Flexibility:** With AV over IP, content can be easily distributed to any location within a network, regardless of physical distance. This flexibility allows for dynamic setups and on-the-fly adjustments to accommodate changing needs.
2. **Cost efficiency:** Reduce the overall cost of AV system deployment and maintenance by leveraging standard networking equipment, protocols, and installation procedures.
3. **Unified connectors:** RJ45 1GbE, SFP+ 10/25GbE, QSFP28 100GbE
4. **Scalability:** AV over IP allows for easy scalability, accommodating a growing number of endpoints without requiring extensive rewiring or hardware changes, making it ideal for small and large installations.
5. **Interoperability**: IP-based protocols and standards ensure compatibility with various devices and technologies, allowing integration with existing AV equipment and future-proofing installations.
6. **Reduce cable clutter:** Use single cable runs containing multiple AV signals and controls.

Issues with proprietary AVoIP solutions

AV over IP offers a versatile, cost-effective, and future-proof solution for distributing audiovisual content in various environments, from corporate boardrooms to educational institutions and entertainment venues. However, many solutions that replace traditional AV infrastructure with IP have been primarily proprietary, vendor-closed solutions running on 1G or 10G networks.

The lack of standards alignment, perceived vendor lock-ins, uncertainty regarding the network capacity requirements for specific use cases, and product interoperability are some of the problems preventing the widespread adoption of AV over IP.

Product interoperability, based on licensed protocols and open standards, has been gaining momentum in recent years. This white paper explores why IPMX stands above proprietary solutions, focusing on its advantages in terms of interoperability, cost-effectiveness, innovation, and scalability. We will delve into the comparative advantages of adopting IPMX standards, highlighting improved scalability, enhanced quality, greater flexibility, and superior security measures as key factors that underscore its superiority for modern AV applications.

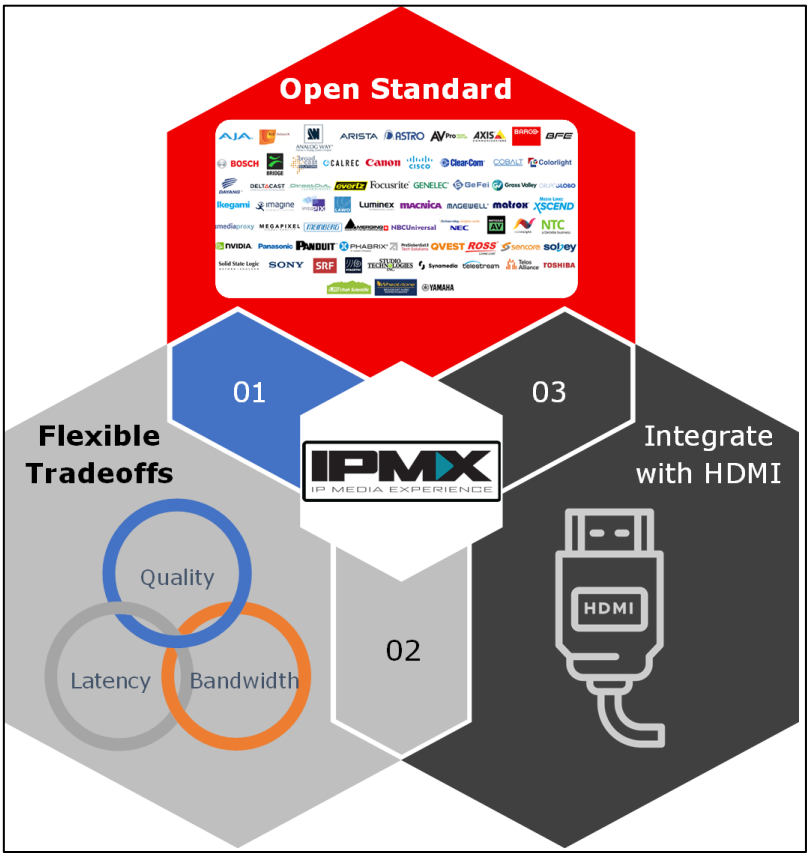
Understanding the basics

What is IPMX?

IPMX takes an open-standards approach to ensure accessibility, ease of use, and implementation are available to all. Its components are written by organizations representing the best interests of the ProAV market rather than the interests of a few or even specific companies. This contrasts with other solutions that, while calling themselves standards, are owned by a single entity that controls their intellectual property and usage, whether in the form of hardware, software, or a combination.

IPMX builds on foundational work from SMPTE, AWMA, and VSF while being promoted and supported by AIMS.

The Alliance for IP Media Solutions (AIMS) is an industry consortium led by broadcast and ProAV engineers, technologists, visionaries, vendors, and business executives dedicated to an open-standards approach that moves broadcast and media companies quickly and profitably from legacy systems to a virtualized, IP-based environment. AIMS' efforts build upon those of leading standards bodies such as the Video Services Forum (VSF), the Society of Motion Picture and Television Engineers (SMPTE), the European Broadcast Union (EBU), the Advanced Media Workflow Association (AMWA) and the Audio Engineering Society (AES).



SMPTE 2110 as a foundation

IPMX uses the SMPTE ST 2110 standard for media transport. It is the de facto IP protocol adopted by the broadcast industry to carry video, audio, and ancillary data over IP networks. Its support for uncompressed and compressed video and audio makes it ideal for proAV applications, but with a few additions.

	IPMX	ST 2110
Common	• Uncompressed media supported (same as ST 2110-20) • Compressed media supported (including ST 2110-22) • ST 2110 networking/PTP definitions supported • Can be paired with ST 2022-7 link redundancy / seamless switching	• Uncompressed media supported (ST 2110-20) • Compressed media supported (ST 2110-22) • ST 2110 networking/PTP definitions • Can be paired with ST 2022-7 link redundancy / seamless switching
Constrained differently	• NMOS (mandatory) • Support for asynchronous networks (mandatory) • Support for asynchronous sources (mandatory) • Support for YUV and RGB content (mandatory)	• NMOS (popular but not 'required') • Support for asynchronous networks (defined; not widely supported) • Support for asynchronous sources (defined; not widely supported) • Support for YUV and RGB content (defined; not widely supported)
Differences	• Support for IT and consumer electronics connections (HDMI™, etc.) • HDCP support; VSF HDCP Key Exchange Protocol • More tools to facilitate device synchronization / PTP on networks to increase ease-of-use and device operability	• No plug event detection or EDID for IT and electronics connections • No HDCP

Summary IPMX & ST 2210 (table credit: AIMS Alliance)

Industry context

IPMX leverages the IP framework to efficiently distribute video and audio content across a vast network without maintaining pairwise connections between each node or managing the routing complexity using traditional matrix routers when deployed across multiple spaces. It simplifies signal routing and the infrastructure needed to scale up, making it an ideal choice for large-scale corporate, educational, and entertainment deployments.

The transition from traditional AV/broadcast formats to IP-based solutions represents a significant leap forward. This evolution enables unprecedented flexibility, scale, and efficiency, empowering organizations to distribute and manage video content more effectively. IPMX, the only open-standard initiative supporting HDMI™ signal types, is pivotal in the transformation, ensuring compatibility, interoperability, and a broad ecosystem of solutions.

How is IPMX different than SMPTE ST-2110?

SMPTE ST-2110 was initially developed and later evolved to help transition SDI to AVoIP. SDI equipment's fundamental properties were:

1. Support for house sync/genlock
2. Separately routable audio, video, and ancillary information

For bandwidth reasons, video content from cameras was popularly compressed in the colorspace to 4:2:2 10-bit during the adoption of SDI.
Once ST 2110 was released and an interoperable model for media and transport was achieved, AMWA facilitated device discovery and registration to improve the networking experience of ST 2110 products significantly. The Network Media Open Specification (NMOS) was born and popularly complemented ST 2110 standards.
Other standards, such as ST 2022-7, accompanied ST 2110 to deal with Seamless Protection Switching for redundancy purposes.
Having achieved easy-to-network interoperable high-performance media over IP and a complete replacement path for SDI, the work in VSF continued to deal with the rest of the market's media-over-IP needs.

TR-10 brought the addition of:

- Consumer electronics and PC/IT signals, including their automation (for example, HDMI with Infoframes/EDID)

- More network profiles that ADD to the pixel-accurate PTP synchronization capabilities at scale were achieved in ST 2110 / ST 2059 including line-accurate PTP that can work on more common and popular AV/IT network switches and support for media distribution on networks where PTP is not required at all.
- TR-10 made support for PC-based content, including resolution support and full color space support (RGB 444) more comprehensive
- Encryption of content (even between competing brands) was a key goal, and two key protocols, the HDCP Key Exchange Protocol (HKEP) and the Privacy Encryption Protocol (PEP), emerged. These can be used individually or concurrently. HKEP allows different brands to exchange HDCP keys commonly. PEP allows IT managers to generate and install privacy keys into products from various brands to achieve an encrypted media exchange, even on products from different makers.

Constraining and extending

IPMX defines a base set of requirements for all IPMX devices and profiles. A substantial portion of IPMX is accomplished by using and strategically constraining SMPTE ST-2110 and AMWA's NMOS API for media node discovery and connection management. ProAV needs 4:4:4 color sampling and RGB color modes, which are inherent in HDMI™ and unavailable in the SMPTE broadcast standard.

New protocols and modes of operation were necessary to support the additional requirements generated by the much larger world of ProAV. Broadcast does not typically handle protected content, but this is critical in live corporate events, corporate AV, and educational environments, so support for HDCP was added.

Furthermore, broadcast video systems typically run in a single, uniform video mode synchronized to a single PTP source. While ProAV systems may operate in this way, the video mode is more commonly constrained by the display and may be one of several resolutions supported by the source. Additionally, the source may change the resolution at any time or go to sleep and stop sending video altogether, even though the source is still present, and the flow is "connected". The idea of this happening in an SMPTE ST-2110 system would give a broadcast engineer the chills.

IPMX incorporates AMWA's NMOS IS-11 Stream Compatibility Management to meet these additional requirements. This feature carries over the capabilities of EDID and hot-plug detection to multicast IP networks, which have the added complexity of codec and bandwidth considerations.

Additionally, IPMX senders generate and send RTCP sender reports containing key stream information. With this information, receivers can quickly handle resolution and frame rate changes from the source. The existing SMPTE ST-2110 standard, which assumes that the system's stream parameters are static, makes this impossible.

Extending the timing model

Although a few articles have been written about IPMX's timing model, it is essential to highlight the differences between SMPTE ST-2110 and AES67. Both require PTP, and neither supports asynchronous sources. For IPMX, there are three supported combinations of synchronous/asynchronous sources and PTP presence.

	Synchronous sources	Asynchronous sources
PTP	• This mode is compliant with ST2110 and AES67. • Best for low-latency applications like live events and interactive displays. • It's the most complex setup. • More relaxed defaults than ST-2110 (timing defined in ST 2056-2) support the full range of its values. • Can add latency to async sources that are time-based corrected. • Seamless switching is possible.	• Quick clock recovery; short gap between switching, or a little latency and buffering • Possible to achieve fully accurate re-alignment between different sources at the receiver. • It is best for everyday use when PTP is available. • Time-based correction is required for ST 2110 and AES67 bridging.
NO PTP	**Undefined** (Operates as no PTP & asynchronous)	• Longer clock recovery; bigger switching gap or more latency and buffering • Sub-frame latency is still possible! • Re-alignment is possible with RTCP sender report data. • Best for ad hoc systems, single source systems, or when sync between different media sources is unimportant. • Easy, low complexity.

Defining how asynchronous sources are handled on the network allows for precise system performance tuning. For example, an esports arena may stream computer sources asynchronously to minimize latency between the gaming PC and the DisplayPort monitor, which may run at a high, non-standard frame rate. This would not be possible with ST-2110, but with IPMX, the stream can be kept in its native form and then re-clocked, and the frame rate converted into a standard video mode for live switching. In another example, correcting the timing at the source may be more efficient. For ad hoc scenarios where you want AV-over-IP to behave more like HDMI™ and DisplayPort from a single connector, the added complexity of PTP is unnecessary.

Interoperability: bridging the gaps

One of the most significant challenges posed by proprietary AV solutions is their tendency to lock users into specific ecosystems. This makes integration with other systems complex and often costly. This siloed approach stifles innovation and limits the potential for system expansion and integration with future technologies.

IPMX's answer to integration challenges

IPMX, based on universally accepted IP standards, offers a stark contrast. Its open standards ensure that devices and software from different vendors communicate seamlessly, providing the foundation for a truly integrated AV environment. This interoperability facilitates a more inclusive and flexible approach to AV system design. It allows organizations to mix and match hardware and software to meet their needs without worrying about compatibility issues.

During Covid, there were many examples of manufacturers not being able to deliver products due to supply chain interruptions leaving customers scrambling to find alternative solutions but realizing it breaks interoperability between devices, leaving functional silos.

How IPMX enhances cost efficiency

IPMX's use of open standards significantly reduces the total cost of ownership. IPMX opens the door to more economical AV implementations by eliminating the need for proprietary hardware and allowing off-the-shelf networking equipment. Furthermore, the competitive landscape fostered by an open-standards approach leads to more cost-effective solutions and innovations, benefiting end-users with lower costs and improved features over time.

For example, IPMX protocols are designed to be implemented using different types of processing, including software running on standard generic processing, FPGAs, ASICs, and more.
IPMX also has profiles that leverage hardware blocks on devices like HEVC and H.264, allowing inexpensive PC equipment and wireless devices/networks to leverage IPMX audio and media flows.

IPMX as a catalyst for innovation

Proprietary systems can quickly become outdated as technological change outpaces the ability of any single vendor to innovate. The closed nature of these systems also means that the potential for third-party innovations is severely limited.

In contrast, IPMX's open nature invites widespread collaboration and competition, driving rapid advancements and fostering a vibrant ecosystem of solutions. Developers and manufacturers can build upon the standard to create new products and features, ensuring that IPMX-based solutions remain at the

forefront of AV technology. This collective innovation benefits all stakeholders and pushes the boundaries of what is possible.

Seamless scalability with IPMX

Scalability is another critical factor where IPMX outshines proprietary protocols. Proprietary solutions often require significant re-investment in new hardware and software to scale up due to their closed ecosystems and compatibility issues.

IPMX, built on the ubiquitous IP protocol, inherently supports scalability. Whether expanding to new locations, adding users, or integrating new technologies, IPMX facilitates growth with minimal friction. This scalability ensures that IPMX-based systems can evolve with organizational development and technological advancements, providing a long-term solution that adapts to changing needs.

IPMX's commitment to security

IPMX does not take security lightly; it incorporates the latest security standards to safeguard data and signal transport. Moreover, IPMX's open standards approach means that the wider community can quickly identify and address security vulnerabilities, enhancing the overall security posture of IPMX-based solutions.

Ensuring safe signal transport in an era where digital security is paramount, proprietary AV solutions often present a mixed bag of security features. Some may offer robust security features, but the closed nature of these systems can hinder the timely identification and remediation of vulnerabilities.

IPMX incorporates the Privacy Encryption Protocol (PEP). PEP is a system that automatically manages cryptographic keys for written digital communications based on a set of Pre-Shared Keys (PSK) stored in Sender and Receiver Devices to control access to media content. A Receiver can access content from various Senders, each possibly having its own PSK. A set of PSKs is securely programmed in each Sender and Receiver Device through a proprietary device configuration interface using a secure communication method.

Applications

IPMX is a versatile solution that meets diverse needs, from broadcast media and corporate communications to education and beyond. Its superior interoperability, cost-effectiveness, innovation, scalability, and security make it the preferred choice for future-proofing AV signal transport across various sectors.

Broadcasting and Live Events

IPMX allows broadcasters to efficiently manage and distribute high-quality video content over large geographic areas, adapting to bandwidth fluctuations and ensuring consistent viewer experiences. Perfect for live streaming, remote production, and content distribution, offering high-quality, low-latency video feeds. In Live events, IPMX provides simple and cost-efficient routing and cabling for audio, lighting, and video.

Corporate Communications

Enterprises leveraging IPMX can facilitate global meetings and presentations with high-quality video and audio without the bandwidth and scalability concerns associated with P2P systems. IPMX is ideal for webinars, online meetings, and corporate training, enhancing engagement through superior video and audio quality.

Education

Schools and universities can utilize IPMX to deliver live or recorded lectures to remote students across the globe, ensuring high-quality educational experiences that scale as enrollment varies. Facilitates e-learning and virtual classroom setups, providing a rich media experience that supports interactive learning.

Conclusion

The shift toward IPMX reflects a broader movement in the AV industry toward open standards and interoperability. Unlike proprietary solutions, IPMX offers a pathway to more integrated, cost-effective, and innovative AV environments. Its advantages are clear: unparalleled interoperability, cost savings, innovation fostering, effortless scalability, and robust security. As organizations look to build and expand their AV capabilities, IPMX represents not just a superior choice but a strategic investment in the future of signal transport technology.

By embracing IPMX, stakeholders can ensure that their AV infrastructure is equipped to meet today's demands and poised to adapt and thrive amid tomorrow's technological evolutions. IPMX's superiority over proprietary solutions is evident, heralding a new era of open, flexible, and advanced AV signal distribution that promises to enrich how we connect, share, and engage with the world around us.