The Evolution of IPMX for AV-over-IP

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The landscape of AV distribution has been rapidly evolving, driven by the increasing demand for high-quality, low-latency, and scalable solutions. IPMX (Internet Protocol Media Experience) has emerged as a key networking protocol in the AV-over-IP domain, offering a robust and flexible standard that caters to the diverse needs of the professional AV industry. Developed by the VSF (Video Services Forum) and AIMS (Alliance for IP Media Solutions), IPMX is built upon the SMPTE ST 2110 standard, originally designed for and widely deployed across broadcast, but now adapted to meet the specific requirements of Pro AV.

The Evolution of IPMX

IPMX was developed to address the limitations of existing AV-over-IP solutions that often lacked interoperability, scalability, and flexibility. While proprietary protocols like Dante and SDVoE served specific needs, they posed challenges in terms of vendor lock-in and the difficulty of integration into different systems. Recognizing this, the VSF and AIMS Alliance sought to create a unified standard that could deliver both high performance and broad compatibility in an open, standards-based approach.

The initial development of IPMX leveraged the ST 2110 suite, which is widely used in broadcast environments for uncompressed synchronous video, audio, and metadata over IP networks. However, for IPMX to be applicable in Pro AV, it required enhancements to address the unique needs of the industry, such as plug-and-play support for asynchronous media, reduced network complexity and cost (optional PTP timing), and the inclusion of features such as HDCP (High-bandwidth Digital Content Protection) and PEP (Privacy Encryption Protocol). Some of these additions also make it easier to interface to widely used HDMI media sources and displays.

IPMX continues to evolve, with recent additions further enhancing its capabilities. Some of the key updates since launch include:

- **Support for Multiple Compressed Video Formats:** IPMX supports both uncompressed and compressed video. While today the dominant codec used is JPEG XS, other codecs supporting higher levels of compression are possible. Flexibility in codec selection facilitates the use of IPMX in environments where network bandwidth is limited.
- **HDCP and PEP Integration:** One of the significant barriers for AV-over-IP adoption in Pro AV was the lack of robust content protection and security. The latest IPMX specifications include support for HDCP and PEP, ensuring that copyrighted or private content can be securely transmitted over IP networks without compromising quality.
- **Precision Time Protocol (PTP) Flexibility:** Although PTP synchronization is optional in IPMX, it is beneficial in applications such as video walls and live events where timing precision is crucial.
- **USB Support:** The upcoming standardisation of USB support in IPMX enables seamless control of remote devices over IP, such as KVM (Keyboard, Video, Mouse), expanding the potential use cases in control rooms, educational environments, and corporate settings.

Benefits of IPMX Versus Competing Protocols

IPMX offers several advantages over competing AV-over-IP protocols, positioning it as the preferred choice for Pro AV applications:

- **Interoperability:** Unlike proprietary protocols, IPMX is an open specification, ensuring interoperability across different vendors' equipment. This reduces the risk of vendor lock-in and allows for more flexible system designs.
- **Scalability:** IPMX's use of standard IP networks enables easy scalability, from small installations to large, distributed AV systems. This is in contrast to point-to-point and fixed bandwidth solutions, which are either limited by distance and the number of supported endpoints, or by the video formats that can be transported.
- **Low Latency:** IPMX is designed to facilitate low latency, which is essential for real-time applications such as live events, medical imaging, and interactive exhibits. Its support for uncompressed (latency in the order of one to two lines of video) and visually lossless compressed video (latency in the order of tens of lines for JPEG XS) ensures that signals are transmitted with minimal delay.
- **Quality:** IPMX supports both uncompressed and compressed video streams, allowing users to choose the appropriate balance between quality and bandwidth usage. This flexibility is not always available in other protocols, which may force a compromise between quality and performance.
- **Network Efficiency:** By leveraging multicast IP transmission, IPMX optimizes network resources, reducing the bandwidth required for transmitting streams to multiple destinations. This is particularly advantageous in environments with high-density AV installations.

- **Content Protection:** The integration of HDCP and/or PEP in IPMX provides a secure path for transmitting protected or private content, a feature that is often lacking (or requires additional hardware) in other AV-over-IP solutions.
- **Control and Security:** IPMX leverages NMOS (Networked Media Open Specification) to provide the "plug and play" capabilities needed to easily add and integrate devices in an IP media workflow. When a device is powered up, its resources become available to all devices on the network, removing the need for time consuming manual configuration of I/O parameters. NMOS also provides authentication, access, and control encryption.

AMD FPGAs and SoCs: Enabling IPMX with IP Cores from Nextera Video and Adeas

As IPMX adoption grows, the role of hardware in supporting this standard becomes increasingly critical. AMD is a significant player in the Pro AV market, offering FPGAs (Field-Programmable Gate Arrays) and SoCs (System on Chips) that are ideal for implementing IPMX solutions.

To ease adoption and accelerate time-to-market, AMD partners Nextera Video and Adeas have collaborated to offer industry-leading FPGA IP cores for SMPTE ST 2110, ST 2059 PTP, NMOS control, and IPMX. Their cores are delivered as RTL IP including all software drivers, daemons, and NMOS system control software and have been broadly deployed and proven worldwide.

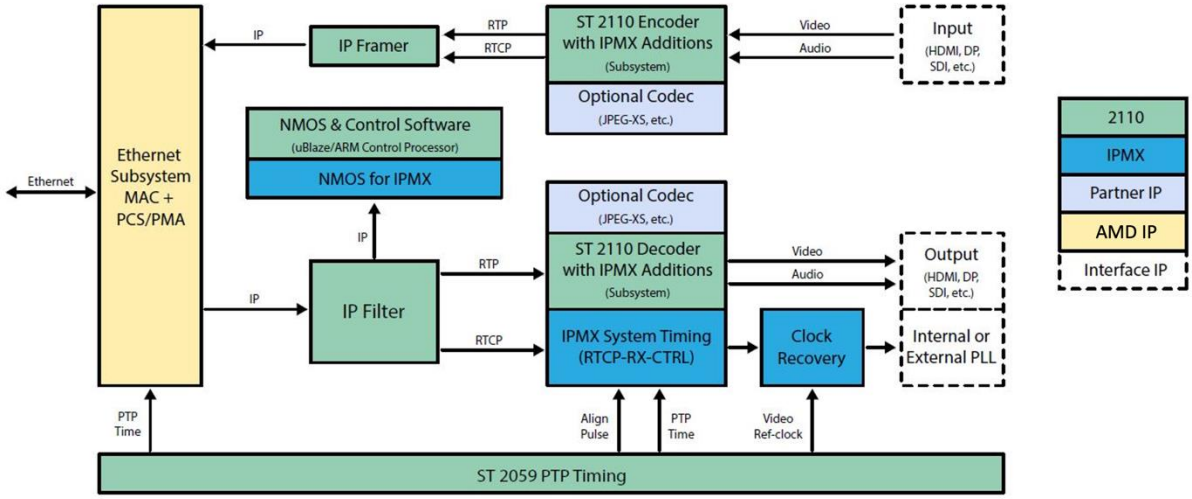

Figure: Nextera Video and Adeas IP Cores for IPMX

Nextera Video and Adeas offer a fully modular IPMX solution which results in highly efficient resource utilization and is resolution and network speed independent, supporting up to 8K and beyond over Ethernet links from 1Gbps to 100Gbps and beyond. Nextera and Adeas provide a

complete transmit and receive reference design, and design services are available for development or customization of hardware, firmware & software.

AMD FPGAs and SoCs provide the flexibility needed to implement IPMX in a wide range of AV applications. These devices can be customized to handle the specific requirements of an installation, such as unique video formats, custom timing requirements, or integration with legacy systems. For instance, the Zynq™ UltraScale+™ MPSoC family combines programmable logic with processor cores, allowing manufacturers to develop highly integrated solutions that can process IPMX streams, manage PTP synchronization, and interface with a variety of AV peripherals such as HDMI®. The integration of Arm® processors within these SoCs allows for the deployment of the sophisticated NMOS control and management features directly on the device, reducing the need for external control systems. This makes them a key system component in the development of standalone IPMX-enabled devices, such as encoders, decoders, and matrix switchers in a variety of use cases:

- Live Event Production: AMD FPGAs and SoCs are used in IPMX-compliant video processing systems that deliver low-latency, high-quality video feeds for live event production. The flexibility of FPGAs allows for real-time processing of 4K and even 8K video, ensuring that live feeds are synchronized and broadcast-quality.
- Corporate AV: In corporate environments, AMD technology-based IPMX solutions enable seamless distribution of video content across large campuses, supporting everything from digital signage to video conferencing. The low-latency and high-quality transmission ensure a consistent and professional AV experience.
- Medical Imaging: In healthcare, IPMX over AMD hardware supports the transmission of high-resolution imaging data in real-time, crucial for applications such as remote surgery and telemedicine. The integration of privacy encryption (PEP) and low-latency transmission is vital in these sensitive environments.

IPMX: Shaping the Future of AV-over-IP

IPMX is shaping the future of AV-over-IP by providing a robust, interoperable, and scalable solution that meets the demanding requirements of the Pro AV market. The ongoing evolution of the IPMX specification, with its support for a range of codecs from uncompressed to highly compressed video, and encryption of control and content such as HDCP, makes it an increasingly attractive choice for AV equipment manufacturers. The role of AMD FPGAs and SoCs in enabling IPMX cannot be overstated; they provide the flexibility, processing power, and integration capabilities necessary to implement cutting-edge IPMX solutions across a wide range of AV applications. As the Pro AV industry continues to grow and evolve, IPMX, supported by AMD technology and IP cores from Nextera Video and Adeas, is poised to be at the forefront of this transformation.