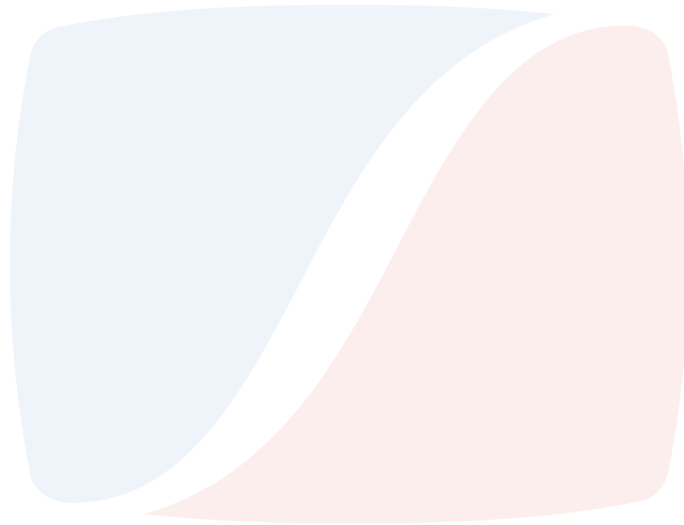




VIDEO SERVICES FORUM

Video Services Forum (VSF) Technical Recommendation TR-10-8

Internet Protocol Media Experience (IPMX): NMOS Requirements



February 23, 2024

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Executive Summary

Internet Protocol Media Experience (IPMX) was created to foster the adoption of open standards-based protocols for interoperability over IP in the media and entertainment and professional audio/video industries. IPMX is based on the SMPTE ST 2110 standard and as such the VSF TR-10 suite of technical recommendations is a set of differences between SMPTE ST 2110 and IPMX.

This Technical Recommendation documents the minimum requirements for IPMX Device with respect to AMWA NMOS support. It documents the requirements and some implementation details related to the AMWA NMOS suite of specifications that concern devices that implement the IPMX TR-10 suite of Technical Recommendations.

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1 Introduction (Informative)

IPMX, which stands for IP Media Experience, is based on two families of specifications. The SMPTE ST 2110 Professional Media Over Managed IP Networks suite of standards for the transport of video, audio, and ancillary/control signals over IP networks, and the NMOS REST APIs from AMWA, which provide discovery, connection management, and control.

IPMX is an accessible, open standard that meets the needs of professional and consumer video and audio users in a wide variety of contexts while giving manufacturers and developers what they need to build low-latency, interoperable, IP based audiovisual products or applications.

This document covers the implementation of the AMWA NMOS API in system that implement TR-10. Other aspects of the IPMX system and their individual requirements are documented in other parts of this Technical Recommendation.

Note: AMWA IS-11 is expected to apply to IPMX implementations. The IS-11 specification is not finalized at this time and will be referenced in a later revision of TR-10-8.

2 Contributors

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3 About the Video Services Forum

The Video Services Forum, Inc. (www.videoservicesforum.org) is an international association dedicated to video transport technologies, interoperability, quality metrics and education. The

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- providing forums to identify issues involving the development, engineering, installation, testing and maintenance of audio and video services;
- exchanging non-proprietary information to promote the development of video transport service technology and to foster resolution of issues common to the video services industry;
- identification of video services applications and educational services utilizing video transport services;
- promoting interoperability and encouraging technical standards for national and international standards bodies.

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4 Conformance Notation

Normative text describes elements of the design that are indispensable or contain the conformance language keywords: "shall," "should," or "may."

Informative text is potentially helpful to the user but not indispensable and can be removed, changed, or added editorially without affecting interoperability. Informative text does not contain any conformance keywords.

All text in this document is, by default, normative, except the Introduction and any section explicitly labeled as "Informative" or individual paragraphs that start with "Note:"

The keywords "shall" and "shall not" indicate requirements strictly to be followed to conform to the document and from which no deviation is permitted.

The keywords "should" and "should not" indicate that, among several possibilities, one is recommended as particularly suitable, without mentioning or excluding others; or that a certain course of action is preferred but not necessarily required; or that (in the negative form) a certain possibility or course of action is deprecated but not prohibited.

The keywords "may" and "need not" indicate courses of action permissible within the limits of the document.

The keyword "reserved" indicates a provision that is not defined at this time, shall not be used, and may be defined in the future. The keyword "forbidden" indicates "reserved" and in addition indicates that the provision will never be defined in the future.

A conformant implementation according to this document is one that includes all mandatory provisions ("shall") and, if implemented, all recommended provisions ("should") as described. A conformant implementation need not implement optional provisions ("may") and need not implement them as described.

Unless otherwise specified, the order of precedence of the types of normative information in this document shall be as follows: Normative prose shall be the authoritative definition; Tables shall be next; followed by formal languages; then figures; and then any other language forms.

5 Normative References

- VSF TR-10-1 Internet Protocol Media Experience (IPMX): System Timing and Definitions
- AMWA NMOS IS-04 version 1.3 (Stable) - NMOS Discovery and Registration Specification
- AMWA NMOS IS-05 version 1.1 (Stable) - NMOS Device Connection Management Specification
- AMWA IS-08 version 1.0 - NMOS Audio Channel Mapping Specification
- AMWA BCP-002-01 version 1.0.0 - Natural Grouping of NMOS Resources
- AMWA BCP-002-02 - Distinguishing Information for NMOS Node and Device Resources
- AMWA BCP-006 - NMOS Stream Mappings
- AMWA BCP-006-01 - NMOS With JPEG XS

6 Definitions

For the purposes of this document, the terms, and definitions of VSF TR-10-1 and the following apply.

IPMX Media Node An IPMX Device represented as a single Node under AMWA IS-04

7 General Provision

- a. IPMX Media Nodes shall expose an AMWA IS-04 version V1.3 NMOS Node API. IPMX Media Nodes should implement the most current version of the IS-04 Node API and may expose these versions in addition to the IS-04 version 1.3 baseline requirement.
- b. IPMX Media Nodes shall support both unicast and multicast DNS-SD for service discovery as described in the Discovery document within the NMOS IS-04 specification set.
- c. IPMX Media Nodes shall enable both unicast and multicast DNS-SD for service discovery by default.

- d. When both unicast DNS-SD and multicast DNS-SD are enabled, a unicast DNS-SD browse shall be performed first.
- e. Per the Discovery document within the NMOS IS-04 specification set, when a Registration API is discovered using unicast DNS-SD, IPMX Media Nodes shall not perform multicast DNS-SD browsing even if the unicast-discovered API is unresponsive.
- f. When a Registration API is discovered, an IPMX Media Node shall register its resources using the Registration API as defined in the Discovery document, Registered Operation section within the AMWA NMOS IS-04 specification set.
- g. When a Registration API is not discovered, an IPMX Media Node shall advertise its resources using the method described in the Discovery document, Peer-to-Peer Operation section within the AMWA NMOS IS-04 specification set.
- h. IPMX Media Nodes shall maintain their registration as documented in AMWA IS-04 including periodic “health” check-ins.
- i. IPMX Media Nodes shall expose unique, immutable, and consistent UUIDs in the IS-04 registry over the life of the product, including consistency over reboots, power cycles, and software upgrades.
- j. IPMX Media Node shall publish descriptive tags as per the AMWA BCP-002-02 for the NMOS Node as well as any NMOS device contained within the IPMX Media Node.
- k. IPMX Media Nodes shall indicate appropriate natural grouping as per AMWA BCP-002-01 for IPMX Senders and Receivers contained within the IPMX Media Node.
- l. IPMX Media Nodes which generate or consume audio streams and offer channel mapping functionality shall implement the AMWA IS-08 NMOS Audio Channel Mapping Specification.
- m. IPMX Media Nodes shall expose an AMWA IS-05 resource. IPMX Media Nodes should implement the most current versions of the AMWA IS-05 API and may expose these versions in addition to the IS-05 version 1.1 baseline requirement.
- n. IPMX Receivers shall support modification of the `transport_params`, `transport_file`, and `master_enable`, via the AMWA IS-05 API.
- o. IPMX Senders shall support configuration of their Sender `transport_params` and `master_enable` via the AMWA IS-05 API.
- p. IPMX Senders shall expose their SDP file via their IS-05 `/transportfile` endpoint.
- q. IPMX Media Nodes shall use the AMWA IS-05 API constraints mechanism to signal that it cannot use certain ports for media streams and reject requests which do not comply with these constraints.
- r. All connection management via AMWA IS-05 under this document shall support the RTP `transport_params` schema, utilizing IPv4 Multicast addressing for streams.
- s. IPMX Media Nodes which generate or consume TR-10-11 media stream that transport JPEG XS essences shall comply with AMWA BCP-006-01.

8 Link Offset Delay

An IPMX Receiver shall use NMOS IS-05 to expose control of the Link Offset Delay attribute. NMOS IS-05 supports parameter extension using the `ext_` prefix. An IPMX Receiver shall use `ext_link_offset_delay` to extend the NMOS IS-05 Receiver transport parameters to include `DLO`.

Note: Below is an example of a IPMX Receiver that has an active value of 30usec for `ext_link_offset_delay`

```
"transport_params": [  
  {  
    "source_ip": null,  
    "multicast_ip": "239.58.85.1",  
    "interface_ip": "192.168.55.85",  
    "destination_port": 50004,  
    "rtp_enabled": true,  
    "ext_link_offset_delay": 30,  
  }  
]
```

IPMX Receivers shall use IS-05 constraints to indicate the valid range for `ext_link_offset_delay`. An IPMX Receiver that is actively receiving an IPMX network stream (active IPMX Receiver) shall specify a minimum and maximum constraint for `ext_link_offset_delay`. When an IPMX Receiver is not active, it shall not specify constraints on `ext_link_offset_delay`.

Active IPMX Receivers shall set the minimum constraint for the `ext_link_offset_delay` parameter to correspond to the earliest moment a packet from the current IPMX network stream can be reconstructed. The minimum constraint value should consider the network transport delay and its potential variations, and the minimum buffering required by the receiver to accommodate its own internal processing.

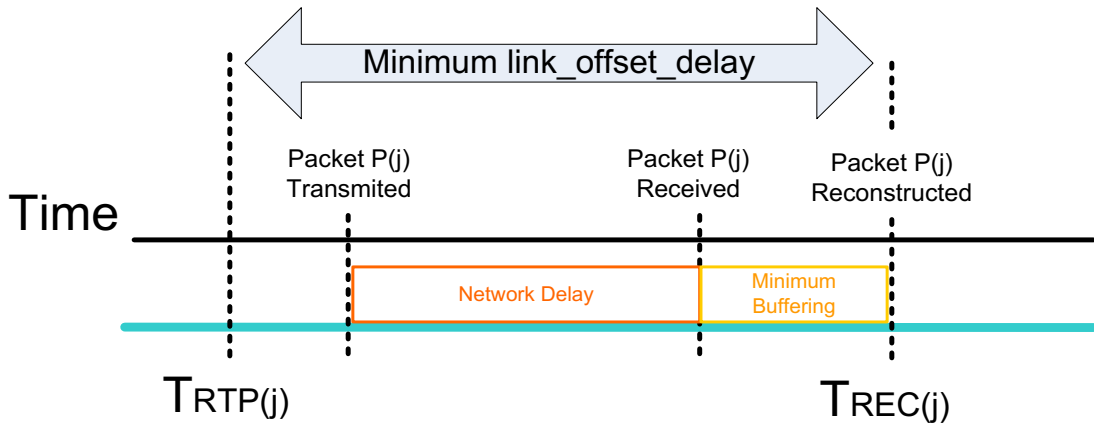


Figure 1 – Minimum link_offset_delay

Figure 1 illustrates the nature of the minimum link_offset_delay constraint. In figure 1 the minimum buffering corresponds to the minimum delay the IPMX Receiver implementation supports.

Active IPMX Receivers shall set the maximum constraint for the ext_link_offset_delay parameter to correspond to the maximum delay supported for the current IPMX network stream. The maximum constraint value shall take into account the network transport delay and its potential variations, and the maximum delay achievable by the receiver for the active flow before the packet overflows the receiver buffer.

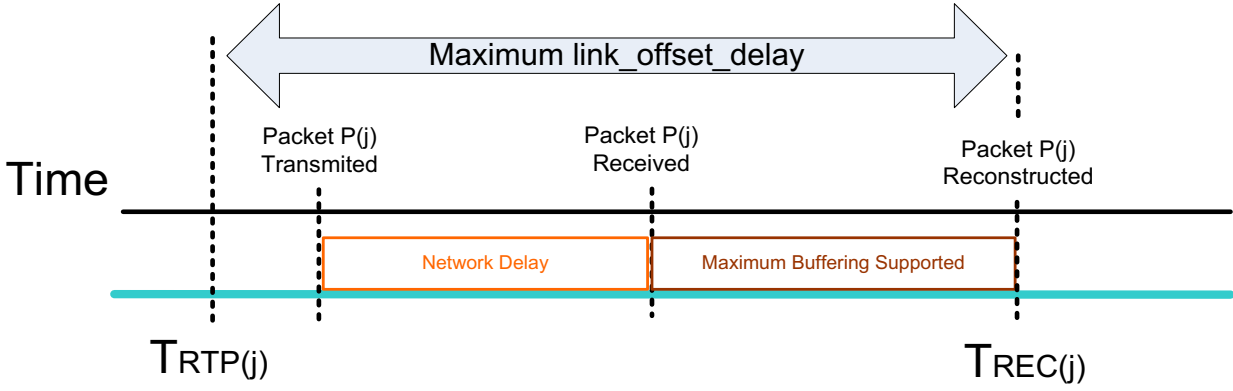


Figure 2 – Maximum link_offset_delay

Figure 2 illustrates the nature of the maximum link_offset_delay constraint. In figure 2 the maximum buffering corresponds to the maximum delay the IPMX Receiver implementation supports.

Note: Below is an example of an IPMX Receiver that supports a minimum D_{LO} of 15uSec and a maximum D_{LO} of 52uSec.

```
[
  {
    "source_ip": {},
    "multicast_ip": {},
    "interface_ip": { "enum": ["192.168.55.85"] },
    "destination_port": {},
    "rtp_enabled": {},
    "ext_link_offset_delay": { "minimum": 15, "maximum": 52 }
  }
]
```

An IPMX Receiver shall support a staged value of ‘auto’ for the `ext_link_offset_delay` transport parameter.

When the `ext_link_offset_delay` transport parameter is set to ‘auto’, on activation the Link Offset Delay of an active IPMX Receiver shall be set to the minimum constraint value for the IPMX network stream the IPMX Receiver is receiving.

When an IPMX Receiver is not active it shall return a value of 0 for the `ext_link_offset_delay` transport parameter.

An active IPMX Receiver shall return the current value of Link Offset Delay when the Receiver parameter for the `ext_link_offset_delay` transport parameter is retrieved from the IS-05 /active endpoint.

When the value of the `ext_link_offset_delay` transport parameter is set to a value that falls within the constraints, the IPMX Receiver shall change its Link Offset Delay to match.

When a new IPMX network stream is selected without specifying a new value for the `ext_link_offset_delay`, the current value shall be used unless the current value does not fall within the `ext_link_offset_delay` constraints. If the latter occurs, the IPMX Receiver shall update the value of its Link Offset Delay to match the either the minimum or maximum constraint for the newly selected IPMX network stream, whichever is closest.

9 Using Link Offset Delay to align multiple receivers (informative)

In this section we demonstrate how the Link Offset Delay Attribute exposed through NMOS IS-05 as documented in section 8 of this document can be used to align the Playout Time of multiple IPMX Receivers.

Given three receivers having different characteristics as illustrated in figure 3 below.

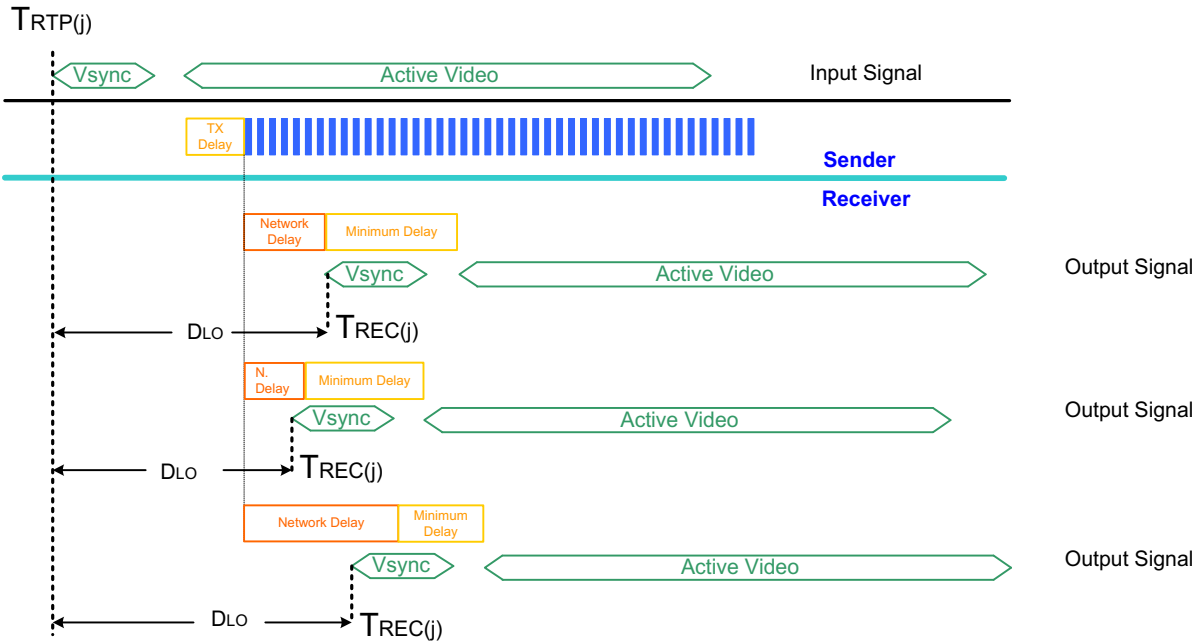


Figure 3 – D_{LO} example

The example of Link Offset Delay illustrated in Figure 3, shows the earliest moment that three video IPMX Receivers, experiencing different network latencies, and having different minimal internal delays, could present a signal on their respective outputs. In the diagram, the TX Delay is the delay between sampling a pixel and transmitting it on the network.

A NMOS IS-05 controller can align the Playout Time of all three receivers by following the procedure below:

1. Retrieve the `ext_link_offset_delay` constraints for each receiver.
2. Examines the minimum constraint for all three receivers and determines the largest value.
 - a. In our case the bottom receiver would report the largest minimum constraint.
 - b. This value indicates the earliest moment that receiver can produce an output based on the current signal being received.
3. Determine if all receivers support having their `ext_link_offset_delay` set to the value determined in step 2.
 - a. A receiver supports this value if the maximum constraint of the receiver is greater than this value.
4. Program the `ext_link_offset_delay` of all receivers to the value determined in step 2

Figure 4 below illustrate the resulting alignment.

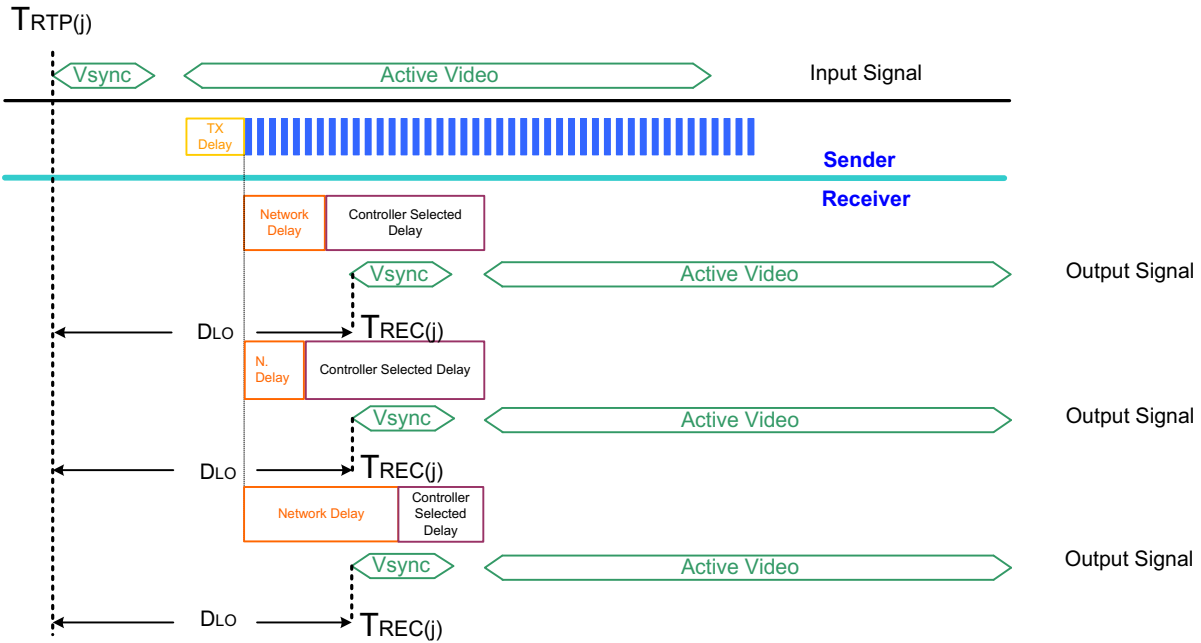


Figure 4 – Alignment of receiver Playout Time using D_{LO}

The example illustrated in Figure 4, shows how Link Offset Delay can be used for coordinating the Playout Time of three different video IPMX Receivers. In this example, the IPMX Receivers are listening to the same Sender but experience different network latencies and have different minimum internal delays. A value for Link Offset Delay that compensates for these variations for each receiver has been programmed into each IPMX Receiver. In the diagram, the TX Delay is the delay between sampling a pixel and transmitting it on the network.