

Joint Task Force on Networked Media

Technical Recommendation
TR-1001-1:2020 v1.1

System Environment and Device Behaviors For
SMPTE ST 2110 Media Nodes in Engineered Networks
Networks, Registration and Connection Management

11 November, 2020

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JT-NM TR1001-1

System Environment and Device Behaviors for ST 2110 Media Nodes in Engineered Networks – Networks, Registration, and Connection Management

Executive Summary

IP-based Media Systems are governed by a multitude of standards and specifications from different organizations, including AES, AMWA, EBU, IEEE, IETF, SMPTE, VSF. Each of the standards and specifications involved is conceived and developed to serve multiple use-cases across multiple industries; many are extremely flexible in nature.

For the purposes of engineering, constructing and maintaining professional media facility infrastructures (including OB vans), the industry requires the ability to easily integrate equipment from multiple vendors into a coherent system. This Technical Recommendation summarizes relevant standards and specifications, and documents some specific additional constraints related to this domain of use. In addition, certain device behaviors are documented which facilitate the deployment of a manageable system. In some cases, this document specifies behaviors or features more strictly than is specified in the underlying standards.

The goal of this document is to enable the creation of network environments where an end-user can take delivery of new equipment (compliant to this recommendation), connect it to their network, and configure it for use, with a minimum amount of human interaction. Specifically, the interaction ought to be limited to acknowledging the equipment's existence (for security reasons), assigning operational names to the signals the equipment generates, and defining any grouping relationships the signals might have with other existing signals. Technical configuration of the equipment in regards to timing, signal transport, and routing interactions is automated by the behaviors and management systems described in this recommendation.

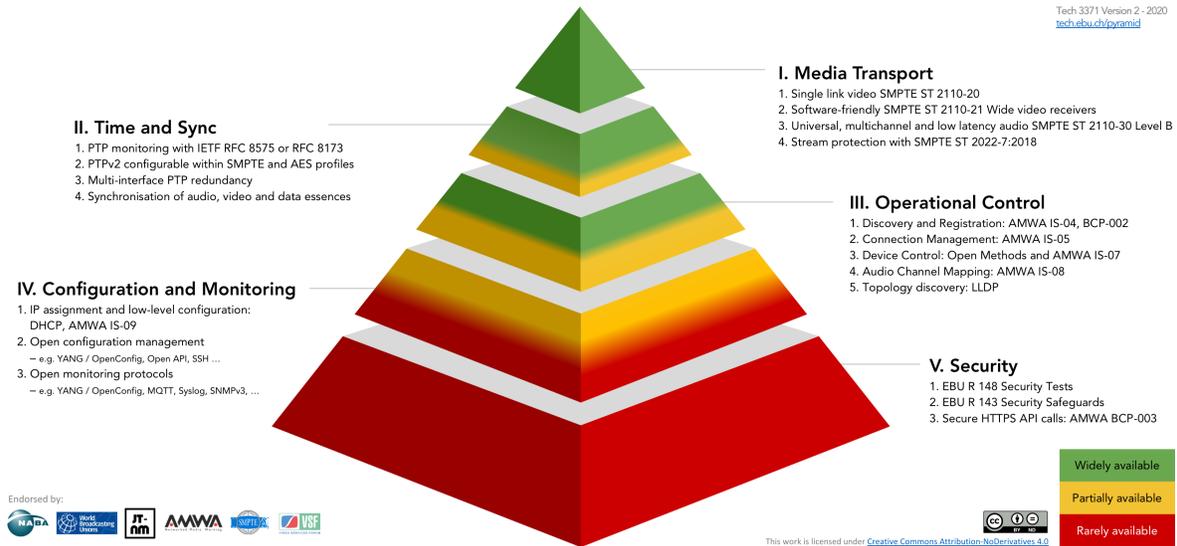
The EBU has developed a TECH document titled, "The Technology Pyramid for Media Nodes"¹ which contains a helpful graphic titled, "Minimum User Requirements to Build and Manage an IP-Based Media Facility using Open Standards & Specifications" which is included below. This Technical Recommendation addresses some of the elements listed in the graphic, but with a particular focus on the system environment and device behaviors for ST 2110 Media Nodes in engineered networks. It does not attempt to address all areas shown in the EBU graphic below. Specifically, this version of this document does not address security, monitoring, or configuration management; these remain as potential topics for future work across the organizations of the JT-NM.

¹ EBU TECH 3371: The Technology Pyramid for Media Nodes – Minimum User Requirements To Build and Manage An IP-based Media Facility available at <https://tech.ebu.ch/publications/tech3371>



THE TECHNOLOGY PYRAMID FOR MEDIA NODES

Minimum User Requirements to Build and Manage an IP-Based Media Facility using Open Standards & Specifications.



2. The JT-NM

The JT-NM (Joint Taskforce on Networked Media) is a self-coordinating group of industry bodies working together on the development of IP technologies for professional media systems.² Admin Group Members include the Advanced Media Workflow Association (AMWA), the European Broadcasting Union (EBU), the Society of Motion Picture and Television Engineers (SMPTE©), and the Video Services Forum (VSF). This document was developed by an ad-hoc group of industry experts including both manufacturers and broadcasters in order to provide guidance and drive towards common solutions for deployment of SMPTE ST 2110-based media networks.

3. JT-NM Documents

This work is the product of several independent groups, coming together under the JT-NM banner with the goal to create an ecosystem that allows end users to build functioning professional media facilities. It is the intent of the JT-NM Admin group that due process standards bodies, trade associations and other industry bodies will undertake work to develop and stabilize the concepts and proposals in JT-NM documents to realize this goal.

This first JT-NM document is created to address the EBU pyramid of user requirements shown above. This document addresses the urgent need for agreement and coordination between the various standards, specifications, open source deployments and work in progress that the industry is currently embarked on. This document lays out an approach to the behavior of Media Devices and the network environment that will be tested and, no doubt improved with time.

² See <http://www.jt-nm.org> for more information



The JT-NM counts more than 300 participants from 175 organizations. More information on the JT-NM including its scope and previously published works may be found on our website jt-nm.org.

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5. IPR Policy

This work was developed under, and is covered by the AMWA IPR Policy Version 3.0. A copy of this policy may be obtained at <https://www.amwa.tv>.

Recipients of this work are requested to submit, with their comments, notification of any relevant patent claims or other intellectual property rights of which they may be aware that might be infringed by any implementation of the AMWA Specification set forth in this document, and to provide supporting documentation. Please make these submissions to info@jt-nm.org.

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6. Scope

This Technical Recommendation enumerates Standards and Specifications, and defines operational behaviors, for Media Nodes, and for the network interfaces and Network Services which form the environment within which these Nodes operate. The domain of intended use of this specification is engineered fixed professional media infrastructures utilizing the SMPTE ST 2110 and AMWA NMOS family of standards. Detailed configuration of Networks and Network Services is outside the scope of this recommendation.

7. Conformance Notation

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



8. Normative References

AMWA IS-04 version 1.2 STABLE - NMOS Discovery and Registration Specification

AMWA NMOS Parameter Registers

AMWA IS-05 version 1.0 STABLE - NMOS Device Connection Management Specification

AMWA IS-08 version 1.0 STABLE – NMOS Audio Channel Mapping Specification

AMWA IS-09 version 1.0 – NMOS System Parameters Specification

AMWA BCP-002-01: Best Current Practice for Natural Grouping of NMOS Resources

IEEE 802.1AB Station and Media Access Control Connectivity Discovery (LLDP)

IEEE 802.1AX-2014 Link Aggregation

IEEE 1588-2008 Precision Clock Synchronization Protocol for Networked Measurement and Control Systems

IETF RFC 1034 DOMAIN NAMES - CONCEPTS AND FACILITIES

IETF RFC 2131 Dynamic Host Configuration Protocol

IETF RFC 5771 IANA Guidelines for IPv4 Multicast Address Assignments

IETF RFC 6763 DNS-Based Service Discovery

SMPTE ST 2059-1:2020 Generation and Alignment of Interface Signals to the SMPTE Epoch

SMPTE ST 2059-2:2020 SMPTE Profile for Use of IEEE-1588 Precision Time Protocol in Professional Broadcast Applications

SMPTE ST 2110-10:2017 Professional Media over Managed IP Networks: System Timing and Definitions

SMPTE ST 2110-20:2017 Professional Media over Managed IP Networks: Uncompressed Active Video

SMPTE ST 2110-21:2017 Professional Media over Managed IP Networks: Traffic Shaping and Delivery Timing for Video

SMPTE ST 2110-30:2017 Professional Media over Managed IP Networks: PCM Digital Audio

SMPTE ST 2110-31:2018 Professional Media over Managed IP Networks: AES3 Transparent Transport

SMPTE ST 2110-40:2018 Professional Media over Managed IP Networks: SMPTE ST 291-1 Ancillary Data



9. Defined Terms

9.1 Sender - entity which generates a media stream (or redundant pair of streams) compliant to SMPTE ST 2110-20, ST 2110-30, ST 2110-31, or ST 2110-40

9.2 Receiver – entity which potentially consumes a media stream (or redundant pair of streams) compliant to SMPTE ST 2110-20, ST 2110-30, ST 2110-31, or ST 2110-40

9.3 Network Services - services which reside in the network environment, which support the Media Nodes, such as DHCP or PTP

9.4 Media Node - physical or Logical collection which includes zero or more Senders and zero or more Receivers, represented as a single Node under AMWA IS-04



10. System Overview

10.1 Network Environment

For the purpose of this document, the logical network environment of Figure 1 will be used to illustrate the environment for the Media Node, including the Network Services.

Media Nodes shall be connected to at least one Media Network, and may have connections to two or more media networks. If more than one Media Network is used (such as “Amber” and “Blue” in the figure) then the active-active redundancy model of SMPTE ST 2022-7 shall be supported by the Media Node.

Media Nodes may have zero or more connections to the Control Network. This Control Network may be a single subnet or a routed environment. If a Media Node has more than one connection to the Control Network, those connections shall, by default, be configured to form a single (link-aggregated) network interface using LACP (IEEE 802.1AX) and are considered a single “interface” for the purposes of this document.

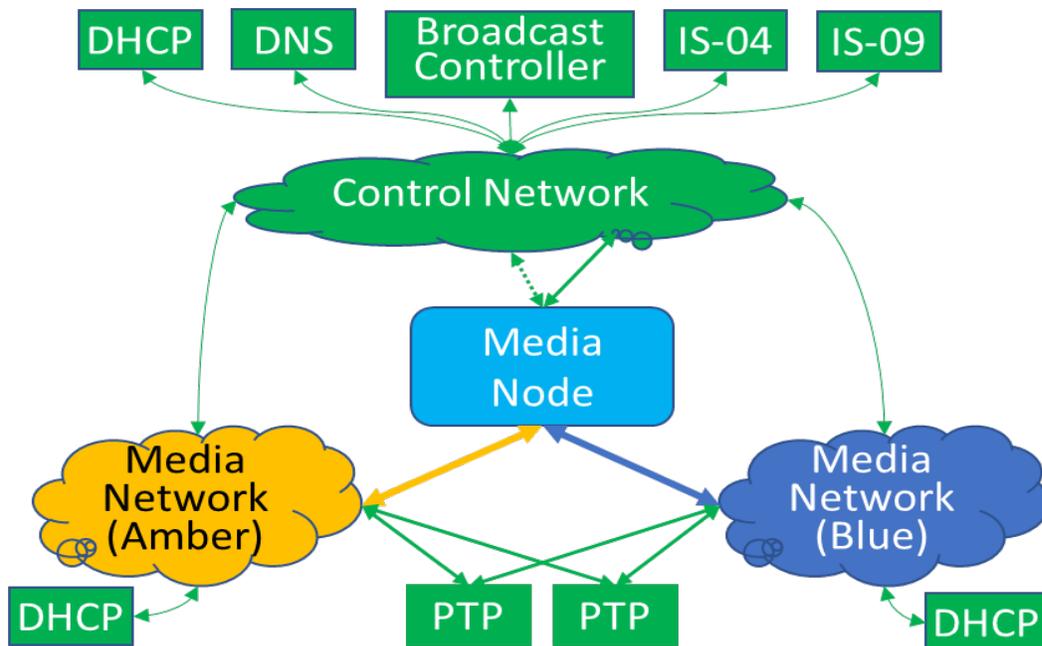


Figure 1 – Abstract Network Environment Diagram

All media traffic (including multicast and unicast essence transports) shall be confined to the Media Networks. Unicast control traffic shall be supported in the Media Networks, including unicast routing connectivity between the Media and Control networks.

10.2 Network Services within the Environment

10.2.1 Unicast Routing

IPv4 Unicast Routing shall be available between and amongst hosts on the Control Network and the Media Network(s). The Broadcast Controller shall be able to communicate with any network interface on any Media Node, and any Media Node shall be able to communicate with the IS-04 registry services and broadcast controllers via unicast from any of its management-enabled network interfaces – Media or Control.

Media Nodes shall not bridge or forward traffic from one network to another under any circumstance.

Each network interface of a Media Node shall have a unique MAC address and a different IP Host Address from the other interfaces on the Media Node. Control Network interfaces, if present, shall be on a separate subnet from Media Network interfaces. The network interfaces to each Media Network shall also be on separate subnets from other Media Network(s). Media Nodes with more than one connection to the same Media Network shall allow the same subnet across the connections to the same Media Network, but shall also allow each interface to be on a different subnet.

Media Nodes shall support ICMP “Echo Request” (a/k/a PING) on all network interfaces.

10.2.2 Precision Time Protocol (PTP)

PTP service compliant to IEEE 1588-2008 and compliant to the profile defined in SMPTE ST 2059-2 shall be available on each Media Network. PTP service is neither required nor prohibited on the control network. Media Nodes are not required to use PTP from the control network for any purpose, even in systems where it is present.

All Network-provided PTP services across all networks shall comply with the frequency accuracy provisions of SMPTE ST 2059-2. Where multiple potential Leader clocks are implemented, these should be derived from a consistent source of time and shall be within an absolute timing accuracy of +/-100ms to International Atomic Time (TAI) when the PTP timescale is in use. Typically, GPS-locked PTP is far tighter than this requirement.

Note: the arbitrary PTP timescale (ARB) might be used in some circumstances. While Media Nodes might synchronize their logging message times to PTP when the PTP timescale is used, if the arbitrary timescale is in use care should be exercised in this regard.

By default, Media Nodes shall not assume the role of PTP grandmaster in normal operation.

Media Nodes which connect to more than one Media Network should carefully choose the best source of PTP across all of their Media Network interfaces.

Media Nodes shall use the PTP parametric values and domain number specified in the System API defined in AMWA IS-09. If the System API is not available, stored values from the last successful operational experience should be used.

Media Nodes should ensure that their internal timebase maintains usable stability during transitions between grandmasters. In the holdover case, Media Nodes should continue to meet their interface specifications for several minutes (20 minutes is a suggested target).



Note: It is critical that Media Nodes apply a careful method across the Media Network interfaces, and not just a simple fail-over -- properly utilizing the clock dataset values from each interface. A common failure case is that one media network, operating in boundary clock mode, might lose its PTP grandmaster connection – in which case its clock dataset values will change to reflect this. Another media network may still have a good PTP grandmaster, in which case its clock dataset values would reflect that, and a correctly operating media node would choose the better interface’s time source. Based on feedback from the SMPTE 2059 interoperability events, the SMPTE is developing additional guidance on operation of PTP across multiple Media Network interfaces.

10.2.3 Link-Layer Discovery Protocol (LLDP)

Media Nodes shall implement IEEE 802.1AB “LLDP” protocol on each Media Network connection in order to identify themselves to the Media Network switches. Where possible, the LLDP information transmitted on the interfaces of a device should include the MAC address of the transmitting port.

Media Nodes shall report their interface information as required under AMWA IS-04 NMOS Node API. In particular, the “port_id” field of each interface object in the node resource must contain the MAC address of the related interface.

LLDP on Control Network interfaces is encouraged but not mandated.

10.2.4 Dynamic Host Configuration Protocol (DHCP)

IETF RFC 2131 DHCP service shall be available on the Control Network and the Media Networks, either directly or via DHCP Relay Agents.

The DHCP service shall provide host configuration information to the Media Node for the network interfaces which request it. Table 1 enumerates the minimum DHCP options which shall be available to all Media Nodes. Facilities are permitted to support additional options as needed.

Table 1 – DHCP Options

Option #	Name	Description
1	Subnet Mask	Subnet Mask
3	Router	Available routers on this subnet, in preference order
6	DNS	DNS Servers
15	DNS Domain	Domain Name
28	Broadcast Address	Broadcast Address
50	Requested Address	Requested IP Address
51	Lease Time	DHCP Lease Time
58	Renewal Time	DHCP Lease Renewal Time (T1)
59	Rebinding Time	DHCP Lease Rebinding Time (T2)
81	Hostname	Client provides FQDN to the server



82	Relay Info	DHCP Relay Agent Information
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Media Nodes shall request option 12 (wherein the DHCP server provides a hostname) and if the DHCP server returns a hostname with option 12 the Media Node shall use it. The Media Node shall create its own unique host name in the event that the DHCP server does not reply with a hostname under option 12. Using a textual representation of the MAC address as part of the name is one way to accomplish this.

Media Nodes shall support DHCP option 81, wherein the DHCP server can request the client to return its FQDN to the DHCP server.

10.2.5 Domain Name Service (DNS)

The Network Environment shall include one or more unicast DNS servers; the addresses of these servers shall be distributed to Media Nodes via DHCP option 6. Media Nodes may supplement or override the DHCP option 6 information with user configuration.

Media Nodes may attempt to register their hostname in DNS; however system security settings might prevent this action from succeeding. In systems which are secured in this manner, the DHCP server may be configured to perform a secure DNS Dynamic Update on behalf of the Media Node.

If more than one DNS server is advertised (or configured) to a media node, it is the responsibility of the environment to provide consistent information across the multiple DNS servers.

10.2.6 NMOS System Parameters (IS-09)

The Network Environment shall provide one or more instances of the System API as defined in AMWA IS-09 NMOS System Parameters Specification. This may be co-hosted by the NMOS Registry or may be provided on separate servers.

Media Nodes shall use unicast DNS Service Discovery (DNS-SD) to locate the System APIs as described in IS-09.

Media Nodes shall, at startup, locate and read the global configuration resource from the System API and use the values from that resource in place of any stored configuration values for the same parameters.

If the System API is unavailable at startup, the Media Node may continue with the startup using stored values from previous operation. Once the System API has been successfully read, Media Nodes should not do any periodic re-checking of it.

In the case where the Media Node cannot locate or cannot access the System API at startup, even after it has begun operation using stored values, the Media Node should periodically attempt to access the System API until it successfully does so, following the exponential back-off guidance of IS-09 section 4.1.

10.2.6 NMOS Registry (IS-04)

The Network Environment shall contain one or more registries implementing AMWA IS-04 v1.2 NMOS Registration and Query APIs. Systems are encouraged to implement the most current versions of the IS-04 API, and may expose these versions in addition to the IS-04 v1.2 baseline requirement.

Media Nodes shall use unicast DNS Service Discovery (DNS-SD) to locate the registration APIs as described in IS-04.



If DNS-SD is not available or does not return a usable registration API endpoint, Media Nodes should attempt registration in the API endpoint used in previous operation (if available). When operating in this manner, Media Nodes shall periodically re-query DNS-SD for a registry service, but not more than once per minute.

Media Nodes should, through product-specific means, provide a status parameter indicating which registration service is currently in use.

Media Nodes shall use the registry heartbeat_interval value specified in the System API defined in AMWA IS-09 when maintaining their registration.

10.2.7 Network Time Protocol (NTP)

NTP service may be available in the control and/or media networks, and if available should be advertised by the DHCP server using the standard DHCP option (option 42). Any provided NTP service should reflect the same time value as the PTP (after accounting for the differences between UTC and TAI time).

10.3 Multicast Media Streams

Media Nodes shall support IPv4 multicast streams, with packet sizes compliant to the Standard UDP Size Limit specified in SMPTE ST 2110-10.

Media Nodes shall support IGMP V3, and shall use the source-specific method if the source address information is provided in the SDP. Notwithstanding the provisions of IETF RFC 5771, Senders and Receivers shall support the entire range of multicast addresses as noted in section 11.3, including the ability to request SSM across this whole range.

Senders should include source address information in the SDP.

Media Nodes should provide a user mechanism for selecting the DSCP markings of the generated streams.

Note: Networks which have specific limitations on multicast ranges for SSM can implement those restrictions through their control systems.

Note: Support of IGMPv3 includes the ability to support IGMP V2 and to dynamically determine which version to use.

11 Requirements and Behaviors of Media Nodes

11.1 Media Node Requirements

Media Nodes shall comply with SMPTE ST 2110-10.

Media Nodes which generate or consume two streams for redundancy purposes shall implement SMPTE ST 2022-7:2018, and shall expose two interface_bindings entries in their IS-04 sender or receiver objects. The first entry of the IS-05 transport_params array shall relate to the first entry of the IS-04 interface_bindings array, and likewise the second entries shall relate.



Media nodes which generate or consume their redundant streams on the SAME Media Network interface shall still expose two (identical) entries in the IS-04 interface_bindings array, referring to the same interface.

Media Nodes which generate or consume video streams shall comply with SMPTE ST 2110-20 and ST 2110-21.

Media Nodes which generate or consume PCM audio streams shall comply with SMPTE ST 2110-30.

Media Nodes which generate or consume non-PCM audio signals mapped into AES3 transport shall comply with SMPTE ST 2110-31.

Media Nodes which generate or consume SMPTE ST 291-1 ANC data streams over IP shall comply with SMPTE ST 2110-40.

Media Nodes shall expose an AMWA IS-05 v1.0 NMOS device connection management API. Media Nodes are encouraged to implement the most current versions of the IS-05 API, and may expose these versions in addition to the IS-05 v1.0 baseline requirement.

Media Nodes shall expose an AMWA IS-04 V1.2 NMOS Node API, and shall register using the IS-04 Registration API as described in section 10.2.6. Media Nodes shall maintain their registration as documented in AMWA IS-04 including periodic “health” check-ins. Media Nodes are encouraged to implement the most current versions of the IS-04 Node API, and may expose these versions in addition to the IS-04 v1.2 baseline requirement.

Media Nodes should implement the AMWA BCP-002-01 “Natural Grouping” practice.

Media Nodes which generate or consume audio streams should implement the AMWA IS-08 NMOS Audio Channel Mapping Specification.

Media Nodes shall support IEEE 1588:2008 PTP timing, compliant to the range of values specified in SMPTE ST 2059-2. Where applicable Media Nodes shall also comply with SMPTE ST 2059-1.

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.

Media Nodes shall expose some kind of unit-specific identifying characteristic (such as a serial number or VM identifier) as part of their IS-04 node or device description field, in order to facilitate locating the specific unit or instance that corresponds to each registry entry.

All Receivers shall support modification of the transport_params, transport_file, and master_enable, via AMWA IS-05.

All Senders shall support configuration of their Sender transport_params and master_enable through IS-05.

All connection management via IS-05 under this document shall use the RTP transport_params schema, utilizing IPv4 Multicast addressing for streams.



11.2 Media Node Startup and Multicast Addresses

Media Nodes shall by default utilize DHCP on all of their network interfaces. In any case where they do not utilize DHCP, they shall provide a manual means of configuration of all of the information which would have been delivered via DHCP.

Note: Typical behavior of professional media equipment is to store current operating settings in a non-volatile manner, and to restore those settings after loss-of-power, so that a whole system can re-start quickly after an outage. In the case of Media Nodes in a networked environment, it is important to distinguish between a device re-starting within the same system environment (such as a reset of one device) and the case of a device being moved from one system environment to another (such as a rental camera at a new job). The situation is made harder by a third case – equipment which has been stored (perhaps in a spares closet) for a long period of time such that its settings are outdated, and then is re-introduced to the environment.

The System API defined in IS-09 includes a System ID, which shall be assigned uniquely (e.g. randomly) in each facility. Media Nodes shall store the System ID and their DHCP-assigned address as part of their current operating settings, and shall check at re-start, before generating any multicast outputs, that the current Network Environment's System ID and DHCP-assigned address match the previously stored values. If the current system ID and address are the same as before, then recalling the previous operating settings might be appropriate and safe, subject to the clause below.

In addition to checking the System ID and DHCP-assigned address, Media Nodes shall compare the timestamp of their last stored parameter information against the version timestamp of the System API global configuration resource. If the Media Node's timestamp is newer than the prevailing version, then the Media Node can use its previous operating settings without further checks.

If the System ID and address do not match the stored values, or the global configuration resource version is newer than the stored settings, then the Media Node shall implement the following behavior:

- Any RTP Transmitter which would be active in the current configuration shall be disabled from transmitting (master_enable set to false), but shall remain advertised in IS-04 and configurable via IS-05
- Any RTP Receiver which would be active in the current configuration shall be “disconnected” as defined in section 11.4
- Any stored registry location information shall be invalidated

If the System API is not available, Media Nodes shall behave as if the System API had supplied a matching ID and an earlier version timestamp, in order to maintain compatibility with current behavior.

11.3 Multicast Address Allocation and Stream Transmit Enable

When a Sender Media Node is added to a new system, a management entity will use AMWA IS-05 to configure the multicast transmit information (transport_params) before or in the same transaction as enabling the transmitter (master_enable = true).

Allocation of multicast addresses and avoidance of conflicts is the responsibility of the management system.



Media Nodes shall support the entire range of multicast addresses from 224.0.2.0 through 239.255.255.255.

11.4 Receiver Disconnect Convention

At times, the Broadcast Controller might seek to disconnect a receiver – such that the receiver receives no signal and takes a receiver-dependent action. Some early receiver implementations used multicast addresses of 0.0.0.0 and/or blank/empty/null SDP files to indicate disconnect status.

In order to avoid doubt and to maximize interoperability, the IS-05 `master_enable` property shall be the definitive indicator of the status of a receiver.

When a broadcast controller activates with `master_enable` set to false, the receiver shall enter the disconnect state. When a broadcast controller activates with `master_enable` set to true, the receiver shall attempt to enter the connected state.

Consistent with REST principles, Receivers should persist the values of the transport-file and transport-parameters if they are not altered in the activation, even if the activation indicates a disconnection.

When in the disconnect state, Receivers must update their IS-04 subscriptions object with the `sender_id` of null and `active` set to false even if the activation did not explicitly set the IS-05 `sender_id` to null. Receivers should persist the original `sender_id` in the IS-05 API even in the disconnected state, if the controller did not set it to null.

When responding to a “get” operation for active parameters, a receiver in disconnect shall return a `master_enable` value of false. This value is the definitive indication that the receiver is in the disconnected state.



Annex A

Changes from the TR-1001-1 v1.0:2018 publication

This revision incorporates the following changes compared to the 2018 publication.

Section	Version	What Changed
Annex A	1.1	Deleted the original Annex A which contained a provisional definition for the System Resource, and added references to published AMWA IS-09 System Parameters Specification throughout the document.
Annex A	1.1	Add a new Annex A for a changelog relative to v1.0:2018
11.1	1.1	Nodes with audio should implement IS-08
10.2.5	1.1	Added text regarding consistency across available DNS servers and user configuration of DNS servers instead of DHCP option 6
11.1	1.1	Corrected the reference to AMWA natural grouping document BCP-002-01
10.2.3	1.1	Clarify that the port_id in the IS-04 interface object is the MAC address of the Media Node's interface
10.3	1.1	Added text regarding user-configuration of DSCP values
11.4	1.1	Significant clarification to the disconnect conventions text
11.2	1.1	Added text about checking System Resource at startup, but never re-checking
10.2.6	1.1	Add reference to IS-09 instead of former appendix A, including refer to IS-09 4.1 exponential back-off in startup case
	1.1	Re-work references to AMWA specs