EBU

OPERATING EUROVISION AND EURORADIO

Tech 3371

THE TECHNOLOGY PYRAMID FOR MEDIA NODES

MINIMUM USER REQUIREMENTS TO BUILD AND MANAGE AN IP-BASED MEDIA FACILITY USING OPEN STANDARDS & SPECIFICATIONS

Version 2.0

Geneva
July 2020

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Abstract

This document presents the requirements of the EBU user community regarding IP-based facilities. The document deals with the ensemble of technologies that a *Media Node*[1] needs to support to enable broadcasters to design, build, operate and maintain an IP architecture based on the SMPTE ST 2110 Standards.

The document is aimed at broadcasters and system integrators who need to define and design their requirements for a live IP infrastructure. In addition, the document provides the industry with a clear understanding of what users expect from mature IP Studio equipment.

The structure of the document follows the concept of the Media Node Technology Pyramid that sets out the minimum stack of technologies needed to build and manage an IP-based media facility.

The work involved in this document was conducted by the experts of the EBU Strategic Programme on infrastructure & security, and it is based on the lessons learned from the first IP-based facility projects within the EBU membership. This second version was updated and enriched to reflect the latest state of the market and practical experience gained by a growing number of implementers.

Acknowledgement

This publication was prepared by a task group within the Strategic Programme on infrastructure & security. The group was chaired by Félix Poulin (CBC/Radio-Canada), Willem Vermost (VRT) with key contributions from: Andrew Wilkinson (BBC), Claire Merienne (FranceTV), Dan Nae (RTS), François Legrand (CBC/Radio-Canada), Franz Baumann (IRT), Ivan Hassan (BBC), Jarkko Haapa-aho (YLE), Jemma Phillips (BBC), Lauri Mäenpää (YLE), Louis Lamarre (CBC/Radio-Canada), Mark Patrick (BBC), Markus Berg (IRT), Markus Ostertag (SWR), Mike Ellis (BBC), Peter Brightwell (BBC), Ruth Sloan (BBC) and Sonja Langhans (IRT).

EBU staff: Ievgen Kostiukevych (Project Manager) and Roger Miles (proofing and layout).

Conformance Notation

This document contains both normative text and informative text.

All text is normative except for that in the Introduction, any section explicitly labelled as 'Informative' or individual paragraphs which start with 'Note:'.

Normative text describes indispensable or mandatory elements. It contains the conformance keywords 'shall', 'should' or 'may', defined as follows:

'**Shall**' and '**shall not**':	Indicate requirements to be followed strictly and from which no deviation is permitted in order to conform to the document.
'**Should**' and '**should not**':	Indicate that, among several possibilities, one is recommended as particularly suitable, without mentioning or excluding others. OR indicate that a certain course of action is preferred but not necessarily required. OR indicate that (in the negative form) a certain possibility or course of action is deprecated but not prohibited.
'**May**' and '**need not**':	Indicate a course of action permissible within the limits of the document.

[1] A Media Node has one or more physical or software-based device(s) that can send (Sender) and/or receive (Receiver) media streams.

Default identifies mandatory (in phrases containing "**shall**") or recommended (in phrases containing "**should**") presets that can, optionally, be overwritten by user action or supplemented with other options in advanced applications. Mandatory defaults shall be supported. The support of recommended defaults is preferred, but not necessarily required.

Informative text is potentially helpful to the user, but it is not indispensable, and it does not affect the normative text. Informative text does not contain any conformance keywords.

A conformant implementation 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.

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The Technology Pyramid for Media Nodes

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

EBU Committee	*First Issued*	*Revised*	*Re-issued*
TC	December 2018	June 2020	2020

Keywords: IP based, media facility, Media Node, Media stream, Technology stack, 2110, NMOS.

1. Introduction

The following are the requirements of the EBU user community regarding IP-based facilities. The document deals particularly with the ensemble of technologies that a *Media Node* needs to support to enable broadcasters and vendors to design, build, operate and maintain an IP architecture based on the SMPTE ST 2110 Standards.

The target audiences are broadcasters and system integrators who need to define and design their requirements for a live IP infrastructure. In addition, the document provides the industry with a clear understanding of what users expect from mature IP Studio equipment.

The document assumes that the reader is familiar with the terms and nomenclatures used in SMPTE ST 2110, together with general IP architecture and design rules.

2. The Technology Pyramid for Media Nodes

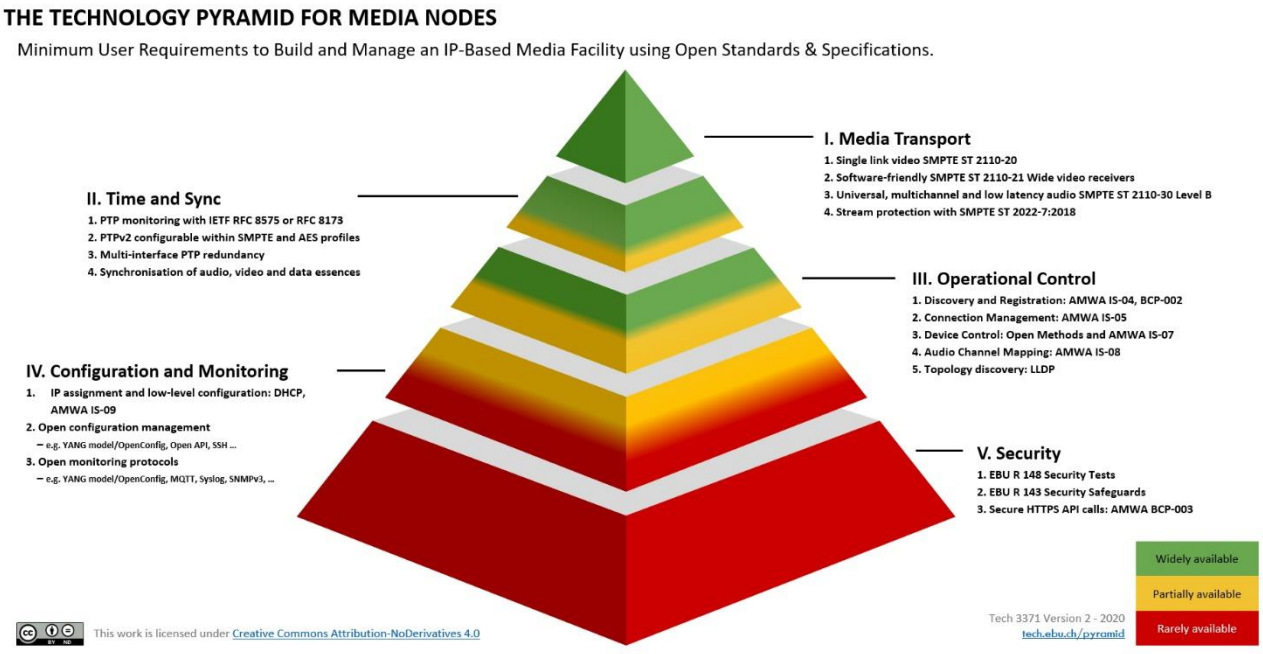

Figure 1: Minimum user requirements to build and manage an IP-based media facility (for clarity, a larger version of this figure is provided on page 13)

3. General Principles

All the technologies and standards used to compose the Media Node Pyramid:

- Shall be designed following best practice cybersecurity principles to reduce the risk of vulnerabilities;
- Should be implementable in software running on standard IT servers, so enabling flexible, agile and scalable infrastructures;
- Should strive to reuse, as much as possible, existing IT and Internet Standards (e.g., IETF, IEEE, W3C, etc.) to leverage the R&D investments of this much wider industry.
- Should use Open standards and specifications, i.e.:
    - Documentation should be adequate for developing a custom solution (e.g. provided reference implementations, API and modules documentations);
    - Documentation shall be accessible to the public, it shall not require a Non-Disclosure Agreement (NDA), it should be actively maintained, and it should be free to obtain so that any implementer or user can consult it;
    - If the standard or specification includes patented technology, it should be covered by a fair, reasonable, and non-discriminatory royalty-free licencing policy (RAND-Z or RAND-RF) or at least shall have fair, reasonable and non-discriminatory licencing policy (FRAND) so that the technology is accessible to all users;
    - New versions should maintain backward compatibility with previous versions in the last 5 years to allow the progressive evolution of systems.

4. Pyramid Layers

The numbering in this section corresponds to that in Figure 1.

I Media Transport

The tip of the Media Node Pyramid comprises Standards necessary for encapsulating and transporting media essences, based on the SMPTE ST 2110 *Professional Media Over Managed IP Networks* suite. However, 2110 is a necessary but insufficient technology to deploy media over IP at the scale of a facility. 2110 is just the tip of the Pyramid!

I.1 Single link video: SMPTE ST 2110-20

.1 For simplicity of operation, troubleshooting and optimally dense use of the network, video Media Nodes should use single link streams (i.e. Media Nodes should not use SMPTE ST 2110-23). For instance, a single 59.94 Hz UHD stream requires a 25 Gigabit Ethernet (GbE) port and a high-density device (such as a multiviewer or a vision mixer) should take benefit of bi-directional 100 GbE.

I.2 Software-friendly SMPTE ST 2110-21 Wide video Receivers

to get the flexibility expected from IP-based media:

.1 Receivers shall support SMPTE ST 2110-21 Wide type so they can receive Wide streams that are generated by software Senders, in addition to Narrow Senders.

.2 Receiving buffer size should be adjusted automatically from the SDP info (`TP=2110TPN, 2110TPNL, 2110TPW`) and can be overridden by the user to optimize latency.

I.3 Universal, multichannel, low latency audio: SMPTE ST 2110-30 Level B

.1 In addition to SMPTE ST 2110-30 Level A, which is compatible with all AES67 and 2110-30 devices, audio Senders and Receivers shall support Level B to support low latency applications;

.2 Audio Receivers shall have a buffer capacity at least 20 times the packet time to allow a range of hardware and software implementations;

.3 Receivers shall be compatible with AES67 including random RTP clock offset so that they can be used with all AES67 Senders on the market;

.4 AES67 Senders shall provide a mode for 2110-30 compatibility, e.g., zero RTP clock offset, so that they can be used across TV, radio and online media production systems;

.5 Media Nodes often need multiple Senders and Receivers so users can group audio channels that belong together in the same stream: 5.1 programme into a 6-channel stream, stereo audio description into a 2-channel stream, 1-channel for a microphone, etc.

I.4 Stream protection with SMPTE ST 2022-7:2018

.1 For protection of streams, Media Nodes shall provide at least two separate Ethernet media interfaces using SMPTE ST 2022-7:2018 *Seamless Protection Switching of RTP Datagrams*;

.2 Receivers shall support SMPTE ST 2022-7:2018 Class D with Ultra Low-Skew 150 µs that is adapted to engineered LAN with adding minimal latency;

.3 Receivers shall report late or lost packets on each redundant stream so that degraded protection can be diagnosed.

II Time and Sync

Real-time media requires synchronisation in many use cases. SMPTE ST 2110 systems rely on IEEE 1588-2008 (PTPv2) as clock synchronization mechanism with media-specific profiles and behaviours.

II.1 PTP Performance

.1 Media Nodes shall not experience visual or audible disturbance when there is an interruption of the PTP clock distribution for up to 5 minutes, so that is it tolerant to short PTP loss.

.2 When the PTP reference returns from a momentary interruption of up to 5 minutes, the Media Node shall gracefully re-align itself with the clock without causing a visible or audible glitch in the media output.

.3 The Media Node shall report about the PTP state and parameters preferably using the IETF RFC 8575 *YANG Data Model for the Precision Time Protocol* or at least IETF RFC 8173 *Precision Time Protocol Version 2 Management Information Base*, so that it can be monitored.

II.2 PTPv2 configurable within SMPTE and AES profiles

.1 PTP parameters of Media Nodes shall be configurable within the union of the ranges covered by the both SMPTE ST 2059-2 profile, the AES67 media profile and the IEEE-1588 default profile so that we can use the Media Nodes for the full range of possible operational scenarios;

.2 However, it is recommended to the users to select an operational point within the range of AES-r16-2016 so that it is compatible with equipment previously delivered on the market that might be limited to one of the two profiles;

.3 PTP Master capable Media Nodes shall be set to slave-only mode by default so that there is

no risk it becomes the Grandmaster the first time it is used.

II.3 Multi-interface PTP redundancy

.1 Media Nodes shall be capable of selecting its master clock across all its media interfaces so that it can use PTP redundancy for seamless failover.

II.4 Synchronisation of audio, video and data essences

.1 To maintain high production quality, the synchronization of audio, video and/or other data streams that have been captured together and have passed separately through a number of Media Nodes, it shall be possible to easily realign them at key points in the production process.

.2 Note that at the time of publication, SMPTE ST 2110-10 is under revision with additional provisions to enable the use of RTP timestamps for end-to-end inter-essence synchronisation purposes.

III Operational Control

The ability to discover media sources and connect them to destinations easily and securely is a key requirement to enabling basic operation. Control of operational parameters enable multi-vendor integration of controllers.

.1 Media Nodes shall pass the tests for the supported NMOS specifications and versions using the latest NMOS Test Suite. [https://github.com/AMWA-TV/nmos-testing].

III.1 Discovery and Registration: AMWA IS-04

.1 Media Nodes shall support the latest published version of AMWA IS-04 *NMOS Discovery and Registration Specification*.

.2 They shall support IS-04 *Node API* with unicast announce so they can be discovered in large-scale routed networks;

.3 They shall support *IS-04 Registration API* calls so that they can register themselves in the registry;

.4 Sources that send essences (video, audio and ancillary data) that belong together shall use the *group hints* tag to get registered as a group, according to AMWA BCP-002-01 *Natural Grouping of NMOS Resources*;

.5 Senders shall provide their SDP information through the *IS-04 transport file*.

.6 When a Sender format configuration is modified (resolution, colour space, number of channels in an audio stream, etc.), the Sender Media Node shall signal the change through *IS-04* to allow a Broadcast Controller to remake the connection if required.

III.2 Connection Management: AMWA IS-05

.1 Receivers shall support the latest published version of AMWA IS-05 *NMOS Device Connection Management Specification* so that they can be connected to Senders that are registered in the *IS-04* registry;

.2 Receivers shall support single and bulk connections and immediate, staged and scheduled activation so that they can do salvos and automated connection scenarios;

.3 Senders shall support *IS-05* for configuration of their Multicast groups so they can be assigned and managed via a controller.

III.3 Device Control: Open Methods and AMWA IS-07

.1 Operational parameters of Media Nodes shall be controlled by an Open method so that they can be controlled by a third-party controller.

.2 If Media Nodes need to act on an event (e.g. GPI) or tally, Media Nodes should support AMWA IS-07 *NMOS Event and Tally Specification*.

III.4 Audio Channel Mapping: AMWA IS-08

.1 Audio Receivers with a matrix capability shall use the latest published version of AMWA IS-08 *NMOS Audio Channel Mapping Specification* so that a Broadcast Controller can select the channel arrangement within a stream to be used by the Receivers.

III.5 Topology discovery: LLDP

.1 Media Nodes shall support *Link Layer Discovery Protocol* (LLDP) part of IEEE 802.1AB so that it can announce on which switch and interface it is connected to inform a Network Controller using AMWA IS-06 *NMOS Network Control Specification* or another proprietary API.

IV Configuration and Monitoring

Ease of configuration, monitoring and alarming is key to successfully operate and maintain an IP based facility.

IV.1 IP assignment and low-level configuration: DHCP, AMWA IS-09

.1 Media Nodes shall support DHCP for static or dynamic IP assignment on all its interfaces so that it can be brought to the network with a proper management of IP addresses;

.2 Media Nodes shall have DHCP enabled at first time boot;

.3 Media Nodes shall support the use of the DHCP options: 1 (Subnet Mask), 3 (Router), 6 (DNS), 12 (Hostname), 15 (DNS Domain name of client), 51 (Address Lease Time); 81 (Client Fully Qualified Domain Name);

.4 Depending on the application, Media Nodes should support the use of the DHCP options: 2 (Time Offset in Seconds from UTC), 4 (Time Server), 7 (Log server), 66 (TFTP Server), 67 (Bootfile-Name), 119 (Domain Search List).

.5 Media Nodes should support IS-09 System Parameters Specification in order to obtain global configuration parameters that are common across the system.

IV.2 Open configuration management

.1 Media Nodes shall be configurable by an Open method so that configuration can be managed by a common tool enabling change management, firmware updates, rollback, etc. Preferably, this should be done by supporting a YANG model/OpenConfig, an Open API, or at least by a remote config file or SSH.

IV.3 Open monitoring protocols

.1 Media Nodes shall provide sufficient Alarming with ability to set a threshold for key fault indicators so that it brings the attention of the operator quickly to solve the issue; This shall be done using an Open method such as SNMPv3;

.2 Media Nodes shall provide real-time Telemetry with detailed information and measurements on timing, media streams and control in a way that a monitoring tool can aid diagnostics and predict system degradation before an outage occurs. This shall be done using Open methods

e.g., YANG model/OpenConfig, MQTT.

.3 Media Nodes should provide historic Logging information about its state, so that it can be used for potential problem investigation. This Log information shall be available using Open methods such as Syslog and should have the ability to set different levels of detail.

V Security

IP networking of real-time media devices brings additional cybersecurity risks compared to isolated SDI connections. All IP devices, including Media Nodes, shall take care to follow cybersecurity best practices. This is an area that still requires work and education in the industry and the user community.

V.1 EBU R 148 Security Tests

.1 Media Node vendors shall provide a report of their products' compliance with the security tests list from the EBU R 148 *Minimum Security Tests for Networked Media Equipment* (or agreed equivalent)

- for the proposed version of the equipment when bidding on RFPs;
- when releasing an update of the product [https://tech.ebu.ch/publications/r148].

V.2 EBU R 143 Security Safeguards

.1 Media Node vendors shall declare their ability to comply with the list of security safeguards from EBU R 143 *Cybersecurity for media vendor systems, software & services* [https://tech.ebu.ch/publications/r143].

V.3 Secure HTTPS API calls

.1 All NMOS APIs shall support AMWA BCP-003 Security recommendations for NMOS APIs The AMWA on security recommendations for AMWA NMOS APIs [https://amwa-tv.github.io/nmos-api-security/].

- Media Nodes shall support TLS 1.2 for APIs, and should support TLS 1.3, with cipher suites as required by BCP-003-01
- Media Nodes should support authorisation of API calls as per BCP-003-02.

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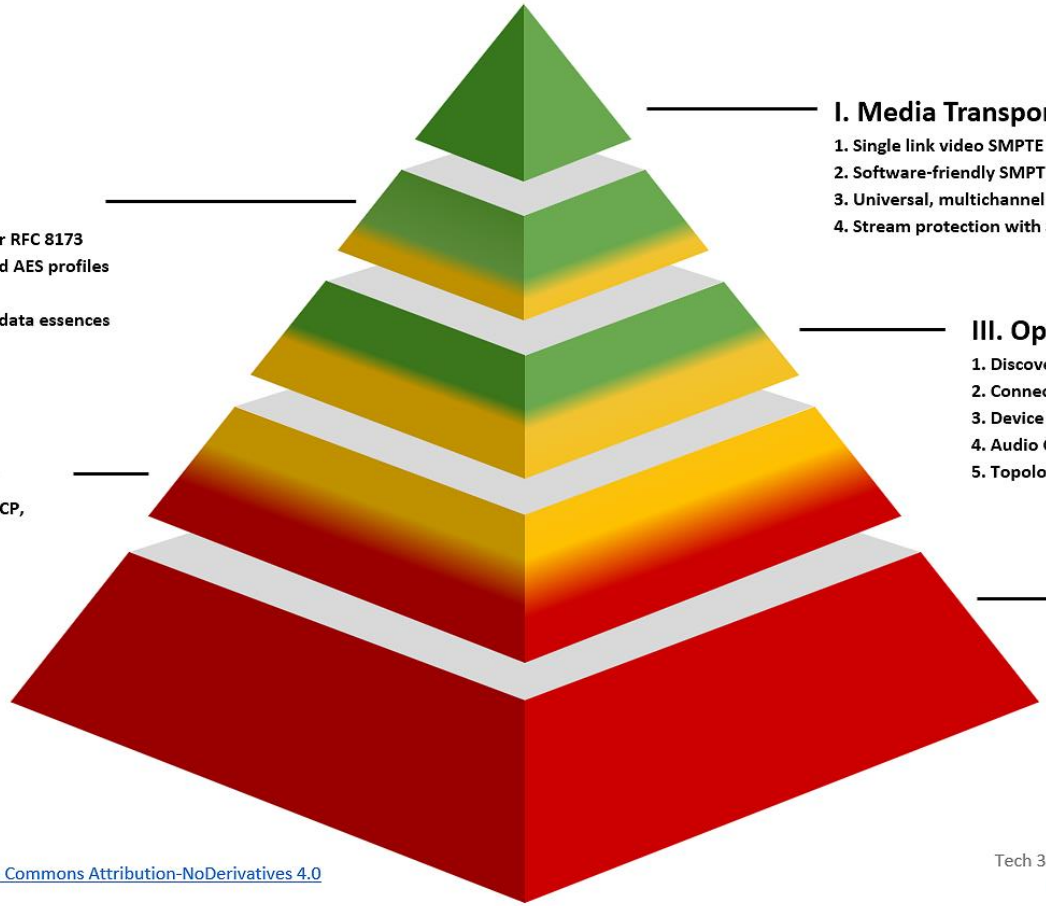

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1. Single link video SMPTE ST 2110-20
2. Software-friendly SMPTE ST 2110-21 Wide video receivers
3. Universal, multichannel and low latency audio SMPTE ST 2110-30 Level B
4. Stream protection with SMPTE ST 2022-7:2018

II. Time and Sync

1. PTP monitoring with IETF RFC 8575 or RFC 8173
2. PTPv2 configurable within SMPTE and AES profiles
3. Multi-interface PTP redundancy
4. Synchronisation of audio, video and data essences

III. Operational Control

1. Discovery and Registration: AMWA IS-04, BCP-002
2. Connection Management: AMWA IS-05
3. Device Control: Open Methods and AMWA IS-07
4. Audio Channel Mapping: AMWA IS-08
5. Topology discovery: LLDP

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   - e.g. YANG model/OpenConfig, Open API, SSH ...
3. Open monitoring protocols
   - e.g. YANG model/OpenConfig, MQTT, Syslog, SNMPv3, ...

V. Security

1. EBU R 148 Security Tests
2. EBU R 143 Security Safeguards
3. Secure HTTPS API calls: AMWA BCP-003

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