

The technology landscape and transition towards IP

Peter Brightwell, BBC R&D

5G-MAG Workshop

Media Production over 5G NPN

21st April 2021



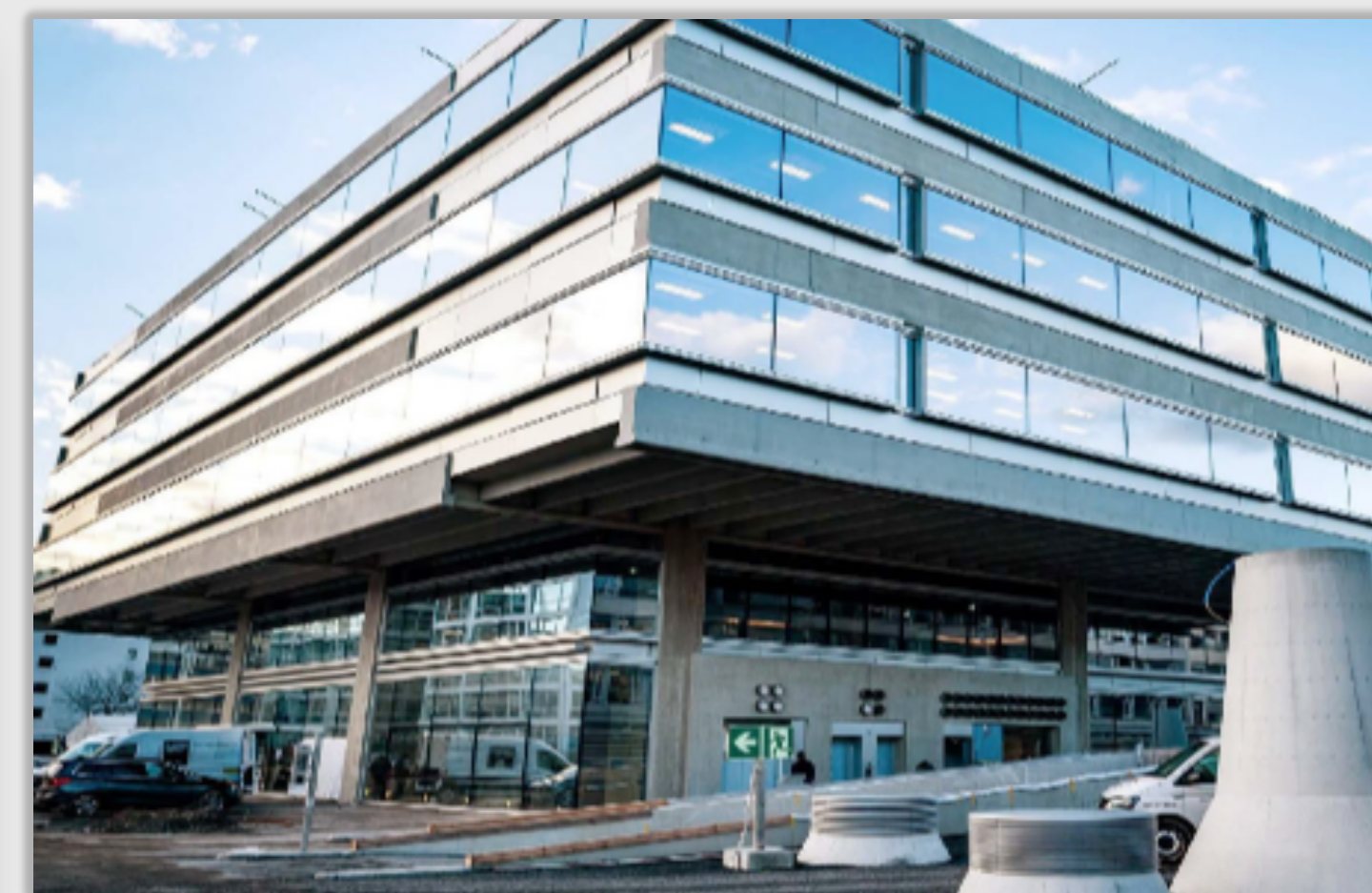
Some of the first IP-based facilities



BBC
Cardiff



CBC
Montréal



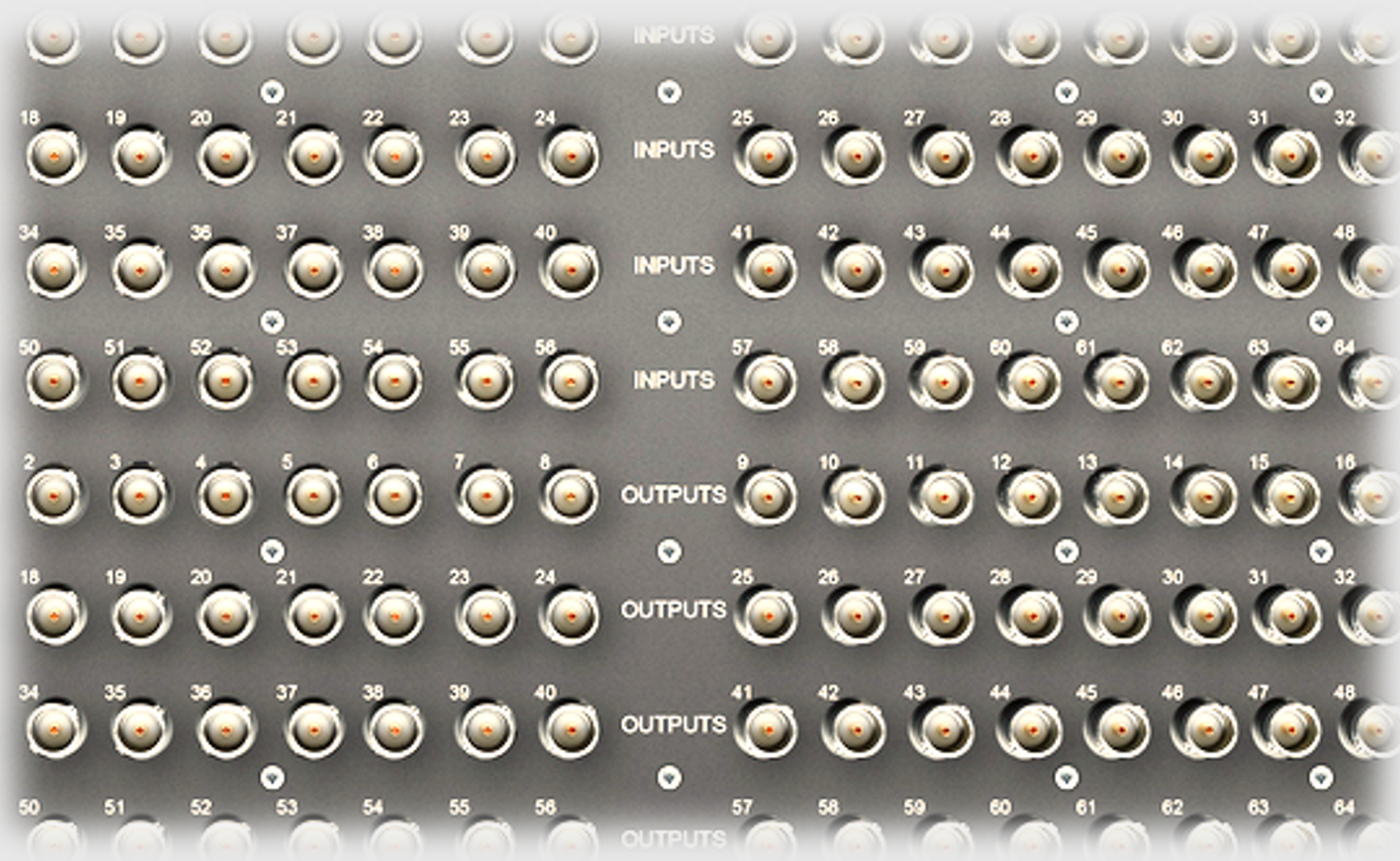
SRF
Zürich

Many manufacturers...

- Live Routing from Grass Valley = Cisco Switches & GV Nodes
- Comms System from Riedel = Artist 128
- TV Production Switches from SAM (GV) = Kahuna
- TV Audio Desks from Calrec = Artemis
- TV Playout from SAM (GV) = Ice & Morpheus
- Studio Cameras from Sony = HDC 4300 & P43
- Radio Studio Desks from DHD = 52 Series
- Radio Drama Desk from SSL = System T
- Graphics = Viz
- Editing = Avid & Adobe
- Replay = EVS
- Systems Integrator = dB Broadcast



Systems integration is changing...



SDI and friends



IP and software

Technical challenges for migration

Media
Transport



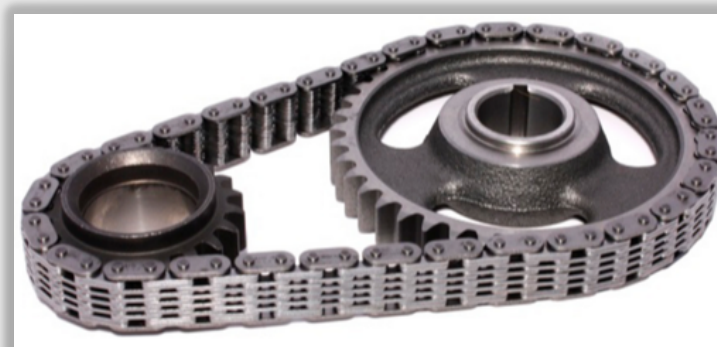
Automation



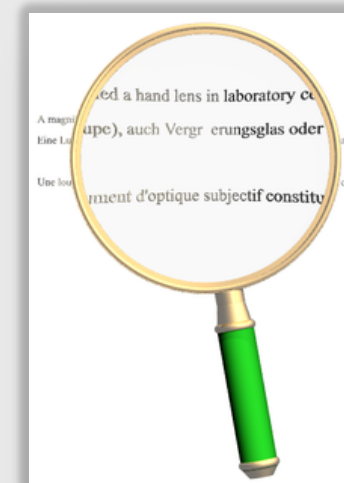
Security



Timing &
Sync



Discovery



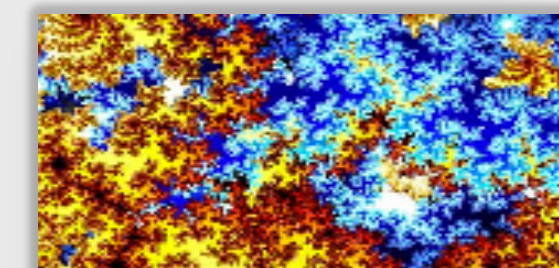
Resilience



Connection



Dynamic
Provisioning



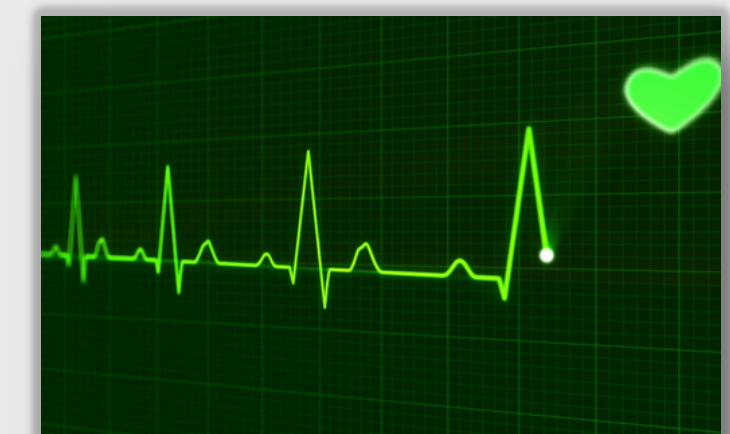
Config &
Control



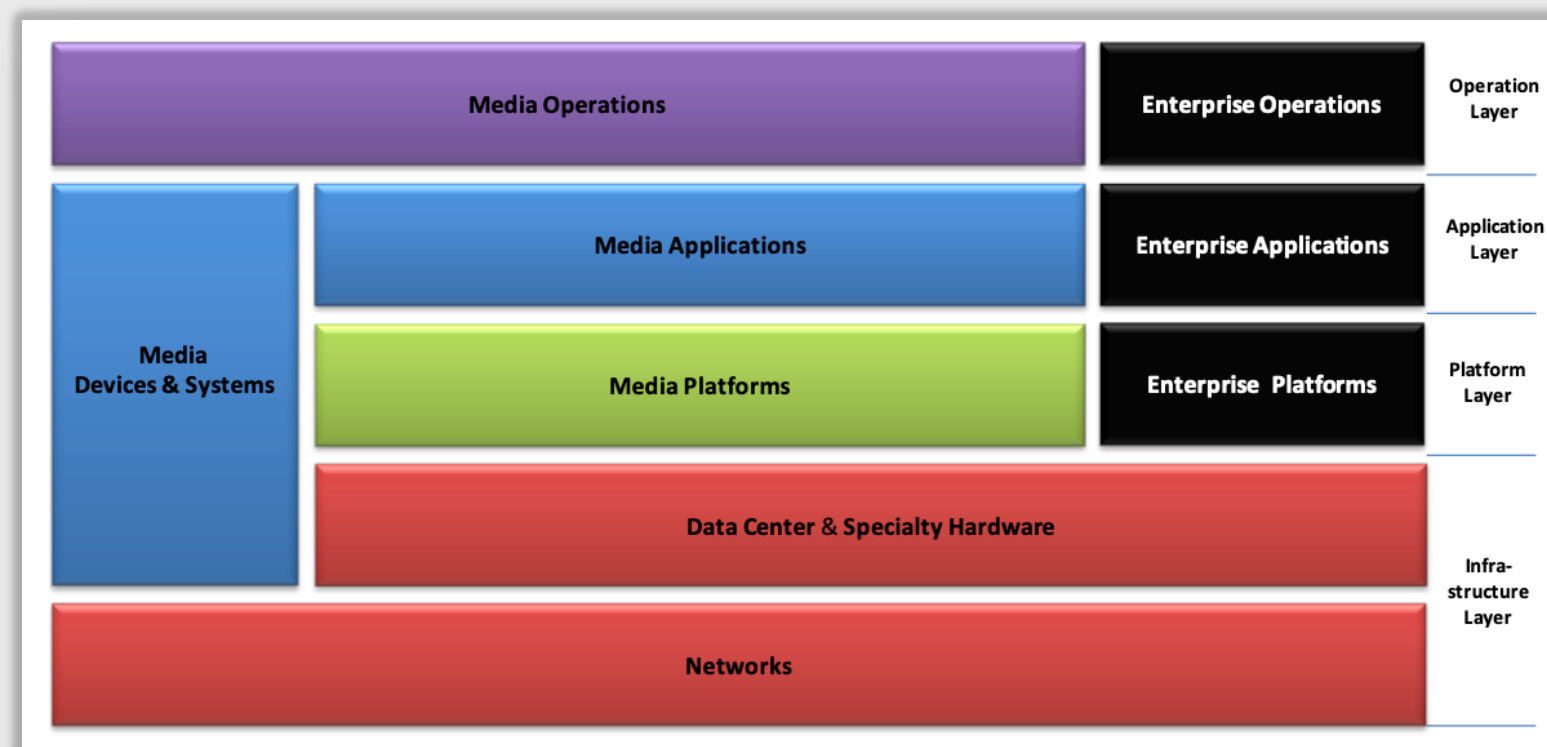
Signalling



Monitoring

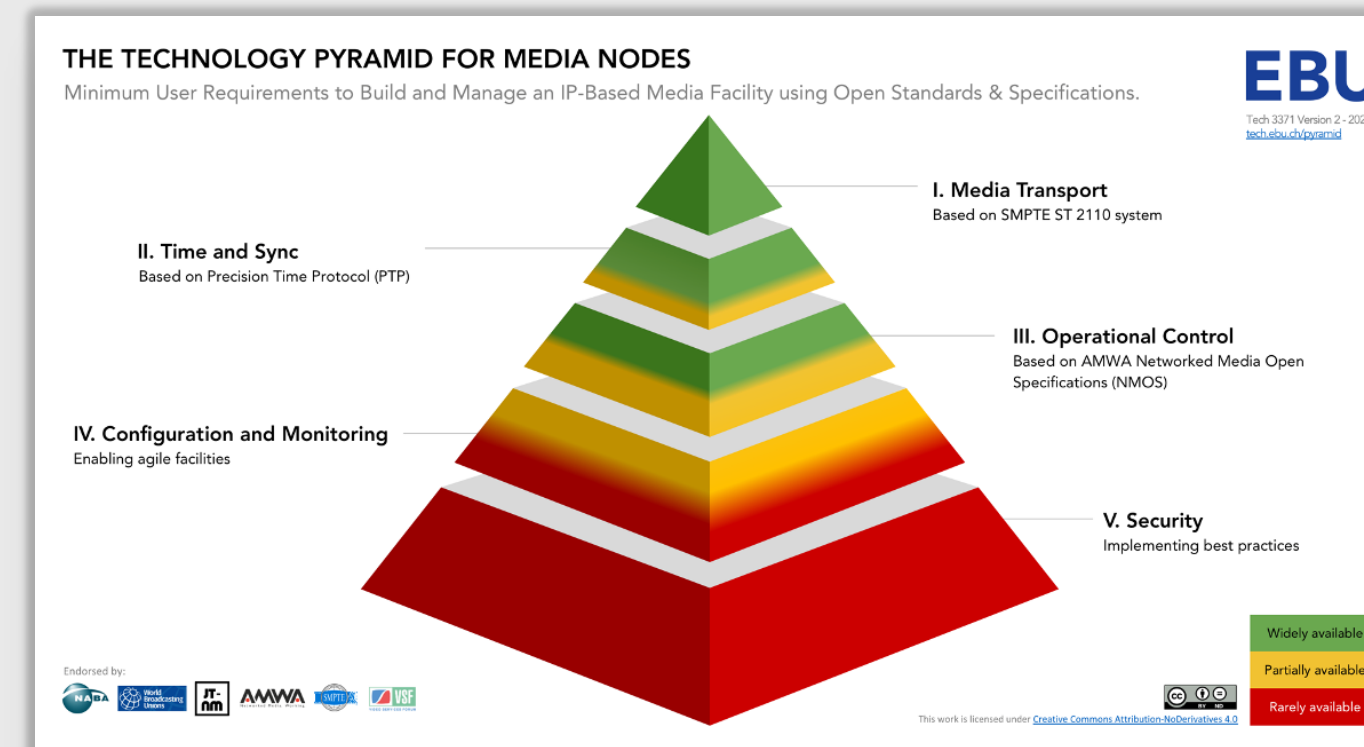


Models for networked media architecture...



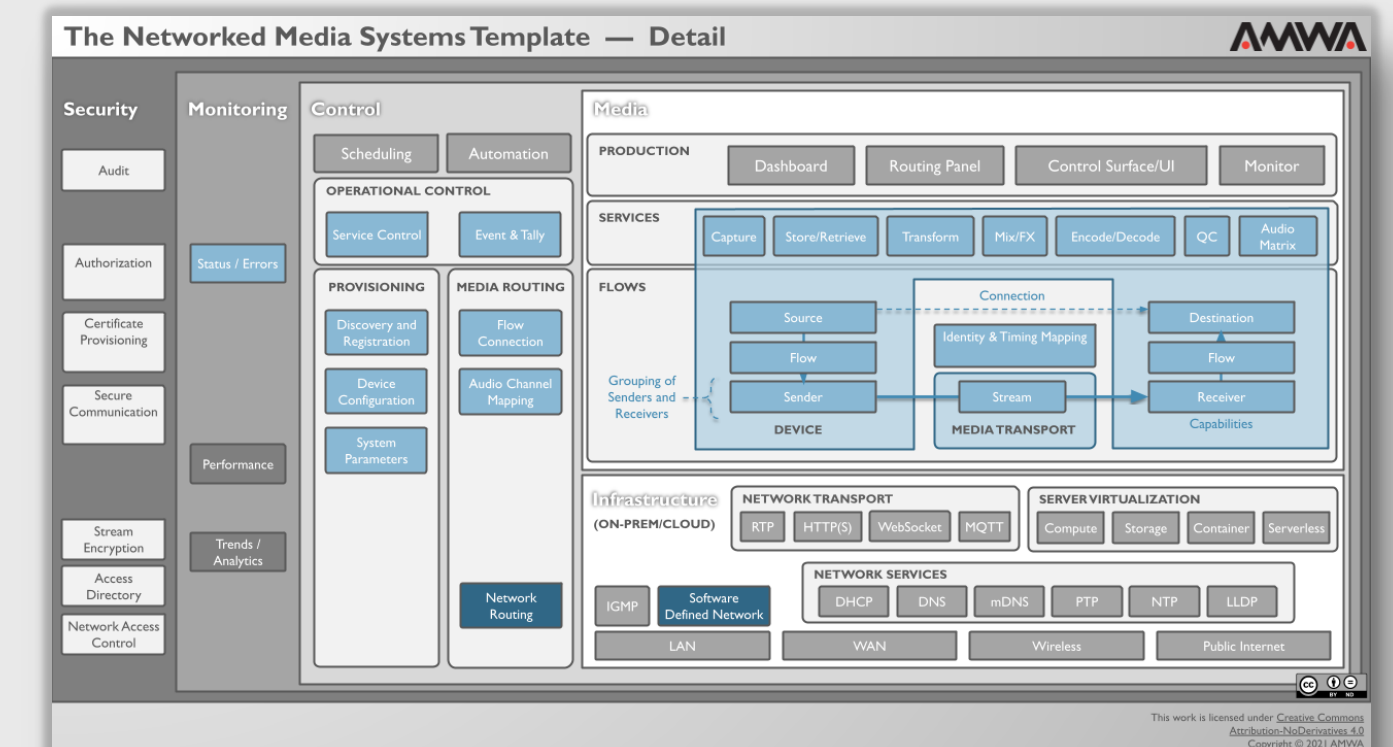
JT-NM Reference Architecture

www.jt-nm.org/reference-architecture



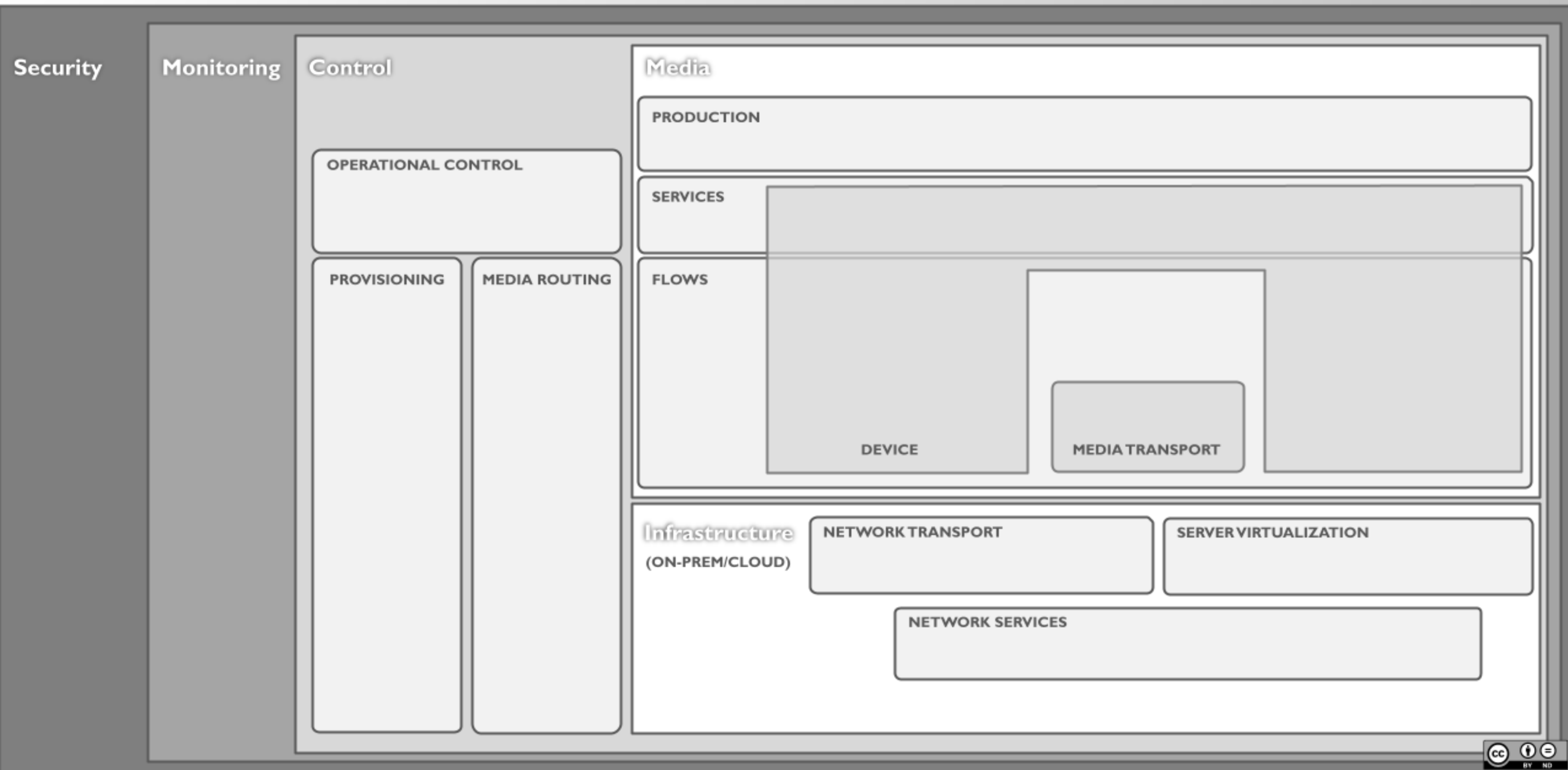
EBU Technology Pyramid

tech.ebu.ch/pyramid

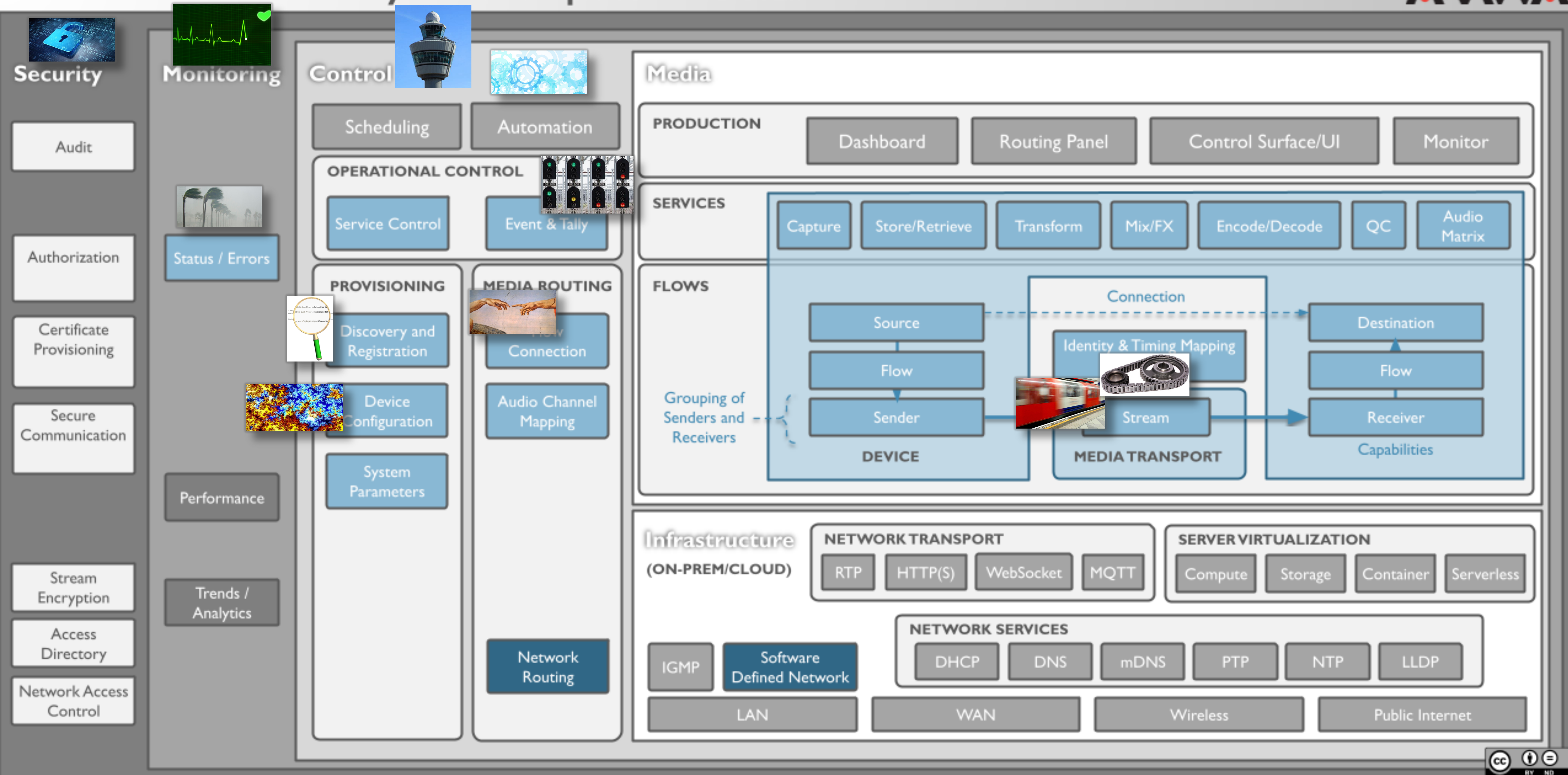


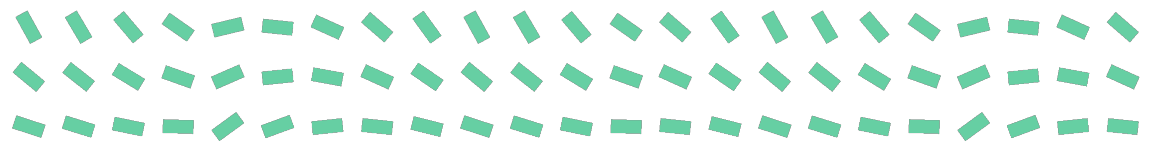
AMWA Networked Media Systems Template

static.amwa.tv/networked-media-systems-big-picture-2021-03-05.pdf



The Networked Media Systems Template — Detail





SMPTE RTP Transport Standards

ST 2022 series

SDI-originated multiplexed streams

- MPEG-TS: 2022-1/2/3/4
- Uncompressed: 2022-5/6/7

Suited to point-to-point links

- Where V+A+D stay together

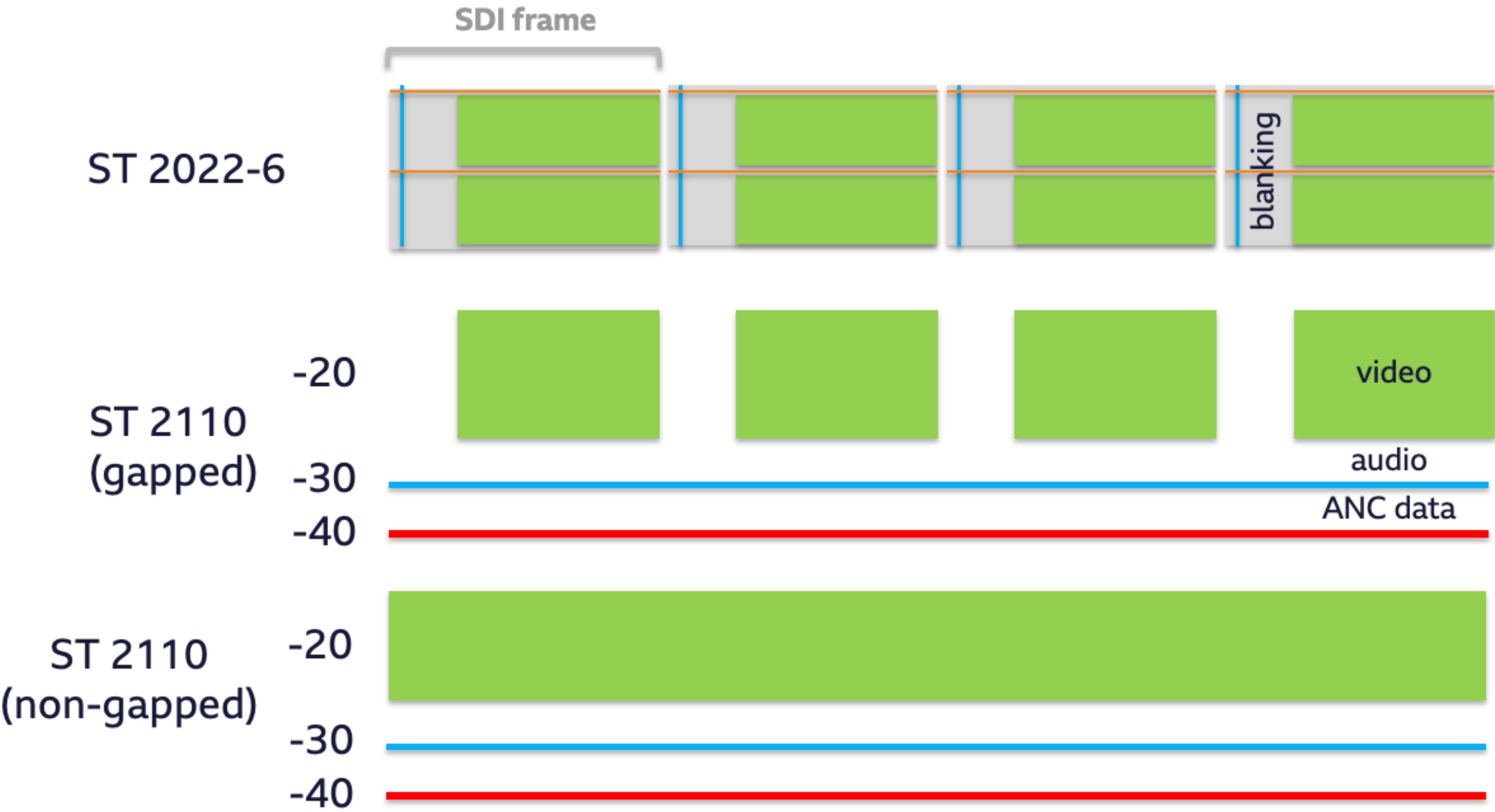
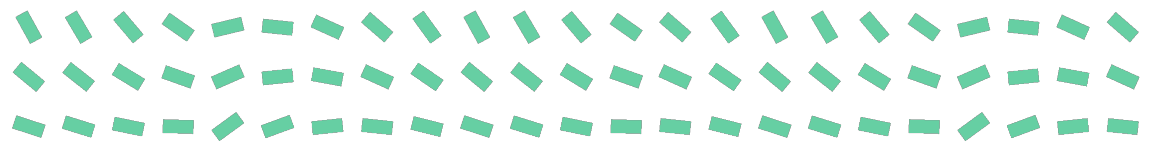
ST 2110 series

Separate elemental streams

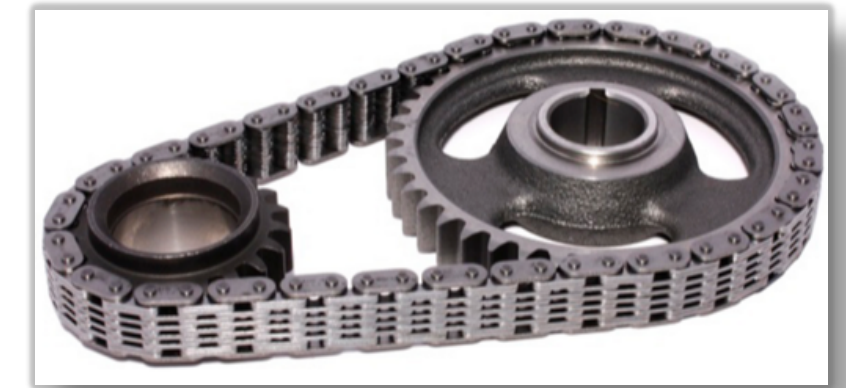
- Video (-2x)
- Audio (-3x)
- Data (-4x)

Suited to production facilities

- Can be routed individually
- Receivers just get what they need
- Typically multicast

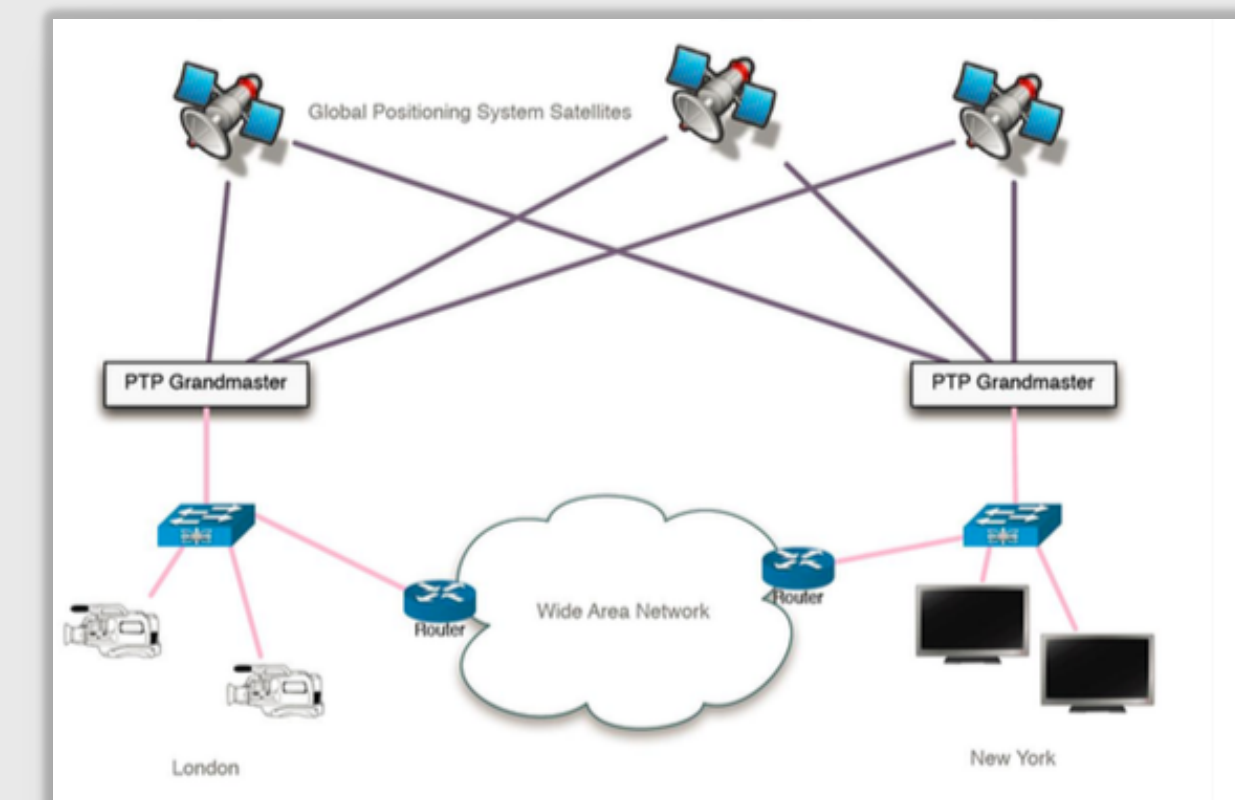


SMPTE IP Transport Timing Standards

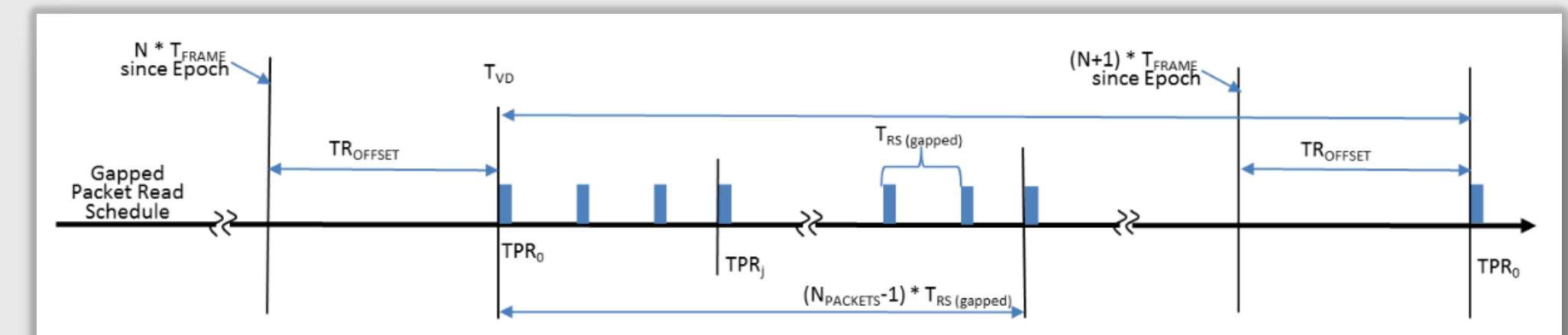


PTP clock replaces traditional video reference signal

- ST 2059-1 defines video alignment point
- ST 2059-2 defines SMPTE PTP profile
- ST 2110-10 defines timing model
- ST 2110-21 defines constraints on video sender
 - when senders should put bits onto network



Not very virtualisation/cloud friendly?



Compressed video



Uncompressed UHD/4K and beyond uses a lot of bandwidth

- Latency requirements make “mezzanine” compression desirable in many scenarios

ST 2110-22 allows mezzanine video codecs within a 2110 environment

JPEG-XS (ISO/IEC 21122) is currently receiving most attention

VC-2 (ST 2042-1) is BBC’s patent and royalty-free codec

HTJ2K is a promising high-throughput variant of JPEG 2000

Newtek NDI (Network Device Interface) is a popular proprietary approach

“Beyond mezzanine” there are many scenarios and many options!

- HEVC/H.265 are becoming commonplace

IPMX: ST 2110 for Pro-AV applications

Low latency IP streaming aimed at education, conferencing, digital signage, unified communications and similar markets

- ST 2110 with mezzanine compression (JPEG XS)
- Simpler timing model
 - PTP but doesn't assume boundary clock capable switches
- IP carriage of EDID information
- HDCP content protection

Other Pro-AV streaming technologies include HDBaseT and SDVoE



ipmx.io



hdbaset.org



sdvoe.org

Don't forget the audio!



After years of competing proprietary approaches, Audinate's Dante is now widely adopted for audio-over-IP

...but...

AES-67 provides a standards-based approach that

- Is compatible with ST 2110 (if configured correctly!)
- Can interwork with Dante
- Is looking beyond the LAN



Audio Engineering Society

aes.org



Wide-area streaming

Beyond the facility, techniques such as FEC, ARQ and bonding become relevant

Proprietary solutions such as Zixi are commonly used today



Haivision's SRT has an open-source implementation and becoming well-adopted

- Often used with local NDI setup for a low-cost studio setup
- Promoted by SRT Alliance



srtalliance.org

VSF's RIST (TR-06) is an open specification that is capable of great flexibility

- Support growing though not as widespread as SRT
- Promoted by RIST Forum



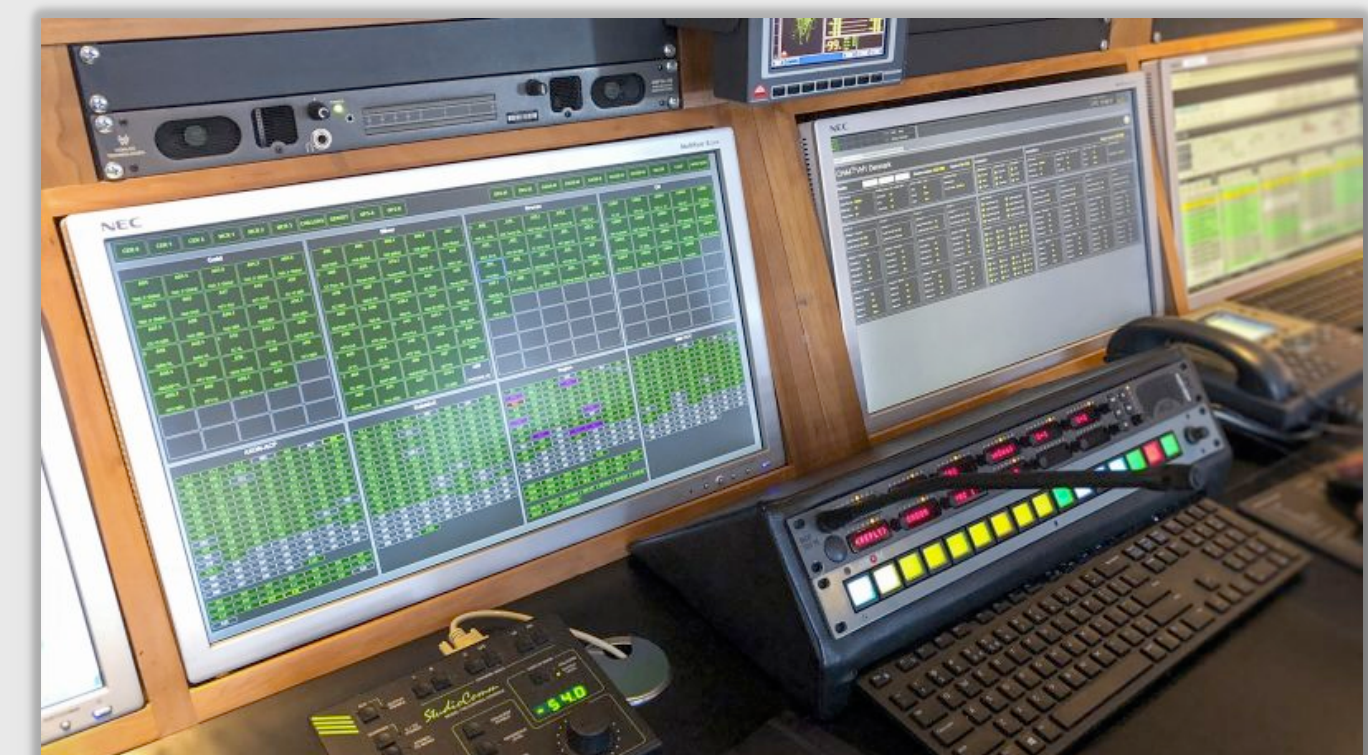
rist.tv

Longer term we may see next-generation approaches from IETF, W3C, etc.

Control in Live IP Media Systems

Has not changed much yet

- Multiple proprietary control interfaces
- Specialised control systems
- Significant expertise and overhead of integration



Control

Scheduling

Automation

OPERATIONAL CONTROL

Service Control

Event & Tally

PROVISIONING

Discovery and
Registration

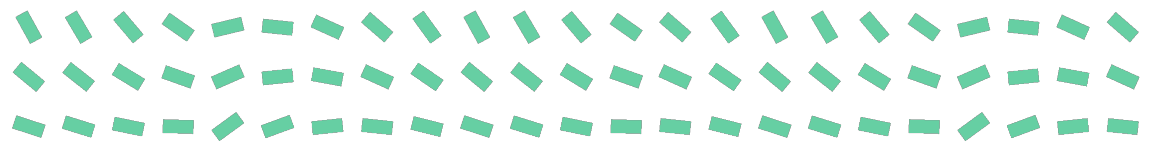
Device
Configuration

System
Parameters

MEDIA ROUTING

Flow
Connection

Audio Channel
Mapping



Advanced Media Workflow Association Networked Media Open Specifications



- Specifications for discovering, connecting and managing resources
- Web-friendly: JSON, REST HTTP, WebSockets, message queues...
- Used with 2110/IPMX but format-agnostic

www.amwa.tv/nmos-overview

NMOS

Networked Media Open Specifications

from

AMWA

HOME OVERVIEW REPO INFO... TOOLS... IS-... BCP-... MORE... SEARCH

Networked Media Open Specifications: Introduction

About NMOS

NMOS is a family name for specifications produced by the Advanced Media Workflow Association related to networked media for professional applications.

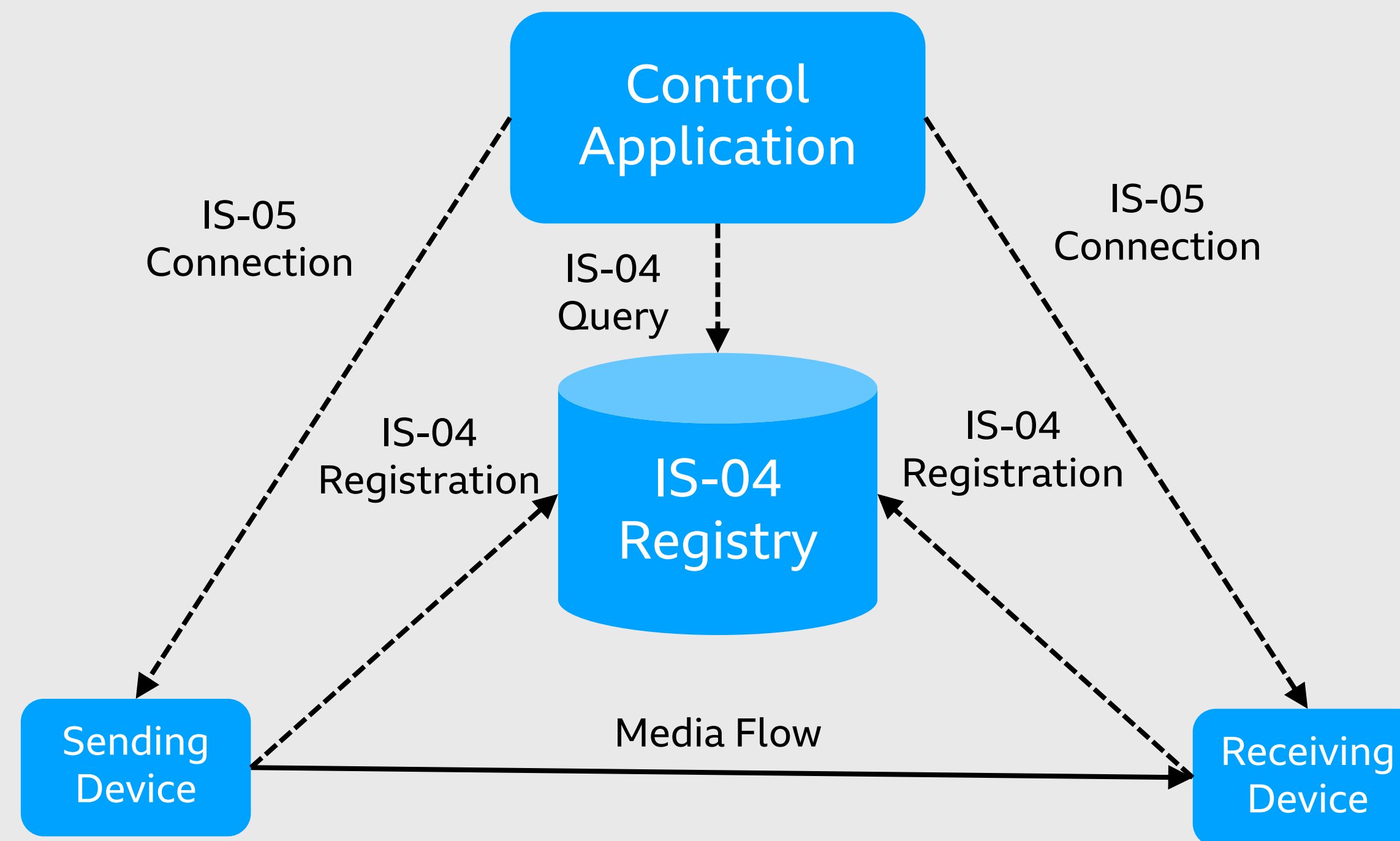
The table below lists the current specifications and provides links to their repositories on [github.com/AMWA-TV](#) and documentation on [specs.amwa.tv](#). The "Version" links will take you to the documentation and download page (1) for the latest release of recent versions of the specification.

The [NMOS API Testing Tool](#) supports the majority of these specifications.

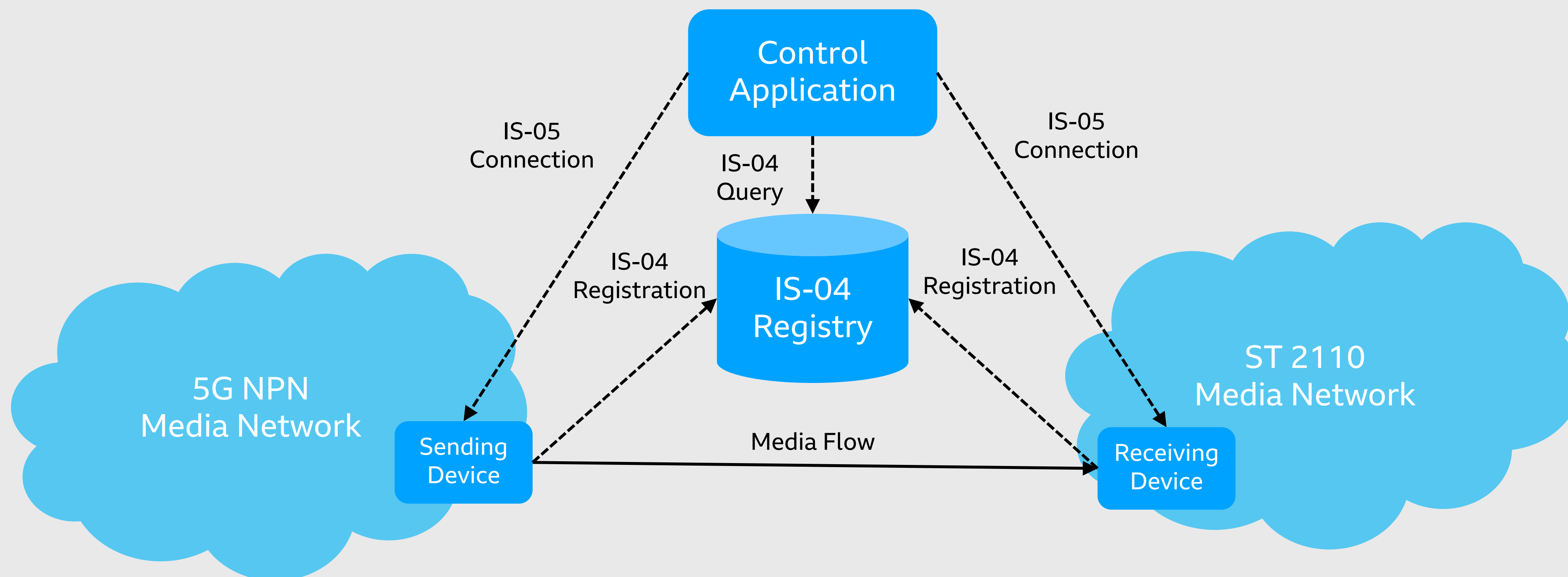
Id	Name	Spec Status	Version(s)	Repository
IS-04	Discovery & Registration	AMWA Specification (Stable)	v1.3 ↓ v1.2.2 ↓ v1.1.3 ↓	nmos-discovery-registration
IS-05	Device Connection Management	AMWA Specification (Stable)	v1.1 ↓ v1.0.2 ↓	nmos-device-connection-management
IS-06	Network Control	AMWA Specification	v1.0 ↓	nmos-network-control
IS-07	Event & Tally	AMWA Specification	v1.0.1 ↓	nmos-event-tally
IS-08	Audio Channel Mapping	AMWA Specification (Stable)	v1.0.1 ↓	nmos-audio-channel-mapping
IS-09	System Parameters	AMWA Specification	v1.0 ↓	nmos-system
IS-10	Authorization	AMWA Specification	v1.0.0 ↓	nmos-authorization
MS-04	ID & Timing Model	AMWA Specification	v1.0 ↓	nmos-id-timing-model
BCP-002-01	Natural Grouping	AMWA Specification	v1.0.0 ↓	nmos-natural-grouping
BCP-003-01	Secure Communications in NMOS Systems	AMWA Specification	v1.0.0 ↓	nmos-secure-communication
BCP-003-02	Authorization in NMOS Systems	AMWA Specification	v1.0.0 ↓	nmos-authorization-practice
BCP-003-03	Certificate Provisioning in NMOS Systems	AMWA Specification	v1.0.0 ↓	nmos-certificate-provisioning
BCP-004-01	NMOS Receiver Capabilities	AMWA Specification	v1.0.0 ↓	nmos-receiver-capabilities
INFO-002	NMOS Security Implementation Guide	AMWA Specification		nmos-security-implementation-guide
n/a	NMOS EDID Connection Management	Work In Progress		nmos-edid-connection-management
n/a	Parameter Registers	Continuing		nmos-parameter-registers

specs.amwa.tv/nmos

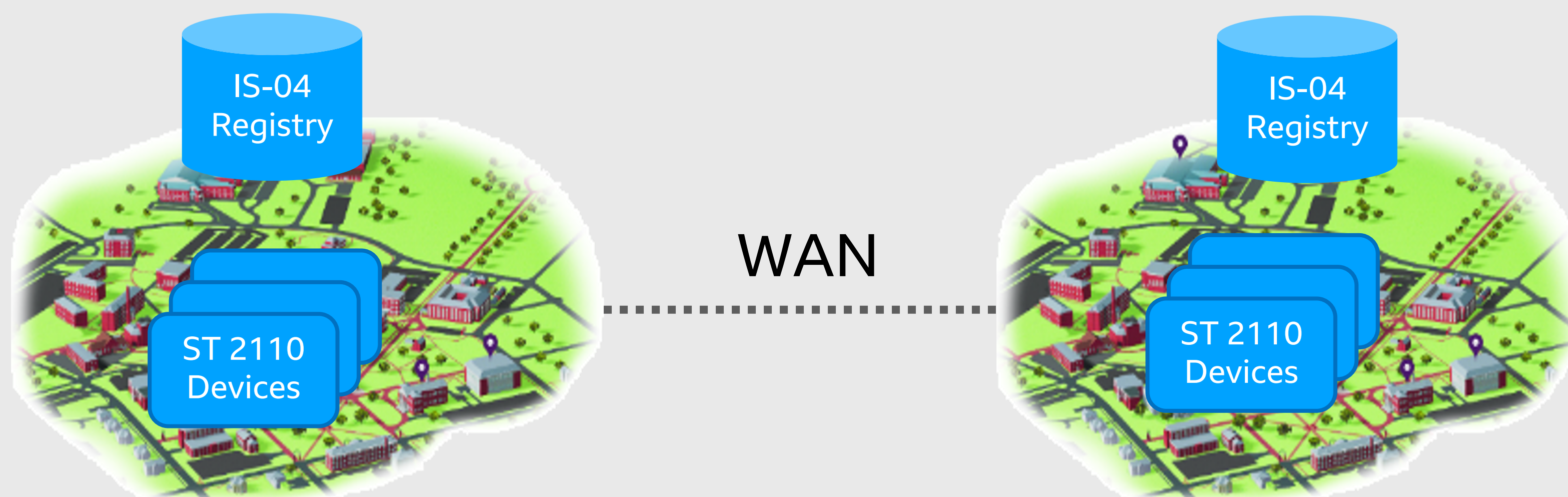
NMOS IS-04 and IS-05



5G-RECORDS and NMOS



VSF 2110-WAN Project



Device Control



There are many protocols to choose from, depending what you want to do. Some examples:

- Ember+ (developed by LAWO) is supported by several video/audio manufacturers
- OCA / AES-70 (developed by Bosch) is supported by several audio manufacturers
- VISCA (developed by Sony) is a serial camera control protocol, adapted to IP
- ONVIF is popular for security camera control
- NDI provides a PTZ camera control API



There are many more proprietary protocols

- ... although market consolidation may make things simpler?

AMWA and 5G-RECORDS are investigating options for device control

Network Control in IP facilities

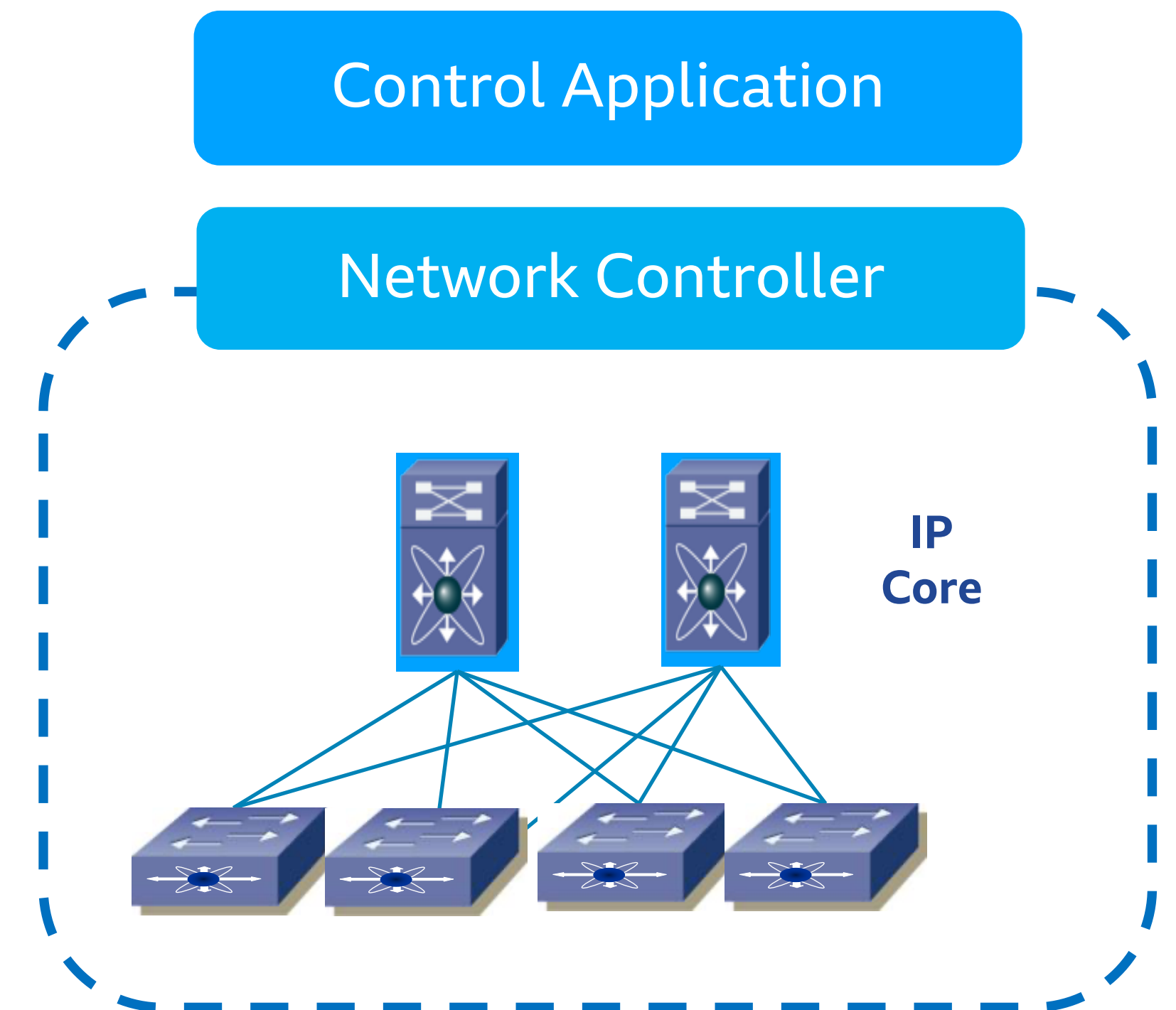
Simplest approach: over-provisioning!

In practice:

- Control flows through IP Core based on available and required bandwidth
- SDN protocols such as Netconf and OpenFlow are useful

(AMWA's IS-06 proposed a common API, but poorly supported)

5G-RECORDS is looking at NEF and PCF for similar functions



Security

The traditional approach...

- Lock apparatus rooms
 - Airgap any networks
 - SDI and friends don't have viruses
- ...no longer applies

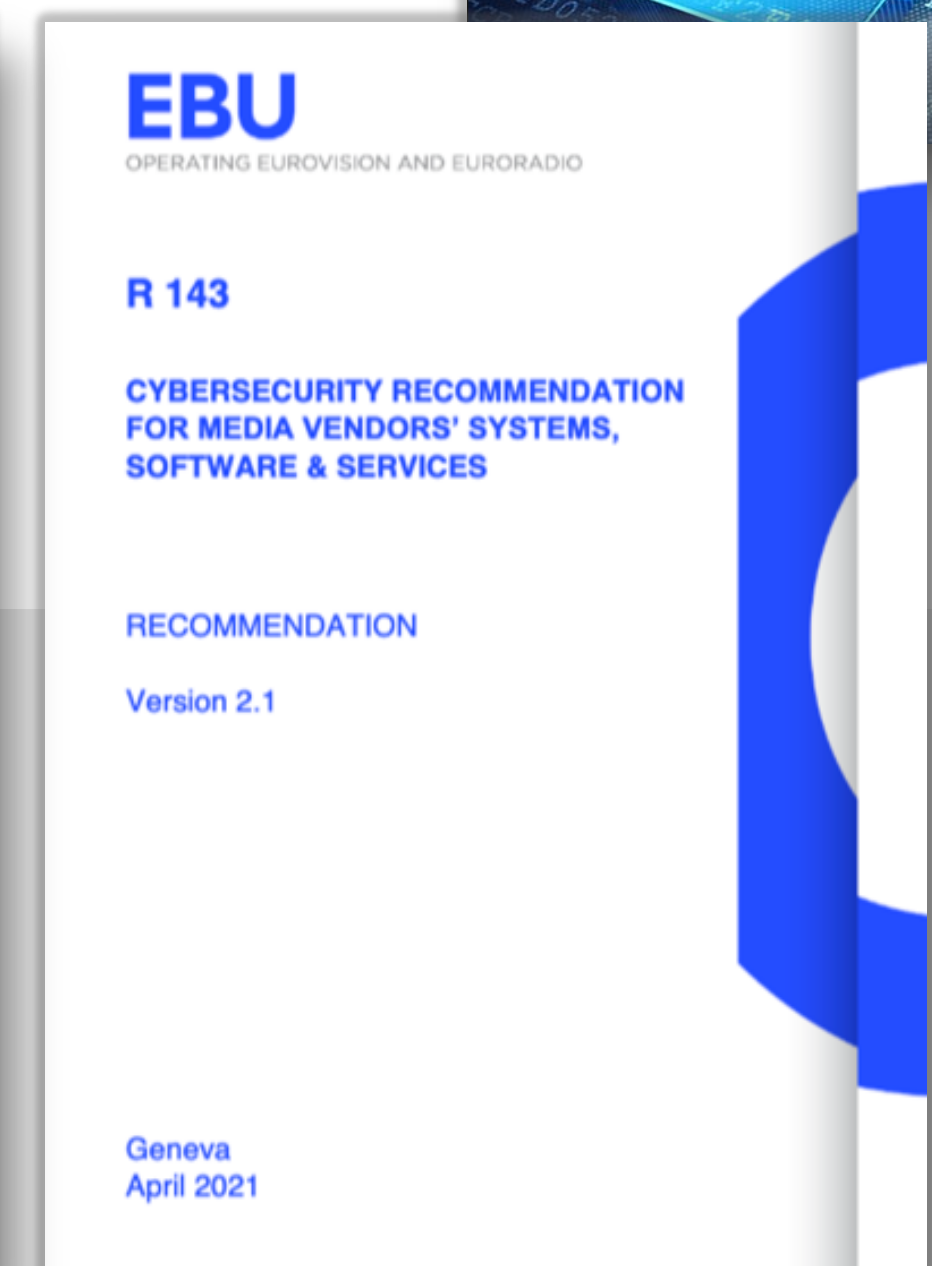
ST 2110 does *not* secure media flow

- So securing the control plane is essential!
- NMOS supports encrypt and authorisation of APIs

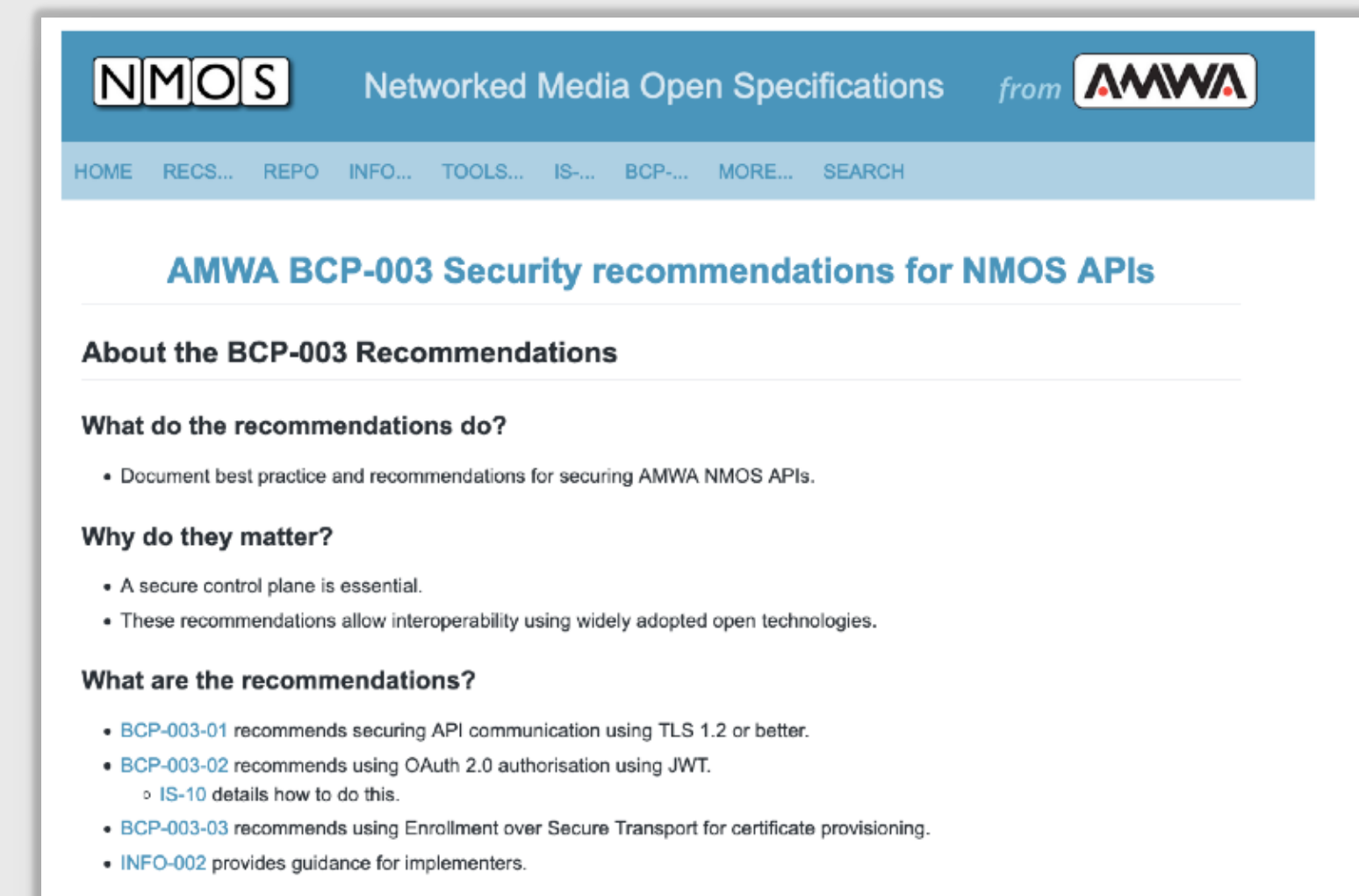
SRT and RIST support encryption and authorisation



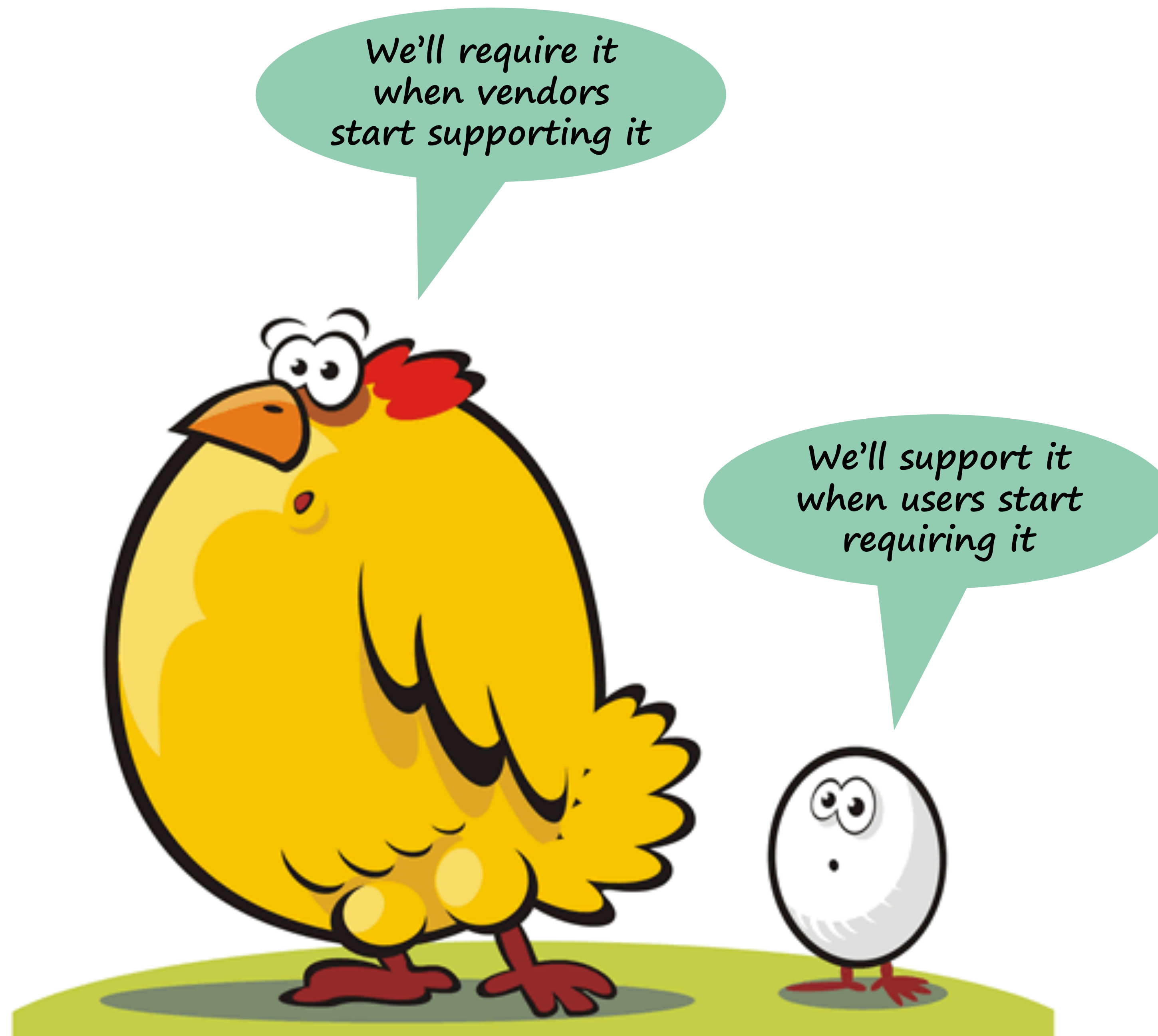
tech.ebu.ch/publications/r148

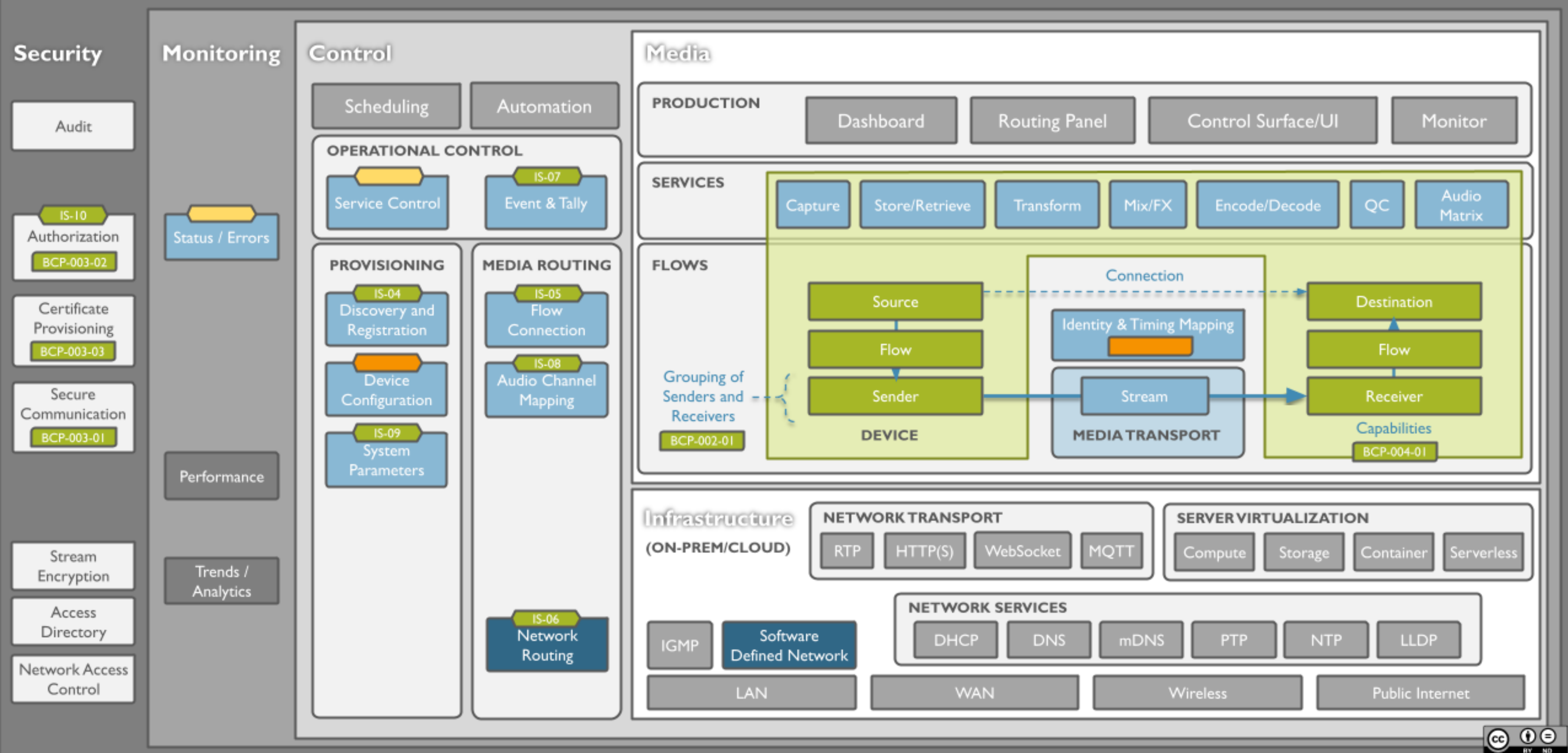


tech.ebu.ch/publications/r143



specs.amwa.tv/bcp-003





NMOS COVERAGE



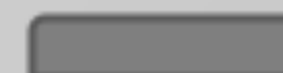
NMOS IN DEVELOPMENT



NMOS FUTURE WORK



INTERFACE SPECIFICATION



BEST CURRENT PRACTICE

Making life easier...



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

jt-nm.org/tr-1001-1

Technical Recommendations
for use of specifications



Live IP Software Toolkit

tech.ebu.ch/list

NMOS Test

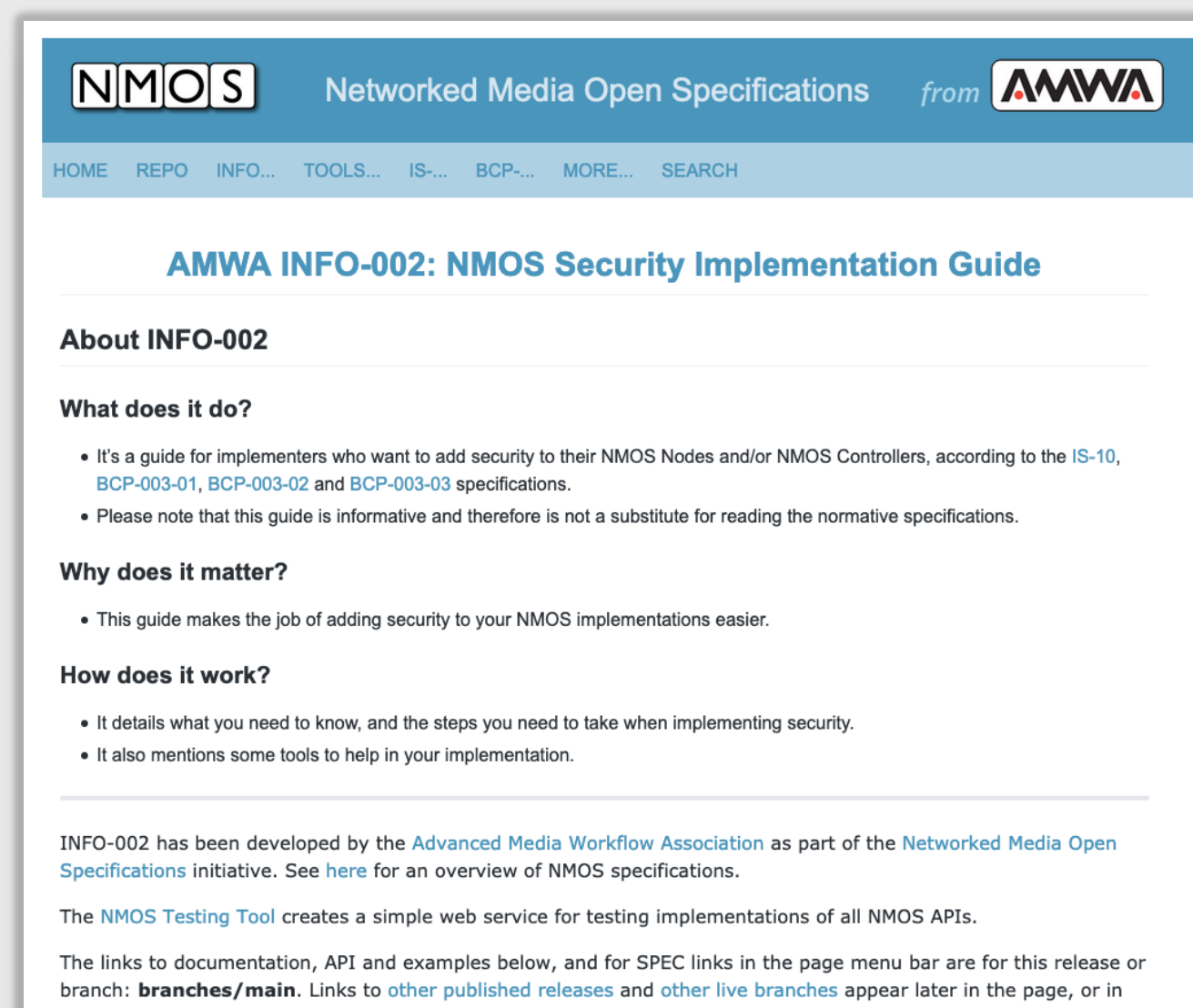
Result for test suite IS-04 Registry APIs on: <http://172.29.80.65:80/x-nmos/registration/v1.2/>, <http://172.29.80.65:80/x-nmos/query/v1.2/>

Failed Tests Run

Test	Pass	Description	Reason	Completion Time	Time Elapsed
__init__	Not Applicable	Test initialisation		16:19:13.352	1.308s
run_tests	Not Applicable	Test setup		16:19:13.363	0.003s
auto_query_1	Pass	GET /x-nmos		16:19:13.369	0.006s
auto_query_2	Pass	GET /x-nmos/query		16:19:13.375	0.006s
auto_query_3	Pass	GET /x-nmos/query/v1.2		16:19:13.382	0.006s
auto_query_4	Pass	GET /x-nmos/query/v1.2/devices		16:19:13.395	0.013s
auto_query_5	Could Not Test	GET /x-nmos/query/v1.2/devices/{deviceid}	No resources found to perform this test	16:19:13.395	0.000s
auto_query_6	Pass	GET /x-nmos/query/v1.2/flows		16:19:13.436	0.041s
auto_query_7	Could Not Test	GET /x-nmos/query/v1.2/flows/{flowid}	No resources found to perform this test	16:19:13.436	0.000s

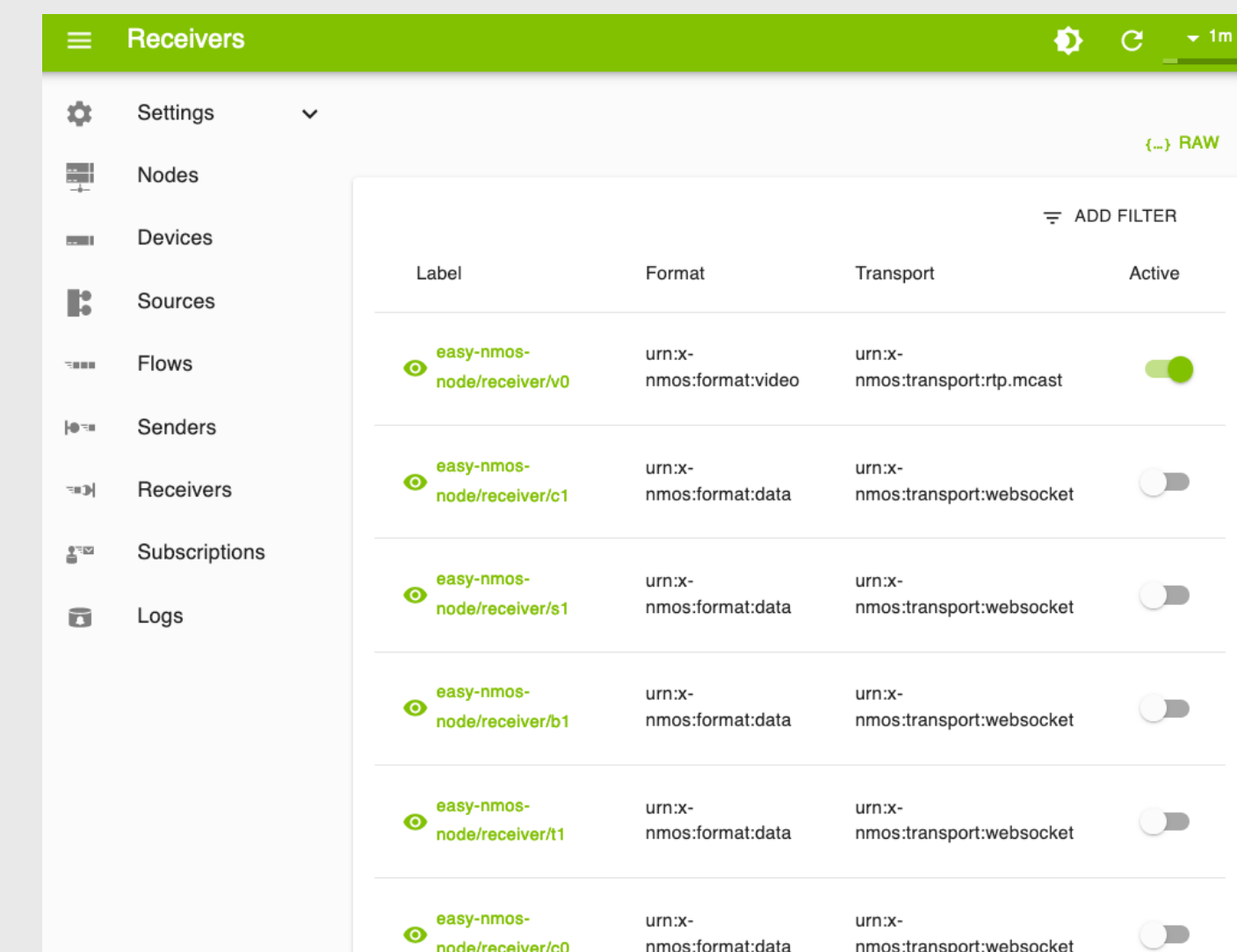
specs.amwa.tv/nmos-testing

Test Tools



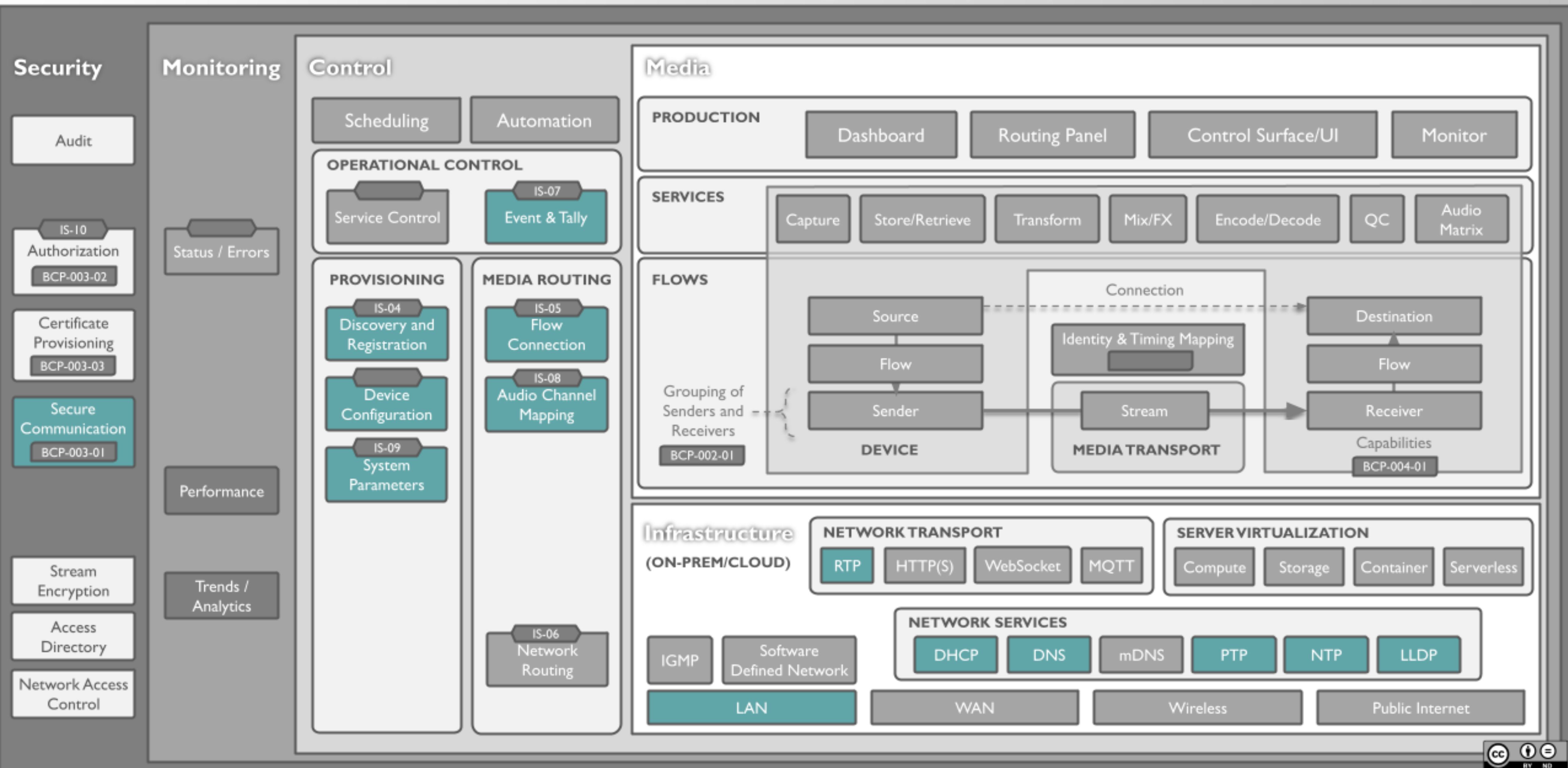
specs.amwa.tv/info-002

Implementation Guides



github.com/rhastie/easy-nmos/

Open Source Implementations

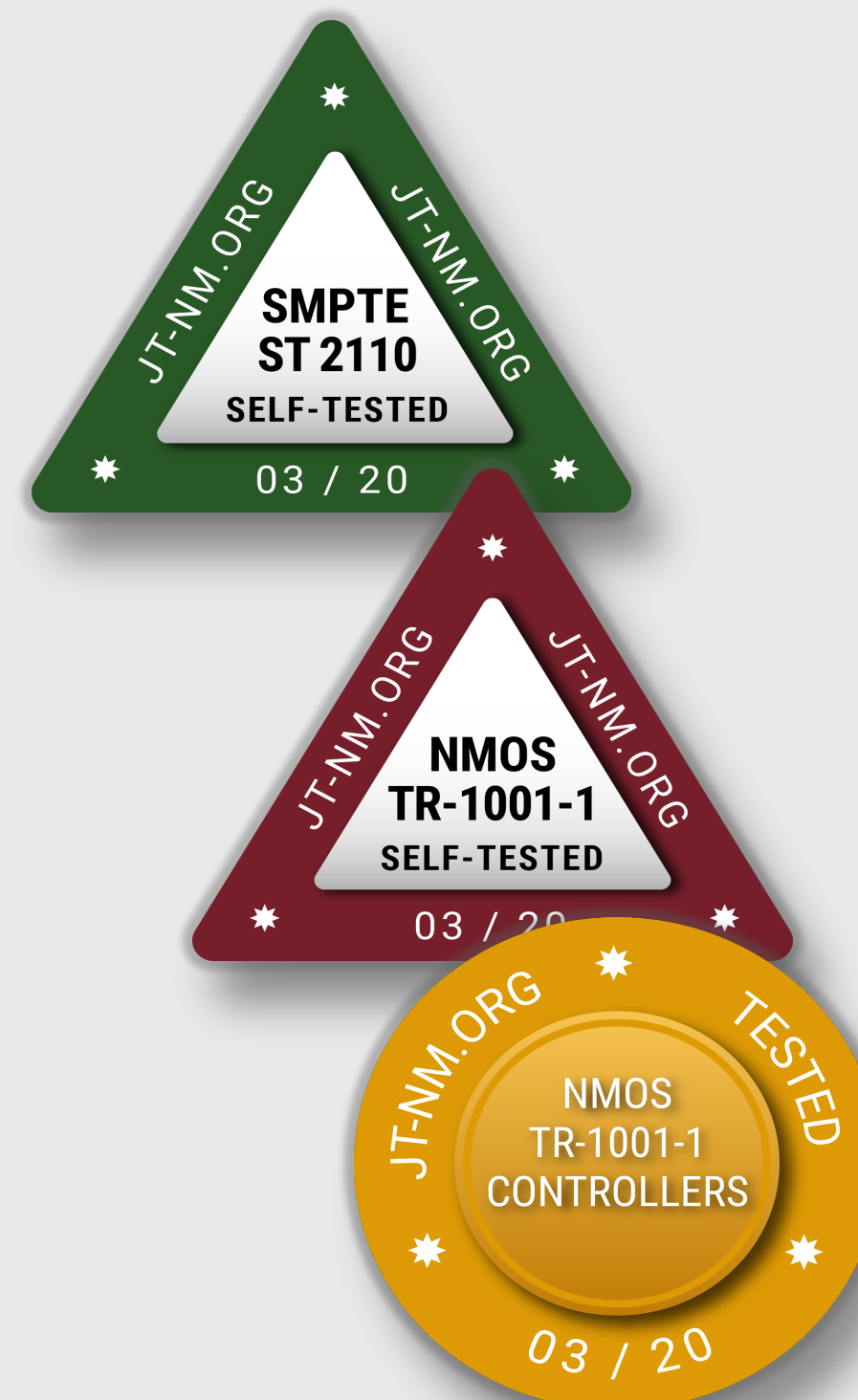


JT-NM Tested



- Industry test programme for ST 2110, NMOS and TR-1001-1
- Physical, remote and self-testing
- Catalogue of tested devices

www.jt-nm.org/jt-nm-tested



Communities

video-dev ▾

≡ All unreads

🗨 Threads

📄 Drafts

@ Mentions & reactions

🔖 Saved items


⋮ More

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europe

events

general


AIMS

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Click to learn about upcoming AIMS events.

The Alliance for IP Media Solutions (AIMS) is a non-profit trade alliance that fosters the adoption of one set of common, ubiquitous, standards-based protocols for interoperability over IP in the media and entertainment, and professional audio/video industries

vMix

Live Production Software Forums


❗ Welcome Guest! To enable all features please [Login](#) or [Register](#).

ForumActive TopicsSearchHelpLoginRegister


vMix Forums

ForumTopicsPostsLast Post


General

General Discussion (11 Viewing)
Discuss vMix here


8,23738,760How to...
by dogg
about 2...

Hardware Compatibility (1 Viewing)
Discuss capture hardware support and any other hardware related issues here


1,6317,559Preferre...
by filade
a day ac

Feature Requests (4 Viewing)
Suggest new vMix features here


3,29613,800API Sho...
by dogg
about 2...

NDI (3 Viewing)
Discussion of all things NDI including vMix Desktop Capture for PC and Mac

6473,731NDI dro...
by ejkra
3 days a

vMix Call (1 Viewing)
All discussion about vMix Call, the remote guest calling feature in version 19 goes here!

5492,482vMix Ca...
by Crim...
2 days a

GT

2901,125Rectang...
by dogg

NDI.tv

NDI*ToolsSDKMarketplace

COMMUNITY

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Be a part of the NDI* Community.



NDI Articles

Ultra Encode Family



Ultra Encode HDMIUltra Encode SDI



Magewell Unveils New Universal

Thai Monastery Wat Na Pa Pong

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🐦 NDI on Twitter

📺 Tutorial Videos

Flexible, lightweight production infrastructure

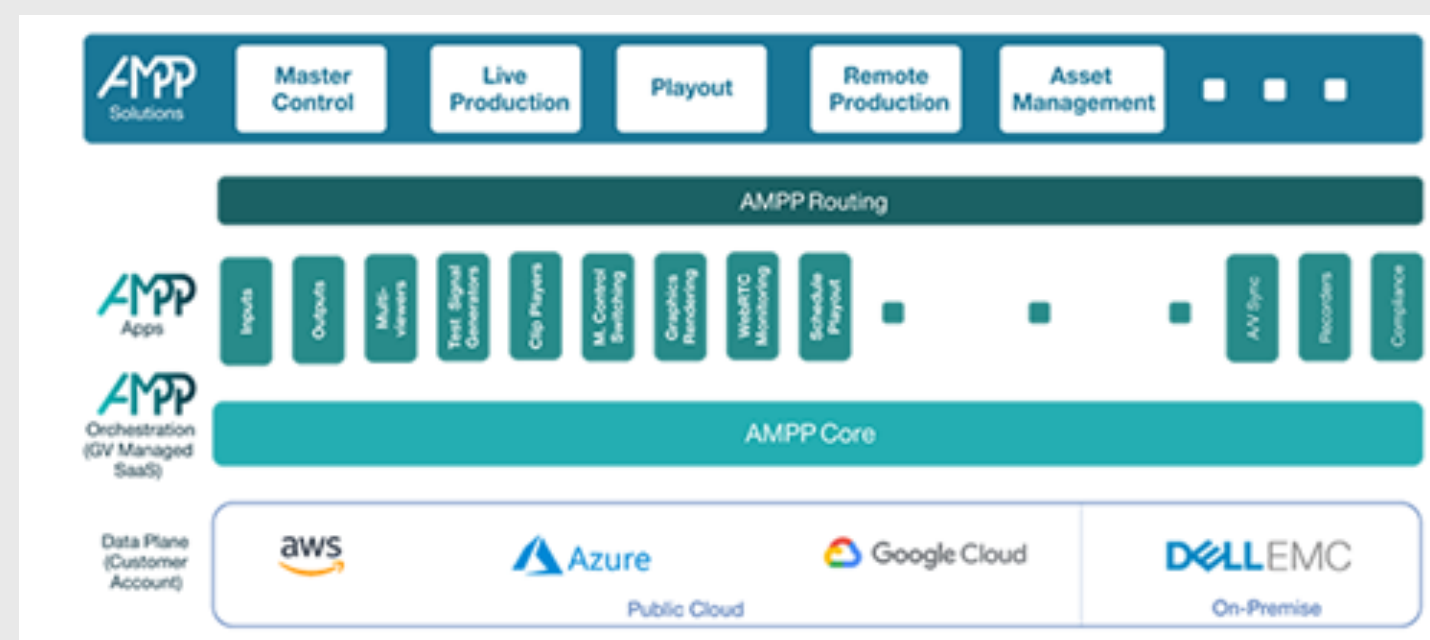


Pandemic has helped accelerate move towards:

- Flexible spaces with lightweight software-based tools
- Pragmatic decisions on technology (NDI, SRT)
- Cloud-based back-end

This is influencing new offerings from the “big players”

- e.g. Grass Valley Agile Media Processing Platform



RTBF Control Room 42



vMix

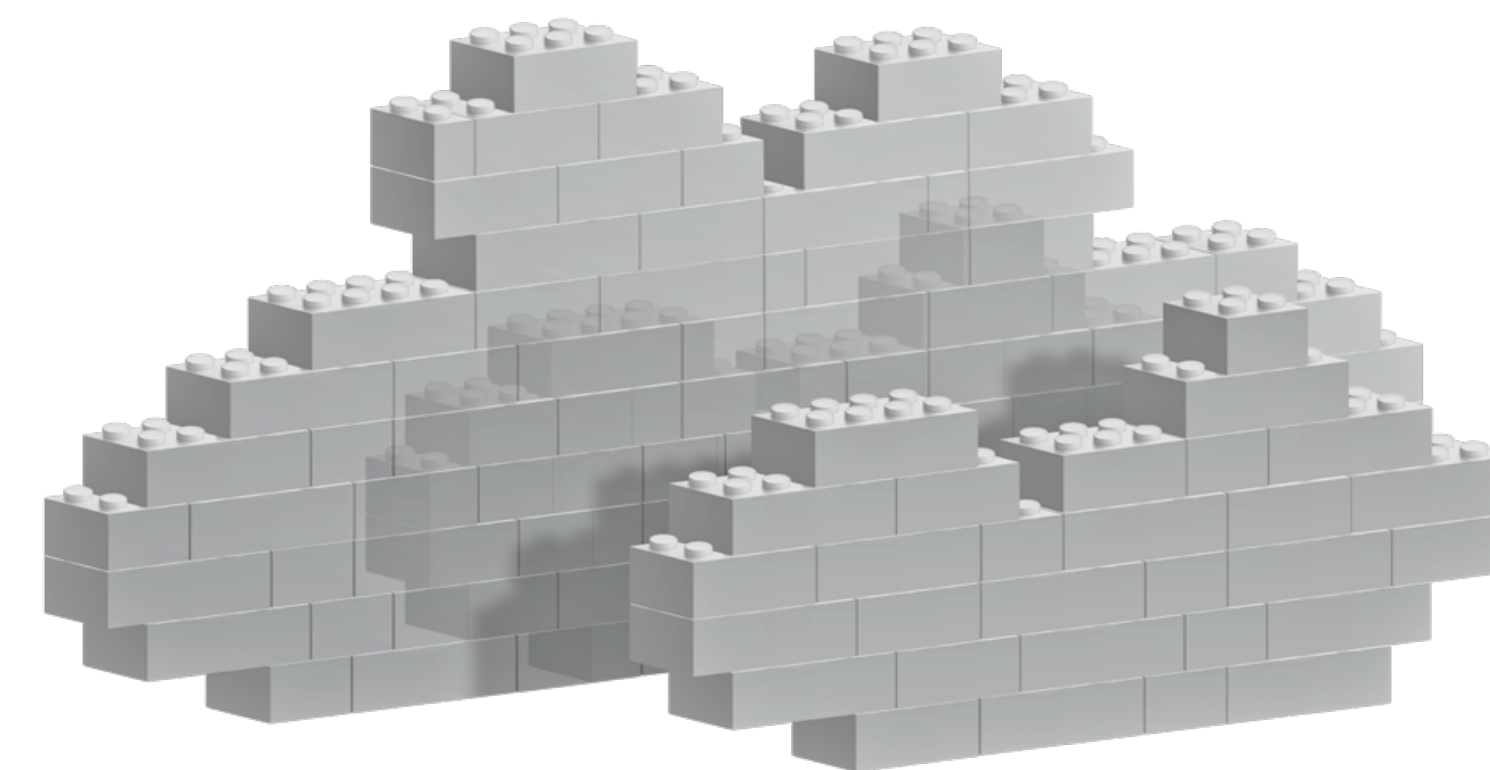
More clouds...

Technology stacks used in clouds are becoming more capable of supporting mid-to-high end live media require

- Kernel bypass and SR-IOV technologies
- AWS's Cloud Digital Interface provides a high-throughput, low(-ish) latency interface between compute instances
- Availability on-premises Azure Stack, Google Anthos, AWS Outpost
- BBC R&D building on-premises clouds with OpenStack

EBU is developing requirement and proofs of concept

VSF: Ground-Cloud-Cloud-Ground looking at what recommendations



Automation

Essential to realise benefits of Live IP

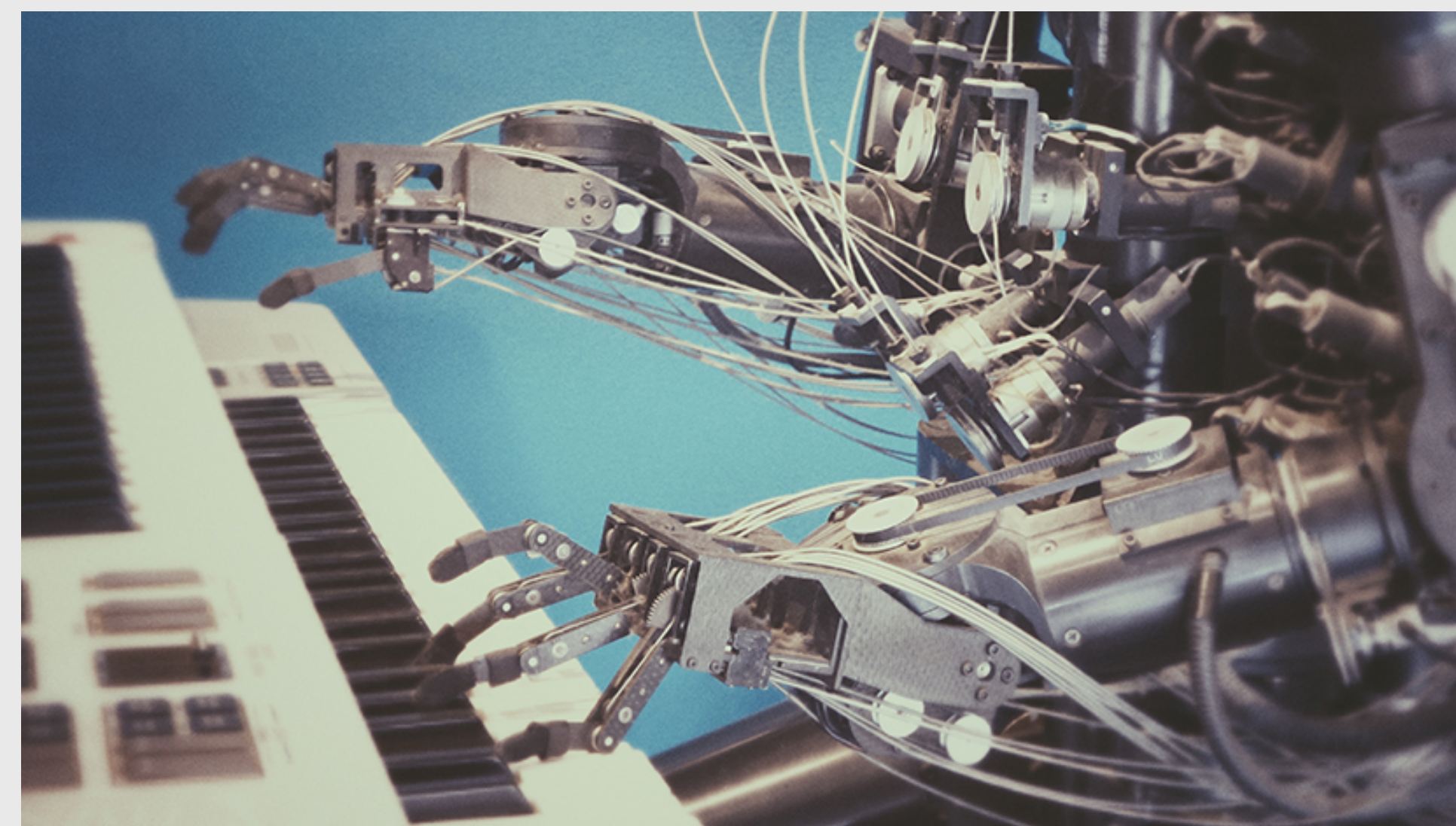
Move away from fixed functions to reconfigurable facilities

Free staff from tedious and error-prone manual activity to concentrate on creative aspects

Learn from wider IT industry

- CI/CD and DevOps methodologies

EBU Automation & Provisioning project



Thank You
peter.brightwell@bbc.co.uk

