



AoIP/AES67: Anatomy of a Full-Stack Implementation

Ievgen Kostiukevych
IP Media Technology Architect
European Broadcasting Union



IP SHOWCASE THEATRE AT IBC – SEPT. 14-18, 2018

Ievgen Kostiukevych, kostiukevych@ebu.ch, Special for IP Showcase Theatre



AOIP IP STACK ON OSI LAYERS

- Layer 1: 100BASE-T, 1000BASE-% (T, X, etc.)
- Layer 2: Ethernet
- Layer 3: IPv4, IGMPv2, DiffServ
- Layer 4: UDP
- Layer 5: RTP (RTSP)
- Layer 6: PCM Audio
- Layer 7: “Network-aware” A/D-D/A



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AUDIO OVER IP IMPLEMENTATION ANATOMY



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Connect To More

Now with AES67



SPOKEN HERE



RAVENNA

AES67 built-in

QSC SYSTEMS

Q-LAN™

W H E A T N E T



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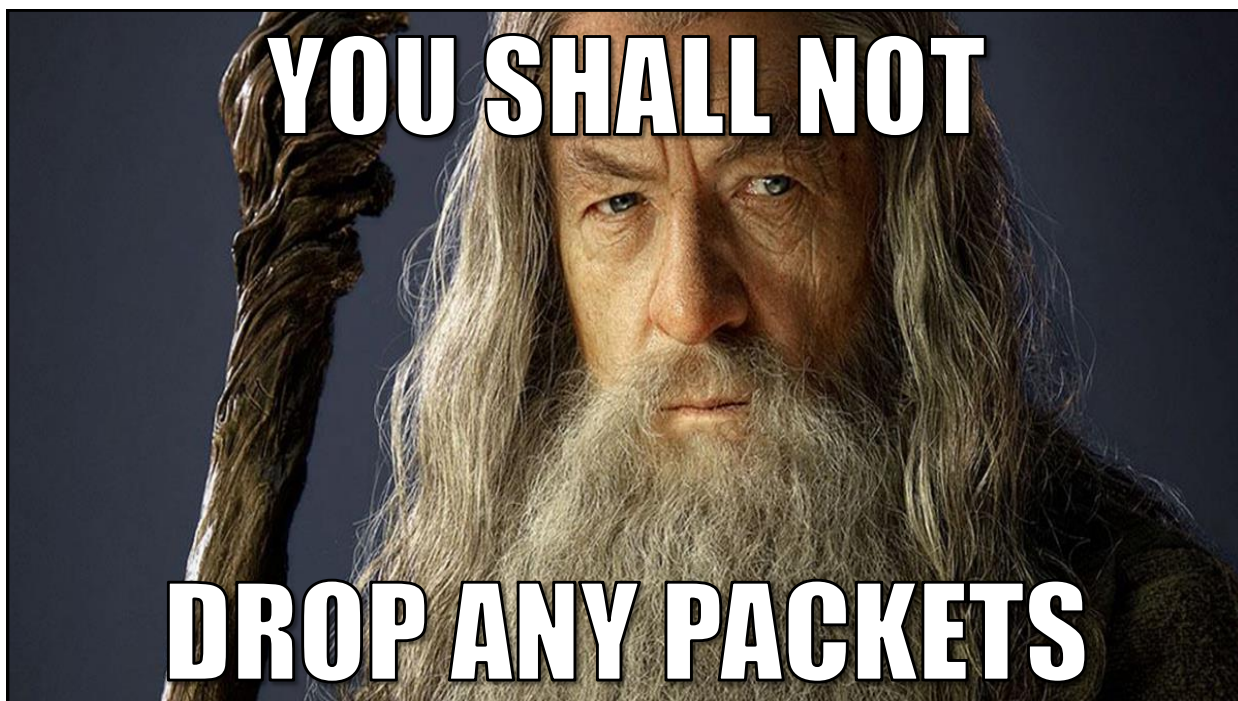
AUDIO OVER IP IMPLEMENTATION ANATOMY


- Audio over IP protocols are packet-based
- Utilize connectionless, unreliable protocol – UDP
- Require additional protocols
- I.E. DiffServ to maintain reliable performance
- I.E. IEEE1588 to keep stable clock and synchronization
- I.E. IGMP to utilize network properly and efficiently

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AUDIO OVER IP IMPLEMENTATION ANATOMY

- Core of all implementations – PCM audio
- Additional functionality is required to be fully operational, configurable and user-friendly
- This functionality is provided by implementation and can vary from one to another

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- How to discover devices?
- How to advertise streams?
- How to subscribe to streams?

AUDIO TRANSPORT

AUDIO PAYLOAD AND ENCODING

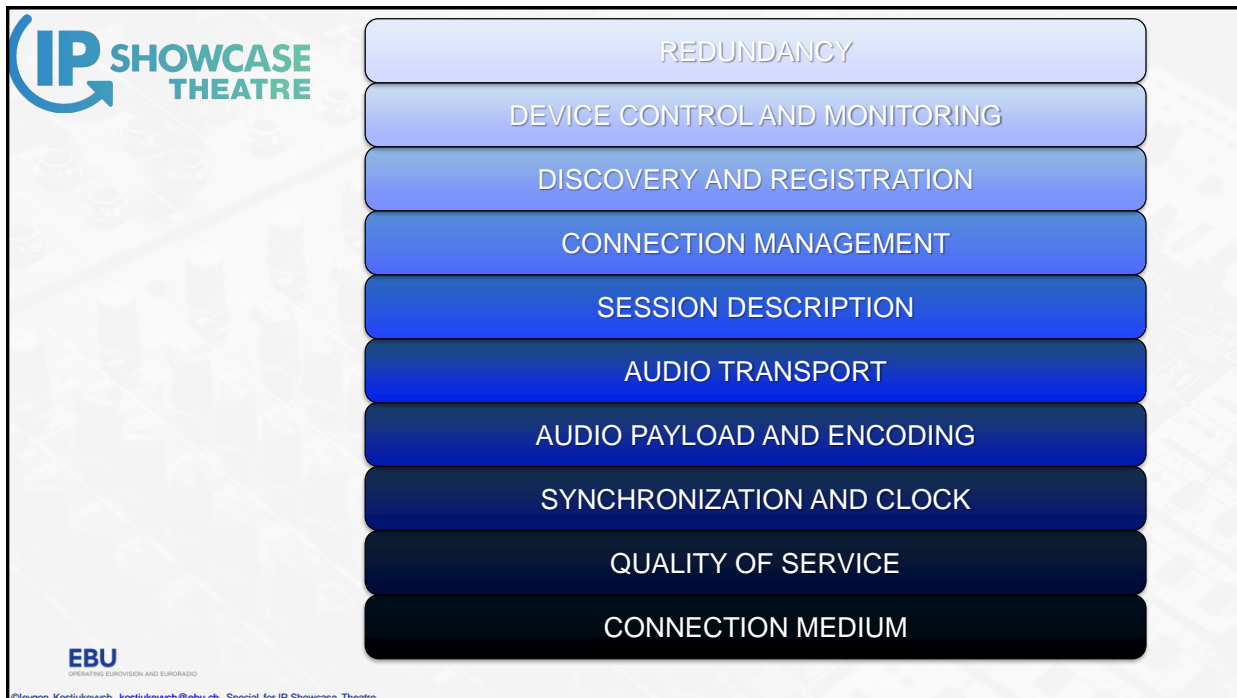
SYNCHRONIZATION AND CLOCK

QUALITY OF SERVICE

CONNECTION MEDIUM

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IP SHOWCASE THEATRE

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	AES67 Livewire+ Connect To More	RAVENNA AES67 built-in	Dante SPOKEN HERE
Device control and monitoring	HTTP, Proprietary	HTTP, Ember+	Proprietary
Discovery and registration	Proprietary	mDNS/DNS-SD (Bonjour)	SAP
Connection management	Proprietary, HTTP, IGMP	RTSP, SIP, IGMP	Proprietary
Session description	By channel number	SDP	Proprietary
Transport	RTP, IPv4	RTP, IPv4	Proprietary, IPv4
Quality of Service	DiffServ/802.1pq	DiffServ	DiffServ
Synchronization	Proprietary	IEEE 1588-2008 (PTPv2)	IEEE 1588-2002 (PTPv1)
Encoding/channel count	PCM, L24 mono, stereo, 5.1	PCM, L16-32 Up to 64 ch. per stream	PCM, L16-32 Up to 64 ch. per flow
Audio payload	48 kHz	44.1 – 384 kHz	44.1 – 192 kHz

IP

Slide concept by Merging Technologies

	AES67 Livewire+ Connect To More	RAVENNA AES67 built-in	Dante SPOKEN HERE			
Device control and monitoring	HTTP, Proprietary	HTTP, Ember+	Proprietary			
Discovery and registration	Proprietary	mDNS/DNS-SD (Bonjour)	SAP			
Connection management	<div style="background-color: #0070C0; color: white; padding: 20px; text-align: center;">  <h1 style="margin: 0;">AES67</h1> <h2 style="margin: 0;">UNDERSTOOD HERE</h2> </div>					
Session description						
Transport						
Quality of Service						
Synchronization						
Encoding						
Audio payload						
IP						

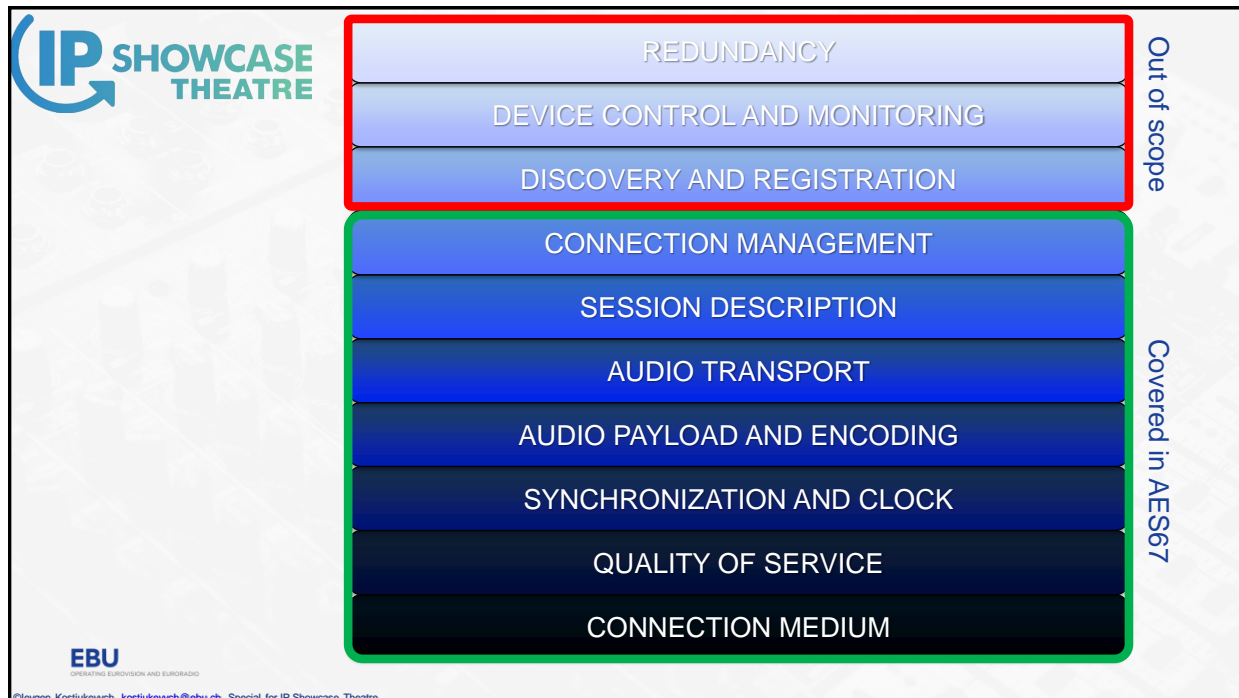
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Slide concept by Merging Technologies

	AES67 Livewire+ Connect To More	RAVENNA AES67 built-in	Dante SPOKEN HERE
Device control and monitoring	HTTP, Proprietary	HTTP, Ember+	Proprietary
Discovery and registration	Proprietary	mDNS/DNS-SD (Bonjour)	SAP
Connection management	IGMPv2 (multicast stream) / SIP (unicast stream)		
Session description	SDP (RFC 7273 for RTP clock offset announcement)		
Transport	RTP/AVC (RFC 3550 & 3551) over UDP over IPv4/IPv6		
Quality of Service	DiffServ: DSCP 46 (EF) - PTP, DSCP 34 (AF41) - RTP, DSCP 0 (BE) - else		
Synchronization	IEEE 1588-2008 (PTPv2), AES-R16-2016 profile is recommended		
Encoding/channel count	PCM, L16 (for 44.1/48 kHz) or L24 (for 48/96 kHz), 1 to 8 channels		
Audio payload	48 kHz recommended default (44.1/96 kHz are possible)		
IP			

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RAVENNA-2-SAP CONVERTER

RAVENNA				SAP				LOCAL						
Streamname	Origin	Multicast	SAP RTSP	AUTO	Streamname	Origin	Multicast	R...	AUTO	Streamname	Multicast	Sou...	R...	SAP
From CALL1 Diggram			rtsp://192.168.11.30:554/By-n...		FocusriteRedNet16R : 32	192.168.5.22	239.67.31...							
From CALL2 Diggram			rtsp://192.168.11.34:554/By-n...		Hapi_90105_2	192.168.9.1	239.67.9.1...							
Hapi_90105_2	192.168.9.1	239.67.9.10/1	rtsp://192.168.9.1:80/By-nam...		Hapi_90105_3	192.168.9.1	239.67.9.1...							
Hapi_90105_3	192.168.9.1	239.67.9.11/1	rtsp://192.168.9.1:80/By-nam...		MMA_Montone_Demo_1	192.168.10.50	239.67.10...							
Lowes PGM out	192.168.2.1	239.67.2.100/1	rtsp://192.168.2.1:8081/By-na...		NTP-Penta-720 : 32	192.168.7.11	239.67.253...							
MMA_Montone_Demo_1	192.168.10.50	239.67.10.1/28	rtsp://192.168.10.50:80/By-na...		uIlet Mini 1 ch 1-2	192.168.15.11	239.67.15...							
MonitorLoop	192.168.2.1	239.1.2.1/1	rtsp://192.168.2.1:8081/By-na...		uIlet Mini 2 ch 1-2	192.168.15.12	239.67.15...							
Monitor	192.168.4.2	239.67.222.222/1	rtsp://192.168.4.2:8081/By-na...		uIlet Standard ch 1-8 from andrew	192.168.15.10	239.67.15...							
SRC 7@node401587	192.168.255.3	239.192.3.32	rtsp://192.168.255.3:554/By-n...		uIlet Standard ch 9-16	192.168.15.10	239.67.15...							
SRC 8@node401587	192.168.255.3	239.192.3.33	rtsp://192.168.255.3:554/By-n...		uTrack24 ch 1-8	192.168.14.10	239.67.14...							
TONE@node401587	192.168.255.3	192.168.255.3	rtsp://192.168.255.3:554/By-n...		uTrack24 ch 17-24	192.168.14.10	239.67.14...							
uIlet Mini 1 ch 1-2			rtsp://192.168.15.11:554/By-n...		uTrack24 ch 9-16	192.168.14.10	239.67.14...							
uIlet Mini 2 ch 1-2			rtsp://192.168.15.12:554/By-n...		Y001-Yamaha-QL1-06aSec : 29	192.168.12.12	239.67.64...							
uIlet Standard ch 1-8 from ...			rtsp://192.168.15.10:554/By-n...		Y001-Yamaha-QL1-06aSec : 31	192.168.12.12	239.67.127...							
uIlet Standard ch 9-16			rtsp://192.168.15.10:554/By-n...		Y001-Yamaha-QL1-06aSec : 32	192.168.12.12	239.67.1.1...							
uTrack24 ch 1-8			rtsp://192.168.14.10:554/By-n...											
uTrack24 ch 17-24			rtsp://192.168.14.10:554/By-n...											
uTrack24 ch 9-16			rtsp://192.168.14.10:554/By-n...											
YAMAHA@node401587	192.168.255.3	239.10.0.3	rtsp://192.168.255.3:554/By-n...											

RAVENNA-2-SAP AES67 CONNECTION MANAGEMENT CONVERTER

[HTTPS://WWW.RAVENNA-NETWORK.COM/AES67/RAV2SAP/](https://www.ravenna-network.com/aes67/rav2sap/)

RAVENNA AES67 built-in

The RAVENNA-2-SAP Converter is firmware developed by ALC NetworkX to help connecting AES67

8:53 AM 9/13/2016

ANEMAN IS THE FIRST CROSS PLATFORM & CROSS VENDOR AUDIO NETWORK MANAGER
[HTTPS://ANEMAN.NET](https://aneman.net)

The screenshot displays the ANEMAN software interface. At the top, it features the title 'ANEMAN IS THE FIRST CROSS PLATFORM & CROSS VENDOR AUDIO NETWORK MANAGER' and the website 'HTTPS://ANEMAN.NET'. The main area shows a network diagram with nodes for 'Horus 80096', 'MassCore (on 10M...)', 'Horus 80131', 'PreMo-00-53-ED', and 'CoreAudio (on Slepini)'. Below the diagram is a 'Devices' table:

Name	Type	Version	Company	Product	Serial
PreMo-00-5...		0	Ward-Beck Systems	PreMo	00:07:F5:00:53:ED
NADAC_100...		3.6.0b32449	Merging Technologies	NADAC	100134
MassCore (...)			Merging Technologies	MassCore	116530457895
Horus_80131		3.6.0b32391	Merging Technologies	Horus	80131
Horus_80096		3.80.0b0	Merging Technologies	Horus	80096

On the right side, there are sections for 'RECEIVERS / OUTPUTS' and 'INPUTS / STREAMERS'. The 'RECEIVERS / OUTPUTS' section lists 'CoreAudio Input 1' through 'CoreAudio Input 8' and 'Audio Device (9-16)' through 'Audio Device (57-64)'. The 'INPUTS / STREAMERS' section lists 'Audio Device (1-8)' through 'Audio Device (57-64)' and 'Input 1' and 'Input 2'. The bottom status bar shows 'Ready for next operation' and system information: 'ENG 4:00 PM 6/27/2017'.

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EMBER+

OCA^{AES 70}
 OPEN CONTROL ARCHITECTURE

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AUDIO OVER IP IN SMPTE ST 2110



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SMPTE 2110 - PROFESSIONAL MEDIA OVER MANAGED IP NETWORKS

Document structure:

- 2110-10: System Timing & Definitions
- 2110-20: Uncompressed Active Video
- 2110-21: Traffic Shaping and Delivery Timing for Uncompressed Active Video
- **2110-30: PCM Digital Audio**
- 2110-31: AES3 Transparent Transport
- 2110-40: Transport of SMPTE Ancillary Data

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SMPTE ST 2110-30: PCM DIGITAL AUDIO

- Defines payload format for uncompressed PCM audio
- Based on AES67
- Introduces additional constraints

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SMPTE ST 2110-30 : ADDITIONAL CONSTRAINTS TO AES67

- ST 2110-10 requires usage of SMPTE 2059-2 PTP profile
- AES-R16-2016 (AES67 PTP Media profile) resolves this
- PTP setting “defaultDS.slaveOnly=true” required
- Media clock to RTP clock offset (Δt_s) must equal zero
(a=mediaclock:direct=0)

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SMPTE 2110: ADDITIONAL CONSTRAINTS TO AES67

- Support for SIP **not** required
- Support for optional redundancy with SMPTE 2022-7 required
- Support for Channel assignment map as SDP attributes required

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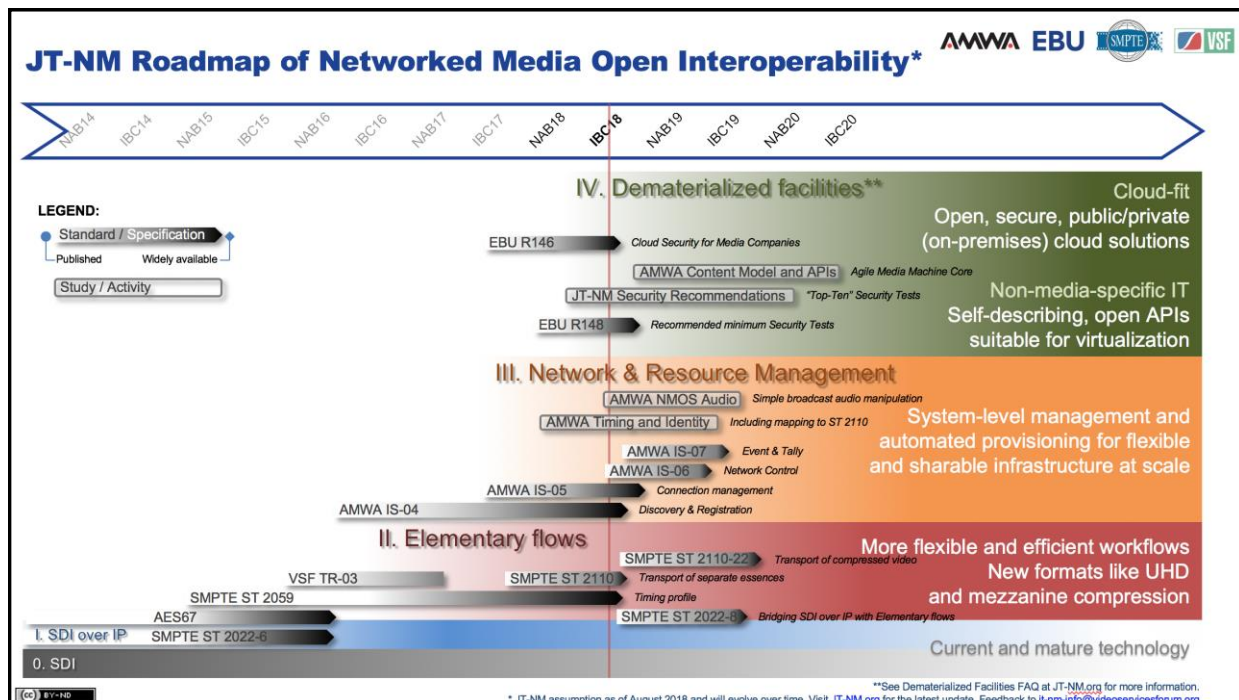
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REDUNDANCY	Covered in ST2110-30
DEVICE CONTROL AND MONITORING	Out of scope
DISCOVERY AND REGISTRATION	
CONNECTION MANAGEMENT	Covered in AES67
SESSION DESCRIPTION	
AUDIO TRANSPORT	
AUDIO PAYLOAD AND ENCODING	
SYNCHRONIZATION AND CLOCK	
QUALITY OF SERVICE	
CONNECTION MEDIUM	

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networked media


NMOS

open specifications

- IS-04 - NMOS Discovery & Registration API
- IS-05 - NMOS Device Connection Management API
- IS-06 - NMOS Network Control
- IS-07 - NMOS Event & Tally

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Minimum Stack for IP endpoints

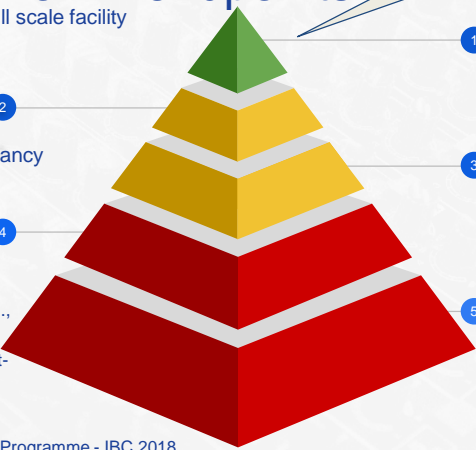
necessary to build and manage a full scale facility

Time and Sync

- PTPv2
- Both SMPTE and AES profiles
- BMCA for multi-interface redundancy

Configuration and Monitoring

- DHCP IP assignment
- Open configuration management (e.g., API, config file, SSH CLI, etc.)
- Open monitoring protocol (e.g., Agent-based, SNMPv3, etc.)



Media Transport

- Video SMPTE ST 2110-20/21 with Wide Rx
- Audio SMPTE ST 2110-30 Level C
- SMPTE ST 2022-7:2018 Protection
- Single link - e.g., UHD on 25 GbE

Discovery and Connection

- AMWA IS-04 Discovery and Registration
- AMWA IS-05 Connection Management
- LLDP Topology discovery

Security

- EBU R148 Tests
- HTTPS API calls
- AD, LDAP or Certificates - Authentication

Widely available
Partially available
Rarely available

EBU Production Infrastructure Strategic Programme - IBC 2018
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WHAT'S NEXT?..



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WHAT'S NEXT?

- Evaluate!
- Educate!
- Get your hands dirty!
- Get in touch!

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Thank You

Ievgen Kostiukevych, European Broadcasting Union
kostiukevych@ebu.ch
+41 79 225 37 35

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