RAVENNA 2020 Webinar Series

RAVENNA
and its relationship to
AES67 & SMPTE ST 2110

Tue, Apr 14, 2020
15:00 h (CEST)

Presenter: Andreas Hildebrand, ALC NetworX
RAVENNA 2020 Webinar Series

Upcoming webinars:

• Tue, Apr 28, 2020 - 15:00 h (CEST):
  **AES67 & SMPTE ST 2110 (Introduction / overview)**

• Tue, May 12, 2020 - 15:00 h (CEST):
  **AES67 & SMPTE ST 2110 (Deep dive)**

More on a **bi-weekly** basis, to be announced on:

• **url**: ravenna-network.com/about-ravenna/trade-shows-events/
• **twitter** : @RAVENNA_Network
• **facebook** : facebook.com/RAVENNA.Network/
• **linkedin** : linkedin.com/groups/7454171/
AES67 & SMPTE ST 2110

- The Vulcan Nerve Pinch to RAVENNA?
What is RAVENNA?
RAVENNA The IP-based Real-Time Media Network

What is RAVENNA?
What is RAVENNA?
What is RAVENNA?

RAVENNA
The IP-based Real-Time Media Network

Real-time Audio & Video Enhanced

Next-Generation Network Architecture
Why RAVENNA?
Networked audio timeline

- 1996: CobraNet patented (FE layer 2)
- 1997: First use for Super Bowl halftime show (Disney Animal Kingdom)
- 1999: Initial RTP standard
- 2001: Gibson MaGIC (FE layer 2) published
- 2002: Gigabit Ethernet Standard
- 2003: EtherSound (FE layer 2) & IEEE1588 (PTPv1)
- 2006: Livewire
- 2007: Dante
- 2008: EBU ACIP
- 2002: RAVENNA R&D team created

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Vision: a platform-independent content exchange technology

Requirements:

- scalable
- fast
- shareable
- flexible
- reliable
- routable
- non-proprietary
- based on standards
Why Networking?

- Availability – increase of network-based services (VoIP / NGN, IPTV, WAN distribution via “codecs” etc.) & performance of infrastructure (Ethernet / Gigabit, fiber, switches / routers etc.)
- Cost efficiency – equipment, cabling, planning, installation
- Flexibility – fast re-configuration / re-routing w/o change in cabling
- Scalability – performance scales w/ capabilities of network infrastructure
- Versatility – add’l services on same network (e.g. control signal, communication, “office” traffic etc.)
- Convergence – direct integration w/ PCs
- Resource efficiency – consolidation of maintenance efforts for engineering & service departments
RAVENNA The IP-based Real-Time Media Network

Layer 1
- ACIP
- RTP
- Media streaming

Layer 2
- Audio over IP
- EtherSound
- AVB
- Livewire
- Audio over Ethernet
- AES50
- MADI
- Dante
- CobraNet
- EtherSound

Layer 3
- TCP
- UDP
- unicast
- Multicast

Confusion
Market Evaluation
Technology Assessment

→ IP!
Why IP-based Networking?

• General advantages of networking: Reliability, flexibility, versatility, accessibility, scalability, cost advantage, maintenance efficiency, ...

• Availability: IP-capable network equipment and infrastructure readily available and widely deployed

• Based on standards: IP standard protocols (the “internet protocols”) are widely supported (e.g. RTP/RTCP, RTSP, IGMP, SDP, DHCP, DNS etc.)

• Routing capability: content can be routed across campus networks and WAN connections without technology change

• Convergence: PCs can participate on the network without dedicated hardware

• Future-proof: IP-based services are growing into all areas of communication
RAVENNA The IP-based Real-Time Media Network

Layer 1

ACIP
RTP
Media streaming

Layer 2

AVB
EtherSound
Livewire
Audio over Ethernet
A-Net
AES50
MADI
Dante
CobraNet

Layer 3

TCP
UDP
unicast
multicast

Confusion
Market Evaluation
Technology Assessment
Take or Make?

→ IP!
## Existing Audio-over-IP solutions / technologies / initiatives:

<table>
<thead>
<tr>
<th>Technology</th>
<th>Purveyor</th>
<th>Date introduced</th>
<th>Technical requirements matched?</th>
<th>Open technology?</th>
</tr>
</thead>
<tbody>
<tr>
<td>Livewire</td>
<td>Telos/Axia</td>
<td>2003</td>
<td>☹️</td>
<td>☹️</td>
</tr>
<tr>
<td>Wheatnet-IP</td>
<td>Wheatstone</td>
<td>2005</td>
<td>☹️</td>
<td>☹️</td>
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<tr>
<td>Dante</td>
<td>Audinate</td>
<td>2006</td>
<td>☹️</td>
<td>☹️</td>
</tr>
<tr>
<td>N/ACIP</td>
<td>EBU</td>
<td>2007</td>
<td>☹️</td>
<td>☺️</td>
</tr>
<tr>
<td>AVB</td>
<td>IEEE, AVnu</td>
<td>2005</td>
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RAVENNA The IP-based Real-Time Media Network

Layer 1
- ACIP
- RTP
- Media streaming

Layer 2
- Audio over IP
- EtherSound
- AVB
- Livewire
- Dante
- MADI
- AES60

Layer 3
- Confusion
- Market Evaluation
- Technology Assessment
- Take or Make?
- TCP
- UDP
- unicast
- multicast

MAKE! IP!
Networked audio timeline

RAVENNA R&D team created
RAVENNA development started
RAVENNA introduced to selected industry partners
RAVENNA published and introduced at IBC 2010

2008  2009  2010
What is RAVENNA?
An “Open Technology” platform:

• Based on technology publicly available
  ⇒ No proprietary “black box” design

• Utilizes standard protocols
  ⇒ Proven technology, widely supported

• Designed to work on existing networks
  ⇒ No new network equipment required

• No proprietary licensing policy
  ⇒ No cost per channel, suits all performance needs

• Draft on operating principles published since June 10th, 2011
What is RAVENNA?

RAVENNA Draft on Operational Principles

Ingredients:
- 20 ml PTPv2
- 500 g RTP
- 1 pkt multicast
- 1 pinch of Bonjour

Cooking order:
1. Stew PTP to order
2. Add RTP
3. Mingle with multicast
4. Add Bonjour on top

Serve hot and Enjoy!
RAVENNA The IP-based Real-Time Media Network

An “Open Technology” platform:

• Based on technology publicly available
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• Designed to work on existing networks
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• No proprietary licensing policy
  ⇒ No cost per channel, suits all performance needs

• Draft on operating principles published since June 10th, 2011
  ⇒ Anybody can implement / support RAVENNA technology

• Supported by renowned companies from the ProAudio industry
  ⇒ Broad market acceptance
RAVENNA Partners (& AES67 Supporters):
RAVENNA Key Features:

- A layer 3 (IP) solution
- Can operate on most existing network infrastructures
- Allows phase-accurate distribution of media clocks
- Full bit-transparency with all media formats
- Supports concurrent operation of multiple media clocks and data formats
- Allows low latency for real-time critical applications
- Capacity scales with underlying network infrastructure
- Supports distribution and synchronization across network segments
- Full network redundancy support (optional)
- Based on standards
- Open technology
Networked audio timeline

- **RAVENNA R&D team created**: 2008
- **RAVENNA development started**
- **RAVENNA introduced to selected industry partners**
- **RAVENNA published and introduced at IBC 2010**
- **AES X192 WG (AES67) started**
- **AVB Ethernet extensions (layer 2)**
- **AES67 published**: 2013
AES standard for audio applications of networks - High-performance streaming audio-over-IP interoperability

Q-LAN  Livewire  RAVENNA  WheatNet  Dante

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AES standard for audio applications of networks - High-performance streaming audio-over-IP interoperability

Q-LAN

Livewire

RAVENNA

WheatNet

Dante

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### AES67 technology components

<table>
<thead>
<tr>
<th>Component</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Discovery</td>
<td>Not specified</td>
</tr>
<tr>
<td>Connection Management</td>
<td>SIP (unicast), IGMP (multicast)</td>
</tr>
<tr>
<td>Session Description</td>
<td>SDP (RFC4566, RFC7273)</td>
</tr>
<tr>
<td>Encoding</td>
<td>L16/L24, 1..8 ch, 48 samples</td>
</tr>
<tr>
<td>QoS</td>
<td>Differentiated Services (DiffServ w/ 3 CoS)</td>
</tr>
<tr>
<td>Transport</td>
<td>RTP / UDP / IP, unicast &amp; multicast</td>
</tr>
<tr>
<td>Media Clock</td>
<td>48 kHz</td>
</tr>
<tr>
<td>Synchronisation</td>
<td>IEEE 1588-2008 (PTPv2)</td>
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RAVENNA The IP-based Real-Time Media Network

AES67
## RAVENNA - The IP-based Real-Time Media Network

<table>
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<td>+ classes adjustable</td>
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<td>Media Format L16/L24 PCM</td>
<td>+ AES/EBU, DSD/DXD, Video</td>
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<tr>
<td>48 Samples per packet</td>
<td>+ 1, 6, 12, 64...</td>
</tr>
<tr>
<td>1-8 Audio channels</td>
<td>+ 64, 128...</td>
</tr>
<tr>
<td>Encoding 48kHz</td>
<td>+ 44.1, 96, 192, 384kHz...</td>
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<tr>
<td>AES67</td>
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**AES67**
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**RAVENNA** The IP-based Real-Time Media Network
RAVENNA
The IP-based Real-Time Media Network

RAVENNA
AES67 built-in
Networked audio timeline

- AES67 published
- RAVENNA in all 12 soccer World Cup stadiums
- First RAVENNA OEM board (ALC NetworX)
- RAVENNA used for ESC (6600 audio signals)
- Telos announced AES67 support (Livewire+)
- QSC announced AES67 compatibility
- Revision of AES67
- Audinate announced AES67 support

2013 2014 2015 2016 2017
Networked audio timeline
SMPTE ST 2110 – Professional Media over Managed IP Networks

The SMPTE ST 2110 standards suite specifies
• the transport, synchronization and description of
  • separate elementary essence streams (video, audio, ancillary data)
  • over managed IP networks (at any speed, from 1GbE to 100 GbE and beyond)
• for real-time production, playout and other professional media applications.
The Bundled Approach: SMPTE ST 2022-6

Published beginning in 2012

- Audio (from HANC)
- Video (from active area)
- Metadata (from VANC)
- Sync/Timing (from frame)
The Essence-based Approach: SMPTE ST 2110

- **IP Packetization of Active Video**
  - Method: SMPTE ST 2110-20
  - Active Video

- **IP Packetization of Audio Channels**
  - Method: SMPTE ST 2110-30
  - Audio

- **IP Packetization of ANC Data**
  - Method: SMPTE ST 2110-40
  - Metadata

Published beginning in 2017
Bundled vs. Essence-based Approach

**A)** SMPTE 2022-6 Stream
- De-packetize
- Packetize
- SMPTE 2022-6 IP Packets
- Video/Audio/Data
- De-embed
- Embed

**B)** VSF TR-03 Streams
- Pack/Depack
- Data
- Audio
- SDI
- Video
- AES67 Audio
- RFC 4175 Video
- SDP File
- De-packetize
- Embed

ST 2022-6

ST 2110
SMPTE 2110 - Professional Media over Managed IP Networks

Document structure (published):

• 2110-10: System Timing & Definitions
  – defines transport layer and synchronization (SMPTE2059, clocks, RTP, SDP etc.)

• 2110-20: Uncompressed Active Video
  – defines payload format for raw video (RFC4175, RTP, SDP, constraints)

• 2110-21: Traffic Shaping and Delivery Timing for Uncompressed Active Video
  – defines timing model for senders and receivers (traffic shaping requirements)

• 2110-22: Compressed Active Video
  – defines payload format for CBR-compressed video (no codec definition!)
SMPTE 2110 - Professional Media over Managed IP Networks

**Document structure** (published):

- **2110-30: PCM Digital Audio**
  - defines payload format for linear audio (AES67, constraints)

- **2110-31: AES3 Transparent Transport**
  - defines payload format for non-linear audio (RAVENNA AM824)

- **2110-40: Transport of SMPTE Ancillary Data**
  - defines RTP payload format for SDI ancillary data (new IETF draft)
SMPTE 2110 - Professional Media over Managed IP Networks

Document structure (audio):

- **2110-10**: System Timing & Definitions
  - defines transport layer and synchronization (SMPTE2059, clocks, RTP, SDP etc.)

- **2110-30**: PCM Digital Audio
  - defines payload format for linear audio (AES67, constraints)

- **2110-31**: AES3 Transparent Transport
  - defines payload format for non-linear audio (RAVENNA AM824)
SMPTE 2110 - Professional Media over Managed IP Networks

Document structure (linear PCM audio):

- **2110-10**: System Timing & Definitions
  - defines transport layer and synchronization (SMPTE2059, clocks, RTP, SDP etc.)

- **2110-30**: PCM Digital Audio
  - defines payload format for linear audio (AES67, constraints)

⇒ AIMS WP on AES67 / ST2110 Commonalities & Constraints
SMPTE ST 2110-30 and AES67 Compatibility

SMPTE ST 2110-30 is a subset of AES67, adding constraints to clocking and streaming.

AES67 mandatory
a=ptime:1

AES67 optional
a=ptime:0.12

SMPTE ST 2110

Now with ST2110!

ST 2110-30 Level A

ST 2110-30 Level B
SMPT 2110 - Professional Media over Managed IP Networks

2110-31 – transparent transport of AES3 audio data

• Can transport any format which can be encapsulated in AES3
  – L24 PCM w/ AES3 subframe meta data (PCUV bits)
  – non-PCM audio and data formats as defined by SMPTE ST 337 / 338
    (i.e. Dolby®E etc.)

• Builds on RAVENNA’s AM824 (IEC 61883-6) payload definition:
  – retains AES67 definitions for synchronization and RTP usage
  – uses **3 bytes** for PCM24 + **1 byte** for AES3 meta data

---

| 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 0 | 1 | 2 | 3 |
| 0 | 0 | B | F | PCUV | DATA24 |

  – RTP payload format signaled in SDP:
    
    a=rtpmap:<pt> AM824/48000/<nchan> - with <nchan> always being an equal number (stereo channels)
    
  – retains all other SDP parms
Audio Metadata over SMPTE ST 2110-31 (RAVENNA AM824)
SMPTE 2110 - Professional Media over Managed IP Networks

AES67 / ST2110 audio compatibility?

24-bit PCM audio
SMPTE 2110 - Professional Media over Managed IP Networks

AES67 / ST2110-30 stream compatibility?

AES67

ST2110-30

Constraints
SMPTE 2110 - Professional Media over Managed IP Networks

AES67 / ST2110 audio compatibility?

AES3 audio
SMPTÉ 2110 - Professional Media over Managed IP Networks

AES67 / ST2110-31 stream compatibility?
Summary (why RAVENNA?):

• Flexibility
  o Wide range of formats, sampling rates and packet times
  o Accommodates any channel bundles

• Performance
  o Full bit-transparency
  o Capacity scales w/ network speed
  o Ultra-low latency possible (“MADI-over-IP”)

• Open technology (can be enhanced / expanded)
  o No licensing, multiple adoptions & OEM provider
  o Based on existing standards
    – Operates on standard / managed IT networks (including routing)
  o Adaptable to emerging standards / technologies through layered approach
    – Fully compatible with AES67 / ST2110
    – SAP / SIP / ST 2059 / ST 2022-7 / NMOS

• Most prevalent technology in broadcast applications
Not at all!
Thank you for your attention!

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