NAB 2015, Las Vegas, April 12th, 2015

Introduction to AES67
&
How to get it
into your Products

Media Networking Alliance

AUDIO AES

AES67

Agenda:

	Topic	Speaker
20 min.	Introduction to MNA	Marty Sacks (Telos Alliance) & Stefan Ledergerber (Lawo)
	AES67 – a quick Recap	Andreas Hildebrand (ALC NetworX)
50 min.	RAVENNA SoM & Reference Designs	
	AudioLAN SoMs	Arie van den Broek (Archwave)
	Digigram OEM Solution	Philippe Delacroix (Digigram)
	JADE Engine	Stephan Türkay
	Axia OEM Solution	Greg Shay (Telos Alliance)
10 min.	Lessons learned from implementing AES67	
15 min.	Q&A	all
	Round-up / AES67 on the Show Floor	Stefan Ledergerber (Lawo)

Media Networking Alliance - Objectives

- Actively promote the adoption and standardization of AES67 as an audio interoperability standard through:
  - Marketing
  - Education
  - Training

Media Networking Alliance - Objectives

- Provide developer support for AES67 products, and actively support those members producing AES67 compliant products, including, but not limited to:
  - AES67 System Development Kit
  - AES67 Test Tools

Media Networking Alliance - Objectives

- Educate the business and end-user communities about the value, benefits and applications for AES67.

Media Networking Alliance - Membership

- The MNA is a non-profit corporation with membership available to all manufacturers, organizations, companies and individuals who are interested in the objectives and purposes of the alliance.

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AES67

AES67-2013 Standard for Audio Applications of Networks:

High-performance Streaming Audio-over-IP Interoperability

published on September, 11th, 2013

Scope:

- **Interoperability guidelines** for professional, low-latency audio over campus and local area IP networks **using existing protocols wherever possible.**
- Excludes:
  - Non-IP networking
  - Low-bandwidth media
  - Data compression
  - Low-performance WANs and public Internet
  - Video (should provide good basis for follow-on video project)

Existing Audio-over-IP solutions / technologies / initiatives:

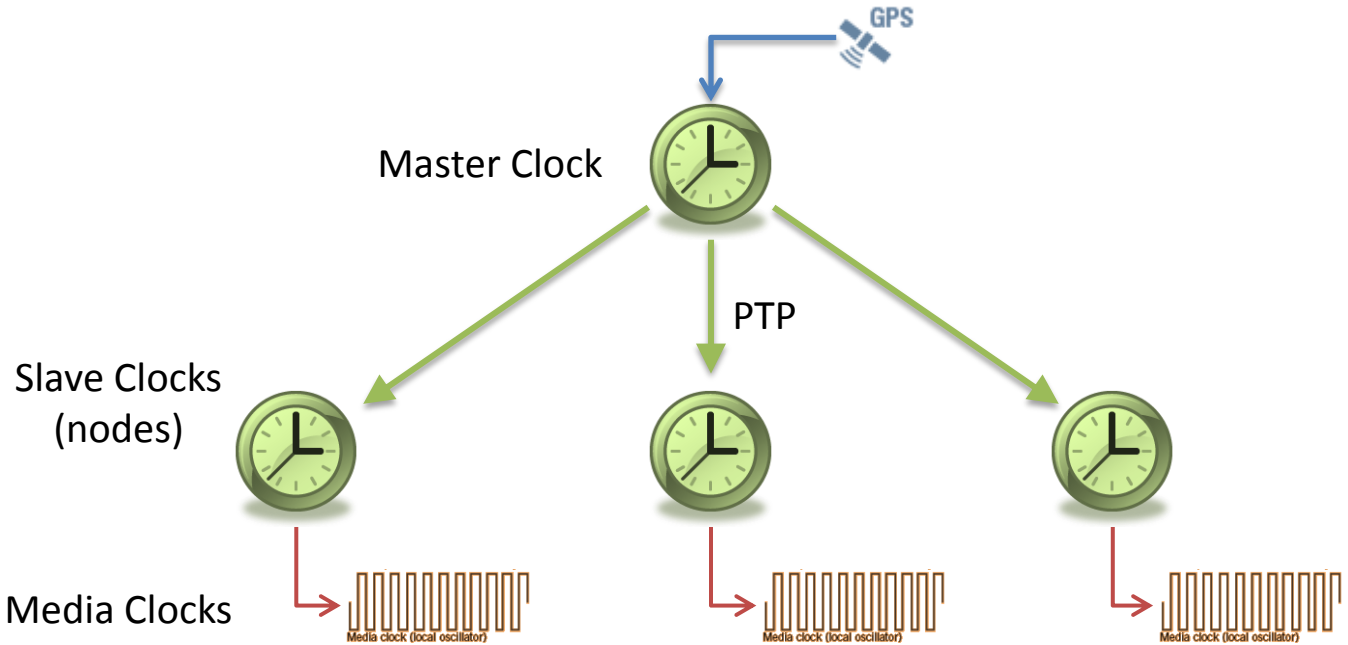
Technology	Purveyor	Date introduced	Synchronization	Transport
Livewire	Telos/Axia	2003	Proprietary	RTP
Wheatnet-IP	Wheatstone	2005	Proprietary	RTP
Dante	Audinate	2006	IEEE 1588-2002	UDP
N/ACIP	EBU	2007	Adaptive (per stream)	RTP
Q-LAN	QSC Audio Products	2009	IEEE 1588-2002	UDP
RAVENNA	ALC NetworX	2010	IEEE 1588-2008	RTP
AVB	IEEE, AVnu	2011	IEEE 802.1AS	Ethernet, RTP

AES67 technology components:

- Synchronization: IEEE 1588-2008, default profile (media profile suggested)
- local media clock generation

AES67 technology components

– time synch & media clock generation:



AES67 technology components:

- Synchronization: IEEE 1588-2008, default profile (media profile suggested)
- local media clock generation
- Network: IPv4 (IPv6), unicast / multicast & IGMPv2
- Transport: RTP/AVC (RFC 3550 & 3551) / UDP / IP

Selected solutions / technologies compared to OSI layer model:

OSI Layer	A-Net	EtherSound	CobraNet	Livewire, Dante & …	AVB	AES67 & RAVENNA
Application						
Presentation						
Session				RTP		RTP
Transport				UDP		UDP
Network				IP		IP
Data Link		Ethernet	Ethernet	Ethernet	Ethernet	Ethernet
Physical	Copper	Copper / Fiber	Copper / Fiber	Copper / Fiber	Copper / Fiber	Copper / Fiber

AES67 technology components:

- Synchronization: IEEE 1588-2008, default profile (media profile suggested)
- local media clock generation
- Network: IPv4 (IPv6), unicast / multicast & IGMPv2
- Transport: RTP/AVC (RFC 3550 & 3551) / UDP / IP
- Encoding: 16 / 24 bit linear, 48 (44.1 / 96) kHz, channel count: 1..8
- Packet Setup: 48 samples (6 / 12 / 16 / 192), max. payload size: 1440 bytes
- Quality of service: DiffServ w/ 3 suggested traffic classes (DSCP)
- Connection management: SDP (refers to RFC 7273 - RTP Clock Source Signaling), SIP (unicast)
- Discovery: excluded, but several recommendations given (i.e. ZeroConf, SAP and others)

AES67 – *the "O negative" of audio networking*

RAVENNA

WHEATNET IP

Q-SYS™

Dante™

IP . AUDIO Livewire

ACIP

AES67 – *the "O negative" of audio networking*

AES67 – *the "O negative" of audio networking*

AES67

AES67

AES67

RAVENNA

AES67 – *the "O negative" of audio networking*

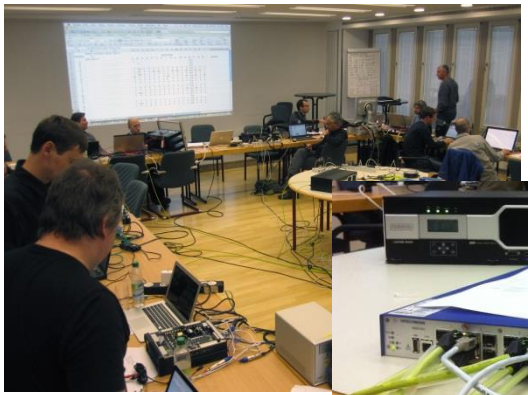
When will it be available?

AES67 – *the "O negative" of audio networking*

When will it be available?

First AES67 plug-fest October 2014 @ IRT in Munich!

- 3.5 days of plugging
  - 22 participants (10 manufacturers, IRT, EBU, SR)
    - 16 products (15 were based on RAVENNA)
      - Lots of streams – millions of packets!



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  - 22 participants (10 manufacturers, IRT, EBU, SR)
    - 16 products (15 were based on RAVENNA)
      - Lots of streams!

Tests included:

- Synchronization (PTP)
- Concurrent multicast streaming between all nodes w/ mandatory stream formats
- Unicast streams and SIP connection setup

☑ AES67 interoperability successfully demonstrated!

AES TG SC-02-12-M: AES67 Development

- Outlining AES67 compliance test guidelines
- Specifying and engineering the compliance tests
- Planning and organizing plug-fests
- Improving the standard specification where necessary
- Participants:
  - anyone implementing AES67
  - parties / individuals with strong interest in AES67 interoperability

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*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 / AES67 Building Blocks from ALC NetworX

(1) COMi.MX RAVENNA / AES67 SoM

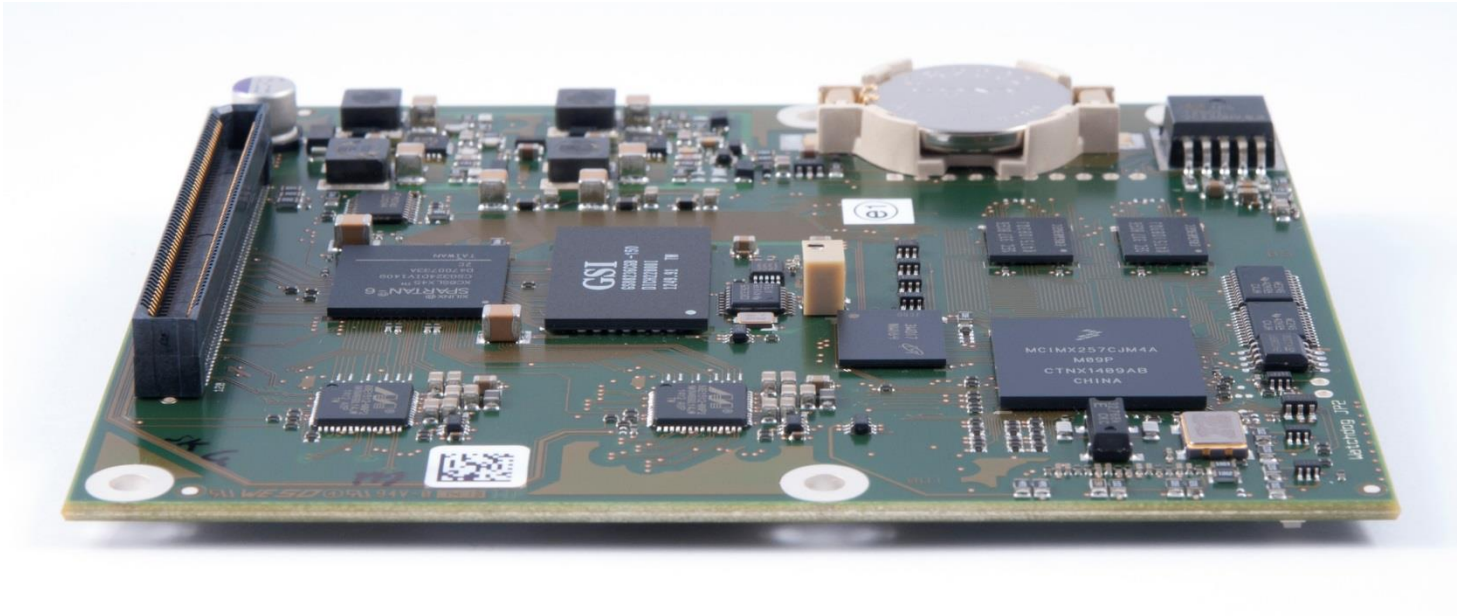
(2) C/C++ RAVENNA / AES67 Software Framework

(3) COMi.MX Reference Design incl. full Source Code Package

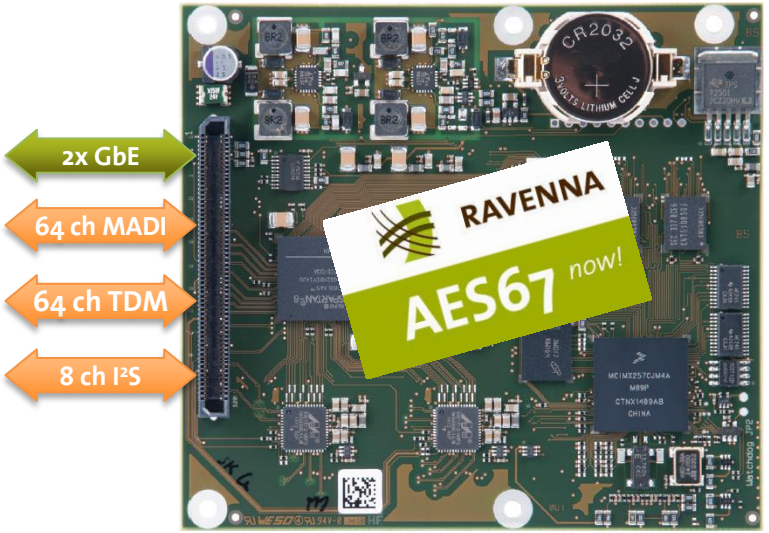
(4) RVSC for Windows

COMi.MX - RAVENNA / AES67 SoM

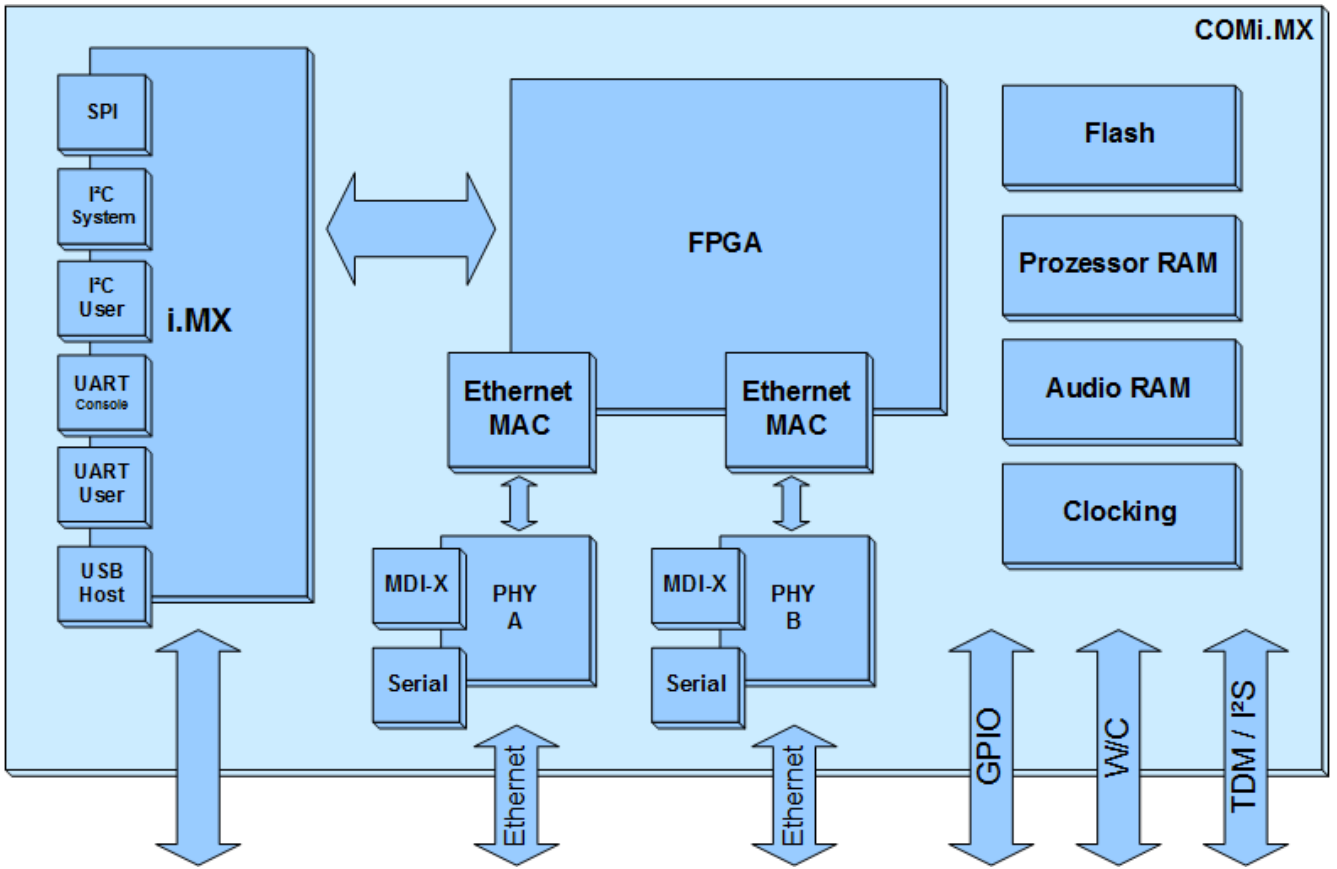
for quick & easy OEM integration



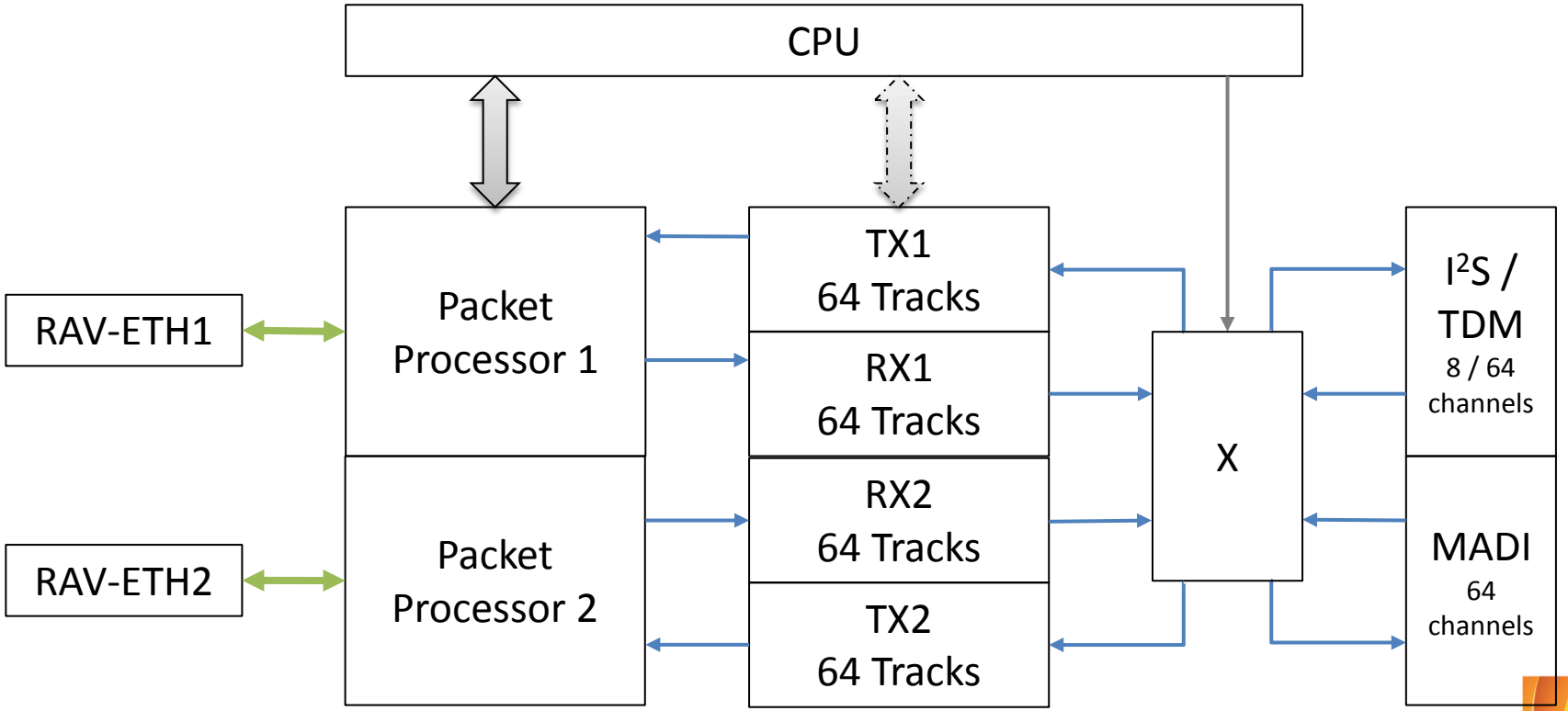
COMi.MX – RAVENNA / AES67 SoM



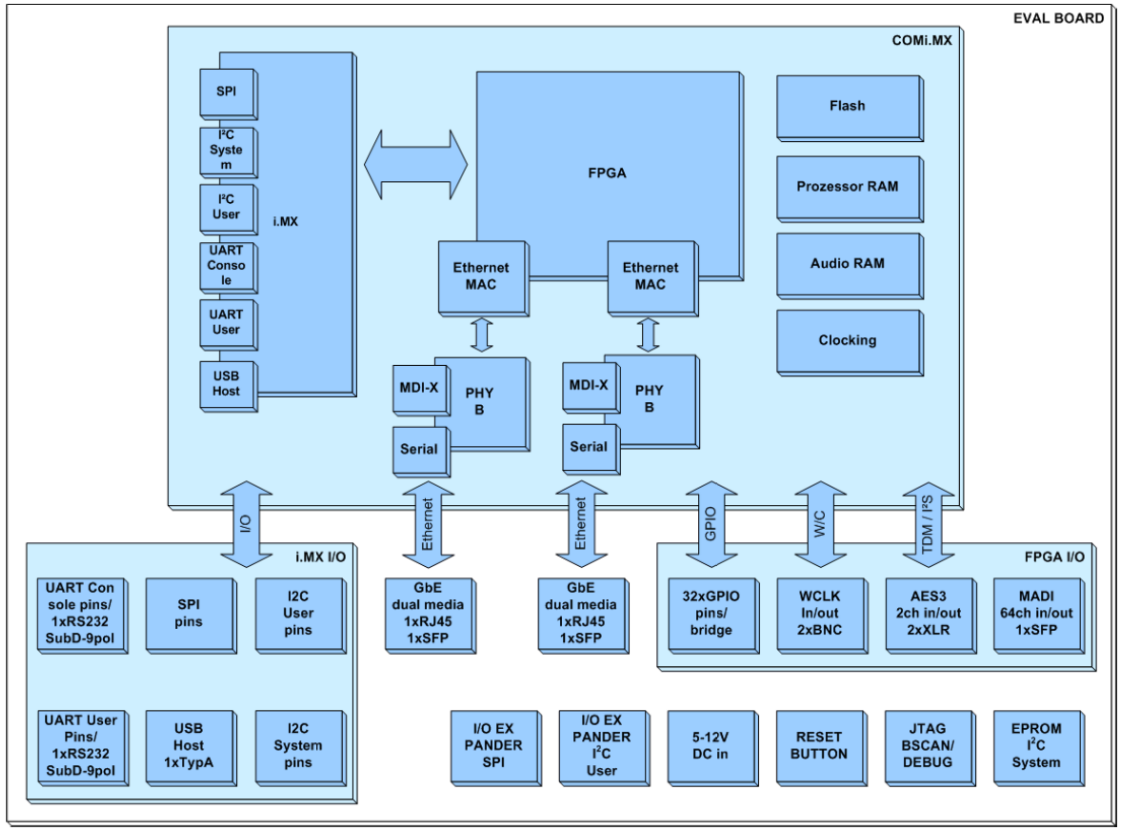
- Fully self-contained RAVENNA implementation
- 2x 64 channels in & out
- Up to 192 kHz sampling rate
- Full AES/EBU bit-transparent operation supported
- Lowest latency support: down to 1 sample/packet!
- Jitter / delay buffer up to 80 ms per channel
- Audio interfaces: I^2S (8 ch) / TDM, MADI (64 ch)
- 4-tier 256 x 256 audio matrix
- Load balancing support through 2 GbE NICs (redundancy w/ later firmware)
- Full AES67 support (w/ firmware update)

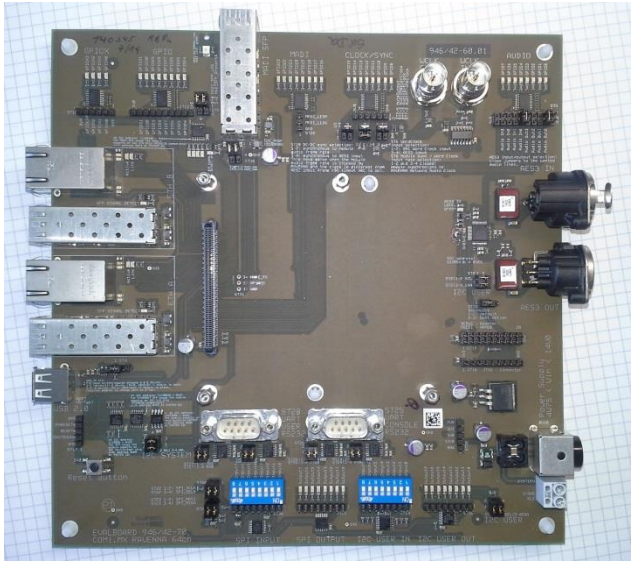

COMi.MX
SPI
I²C System
I²C User
UART Console
UART User
USB Host
i.MX
FPGA
Ethernet MAC
Ethernet MAC
MDI-X
PHY A
Serial
MDI-X
PHY B
Serial
Flash
Prozessor RAM
Audio RAM
Clocking
Ethernet
Ethernet
GPIO
VI/C
TDM / I²S

COMi.MX – data flow (parallel operation):

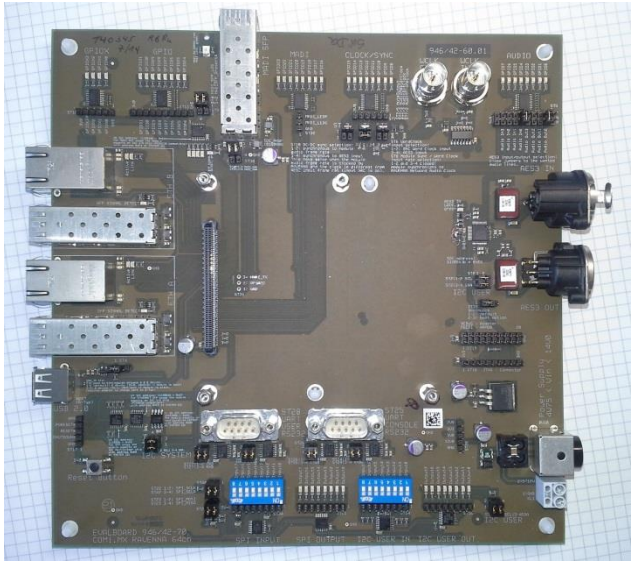


COMi.MX – Eval Board





COMi.MX – Eval Board



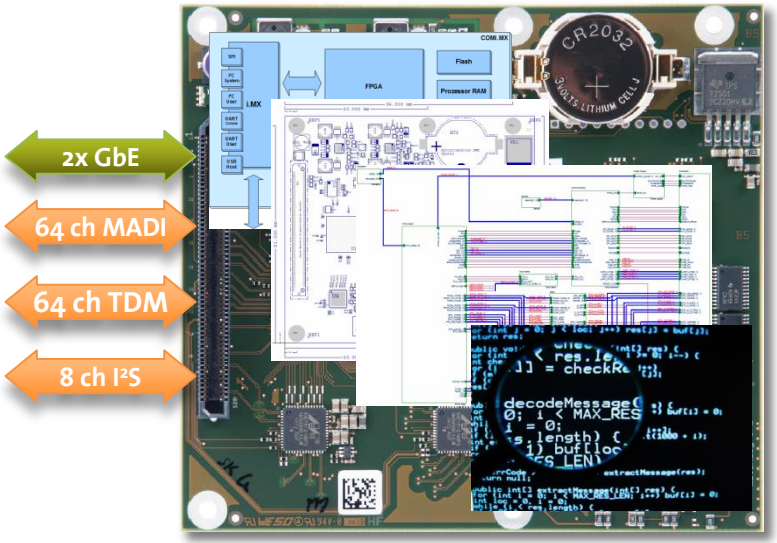
- Test and evaluation board for COMi.MX
- Single voltage power input (4.75 – 15 V DC)
- AES3 in / out (2 x XLR)
- 64 channel MADI in / out (1 x SFP)
- WCLCK in / out (2 x BNC)
- Dual GbE NICs (2 x RJ45 / 2 x SFP)
- 1 x UART system console (RS-232 SubD-9)
- JTAG Debug Port
- Access to: I^2C (system + user), UART user, USB 2.0 (A/B), SPI, all GPIO lines

RAVENNA/AES67 Software Framework

- C/C++ source code:
  - IEEE1588 clock protocol stack (based on ptp4L)
  - RAVENNA/AES67 streaming engine
  - Configuration & connection management
  - Advertising & discovery
  - Ember+ support

  → Audio interface driver needs to be supplied by manufacturer (platform-specific)
- Technical documentation
- Complete Linux environment & development tool chain
- Reference platforms: COM8313 and Linux-PC

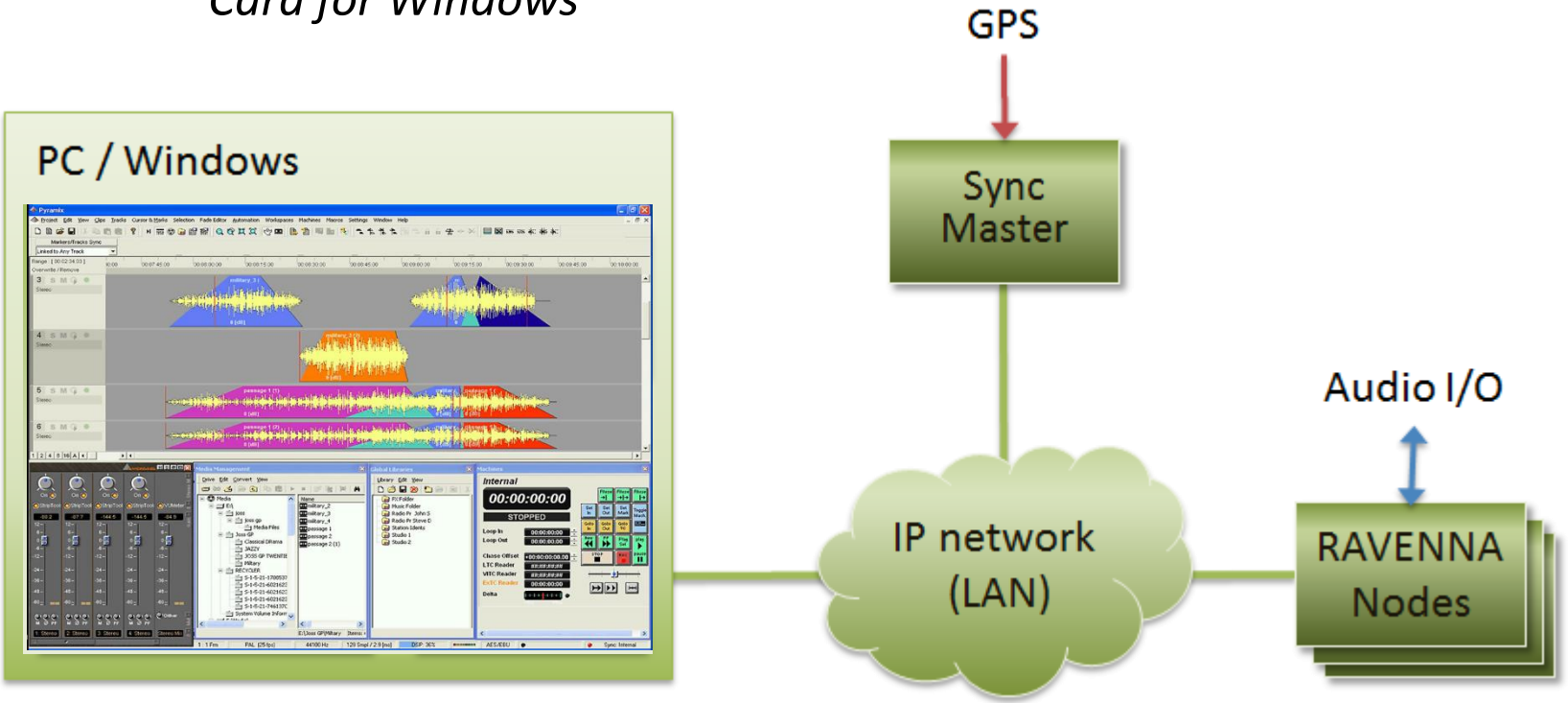
COMi.MX – Reference Design



SoM design & source code package:

- Functional VHDL project w/ full VHDL source code for Xilinx Spartan6 on COMi.MX
- Schematic diagrams of COMi.MX board
- RAVENNA/AES67 software framework
  - C/C++ source code
  - Complete Linux environment & development tool chain
- Technical documentation
- Basic technical support

RVSC – RAVENNA Virtual Sound Card for Windows



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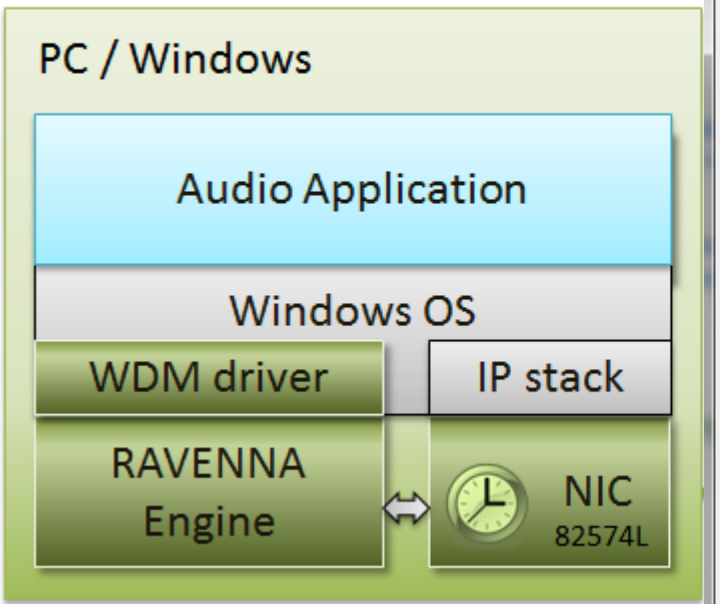

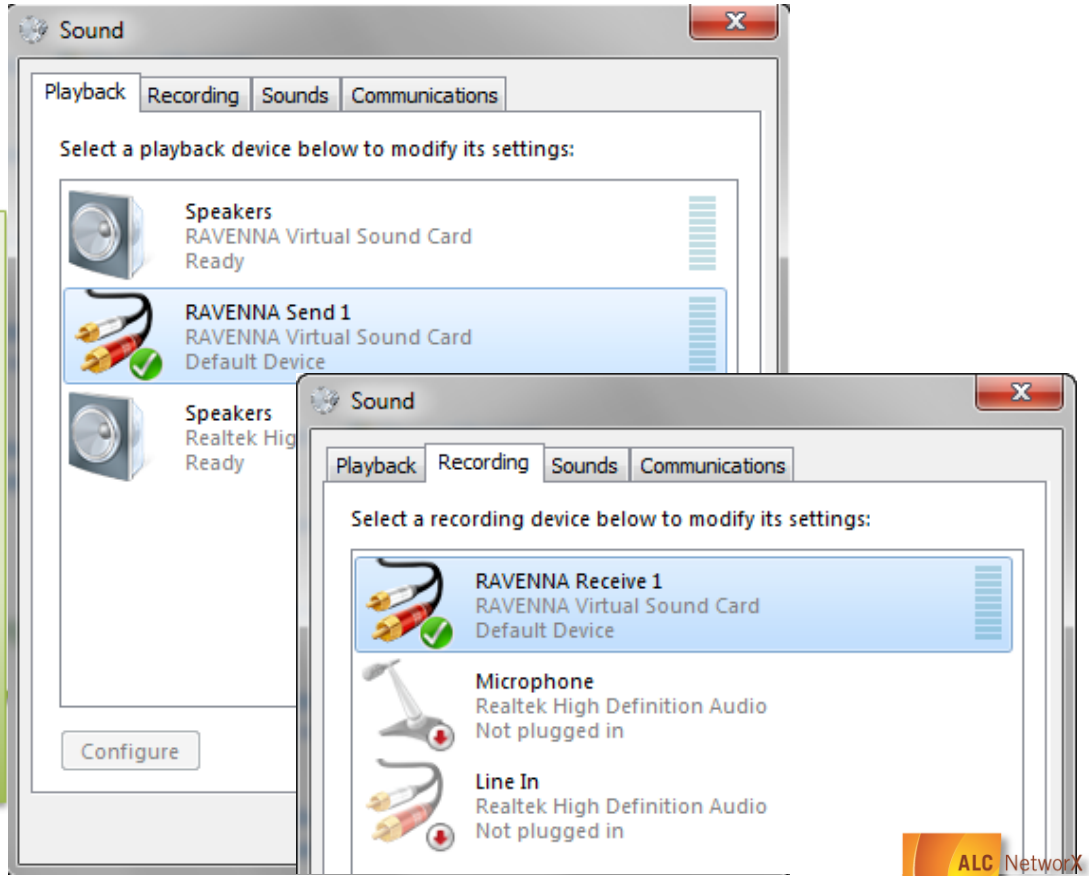

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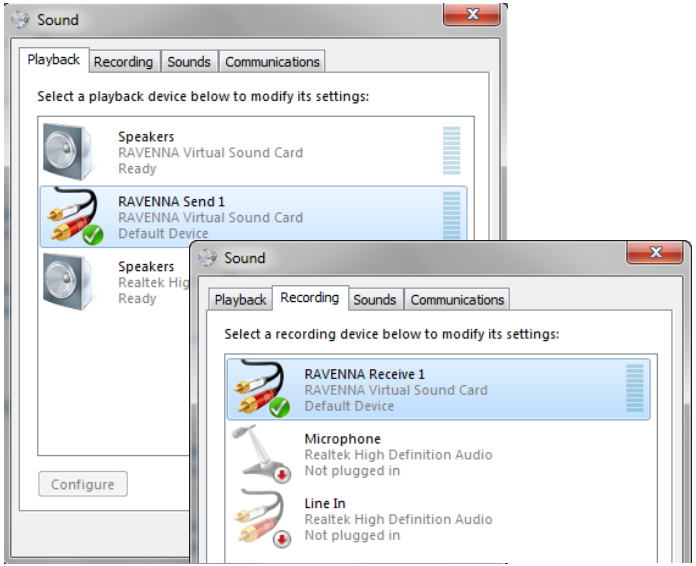

- Available for Windows 7 & 8
- Supports WDM driver model
- Up to 64 channels playback / record
- Typ. processing latency: ~ 15 ms
- HW PTP support through Intel 82574L or i350
- AES67 support (multicast-only)
- Free version w/ 2 playback & 1 record WDM device
- Full version available to RAVENNA partners for OEM integration

Thank you for your attention!

RAVENNA booth in Central Hall
C2218

Contact information:

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www.ravenna-network.com

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NAB 2015, Las Vegas, April 12th, 2015

How to get it into your Products:

Media Networking Alliance

AUDIO AES

AES67

ARCHWAVE connecting audio

Arie van den Broek
CEO Archwave

ARCHWAVE connecting audio

Distinct Networked Audio market segments:

Large scale systems:

- Targeting Broadcast, Fixed install
- High node & channel count
- Knowledgeable audience

- Key decision parameters:
  - Technology
  - Interoperability

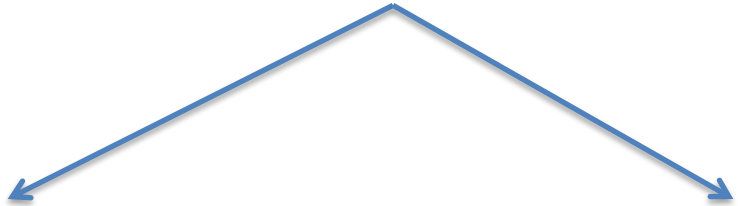
Mid & smaller scale systems:

- Targeting MI & Sound Reinforcement
- Lower node & channel count (<64ch/<25)
- More ‘Novice’ audience & user base

- Key decision parameters
  - Ease-of-Use / Simplicity
  - Cost, cost & cost…

ARCHWAVE connecting audio

Distinct Networked Audio market segments:



Large scale systems:

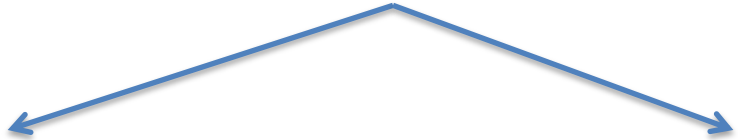
Mid & smaller scale systems:

Mass-adaption requires tailored solutions
for **each** segment

ARCHWAVE connecting audio

Our Approach:

Distinct Networked Audio market segments:



Large scale systems:

Integrated Solutions
RAVENNA
AES67 now!

Mid & smaller scale systems:

AUDIOLAN

ARCHWAVE
connecting audio

Integrated Solutions
RAVENNA
AES67 now!

Modular solutions for Large Scale systems:

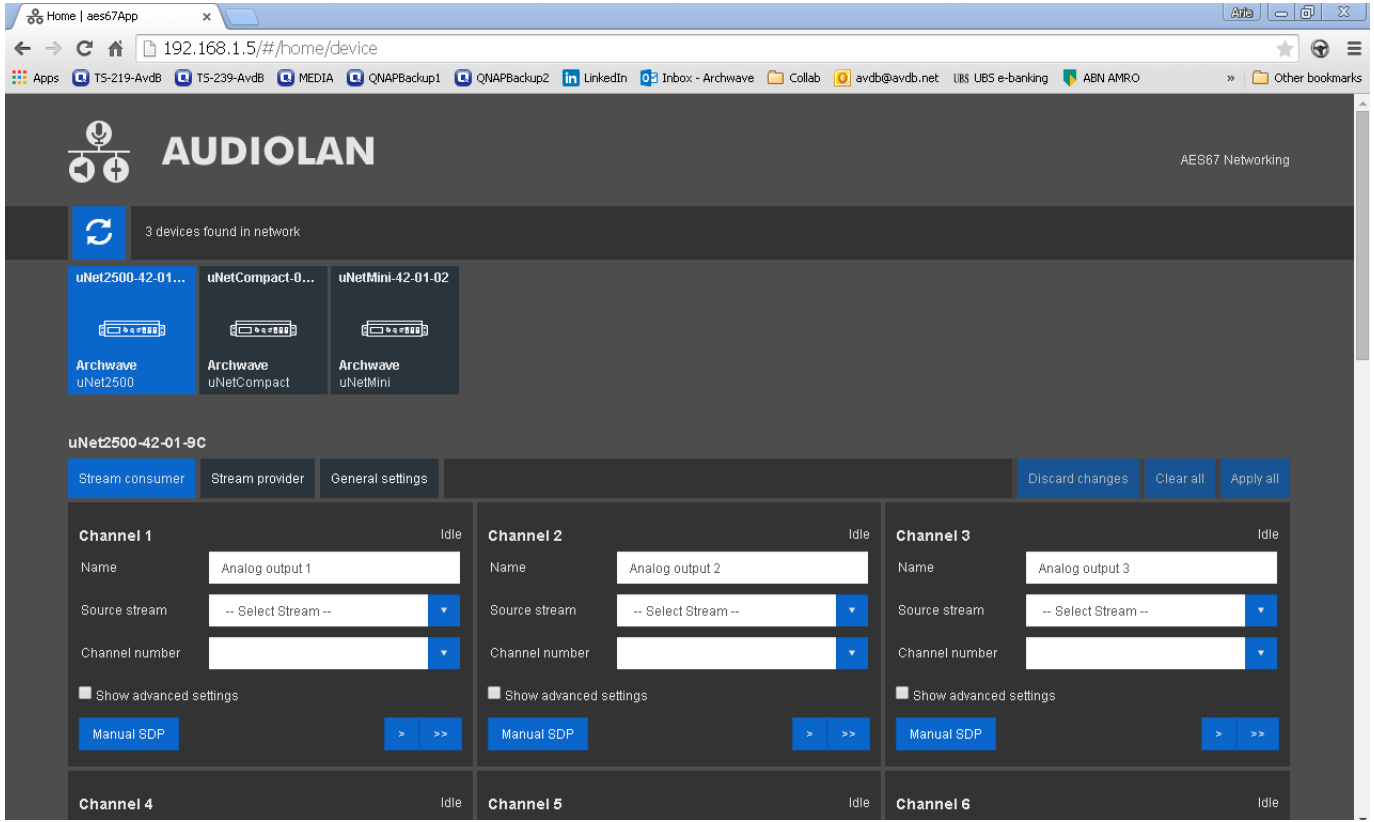
- **uRec Standard:**
  - Up to 32 channels of networked audio
  - Up to 32x32 USB-streaming
  - Up to 32 ch direct to USB media recording
  - 3-way USB-Network-AVport Bridging ***(new!)***
- **uNet Compact:** Up to 16ch of networked Audio
- **uNet MINI:** Up to 4ch of networked Audio (June)
- **uNet Center:** Up to 64ch of networked Audio (end 2015)

Integrated user-friendly web interface

Targeting end-node implementations

ARCHWAVE connecting audio

Web interface



ARCHWAVE
connecting audio

ARCHWAVE connecting audio

AUDIOLAN

Integrated Solutions RAVENNA AES67 now! + CopperLan

Modular solutions for small to mid-scale systems:

- Modular hardware solutions from 2 to 32 audio channels

- Integrated command & control based on CopperLan providing
  - Unique 3-way command & control:
    - ❖ Ravenna/AES67 compliant web interface
    - ❖ User-friendly audio matrix software (Win/OSX/IOS/Android)
    - ❖ uLink hardware-only configuration

- Full MIDI integration

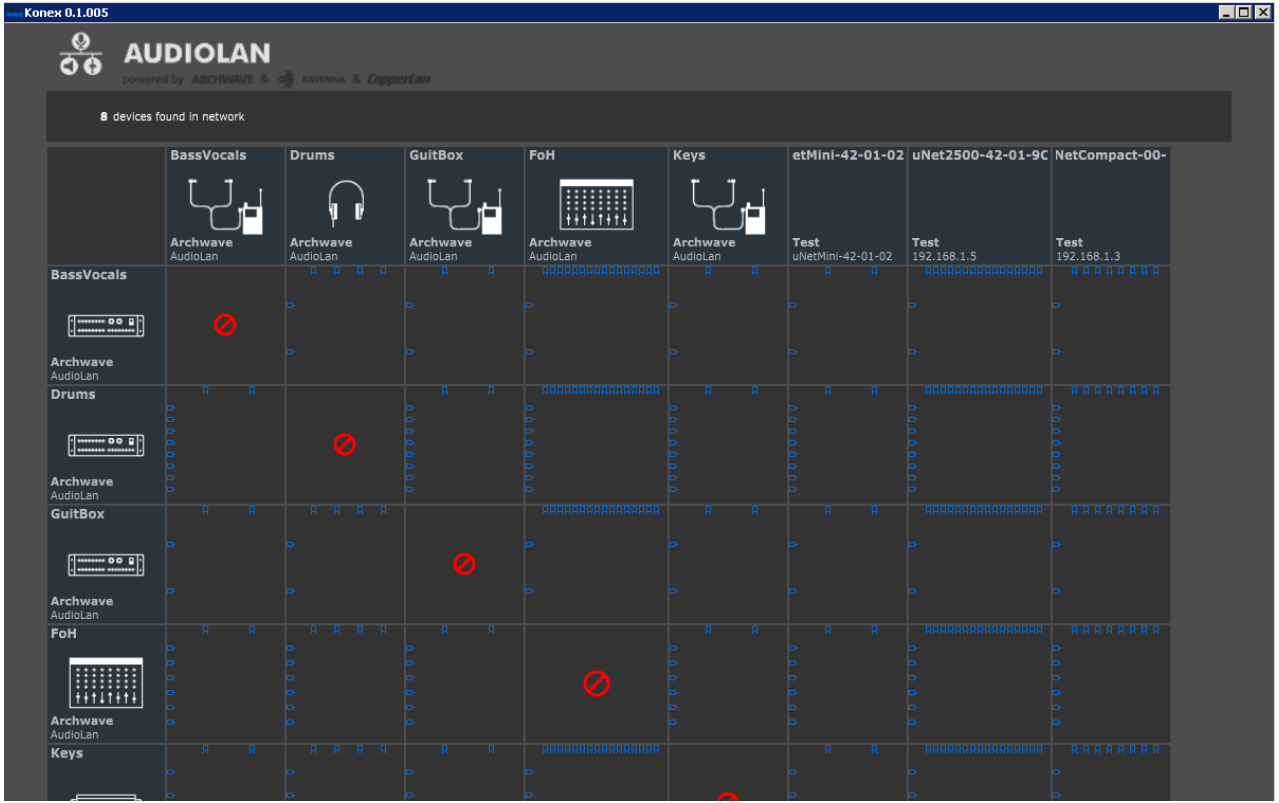
- targeting complete system implementations up to 64 channels

ARCHWAVE
connecting audio

Konnex Manager

Main page

Win/OSX/IOS/Android

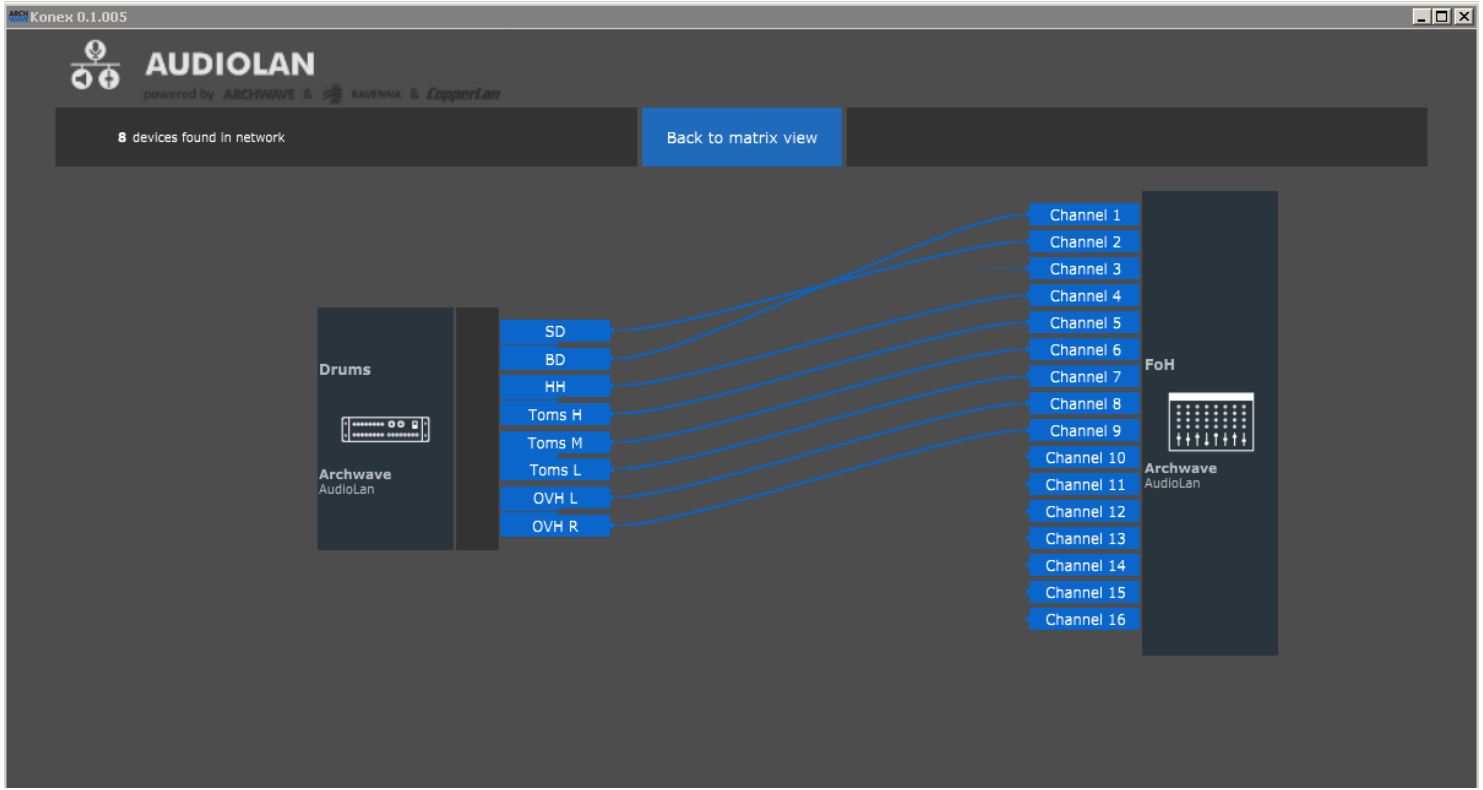


ARCHWAVE
connecting audio

Konnex Manager

Connection page

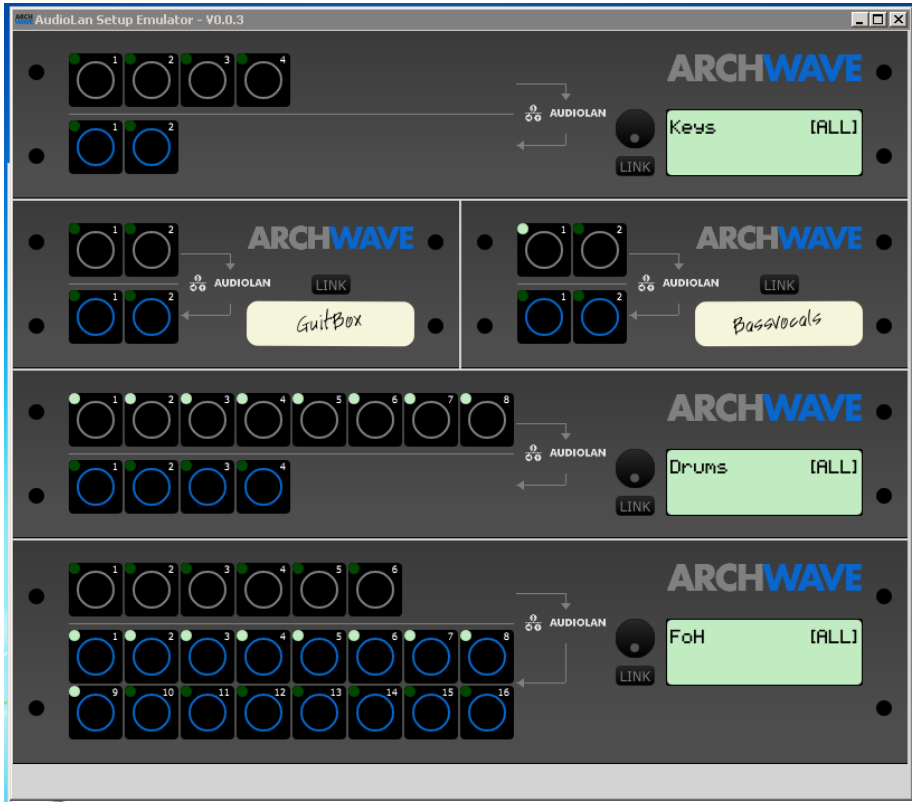
Win/OSX/IOS/Android



ARCHWAVE
connecting audio

uLink concept

Hardware only configuration



ARCHWAVE connecting audio

Our Approach:

Distinct Networked Audio solutions:

Large scale systems:

Integrated Solutions RAVENNA AES67 now!

Mid & smaller scale systems:

AUDIOLAN

Integrated Solutions RAVENNA AES67 now! + CopperLan

ARCHWAVE connecting audio

Our Approach:

Distinct Networked Audio solutions:

Large scale systems:

Integrated Solutions
RAVENNA
AES67 now!

Range of modular network solutions:
- from 2 to 32 audio channels
- USB-Network Bridging (new!)
- targeting node implementations

Mid & smaller scale systems:

AUDIOLAN

Integrated modular solutions consisting of:
- modules from 2 to 32 audio channels
- Integrated command & control
- Integrated, user-friendly matrix software (Win/OSX/IOS/Android)
- MIDI
- targeting complete system implementations up to 64 channels

ARCHWAVE
connecting audio

Thank you !

Contact Details

Phone: +41 44 820 36 77 | Fax: +41 44 820 36 78
E-Mail: info@archwave.net | Web: archwave.net

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Profile

For more than 30 years, through constant innovation and the development of fruitful partnerships, Digigram has been influential in energizing the industry, raising standards, and pushing forward technological development

Positioned at the convergence of professional audio and video with IT, Digigram offers solutions that enable users worldwide to increase their competitiveness through change

Sound cards | Audio over IP codecs | Video over IP codecs | Services

www.digigram.com

digigram

Audio Networking Solutions

2001 : EtherSound©

- Proprietary ultra low latency on LAN Ethernet Level 2

2006 : Visiblu Networking Audio Operating System

- Including FluidIP smart audio streaming engine on WAN-IP

2007 : Full ACIP interoperability

- EBU Tech 3326 recommandations on WAN-IP for point to point

2011 : Full commitment to RAVENNA

- Low latency synchronous audio network over LAN-IP

EtherES Sound

FLUIDIP

RAVENNA AES67 now!

digigram

AoIP through the workflow

digigram LX-IP RAVENNA / AES67 Sound Card

- Full RAVENNA and AES67 compliance
- Up to 256 RAVENNA channels In / Out from multiple streams
- Ultra-low latency: down to 1 audio sample per packet => as MADI !
- 64 / 64 MADI I/Os for seamless transition to RAVENNA (option)
- Full routing capability
- Windows and Linux drivers
- PCI express bus

digigram

ACIP ⇔ RAVENNA / AES67
IQOYA AoIP codecs

- IQOYA *CALL Program Contribution codec
- IQOYA *LINK Program Distribution codec
- Fully ACIP Tech 3326 compliant stereo codecs
  - PCM 16/24 bits, ISO MPEG 1/2 layer I,II & III, Fraunhofer® MPEG-4AAC, AAC-LD, HE-AACv2, AAC-ELD, OPUS Music and Speech, e-APTX
- AES/Analog I/Os, RS232 & GPIOs tunneling
- Multiple Fail-over and redundancy schemes
- Embedded Linux/ARM pure software processing
- Now RAVENNA/AES67 I/Os

=> Perfect bridge between studio AoIP (LAN-RAVENNA/AE67) and remote Broadcasting and transmission (WAN-ACIP)

ACIP

RAVENNA AES67 now!

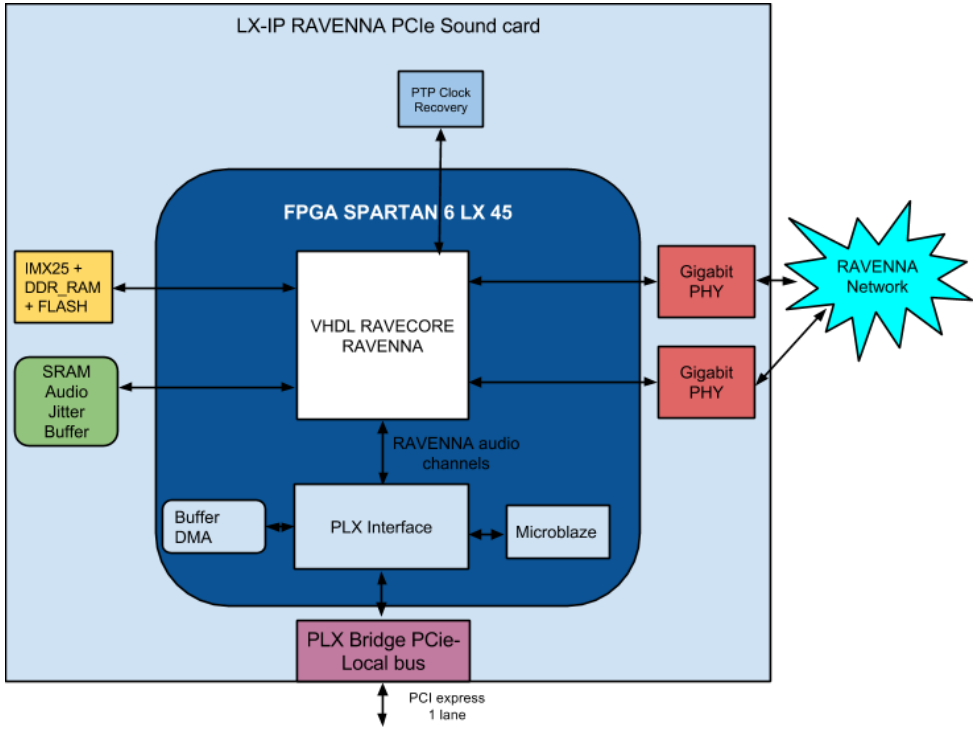
ACIP

Customised AES67 OEM Solutions

- Technology derived from the Digigram products
- LX-IP RAVENNA OEM board with specific drivers and/or firmware
- Fully custom hardware design based on LX-IP reference design
- Pure embedded software solutions under Linux derived from IQOYA visiblu middleware
- Flexible business models : NRE, custom product, OEM modules, royalties ..

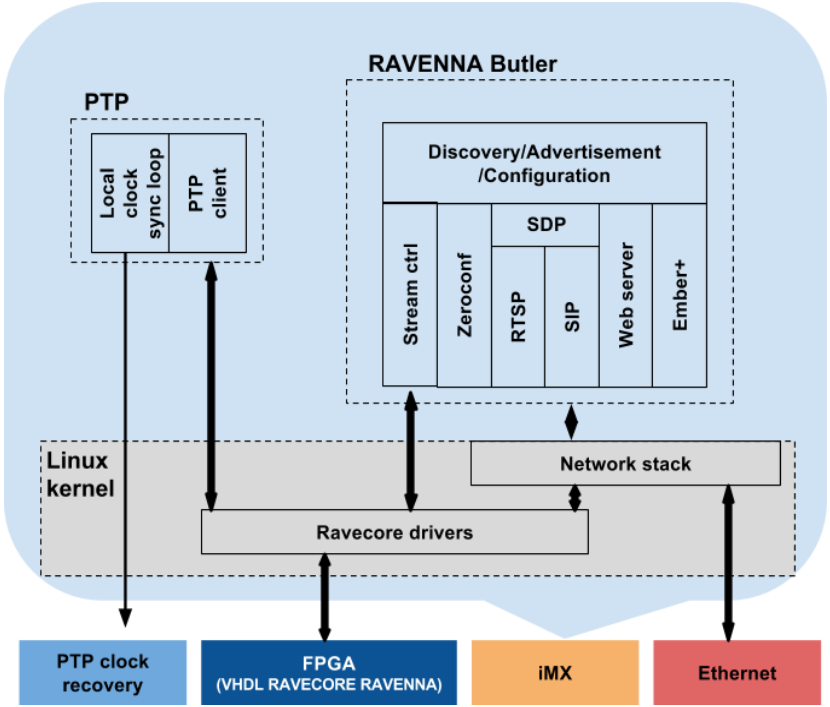
digigram

LX-IP Hardware architecture



digigram

LX-IP Software architecture



Questions ?

Thank you !!

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Agenda:

	Topic	**Speaker**
20 min.	Introduction to MNA	Marty Sacks (Telos Alliance) & Stefan Ledergerber (Lawo)
	AES67 – a quick Recap	Andreas Hildebrand (ALC NetworX)
50 min.	RAVENNA SoM & Reference Designs	
	AudioLAN SoMs	Arie van den Broek (Archwave)
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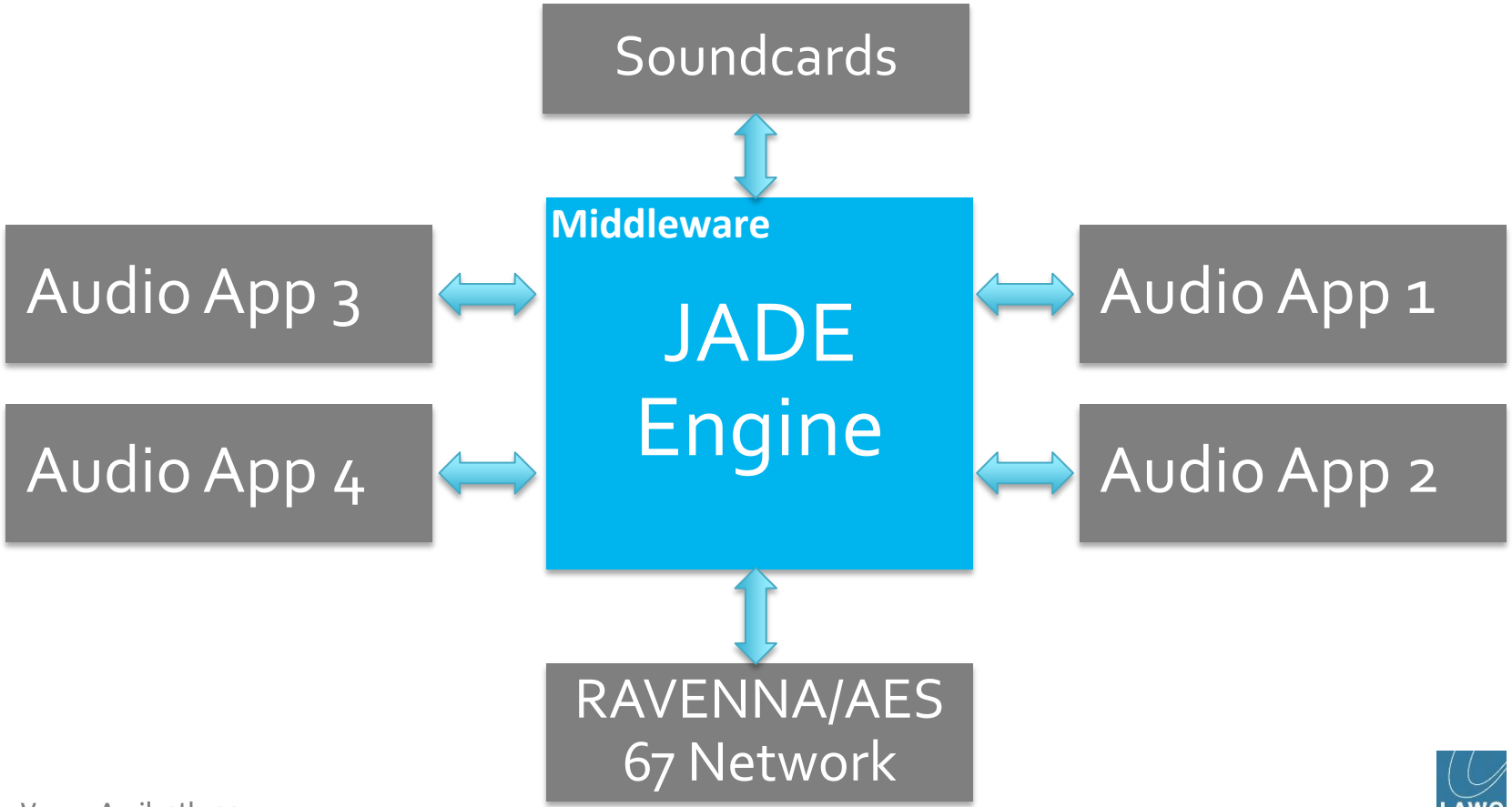
JADE Engine
AES67/RAVENNA for PCs

Stephan Türkay – Product Manager Radio/OnAir – Lawo AG


Soundcards
Middleware
JADE Engine
Audio App 3
Audio App 1
Audio App 4
Audio App 2
RAVENNA/AES 67 Network

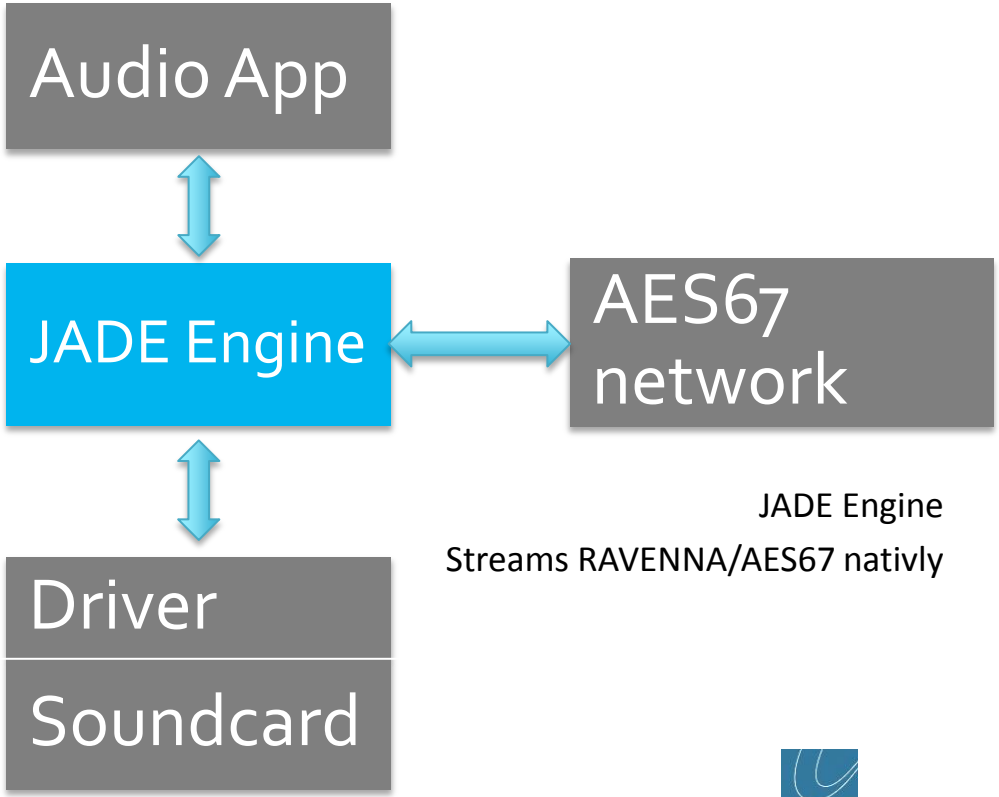
what is in the box ?

- mix and route pc audio signals
- native RAVENNA/AES67 streaming
- VST plugin host
- extensive signal metering
- save and recall complete environments
- ember+ remote control
- scripting interface

getting you connected

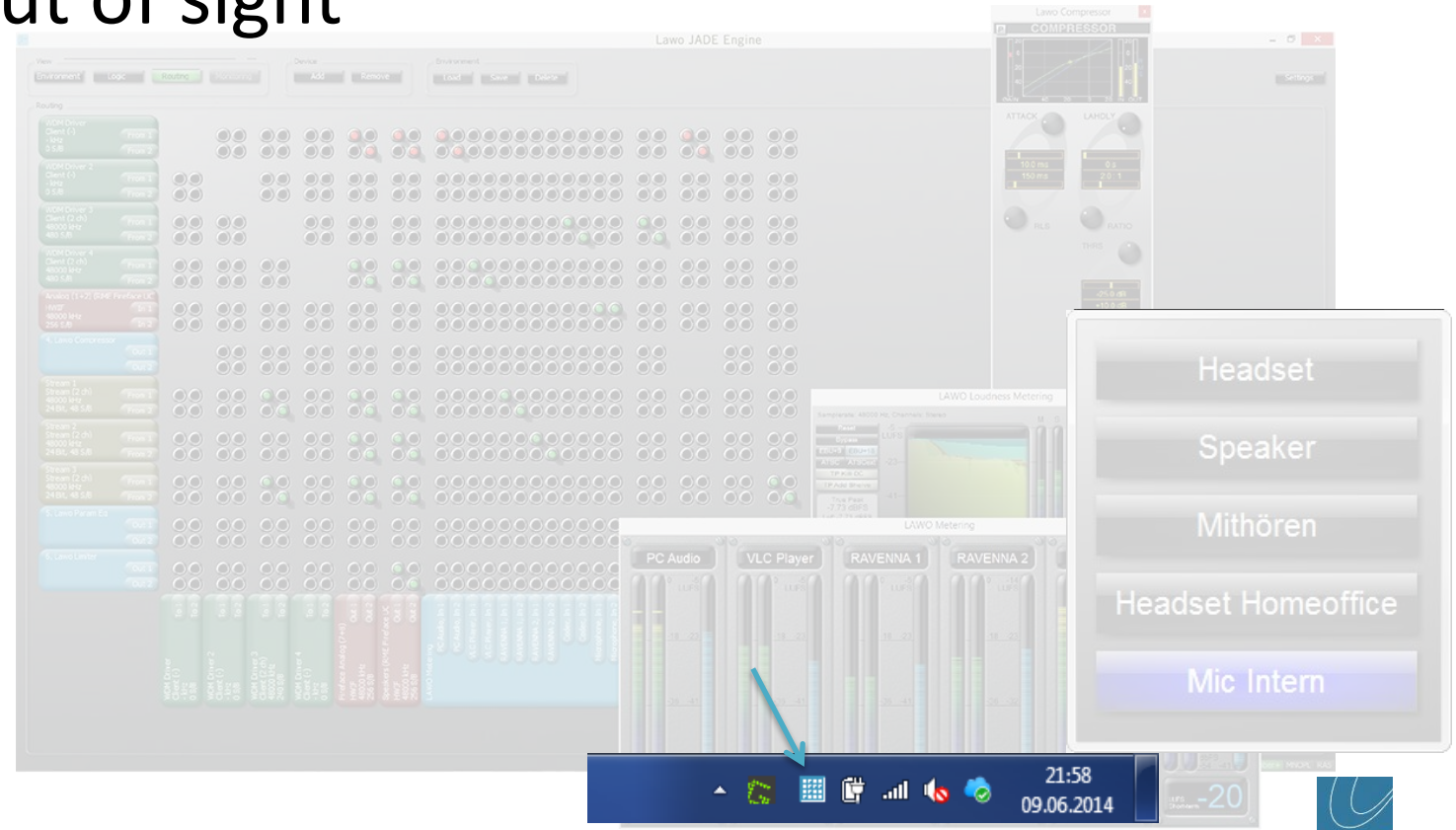
JADE Engine emulates multiple virtual soundcards / hosts VST plugins

JADE Engine is able to load soundcard drivers



JADE Engine Streams RAVENNA/AES67 nativly

getting out of sight



THANK YOU

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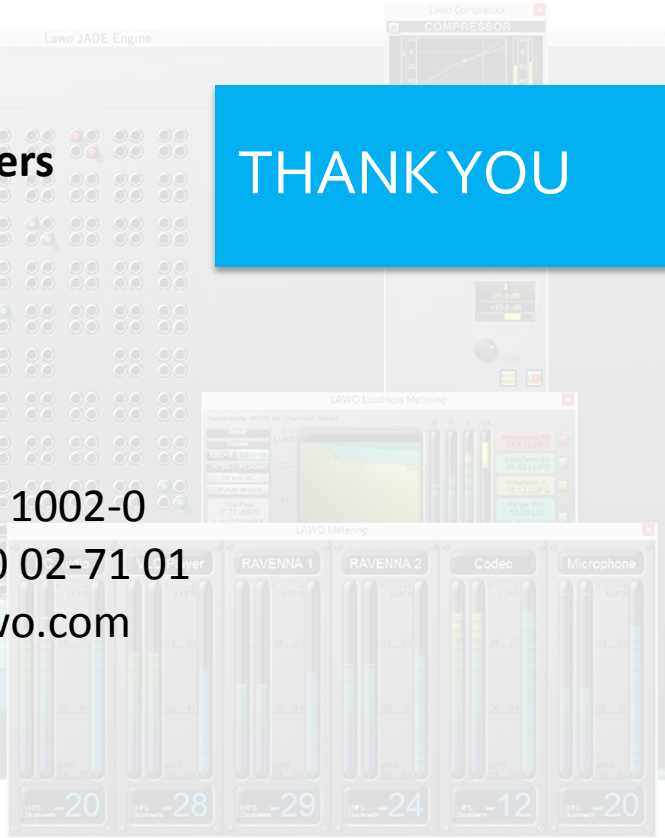

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TA
THE TELOS ALLIANCE™
Create. Communicate. Connect.
Telos®
Omnia®
25 seven™
AXIA®
LINEAR ACOUSTIC®

OEM Livewire+ AES67 from Telos Alliance

Greg Shay
Chief Science Officer

The Telos Alliance
Cleveland, Ohio

Greg.Shay@TelosAlliance.com
www.telosalliance.com

Background:

- Axia Livewire Partner Program, very successful past 10 years
- Nominal cost
- Was a reference design, with all sources, hardware schematics, FPGA, firmware, software source code.
- Linux driver source code
- However, no direct support, no design support. Online forum for answering questions about the reference design.
- The intention was the partner would digest and internalize the principles of the Livewire interface design, and make it their own.

New: OEM Livewire+ AES67

- This is a new announcement at NAB 2015 !
- The details and specifics of the deliverables and the license will be worked out in the next 6 months.
- Planned are 2 tiers, using the model of the open source industry
- Tier 1 : Reference design source files provided, very nominal cost (close to free), but no support or design assistance.
- Tier 2 : NRE cost, and generously flexible implementation royalty terms, for which we will provide implementation support and verification testing.

New: OEM Livewire+ AES67

- Livewire+ is a suite of solutions over IP, for making whole studios and facilities.
- Includes audio, control, discovery and management, all over IP.
- Includes industry standard AES67 Audio over IP.
- Includes legacy Livewire audio over IP.

AES67 intellectual property

- The Telos Alliance will indemnify partners using the OEM Livewire+ AES67 technology against any intellectual property claims.

Why are we doing this?

- We are confident AES67 is safe.
- One year ago we made this public statement.
- Nevertheless, this solution takes away any remaining shred of doubt, and allows the Telos Alliance to share its confidence with our OEM partners to proceed now with industry standard AES67.

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Sharing Experience of Implementing AES67

Greg Shay
Chief Science Officer

The Telos Alliance
Cleveland, Ohio

Greg.Shay@TelosAlliance.com
www.telosalliance.com

What does it take to implement AES67?

First by comparison:

If you have implemented Livewire, AES67 is the same basic methods, a number of details are different:

- IEEE-1588 sync is used instead of Livewire Sync, but even both of these used timestamps in clock packets.
- The clock sync PLL daemon ‘xsync’ was rewritten to use the new packet format, and the lower clock packet rate adjusted PLL control loop parameters.
- Packet timestamps used to phase align audio blocks between channels, instead of individual stream buffer initialization logic.

AES67 comparison to Livewire, cont.

- AES67 unicast mode requires the addition of SIP protocol to initiate audio connections (*S*ession *I*nitiation *P*rotocol).
- Open source, high quality, proven SIP stacks available (example ‘PJSIP’ from www.pjsip.org)
- AES67 multicast configuration can remain simple, just like Livewire channel numbering, but use full 239.192.. multicast IP addresses.
- The AES67 mandatory 1ms packet mode, becomes a third packet size, between 250usec Livestreams and 4ms standard streams.
- Use of SDP text descriptions for stream type and packet size description actually simplifies and clarifies knowledge of types.

The fundamentals of implementing AES67:

- Software, Firmware or FPGA implementations possible, all with their own advantages and tradeoffs.
- IEEE-1588 being an industry standard, is supported in hardware in almost all of the big name modern processors and Ethernet interfaces. Freescale, Marvell, Intel, Xilinx, Altera, and others..
- AES67 shares the use of IEEE-1588 with AVB (and future SMPTE), so many 'AVB media' features can be directly used for AES67. From this point of view, and AES67 implementation can be viewed as an AVB implementation but with full IP stack headers on the packets, and without the need to use special switches for network bandwidth reservation.
- IEEE-1588 timestamping can be done directly in FPGA, too, but usually is worth choosing a component with hardware ready.

The fundamentals of implementing AES67:

- Many motherboard and server Ethernet interfaces have IEEE-1588 hardware support. Intel has been very good on this. Most of the time the OS/driver features must be turned on.

Software vs Firmware vs FPGA

- Software implementations are limited by the real time latency of the OS. Windows is typically ~ 10ms – 20ms. A software implementation may be able to take advantage of motherboard IEEE-1588 sync and drivers, and produce and consume 1ms packets, but the 1ms packets will be in groups, or bunches.

- This will require the AES67 ‘Link Offset’ of the next device to be set higher, preventing low latency operation even with 1ms packets.

Software vs Firmware vs FPGA

Firmware:

- Many good RTOS (Real Time OS) available, suitable for implementing low latency 1ms packets and below.
- IEEE-1588 features in hardware in many microprocessors (ex: Freescale iMX6 family).
- Eventually the audio channel count may become limited by the amount of CPU consumed formatting packets, headers, moving data, and buffering many streams audio.

Software vs Firmware vs FPGA

FPGA:

- Hardware – like speed and no latency problems.
- Excellent for super low latency modes and high channel counts.
- Timestamping packets for 1588 sync can be done in FPGA.
- More difficulty implementing protocol stacks and 1588 sync control loop logic.

A combination may be optimal, and most open for different needs:

For further reference:

NAB 2013 paper, by the author:

“Taking the ‘Sting’ Out of Evolving Digital Audio Networks”

Available on www.telosalliance.com website, or on request.

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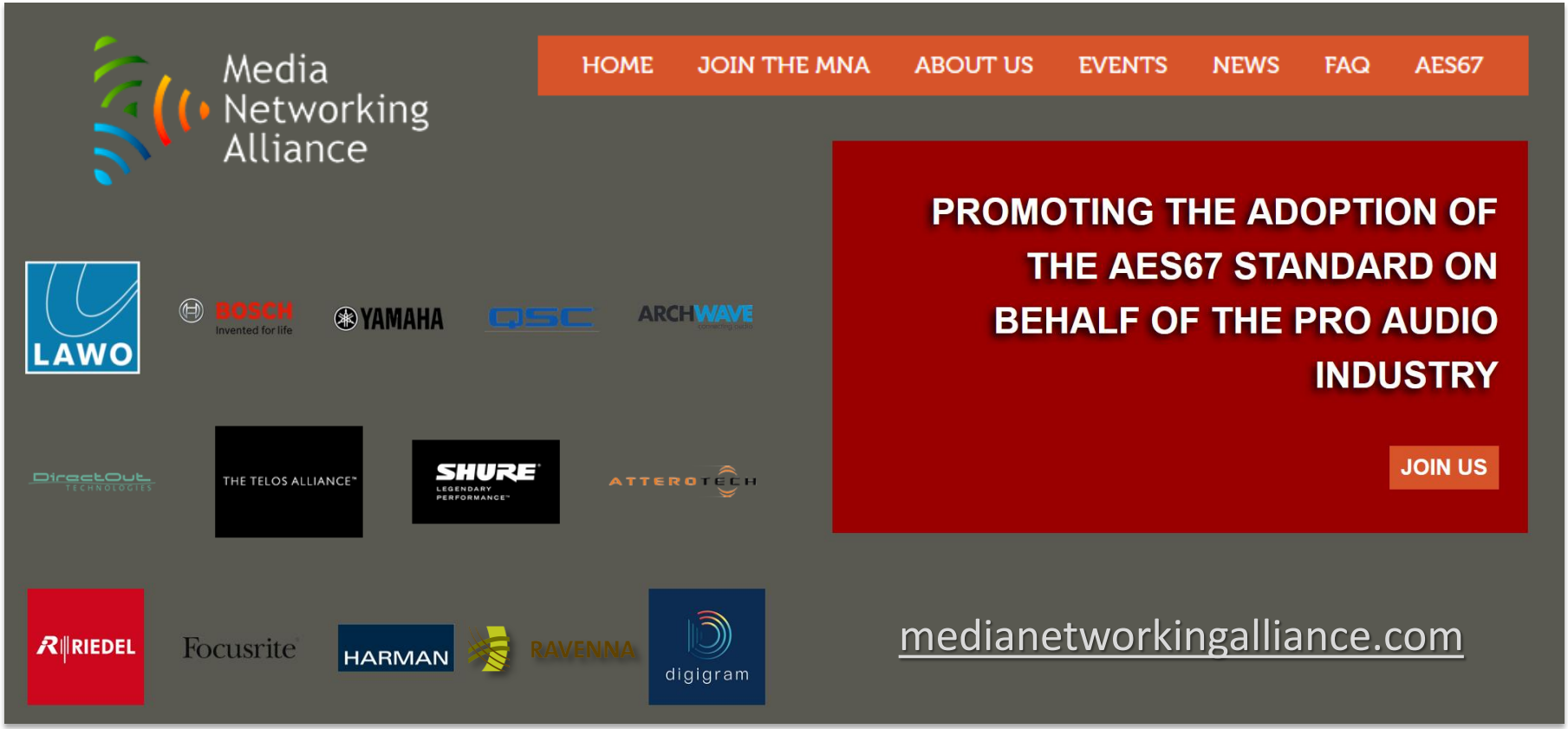
AES67 at the NAB show:

- ALC NetworX – C2218
- Archwave – C2218
- Digigram – C1858
- DirectOut – Josephs Electronics C6948
- GatesAir – C3107
- Genelec – C3258 or C2218
- (Jutel – C2218)
- Lawo – C2218
- Merging Technologies – C3239
- Neumann – C2055 or C2218
- Orban – N5007
- Riedel – C4937
- Sound4 – C549
- Studer – C2851
- Telos Alliance – C549
- Wheatstone – C755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