

**EVERYTHING YOU NEED TO KNOW
TO TRANSITION TO AN IP STUDIO.**

AES67 & AOIP:
**THE TIME
IS NOW**

FROM THE COMPANY THAT INVENTED
AOIP FOR BROADCAST.

A few words

IP Audio: The Time Is Now

By Angi Roberson, Director of Marketing, Telos Alliance & Marketing Working Group Co-Chair, Media Networking Alliance



ANGI ROBERSON

“Proceed confidently into a mainstream AoIP infrastructure.”

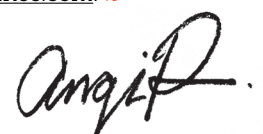
Welcome to the Telos Alliance’s first AoIP e-book. In this edition, we’re focusing on all things AoIP, IP Interoperability, and AES67. Telos Alliance has been doing AoIP for a very long time. We invented AoIP for broadcast in our early work for Axia, which resulted in our AoIP protocol, Livewire, and now Livewire+ AES67.

Much of that early work informed the interoperability standard we now know as AES67. In fact, we were founding members of the working group that developed the standard, and that work continues through our active participation in the Media Networking Alliance (MNA), Alliance for IP Media Solutions (AIMS), and the Open Control Architecture Alliance (OCA), also known as AES70. And we

continue to be on the forefront of development of new standards like IS-04 (NMOS), as well as refinement of existing ones.

Broadcasters are now beginning to know enough about AES67 and interoperability to understand its primary benefit, which is to help them proceed confidently into a mainstream AoIP infrastructure that is able to connect with other equipment and studios that use different AoIP standards, as long as both support AES67. This is a huge ‘green light’ to engage AoIP at all levels of the broadcast workflow.

We hope you enjoy this e-book, and welcome your comments. Email us at feedback@telosalliance.com.



5 Tips for General Managers Considering AoIP

By Addison Burnside, Engineering Intern, Telos Alliance

If you're a general manager, considering an Audio over IP (AoIP) network for your facility makes sense. The technology is faster, cheaper, and better than previous methods to build broadcast facilities. By converting to AoIP, you not only tap into the power of current technology, you allow your facility to leverage the enormous universe of "off the shelf" IT devices that are used worldwide, and not just in the broadcast industry. Here are our top five considerations for general managers thinking about a move to AoIP.

1 Invest in Central Infrastructure First.

Investing in your IP infrastructure before you start converting to IP-based studio equipment allows you to enjoy the low cost and high flexibility of an AoIP system before converting your individual studio(s). Get your network started and then you can convert studios as time and budget allow.

2 Convert Your Studio Over Time.

Some GMs think that converting a facility to IP is something that has to be done all at once, much like old TDM systems. But because existing analog and new AoIP can coexist nicely, the conversion to IP can be made gradually, one studio at a time. You can work your way down a hallway containing multiple studios and tackle them individually over an extended period of time, updating as desired or as budget permits. All at a modest incremental price point. Older technologies before AoIP required a wholesale change involving robust infrastructure and many rooms of equipment resulting in very high cost.

3 Converting to AoIP Is Less Expensive Than Replacing an Analog System.

Changing a facility all at once, like a TDM system mandates, comes at a large price even to do a small project. For one, it requires the purchase of a proprietary mainframe that acts as a hub. Unlike TDM and other proprietary systems, the cost barrier to entry is not applicable to AoIP because you can convert room by room. To make it even less costly, Axia consoles have built-in Ethernet switches, eliminating the need to buy an external switch to connect the components within that single room or studio. Finally, integration is faster and cheaper than an analog system because the time and labor required to run and terminate the masses of audio cable previously required is eliminated.

4 AoIP Offers Infinite Scalability.

TDM card cages are not scalable, which means you must think about and plan for future upgrades when you first build the system. Not so for AoIP systems. Because AoIP is scalable, you don't need to worry about upgrading other systems over time. It costs big bucks to plan for the future expansion of a proprietary system compared with expandable and price-efficient Ethernet switches. And when it is time to upgrade, having an IP backbone makes it incredibly easy and inexpensive to upgrade other systems—like your on-air phone system, profanity delay, satellite receivers, or automation system. And there are great benefits of upgrading those systems to IP as well. Check out our [Broadcast VoIP Telephone ROI ebook](#) on how replacing your old analog phones with a VoIP system can pay for itself in as little as 18 months.

5 Building In Redundancy Is Cheaper.

Because they're all connected by Ethernet, AoIP-networked devices can be swapped out quickly and easily. This makes it affordable to keep spares or reallocate resources in the event of a failure. With an analog system, on the other hand, you have to change out hardware, not just change the configuration. For example, you'll have to go to the frame to remove wires and re-patch them, move gear, and more. Ultimately, this ability to build in redundancy makes an AoIP system more reliable.

Is Your Equipment Fully... AES67 Compliant?

AES67 compatibility and compliance are not one in the same. This short guide explains the difference, and why you should care.



Marty Sacks

VP of Sales, Support & Marketing,
Telos Alliance

One of our goals at the Telos Alliance is to further the adoption of AES67, the standard for audio-over-IP designed to allow interoperability between various IP-based audio networking systems, like our own Livewire+ AES67, Ravenna, Q-Lan, and Dante. So we hear the terms AES67 compliance and AES67 compatibility thrown about a bit, often with reckless abandon. And while they may sound the same, the difference between compliance and compatibility is huge. Here, we'll spell out those differences and explain why it matters.

AES67, like all standards, can be minimally implemented. But when standards are minimally implemented, well, they minimally get the job done. It's possible to achieve a level of audio interoperability using AES67, yet still not fully comply with the standard. Simply put, compliance means that every single aspect of the

AES67 standard is met. 'Compatible' means some of the standard is complied with. There is a big difference.

One aspect of AES67, for example, calls for Unicast mode using SIP. This could be the exchange of audio between city pairs using AES67. Normally, city-to-city connections are created using a wide area network where multicast streams normally found in AoIP aren't likely to be supported. If your audio network's native AES67 protocol or your specific gear doesn't support Unicast, you might not be able to move audio back and forth without purchasing additional gear.

A full implementation of AES67 is required at the protocol level and by the manufacturer of the gear you are purchasing to be assured of Unicast mode using SIP.

So why don't all AES67 protocols and manufacturers support Unicast mode using SIP? Because implementing it into the standard is fairly challenging. But it's important. Despite the fact that it is hard work, we know from our experience with IP codecs that it's a capability that our customers want. Unfortunately, in an effort to stamp their products with AES67 with the least amount of effort, some manufacturers and protocols take the shortcut and leave it out altogether. Those protocols and manufacturers are no longer AES67 compliant because they did not comply with this part of the standard.

Unicast is just one instance of an AES67 standard that isn't complied with by all manufacturers and protocols. There are others. One AoIP protocol, for example, dynamically assigns IP addresses to its network-connected devices in AES67 mode. This is analogous to your mobile number changing every time you power it up. As you can imagine, this can wreak havoc on other network devices intending to share audio using AES67.

There is no AES67 task force out there policing whether or not protocols and gear are fully compliant or merely compatible. It's a good idea to confirm AES67 compliance before you choose your protocol and equipment. This will give you the best performance both now and in the future. 🌀

Livewire+ AES67

Did you know that Telos Alliance's Livewire+ AES67 protocol is inherently fully AES67 compliant? That means you get all the functionality that the standard specifies. Plus, Livewire+ AES67 goes beyond AES67's audio interoperability to add GPIO, program associated data (PAD), and advertising/discovery. TelosAlliance.com/Livewire

Case Study

STONE COLLEGE RADIO NETWORKS WITH LIVERWIRE+ AES67



Jack Higgins, Audio and Music Technician for Tone Radio

Tone Radio, the student-run radio station at the University of Gloucestershire in the UK, had been planning a switch from an analog studio environment to a digital one for many years. The desire to free up space, the need for a mixing console and engine that could do all the legwork, and the desire for a studio experience where anyone (like first-year students with no radio experience at all) could walk in and feel completely at ease led the students at Tone Radio towards Livewire+ AES67-enabled products, namely, the Axia iQ console + QOR.32 engine, which together are fully AES67-compliant.

"Initially the plan was just to replace the console and outboard gear that lived inside our old studios," says Jack Higgins, Audio and Music Technician for Tone Radio. "The old consoles for many years had been live music, analog mixing desks, which to an inexperienced user can be a little daunting. In many cases these mixers were second-hand, so would be prone to completely breaking down."

When the students purchased and installed the Axia iQ and QOR.32 at Tone radio, the media school at the university took notice of how easy the product was to use, then made the decision to implement the same console setup in two additional studios that are used to train radio producers and journalists.

"If students are in an environment that they can get to grips with from day one and not have to worry in great length about using the technology, then they can focus on creating great content, which is the real reason we turn on the radio!" says Higgins.

Flexibility in the products also allows for the university's more technically minded students to push themselves towards more creative goals, harnessing the true power of the technology.

"Looking forward, we plan to expand our Axia network across our campus using Livewire and the AES67 AoIP standard, helping our students make programs that will excite their listeners," Higgins adds. "We keep coming back to Axia equipment because we know it will work with what we've already got."

"We keep coming back to Axia equipment because we know it will work with what we've already got."

A few words about Choosing a Baseline AoIP Protocol

It's one of the most important decisions you can make when designing your IP studio.



Dave Ramsey Studios

Since the AES67 standard was ratified nearly three years ago, a paradigm shift has occurred in the broadcast industry with AoIP becoming the topic both around the water cooler and in facilities around the globe.

By now, you probably already know and understand AoIP's benefits: It saves money. It makes for more efficient workflows. It reduces the amount of equipment you need. It eliminates massive amounts of wiring. It leverages "off the shelf" IP-based components from the larger IT industry for easy integration.

From this point on, you want your entire facility to take full advantage of this revolutionary tech. But as you embark on switching your studio or facility to an AoIP infrastructure, it's important to understand the choices you're making in both equipment and in interoperability protocol available from

different manufacturers. Think through the entire process of converting/creating an AoIP facility and consider key aspects of AoIP workflows *before* you choose a baseline protocol. Because the decisions you make at this earliest stage in your studio's AoIP design will affect future capabilities in a profound way that you might not have predicted.

Why is this so important? Because a baseline standard will define a set of capabilities beyond the most basic audio interoperability made possible by AES67. For example, AES67 does not define Advertising/Discovery, Control, or Program Associated Data (PAD) handling. Livewire+ AES67, on the other hand, has each built in today.

Advertising System. With Livewire+ AES67, every source has a text name and numeric ID. These are transmitted from source devices to the

network. Any device can build lists of all available sources from which users can select. Without this capability, it is much more difficult to use the audio on an AoIP network.

GPIO. Most audio these days needs associated control. Choose a baseline AoIP protocol that touts AES67 but does not include GPIO, and you may not be able to easily start and stop external gear! At the very least, a console needs to send a start closure to the delivery system. Satellite receivers have control outputs that need to be routed to delivery systems. Telephone systems need dialing, line status, hold, transfer, etc. Even the simplest source, like a control-room microphone, needs a way to convey status to the on-air lights.

Most conventional control has been built up in a separate network of cables for GPIO "contact closures." Ethernet

can transport GPIO data, dramatically simplifying cabling—some AoIP systems don't support this. Livewire+ AES67 offers this capability to replicate traditional start/stop control. But it continues from there, supporting sophisticated remote operation of studio equipment over Ethernet, which allows the network to transport much more advanced information than just simple start commands. For instance, control of telephone systems and codecs can follow fader assignment and be accessible from any location. With a high-bandwidth network linking everything and a flexible communication protocol, the door is open to many interesting possibilities.

PAD. Livewire+ AES67 also supports Program Associated Data (PAD). Devices that generate PAD plug into the Axia network; the information they supply is sent along with its associated audio, and any devices that need it can also plug into the network and retrieve it. Use of standard networking protocols means that you can send audio and PAD together, without incurring extra costs for separate audio and data networks.

Finally, when choosing a protocol, it's also important to carefully look at the feature set and user interfaces of the gear. Have some of your on-air people examine the control surfaces and talk through what's on their wish list to see what capabilities they may want down the road. Drill down on specific pain points or throw out new scenarios—like handling phone calls or having a producer in a different room. Having a highly configurable system, and one that picks up where AES67 leaves off, will allow you and your team to make clever solutions.

by **MARTY SACKS**

Case Study

NETWORKING A HUGE FACILITY MADE EASY



Shawn Basha—Newcap Radio's Director of Engineering in the Canadian province of Newfoundland & Labrador—removed thousands of feet of copper wire for a facility-wide upgrade to VoIP and AoIP technology. Shawn manages nearly 30 transmitter sites—radio stations and repeaters alike. After all, Canada's easternmost province is a huge area.

Because of the large territory, when Newcap made the move to Axia IP consoles, it started with the main plant in St. John's, where eight of the stations Shawn manages are co-located.

"We were all really excited because we didn't know a whole lot about the technology when we first talked about installing it," he explains. "The Axia system is awesome. The routing is amazing; we can bring up any channel anywhere at any time and in any building, so everything is super easy... especially in a facility where you're running eight radio stations!"

The central newsroom that feeds the eight stations with live and recorded newscasts was one of the primary upgrades, where multiple Axia DESQs, iQs, and console engines were installed, all 100% AES67-compliant.

Since the success of the St. John's install, Newcap has continued to deploy Axia at other facilities across Newfoundland & Labrador, and plans on rolling it out across the entire network.

"NewCap as a whole has pretty much standardized on Axia," Shawn says. "It's also been great for the on-air staff. They really don't have to do anything. It's pre-programmed for them. They just press a button, and it takes their hands off of it, which makes it easier for us. Even though we could have very easily switched over to the new analog systems, the Livewire+ AES67 Audio over IP makes it totally easy throughout the whole facility. We love it!"

What's in a Protocol? Livewire at a Glance

2003

Axia Introduces Livewire
The First AoIP Protocol for Broadcast

100+

Livewire Partners

7,000+

Axia AoIP Consoles On-Air Worldwide

70,000+

Livewire-Connected Devices Installed



Founding Member
Media Networking Alliance

AES67
Working Group

Charter Member
AES67 Working Group



Member
Alliance for IP Media Solutions



Member
Open Architecture Control



Telos Alliance's Fully AES67-Compliant Protocol

Find more information: TelosAlliance.com/Livewire

4 Tips to Make AoIP Easier With Ethernet Switches

By Milos Nemcik, Project Manager, Telos Alliance

1 Choose the Right Switch

Broadcasters used to spend tens of thousands of dollars to purchase what amounted to a card cage to hold audio I/O cards and a processor card to control a TDM buss. Today, for under \$1,000, an Ethernet switch can replicate all of that infrastructure more reliably. Additionally, there are a lot more resources, in terms of R&D and quality engineering for mass markets, built into every new Cisco switch than in switches from small manufacturers that just sell to broadcasters. This translates to AoIP being a much better value than TDM and other proprietary solutions.

2 Size Matters

Switch selection primarily depends upon the size of the system for which you're planning. Studios with just a few consoles won't need the same switch as a facility with 20 studios. Buy enough capacity to handle moderate future expansion. But you don't want to over-buy either, as every wasted switchport adds cost overhead to your installation—money you could be spending on other gear. Find a large list of Cisco switches that are compatible with Axia gear at www.AxiaAudio.com/switches.

3 Don't Take Short Cuts

In AoIP, "good enough" usually isn't. Beware of manufacturers recommending switches from the local office supply store—these are frequently not managed switches, and once the audio starts flowing, packets *will* be dropped. If you're buying Axia, you also have the option to buy console mixing engines, which include integrated Ethernet switches, custom-built for AoIP. We also make xSwitch, a nice standalone AoIP switch with PoE, which can in turn power other networked audio interfaces. An advantage of these purpose-built switches is that they are preprogrammed, reducing installation time.

4 Redundancy Is Non-Negotiable

When it comes to studio network redundancy, switches with back-up power supplies are easily available and are not so expensive, giving you plenty of peace-of-mind per dollar spent. Multiple switches (or blade-based switches) can also be deployed, with separate studio runs, enabling a complete back-up switch fabric. The Telos Alliance supports this level of redundancy with edge devices like our xNode audio and logic I/O adapters, and our PowerStation console engine, both of which include multiple IP connections for just such cases.

Moving Toward Audio Video Over IP for TV



The global television broadcast community is poised at the brink of the next great revolution in technological advancement: Audio and Video over IP. The great leaps that we've witnessed over the last 50 years—from black-and-white to color, mono to stereo, analog to digital, 4:3 to 16:9, SD to HD, and stereo to 5.1—have benefitted the viewer at home each step of the way. However, in the backrooms of TV stations, broadcast engineers around the world have toiled over system designs, white papers, and equipment catalogs while manufacturers have raced to bring out the next best widget designed to do the job.

The AoIP revolution is markedly different because unlike the previous examples, it is arguably a case of the tail wagging the dog. Audio and video over IP is about increased efficiency, meaning streamlined systems ultimately designed to do the same job more simply and for less money using the enterprise network architectures that already surround us. The result will greatly help enable the transition from HD to UHD and from surround sound to immersive

audio, but right now the result will be transparent to the viewer. Unfortunately, the path to utopia is confused by competing protocols, diverse expert opinions and marketing spin that would embarrass even the most unscrupulous politician.

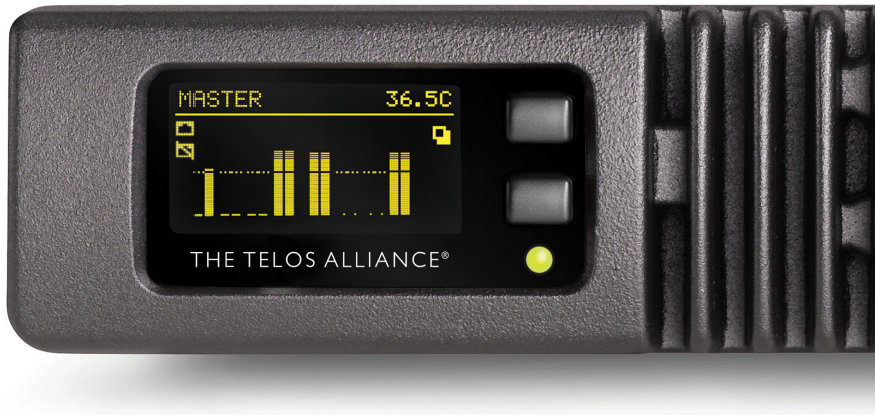
Thankfully, for those of us who inhabit the world of audio, the picture is a little clearer than that of our video-centric brethren. Network audio systems have been with us since the 1990s, AoIP since the introduction of Livewire—the first AoIP protocol designed for broadcast by the Telos Alliance—in 2003. Since then, over a dozen competing protocols have entered the market, each one serving a part of the pro audio and broadcast community with their own needs, flourishing particularly in live sound, the install market, and radio. TV has been surprisingly slow at embracing IP technology, despite the fact that it is both proven and mature. Broadcast television is taking baby steps and using IP connectivity as a point-to-point replacement for MADI while the true advantages of an IP-based audio workflow seem

“AES67 brings us one step closer to unleashing the power of an all-IP audio and video infrastructure.”

to be hidden in plain sight.

Part of the problem undoubtedly lies in the confusion surrounding competing protocols and the fact that the customer is having to make a choice based upon the availability of compatible equipment rather than the ability to choose best-of-breed with complete impunity. This situation serves no one except for those companies who stand to profit from the license model that adopting a specific protocol fulfills. Fortunately, the will of the majority is bigger than the motive of any individual company. The case for interoperable AoIP standards has been gathering momentum and is now recognized in the form of the

THE TELOS ALLIANCE®



For TV AoIP applications, the Telos Alliance SDI xNode can de-embed two separate HD/SD-SDI inputs, converting up to 16 channels of audio to the Livewire+ AES67 AoIP format. The audio is available as a Livewire network source or can be re-embedded into two separate HD/SD-SDI output streams. Compensating video delay for each SDI input ensures audio/video synchronization is maintained.

AES67 AoIP transport standard.

In a relatively short span of time, since the publication of AES67 in September 2013, an increasing number of companies have embraced the new standard with many of the organizations behind the competing protocols having now launched compliant or compatible solutions. Now, with an ever-increasing number of manufacturers recognizing the need for interoperability and the message behind the advantages of AoIP becoming clearer, AES67 seems to have reached critical mass. AES67 is not only gaining momentum on the audio side of the production chain. Several key companies whose interest in IP is focused more on the video side are also recognizing AES67 as the logical method of audio transport for use where audio and video signals are tied. The Alliance for Media Solutions (AIMS)—a not-for-profit trade organization founded by leading companies to foster the adoption of industry standards for the broadcast and media industry as it transitions from SDI to IP—sees AES67 as the most technically viable and industry-endorsed standard to be used to transport audio paired with

video. This ringing endorsement from the video side of the TV broadcast workflow further shows why users should now invest in AES67 technologies.

The AES67 deliberately avoided mandating either a control or discovery mechanism when publishing the standard, allowing manufacturers to develop their own bespoke methods while maintaining the ability to interconnect with any AES67 audio stream. The fact that AES67 uses SIP for connection management means that routing can be controlled without the need for discovery, providing the stream addresses are known. This means that a dynamically switched audio routing system can easily be constructed using AES67-compatible equipment with frame accurate switching achieved when using a system-wide PTP clock. In essence, everything that can be done now using an expensive baseband routing infrastructure can be replicated across a managed network, including the mapping of an AoIP router layer alongside an SDI video matrix. This capability can help to smooth the transition to a video and audio IP world by enabling the designer to adopt an AoIP

system that will still be state-of-the-art when Video over IP catches up.

AES67 helps to bring us one step closer to unleashing the power of an all-IP audio and video infrastructure. AoIP has the potential to bring converging subsystems that would otherwise have remained separate, together. By bringing together telecommunications, intercom, in-studio audio, and external audio into one system, users dramatically decrease the number of physical interconnections, cabling, patching, routing, distribution, and terminal hardware. The emergence of agnostic IP stream control and routing makes the management of IP audio simple and coherent. No longer are contribution and communication feeds tied up to their own matrix, nor does program audio need to be routed independently for both on-air and in-studio feeds. Access becomes open and devolved and the concepts of role-specific signal paths are flattened. Everything is just “audio”—low-latency, program-quality, 24-bit multi-channel sound. 🔄



Martin Dyster

Vice President, Business Development,
TV Solutions Group, Telos Alliance

AoIP: 2003 to Now!

Take a stroll with us down memory lane from the earliest days of AoIP and AES67 to now.

2003

2003: Axia Introduces First AoIP Protocol

The Telos Alliance introduces purpose-designed AoIP for Broadcast facilities with Livewire.

2006: Audinate Is Formed

Audinate is formed to commercialize the Dante protocol, proving AoIP has applications beyond Broadcast

2010: The Audio Engineering Society Forms the x192 Working Group

Designed to specify protocols and interoperability guidelines for professional, low-latency streaming audio over high-performance IP networks, the AES-x192 working group is formed. Telos Alliance backs the group financially to move interoperability from dream to reality.

2013: Telos Alliance Introduces Livewire+ AES67 Protocol

Livewire+ AES67 launches, based on the Livewire protocol with enhancements to comply with AES67 standard and support for future interoperability standards. The first AES67-compliant products are shipped, the xNode family of IP-Audio interfaces.

2015: Alliance for IP Media Solutions Formed

AIMS is launched to foster IP solutions that offer complete interoperability, open standards, and that integrate into media workflow environments.

2017: Livewire Continues to Set the Standard for AoIP Protocols

The Telos Alliance continues to push the envelope with Livewire+ AES67, which is as cutting-edge now as it was then thanks to Axia's 14+ years of AoIP experience and refinement. No other protocol can say that. With support for GPIO, PAD, & advertising/discovery, plus AES67 compliance, the Telos Alliance continues to set the industry standard for broadcast AoIP.

2004: First Broadcast Studio Created

Auburn University's WEGL-FM 91.1 in Auburn, Alabama, installs Axia Livewire consoles and technology, becoming the first AoIP radio station.

2008: Wheatstone AoIP Protocol Comes to Market

2010: ALC Networkx Introduces Ravenna

2013: The AES67 Standard Is Ratified

Standard for providing comprehensive interoperability recommendations for synchronization, media clock ID, network transport, encoding and streaming, session description, and connection management is ratified.

2014: Media Networking Alliance Formed

The MNA is formed to promote the AES67 standard. The Telos Alliance, Lawo, Bosch, and Yamaha are founding members.

2016: AES70 Is Ratified

The AES standard for audio applications of networks—Open Control Architecture—is ratified, defining a scalable control-protocol architecture for professional media networks.

2017



Want to Learn More About AES67, AoIP, and the Telos Alliance's Livewire+ AES67 AoIP protocol? Contact us!

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