Explore the Infinite Possibilities in Your Studio

AoIP has given designers the opportunity to implement stunning, feature-rich functions unheard of 20 years ago

By **Chris Wygal, CBRE**

Years ago, a box with blinking lights connected our office computers to each other and to the internet. The non-descript box was called a switch or a router. Occasionally engineers at radio stations would take care of IP needs; but IP was IP and radio was radio.

However, as the planet began to witness a reshaping of telecommunications via the internet, the broadcast industry realized: If these switches and routers can accommodate massive amounts of data transfer, can our audio infrastructure live on them too? The answer was "yes," and our industry was introduced to the concept of audio over IP.

For many, it boiled down to an issue of trust. Granted, standalone time-division multiplexing systems from companies like Wheatstone and Harris had been in service since the early 2000s. So the idea of packetizing audio wasn't a foreign notion. But in the mid-2000s, when AoIP rolled out in full bluster, the radio industry had some reckoning to do: Should we really put our entire audio plant on an IP platform? Is that safe?

Fast-forward to today. Audio over IP is a proven success. It has given engineers and studio designers the opportunity to implement stunning, feature-rich functions that were unheard-of 20 years ago. Fortunately, AoIP development has continued at light speed and numerous options for optimizing AoIP networks are virtually a click away.

Part 101 now allows for use of 11 GHz, and high-speed IP radio links can be used to connect and extend AoIP networks such as those discussed here.

AOIP CONSIDERATIONS

The student station and the regional radio network at Liberty University underwent studio relocations in 2011 and 2013. Both facilities benefitted from the services of a large university IP infrastructure. Cisco Catalyst switches and Cisco routers were in place at both facilities for day-to-day office use. The needs of the student broadcasters and the increasing market share of the radio network were discussed and we concluded that office data and AoIP could both live on our switch stacks. The next step was to select an AoIP platform. Leaders in this space include Wheatstone, Axia and Lawo; Calrec has recently come back into radio with an IP offering as well. In the case of Liberty University, our radio operations had a relationship with Wheatstone, so we settled on WheatNet.

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Wheatstone's IP88AD analog and digital blade, front view. Blades are used to interface the AoIP network in to the remainder of the radio station's studio system

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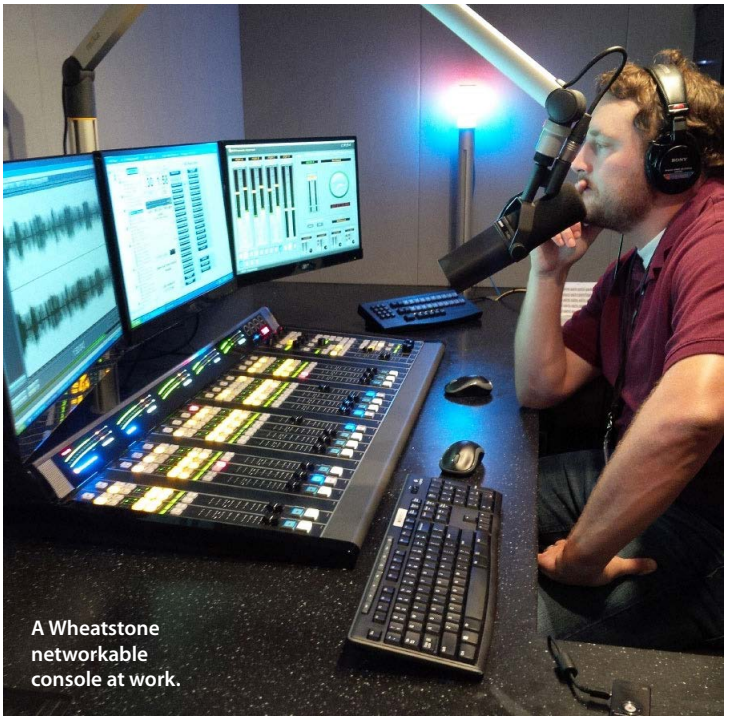
Regardless of your vendor of choice, AoIP studio design is a game-changer. It negates the need for audio I/O termination at the console. The board becomes a glorified mouse and is responsible only for the human element involved in on-air and production. In an AoIP environment, the analog and digital I/O along with GPIO control should all terminate in one central location.

This is where Wheatstone Blades, Axia xNodes and Lawo Power Core I/O devices exist. They are all racked up with the IP switch, but with one exception. AoIP platforms generally provide I/O devices that live in the same room *with the console*. Wheatstone, for example, provides a "Console Blade" that handles in-studio devices like microphones, CD players, headphone amps and studio speakers. This model allows wiring to stay in the rack, while the console does no more than provide a control point for the AoIP network.



A Wheatstone networkable console at work.

The first AoIP consideration involves "Layer 1" (see the Open Systems Interconnection model). What do we need to interconnect this AoIP gear? At our network, the studios were wired for analog and AES with 30 runs of Category 5 cabling each. The Cat-5 installation proved to be a good choice when the time came to install WheatNet. Wheatstone consoles and console Blades only need one Cat-5 cable (as a minimum) to connect to the IP switch. This would be the same for Axia consoles and xNodes and Lawo consoles and Power Core interface products. So the wad of 30 Cat-5 cables per studio effectively was reduced to two, but all the cabling was left in place and terminated on RJ-45 patch bays in the studios and in engineering. This leaves ample utility cabling for nearly everything.

The next AoIP considerations involve OSI Layers 2 and 3: the switches and routers. At our facility, the broadcast staff has little access to switches and routers. This introduces an important point: If IT folks are available, use them. Also, take them to lunch. My good friend Tirian is our local IT expert and his help in this endeavor was and is invaluable. Broadcast engineers have plenty to do. If IP Layer 2 and 3 issues can be delegated, consider it a Godsend.

With IP switches (Layer 2) and AoIP, the marriage can sometimes be "plug and play" (within reason). Wheatstone and Axia boast excellent results using "off-the-

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Even inexpensive 5.8 GHz radio links can be used to connect and extend AoIP networks. The smaller dish, running at 60 GHz, is actually used to extend a network between neighboring buildings.

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shelf" gigabit switches. This is good news in theory, but there are important considerations. First, AoIP systems use multicast protocols to move data packets to and from specified devices. Essentially, without multicast, the payload from each AoIP device would be broadcast and made available to IP network resources that aren't relevant to AoIP devices. This would eat up unnecessary switch bandwidth. Nonetheless, even with multicasting in action, for the reasons of prioritizing AoIP traffic, manufacturers strongly suggest dedicating an AoIP-only switch. However, when this option isn't viable, VLAN (virtual local area network) and IGMP (internet group management protocol) configurations will be required to segregate AoIP data. IGMP "snooping" or an IGMP "querier" manages multicast traffic and only sends the data frames to devices that request it. Another function called QoS (quality of service) is employed in managed routers. It prioritizes data packets and can be useful in congested data environments.

In our specific installation, we needed one WheatNet Blade for every eight audio sources and destinations. Our AoIP network as a whole involves 12 WheatNet products that could potentially load the Cisco switches with approximately 790 Mbps of IP bandwidth. For example, a WheatNet 88ad Blade, depending on configuration details, can use as much as 73.7 Mbps of throughput. As it turns out, the Cisco Catalyst gigabit switches have 40 GB backplanes, which means we are only utilizing 1.97 percent of the switch throughput. This is good news for a network with potential studio expansion in mind.

While off-the-shelf router/switch combos may do the job for very small AoIP installations, managed switches and routers from Cisco Systems, Juniper Networks and Arista Networks (to name only a few) are highly recommended. AoIP systems are designed to do their best work in well-managed Layer 2 and 3 environments. It can be worth the investment in contracting with qualified IT personnel who can take the IP infrastructure to a better level. However, IT guys aren't necessarily broadcasters. Switch configuration MUST be a team effort! Additionally, we have backup switches with our exact switch configurations readily for deployment in the event of a switch failure.

TYPICAL AOIP GEAR INTERFACES

It might be time to take a break from the "IP" part of AoIP and talk about the "audio" part. Remember that AoIP networks do not send audio through the console surfaces. The goal is to reduce wiring, enhance routing and processing and control, and to centralize the audio plant.

Using, for example, the aforementioned interfaces, we bring our audio world into the IP world. Blades and xNodes have a combination of RJ-45 and DB-25 connectors that are used for audio I/O and GPIO connections. The Lawo Power Core has DB-25 connectors as well as MADI fiber terminations; the 2-RU core for the Calrec Type R includes I/O. Blades, xNodes and Power Core each have considerations for microphone, AES and analog inputs and outputs.

A fantastic case for the "cross-connectability" inherent

to AoIP systems is GPIO routing. As an example, in our facility, on a Wheatstone E1 console, when the board op pushes one of the user-programmable buttons, the relay closure happens on a Blade in engineering and it starts automation playout.

Another example involves our tally lights, which are actually powered from the engineering room, not their corresponding studio. This means that a microphone channel in production can issue a GPIO command to close a relay on a Blade in engineering that will turn on the light. Also, all of this is configured from my computer in my office.

There are infinite possibilities when it comes to using AoIP to move things around the facility.

WheatNet, as an example, uses software to control each Blade and console, IP Navigator being the primary tool. It is used for audio and GPIO XY routing as well as Blade configuration and salvo/macro programming. Glass-E is used for virtual control of each console. Aura1 ip Pro is used to control the built-in audio processors on the Blades. Essentially, any PC can be assigned to the WheatNet network and control of the entire audio plant is available from anywhere in the world (which is why reasonable IP security measures are vital!). Axia offers software options like Pathfinder and SoftSurface, and Lawo uses VisTool for all the same functions.

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INTER-FACILITY TRANSPORT VEHICLES

So far we've taken the lid off of AoIP as it pertains to in-studio applications. However, an AoIP platform can exist in more than one location. Whether over commercial IP, fiber or Part 101 microwave, VLANs can extend local AoIP networks to areas far and wide. The most common example of facility-to-facility AoIP would be STL links. For this, WheatNet provides the Network EDGE Blade. It interfaces with publicly addressable IP routers or IP wireless radios and it conditions bandwidth to handle latency and packet loss. Axia uses the xSwitch to extend its Livewire+ AoIP network and has a fiber connectivity option.

Point-to-point IP radio links are becoming less expensive, are unlicensed or licensed and can generally carry IP data more than 20 miles. While an unlicensed system may be cheaper to operate, it is still prone to interference. Additionally, traditional IP transport over a commercial internet provider can be a safe bet. It is important to take latency and packet loss into consideration when sending audio over the public internet, but delay times can be as minimal as 3 or 4 milliseconds, and unless provider service is chronically poor, overall results can be remarkably stable.

AOIP INTEROPERABILITY

An interesting caveat involving AoIP-capable devices has raised this question: "How can differing products recognize each other and speak the same language over Ethernet?"

The question is answered through technologies like Dante, Livewire, Ravenna and AES67. These use OSI layer protocol standards that, put simply, allow otherwise competing audio devices talk to each other. For example, WheatNet and an Omnia.9 processor can live on the same AoIP network and transfer audio to one another because they are both AES67-compliant. An Orban processor and Axia can work together because they adhere

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to the Ravenna standard. Axia's proprietary Livewire+ products can talk to a multitude of other products because it is also AES67-compliant. AoIP interoperability products like AES67 synchronize and unify protocols, namely RTSP, across various manufacturers. It's important to note that networked audio devices bypass the D/A and A/D conversion process by converting the I/O to an IP stream via the device's network port.

A GOOD DEAL

When we decided to eliminate our trusty, tried and true analog and AES audio architecture, it didn't happen without some level of anxiety. Let's face it: You put tone on a pair, and chances are you'll hear it on the other end. AoIP design takes away the bare-bones, familiar approach to audio and GPIO routing. It also requires that we learn IP networking, hire good IT people, or both.

Nonetheless, even though AoIP is a radical departure from what seems normal, the benefits far outweigh the initial angst. We are yet to regret any aspect of our AoIP installation. It continues to amaze us with its inherent capabilities. Plus, our IP infrastructure was designed in such a way that we anticipate no problems with growth and scalability. Twelve years ago, AoIP for studio audio infrastructure was somewhat of a leap of faith. Today, it has become standard for radio operations that are looking ahead to what IP technology has in store.

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