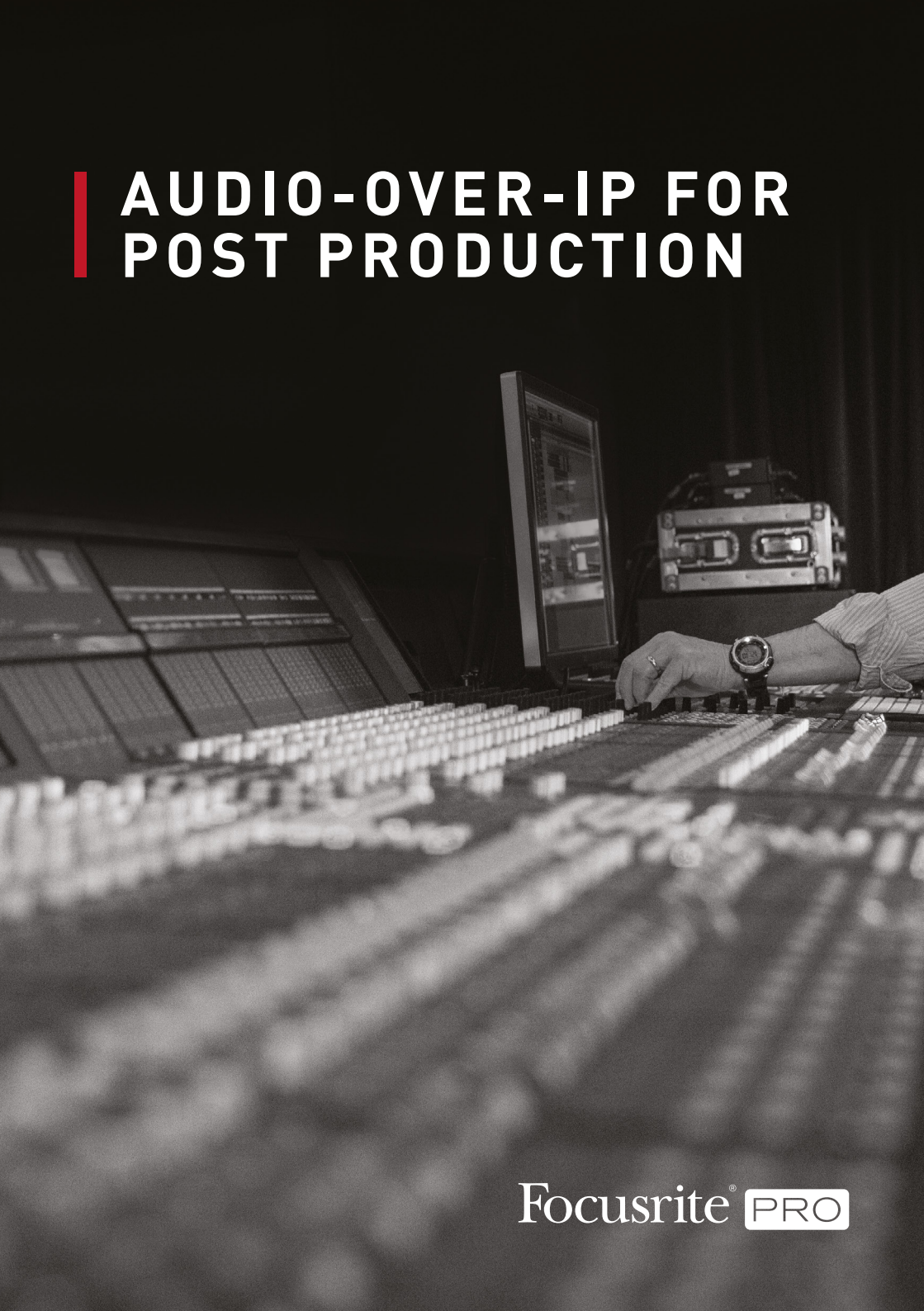
AUDIO-OVER-IP FOR POST PRODUCTION



Focusrite® PRO

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Cover photo credit: Chris Mayes-Wright

1. INTRODUCTION

Although they overlap considerably, it's possible to argue there are three distinct chapters in the evolution of audio recording and post-production. First there was the exclusively analogue chapter that began with the invention of sound recording and tape-based linear editing. Workflows were cumbersome and edits slow. Next, with the development and arrival of digital recording and editing in the 1980s, the serially connected digital chapter began and non-linear editing became possible. Multiple workstations with independent users could be interconnected using distributed clock signals and multi-channel digital audio protocols. And then, as a result of the 1980s development of the TCP/IP communications protocol on which the internet is built, the network connected audio-over-IP (AoIP) chapter began in the early 2000s.

Today, in 2018, AoIP technologies are fully established in the 'wild'. Countless studios, theatres, permanent or temporary music venues and commercial premises employ AoIP systems to great effect. Many sound stages are using AoIP to some extent; some are leaping ahead in terms of flexibility with full-scale networked audio systems. But despite this, AoIP has a long way to go to achieve market saturation in post-production. So this guide has been assembled to help inform pro audio professionals who want to learn more about Audio Over IP as it relates to their field. So if you've ever wondered if AoIP will suit your way of working (the answer is probably yes), or if it will make all your existing gear instantly redundant (it needn't), or if will expose your work to security risks (it needn't), keep reading because those are the kinds of questions we'll be aiming to answer.

Image: In a large-scale Dante system, audio devices and network infrastructure play side-by-side. Photo credit: Formosa group.

We'll start in the first section by examining two fundamental questions. First, what actually is AoIP? And second, what is the Dante technology employed in all Focusrite Pro AoIP products, and how does it work?

1.1. What is AoIP?

As soon as audio was digitised and digital network communication protocols were developed, the arrival of AoIP was really only a matter of time. If it were not self evident already, the 'IP' in AoIP stands for Internet Protocol (TCP/IP stands for Transmission Control Protocol/ Internet Protocol) and that means, in terms of the way it transmits and handles data, AoIP plays fundamentally by the same rules as the internet and the local networks we've become familiar with. AoIP has one significant difference however and that concerns the way it preserves the all-important time-domain information of audio. Conventional data, transmitted via either the internet or a local network, is split into manageable chunks, called packets, with each chunk having a digital label attached to define firstly its destination and secondly where it belongs in the complete dataset when the chunks are re-assembled. What conventional network data packets don't normally have however are labels attached that define their time domain information; the packets just arrive at their destination, 'as and when', as we know all too well.

A lack of packet time-domain information would of course be fatal for audio data that's to be distributed in real time around a network, and time-domain information is fundamentally what AoIP technology adds to conventional network protocols. Adding time domain information is far easier said than done however and there's two important aspects to it. Firstly there's the time-domain information that ensures multiple linked channels of digital audio retain their inherent timing relationships. This ensures, for example, that the two channels of a stereo signal remain perfectly in phase, and that no significant jitter is imposed on the signal that would otherwise result in distortions arising following digital to analogue conversion.

The second time domain aspect that AoIP technology addresses is overall signal latency. To be of any value in audio recording and performance installations, the typical latency we're all used to from conventional networks, whether they be closed Local Area Networks (LANs) or the wider internet, would be completely unworkable. So AoIP hardware is engineered and configured to achieve network-wide latency figures, across all audio channels in both directions (record and monitor), of well under single figure milliseconds. Before we move on to describe the Dante AoIP technology that's embedded within all Focusrite Pro AoIP hardware, perhaps a quick paragraph on the potential of AoIP wouldn't go amiss.

Despite the huge advances brought by the development of digital audio technologies, the recording and post processing of sound has remained up until now a fundamentally closed, end-to-end, process. In contrast, and apart from massively increasing the potential channel count and minimising the cable overhead (that heavy and expensive multicore becomes a single network cable), AoIP potentially makes audio production an open, parallel, distributed and collaborative process. More I/O and interface capability can be added at will, and the same audio data can be made available to multiple workstations simultaneously to become a shared resource. While the traditional workflows of audio production needn't change with AoIP, the potential for new and far more efficient and flexible ways of working are almost limitless.

1.2. What is Dante?

Audinate's Dante technology has become the ***de-facto*** standard for AoIP and, along with Focusrite Pro, numerous other pro audio manufacturers offer Dante equipped hardware. Using fundamentally the same Ethernet technology employed in consumer and commercial data networks, Dante enables multi-channel uncompressed digital audio distribution with minimal latency at sampling rates of up to 192kHz. Dante AoIP can even share an existing network infrastructure with conventional network traffic. (Dante-equipped hardware from any manufacturer will always be compatible in terms of AoIP network visibility, however, some technical features specific to one manufacturer may not always be available across an AoIP network to hardware from a different manufacturer.)

As described in the previous section, Dante technology segments audio data and wraps it in IP packets suitable for transmission across an Ethernet network using Cat 5e, Cat 6 or fibre-optic cables. Each data packet carries with it timing information and the source/destination network addresses, enabling it to be instantly routed through the network and reassembled when required for conventional audio processing or distribution. In some respects Dante can be viewed as a digital audio interface technology, similar to USB, Firewire or Thunderbolt, which is appended to familiar DAW hardware. A laptop user with a single Dante device, for example, can operate a simple system with a single Ethernet cable running between computer and interface. However, the range of potential functionality and versatility provided by Dante — when used to its full, networked potential — far exceeds any conventional interface, explodes traditional working practices, and enables multi-user, cross platform, and mixed-site operation.

1.3. Dante Network Infrastructure

While it is possible for a simple AoIP installation, such as a laptop and a Dante-equipped DAW interface, to operate on a direct connection without any external network, systems with more than two network devices will require connection via a network switch and cabling. Standard switch hardware designed for conventional IP networks is used, as is standard Cat 5e, Cat 6 or fibre-optic cabling, and Dante AoIP can even share a network with conventional network traffic. There is no need in AoIP networks to employ switch hardware or cables aimed specifically at audio systems. In order to ensure low latency and glitch-free operation, the network infrastructure should comply with the following technical constraints:

- Gigabit throughput inter-switch connections (100Mbps switches can be used but channel count will be limited and latency will increase)
- Managed switching (preferred not mandated) that provides information about the operation of each network link
- Quality of Service (QoS) functionality
- Diffserv (DSCP) QoS with strict priority
- Cat 5e, Cat 6 or fibre-optic cable.

Note: EEE (Energy Efficient Ethernet) technology that reduces switch power consumption during periods of low network traffic (also sometimes known as Green Ethernet and EEE802.3az) is totally incompatible with Dante, and should be disabled or avoided at all costs.

1.4. Dante Software Applications

As well as developing the Dante hardware technology that makes Focusrite Pro equipment operate, Audinate produces three Dante software utilities that provide Dante interface, network configuration and management functions on Windows and OS X. The three apps are described more fully in Section 3 of this article but briefly they provide the following functions.

Dante Virtual Soundcard (DVS) enables audio applications such as Pro Tools and Logic Pro running on Windows and OS X computers to connect to and access Dante-equipped audio hardware directly from the computer's network socket. DVS is not required when using a dedicated Dante card, such as the RedNet PCIeR.

Dante Controller is the core Dante utility that enables network subscription management (aka signal routing), and a host of device-level options to be configured.

Dante Domain Manager provides network management and security functions such as user authentication, role-based access control and network audit. Domain manager can also be used to configure project based subnets within a single Dante network.

1.5. Dante & Focusrite Pro

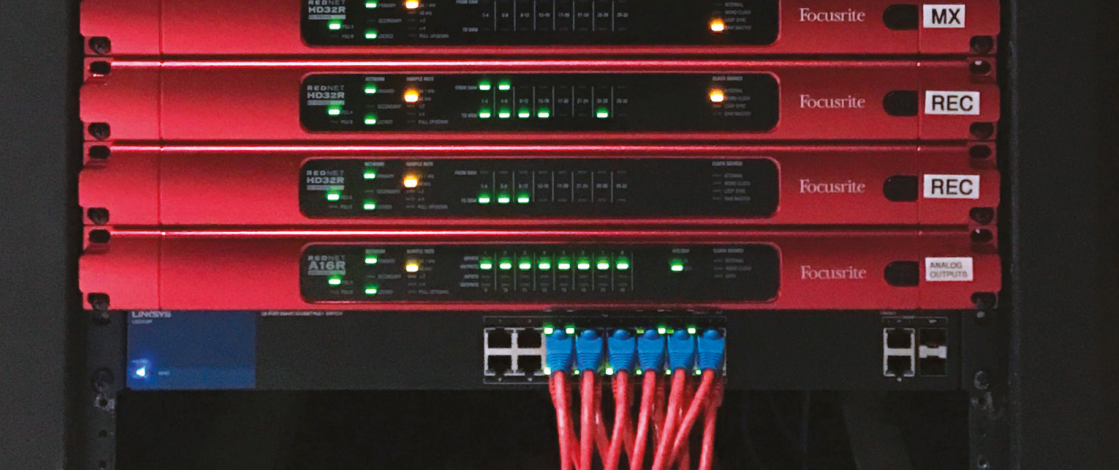
Focusrite Pro manufactures a wide range of Dante equipped hardware aimed and audio recording, live sound and audio post-production that can be combined to create hugely capable audio production installations. These products fall within the Focusrite Pro product family comprising of the following product groups.

RedNet Audio Interfaces

The products comprise the building blocks that make RedNet the most comprehensive and capable implementation of AoIP available. A wide range of I/O options is available as are 'bridge' devices that enable the integration of AoIP with existing analogue, digital (AES, S/PDIF or ADAT), Thunderbolt and MADI infrastructure.

Red Audio Interfaces

These products combine the functionality of Thunderbolt DAW interfaces, equipped with mic inputs and line/digital I/O, with those of a Dante equipped mic/line preamps.



2. BENEFITS OF AoIP

Professional audio practitioners have over the decades developed numerous workflows and practices that operate extremely well. Similarly, manufacturers of professional audio equipment have developed technical solutions that accommodate and enable the workflows and practices, while also recording, storing and reproducing audio with incredible fidelity. Now however, AoIP has the potential both to change the established workflows and practices, and to make obsolete some classes of audio hardware. So, especially in commercial audio installations where time is precious and clients come first, the benefits of AoIP need to be significant and indisputable.

"RedNet offers us advantages like being able to get rid of our old patch bays and cables and make networked connections within the studio. We were able to do this incredibly cost effectively with RedNet. It really makes a huge difference."

— Craig Holbrook, Westwind Media

Image: An audio-over-IP system can vastly simplify and condense otherwise expansive and cumbersome audio systems. Photo credit: Westwood Media.

2.1 Audio Quality

Focusrite has been at the forefront of professional audio quality for three decades and everything we know about sound is invested in RedNet hardware. But the concept of AoIP additionally brings its own fundamental benefits in terms of sound quality. Firstly, once converted from analogue, AoIP keeps audio data in the digital domain until it is finally converted back to analogue for monitoring. Round-trip digital-analogue-digital or analogue-digital-analogue conversions that are sometimes unavoidable in traditional workflows are minimised.

Secondly, AoIP is immune from distortion, signal degradation, cross-talk, response errors, interference and noise in a way that traditional audio distribution — analogue or digital — can never be. The segmented and packaged nature of AoIP data, with its attendant error correction and timing information means that those traditional problems of audio signal transmission don't even so much as get a foot in the door. By definition, the audio data at any network node is exactly the same as at any other.

Thirdly, the timing uncertainty and consequent distortion of conventional end-to-end digital audio signal chains, often known as jitter, is greatly diminished, to the extent that its affects are negligible in AoIP systems. This is because, at each node where the audio data packets are reassembled, they are re-clocked to a network-wide high precision timing signal.

2.2 System Expansion

Every audio engineer has been there – that point where you run out of inputs, or channels, or tracks. And by the very nature of conventional signal paths, analogue or digital, adding more is never entirely straightforward. The only solution is often a whole-scale studio revamp. Not with AoIP and RedNet. The current maximum channel count of an optimally configured Dante AoIP network is an extraordinary 1024 (512 x 512) per link, but probably the more significant fact for users is that access to more channels is simply a case of adding another Dante I/O device to the network. Need eight more mic inputs for, say, an ADR or Foley session on the sound stage? Simply plug-in a RedNet MP8R Remote Control Mic Pre to the Dante network. The network will automatically identify the device and make its mic inputs available, probably quicker than you can find the microphones to plug in. And then, when you need yet more inputs, just do it again, and again, and again.

2.3 Workflow Benefits

The potential for system expansion with an AoIP infrastructure goes further than just increasing the channel count of a single-room studio or sound stage; it's also about expansion and flexibility of working spaces and operating practices. In just the same way that more I/O can be added, so can more people. Added workstations open up the potential for collaborative working in multiple rooms, or running multiple projects in the same facility on the same AoIP network. Just as with the addition of more I/O, a second workstation can be followed by a third, or a fourth, or maybe an occasional freelancer with a laptop. On busy review screenings, RedNet AM2s can provide every executive with a dedicated headphone mix and volume control. Wherever a network point can be found, an audio workstation can spring up.

2.4 Compatibility

RedNet and Dante can of course not exist entirely outside the conventional audio recording and post-production infrastructure of traditionally connected hardware. Every potential RedNet user is likely to have made significant investments — both commercially and in terms of the development of working practices and expertise — in conventional workflows, signal chains and hardware. So RedNet hardware and systems are designed to be able to work with this existing infrastructure rather than render it obsolete. For example, a variety of RedNet hardware products offer line-level I/O with A-D/D-A conversion that can be used to provide AoIP access to conventional mic/line preamps and esoteric outboard hardware. And similarly, other RedNet hardware provides AoIP bridge functions for ADAT, S/PDIF, and AES3 (AES/EBU) format digital signals, and for MADI multi-channel digital streams. Pro Tools | HD is also catered for directly with DigiLink-equipped RedNet I/O hardware, and even older Pro Tools TDM systems can be fully integrated with AoIP.

3. DANTE SYSTEM MANAGEMENT

AoIP brings with it some specific system-management considerations that may be unfamiliar to users of conventional audio hardware. Once the general concepts have been grasped, the power of AoIP is easily tapped.

3.1. Control Software

The software tools that are included with all RedNet hardware make AoIP system management and configuration straightforward and intuitive.

RedNet Control 2

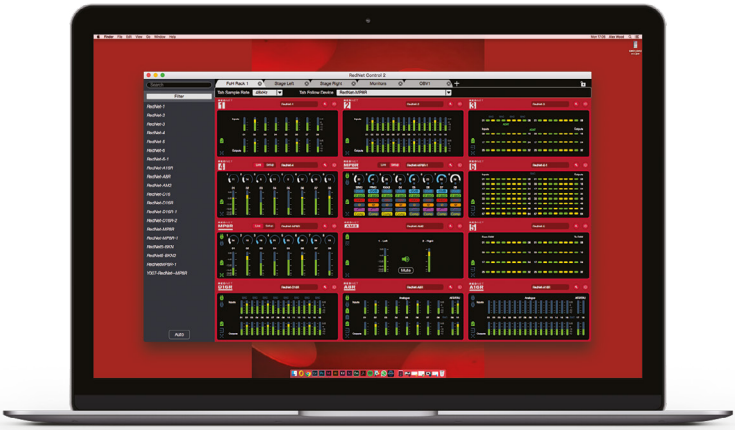
Based around a tabbed GUI, ***RedNet Control 2*** provides control over any RedNet system, from just a few units up to an maximum of 600 devices. The utility enables monitoring, metering and control over all device parameters. Available RedNet devices are displayed graphically, and can be dragged and dropped from a sidebar list into a customisable setup. Each of up to 50 tabs can display up to 12 devices in a grid-based layout. Devices can be grouped logically on each tab, so one tab could represent an area of a multi-location system, for example.

Dante Controller

This utility provides simple and intuitive access to the network-level routing and configuration of Dante-equipped AoIP hardware. ***Dante Controller*** automatically discovers network devices, enables one-click signal routing, and provides editable device and channel labels. ***Dante Controller*** can additionally provide device- and network-status information such as device-level latency, clock status, bandwidth usage, and event logging. The application can also save and recall network configuration presets and enable routing configurations to be edited offline.

Dante Virtual Soundcard

Dante Virtual Soundcard is for many users the entry point to AoIP. It enables Dante-equipped DAW interface hardware to connect directly to a computer running a DAW application via the computer's network socket. Such systems will then work in exactly the same way as the familiar USB, Firewire or Thunderbolt interface with audio inputs and outputs available via the DAW's signal-routing panels. The major difference is that if more audio I/O is required it can be added simply through the addition of an off-the-shelf network switch and further RedNet hardware. When using a Dante interface card, such as a RedNet PCIeR card — which delivers 128 channels in and out with extremely low latency — Dante Virtual Soundcard is not required.



Dante Domain Manager

Dante Domain Manager is a server application that brings traditional IT network manager functions to AoIP systems. For most users, ***Dante Domain Manager*** is only appropriate when an AoIP system grows to include multiple workstations and users. As well as traditional IT manager functions such as network security, monitoring and maintenance, Dante Domain Manager offers the functionality that can ensure complex multi-user AoIP networks can be protected from unauthorised access and unintended modification to both device level configurations and audio data. ***Dante Domain Manager*** can also enable the establishment of subnets within a single AoIP network that can, for example, create discrete project based groups of I/O hardware.

3.2. Dante System Configuration

Along with AoIP system management tools that are likely to be unfamiliar to conventional audio system users, AoIP systems necessarily bring with them some technical configuration parameters that are worthy of study by system administrators.

3.2.1. Clocks

As we've described in previous paragraphs, AoIP systems rely on timing information attached to data packets. However, unless each hardware device on a network is synchronised to the same absolute time, the packet timing information is worthless as there is no fixed reference. So, in order to provide absolute clock data for each network hardware device, in addition to carrying the audio data, the network connections also carry data for maintaining sync.

The concept of clock signals is of course familiar in conventional distribution of digital audio, however if a similar a system were to be employed in a network paradigm it would soon fail: firstly, conventional clock signals are relatively difficult to maintain without noise and signal deterioration over long distances, and secondly, a continuous high frequency clock signal demands significant data bandwidth.

The clock solution in AoIP systems is defined by an existing standard: IEEE 1588 v1 Precision Time Protocol, or 'PTP' for short. (To be specific, some other AoIP systems use v2 of this protocol; Dante employs v1.) In a PTP-clocked system, each device on the network incorporates its own high-stability oscillator, known to resonate at a specific high frequency — albeit one subject to environmental influence such as pressure and temperature. The oscillator provides each network device with a stable independent internal clock that ensures it can process its own data. The network devices basically count time for themselves. The missing factor is synchronisation. For example, two devices in different locations with different temperatures and pressures may count at a slightly different rate. So the PTP protocol overcomes clock variation by distributing regular time updates around the network

ensuring that all the connected devices re-calibrate themselves at regular intervals: normally once every 250ms. Instead of distributing a continuous stream of very high frequency clock pulses (as would a word clock system), PTP repeatedly distributes actual time (technically, it might not be the actual, local time) frequently enough that every device on the network can stay in close enough sync to guarantee network stability and low latency, minimal jitter, glitch-free audio. This frequency is defined by the expected drift of the device's oscillators, and is in the region of every few hundred milliseconds.

When Dante networks are connected, the clock functions can either be left in a default configuration where the ***Dante Controller*** utility automatically identifies the most stable device clock and 'elects' it as the master from which the PTP signal is derived, or alternatively, a specific hardware device can be 'manually' designated as master. This might be an appropriate option if, for example, hardware devices are expected to be regularly swapped in and out of a network.

There is one more aspect to AoIP clocking that we'll touch on, and that concerns integration with external non-network audio infrastructure. An example might be MADI or AES/EBU digital audio streams that are required to be available to AoIP I/O hardware. In order to facilitate this, RedNet hardware provides word clock outputs that present a conventional clock signal derived from the network PTP clock. This enables external digital audio to remain in sync with network audio, but also we can synchronise to an external clock or an incoming AES3, ADAT, S/PDIF or MADI connection.

"The biggest problem with any technology is that it gets in the way of being creative, because it takes some of your mental bandwidth to deal with the technical things. RedNet is the very definition of plug and play. It's fast and you don't even know it's there. That's the best thing you could ever say about any technology."

— Bill Johnson, VP Engineering, The Formosa Group

3.2.2. Sample Rates

In conventional audio installations the project sample rate is one of the fundamental technical parameters, and once set, it's unlikely to change. The same constraint is fundamentally true of AoIP installations, however in a multi-workstation systems where there may be a requirement for users simultaneously to work on different projects, or perhaps different elements of the same project. It is possible, using ***Dante Domain Manager***, to configure multiple subnet clock domains and different sample rates. Imagine a scenario where two projects are underway employing I/O and processing on the same Dante network. One project is a music to picture edit with the audio data recorded at 44.1kHz, while the other is an audio mix destined for Netflix with an audio sample rate at 96kHz. With a network wide clock signal, or even with a conventional infrastructure synced to a single-source word clock, the mixed sample rate scenario wouldn't be feasible, but with Dante subnets configured, one network can be temporarily spilt and the two projects can run concurrently.

3.2.3. Unicast & Multicast

Unicast and multicast are terms that describe different network data transmission formats. Unicast describes a hardware device configuration where a sending device transmits the same data in parallel to all network devices. Unicast is the Dante default format and it enables simple network routing configuration, however it can be wasteful of network bandwidth.
The alternative to unicast is multicast. Multicast describes a hardware device configuration where a sending device transmits one or more specific data streams only to each downstream devices that need to receive them. Multicast is significantly more efficient in terms of network bandwidth, and is therefore suited to larger and more complex installations, however it also requires more custom network configuration within ***Dante Controller.***

3.2.4. Network Redundancy

There's probably nobody involved in audio who's not experienced the dismay of a cable or connector unexpectedly failing. Just like conventional systems, AoIP installations are reliant on cables that can be inadvertently disconnected, accidentally mangled, or just randomly fail, so they are not immune from cable woes. If a cable is disconnected, for whatever reason, an entire AoIP network may go silent. Dante AoIP systems can offer one great advantage over conventional audio systems: redundancy. Look at the rear panel of most RedNet hardware and you'll see two network sockets: primary and secondary. The secondary socket is there to enable an entire back-up network, with its own separate cables and switch infrastructure to be built. When a secondary network is available, Dante can switch automatically and instantly if the primary network fails.

4. EXTERNAL COMPATIBILITY - AES67 AND AES70

While Dante is now the most prevalent AoIP technology found in audio installations, there are other media networking technologies in the arena and in recent years manufacturers in the sector have cooperated on establishing technical standards that ensure a basic level of compatibility between them. These standards are known as AES67 and AES70. All Focusrite Pro RedNet hardware complies with AES67 and AES70 where appropriate.

4.1. AES67

AES67 describes a set of rules and protocols that establish the connectivity of AoIP devices so that when connected to a common network they will be able to exchange audio data. However, in reflecting the wide variety of functionality required in AoIP hardware, AES67 is a relatively narrow standard that leaves significant latitude for manufacturers to implement high-level functions appropriately for their particular customers. This means that while all AoIP hardware that conforms to AES67 will be compatible at a basic network level (i.e. audio will pass without hinderance), specific functions implemented on one device may not be compatible with apparently similar functions on a device from a different manufacturer.

Image: A pair of Focusrite HD32R 32x32 Pro Tools | HD interfaces connect a workstation to the Dante network. Photo credit: Formosa Group.

4.2. AES70

AES70 is often seen as intimately linked to AES67, but in reality they are two distinct standards and need not always go hand in hand. While AES67 defines the basic level of AoIP network interoperability, AES70 more specifically defines protocols for network monitoring and configuration including functionality such as the creation and deletion of signal paths and control of signal processing. In AoIP installations consisting of hardware from just one manufacturer, compliance with AES67 and AES70 is likely to be somewhat academic. However, with an increasing number of audio hardware manufacturers introducing AoIP enabled devices, the interoperability that the two standards ensures means that mixed protocol and mixed manufacturer installations are viable.

5. DATA SECURITY

In Section 2 we touched on the ***Dante Domain Manager*** application and how it can enable an AoIP network to be protected against unauthorised access, or simply secured against the innocent mistakes that can potentially arise when data and, effectively, I/O hardware, is shared across multiple workstations. These issues are of such importance however that covering them more comprehensively is worthwhile.

5.1. Working Practices

Despite the advanced technological nature of AoIP, the first step in maintaining secure and stable operation is a human one. Access to any audio system should be managed using a common-sense approach and strict procedures. For example, in a conventional analogue studio, the connections between rooms and devices are made using physical patch cables. Say, an engineer working in Control Room 1 sees that the Live Room is patched to Control Room 2, he or she ought to check if someone else is using the patch cables before pulling them from the patch board. In an AoIP system, even though the patch connections are virtual rather than physical, the same checking should still happen. All those with system privileges to configure the network, its patches and assignments must play by the same rules. However, that's sometimes easier said than done, especially in large facilities with multiple engineers simultaneously using the network.

5.2. PIN Lock

So to help with these issues Dante incorporates a four-digit PIN-lock function that enables access restrictions to be imposed on mission-critical system functions. Lockable functions include routing settings, sample-rate changes, remote controlled reboot of devices, and network settings changes. The PIN-lock function can provide a significant increase in system security, but is not without issues. For example, if one engineer finishes a session with the routing setup locked, the next engineer will see locked I/O that is not in use.

It's this kind of situation where agreed system-access procedures are important. The best practice is to assume that, if I/O is locked, it's in use. But if it's possible someone forgot to unlock it, then a simple fall-back communication procedure, a phone call, a text message or a group chat perhaps, can be used before changes are made.

5.3. Restricting Physical Access

PIN-locking Dante's routing functions is one way to avoid accidental mis-clicks by authorised network users. But it's also possible for entire sections of an AoIP network to be kept off-limits to prevent people with malicious intent gaining access. Such measures may be particularly appropriate in installations where audio data is sensitive – think confidential commercial or government material, or high-profile film and TV projects. The key requirement is to keep data out of reach, yet still maintain the flexibility of a multi-user and expandable system.

The most basic step is to restrict physical access to the network and keep potential intruders away from network ports. Simply not installing network ports in unattended or public areas of the studio premises is a good start. Part of the appeal of AoIP that we've already described however is that it enables a workstation to pop up anywhere there is a network port — maybe on a busy day the studio lounge temporarily plays host to an audio freelancer with a laptop. So in restricting network ports it may be that one of the great benefits of AoIP is diluted.

Similarly, a busy post or recording studio often buzzes with staff, engineers, clients and creatives of all types coming and going, so identifying who is supposed to be present and what they are actually doing is not always straightforward. Somebody might have a perfectly legitimate reason to be on the premises, but no reason to be absentmindedly intercepting Dante audio from network devices via the network socket under the desk, which they're using to send a couple of emails.

5.4. Network Control

The next level of protection for a Dante based AoIP network is to control who gains access to the network itself. Username and password procedures can be implemented through ***Dante Domain Manager*** to grant permission to a controlled list of users. Audio hardware on the network can also be ring-fenced with access tied to usernames using an Access Control List (ACL). Implementing usernames, passwords and an ACL is of course not exclusive to AoIP systems — conventional network administrators have employed such techniques for decades.

Another access-control option that can be implemented if the network hardware doesn't tend to change regularly is to control which devices appear on the network. Whether it's a computer, a standalone recorder, or an A-D/D-A interface, every networked device has a unique identifier called a MAC address and network access can be granted only to approved MAC addresses. Again, configuring MAC address based network visibility is common in conventional network management and should be well within the capabilities of most experienced network administrators.

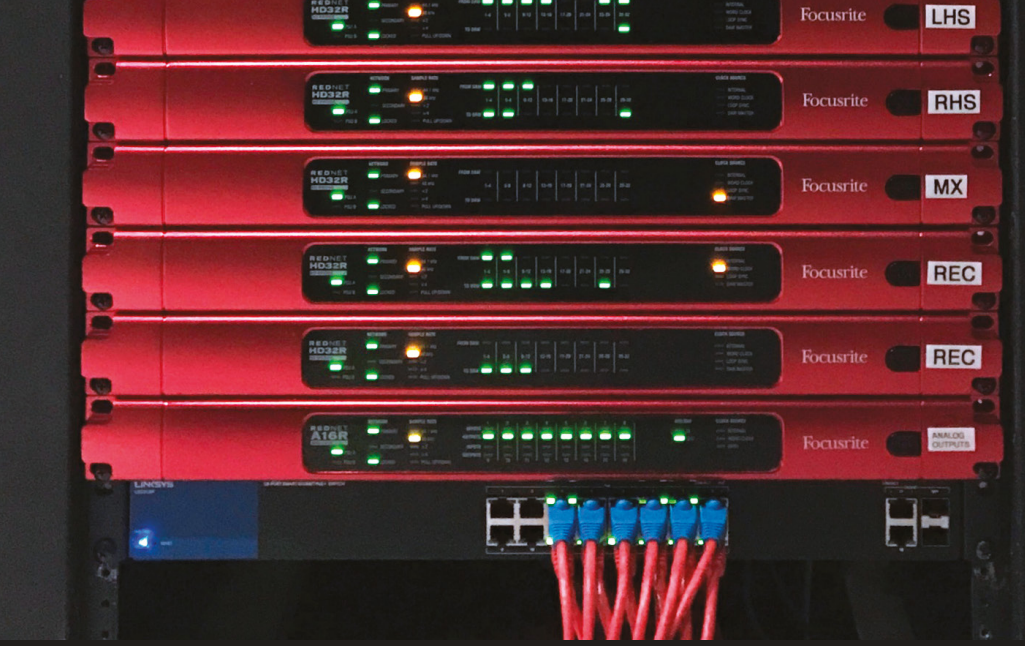
5.5. Security & Audio Stability

The security of an AoIP network and installation is not just about unauthorised use and data theft however; security and quality of service is also vital. An AoIP system is close to useless if its users can't be confident of glitch and drop-out free network performance, so Dante uses standard network configurations such as Quality of Service (QoS) to attach a priority tag on every packet of network traffic. If, for example, a network switch receives two packets at once, it will prioritise the QoS-tagged packet.

On smaller systems, or in scenarios where there isn't dedicated IT support, the notion of setting up an IP network could be quite daunting. There are some simple steps that can be taken to make things run smoothly however. For example, 'Managed Layer-3' network switches are only slightly more costly than non-managed alternatives, but offer more flexibility when it comes to configuring and customising networks. For username and password control, a server will be required to run Dante Domain Manager, but a server will also add the benefit of providing remote storage for things like session templates. And the actual cost of implementation can be surprisingly low.

6. INTEGRATING AoIP WITH CONVENTIONAL WORKFLOWS AND SYSTEMS

- **6.1 - Case Study : Westwind Media** - Four-stage mix facility with comprehensive Dante AoIP infrastructure
- **6.2 - Case Study : The Formosa Group** - Extensive AoIP infrastructure relies on Dante & RedNet



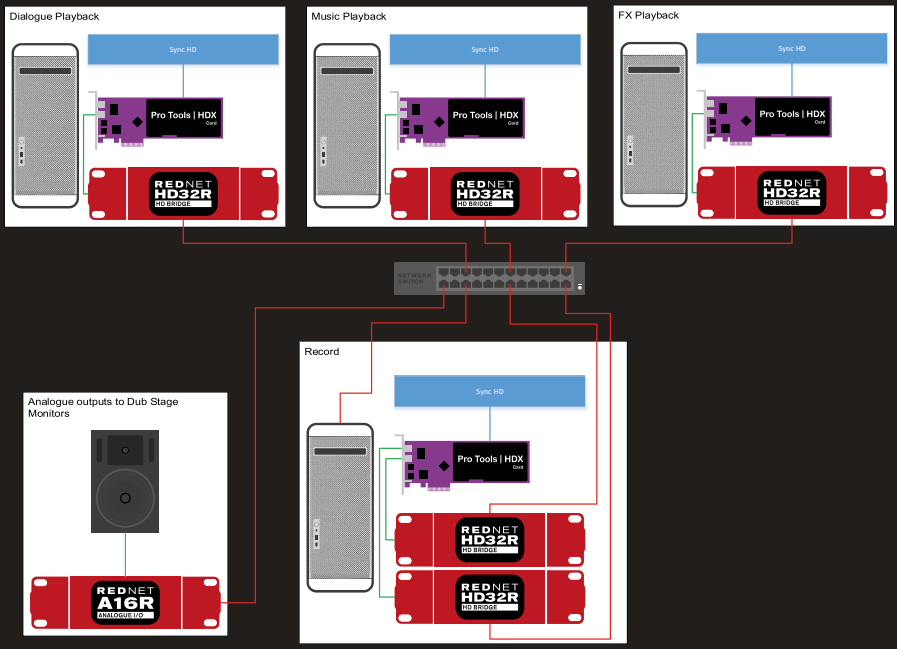
CASE STUDY: WESTWIND MEDIA

Four-stage mix facility with comprehensive Dante AoIP infrastructure

Westwind Media's large-scale facility in Burbank, CA provides post-production picture and audio finishing services to TV and film clients. Recent studio upgrades include a total of 29 Focusrite RedNet devices, which were installed across all four of Westwind's sound-mixing stages.

Each mix stage houses five RedNet HD32R units: one each for playback of music, dialogue and effects, and two for the stems recorder. All of the Pro Tools systems are outfitted with Avid Pro Tools | HDX cards, and Avid D-Control consoles provide industry-standard work surfaces in every room. Each mix stage also houses one RedNet A16R to provide analogue audio for the stage's monitors, and there are three RedNet AM2 units per stage providing headphone feeds for the playback systems. Additionally, there are spare RedNet A16R and D16R units available to any stage for additional analog or digital I/O as needed.

"The RedNet systems really filled a huge need at the studio," says Craig Holbrook, the studio's Chief Engineer. Not only does the new system significantly increase each mix stage's I/O count, it also streamlines the day-to-day operations of the facility. For instance, if a client books a Dolby Printmaster, Dolby can bring in a Dolby Digital Mastering system (DMU), a necessary component in creating Dolby Digital soundtracks, which can quickly be integrated into Westwind's workflow through one of the RedNet D16R units. Holbrook comments, **"we can connect [the DMU] on a single Cat-6 cable quickly and reliably. We've eliminated the potential for connectivity problems. That's one less thing to think about during a session; for the client and for us."**



Westwind Media's RedNet inventory:
15x RedNet HD32R 32-channel HD Dante® network bridges, 4x RedNet A16R 16-Channel Analog I/O interfaces, 9x RedNet AM2 Stereo Audio Monitoring Units, 1x RedNet D16R 16-channel AES3 I/O interface.

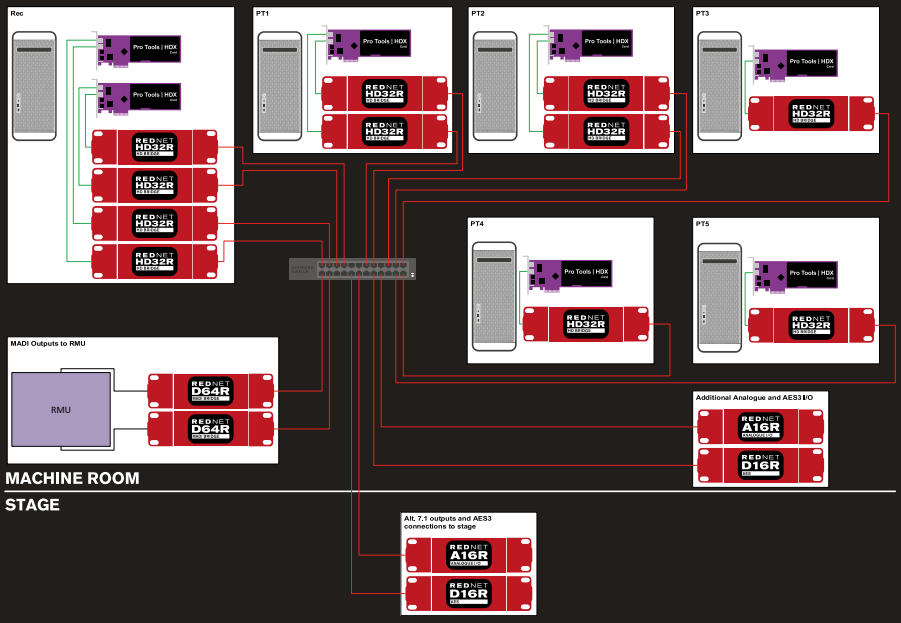
CASE STUDY: THE FORMOSA GROUP

Extensive AoIP infrastructure relies on Dante & RedNet

The Formosa Group is a collective of professionals who are cornerstones of the sound teams for titles like Game of Thrones, Transparent, SWAT, Scorpion and other hit television and film properties. The Formosa Group brings massive technical and creative talent to bear on the content explosion taking place in recent years. To keep up with demand, The Formosa Group turned to Focusrite RedNet audio interfaces to increase efficiency and effectiveness of their expanding campus of facilities.

The Formosa Group now boats seven locations around LA. Common to all facilities is an AoIP backbone that relies on RedNet and Dante. Across the numerous sites, more than 70 RedNet units enable high I/O counts, streamlined workflow and, most importantly, trouble-free operation to Formosa technical teams, allowing the Formosa empire to offer the highest client experience.

Critical to Formosa's operation is RedNet's ease of use, as Bill Johnston, Vice President of Engineering at The Formosa Group says. **"Our mantra has always been 'simplicity, and that's what the RedNet technology does for us. It makes things simple, transparent and very reliable."** Johnston points to a common signal path now used in several of The Formosa Group's facilities, in which the output of all of the studios' Avid Pro Tools | HD systems are interfaced through RedNet HD32R units, then into a BSS Soundweb London BLU-806 Dante-compatible processor, which feeds the Crown DCI Series amplifiers used to power the facilities' monitoring systems. **"We've been using the BSS processors as the Dante interface for the amplifiers, but now that the newer Crown amps are Dante compatible, we'll be able to go directly into them in the future just using the AM2 units,"** Johnston explains. **"At that point, we have a digital audio signal all the way until it reaches the actual speakers."**



Formosa Group RedNet inventory:

38x RedNet HD32R 32-channel HD Dante network bridges, 10x RedNet D16R 16-channel AES3 I/O's, 1x RedNet A16R 16-channel analogue I/O interface, 2x of RedNet 6 MADI bridges, 12+ RedNet AM2 stereo audio monitoring units, RedNet 2 16-Channel A-D/D-A interfaces

Apart from simplifying the system and maintaining the signal integrity, Johnston says putting the facilities on RedNet has streamlined their workflow significantly, in the process bringing costs down. **"Once the audio is on a network, we can pull it from anywhere to anywhere just by bussing it, so we don't have to send it through a router,"** he says. **"That eliminates the need for, and the expense of, MADI routers and MADI interfaces."** In fact, he says, selling the studios' old MADI infrastructure has helped pay for more RedNet units throughout the new facilities. And since RedNet has its own internal clocking—the RedNet A16R also outputs word clock—it can sync easily with the rest of the digital infrastructure in each studio, further expediting workflow. **"We're using multiple Pro Tools systems but through RedNet, we only need a single Sync I/O for everything. In fact, Avid told me, 'You can't do that—it won't work.' And I said, 'But we're doing it and it is working!'"**

7. FURTHER READING

If you've reached the end of this piece, further reading might well be the last thing on your mind, however there are numerous worthwhile resources available online that can provide a wealth of useful AoIP information and guidance.

Audinate provides a huge volume of Dante support documents, FAQs, case studies and training videos via both its own website and its YouTube channel.

For support documentation start here:

- **https://www.audinate.com/resources/technical-documentation**

For FAQs go here:

- **https://www.audinate.com/resources/faqs**

For case studies go here:

- **https://www.audinate.com/solutions/markets**

For training videos go here:

- **https://www.audinate.com/resources/videos**

And for Audinate's Dante YouTube channel go here:

- **https://www.youtube.com/user/audinate/videos**

The product pages of the Focusrite Pro website cover the basics of each RedNet hardware device:

- **https://pro.focusrite.com/category/audio-interfaces**
- **https://pro.focusrite.com/category/audio-over-ip**

The Focusrite Pro website also carries a large collection of AoIP case studies and technical articles here:

- **https://pro.focusrite.com/case-studies**
- **https://pro.focusrite.com/technical-articles**

Focusrite also regularly publishes technical articles, case studies and more technology pieces on the medium.com publishing platform.

- **https://medium.com/focusrite-spectrum**

In addition to Focusrite and Audinate's online support and information, there are a number of news, commentary and blog sites that cover AoIP and associated technologies. A few examples of these are here:

- **https://www.thebroadcastbridge.com**
- **https://www.pro-tools-expert.com**
- **https://resurface.audio/**

8. CONTRIBUTORS

Author: Phil Ward
Case Studies: Clyne Media
Editor: Chris Mayes-Wright

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