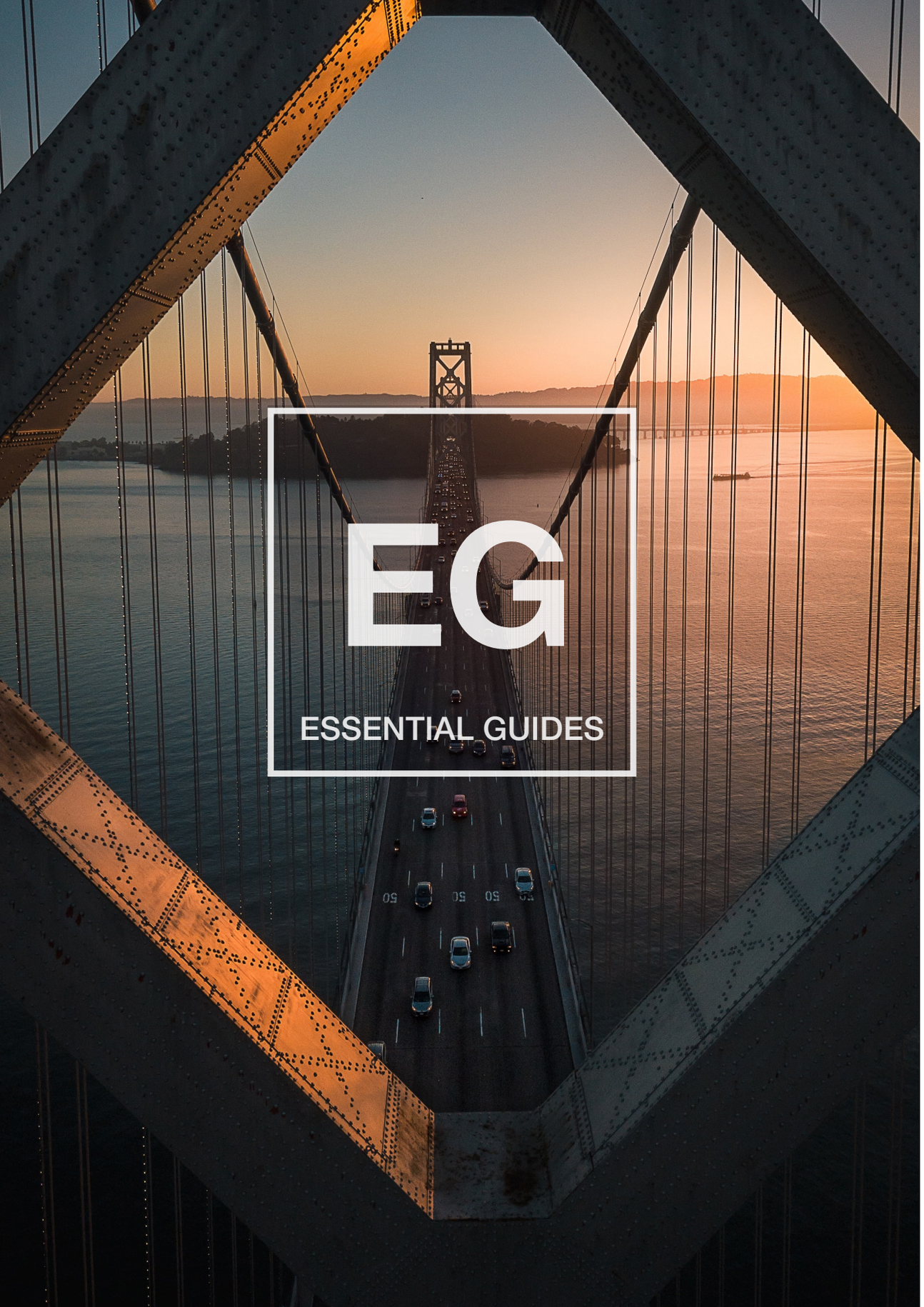

BROADCAST
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Essential Guide:

Comms In Hybrid SDI - IP - Cloud Systems

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Introduction

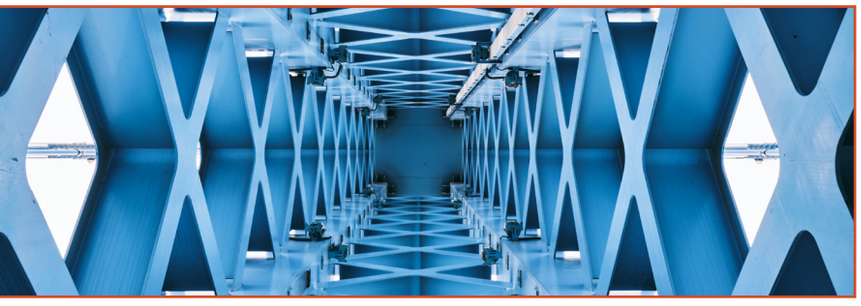
By Dan Duffell. *Content Director at The Broadcast Bridge.*

Comms is one of the constants of broadcast production. The network architecture upon which we must deploy our comms systems is constantly changing. This Essential Guide explores the ever evolving combination of baseband, IP and cloud-based infrastructure, comms must reliably traverse.

Our teams and our production facilities are responding to the need to be more flexible and scalable, and often this means people and resources which are distributed across multiple locations, and increasingly with remote sports production, those locations can be thousands of miles apart.

IP networks are rapidly becoming the backbone of our broadcast infrastructure because the flexibility and scalability they bring enables these new distributed workflows. Many completely new facilities are deploying 100% IP infrastructures, but most systems are using a combination of IP, SDI and new cloud-based workflows. System designers are selecting a hybrid mix of technologies, leveraging the best combination of systems to fit the workflow and budget requirements at hand. Deploying effective comms within this dynamic infrastructure presents some interesting challenges.

This Essential Guide discusses the demands placed upon IP native & hybrid comms systems for scalable and remote teams, and some of the approaches deployed to meet the challenges.



Contents

Comms In Hybrid SDI : IP : Cloud Systems

By Kevin Emmott. *The Broadcast Bridge.*

We examine the demands placed on hybrid, distributed comms systems and the practical requirements for connectivity, transport and functionality.

The Silent Partner

Intercoms are the silent partner in every broadcast environment, quietly keeping every single person on a production in the loop.

Production personnel on a live broadcast can be anywhere. From the director in the heart of the control room, to talent on the studio floor, camera operators, runners and floor managers, so efficient and reliable communication is essential. It is the comms that ensures everyone hears exactly what they need to hear, when they need to hear it, wherever they are.

Today, with more productions split across multiple sites and reporters operating in remote locations, and with all of them embracing different connectivity formats, the comms system provides the fabric to manage the entire signal flow. Whether it's the interruptible foldback in the talent's earpiece or the instructions to camera four to switch to a wider shot, the comms system delivers the connectivity for anyone to talk to anyone else across panels, belt-packs and radios.

But intercom systems are not just about guaranteeing a quality of service for all these signals; they are also about how they are managed and controlled, who has access to them and how everything hangs together.

Geography has always been an important consideration in broadcast communications, but changes in the way broadcasters work have had a massive impact on how intercoms are delivered and moves towards IP-infrastructures are demanding step-changes in how these networks are managed and where they might go next.

Meanwhile, the decoupling of audio from video is encouraging the adoption of scalable cloud-based workflows.

Nothing is the same as it was. And that's a good thing.

The Big Shift

Analog comms systems have always provided reliable one- and two-way communication between selected people, or Partylines between multiple people at the same time. And they still do, but VoIP, Dante, AES67 and SMPTE 2110 networks are changing the game. Established IP protocols are not only simplifying connectivity, but they are making it more efficient by carrying more signals of asynchronous audio down fewer cables.

This is nothing new. In fact, non-synchronous broadcast audio transport dates back to the 1990s when the telecoms industry first used fixed data packets to transfer audio over long distances. As a point-to-point infrastructure it was not as flexible as modern IP networks, but it proved the use case of using packets for transferring real-time data.

Today, IP infrastructure promotes much greater flexibility at lower latencies, it is an enabler for cloud workflows, and it is hugely scalable. It enables companies to provide remote support, and it does all this using cost-efficient COTS equipment.

The reason that broadcasters have been able to take advantage is that they are all on the same roadmap. Thank goodness for standards.

We Have Standards

Since its introduction in 2016, the SMPTE 2110 (ST2110) standard has governed all broadcast IP infrastructures and covers how video and audio media streams are packetized on a network. But while the audio element (ST2110-30) is based around the AES67 standard, it doesn't mean that all AES67 devices are compliant with ST2110.

Despite differences, which include support for IGMPv3 which enables multiple devices to receive the same stream, they both share the same approaches to important shared components, such as adherence to the RTP (Real-time Transport Protocol) and time alignment with PTPv2 (Precision Time Protocol), both of which we will cover later.

It's not to say other IP codecs don't exist either; they do, and proprietary protocols like Dante and Ravenna are no strangers to broadcast infrastructures, although all are compatible with ST2110 streams.

Power & Control

Adherence to the ST2110 standard helps create cross-vendor support and eases the transition from more traditional SDI networks to IP networks, but it is only part of the story. ST2110 only covers encoding, transport and synchronization of broadcast media streams.

To be truly effective, the discovery and management of devices on a network should also adhere to interoperable standards. As a consortium made up of the Advanced Media Workflow Association (AMWA), SMPTE, the EBU, and Video Services Forum (VSF), the Joint Task Force on Networked Media (JT-NM) provides a series of recommendations with guidance on how to approach these aspects.

NMOS IS-04 and IS-05 both have wide support from audio for broadcast manufacturers. IS-04 provides a way for devices to advertise what media streams they are outputting, and once advertised NMOS IS-05 forms connections between them. IP networks require these as an absolute minimum, while recommendations like IS-07 (which provides the potential to stream status and control data with GPIO-style switching) and IS-08 (which gives IP networks the ability to do audio channel mapping), continue to add value.

Building Bridges

These are all important considerations for broadcasters, but more crucially for broadcast vendors; without interoperability, IP has few benefits to leverage.

Keeping up to date with evolving standards is one of the biggest challenges for technology suppliers. Unhelpfully, they don't develop at the same rate, and interoperability is compromised further because vendors don't implement changes at the same rate as each other.

Large IP infrastructures are constructed using a combination of technologies made up of islands of IP, and bridges which connect these islands together. These bridges, or gateways, provide the glue which allow IP networks to operate, and are the reason why most broadcast IP networks are hybrid SDI/IP systems. They work by embedding and de-embedding multiplexed audio between SDI/MADI and ST2110, and often incorporate additional codecs like Dante.

Launched in 2006, Audinate's Dante is well-liked by audio folks because it already does everything they need; it discovers, routes, and manages signals under the hood, and is well established in many broadcast infrastructures. But if the main transport is over ST2110, it needs bridging.

No Such Thing As A Standard IP Network

Although the industry seems to currently have settled on ST2110 and NMOS for transport and management, every single IP network is constructed using different combinations of equipment, and network designers have to approach each project on its own merit.

In addition, unless an IP infrastructure is a greenfield build, switching to IP from a traditional baseband network is not easy; particularly if the broadcaster is still on air at the time.

And we haven't even mentioned the cloud yet (but, inevitably, we will).

Shifting Infrastructures

Broadcast workflows are nothing like what they were, and robust connectivity has changed the landscape more than anything. As access to connectivity continues to evolve, broadcasters have more options to move data around, and that connectivity means that every production can be designed to meet production needs in the most efficient way possible.

Technologies like private 5G, mesh networks, LEO satellites, dark fiber and even public internet can all provide effective transport, and these things are making a big difference, especially to distributed production.

Remote and distributed production has long been a discussion point for broadcasters, but world events in 2020 forced the issue and people latched on quickly. Now it's on the table for every outside broadcast. With no requirement to ship expensive equipment to a venue and staff it with multiple engineers and professionals, remote production has opened the door to more content, while hybrid models with distributed audio processing across multiple sites is much more common.

It's all about using the right tool for the job.

Monitoring

For audio, where distance equals latency, remote production tends to mean remote control of a processing engine at the venue. The mixer might be in a different location (it could be a studio, another OB truck, or their home) but the audio processing is at the venue. A big part of why this is important is down to comms, and it's the biggest challenge for remote broadcasting as production teams become more geographically distributed.

Every broadcast uses in-ear monitoring (IEM) where on site production personnel need to hear themselves and production comms in real time. Talent also use interruptible foldback (IFB), which are mix-minus feeds from the studio consisting of a

full programme mix, minus their own voice.

Distance makes this difficult due to the time it takes to move those signals around, so remote control of on site processing (often referred to as “edge” processing because of where it is located) is highly effective.

But distance is not the only latency that comms needs to plan for.

Latency

IP decouples the audio from video so that each is treated independently, which means that every audio signal needs to be resynchronized relative to one another. With sources coming in from many different locations,

time-alignment can be complex, and IP systems have to be adept at managing sync and latency.

How signals are being delivered plays a role; are they on dedicated fiber links, on public internet, Wi-Fi, satellite, or 5G cellular data? Some of these won’t be deterministic. How does that change things? Some timings may drift depending on the route taken, and introducing more switch hops introduces even more latency.

The conversion of analog signals to data packets also takes time, and the analog to digital (A/D) conversion to transport the signal needs to be reversed at the other end with a similar digital to analog (D/A) conversion. Network design will play a role in this too, as total delay will depend on the combination of equipment the signal passes through.

Even the structure of the ST2110 data packets has an influence, with packet times having an effect on bandwidth and latency due to how long everything takes to packetize. Forward-thinking network designers can also influence these.

Sync & Timing

In all these cases, tracking timestamp within data flows is critical to realigning them later. ST2110 uses the Real-Time Transport Protocol (RTP) to help align signals with variable latencies. It does this by using buffers to compensate and align signals which arrive from multiple places.

RTP is time aligned with PTPv2, a Precision Time Protocol used by ST2110 which provides timing for every device on an IP network by syncing to a grand master clock (GMC). The GMC can be either a dedicated device or any device on the network, and every networked device is assigned a leader/follower relationship. This covers everything, from vision switchers to cameras to intercoms.

All this means that rather than embedding the audio with video signals, ST2110 processes audio and video independently of external timing processes, synchronizing everything relative to these timestamps instead.

It’s a different way of working, but it also gives broadcasters the ability to do things in new ways, helping to usher in the possibility of cloud production.

Hybrid Cloud

In practical terms, cloud production isn’t the same as traditional production – there are no big audio processing engines in the cloud which operate the same as an on-prem or edge processer. Not yet.

In most cases, cloud production is a hybrid of remote production methods, where audio signals might be sent into the cloud rather than a remote operations center (ROC), and latencies can be influenced by carefully choosing where the cloud processing location is. Like choosing to use edge processing for IEM at a venue, network designers can influence latencies for control by using cloud facilities which are closer to the control.

But the point is that it is all hybrid. The cloud extends the number of options available to broadcasters to tailor the production for the most efficient use of facilities: on-prem, outside broadcast, remote production, or a combination of all three. Hybrid models are a big part of today’s broadcast landscape and the cloud will increasingly be seen as an additional DSP resource which can be accessed when it is appropriate to do so.

Endpoints

Intercoms have to work within this rapidly evolving environment, dealing with hybrid systems which change depending on the production, and with inherent latencies in increasingly remote and distributed workflows.

The requirement to have reliable comms is unchanged, and as we have established, intercoms are the silent partner in broadcast environments; they should be invisible to the customer. The customer just needs them to work.

All this means that broadcast intercoms have to tick a number of boxes.

- They must be flexible to work with different network designs.
- They must be upgradeable to adapt to changes in technology, and to integrate into evolving infrastructures, such as changes in hardware or orchestration systems.
- They must be scalable to account for changes and flex with requirements.
- They must be versatile enough to deal with different signal and codec

types, and handle them all in a transparent manner.

The same design considerations still exist, such as identifying endpoints and configuring permissions on each one, such as who needs to talk and listen, and who just needs to listen. Modern comms networks need to be able to pivot, and comms networks are no longer just about choosing the right hardware for today's job; they need to adapt to evolving requirements without the customer having to invest in additional equipment or services.

Software-defined Hardware

Software-defined hardware is a way that vendors are helping meet these challenges, promoting flexibility to adapt to whatever ecosystem is working today, as well as helping to future-proof systems for tomorrow. Modular systems which can be adapted to meet changing needs are also more commonplace, with hardware panels which can combine multiple features like intercoms, router control panel and audio monitors on a single device.

As well as being able to quickly adapt to different environments, modular software and hardware takes up less rack space and consumes less power and can also reduce the number of switch ports on a network.

It's all about working harder as well as smarter.

IP Does A Lot Of The Work, But So Does Everyone Else

Thanks to IP standards like ST2110 and NMOS, most IP equipment delivers interoperability, and most vendors supply bridges to maintain the relevance of their incumbent equipment.

This gives broadcasters a choice of orchestration systems to manage the delivery of media data over IP networks. Orchestration systems provide a single point of control for managing and configuring IP broadcast systems, and the enormous benefit of the industry's adherence to ST2110 and NMOS means that there are a number to choose between.

Intercoms has to play the same game, keeping across all the recommendations, to make it easy for broadcasters to integrate, automate and centralize their operations along the same lines.

But is also demands more open collaboration with other technology companies, across all the broadcast disciplines. Organizations like the Alliance for IP Media Solutions (AIMS), whose sole aim is to foster the adoption of industry standards to enable the shift to IP, are integral to this. Encouraging regular interops between a range of manufacturers, they build relationships and encourage conversations to explore how systems work with each other in real environments.

Scaling Up

IP is already delivering the goods, but it's not an easy path to tread and every single implementation item has to be planned and tested individually.

It enables cloud integration, and it emboldens remote working; it enables broadcasters to quickly scale up a network infrastructure without physical rewiring; it creates efficient systems which are designed around production requirements; and it leverages existing network infrastructures and COTS equipment, reducing costs and simplifying installation.

We're all in it together, and we can all reap the benefits together.

But to make it all work, we all need to work together too.

Sponsors Perspective: NFL Media Relies On AoIP

Comms To Keep It's Productions Running Smoothly

By Jake Dodson. *Executive Director Product Management - Riedel Communications.*

The team at NFL Media share invaluable insight into the truly huge AoIP comms system at their Hollywood Park production center.

For the production teams at NFL Media, perhaps the most useful technology is an easily scalable Audio-over-IP (AoIP) broadcast communications system that reaches into every part of the facility-wide SMPTE 2110 IP infrastructure they've set up.

It's used on a daily basis by dozens of engineers, producers, talent, and system operators that oversee the production of content for the National Football League's direct-to-consumer presence online and on mobile devices.

The NFL's West Coast home is located on Los Angeles Rams owner Stan Kroenke's $5 billion, 296-acre Hollywood Park (in Inglewood, Calif.) property. The production facility was completed in 2021 and includes the official home for NFL Network, NFL.com, NFL RedZone, the NFL app, and NFL Media. (The league moved from aging facilities in Culver City and now boasts a state-of-the-art, all-IP facility with backup generators and transmission systems for redundancy.) The headquarters is connected to all 30 NFL stadiums via 10-Gbps interface and all 32 NFL practice facilities.

Comms Is Crucial

The production technical team at NFL Media, led by senior tech manager Rhett VanBuskirk, helps produce studio and remote shows from its dedicated facility in Inglewood, as well as podcasts, streaming media programming, and eight live televised games (including two in London and two in Germany) each season on the NFL Network Channel—which is seen by millions of online and mobile users worldwide. Live games played in the U.S. are produced with the help of Game Creek Video and NEP, two entities that also help televise NFL games for CBS Sports.

"Comms is crucial to everything we do here at NFL Media because we have people in multiple locations that need to reliably communicate," said VanBuskirk. He added that any comms signal can be routed to any location desired—either within the building or elsewhere. "From starting the game on time with the local referees, to the talent in the booth and the entire production team in the studios, they all have to be on the same page and coordinate with reliable intercom systems. Everything is time based when you start doing a live broadcast, so coordination—including letting everyone know when we're going in and out of commercials—is essential."

The comms part of NFL Media's workflows are supported by a system that features a Riedel Artist ST2110 IP intercom system with over 2,000 ports. The main production facility also has fiber connections to to SoFi Stadium, which is located next door to the NFL's new building in Inglewood. They also use over 100 Riedel Bolero wireless belt packs across its six production studios and several dozen others for teams working remotely.

VanBuskirk helped design the workflows and oversaw the install of the comms and audio systems at NFL Media, which took nearly two years to complete. One and a half of those years was at the Diversified Systems Inc Burbank facility, and then the system was brought over to Inglewood for a quick 3-month install to start the 2021/22 season.

There are also 40 Bolero antennas that are utilized for the wireless belt packs to support the 6 studios and control rooms.

AoIP Networking Gets It Done

The control rooms - supporting such programs as "NFL Total Access" and "NFL GameDay" with a 5,970-square-foot soundstage that provides 360-degree camera views and a catwalk for talent - features a 12-foot wall of high-definition screens that can simultaneously display 253 different video feeds, including shots from

the 30 NFL stadiums, as well as a multitude of audio resources available at the touch of a few buttons.

NFL Media is currently producing 1080p60 broadcasts with Dolby 5.1 audio, but VanBuskirk said the IP infrastructure in place is capable of 4K/60 fps with Dolby Atmos 7.2.4 audio and can scale to any format in the future, including HDR or 8K. To bring this all together, the NFL Media facility has nearly 18,000 Dante audio network connections, 16,000 MADI connections, and 2,000 Riedel intercom channels. VanBuskirk claims it's one of the larger Dante installations in the world.

The facility is also utilizing Dante Domain Manager network management software to secure the various audio networks and allow for expansion. It enables user authentication, role-based security and audit capabilities for the in-house Dante networks.

The Dante network and Domain Manager software layer, in tandem with Riedel's Director configuration software, makes it easy for the engineering staff to quickly and easily reorganize audio workflows to bring together the equipment and people needed for any production. Due to the flexibility that the SMPTE 2110 IP standard affords, different control rooms or audio mixing rooms can share resources, or they can be operated separately.

Finding (& Controlling) Devices On the Network

Working with an IP infrastructure also makes equipment easier to handle and devices easier to add (and identify), using the Networked Media Open Specifications (NMOS) protocol to an established network. Every belt pack is accessible on the network via the Bolero Net. Antennas are connected over a strand of one gigabit/second fiber or Cat5 cable - and it makes connecting those involved with the production so much simpler. Supporting NMOS allows a third-party system to automatically discover all of the panel's control elements, like its lever keys or touch screens, and assign any desired functionality to anyone crew/talent member.

And because they are using an end-to-end 2110 signal flow, it's also taking advantage of SMPTE ST 2110-30/AES67 audio networking to route the mix-minuses (clean feeds) and program audio where they need to go with an Imagine Communications 2110 router controlling Riedel intercom mainframes at production headquarters. There's also a healthy amount of Dante and MADI connectivity to the facility's mainframe comms panels involved as well.

Scalability Saves Time And Money

"With an IP network, expanding our comms capability is really easy." he said. "Using an IT facility infrastructure like we have here at NFL Media also saves a lot of money in hardware and external devices. But expandability is probably the biggest thing and we take advantage of this capability within the building on a regular basis. It's easy to add panels and configure ports. I can extend the network from NFL Media to remote crews in the field and across the globe for our international games using a comms panel to communicate with anyone at our Inglewood facility as if they were sitting right next to each other."

While the Riedel systems in place work intuitively, VanBuskirk said that it's important to have an IT team capable of setting up the network.

"Because that's where the challenges are going to be," he said. "It's all about IT network planning and workflows that are needed to move the comms signals around to set up reliable connections between involved parties. The Riedel audio networking equipment gives us the ability to provide access to certain crew members while denying it to others that don't need it. Having too many people on the party line can get tricky and unproductive at times."

Give Me A Line

When a production crew member needs to be added to the audio comms network, that request is sent to the Engineering department, which acts as the administrator of the network and makes the necessary adjustments in Director, which is Riedel's user interface for Artist. Director allows the individual panels to have key assignments, labels, and color codes.

VanBuskirk said good planning helps stay ahead of the game.

"It's about supporting the talent with mix-minuses, which is basically a program feed where they don't hear themselves echoing back, but they hear the other people that are talking to them," he said. "The routing that we can do with the digital IP comms system helps speed that process up. This is huge for us because we do a lot of routing for different shows."

Controlling Access To The Comms Network

NFL Media leverages a "Talk/Listen" workflow where crew members with the proper access can choose what to listen to from scroll lists on the panel, or Director programming. Audio mixers can also add in crew names for those in the production department they need to talk to.

Owing to the flexibility of the Riedel equipment, some crew members can be locked out of the full comms network and only listen in to what's being said. Using Riedel's Edit Conference feature, select operators

with edit rights can add or remove members from conferences and even assign listen only or full Talk/listen rights to any member directly from the RSP-1200 series Smartpanel.

“We really like the lever key functions on the SmartPanel and the volume mute knob within the key,” said VanBuskirk. “The lever key also has very good tactile feedback for when you’re talking and listening because you’re usually looking at monitors in front of you while you’re using it. So it’s nice that it has a really good feel. We also like the bright displays on the panel, which you can change to show large fonts that are easy to see for the operators. You can also have a 16-letter subtitle under it. That’s very handy. Finally, the fact that they blink when someone’s calling you helps the operator instantly recognize who’s calling them.”

Wired vs. Wireless Beltpacks… & Cellphones

For audio production, the various studios are equipped with a mix of 11 Solid State Logic System T Dante-enabled broadcast production audio consoles.

Within the control rooms at NFL Media in Inglewood, all 200 Riedel comms panels are hard-wired throughout the building. Wireless belt packs are mainly used in the studios by the camera operators, stage managers, and other people that need to move around. Both types work the same when it comes to features and functionality. In some cases crew members use their personal cellphones to communicate, utilizing the built in blue tooth feature of Bolero. There are 96 phone lines ported directly into the comms frames. NFL reporters often do call in from their phones right into the comms system.

There are some instances when individual comms signals need to be embedded into a party line of crew members, like if a TD wants to listen to the show announcer for cues. They then use the 1232 SmartPanel to click over to that specific audio feed. They often embed mix-minus feeds in comms for NFL Media’s outbound news content as well.

The Bolero wireless beltpack itself features six intercom channels and a separate “Reply” button for communicating with the last caller. The beltpack can also be used without a headset like a walkie-talkie radio, utilizing an integrated mic and speaker.

The beltpacks support Bluetooth, allowing either a Bluetooth headset or a cellphone to be connected. When a cellphone is connected, the beltpack becomes “hands free,” so NFL Media users can receive calls on their phone and talk and listen via their beltpack headset. Users can also inject their phone calls directly into the intercom channels, providing another level of workflow flexibility.

Using The Cloud For Signal Distribution

NFL Media maintains its own private cloud for the distribution of comms and data back and forth to Inglewood, particularly to connect crews in the field.

“The cloud gives us a lot more flexibility to send and receive signals to and from literally anywhere,” said VanBuskirk. “Once we put encrypted signals in the cloud, we can receive them anywhere.”

Comms Ensure Production Success

At NFL Media, it’s clear that the use of an AoIP intercom infrastructure that is properly set up and configured helps coordinate production staff quickly and efficiently to ensure everything (and everyone) is working at their best. With hundreds of people serving different production positions across the 296-acre Hollywood Park, keeping the lines of communication open is vital to NFL Media’s frenetic content creation.

In short, the key to a cohesive crew is effective communication. It’s essential to make sure that everyone understands their roles and is aware of what is expected of them. This ensures the production workflow will go smoothly.

“Properly deployed comms minimizes errors and adds value to a production’s success,” said VanBuskirk. “We often say team collaboration is critical to productivity and comms are a very important part of any production workflow.”

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