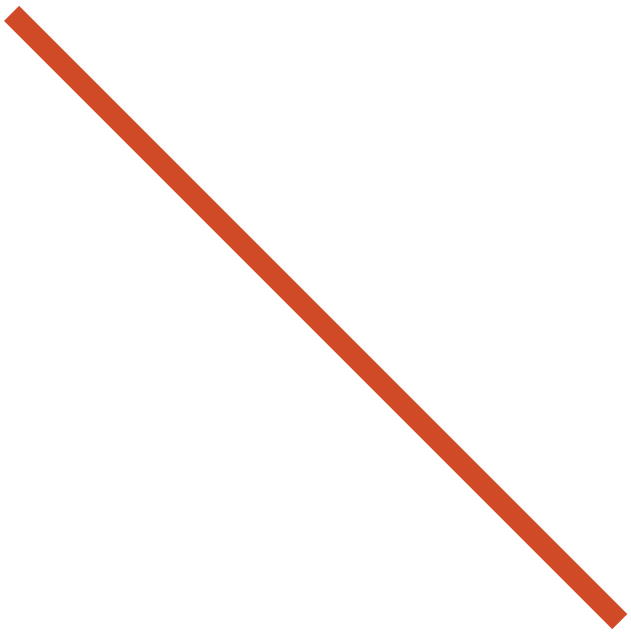
BROADCAST
THE BRIDGE

# Practical SDI and IP



# Essential Guide

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# Introduction

SDI has been and continues to be a mature and stable standard for the distribution of video, audio and metadata in broadcast facilities. From its inception in 1989 to the modern quad-link 12G-SDI available today, it has stood the test of time and even with the advent of IP and Ethernet, it shows no sign of waning.

IP is making a significant impact in broadcast facilities throughout the world and is starting to show its true worth. It's flexibility and scalability empower engineers to future proof their facilities and meet the growing demands of new formats, especially as we move to 4K and 8K.

HDR, WCG and higher frame rates are all contributing to the immersive experience and broadcasters are looking for methods to integrate these formats into their facilities. SDI is more than capable of this, but IP also has much to offer.

Although we speak fondly of SDI and are quite happy to discuss the challenges of IP, SDI's ease of use has not always been a given. Early adopters would regularly find new challenges that they were not aware of when building their facilities. Cable types, lengths and equalizers all seemed to conspire against the engineer. A lack of test equipment further exasperated the challenges and made SDI integration a challenge.

We often forget this when considering IP installations. There will be a point where IP is as easy to install as SDI, and it's fair to say we're not there yet, but the benefits IP has to offer far outweigh the challenges we experience. Prior to SDI we used three cables for RGB distribution in graphics and VT areas to maintain the highest possible video standards and making the cables exactly the same length to stop RGB registration issues was a challenge in itself.

Through the adoption of ST-2110, broadcasters are able to gain unprecedented flexibility. This isn't just about increasing the size of a facility, but also the number of formats that can be combined in one network. Abstracting away the video, audio and metadata from the underlying transport stream, as with ST-2110, gives us the opportunity to distribute, combine, and process video, audio and metadata with great innovation.

Interoperability wasn't always a given, even with SDI. Prior to SMPTE's specifications for inserting audio into the "spare" blanking data, several vendors implemented their own methods of achieving this. These solutions were often proprietary and completely inoperable. Inserting audio into an SDI stream using one vendors solution could not be guaranteed to work with another.

The big advantage of IP is that it is software driven. This will allow early adopters to future proof themselves so that as interoperability progresses, then so will their own facilities as many of the solutions will be software upgrades.

SDI and IP both have their place in broadcast facilities and provide solutions for many different workflow scenarios and in this Essential Guide, we look deeper into the solutions SDI and IP both offers.

Tony Orme
Editor, The Broadcast Bridge

Tony Orme.

# Practical SDI and IP

By Tony Orme, Editor at The Broadcast Bridge

**Broadcasters seem to be faced with a bewildering choice between SDI and IP. Is one better than the other? Are there specific applications for IP or SDI? In this Essential Guide, we take a deeper look at SDI and IP to answer these questions, and more.**

Although SDI is now considered a robust, reliable, and interoperable format, it hasn't always been that way. When video was first digitized, we used SMPTE's ST-125 to distribute digital 4:2:2 component 525 and 625 video over parallel interfaces.

The SMPTE ST-125 format was effectively the predecessor to SDI as the sample rates and formats were similar. The luma component was sampled at 13.5MHz and each of the Cb and Cr signals were sampled at 6.75MHz, both with 10bit depths. A 27MHz oscillator was used as the base sample clock giving a total data rate of 27MWords per second. In this context a word was 10 bits and laid the path for 270Mbit/s SDI.

## Parallel Digital Video

The physical connectivity of ST-125 consisted of a D-Type 25 pin connector. Balanced pair ECL logic provided the ten data signals for each of the bits as well as a separate 27MHz clock signal. Due to the resistance, capacitance and inductance in the connecting cable, data skew and HF attenuation was inevitable, resulting in limited cable lengths.

SMPTE's ST-259M SDI specification provided a method to serialise ST-125 and pass the signal over installed coaxial cables. This greatly improved reliability and the transmission distances were much greater.

This may have solved the initial challenges around distribution, but the interoperability was still to be addressed, especially when vendors started to insert audio into the ancillary areas of the data stream. Originally, some vendors used the available data in the line syncs and while others used the vertical blanking. It wasn't until SMPTE released ST-272 that audio insertion and extraction was formalized and became truly inoperable.

## SDI Early Adopter Challenges

It's not been an easy ride for SDI and any early adopters will remember the challenges faced, even when trying to find the right cable. The primitive equalizers at the time severely restricted the cable available giving rise to high costs and restricted availability.

Even chroma keying had its issues. Before SDI, full bandwidth RGB was fed directly from the camera to the chroma key processor. However, as SDI uses YCbCr, the color bandwidth is limited causing challenges for the chroma key processor. Instead of relying on full bandwidth 4:4:4 color RGB signals, it had to compromise with 4:2:2 YCbCr color bandwidth.

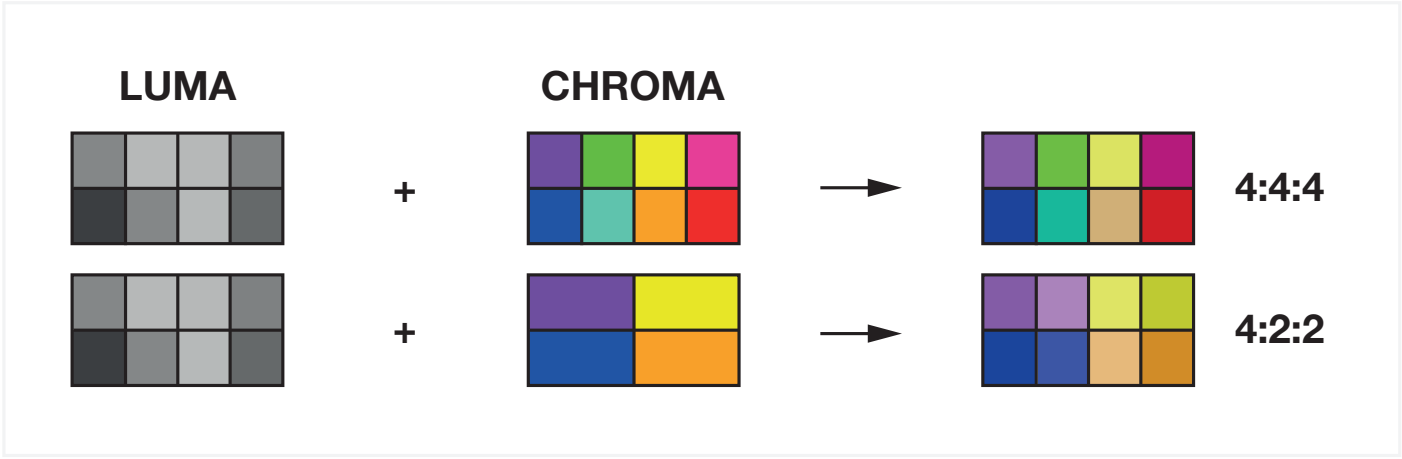
Interoperability is another phrase that is often banded around, but some caution must be exercised when referring to SDI. For example, HD-SDI is definitely not compatible with SD-SDI, the data-rates and bit stream definitions are worlds apart. There are further divisions when we start to look at Dual and Quad 3G, or 6G, or 12G. Although these are all SDI standards, interoperability cannot be assumed.

This is the crux of the challenge when considering IP. We tend to look at SDI through the historic lens of our rose-tinted spectacles. Over thirty years have passed since SMPTE released the first ST-259M specification, longer if we consider ST-125. We've forgotten about the pain we collectively went through all those years ago. It's not that SDI is perfect, by any stretch of the imagination, it's just that we are now more aware than ever of its strengths and weaknesses.

## IP Enabling Technology

IP has exciting potential for broadcasters. Although IP is only a transport stream, it's an enabling technology that further improves efficiencies and delivers new opportunities for program makers.

It is the advent of SMPTE's ST-2110 suite of standards that has really enabled IP to form the core part of a broadcast infrastructure. In effect, ST-2110 has abstracted away the video, audio, and metadata essence away from the constraints of the underlying hardware. This allows us to process the essence streams independently of each other and multiple formats can be mixed on the same network without any special configuration.




RGB signals use 4:4:4 color subsampling, that is full bandwidth chroma. SDI uses 4:2:2 color subsampling giving half horizontal and vertical chroma bandwidth. This provided some interesting challenges in the early days of SDI as chroma keyers preferred to use 4:4:4 to derive the optimal key, however SDI would only provide 4:2:2. This was soon dealt with by vendors and chroma keyers were able to provide high quality keying in 4:2:2 SDI.

The inbuilt-clocking mechanism of SDI makes it robust and easy to use. Connecting a camera to a monitor is an easy and straightforward task as the pictures will instantly appear, without further configuration. However, this strength is also a weakness as it makes systems rigid, it's often difficult to mix 30/1.001fps and 25fps systems on the same network or connect HD-SDI to SD-SDI. It can be done, but involves processing electronics and it's not a standard method of operation.

Deciding between SDI and IP is a seesaw compromise between flexibility with complexity, and rigidity with ease of use. SDI, although relatively static and rigid is easy to use, but only because it's a well proven and understood technology. Whereas IP is new to us and we're still trying to solve many of the challenges we don't yet know we have.

## Timing and Interoperability

It's fair to say that IP is providing us with some interesting challenges, predominantly around the areas of timing and interoperability. For timing, we've had to learn a whole new system of timing distribution and control through PTP, and for interoperability we're expecting plug-n-play to work as reliably as computer networks now operate.

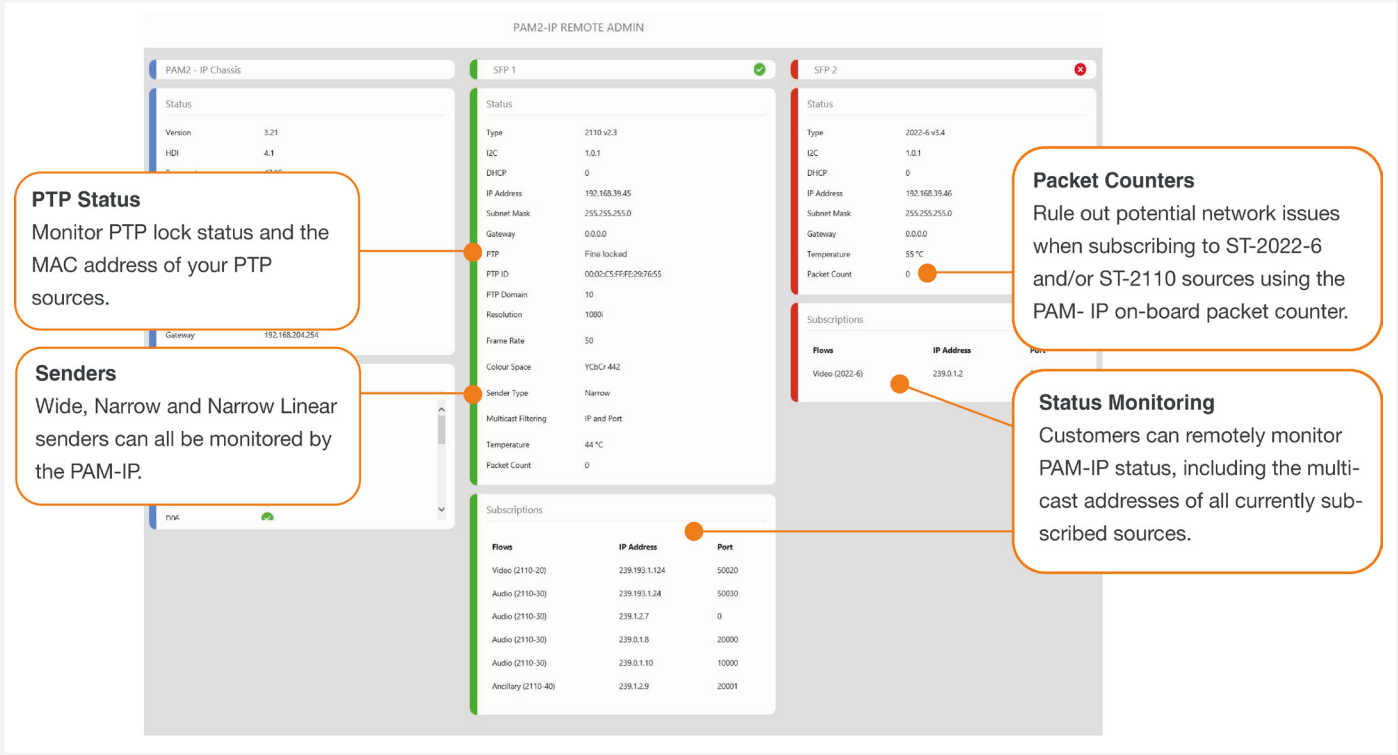
But again, it's worth remembering that plug-n-play in Windows and Linux desktops has only recently become reliable. In the early days of office computing network solutions such as Novell's NetWare was available, but this required highly skilled network engineers to make even the simplest network operate. And installing an ethernet card into a Linux PC in the early 1990's could easily turn into a day's work. Not now, we simply move from WiFi zone to WiFi zone without thinking about the complexity going on in our mobile phones and laptop computers.

NMOS has made some amazing advances with interoperability and many vendors are embracing the need to not only make their systems interoperable, but to make them easy to use. We're not yet in plug-n-play territory but the future is definitely bright and its only a matter of time before self-discovery and automatic configuration will become common place.

## Thousands of Multicast Streams

It's not uncommon for an IP broadcast facility to have tens of thousands of essence streams in a station. Each camera will have multiple video inputs and outputs as well as control, tally and intercom connections. Multiple six camera studios combined with all the associated graphics, playout and processing, soon mounts up and tens of thousands of IP multicast essence streams soon becomes a reality.

The advent of IS-04, -05, and -06 will easily facilitate management and control of broadcast facilities paving the way for software defined networking and highly dynamic and configurable systems.




Vendors are now providing products with both IP and SDI connectivity, such as TSL's PAM1-IP-3G and PAM2-IP-3G.

Control is another aspect of IP where NMOS is making great in-roads. After nearly a hundred years in the broadcast industry, few would predict the death of the GPI, but the introduction of a well-defined protocol, such as AMWA NMOS IS-07, provides a reliable and convenient method of carrying time sensitive information including tally and control panel push buttons. GPI's stretch deep inside many broadcast facilities but having a well-defined IP exchange method delivers greater integration and interoperability.

PTP is exciting as we can distribute timing information over the same network as the essence streams giving unimagined flexibility and efficiency. We certainly have to start thinking differently in terms of how our network is connected as SDI is a point-to-point system, but IP networks are more of a mesh configuration.

## Knowledge and Experience

SDI still has its place and will continue for many years to come. Although our perception may be that it's easier to use than IP, at the moment, this is based on our years of experience of working with it and the knowledge we've gained. Fly-aways and static systems such as SNG trucks all benefit from the rigidity that SDI offers, especially in news environments where time is critical for real-time broadcasts, but it's now only a matter of time before IP catches up.

IP also allows us to benefit enormously from the innovation in IT. Vendors are already building ethernet switches with speeds of 400Gb/s, and 800Gb/s is actively being considered and designed. SDI has a natural limit in terms of routing size as we get to the point of diminishing returns, especially when we start looking at dual and quad SDI. All of a sudden, our router halves or quarters in size.

SDI may work well for some broadcasters as they don't need to be concerned with the flexibility that IP offers. Instead of seeing IP technology overtaking the world, what we're tending to see is a greater demarcation between SDI and IP applications.

When considering whether to use IP or SDI, it might just be worth remembering that SDI didn't just happen magically. As an industry, we went through a lot of pain to make it work as reliably as it does today. But with IP, much of the groundwork has already been done for us by the IT industry. Yes, broadcast is a specific use case, but the incredible benefits to be gained are just around the corner.

# The Sponsors Perspective

## What is SDI and Where is it Going and Why IP?

By Mark Davies, Director of Products and Technology, TSL

SDI is one of those technologies that is so well established and ubiquitous it can almost be taken for granted.


It has been a mainstay of broadcast technical infrastructures, both in TV studios and outside broadcast (OB) trucks, for so long people could be forgiven for thinking it will always be there. But, as with many other formats before it, SDI is reaching a point where its dominance is being challenged in a technology market experiencing significant changes that call for more effective solutions.

The continuing move towards 4k/UHD (Ultra High Definition) resolution production and delivery, championed by streaming services Netflix and Amazon Prime, is only increasing the pressure on SDI and the traditional infrastructures based on it. With broadcasters and OTT operators already considering following the lead of NHK in utilising 8k for prestige live events - as the Japanese broadcaster is for the 2020 Olympics in Tokyo - and the possibility of even higher resolutions, those limitations will be even more apparent.

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IP has long been held up as the successor to SDI but it is only now that the younger technology is proving itself as the way ahead. The demise of SDI has been predicted in recent years and since I joined TSL Products three years ago there has been a significant increase in the number of people depending on IP. But it will not be an easy transition between the two and people are still talking about SDI, despite the number of new studios and OB trucks that are now being built with IP foundations rather than its more venerable competitor.

SDI was a major move on from analogue component video, which, with composite, had been one of the two main formats in broadcast video during the 1980s. In those days TV centre installations demanded much more space, cabling and interfacing than they do now. This was largely due to the need for two routing systems; one for video, one for audio.

The beauty of SDI was the ability to carry digital component video and digital audio down a single coax cable. Only one router was necessary because audio was embedded into the video signal. In that respect, SDI was a transformative technology but perhaps engineers and integrators working with it in the 1990s did not imagine they would still be using it in 2020.

A major turning point came in 2016. There was the belief that UHD would become a requirement for live coverage of sport and other events but to become a reality it needed both broadcast and IT manufacturers to work together closely and deliver the overall system. While 12G-SDI is able to accommodate UHD signals, operators and broadcasters now have to consider at this point whether they should be building an OB truck or studio based on that format. In a couple of years time customers could be specifying 8k, which would call for a Quad Link approach and a return to more than one length of cable.

This could be considered a backward step, particularly because SDI was the technology that got broadcasting on to one coax and away from multiple routers. The market as a whole is shifting even further away from proprietary, traditional approaches.

It is understandable that some people are still wary of IP. It certainly had its teething troubles - as did SDI, and we are already seeing manufacturers of 3G-SDI products seriously consider the prospect of upgrading their products to support 12G-SDI. IP is a major investment for our customers, who will wonder how long an installation will last before they have to replace it again. The promise of IP however is that once the infrastructure is in place it does not have to be replaced. Whether the content is HD, 4k, 8k, live or recorded, the IP switches can handle it and remain in place because they are just passing packets of data.

Mark Davies, Director of Products and Technology, TSL

TSL are now seeing the biggest growth for our company in the adoption of IP products, yet we remain committed to SDI because there is no need to fix what isn't broken. After all, everything comes down to application and we feel a responsibility to ensure that broadcasters and media owners are armed with the latest knowledge and tools that will make their lives easier. By keeping our ear to the ground and working alongside our customers we will continue to design products and solutions that empower and allow them to take ownership of their systems. To benefit them with extended life-time value so that when they do invest with us, underlying infrastructure and skillset is the least of their concerns.

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