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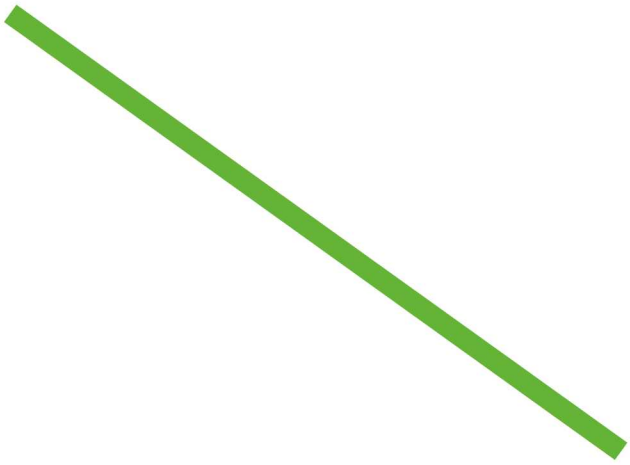
Connecting IT to Broadcast

Flexible IP Monitoring



Essential Guide

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ESSENTIAL GUIDES

Introduction

By Tony Orme, Editor at The Broadcast Bridge

Video, audio and metadata monitoring in the IP domain requires different parameter checking than is typically available from the mainstream monitoring tools found in IT. The contents of the data payload is less predictable and packet distribution more tightly defined leading to the need to use specialist media stream centric monitoring tools.

ST2110 is the first step for many into the IP world. To keep latency low, the designers restricted ST2110 IP packet distribution to tight tolerances so that smaller receive buffers are required, which in turn leads to lower latency. This is quite a unique method of operation for IP networks as packets in traditional IT workflows tend towards a more flexible distribution. To rebuild the data for the higher-level applications, large buffers are needed at the receiver which in turn leads to higher latency.

Although PTP is used in wider industry, regular NICs (Network Interface Cards) are not able to meet the tight timing constraints ST2110 demands and specialist NICs with hardware PTP processing are required. This further leads to the complexity broadcasters demand from their monitoring equipment.

The data domain in a broadcast IP environment represents the video, audio and metadata. Other than when using test signals, it's difficult to predict data values with any certainty due to the dynamic nature of video and audio. Our human visual and auditory systems are extremely adept at detecting differences and faults. Hence the reason that broadcast engineers often opt to display the video data on screens and listen to the audio data on loudspeakers.

Monitoring in the traditional broadcast sense is merely representing the underlying data in a different domain, that is vision and sound. Looking at thousands of data samples flying past our eyes may have its occasional use, but the best method we have of detecting faults and monitoring quality is by displaying on a screen and listening on loudspeakers.

Using traditional IT monitoring simply does not provide the level of monitoring we need, it certainly has its uses and it provides us with a great deal of information about the underlying IP distribution and accuracy of data, however, it does not provide us with a useable visual and auditory monitoring system.

It is possible to retrofit video and audio monitoring devices to traditional IT monitoring tools, however, it's inevitable that code will need to be written to facilitate this and it's very difficult to achieve a workable link between the two. Often, when looking at a video image we will want to simultaneously look at the waveform diagram and vectorscope, as well as the underlying transport stream. This is very difficult to achieve when using diverse and disconnected unit solutions, especially when working under the pressure of live television, such as high value sporting events.

Having an integrated monitoring solution that easily and ergonomically connects the monitoring of the video, audio and metadata, with the underlying IP transport stream is critical for anybody working in broadcast facility. Although the data in the IT monitoring equipment may be the same as that in the integrated broadcast solution, the ability to switch between the different monitoring domains is key.

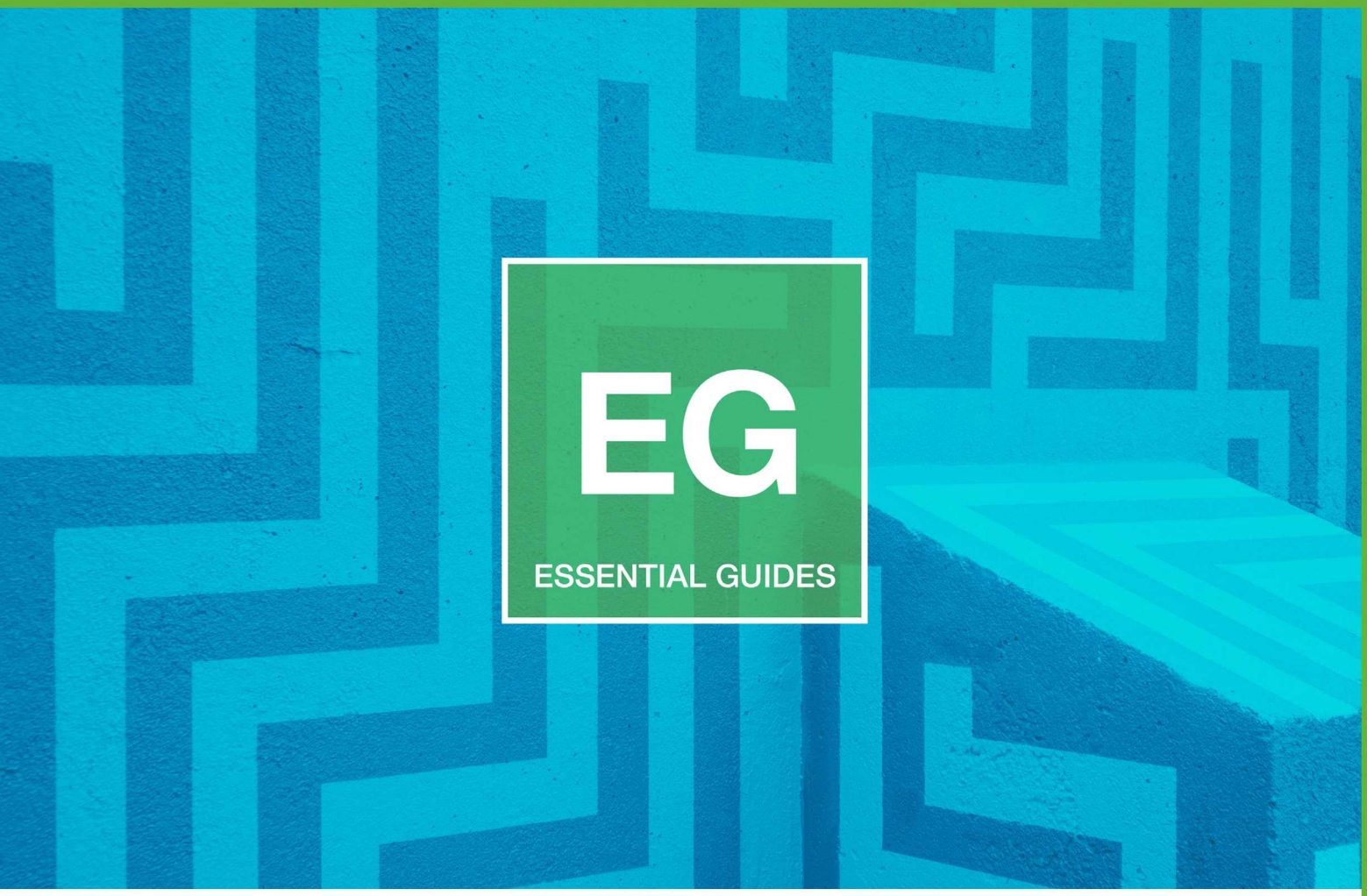
Tony Orme.

There's also a new set of metadata emerging from the use of systems such as HDR. The metadata is essential in describing the display and acquisition formats so that the best immersive viewing experience can be maintained. We need to be able to not only monitor this data, but also monitor it in real time in the context of the streaming video and audio for the television production.

Advanced monitoring is one of the most important tools for any broadcaster either transitioning to IP or already there. Integrated monitoring takes this process one step further and delivers a complete toolset that helps broadcasters maintain their audiences and enhance the immersive experience.

Tony Orme
Editor, The Broadcast Bridge

Flexible IP Monitoring



By Tony Orme, Editor at The Broadcast Bridge

Transitioning to IP delivers incredible opportunity for broadcasters. But the asynchronous nature of packet switched networks is new for most engineers and being able to understand what is going on within the network is essential. The best method we have of observing a networks behavior is through monitoring and IP even has advantages here too.

With the benefit of hindsight, it's now clear that SDI networks are relatively easy to understand. The point-to-point connectivity of synchronous signals increases their predictability but at the expense of flexibility. But with IP and the packet switched network topology, we increase flexibility at the expense of predictability.

A consecutive stream of IP packets does not guarantee each packet will take the same route through a network. Even with the relatively straight forward spine-leaf or monolith switch technologies broadcasters are opting for, there is scope for packets to vary their route within the network leading to out of sequence packets arriving at the receiver.

Network Practicalities

Packet multiplexing is the fundamental method of operation within an ethernet switch leading to a potential to increase packet jitter, which in turn will lead to timing anomalies if the jitter is excessive.

It's clear that there is a lot more to monitor within an IP network than was required with SDI. However, this level of complexity far outweighs the limitations of the static SDI systems and provides dynamic and scalable IP. And that's before we start considering the advances in the viewers immersive experience with HDR and Wide Color Gamut (WCG).

Sports has traditionally been the leader for exhibiting the forefront of technological excellence. HD, UHD, WCG and HDR are just a few of the technology advances that have been demonstrated in major sports events. Each new technological advance adds further weight to the sports story allowing production teams to continually build on their productions to create truly outstanding programs.

OB Advances

IP is further adding to this list of technology accolades as OB trucks seemed to be a natural fit with the technology. The reduction in equipment space and weight has delivered incredible benefits and that's before we even think of the application agnostic benefits IP brings.

Monitoring is our window on reality. We have no way of understanding what is happening within a network if we cannot monitor it. With SDI networks we could use a variation of an oscilloscope, however, with IP networks life is much more interesting. Not only do we need to consider the detail of the transport stream, but also how the media specific data being transported is behaving.

This is one of the areas where the SDI analogy starts to break down when thinking about IP networks. The video and audio were an intrinsic part of the SDI transport stream. The bit rate, frame rate, color subsampling and frame size were all a function of the SDI synchronous system and inherently tied to the fundamental clock of 270Mb/s, 1.485 Gb/s or 1.485/1.001 Gb/s, for example. But this is no longer the case with IP networks.

Flexibility And Complexity

By separating the application video and audio from the underlying IP transport stream we've massively increased our system flexibility and scalability, but at the cost of complexity.

As each IP packet has its own source and destination address, the network itself can determine the optimal route when transferring packets. This often means that systems outside the direct control of the broadcast infrastructure are determining how packets traverse a network.

Although software defined networks are growing in popularity for broadcasters, and there is some analogy between them and SDI routers, it's important to remember that the intelligence and routing options exist at the packet level. This routing is fundamental to IP networks and is one of the reasons the internet is so successful, and why IP networks for broadcasters will increase in popularity. However, an unintended consequence of IP networks is that they are considerably more complex than SDI networks, hence the need for flexible monitoring.

IP Packets Underly Media Streams

It's interesting to think of video and audio essence, and even metadata as just data, and in the IT world, this is exactly what they are. But in broadcast infrastructures we cannot completely separate the data from the IP network as it is intrinsically aligned, especially when we start to think about PTP timing.

SMPTE's ST2110 can and does work independently of the IP network. This can be seen when media is streamed and stored to a hard disk drive. But unlike more general IT data, ST2110 imposes a rigid timing structure on the streaming and temporal gapping of packets. And this is one of the reasons why specialist monitoring tools are needed for broadcast engineers.

It is possible to use IT centric monitoring and logging tools, and many broadcasters do in some circumstances, but the complex interaction of the media essence and the IP network demands that broadcast specific tools are used. Furthermore, IT monitoring generally doesn't measure packet distribution to any great accuracy, and certainly not to the detail needed for ST2110. IT expects the IP packet distribution in a network to be bursty and evenly gapped packets are a bit of an anathema.

Monitoring Convenience

For broadcasters, monitoring is not limited to the transport stream. Due to the high bit rate of video, it's often more convenient to view the decoded pictures on a screen as opposed to looking at thousands of numbers flying-by representing the video. However, we still need to look at some of the measured values and a combined IP, video, audio and metadata system can provide this.

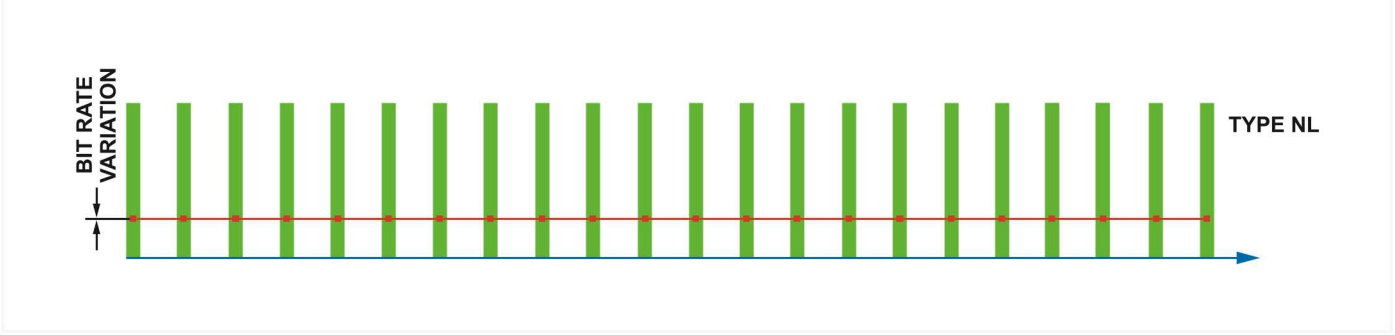


Fig 1 – ST2110 specifies tight timing tolerances of the packet distribution and this diagram shows a consequence of this as the instantaneous peak rate is significantly higher than the long term average, this leads to the buffers being kept small so the latency remains low.

Software systems provide the flexibility and scalability to provide a holistic monitoring system, but custom hardware designs still have their place, especially when we combine the two together.

Measuring IP packet timing is critical for ST2110 systems due to the tight tolerance of the sender timing specification. This ensures that packets are evenly gapped and don't burst so that buffers can be kept small, thus leading to low latency. Calculating the time distance between packets for compliance is often a challenge in fully software devices as the NIC (network interface card) will copy the packets from the ethernet network directly into a memory buffer and wait for the operating system to transfer the data to the application memory. This results in any quantitively temporal relationship between the packets being destroyed.

Hardware Improvements

There are some software acceleration methods available to improve and speed up packet processing, such as kernel bypass, however, this still does not restore the temporal information destroyed by the NICs' receive buffering process. Even writing the data packets one by one directly into the application buffer to bypass the NICs buffer wouldn't help as the timing reference in most operating systems uses a software wrapper for the hardware clock resulting in indeterminate measurement jitter.

One method that is available to improve temporal packet measurement on the actual ethernet wire is achieved using the hardware timestamp. Here, the NIC appends a field representing the time that the packet entered the NIC (prior to being stored in its buffer) so an absolute timestamp of the packet can be achieved and maintained throughout the packets history when residing in the server. As the NIC has one source of calibrated time-truth, all other packets entering it will have a timestamp relative to its own absolute time so meaningful temporal packet measurements can be achieved.

Not only does this method require specialist NICs but it also requires a great deal of knowledge of the underlying operating system on the part of the programmer as custom software drivers will need to be provided to take advantage of these features. Furthermore, the NIC can provide hardware PTP synchronization so greater PTP measurements can be achieved.

Coordinating Solutions

Combining the high-speed hardware with the flexibility of the software provides a monitoring solution that specifically meets the unique needs of broadcasters.

Sports has also driven the adoption of HDR and WCG. However, the transition to HDR is much more complex than moving from HD to UHD and 4K. Whether down converting HDR to SDR or vice versa, the high dynamic space is difficult to convert and even more difficult to provide dual SDR and HDR services. SDR is still needed for HD and providing two cameras at each camera position, along with dual channeling all the production workflow is just not viable. Converting between SDR and HDR further demands accurate and flexible integrated monitoring.

Software flexibility further allows overlays to be placed on the image allowing those who are less familiar with the traditional waveform monitoring type products to take advantage of the vast amount of information available. Whether this might include HDR and exposure zones, or colorimetry gamut detection, the availability of flexible monitoring screens can meet the needs of many different production skill sets and engineering disciplines.

Flexible Monitoring

The new breed of network IP broadcast monitoring systems encourages distributed monitoring and viewing. The signal analyzing device can be separate from the screen presenting the data allowing multiple screens to be physically separated from each other and the analyzing device itself. This physical disconnect, made possible through IP networks, helps keep system infrastructures simple and reliable as specialist cabling is not required in each monitoring position.

The data analyzer and capture unit acquire and process the data from anywhere on the network and provide all the real-time analysis near the connection in question. Monitoring information provided to the user is a representation of the data that can be streamed to a whole multitude of devices, from desktop units to hand-held WiFi devices. Thus, freeing the user from the confines of working within the proximity of the physical monitoring device.

Hardware form factors have had a lasting effect on monitoring due to the ergonomic requirements of operational positions. Racks engineers, production crew and editors all need easy access to the monitoring screens and the separated nature of the data analyzer and capture units from the remote monitoring further enables this, especially when operational positions need to be attended for many hours at a time.

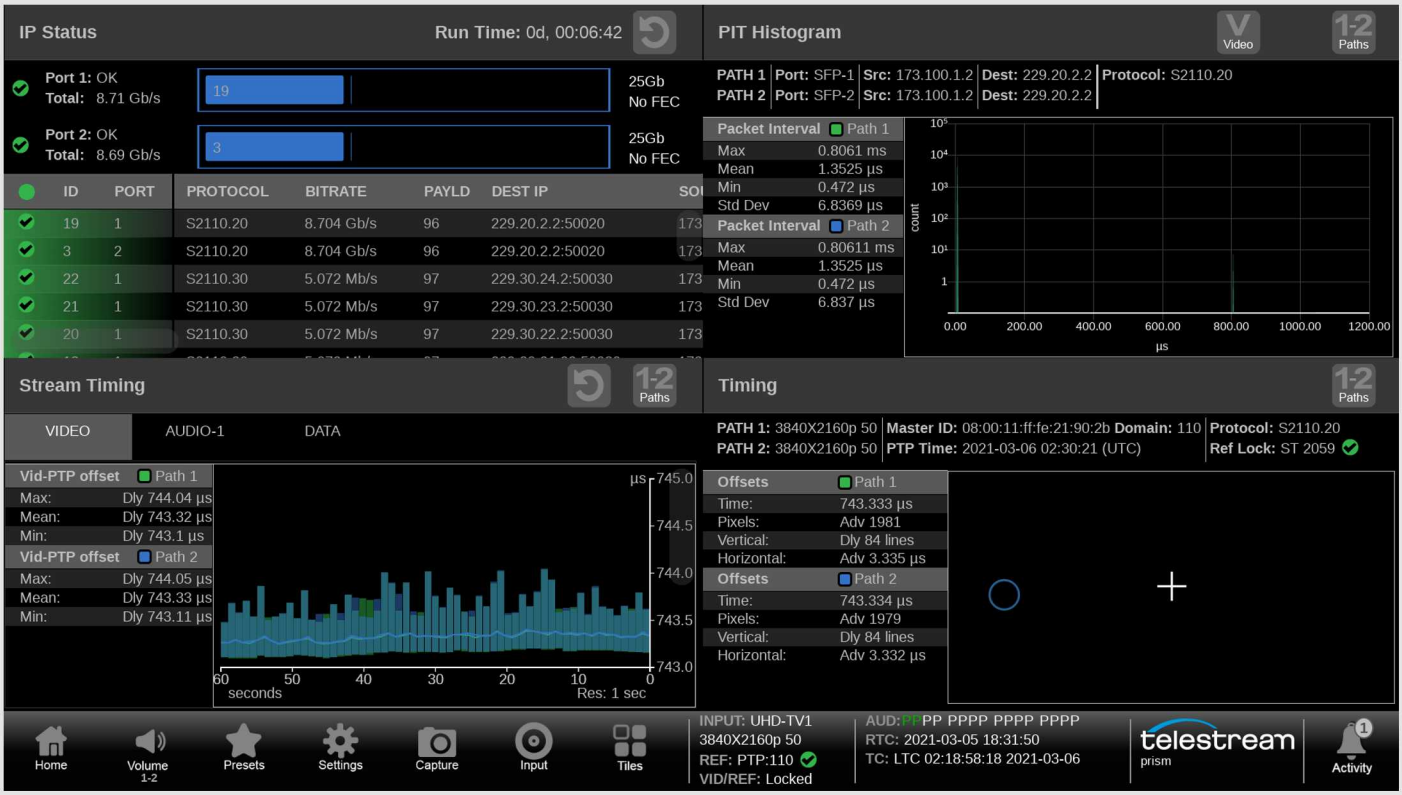
Advanced monitoring solutions are taking the risk out of migrating to IP. Being able to see what is going on at the transport layer within the context of the media is essential for any broadcaster looking to migrate to IP. Having software enabled systems makes the ability to upgrade to new formats more straightforward as the key hardware, such as hardware timestamp enabled NICs, works across multiple media specifications. Furthermore, future proofing is guaranteed and as an example, moving to 8K becomes a matter of upgrading the software.

The Sponsors Perspective

PRISM Waveform Monitors: Form Is Temporary, But Class Is Permanent?

By Charlie Dunn – Senior Vice President of Tek Video Business Unit.

In the beginning, there was television. And whenever people tried to make television programmes effective video signal monitoring was an essential pre-requisite.



Tektronix Video Group invented the Waveform Monitor over 50 years ago and ever since, the company has been at the cutting edge of every technology development, providing test instruments that enable video engineers and operators to create great content. From monochrome to color, analogue to digital, SD to HD, the company has consistently been the #1 supplier of video test equipment.

Recent years have seen the broadcast industry undergo multiple simultaneous and seismic technology and business transitions. HDR and Wide Color Gamut; HD to UHD and even 8K resolutions; 3G SDI to 12G SDI, migration towards IP networks and remote production. The challenge we face is to create the tools that our customers can use to make these changes within their organizations, incrementally and at a speed that suits them.

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When the PRISM Waveform Monitor launched, we focused on the new measurement problems that would arise in the shift to IP networks. Our initial goal for this platform was to help early adopters make the first transitions to IP systems and rapidly this became an engineer's favorite instrument. Our long-term goal, was step up to broader spectrum of industry transitions knowing that the IP migration would just be one part of what our customers were facing.

Since we joined the Telestream organization, collaboration with colleagues in this media-focused technology company has accelerated the pace of our innovation. The result is a completely new class of video instrument: the software-defined waveform monitor.

We have announced six new models in our PRISM waveform monitor line. With these new additions, the PRISM family now offers a complete range of software-defined monitoring instruments, covering use cases from operational SDI monitoring to engineering grade IP analysis, with a common user interface throughout. Designed to support both local and remote production situations up to 8K HDR, being software-defined means that customers can purchase a base model and add features as and when required by simply purchasing a software license.

The PRISM technology platform has enabled us to create a range of form factors at affordable entry level price points, while retaining a "no penalty" software upgrade path to add higher end features as required. We have effectively re-invented monitoring for the needs of a new generation of users and challenges.

Aligning with one of the major trends in the industry, remote operation scenarios are supported, including full feature over-the-network viewing of the PRISM display screen (NoVNC required). Now, PRISM provides remote access to an instrument for maintenance and diagnostics, which is a feature that many customers regard as invaluable in their day-to-day operations. When used with the Inspect 2110 probe, customers can expand their remote visibility by getting detailed monitoring and analysis of ST2110 IP video across their entire network. When an area of concern is flagged by Inspect 2110, a single button press launches any stream in PRISM for deep ST 2110 video waveform, audio, data, and PTP analysis to find and fix faults fast.

The new PRISM models fit shallow racks and tight spaces with a 3RU, ½ rack, 5-inch-deep mechanical design that does not compromise capability (4K/8K HDR/Wide Color Gamut, 4 inputs, Dolby ED2 with Dolby ATMOS support planned, 10/25G-IP and 12G-SDI). With a unique set of HDR tools, including the patented STOP waveform, user defined False Color, Light Meter and CIE charts, PRISM focuses on content and offers multiple user interface options that can be tailored to different user roles. Some of those rely heavily on the display so we offer both single and dual screen models with 65% more display area in same rack space as competing products. This makes it perfect for tasks like multi-camera shading.

Beyond the technical specs, we have created a modern user-configurable instrument that is easily adapted to the needs of engineers, colorists, camera shaders, editors, and others. Several patented displays empower creative staff to identify and correct over-exposure or colors that do not display as intended. The UI is easy to learn and use. Customers tell us that their operators learned to use PRISM in just a few minutes with no formal instruction. Adapt it to you needs, then just use it.

The Covid19 pandemic was unforeseen, but the move to remote production was not. The pandemic restrictions accelerated the change for many of our customers, but in designing the PRISM family we anticipated the need for remote operation, by allowing full remote control, viewing and operation through NoVNC access.

PRISM forms the base of our waveform monitoring range for many years, and the platform enables us to adapt more quickly to whatever changes are coming next. We are getting positive feedback from customers on the features and flexibility, but we are also delighted that the use of a common software defined platform has allowed us to reduce the entry price by about 25%, making it easier for any size of media company to invest in the best waveform monitors.

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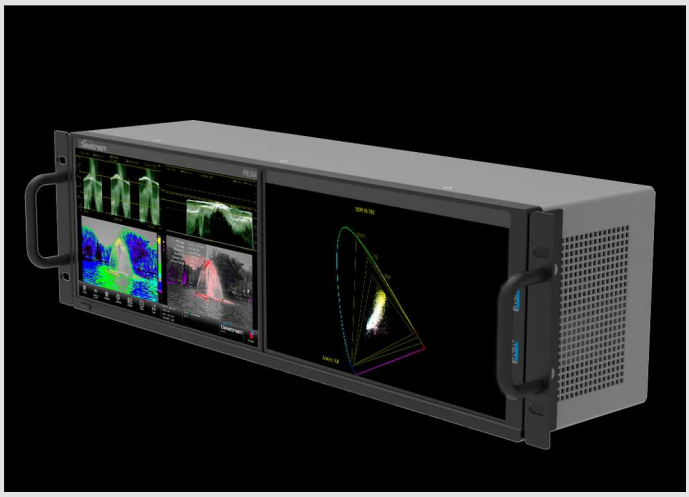
Inspect 2110 Creates Killer Combination With PRISM

One of the common threads in customers transitioning to ST-2110 systems has been to increase the scale of their routing infrastructure to consolidate and thereby simplify different elements of a larger operation. As these networks scale up, in addition to needing a deep analyzer like a PRISM, we saw that customers needed more visibility (a forest view) across the entire network to know that things were ok: is the PTP reference good? Are my redundant paths identical? Are my UHD flows really UHD flows? When we joined Telestream a year ago, we immediately teamed up with the network monitoring team, IQ, to collaborate on creating the Inspect 2110 monitoring probe which can automate the monitoring of a large-scale video network by flagging common issues that can then be directed to PRISM for the detailed analysis.



Instruments like PRISM tend to be analyzers. They will look at a few selected signals on which users can then perform a series of deep analytic measurements. They are ideally suited to the job performed by individuals working in QC, Live Production, Post Production and Engineering. However, for those in Operations who are responsible for ensuring that all the signals being used in a facility or being transmitted are correct they need tools that will monitor signals on a large scale, but that perform less in-depth measurements than an analyzer. This is about visibility and warnings rather than deep analysis and diagnostics.

As broadcast operations migrate from SDI to IP, there is a need for test & measurement systems that support this sea-change in operating environment. At Telestream, our new Inspect 2110 probes provide the large-scale monitoring required in an operational environment.

There are numerous network statistics that can be harvested from infrastructure equipment such as switches. Inspect 2110 looks at that information. However, what sets Inspect 2110 apart is its ability to look at the actual content being carried and to check whether it is correct. Totally configurable for the environment in which it will be used, the 2110 probe provides a dashboard, thumbnails, hierarchical warning, and error alarming with comprehensive logs, all designed to help operators to rapidly respond to systems issues in an informed way. The probes can be positioned to provide visibility across the whole workflow from acquisition, through contribution and in the facility. Each probe can monitor up to 100Gbps of ST 2110 video, audio, and data.

Inspect 2110 uses the system SDP files to ensure that the content is correct. The probe compares the primary and redundant streams to ensure they are the same, that neither service is degraded and that the timing is correct to enable secure switch over when required. Inspect also monitors the system PTP and will report changes of events on the system, for example a change in the Grandmaster.

Should deep analysis or diagnostics be required, Inspect 2110 provides automated direct click connectivity to PRISM, providing an industry leading combination of ST 2110 monitoring and deep analysis.

Throughout its development, we have future-proofed Inspect 2110's design at every stage. It features an API-first container-based microservice architecture for automation, which is ready for cloud-centric architectures.

Expanding the PRISM platform to this level was always our vision from day one, but the combined collaboration with the Telestream IQ network experts and the Inspect 2110 product has surpassed everyone's expectation of what can be achieved. We've built a truly unique monitoring system that bridges the SDI/IP divide.

With Inspect 2110 and PRISM operating in combination we have developed the first ST 2110 Monitoring & Waveform Monitor single vendor solution.

Charlie Dunn – Senior Vice President of Tek Video Business Unit.

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