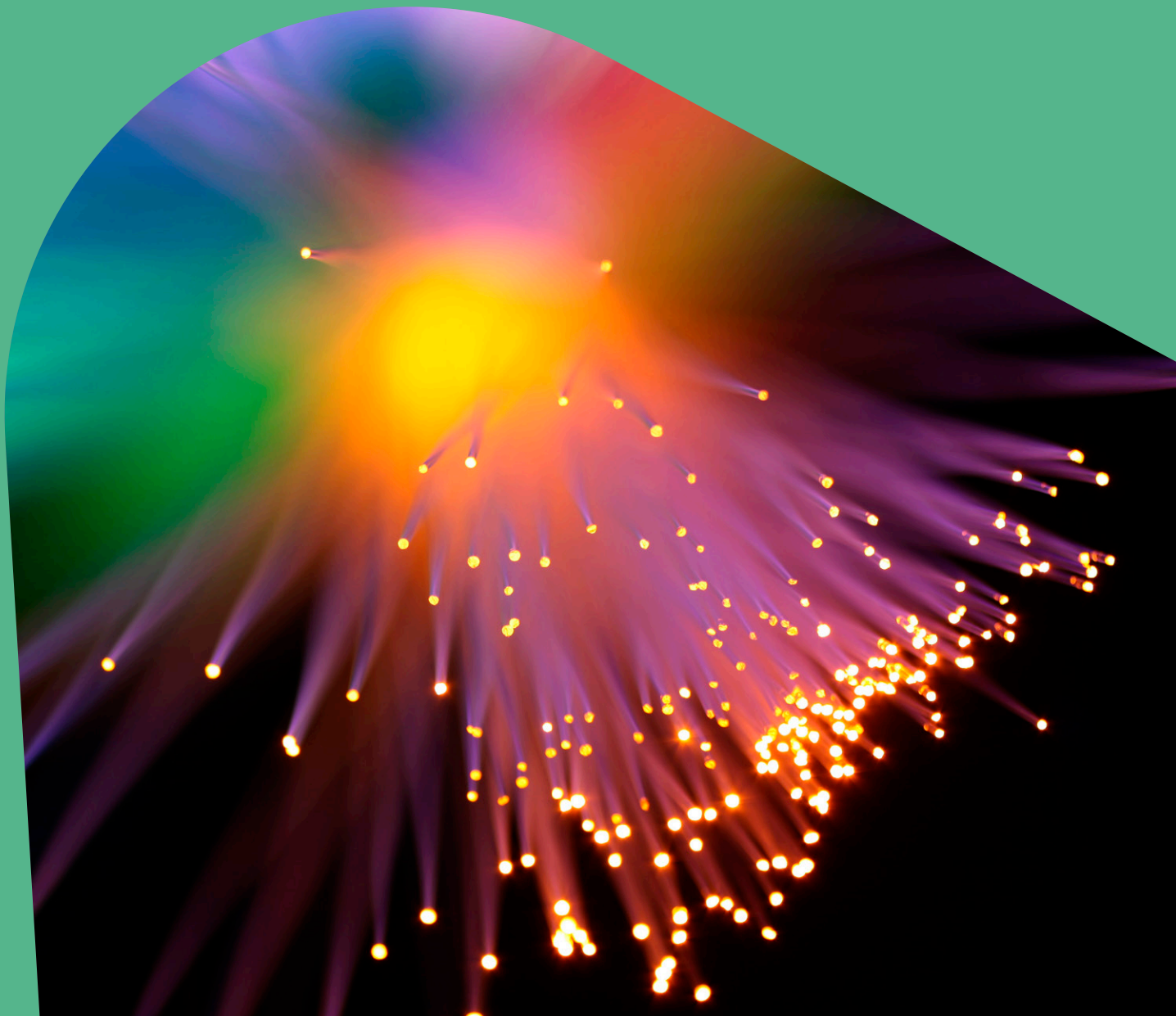

VISION PAPER

The Dynamic IP Blueprint: Unleashing Creativity in Live Media

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The Dynamic IP Blueprint: Unleashing Creativity in Live Media

Internet Protocol (IP) will undoubtedly become the *de facto* method for connecting broadcasting and the broader media technology ecosystem in a future that is not as distant as some in the industry might believe. The change is already underway. What is also clear is that the transition is by no means a “big bang” moment, but rather an incremental evolution that will impact media and entertainment organizations at different points over the next decade.

The Grass Valley Dynamic IP Blueprint is our vision of how we can make this transformation easier for all our customers and deliver more value at each stage of the journey. The Blueprint has different layers that provide guidance around technical and financial considerations. One of the most fundamental is that IP, even with all its benefits, needs to match the operational reliability and – in many ways – simplicity of existing standards, such as serial digital interface (SDI).

The aim is to deliver an IP-based experience that enables both a practiced broadcast engineer and a less-skilled operator to get the job done – whatever their particular production or playout task may be. What’s more, they should have tools and processes that are as robust, performant and reliable as those utilized by today’s modern studios and outside broadcasting (OB) units.

As such, the Dynamic IP Blueprint is a guiding star for our engineering efforts to ensure that every category

of solution – from cameras, through routing infrastructure and switching, to production, master control and playout – has both an SDI and IP option. In many instances, the object is to provide a hybrid solution that supports both. In more advanced cases, engineers are implementing entire physical products, such as mixers, as wholly software or cloud equivalents.

The Blueprint also recognizes that more workflows are going to be delivered from the cloud. The rationale is simple. The cloud offers the shortest route to scalable, on-demand capacity across computing, networking and storage, providing the perfect resource for the media industry’s direction of travel. In an era of over-the-top (OTT), video on demand (VoD) and direct to consumer (DTC), more media enterprises are turning each year to the cloud to enhance workflows, with early adopters using cloud first in remote production and playout applications.



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IP: the on-ramp to the future

For many pioneering media companies producing live content, the ability to integrate physical infrastructure and manage it via systems within the cloud has become a critical business imperative. At Grass Valley, we see IP as the on-ramp to the cloud-based media world of the future, freeing producers of live content to tell the stories they want, in the way they want with a much better utilization of their assets.

The Dynamic IP Blueprint offers a route to production workflows that leverage IP as a foundational layer. This IP grounding provides an efficiency, agility and dynamism that enables media and entertainment companies to not only drive down production costs, but focus on creating content that more vividly captures the backstory and drama of a live event as it unfolds.

Indeed, the shift to IP offers live content producers the ability to do so much more than they can now. It can give them the flexibility to: manage all of the production workflows in native 4K; utilize all the video feeds they need to cover all the compelling aspects of a live event as it unfolds; easily integrate world-class switchers; provide high-speed replay; and tap the very best production talent regardless of location, because the remote production workflow enables people to work from anywhere. It also gives media companies the flexibility to experiment without heavy investment in infrastructure — they can test live programming to see if it works and captures the audience it needs without the risks that building up a physical studio entails.

The ultimate impact of IP-based workflows is that they unleash

creativity. They offer new possibilities to media players fashioning content across a whole spectrum of categories and formats — from sports to entertainment to breaking news, whether live on linear TV, streamed on demand, clipped for social media, or all three. Crucially, media companies want to be able to do all those things using methods and technologies that offer the same unflinching, trustworthy, high-quality performance the industry has expected for decades — and IP is delivering just that.

The digital evolution

Those in the industry telling media enterprises that shifting to IP — and ultimately cloud — would be premature, fail to see the bigger picture. The change to IP is not the first wholesale replacement of the TV industry's underlying "plumbing" — i.e., the technological underpinning of the business. We have seen before and are seeing again the wholesale replacement of the mechanism connecting the flow of media, signaling, control and metadata that enables everything from a live sports OB to a complex studio production.

The shift from analog to SDI and now IP (primarily optical) is part of an ongoing process of continual innovation that has driven the TV industry for decades. And it has been a natural evolution in each case — not a sudden jump, but a series of incremental developments. At the heart of the ongoing change is the wider digitalization of society. From tubes to silicon, the TV industry has tended to keep in lockstep with technologies that help media companies to improve content quality, enable creativity and reach a wider audience — all while driving down costs.

From the 1950s through the 1980s, TV production had relied on analog composite or component video as the two main formats in broadcast. This analog signaling required a mass of cabling, interfaces and switching equipment that was bulky and, worse still, required separate routing for audio and video. The early 1990s heralded the arrival of Society of Motion Picture and Television Engineers' SMPTE 259M serial digital interface — thankfully shortened to SD-SDI — along with a standard definition system that included options such as embedded audio, timecode and packetized data.

The beauty of SDI was the ability to carry digital audio and video, component or composite, down a single coaxial cable. Only one router was necessary because the audio was embedded into the video signal. SDI was transformative and, between 1989 and 2016, the technology underwent several upgrades to support 720p, 1080i and 1080p — which meant bandwidth increased from the original 360 Mb/s to the latest revision of 12G-SDI, which can natively support UHD via its 12 Gb/s bandwidth.

SDI makes way for IP

But, just as other areas of digitization have impacted the consumer and business worlds, so has the need to advance and improve on the TV industry's digital foundation. For two decades (1990-2010), the transition to SDI was the priority for the entire industry — with broadcasters moving from analog to SDI, or upgrading from SD-SDI to HD-SDI, Dual Link or 3G-SDI.

The ongoing development of SDI was leading media players toward IP and the growing range of benefits, seen as “theoretical” by some and simply the future by others. To compare just one factor — bandwidth — we can see that when 3G-SDI was launched in 2006 as a more elegant single-wire solution for delivering 1080p, its effective operating bandwidth was

just under 3 Gb/s. Although 3G-SDI represented a big jump in terms of broadcast bandwidth, it was trailing behind pure IP-based technologies as 2006 was also the same year that IEEE 802.3an — or 10 Gb/s Ethernet over copper twisted pair cable — was also launched.

Global industry groups, in particular the Ethernet Alliance, started working under the aegis of the Institute of Electrical and Electronics Engineers (IEEE) to chart out a path to extend the 802.3 protocol to operating speeds of 40 Gb/s and 100 Gb/s to provide a significant increase in bandwidth while maintaining maximum compatibility with the installed base of 802.3 interfaces. The sheer volume of IEEE 802.3 standard switchers and routers being sold into

enterprises of all types meant that, based on raw performance versus cost, it started to become obvious that IP could offer the TV industry a far more economical way of meeting the need for more HD workflows. Although the transition to HD was the driving factor for HD-SDI, the TV industry started getting envious of the introduction of UHD at the start of the 2010s, led by YouTube and other internet video pioneers.

The upshot was the early part of the decade became a bit of a wild west moment for the TV industry. SDI was in transition and IP was emerging — but not always coherently — with different vendors and industry groups having slightly different ideas on how to wrangle IP into a true industry-wide standard.

THE DYNAMIC IP BLUEPRINT — Pillar 1: Infrastructure Management

The infrastructure needed to connect broadcast technologies has been dominated by SDI for the last two decades. Although the standard is widely understood, reliable and interoperable, it has a number of limitations. It is signal routing, rather than packet-switching technology, and as such, building SDI workflows is inherently constrained by the physical SDI router hardware — whereas IP has far fewer constraints. SDI has a maximum of 12G capacity compared to the current 400G and the upcoming 800G iteration of ethernet over single-mode fiber. As a switching protocol, IP offers a greater degree of flexibility and is the most widely used protocol across all forms of communications.

However, expecting skilled broadcast engineers to become IP networking specialists overnight is neither realistic nor desirable. As such, one of the fundamental pillars of the Dynamic IP Blueprint is to bring the same plug-and-play capability inherent to SDI into the world of IP media operations.

This task has been made somewhat easier through adherence to SMPTE ST 2110, SMPTE ST 2022-6 and SMPTE ST 2022-7 standards along with techniques such as Networked Media Open Specifications (NMOS). At present, much of this effort is aimed at allowing seamless interoperability between SDI and IP, as most

organizations are still in transition and are running hybrid workflows that use both methodologies.

The underlying goal is to ensure that consistency is maintained across every workflow, regardless of whether it originates and terminates in SDI or IP. The goal of SDI-IP seamlessness also recognizes that not all workflows will use end-to-end equipment from Grass Valley. So, our aim is to build functionality in tune with industry-agreed standards to make the job of both operating and managing these complex environments easier.

To give a concrete example, GV Orbit, our System Orchestrator for SDI, hybrid and IP networks, allows both IP and SDI devices to be discovered automatically and added to a workflow — and dynamically route video streams between these different protocols without having to reconfigure the process manually. By adhering to the SMPTE ST 2022-7 standards, if an element fails, GV Orbit performs hitless changeover on redundant IP flows to deliver the resiliency that would be expected from an end-to-end SDI workflow.

Critically, these dynamic orchestration capabilities are available for both GV Fabric switches and the majority of commercial-off-the-shelf (COTS) Ethernet switches from every major vendor — again recognizing the diversity of broadcast supply chains and the different stages of adoption across the broadcaster community.

Nonetheless, the impact of the shift to IP that began cannot be underestimated. In many ways, the move to IP may be the last seismic shift in signal transport the media and video industry sees. And the transition to IP has been occurring alongside the development of file-based production workflows and the broader shift to more software and less hardware — all of which are interconnected. It is ultimately laying a foundation for a more fundamental change in production and broadcast workflows that is revolutionizing how we capture, produce, distribute and monetize content.

Taming the wild

The formation of the Alliance for IP Media Solutions (AIMS) in 2015 — which brought together Grass Valley, Imagine Communications, Lawo, Neveon and Snell Advanced Media — brought a degree of stability to the switchover process. The alliance began focusing on promoting

the adoption, standardization, development and refinement of open protocols for media over IP. This movement to open protocols initially started around VSF TR-03 and TR-04, SMPTE ST 2022-6 and AES67.

Over the next few years, AIMS members and other manufacturers started to — mostly — fall into alignment with the SMPTE ST 2110 standard suite emerging during 2017 — including the first fully IP OB trucks. SMPTE ST 2110 is significant because it provides a standard to separately route and break away streams of audio, video and ancillary data over IP networks in real time for the purposes of live production, playout and other professional media applications. Each essence flow may be routed separately and accurately brought together again at the endpoint. The component flows are synchronized, so the essence streams are co-timed to one another while remaining independent.

Although several vendors could do this already, they did so through propriety systems that reduced the choice of suppliers and flexibility for end customers.

The business impact of SMPTE ST 2110 is also significant, equipping the industry to face new frontiers being pushed by transformative developments in online media and devices. However, SMPTE ST 2110 is part of wider portfolio of technologies including IP, file-based workflows, virtualization and networking that in aggregate is transformative. For broadcasters and production facilities trying to meet the drivers of more OTT delivery amidst a sea of new platforms and smart devices, this portfolio of technologies, underpinned by IP, enables a new degree of flexibility that the world of SDI was never designed to accommodate.

THE DYNAMIC IP BLUEPRINT – Pillar 2: Device Management

The second pillar of our Dynamic IP Blueprint focuses on device management. With the transition to IP, especially during a period when we are really seeing a hybrid workflow approach, the number of devices and related software elements has grown for many broadcasters and others within the media industry. Highly specialized devices, such as cameras and switchers, are increasingly joined by IP-based data and audio switching and routing technologies and a lot more software — both local and in the cloud. Resiliency is crucial and every element will have redundancy built in, from simple features such as dual power supplies to full active/active connectivity that spans to multiple data centers. Yet this brings with it a much higher management burden — especially as many of these elements will require continuous updates as new features are added, bug patches are needed, and changes to configurations are required to address new workflows.

To deal with these challenges, the device management pillar aims to simplify how devices are discovered, integrated into workflows, used and managed over their entire lifecycle. This approach to device management can include tasks such as taking a snapshot of an entire broadcast environment from a logical device connectivity standpoint, so that it can be tested and modified safely if changes need to be made.

Other examples include the ability to remotely carry out upgrades of firmware and software elements and then test for validity — or rollback to last “known good” — if there are problems. Part of the challenge is that currently not all equipment adheres to open interoperability standards — Grass Valley equipment included — and our engineers continuously work to ensure that all our products — hardware, software and cloud-based — all work seamlessly together. This effort also extends to key partners across the world of networking, audio, graphics and many other areas so that engineers don’t have to resort to command-line interfaces to enact potentially undocumented changes.

This device management pillar is a moving target, as there are hundreds of vendors and categories of products that can potentially reside within the broadcast and production environment. This task is getting easier as more hardware evolves into software equivalents, but our approach of starting with leading vendors and working our way down through more niche equipment means that we can address the needs of the largest segment of the broadcast community with device management capabilities that help them streamline their hybrid IP/SDI operations and gain tangible benefits today.

Ready to adapt

For all of the technical benefits that IP offers, the single-most important attribute it provides is a new level of flexibility to match the modern media and entertainment industry requirements. Today, in 2021, media and entertainment is a \$1.7 trillion per year industry. And unlike at the outset of the internet revolution 30 years ago, the industry is no longer dominated by linear broadcasts delivered to a boxy television situated in the family room.

The modern industry has blurred the lines between content rightsholders, content producers, aggregators,

distributors, and service providers. Today, the world's largest e-commerce retailer is also the second-largest subscription VoD service provider. Telecommunication service providers are now the most dominant owners of sports rights. Digital platform advertising has eclipsed TV advertising — and consumers are spending more time watching video content on connected devices than on large screen TVs, [according eMarketer](#). The current landscape of the TV industry is more disrupted, diverse and fragmented

than it has been at any point in history — and the storm is far from subsiding.

This turbulent, yet exciting, time that is brimming with opportunities is why IP has become the focal point for media executives across the globe — indicated by the fact that the highly influential [Devoncroft annual report](#) has ranked IP in the top three most important “Commercial Trends in Global Media Technology Sector” for the last five years in a row.

THE DYNAMIC IP BLUEPRINT — Pillar 3: Software Processing and System Orchestration

The final pillar of the Dynamic IP Blueprint is software processing and system orchestration. In many ways, this pillar overlaps with the other two but is rapidly growing in importance as software within broadcasting becomes more prevalent. At Grass Valley, we are seeing common tasks such as format and frame rate conversion moving away from dedicated customer ASIC appliances and into soft-appliances such as our Universal Compute Processor series of products.

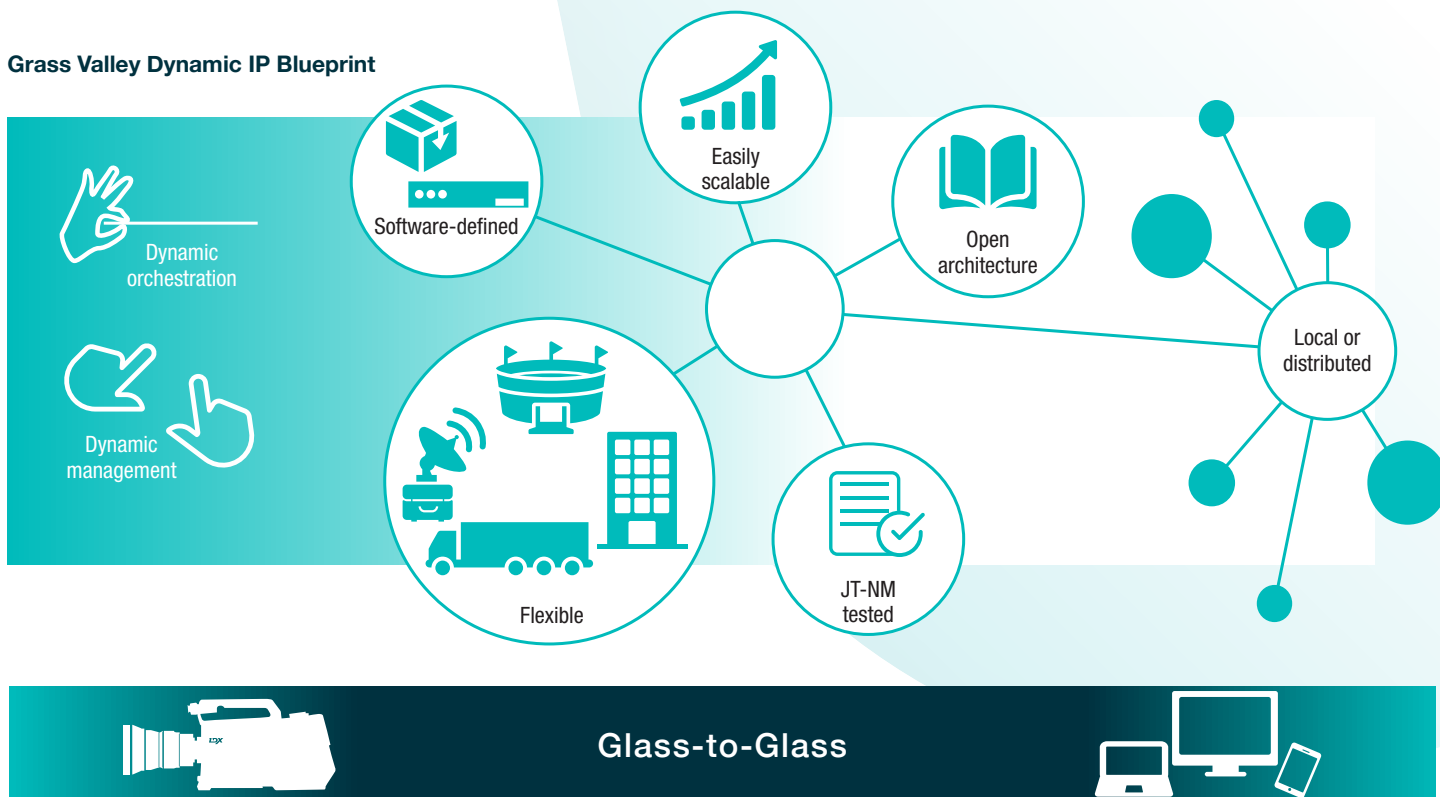
There has always been an element of software within modern, digital production technologies. Looking into the heart of, say, a GV Masterpiece 12G-SDI Master Control Switcher, there are many software elements that control audio capabilities, channel branding and multichannel video program distribution. However, this equipment is tied explicitly into the underlying hardware — and as such is only able to perform the functions of a master control switcher. Masterpiece is unquestionably more powerful compared to “software only” equivalents — consider, say, the 10x UHD or 42x 1080p inputs the GV AMPP Master Control software is running in the cloud. But, the number of inputs and outputs provided by GV AMPP Master Control is growing rapidly. In addition, the GV AMPP solution can be purchased on-demand and deployed anywhere there is IP connectivity. And, in many instances, it offers a much better Capital Expenditure (CapEx) to Operational Expense (OpEx) balance that opens the way for a broader array of use cases.

GV AMPP Master Control is containerized software living in a cloud instance. Similarly, GV AMPP Layout and GV AMPP Audio Mixer sit within a growing ecosystem of AMPP elements that can be integrated in the cloud to deliver a fully virtualized master control room (MCR). The result is an MCR that can be spun up and configured in hours, used for an event or production, and then spun down when the event is over to save running costs.

The same approach is also being seen with OB trucks and flypacks — where software running on COTS and GV Universal Compute Processors can be reprogrammed to create a design that meets the needs of the event. The result is content producers are not always forced to buy and deploy more capacity than is actually needed.

This shift from a broadcast model predicated on specialist hardware to a software-centric approach is still at an early stage. A primary driver is new revenue imperatives, as content needs to work harder, with more versions, across more platforms and geographies to counteract the declining value of advertising revenue per asset. The shift is progressing rapidly and over the next decade will start to become the accepted standard for how we design and implement complex production and distribution workflows.

Grass Valley Dynamic IP Blueprint



IP in the real world

The shift to IP is no longer being driven mainly by theoretical benefits, but by genuine advantages we are already seeing in the real-world scenarios that are playing out across the industry in media enterprises of all types.

Take as an example Electronic Arts' Competitive Gaming Entertainment, the company's esports division, which uses GV AMPP (Agile Media Processing Platform) to enable fully distributed remote production for its competitive gaming events, EA SPORTS™ FIFA 21 and Apex Legends. The end-to-end cloud workflow is only possible via IP. It allows EA to deliver broadcast-quality storytelling to its global fanbase, regardless of where the live tournament is taking place – with a production team able to work from their respective homes. In an industry first, the workflow utilizes Grass Valley's GV Korona switcher control panel connected over the public internet to a K-Frame production center engine running on GV AMPP.

At the other end of the spectrum is the BBC, the world's oldest public broadcaster. For its BBC Cymru Wales operation, the corporation has established its first facility built completely around IP technology. When it launched in 2020, it was the world's largest SMPTE ST 2110 IP routing system for broadcast. Grass Valley's IP orchestration and routing system lies at the heart of a network capable of carrying around 6 Tb/s of live media traffic around the 150,000-square-foot site. Grass Valley systems are also central to the UK media giant's new playout operation, supporting BBC1 Wales, BBC2 Wales and fellow publicly-owned Welsh media company S4C. IP-enabled Kahuna switchers have been installed alongside a fully redundant Morpheus and ICE Panoplay system, with Morpheus deployed as a wholly virtualized system.

We are seeing numerous Grass Valley customers around the world moving to IP. The list includes companies

specializing in outside broadcast that want to take advantage of cloud-based production and simpler distribution. We are also working with studios that have physically run out of space and are replacing bulky SDI equipment with more compact and scalable IP infrastructure; their systems are now able to support IP cameras and more software-based tools, enabling them to deliver innovative graphics and highly automated productions. The list of transitioning clients also contains media companies utilizing IP to make content distribution via OTT and on-demand services easier. None of this is happening overnight. When you look at the detail, what you will see is often incremental change – where IP being introduced is offering value and helping to achieve a long-term strategy while, in many cases, co-existing with traditional SDI workflows.

For all its benefits, the shift from SDI to IP is not a zero-sum game. Many media enterprises are still in a transitional mode as they sweat their assets for as long as possible. In much the same way that the telecoms industry underwent a decade-long transition to a fully digital ecosystem, the TV industry is making its move through an “as and when” methodology with respect to IP. No differently than when they made the change to DTV (HDTV) from analog (SD), each organization must do so at its own speed, in accordance with what makes sense for the business.

Although the shift to IP may result in media’s own decade-long transition, the transition to a format-agnostic IP world is likely to be the last time we have a fundamental “rip and replace” of decades worth of infrastructure. We can then finally get to a point where we can focus on business issues and devote our energies to creativity and connecting with the audience – and far less on plumbing.

Many media enterprises make clear that adopting IP infrastructure is part of an ongoing effort to align their technology with their business imperatives. For some, this might be the push toward using a more

flexible and often virtualized software-based production and distribution environment rather than hardware. Moving from a CapEx-based model to an OpEx-driven one is an approach that many media companies are now either already moving to, or are seriously considering. In part, this particular shift is to not only gain agility but also to take advantage of new media processing techniques offered by the cloud. For others that are building greenfield sites, IP is a more economical approach that allows them to create shared media networks using commodity switching and routing equipment combined with lower-cost IP cameras, audio elements and software-based tools like multiviewers and mixers.

The most significant change we have seen so far during this transition is that finally, as an industry we have an agreed standard that is fit for purpose in SMPTE ST 2110. Although that standard enables IP workloads, by itself, it cannot overcome technical challenges faced within the cloud. However, pioneers such as Grass Valley have made huge strides solving some of the inherent problems around timing, automation, latency and scale that still pose hurdles to mass adoption of cloud-based technologies.

Yet it all goes back to the same fundamental benefit: that the inherent flexibility offered by IP-based systems, as demonstrated by everything from Google to smartphones, aligns with not just the TV industry but the overarching direction of our society. From a specific media industry perspective, IP not only offers the ability to generate new efficiencies, flexibility and scalability; it frees media companies and other rightsholders to create live content that is more exciting, enthralling and just plain fresh than what they can do now. This flexibility is becoming critical to retaining and winning new audiences in an age when there is more fragmentation, choice and competition among media players than ever.