SONY

nevion

Whitepaper:

Reimagining broadcast control

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Introduction

With the shift from SDI to IP and from hardware-defined to virtualized functionality, live production is undergoing a significant technological transformation that is reshaping its logistics and economics.

However, the potential benefits of this shift could easily be undermined by a critical element: broadcast control systems (BCS).

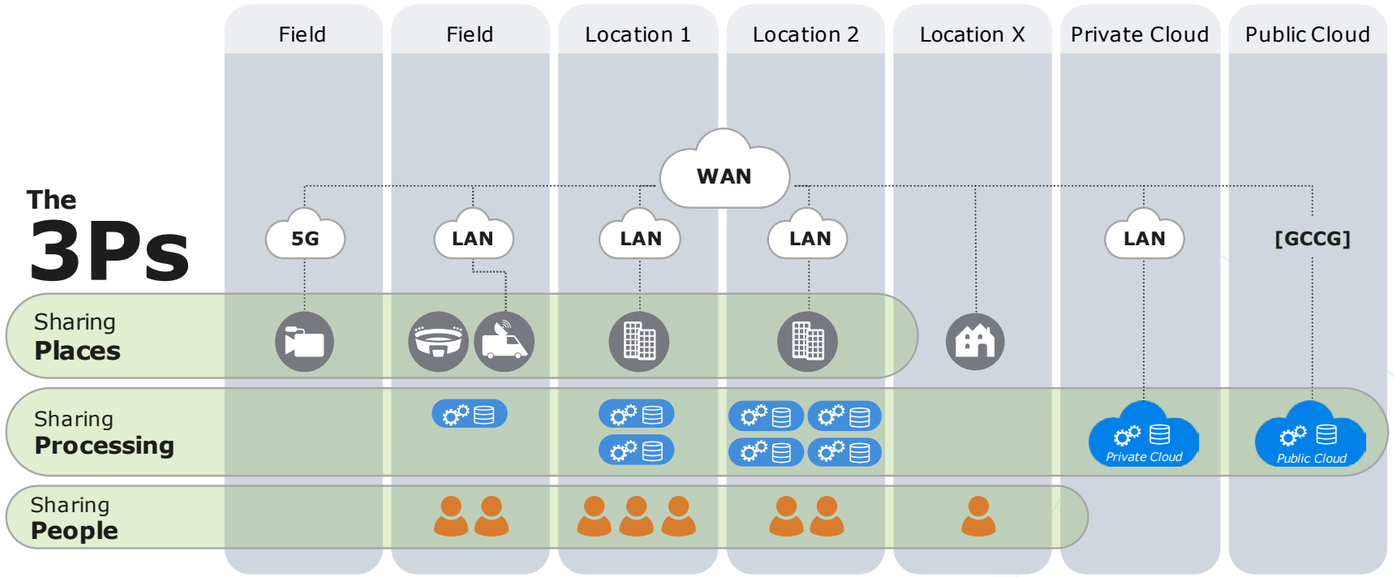
The transformative potential of IP and functionality virtualization

IP and functionality virtualization are driving the most significant technological and business changes the broadcast industry has seen in decades.

IP network technology overcomes the distance limitations of SDI technology, allowing content production resources – places, processing, and people (the 3Ps) – to be shared and utilized regardless of their location. This means, for example, that processing resources such as replay servers, switchers, mixers, multi-viewers, and video encoders/decoders, can be located in multiple locations, including on-premises, in a private data center, or in the public cloud – without impacting their usability.

Meanwhile, software-defined resources are increasingly being used alongside, or instead of, hardware-only resources. Software enables functionality to be virtualized, providing greater flexibility to adapt rapidly to changing production needs.

Together, IP and virtualization are revolutionizing live production workflows and, by extension, the business of broadcast content creation.



Broadcast control systems could limit this transformation

The transformative potential of IP and virtualization could easily be limited by taking a legacy approach to broadcast control however.

Historically, broadcast control systems have managed relatively static resources, that are local, with fixed functionality, and limited sharing potential. The new technological landscape is vastly different and the BCSs need to evolve to take advantage of it.

A new approach is needed

This whitepaper explores how productions are changing and why BCSs must be reimagined to fully leverage modern production infrastructures.

While recognizing the ongoing relevance of many aspects of current broadcast control systems, this paper questions whether systems designed for the SDI era are suitable for a dynamic IP and virtualized environment, or whether a fresh approach is needed.

Live production is **changing**

IP and virtualization are revolutionizing live production workflows, making them more flexible, cost-effective, and indeed, more sustainable. The changes in production are profound and create many challenges for the control of broadcast operations.

A more diverse and dynamic production

To capture and keep viewers' attention, broadcasters must continuously create content that caters to specific interests. These productions vary widely in diversity and scale, from small, impromptu political interviews with members of the public to large-scale sports and esports events – each distinct from the other. Productions may often occur simultaneously and involve multiple locations.

In this context, automation is crucial for managing this diverse set of production requirements dynamically, without dramatically increasing production resources. Without proper automation, smaller productions become economically unviable, large productions exorbitant and broadcasters cannot generate a profit from their content.

Multiple locations

The benefits of remote production are widely accepted today, with IP technology making it easier to distribute production resources to the most appropriate locations from technical, staffing and business points of view. For example, production staff can work from a central gallery while content is captured elsewhere and processing resources can be located in one or more datacenters for easy access and sharing.

Production staff located anywhere

The production staff may be in any location during the production, including on-site, at one of the other production locations or indeed at home. The team might not always be in the same place and individual staff may work from different locations over time.

Conversely, some locations, such as small regional news studios or lightweight sports production, may not have any production or technical staff on-site and in the extreme case, cameras may also be remote controlled or auto-tracking.

Hybrid ground and cloud workflows

Having already made an impact on playout and distribution, cloud technology is now making its way into live production – either together with, or instead of, ground resources (e.g. on-premises). The cloud allows broadcasters to align their processing capacity to production requirements, and in particular, to handle peak loads when needed (for example for a major event).

Currently, the cloud is typically used by broadcasters for tier 2/3 type productions, but the expectation is that it will also be used in time in tier 1, at least as extension of ground resources.

More software-based resources (virtualization)

Software has not only made in-roads into live production in the form of cloud services, but it is also increasingly becoming the core of ground-based processing, either on COTS (commercial off the shelf) hardware or on generic hardware appliances that are able to support different capabilities (take on different functional roles).

The main benefit of software-defined processing is the immense versatility it offers. The same piece of equipment can be performing multiple very different tasks at any one time (for example JPEG XS video encoding and audio processing) and be reconfigured dynamically to perform different tasks later. Effectively, those are virtualized processing resources.

More dynamically assigned shared resources

One of the major benefits for broadcasters of moving to IP and virtualization, is the ability to share processing resources and to allocate them dynamically, irrespective of where they are located relative to the users. So for example, a media node or a switcher might be used by multiple productions at the same time. This reduces idle time of expensive hardware and software and translates at the business level to a much higher use of resources and a reduced need for investment in duplicated equipment.

A more flexible, diverse and complex infrastructure

With the shift to IP in live production, the underlying infrastructure becomes significantly more flexible, but also more diverse and complex.

In a traditional environment, managing just a few SDI routers with simple control protocols (like SWP-08, Ember+, etc.) and some end-devices via parameterization is straightforward.

However, in an IP environment, connectivity must be managed for all devices on the network, or even across multiple networks. While the NMOS suite of specifications can handle much of this connectivity, the control system must now interact with hundreds or thousands of devices to perform simple routing.

Multiple media formats in same production

In the past, broadcasters typically used a single house format for both video and audio. However, in today's dynamic environment, this approach is becoming a bottleneck for supporting diverse production requirements.

One key benefit of IP is that it is format-agnostic, with IP-based devices generally supporting a variety of formats, including content formats (e.g., UHD, HD, Dolby, stereo audio) and transport formats (e.g., SMPTE ST2110, NDI, Dante).

With IP, it is now possible to produce in the most appropriate formats, rather than a monolithic house format. Necessary conversions between formats can be performed automatically.

Summary: a very different environment

Taken together, the changes in live production create a very different environment, which was never envisaged when today's broadcast control systems were developed. The new requirements are examined in the next section.

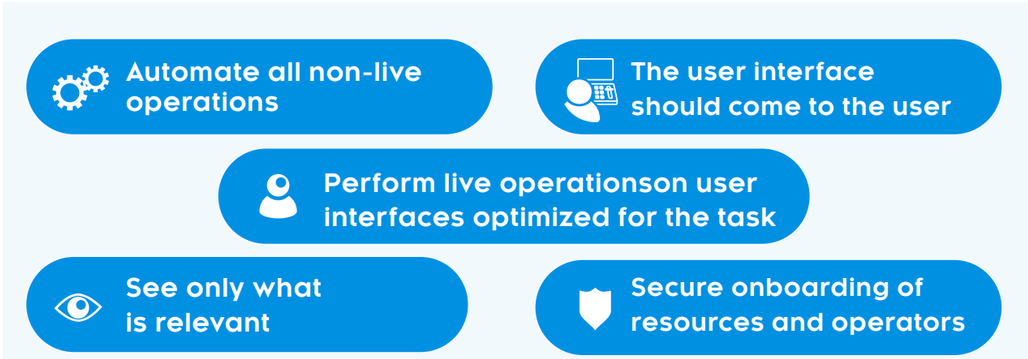
IP and virtualization are revolutionizing live production workflows.

New requirements for broadcast control

The Golden Rules

The substantial changes in live production that come with the shift to IP and virtualization mean that broadcast control systems need to evolve – otherwise they will become an obstacle to enjoying the workflow-transforming benefits the new technologies enable.

Experience from recent IP-based production infrastructures show that, at the highest level, there are a few simple “golden rules” for a broadcast control system for the new IP and IT world.

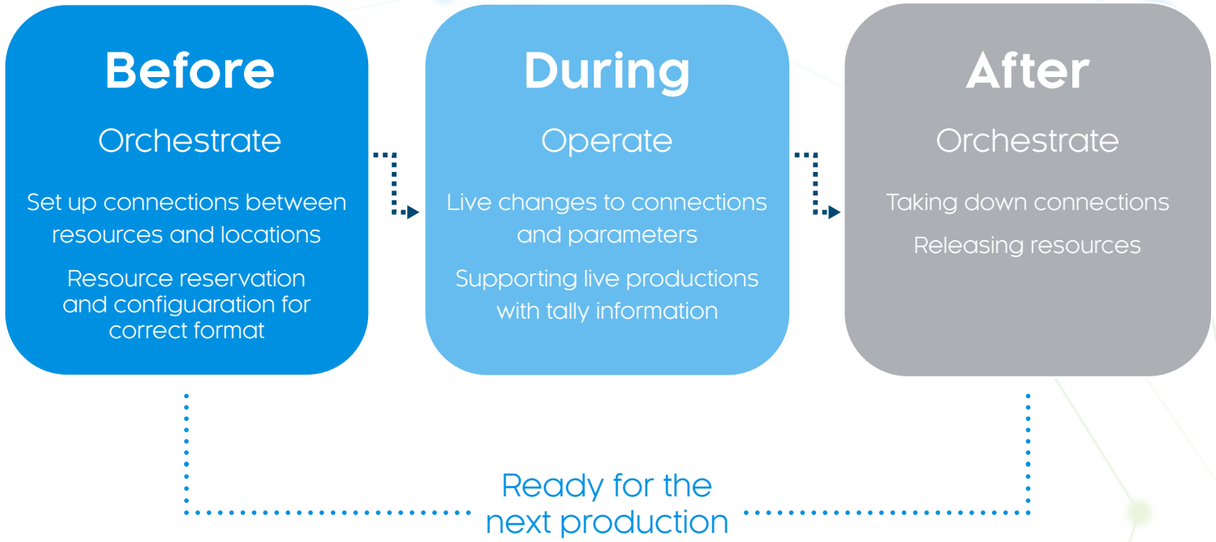


Automate all non-live operations

In an IP and virtualized environment, one of the key requirements of a broadcast control system is to automate any task that does not need to be controlled explicitly.

This obviously applies to all aspects of the live production itself, including ensuring tally/UMD and intercoms adapt automatically to the situation, regardless of where the equipment and staff are located. However, automation is even more critical in the set-up and take down of the production.

In the past, signal chains were typically dedicated to specific productions. In the new IP and virtualized environment, signal chains are much more



dynamic. Resources are shared and may be changed for each production. As a result, broadcast control now extends beyond the actual production. Not only does it involve making live and ad-hoc changes during the production, but also reserving the required shared resources before the production and tearing down and freeing up those resources afterwards. Much of what happens before and after a live production can and should be automated.

Shared resources need to be allocated on a timeline before the production and released afterwards. This means that the control system must know when resources are reserved for a particular production and handle contention that may arise if a live operation needs to overrun.

The broadcast control system must find end-to-end paths and appropriate resources to support operational needs, such as format conversion or video/audio processing. This “resource routing” is fundamental for automating productions that depend on shared resources.

Scheduling resources is already necessary today, but it will become even more critical in the future as more processing moves to software and to a hybrid on-premises/cloud model.

Resources can be dynamically instantiated on demand, depending on the availability of underlying compute and/or graphics capacity. Managing this complexity manually is impractical, making automation of the pre- and post-production phases essential.

The user interface should come to the user

Broadcast control systems must enable staff to work easily from anywhere. The user interfaces should follow the user and not be locked to a particular location such as a production control room (PCR). For example, there may be situations where performing camera shading remotely is preferable and operators should access appropriate control surfaces wherever they are seated.

Standardizing operator stations is crucial for this flexibility. Operators should log in from any station and access the necessary production control surfaces. This applies to workstations, touchscreen and hardware panels, where the interface can adjust dynamically based on the logged-in operator and current production.

While certain dedicated control surfaces like video/audio mixer consoles limit flexibility to some extent, broadcasters can explore centralizing replay and graphics operators in shared spaces for more versatile use across productions.

Some broadcasters have embraced multi-functional rooms where the entire setup adapts for specific productions or different functions. Here, the broadcast control system plays a key role by automating room configurations based on production requirements.

Broadcast control systems must enable staff to work easily from anywhere.

I'm a
Production Operator

I need to know how the automation of the setup of screens, comms and panels for the current production would allow me to sit down anywhere and see the right things.

I'm a
Technical Operations Manager

I need tools that allow me to fetch external feeds, manipulate feeds in the production (audio shuffle etc), change the production setup (routing) and allow my comm production and in the MCR.

I'm a
Systems Engineer

I want a comprehensive set of tools that allows me to do fault-finding and correction in the system. I need extensive monitoring tools within the BCS. Also, I want to know about role-based access control (security model) and processes for onboarding new devices and people.

Perform live operations on user interfaces optimized for the task

Running a live production is a complex task involving numerous technical aspects. Regardless of the type of production — small or large, simple or complex, single or multi-location — the goal should be to allow the operators focus on their job, by hiding any underlying complexity that is irrelevant to them.

It's easier for operators to navigate the system when they are presented with information directly related to their job. For example, a vision mixer operator may want to control how sources are presented into the vision mixer without needing to see where the sources originate or how they are routed. Therefore, a broadcast control system should be able to break down the end-to-end workflow into multiple steps, each relevant to the specific operator role. To cater to different production roles within the same system, the user experience must be customizable and tailored to the needs of each user role. Production staff typically benefit from focusing on the logical connections between resources, while operations and engineering staff need to see the underlying physical connectivity to perform their tasks effectively.

From an operator's perspective, it's also crucial to access everything from a single interface, without needing to log into multiple systems in a distributed production environment. If this isn't possible, it can reduce work efficiency and hinder resource utilization.

I'm a
Network Engineer

I need to do system integration, I want to know about REST API, Ansible scripts to Prometheus and Grafana. I would also like to know about the cluster deployment, that I can stage my deployment and that you can help me with onboarding scripts for devices and people.

I'm an
MCR Operator

I want to schedule the various external incoming feeds (WAN feeds), the outgoing production feeds as well as monitor the health of these feeds and the datacenter devices.

See only what is relevant

A broadcast control system must hide the underlying complexity, to make it easy for the broadcast operators to do their job.

Templating productions: Defining a production from scratch every time is not practical. A lot of productions are recurring with the same or very similar logical setup – even if the actual resources used may vary (as mentioned previously).

For the sake of efficiency, it makes sense to be able to define the set-up once, and then reuse later on, with some adjustments if necessary.

In the past, salvos (or macros) could support this. Salvos are however very technical, as they relate to the physical connectivity (crosspoints) required. The end-result is often that the production is locked to a particular set of resources.

An approach much more suited to an IP and virtualized world is to template the logical building blocks of a production, including studio, datacenter and gallery resources. The set-up is then established at a higher level without considering details about what physical devices will be used (e.g. cameras or vision mixer). Mapping templated to physical resources may be done later before the production goes live and this information is known. This approach is called templated productions.

Intent-based approach: Currently, broadcast operators are accustomed to selecting devices for a particular setup either specifically or from a pool, which requires knowledge about the underlying infrastructure.

In a more dynamic environment, which increasingly has software-defined resources, some of it in the cloud, it's no longer possible for them to do that. To leverage the potential offered by IP and virtualization, it is necessary to move towards a more "intent-based" way of working, i.e. where the operator specifies what needs to be done rather than worrying about finding the processing resources to do it.

> A broadcast control system must hide the underlying complexity, to make it easy for the broadcast operators to do their job.

For instance, an operator may need to convert an incoming SDR feed to HDR for a production the following Tuesday from 2pm to 4pm. The system should take care of allocating the processing resource needed to perform that conversion, regardless of where it is, and based on its knowledge of available capacity at the time of the production.

The operator need not concern themselves with the underlying complexity involved in executing their production requirements.

Secure onboarding of resources and operators

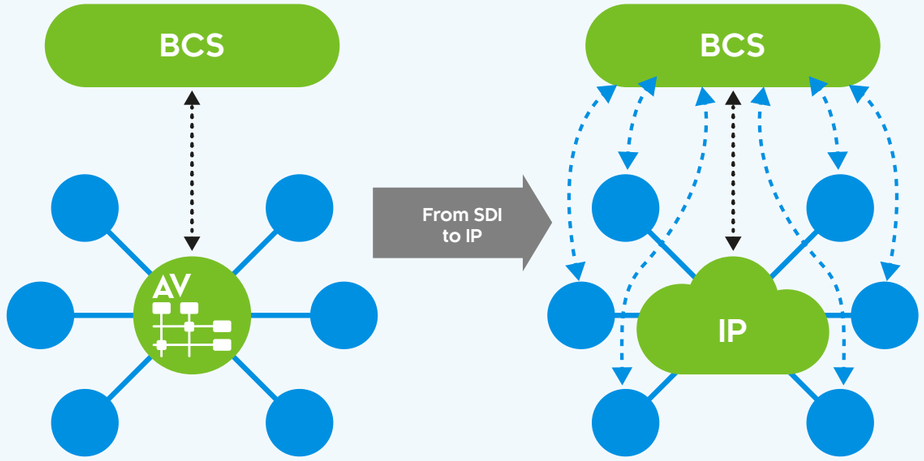
Traditionally broadcast controllers have operated in a closed "walled garden" environment, so have been able to rely largely on insecure protocols, which are not up to modern security standards, and often have no authentication or encryption built-in.

With IP, the infrastructure becomes more distributed, and indeed, production staff may be spread across locations. Therefore, it is no longer possible to deploy the entire infrastructure inside a walled garden.

Consequently, security becomes much more important. It is essential to implement secure communication between the broadcast control system and end-devices, which allows end-devices to be deployed at remote locations that may be more prone to attacks. Ideally the broadcast control system should adopt a zero-trust approach when on-boarding devices.

The broadcast control system itself also contains mission-critical data and must be protected with proper authentication, authorization, and accounting (AAA) mechanisms. This is key to ensuring the identity of operators, protect against malicious use, and create an audit trail that can be examined when security issues are investigated.

Other key considerations



Scaling

Traditional broadcast control systems manage a few central video/audio matrices to route signals between inputs and outputs, sometimes using tie-line management to interconnect multiple matrices.

However, transitioning to IP changes this dramatically. It requires controlling every end-device on the network to route streams between sources and destinations. Furthermore, this is not about changing a few parameters, it's also about spinning-up/down software as required on COTS or re-programming general hardware appliances to meet production needs.

The NMOS suite of specifications can be used for many IP-based broadcast devices, but the control system still needs to scale to handle the increased load. Additionally, each end-device must be monitored to ensure correct configuration and proactively detect errors that may impact production workflows.

Experience in the field shows that current broadcast control systems struggle to scale for hundreds or thousands of end-devices on a network. This often necessitates segmenting control into multiple systems, leading to reduced resource sharing and cooperation across the organization. The real solution is a system that can truly scale.

Network control – optional but desirable

In an SDI world, controlling audio/video matrices is fundamental to broadcast operations. In the IP world, network control is optional, as technologies like IGMP/PIM can let the IP network manage signal flows itself.

However, in larger IP networks, direct control – also known as Software Defined Networking (SDN) – is desirable. SDN offers significant benefits, including deterministic routing, stream-aware load-balancing, easier troubleshooting, faster switching times, and the ability to perform planned network maintenance.

While detailed discussions about SDN are beyond the scope of this document, it's important to note that SDN encompasses a wide range of approaches. These range from fairly static, media-agnostic systems that require reconfiguration as circumstances change, to dynamic, media-aware, and automated solutions.

Hybrid SDI/IP workflows

While IP is clearly the future of live production, SDI will continue to play a role in production for some years to come.

Supporting hybrid SDI/IP workflows is therefore an essential capability for any broadcast control system in order to ease the transition to an all IP and virtualized production environment.

Conclusion
evolve or re-imagine?

Undoubtedly, many of today's broadcast control functions remain essential in IP and virtualization-based live productions, such as tally, alias naming and parameter control. However, to fully leverage the transformative benefits of new technologies, broadcast control capabilities must expand dramatically.

IP eliminates past limitations of distance and format. Production teams can collaborate across longer distances and resources can reside in data centers for shared use. Virtualization adds flexibility, enabling dynamic changes in functionality. Together, IP and virtualization create significantly more fluid production environments.

For broadcast control systems, the challenge is to blend familiar control methods with innovative automation approaches like production templates, event scheduling and resource allocation.

Yet, this is just the beginning for future broadcast control systems. IP and virtualization also pave the way for data-driven workflows, where production aspects can be analyzed and optimized using data from the network, devices and applications. This opens new avenues for integrating artificial intelligence (AI) into broadcast control systems.

AI could make broadcast control systems more adaptive, efficient and intelligent, empowering operators to deliver high-quality content across diverse platforms and formats.

This evolution poses a significant challenge to traditional broadcast control systems rooted in the static world of SDI. It's time to explore new approaches – which could of course cohabit with existing BCSs.

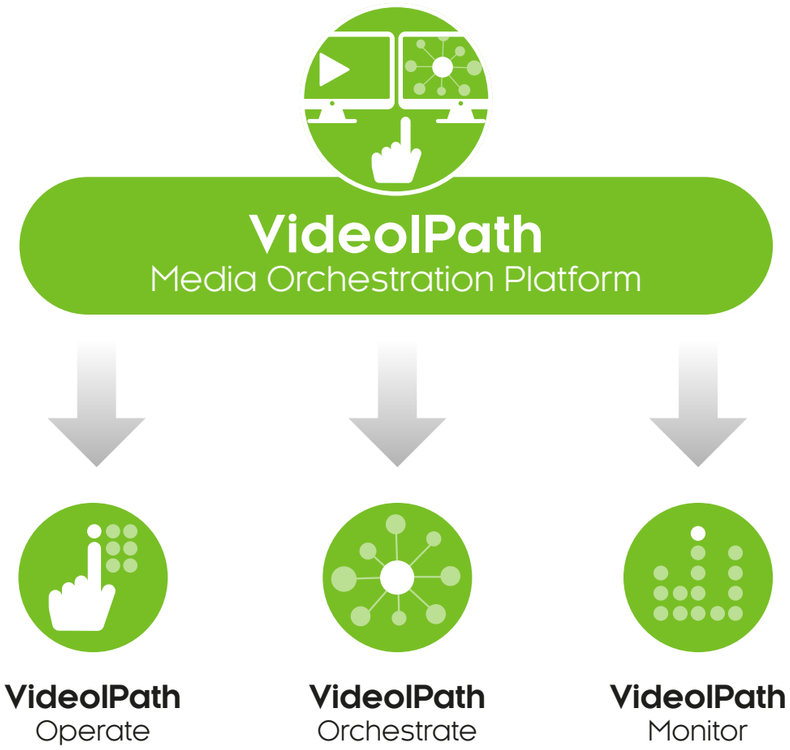
This is just the beginning for **future broadcast control systems.**

Nevion VideoIPath Operate
Broadcast control

NETWORKED LIVE

A key component of Sony's Networked Live offering, Nevion VideoIPath is a media orchestration platform that is widely deployed by broadcasters and telecom service providers throughout the world in applications as diverse as contribution, remote production, facilities, OB trucks and GCCG (ground-to-cloud-cloud-to-ground). VideoIPath is also an open system that allows it to be integrated into existing environments, with interfaces to any device and equipment and support for familiar control surfaces.

Leveraging Sony's extensive experience in broadcast control, VideoIPath, which has a long-established market-leading position in media network orchestration, has rapidly evolved in recent years to provide broadcast operations functionality designed to maximize the benefits of an IP and virtualized infrastructure.



For more information about Nevion VideoIPath, visit:
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