Virtualized News Production

Toward Live Production in the Media Data Center.

A Case Study.

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ROSS

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01 INTRODUCTION

This paper is a case study about how we, Ross Video, created a complete virtualized IP video Newsroom Production System, hosted on Cisco UCS infrastructure and orchestrated its life-cycle with Cisco hybrid multi-cloud technology.

Our main purpose was to gain additional practical experience with some key technologies including: IP and Data Center Technology for Broadcast and Virtualized Production, together with how to orchestrate them within the context of a Media Data Center.

This paper is about what we learned. It covers the demo, the technology choices and trade-offs involved and some of the tools we developed along the way.

We will also share our conclusions about what this all means today, where dual-technology production is the practical reality, and the future where Software Defined Production will become the new common sense.

But before we dive into the technology, let's have a look at the reasons our mutual customers are asking for solutions based on Video over IP and Software based workflows.

02 MOTIVATION

The big four benefits that our customers are seeking from virtualized production are Utilization, Flexibility, Centralization and improved Resilience.

02.1 UTILIZATION OF EQUIPMENT

This can be low for some broadcast equipment. One of our broadcast customers estimates that their overall equipment utilization is only 25% - which adversely impacts their bottom line. Imagine the worst-case scenario where a keyer is used once per day for a 30-minute show and sits idle the rest of the time – that amounts to less than 3% utilization!

02.2 FLEXIBILITY

Ross Video products are designed for flexibility. For example, we can produce numerous shows on a single switcher by assigning parts of the overall system to each show, and we can create logical video routers within a larger overall frame.

But many products are not. Indeed, products designed for a single purpose are commonplace. Think of up/down/cross conversion, audio embedders, etc. This results a lack of flexibility which adversely affects utilization.

02.3 CENTRALIZATION

Often broadcast talent, such as for a local news show, works from their home city, but the production facilities that add graphics and insert national stories into the show are at a centralized location. This allows shows for multiple cities to share overheads leading to improved efficiency.

Today this is accomplished with a lot of complexity and effort. We have several customers who use dark fiber to share SDI signals with remote controlled equipment at their local outlets, and the bulk of processing is done in a central location. The fact that this is worth doing despite the significant effort underlines the value of centralization to them.

We also hear from our customers that they want to deploy new services, more quickly at less cost.

We can speed up service deployment with more flexible resources and centralized operations. This might require putting a new studio into production or be as simple as adding another graphics layer to a production quickly and easily.

02.4 RESILIENCE

Increased resilience is one of the primary benefits of a Software Defined Production environment. If part of the video processing chain has a failure, the ability to quickly spin up a new version of the failed components without having to re-cable equipment is a huge time saver.

A Media Data Center also allows entire production chains to be spun up quickly and, in installations with large numbers of productions, the ability to provide N+M redundancy instead of full dual redundancy becomes a realistic option.

At the outset of this project, we outlined these common challenges is to ensure we kept them top of mind through our “learning by doing” process. This paper isn’t about simply pushing a new technology. We are now sharing these results widely to inform the conversation that’s underway in the industry helping to change and improve how these technologies are used and implemented.

03 TECHNOLOGY & BUSINESS TRANSITIONS

Some of the systems we use in broadcast can be virtualized today, some are further out.

Obvious candidates for virtualization today are products that do not touch content directly, such as Newsroom Control, Media Asset Management and Production Automation systems. These are Media Data Center ready today because they're patterned on traditional database applications with HTML front ends.

Things get trickier to virtualize when a product processes real-time content. Ross Video's CEO, David Ross has a 4-Stage model for this type of product which characterizes their transition from today's SDI-based production, and the eventual future state of all-IP, all-COTS, all-virtual, all-the-time.

03.1 ROSS PRODUCT TRANSITION MODEL

03.1.1 Stage 0 – All SDI

You've got to start at Stage 0, which describes the traditional SDI-based set-up.

- Devices are single-purpose – though it's worth mentioning that some large routers and switchers can be logically segmented to make them more flexible.
- The routing is done by circuit-switched cross-points, and device I/O is dominated by SDI.

03.1.2 Stage 1 – Adapting to IP

Stage 1 signals the introduction of some COTS routing into the broadcast infrastructure.

Devices are adapted to IP as necessary by changing the I/O cards, or using specialized NICs, but they still measure inputs & outputs in terms of channels in which, for example, a UHD channel counts as much as a regular HD one.

03.1.3 Stage 2 – IP Adaption

You can recognize Stage 2 when the routing needs are dominated by COTS IP routers, and the devices support IP for I/O natively. By "natively" we mean that the connectors are bi-directional, and the devices process the network packets. So, we flip from counting channels, to measuring bandwidth. Thus 4 channels of 3G are equivalent to 1 channel of UHD.

The processing needs to be multi-purpose and reconfigurable to support the flexibility of the I/O.

03.1.4 Stage 3 – Media Data Center

Stage 3 is where the processing itself is provided as software on generic COTS technology. It can be packaged as containers and VMs, which share a common resource pool yet continue to meet the hard, real-time demands of broadcast.

03.2 CISCO BUSINESS TRANSITION MODEL

David Ross' 4-Stage model nicely characterizes what's happening at the product level along this journey to the data center. In addition, we need to look at how business will evolve through this transition. Cisco models this as three shifts:

03.2.1 Shift 1 – SDI to IP

The first shift puts content on IP networks making it possible to process in data centers and the cloud. Shift 1 does not fundamentally change business operations or processes.

03.2.2 Shift 2 – Virtualization & Cloud

The second shift is where the benefits of IP start to occur with increased flexibility and deploy-ability of virtualized solutions that deliver scale-out economies through higher utilization. But, at this point we've still only really replicated the original operations.

03.2.3 Shift 3 – Re-imagination

The third shift is one of strategic enablement because it is now easy for new services to be rapidly deployed, market-tested, fine-tuned and scaled-up.

03.3 WHERE, IN THE TRANSITION TO IP VIRTUALIZATION IS OUR CASE STUDY?

The broadcast workload we developed in this case study is at Stage 3 in the Ross / Shift #2 in the Cisco transition models.

- All content I/O is via IP which is natively supported by Ross XPression graphics and clip player systems.
- All the processing is COTS, based on Intel Xeon CPU and NVIDIA Quadro GPU.
- All the routing is COTS, and this is how the Ross DashBoard-based IP multi-viewer accesses and displays the content.

But it's still a familiar workload that just happens to have been virtualized, which is why it's at Shift #2 on Cisco's model.

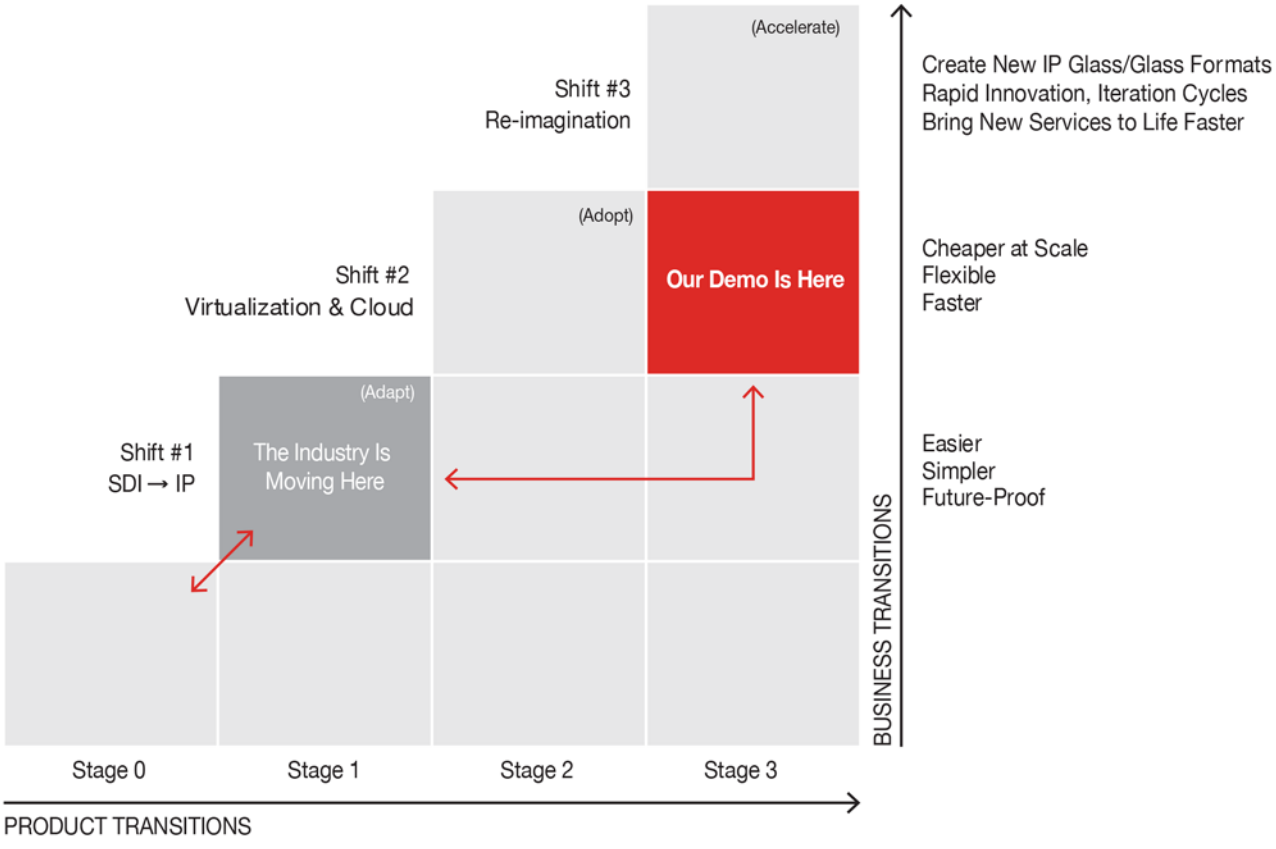


Figure 1 - Product and Business Transition Model

Our workload's outputs are limited to the clips and graphics needed by the show. To turn those into Television, we need to feed them into a production switcher via IP to SDI convertors where they can be combined with live feeds and other content. In other words, to be useful today, our Stage 3 / Shift #2 island needs to feed into a Stage 1 / Shift #1 delivery chain for full production.

And this underlines the reality that there is a transitional period in which Media Data Center technology operates side-by-side with SDI-based solutions. Let's call this the "dual-technology" approach that rapidly delivers the benefits we stated in the introduction, but also saves money because it lets existing plant and products continue to support the delivery chain.

04 NEWSROOM IN A BOX … IN A DATA CENTER

04.1 WHAT WE BUILT

We built a 4-channel, automated news production system illustrated with selected screen grabs in Figure 2 which used the Ross Products listed in Table 1.

ROSS PRODUCT	ROLE
Overdrive	Production Automation
Caprica	Device control – the XPressions and an external switcher, though for our demo we used a switcher emulator
Inception News	News authoring and run-down server
Streamline	Media Asset Management
XPression Studio	Title and Graphics
XPression Clip Player	Interstitials, stings , segments
XPression MOS Gate-way	Control integration with Inception News
XPression Project Server	Rapid deployment of different graphics projects – e.g. for morning and evening newscasts

Table 1 - News Production Solution Workload

The server also hosted two NVidia Quadro 4000 GPUs which were pinned to the Ross XPression Studio and XPression Clip Player instances to make them available to those VMs.

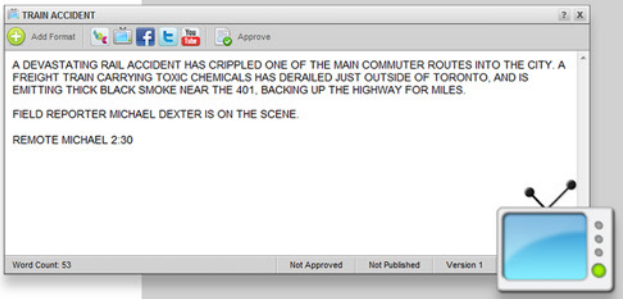
The fact that these products were hosted on VMs was invisible to the system users since the UIs were:

- Served to the client as HTML5 GUIs (Streamline, Inception News);
- Hosted by DashBoard, which runs on a client PC (Caprica);
- Hosted by the OverDrive client (which is installable from the OverDrive server);
- Running under production automation (all the XPression products).

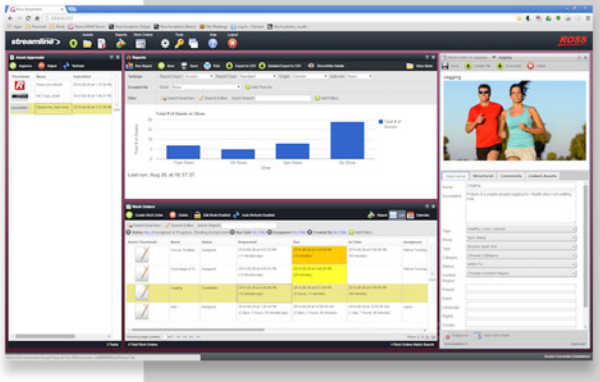
For maintenance and troubleshooting access to the VM's, we used common desktop sharing solutions including SSH, Remote Desktop, VNC and TeamViewer.

We used NewTek's NDI® as the IP Video technology to share the AV content produced by this workload with downstream production. XPression supports NDI as both an input and output format, and DashBoard accepts and displays NDI feeds which made it possible for us to build an all-IP MultiViewer as a DashBoard custom panel to monitor the workload.

OVERDRIVE



INCEPTION



STREAMLINE

XPRESSION

Figure 2

04.2 INTRODUCTION TO OUR TECHNOLOGY STACK

Let's move on to look at the system that supported this workload. It's instructive to break it down into technology layers as shown in Table 2.

LAYER	DESCRIPTION
Solution	This comprises the Ross services, content flows, and user-interfaces that allow operators to create, in the case of this workload, a news show.
Solutions Orchestration	The Cisco hybrid multi-cloud solution system crafts end-to-end workflows from independent part pieces managed in the services layer. This layer is responsible for end-to-end service assurance and (can) make dynamic changes to the deployments if necessary. It is a layer that maintains the global deployment.
Services Orchestration	The Cisco hybrid multi-cloud solutions spins up, maintains and tears down all services that are part of a media workflow. It is the responsibility of the services orchestration functionality to keep all virtualized and cloudified part pieces active.
Platform	The services that make the physical hardware available as virtualized resources such as VMWare vSphere, and NewTek NDI.
Infrastructure	The physical servers, network switches etc employed in the solution.

Table 2 - Technology Stack

We've already described the Solution layer, we'll start at the bottom of the stack and work up.

04.3 INFRASTRUCTURE LAYER

If we supplied the Ross products listed in Table 1 as turnkey systems, they would occupy a total of 14 rack units. Virtualization technology, and the data center class server deployed, enabled us to right-size the resources used by each VM, and host them on a Cisco UCS server that occupies just 2 RU. On this measure alone, we gained a 7x improvement in resource utilization!

04.4 PLATFORM LAYER

Our workload required 8 separate VMs, plus another 7 to host the various management services for Solutions and Services orchestration (Cisco hybrid multi cloud) and VMWare vSphere which is the main platform technology.

04.5 SERVICES ORCHESTRATION

The services orchestration layer is responsible for interfacing with all things cloud. Whether a virtual appliance needs to be deployed on public clouds such as AWS and Google cloud, or private cloud systems with VMware, bare-metal services, or Kubernetes as orchestration systems, the service orchestration layer is responsible for converting abstract descriptions of a virtualized entity (say, a Ross XPN virtual machine) and deploying those onto a cloud that can host that virtualized entity (say, Ross XPN on a VMware system). Thus, generally, the services orchestration layer can be considered a series of adapters that jointly adapt a (formal) description of an application, such as a complex media workflow, to the nuts and bolts of actually deploying (virtual) appliances. Once a (virtual) appliance is active, the services orchestration layer is to provide feedback from an actual deployment to the solution orchestration layer for addressing issues with deployments.

Oftentimes and cited earlier in this paper, any realistic media workflow includes configuration of physical assets. These may include Ethernet-based networks, routers, switches, SDI gateways, and other physical media appliances that need to be configured for the complex media workflow. The Cisco hybrid multi-cloud service layer provides adaptions towards such devices to facilitate smooth transitions of media workflows from today's bespoke physical deployments to tomorrow's virtualized and cloudified solutions.

In this paper's example, Ross virtualized newscast-in-a-box, Cisco's Cloud Center (CCC) as part of Cisco's hybrid multi-cloud system is used to interface to VMware. It is used to boot up and maintain the 8 virtual machines on VMware, which runs on a Cisco UCS platform.

04.6 SOLUTIONS ORCHESTRATION

The solution orchestration layer is the heart of Cisco's hybrid multi-cloud orchestration layer. Complex media workflows are first defined in abstract (YAML-based) models. These models indicate what part pieces make up a complex media workflow (such as Ross' virtual newscast-in-a-box), how these part pieces are related to each other, what interfaces need to be maintained between the part pieces and what kind of underlying cloud systems are needed to deploy the complex media workflow.

Once complex media workflows are modeled, such as the Ross complex media workflow, Cisco's hybrid multi-cloud orchestration system maps the model onto the available resources: it selects which (cloud) services are used for what parts of the complex media workflow. Cisco's hybrid multi-cloud orchestration system allows the user to augment the model to make it acceptable for deployment by way of a user interface. The mapping function may use various kinds of workload placement functions to efficiently lay out the complex media workflow across the available resources. Cisco's hybrid multi-cloud orchestration tool set this kind of differentiation to enable the user to select the most appropriate optimization strategy. In the virtual newscast-in-a-box case, we use straightforward placement techniques: all appliances need to run on VMware. For more complex cases with hybrid deployments (bare metal, Kubernetes, VMware and public cloud), workload placement is key.

As shown in Figure 3, the Cisco hybrid multi-cloud orchestration user interface shows all components that are part of the Ross newscast-in-a-box virtual deployment. As described elsewhere, it is comprised of a series of virtual machines (Streamline server, Overdrive server, Inception server, Caprica server, XPN project server, XPN MOS gateway, XPN graphics and XPN clip player) and by way of the user interface individual wiring and operation status can be displayed. The user interface can be used to assess the performance and availability of each of the individual servers that make up the virtual newscast-in-a-box service.

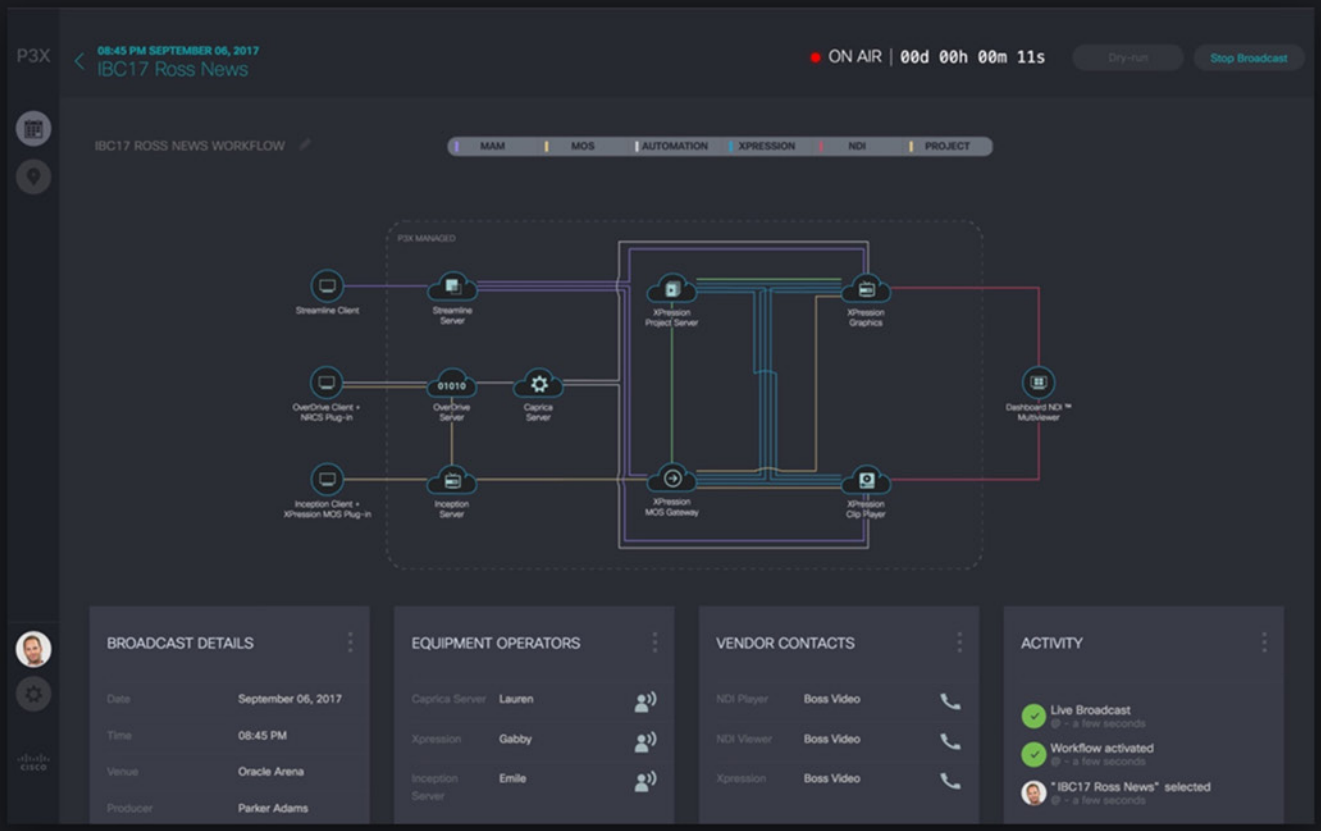


Figure 3: Cisco hybrid multi-cloud orchestration user interface

It was straightforward to integrate our News Production Solution with the Solutions Orchestration Layer by developing a microservice to adapt this layer's API's to a DashBoard custom panel that provided workload status, and the IP multi-viewer monitoring of the workload's feeds. It also provided an alternate UI to start and stop the workload separately from Cisco's hybrid multi-cloud's UI if desired.

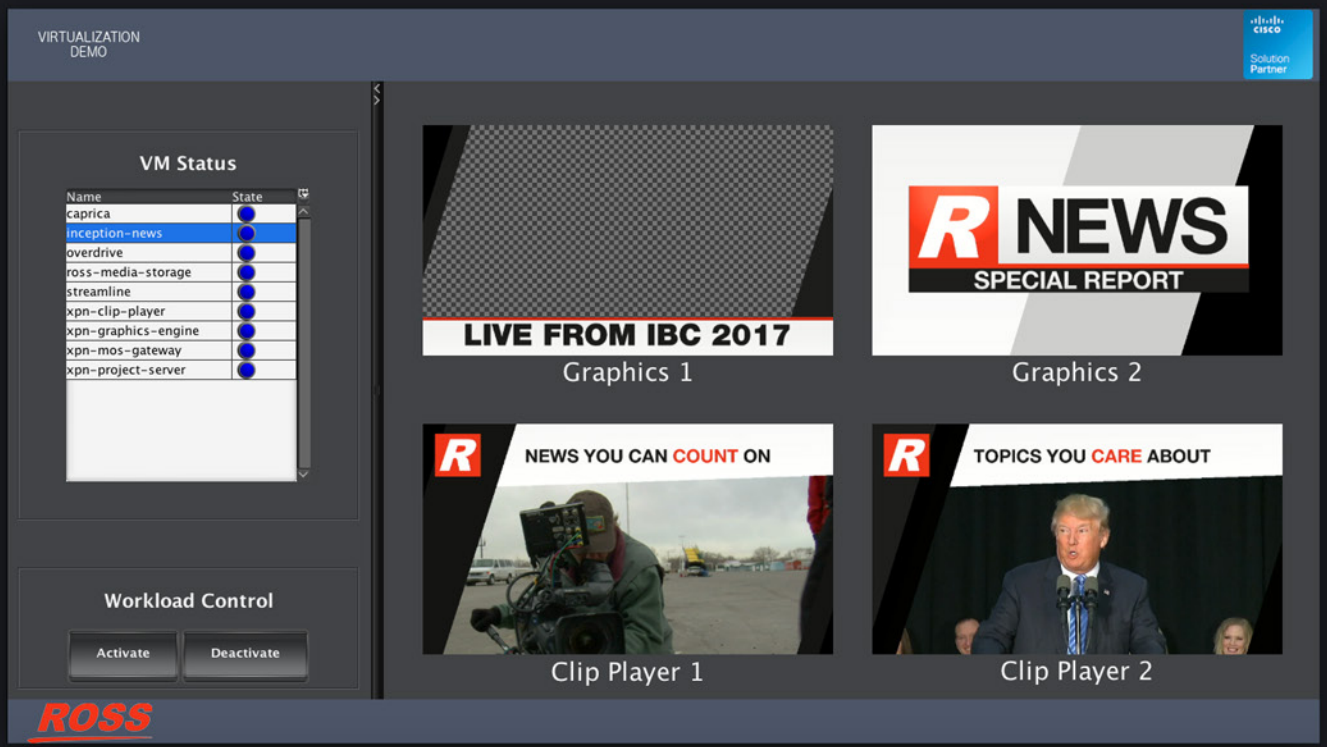
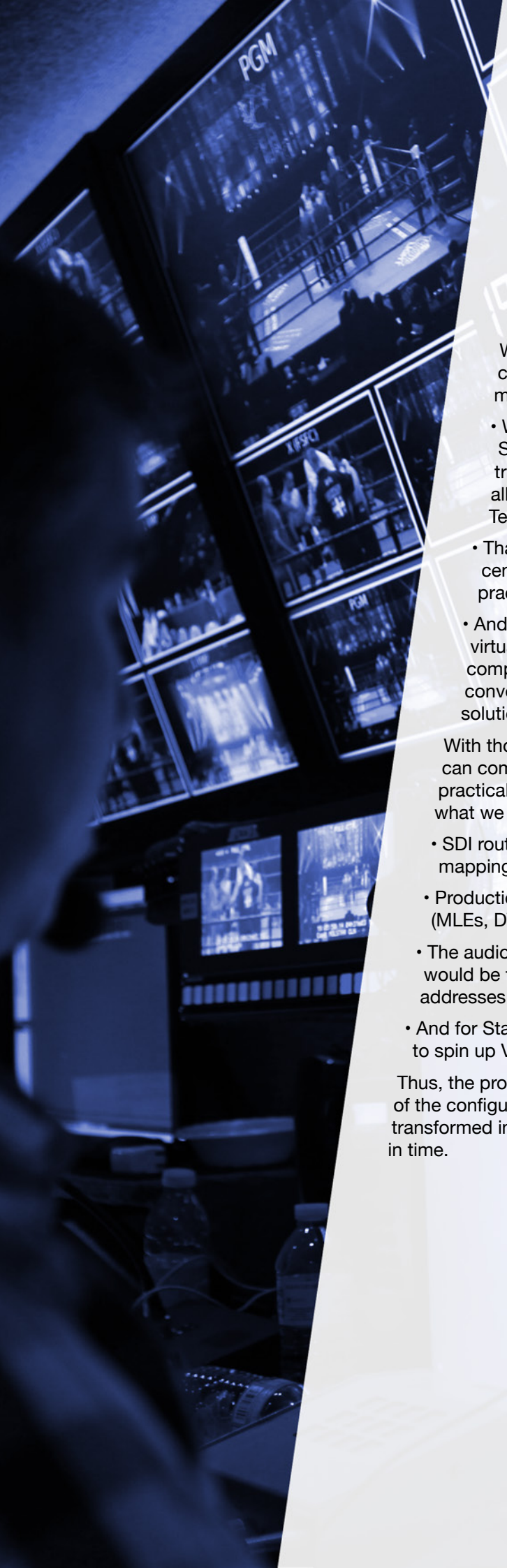


Figure 4 - Screen grab of DashBoard IP MultiViewer & Orchestration Integration



05 WHERE NEXT?

We stated in this paper's introduction that our purpose in creating this tech demo was to learn by doing. Some of the main takeaways are:

- While we did create a News Production Island at "Ross Stage 3, Cisco Shift #2" of the product and business transitions facing our industry, it is clear that more traditional, albeit IP-adapted, support is required to turn this into Television today.
- That means that dual-technology operations where data center technology combines with SDI infrastructure is the next, practical stepping stone for most broadcast operations.
- And that means the broadcast functions that are hard to virtualize either because of high channel count, processing complexity, or both (think SDI routers, switchers and edge convertors) should provide suitable API's to allow integration into solutions orchestration as defined in this paper.

With those APIs in place, the whole, dual-technology system can come under Software Defined Production control, and be a practical proposition on today's technology. Here's a summary of what we think a dual-technology solution would look like:

- SDI routers that support the reservation of logical matrices and port mapping within a larger physical router.
- Production switchers that permit the allocation of subsystems (MLEs, DVEs, etc.) and I/Os (both SDI and IP) to the production.
- The audio, video, and metadata flows needed for the production would be translated into salvos for SDI routers, and VLANs and IP addresses within the data center component.
- And for Stage 3 components of the workload, it equates to the ability to spin up VMs from the appropriate templates.

Thus, the production workload, would be a human-readable definition of the configuration, topology, operation and content which can be transformed into whatever production solution is required at that point in time.

06 DID WE REALIZE THE PROMISE OF VIRTUALIZATION?

Having created and evaluated our Newsroom in a Box … in a Media Data Center, we can draw some conclusions about the ability of the technologies and tools we used to deliver on the promises of Virtualization and IP for Broadcast today.

It's worth stating that the end-result looked and behaved just like a non-virtualized newsroom production system would. And that's the whole point! Operations should not have to change to benefit from Media Data Center technology.

But because it was created as Software Defined Production this newsroom system has much better characteristics for increased Utilization, Flexibility, Centralization and Resilience.

06.1 UTILIZATION

The 2RU datacenter server we used to host these VMs, replaces the 14RU that would be occupied were we to use turnkey versions for each of these products. Think of the savings in space, power, cooling, and cabling that this represents. Think of what else you could do with the 12RU we freed up!

06.2 FLEXIBILITY

The server is COTS, so it can be used for something else once our news show is done.

06.3 CENTRALIZATION

Because our solution uses IP for video and audio transport, it is relatively easy and cost effective to centralize it.

06.4 RESILIENCE

There are a couple of ways to look at resilience in a Media Data Center context – smart orchestration systems rapidly detect and fix failures, sometimes by moving active VMs to different hardware with no disruption to services. We did not demo this type of resilience, and, because our GPUs were pinned to the XPression VMs, it would not be possible to instantly relocate them to different hardware with current data center or GPU virtualization technology.

The other way to look at resilience that we can lay claim to is the scope for N+M redundancy that this solution supports. Consider the case of a broadcast network with many local affiliates – let's use 20 as an illustrative number. The production systems for each affiliate can be centralized as 20 systems in a data center. To which we could add a few spare servers that can be rapidly deployed to take the place of any one system that failed. This is clearly much cheaper than providing full dual redundancy for each station. And much more resilient than today's common alternative: providing no redundancy.

07 CONCLUSIONS

Our technology demo has shown strong evidence that Virtualization and IP for Broadcasting together can deliver the looked-for benefits of increased Utilization, better Flexibility, easier Centralization of production facilities, and their improved Resilience.

It has also shown that the quickest and most practical path to realize these promises is to adopt a dual-technology approach that combines the best of SDI-based infrastructure with Media Data Center Solutions Orchestration and that this can be enabled by the SDI-based products providing Orchestration APIs, and IP-adapted I/O.

The use of Media Data Center technology to support Broadcast workloads is still at an early stage of development. At Ross Video we're committed to realizing the benefits it promises by adapting it to existing production solutions where appropriate, and adopting it fully where possible.

08 ACKNOWLEDGMENTS

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