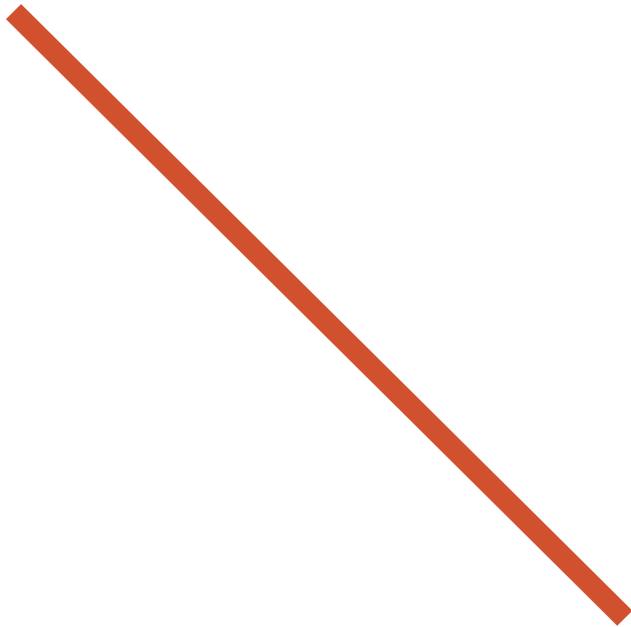


KVM for Broadcast



Essential Guide

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ESSENTIAL GUIDES

Essential Guide to KVM in Broadcasting



By Tony Orme

As broadcasters move to centralized hardware infrastructures, the need to free operational broadcast environments of computers and workstations is increasing.

Before computer networking was common place, users needing to move large files between machines had to resort to using floppy disks, or understand the intricacies of file transfer protocol (FTP). Computers had to be physically accessible so the disk could be inserted into the drive, then placing it on a desk with a large CRT monitor balanced on top of it, or on its side, in a tower position next to the user's feet, ready to be kicked and have the cables knocked out.

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As computers grew in popularity they were networked together, and the need for them to be within touching distance of the operator was reduced. Due to the fear of virus infections, IT departments actively discourage the use of transferable media and would often remove the floppy disk drives altogether.

Centralization Improves

Moving workstations to a centralized infrastructure solves space, environment and security problems quickly.

Maintenance is greatly simplified and the life of the IT engineer is improved as they don't have to crawl around the floor trying to recover a workstation for replacement. And most importantly, the user experience is improved.

Virtualization builds on centralization. Using low level software, a server is time division multiplexed to divide it into several smaller computers. Each computer instance has its own operating system and allocation of disk space, and takes it in turn to use the server's microprocessor under the control of the virtualization software, in a similar way to old mainframe computing, but much faster.

In resilience mode, multiple servers are networked together so the virtualized computers can be spread across them, if one server fails, the virtualization software automatically switches the affected instances to the working servers and users stay on-line and keep working. IT engineers repair the faulty server and switch it back into the virtualized cluster when its fixed, and the user experiences continued operation with no down time.

Once the workstations are moved to the datacenter we need to add desk control for the keyboard, video and mouse. USB and analogue video repeaters are available but they suffer from two problems; they need specialist cables and connectors, and experience signal loss due to long cable runs. Even with repeaters the signal will deteriorate and start to introduce errors, and as video continues to move to digital HDMI and DVI, distance problems become more of an issue.

Modern KVM's, with IP network distribution are a solution to this problem. Two systems are available; paired and remote desktop protocol (RDP).

Paired systems consist of a transmitter placed with the workstation in the datacenter and a receiver on the user's desk. The video, keyboard, sound, USB and mouse ports are connected to the transmitter in the datacenter. These signals are encoded into IP packets and distributed in the network like any other IP enabled device. A small, low power receiver placed on the user's desk decodes the IP packets and presents the keyboard, video, audio, USB and mouse operations to the user as if they were sat next to the computer.

One major advantage of paired KVMs, from an engineer's point of view, is that they are operating-system independent, and don't need the computer software to be running for them to work. The video signal is transcoded onto the IP link and sent to the receiver, along with the keyboard, mouse, audio and USB, allowing server boot information to be seen at the user's desk, a powerful feature for installation and system debugging.

Early KVM's didn't have IP networking functionality and could only provide point to point connections over CAT5 cables using specialist analogue frequency modulation methods. They couldn't route through IP networks and were limited in the distance they could reliably function. However, they did solve the problem of having a computer situated on the users' desk, albeit in a limited way.

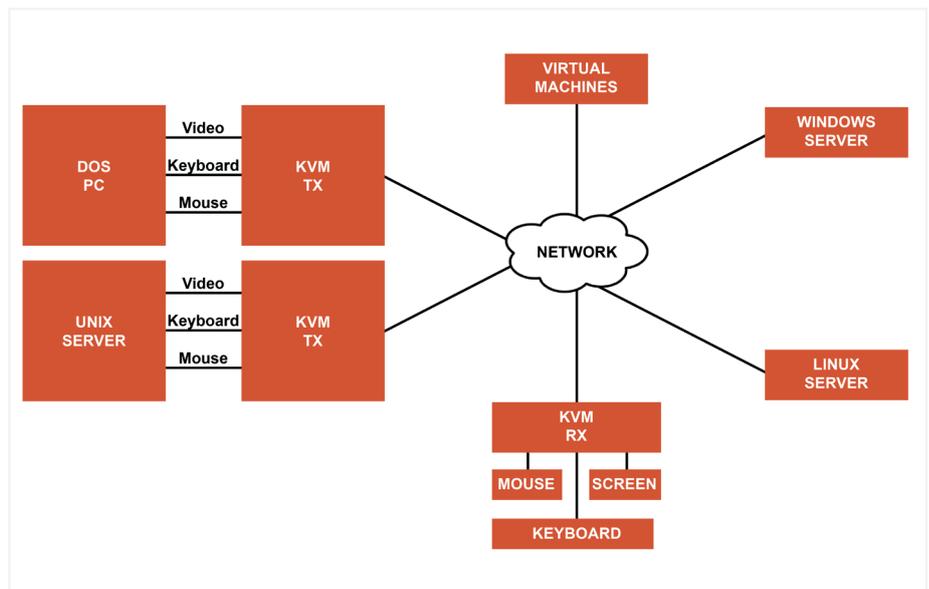


Diagram 1. KVM's seamlessly integrate legacy computers with public and private cloud infrastructures.

A second mode of KVM operation uses RDP systems adopted in Windows, MAC and Linux operating systems. Advanced IP networked KVM's use RDP and provide the same user experience without the need for a transmitter box at the datacenter. Although these systems won't provide server boot information (the RDP must be operational for them to work, and hence the operating system must be running), they are highly tuned to server operating systems and provide a better user experience for day to day work.

KVM's, through IP networks also facilitate multicasting, a method of distributing video to many monitors.

One other option worth mentioning is Secure Shell (SSH), a cryptographic network protocol allowing control of servers over unsecure networks. SSH is a command line operation and is only useful for maintenance functions, it certainly can't be used for editing or graphics operations.

Cloud Integration

Broadcast stations have a great deal of legacy computer equipment, and some of it is very old. Paired KVM gives you freedom to backhaul legacy equipment to the safety of a datacenter without having to worry about the operational implications. Furthermore, paired and RDP KVM's can be mixed within a system to seamlessly integrate legacy, cloud and private datacenter infrastructures giving the same user experience.

As well as moving user computers from the control room to the racks room, there are many other applications broadcast television can benefit from.

For some productions, presenters use large, in-vision, interactive touch screen displays to show football scores or election results. Reliable operation requires the server to be located close to the screen, but video processing requires cumbersome, noisy high-specification servers.

Sound engineers will be distracted by the fan noise when using localized servers, and it's difficult for IT engineers to maintain the servers if they are within close-proximity to the presenter, and having a backup system would only double the problems.

KVM's free the presentation area from large noisy servers. A small KVM receiver placed near the monitor allows cables to be tidied away and the camera view kept clear. Moving servers to the datacenter, racks room, or some other controlled area provides easy maintenance and backup systems.

Outside broadcasts benefit even more. With a presentation area at the stadium, touch screen video servers could be placed back in the studio racks room. Using KVM's, video, audio, keyboard and mouse signals are sent back over an IP network to the outside broadcast.

Placing hardware at the studio reduces the rig time, number of experts on site, and keeps noisy fans away from the microphones. Stadiums are difficult for sound engineers to mix at the best of times, and having to contend with noisy server fans is an unwelcome intrusion.

IP-Multicasting enables video to be viewed locally in the stadium and remotely at the studio. Routers are configured using Internet Group Management Protocol (IGMP) to send copies of datagrams to requesting devices. Using simple network configuration, an IGMP router with attached monitor in the control room, displays a copy of the video feed from the contributing KVM device.

Backhaul Broadcast Services

IGMP is used to configure networks so that the video from the KVM transmitter will be directed to several monitors. The beauty of IGMP is that datagrams are not duplicated; if two monitors are connected to one switch, only one datagram feed is sent to that switch. In effect, IGMP is acting like a video distribution amplifier.

We can have many monitor feeds and even more user positions, and users in the control room would operate the keyboard and mouse to the video server without disturbing the video or taking away control.

Using centralized hardware, outside broadcast production units can share studio resources when one unit is being used and another is in transit. Routing with KVM keeps the expensive hardware back at the studio allowing it to be multi-tasked, further decreasing weight and power consumption in OB vehicles.

KVM's connect to multiple servers. For example, four monitors are used to connect to four different servers, all through the same KVM. A single keyboard and mouse removes the need for multiple control and keeps the work area simple and tidy. Using hi-end codecs, KVM's provide high quality video displays, making them extremely powerful for broadcast applications.

Different modes of operation are available; view-only prevents other users from taking control of the computer, and share-mode allows each user to take control of the mouse and keyboard to enter information.

All of this is achieved without having to run a single extra video or audio cable, a massive bonus for any facility.

If the server crashed or needed urgent software intervention from an engineer, they could fix it from anywhere in the network, whether they're in the studio control room, stadium, or the chief engineers home. If you have an KVM receiver and network feed, you'll be able to access the video server anywhere.

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IP Multicasting

IP Multicasting is the unsung hero of the IP world. It acts like a video or audio distribution amplifier, but with the advantage of not needing any additional cables.

The source device, such as a camera, microphone or graphics server has no knowledge of which devices are receiving their outputs, in a similar way to traditional broadcast equipment using DA's. The sound desk has no knowledge of the destination of its outputs, only that they are seeing a low impedance load to a DA at the end of a twisted pair. The Ethernet output of a camera has no knowledge of where its datagrams are going and can only see the network interface card of the IP-router it is connected to.

Saving Network Bandwidth

An alternative method to multicasting would be to set the graphic servers destination address of each device requiring the stream. This would cause two problems, firstly, the overhead of having to set the IP destination of each different destination is an administrative nightmare and would be unworkable. Secondly, we would increase the network load by the number of destinations set in the graphic servers routing table, as each datagram would be individually sent to each device requiring the stream.

Multicasting solves both problems as it relies on the receiving equipment to opt-in to the feed, and IP datagrams are only sent once to each group destination, with the network routers providing duplication only on the network branches that need the stream. There are three key concepts in a multicasting system; the group address, reverse path forwarding and Internet Group Membership Protocol (IGMP).

IGMP Communicates Multicasting Information

The multicast group address is the destination IP address of the graphics server creating the video stream. The multicast group addresses are special IP addresses constrained in the range 224.0.0.0 to 239.255.255.255, approximately 248 million groups. Some of these are reserved and a full list can be found at the Internet Assigned Numbers Authority (IANA).

IGMP provides the mechanism for equipment receiving the stream (monitors etc) to tell its router that it wants to receive a specific group. Each IP-router passes this information along the line to the source equipment so that only the networks that require the stream relay it, thus reducing network congestion.

In diagram 2 the router will periodically send an IGMP Host Membership Query message to all devices connected to its networks, in this case the sound desk responds with an IGMP Host Report Group-1 and Group-2 message, advising the router that it wants to receive Mic-1 and Mic-2 audio streams. Mic-3 (Group 3) is not sent to the sound desk as the sound desk did not opt-in to receive that group.

Source Address Routing

Unicast routing works by looking at the destination IP address of the datagram and comparing it to its look-up table so the router knows where to forward the datagram to. Multicast routing uses the source address in the IP-datagram to route back to find out where the source of the datagram is, a system called Reverse Path Forwarding (RPF).

The beauty of IP networks in general, and multicasting specifically, is that the data can move in both directions simultaneously and doesn't require extra cable.

If a producer wants to watch the studio output in their office, their desktop computer or tablet can be easily configured to receive the group address of the studio output. No configuration will be required by the IT department, and no additional cables will need to be run to their office.

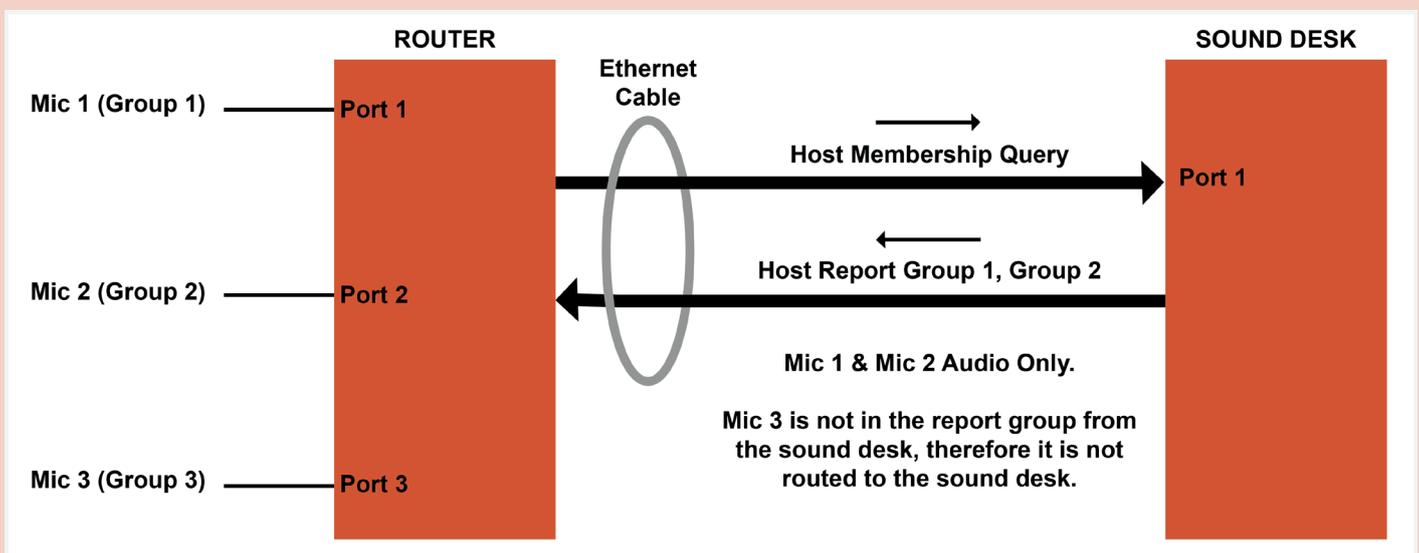


Diagram 2. IGMP is used by devices to opt-in and opt-out of multicast feeds.

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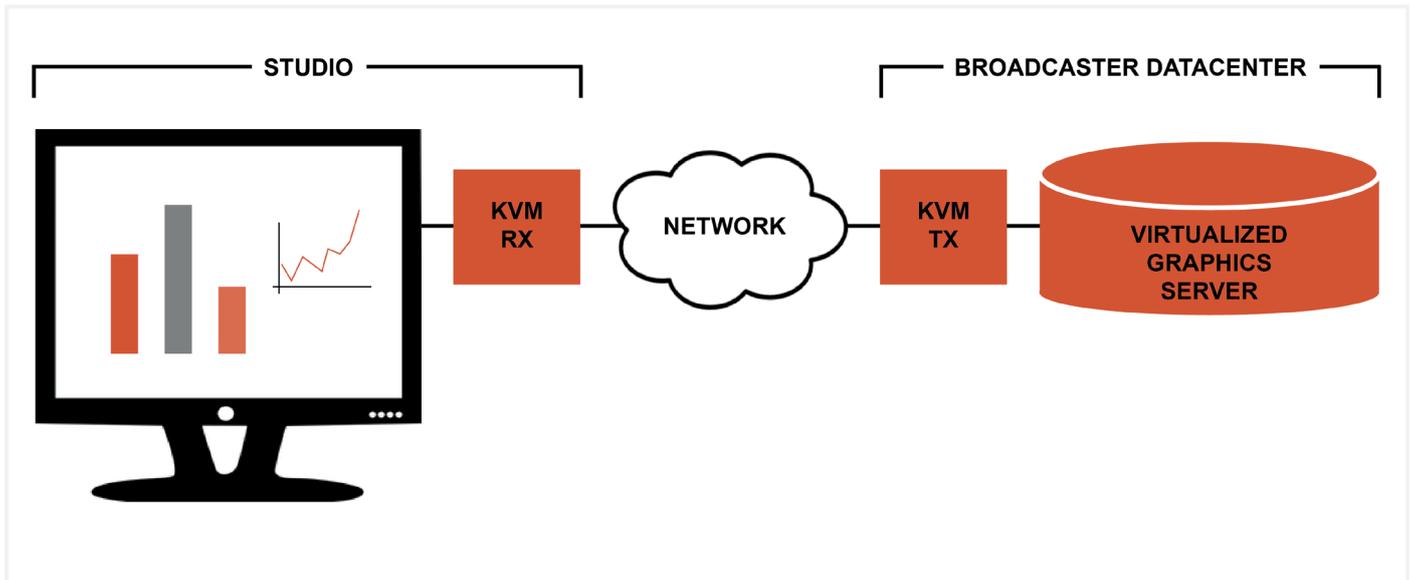


Diagram 3. In Vision Studio Monitor uses KVM to move noisy expensive hardware to the datacenter.

KVM's are used to upgrade software on different remote servers. Using a USB key the engineer would be able to upgrade any computer from their KVM receiver. Being able to log onto any computer with an attached receiver provides efficient secure software upgrades.

When KVM's are networked together, the engineering administrator centrally configures each of the receivers to change privileges and access rights, USB and sound ports are enabled and disabled, and different modes for sharing and viewing are set up.

Compression is used to reduce network bandwidth so the video doesn't take up all the networks data. If higher bandwidth solutions are required KVM switchers can be used.

KVM Switching

Black Box have achieved this with their DKM FX KVM switching solution. These units use IT CAT5, CAT6 or fiber connectivity giving higher quality video than a standard Enterprise IT infrastructure.

The DKM FX allows direct connection of SDI, 3G-SDI, HDMI and DVI outputs from servers, format conversion is provided and different types of video connectors can be used.

Applications using datacenter servers benefit from KVM switching. The best of both worlds is achieved; high speed video, audio and control is distributed over an IT infrastructure, and SDI speed and response times are delivered. There are no network switches to compromise the video quality or slow the system response. Long SDI and specialist cable runs are not needed, and the working environment for operational staff is greatly improved.

Security is increased as the number of people requiring external access through the network to servers is restricted to a few key personnel, and secure connection to computers can be provided with authentication. Providing an additional layer of security, holders of an authorized KVM unit will only be given access to the servers.

User Perceptions

One of the main blockers for moving users of software based systems to centralized hardware control, is their perception that a high-performance computer or server must be close to them. Editors, designers and operators have grown accustomed to having physical hardware in their locality, whether it's a high-end MAC for graphics design, or a Tower PC for editing.

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Data connections providing broadcaster bandwidths to public clouds, and off premise datacenters are still not within mainstream reach for normal operation. In the future, internet connections of 1Gbps will be available on every desk, and more specialist workstations like graphics and editing will have 10Gbps and even 100Gbps available, thus removing the need to have high-end servers near their workstations.

It is possible to centralize hardware using SDI to route the video back to the editor or graphics artist, but they still suffer the same delay problems with keyboard and mouse control systems. And it further restricts the datacenter location as it must be within the bounds of an SDI network.

Improve Security

One of the prejudices against centralized hardware and cloud computing over IP is that it is slow and unresponsive, especially when displaying HD video. However, backhauling high performance servers and installing KVM's gives users the speed and response they need, and is an intermediary step to educating users to the benefits of centralized hardware. It provides the best of both worlds; a centralized hardware solution over an IP network, and dispensing with the expensive specialist broadcast hardware.

KVM's help us change mindsets so users grow accustomed to using remote virtualized hardware. Using KVM's, different users from all over the world can use backhauled centralized hardware giving us a "follow the sun" approach to productivity.

Purely KVM infrastructures discourage users from storing files locally on computer hard disk drives, all company files are stored centrally in the datacenter and tracking of file movements is easily achieved, especially important when your clients provide block buster films and worry about copyright infringement. In this case, proving that your security systems are robust is much easier if employees cannot locally copy files.

Broadcast transmission systems need to become harmonized production-line processes delivering cost savings, efficiencies and the reliability that business owners demand. Centralized hardware delivers this and is a powerful concept for broadcasting, and the introduction of KVM's makes the transition and implementation much easier.

KVM Essential Guide



By John Hickey, Senior Director KVM Services, Black Box

Group consolidation over the past few decades has seen an increase in ownership by major networks including ABC, CBS, NBC and Fox, as well as broadcast groups such as Sinclair, Nextar and Tegna Media. Owners have optimized operations by removing local master control rooms and replaced them with central MCR hubs, although they're a great improvement, each time a new channel is added significant amounts of hardware, time and capital is still required.

An alternative to rigid hardware based MCR's is Virtual-MCR's, they're built by leveraging the power, agility and flexibility of IP cloud architectures. Vast amounts of storage are connected to COTS servers through hi-speed networks, forming the backbone of software-defined workflows. Processes are automated giving more dependable workflows, and the whole system becomes reliable, cost predictable and scalable.



KVM front view provides simple user connectivity.

Virtualization is the Way Forward

Today, broadcasters are transitioning to virtual MCR's, providing global programming, playout, delivery and network operations with this new technology.

Virtualization has a long-established history dating back from the 1960's IBM mainframes, to year 2000 with VMWare and Citrix. Virtualization makes efficient use of a server's resources. Even when running a high-end video transcoder application, a stand-alone server spends a lot of its time doing nothing productive as its utilization is generally low. Virtualization overcomes this as it logically splits the server resources into defined blocks that run their own operating systems and applications, giving the impression that many computers are running, when in fact it is only one.

The bottleneck with virtualization is the human interface; screen, keyboard and mouse. Although one server can masquerade as many computers, it generally only has one screen, keyboard and mouse, making it difficult for more than one person to use.

Operating systems such as Windows 7 and 10 have the remote desktop protocol (RDP) built into them giving a network graphical interface. Enhanced versions of RDP (called RemoteFX) and other protocols such as VMWare's use of PCOIP and Citrix's HDX have dramatically improved the user experience. Using hardware accelerators at the user end also improves on RemoteFX/PCOIP/HDX giving the impression the computer is next to the operator, when in fact it may be many miles away. Using the same technology, an operator can connect to multiple computers in private as well as public clouds, giving a seamless user experience.

Fast Roll Out for New Channels

The driving reason for broadcasters transitioning to virtualized IP-Cloud architectures is that new channels, delivery methods, and formats are rolled out quickly in response to viewer demand. Where software defines the production process, the cloud enables content storage/distribution. Commodity-priced IT hardware serves as the access and control interface. The traditional hardware-based TV production model, with its purpose-built facilities for each channel, does not offer this kind of speed or flexibility.

Disney/ABC Television is virtualizing its stations and moving channels to IP-Cloud virtual MCR's. The BBC has moved audio file storage, mixing, and playout into a single data center, providing local stations with IP access to centralized resources, creating and transmitting on-air programming.

Over the past five years, IP and cloud-based production models have evolved from being of little interest to broadcasters, to becoming a top technology project, as highlighted in Devoncroft's 2015 Big Broadcast Survey; in 2009 "Cloud was not a requested technology trend from vendor, end user or community", by 2014 "Cloud cited as a top five technology project". In five years Cloud, has gone from not required to full installation.

IP virtualization has a compelling business case carrying it forward. However, broadcast television is unique due to the massive amount of data we must reliably ship in real-time, leading to SDI being prevalent in broadcast systems, and a transitional hybrid model is emerging. SMPTE2022-6 is a good start in moving SDI to IP, but it is not sufficient to create a full end-to-end solution. Many in the field estimate that it will take between five and ten years for SDI in broadcasting to end.

We are embarking on a long transition journey and our systems must be able to operate with legacy equipment as well as new virtualized technologies. Intelligent KVM's such as the Black Box InvisaPC provide the best of all worlds, they interface to legacy servers as well as cloud services, and make Amazon Web Services and Azure work harmoniously alongside historic broadcast systems.



KVM rear view keeps cabling to a minimum.

Find Out More

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