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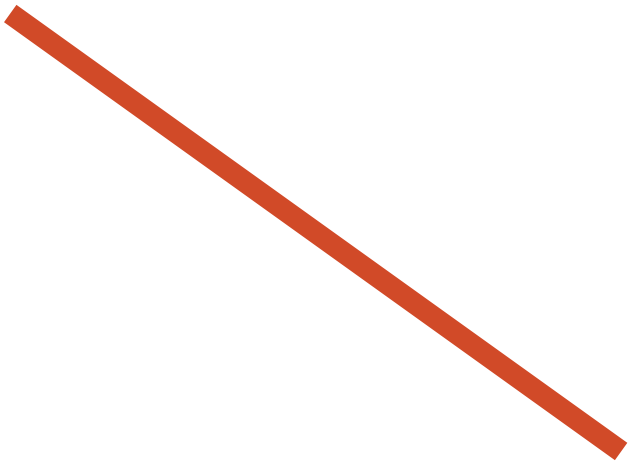
IP KVM – Delivering For Broadcasters



Essential Guide

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ESSENTIAL GUIDES

Introduction

By Tony Orme, Editor at The Broadcast Bridge

Having a collection of PCs and MACs stacked under a desk to facilitate the multitude of operational requirements not only proves difficult to operate but challenges our modern ideas around security and makes maintenance almost impossible.

The need to operate numerous computers within the confines of a desktop workstation isn't new, but what has changed is the need to deliver a refined user experience, improved security and advanced maintenance capabilities. Although KVM has been with us for as long as we've been using x86 computers, the introduction of KVM control over IP has been a real game changer.

Not only has the user experience greatly improved, but maintenance has been streamlined and security tightened. We've been able to install computer servers and desktops in datacenters for some time, however, the switched circuit KVM systems previously available greatly limited the distance the computers could be installed from the user and often resulted in complex infrastructures. IP KVM has changed this.

One of the principal reasons for using IP is that we can take advantage of the massive innovation in the IT industry and use a common protocol interface to distribute our data. IP is ubiquitous and combined with ethernet and WiFi delivers the majority of our communication needs.

The massive increase in switcher speeds combined with link bandwidth improvements has further expanded the use of IP within the broadcast industry. 10Gb links can easily transport baseband progressive HD video and if visually lossless compression is used then 4K60p is easily achievable.

In a short space of time tape formats have been replaced by digital storage and VT edit machines have been replaced by high-performance computers. Consequently, IP is growing in strength for broadcasters as it's the easiest method to move media assets around the compute and storage systems within modern broadcast facilities.

High value media assets need to be kept secure. Not only do broadcasters need to know where their data is at any time, but who is accessing them and from where. Keeping media assets on desktop workstations where anybody can easily access it is no longer an acceptable method of operation. Broadcasters are finding they must guarantee asset security, especially if you're working with the edit masters from the next block buster movie.

By moving the compute power and storage capability to secure datacenters with restricted and monitored access, broadcasters are better placed to meet the demands of modern media asset security. IP KVM enables improved security as it facilitates and encourages moving high value assets to datacenters. Importantly, this includes secure storage of the disk drives which could be easily removed from desktop computers by malicious actors.

Maintenance is often challenging when computers are stacked under desks. Not only is it difficult for engineers to access the machines, but offices and office-edit suites are generally far from being ideal environments to store high value media and expensive computers. Dust, condensation and the occasional cup of spilled coffee all conspire against the desktop working environment to the determent of the precision electronics situated under them.

Tony Orme.

Computers consume increased power when rendering high quality video resulting in the fans spinning at high speed to cool down the processors, often resembling a jet aircraft preparing for take-off, and further reducing the user experience.

Moving desktop computing to its rightful place in the datacenter improves the user experience as well as improving security and better facilitating maintenance. IP has made KVM much more versatile than it has been in previous years and is a must for any broadcast facility looking to improve the workplace and advance high value media asset security.

Tony Orme
Editor, The Broadcast Bridge

IP KVM – Delivering For Broadcasters

By Tony Orme, Editor at The Broadcast Bridge

In the perfect world, one computing device would meet all of our needs. We would be able to edit 4K video, answer our emails, and access web sites from the luxury of one machine. Although this may not be directly achievable due to security and operational challenges, the latest generation of KVMs streamline the user experience giving the illusion of the utopian workflows we are craving for.

Remote working has become a fact. Probably more out of necessity than a business requirement, but the need to remove ourselves from our physical place of work has become a reality. These interesting times have demonstrated the capability of how new working environments can benefit us greatly.

KVM, in its most primitive form of mechanically switched VGA, PS2 and serial control, has been with us for as long as we've used x86 computers. Early on, pioneers realized that for many applications, multiple dedicated machines could work as efficiently than a single mainframe type approach. The challenge with this methodology has been how to interact with multiple computers simultaneously.

Multiple Platforms

Further challenges present themselves as operators prefer to use some computer platforms instead of others. For example, a Mac OSX for editing, Windows PC for office administration and a Linux machine when deploying web development tests. All these machines could easily be required by one person throughout their working day.

Multiple keyboards, mouse controllers, and trackpads all conspire to complicate the workflow making the working environment challenging and difficult. As the number of computers increases then the physical working space becomes compromised and potentially chaotic. And as CPU speeds increase then the cooling fans become even noisier further impacting the working environment.

Dedicated equipment rooms help solve many of the operational and environmental challenges. Having the computer servers installed in airconditioned and secure rooms not only protects the servers and data but reduces many of the environmental issues for the users. The big challenge is understanding how to deliver the human interface controls needed to maintain their efficient operation.

Consolidating Cloud

Virtualized and cloud computing is making a major impact on broadcast television. As well as providing many office and administration applications, virtualized machines are finding their way into the broadcast infrastructure to improve workflows and increase efficiencies. Many operational applications can be accessed and controlled through web interfaces, but others require the user to look at the GUI output on a screen.

Modern KVM solutions provide a whole array of different working practices to help users and system administrators. A balance between operational efficiency, ergonomics, and technical capability can be easily struck. For example, an editor using a high-end editing package may want to keep their MAC under the desk to maintain the highest video quality using preview and edit monitors, but at the same time be able to answer their emails on a virtualized Windows computer.

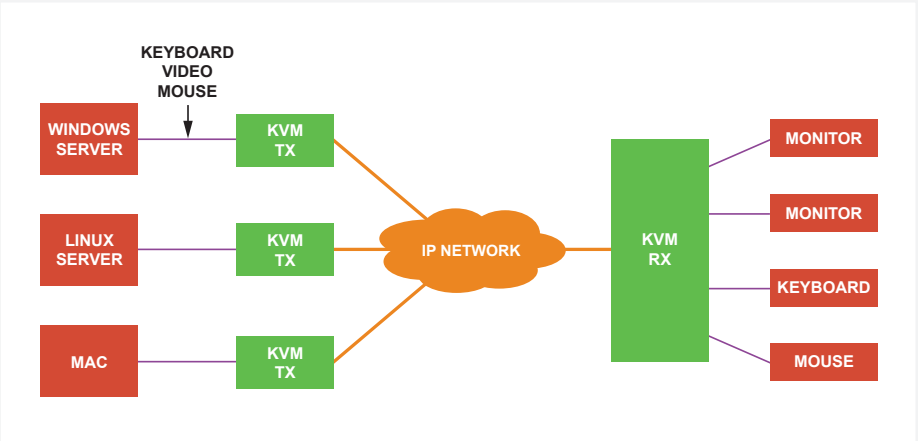

Figure 1 – KVM transmitters and receivers are used to multiplex the video and audio streams, keyboard and mouse signals onto IP networks so they can be decoded at the user's desk. As well as improving security, this method also provides a much-enhanced working environment..

Virtualized computing makes support much easier as IT engineers don't need to crawl around the floor trying to get to a suspect machine. Instead, they can interrogate the instance from anywhere with a secure network connection. Disk backups are easily achieved, and system wide monitoring can be better facilitated with centralized COTS servers running multiple instances through virtualization.

Improved Reliability

Instead of festering in dusty and environmentally challenged offices and studios, the servers are housed in datacenters with controlled temperature and humidity, along with conditioned and regulated power. Their reliability improves considerably, especially when we start to consider the many different configurations that allow the virtualized instances to be spread across multiple servers.

From the humble 256 color "320 x 200" pixel VGA to the incredible 4K displays available now, computer displays have grown considerably over the past thirty years. And with the increase in resolution and color, so has the user's expectations. Blocky and poorly rendered graphics with visible banding are no longer acceptable, only the highest quality will do, especially in a digital world.

Maintaining High-Quality Video

This presents an interesting challenge for KVM solutions as transferring such high-quality video over any distance is a difficult task. Fortunately, video compression has achieved incredibly high levels of quality with HEVC compression achieving visually lossless images with only mild compression. For example, a 4K/UHD 60Hz baseband signal has a bandwidth of approximately 12Gbits/s, if we apply only 3:1 compression then the resulting signal has a bandwidth of approximately 4Gbits/sec. One, or maybe two 4K/UHD signals could easily be transported over a 10Gb network link.

Using the mildest of compression now opens up a whole new experience for us as we can transport multiple 4K/UHD computer monitor feeds over a 10Gb network. Although this would require some network design and bandwidth management, 10Gb networks are easily achievable giving users two simultaneous video feeds to one workstation.

A KVM extender will be required and the outputs of the datacenter servers will need to be compressed in the transmitting box, then distributed over a network, and then to the user's workstation where the receiver box will decode the compressed the video to provide the baseband HDMI feeds for the desk monitors.

Improved User Ergonomics

Assuming the user requires their MAC for editing at their workstation then the receiver box will have a separate HDMI input facilitating switching between the local MAC and remote virtual Windows machines. The hotkey switching is achieved locally from the keyboard to provide a seamless transfer between the actual computers.

Quite often a user will require multiple monitors with live video feeds from each of their computer instances. From the example earlier, the Mac editor will require one screen, and both the Linux and Windows instances will require separate screens. The glide facility provided by the KVM receiver will allow the mouse to seamlessly move across all three screens giving the illusion of a single interface. In fact, the KVM receiver is able to detect where the edge of one screen ends and the start of the next begins so it can switch the mouse control signals to the appropriate Mac, Windows or Linux device.

At this point, the user's workstation is greatly simplified as their environment only consists of the KVM receiver, MAC computer, keyboard, mouse and monitors. Further resource in the datacenter can even be accessed through the hotkey switching.

Improved Security

If the user is willing to accept a visually lossless video feed, then the MAC can be moved to the datacenter too. Not only will this deliver a better working environment for the user but also provides a superior storage area for the MAC computer further improving its reliability.

Protecting media assets is often a priority for broadcasters and production facilities. Their high-value cannot be underestimated, especially when working with yet-to-be released movies and episodic series.

Moving all the hardware from the user's workstation to the datacenter not only provides an improved working environment but also improves security. Datacenters can be built to very high security standards for both network and people access. Having computers stored under desks makes them vulnerable from theft and tampering. Moving them to the datacenter improves security considerably.

Centralized control of the KVM system allows system administrators to control access to the workstations KVM receiver, further adding layers of security.

IT Engineer Pool

A major advantage of this system is that the KVM transmitter and receiver work over an IP network. Although there may be some specific routing required for the correct QoS on the network links to provide the optimal video latency and keyboard/mouse operation, the networks core switch is readily available and understood by network engineers.

One of the benefits of moving to IP is that broadcasters can take advantage of IT innovation and working practices. Network design and operation generally follows well understood connectivity and configurations. Companies such as Cisco provide training programs with certification such as the CCNA (Cisco Certified Network Associate). This teaches a methodology for design and support of IP networks that cover the vast majority of network requirements.

Using standard network topologies allows KVM users to take advantage of this standardization giving access to a greater pool of already trained network engineers. Although earlier KVM systems may have used dedicated routers specifically to switch KVM signals and video feeds, the adoption of IP both reduces costs and greatly simplifies support.

Latency Considerations

Although packet switched networks such as IP deliver greater flexibility than their circuit switched counterparts, we must be careful about keeping latency under control.

We should put latency into context. For example, for general keyboard and mouse operations it's often difficult for us to perceive above 100-150ms of latency. A latency of 150ms should be achievable in a well-designed and configured private network. The critical point is that we are able to adapt our hand to eye coordination relatively quickly. Consequently, it's better to focus on realistic and achievable latencies than continuously trying to achieve unrealistic low latencies.

Resilience is usually inbuilt into enterprise networks giving an unexpected benefit for users of KVM over IP. Resilient networks are self-healing and provide greater reliability for users. As the KVM systems sits on top of the IP network, any failures are automatically rectified without user intervention. The KVM monitoring system may notice there has been a network change and even log it, but the user will be unaware of these changes most of the time.

IP Strengths

IP is a best effort delivery system by design and does not guarantee the reception of the packet at the destination device. Although this may seem a bit lacking in the original IP design, it turns out to be one of its greatest strengths. By keeping the packetized data structure simple it is possible to transport the IP datagram over many different types of transport stream. Broadcasters generally use ethernet as the transport stream and IP packets reside within the ethernet data frame.

As an IP datagram progresses its journey it will often encounter many different types of transport stream such as WiFi or fiber. The simplicity of the IP datagram allows it to easily switch between different hardware interfaces.

TCP is a protocol that adds a layer of data validation to guarantee delivery of the underlying data, in this case, the keyboard and mouse information. As with all things engineering, there is always a compromise. Although TCP guarantees delivery, the price we pay for this is increased latency.

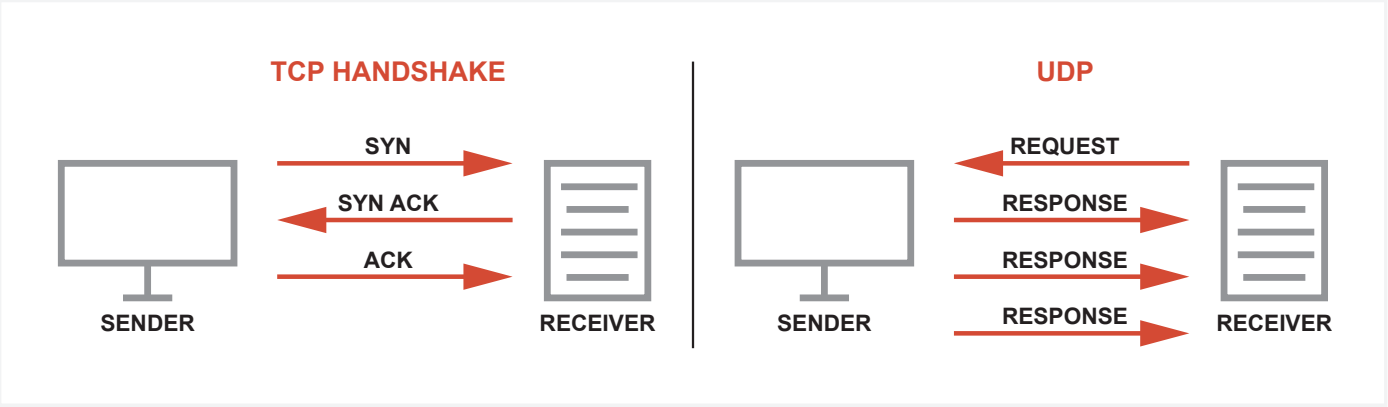

Figure 2 – TCP adds a layer of data delivery guarantee to a network at the potential expense of increased and indeterminate latency. Using UDP in enterprise networks reduces latency to improve video and audio distribution.

TCP Compromise

Every key press, mouse-click and move are essential to the user. To maintain high user confidence in systems, all of the control information must be reliably exchanged between the user's workstation and servers in the equipment room with the minimum of latency possible. Even the delay of a single mouse-click or delay of a mouse drag can cause uncertainty with users.

To avoid flooding a network with data, TCP uses congestion control to moderate the number of IP packets it sends at a time and network switches use buffers to reduce the chance of oversubscription within a link. However, one of the strategies used to avoid sending too much data into a link is to drop TCP packets, thus forcing the sender to back-off its transmission rate. The sender detects packets have been dropped and then resends them. Hopefully on this occasion there is sufficient capacity on the link and the IP packets can be sent unhindered.

The packet drop method is effective and most of the time the user is unaware this is occurring. However, the major challenge is that latency can increase and become indeterminate. It's perfectly acceptable to send system messages, including keyboard and USB device information using TCP as they are not time critical, and we need to ensure all messages arrive at devices even in the face of packet loss in the network.

Typically, keyboard and USB devices (such as flash drives) need reliable exchange and therefore use TCP. This also guarantees that keyboard messages and specifically key operations arrive at the devices in order, so they do not become confused on the state of particular buttons. As these messages are short, they utilize minimal network bandwidth.

UDP Efficiency

UDP (User Datagram Protocol), is another protocol within the IP stack and provides further addressing information for the IP packet but still uses the send-and-forget policy. We make the assumption that enterprise networks are very reliable and it's unlikely that UDP packets will be lost.

As UDP does not have a congestion control function the network switch will not opt to drop them if a link is starting to oversubscribe. Switches can even be configured to prioritize UDP packets in favor of TCP when links are becoming busy.

UDP is often used to distribute high-bandwidth video and audio unless protecting against lossy networks such as WiFi. IGMP (Internet Group Management Protocol) is often used to multicast video streams so many different receivers can "tap" into the video distribution feed. This requires network switches to support the IGMP protocol and allow pruning of multicast streams so that only the required devices receive the stream. This improves network efficiency and reduces the risk of congestion.

KVM is proving its worth in broadcast and media facilities, especially when we consider all the benefits IP solutions deliver. Security, resilience and improved operational environments combine to further improve flexibility for the broadcast and media facility, as well as the people using the workstations.

The Sponsors Perspective

Emerald - Moving The KVM Story Forward

By John Hickey, Senior Director KVM and R&D, Black Box

KVM (keyboard, video, mouse) switching and KVM extension provide access to critical IT assets. They might be deployed to give desktop users access to multiple computers from a single console, keyboard, and mouse, or implemented by facilities to enable distribution of high-quality video, audio, and peripheral signals across networks and through hybrid physical and virtualized server infrastructures.

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These capabilities are valuable in control rooms and production environments in broadcasting, post-production, air traffic control, industrial manufacturing, and other collaborative environments. The maturation and embrace of IP technologies across these sectors has made space for IP-based KVM systems and the numerous benefits they offer. This is why Black Box has gone all-in on designing KVM technologies that support future-proof concepts such as IP distribution and virtual machine connectivity.

Taking KVM To The Next Level

Black Box began developing the next generation of IP-capable KVM systems a little more than four years ago to support the evolution of control room technology and workflow. We recognized that organizations were interested in technologies that could deploy with greater flexibility to enable greater efficiency and productivity. We saw KVM technology as a critical enabler of change.

Driving change in the control room environment was a desire to move from physical machines to virtual machines and from proprietary systems to Ethernet and IP-based systems. Those two key trends would shape not only the evolution of control rooms, but also the development of KVM systems.

The philosophy behind our KVM development was to facilitate seamless integration of access to physical machines and virtual machines, using standard IP Ethernet infrastructure and a software-based approach focused on allowing people to control their workflow.

Uptake of such products gained momentum as broadcasters increasingly migrated to IP from traditional proprietary KVM systems. Presenting new requirements in terms of social distancing and remote work, the COVID-19 pandemic accelerated this trend. Businesses embraced our new IP-based KVM system because it offers capabilities and characteristics critical to maintaining operational efficiency and to achieving the agility and scalability so valuable in a time of rapid change.

As more and more businesses look at how they can build scalable, fault-tolerant control room systems, the shift to virtual workloads — enabled by KVM technology — is often a key element in system design. Fault tolerance can also be improved by establishing multi-site operations. Remote access thus is an important aspect of current and future control room designs. It addresses the requirements of distancing and remote work while supporting the distributed operations that contribute to greater fault tolerance.

The move toward software-based systems and workflow automation has likewise fueled adoption of advanced KVM systems. At the click of a button, authorized users can instantly reconfigure a video wall layout, the video and data being piped to specific operator workstations - both local and remote - and many other elements of the control room environment.

An equally important benefit of sophisticated, IP-based KVM systems is that they allow businesses to run standard IT networks already familiar to staff and to scale up systems very rapidly. One advantage of leveraging Ethernet infrastructure is that a business can scale the network from 1 GbE to 10 GbE to 100 GbE as needed. The attachment at the edge to KVM appliances might be a 1 GbE connection, with links to both physical and virtual machines. As that switch gets filled up, the business can aggregate multiple switches with a larger 10 GbE or 100 GbE switch to create a leaf-and-spine model of networking, building a bigger topology with flexibility in adding new ports that proprietary systems can't provide.

Those four trends — virtualized workflow, multi-site focus, software-based-for-workflow automation, and network-based — will be key to the way control rooms and KVM are going to operate moving forward.

Addressing Future Growth And New Requirements

Looking forward, we see KVM technology and systems evolving to support broader integration.

More specifically, we envision extensive integration with standard IT infrastructure, including SNMP managers, active directory servers, and other tools that IT departments use to manage their business. The shift of KVM from proprietary to IP-based technology will allow it to become part of that standard flow rather than remain a special on-the-side element.

We also anticipate increased integration with devices, not just with respect to different types of video sources, but also in terms of more varied ways of linking into systems within a controller. REST APIs today serve as a primary means of linking up different systems so they can interoperate and interact. One example of this integration, already deployed within a real-world control room environment, is the Lawo VSM driving the Black Box Emerald KVM system at the click of a button.

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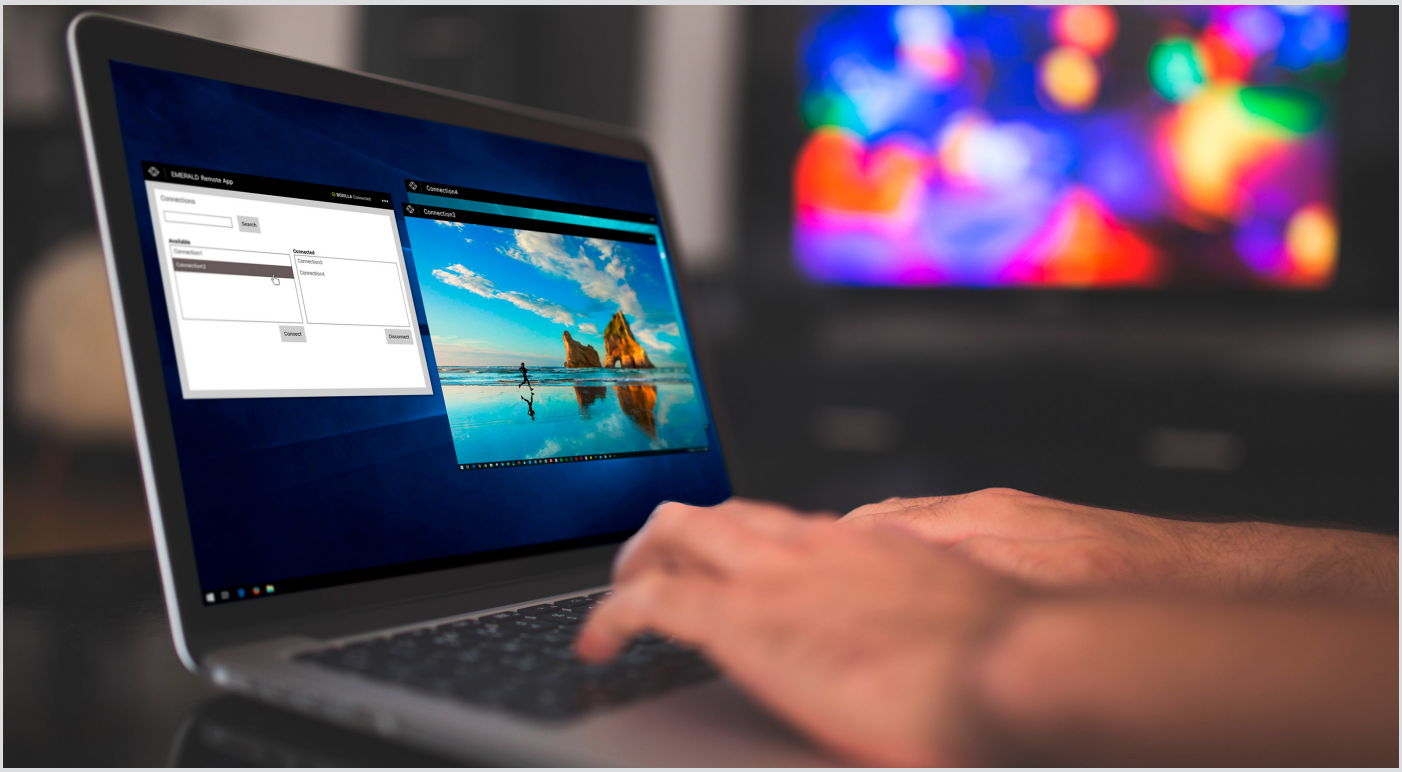

In fact, in developing and expanding our Emerald unified KVM product line, we have been dedicated to ensuring interoperability. When they buy Black Box KVM systems, our customers can be confident that those products have been tested extensively with third-party devices.

As always, security will be a concern for future KVM implementations. As various businesses re-examined their operations moving into the COVID era, they began to realize that proprietary KVM systems and traditional KVM models were a barrier to remote operations because they made it difficult to enable secure remote access. Now, by shifting to Ethernet and IP-based KVM, businesses can take advantage of standard networking technology rules, VPNs, and other mechanisms of control essential to optimizing both access and security.

IP-based KVM systems benefit from the hundreds of millions, if not billions, of dollars spent every year better protecting IP networks. This gives IP networks much better protection in general than any proprietary system can achieve. When just one company drives a proprietary model, a measure of protection might be achieved through obscurity, but vulnerabilities are far less likely to be identified and addressed. Within the IP world, efforts to mitigate the potential for breaches is both broad and continuous.

Moving Forward With Black Box

We anticipated the need for a future-proof, IP-based KVM system years ago, and we've seen the technology come into its own in enabling the evolution of control room operations. As this market continues to evolve, our KVM technology will drive more IP-centric integration of third-party systems, make it easier to automate workflows, and allow operators to focus their time and energy on their work rather than on the tools they use to perform it.

The Emerald KVM line allows organizations to explore new and better ways of working. For this reason, the use cases for our Emerald products are expanding into a broad variety of applications — broadcast, postproduction, live production, and others — where IP-based KVM delivers valuable benefits. With the ongoing development of our next-generation, IP-based KVM system and a strong team of experienced technicians, we're helping broadcasters around the globe to establish more flexible, secure, and future-proof remote access and signal distribution infrastructures every day.

John Hickey, Senior Director KVM and R&D, Black Box.

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