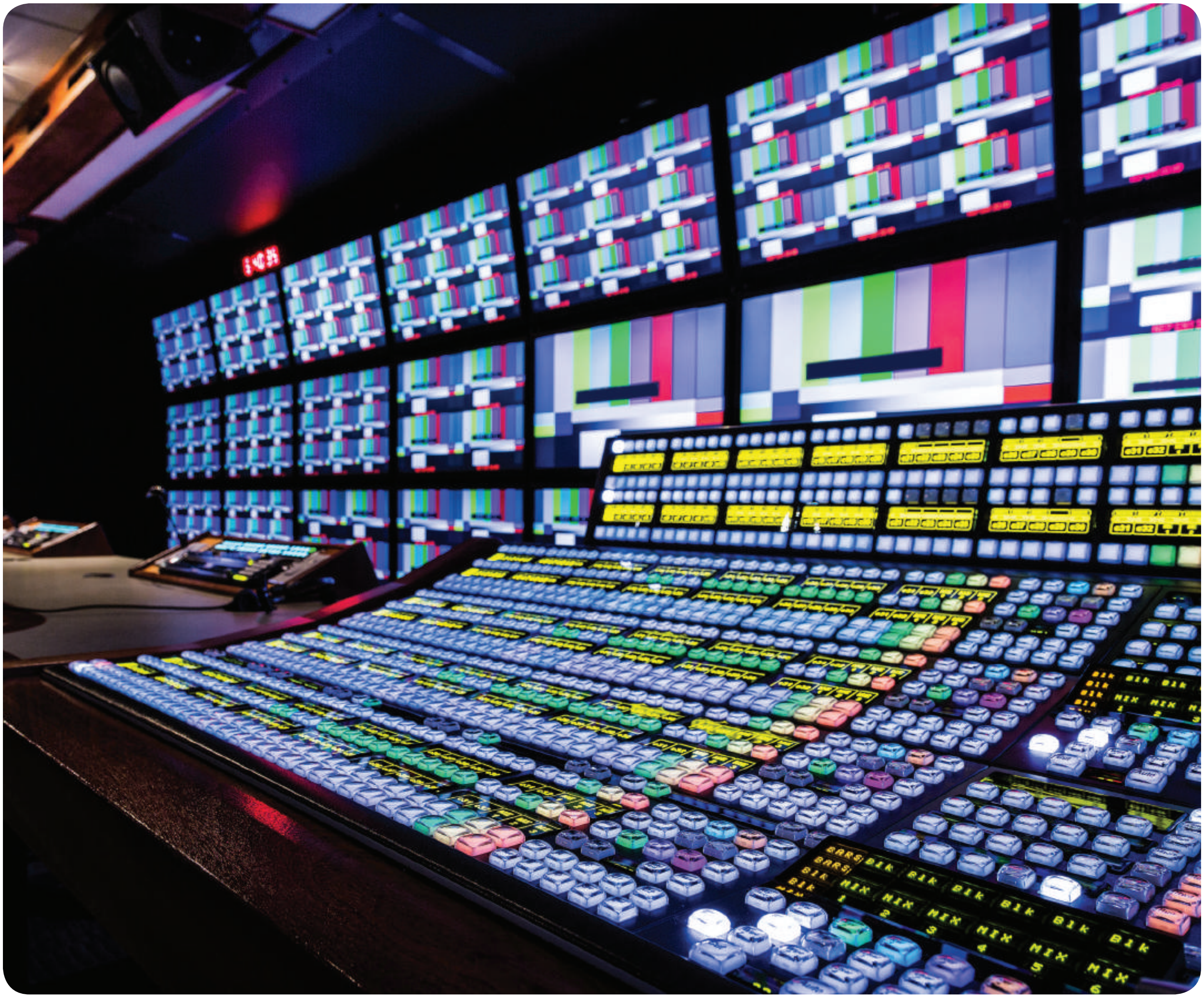

KVM TECHNOLOGY FOR BROADCAST

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INTRODUCTION

KVM systems have long been one of the hidden foundations of a broadcast facility. They have evolved from being an occasional use tool for setup and troubleshooting into one of those infrastructure items that are used every moment of the day but are often not at the top of the list when describing the features of a new facility. Just like the foundation of a building, the KVM system is one of those unseen elements that support the entire system.

As computing platforms take on an ever-increasing role in broadcast systems, the ability to gain access quickly and reliably to those platforms becomes more important. Early adopters of KVM systems often found them to be a necessary evil: a solution that provided some of the needed features in terms of usability and space savings, but that often left the users frustrated with system performance and scalability. Modern KVM systems have made enormous progress in addressing and overcoming those frustrations.

Current KVM systems can offer a wide range of platforms with a host of options to address the requirements of a broadcast facility, from direct-connected systems to those that make use of customer-supplied IP networks. These systems can allow the users to dictate the shape, the number of inputs and outputs, and, largely, the size of these KVM systems, as well. Whatever the requirements, it is possible to design a system that meets those needs. Systems can be architected to accommodate large distances, high performance, and varying levels of system redundancy and resiliency.

Read on to find out how the latest generation of KVM systems compare to what you know about KVM technology, and learn how they can be integrated into the broadcast plant.

EVOLVING TECHNOLOGY

SYSTEM ARCHITECTURE

Traditional analog KVM equipment was architected for a limited use case: to connect a large number of servers to a small number of user stations or user interfaces. These were usually servers running background applications, which needed only occasional user intervention. These systems tended to be deployed in situations where the source devices and user stations were in close proximity to each other. In fact, the analog technology required by these systems required that this be the case.

In many broadcast applications, this proved to be a case of a square peg in a round hole. The more common use cases were switching rapidly between main and backup equipment in on-air critical applications and sharing high cost specialized equipment between multiple user stations. In these cases, relatively few sources were shared among a larger number of users, and it was also a common occurrence for the source devices to be housed in an equipment room a considerable distance from the UI. Advanced features such as audio support, high speed data buses (USB 2.0/3.0), and serial controls were simply not available.

Modern KVM systems, based on newer digital technologies, eliminate many, if not all, of these architecture limitations. These digital KVM systems typically fall into two main categories: direct connected KVM systems and IP network connected systems. Both of these offer the system designer a great deal of flexibility to tailor all aspects of the system to meet specific requirements.

DIRECT CONNECTED SYSTEMS

For most direct connected systems, gone are the days of fixed inputs or outputs that may designers have come to expect. Systems are equipped with data ports that can be configured as inputs or outputs as required. A variety of matrix sizes are available, and users can select from fixed port or modular platforms, as dictated by their needs. Numerous options exist for the type of endpoint that can be deployed, as well as for copper or fiber interconnections between endpoints and matrix.

Matrix Control – Control of the KVM switch can be done using in-band signaling from KVM equipped UIs or from third-party control systems via an API. Users can select from a source list generated by an on-board on-screen display (OSD) generator housed in the receiver unit or through user configured hot keys. Sources and destinations can be grouped into containers, including a number of endpoints, with the control system treating each of these containers as a single source or destination. This can allow the more common KVM endpoints to be grouped with specialized endpoints, such as high speed USB or SDI video, and switched as a single entity.

Hot keys or macros can be configured to allow multiple endpoints to be switched simultaneously. This would be particularly useful in main/backup scenarios where a number of UIs would need to be switched at the same time or in cases where an entire production control room needs to be reconfigured between shows. The configuration change can occur instantaneously with a single keystroke.

System Resiliency – The UI of broadcast equipment has transitioned from being a background configuration tool to the main point of control for many on-air systems. Maintaining these control paths at all times is critical for continuity of on-air operations. The control systems of KVM switching systems have evolved to support this level of operation. Resiliency is built into the control system to ensure that controllers can be hot swapped quickly.

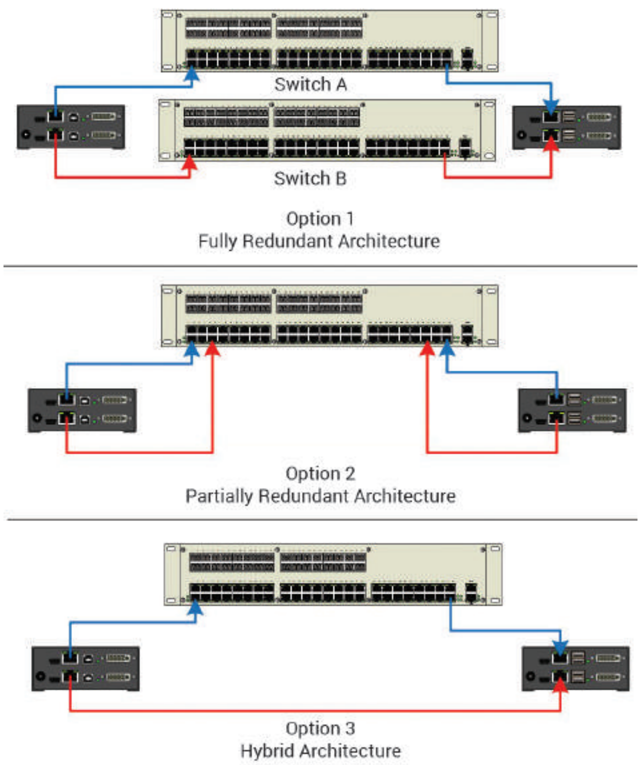
System protections can also be integrated into the overall design of the system. For high criticality installations, it is possible to use endpoints with redundant matrix connection points. These connections can feed back to different I/O cards of a single matrix or to redundant matrices. For source endpoints, the signals from the source computers would be fed to both matrices simultaneously. For destination endpoints, the receiver would monitor the status of both of the inbound signals. The users can specify the signal to use when both are present, and the receiver would automatically fail over to the alternate if one of the connections is lost. The two matrices would communicate with each other over the network to maintain the switch configurations in sync.

A hybrid implementation is also possible for those who cannot support the additional cost of a second matrix. In this scenario, certain endpoints are direct connected via the secondary connection points while the primary points are connected to the matrix. In the event of the failure of the matrix, the receiver would fail over to the alternate connection, a direct connection to the source device transmitter. This architecture would eliminate flexibility and switching functionality in the redundant mode, but provides absolute continuity in the UI connection. See Figure-Redundancy Options.

Port Flexibility – When configuring the modular platforms of the direct connected matrix systems, users can chose from different I/O port speeds to best suit their requirements. Standard connection speeds for keyboard, video and mouse are approximately 1Gbps at the lower end of the scale with medium and high speed ports available to support specific applications such as USB 2.0 /3.0 and baseband video signals.

In addition to port speed options there are options for the connections between the endpoints and the matrix. I/O cards are equipped with SFP cages that will accept a variety of SFP modules. Standard ports can be equipped with copper SFPs (RJ45 over UTP cables) or fiber SFPs for either single or multimode fiber.

Redundancy Options



Medium and high speed ports will require fiber SFPs (single mode or multimode) to accommodate the higher data rates of those ports.

The high speed ports can also take advantage of the recent advancements in SFP technology to allow additional connectivity options. These ports can be equipped with SFPs to allow the direct connection of SDI video, 3G-SDI, HD-SDI or SD-SDI on coax or SDI over fiber, or HDMI version 1.3 sources directly into or out of the KVM matrix without the need for outboard conversion equipment. This allows high resolution video sources to be switched alongside the traditional UI signals for greater flexibility in monitoring options.

IP-BASED SYSTEMS

The change to digital technologies in KVM systems has also allowed KVM switching to be implemented over converged IP networks. The dedicated KVM matrix switch is replaced by a COTS Gigabit Ethernet capable IP switch. KVM transmitters and receivers are connected to the IP switch via standard Ethernet connections. IP-based systems offer even more flexibility than the direct connected systems in terms of system architecture. The physical reach of the KVM system has become equal to that of the IP LAN. As long as there is sufficient bandwidth across the network between transmitter and receiver, the KVM system is there.

It is even possible to design certain configurations of IP-based KVM to reach past the boundaries of the high speed internal network to make use of public networks or the internet. IP based KVM transmitters can be specified with VNC capabilities to allow users to connect to host machines remotely via low bandwidth, high latency networks (WAN or the internet) for certain types of operations.

System Control – Control of the IP-based KVM system is managed by standalone system managers. These devices maintain information about the available KVM devices and connection status of endpoints in the network, facilitating the connection of transmitters to receivers via the network. As with direct connected systems, KVM switch commands are initiated in band by the receiver, using data obtained from the system manager. Once the connection is made, the endpoints communicate directly via the IP network.

Access to the KVM system is controlled by user login. The system is configured to provide a unique profile for each user that governs their access to sources devices, including the level of access that they are able to employ. These logins can be based on the user's standard company login through Active Directory. Configuration and status can be created and managed via a secure web-based management suite.

The control system allows the user to configure the data stream that is delivered to the receiver unit. The user can pick from discrete sources (a complete data feed from a transmitter) or create a virtual channel. A channel can be built using source signals from different KVM transmitters, e.g., the video from server A and the audio from server B. These channels are available in the system source list, much like the complete data feed from a particular KVM transmitter.

Another useful feature of an IP-connected KVM system is its ability to of make use of IP multicast protocols to provide point to multipoint distribution of KVM feeds for monitoring or collaboration. Different types of connection modes include:

- Shared Mode: All receivers are connected in parallel to a particular source. All human interface devices (HID), including keyboards, mice, tablets, etc. are connected simultaneously.
- Exclusive Mode: Multiple users can monitor the video and audio feed; however, the first user to connect to the source has exclusive right to the HID connections (only one keyboard and mouse connected).
- View-Only Mode: User can connect to a source only to receive the video/audio feed. No HID connections are possible.
- Private Mode: A single user is granted access to a particular source. Once that connection is made, all other user connection requests are rejected until the user releases the connection.

The various modes can allow users to make use of the KVM system in a number of different workflow scenarios outside of the standard one-to-one mode, such as status monitoring of alarm UIs, training or job shadowing, and signage throughout the facility, while still providing users with the privacy and security capabilities needed for confidential use, such as email and confidential documents.

System Resiliency – System status of the IP-connected system is stored in the system manager. Redundant system managers can be operated in an online or hot redundant mode to improve system reliability. Handover from one system manager to the other is seamless. The system manager is only involved prior to the time a switch is made to allow the user to select the appropriate source. Once the connection is made, the communication is directly between the transmitter and receiver.

The IP-based systems take advantage of a persistent link mechanism to retain their connection information in the event of a power cycle. This means that as soon as all the elements in the connection path (transmitter, receiver, and network) are powered up, the units will restore their KVM connection. There is no need to wait while the system manager boots up and resumes operation to restore the KVM connection.

IP-based units can be equipped with redundant Ethernet ports. These ports can be used as redundant data connections, or the ports can be can be ganged for higher network bandwidth. When the ports are used in the ganged mode, a single port can retain the KVM connection in the case of failure of one of the links. The system automatically adjusts the network traffic to route all the KVM data down the single link.

Port Flexibility – The IP-based systems do not have the same level of port flexibility that the direct connected systems are able to provide. Due to their 1 gigabit Ethernet communications protocol, they are equipped with RJ45 1Gbps copper ports and a SFP card cage for optional single mode or multimode 1Gbps SFPs. Baseband digital video or high speed data interfaces are not feasible over this type of link; however, the 1Gpbs bandwidth is more than enough to carry the standard keyboard, video, and mouse signals of a typical UI.

Virtualization – IP-based systems can be used to take advantage of the current IT trend towards virtualization. IP-based KVM systems can be selected to act either as zero clients for virtualized machines or as traditional KVM receivers connecting to PCs via a KVM transmitter. This type of system allows the user to connect to a mix of virtualized and traditional PCs, allowing a gradual transition to a virtualized environment. These types of system are even suitable for deployment across WAN architectures since they typically require lower bandwidth than the 1 Gigabit connected systems.

SYSTEM SCALE

Traditional analog systems tended to be difficult or impossible to scale past a fixed upper limit. The largest switches available topped out in the range of 64 inputs, while only offering up to 16 outputs. To implement large systems, it was necessary to cascade multiple layers of switches, which tended to be prohibitively expensive and difficult to control and compromised the end-to-end performance.

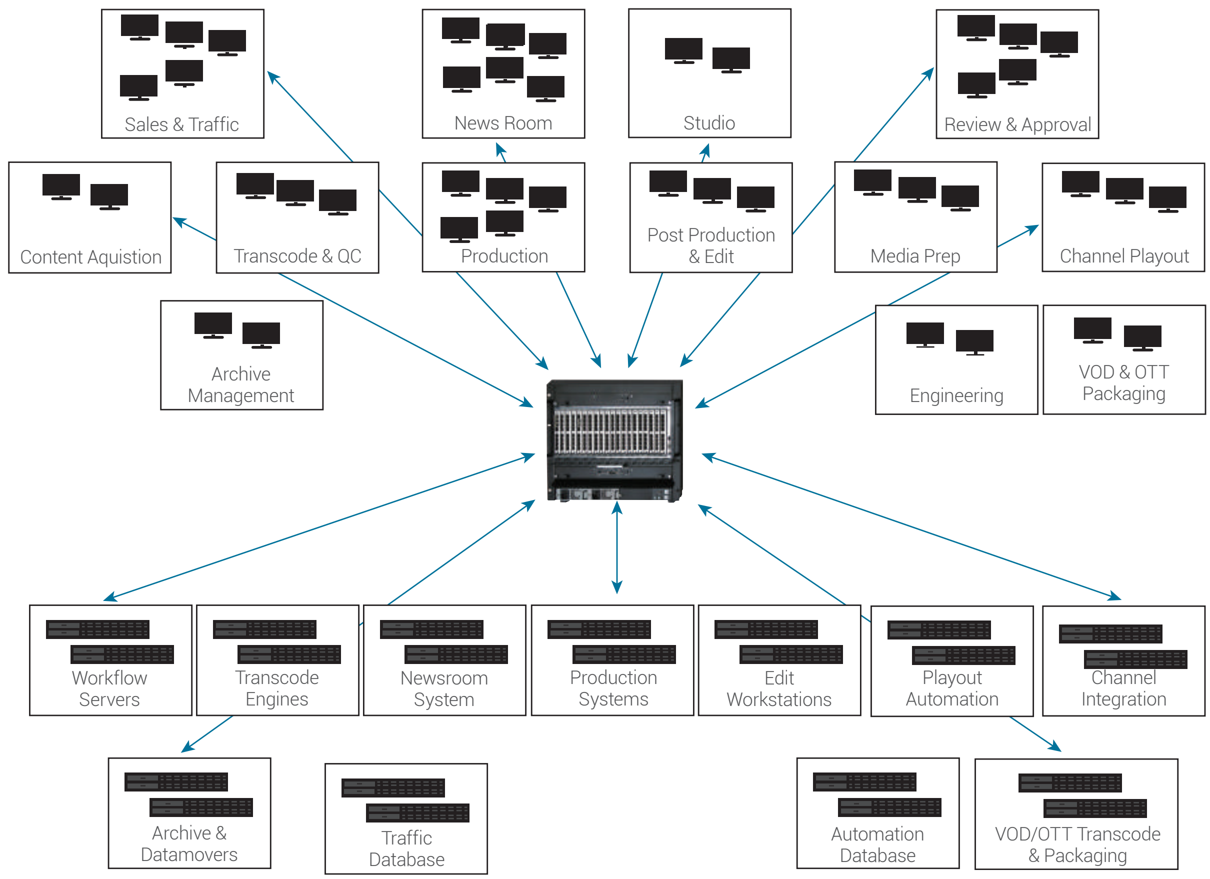
Current KVM technologies have largely eliminated the issue of system scale. For the direct connected system, small to large systems can be accommodated in a single frame, while very large systems are possible using tie lines between matrices managed by a sophisticated control system. With an IP-connected system it is possible to implement an even larger range of scales, from two endpoints to thousands of endpoints, with theoretically no upper limit to the size of the system.

KVM systems can now easily be deployed on a scale that spans the entire broadcast facility. This is possible for even the largest broadcast centers, with every computer UI connected to a single integrated system. See Figure-Enterprise KVM System.

This type of enterprise-wide deployment can provide the broadcaster a number of benefits:

- Flexibility – Staff can access whatever systems they need to throughout the facility from any location.
- Efficiency – Staff can accomplish their tasks faster and with less organizational latency.
- Responsiveness – Staff can respond to emergencies and failures, quickly assess the problem, and smoothly switch to backup system to restore operations.
- Reduced Cost – Capital costs and licenses fees could be reduced as users are able to make better use of resources by sharing devices and user interfaces.
- Improved Workspace – The design of operational environments can be streamlined with the KVM system, providing access to a variety of interfaces at a single position, improving ergonomics, and reducing clutter.

Enterprise KVM System



DIRECT CONNECTED SYSTEMS

Matrixes frames range in size from just a few ports up to approximately 300 ports with larger (600-port) frames soon to be released. Switches can be supplied as fixed-size systems with all the ports populated or as a modular chassis with empty slots that can allow the user to grow the system as their needs evolve or as new features are added to the platform.

In addition to platform options for the matrix switch, there are options for the KVM transmit units, as well. High density, card-based solutions are available for the KVM transmit modules. These frames decrease the space required by the KVM transmitters while simplifying installation and providing redundant power supplies to the active components.

IP-BASED SYSTEMS

IP-based systems offer even more flexibility in terms of system architecture. There is no theoretical limit to the number of end points that can be added to an IP-based KVM system. The only practical limitation is the bandwidth of the user-supplied network that supports the system. IP-based systems are considered the best choice for very large systems, although it is recommended to examine the load that the KVM system may impose upon the network, and consider dedicated network infrastructure for the KVM system to ensure performance.

PERFORMANCE

With their use of analog connections, legacy KVM systems had limits on the resolution and distance that the signals could be transmitted. Complex and difficult to configure skew compensation circuits were required to overcome the video issues generated by the KVM transmission technology. In addition, the devices often functioned as USB hubs for peripherals, requiring a re-enumeration of the USB devices each time a switch was made. This resulted in a 10 -15 second delay after each switch until the UI became usable.

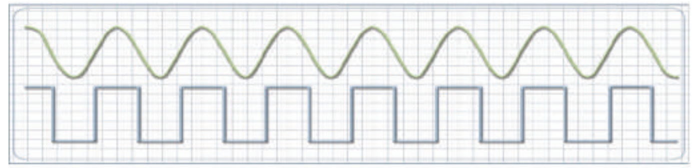
Digital KVM systems have evolved to overcome both of these performance issues. Video compression techniques are applied to video signals to reduce the data that needs to be exchanged between transmitter and receiver. USB devices are handled differently, as well. KVM transmitters used in these systems ensure the host computers maintain the peripheral devices as active, allowing in-band control and instantaneous response of peripheral devices.

Frame rates of modern digital KVM systems have been designed high performance while carrying high resolution full motion video. A frame rate of 50 fps or greater is required to support smooth mouse or tablet tracking. These rates are easily supported by the current systems for all video resolutions below 4K. Systems supporting 4K 60fps video are also available.

End-to-end processing latency is the second major factor that impacts usability of KVM systems. Video compression is typically the main contributor to end-to-end delay. Currently, these delays are typically in the range of 24 ms one way or 48 ms round trip. This delay starts to become noticeable for the user once it reaches the range of 70 -80 ms, making the latency performance of a typical KVM system well below this threshold.

The video compression parameters can be adjusted by the user to ensure that video quality parameters are given the highest priority in the compression process. For applications where colorimetry is important, color depth can be preserved while video frame rate is decreased. In cases where video resolution may be more important, frame rate is preserved and color depth is reduced. These parameters can be set per transmit device to optimize the performance of each source on the system.

The bandwidth required by a digital KVM link is dependent primarily on the content of the video portion of the KVM signal. High resolution, full motion video can require the system to provide the maximum bandwidth of the channel (approaching 1Gbps for standard connections). For much of the video included in typical UI display, all or some portion of the screen will be static text or backgrounds. This significantly reduces the required bandwidth of the connection. While full motion video could require a bandwidth of up to 950 Mbps, a typical automation rundown screen of text and backgrounds could require a bandwidth down in the 50-70 Mbps range. This would place significantly lower loads on the switching fabric supporting the KVM system.



Analog versus Digital

DIRECT CONNECTED SYSTEMS

Direct connected systems have flexibility in the port speed at the KVM matrix. This can allow higher speed ports to be used to support those signals that required higher performance. A DVI single link connection full motion video could have a data rate of up to 3.6Gbps. For data port speeds of 1Gbps, a compression ratio of approximately 4:1 is applied to the signals to allow them to pass through the system. This ratio can be reduced for higher speed ports.

For applications where uncompressed video is required, smaller scale direct connected systems can be deployed that apply no compression to the video signal. These systems provide a cost effective solution that allows in the range of 20 -25 sources to be connected to a small number of users over UTP copper cabling. These systems can support uncompressed video resolutions up to 1920 x 1200 through DVI-D or DisplayPort interfaces.

IP-BASED SYSTEMS

IP-based KVM systems are limited to the 1Gbps interface speed of the underlying IP network. This provides enough bandwidth to carry full motion video in a visually lossless mode and more than enough bandwidth for a typical UI video display. IP-based systems are subject to the same compression delays for the video portion of the UI, approximately 24 milliseconds (ms) for each path. In addition, there would be the end-to-end switching latency of the network. These figures tend to be very small, ranging from almost unperceivable in small networks to in the range of 1 ms end-to-end for very large campus style distributed networks. This performance places these systems well within the range of acceptable hand eye coordination of a maximum of 70 ms latency outlined above.

FORMAT FLEXIBILITY

Legacy KVM systems were limited in the signals that they were able to support. Video resolution was limited to an upper limit of 1920 x 1440 single link, and the interface was often required to be analog VGA. PS2, SUN, and USB peripherals were supported, but USB was limited to HID class devices only. No high speed data connectivity was available. The transition to digital technology for KVM has enabled a much broader range of connection types.

DIRECT CONNECTED SYSTEMS

Signal Support – A variety of video and data formats are currently supported in the direct connected KVM systems. UI video can be supplied to the KVM system in VGA, DVI (single or dual link), HDMI, or even SDI. Resolutions up to 4K or 3840 x 2160 at 60 frames per second are supported.

SDI and HDMI signals can be supported in two different ways. These signals can be used as the video portion of a KVM signal by feeding them to a KVM transmitter to be packaged with the keyboard and mouse signals, or they can be fed directly to the matrix via signal processing SFPs to provide monitor only signals.

Keyboard and mouse signals via standard USB or legacy PS2 connections are addressed by the base transmit and receive units. Advanced control options such as USB HID or embedded USB 2.0 can be accommodated by correctly equipped transmit and receive units. This method is also used to address audio and RS-422 serial control signals. Digital audio (SPDIF on coax or Toslink) and analog computer audio can be carried embedded in the KVM signal using correctly equipped end units. The same applies to RS-422.

IP-BASED SYSTEMS

IP-based systems are limited in the formats that they can accept. IP systems are limited to DVI video input, although dual single link DVI and DVI dual link video with resolutions up to 2560 x 1600 can be supported. For server type systems that only offer VGA outputs, specially designed converters can be supplied that are port powered and integrate well into the rear of the server for a clean installation. USB connectivity is available for HID class devices such as keyboards, mice, and touch screens. Analog computer audio is supported, as well.

ADVANCED FEATURES

The use of digital technology in KVM systems facilitates a number of advanced features not previously possible in legacy KVM systems.

Extended Desktop – Hardware devices and applications are currently available to allow users to share keyboard and mouse functions across multiple discrete workstations. As the mouse travels off the edge of a desktop display, the interface to that device is handed from one computer to another. Keyboard connectivity tracks the mouse movement, and the keyboard is interfaced to whichever device displays the mouse pointer.

This type of functionality is integrated into direct connected KVM matrix systems. User stations connected to adjacent ports of a matrix I/O card can be configured to share a single keyboard and mouse across up to four source devices. This can provide significant space savings and reduce clutter at an operator position.

Source Thumbnail Switching – Selected direct connected KVM systems are capable of generating low resolution thumbnail images of the various sources connected to the KVM switch. On each output of the switch, the user can view a mosaic of thumbnail images of the sources available to that output. The user can use these thumbnails as a source selector to switch the full UI of the user station to that source.

Multi-View KVM – It is possible to include an outboard device to the KVM system to allow up to 4 KVM video outputs to be displayed on a single monitor. Four discrete KVM receivers would be connected to this downstream unit with the output feeding a single display. That display would allow the user to view up to four full motion video feeds simultaneously on a single UI. Keyboard and mouse are also connected to the mosaic generator allowing the user to select which desktop they wish to interact with by clicking on the related image with the mouse pointer. The user can configure the number of images displayed from 1 – 4, and can size and position the images to suit their needs.

BROADCASTER CENTER REQUIREMENT

The best way to judge the usefulness of the various features of a technology is to see it deployed in real world scenarios. The following section will describe two common environments in a typical broadcast center: the production control room and master control. In each of these examples, a theoretical system will be described, detailing the various features in the system used to support each specific use case.

MULTI-USE PRODUCTION CONTROL ROOM

In many broadcast facilities the production control room is the highest value technical asset in the building. It is the core of all live productions, and needs to be flexible enough to allow a variety of production styles, from highly efficient automated productions using minimal staff to high profile special events with a full production crew.

Imagine a typical TV station production control room. This room will be used as an automated control room for a significant portion of the day, producing several live talk shows and news programs, as well as numerous short news updates. For these productions, the facility will be staffed with only three people: director, production, and audio operator, with the director operating the production automation. For the evening news program, the room will be staffed with a full production crew of six people. In this case, the automation system will be running in production assist mode under control of the technical director.

A properly designed KVM system is a key part of obtaining this flexibility, providing operators instant access to the production tools they need while allowing the room to be reconfigured at the push of a button.

The system in Figure-Production Control KVM System (Page 11) is based on a direct connected matrix system that also incorporates IP elements, integrating end points to access virtualized applications. A modular KVM matrix has been selected for this application equipped with a mix of high speed and mid-speed I/O boards. This will allow a number of high speed interfaces, such as SDI and USB 3.0 data connections, as well as the traditional KVM interfaces.

The server-based production equipment is connected as sources to the KVM system. These will include the production automation servers, graphics engines, video playback servers, and digital audio workstations. The use of a KVM system allows the units to be housed in the central equipment room, providing the best operating environment for that equipment: a well ventilated, dust free location that eliminates the heat and fan noise of the equipment from the control room. In addition the traditional core technical components being located in the equipment room, the use of a KVM switch allows many of the PC-based clients to be housed there, as well. This allows these critical machines the same advantages as the main components: an environmentally controlled operating environment with fewer equipment failures and a further reduction of noise and heat in the operator environment.

Since these devices are located in close proximity to each other, a frame-based mounting solution can be used for the KVM transmitters. This high density solution eliminates wasted space and provides for a clean installation of the various keyboard, video, and mouse connections. The frame approach eliminates a single point of failure in the system by providing redundant power supplies. It also does away with the need for multiple "wall wart" type transformers in the main power distribution.
See Figure-KVM Transmitter Frame.

KVM Transmitter Frame

The unique requirements of a number of the source devices require special interface modules in the KVM transmitters. The automation clients require a dual-head KVM transmitter with embedded USB 2.0 to support a touch screen interface. The production servers will require a variety of specialized endpoints supporting USB 2.0 and 3.0, digital audio, serial control, and HD-SDI video. These interfaces are detailed below:

- Technical Director – A dual head and USB 2.0 supported receiver for the automation touch screen interface. The TD position will be equipped with RS-422 support to allow the TD to control the robotic camera client workstation for manual camera positioning.
- Director – A second dual head receiver with USB 2.0 touch screen support for the production automation client.
- Producer – A traditional KVM interface coupled with a HD-SDI output and monitor. The producer can connect with the news room computer system (NRCS) or other clients, as needed. The HD-SDI output would allow the producer to view a variety of video feeds from the core router.
- Graphics – A HD-SDI interface in addition to the USB 2.0 enabled KVM interface with an attached graphics tablet. A HD-SDI interface will be installed from the CG engine to the matrix, as well as the UI from the CG control client. These two source and destination endpoints will be grouped into containers to simplify the selection of these sources.
- Video Playout – A number of specialized interfaces to both the playout server and the playout control clients. These include a HD-SDI interface from the playout server and a HD-SDI output to a monitor at the operator position, along with the USB 2.0 embedded KVM link between the play out client workstation and the operator position to support the dedicated USB connected jog/shuttle control panel along with a multi-channel audio interface. An additional high speed interface has been added to this position to support USB 3.0, allowing the operator to connect a removable media drive to the server system.
- Audio Operator – The Digital Audio Workstation (DAW) and the audio operator position would have a similar interface. The DAW and user interface will have USB 2.0 support with multi-channel audio. It will also have a USB 3.0 interface to allow import or export of audio files to the server from the operator position.

The use of a KVM system in this control room provides a variety of benefits. In automated mode, the user can switch between main and backup automation clients quickly in the event of a failure of the main client. The primary automation interface can be routed to either the technical director or director position, depending on the use case. In manual mode, the KVM system would be used to connect the various client interfaces to the operator user stations and to provide the operators with access to their personal corporate accounts, in this case, running in a virtualized environment. Video playback or character generator operation could be achieved from any position. The room can be quickly reconfigured from automated mode to manual mode by executing a macro on the KVM system.

Operating in manual mode would require the operators to connect to their personal company accounts for access to the NRCS program rundown and email. These connections could be done through the assignable zero clients, accessing the users virtual company accounts and connected as sources to the main KVM switch.

These zero clients would be configured to act as a pool of devices in private mode, allowing only a single KVM user permission to access a source. Once the first connection is made, all other connection requests are denied until the user releases the connection. This would allow users to access their private company accounts, such as email and confidential documents, knowing that no other users of the system would be permitted to view those connections.

Even greater flexibility could be derived from the KVM system if the facility had more than one production control room (PCR) connected to the KVM system. In that scenario, production resources and user stations could be assigned as needed across both facilities. This would allow a PCR to swap out particular devices quickly in case of a device failure or augment its normal complement of equipment with resources typically assigned elsewhere for special events that that require extra resources.

MASTER CONTROL AND DISASTER RECOVERY FACILITY

Master control of a broadcast facility is another area that often benefits from support from a KVM system. The move to file-based workflows has dramatically increased the number of computer based devices used in the acquisition, storage, preparation, and playout of content. In addition to the servers used for automation, servers have been added to the master control environment to manage acquisition, transcoding, storage systems, digital archives, and the generation of the linear channels with "channel in a box" solutions. Each of these components of the operation will require a number of UIs, some to various clients that allow the operations staff to control and monitor the operation of these systems and others to the servers themselves for maintenance and troubleshooting purposes.

Designing the workspaces to provide access to these systems has become increasingly difficult as the traditional master control panel competes for space with an increasing number of keyboard and mouse interfaces. Add into that environment the current trends towards additional channels or new distribution paths for existing channels, e.g., OTT streaming and VOD, and the congestion only increases. A properly deployed KVM system can allow operators to access what they need while allowing a comfortable, easy-to-use workspace.

Figure-Content Acquistion and Master Control (Page 12) depicts the content acquisition and playout systems for a multichannel facility with an off-site disaster recovery facility. This system makes use of an IP-based KVM system with redundant system managers, in conjunction with a virtualized system at the disaster recovery (DR) facility using zero client endpoints. In this situation, the relatively low bandwidth requirements of the various device UIs, automation, transcode, archive, master control, database servers, and device control servers, along with the need to connect to a remote disaster recovery facility, make an IP-based system the best fit for the requirements.

The various automation and signal processing and switching components at the main facility are all connected to the IP-based KVM system. This system uses transmitter and receiver pairs connected via 1Gbps Ethernet connections to a user supplied network switch. These KVM endpoints only support DVI-D connections. For the system components running on server hardware that only provides VGA video, an outboard VGA – DVI converter is used.

These external converters are port powered from one of the source device USB ports, and are designed to integrate well into the KVM system and provide a clean installation.

Signals enter the facility via external links and are captured to a workspace in the shared storage system. Workflows are managed by an orchestration engine that moves the content between catch servers, transcode engines, automated QC, and central storage as the content is conformed to the house format of the station. Once the content has passed the QC process, it could be forwarded to post production for editing or ingested into the automation system, timed and tagged with various metadata, and returned to the long term managed storage system to be played out via one or more of the channel integration systems under control of the automation playlists.

These activities reach throughout the organization and require input from various departments. The systems that are used to implement these processes make use of a variety of types of user interfaces. The workflow orchestration main user interface is done via web services. These interfaces are often reached through the user's company desktop running on a virtual machine. These would be accessed via a zero client. There are dedicated clients for these systems, as well. These are typically for in-depth management of the system and dashboard clients that provide a high level overview of the operation. Connecting these clients to a KVM system ensures that these systems can remain accessible to users throughout the day from various operator positions as different shifts take responsibility for the operation. The KVM system can also provide high-level monitoring access to the entire system to any user with the correct permissions.

Some of these clients may be dual screen. For example, the automation clients are dual-screen workstations capable of managing multiple channel playlists. The KVM system carries the dual-screen playlist UI signals from the automation client workstations, housed in the core equipment room, across the network to the various operator positions. The use of the KVM system could allow the users to switch from one automation UI to another easily as their work schedule requires. This could allow the operators to perform ingest operations, event based operations, or linear channel control from the same operational position.

The KVM system also allows for fast transition from one deceive to a backup device in the event of a device failure. Instead of operating in a one-to-one redundancy mode for each on air device, the system can operate in a N+1 redundancy mode with the backup device quickly switched into whatever slot is required in an emergency.

Much of the processing work related to this system is done by background servers, the transcode engines, the archive managers, data movers, automation databases, and channel playout servers. While these devices typically do not require significant user interaction, placing them on the KVM system makes them accessible from anywhere on the network. Configuration and troubleshooting operations can be done from a variety of locations, instead of requiring the engineers to spend endless hours standing at a keyboard tray mounted in the equipment room.

In this system, the disaster recovery facility is achieved by implementing the typical master control systems on virtual machines running on typical COTS server hardware. Content for the various linear channels consists of file based content stored locally at the DR site and video over IP streams delivered across the network. The outbound feeds generated in the DR facility are similarly fed as video over IP to various points in the distribution network where they can be substituted for the signals from the main facility.

Access to the disaster recovery systems is achieved using zero clients connected to virtual machines; either directly via the DR facility network or remotely across the company WAN. The ability to interface to the DR systems remotely can prove invaluable, particularly during the transition of services to the DR facility and restoration at the end of the event. For situations where the move to the DR facility is precipitated by an upcoming weather event, where some advance warning is available, operators in the main facility can initialize the DR systems, affect the transfer, and possibly even operate the DR systems remotely across the WAN for a period of time while relief staff is en route to the remote facility. This would be done using the zero client and UI located in the main facility connected to the remote DR systems across the WAN.

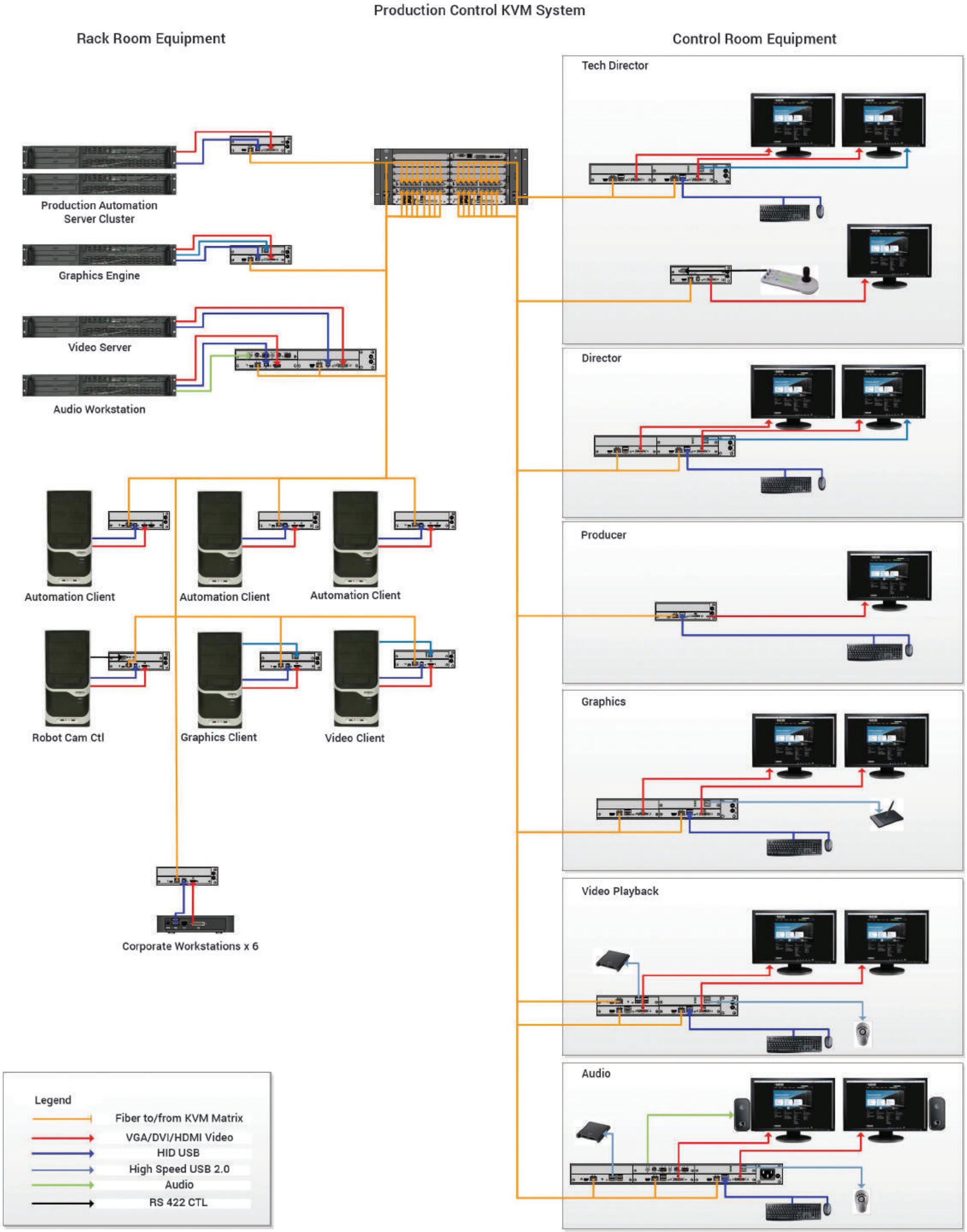
Throughout the event, staff can operate the DR system in a manner closely resembling normal operations using the various zero client interfaces to access the virtual machines running the automation playlists. It would even be possible to have a number different locations monitor the state of operations across the WAN provided they also had sufficient connectivity.

Once the event had completed, the restoration of service back to the main facility could be achieved seamlessly by first transferring control of the on air DR systems to operators at the main facility using the remote zero client UI. This allows those operators to make the change back to the main facility at the time best suited to the program schedule. The remote connection to the DR system could also be used extensively for training purposes, allowing the staff to practice use of the DR systems remotely without requiring them to be present at the DR facility.

CONCLUSION

KVM systems have come a long way from their roots, buried at the heart of a data center rack room. They continue to evolve, providing the vital link between the operations staff and the technologies used to create and distribute content. These important tools have continued to evolve to keep pace with an ever-expanding array of technology and platforms, while at the same time increasing their usability, performance, and reliability.

Regardless of your requirements, it is possible to choose the right combination of equipment to fit those needs, whether that is extending a single user interface on a workstation or a complex virtual environment with thousands of endpoints operating to the latest performance specifications. As with any complex system, the path to a successful deployment lies with correctly determining the objectives for the system, then choosing the partner best suited to assist you in selecting from the widest possible range of solutions to arrive at the mix of products that best fits your needs in terms of functionality performance and budget.


Production Control KVM System
Rack Room Equipment
Control Room Equipment
Tech Director
Production Automation
Server Cluster
Graphics Engine
Video Server
Audio Workstation
Director
Producer
Automation Client
Automation Client
Automation Client
Robot Cam Ctl
Graphics Client
Video Client
Graphics
Video Playback
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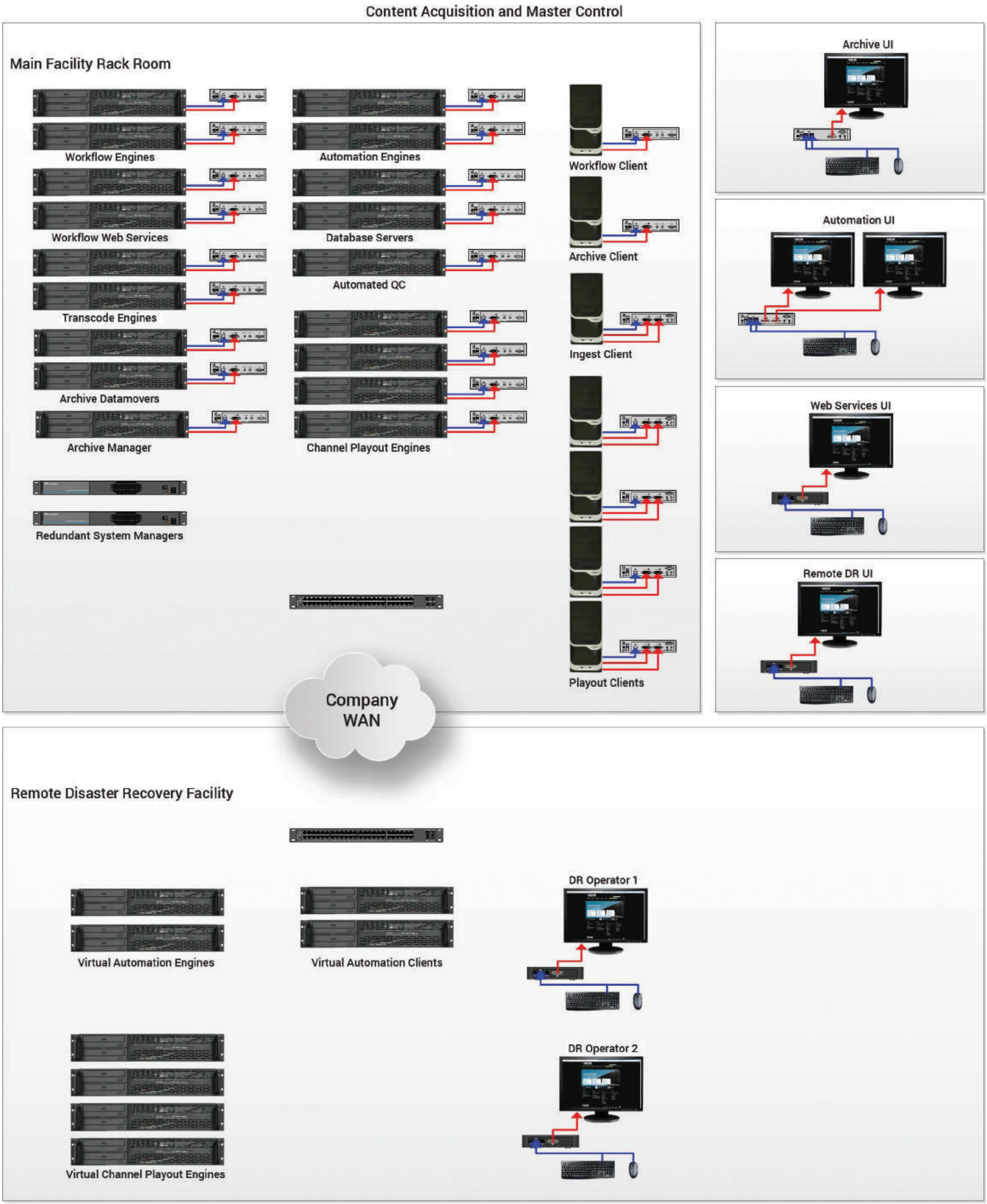
Content Acquisition and Master Control
Main Facility Rack Room
Workflow Engines
Automation Engines
Workflow Client
Workflow Web Services
Database Servers
Archive Client
Automated QC
Transcode Engines
Ingest Client
Archive Datamovers
Archive Manager
Channel Playout Engines
Redundant System Managers
Playout Clients
Company WAN
Archive UI
Automation UI
Web Services UI
Remote DR UI
Remote Disaster Recovery Facility
Virtual Automation Engines
Virtual Automation Clients
DR Operator 1
DR Operator 2
Virtual Channel Playout Engines