

NICs

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Evolution of KVM Technology

by Keith Parsons

KVM is a TLA

To get started on this article, I must first state KVM is a TLA. “What’s a TLA?” you ask. In our industry we are inundated with TLAs: Three Letter Acronyms. One of these is KVM. KVM stands for Keyboard, Video and Mouse. This acronym encompasses an entire range of technologies designed to share, extend and access these three signals from a computer.

One drawback of how our computer systems have evolved is the continuation in the use of analog electrical signals for input and output of the computer. Because of this, our keyboards, mice, and monitors have been required to be very close to the computer. Of course, we can use extender cables, but we are still very limited. Because of these limitations, engineers have designed solutions to “get around” these KVM issues.

Part of the charter of the Institute for Network Professionals is to bring technology to network professionals worldwide. To help reach this goal, late last year I embarked on a European road tour to take a lecture on KVM technology to our membership and other network professionals. This article is an encapsulation of that presentation.

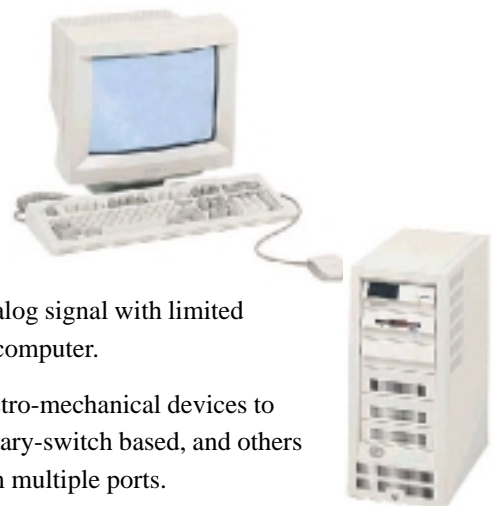
Network Administrative Functions

Network administrators have entire ranges of responsibilities, most of which concern the management and administration of computer networks. These networks consist of three parts. **Client Side:** computers on the desks and in the cubicles of the companies’ employees. **Server Side:** those computers and servers housed in server rooms - sharing the various computing resources to the clients. And finally the **Network:** the cables, routers, hubs, etc. that comprise the ‘pipes’ connecting the clients and servers together.

This article addresses the management and control of the Server and Network resources. We’ll concern ourselves with how KVM technology can help network professionals do their jobs better, quicker and faster.

One to One

Without the use of KVM technology, each computer is attached to a single monitor, keyboard and mouse. This arrangement has worked well for a generation. Most people’s desks have this very setup. It works well because computers were designed this way. The video out is an analog signal with limited distance and thus monitors need to be placed close to the computer.



The first steps toward KVM solutions were the use of electro-mechanical devices to share or split the electrical signals. Some of these were rotary-switch based, and others used push buttons to mechanically switch the signals from multiple ports.

We’ve all used these to switch parallel printers, and some have even ventured to use these of devices to switch keyboard or video signals. In the past I’ve used these at many client sites to clean

up server rooms by sharing a single monitor and keyboard to multiple CPUs. The problem with these mechanical switches showed themselves when it took multiple accesses to get the signals to change.

Then we added GUI environments to our server rooms and ran into difficulties with the keep-alive signals the OS required from the mouse port. You'd calmly switch a mouse and the first computer would crash.

Something needed to be done, and necessity usually means some engineer will develop a solution. On to our story of the evolution of KVM technology.

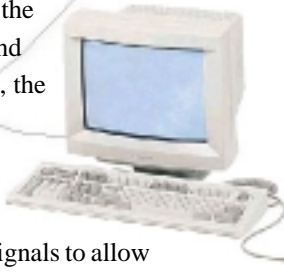


Distant to One

The first step in this path was to help solve a unique situation: what happens when we need to have access to a computer in a hostile environment? How do you best protect the investment in computer technology when the environment is dangerous? An obvious answer was to move the expensive CPU away from the environment, leaving behind only the more sturdy parts, the keyboard and monitor.

Thus the first implementation was the ability to amplify the KVM analog signals to allow for much longer extension cables. From the initial maximum distance of some 30 feet, these amplifiers allowed for new distances of up to 500 feet. For the first time, these new KVM amplifiers allowed factory floor access to computers in a server room.

Engineers figured they had found something when they realized they could do more than just extend the distances between CPU and monitors, they could also allow for the switching between devices.



One to Many

Now that we had the ability to not only extend the KVM signals, but to also switch between



them, the technology was now ready to really break out. The next phase allowed for multiple CPUs to be attached to a single set of Keyboard, Monitor and Mouse. This is the situation in most server rooms today. A single KVM is attached to a rack of servers. From this single KVM station a network administrator can access any of the servers in the rack.

This step in the evolution has saved millions of dollars for companies. The savings include the obvious in not needing to purchase keyboards, monitors and mice for each server. Perhaps more important is the savings in the server room environment. With server room space at a premium, in some co-location environments a company may be charged not only by the square foot, but also the 'U' heights of the rack-mount equipment.

The room is now cleaner, quieter, and uses far less electricity. The electrical saving is two fold. Without the extra monitors we save the electricity they would have consumed, but more importantly we've also saved the electricity needed to cool the room after the monitors have dissipated their excess heat into the room.

Studies have shown these environmental savings exceed in the first year the savings from not needing to purchase excess equipment.

The first step towards the number of devices was the simple cascading of multi-port switches. To get more than 8 CPUs, one might cascade eight of the 8-port switches into a single 'master' 8-port switch and thus get a total of 64 computers. This works, but a user may have trouble remembering which computer he is attached to.

Anyone to Many

This was a great step forward. Network professionals could now access any of the machines on a single rack, right from a set of KVM on the rack. But as we might expect, they tired of the need to go to each individual rack to access the servers located there. The next phase required a fundamental change in the way KVM technology worked. Up to this point when someone requested a different CPU all the changes happened within the KVM local switch device. What

was needed for multiple users to access multiple CPUs was the development of a KVM switch fabric. Instead of individual KVM switches having a single user console, one keyboard, mouse and monitor connected directly to the CPUs, we now needed to have the CPUs attached to a “network” of KVM switches and the user consoles also attached to the same “network.”

Unlike the data networks we’re used to, this new KVM switch network relies on analog signals. Though it might look like a data network on the physical side, Cat-5 cables, switch boxes, etc., it is fundamentally different. In a data network the computer must have a NIC (network adapter card) installed inside the computer. In addition, the computers’ Operating System must be loaded, and proper NIC drivers installed. Additionally, a network protocol stack must be running in order to allow access to this computer through the data network. In contrast, the KVM switch network only uses the analog signals supplied by the video out port, keyboard and mouse ports. Even without any operating system or software loaded, the KVM network can “see” the computer as it is, even during the boot cycle. This fundamental difference will be even more evident as we progress in the evolution of this technology.

So, at this phase of the evolution we’ve added a KVM switch matrix, a fabric of analog keyboard, video and mouse signals. All CPUs are attached to the network, and then user consoles are also connected. This means any of the user consoles can now be connected to any of the CPUs.

I’ve helped install KVM switch networks that allow for large data networks to be controlled from a single console. The terminology in this industry is to quote KVM solutions by Users/CPUs. So you might hear of KVM solutions in a format of 16/800. This means 16 user consoles



attached to 800 servers allowing for any network professional, at any of the user consoles to access and control any of the servers in the network.

By the way, this access is all considered *Out-Of-Band*. (See sidebar below for further details.)

Connect to Anything

After network professionals found this easier method of managing their computers on the server side of their responsibilities, they longed for the same solutions with respect to the network components. Again engineers were up to the task and added this functionality to the KVM products. First we wanted access to those

In-Band -vs- Out-of-Band

Data networks have very high speed access between their clients and servers. Servers share resources with clients and each other. The entire network is designed to share digital data via high-speed access. Speeds within the LAN might be 100Mbps and the WAN links from 56K to 45Mbps. Access to clients, servers and/or network devices is through this data network. This represents an In-Band solution.

In contrast to the In-Band solution, and Out-of-Band solution does not access the data network. Perhaps access is via a dial up connection directly to a modem. However, in the case of a KVM network, the access is via an analog KVM switch network fabric. This allows for access to individual computers not through their NIC ports, but rather through the computers’ video and keyboard ports.

This distinction is most evident when the data network is down. If there is no access to a computer through the data network only, then there is no access during a network outage. Comparatively, the Out-of-Band KVM network allows access and control directly to the computer via its analog keyboard and video ports.



other CPUs that didn't run on an Intel platform, you know, like HP boxes, Sun boxes and even those pesky Macintoshes. These still have video and keyboard signals that must be added to the KVM switch fabric, but they work at different electrical specifications. To solve their connectivity to the KVM network small converter boxes need to be added to their keyboard, mouse and video ports.



This added an entire range of UNIX, and Macintosh computers that we could add to our KVM out-of-band network but left out the network components themselves. We needed a solution to access and manage the routers, hubs, switches and other terminal-based devices. These all work with the VT-100/Telnet standard. What the engineers added was the ability to take these serial signals, convert them to standard video and process them just like other KVM signals.

Some have wondered why you'd want to access these network devices via their serial console ports when you can manage the device via Telnet. When the network is up and running, I agree with you. It is usually quicker and easier to manage these devices *in-band*. But sometimes when the network is down, the only way to access or reset the network devices is through the simple serial console port. (This is a great story of how this technology works, using a small single-board computer to be the "in-between" for the serial port and the KVM signal)

Now, from the same user console we can control and manage Intel-based servers, Sun, HP, Mac and other Unix servers. We can also manage the network devices directly from their console ports.



Distant to Many

I've been in many network data centers using this KVM switch network to manage both their servers and their network from a central series of user consoles. But invariably I get asked by the local administrators if their might be a way to do their work from the comfort of their office instead of the sometimes-hostile environment in server rooms. (They are always either too hot, or mostly too cold. They have no comfortable furniture and are sometimes pretty lonely places.)

Thus we come to the next transition in the technology that takes us back to the roots of this evolution. We need to add a distant user to the KVM network. A solution here is to have an amplifier added to one of the user consoles to allow for access to the KVM network of resources from a distance. These can be up to 500 feet away from the central user consoles.



Anywhere to Many

All right, we are nearly done with our story. We can now access any type of network or server equipment not only from the user consoles in the server room, but also from the comfort of our offices.

This doesn't seem enough, though. Not enough when it's two o'clock in the morning and an administrator's pager goes off. This situation happens all too frequently for those of us responsible for keeping the network up 7X24. The solution has been to get up, getdressed, drive into work, evaluate the situation, and then reset the offending device. Back in the car for the trip home, and then hopefully back to sleep right before the alarm rings.

The engineers again have come to the rescue with the ability to access the KVM network from a remote location, like your nightstand. Remember, the KVM network is out-of-band. So even if the data network is down, or confused, you can still access all of your servers and routers remotely.

Now is a great time to pause and reflect on the differences between Remote Control and Remote Access. When accessing your network from a distant remote location, one option is to use a RAS server and dial in to the network. Your remote computer is authenticated directly on your home network, just as if you were there, but with a very slow network connection. (Perhaps the difference might be as great as 100Mbps with a NIC on the local LAN compared to .028Mbps via a modem connection to a RAS server.) This method allows for all the same rights, services and resources as if you were connected locally albeit much slower.

The second alternative is to dial into a single computer already connected to the network. Then across the slow dial-up link the only thing being transferred are screen updates. This is the method of a terminal server or PC Anywhere connection. The access is still quite slow, comparably, but less information needs to transverse the slow dial-up link.

Engineering a solution for remote management of a KVM switch network required adding a CPU in



the loop, kind of like the solution for serial terminal connections, but this time running a remote control software package instead of a terminal emulation package. The benefits of this type of connection allow for user access to sick machines and the ability to watch a remote server through the boot process. Many other remote control solutions require the remote server to have a working operating system, NIC drivers, and protocol stack.

Accessing remote computers via their video and keyboard ports is a far superior method. Think of the common situation where the remote server might have a floppy in the drive. Each time the server re-boots the floppy OS loads instead of the version on the hard drive. With KVM remote access a network professional can remotely boot the system, hit the F2 key and access the BIOS setting to reset the boot policy to not boot from the floppy, then reset the computer again. (Try that with any other solution!)



How I Use KVM

I personally have a great setup using KVM technology. After testing this new system for a couple of weeks I've concluded there is no other way to work!

On my desk is a KVM user console. Big words for just having a Monitor, Keyboard and Mouse. This is connected to a small local One-to-Many KVM switch. This allows me to access one of three local computers in/on my desk. I can manage my personal laptop, my spare laptop in my credenza, or my large desktop PC with CD-R.

In addition, I've connected the fourth KVM port on the local switch to a larger KVM switch network. This network includes all our office servers, a couple of test machines, and our network routers.

From my desk I can access any of my local machines, and also have access to any of our network resources. Without going to the server room. Its taken a couple of weeks to learn to use this new resource. I caught myself the other day getting up to fix a problem on the mail server, then remembered that I could just tap a couple of keys and solve the problem directly from my desk.

I wouldn't trade this setup for the world . . .

Well, maybe for the *whole* world.

How about another situation where a Windows NT machine Blue-Screens or a NetWare server Abends. Just remotely rebooting the machine might not be enough, like some products that allow you to simply power-cycle the computer. A good network administrator needs to know the whys and wherefores of the server crash. This information is available on the computer screen. With a KVM remote solution the admin can see the final screen just as if they were in the server room.

Can you see the additional benefit of an out-of-band remote access to servers and network devices?

Examples of Solutions

My experiences in the successful deployment of KVM technology solutions include large data centers with hundreds of servers, to technology labs with up to a hundred test machines. Most large companies have already implemented this type of solutions. Why? Because it makes sense, both to the bean-counters who like to see the cost savings, but more importantly to the individuals actually managing networks. These hands-on administrators love KVM solutions because they makes their lives better.

The administrators managing the new Novell Global Network Operations center are thrilled to have access to their hundreds of computers from a central set of user consoles. But more importantly, they individually like the ability to manage their responsibilities from their offices

and also remotely from the home computers during off hours.

Perhaps the technicians working in Microsoft's labs who have installed KVM solutions wouldn't like their supervisors to know that it is entirely feasible, with a fast cellular connection, to manage and reset servers from the enviable position of being on a fishing boat.



Large data centers, like an enormous 1000+ server room in Germany supporting a catalog sales company, can show off their entire network to visiting dignitaries from a central console area.

Even smaller server rooms can benefit from this type of management control. The airline SAS has a remote office in the far North above the arctic circle. An eight-hour flight from the network administrator in Oslo, Norway was required to manage the servers there. This type of out-of-band KVM network allowed for their technical team to remotely upgrade the system with only the local help to insert CDs as needed.

What might KVM technology do for your company?

Anyone from Anywhere to Anything

So we've followed the evolution of KVM Technology from the original One-To-One situation, through One-To-Many, Many-to-Many, Many-to-Anything, and finally the ability to access the KVM fabric from anywhere. So basically, we end up with the ability to access anything, from anywhere.



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Network Solutions Using KVM Technology

During my travels through Europe I had a chance to discuss KVM technology with many network professionals. I was surprised by some of the unique uses for this technology. We all can see the value in Server Rooms. The addition of Distant Access to Server Rooms was the latest trick in getting administrators to work on the network from the comfort of their offices.

Some shops have taken to replacing their old OEM 8-port KVM switches, where each switch was attached to a single server rack, and installed a new KVM switch fabric. Thus allowing for a merging of all their server racks into a central set of user consoles.

Managing networks Out-of-Band is another boon to network professionals everywhere. Accessing all the network devices as well as servers from anywhere in the world is great. Some network administrators in Washington state like the new system so much, their boss took away the pay differential for wearing a pager, because it was just too easy to work on the network without coming in to the office. (Ok, perhaps this isn't a good reason)

Another group has used KVM technology to setup their classrooms, classrooms where students used to load additional software or play on the machines. Now all the computers are behind the instructor, and the students only have a KVM setup on their desks. Productivity in class has shot way up.

A shop in Utah has moved all their computers off their employees desks. Only an LCD monitor, keyboard and mouse are left on the desks. All the computers are now housed in the server room. One standard computer configuration is used and all user space is defined on the network. If one computer happens to go down, a network technician swaps out the machine and the employee is back up and running.

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