The Keyboard/Video Switch White Paper

A Close Look at Modern Keyboard/Video Switching

by Tony DeKerf and Gary D. Davis

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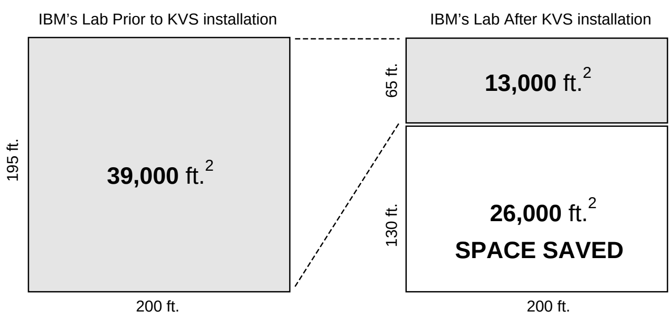
Keyboard/Video Switching (KVS) devices solve problems for Facilities Managers, LAN (local area network) Administrators, Developers of hardware and software, and for anyone who wants to control multiple platforms with a single monitor and keyboard. Products are being developed that will allow you to control dumb terminals and various types of PCs from a single monitor and keyboard. Let's examine some of the benefits.

• Benefits to Facilities Managers

KVSs let you put a lot more computers in a given space, or enable you to use much less space for a set number of computers. In one lab, for instance, IBM Corporation installed KVS and went from 39,000 square feet to 13,000 square feet — a reduction of 67% in required floor space! Imagine what you could do with that kind of space savings. (You can slash floor space requirements even more dramatically by combining special computer racking systems with KVS.)

Because KVS lets you use far fewer monitors, your month-



KVS Saved IBM 67% in Floor Space in One Lab

ly power bills will be much lower. The typical 14-inch VGA color monitor, for example, draws about 75 watts of power. With a typical KVS controlling 8 computers from a single monitor, you reduce the monitor count by 82%. In a server room or lab operating around the clock, 8 monitors would use 14.4 kilowatt hours (kWh) per day, whereas the single monitor would use just 1.8 kWh per day. That 12.6 kWh saved each day amounts to 4,600 kWh annually. A typical utility, Pacific Gas & Electric, charges about 12.5¢ per kWh. That calculates to be about $575 a year saved in direct electrical consumption — but you actually save a lot more.

...the power savings alone of an 8:1 keyboard/video switch, in one year, will be about $1,035.

You save in air conditioning costs because you don't have to remove the BTUs (British Thermal Units, or heat) generated by those eliminated monitors. Using an average K-factor of 2.0,which calculates to 60 watts of air conditioner power required to prevent heat build-up for a single 14″ monitor, the annual HVAC (heating/ventilation/air conditioning) power savings for this 8:1 KVS setup will be 3,700 kWh, which saves you another $460 annually.

Thus, the power savings alone of an 8:1 keyboard/video switch, in one year, will be about $1,035. To this, add the savings in floor space, and you can see the switching will just about pay for itself in the first year of operation (there are actually much greater savings for your company if you consider capital acquisition and maintenance for the keyboards and monitors [see last paragraph on this page], and operator productivity).

• Benefits to LAN Administrators

When you have a monitor and keyboard attached to every CPU in your data center, the operator typically must walk up and down long aisles of computers to review the operating status of each server, gateway, bridge, etc. By allowing you to create a single-seat console for dozens of servers, Keyboard/Video Switching makes your management task much easier.

If you're the operator, you will really appreciate how much more relaxed you feel at the end of the day.

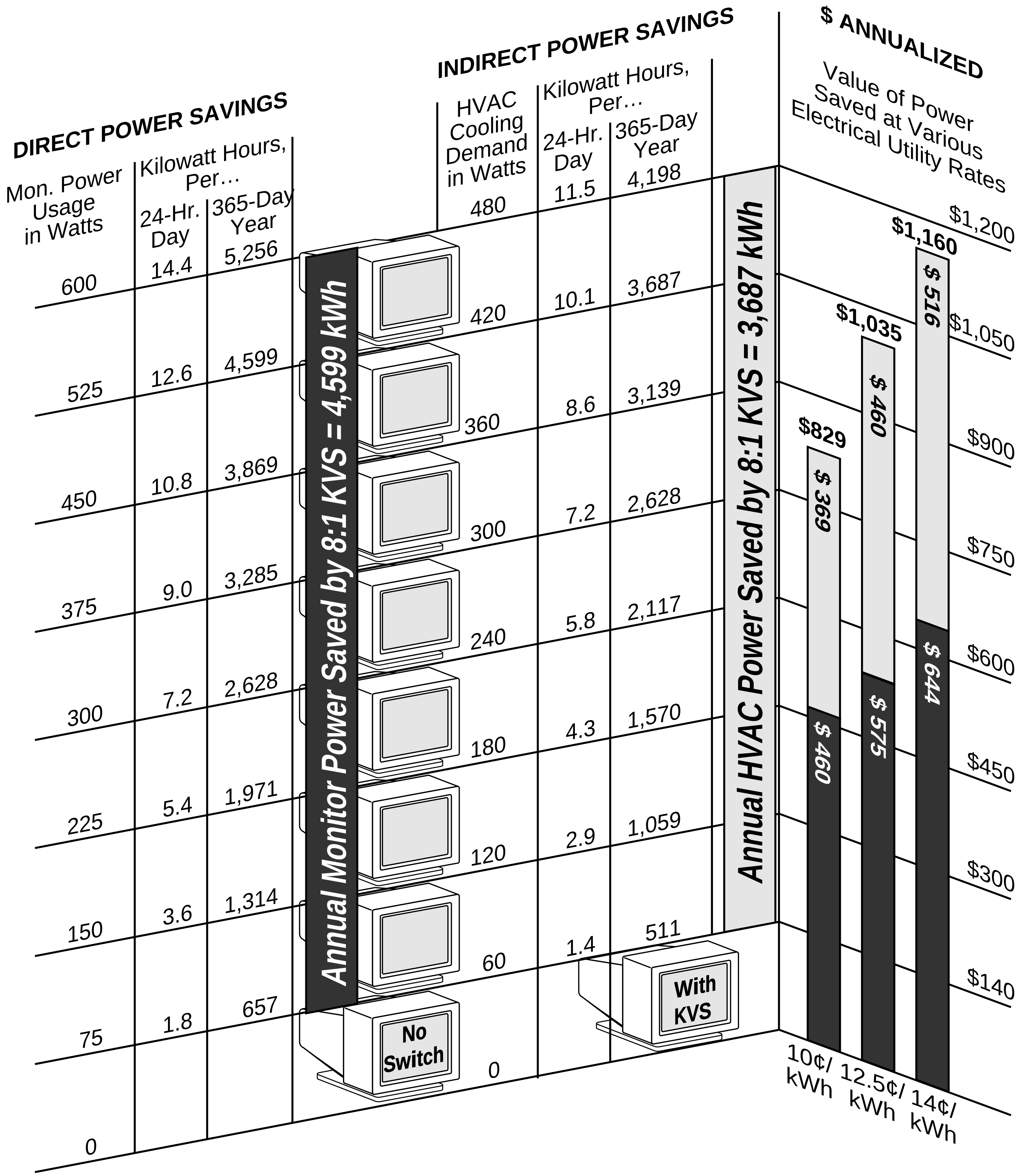
Because an operator can access data and examine system status with the touch of a finger, instead of standing up and walking around to locate the desired monitor and keyboard, productivity increases measurably. If you're the operator, you will really appreciate how much more relaxed you feel at the end of the day.

As we pointed out to Facility Managers, you will save a tremendous amount of physical space by using KVS. Particularly as downsizing continues and as you add servers for burgeoning E-mail systems, fax servers, etc., you will appreciate the ability to add these servers without having to provide space for more monitors and keyboards. A 50% savings of floor space is typical when using KVS, and you can get down to 33% to 25% the floor space if you combine specialized computer racking systems with KVS.

Saving space certainly matters, and related to that is a reduction in clutter. With fewer components physically scattered around the data center or lab, it is easier to maintain the remaining equipment. It is far less likely that a stashed keyboard will slip off its precarious perch on an overcrowded desk. And there will be far less cost associated with annual maintenance of keyboards and monitors.

A 50% savings of floor space is typical when using KVS, and you can get down to 33% to 25% the floor space if you combine specialized computer racking systems with KVS.

If you are installing new systems, the cost of the KVS will be offset completely by the money saved on monitors, keyboards (and mice if you use them). For example, a typical 14″ VGA monitor sells for about $300, and a 101-key keyboard is about $50. If some suggest that mono monitors are much cheaper than VGA, remember that color has a much better interface, especially with the ever-more-popular GUIs (graphical user interfaces). Let's suppose you eliminate seven such monitors and keyboards with a single 8:1 KVS. The switch and cables will cost under $2,000. The monitors and keyboard savings are over $2,400 – an immediate savings of over $400. That savings may be reduced if the keyboards come with the computers, but you still have the ongoing power and maintenance savings we have previously described, so the switch not only pays for itself, it pays you back big dividends year after year.



Direct & HVAC Power Savings and Annual Dollar Savings with One 8:1 Keyboard/Video Switch
(Calculate greater savings with more CPUs switched to 1 monitor)

- **Benefits to Software and Hardware Developers**

The developer must test his software or circuitry on a variety of computers. For this reason, the typical developer's office is, itself, a mini-lab equipped with two to four workstations. A 10′ x 10′ or 12′ x 12′ cubicle can become very crowded – where ARE you going to put the file cabinet? The guest chair? The answer is to use KVS!

An economical 4-port keyboard/video switch enables the developer to place a single monitor and keyboard on his or her desk… in a comfortable, easy-to-use position. There is still room for reference documents, a telephone, even a photo of the family.

For the developer who is operating a large lab, the benefits of KVS are substantial.

Space savings and increased productivity, due to operator comfort, are clearly justifications for KVS in the developer's office. But equally important is a reduction in exposure to potentially harmful electro-magnetic and electro-static radiation. Numerous studies have been done, with more under way, and the jury is still out as to the actual hazards associated with ELF and VLF fields (Extremely Low Frequency and Very Low Frequency). Do they lead to metabolic changes on a cellular level? Do they cause cancer? Do they cause eyestrain? While the answers are arguably inconclusive, it is certain you will reduce the direct exposure to a potential hazard by reducing the number of monitors in close proximity to the operator. KVS definitely reduces such exposure — simple division lets you calculate and measure the protection.

For the developer who is operating a large lab, the benefits of KVS are substantial. You will save a huge amount of floor space… in some cases making the difference between being able to fit the lab in your current facility or having to look for a new building. Additionally, you need only refer to the prior discussion for LAN Administrators to understand that the equipment and maintenance cost savings apply equally in the lab.

…equally important is a reduction in exposure to potentially harmful electro-magnetic and electro-static radiation.

Some KVS manufacturers provide the ability to remotely locate the KVS from the computers or to allow dual (or multiple) operators access to the same KVS-connected computers. With remotely located access to the switch, it becomes possible to bring a lab full of computers to the developer's office desk where they can be accessed (and rebooted) by a single keyboard and monitor without having to use any network hardware or software.

Is KVS for every situation? Frankly, no. However, there are many ways to approach KVS, and we encourage you to evaluate it carefully, with currently available technology, to make sure you are taking advantage of the best technological solution to your needs.

- **What If You Have a Mix of PCs and Dumb Terminals?**

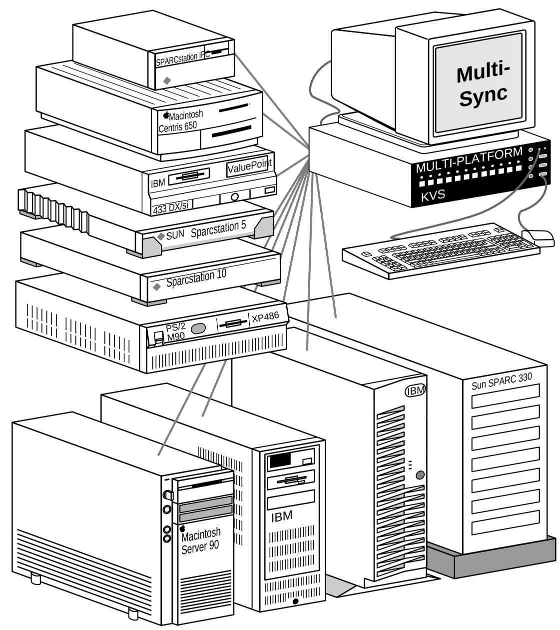
Currently, if you have to access data processing resources via dumb terminals and communications lines, and you also have to access servers or workstations locally via video and keyboard connections, you must have at least two monitors and keyboards — often many more. We understand that products are now in development, and may soon be available that will enable you to mix various terminal-emulation modes with direct PC-connection modes. Such a product would enable you to reduce a mix of terminals and PC monitors and keyboards to a single monitor and keyboard. Keep an eye out for new product announcements. (Contact the authors of this paper for up-to-the-minute information if you wish.)

- **News for Those Who Have a Mix of PCs, Macs and Suns**

Today's complex network environments often call for a mix of servers, including Intel-based or clone x86 platforms, Macintosh 680xx or power PC platforms, and/or Sun Sparc platforms. Conventional KVSs have been available to switch any one of these platforms, but until recently, you would still need at least one monitor, keyboard, and often a mouse for each of the different architectures.

Some of these products enable the use of a common VGA or multisync monitor to display the PC, Mac and Sun video…

Now there are products that include the necessary conversion capability so that a single monitor, keyboard and mouse can be used to control a combination of PC, Mac and Sun platforms (there are some restrictions as to specifically incompatible models). And there will soon be products that also enable you to add dumb terminals to this mix.



The benefits of reduced monitor and keyboard count… space savings, power savings, ease of control… thus encompass the broadest range of platforms.

There are even greater cost benefits than one might recognize at first glance. Typically, Macintosh monitors cost more than similar PC monitors, and Sun monitors cost substantially more. Some of these products enable the use of a common VGA or multisync monitor to display the PC, Mac and Sun video, thus saving a substantial initial investment in more costly monitors. Often the monitor savings more than offset the cost of the switch, and you then continue to save money from the ongoing power savings of a reduced monitor count.

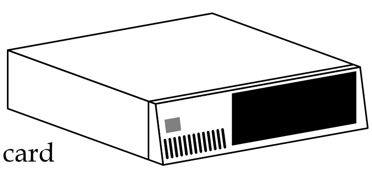
To understand how switches function, it is helpful to understand something about video and keyboard circuitry. In the following paragraphs, you will find an overview of the types of video signals, and what the various acronyms mean. You will also learn a little about keyboard functions and how switches (and CPUs – Central Processing Units) deal with the keyboard. Relax – you don't need to know much about electronics or math to comprehend this discussion. Monitor and keyboard functions are generally transparent to the user, and only matter when you are purchasing components, assembling a system, and initially setting it up. They do matter to the switch, though, as you will learn. If you want to know more about these video and keyboard functions, see "Product Function for the Technically Oriented Reader" on page 8.

• Video

Three primary considerations for handling video signals are the resolution, color depth, refresh rate and sync frequency. *Resolution* describes the number of dots that can be displayed horizontally and vertically on the monitor screen. These dots are technically called picture elements, or *Pixels. Color depth* refers to the maximum number of colors that can be defined and displayed at once. Vendors discuss color either in bits of data they use to define the colors or as a numeric value for the numbers of colors that are available. *Vertical Sync Frequency, which is the same as Frame Rate or Refresh Rate* on non-interlaced displays (see page 9), and is indirectly related to the Horizontal Sync frequency, describes the number of times per second the screen imaged is updated (refreshed). The important factor here is that you cannot mix video cards based on one sync frequency with monitors based on another, with one exception; some monitors are "multi-sync," which means they can synchronize to different video refresh rates (and often to different resolutions).

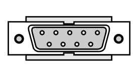
The digital representation of the color may be fed directly to the monitor for interpretation, but more often the video driver card converts it to a modulated analog signal (i.e., one continuously varying in voltage rather than defined by numbers), and this analog signal goes to the monitor.

• Digital Video for PCs



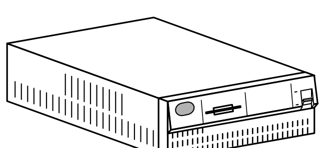
Early PC monitors utilized TTL signals (Transistor-Transistor Logic) to convey video from the display adapter card to the monitor. These are 5-volt digital signals, with the video intensity defined by a numerical value. The TTL monitor circuitry includes digital-to-analog converters (DACs) and amplifiers to map these digital signals onto the screen at the appropriate intensity.

While the term "TTL-based video" may not be familiar, you have probably heard of MDA (Monochrome Display Adapter), CGA (Color Graphics Adapter) and EGA (Extended Graphics Adapter) cards. These cards are all TTL-based and they typically use DB-9 (9-pin D-connector) outputs.



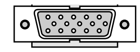
DB-9 Connector for CGA/MDA/EGA

• Analog Video for PCs



Further along in PC development, manufacturers began to use analog signals to convey video from the display adapter card to the monitor. Here, the video intensity is defined by a continuously-variable voltage that typically ranges from zero to 700 millivolts (mV) DC per color defined. The monitor includes circuitry to map these signals onto the screen, and amplifiers that deliver the appropriate intensity.

Analog-based video encompasses VGA (Versatile Graphics Array), SVGA (Super VGA), and XGA (Extended Graphics Array) cards.

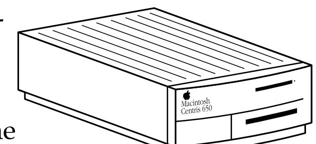


HDD-15 Connector for VGA/SVGA

Analog cards typically have higher resolution (more pixels displayed) than TTL cards.

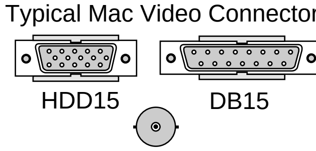
Technical details may not matter to you, but this does; you cannot directly connect a TTL video card output to a VGA monitor, or vice-versa. First of all, the cables do not mate, but if you were to somehow wire up an adapter, you would fail to see the correct image, and you could easily damage the monitor circuitry. Analog cards typically use HDD-15 (15-pin D-connector) outputs. Not all 15 pins are used for signals, but in XGA-II video additional pins are used to convey coded information about the monitor back to the video card.

• Macintosh Video



The Macintosh series of computers from Apple have evolved in a different path from PCs, but there are many similarities. Early Macs had built-in monochrome video (the Mac, Mac Plus, and Mac SE). First via third-party adapters, and subsequently through Apple's own designs as well, plug-in video adapters made it possible to use larger external monitors — color, gray scale or monochrome. The Mac SE and all subsequent Mac II and Power PC Macs have this capability.

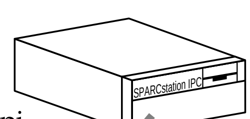
Typical Mac Video Connectors



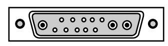
Depending on the third party vendor, the interface between the adapter card and the monitor will vary – DB-15, HDD-15 and single or multiple BNC (coax) connectors are common. Apple also supplied built-in video circuitry on the motherboard with external video output on a number of platforms, including the Mac IIcx, Mac IIci, and most of their 68040 ("Quadra" and "Performa" series) and Power PC platforms. The color depth varies from monochrome to 16.7 million colors, and screen resolution varies as well. For this reason, and because the Mac operating system relies on a window-based GUI (graphical user interface), all but the earliest Mac models return information from the monitor (or video card) to the operating system. Video sense data indicates the resolution and color depth of the monitor being used so the operating system can render its windows appropriately.

These complexities are a key reason why a Mac KVS was not introduced until several years after PC switching became available. The Macintosh's keyboard and mouse signals are also defined by a different electronic standard (the ADB, or Apple Desktop Bus), which is why an ordinary switch cannot be used to handle Macs and PCs together.

• Sun Video



The Sun Sparc platform is a RISC-based (Reduced Instruction Set Computer) workstation or server that typically is equipped with a large, high-resolution monochrome or color monitor. Sun has sold their own monitors that match their video card refresh rates, color depth and resolution. Sun color monitors, for example, have special 13W3 connectors with three coaxial conductors and ten additional pins, providing R-G-B video as well as two-way sense data. Such monitors and cables are expensive. Some who use Sun platforms for servers prefer to take advantage of a serial output on the Sun unit. Sending serial data to a dumb terminal does not produce the same high-resolution, high data rate image, but for a server this is often perfectly acceptable, and the advantages are not only a cost savings in the monitor, but also reduced demands on the CPU for video I/O (input/output) functions , freeing the CPU to do a better job of “serving.”


13W3 Connecto
for Sun Video

Switching Sun video has required a switch that is capable of sufficient bandwidth, and that has the proper connections, to accommodate the Sun monitors. The Sun keyboard layout and signals are also different from PC or Mac, which is why, until recently, a single switch could not mix Sun with other platforms.

• NTSC Video

In the United States of America, broadcast television has relied for decades on a video standard defined by the NTSC (National Television Standards Committee). NTSC is an analog signal. TV sets cannot generally be connected directly to computers due to a number of differences in the way they define the video signal.

• Keyboards and Mice

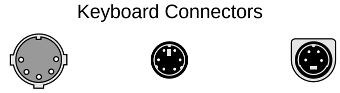
Today’s workstation and server keyboards all have roughly the same set of alphabet, punctuation and numeric keys. Keyboards generally have 85 or 101 keys, though there are many exceptions. In any case, you will not find 85 or 101 wires coming out of the keyboard — typically just 5 or 6 wires — because keyboards include circuitry that scans the keys to determine which are being held down, and then codes that information into signals which can be defined by an 8 bit serial data stream.

With a few exceptions, most computers use ASCII definitions inside their memories. ASCII is an acronym for American Standard Code for Information Interchange (pronounced “ass-key”). Keyboards, however, use a concept called “scan codes” which tell the computer which key is being actuated. Each keystroke actually generates two scan codes: one on key-down, the other on key release. The keyboard BIOS (in PC/AT class machines) or the main BIOS (in PC/XT class machines) translates the scan code pairs into ASCII characters. This lets KVS manufacturers use oddball key sequences, such as “NUM LOCK” + “–” or “CTRL” + “CTRL” to initiate channel switching or other special functions. Some keyboards have unique features that render them incompatible with certain computers.

Note that the ‘A’ in ASCII is American. Unicode is a newer character coding scheme that is just being introduced. It is designed to support more non-English languages, and you can expect changes in KVS products to support unicode-based keyboards and operating systems.

Most PCs use one of two different types of keyboard connectors. IBM’s older “PC-AT” style keyboard had a 5-pin round connector which was widely copied. Later, with the PS/2 series, IBM changed to a smaller mini-DIN (Deutsche Industrie Normen, a German standards organization) 6-pin round connector. Today, various clone manufacturers use AT or PS/2 style keyboard connectors, and some manufacturers vary the keyboard connector from model to model (don’t make any assumptions about the connectors on different AST, Dell, or HP models).

Keyboard Connectors


AT Style 5-Pin DIN | PS/2 Style 6-Pin miniDIN | Mac ADB 4-Pin miniDIN

While adapters can be used to change from one pin configuration to the other, there are electronic differences between some computers that are not so easily converted; the so-called key scan codes may differ, too. A keyboard/video switch that is built to accommodate any PC must be able to handle these variations gracefully, and you will find some switch models do a better job with certain PCs than do others. Often a firmware update in the switch will be required to accommodate some new model of PC.

Mouse Connectors


Serial Mouse DB9 | PS/2 Style 6-Pin miniDIN | Mac ADB 4-Pin miniDIN

Macintosh computers (except the very earliest models) use a separate bus for keyboard signals; the ADB (Apple Desktop Bus) connector is a 4-pin mini DIN connector. It carries not only keyboard, but also mouse (or trackball) signals. Other accessories can be attached to the ADB as well (including modems, graphic tablets, and software copy-protection “keys”).

While the mouse or trackball (which is an upside down mouse that stays in one place) is almost essential to use of the Macintosh operating system, it is not mandatory for PCs. Mice were introduced after the original PCs had been built, so mouse capability was initially introduced to PCs via plug-in circuit cards. This third-party approach resulted in three different types of PC mice: the bus mouse, the serial mouse, and the PS/2 mouse. Bus mice are the least common today. The Serial mouse was popularized by Microsoft and uses a DB-9 connector just like that of a TTL video circuit, but the connector sex avoids any chance of mis-plugging. The PS/2 mouse, introduced by IBM and now emulated by many vendors, uses a mini-DIN 6 connector just like the PS/2 keyboard (don’t confuse those connectors). Each PC’s operating system (O/S) must be equipped with the appropriate driver software to match the type of mouse in use. If you use a simple adapter to hook up a true PS/2 mouse to a PC with a serial mouse port, it won’t work properly. There is a class of mice labeled “Serial – PS/2” that can work in either serial or PS/2 mode, depending on the adapter cable. These mice have a female DB-9 serial connector and the adaptor converts to PS/2. They are actually two-mice-in-one, and unused pins in the DB-9 connector carry the PS/2 signals. This is why an ordinary PS/2 mouse will not worked with a serial adaptor.

Most PC mice have three buttons, though some may have two buttons. Mac mice generally have one button, though some have two.

Sun workstations use a completely different type of mouse (3-button, with optical scanning instead of a rolling ball), and the Sun mice have different connections (8-pin Mini-DIN) and unique driver software.

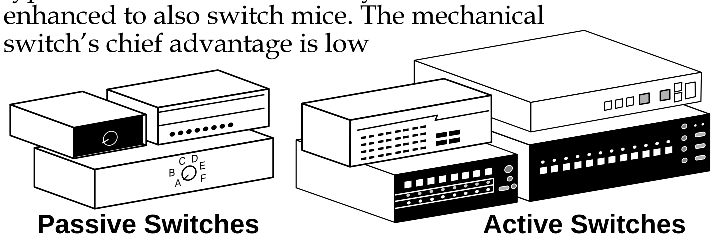
Sun, Mac and PC mice (or trackballs) are not interchangeable, even though they may look somewhat alike.

Dumb terminals use several different standards for keyboard coding and connectors. They do not use mice. Teletype machines (TTY) originally used a 5-bit Baudot code, which later evolved into ASCII 7-bit code, which was then picked up by early CRT displays. These were commonly known as "glass teletypes." The ANSI code (American National Standards Institute) defines the character sequences to do things such as switch to high intensity, blink, underline, and position the cursor on a glass teletype. DEC (Digital Equipment Corporation) used a slightly different ASCII code set in the VT-100 terminal series.

How Does A Keyboard/Video Switch Work?

• Passive Versus Active Switches

The earliest and least complex switches were passive. That is, they had no powered electrical components in them. You would turn a rotary switch, or engage one of several interlocked push button switches, to connect the attached monitor (and sometimes a keyboard) to the desired computer. This type of switch is still sold today, and some have been enhanced to also switch mice. The mechanical switch's chief advantage is low initial cost, but it has a number of offsetting disadvantages, as we discuss later.



Passive and active switches can look very similar; the differences are internal.

Active KVSs have powered circuitry that switches the video and keyboard signals (and in many cases the mice, too). Depending on the switch design, you either push up/down buttons to step through connected CPUs, you press direct-select pushbuttons, or you place the switch in an auto-scan mode that cycles through the connected CPUs at some preset interval. Some models also permit direct selection of the desired CPU by means of keyboard commands. While the active KVS is more costly (though sometimes not much more) than the passive KVS, it is also a superior solution for most applications.

With few exceptions, the operating system software and/or the BIOS (basic input/output system) of the PC checks for the presence of a connected keyboard when you first power up (boot) the computer; if no keyboard is connected, you see an "error" code on the monitor, and the system does not start up properly. For this reason, a passive KVS-switched computer can be booted only if the switch is set to that computer. After a system shutdown, it will take a long time to start up each computer in sequence, as someone has to manually switch to each computer and turn it on.

Better-designed active keyboard/video switches emulate the presence of a keyboard (and mouse) to all connected CPUs. This means that you can turn on all the computers at the same time, and they will all boot at once rather than one at a time. Switches that have such emulation are known as "automatic booting" switches for this reason. They reduce the incidence of hung systems during operation, too, because each computer "thinks" it is connected to a keyboard whether or not you have actually selected the computer with the switch.

Most of the focus of this document is on the active KVS because this type of switch is the most popular and most versatile.

• How Does the Active KVS Work?

As we have said, the active KVS emulates the presence of a keyboard to each computer. The originator of keyboard scan codes, IBM, defined three Scan Sets: Scan Set 1 was for the XT computer, Scan Set 2 was for the AT architecture, and Scan Set 3 was for 3270 terminals, which shared the same keyboard as PCs. Most clone vendors use Scan Set 2 (AT). IBM and a few other vendors instruct the keyboard to switch from Scan Set 2 on power-up to Scan Set 1, which lets them eliminate the keyboard translator microprocessor on the motherboard. Earlier PS/2s (Model 30 thru Mid Model 70) use Scan Set 2, while later PS/2s (such as Model 80, 85, 90, 95 and 77) use Scan Set 1. The real issue is whether the KVS can do all three, just like the IBM 101-key keyboard. This requires a microprocessor (or "intelligence") in the switch. Similar considerations apply to mouse operation (serial vs. PS/2), if the switch supports mice.

Video is more complex. Some switches merely pass the video through the switch, routing the signal from the selected CPU to the connected monitor. However, better switches correctly terminate the video output of non-selected computers to keep the computers' video cards correctly loaded and to avoid spurious signal emissions that might otherwise cause interference (fuzzy, ghost images on screen). At least one switch provides separate R/G/B intensity adjustments for the connected monitor to compensate for color shift due to cabling or differences in video driver cards. When it comes to switches for XGA-II, Sun or Macintosh, the switch circuitry also must return appropriate codes to the computers indicating the size, resolution and color depth of the connected monitor.

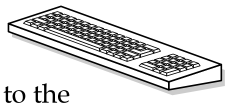
Certain highly-capable KVS models also include circuitry to convert between video formats (i.e., Mac or Sun to VGA), and to convert between various keyboard and mouse coding schemes. This circuitry makes it possible for a single device to offer cross-platform switching capability.

Without special provisions, keyboard and video cannot travel over long cables because these high-frequency signals become distorted by the reactance of the cables.

Without special provisions, keyboard and video cannot travel over long cables because these high-frequency signals become distorted by the reactance of the cables. (Reactance is an electronic characteristic that is present in all cables, and the longer the cable, the more it will degrade a high frequency waveform.) It is possible to reduce the degradation caused by cable reactance by (a) using higher quality cables, (b) using buffer and booster amplifiers, and/or (c) converting the electrical signals to light instead. Some active KVS products, with or without adapters, provide for buffered signal interfaces — that is, they intercept and amplify the signals — making it possible to extend up to several hundred feet the distance between the switch and the computers, or between the switch and the monitor and keyboard. Some products recently announced use fiberoptic technology (light transmitted along glass fibers instead of electrical signals in copper cable) to extend the switched distance to more than one thousand feet; such switches are typically more expensive.

Product Function for the Technically Oriented Reader

• Keyboard Switching



The old IBM PC/XT keyboard was a 1-way device. It generated signals that went to the computer. The IBM PC/AT and subsequent platforms used a two-way data path, with some probe of the keyboard by the computer. To be effective, the active KVS must emulate the presence of the keyboard to the computer when that computer is not selected on the switch. As indicated previously, not all scan codes are the same, so the emulation can be tricky. Store-and-forward technology is used for emulation in better switches.

A handful of platforms have keyboard anomalies. AST's keyboards use IBM's scan codes, but introduce variations in signal timing and drive capability, which makes physical interface tricky. Compaq pioneered autosensing XT/AT keyboard technology. When IBM introduced their 101-key keyboard with autosensing, they did it differently from Compaq (was this arrogance?). Compaq has not fully implemented the IBM autosensing protocol, but has adopted multiple scan sets. Thus, effective switch emulation of IBM's and Compaq's various keyboards can be particularly daunting. At one time, NCR and Leading Edge used the "Keyboard Reset" signal defined only on the old 5-pin DIN connector, which had to be passed through to the CPU for successful booting; these were XT and early AT computers, now mainly obsolete. Macintosh keyboards use different scan codes, but they are 1-way. The Mac CPU will boot with or without a keyboard, so keyboard emulation is not needed on the Macintosh. Like the Macintosh, the Sun keyboard and mouse share connections via a common bus, though the busses are different and Sun uses different coding and connectors than does Apple.

In addition to consideration of scan codes and connectors, as previously discussed, keyboard power specifications are also an issue. The switch must apply the correct power to the connected keyboard (remember, keyboards contain active circuitry). In some cases, the switch itself is powered by the keyboard output power from connected computers, so there must be compatibility in that specification, too.

Most PCs have 5-volt keyboard power output, typically at 0.75 to 1 amp of current. Switches that are powered by the computer's keyboard output will not function reliably, or at all, if the computer does not meet the design specification. Some early AT&T and TI computers, had 12-volt keyboard circuits with 9-pin D-connectors (TI did have a model with a 5-pin DIN that used 12 volts). Some Dell computers fall below 5 volts, and some IBM PS/2 models fall below 0.75 amperes (though they are adjustable internally). You may be able to purchase an in-line power adapter that interrupts the power from the computer's keyboard output and supplies proper power to the switch. There may not be a way to switch completely non-standard keyboards.

It can be beneficial if the KVS stores key scan codes and mouse type information about each PC in non-volatile memory. Should power to the switch be interrupted, you would not then have to reboot each CPU in order to restore proper switch operation. Absent this feature, you may want to put the KVS on a UPS (Uninterruptible Power Supply).

• Mouse Switching

We have already discussed the bus mouse, serial mouse, PS/2 mouse, Sun mouse and Mac mouse. Each uses a different connector and driver.

Switches that do accommodate mice generally require a separate microprocessor to emulate the mouse (Macs do not require mouse emulation). The switch may be designed to allow more than one type of mouse to be connected to it, routing the appropriate mouse to a given computer. A few highly sophisticated switches include intelligence to convert the control codes from a given mouse to properly drive a variety of connected computers.

The point is … not all switches are created equally, and you need to consider how their design affects performance in your application.

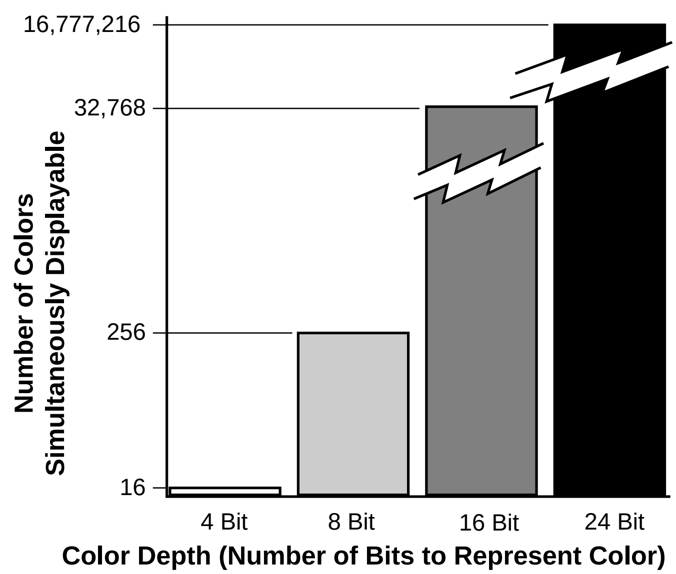
Some KVSs provide one microprocessor for the keyboard and another for the mouse, while some use a single microprocessor for both functions. Each approach has its pro's and con's. Dual microprocessors can create problems if the microprocessors do not switch in perfect synchronization as the user selects various computers. KVSs with a single microprocessor for both keyboard and mouse may rely upon that microprocessor to control up to six switching channels (i.e., six computers). This avoids synchronization problems, but may cause delays if the microprocessor cannot keep up with the demands of the six mouse and six keyboard emulated ports. At least one manufacturer uses a single microprocessor per channel (per switched computer), thus avoiding synchronization and throughput problems. The point is … not all switches are created equally, and you need to consider how their design affects performance in your application.

• A Video Refresher

Before you can truly understand the way KVS products handle video, you must understand the types of video that are found in today's computing environment. Using the KVS is a lot easier.

Color Depth

A monochrome monitor is a not a 1 bit display; the screen can be off, on, or high-intensity for a given pixel. When the



electron beam in the CRT (cathode ray tube) turns on, the phosphor color of a typical monochrome display will be white, green or amber. One variation is the gray-scale monitor. Gray scale monitors use 2, 4 or 8 bits of data to define 4, 64 or 256 levels of intensity for each monochrome pixel — not just on/off.

Today, you may find color monitors that use 4-bit, 8-bit, 16-bit or 24-bit data words to define, respectively, 16, 256, 32,000 or 16.7 million colors. 32-bit color display cards are available, but they actually use 24-bits to define the displayed color and the remaining 8 bits for other functions (overlays, transparency, cut/paste channels, etc.). Color monitors utilize three different phosphor dots (red, green and blue) to define a single pixel. Each phosphor can be illuminated to varying degrees of intensity, depending on the available color depth of the display card driving the monitor. In a 256 color display, colors are defined by color tables, and each entry has three six-bit color fields. Thus, the scale of possible colors is 64x64x64, or 262,144 possible colors, but only 256 at any one time.

A 16.7 million color display uses an 8-bit intensity signal to define 256 levels of brightness for each of three colors; mixing three color's 256 x 256 x 256 levels of intensity produces 16.7 million colors, so palettes are not necessary. [You will sometimes find 32-bit color software used for 8–bit representations of 4-color CMYK (Cyan-Magenta-Yellow-blacK) printing, but the monitor is inherently a 3-color device, so it needs a maximum of 24 bits, not 32.]

Sync

While sync frequency is directly proportional to refresh rate, it is not the same thing. Typical vertical sync frequencies vary from 57 Hz (Hertz, or cycles per second) to 81 Hz. The frame rate, or refresh rate, equals the vertical sync frequency in a non-interlaced monitor. For an interlaced monitor, frame or refresh rate is half the vertical sync frequency. For example, 70 Hz interlaced paints a new screen 35 times per second. The non-interlaced video requires significantly higher bandwidth.

The horizontal sync frequency is measured in kiloHertz (kHz, or thousands of Hertz). It is derived by multiplying the vertical sync frequency (refresh rate in non-interlaced mode or 2 x refresh rate in interlaced mode) by the number of horizontal lines. In other words, the sync frequency also increases with greater numbers of pixels displayed. The typical horizontal sync frequency for a 14-inch VGA monitor is about 31.5 kHz, though very high resolution monitors can have sync frequencies upwards of 100 kHz. The video bandwidth, however, is… about 28 MHz.

Video bandwidth is calculated using the sync frequency, interlace and the number of pixels displayed, as well as the blanking interval, or dead space between images. Video bandwidth is equal to: (H pixels x V pixels ÷ Interlace factor) x Vertical sync rate. For typical VGA, uncorrected Video Bandwidth= (640 x 480 ÷ 1) x 60 = 18.4 MHz. If you take the total time available for a horizontal scan line and the corresponding retrace, and divide this by the actual time used to display pixels, you get a factor of 1.45; when multiplied by 18.4, this yields 26.7 MHz. Similarly, the wasted time in vertical retrace yields a factor of 1.03, resulting in 27.5 MHz actual video bandwidth.

Interlaced monitors (monitors with a lower refresh rate) will flicker more; you may notice this if you move your eyes quickly, chew gum while viewing the screen or view from a distance. The larger the screen (or at least the higher the resolution), the higher the actual horizontal sync frequency for a given refresh rate. Rapid refresh rates (for stable, low-flicker images) and large, high resolution images require ever more video bandwidth, which requires faster more costly circuitry and higher-quality controlled-impedance cabling. This is why a given switch that works acceptably with VGA may degrade an SVGA or an XGA image.

Video Signal Processing

A KVS made strictly for PC switching should provide video buffering. The signal enters the KVS after emerging from the various computer display card outputs. The KVS buffers and terminates the video signals. It then passes signal from the selected computer to the monitor.

When mixing computer platforms, the KVS may not only buffer the video, it may also translate the signals from the various computers to work with a single monitor. Mac and Sun platforms typically have vertical and horizontal sync frequencies that differ from PCs. In some cases, a multi-sync monitor can handle conversion between video sync frequencies, though there are other aspects to the conversion that may still have to be handled by the KVS (video sense data, for example).

Aside from the Mac's different sync frequency, it also requires that information about the monitor size (or resolution) and color depth be returned to the operating system. A mechanical switch that handles Mac video typically is equipped with jumpers or DIP (Dual In-line Package) switches. The user manually sets up the KVS so it returns appropriate information to the connected Macs using 10 data bits.

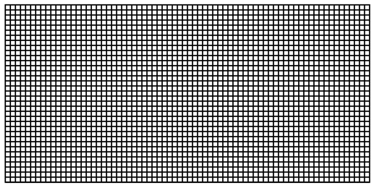
Even though resolution data may be returned to the computers by the KVS, not all KVS products are capable of displaying all resolutions. Resolution capability is dictated by both the bandwidth capability of the KVS (and its cables), and by the KVS's firmware (code written to one or more integrated microprocessors in the switch). While most KVSs support higher resolution VGA, SVGA and XGA directly, some require external hardware or the use of a multi-sync monitor in order to provide a crisp display at high resolution. Sun monitors, while offering high resolution, cannot normally be used on anything but Sun platforms because they operate at a fixed frequency atypical of PC monitors.

Some manufacturers of active KVSs utilize integrated circuits to process the video. If the ICs are not of high quality, and do not utilize sufficiently high bipolar power supply voltage, the ICs can impose bandwidth limitations and cause high video distortion (you see this as smearing, ghosting or a general lack of clarity). Typical 5 Volt PC power supplies do not yield exceptionally good results with ICs. At least one manufacturer uses discrete transistors in the video circuit, which, with good video amp design and ample adjusting points, provide the extended bandwidth necessary for low video distortion.

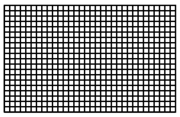
If the video signal is not properly buffered, there may be a bright flash (a "glitch") when you switch between computers. To avoid glitching, at least one KVS manufacturer buffers the incoming video signal, terminates it, then buffers it again. This dual stage amplification provides a clean video image without glitching, and it assures proper termination of the video signal to each connected computer.

Monitor Types & Standards

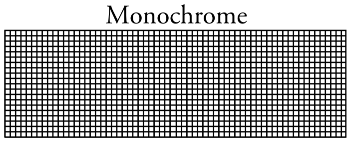
First there was TTL (Transistor-Transistor Logic). The original PC video signal was capable of limited resolution. The MDA (Monochrome Digital Adapter) provided single-color display at a resolution of 720 H (horizontal) by 350 V (vertical) pixels. Typically, you would see white or green type against a black background. European research indicated that amber was less fatiguing, so soon yellow-on-black monitors appeared. All used the same MDA card, just different phosphors in the CRT.



MDA • Uniform Resolution Map

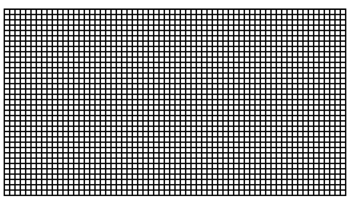


CGA • Uniform Resolution Map



CGA • Uniform Resolution Map

The CGA card gave us up to four colors displayed at a resolution of 320 H x 200 V, or it could be switched to operate in single-color mode at 640 H x 200 V pixels. Thus, you could sacrifice color depth in favor of resolution where that was desirable (i.e., for text display).

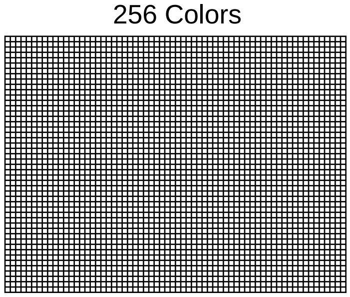


EGA • Uniform Resolution Map

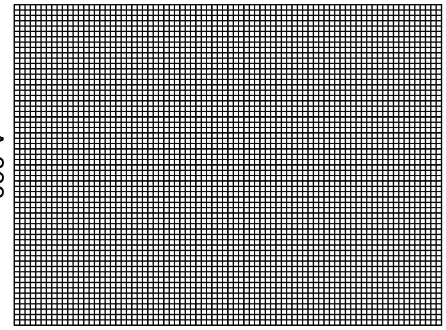
The EGA card increased the color depth and resolution. You could have 16 colors displayed at a resolution of 640 H x 350 V pixels. By today's standards, neither CGA nor EGA is impressive, but they were adequate for text and primitive graphic display.

Because TTL video uses modest amounts of RAM (random access memory), many servers today are still equipped with these cards. In situations where the display is seldom viewed, and is not viewed for long, it is reasonable to trade off resolution and color depth for maximum available memory.

IBM introduced VGA in 1987 when it rolled out the PS/2 family. VGA, using analog monitor technology, is capable of displaying up to 256 colors simultaneously with a resolution of 640 H x 480 V pixels. VGA preserves about the same aspect ratio as EGA, but with 16 times the number of colors. VGA uses a zero to 700 mV signal in discrete steps; the more colors, the smaller the steps. For example, 256 color mode is 8/3 bits per color, or 100 mV per step. The super-fidelity cards of 16.7 million colors based on a 24 bit color field (8 bits per color) have 256 steps of approximately 3 mV per step per each of three phosphor colors. Third party vendors pushed VGA to higher limits, with SVGA modes of 800 H x 600 V pixels or 1024 H x 768 V pixels. Both modes provide graphic designers and CAD users with fine lines and well-formed type, allowing them to work long hours on complex images with less visual fatigue. The 1024 H x 768 V pixel display on a 19^2 to 20^2 diagonal monitor affords the opportunity to view a 2-page (11^2 x 17^2) page layout at full size WYSIWYG (What You See Is What You Get) minus about a half inch border; at slightly reduced image size, you can view out to the page edges.

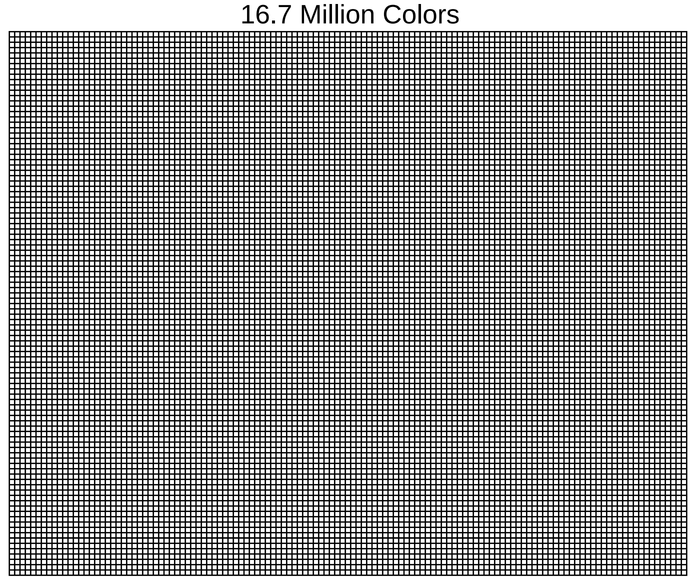


VGA • Uniform Resolution Map



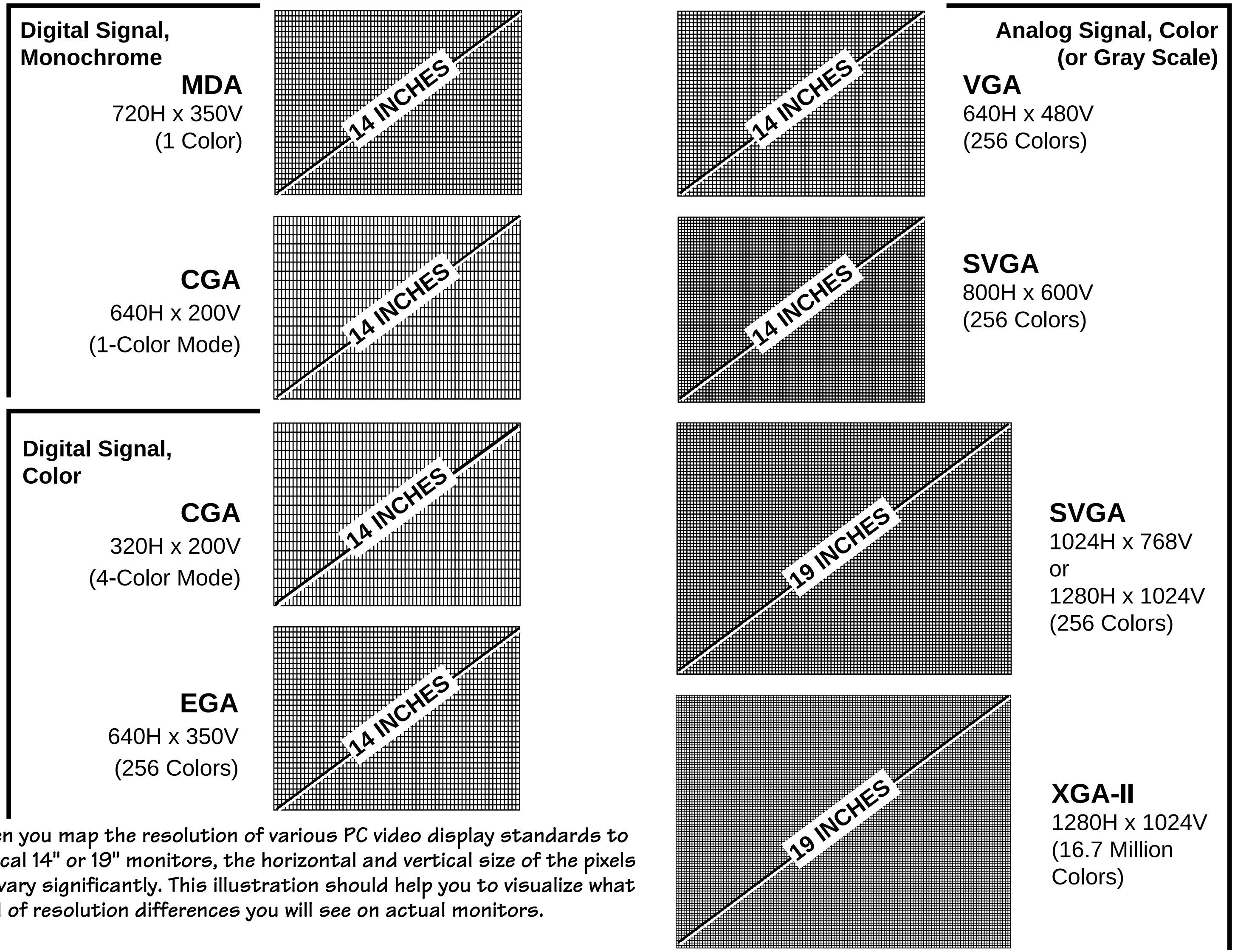
SVGA • Uniform Resolution Map

Some designers, multimedia producers, and CAD operators required still higher resolution, and IBM introduced 8514/A video, which had a 1024 H x 768 V resolution in interlaced mode, as well as VGA compatibility. This approach had flicker problems, and has been largely abandoned in favor of the subsequent XGA standard, which is capable of color depths to 16.7 million simultaneously displayed hues (i.e., virtually continuous display of the full color spectrum without banding), and optional resolutions of up to 1280 H x 1024 V pixels. Because a given monitor might not be capable of displaying such high resolution images, or since high res mode might not be desirable if the screen size were small, XGA-II video monitors include signal wires that "tell^2 the display card about the type of monitor in use so the card can generate appropriate images.



XGA • Uniform Resolution Map

As we outlined earlier, Macintosh models that support external video do it either through video circuitry built into the motherboard, or via plug-in display cards. Mac video is analog. Those Macs which use motherboard-based video dif-



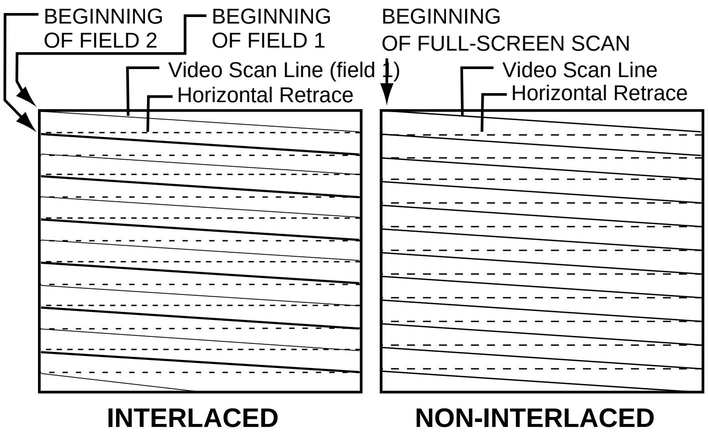
When you map the resolution of various PC video display standards to typical 14" or 19" monitors, the horizontal and vertical size of the pixels will vary significantly. This illustration should help you to visualize what kind of resolution differences you will see on actual monitors.

fer in the maximum resolution and color depth, and often both can be increased by plugging in additional video RAM. Currently, the maximum onboard video capability of Macs is as high as 16.7 million colors and as high as 1152 H x 870 V pixels, though there may be a trade-off of color depth for resolution. Plug-in display cards are available with resolutions up to 1280 H x 1024 V pixels (a few cards offer extremely high resolution of about 1664 H pixels x 1280 V) at color depths to 16.7 million. The refresh rate of Mac monitors is not fixed either, but it is generally about 72 Hz on better video card/monitor combinations. The method of sync is also different from PC monitors; Mac video color cards superimpose the sync pulse on the green video signal. To further complicate matters, some newer Mac models are capable of connection to VGA monitors with the addition of an inexpensive in-line adapter cable.

In order to mix conventional Mac video with PC video in a given KVS, and to drive a shared VGA monitor, it is necessary to strip the sync from the "green" Mac video line, then regenerate it for proper feed to the VGA monitor's sync line. As we mentioned previously, the KVS must also return a code to the Mac indicating the resolution and color depth of the connected monitor.

NTSC Video is Not Optimum for Computers

NTSC video is analog, as is VGA, but that's about the only similarity. The frame rate is just under 30 Hz; that is, there are about 30 full images per second being displayed. However, because each TV style image is drawn by two sequential scans of the screen, one beginning in a corner of the screen and the other beginning in the middle of the screen, the effective refresh rate per scan is about 60 Hz (see illustration, page 12). Phosphor persistence (the amount of time it glows after being hit by the electron gun) plus human perception tends to merge the two low-resolution scans into a single higher-resolution full-screen image. This kind of TV display is known as "interlaced" video. Interlaced fields are intended to reduce video bandwidth, but because an entire screen is produced at half the Vertical Sync rate, this causes flicker. Interlacing, in itself, does not cause reduced sharpness, but the monitors that rely on interlacing to get higher resolution are usually cheaper and inherently less sharp than more expensive, non-interlaced monitors. Computer video is increasingly non-interlaced (interlaced is dying despite a large installed base); non-interlaced means each scan is a whole frame that sweeps the entire screen with the entire video image, not two fields per frame with half the image information. To connect a computer to a TV, circuitry is needed to convert the video to interlaced images at the



Interlaced NTSC Video (left) vs Non-Interlaced Computer Video

correct vertical sync frequency. Typically a loss of resolution and a degree of jitter or aliasing occurs with this conversion.

With the exception of a few TV sets that have "monitor" capability (defined as separate R/G/B or red/green/blue and sync inputs), the TV is meant to receive an ultra-high-frequency phase-modulated broadcast signal that contains the video and audio information. Thus, in order to connect a computer to a TV set, as opposed to a TV monitor, a modulator is also required. The modulator converts RGB video to TV channel 3 or 4 frequency signals that are subsequently treated by the TV receiver just like a normal broadcast station's signal.

Full-size, full-motion NTSC broadcast Television images require 4 MHz to 6 MHz of bandwidth (MHz is a Mega Hertz, or one million cycles per second). A 90 MHz Pentium-equipped computer will require almost all its processor power to handle full-motion broadcast video with audio. [TV sets don't have to have such processing power because they typically handle the signal in the analog domain, not as a digitized data stream.] However, broadcast video demands are slight in comparison to a high-resolution computer monitor displaying 1024 x 768 pixels at 72 Hz vertical sync rate. That monitor is displaying 56 million pixels for each of 3 colors. This requires a video bandwidth of 70 MHz (the dot rate for a single color) unmodulated — a lot of processing power for any computer workstation. And if you are using 16.7 million colors, that eats up memory, too. All this explains why TV sets are not generally used for computer display, nor can the TV tuner be used as a video switch (just in case the thought occurred to you).

• Operating System Considerations

Strictly speaking, the KVS should be independent of the computer's operating system (O/S). After all, you hook up a monitor and keyboard to a platform. Then you install whatever O/S you wish to run — DOS, Windows, OS/2, Deskview, System 7 (the current Mac O/S, which is NOT PC compatible), Unix, Xenix (Microsoft's version of Unix), etc. Why should it matter to the switch what software is installed?

The simple answer is that the O/S should not matter, and the switch "should not care" what operating system is in use.

In reality, in some cases the O/S does matter, and compatibility is a function of how well the emulation is implemented. The KVS must return the correct keyboard and mouse codes to the connected computers. For example, KVSs that don't understand about different scan sets inside the IBM-101 keyboard will have problems. To the extend that the O/S affects the code interchange, the KVS must be set up to interact properly with the O/S.

The simple answer is that the O/S should not matter, and the switch "should not care" what operating system is in use.

Intelligence in the KVS handles this interaction, and the intelligence is generally coded in firmware. If the firmware does not match the mouse or keyboard drivers in the O/S software, control can be erratic. You may have lags in mouse response, delayed keyboard response, or a complete failure to function. Sometimes it just takes a software update to a current driver or version of the O/S, or a firmware update on the KVS, to fix the problem.

Sometimes what appears to be an O/S compatibility issue turns out to be an indirectly related driver issue. There may be certain video or mouse drivers, for example, that are configured and selected along with the operating system. When you install or select a different O/S and encounter problems, you may inadvertently have selected these different drivers. For example, if the video driver changes from 640x480 resolution to 1024x768, the monitor connected to the KVS may suddenly fail to display a satisfactory image. Changing a 'config' file on the offending platform would correct such a problem without any need for hardware changes or adaptors.

If you have a concern about utilizing a particular operating environment with a KVS, consult the KVS manufacturer or a knowledgeable consultant with access to up-to-date information. Then, be sure to get a money-back or model exchange satisfaction guarantee just in case things don't work as expected.

•Hardware Considerations

It is easy to mistake O/S compatibility for other aspects of compatibility because some computers that use different operating systems ALSO rely on different electronic standards. Aside from issues of the proper connector type (for mating cables), the computer itself can affect compatibility. The IBM RS-6000, which is a RISC-based computer that typically runs the Unix operating system is not compatible with a typical PC KVS handling Windows or DOS — not because of the O/S, but because of differences in keyboard scan codes.

DOS, Windows and OS/2 typically run on Intel-based CPUs, and clones of those CPUs. This includes the 286, 386, and 486 series chips. The 586 series, otherwise known as the Pentium, is the latest extension of the x86 series. Some KVSs have had difficulties with the Pentium (Then again, so did Intel itself at one point).

The x-86 series chip is based on CISC architecture (Complex Instruction Set Chip). RISC (Reduced Instruction Set Chip) architecture is favored for running the Unix O/S and variants of Unix. Thus, if a Unix-based computer has compatibility problems with a particular KVS, it may be the O/S or the computer architecture causing the conflict, and you will need to consult the KVS manufacturer to resolve the issue.

Unix (and Unix variants) can run on Motorola 680xx series chips. Several computer manufacturers use these CPUs for Unix or other O/S's, including the original Macintosh O/S. The latest crop of Macintosh products have migrated from the 680xx family of CISC chips to the Power PC RISC CPU family (the Power PC architecture was a joint development effort of IBM, Apple and Motorola). IBM is also bringing products to market based on the Power PC CPU family. The Power PC can be overlaid with various operating systems, including Macintosh System 7, Windows, OS/2, and Unix. In summary, it is essential that you verify that a given KVS will work not only with the operating system(s) you plan to use, but also with the particular hardware platforms on which those O/S's are running.

Network environments (Novell Netware, Banyan Vines, etc.) are NOT O/S's, but they can impact KVS operation if someone patches the scan code set. Normally, the environment will not matter.

• Methods of Switching

We have already described, briefly, the methods of switching: direct selection via pushbuttons, indirect selection via step up/step down buttons, direct selection via keyboard commands, and scanning of connected computers in sequence. Let's discuss these approaches in more detail.

To some users, direct access to a given computer is essential. They do not wish to wait for the scanning to get to the platform of interest, nor do they wish to take the time to step through various platforms with incrementing (<|>)buttons. Manufacturers who provide direct access via pushbuttons on the switch offer the simplest, most cost-effective approach for direct access. However, it may be necessary to physically place the switch at a location that is out of convenient reach of the operator. This may, for instance, permit many computer-to-switch cables to be kept short (which saves money and avoids signal degradation), and then the only longer cables are those run to the monitor, mouse and keyboard; since the KVS can buffer these signals, the extra distance on this side of the switch does not necessarily cause any degradation. With the switch out of reach, however, another method of computer selection must be provided.

Keyboard access is one obvious answer; allow command keys or an escape-sequence-activated series of hot keys to select the computer being accessed. Ideally, there should be no need to modify the software on the various computers to effect keyboard switching (you want the operation to be seamless to the computers), and in better-designed KVSs this is the case. Another approach is to provide a remote control for the KVS; some manufacturers do this, but the feature can be more costly than use of keyboard access, and it places another piece of proprietary equipment on the desktop. On the other hand, a remote control avoids any chance of accidentally issuing an incorrect command to a given computer when you had intended to issue a switching command. In some cases, a remote can save money – by allowing the switch itself to be closer to the CPUs. Here, multiple, short CPU–to–switch cables and one long switch–to–remote cable may be used instead of multiple long cables.

You may also wish to examine special features to see if they are important to you. Some switches, for example, offer a Broadcast Mode, in which keyboard commands can be assigned to multiple computers. This may save time when issuing shut-down commands to a rack full of computers in the event of an emergency, or for simultaneously initiating routine backup, loading new software, and so forth on multiple computers. Some KVSs that provide for automatic scanning of various computers do so in a fixed sequence and at uniform dwell times (dwell is the amount of time a given computer stays selected); other KVSs let you select a subset of computers to be scanned, let you arrange the order in which they are scanned, and let you set different dwell times for each computer so that you can spend more time viewing the most important-to-see platforms. Depending on the KVS's design, to halt scanning when you see a screen requiring your attention, you may have to press a button on the KVS, use a keyboard command, or simply touch the mouse or keyboard.

Look carefully at not only the presence of a feature, but at how the feature is implemented!

• Other Issues to Consider

When selecting a KVS, consider its behavior with regard to switching delays, video glitches, proper operation of ALL keyboard features (caps lock and num lock indicators for example), correct mouse response and tracking, and overall reliability.

Also, consider whether it is possible to expand the number of switching channels without having to add another monitor and keyboard. Does the switch allow for an expansion device? Do you lose a port on the base unit switch when you add an expansion device? Do you have to operate multiple switch controls after expansion, or do you retain single-point computer selection capability? These are important considerations that may not be discussed in the manufacturer's advertising.

Dollar Factor$ —Obvious and Hidden

You can compare the price tag on a given switch , including its required cables and accessories, to another and get some feel for the relative costs of this KVS versus that one. And you can compare the cost of the KVS with a single monitor and keyboard to that of one monitor and keyboard (and mouse if applicable) per computer. Such an analysis, however, will not really give you a clear picture of the true cost of implementing KVS.

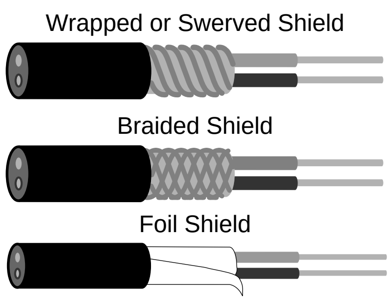
• KVS Direct Costs

Most active keyboard/video switches for a particular type of platform are priced similarly. Some platforms are more costly to switch (with wider bandwidth or special connectors or instance) so the available KVSs for that task may be priced differently; Sun Sparc platforms come to mind here. Some switches offer extraordinary capabilities, such as multi-platform compatibility (PC/Sun/Mac), extreme distances (beyond the typical 5 to 25 feet between computer and switch), or multi-user access, so their costs may be significantly higher.

We suggest that you add up the cost of the switch plus cables and necessary accessories (power supplies, remote controls, mounting hardware). Then subtract the cost of all the monitors (and mice) you won't need, and divide this by the number of computers being switched. If the result is a positive number, you get an idea of the direct switch cost per switched computer. Negative numbers indicate how much you'll save per switched computer. Of course, you will have indirect savings, too. Also,consider whether the switch offers built-in mouse support for the day you go to a GUI, like version 4 of Novell or Windows NT — in fact, consider whether you can use both serial and PS/2 mice. Overlooking this factor because you don't use mice now can cost a lot later on, and may even require purchasing a new switch.

• Cables

Some manufacturers offer relatively inexpensive cables, but require you to purchase separate cables for the mouse, keyboard and video lines. When you add up the cost, it may be the same or more than cables from a manufacturer who offers a single, combined cable (which is easier to work with). Some manufacturers require you to daisy-chain connections from one computer to the next on the way to the switch; this may save in overall cable length, but it makes things more complex if you want freedom in layout of individual computers, or if two platforms happen to use different keyboard or mouse connectors. And, as stated previously, not all cables are of equivalent quality; cables with controlled impedance cost more, but impose less signal degradation. (If the capacitance between conductors is incorrect, the cable becomes a low pass filter, reducing bandwidth and impairing video quality.) Adequate shielding is important to reduce interaction and interference; cables differ drastically in this regard. For example, they may have swerved (wire wrapped), braided, or foil shield; these methods of shielding trade flexibility against shield effectiveness and durability. Coaxial cable can be beneficial here, though it is typically more costly and less flexible than other cables.



The type of shielding used to make a cable has a significant impact on the effectiveness of the shielding, as well as the cable's electrical stability, and its physical durability and flexibility.

• KVS Reliability and Support Costs

There is no question about it… when you use a KVS, you are creating a single point where a failure can affect your access to multiple computers. Thus, KVS reliability is a crucial concern. *The KVS should be manufactured by a vendor with a proven track record, using top-quality components and extensive quality controls.* Its design should be conservative, and should be such that a switch failure in one channel does not cause computers on other channels to be affected, nor does it damage the computer.

In general, the most common source of failures in electronic devices is the power supply, so it is important to have a reliable supply. Not only can the loss of power immediately cause all operation to cease, the power supply itself generates heat which, if transferred to nearby electronic circuits, can shorten component life. Some manufacturers try to alleviate the heat problem by using external power supplies. If large enough to power a multi-port KVS, they can fall out of an outlet, making them a potential weak point (secure external supplies carefully if you use them). One manufacturer of KVSs takes a novel approach by using the same power that would have been used to power the keyboard on a given computer to instead power the corresponding circuitry in the KVS; with one external "power supply" (computer) per port, this KVS has a distributed power supply so no single failure will bring down the entire KVS, and there is no power supply inside to generate heat. However, if the KVS draws too much power from a computer, it can blow an internal fuse on the computer (typically a motherboard-mounted pico fuse); while this can be replaced, it is inconvenient, so you will want to be sure that the computer can support the power drain of such a switch. Most of the active switches are reliable today, but there are differences. Caveat Emptor.

Reliability issues notwithstanding, anything can break and it may. So you will want to look closely at the warranty and, equally important, at the support available from the manufacturer and from the vendor that supplies you with the KVS. You will want to know that replacement product is readily available. And you will want to select a product made by a manufacturer who will be around a year or several from now.

A related issue is whether the product will continue to keep up with technological advances in your computer setup. While computers made offshore may be perfectly acceptable (you probably use domestically produced software on them anyway), the KVS is a product that must be updated often to maintain compatibility with new types of computers and O/S variants. Domestically designed switches (whether they are actually manufactured domestically or abroad) can more easily keep up with the engineering changes necessary to avoid obsolescence — or more accurately, to avoid unanticipated incompatibilities (typically, this involves changes in the firmware, so check on upgrade policies, too).

Make the right choices in these areas, and your KVS will deliver not only initial cost savings, but ongoing savings from the lack of a need to power and cool multiple monitors. Make a poor choice, and downtime can eat up those savings in a hurry.

• Efficiency & Productivity — Less Tangible But Very Significant Sources of Savings

Because the KVS enables an operator to sit (or stand) in one place while checking tens of computers, that operator can be much more productive. While the KVS may require a fraction of a second (or even a second) to change from one computer to the next, this is less time than it takes the operator to stand up, much less walk 5 or 10 feet to another computer as would be required without the KVS.

Because there are fewer monitors and keyboards, there are fewer components to be maintained. This saves time and money in the long term – over and above the direct acquisition costs or power costs.

In situations where a single operator would otherwise be working in front of multiple CRTs, the KVS dramatically reduces exposure to potentially harmful VLF (very low frequency) electromagnetic fields and electrostatic fields. Many believe this to be significant in protecting the health of the operator. If this is the case, then the KVS will save an unspecified amount in direct and indirect medical and workman's compensation costs. This would also positively impact workforce productivity.

Finally, the greatest hidden savings may be that the KVS allows you to stay in the current space and avoid a costly move or build-out.

Particularly in small office environments, the KVS goes a long way toward reducing visual and physical clutter. The cleaner, neater layout facilitates operator concentration, thus improving productivity. When you are dealing with personnel earning $30,000 to $100,000 annually, a few percent greater productivity can add up to a lot of dollars annually — probably enough to pay for the KVS in the first year alone.

Finally, the greatest hidden savings may be that the KVS allows you to stay in the current space and avoid a costly move or build-out. It is not unusual for the installation of KVS to cut floor space requirements down to one half or one third of an unswitched configuration. If you combine KVS with a suitable racking system designed for multiple computers (not just bakery racks or warehouse shelving), you will save even more floor space while significantly improving maintenance access so it takes less time to service the computers. It is common to see floor space requirements drop to from one-third to one-fourth that of the non-switched, non-racked computer room.

Who Created This Document?

The KVS White Paper was written by Tony DeKerf, president of Tron International, Inc. and by Gary D. Davis, president of The WorkCenter Corporation.

Both firms have specialized in designing computer rooms and testing labs since 1989, with an emphasis on the use of Keyboard/Video Switches to maximize the capacity of available floor space and optimize work flow. In fact, when the concept of Keyboard/Video Switching was in its infancy – with only a few available brands – Tron International was a pioneer in the installation of KVS products in large computer labs and multi-server environments.

Today, both firms provide sales engineering, installation, and support services for a variety of KVS manufacturers. When you consider the use of a KVS, it is important to know if the manufacturer provides related products, such as sharing devices, to most efficiently utilize the product's features. Tron International and The WorkCenter employ technically oriented people who are familiar with the LAN administrator's responsibilities. They can help you configure an array of products to meet the special needs of a broad spectrum of users. If you have an application that you feel involves an unavailable (as yet undeveloped?) product, we suggest discussing the application with the authors of this paper — they may know whether a particular vendor has a suitable new product or one in development. On more than one occasion, customer consultations and the field engineering efforts of our firms, have resulted in manufacturers creating new or modified products to meet the newly identified need.

If you have initially had a negative impression of the whole concept of KVS, you are not alone. Be aware, though, that many delighted users of KVS were initially skeptical.

If you would like information on a specific product, or consultation regarding a particular application, please contact us:

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The Keyboard/Video Switch White Paper

A Close Look at Modern Keyboard/Video Switching

by Tony DeKerf and Gary D. Davis

Revised 4/20/95

The WorkCenter Corporation

TRON INTERNATIONAL, INC.

Help a Friend *and* Save a Tree

When you're done with this document, don't discard it. Instead, give it to an interested associate. He or she will probably appreciate your thoughtfulness, and ultimately we will avoid having to send out hundreds or thousands of additional copies. That saves paper and trees and lots of other natural resources. KVS is a "green" concept in that it saves power, and you can save even more resources by passing this on.