BLACK BOX
NETWORK SERVICES

USB True Emulation for KVM Switches

Transparent and reliable USB KVM switching technology.

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We're here to help! If you have any questions about your application, our products, or this white paper, contact Black Box Tech Support on **0118 965 6000** or go to **www.blackbox.co.uk** and click on "Live Chat."

Introduction

Remember the good old days? Car journeys needed maps not satellites, mobile phones were too large to lose, and the Bakelite® knob on your keyboard/video/mouse (KVM) switched you between computers in a manner more befitting the age of steam than silicon. Since then, computers have advanced greatly in speed and sophistication. So too have their peripherals and, in response, KVM switches have continually evolved to meet each new challenge.

However, one problem has traditionally proved to be a tough nut to crack: how to switch USB devices transparently and reliably. The trouble is that although USB appears to be easy on the outside, there's more going on inside than you might expect. This has led to various difficulties that have spawned a number of possible solutions.

Black Box Explains

USB, a force for good…connections.

Since its inception in 1995, the Universal Serial Bus (USB) standard has proved to be an increasingly successful way to connect a diverse range of devices and make them cooperate. Before USB, the back of any personal computer represented a history lesson in stringing things together: Parallel printer ports sat aside serial ports; keyboard and mouse connectors jostled with joystick ports, and SCSI sockets battled for attention alongside FireWire® links. Things weren't much better at the front of the computer either, where an endless series of software drivers and applications were required to "paper over the cracks" that appeared as each interface method was pushed to its limits. During the 1990s, Apple® Mac® computers told a similar story, but with fewer difficulties. USB provided, and continues to provide, a common solution to all the applications mentioned above. It has succeeded primarily because it's well supported, it's quick (in its version 2.0 form), and it's easy to use. That ease of use comes about because it works hard in the background with a series of carefully defined processes to ensure that devices and computers can operate together in a coordinated manner.

Enumerated USB Switching

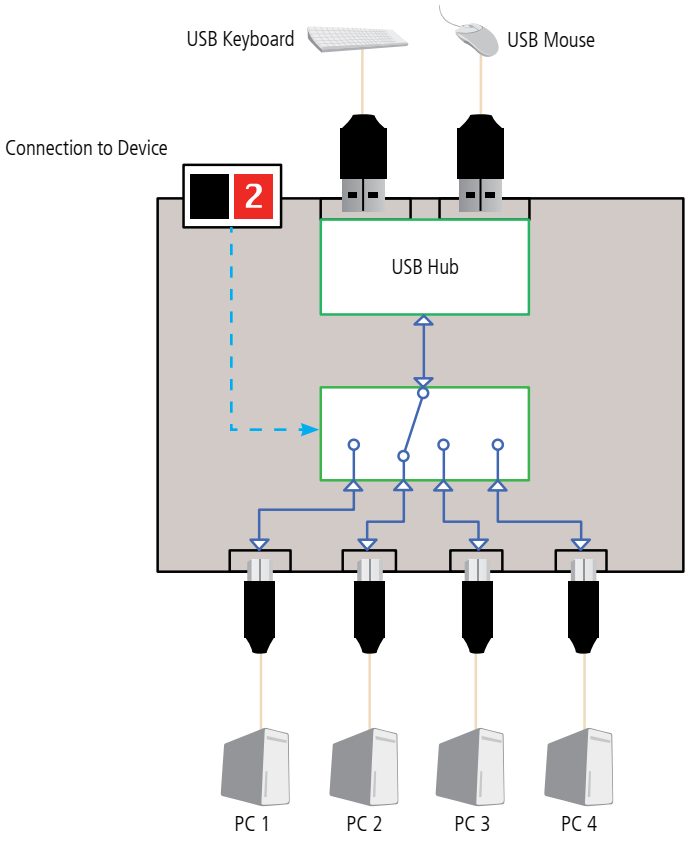
The earliest attempts to switch USB devices applied a relatively "hands off" approach. Remember the old KVM switch with the mechanical knob and no intelligence? An enumerated USB switch is the electronic equivalent. The name is derived from the initiation process (enumeration) that every USB device goes through each time it is connected to a computer. With enumerated switches, a connected USB device is required to perform a full initiation every time it is switched; just as if you had pulled out the plug and then reconnected it.

Enumerated switches simply pass all signals straight through between the USB device and the computer; they do not attempt to interpret any data. This is both a good and bad thing, depending on the type of USB devices that you are using. For most devices, this offers an advantage because the switch just leaves them to get on with their jobs without any interference or any drain on performance. The disadvantage is with USB keyboards and mice because you can no longer use them to control the switching process—a quick and simple control method expected by most users. Switching reliability is also an issue that has plagued enumerated switches, particularly when used with certain USB devices and particular operating systems. The next challenge was obviously to make a more reliable USB switch that could listen and react to connected devices.

Black Box Explains

What is enumeration?

The USB interface was designed from the outset to allow a wide variety of devices to be connected and disconnected from the host computer at any time. A crucial part of this process is called enumeration. As a USB device is connected, it introduces itself to the host computer and the host allocates a unique identifying number between 1 and 127. This whole process takes between one and seven seconds (depending on the number of devices being connected and the operating system) and must be done every time that a device is connected to the host—even if it has been previously connected.



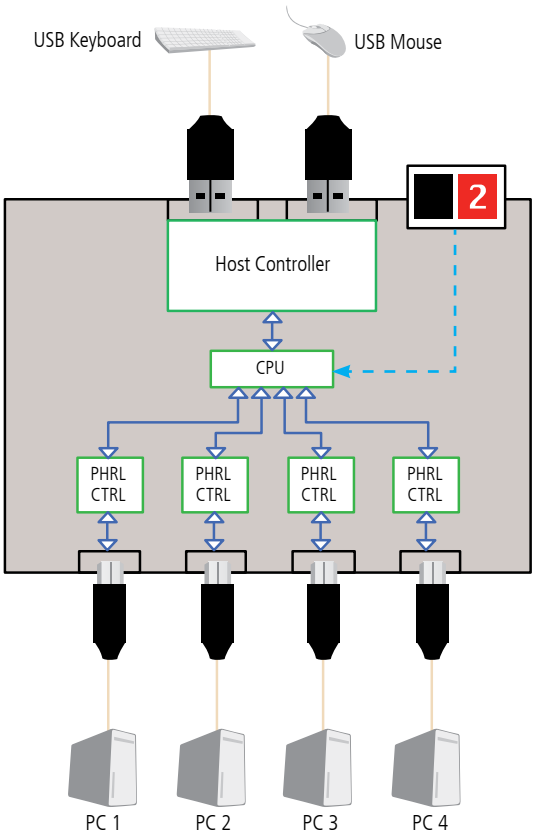
The inside view of a typical enumerated USB switch.
The keyboard and mouse are linked to a hub, which then feeds via a simple electronic switch to the selected computer.

Emulated USB Switching

Keyboard and mouse switching control was perfected many years ago for PS/2® style devices. Because of their simplistic data streams, it was relatively straightforward to read their inputs, strip out the switching control information, and then repackage the remainder for the computer. Achieving the same for USB data streams has been much tougher with the added complexity of the USB standard and its signals.

The problem was eventually solved, with the emulated USB switch. As the name suggests, the characteristics of the attached USB device are recreated, or emulated, once the required switching control information has been removed from the data stream. A neat side effect of the technique is that each computer can be fooled into thinking that the USB device is permanently connected to it, even when the device is switched to another computer. This means that the enumeration process for the USB device takes place only once, during the first time the device is powered on. After that, a computer merely sees a dormant version of the USB device whenever the device is actually connected to a different computer.

However, although emulated switches cured a number of shortfalls associated with their enumerated cousins, there still was one main limitation to their operation. It remained a complex task to dynamically assume the identity of a USB device, distribute it among the connected computers and maintain all the necessary signals, states, and processes. Therefore, manufacturers, including Black Box, relied upon a fixed keyboard and mouse profile that is declared to each computer, regardless of the actual connected devices. This precluded the use of any special keyboard buttons or mouse features over and above the standard layouts.



The inside view of a typical emulated USB switch.
The keyboard and mouse are linked to a host controller (a sophisticated USB hub) and then through to the microprocessor (CPU) which performs the data capture and switching processes.

The currently active connection is then linked via a peripheral controller to the selected computer.

True Emulation

To overcome the limitations associated with even emulated USB switching techniques, True Emulation was developed.

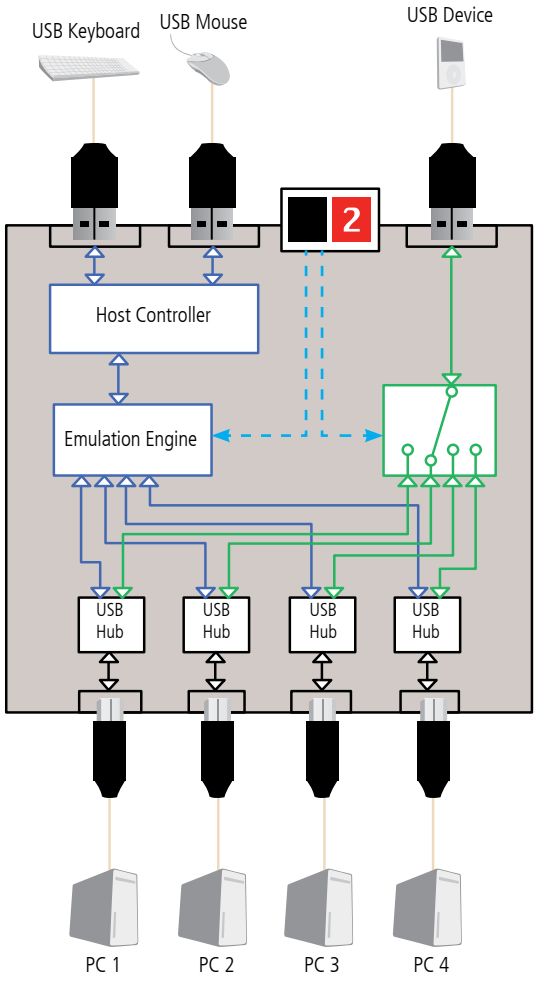
With True Emulation, the complete identity of the keyboard and mouse can be copied and then presented to all the connected computers. This means that any keyboard offering special function keys or any mouse with extra features will be fully supported at each computer. As with the previous emulation method, the unselected computers will continue to see the identities of the keyboard and mouse, which means that no enumeration is necessary when their link becomes active once again. This not only helps to make reconnecting faster, it also increases switching reliability. This is important because USB links are at their most vulnerable during the enumeration process.

In addition, a new high-speed circuit handles all the required extra tasks. Called the Emulation Engine, it fully emulates the USB device identities, and it interprets keyboard and mouse data streams. The result is full support for KVM switching control via hotkey presses or the third button/scroll wheel of a mouse. For local installations, this is useful; for remote applications, such as KVM via IP, it is essential.

Because other USB devices don't necessarily need the benefits of True Emulation like USB keyboards and mice do, there are one or even two enumerated circuits (shown in green within the diagram **at right**) alongside the True Emulation feature (shown in blue). This enables the other USB devices to operate at their highest speeds without any intervention. The enumerated circuits benefit greatly from the USB hubs that are jointly used with the True Emulation system. Because they interface directly and permanently with each computer, they help to stabilize the dormant links, making errors during enumeration much less likely.

The dual switching arrangement provides further flexibility because the True Emulation and enumerated sections can be switched in unison or independently of each other, as required. Thus, your various peripherals can operate with different computers at the same time.

You can find True Emulation in a KVM switch near (or far from) you soon, like in the Black Box® ServSwitch Wizard™ 8-Port DVI Dual-Link (USB) (KV2008A), a professional desktop KVM switch with USB True Emulation technology. When a user connects USB devices, the ServSwitch Wizard 8-Port DVI Dual Link (USB) simultaneously and accurately emulates the character of the devices to all computers. The user can share high-end video and any four USB peripherals between eight workstations. The Wizard offers true DDC EDID support and enables users to switch up to eight PCs via hotkeys, mouse, or RS-232/V.24. It can be switched synchronously with other ServSwitch Wizard switches, and the stereo audio switches independently from the video signal. A 4-port model (KV2004A) is also available.



The inside view of a True Emulation USB switch. *The emulated section of the switch is shown in blue and handles only the keyboard and mouse. This section relies heavily on the emulation engine, a custom circuit that is closely allied with each of the USB hubs. These ensure that all connections to the computers remain active.*

The enumerated section of the switch is shown in green and handles other USB devices and also uses the USB hubs to link with the computers.

About Black Box

Black Box Network Services is a leading connectivity solutions provider, serving 175,000 clients in 141 countries with 193 offices throughout the world. Catalogue and on-line offerings from Black Box include more than 118,000 products including desktop, enterprise, and IP-enabled KVM switches and USB hubs, switches, and extenders. The ServSwitch Wizard™ 8-Port DVI Dual-Link (USB) (KV2008A) is a professional desktop KVM switch with USB True Emulation technology. Black Box's extensive line of USB extenders includes CATx, fibre, and wireless. To view Black Box's comprehensive offering, see our Web site at www.blackbox.co.uk.

Black Box is also known as the world's largest technical services company dedicated to designing, building, and maintaining today's complicated data and voice infrastructure systems.