ADDER®

WHITE PAPER
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USB True Emulation

Transparent and reliable USB switching technology

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Remember the good old days? Car journeys needed maps not satellites, mobile phones were too large to lose and the Bakelite® knob on your KVM switch moved 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 (Keyboard, Video & Mouse) switches have continually evolved to meet each new challenge. However, one problem above most others has traditionally proved to be a tough nut to crack:

How to switch USB devices transparently and reliably?

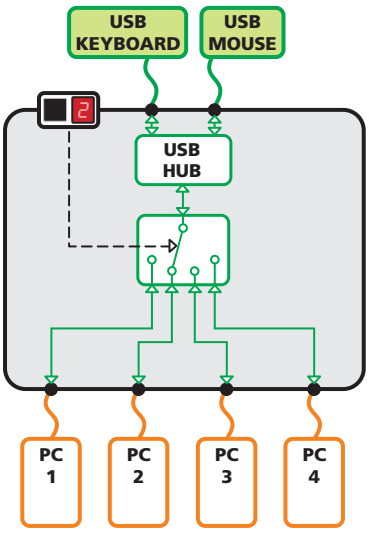
The trouble is that while USB appears to be easy on the outside, there's more going on under the covers than you might expect. This has led to various difficulties that have spawned a number of possible solutions.

USB, a force for good… (…connections)

Since its inception in 1995, the USB (Universal Serial Bus) standard has proved to be an increasingly successful solution to one big problem. Namely, to offer a straightforward way to connect a diverse range of devices and make them cooperate.

Before USB, the rear end 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 end 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. Apple Macs during the 1990's told a similar story, albeit with slightly more of a coordinating hand from their creator.

USB provided, and continues to provide, a common solution to all of the 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 device and computer can operate together in a coordinated manner.



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.

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.

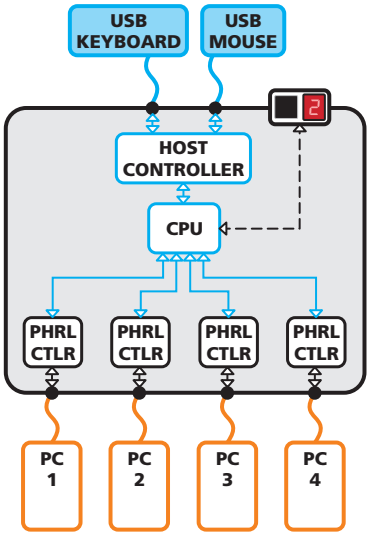
The name is derived from the initiation process (enumeration) that every USB device goes through each time it is connected to a computer. Enumerated switches are so called because a connected USB device will be required to perform a full initiation every time it is switched; just as if you had pulled 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 hit on performance. The disadvantage becomes apparent 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. Reliability of switching 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.

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 emulated USB switch.
The keyboard and mouse are linked to a host controller (a sophisticated USB hub) and then through to 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.

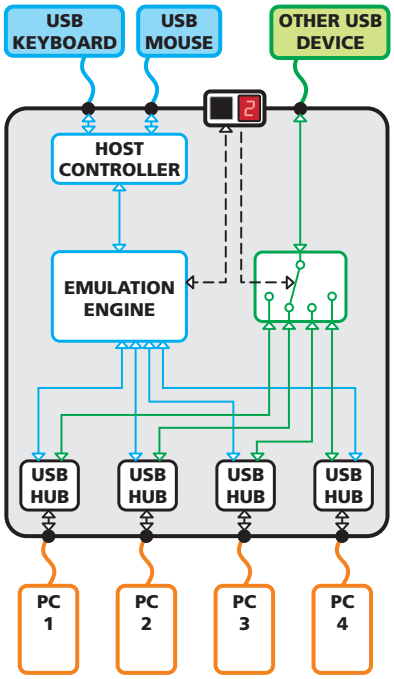
Emulated USB switching

Keyboard and mouse switching control was perfected many years ago for PS/2-style devices. Due to 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 due to the added complexity of the USB standard and its signals.

The problem was eventually solved, leading to the creation of 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 used 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 power 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, while emulated switches cure a number of shortfalls associated with their enumerated cousins, there has always been one main limitation to their operation. It remains a complex task to dynamically assume the identity of a USB device, distribute it among the connected computers and maintain all of the necessary signals, states and processes. Therefore, manufacturers, including Adder, have 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 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 to each of the USB hubs. These ensure that all connections to the computers remain active. The green enumerated section of the switch handles other USB devices and also uses the USB hubs to link with the computers.

True Emulation

Mindful of the limitations associated with the previous USB switching techniques, Adder set about creating a more effective and elegant solution. After a great deal of research and development, True Emulation is the result.

For the first time, True Emulation allows the complete identity of the keyboard and mouse to be copied and then presented to all of the connected computers. This means that any keyboard offering specialist 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 speed up the rate of reconnection, but also raises the reliability of switching because USB links are at their most vulnerable during the enumeration process.

As part of the development process, Adder engineers created a new high speed circuit to handle all of the required extra tasks. We call it the Emulation Engine and in addition to fully emulating the USB device identities, it is also responsible for interpreting 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 an essential switching control function.

Early in the design process we determined that the benefits afforded to a USB keyboard and mouse by True Emulation were not necessarily required by other USB devices. That is why you will also find one or even two enumerated circuits (shown in green within the block diagram) alongside the True Emulation feature (shown in blue). This allows those 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 stabilise 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.

Thanks to the focus and tenacity of the Adder engineering team, True Emulation is already making its presence felt. Although you won't actually see it, expect to enjoy the benefits that True Emulation brings in a KVM switch near (or far from) you soon.

About Adder

Adder is a leading developer and manufacturer of KVM switches, video and audio extenders, KVM-over-IP devices, and remote management solutions. By empowering IT professionals to securely manage technology resources anywhere in the world, Adder solutions help customers make the best use of those resources while driving down total cost of ownership. In addition, through its advanced video and audio extension solutions, Adder is enabling the next generation of digital signage.

More information about Adder and its solutions is available at www.adder.com.

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