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An Icron Technologies White Paper »

ExtremeUSB®

» An overview of the protocol, benefits, availability and applications of this patented USB extension technology.

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EXTREME USB®

Abstract

Universal Serial Bus (USB) is the most successful interface in the history of the PC, with well over ten billion USB devices in the global market and counting. Due to its flexibility and simplicity, USB has become the de facto standard for peripheral connectivity spanning broad markets and applications. USB is designed to allow many peripherals to be connected using a single standardized interface. It provides an expandable, fast, bi-directional, low-cost, hot-pluggable, plug and play serial hardware interface allowing computer users to connect different peripheral devices into a USB port and have them configure automatically, ready for use.

As versatile as USB may be, it is restricted to an operational distance limitation of 5 meters for USB 1.1/2.0 and approximately 3 meters for USB 3.0. This persistent drawback to USB functionality was resolved by the introduction of ExtremeUSB®. Introduced by Icron Technologies, ExtremeUSB is a series of patented technologies designed to overcome USB's distance limitations.

This white paper takes a look at the USB specification and describes how the ExtremeUSB protocol works transparently to enable USB functionality up to 10 kilometer distances.

Introduction to USB

History

Universal Serial Bus was developed in the mid-1990s to standardize the connection of computer peripherals (including devices such as keyboards, mice, printers, scanners, mass storage devices, digital cameras, video cameras and audio devices) to computers; both to communicate and to supply electric power.

Slow out of the gate in early 1996, USB 1.0 never really caught on due to timing and compatibility issues associated with hubs. In late 1998, USB 1.1 was released addressing these issues and USB adoption has never looked back, evolving to USB 3.0 today and soon to be USB 3.1, as shown in *Table 1*. All versions of USB are governed by the non-profit association USB Implementers Forum (USB-IF). USB specifications and all related documents are downloadable from the USB Implementers Forum web site (usb.org).

Standard	Release Date	Throughputs	Typical Applications
USB 1.1	1998 (September)	Low-Speed 1.5Mbps Full-Speed 12Mbps	Keyboard, mouse, game controllers, microphones, printers, web cameras
USB 2.0	2000 (April)	High-Speed 480Mbps	Flash drives, hard drives, web cameras, data acquisition devices
USB 3.0	2008 (November)	SuperSpeed 5.0Gbps	Machine vision cameras, solid state drives
USB 3.1	2013 (July)	SuperSpeed+ 10Gbps	To be determined - Expecting first products to be available in mid/late 2014

Table 1 - USB Revision History

Features and Benefits

Long after replacing serial ports, parallel ports, PS/2 ports and other legacy connectors, USB has continued its adoption through incremental bandwidth upgrades, a rugged common connector for all peripherals, and by its universal acceptance. Computer peripheral designers and manufacturers rely on the fact that almost every computer will have a USB port, which is not true of other competitive connectors. In recent years, USB has demonstrated its flexibility and resiliency by having been adopted for powering mobile and wireless devices, medical and military equipment connectivity and for industrial factory floor uses.

Benefits of USB include:

- Single connector type: USB replaces the different legacy connectors on a computer with one well-defined, standardized USB connector. Standardization eliminates the need for different cables and connectors and simplifies the design requirements for computer periferal devices.
- Hot-swappable: USB devices can be safely plugged and unplugged as needed while the computer is running.
- Plug and Play: Operating system software automatically identifies, configures, and loads the appropriate device driver when a USB device is connected.
- High-performance: USB offers low-speed (1.5 Mbps), full-speed (12 Mbps) and high-speed (up to 480 Mbps) transfer rates that can support a variety of USB peripherals. USB 3.0 (SuperSpeed USB) provides throughput up to 5.0 Gbps.
- Expandability: Up to 127 different peripheral devices may theoretically be connected to a single bus at one time.
- Power supplied from the bus: USB distributes the power to all connected devices eliminating the need for an external power source for low-power devices. High-power devices may still require their own local power supply. USB also supports power saving suspend/resume modes.
- Easy to use for end user: A single standard connector type for all USB devices simplifies the end user's task at figuring out which plugs go into which sockets. The operating system automatically recognizes the USB device attachment and loads the appropriate device drivers.
- Low-cost implementation: Most of the complexity of the USB protocol is handled by the host, which along with low-cost connection for peripherals makes the design simple and economical.

USB Does Have One Significant Drawback

Despite the numerous benefits of USB, there is a major drawback: cable distance limits. USB 1.1 and 2.0 have a cable limit of 5 meters and while USB 3.0 has no specified limit, a distance of approximately 3 meters is the effective range for reliable transmission due to its higher throughput.

There are many applications requiring computers to be located beyond 5 meters from the user or USB peripheral. Some examples include situations where the computer must be located away from the user in secured locations, on factory floors or areas where environmental conditions (heat, cold, moisture, vibration, etc.) prevent the computers from being in the same proximity as the user, or in machine vision/security applications where cameras are located in hidden locations.

There are options available today to extend USB; however, with varying achievable distances and solution practicality, some are more viable than others. USB extension up to thirty meters can be achieved by daisy chaining up to five hubs to increase distance for USB 1.1/2.0. However, this kludged solution may require power at every second hub, limits how many devices or additional hubs can be used at the remote side and, with multiple connection points, raises concern about breakage or disconnects. Typically, this type of extension solution is not very practical or reliable.

Fortunately, another USB extension solution is available. Shortly after USB 1.1 peripherals became available to the market, a robust single cable extension technology known as ExtremeUSB was introduced. ExtremeUSB reflects a suite of patented technologies to extend USB 1.1, USB 2.0 and USB 3.0 distances well beyond the limits of USB specifications.

Overview of ExtremeUSB®

Introduction

ExtremeUSB was developed and patented by Icron Technologies (icron.com), to enable native USB connections to extend beyond the distance limitations imposed by the USB standard as outlined earlier. ExtremeUSB manages the strict timing requirements of the USB specification to enable USB connections over any physical transmission media, including twisted pair copper cabling (Cat X), fiber optics and wireless.

Typically, a USB extender system will have a local extender end that connects to a host such as a PC or Mac, and a remote extender end that connects to a USB peripheral such as a keyboard, mouse, or camera. These two extender points are joined by the transmission media which increases the distance as shown in *Figure 1*.

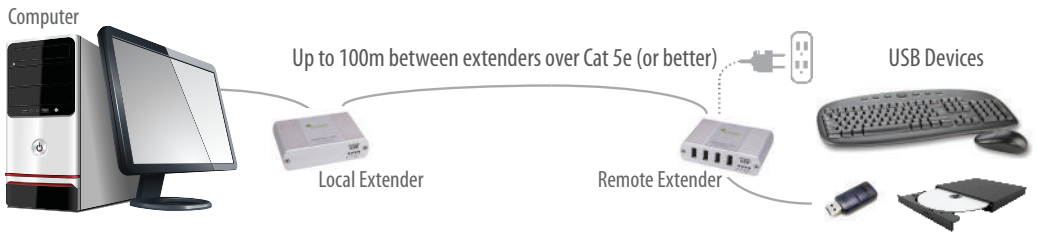

Figure 1 - USB Extender System Topology

ExtremeUSB Protocol

When extending USB, the local extender handles the expectations of the host computer, and the remote extender handles the expectations of the USB devices. If the distance is beyond spec, the extra time required to transmit packets disrupts the expected data flow, causing USB performance issues such as latency or non-recognition.

ExtremeUSB manages the turnaround time expectations in the USB protocol between the local and remote points to maintain transmit and acknowledge requirements in a transparent, driverless fashion suitable for any transmission media type. ExtremeUSB utilizes specialized algorithms and handling techniques to manage and overcome error situations unique to separate USB transfer types. By keeping this USB link active via proxy during the increased delays from extension, ExtremeUSB enables USB 1.1/2.0 extension up to 10 kilometers over fiber cabling and up to 500 meters over Cat X.

Benefits and Availability of ExtremeUSB

Aside from the obvious benefit of distance extension, ExtremeUSB offers other features to maintain an easy to use, consistently reliable experience with all USB compliant devices, primarily:

- Transparent USB extension
- True plug and play; no software drivers required
- Works with all major operating systems: Windows®, Mac OS X®, and Linux®

While Icron's patented ExtremeUSB technology is featured in Icron's own branded USB and USB+video extension products, it is also made available to the market by Original Equipment Manufacturers (OEMs) incorporating this technology into their own products. The inclusion of the ExtremeUSB suite of features in USB and USB+video extension products is easily recognizable by the representation of the ExtremeUSB logo on a product's faceplate, packaging or in its respective promotional materials. The ExtremeUSB logo is shown in *Figure 2*.

Figure 2 - ExtremeUSB logo

ExtremeUSB Applications

Whenever the distance between the host machine and USB device is greater than 5 meters for USB 1.1/2.0 or 3 meters for USB 3.0, USB extension comes into play. This spans a variety of markets and applications including: keyboards, mice, hard drives, medical imaging equipment, gaming consoles, interactive whiteboards, boardroom conferencing systems, factory inspection and assembly, military communications, digital signage, security cameras, mining and petroleum exploration equipment, post production editing machines and many more.

Examples of USB extension applications in classroom, hospital and factory environments, all using ExtremeUSB technology are shown in *Figures 3* through *5*. Note: LEX refers to the Local Extender and REX to the Remote Extender.

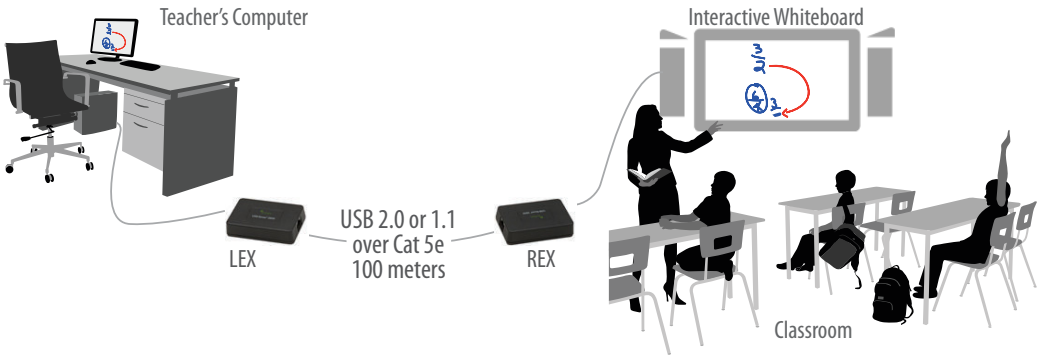

Figure 3 - USB Extension of an Interactive Whiteboard in a Classroom Setting

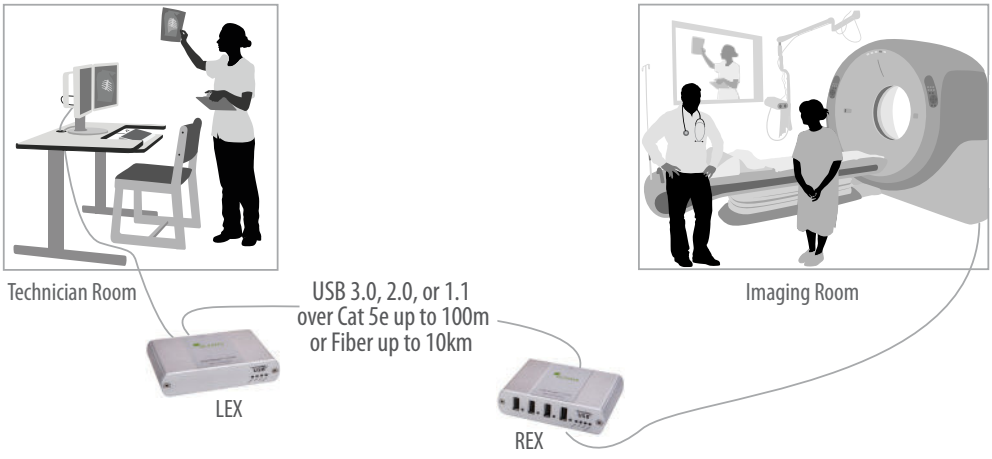

Figure 4 - USB Extension of MRI in a Medical Facility Setting

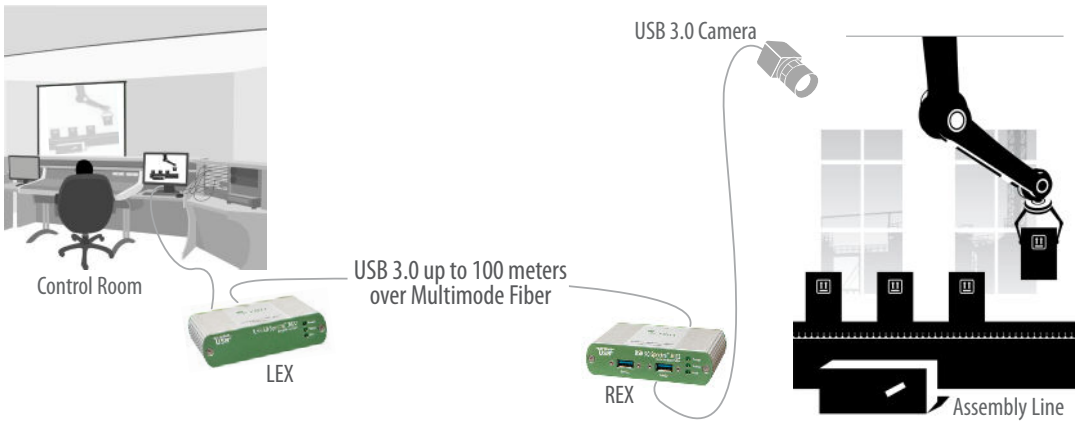

Figure 5 - USB Extension of Machine Vision Inspection in a Factory Setting

Summary

Universal Serial Bus (USB) is the de facto standard for computer connectivity, having long replaced legacy interfaces with its numerous benefits. USB continues to be the most globally adopted computer interface by enabling next generation peripherals through incremental bandwidth improvements. Beyond computer connectivity, USB has demonstrated its value-add versatility by having been adopted for powering mobile devices, medical and military equipment connectivity and for industrial floor use.

As successful as USB is supporting peripheral connectivity, it does have the persistent drawback on cable length, which is limited to 5 meters for USB 1.1/2.0 and 3 meters for USB 3.0. To address this limitation, Icron Technologies developed and patented innovative USB extension technologies identified by the ExtremeUSB logo. The ExtremeUSB suite of features eliminates USB distance restrictions by managing the turnaround timer in the USB protocol and maintaining transmit/acknowledge timing requirements while providing a USB transaction proxy over a longer reach connection. Through this technique, USB distance extension up to 10 kilometers can be achieved with no noticeable effect to the end-user experience.

ExtremeUSB is featured in products from Icron Technologies, as well as from other product manufacturers in their branded USB and USB+video extension products. In addition to the obvious benefit of distance extension, ExtremeUSB offers other features to maintain an easy to use, consistently reliable experience with all USB compliant devices, primarily:

- Transparent USB extension
- True plug and play; no software drivers required
- Works with all major operating systems: Windows®, Mac OS X®, and Linux®

Improving the operational distance of USB enables a broader range of market applications, including medical, military, industrial automation, machine vision, education and pro AV. Without sacrificing peripheral performance or expectation, ExtremeUSB extension provides a simplified, consistent and transparent user experience.

About Icron Technologies Corporation

Icron Technologies is a leading developer and manufacturer of high-performance USB and video extension solutions for commercial and industrial markets worldwide. Icron's patented extension technology extends PC Video and USB devices over many media types including Cat 5e, Fiber, Wireless, DisplayPort®, and over a corporate LAN. Icron's extension products are deployed in a wide range of applications including pro AV, industrial automation, machine vision, medical imaging, aerospace, interactive whiteboards, remote desktop extension, security, enterprise computing and isolated USB, or anywhere a PC needs to be remotely located from a display or peripheral device.

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Extending Connections™

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