USB 3.0 Technical Overview

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Agenda

- Introducing MCCI
- Technical Overview of USB 3.0
- Demonstration
- USB 3.0 Software Challenges
- New Device Classes for USB 30
- Conclusion

Introducing MCCI

About MCCI

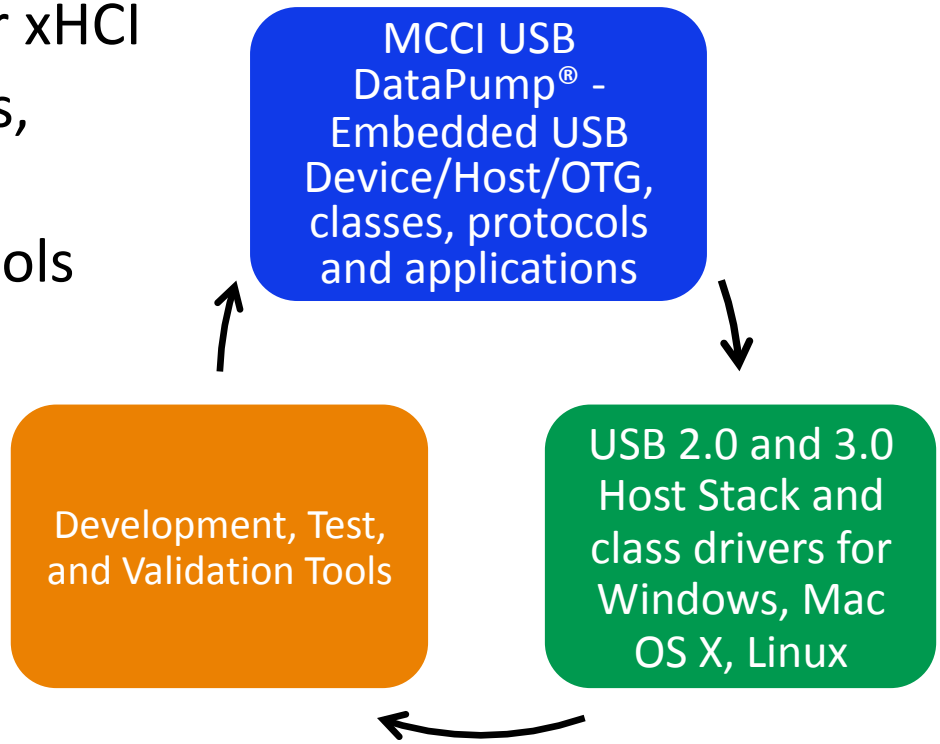
- World Leader in USB technology, system engineering specialists since 1995
- Worldwide headcount: 85
- Focused on cell phone industry
  - Over 600 million products use MCCI technology
  - Two of the top five handset vendors
  - Three of the top five handset platform vendors
- Additional market base in set-top boxes, car navi systems
- Test services reinforce system capabilities
  - One of 5 USB-IF certified test houses world-wide
  - Microsoft WHQL test services
  - One of two ExpressCard test houses

MCCI Worldwide

MCCI USB Product Offering

End to End Solutions for USB 2.0 and 3.0

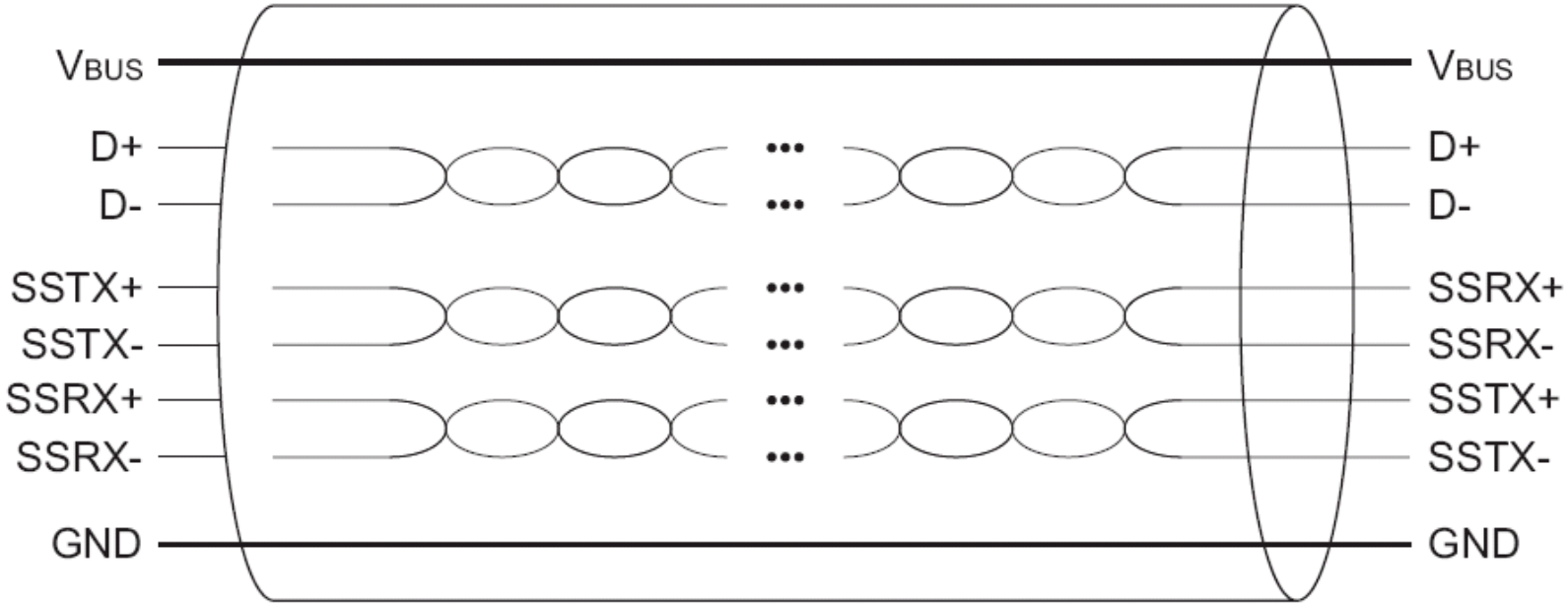
- Embedded Device/Host/OTG
- Applications (MTP, PictBridge)
- Windows Host Drivers for xHCI
- Class drivers for Windows, Mac OS X, Linux
- Development and Test Tools



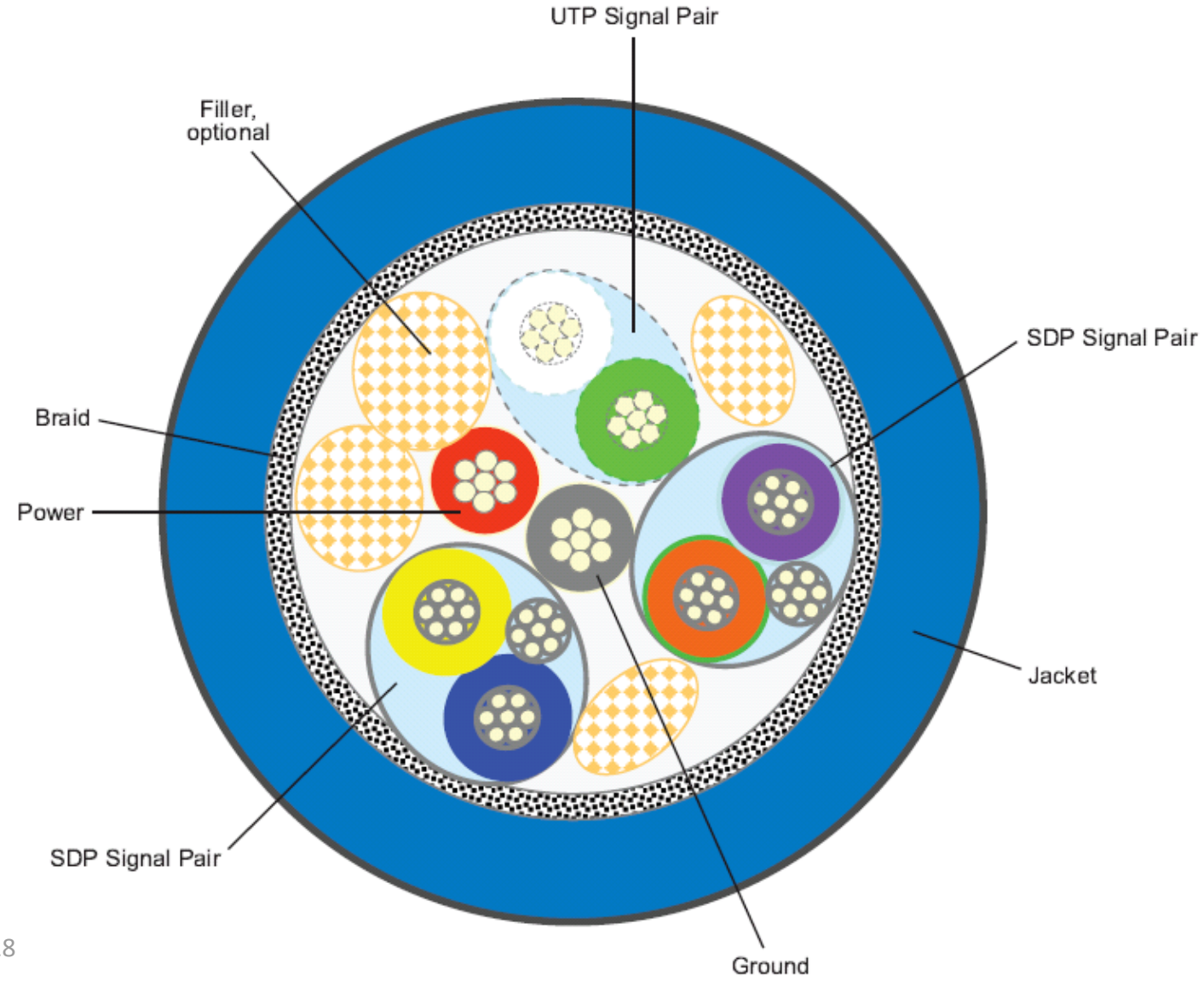
Technical Overview of USB 3.0

Technical Overview

- USB 3.0 starts with USB 2.0: Vbus, D+, D-, GND
- It adds two new signaling pairs: SSTX+/- (Super Speed transmit) and SSRX+/- (Super Speed Receive)
- These new signals operate independently of and in parallel to the USB 2.0 bus

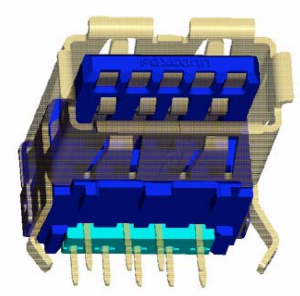


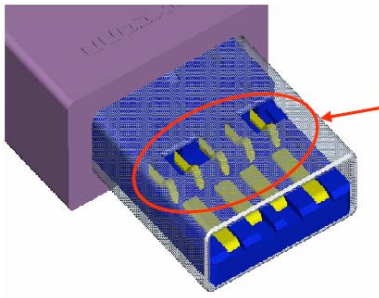
USB 3.0 Cable Details



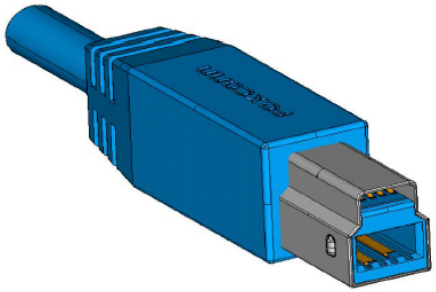
Connectors

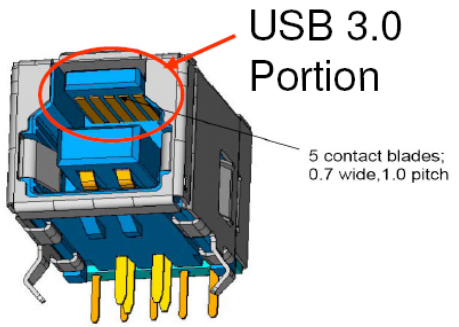
Type A connector uses staggered contacts



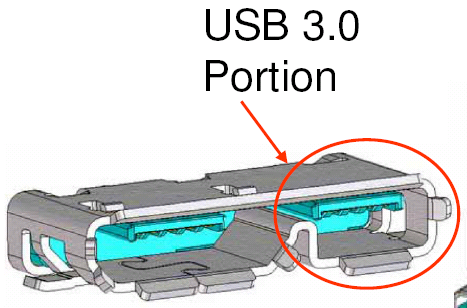


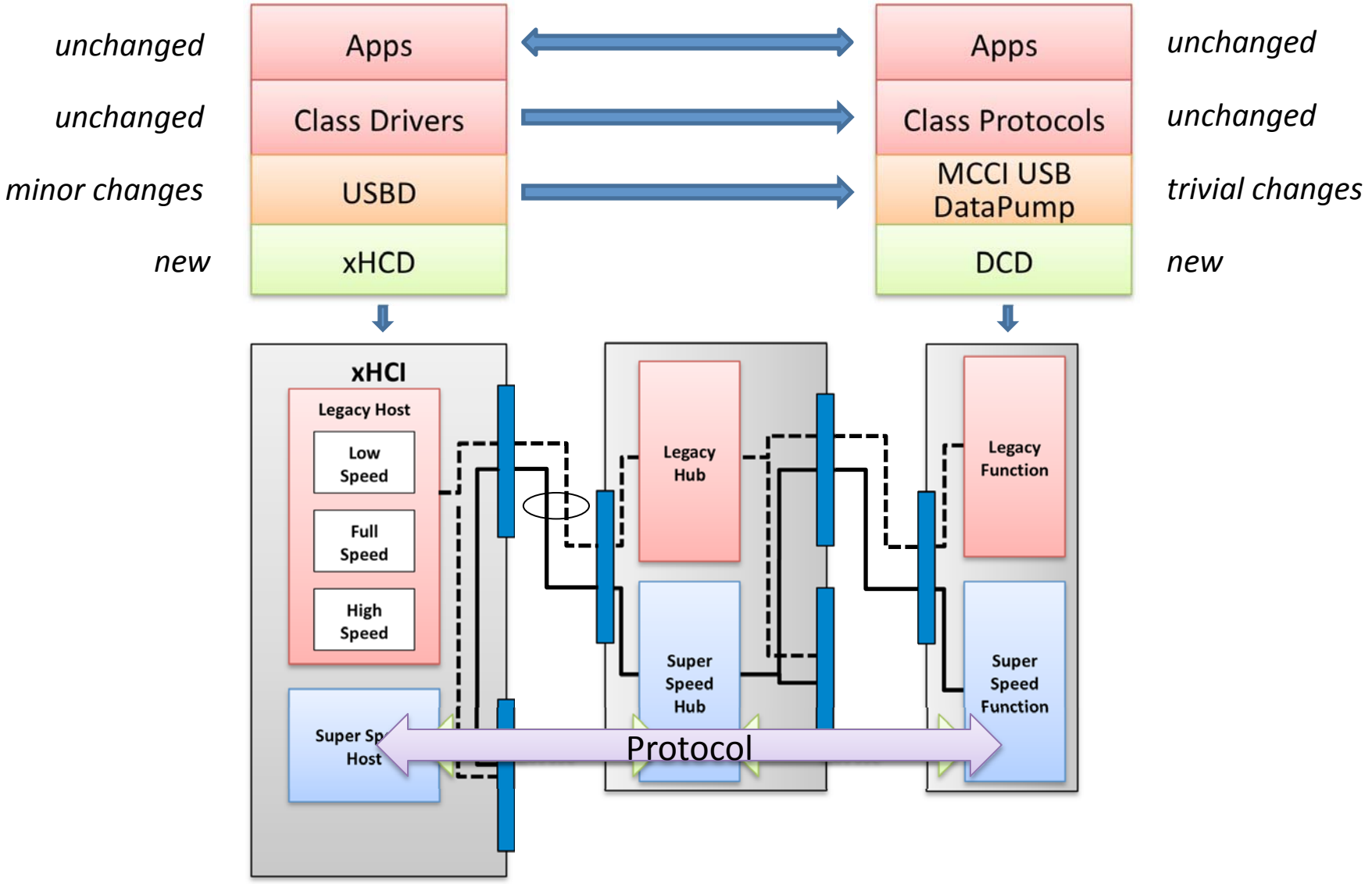
Type B connector uses second connector above older connector





Micro A/B uses side-by-side configuration




unchanged
unchanged
minor changes
new
Apps
Class Drivers
USBD
xHCD
Apps
Class Protocols
MCCI USB DataPump
DCD
unchanged
unchanged
trivial changes
new
xHCI
Legacy Host
Low Speed
Full Speed
High Speed
Super Sp
Host
Legacy Hub
Super Speed Hub
Legacy Function
Super Speed Function
Protocol
USB 3.0 Host
USB 3.0 Hub
USB 3.0 Device

Layers of the Specification

- Physical (cables, connectors)
- Link (point to point)
- Protocol (host controller to device controller)
- Device Framework (host USBD to device framework software)
- Device Classes
  - Hub: expands one host port to many device ports
  - Application classes: connect OS applications to standard device functions

Comparing USB 3.0 to USB 2.0

	USB 3.0	USB 2.0
Bus Type	Routed at link layer	Broadcast
Hub Technology	Link-level router	Bit-level repeater
Bus clock	Spread spectrum	Fixed
Power Management	Pervasive, managed primarily by hardware	Basic, managed by software on host
Raw bit rates	5 Gbps	1.5, 12, 480 Mbps
Signaling	voltage mode, dual simplex	voltage mode (LS, FS), current mode (HS), simplex
Flow control	direct interaction between source and sink	polling by host
Error control	reliable link-level transport	broadcast end-to-end only
Bus Power	900 mA	500 mA
Published	2008	1995/1999

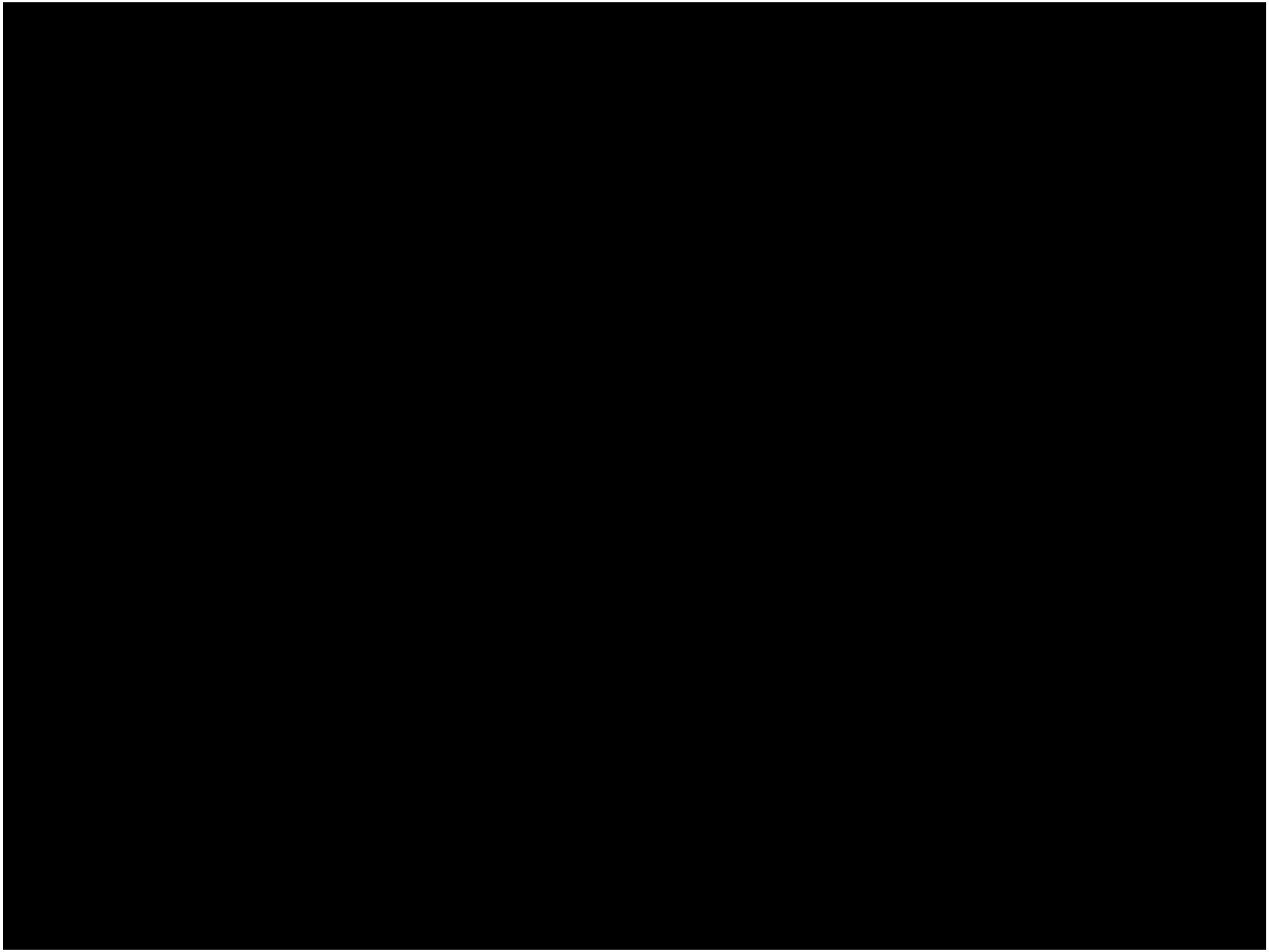
Technical Benefits

	USB 3.0	Benefit
Bus Type	Routed at link layer	Power reduction
Hub Technology	Link-level router	Power reduction
Bus clock	Spread spectrum	Reduced EMI
Power Management	Pervasive, managed primarily by hardware	More bits transferred per Watt, compared to USB 2.0
Raw bit rates	5 Gbps	More bits per second
Signaling	Voltage mode, duplex	Reuse proven PCIe / SATA phy technology
Flow control	Direct interaction between source and sink	Power reduction
Error control	Reliable link-level transport	Localized error recovery
Bus Power	900 mA	More power for drives, etc.
Published	2008	Matches needs through 2015

Infrastructure

- Development USB 3.0 hosts
  - USB-IF PDK
- Host hardware: NEC, Fresco Logic
- Host software: hardware vendors, Linux, MCCI
- Licensable IP: Synopsys, PLDA, Faraday, Gennum Snowbush
- Device Software: MCCI
- Test Equipment
  - Analyzers: LeCroy, Ellisys
  - Electrical testers: LeCroy, Ellisys
- Compatibility Test Labs
  - USB-IF Workshops
  - Intel PIL
  - Independent labs

Demonstration



USB 3.0 Software Challenges

xHCI – Key Software Issues

- Single controller supports low, full, high and super speeds
- Scheduling and bus management handled internally
  - EHCI operates by processing linked lists in system memory
    - EHCI continually accesses system memory to keep USB bus running, even when there's no data to move
  - xHCI operates on lists held internally
    - No system memory accesses needed to keep bus running, until data must be moved
- xHCI can achieve much lower system power, but system software must change (even for high/full/low speed)

Host Software Changes and Issues

- USB 3.0 hubs are similar to, but not identical to, USB 2.0 hubs
  - Finite state machines and control operations are different
  - Adding USB 3.0 support to an existing USB 2.0 hub driver may destabilize the USB 2.0 driver
  - Early hubs will have bugs
- Legacy enumeration is different when working with xHCI
  - TT support is substantially different
  - Enumeration of legacy devices is different
- Billions of legacy devices shipped
  - Test matrix is huge
- USB 3.0 host adds “streams”
  - New API

Device-Side Changes

- USB 3.0 adds Super Speed
  - 400 MB/sec theoretical max
  - Requires efficient hardware
    - Flexible DMA engine with scatter/gather and good support for short/zero-length packets
    - Minimize software intervention for “ordinary” things
  - Requires efficient software
    - Zero copy architecture
    - Minimize “round trips”
    - Careful CPU cache management
    - Able to tune for bus bandwidth and interrupt mitigation, so that Super Speed USB can co-exist with other applications
  - Debugging with printf() will be difficult

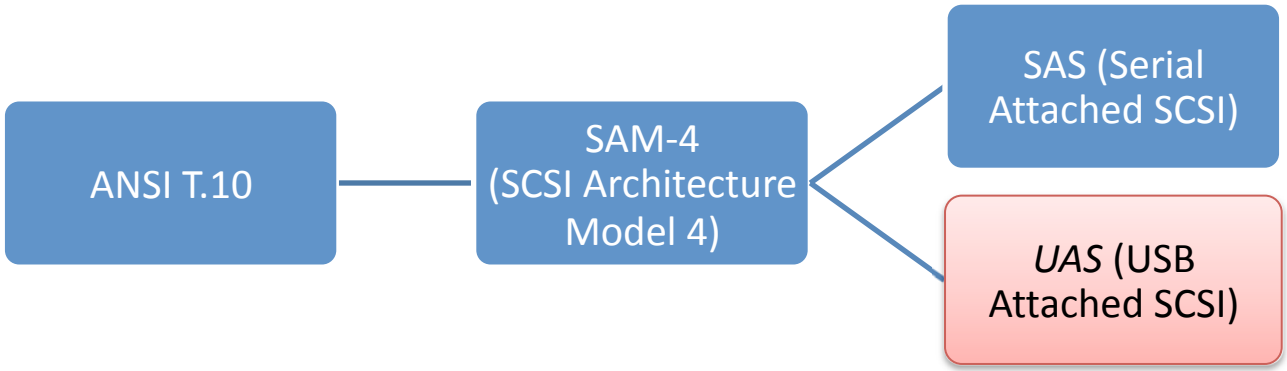
Legacy Issues (Devices)

- Devices have to work with USB 2.0 hosts
  - This will be major use case for next year or two!
  - Must include production-quality USB 2.0 device controller hardware
  - If USB 2.0 controller hardware is not integrated with Super Speed hardware, then may need two software stacks
  - Devices have to disconnect from legacy when Super Speed connect is detected
- The USB 2.0 portion must meet USB 2.0 logo test requirements

New Device Classes for USB 3.0

UAS: USB Attached SCSI

- In order to get maximum benefit of USB 3.0, the mass storage protocol has to be improved
  - Current BOT (Bulk Only Transfer) protocol doesn't allow overlapped operations and out-of-order completion
  - BOT doesn't match modern SCSI architecture



More on UAS

- The host can issue multiple commands to the device concurrently
- USB 3.0 streams are used by the mass storage device to complete commands in optimum order
- All the features available on SATA or SAS are now available for storage connected over USB

Video Display Class

- USB 3.0 is fast enough to carry full HD uncompressed
- New workgroup at USB-IF is developing a standard device class
- Use cases
  - PC or STB host streaming HD content
  - Mobile device streaming MP-4 content
  - Mobile or embedded device using USB display for user interface
- Publication probably in early 2010

Conclusion

Conclusion

- It's now possible to develop USB 3.0 Super Speed devices
- Super Speed offers real speed advantages
- The USB 3.0 specification is well designed and carefully thought out, to allow very rapid adoption
- Software and practical issues suggest partnering with a strong software and technology company such as MCCI

Thank you!

Supplemental slides

MCCI USB DataPump

A complete embedded USB 3.0 Host/Device stack for cell-phones and other intelligent products.

USB Device Features	USB Host/OTG Features
• USB 3.0 Super Speed, High Speed, Full Speed • Multi-function, multi-mode • Audio, Video and HID (web cam, VoIP) • CDC ECM, EEM and NCM for TCP/IP • CDC ACM, WMC and MCPC GL-004/005 for multi-function cell-phones. • Mass Storage UAS and BOT • Still Image Class (PictBridge, MTP) • Device Firmware Update (DFU) , for firmware update over USB • Various special purpose and custom protocols	• Hub • Composite (for multi-function devices) • ACM/WMC • OBEX • Mass Storage • HID • USBSIM Classes (UICC, EEM)

Portable across CPUs, little/big-endian, HW platforms, OS, compilers, development platforms

Windows Drivers

- MCCI provides all the software necessary to use a USB 3.0 SuperSpeed device on Windows
  - xHCI Host Controller Driver
  - Hub Driver
  - Composite Driver
  - UASP Driver for Hard Drives
  - Support Windows 2000, XP, Vista, Windows 7
  - Support all existing USB 2.0 devices and their drivers
  - Support all existing device classes

Kinds of Host Stacks

- Embedded stacks
  - Normally support host, hubs, specific devices
  - Drivers specified at compile time
  - Low memory footprint
  - Efficient but not flexible
- Windows-compatible stack
  - Supports any current or future USB device
  - Loads drivers at run time
- Embedded stack on Windows
  - Uses embedded stack approach for low memory footprint
  - Devices are pre-configured, so test matrix is small