USB
(Universal Serial Bus)

Presentation to UCHUG - 2/06/08

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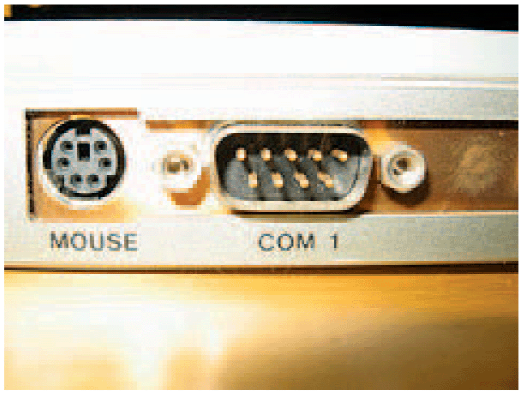
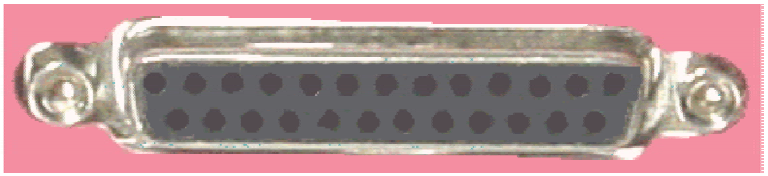
What is USB?

- Universal Serial Bus
- A computer peripheral interface
- Ubiquitous across all computer platforms
- Several variations - continues to evolve
- Hot-swapable
- Provides three advantages
  - Port expansion
  - Performance
  - Standard connection method

In the Old Days . . .

- Mice and keyboards only connected to dedicated connectors or serial port
- Networking (as such) was only through serial com port
- Printers had their own connector
- Not much else!





Typical Performance

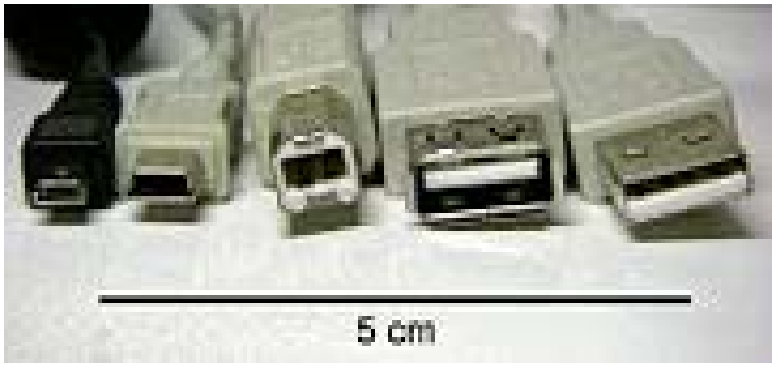
Connection / Port	Maximum Speed	Connector Pins
Standard Parallel Port	0.115 MBytes/s	25
Enhanced Parallel Port	3.0 Mbytes/s	25
Extended Capabilities Port	3.0 Mbytes/s	25
Standard RS-232 COM Port	.03 Mbytes/s	9
PS-2 Port		6
USB 2.0	60 Mbytes/s	4

USB provides much higher data transfer speeds, with fewer wires!

Birth of USB

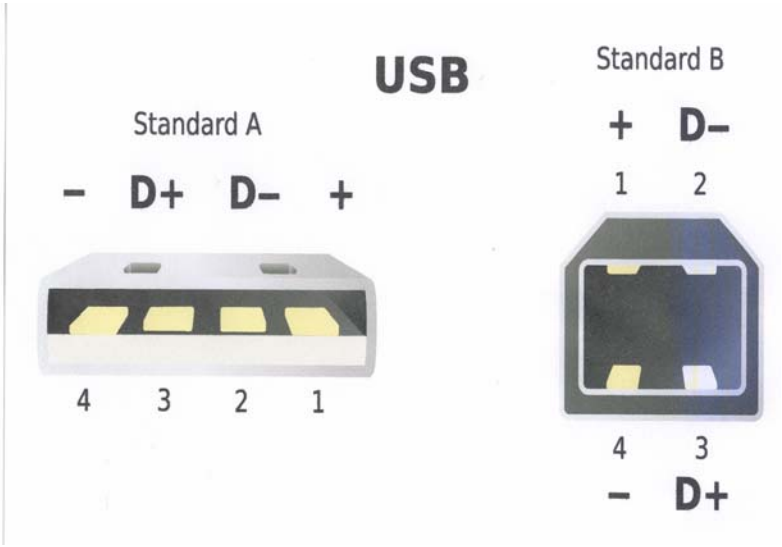
- Defined by Intel and other industry leaders in early 1990s
- Ease of use was primary goal
- Four-wire interface
- Point-to-point, host-target architecture
- Bus expansion
- Replace legacy connectors

USB Connectors



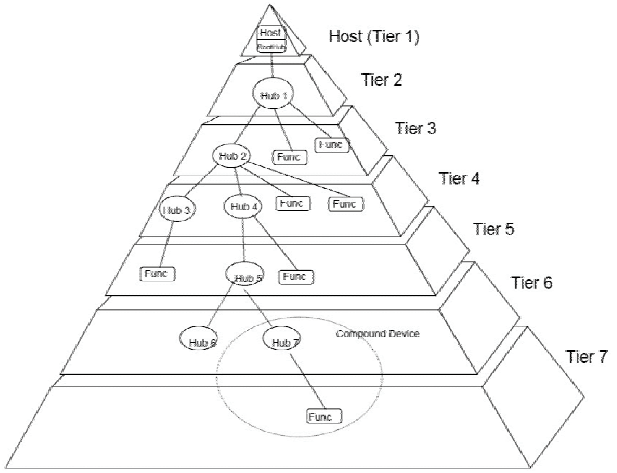
USB Cables

- Four wires (+5V, Return, data twisted pair)
- Up to 5 m (16.4 ft)
- Longer connections use hubs or active extensions
  - Active extension incorporates a bus-powered hub



USB Details

- Host initiates all transfers
  - Target can be “dumb”
- Three device types
  - Host controllers
  - Hubs
  - Functions (Peripherals)
- Accommodates 7 tiers
  - 5 hub levels, 127 devices



Physical interconnect is a tiered-star topography

Host Controller

- Only one host in any USB system
  - Typically implemented in PC chipset (root hub)
  - Host responsibilities
    - Detect attachments and removals
    - Manage control and data flow between host and devices
    - Monitor status and activity
    - Provide power to attached devices
  - Class drivers included in most operating systems

Hubs

- Combined splitter and repeater
- Must detect connections and disconnections downstream and report to host
- Must manage downstream power
  - Bus-powered hubs (Power from upstream)
    - Must draw no more than 500 mA from upstream
    - Must supply 100 mA to each downstream port
  - Self-powered hubs (External power source)
    - May draw up to 100 mA from upstream
    - Must supply 500 mA to each downstream port

Peripherals

- Logical or physical device that performs a function
  - Examples: Keyboards, mice, printers, Flash memory devices, external drives, audio players, digital cameras
- Four types of data transfers
  - Control (all devices must support)
  - Interrupt (keyboards, mice, joysticks)
  - Bulk (printers, scanners, storage devices)
  - Isochronous (web-cams, speakers)

Peripheral Power

- Bus-powered
  - Low-power: May draw up to 100 mA
  - High-power: May draw up to 500 mA
- Self-powered
  - May draw up to 100 mA from upstream
  - Can have a low-power suspend state
- How a device reports itself determines how much current it can draw
- Battery charging of devices

USB Evolution

- USB 1.0 - January 1996
  - LS (low-speed): 1.5 Mbps
  - FS (full-speed): 12 Mbps

- USB 1.1 - July 1998 - major clarifications
- USB 2.0 - April 2000
  - Full backwards compatibility with USB 1.1
  - Adds high-speed: 480 Mbps

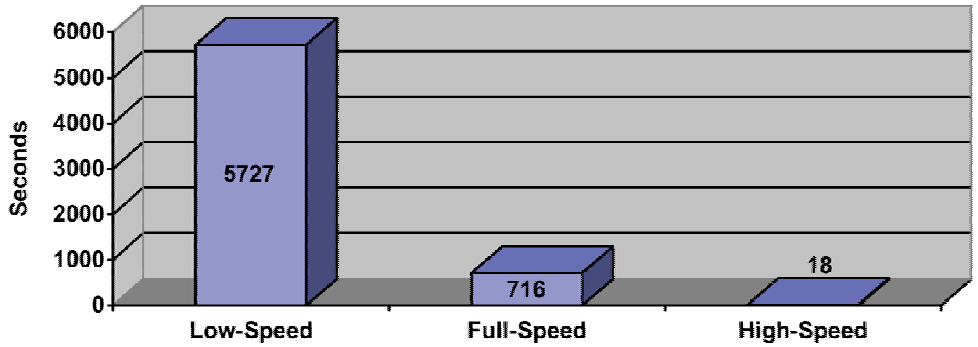
USB Evolution

- USB OTG - July 2003 - portable devices
  - Adds limited host capabilities to peripherals
  - Intended to share data without a computer
    - Sharing data between PDAs
    - Printing directly from camera to printer
  - Supplies only 8 mA; has limited target list
  - Same three speeds as USB 2.0
- Wireless USB (WUSB) - May 2005
  - Up to 480 Mbps at 3 m, 110 Mbps at 10 m
  - Encrypted data

USB Uses

- Human Interface Devices
  - Keyboards, mice, joysticks, game controllers
  - Low-speed, interrupt data transfer
    - Mice are polled every 8 ms, respond with 32 bits
- Mass Storage Devices
  - External hard drives, DVD/CD-RW, floppy, zip, Flash card readers, USB Flash drives

Time required for 1 GB data transfers

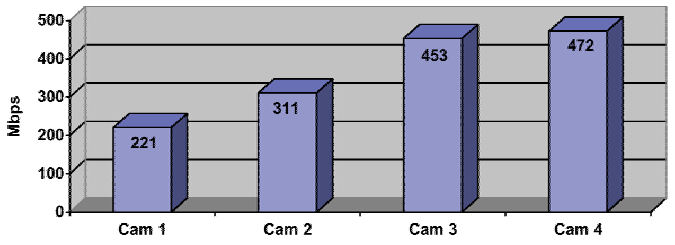


USB Uses

- Digital Cameras, Portable Media Players
  - Similar to mass storage, so speed is important
    - Will also use high speed, bulk data transfers
- Printers
  - Also uses high-speed
- PC Cameras or Webcams
  - High-speed, isochronous transfers

Table 1. WebCam Bandwidth Requirements

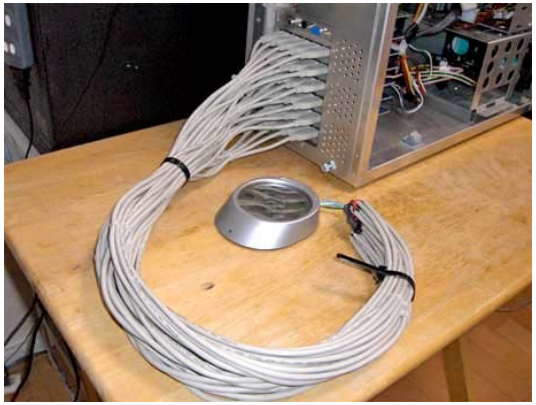
	Cam 1	Cam 2	Cam 3	Cam 4
Horiz. Pixels	640	800	1024	1280
Vert. pixels	480	600	768	1024
Frames / sec	30	27	24	15
Bits / pixel	24	24	24	24
Raw BW (Mbps)	221	311	453	472



Novel USB Devices

Fondue Pot

Warming Gloves



Cooking Pot

Warming Slippers

Microscope

Foam Missile Launcher

Novel USB Devices

Thumb Drive

Chameleon

Vacuum Duck

Pencil Sharpener

Novel USB Hubs

Engine Hub

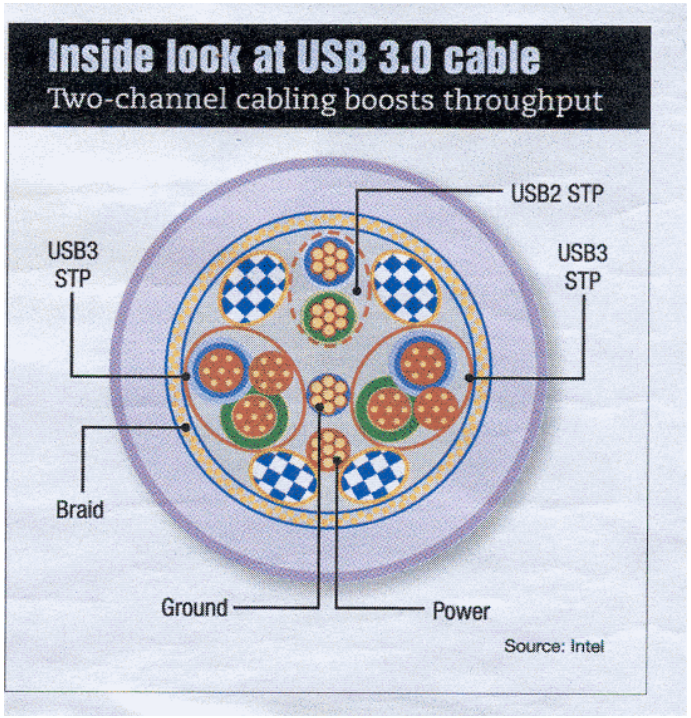
Tape Dispenser Hub

Self Destruct Hub

Gold Brick Hub

The Future of USB

- USB 3.0
  - Intel leading effort for specification for 4 Gb/s transfers
  - 300 MB/s of useable data transferred
  - Also called SuperSpeed USB
  - Aims to kill IEEE 1394 (Firewire)
  - Uses two twisted pairs
    - Data
    - Acknowledgement
  - Due to release spec in 2008



Acknowledgements

- Dan Harmon, “Which Version of USB is Right for Your Application (Parts 1-2)”, www.planetanalog.com
- Rick Merritt, “USB 3.0 Effort Aims to Smoke FireWire”, EE Times, 9/24/07
- Wikipedia - USB