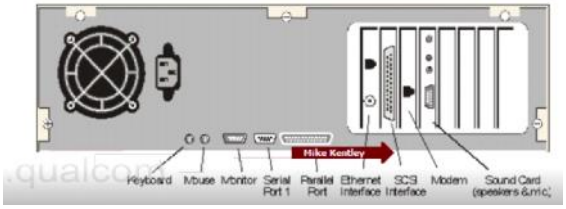
Intro

Sunday, January 9, 2022 4:38 PM

USB – high Speed Serial Interface
– plug and play
– power and Data on same cable.

Why USB

- Circa 1994 -- Popular PC Based Interfaces:
  - RS232, IEEE1295, SCSI, PS/2, Game Port
- These are not shared interfaces
  - If you want two printers, you need two printer cards
  - In most cases you have to open the PC to install the cards
- Each device has different programming interfaces and connectors
- Connectors are large – 4 to 50 pins



- Limited System Resources
  - Ports, IRQ's, memory
- End User Concerns
  - Peripherals must be Plug and Play
    - Don't want to configure IRQ's etc
  - Don't want to open the PC to add features
    - "Scary" for consumers, risk of breaking something
  - Would like simple cabling, especially for power
- Computer Industry Concerns
  - Sell more CPU's, computers and peripherals
  - Create new markets
  - Requires low cost PC's, low cost peripherals, low customer support requirements

Protocol designed to be cheap to implement on the peripheral

- <7,500 gates plus some memory
- Microprocessor not required!
- Device complexity vs. cost tradeoffs

USB

→ low Speed – low cost
- 1kB/s
- Mouse, Uninterrupted Power Supply
- Bit Banged in S/W with GPIO ports
- Unshielded, Untwisted

→ Full Speed
- 500KB/s – 1MB/s
- Shielded and twisted pair
- PHY layer mostly digital

Con: system sets elapsed fast

→ High Speed (Upgraded)
- 20-30MB/s
- Same cables
- High Speed analog PHY
- Custom drivers 40-50MB/s

Bit Banging → use software to drive signals and ensure protocols and timings are met. less reliance on H/W and all responsibility to S/W.
eg S/W directly sets and samples states of GPIO
– In contrast dedicated H/W (UART, SPI) satisfies these requirement

- Bit Banging low cost and used in embedded device.
- allows device to implement different protocol with no/minimal changes to H/w.

USB features

Feature	Description
Low Cost	The USB provides a low cost serial interface for attaching peripheral devices to PCs.
Hot Pluggable	Device attachment is automatically detected by USB and software automatically configures devices for immediate use.
Single Connector Type	The USB defines a single connector used to attach any USB device. Additional connectors can be added with USB hubs.
127 Devices	Supports the attachment of 127 devices per USB bus.
Low-, Full- & High Speed Devices	USB supports three speeds: 1.5Mb/s, 12Mb/s and 480Mb/s
Cable Power	Peripheral can be powered directly from the cable. 5.0v dc power is available from the cable. The current available can vary from 100ma - 500ma depending on the hub port.
System Resource Requirement Eliminated	USB devices, unlike their ISA, EISA, and PCI cousins require no memory or IO address space and need no IRQ lines.
Error Detection and Recovery	USB transactions include error detection mechanisms that are used to ensure that data is delivered without error. In the event of errors, transactions can be retried.
Supports four transfer types	The USB defines four different transfer types to support different transfer characteristics required by devices. Transfer types include: Bulk, Isochronous, Interrupt, and Control transfers.
Power Conservation	Device suspend (~2.5mA of current per device) mode.
Bus can be extended	Hubs can be attached to extend USB.

Enhanced System Performance
True Hot Plug Support
Expandability. Many devices share interface.
Low Cost Endpoints. Complexity on Host PC
Reduced Support Costs
- USB "just works"

Consumer Oriented
- Interoperability testing and Certification
- USB Logo Program

USB Spec Truly Universal.

- Specification covers hardware, software, electrical, mechanical - independent of CPU or Operating System.
- Standards provide for rigorous certification before use of USB Logo.
- Standard class drivers make peripherals useful on PC, Mac, Server and Embedded.
- Enabler for "Legacy Free PC".
- Same peripherals work on anything – PC, Mac, Embedded, Mainframe, Server.

USB 1.0 2.0 3.0 vs LS FS HS

NOT Same

- USB 1.x → 1.0 and 1.1
  - Original implementations of USB from 1994 and 1998.
  - Superseded by USB 2.0.
  - Referred to as "Classic USB" by USB Developers.
- USB 2.0 → Current USB technology.
  - Anything certified after July 2000 was certified against USB 2.0 specification.
  - Superset of USB 1.x functionality.
  - It is incorrect to refer to Full-Speed or Low-Speed as USB 1.x devices unless they are older devices certified to the USB 1.x specs. Newer devices are USB 2.0 Full-Speed or USB 2.0 Low-Speed.

USB application

- Streaming audio and video.
- Guaranteed delivery of large blocks of data.
- Separate control/status and data path to device using multiple endpoints.
  - Analogous to TCP/IP ports – i.e. 127.0.0.1:80, 127.0.0.1:25 or PCIe Virtual Channels.
- Multiple instances of device with no special software
  - Example – Multiple USB Disk or Flash Drives on One Computer.
- Multiple USB devices in same package

USB Cons IMP

- Long Distance Cabling
  - Limit is six 5 meter cable segments, separated by up to five hubs (30 meters).
  - Worst case timings are built into host and device hardware.
  - There are long-distance solutions that are not covered by USB specification.
- No Electrical Isolation
  - Special hardware is available to provide optically isolated endpoints. No specific solution covered by USB Specification.
- No Peer-to-Peer Communications
  - USB is a master-slave bus. The Host always initiates all

- Multiple instances of device with no special software
  - Example – Multiple USB Disk or Flash Drives on One Computer.
- Multiple USB devices in same package
  - Example -- Composite USB Device – printer/scanner/copier.
  - Transparent to application and device driver software. Host OS hides the details.

→ allows product development rather than focus on USB
- ↓ Time to market
- lower development cost & BOM cost
- Reduced customer support.

→ Works best for consumer grade peripheral

endpoints. No specific solution covered by USB Specification.

- No Peer-to-Peer Communications
  - USB is a master-slave bus. The Host always initiates all transactions. Devices are always slaves.
- Cannot Deliver Large Amounts of Power
  - USB Specification limits devices to 100mA, or 500mA if Host/Hub can supply that amount.

→ PC centric
- Host always initiates transaction
- Host can be complex

→ Targeted at Consumer Grade devices
- Short cables
- power delivery limit
- consumer grade connectors.

USB Host are complex.

- Requires Kernel drivers
- USB device configuration
- Vendor ID (Fee)
- Specialized HW / SW to drive USB
- USB host pluggable easy for PC but difficult for embedded applications.