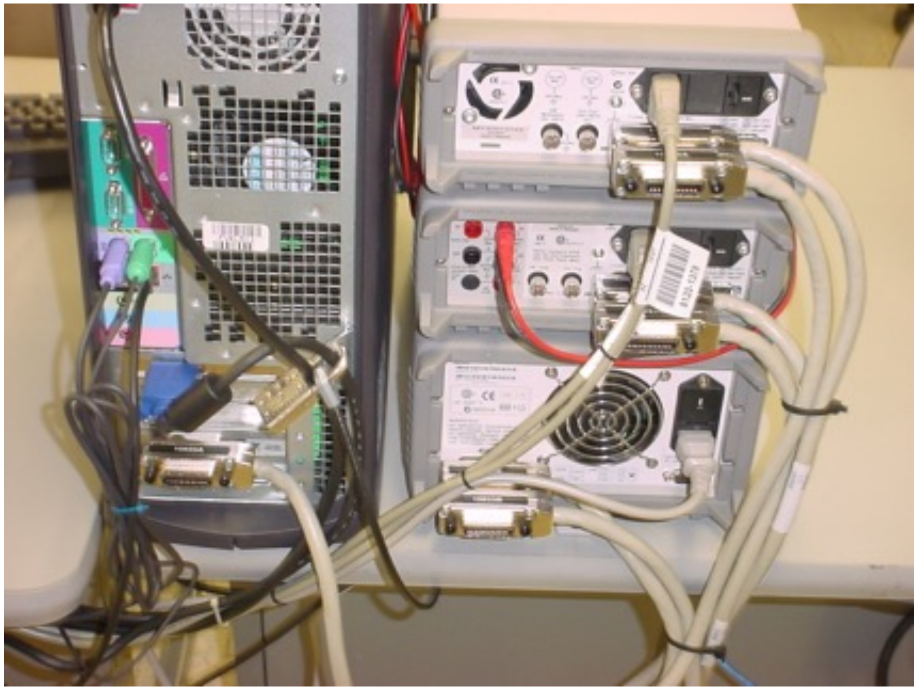
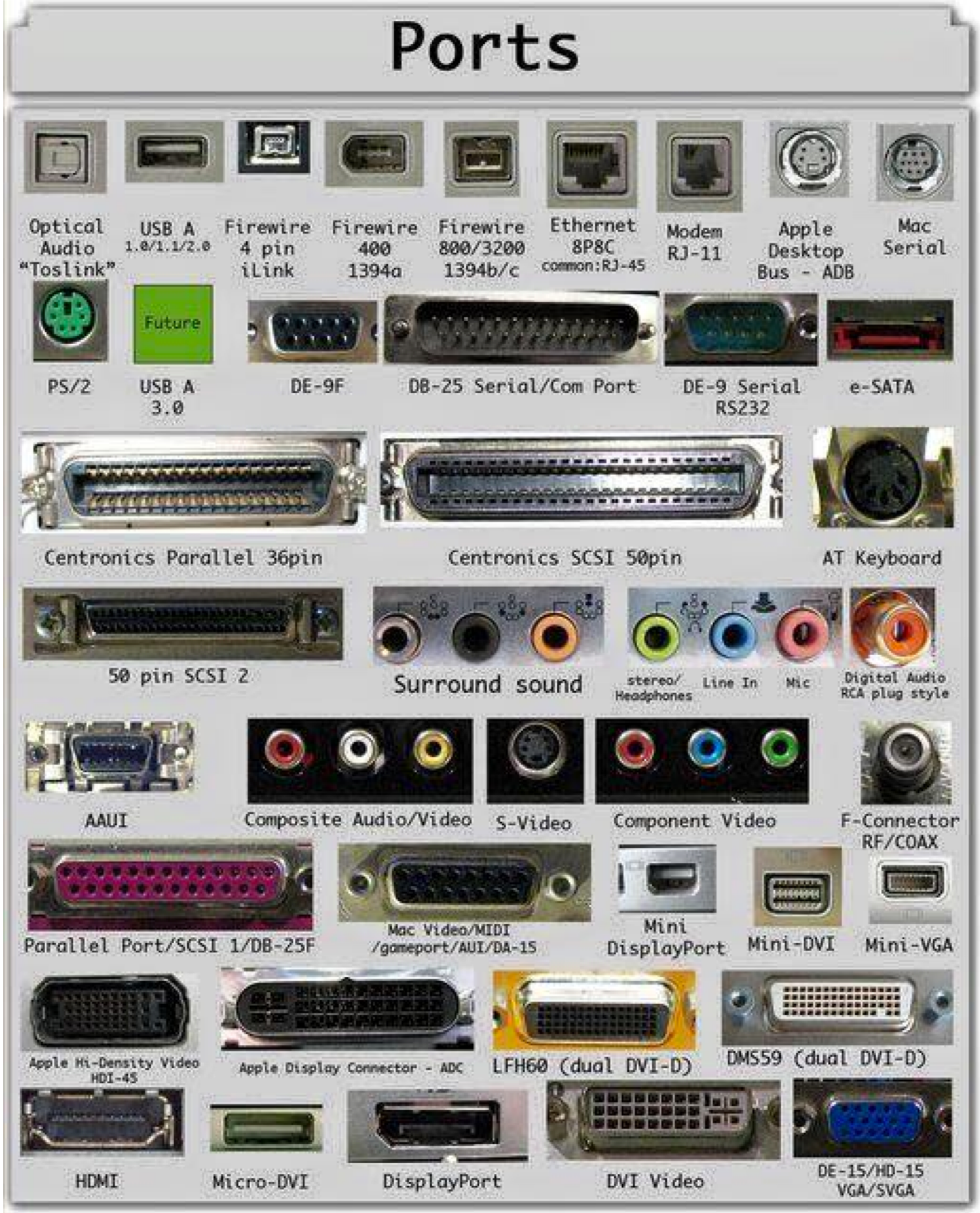
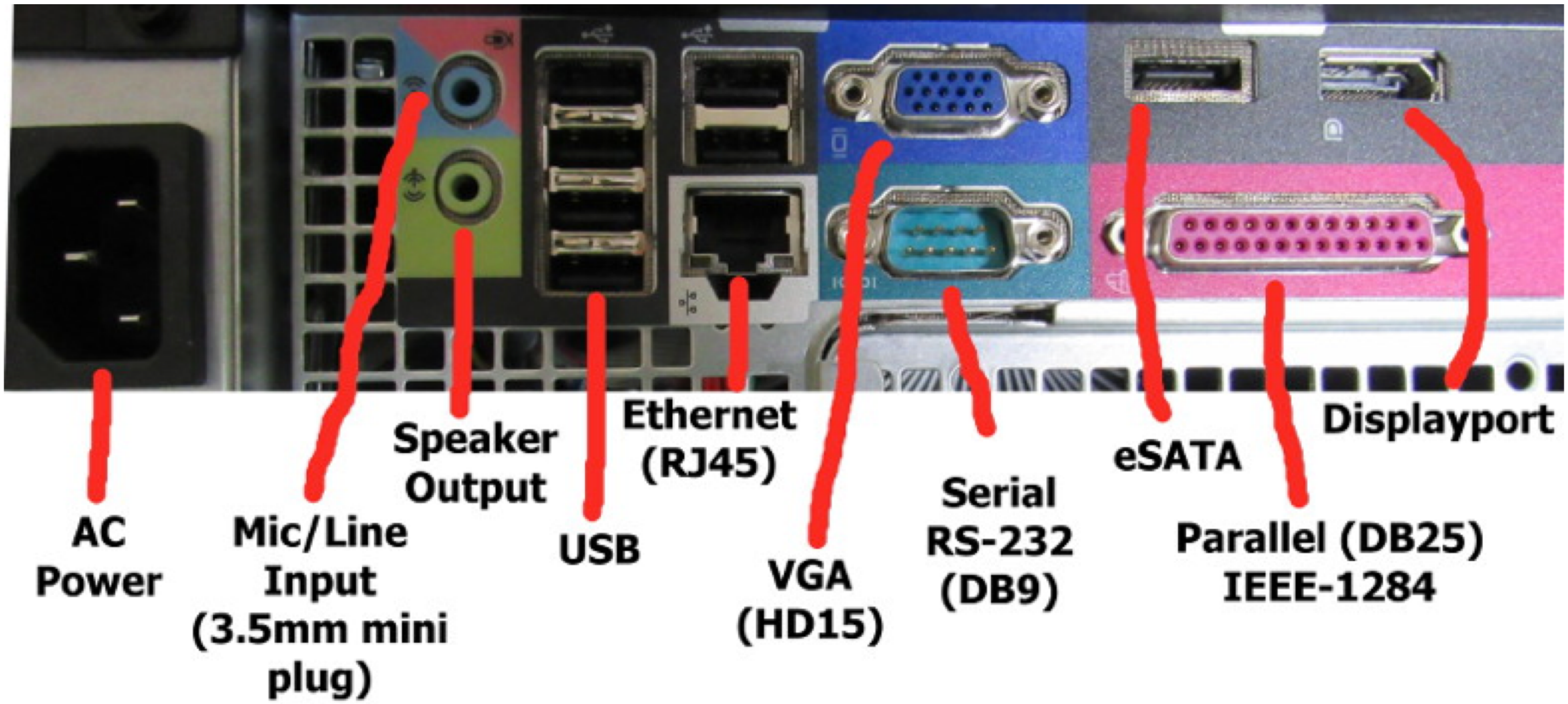


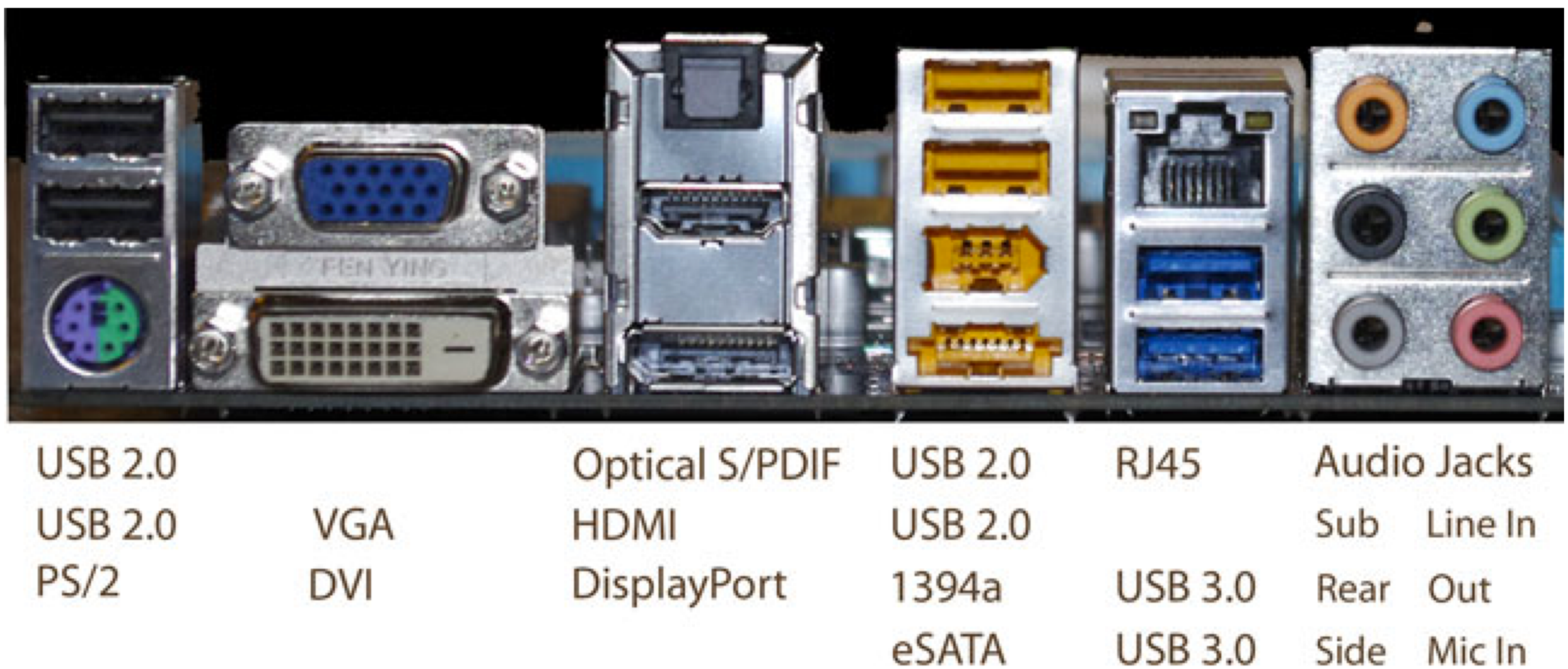
Computer Interfaces

Serial, Parallel, GPIB

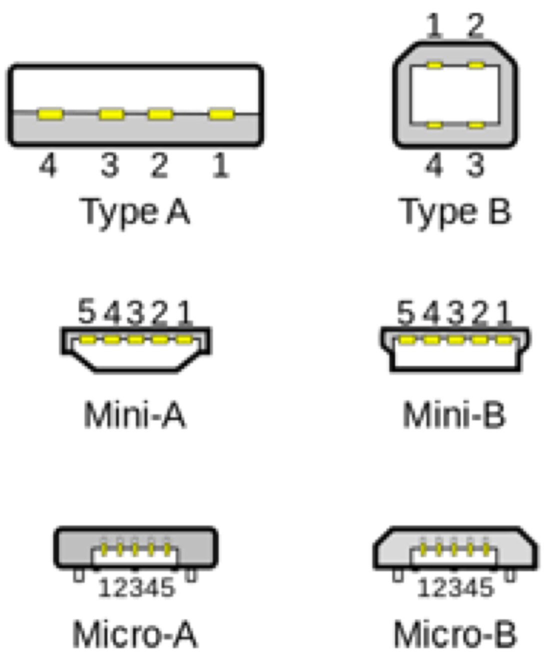
slide courtesy E. Michelsen


Ports
Optical Audio "Toslink"
USB A 1.0/1.1/2.0
Firewire 4 pin iLink
Firewire 400 1394a
Firewire 800/3200 1394b/c
Ethernet 8P8C common:RJ-45
Modem RJ-11
Apple Desktop Bus - ADB
Mac Serial
PS/2
Future
USB A 3.0
DE-9F
DB-25 Serial/Com Port
DE-9 Serial RS232
e-SATA
Centronics Parallel 36pin
Centronics SCSI 50pin
AT Keyboard
50 pin SCSI 2
Surround sound
stereo/ Headphones
Line In
Mic
Digital Audio RCA plug style
AAUI
Composite Audio/Video
S-Video
Component Video
F-Connector RF/COAX
Parallel Port/SCSI 1/DB-25F
Mac Video/MIDI /gameport/AUI/DA-15
Mini DisplayPort
Mini-DVI
Mini-VGA
Apple Hi-Density Video HDI-45
Apple Display Connector - ADC
LFH60 (dual DVI-D)
DMS59 (dual DVI-D)
HDMI
Micro-DVI
DisplayPort
DVI Video
DE-15/HD-15 VGA/SVGA


AC Power
Mic/Line Input (3.5mm mini plug)
Speaker Output
USB
Ethernet (RJ45)
VGA (HD15)
Serial RS-232 (DB9)
eSATA
Parallel (DB25) IEEE-1284
Displayport


USB 2.0
USB 2.0
PS/2
VGA
DVI
Optical S/PDIF
HDMI
DisplayPort
USB 2.0
USB 2.0
1394a
eSATA
RJ45
USB 3.0
USB 3.0
Audio Jacks
Sub
Line In
Rear
Out
Side
Mic In

USB Types



		USB 2.0 High Speed 480 MBit/s	**USB 3.1 Gen 1** (formerly USB 3.0) Super Speed 5 GBit/s	**USB 3.1 Gen 2** (formerly USB 3.1) Super Speed Plus 10 GBit/s
Without Power Delivery	Without DisplayPort			
	With DisplayPort			
With Power Delivery	Without DisplayPort			
	With DisplayPort			
Thunderbolt 3 With Power Delivery and DisplayPort				

Common Implementations of Interfaces

- Parallel port (8 bits per shot)
- Serial (RS-232, RS-485)
  - usually asynchronous
- GPIB (IEEE-488) parallel
  - General Purpose Interface (or Instrument) Bus
  - originally HPIB; Hewlett Packard
- DAQ card (data acquisition)
  - like national instruments A/D, D/A, digital I/O

A quick note on hexadecimal

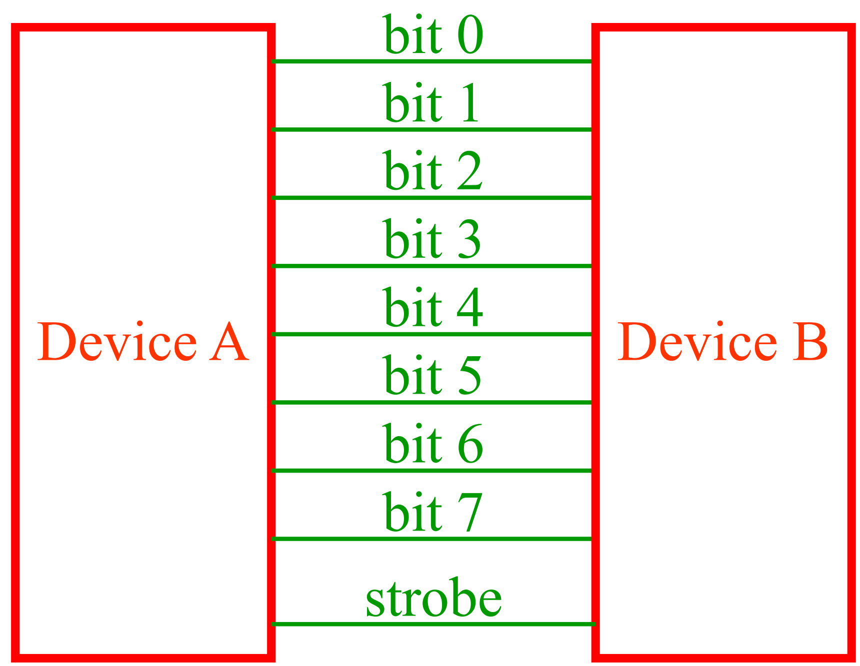
decimal value	binary value	hex value
0	0000	0
1	0001	1
2	0010	2
3	0011	3
4	0100	4
5	0101	5
6	0110	6
7	0111	7
8	1000	8
9	1001	9
10	1010	a
11	1011	b
12	1100	c
13	1101	d
14	1110	e
15	1111	f

Hexadecimal, continued

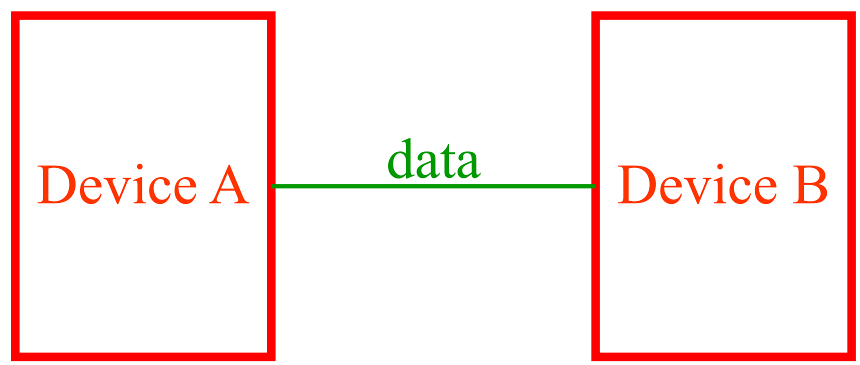
- Once it is easy for you to recognize four bits at a time, 8 bits is trivial:
  - 01100001 is 0x61
  - 10011111 is 0x9f
- Can be handy because the ASCII code is built around hex:
  - 'A' is 0x41, 'B' is 0x42, …, 'Z' is 0x5a
  - 'a' is 0x61, 'b' is 0x62, …, 'z' is 0x7a
  - '^A' (control-A) is 0x01, '^B' is 0x02, '^Z' is 0x1A
  - '0' is 0x30, '9' is 0x39

Exchanging Data

- Parallel: Fast and expensive
  - devices A, B simple, but cabling harder
  - strobe alerts to “data valid” state

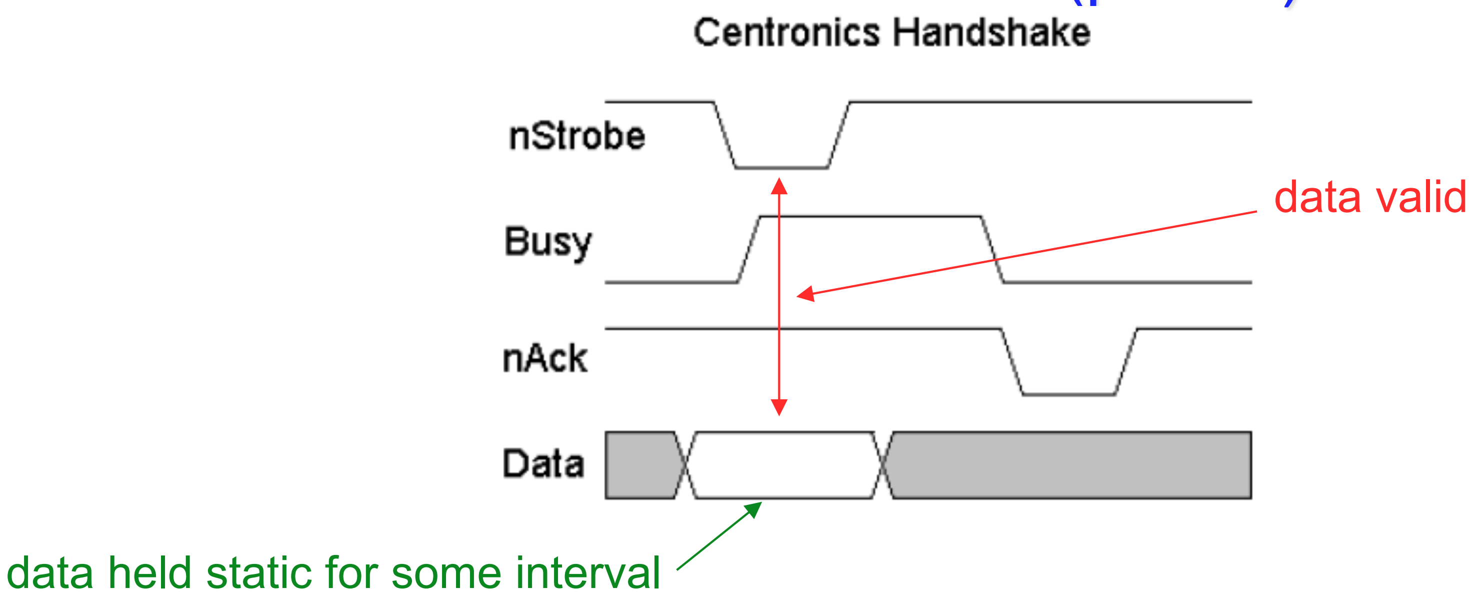


- Serial: Slow and cheap
  - but devices A and must convert between serial/parallel



The Parallel Port

- Primarily a printer port on the PC
  - goes by name LPTx: line printer
  - usually LPT1
- 8 data bits
  - with strobe to signal valid data
  - can be fast (1 Mbit/sec)
- Other control and status bits for (printer) communication



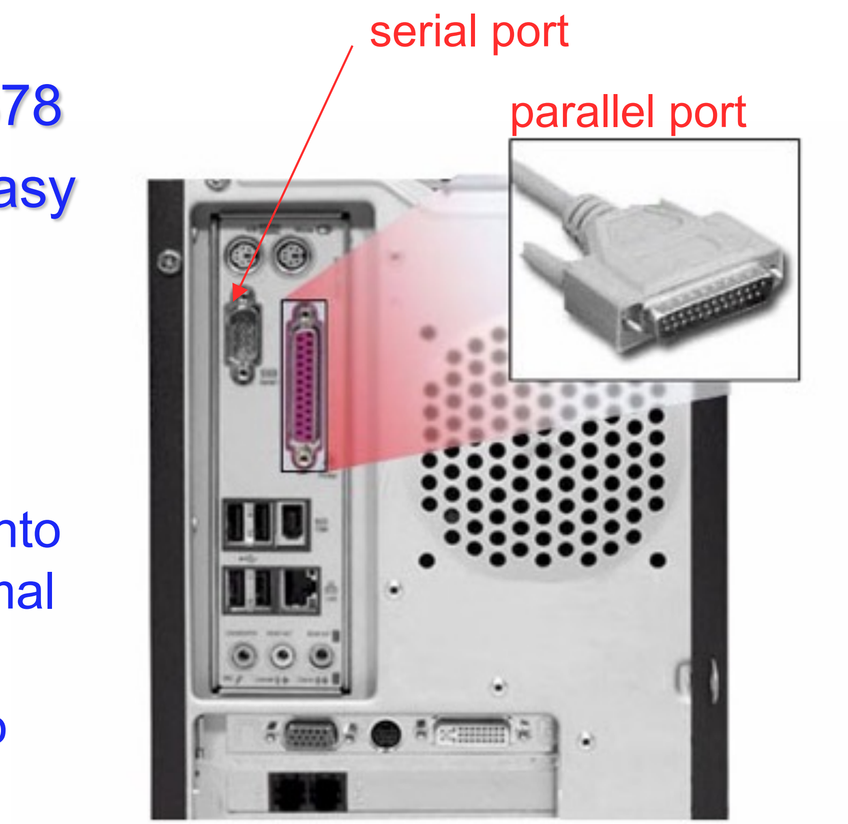
see http://www.beyondlogic.org/index.html#PARALLEL

Parallel Port Pinout

Pin No (D-Type 25)	Pin No (Centronics)	SPP Signal	Direction In/out	Register	Hardware Inverted
1	1	nStrobe	In/Out	Control	Yes
2	2	Data 0	Out	Data	
3	3	Data 1	Out	Data	
4	4	Data 2	Out	Data	
5	5	Data 3	Out	Data	
6	6	Data 4	Out	Data	
7	7	Data 5	Out	Data	
8	8	Data 6	Out	Data	
9	9	Data 7	Out	Data	
10	10	nAck	In	Status	
11	11	Busy	In	Status	Yes
12	12	Paper-Out PaperEnd	In	Status	
13	13	Select	In	Status	
14	14	nAuto-Linefeed	In/Out	Control	Yes
15	32	nError / nFault	In	Status	
16	31	nInitialize	In/Out	Control	
17	36	nSelect-Printer nSelect-In	In/Out	Control	Yes
18 - 25	19-30	Ground	Gnd		

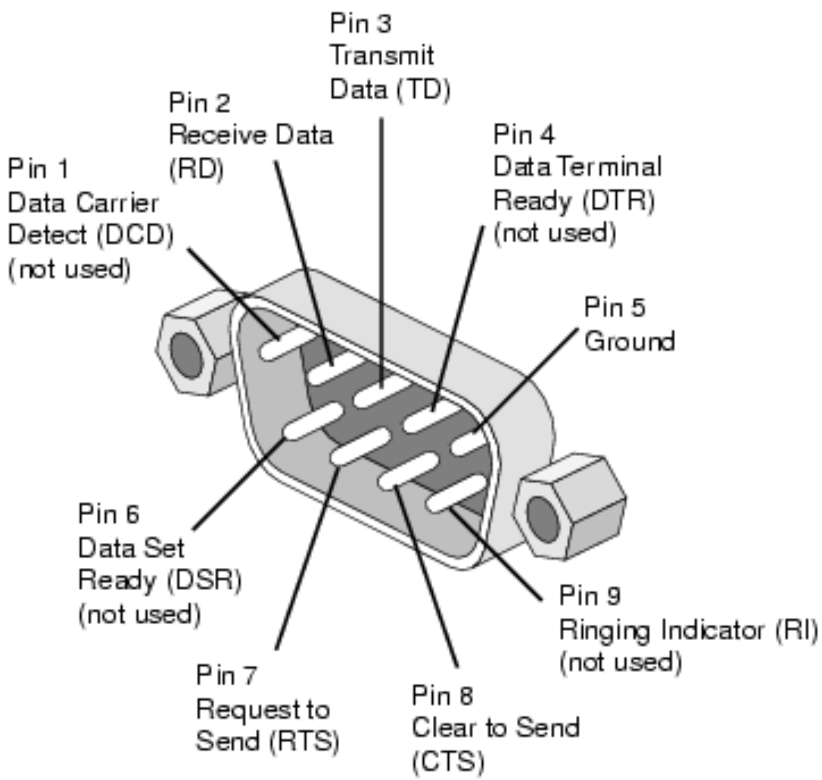
Parallel Port Access

- Most PCs have a DB-25 female connector for the parallel port
- Usually at memory address 0x378
- Windows 98 and before were easy to talk to
  - but after this, a hardware-abstraction layer (HAL) which makes access more difficult
  - one option is to fool computer into thinking you're talking to a normal LPT (printer) device
  - involves tying pins 11 and 12 to ground
- Straightforward on Linux
  - direct access to all pins



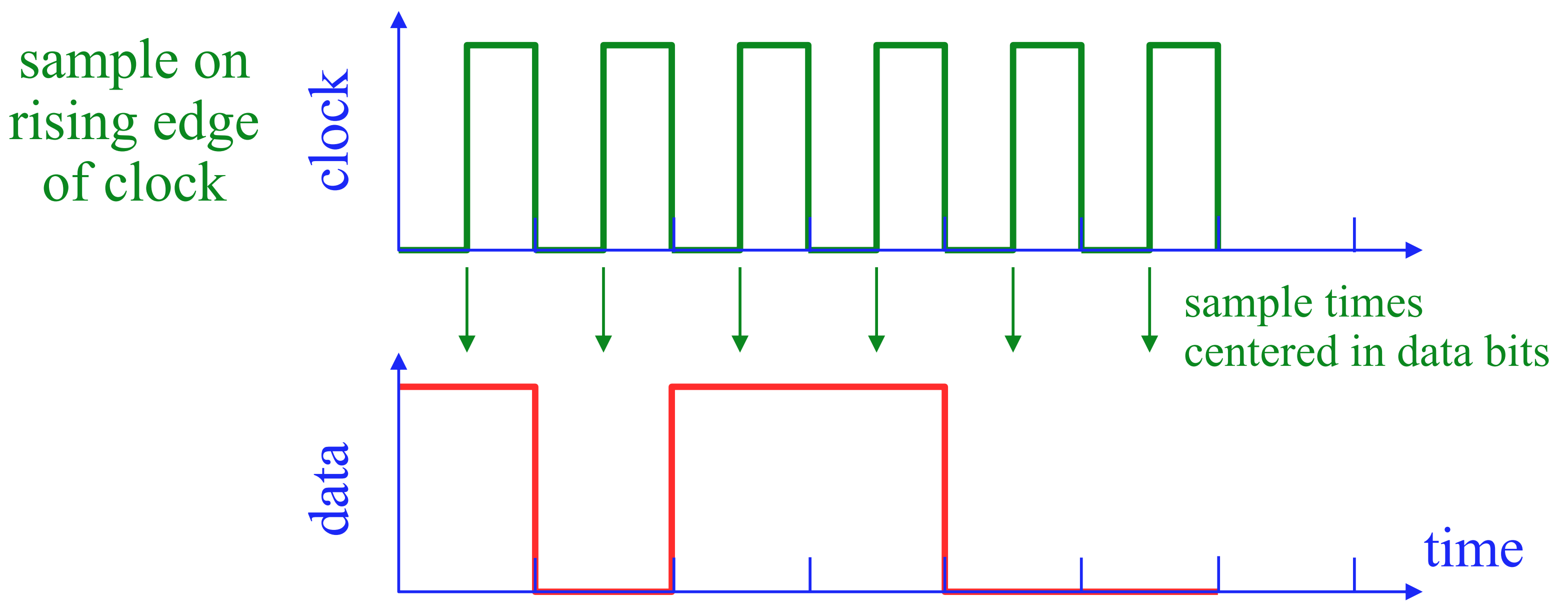
Serial Communications

- Most PCs have a DB9 male plug for RS-232 serial asynchronous communications
  - we'll get to these definitions later
  - often COM1 on a PC
- In most cases, it is sufficient to use a 2- or 3-wire connection
  - ground (pin 5) and either or both receive and transmit (pins 2 and 3)
- Other controls available, but seldom used
- Data transmitted one bit at a time, with protocols establishing how one represents data
- Slow-ish (most common is 9600 bits/sec)



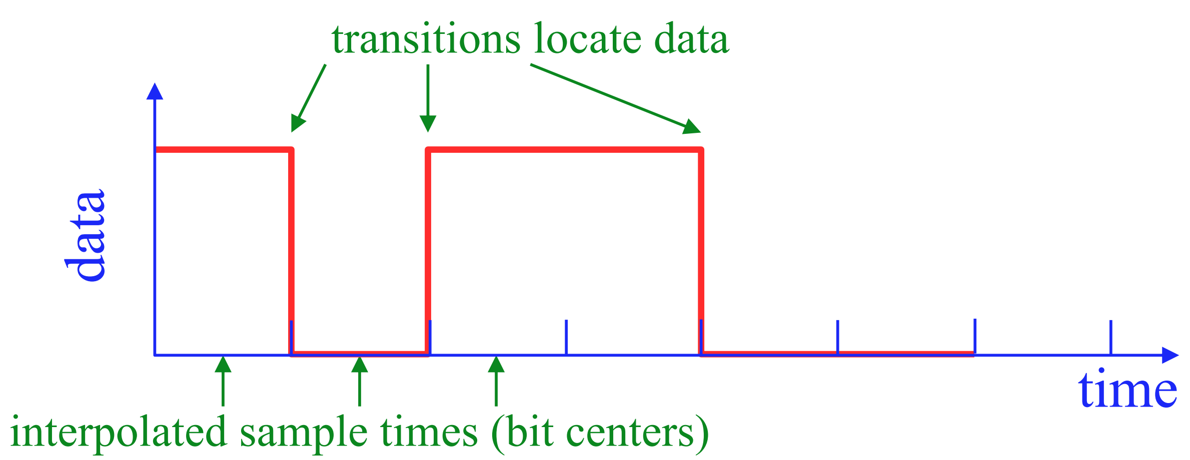
Time Is of the Essence

- With separate clock and data, the transmitter *gives* the receiver timing on one signal, and data on another
- Requires two signals (clock and data): can be expensive
- Data values are arbitrary (no restrictions)
- Used by local interfaces: V.35, (synchronous) EIA-232, HSSI, etc.
- As distance and/or speed increase, **clock/data skew** destroys timing



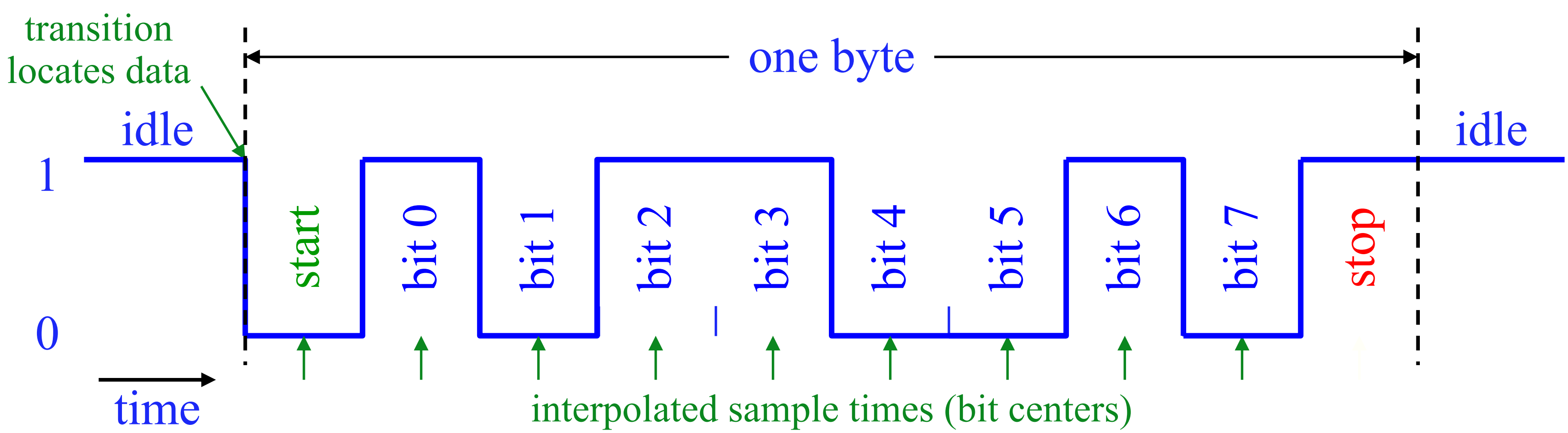
No Clock:
Do You Know Where Your Data Is?

- Most long-distance, high speed, or cheap signaling is **self timed**: it has no separate clock; the receiver recovers timing from the signal itself
- Receiver knows the *nominal* data rate, but requires **transitions** in the signal to locate the bits, and interpolate to the sample points
- Two General Methods:
  - Asynchronous: data sent in short blocks called **frames**
  - Synchronous: continuous stream of bits
    - Receiver *tracks* the timing continuously, to stay in synch
    - Tracking requires sufficient **transition density** throughout the data stream
    - Used in all DSLs, DS1 (T1), DS3, SONET, all Ethernets, etc.

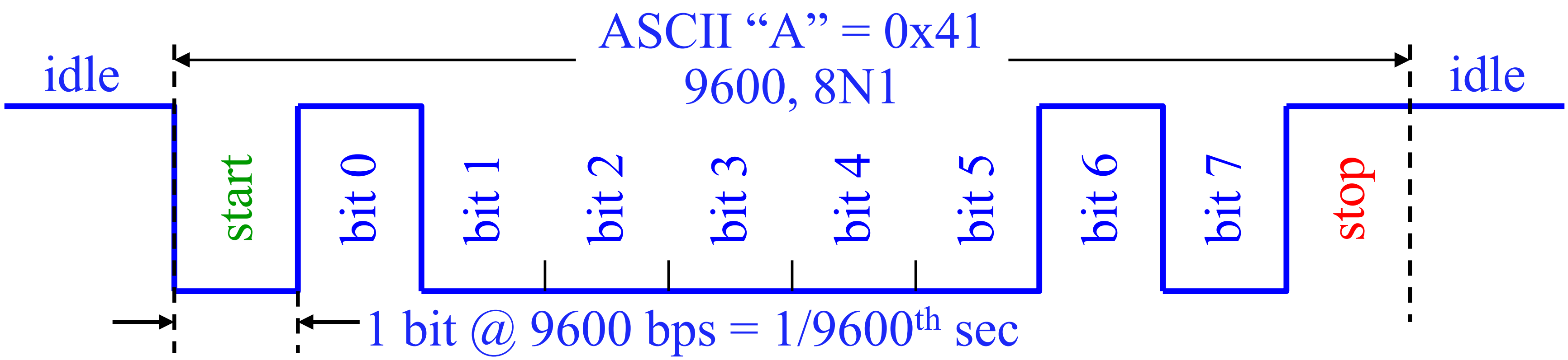


Asynchronous: Up Close and Personal

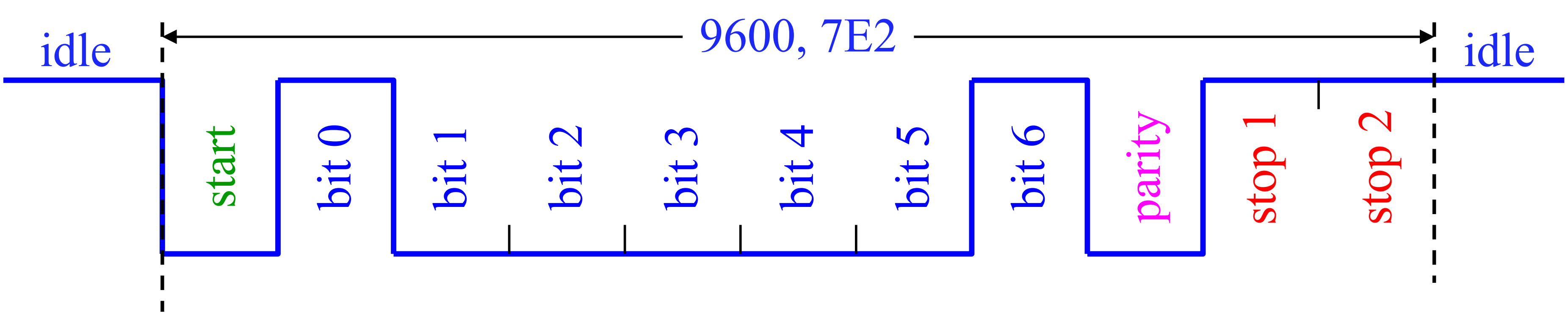
- **Asynchronous**
  - technical term meaning "whenever I feel like it"
- Start bit is always 0. Stop bit is always 1.
- The line "idles" between bytes in the "1" state.
- This guarantees a 1 to 0 transition at the start of every byte
- After the leading edge of the start bit, if you know the data rate, you can find all the bits in the byte



Can We Talk?



- If we agree on 4 asynchronous communication parameters:
  - Data rate: Speed at which bits are sent, in bits per seconds (bps)
  - Number of data bits: data bits in each byte; usually 8
    - old stuff often used 7
  - Parity: An error detecting method: None, Even, Odd, Mark, Space
  - Stop bits: number of stop bits on each byte; usually 1.
    - Rarely 2 or (more rarely) 1.5: just a minimum wait time: can be indefinite



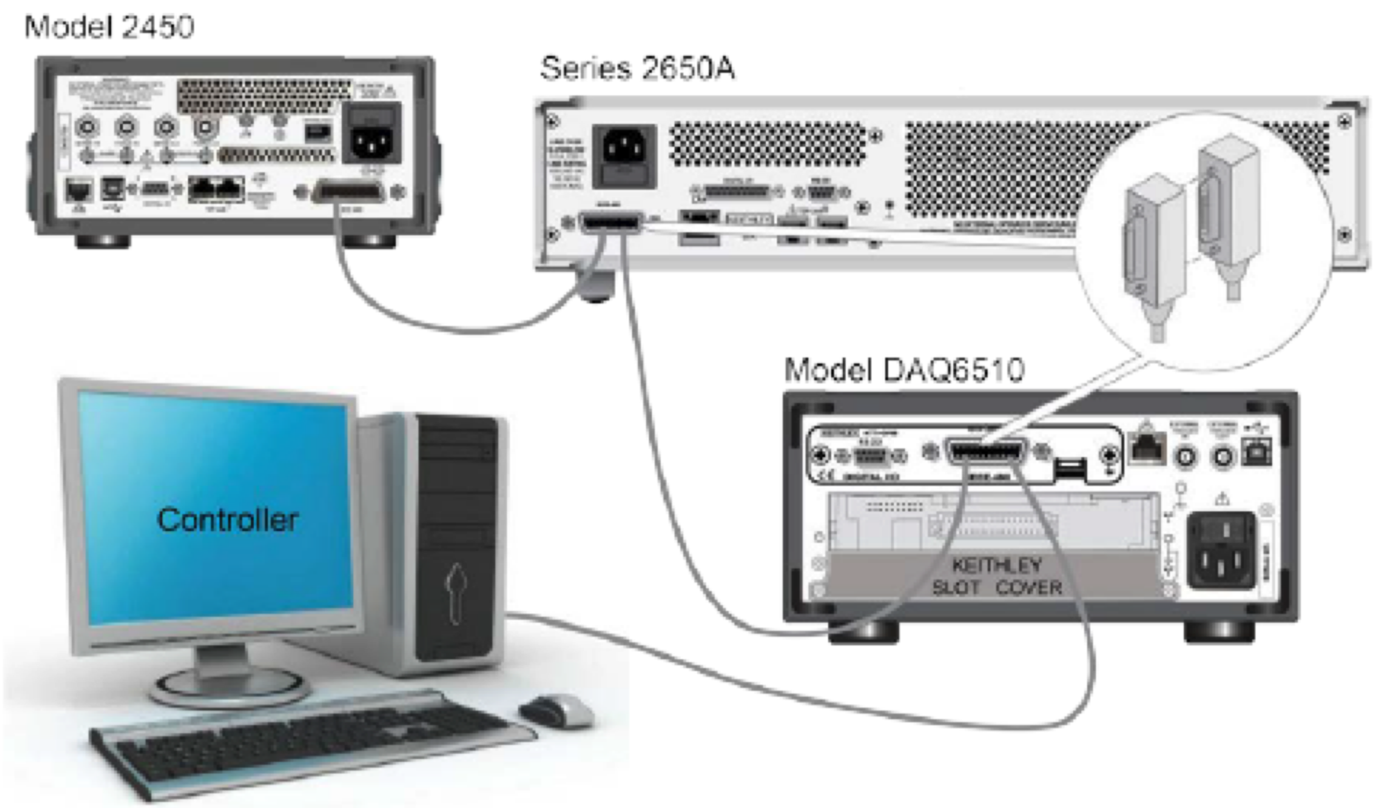
RS-232: most common implementation

- RS-232 is an electrical (physical) specification for communication
  - idle, or "mark" state is logic 1;
    - –5 to –15 V (usually about –12 V) on transmit
    - –3 to –25 V on receive
  - "space" state is logic 0;
    - +5 to +15 V (usually ~12 V) on transmit
    - +3 to +25 V on receive
  - the dead zone is from –3 V to +3 V (indeterminate state)
- Usually used in asynchronous mode
  - so idles at –12; start jumps to +12; stop bit at –12
  - since each packet is framed by start/stop bits, you are guaranteed a transition at start
  - parity (if used) works as follows:
    - even parity guarantees an even number of ones in the train
    - odd parity guarantees an odd number of ones in the train

GPIB (IEEE-488)

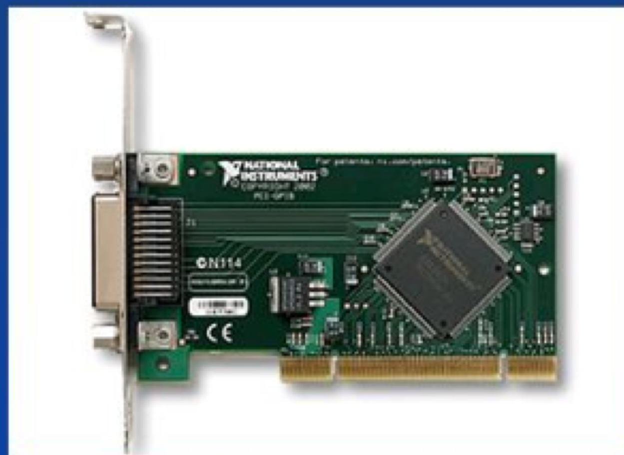
- An 8-bit parallel bus allowing up to 15 devices connected to the same computer port
  - addressing of each machine (either via menu or dip-switches) determines who’s who
  - can daisy-chain connectors, each cable 2 m or less in length
- Extensive handshaking controls the bus
  - computer controls who can talk and who can listen
- Many test-and-measurement devices equipped with GPIB
  - common means of controlling an experiment: positioning detectors, measuring or setting voltages/currents, etc.
- Can be reasonably fast (1 Mbit/sec)

PGIB – Daisy Chaining



General Purpose Interface Bus (GPIB)

PCI



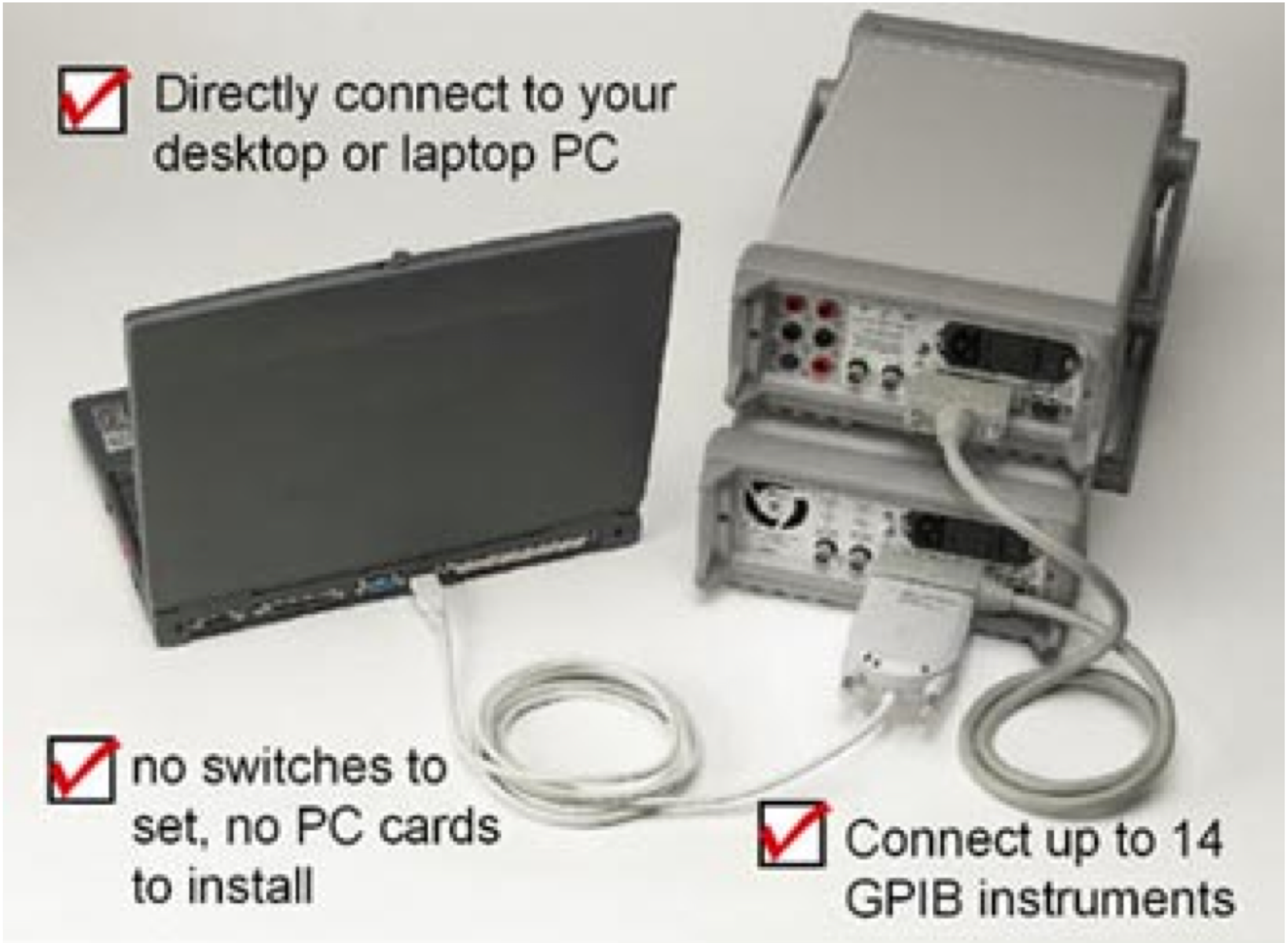
cable

USB

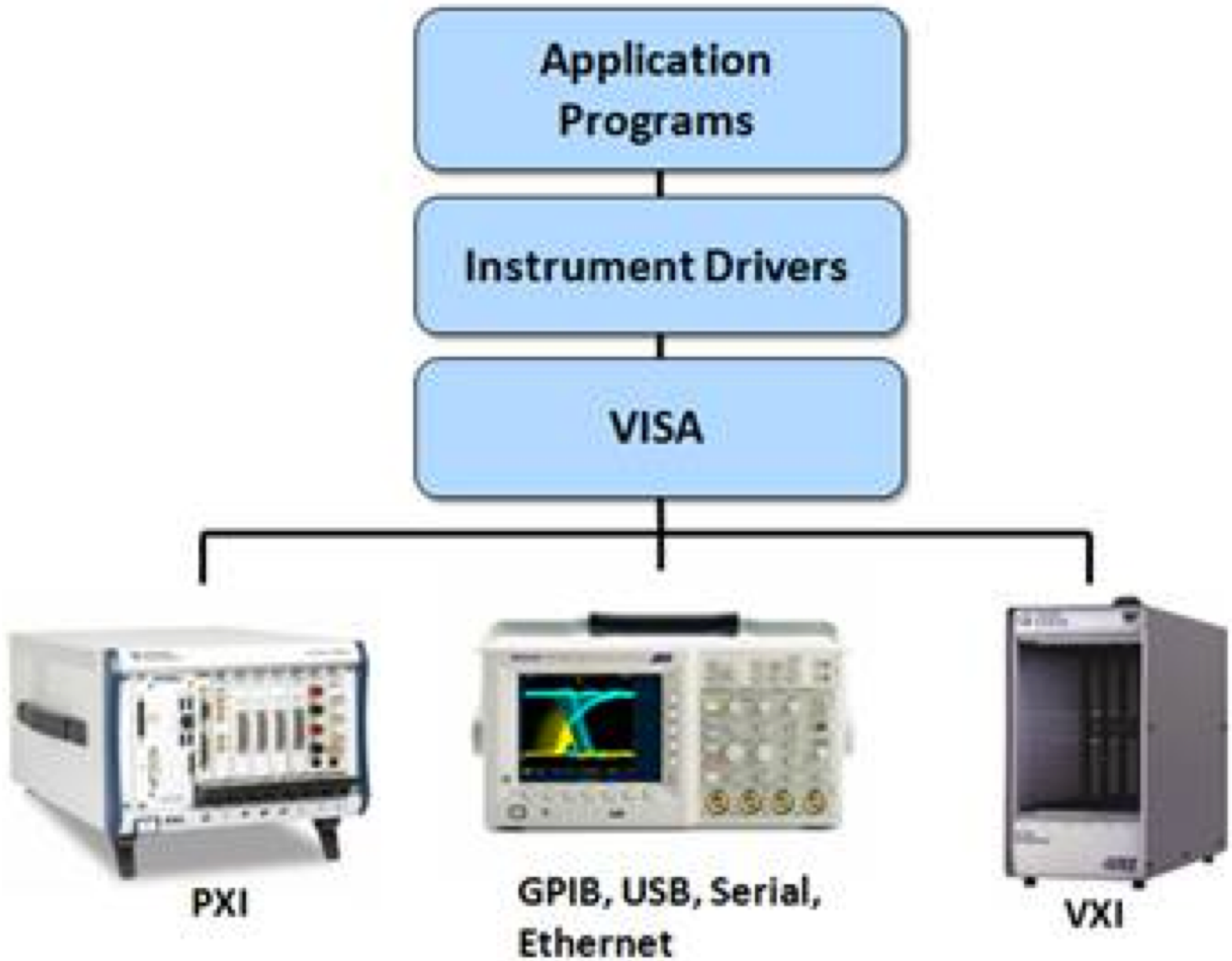
connector

Keysight Technologies 82357B Data Acquisition USB/GPIB Interface

Keysight Technologies 82357B Data Acquisition USB/GPIB Interface



Using VISA


Application Programs
Instrument Drivers
VISA
PXI
GPIB, USB, Serial, Ethernet
VXI