Design and Build
a
Personal Computer

PART 1

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Build it yourself vs. Buy?

(Ask yourself if you agree to the following advice from PC Magazine)

Build

- If **average-performing** PC, you can maybe save money since everyday prices competitive with what PC manufacturers pay
- You can ensure **industry standard** **O**riginal **E**quipment **M**anufacturer's (**OEM**) parts (unlike Dell who *might* use their own proprietary parts)
- Learning is fun
- **You control design** (both initial, and any required fix or upgrade)

Buy

- If **high-performance** PC, manufacturers (e.g., Dell), who *mostly* assemble **OEM** parts, probably do it cheaper since they buy parts in bulk at prices not available to everyone yet
- Learning **curve** not as steep
- More comprehensive warranty and service (e.g., you don't have to **diagnose** problem, **or fix** it)

PC Design Steps

(Note that steps 1 and 2 should be done at the same time),

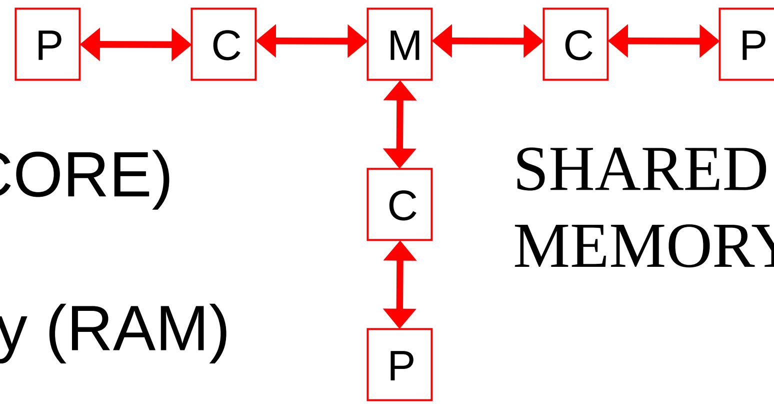
And you may want to do step 3 first

1. **Pick <u>CPU</u> (and number of cores and chip set)**
2. **Pick <u>RAM</u> *“main memory”* and <u>Motherboard</u>**
3. **Pick <u>Graphics Board and Monitor</u>**
4. **Pick <u>Drives</u>**
5. **Pick <u>other specialty boards</u>**
6. **<u>Power</u>**
   - **<u>Clean</u>**(a concern for networks and factory settings)
   - **<u>Sufficient Supply</u>**
   - **<u>Cooling</u>**

- Think about **<u>FUTURE PC’s</u>**

PC Design Steps (Pick CPU)

- Multi-core, (multiple CPU's in chip package)
  - Don't assume speed-up proportional, yet! – there is recent research on treating Cores like network nodes where performance of overall system actually increases with more nodes, unlike the decrease in performance when many more cores share one memory
  - SMP (**S**ymmetric **M**ulti-**P**rocessing)



SHARED MEMORY !

P = Processor (CORE)

C = Cache

M = Main Memory (RAM)

- Cache(s) common "on-chip" (usually now in same chip package, and on same **silicon chip** -- i.e., same piece of silicon chipped off of wafer that is sliced off of big cylindrical ingot)
  - Typically L1 cache now integrated into CPU''s ("CORE's")
  - Typically L2 cache connected to CPU's via "Back-Side-Bus" (in same chip-package!) connecting everything together on the chip (unlike the **FSB** Front Side Bus which connects the CPU chip package to the main memory RAM on the motherboard

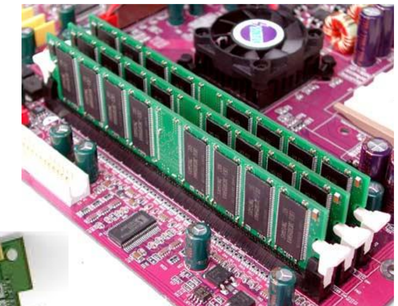
- Cooling requirements (e.g., heat-sink, dedicated-fan, heat-pipe, liquid)
  - Especially if you plan on overclocking CPU

PC Design Steps (Pick CPU) cont.

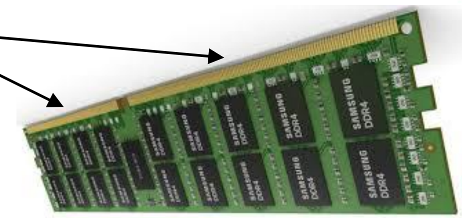
- CPU clock speed's
  - CPU's fastest thing in computer
    - Faster than Motherboard and RAM
- Intel or AMD (**A**dvanced **M**icro **D**evices) brand
  - Same "Family"
    - Same machine instruction set even though there's a different underlying architecture implementing it
- Much more $ for *"bleeding-edge"* (better to buy *hottest* from six months ago, for anything)
- 64-bit processing (for both data and addresses)
  - Big chunks of **DATA** (e.g., multimedia) … but Graphics Card does much more!
  - Large **ADDRESS** space (bigger than physical RAM -- i.e., need VIRTUAL ADRESSING)
    - i.e., CPU and all Software uses 64-bit Addresses' (2^64 = 16 Billion Billion) even though Physical Memory much Smaller!! (e.g. 2^40cpu_pins_for_RAM = a Terabyte of RAM, so typically only 40 address pins coming out of the CPU chip package)

PC Design Steps (Pick RAM *"main memory"*)

- Pick RAM and Motherboard at same time (i.e., to match FSB bus speed)
- RAM (**R**andom **A**ccess **M**emory) used as ***"Main Memory"*** in PC
- **Dual** **I**n-line **M**emory **M**odules (DIMM's) plug into sockets on motherboard



Two rows of connectors



- *This **"Main Memory"*** is **D**RAM
  - (i.e., **D**ynamic -- volatile and needs to be **refreshed**)
- Many variations of DRAM; some more recent:
  - DDR (Double Data Rate) uses both positive and negative clock edges
  - DPRAM (Dual-ported RAM) allows multiple reads or writes at nearly the same time
- Also, motherboard may have Dual-Channel capability to allow two banks of RAM to work concurrently
- Caches use **S**RAM

  (**S**tatic -- although volatile, does not need to be **refreshed**, also **faster**, but **less dense** and **more expensive**)

SEE MORE ON RAM HERE

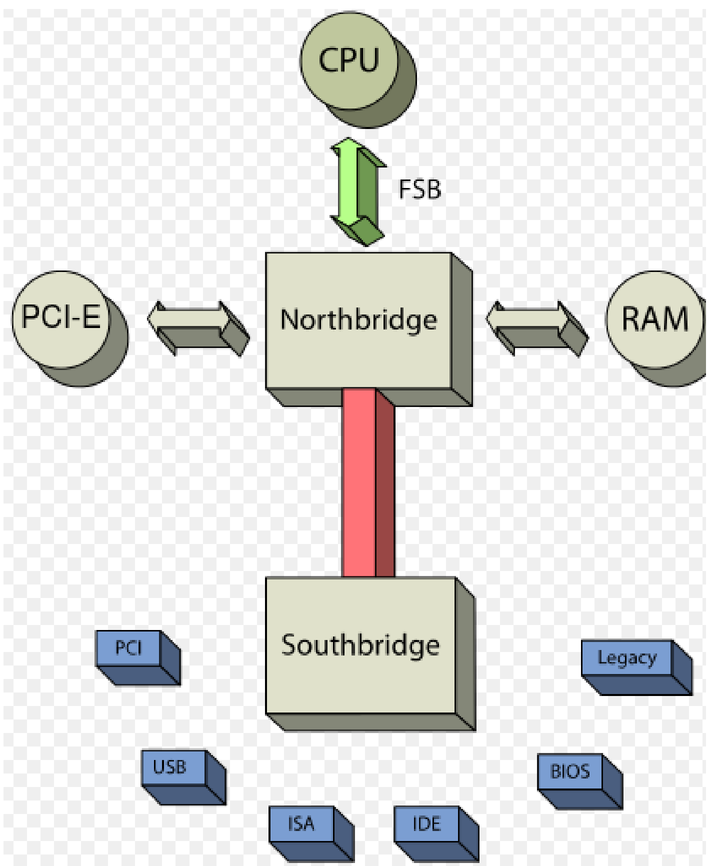
Images from: http://www.simmtester.com/page/news/showpubnews.asp?num=171

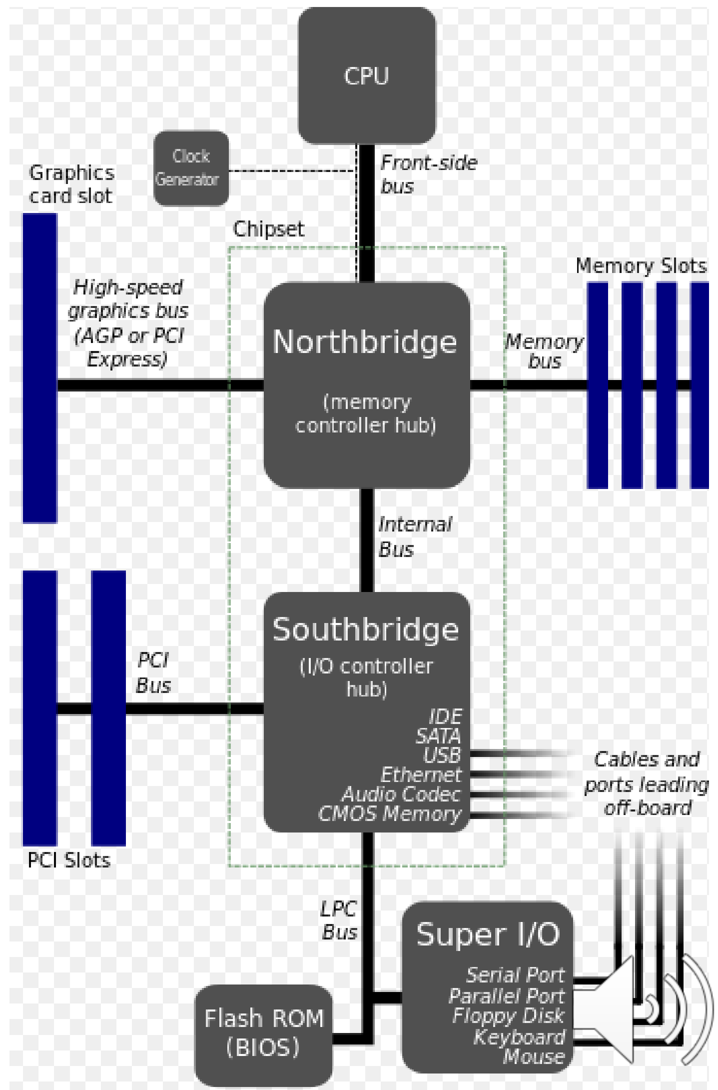
PC Design Steps (Pick Motherboard)

- Match speed of CPU, RAM, and Motherboard **F**ront-**S**ide-**B**us (**FSB**) which connects CPU and RAM
- Make sure it has socket to to plug in your CPU (i.e. Intel or AMD)
- Make sure it has correct **chip-set** to handle your CPU, RAM, Graphics Card, and other I/O needs

  Northbridge for RAM and video card control,
  and restricts overclocking

  Southbridge for power, clock, and other I/O control



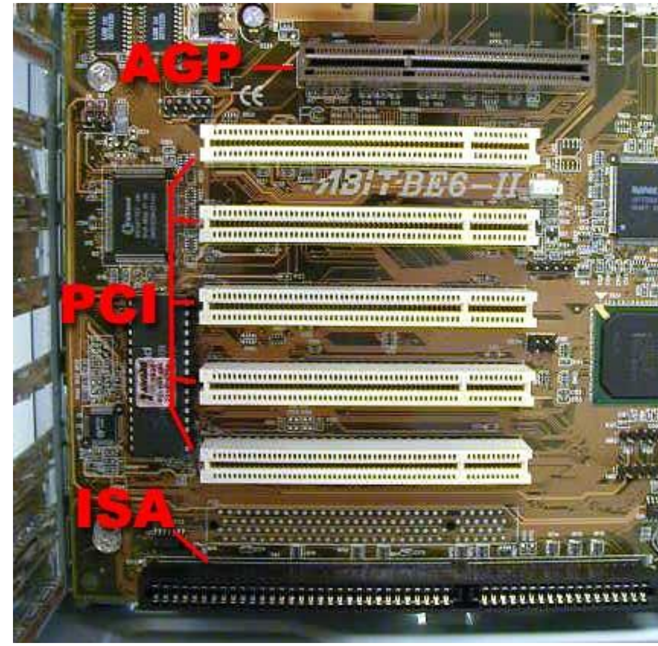


Images from:
https://en.wikipedia.org/wiki/Northbridge_(computing) v

PC Design Steps (Pick Motherboard)

- May want **Dual-Channel** capability (can handle two banks of RAM concurrently)
- Make sure Motherboard can **handle your Graphics Card**

  (NVIDIA, etc)



OLD:

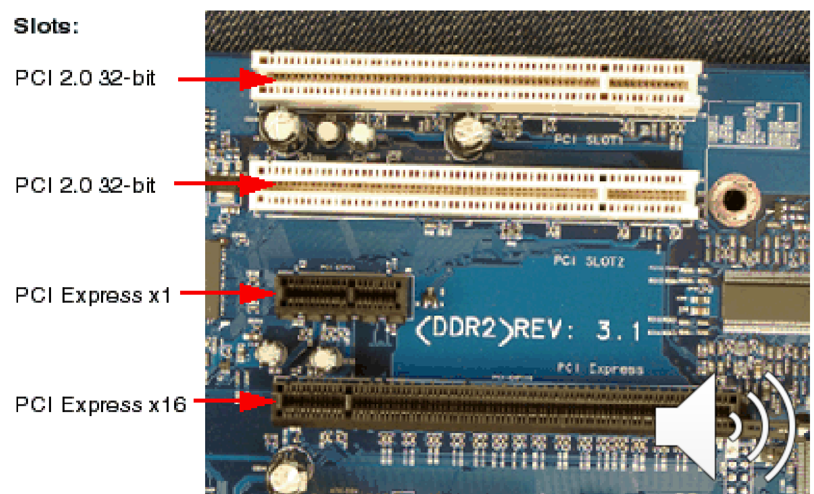
- **AGP** ("Accelerated Graphics Port")
- **PCI**
- **ISA**

RECENT:

PCIexpess (not a bus protocol)

ISA, PCI, and AGP use PARALLEL communication of data

*PCIexpress uses a packetizing **SERIAL** protocol like that used for Ethernet TCP/IP, and then many serial lines are implemented in parallel*



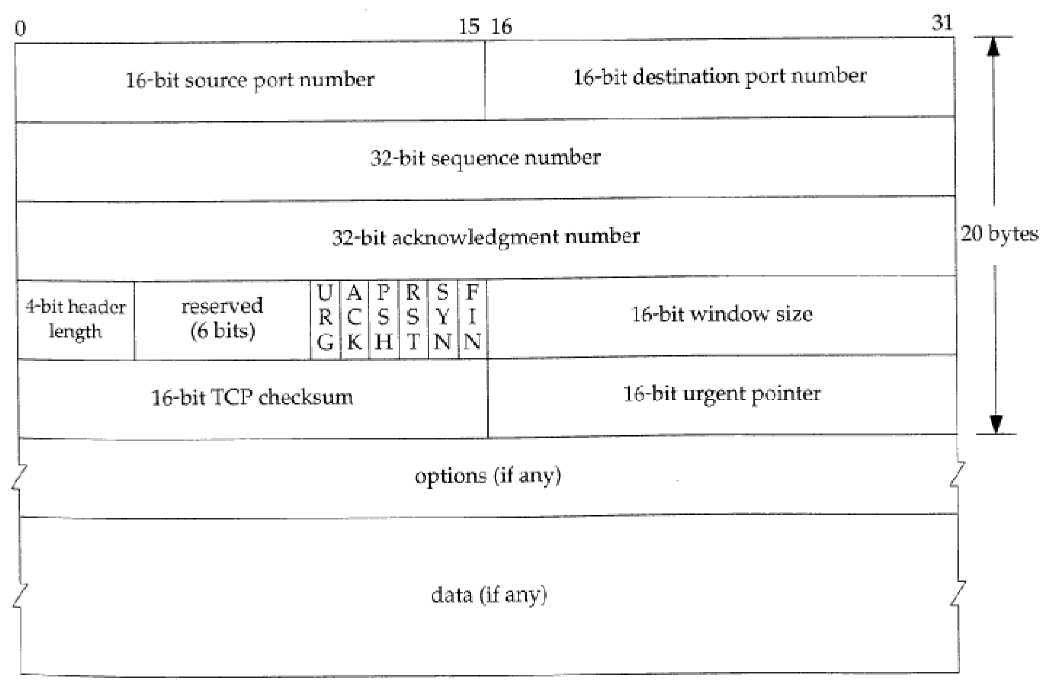
DATAGRAM (i.e., a "Packet")

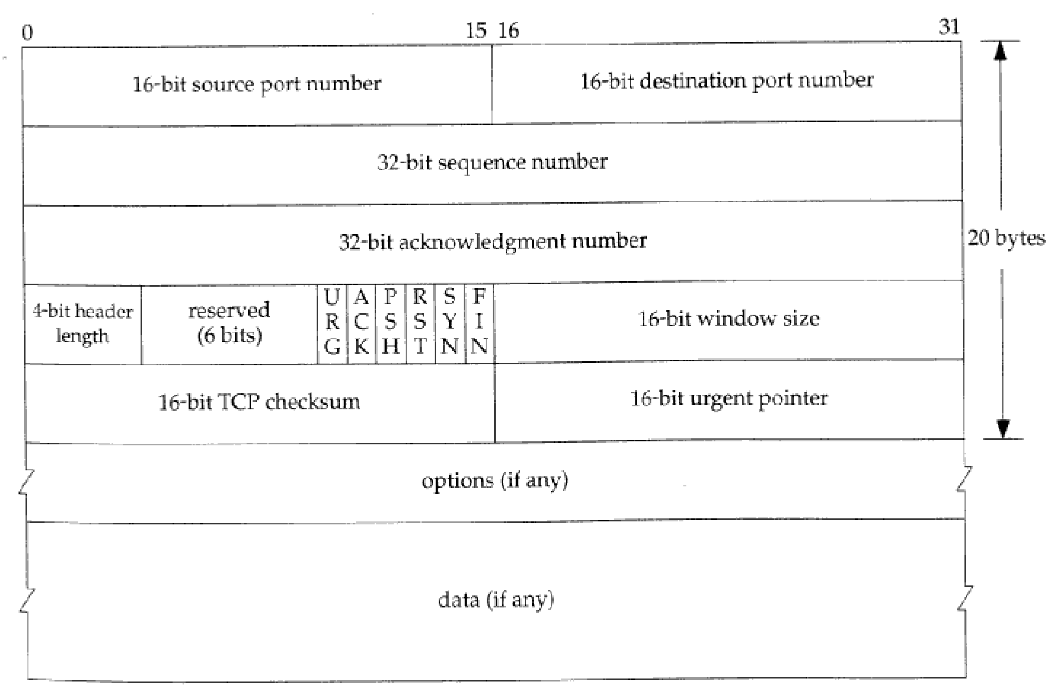
for TCP/IP (Transmission Control Protocol/Internet Protocol)

From TCP tutorial
(http://www.ssfnet.org/Exchange/tcp/tcpTutorialNotes.html):

TCP HEADER

TCP data is encapsulated in an IP datagram. The figure shows the format of the TCP header. Its normal size is 20 bytes unless options are present:





SrcPort and **DstPort** fields identify source and destination ports. These plus source and destination IP addresses combine to identify each TCP connection.

sequence number identifies byte in data stream from sending TCP to receiving TCP that the first byte of data in this segment represents.

acknowledgement number is next sequence number that sender of acknowledgement expects to receive. i.e., sequence number plus 1 of last successfully received byte of data. This field is valid only if ACK flag is on. Once a connection is established Ack flag is always on.

Acknowledgement, **SequenceNum**, and **AdvertisedWindow** involved in TCP's sliding window algorithm.The Acknowledgement and AdvertisedWindow field carry info about flow of data going in other direction. In TCP's sliding window algorithm receiver advertises a window size to sender using the AdvertisedWindow field. The sender is then limited to having no more than a value of AdvertisedWindow bytes of unacknowledged data at any given time. The receiver sets a suitable value for the AdvertisedWindow based on the amount of memory allocated to the connection for the purpose of buffering data.

header length (in 32-bit words) Required because length of options field is variable.

6-bit Flags field used to relay control info between TCP peers. SYN and Fin flags for establishing and terminating a TCP connection, ACK flag is set any time Acknowledgement field is valid, implying that the receiver should pay attention to it. URG flag signifies this segment contains urgent data. When set, UrgPtr indicates where non-urgent data in this segment begins. PUSH flag signifies sender invoked push operation, which indicates to receiving side of TCP that it should notify the receiving process of this. RESET flag signifies receiver has become confused and so wants to abort connection.

Checksum (FOR ERROR DETECTION) is a mandatory field calculated by sender, then verified by receiver.

Option field is maximum segment size option, called MSS. Each end of connection normally specifies this option on first segment exchanged. It specifies maximum sized segment sender wants to receive.

D**ata** portion of TCP segment (optional, but it's the actual data you are most likely trying to send!) i.e., everything else is communication overhead !!

PC Design Steps (Pick Motherboard) cont.

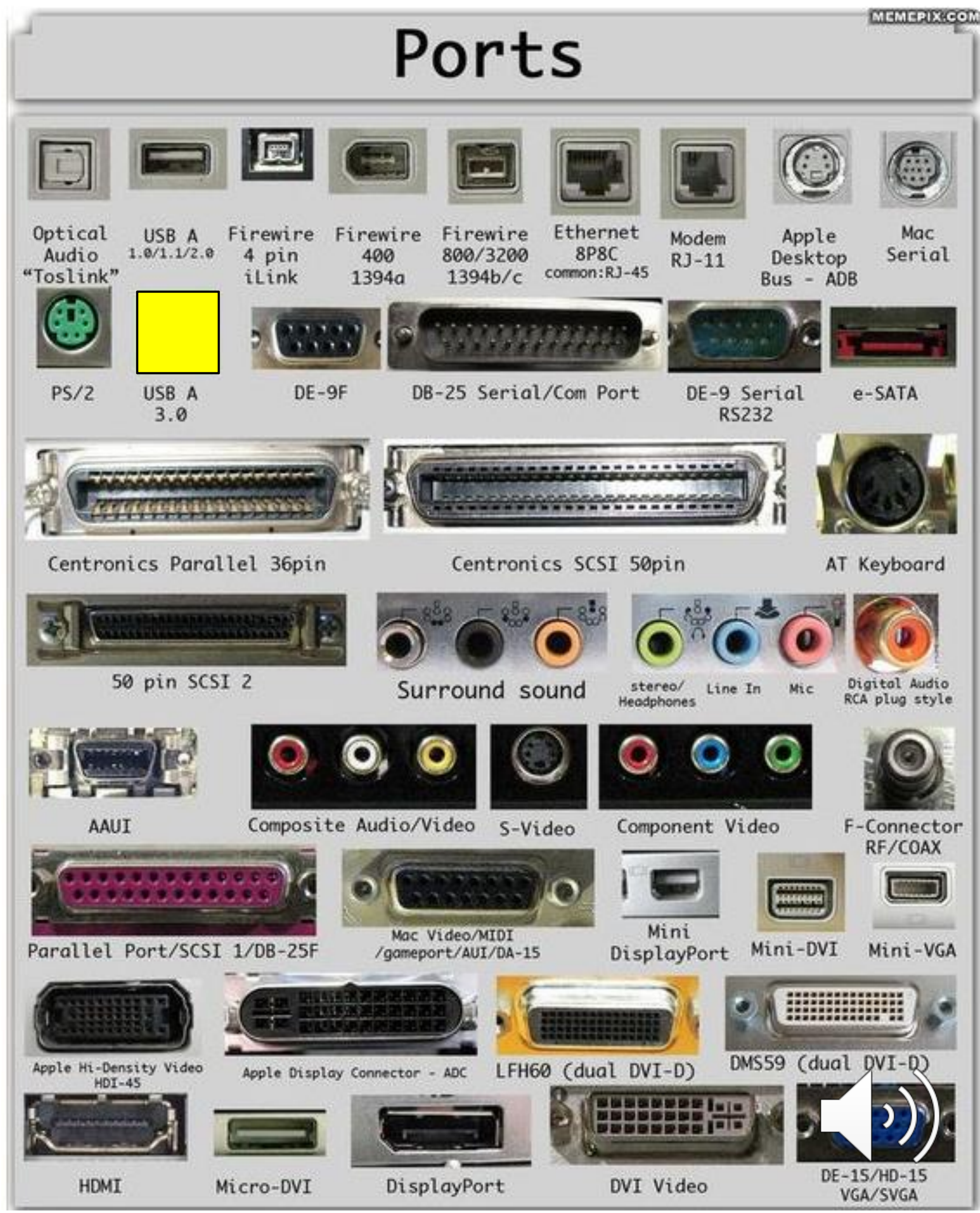
- On-board Connectors
  - **Jumpers** are connectors for electrical pins sticking up from motherboard
    - To set: (1) CPU frequency; (2) Front Side Bus frequency; (3) CPU voltage
    - Now many motherboards have auto-detection to do this for you
  - **Disc Drive** Connectors
    - **IDE** pins sticking up from motherboard *("parallel" ATA)*
    - **SERIAL ATA** (**newest**), flat red cable from motherboard
    - **RAID** (**R**edundant **A**rray of **I**ndependent **D**isks) *(redundant drives for fault-tolerance)*
- ATX **Power Connector** from power supply for 3.3 volts, 5 volts, and 12volts DC
  - 3.3 and 5 volts for digital logic circuits (e.g., CPU, RAM, chip set, etc.)
  - 12 volts for fan, disk drives, motors, etc.
  - May need special power for sophisticated cooling systems

PC Design Steps (<u>Pick Motherboard</u>) cont.

- **<u>USB</u>** (**<u>U</u>**niversal **<u>S</u>**erial **<u>B</u>**us)
  - Replacing all Parallel and Serial
    - Like DIN-5 PS/2 and AT Keyboard jacks
  - >100 peripherals simultaneously
  - Hot insertion and removal
- **<u>eSATA</u>** for external storage
- **<u>SCSI</u>** (**Small Computer System Interface**)
  - Connect multiple Hard drives
- **<u>FireWire</u>** for cameras and portable storage

- **<u>Network</u>** Ethernet jack “Rj-45”
- **<u>Dial-up</u>** phone jack (modem) “Rj-11”

- **<u>VGA</u>** (**<u>V</u>**ideo **<u>G</u>**raphics **<u>A</u>**rray)
- **<u>DVI</u>** (**<u>D</u>**igital **<u>V</u>**isual **<u>I</u>**nterface)
- **<u>Audio</u>** jacks
- **<u>HDMI</u>** (**<u>H</u>**igh-**<u>D</u>**efinition **<u>M</u>**ultimedia **<u>I</u>**nterface)
  - Audio and Video



Go To PART 2

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