

Computer Fundamentals

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Lecture 9





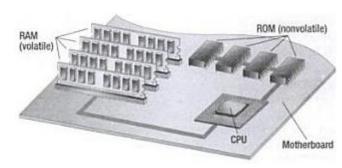
Memory

- > Stores open programs and data
- > Small chips on the motherboard
- > More memory makes a computer faster





- Non-volatile memory
 - ☐ Holds data when power is off
 - Read Only Memory (ROM)
 - Basic Input Output System (BIOS)
 - Start-up instructions for turning on the system
 - Boot-up information
 - □ Power On Self Test (POST)
 - Ensuring that system functioning properly
 - o Ensure presence of necessary hardware
- > Flash memory
 - Data is stored using physical switches
 - Special form of nonvolatile memory
 - ☐ Camera cards, USB key chains







- Volatile memory
 - ☐ Requires power to hold data
 - Random Access Memory (RAM)
 - □ Data in RAM has an address
 - CPU reads data using the address
 - ☐ CPU can read any address







- > SIMM
 - ☐ Single in-line memory module
 - ☐ Used from early 1980s to late 1990s
- > DIMM
 - □ Double in-line memory module
- > SO-DIMM
 - ☐ Small outline DIMM
 - Have small size
 - Designed for laptops





- SIMM vs. DIMM
 - □ DIMM has twice as many pins compared to SIMM
 - Although the number looks similar
 - Connectors on either side are connected to each other in SIMM
 - Electrical contacts redundant on both sides of module
 - □ SIMMs have 32-bit data path, while DIMMs have 64-bit data path





- > DRAM
 - ☐ Dynamic RAM, often used as main memory
 - ☐ Stores each bit of data in a capacitor
 - Capacitor either charged or discharged
 - o States represent two values of a bit,
 - Storage cell is dynamic
 - Needs to be recharged periodically to compensates for charge leaks
- > SRAM
 - ☐ Static RAM, often used as cache
 - ☐ Uses flip-flop circuitry to store each bit
 - ☐ Storage cell is static
 - Needs no periodic recharged
 - ☐ Still volatile, data lost when not powered
- > SDRAM
 - Synchronous DRAM
 - ☐ Kind of DRAM synchronized with clock speed of microprocessor
 - o Operation of external pin interface coordinated by clock signal

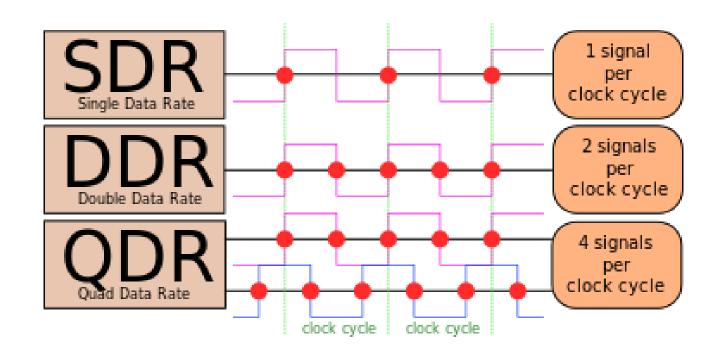




- > SDR SDRAM
 - ☐ Single Data Rate SDRAM
 - □ Transfers data on rising edges of clock signal
 - □ Delivers single bit of data per signal line per clock cycle
- > DDR SDRAM
 - Double Data Rate SDRAM
 - □ Transfers data on both rising and falling edges of clock signal
 - □ Delivers two bits of data per signal line per clock cycle
- QDR SDRAM
 - Quad Data Rate SDRAM
 - □ Transfers data on rising and falling edges, and two points in between
 - □ Delivers four bits of data per signal line per clock cycle











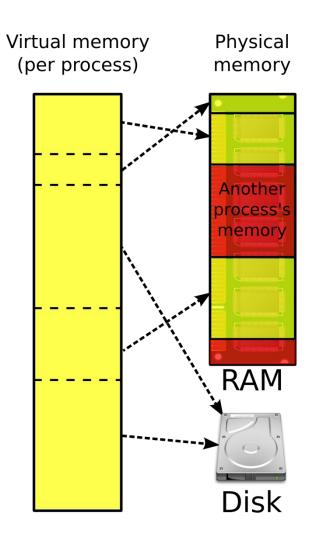
Components Affecting Speed

- > Registers
 - Number of bits processor can handle
 - Word size
 - o Indicates amount of data computer can work on at a time
 - ☐ Larger indicates more powerful computer
 - ☐ Increase by purchasing new CPU





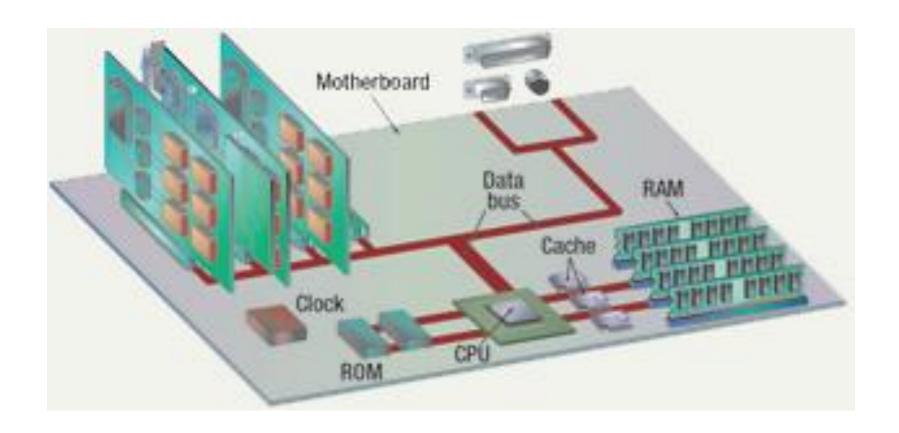
- Virtual RAM
 - □ Computer is out of actual RAM
 - Another drive used to emulate RAM
 - Computer swaps data to this virtual RAM
 - Least recently used data is moved





Source: https://en.wikipedia.org/wiki/Virtual_memory









- The computer's internal clock
 - ☐ Quartz crystal
 - Molecule vibrate at a fixed rate when electricity provided
 - Frequency determined by thickness of crystal
 - ☐ Every tick causes a cycle
 - Time for turning transistor off and back on again
 - Speeds measured in Hertz (Hz)
 - Modern machines use Giga Hertz (GHz)
 - Each instruction require a given number of clock cycles



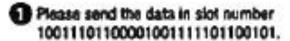


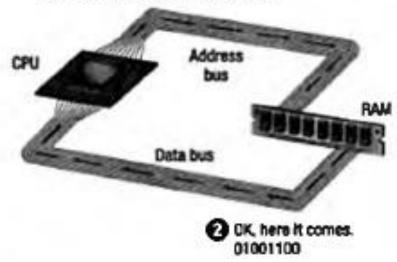
- > The bus
 - ☐ Electronic pathway between components
 - Expansion bus connects to peripherals
 - System bus connects CPU and RAM
 - o Data bus
 - Address bus
 - ☐ Bus width is measured in bits
 - Speed is tied to the clock

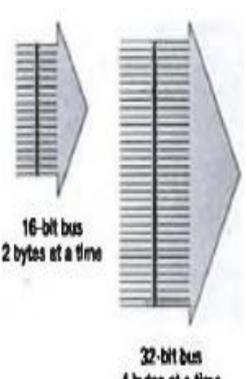




- System bus operation and sizes
 - □ Data bus connects CPU, memory and hardware
 - □ Address bus connect only CPU and memory
 - Carries memory addresses











8 bytes at a time





- Bus standards
 - ☐ Industry Standard Architecture (ISA)
 - □ Local bus
 - ☐ Peripheral component interconnect (PCI)
 - □ Accelerated graphics port (AGP)
 - ☐ Universal serial bus (USB)
 - ☐ IEEE 1394 (FireWire)
 - □ PC Card





- > Industry Standard Architecture (ISA) bus
 - ☐ 16-bit data bus
 - Widely used in 80's
 - ☐ Later on used for attaching slow devices
 - o Modems
 - Input devices
 - o Etc.
- > Local bus
 - ☐ Used to attach fast devices
 - Runs between components on motherboard





- > Peripheral control interface (PCI) bus
 - Connects video and sound cards to motherboard
 - Card can not access system memory directly
 - Card can only access its own memory
 - ☐ Found in most modern computers
- > Accelerated Graphics Port (AGP) bus
 - Connects modern video cards to motherboard
 - o Allows video card to access system memory directly
 - ☐ Extremely fast bus
 - 3-D support
- Universal Serial Bus (USB)
 - Connects external devices
 - ☐ Hot swappable
 - ☐ Allows up to 127 devices
 - Hub layout or daisy chain
 - ☐ For cameras, printers and scanners







- > IEEE 1394 (FireWire) bus
 - Connects cameras on Macintosh and IBM
- > PC Card bus
 - ☐ Used on laptops
 - ☐ Hot swappable
 - Devices are the size of a credit card
 - Expansion of memory



Bus Type	Width (bits)	Transfer Speed	Hot Swappable
AGP 8	32	2.1 GHz	No
FireWire	32	400 MHz	Yes
ISA	16	8.33 MHz	No
PC Card	32	33 MHz	Yes
PCI	32	33 MHz	No
USB 2.0	32	480 MHz	Yes



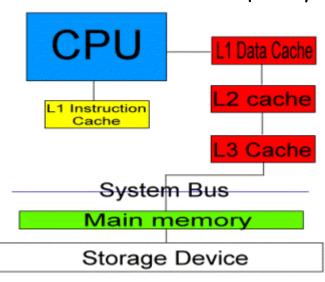


- > Modern microprocessors process data in short time
 - ☐ However, quick access to data required
- > If data not available, processor has to wait
 - ☐ Results in reduced performance
- > Current processors process instruction in nanoseconds (ns)
- > Time for fetching data from main memory is about 100 ns
- > Solution???





- > Make main memory faster
 - □ 1 ns memory extremely expensive
 - □ 100 ns memory widely used
- > Add cache memory right next to microprocessor
 - ☐ Placed on the same chip
 - ☐ Frequently used data and instructions resides in cache
 - ☐ Also RAM type
 - ☐ Improves overall performance
 - Fast access to frequently-used data and instructions





Source: http://www.pantherproducts.co.uk/index.php?pageid=cpucache



- > Cache memory
 - ☐ Very fast memory
 - ☐ Holds common or recently used data
 - ☐ Speeds up computer processing
 - Moving data between CPU and RAM takes time as RAM is slow
 - CPU checks if data is in cache
 - Most computers have several caches
 - o L1 holds recently used data
 - L2 holds potential upcoming instructions
 - L3 holds possible upcoming instructions

