



Computer Fundamentals

Dr. Safdar Nawaz Khan Marwat
DCSE, UET Peshawar

Lecture 9



Memory

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



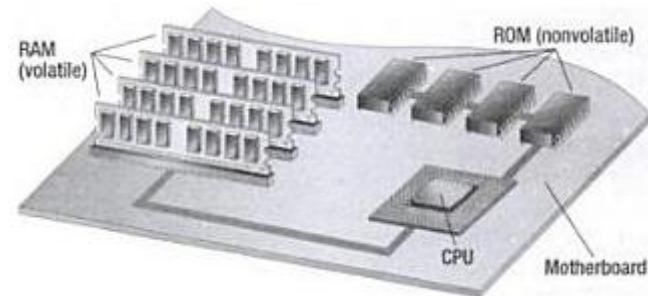
Memory (cont.)

➤ 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
 - Ensure presence of necessary hardware

➤ Flash memory

- ❑ Data is stored using physical switches
- ❑ Special form of nonvolatile memory
- ❑ Camera cards, USB key chains





Memory (cont.)

- 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





Memory (cont.)

- **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



Memory (cont.)

➤ 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



Memory (cont.)

➤ DRAM

- ❑ Dynamic RAM, often used as main memory
- ❑ Stores each bit of data in a capacitor
- ❑ Capacitor either charged or discharged
 - States represent two values of a bit,
- ❑ Storage cell is dynamic
 - Needs to be recharged periodically to compensate 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 recharging
- ❑ Still volatile, data lost when not powered

➤ SDRAM

- ❑ Synchronous DRAM
- ❑ Kind of DRAM synchronized with clock speed of microprocessor
 - Operation of external pin interface coordinated by clock signal

Source: <https://www.quora.com/What-is-the-difference-between-DRAM-SRAM-and-SDRAM-Which-one-is-the-best-RAM-technology>



Memory (cont.)

➤ 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

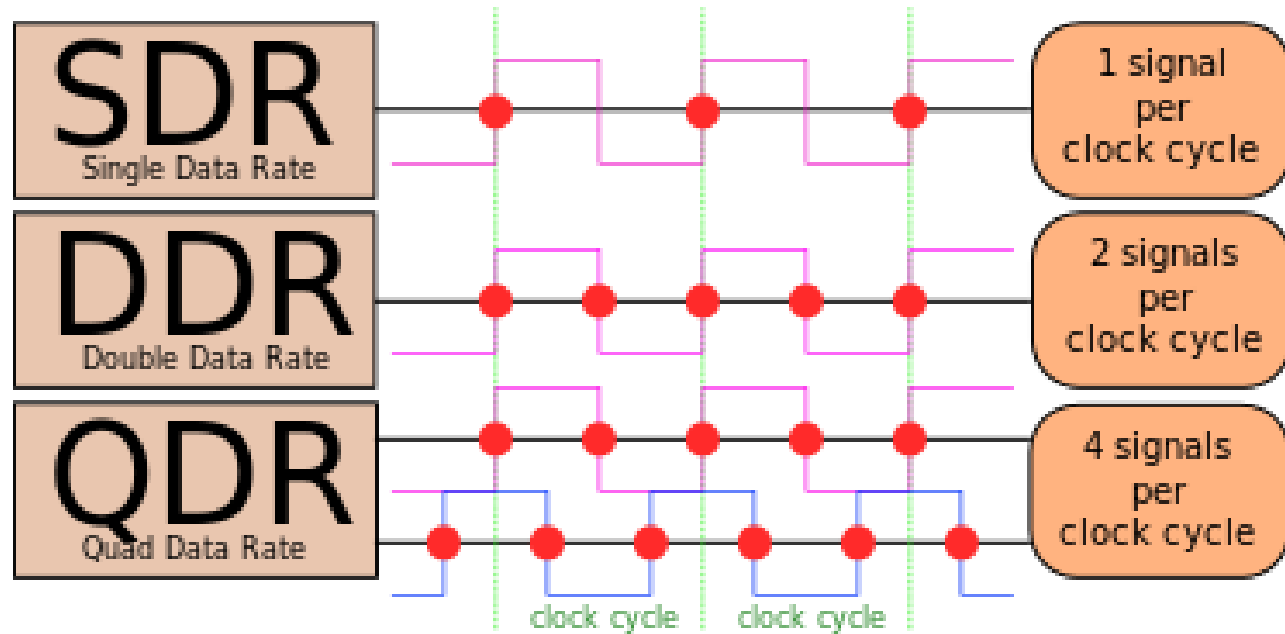
➤ QDR SDRAM

- ❑ 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

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



Memory (cont.)



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



Components Affecting Speed

➤ Registers

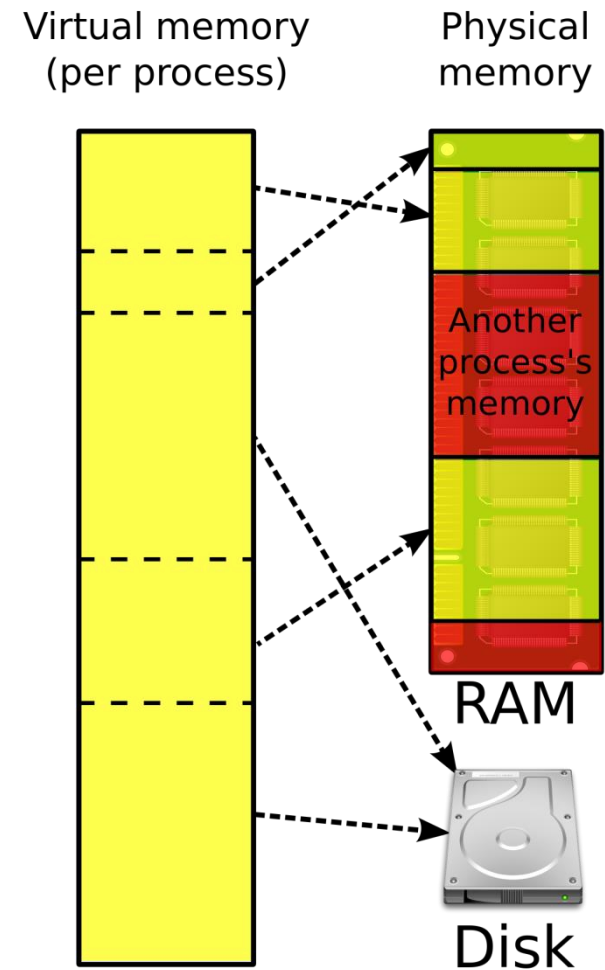
- ❑ Number of bits processor can handle
 - Word size
 - Indicates amount of data computer can work on at a time
- ❑ Larger indicates more powerful computer
- ❑ Increase by purchasing new CPU



Components Affecting Speed (cont.)

➤ Virtual RAM

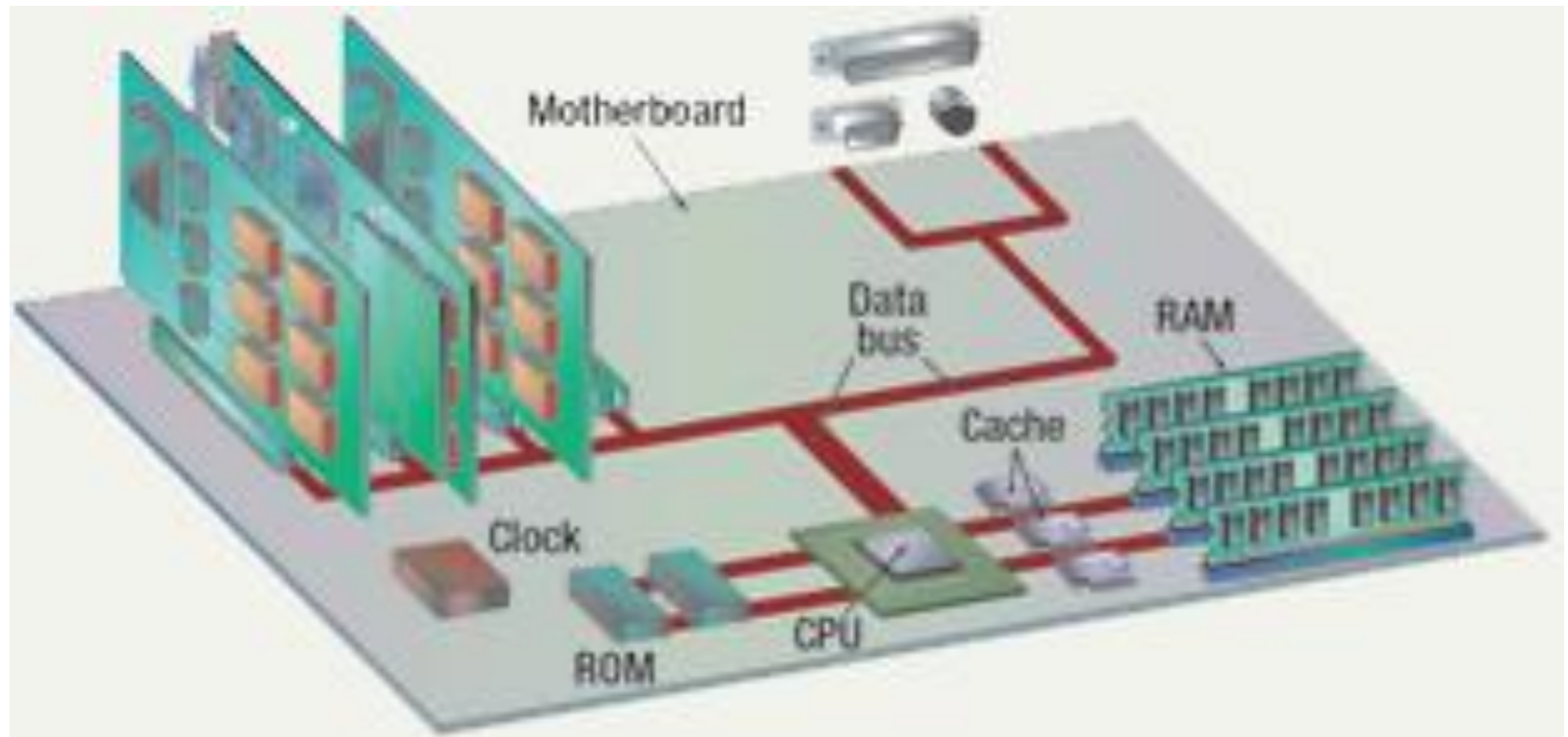
- ❑ Computer is out of actual RAM
- ❑ Another drive used to emulate RAM
- ❑ Computer swaps data to this virtual RAM
 - Least recently used data is moved



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



Components Affecting Speed (cont.)





Components Affecting Speed (cont.)

- 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



Components Affecting Speed (cont.)

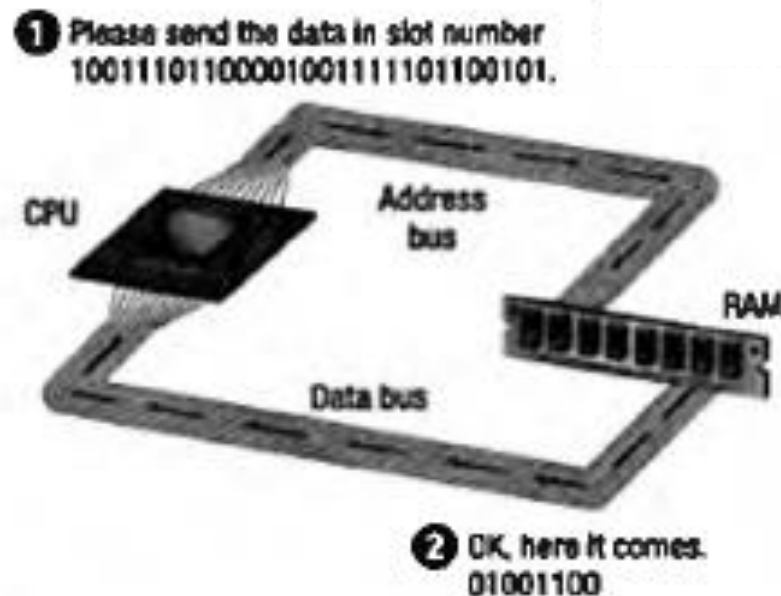
➤ The bus

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



Components Affecting Speed (cont.)

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





Components Affecting Speed (cont.)

➤ 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



Components Affecting Speed (cont.)

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



Components Affecting Speed (cont.)

- 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
 - 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



Source: https://www.reddit.com/r/raspberry_pi/comments/4upogl/question_daisy chaining_of_usb_for_up_to_10



Components Affecting Speed (cont.)

- 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



Performance Specifications of Common Buses			
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



Components Affecting Speed (cont.)

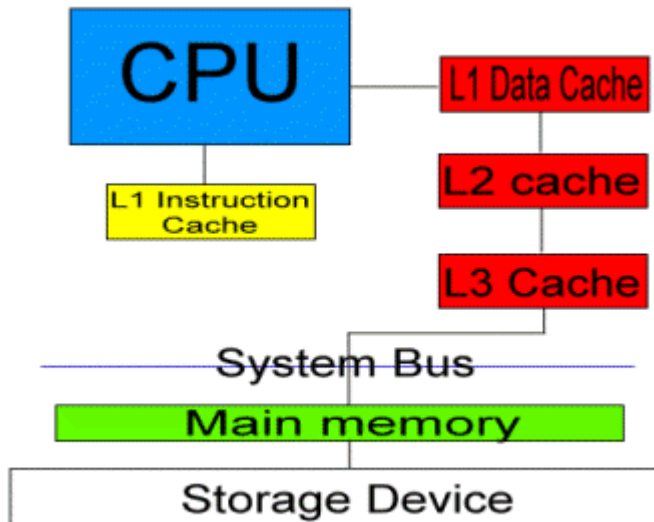
- Modern microprocessors process data in short time
 - ❑ However, quick access to data required
- If data not available, processor has to wait
 - ❑ Results in reduced performance
- Current processors process instruction in nanoseconds (ns)
- Time for fetching data from main memory is about 100 ns

- Solution???



Components Affecting Speed (cont.)

- 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>



Components Affecting Speed (cont.)

➤ 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
 - L1 holds recently used data
 - L2 holds potential upcoming instructions
 - L3 holds possible upcoming instructions

