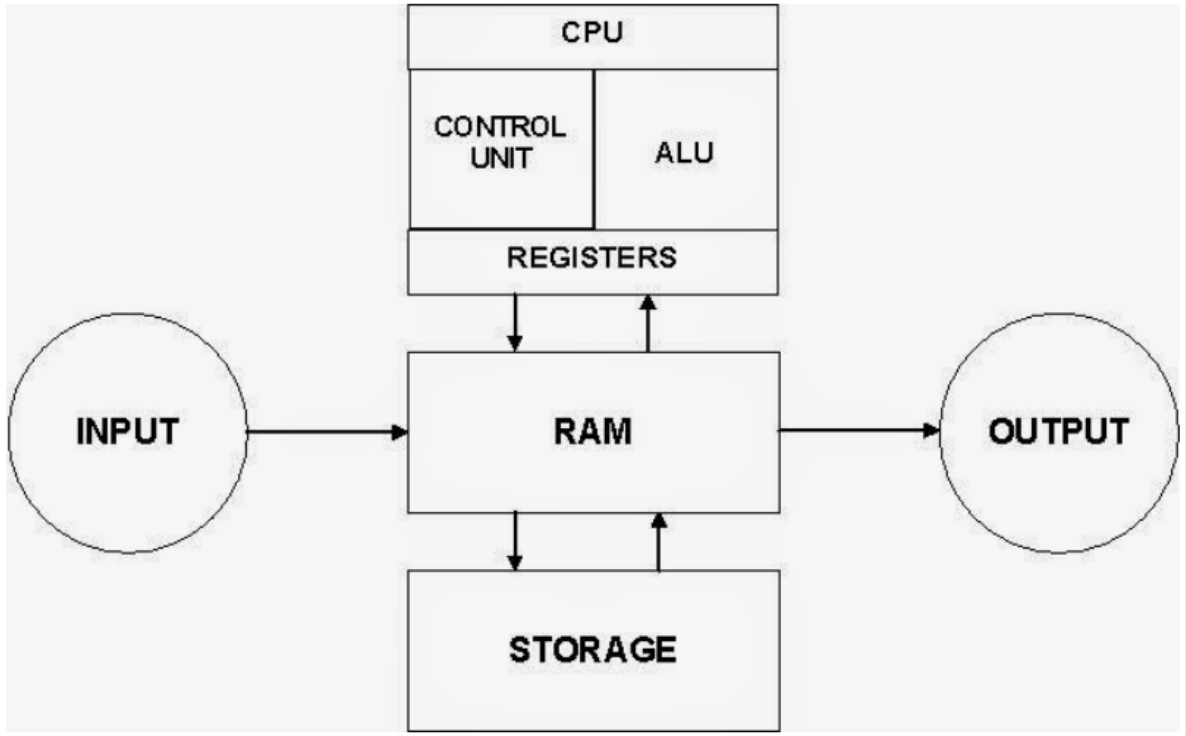
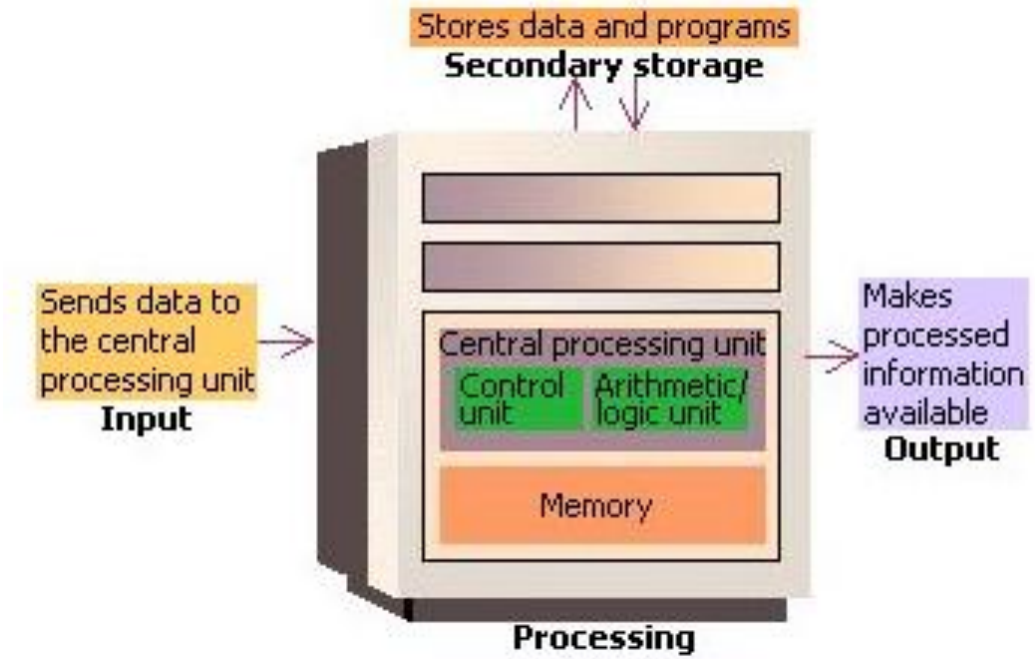
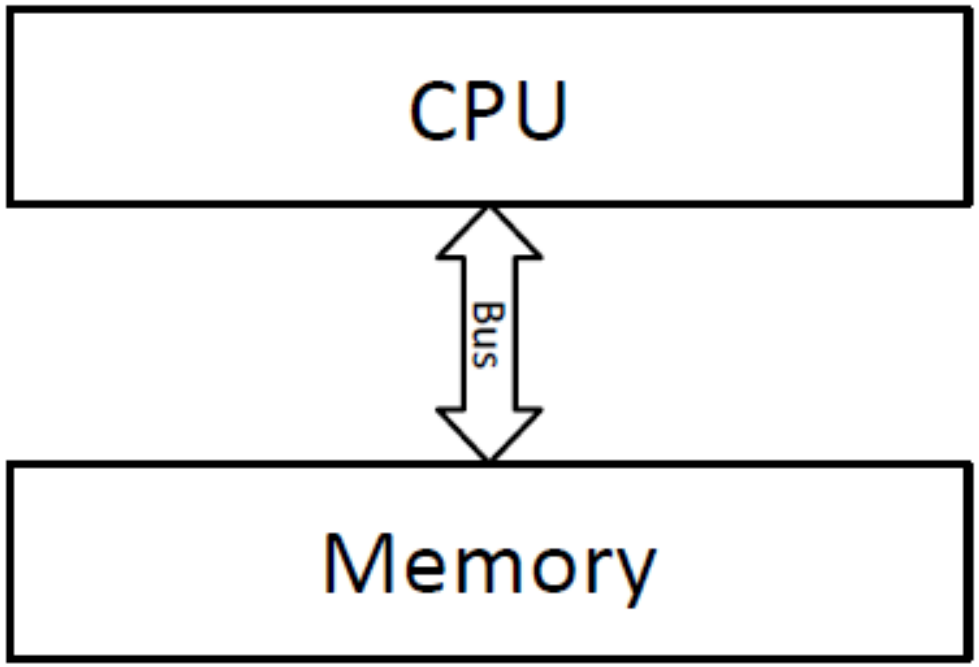
CS 520
Basic Computer Architecture

Basic Computer Components



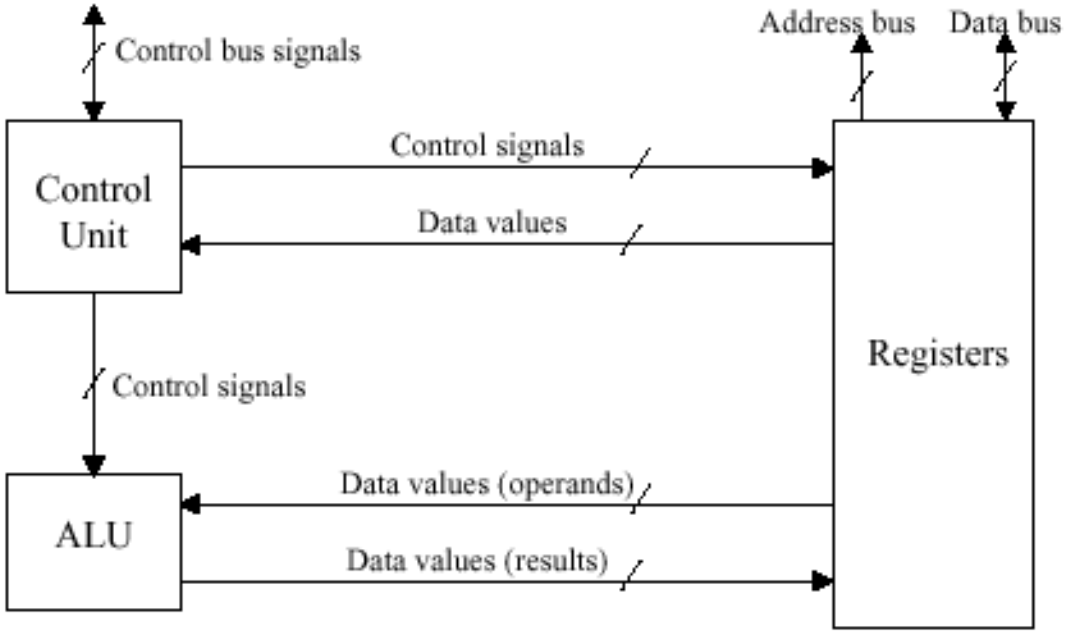


CPU Memory Interaction



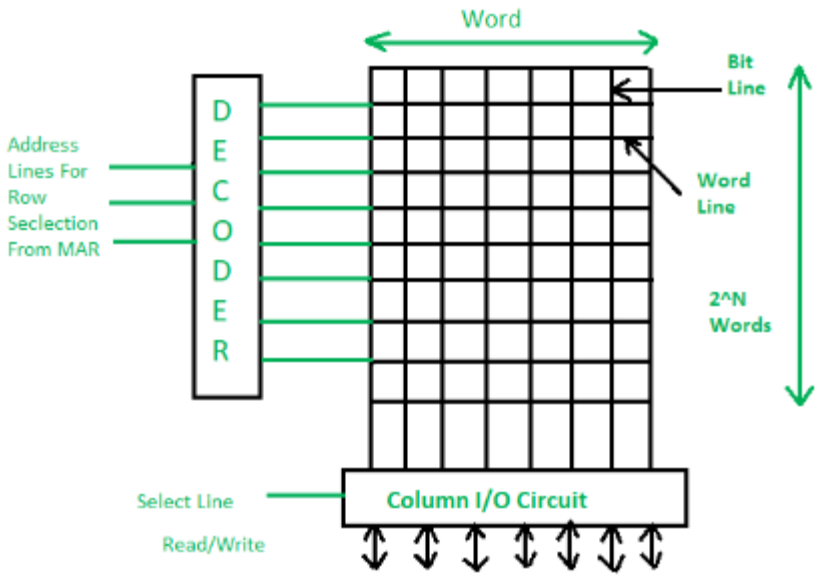
CPU

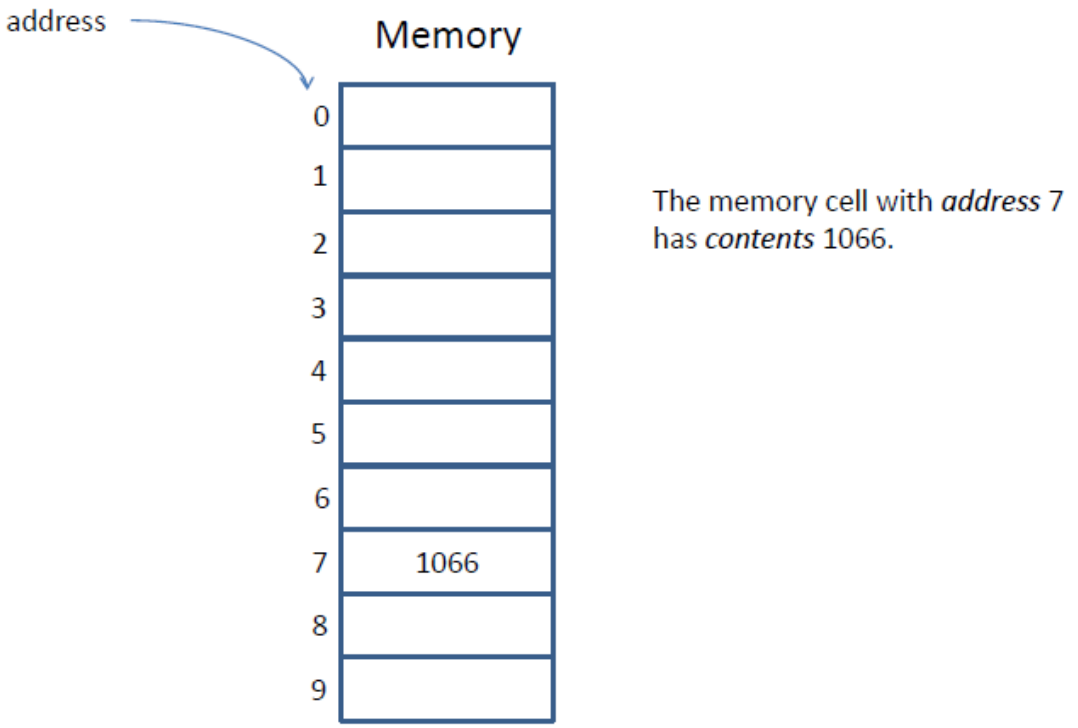
- Central Processing Unit
  - Control Unit – decides what to do
  - ALU (Arithmetic & Logic Unit) – does things
  - Registers: Units that hold values



Memory

- Stores instructions and data
- Array of cells
- Index of a cell is its ***address***
  - Address of a cell
  - Contents of a cell





The memory cell with *address* 7 has *contents* 1066.

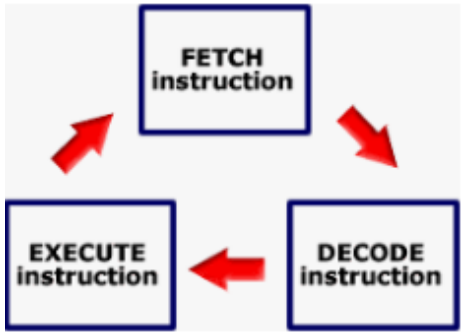
Memory Contents

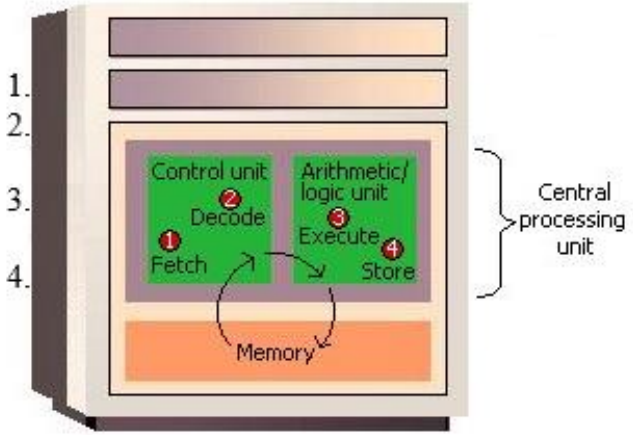
- Bits of information (0s & 1s)
- There is no tag indicating what kind of information (integer, floating point number, instruction, etc.) is in a cell
- It is all about how information is interpreted

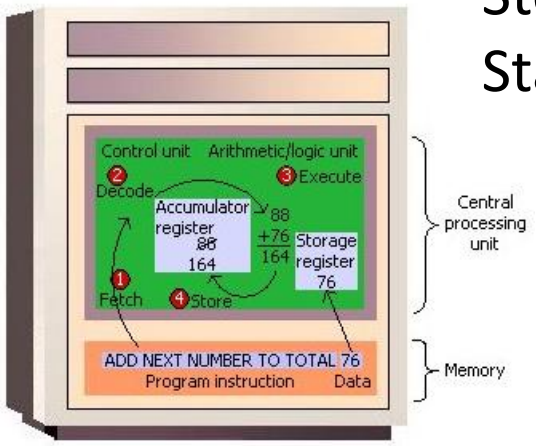
Example of an instruction

- Add contents of memory cell 10167 to Register 3, interpreting the two operand values as integers
- Note: the instruction must supply the interpretation of the bits being manipulated
- The operands themselves can come from different sources depending on the type of instruction (addressing format) – like memory & a register as in the above example
- This allows us to do tricky things like storing a value as integer, and later interpreting that as an instruction or something else!

Control Unit - Fetch Decode Execute Cycle







Fetch

- Determine address of next instruction
- Fetch next instruction
- Decode next instruction
- Fetch operands

Execute instruction

Store results

Start Fetch cycle again

Program Counter

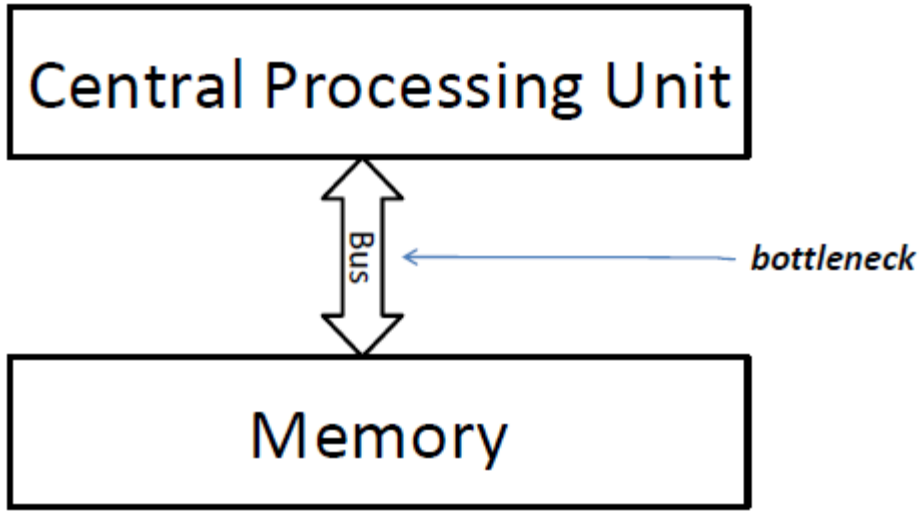
- There is a dedicated register that tracks the address of the memory cell that contains the next instruction to be executed
- The generic name for this register is the ***program counter (PC)***
- Normally it increments sequentially while it executes one instruction after another, but the PC can be changed directly in cases where the program needs to jump around to specific areas (for loops & repetition, for example)
- On the Intel IA-32 architecture, for example, the program counter is called the ***eip*** register (**e**xtended **i**nstruction **p**ointer)

Stored-Program computers

- Storing both the data and the program in memory is something that modern machines do
  - They are often referred to as stored-program computers also known as Von Neumann machines (attributed to the early computer architect Von Neumann)
- Storing the program in memory helps us:
  - To use Compilers and linkers
  - To create Self-modifying programs (dynamic linkers)
  - Just-in-time translation (Java bytecode to Intel machine code can be very slow) – program that modifies itself on the fly

Stored-Program computers

- Stored-Program computers also have some drawbacks due to the fact that all data & instructions must pass through the bus



- Memory is much slower than the CPU, so the CPU get stalled a lot while waiting for the data to be sent/received to memory (fetch, store for each instruction)