Computing Basics

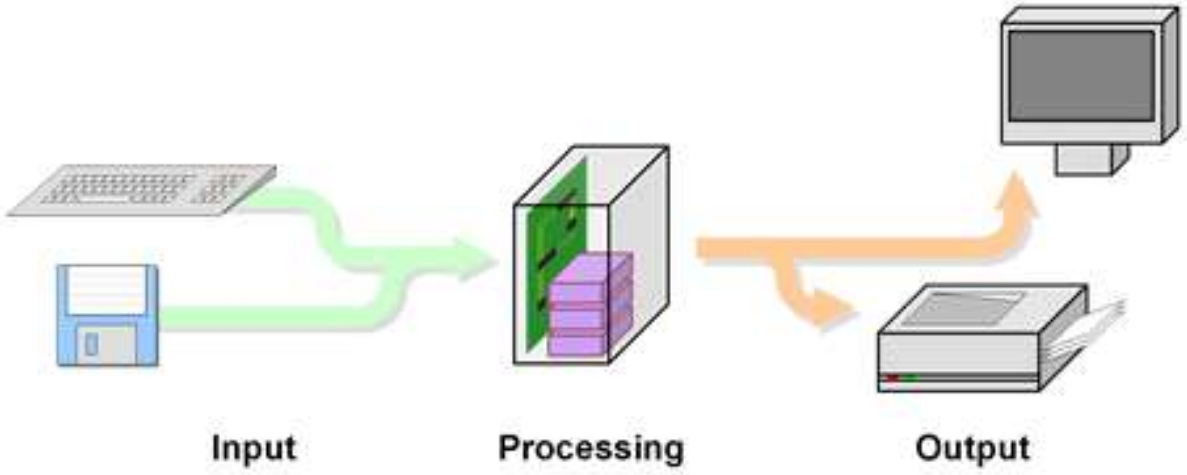
The Processing Model

Parts of a Computer

The Processing Model

- A computer processes information according to a set of instructions, and remembers what it did.

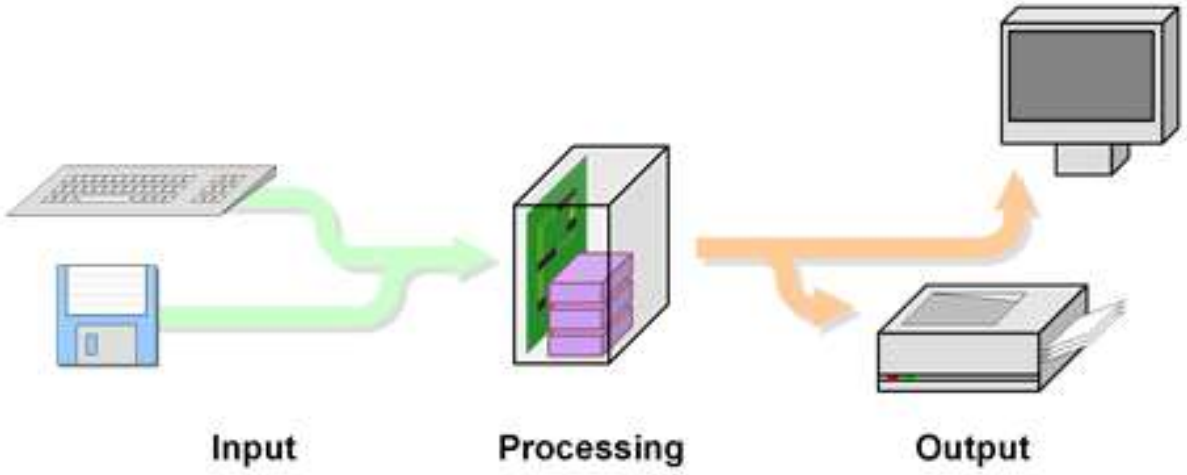
- We would thus expect a computer to have hardware for collecting input, performing ‘processing’ and producing output



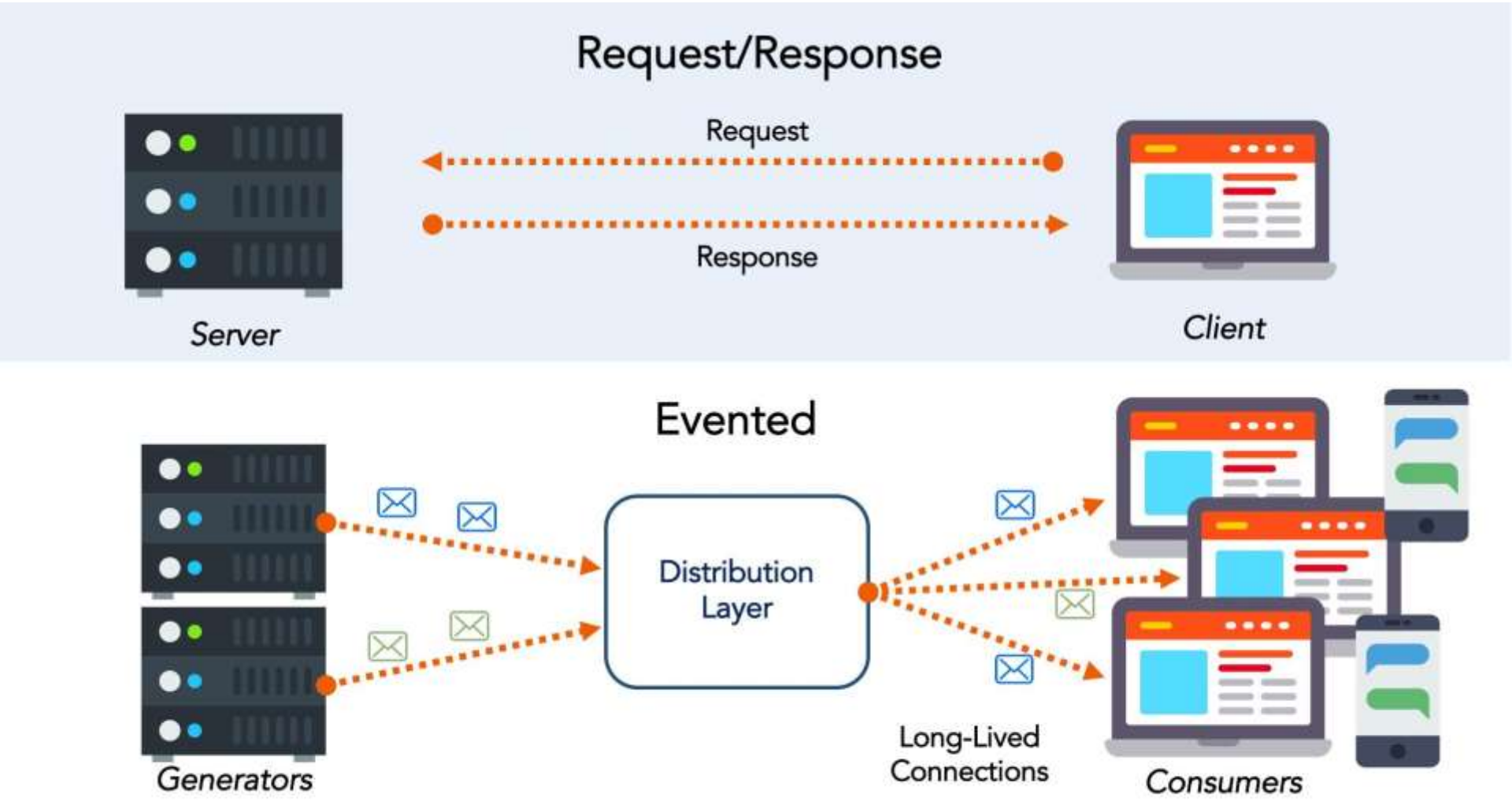
Hardware components

- A computer processes information according to a set of instructions

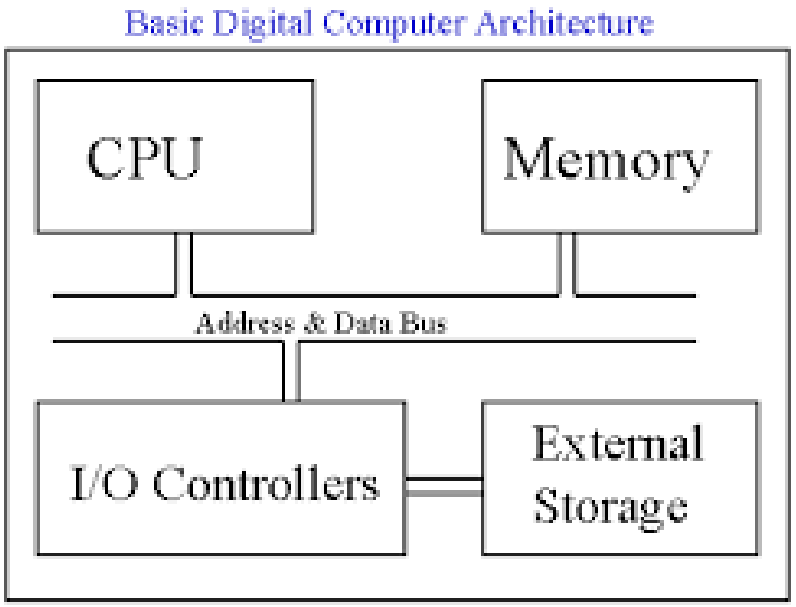
- We would thus expect a computer to have hardware for collecting input, performing ‘processing’ and producing output

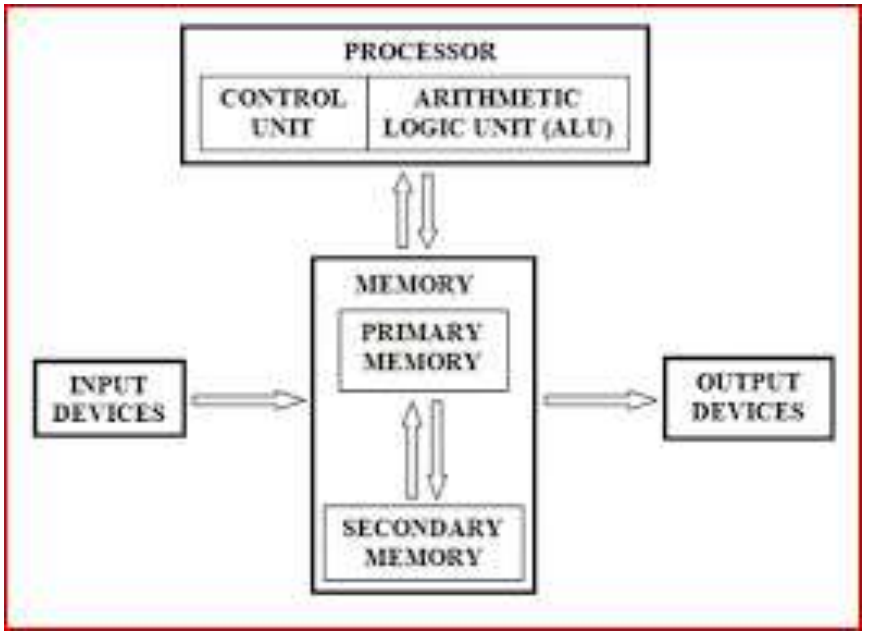


Event Driven Processing



Basic Computer Architecture

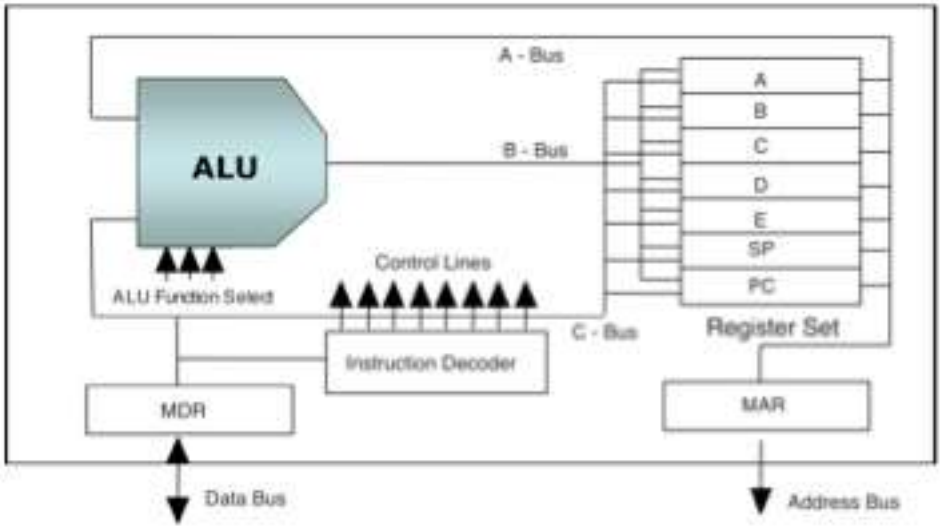




CPU

- Central Processing Unit (CPU) fetches, decodes and then executes instructions that perform
  - arithmetic
  - logic comparisons
    - e.g. “is number1 equal to number2 ?”
  - other operations
    - e.g. “skip the next 50 instructions”

CPU

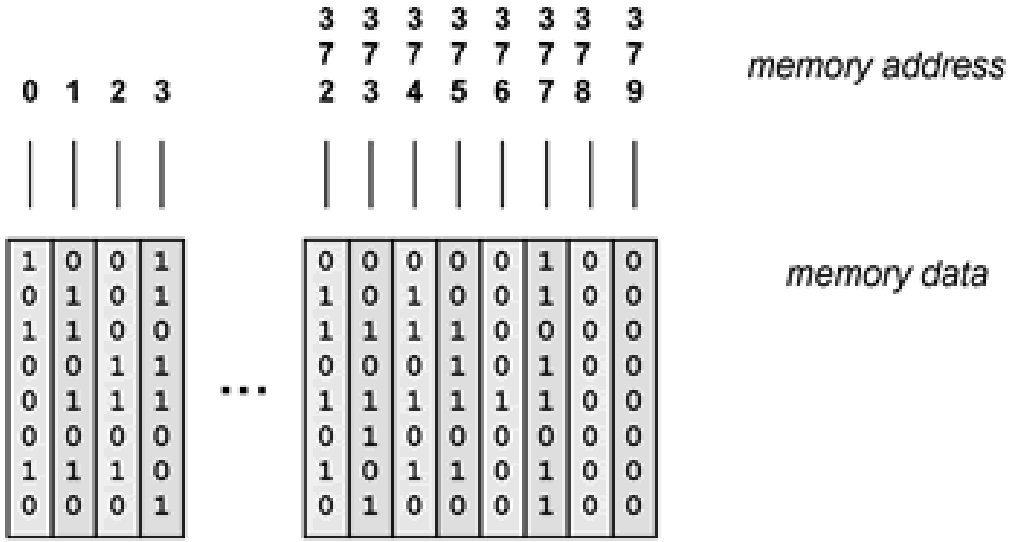


- *Arithmetic Logic Unit* (ALU) performs arithmetic and logic functions
- *Registers* - high speed 'scratch pad' to store data currently being processed
- *Memory Buffer Register* (MBR) – stores data just received from, or about to be written to memory
- Memory Access Register (MAR) – stores address of memory to be accessed next
- *Program Counter* (PC) – stores address of next instruction

Memory

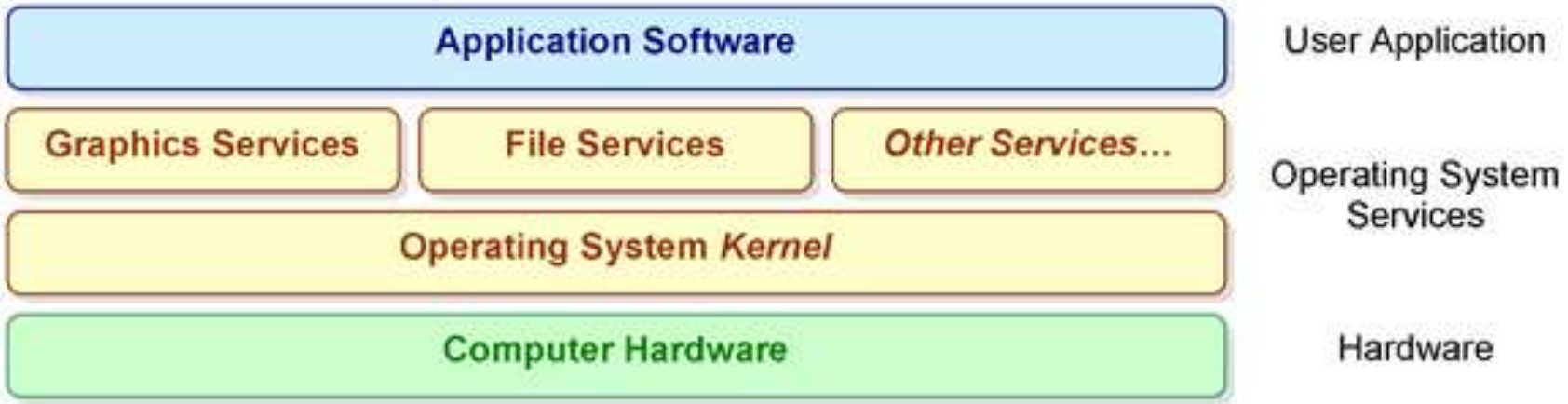
- Each byte of memory has an address
  - numbered sequentially
  - individual bits not addressable, just (usually) bytes

- An address length of N bits can express 2^N numbers ($0..2^{N-1}$)
  - so maximum size of memory limited by length of address



Operating system

- Provides a layer between hardware and user applications
  - attempts to protect hardware from user
  - manages resources in efficient and ‘fair’ manner
  - hides hardware details from user and application programmer



System Basics

Typical desktop system

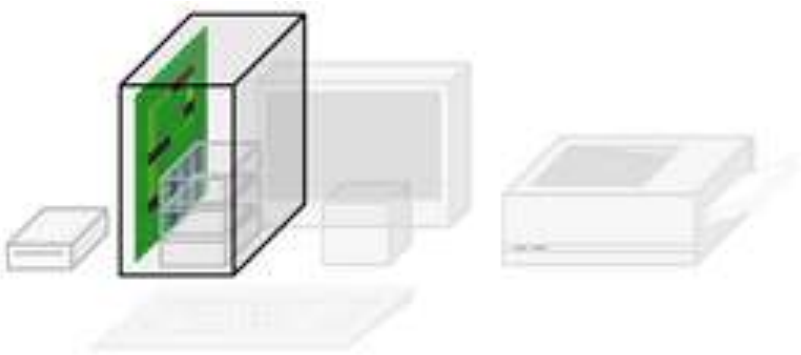
Desktop motherboard architecture

Data links & legacy connections

Data error detection and correction

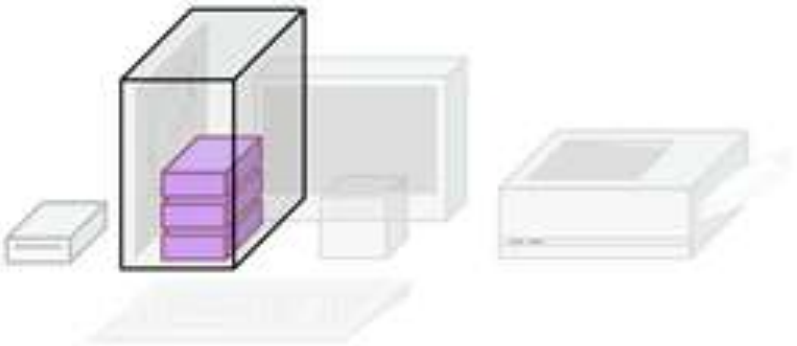
Coding schemes

A computer system

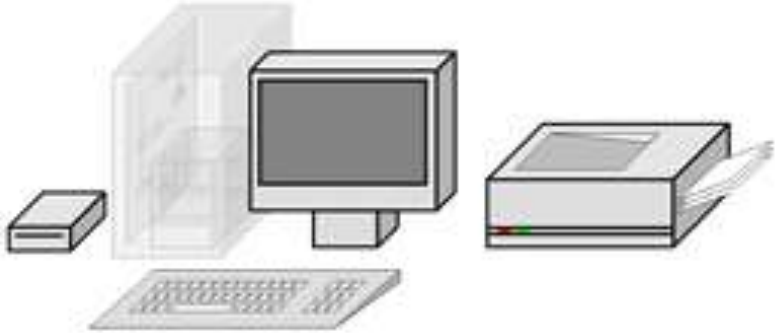


- Motherboard
  - main printed circuit board (PCB)
  - houses CPU socket and slots for main memory
  - expansion slots
  - expansion card functions are increasingly being moved to the motherboard

A computer system



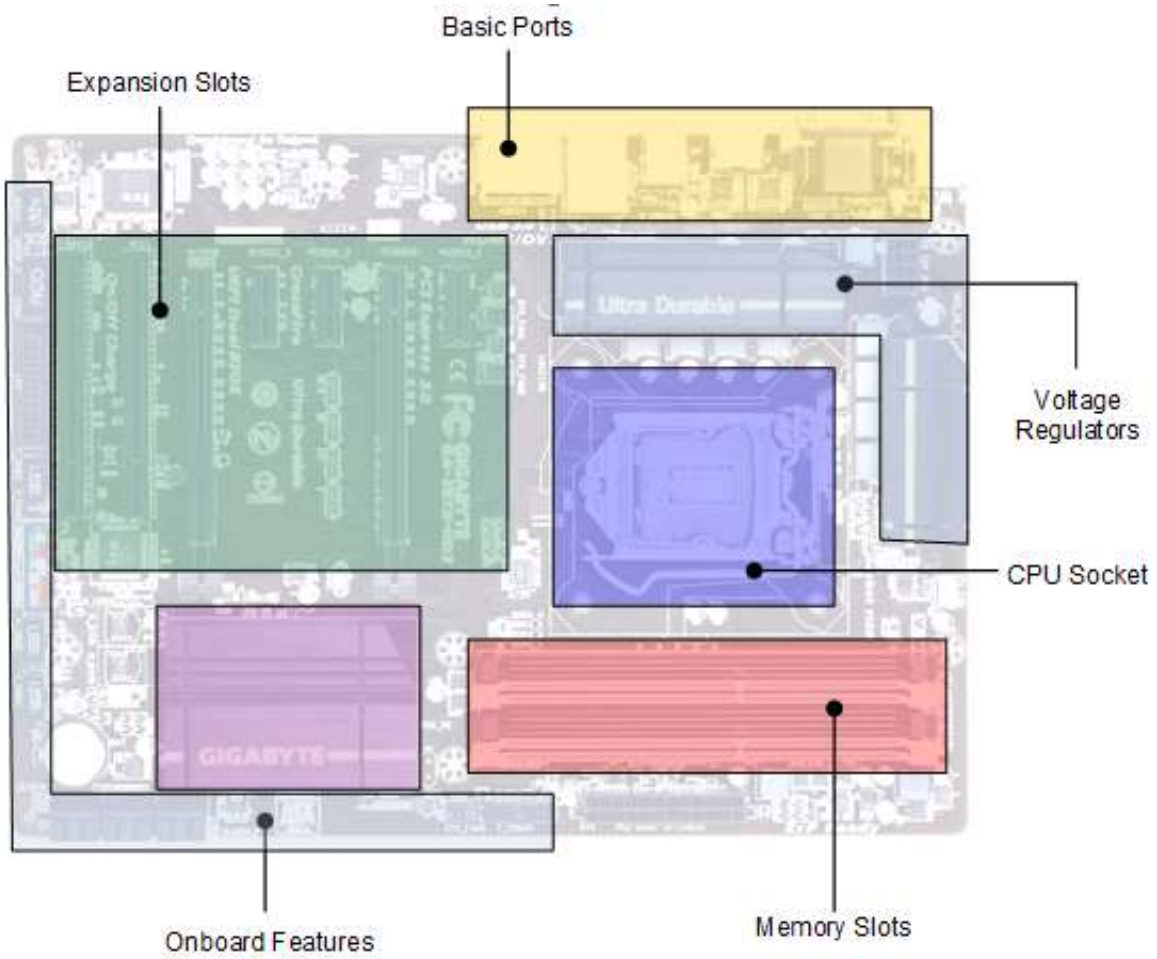
- Internal Expansion
  - inside computer case
  - expansion cards such as network cards, graphics cards etc.
  - internal hard drives



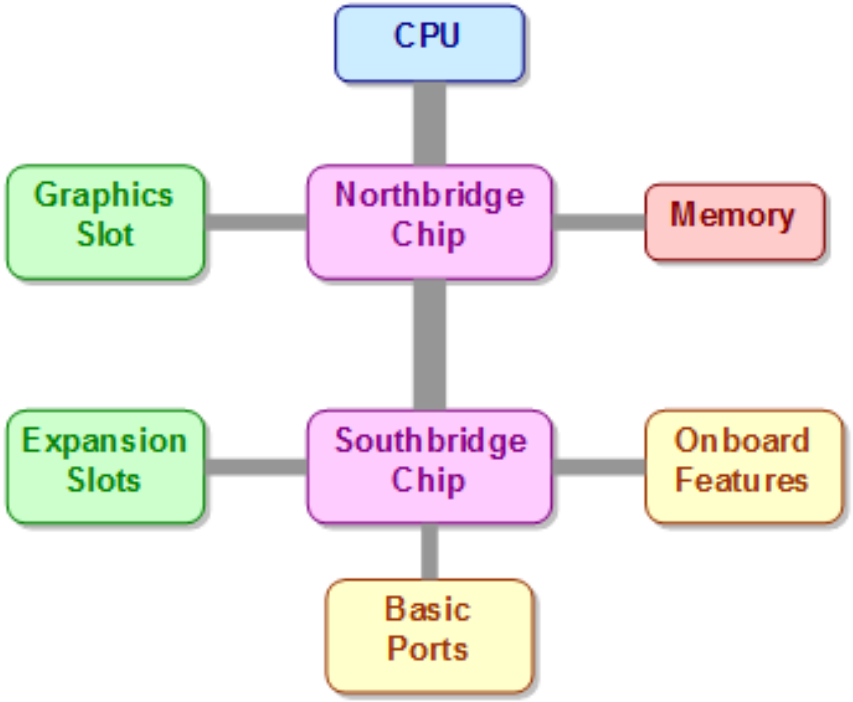
- External Expansion
  - outside computer case
  - non-critical functions
  - peripherals such as keyboards, mice, printers etc.

Desktop motherboard architecture

Photo: Gigabyte Co



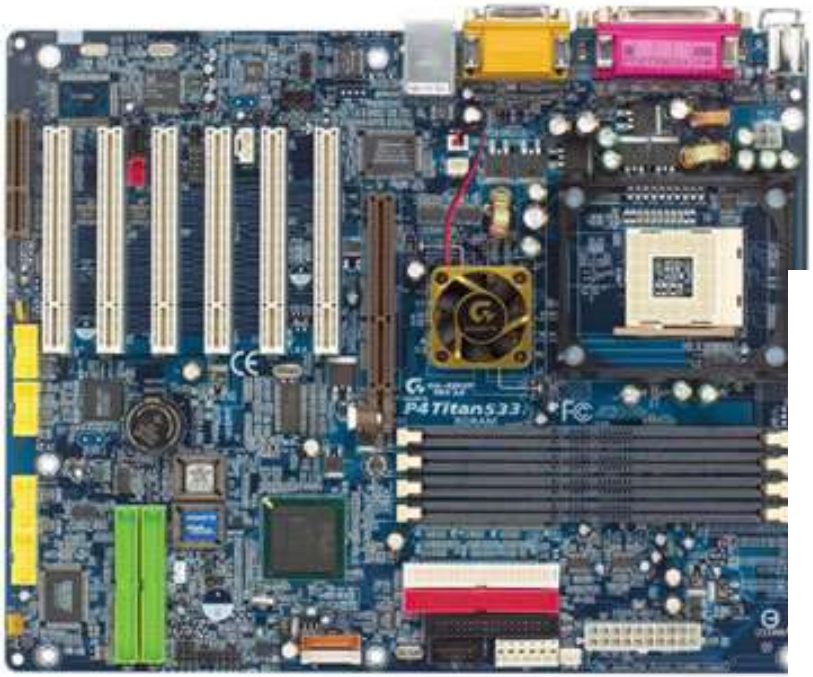
Chipset: Legacy



- CPU interacts with many components
- Chipset controls communication between CPU and other components

- Northbridge chip connected directly to CPU (to minimise latency) and handled high-speed components (e.g. RAM)
- Southbridge connected to northbridge and handled slower components (e.g. disk drives)

Chipset: legacy



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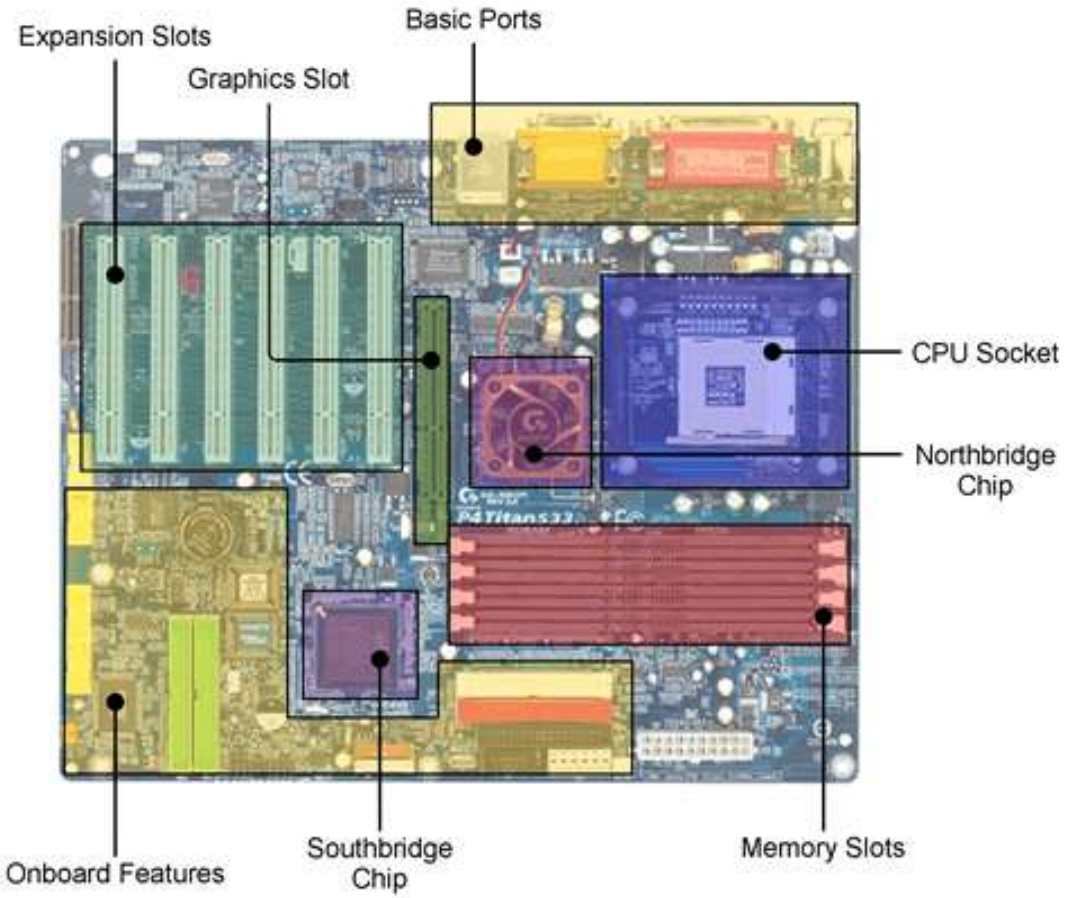
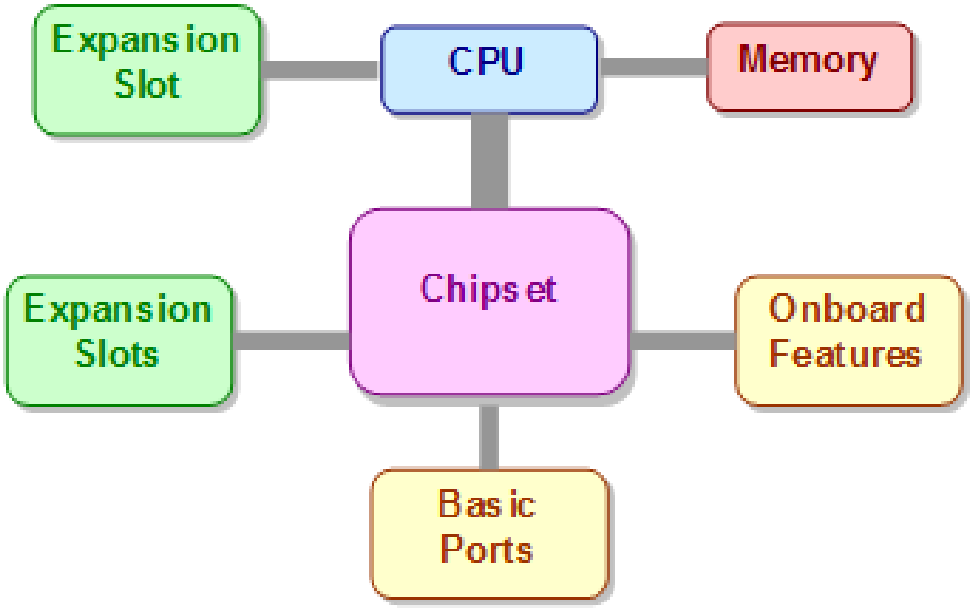


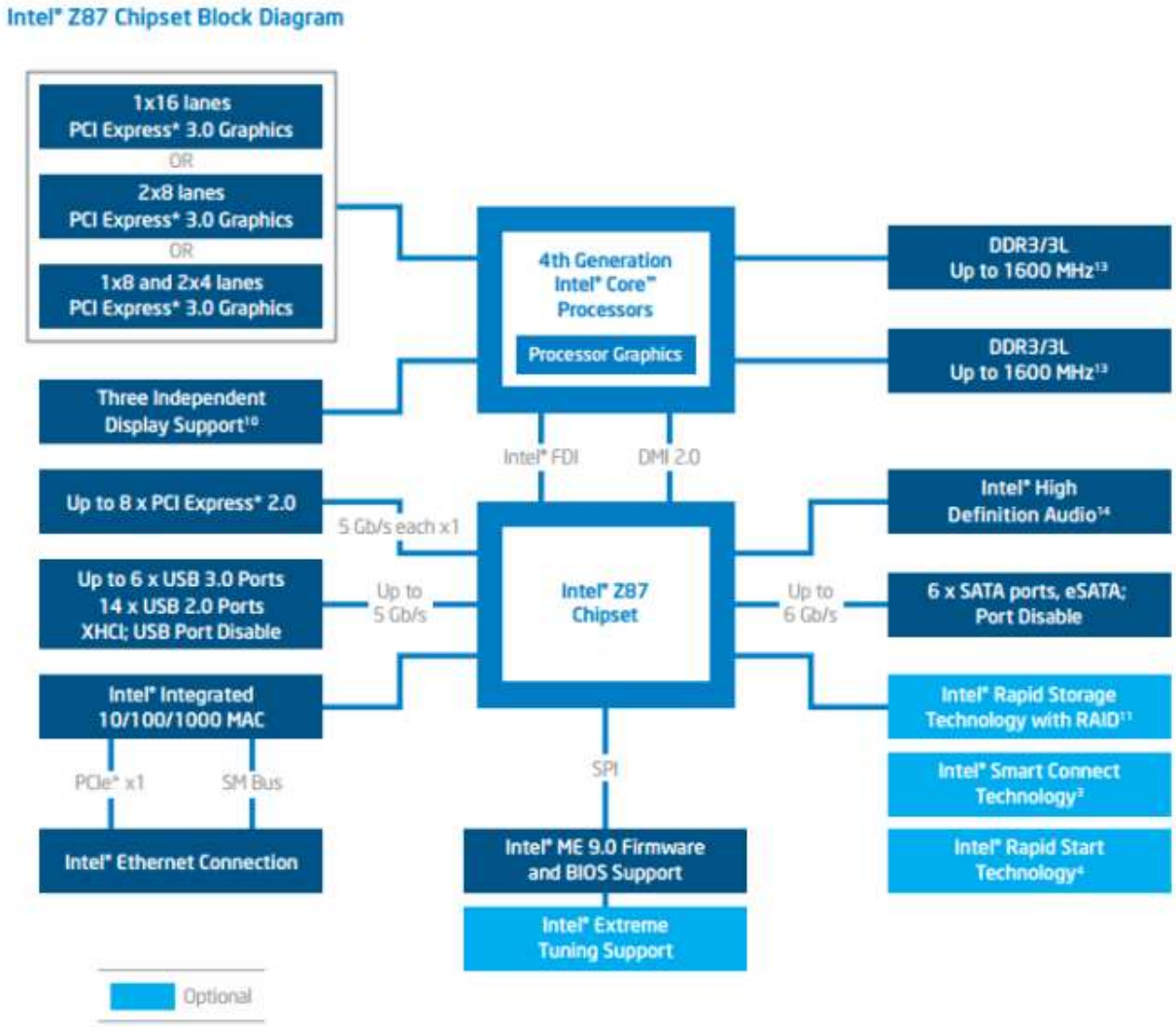
Chipset: modern



- As manufacturing techniques improved and more complex CPUs became possible, control functions migrated to the CPU
  - e.g. memory controller
  - e.g. high speed expansion interfaces

- Northbridge remnants and southbridge merged into a single 'chipset'
- Smartphones etc. use a combined CPU & chipset & memory: 'System on a chip'

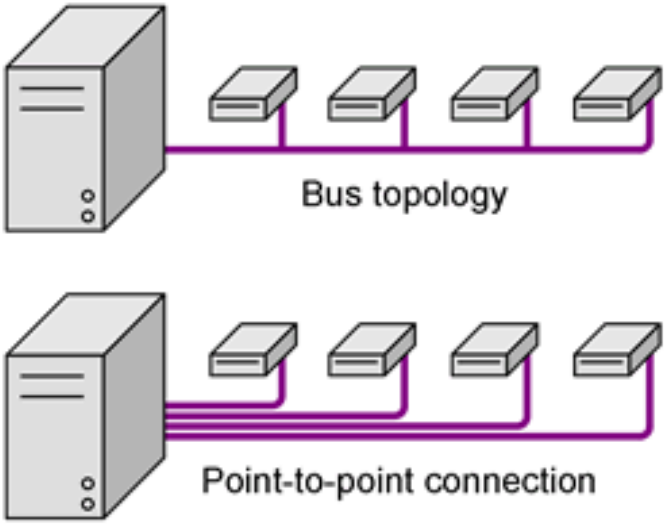
Chipset: modern



- Intel Z87 chipset
  - high level of integration

diagram: Intel Corporation

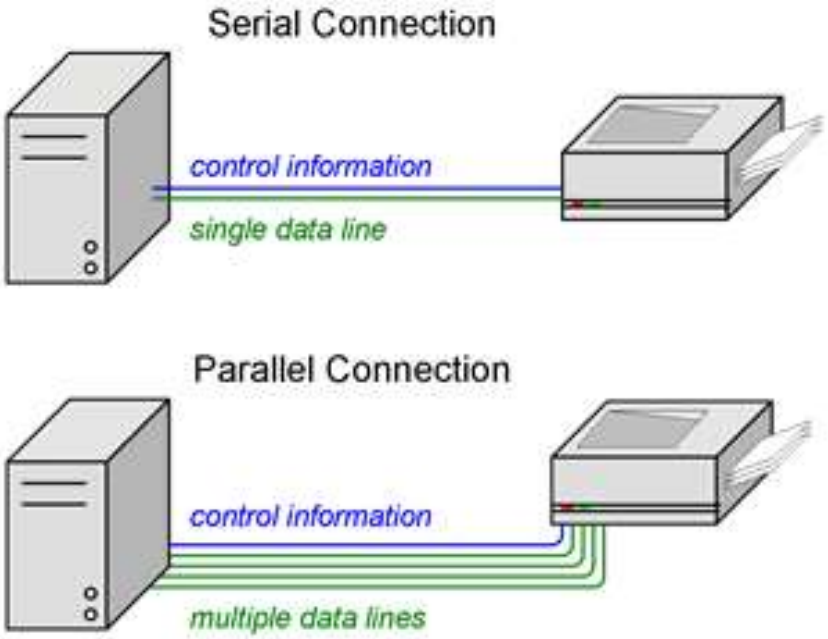
Data links



- Between components are data links
- Typical topologies are bus (most common) verses point-to-point

Data transfer is either:

- Serial: one bit at a time sent on a single wire
- Parparallel: multiple wires used to transfer multiple bits at the same time



Data links

- Parallel connections tend to suffer from electrical cross-talk
  - so serial can transfer data reliably over a longer distance
  - serial transfer common now for peripherals due to increased computer interface speeds

Devices differ in when they can be connected:

- *Hot-swappable*: can be plugged in or unplugged while the computer is switched on
- *Warm-swappable*: can be plugged/unplugged when computer is in sleep mode
- *Cold-swappable*: should only be plugged/unplugged after switching off the computer
  - otherwise you risk data loss, or a computer crash, or a dangerous short circuit

Legacy interfaces

- A legacy interface is one that has been superseded but persists for various reasons
  - e.g. large existing stock of devices using it
  - good enough or cheap enough to continue to provide it

- e.g. legacy keyboard & mouse ports
- legacy parallel port

- e.g. legacy AT keyboard connector & PS/2 mouse connector verses more modern USB connector

Legacy interfaces

– e.g. ye olde RS-232 serial port (since the 1960s!)

– e.g. a parallel printer cable