Machine Architecture
CPU Architecture

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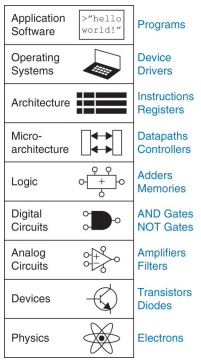
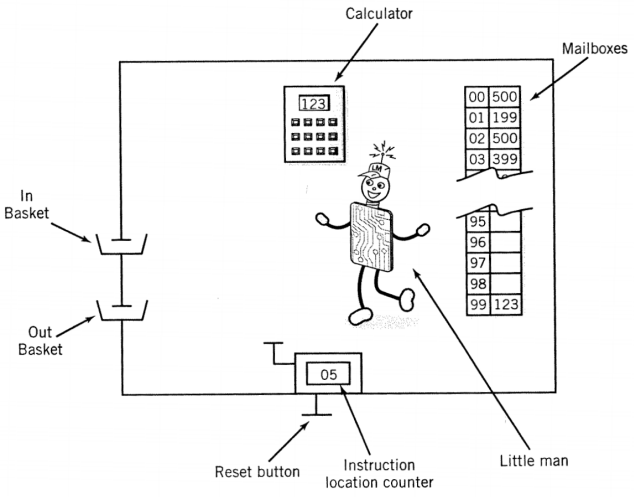
Levels of abstraction

Machine architecture
Second half of term

Digital electronics
First half of term





Mailboxes have a 2-digit address, so 100 mailboxes is the limit.

Each mailbox contains a slip of paper with 3 digits on it.

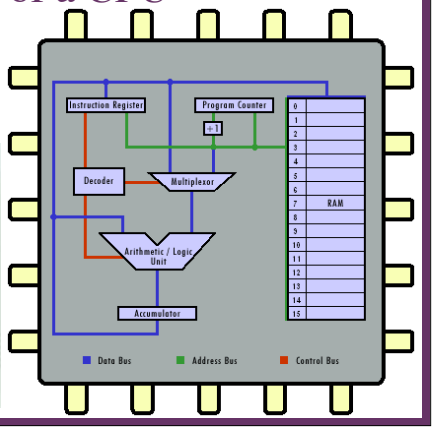
There is a calculator, which can only display 3 digits.

There is a 2-digit counter with two buttons on – the first button increment the counter by 1, the other resets it to 00.

There is an input and output tray – the user can put slips of paper with 3 digits on in the input tray, to be read when the little man next looks at his in tray.

Likewise the little man can write 3-digit notes and put them in the out tray, to be read by the user.

Components of a CPU



Five major components

Memory – RAM – 'the mailboxes'

Registers – special memory locations that can be accessed very fast.

Three registers are shown: the Instruction Register (IR), the Program Counter (PC), and the Accumulator.

Arithmetic/Logic Unit (ALU) – 'the calculator'

Buses – bundles of tiny wires that carry data between components.

The three most important buses are the address, the data, and the control buses.

Control Unit – responsible for directing the flow of instructions and data within the CPU.

In the diagram the Decoder and the Multiplexor compose the Control Unit.

Components of a CPU

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Registers

"Work space" of the CPU

Storage locations in the CPU, often with a defined purpose and wired to perform that purpose.

Hold a binary values temporarily for:

- Storage
- Manipulation
- Calculation

Manipulated directly by the Control Unit (CU)

Size of registers can vary from 1 to 128 bits

Registers

Accumulator - Considered part of the ALU

General purpose registers used for

- Holding data
- Holding interim and final results of arithmetic operations
- Holding data waiting to be transferred between different memory locations
- Holding data waiting to be transferred between I/O and main memory

Registers

Registers in the Control Unit:

The Program Counter (PC)

Holds the address of the next instruction to be executed

Instruction Register (IR)

Holds the actual instruction being executed

Flags

1 bit registers used to keep track of special conditions

E.g. Arithmetic carry, Overflow, Power failure, Internal computer error

Flags are grouped together in one or more status registers (SR)

Registers

Memory management

Memory Address Register (MAR)

Holds the address of a memory location to be accessed

Is always written to – never from

Memory Data Register (MDR)

Holds the value that is being stored to or retrieved from the memory location currently addressed by the MAR

May be written to or from

Also known as the Memory Buffer Register

Buses

The physical connection that makes it possible to transfer data from one location in a system to another is called **a bus.**

Buses are used to:
- Transfer data between the different points on the CPU
- Transfer data between the CPU and main memory
- Transfer data between computer peripherals and the CPU

A bus is a group of electrical conductors (**lines**) used to carry signals.
Four general categories of lines:
- **Data**
- **Address**
- **Control**
- **Power**

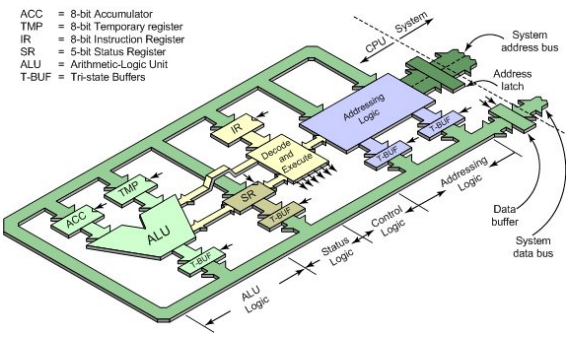
Buses

Point-to-point
Bus carries the signal from a specific source to a specific destination
e.g. Home PC to printer

Broadcast
Bus used to carry signals to many different devices

Bus Interface Bridges
Allow communications between the different buses
External Bus
PCI – Peripheral Control Interface bus
USB – Universal Serial Bus

Components of a CPU



Binary

So far a real CPU looks very much like the LMC, but with a few more instructions.

Of course, in a real CPU, everything is in **binary**…

So we need to know how to:

- represent numbers in binary
- represent negatives
- add, subtract, multiply and divide binary numbers