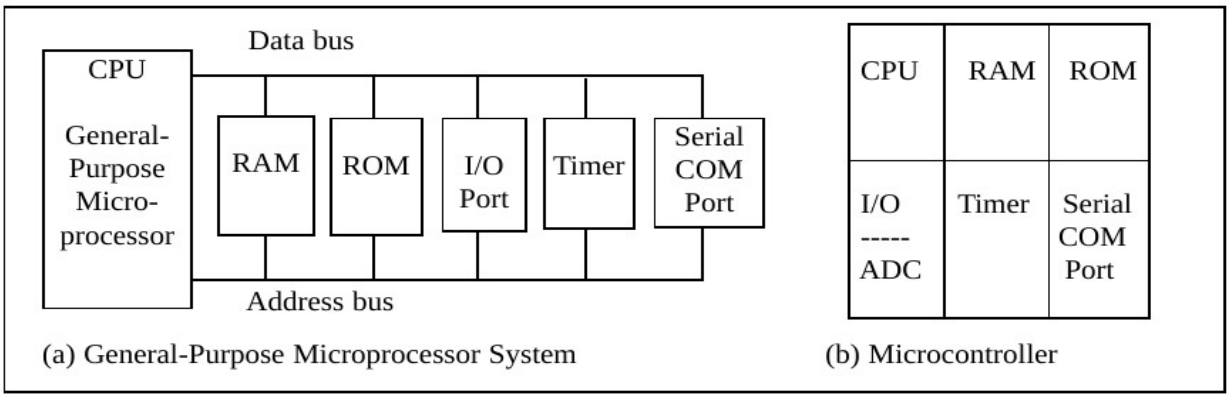
MODULE 1: EMBEDDED SYSTEMS & AVR MICROCONTROLLER ARCHITECTURE

A microcontroller is a single chip computer. In addition to the CPU, it contains RAM, ROM, I/O ports, Timers etc. It is mostly used in embedded systems. Examples of 8 bit microcontrollers are: Intel 8051, Atmel's AVR, Zilog's Z8, Microchip's PIC. These are different from each other in their architecture, registers, instruction set etc. So programs written for one microcontroller will not run on the others. So for selecting a microcontroller, three factors are commonly considered.

1. It must fulfil the task efficiently and cost effectively, which includes
   - Speed, Packaging, Power consumption, capacity of RAM and ROM, I/O pins and timers
2. Availability of software and hardware development tools such as compilers, assemblers, debuggers, and emulators.
3. Availability of the microcontroller in required quantity.

Comparison of Microcontroller with Microprocessor:

Microcontroller	Microprocessor
Special purpose	General purpose
Contains RAM, ROM and IO ports in the chip	RAM, ROM and I/O ports are to be added externally
Not able to add extra memory or I/O ports	Flexible to add extra memory or I/O ports
Used in Embedded systems (appliances like Printer, TV, Camera, Security systems etc.)	Generally used in Computers
Use single voltage power	Use many levels of voltage power
Use more number of registers	Use less number
Generally based on Harvard architecture	based on Von Neumann model



AVR Microcontroller Architecture:

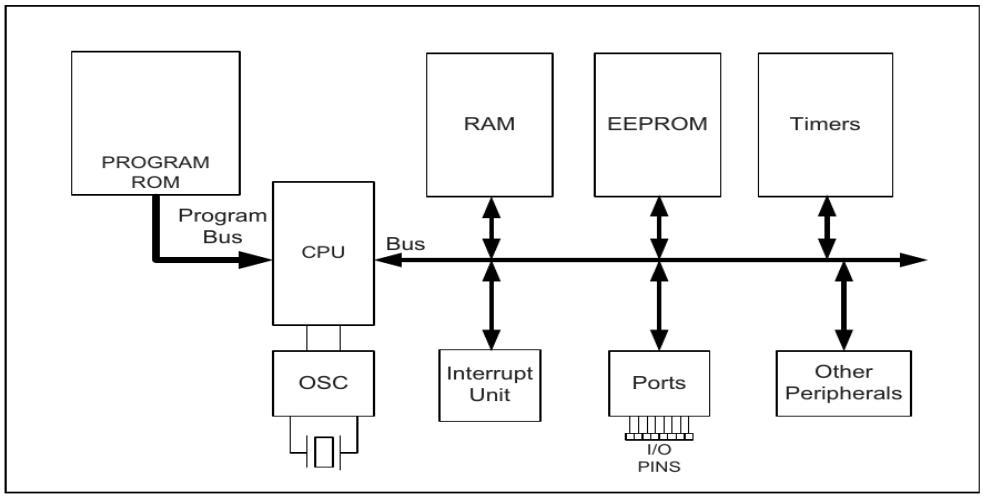
The basic architecture of AVR was designed by two students of Norwegian Institute of Technology (NTH), Alf-Egil Bogen and Vegard Wollan, and then was bought and developed by Atmel in 1996. AVR stands of Advanced Virtual RISC or Alf and Vegard RISC.

AVR Family

▪ AVRs are generally classified into four broad groups:

1. Classic AVR
2. Mega AVR
3. Tiny AVR
4. Special purpose AVR (Used for specific applications, such as USB controller, LCD controller, Ethernet controller etc.)

Simplified Block diagram of an AVR microcontroller:



AVR ATMega32

ATmega32 is 8 bit AVR microcontroller and its major features are:

- 32 General Purpose Registers
- 32 KB Code ROM (Flash)
- 2 KB SRAM
- 1 KB EEPROM
- Four I/O ports
- 8 channel 10 bit ADC
- Three Timers

ATmega32 Data Memory

Atmega32 Data memory is divided in to three parts:

1. General Purpose Registers (GPRs)
2. I/O registers
3. General Purpose RAM

General Purpose Registers:

There are 32 general-purpose registers. These are called R0,R1...,R31. Size of each register is one byte. These registers are located in the lowest addresses of the data memory, ranging the address from 00 to 1F. These registers can be used for arithmetic and logic operations

I/O registers:

The I/O registers are used for special functions such as port operations, timer control, serial communication etc.. It is also called Special Function Registers (SFRs). The I/O memory of Atmega32 is 64 Bytes.

General Purpose RAM:

This memory is used to store data and parameters. Its size varies from one AVR microcontroller to other. ATmega32 has 2KB General Purpose RAM. The total data memory of ATmega32 is 2144 Bytes (32 B GPR + 64 B I/O registers and 2044 B RAM). Following figure illustrate the structure of Data memory.