Embedded Systems

4th Stage

Lecture Three

Assist. Prof. Dr. Yasir Amer Abbas
Computer Engineering Department
2020

Embedded Systems

Lecture Three

Embedded System Processor

Application Specific Integrated Circuits. (ASIC)

Programmable logic devices(PLD's)

Commercial off-the-shelf components (COTs)

1. EMBEDDED SYSTEM PROCESSOR

- Embedded systems are domain and application specific and are built around a central core. The core of the embedded system falls into any of the following categories:

  General purpose and Domain Specific Processors

  - Microprocessors

  - Microcontrollers

  - Digital Signal Processors

GENERAL PURPOSE AND DOMAIN SPECIFIC PROCESSOR.

Almost 80% of the embedded systems are processor/ controller based.

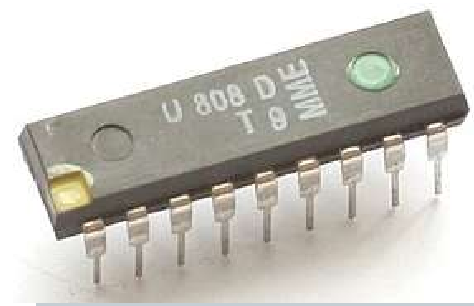
- The processor may be microprocessor or a microcontroller or digital signal processor, depending on the domain and application.

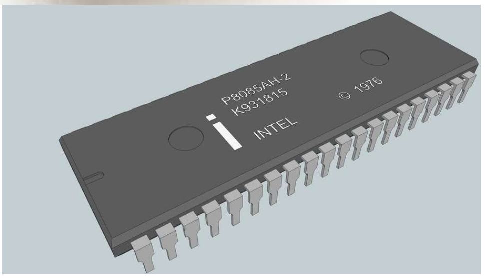
1.1 MICROPROCESSORS

A microprocessor is a silicon chip representing a central processing unit. A microprocessor is a dependent unit and it requires the combination of other hardware like memory, timer unit, and interrupt controller, etc. for proper functioning.

The developers of microprocessors.

- Intel – Intel 4004 – November 1971(4-bit).
- Intel – Intel 4040.
- Intel – Intel 8008 – April 1972.
- Intel – Intel 8080 – April 1974(8-bit).
- Motorola – Motorola 6800.
- Intel – Intel 8085 – 1976.
- Zilog - Z80 – July 1976.

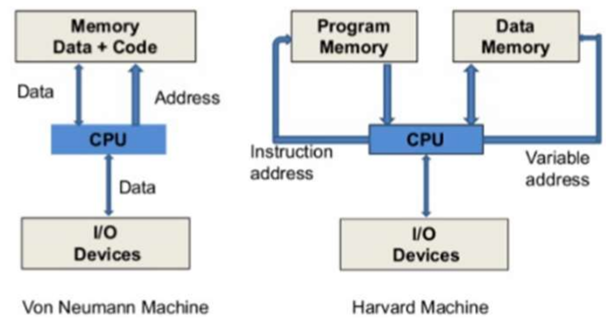




1.1 MICROPROCESSORS

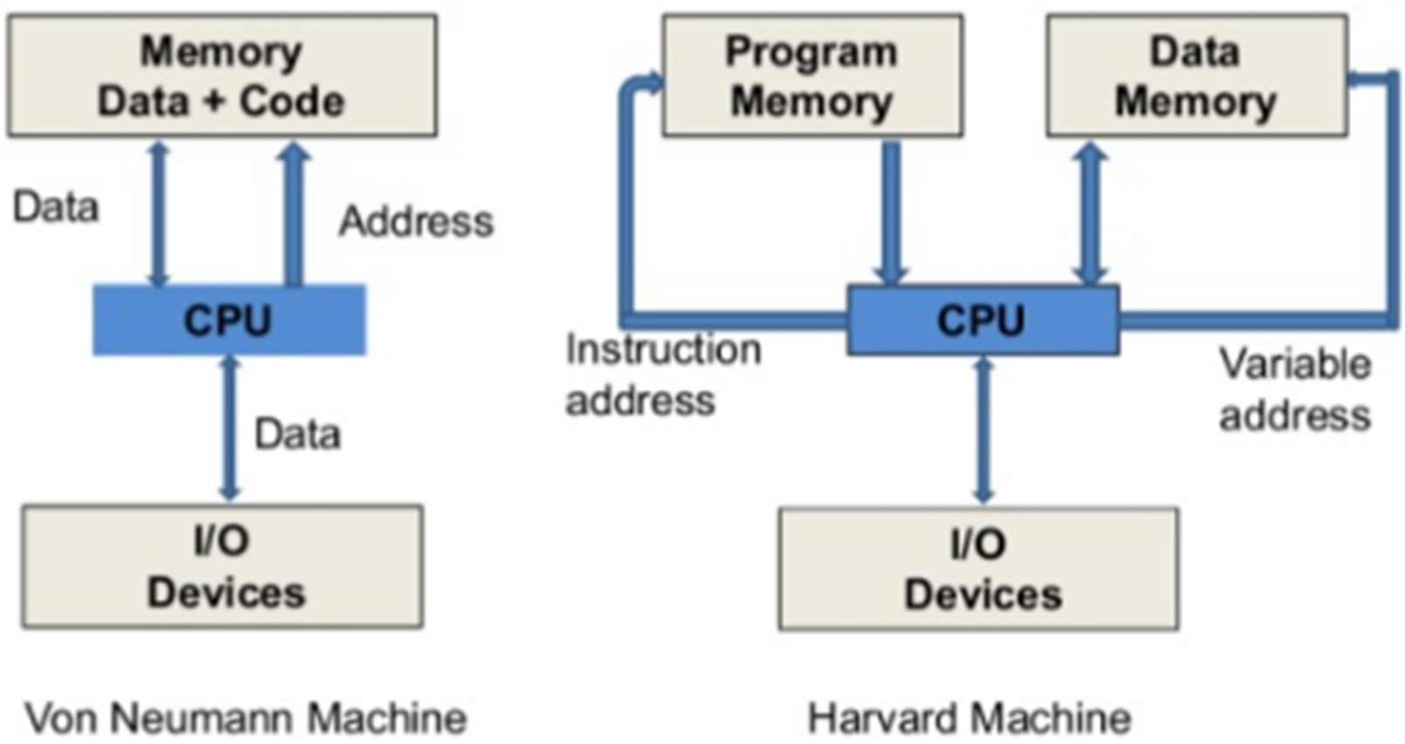
Architectures used for processor design are Harvard or Von-Neumann.

- **Harvard architecture**
  - It has separate buses for instruction as well as data fetching.
  - Easier to pipeline, so high performance can be achieve.
  - Comparatively high cost.
  - Since data memory and program memory are stored physically in different locations, no chances exist for accidental corruption of program memory.



- **Von-Neumann architecture**
  - It shares single common bus for instruction and data fetching.
  - Low performance as compared to Harvard architecture.
  - It is cheaper.
  - Accidental corruption of program memory may occur if data memory and program memory are stored physically in the same chip,

Harvard Vs Von-Neumann Architectures



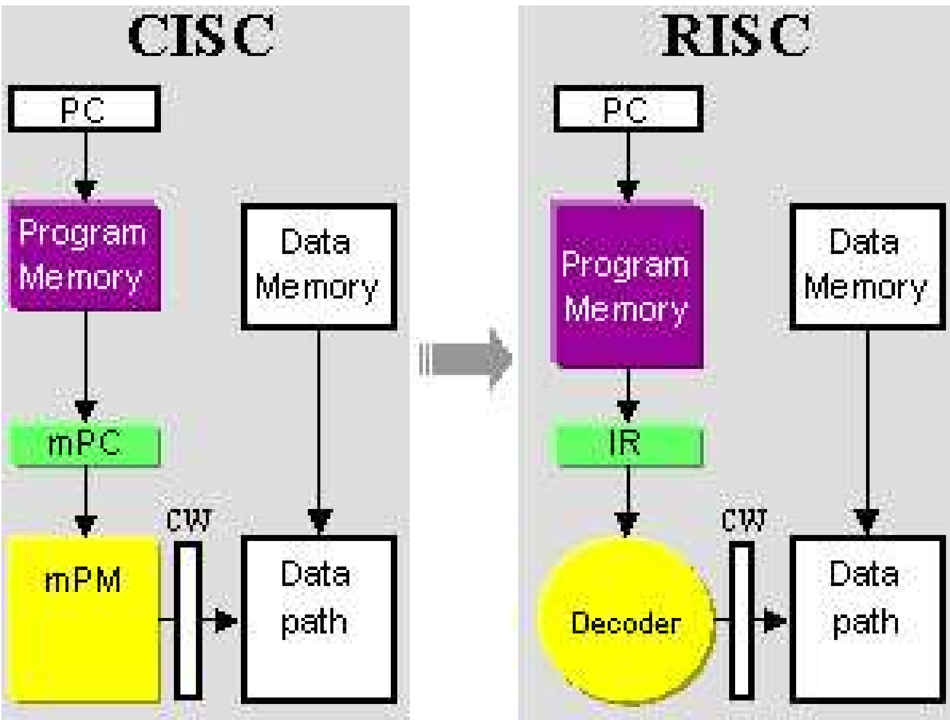
1.1 MICROPROCESSORS

- RISC and CISC are the two common Instruction Set Architectures (ISA) available for processor design.
- **RISC**
  - Reduced Instruction Set Computing
  - It contains lesser number of instructions.
  - Instruction pipelining and increased execution speed.
  - Orthogonal instruction set(allows each instruction to operate on any register and use any addressing mode.
  - Operations are performed on registers only, only memory operations are load and store.
  - A larger number of registers are available.
  - Programmer needs to write more code to execute a task since instructions are simpler ones.
  - It is single, fixed length instruction.
  - Less silicon usage and pin count.
  - With Harvard Architecture.

1.1 MICROPROCESSORS

- **CISC**
  - Complex Instruction Set Computing
  - It contains greater number of instructions.
  - Instruction pipelining feature does not exist.
  - Non-orthogonal set(all instructions are not allowed to operate on any register and use any addressing mode.
  - Operations are performed either on registers or memory depending on instruction.
  - The number of general purpose registers are very limited.
  - Instructions are like macros in C language. A programmer can achieve the desired functionality with a single instruction which in turn provides the effect of using more simpler single instruction in RISC.
  - It is variable length instruction.
  - More silicon usage since more additional decoder logic is required to implement the complex instruction decoding.
  - Can be Harvard or Von- Neumann Architecture.

1.1 MICROPROCESSORS RISC vs CISC



Complex instructions
One instruction = several CW
PM standard

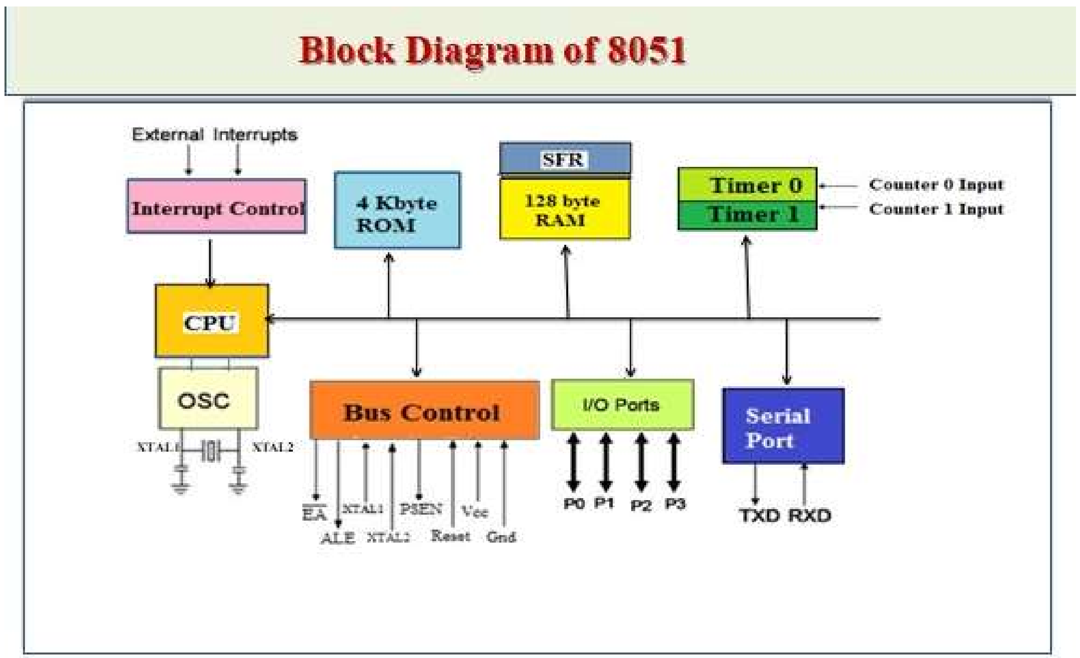
Simple instructions
One instruction = One CW
PM longer

	von Neumann	Harvard
RISC	ARM7	ARM9
CISC	Pentium	SHARC (DSP)

Microprocessors

1.2 MICROCONTROLLERS.

- A microcontroller is a highly integrated chip that contains a CPU, scratch pad RAM, special and general purpose register arrays, on chip ROM/FLASH memory for program storage , timer and interrupt control units and dedicated I/O ports.

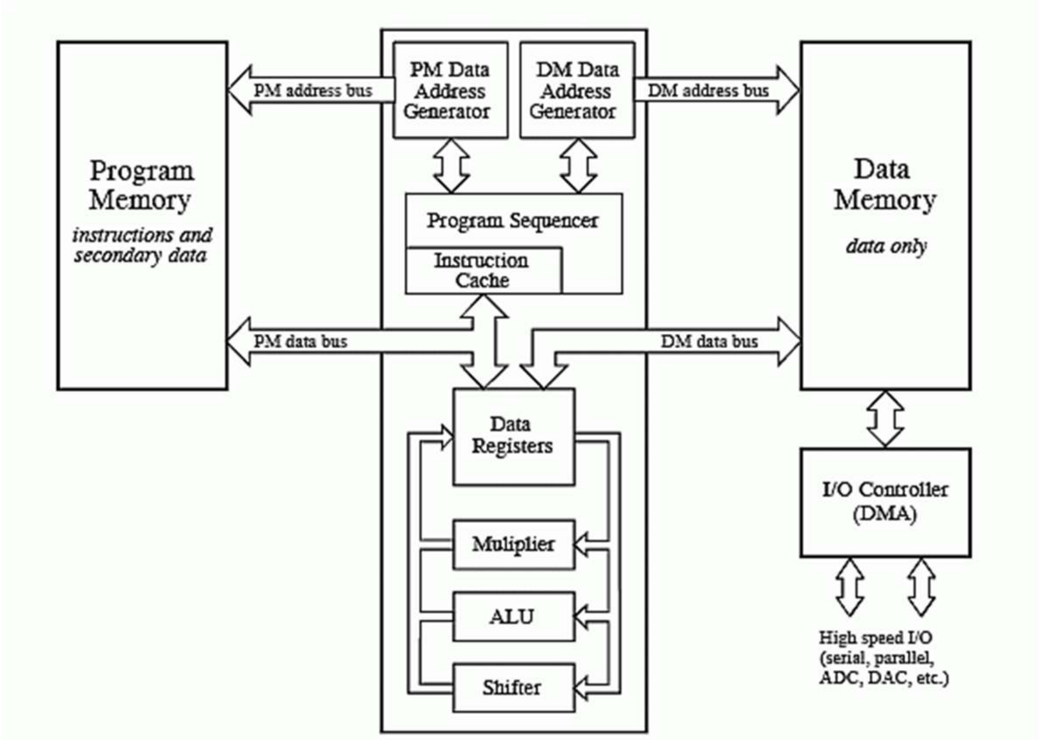


1.2 MICROCONTROLLERS.

- Texas Instrument’s TMS 1000 is considered as the world’s first microcontroller.
- Some embedded system application require only 8 bit controllers whereas some requiring superior performance and computational needs demand 16/32 bit controllers.
- The instruction set of a microcontroller can be RISC or CISC.
- Microcontrollers are designed for either general purpose application requirement or domain specific application requirement.

1.3 Digital Signal Processors

- DSP are powerful special purpose 8/16/32 bit microprocessor designed to meet the computational demands and power constraints of today's embedded audio, video and communication applications.
- DSP are 2 to 3 times faster than general purpose microprocessors in signal processing applications. This is because of the architectural difference between DSP and general purpose microprocessors.
- DSPs implement algorithms in hardware which speeds up the execution whereas general purpose processor implement the algorithm in software and the speed of execution depends primarily on the clock for the processors.



- ***DSP includes following key units:***

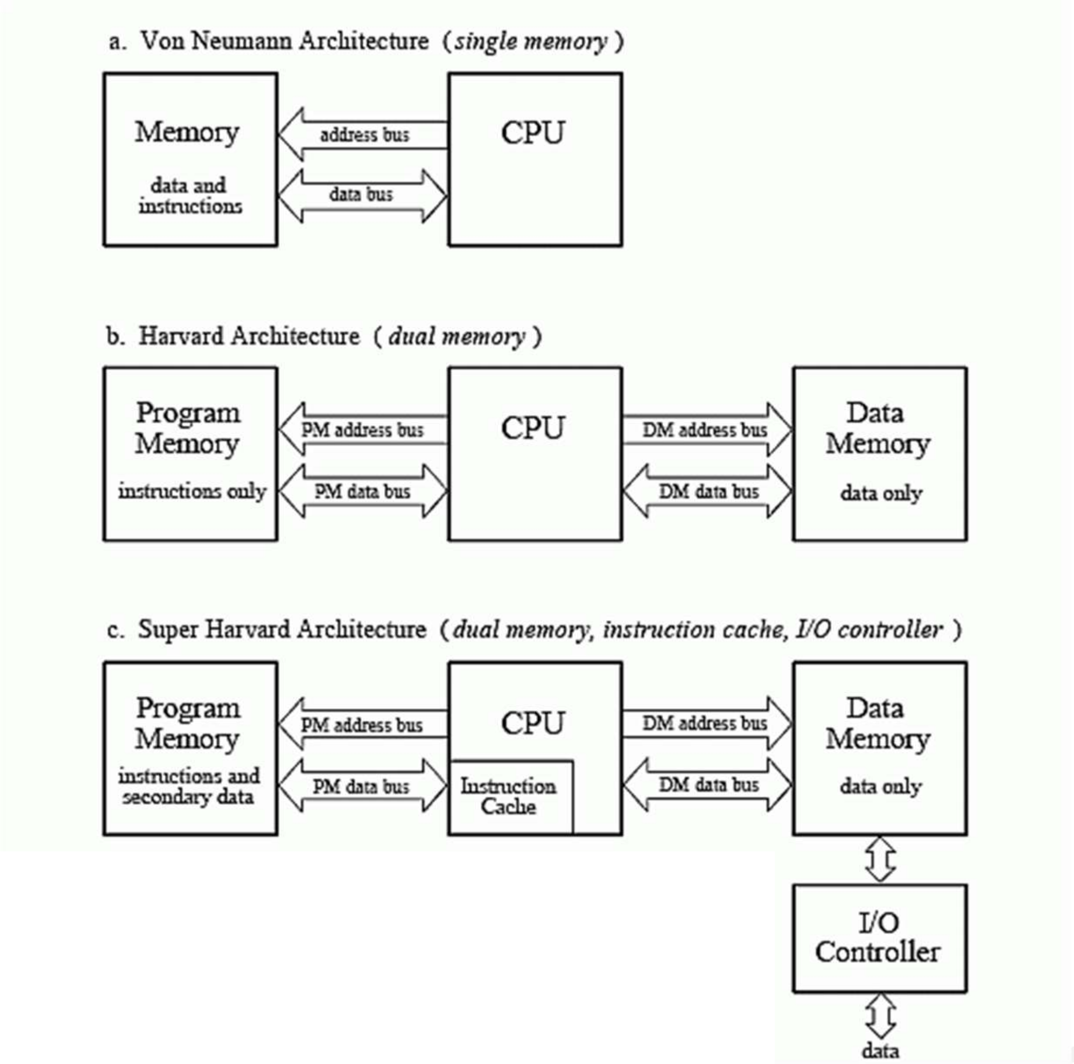
1.3 Digital Signal Processors

- **Program memory:** It is a memory for storing the program required by DSP to process the data.
- **Data memory:** It is a working memory for storing temporary variables and data/signal to be processed.
- **Computational engine:** It performs the signal processing in accordance with the stored program memory computational engine incorporated many specialized arithmetic units and each of them operates simultaneously to increase the execution speed. It also includes multiple hardware shifters for shifting operands and saves execution time.
- **I/O unit:** It acts as an interface between the outside world and DSP. It is responsible for capturing signals to be processed and delivering the processed signals.

Examples: Audio video signal processing, telecommunication and multimedia applications.

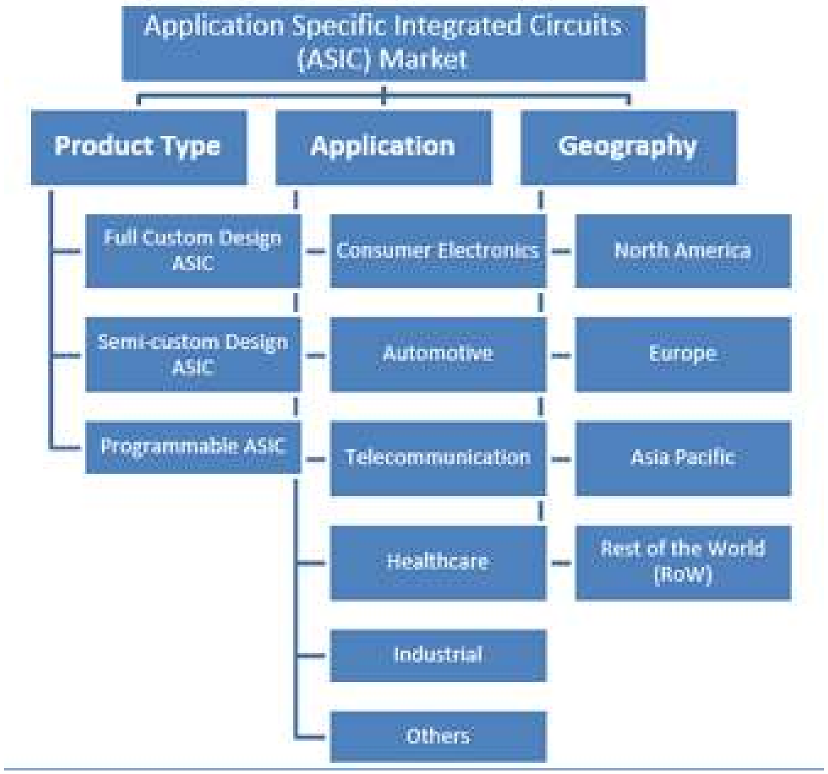
SOP(Sum of Products) calculation, convolution, FFT(Fast Fourier Transform), DFT(Discrete Fourier Transform), etc are some of the operation performed by DSP.

EMBEDDED SYSTEM PROCESSOR ARCHITECTURE



2. Application Specific Integrated Circuits. (ASIC)

- ASICs is a microchip design to perform a specific and unique applications.
- Because of using single chip for integrates several functions there by reduces the system development cost.
- Most of the ASICs are proprietary (which having some trade name) products, it is referred as Application Specific Standard Products(ASSP).
- As a single chip ASIC consumes a very small area in the total system. Thereby helps in the design of smaller system with high capabilities or functionalities.
- The developers of such chips may not be interested in revealing the internal detail of it .



3. Programmable logic devices(PLD's)

A PLD is an electronic component. It used to build digital circuits which are reconfigurable.

A logic gate has a fixed function but a PLD does not have a defined function at the time of manufacture.

PLDs offer customers a wide range of logic capacity, features, speed, voltage characteristics.

PLDs can be reconfigured to perform any number of functions at any time.

A variety of tools are available for the designers of PLDs which are inexpensive and help to develop, simulate and test the designs.

PLDs having following two major types.

3. Programmable logic devices(PLD’s)

3.1 CPLD(Complex Programmable Logic Device):

CPLDs offer much smaller amount of logic up to 1000 gates

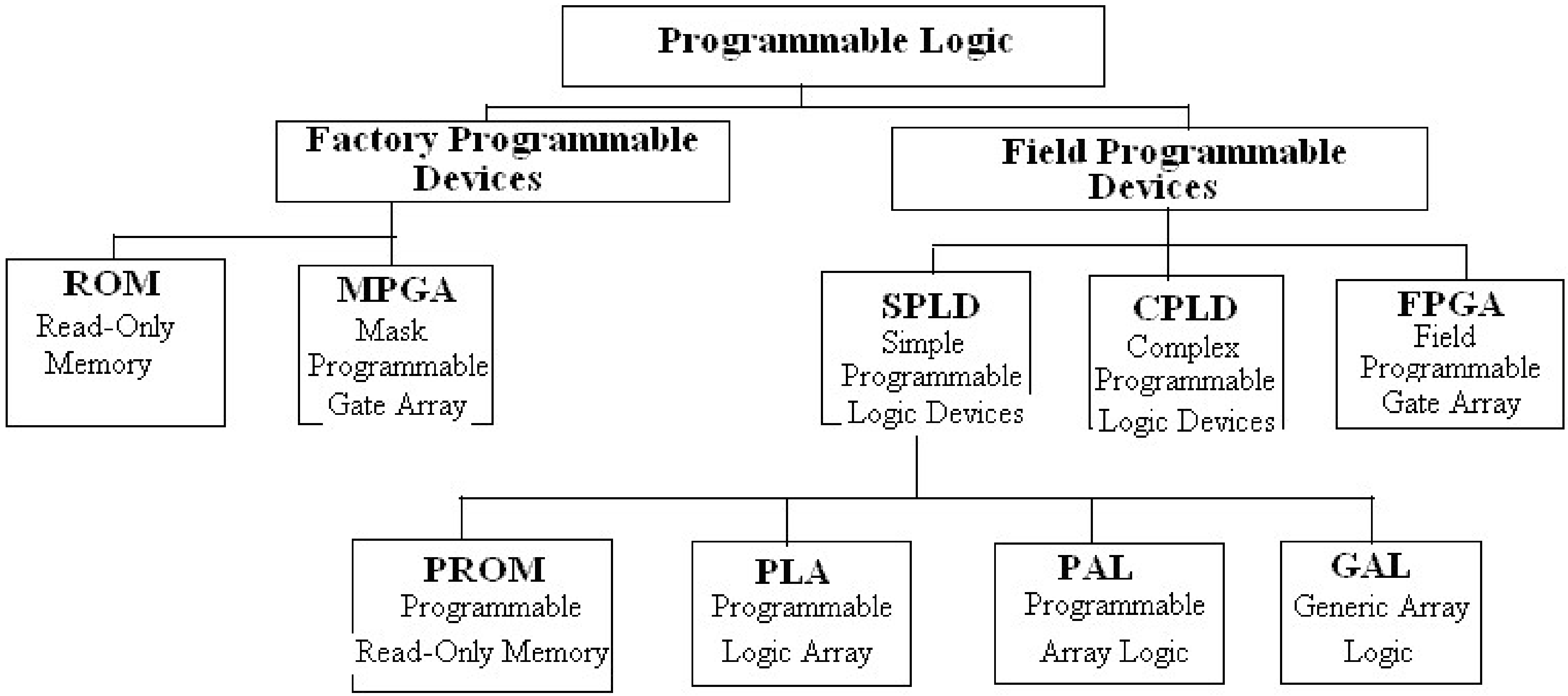
3.2 FPGAs(Field Programmable Gate Arrays):

It offers highest amount of performance as well as highest logic density, the most features.

Advantages of PLDs :-

- PLDs offer customer much more flexibility during the design cycle.
- PLDs do not require long lead times for prototypes or production parts because PLDs are already on a distributors shelf and ready for shipment.
- PLDs can be reprogrammed even after a piece of equipment is shipped to a customer

3. Programmable logic devices(PLD's)



4. Commercial off-the-shelf components (COTs)

A Commercial off the Shelf product is one which is used 'as-is'.

- The COTS components itself may be develop around a general purpose or domain specific processor or an ASICs or a PLDs.
- The major advantage of using COTS is that they are readily available in the market, are chip and a developer can cut down his/her development time to a great extent
- The major drawback of using COTS components in embedded design is that the manufacturer of the COTS component may withdraw the product or discontinue the production of the COTS at any time if rapid change in technology occurs.

Advantages of COTS:

- Ready to use
- Easy to integrate
- Reduces development time

Disadvantages of COTS:

- No operational or manufacturing standard (all proprietary)
- Vendor or manufacturer may discontinue production of a particular COTS product

4. Commercial off-the-shelf components (COTs)

Examples of Commercial off the Shelf (COTS) Software

- Education/training software
- Accounting packages
- Contract management software
- Medical billing
- Invoicing
- Accounts payable
- Sales tax processing
- Project Management software
- Warehouse management
- Order Management
- Inventory management
- Supply chain management

THANK YOU

Dr.Yasir Amer Abbas

Phone

Email dr.yasiralzubaidi@gmail.com, yasiramerabbas@gmail.com

Website https://www.researchgate.net/profile/Yasir_Abbas4