



A seminar report on

“ARM PROCESSOR”

Submitted

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Certificate

This is to certify that

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In satisfactory manner as a fulfillment of the requirement of the award of
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Seminar Guide

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By

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Abstract

What is an ARM processor?

ARM, which is an acronym for ADVANCED RISC MACHINE, is a popular 32-bit processor.

An ARM processor is one of a family of CPUs based on the RISC (reduced instruction set computer) architecture developed by Advanced RISC Machines (ARM).

Initially ARM was known as Acorn RISC machine as 1985 Acorn Computer Ltd. Developed a processor based on a design on RISC principal published by few students in University of Berkley, USA.

Acorn merged up with Apple computers and VLSI technology group in 1990 and rename ARM as “Advanced RISC Machine”.

The group came up with ARM6 and ARM7 in 1991 where ARM6 introduced first embeddable processor in this series and ARM7 came up with multimedia support which made it a huge success till date.

Why ARM?

ARM processors are extensively used in consumer electronic devices such as smartphones, tablets, multimedia players and other mobile devices, such as wearables. Because of their reduced instruction set, they require fewer transistors, which enables a smaller die size for the integrated circuitry (IC).

The ARM (architecture) has good performance per watt (MIPS per milliamp - Energy Efficiency, which is particularly important for Battery-operated Mobile Devices), and attractive prices. The licensing scheme for ARM intellectual property is the cause of success.

In 2011, the 32-bit ARM architecture was the most widely used architecture in mobile devices and the most popular 32-bit one in embedded systems.

In 2013, 10 billion were produced and "ARM-based chips are found in nearly 60 percent of the world's mobile devices".

Most powerful ARM

The Fujitsu A64FX is one of the most powerful Arm-based processors in the world, and the world's fastest supercomputer features over 150,000 of them. The beating heart of Fugaku, the world's fastest supercomputer, is the Fujitsu A64FX Arm-based processor.

ARM v/s its counterparts

ARM chips are usually slower than their Intel counterparts. This is largely due to the fact that they are designed to compute with low power consumption. While most users wouldn't notice a difference in their respective devices, Intel processors are designed for faster computing.

Trump card of ARM

ARM Processor is very affordable as it does not need expensive equipment's for its creation. When compare to other processors, it is created at much lesser price. This is why they are apt for making of low cost Mobile phones and other electronic devices.

They were initially designed for performing at lesser power. They even have lesser transistors in their architecture.

ARM performs single operation at a time. This makes it work faster. It has lower latency that is quicker response time.

The processor uses load store architecture that stores data in various registers (to reduce memory interactions).

Downside

It is not compatible with X86 hence cannot be used in Windows and the speeds are limited in some processors which might create problems.

ARM Processor needs very highly skilled programmers because of importance and complexity of execution (processor shows lesser performance when not executed properly.).

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Introduction

About processors:

- ❖ The definition of a processor is someone or something that prepares or treats something, or makes something happen.
- ❖ In computing, a processor or processing unit is a digital circuit which performs operations on some external data source, usually memory or some other data stream.
- ❖ It typically is a logical circuitry that responds to and processes the basic instructions that drives a computer.
- ❖ The processor in a personal computer or in any small device is called as microprocessor.
- ❖ A processor is the core of all computing devices that executes instructions held in the memory.

REGISTERS: Registers are temporary storage located inside the CPU that hold data and addresses.

- ❖ All Processors have a basic set of registers to hold the data, instruction set to process the data, to specify higher and lower privilege modes of execution.

ARM PROCESSOR:

- ❖ ARM stands for (ADVANCED RISC MACHINE).
- ❖ Initially ARM was known as Acorn RISC machine because in 1985 it was developed by a company named as Acorn computer Ltd.
- ❖ Arm Ltd. (stylized as arm) is a British semiconductor and software design company based in Cambridge, England.[10] Its primary business is in the design of ARM processors (CPUs).

- ❖ It is considered to be market dominant for processors in mobile phones (smartphones or otherwise), tablet computers and for chips in smart TVs and in total over 160 billion chips have been made for various devices based on designs from Arm.
- ❖ ARM Holdings is a multinational semiconductor group that doesn't manufacture any CPU; instead, they design them and then sell the architecture under licensing. The designs are used to build microprocessors as well as microcontrollers, but what ARM provides is just the core.
- ❖ Based on RISC principle published by few students in University of Berkeley, USA, Acorn developed their first ARM processor with less than 2500 transistors which operated at 6MHz in 1985.
- ❖ There have been several generations of the ARM design, The original ARM1 used a 32-bit internal structure but had a 26-bit address space that limited it to 64 MB of main memory. ARM2 came up in 1987, after that ARM3, ARM4, ARM5 were developed but were not that popular, But in between Acorn merged up with Apple Computers and VLSI technology group in 1990 and came up with ARM6, ARM7, where ARM6 was introduced as first embeddable processor and ARM7 came up with multimedia support which make its features so popular.
- ❖ Arm Ltd. develops the architecture and licenses it to other companies, who design their own products that implement one of those architectures— including systems-on-chips (SoC) and systems-on-modules (SoM) that incorporate different components such as memory, interfaces, and radios.
- ❖ ARM design become so popular that iPad and iPhone 4, the iPod touch (4th Generation) uses a custom ARM-based "system on a chip" that Apple refers to as an "Apple A4" processor.

Technical specification

- ❖ ARM previously an acronym for Advanced RISC Machines and originally Acorn RISC Machine) is a family of reduced instruction set computing (RISC) architectures for computer processors.
- ❖ Technically, ARM is a microprocessor, or, more specifically, a microprocessor architecture. The thing to understand, is that it doesn't represent a physical microprocessor, but the design that allows to build one.
- ❖ ARM is a CPU architecture (more accurate, a family of related CPU architectures). If we put that CPU on a chip all by itself, we have a microprocessor, If we combine it with ROM, RAM and peripherals on one chip, we have a microcontroller.
- ❖ The ARM in itself has a high computational capability, which can be used to a very high extent. With rich set of instructions and powerful register set makes ARM a microprocessor.



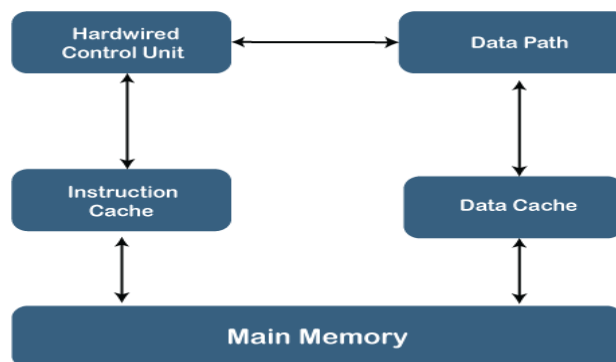
ARM ARCHITECTURE

There are two types of Instruction Set Architectures :

1. RISC(Reduced Instruction Set Computing)
2. CISC(Complex Instruction Set Computing)

RISC(Reduced Instruction Set Computing)

- ❖ In RISC architecture number of instruction are reduced due to which calculations are faster which makes the processor performance based.
- ❖ RISC have smaller set of instructions with few addressing modes.
- ❖ RISC instructions are calculated in a single clock cycle due to which time of calculation reduces.
- ❖ RISC handles most of instruction through registers.
- ❖ Decoding the instruction is simpler which gives high efficiency.
- ❖ Require less Disk space for a same program which is used in CISC.

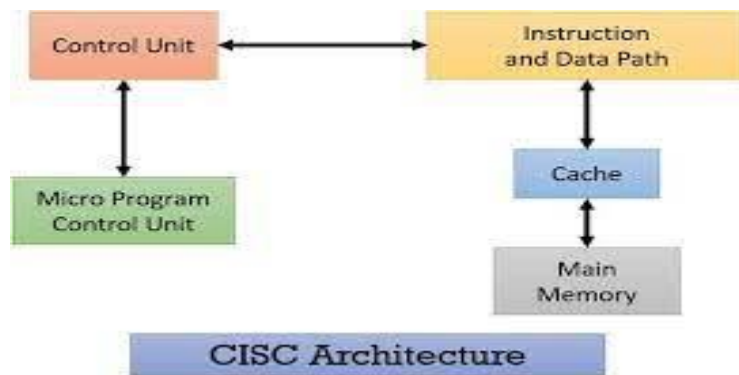


RISC Architecture

CISC(Complex Instruction Set Computing)

- ❖ It is a type of Architecture in which instructions are in complex form due to which calculation becomes slower.
- ❖ Its main focus is on the hardware.

- ❖ CISC have larger set of instruction with many addressing modes.
- ❖ CISC instructions are calculated in multiple clock cycle due to which time of calculation increases.
- ❖ In CISC most of the instructions are handle by memory directly.
- ❖ Decoding the instruction is complex due to which it is used in low-end applications such as security systems, home automation.
- ❖ Require more Disk space for a same program which is used in RISC.

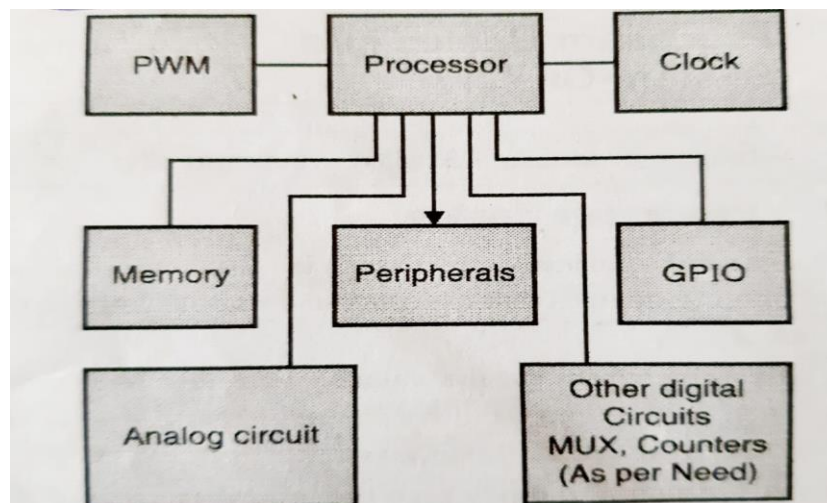


RISC in ARM

- ❖ ARM is RISC based processor due to which it makes ARM a performance based processor.
- ❖ The biggest feature of Risc is all instruction are of same size so ARM has 32 bit instruction so at one cycle it fetch 32 bit of instructions.
- ❖ Only load and store instruction have direct access to the memory.
- ❖ In RISC architecture there are less number of transistors as compare to CISC due to which less hardware is needed for ARM.
- ❖ Less hardware means less chip size that means less power consumption, which makes ARM a efficient and performance based processor.

System on Chip (SoC)

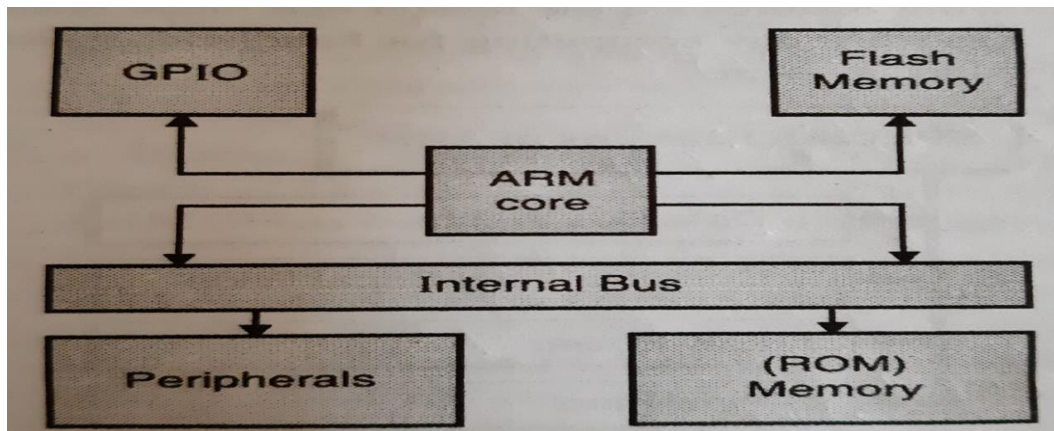
- ❖ A Soc packs the whole system on a small chip.
- ❖ It is an integrated circuit that holds together several peripherals like memory (RAM/ Rom), digital connections, analog connectivity, clock, GPIOs with a processor at its core is called as System on chip.
- ❖ Best example is Raspberry pi.
- ❖ A SoC holds a processor/core that is the main part which handles the coordination of all the other components on the SoC and does the general instruction processing.
- ❖ SoC can have digital and analog peripherals as per the requirements. Some of the digital peripherals are Timer, Pulse Width Modulator, Multiplexers, counters etc. , Whereas in analog peripherals are op-amps, ADCs, current voltage sources, etc.
- ❖ SoC also has General Purpose Input Output(GPIOs) mechanism in the form of pins so that external devices can be mounted on the SoC for application development.



THE ARM SoC

- ❖ When a fabricated chip has an ARM core and required peripherals to operate as a whole system it is termed as ARM Soc.

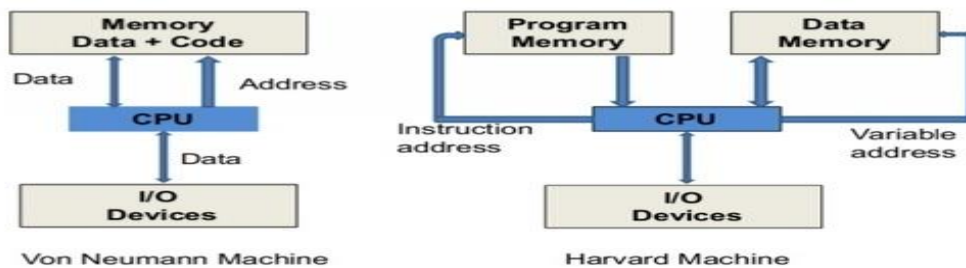
- ❖ The ARM SoC has ARM processor at its core processing unit which has all the power of computation, data movement, logical operations, control flow and decides how all peripherals and other components are going to interact with each other.
- ❖ The ARM core can be attached with basic peripherals and can be deployed to act as a Microcontroller unit as well.



ARM MEMORY MANAGEMENT

- ❖ There are basically two models on which the memory are managed and processors are made:
 - Von-Neumann model.
 - Harvard model.
- ❖ According to von-neumann model there should be only one memory where all programs should be stored and all data also stored .
- ❖ According to Harvard model there should be two separate memories for programs and data.
- ❖ 8051 is the example of Harvard model where 64kb data is for data memory and 64kb is for program memory.
- ❖ ARM is based on Von-Neumann model that is common memory.

Von Neumann vs. Harvard Architecture



FEATURES OF ARM THAT MAKES IT SPECIAL

○ Data Bus Width

- ARM has 32 bit bus width which means that ARM can process 32 bits of data for reading and writing purpose one clock cycle.
- Due to this performance of ARM becomes higher.
- This capability makes the ARM application comparatively faster.

○ Low Power

- Because of the RISC design ARM processor has minimum number of hardware requirement which lead to lower power consumption for ARM based embedded systems..
- ARM varies between 60MHz to 1GHz, This low operating frequency of ARM makes it a desirable microprocessor for power saver application.

○ Pipelining

- Pipelining is the process of flowing of instruction from the processor through a pipeline. It allows storing and executing instructions in an orderly process.
- Pipelining is a technique where multiple instructions are overlapped during execution.
- Pipelining is provided in a processor for faster execution of the instruction. In pipeline the operation of the instruction is divided into sub stages which are used to improve the performance of the processor.
- In Normal processors pipelining divides the instruction in
 - “Fetch->Decode->Execute” stages .
- But in ARM Pipelining divides the instruction in
 - Fetch->Decode->Execute->Execute->Execute.....
- ARM7 follows 3 stage pipelining(Fetch-Decoding-Execution), ARM9 follows 5 stage pipelining (Fetch-Decoding-Execution-Buffer-Write) and ARM10 has 6 stage pipelining.
- **Multiple Register Instructions**
 - According to ARM methodology there is no direct access to memory.
 - ARM processor follows ARM methodology so the instruction use registers for instruction storage due to which it make it fast.
 - Apart from LOAD and STORE instructions all other instruction in ARM are register based instruction only.
 - This feature makes the execution of an instruction faster .
 - RISC Processor are heavy based on register work .
 - ARM has Arm has 37 registers where 32 bit each 16 available at a time (Ro.....R15) rest registers are at bank register.
- **DSP Enhancement.**
 - DSP means Digital Signal Processing.
 - It is use of DSP is usually to measure , filter or compress continuous real-world analogy signals.

- Many of upcoming embedded systems works with complex DSP instruction.
- DSP can be added to the ARM core due to which RISC methodology of ARM have additional features of hardware which is actually a CISC philosophy.
- But wherever necessary such add-ons can be added to the ARM to make it application specific.

Conclusion

Arm is Advanced risc machine which is owned by ARM Ltd, which is a British semiconductor and software design company.

ARM is a microprocessor design more specifically a microprocessor architecture.

It works on RISC architecture ie. Reduce Instruction set computing.

ARM SoC has ARM processor at its core processing unit which has all the power of computing, data management, logical operations, control computing, data movement, logical operations, control flow.

In memory management ARM is based on VON-NEUMANN Architecture or model according to which it has common memory.

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