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Assignment : Critical Analysis On ARM , RISC, CISC and AMD Processors

Course: Computer Architecture

ARM Architecture

ARM architecture refers to a type of processor architecture commonly used in mobile devices. It stands for Advanced RISC Machines and is known for its power efficiency and performance. It's the foundation for many popular processors used in smartphones, tablets, and other portable devices.

The architecture can be divided into A, R, and M profiles. A profile is mainly for applications, R profile is for real-time and M profile is for Micro-controller. A profile helps to maintain high performance and is designed to run the complex system in Linux or Windows. R profile checks for systems with real-time requirements and is found in networking equipment or embedded control systems. M

profile is used in IOT devices and can be synchronised with small and high-power devices.

ARM processors are a family of central processing units (CPUs) based on a reduced instruction set computer (RISC) architecture. ARM stands for Advanced RISC Machine. ARM architectures represent a different approach to how the hardware for a system is designed when compared to more familiar server architectures like x86(**x86** is an Intel CPU (central processing unit) architecture that originated with the 16-bit 8086 processor in 1978. Today, the term "x86" is used generally to refer to any 32-bit processor compatible with the x86 instruction set).

Components on ARM architecture

- The instruction set in the architecture describes the function of each instruction and explains the representation of the instruction in the memory through encoding. With the help of these instructions, it is easy to manage the architecture and the microprocessors.
- Priority encoders help to load the instruction and to

store it in the specified register in order to manage the files. This helps to identify the registers and instructions easily in the architecture.

- Multiplexers are used in the architecture to manage the operation of processor buses. The components are instructed to work in behavioural mode and the components are implemented as an entity. The architecture of the entity is optimised depending on the application of the processor and helps to construct and maintain the design.
- The Control unit controls the entire process of the architecture and manages the system operation. It can be made of circuits or can be the combination of functions and circuits in the design. Timing is managed in the control unit and works with a combination of a state machine in the processor. The operation in the processor is managed and controlled with the help of signals from the control unit as these are connected with different components in the system.
- There is a register set in the architecture to help in managing the registers with their corresponding time

in the structure. It is important to check for the number of registers and the size of the same for the proper functioning of the system. The function of registers is to manage the files and keep them in the proper place and check for their initial state in the processor.

- Features of ARM processor

1. Multiprocessing Systems: ARM processors are designed to be used in cases of multiprocessing systems where more than one processor is used to process information. The First AMP processor introduced by the name of ARMv6K could support 4 CPUs along with its hardware.

2. Tightly Coupled Memory: The memory of ARM processors is tightly coupled. This has a very fast response time. It has low latency (quick response) that can also be used in cases of cache memory being unpredictable.

3. Memory Management: ARM processor has a management section. This includes Memory Management Unit and Memory Protection Unit. These management systems become very important in managing memory efficiently.

4. Thumb-2 Technology: Thumb-2 Technology was

introduced in 2003 and was used to create variable-length instruction sets. It extends the 16-bit instructions of initial Thumb technology to 32-bit instructions. It has better performance than previously used Thumb technology.

5. One-Cycle Execution Time: ARM processor is optimised for each instruction on the CPU. Each instruction is of a fixed length that allows time for fetching future instructions before executing the present instructions. ARM has CPI (Clock Per Instruction) of one cycle.

6. Pipelining: Processing of instructions is done in parallel using pipelines. Instructions are broken down and decoded in one pipeline stage. The channel advances one step at a time to increase throughput (rate of processing).

7. A large number of Registers: A large number of registers are used in ARM processors to prevent large amounts of memory interactions. Records contain data and addresses. These act as a local memory store for all operations.

Benefits of ARM architecture

For smartphones, Arm IP balances high-performance for more complex and compute-intensive workloads with sustained and efficient performance to deliver more than

enough battery life for all-day productivity and play.

RISC

A processor architecture that shifts the analytical process of a computational task from the execution or runtime to the preparation or compile time. By using less hardware or logic, the system can operate at higher speeds. RISC cuts down on the number and complexity of instructions, on the theory that each one can be accessed and executed faster

This simplification of computer instruction sets gains processing efficiencies. That theme works because all computers and programs execute mostly simple instructions.

RISC has five design principles:• Single-cycle execution — In most traditional central processing unit (CPU) designs, the peak possible execution rate is one instruction per basic machine cycle, and for a given technology, the cycle time

has some fixed lower limit. Even on complex CPUs, most compiler-generated instructions are simple. RISC designs emphasise single-cycle execution, even at the expense of synthesising multi-instruction sequences for some less-frequent operations.• Hard-wired control, little or no microcode — Microcode adds a layer of interpretive overhead, raising the number of cycles per instruction, so even the simplest instructions can require several cycles.• Simple instructions, few addressing modes — Complex instructions and addressing modes, which entail microcode or multi-cycle instructions, are avoided.• Load and store, register-register design — Only loads and stores access memory; all others perform register-register operations. This tends to follow from the previous three principles.• Efficient, deep pipelining — To make convenient use of hardware parallelism without the complexities of horizontal microcode, fast CPUs use pipelining. An n-stage pipeline keeps up to “n” instructions active at once, ideally finishing one (and starting another) every cycle. The instruction set must be carefully tuned to support pipelining.

The hardware of RISC architecture is designed to execute the instruction quickly, which is possible because of the more

precise and smaller number of instructions and a large number of registers.

In RISC, the data path is used to store and manipulate data in a computer. It is responsible for managing data within the processor and its movement between the processor and the memory.

The processor uses a cache to reduce the access time to the main memory. The instruction cache is beneficial for retrieving and storing the data of frequently used instructions. It speeds up the process of instruction execution. The data cache provides storage for frequently used data from the main memory.

The RISC architecture is proof of the effectiveness of simplicity in computer architecture. Because of its use of a condensed and highly optimised set of instructions, single-cycle execution, and efficiency-focused design, processors are now quicker, more flexible, and more energy-efficient. RISC architectures are more energy-efficient, use fewer transistors, and can run at faster clock rates than other designs. The fundamentals of RISC architecture remain crucial even as the computer landscape changes, ensuring that performance and efficiency stay at the fore of technological advancement.

CISC Processor

CISC stands for **C**omplex **I**nstruction **S**et **C**omputer. CISC processor is a classification of microprocessor-based of CPU design that operates on large and complex instruction sets so as to execute various tasks using the least possible codes. It is based on more than one instruction per cycle execution approach.

More simply, we can say, the design of the CISC processor is based on the approach to complete the whole operation in few lines of the assembly language code.

Features of CISC Processor

The CISC processor exhibit the following features:

- **Decoding**: The instructions are of complex nature,

thus offers complex instruction decoding.

- **Instruction size**: The instructions within this processor are large in size and are of variable nature.
- **Data Types and Addressing Modes**: It involves more data types and complex addressing modes.
- **General Purpose Registers**: The operations are performed in the memory itself and the results of operations are also stored within the memory so due to this reason less general-purpose registers are needed in the case of CISC processors.
- **Clock Cycle**: As the size of instructions here is variable thus more than one clock cycle may be used for instruction execution.

CISC Approach

Previously, we have discussed the RISC approach where the compiler's work is more in simplifying a complex instruction into multiple simple instructions that can be executed in a pipelined manner so as to perform the desired operation at a faster rate. However, in this case, the compiler's work for instruction simplifying is reduced to a great extent as the hardware is designed to even execute

complex instructions.

CISC architecture allows the processor to complete the task in the least possible codes of the assembly language. In the RISC approach, we have discussed that in order to perform complex instructions, the processor performs various commands that resultantly perform the desired operation.

Suppose MUL is a complex instruction the result of which gives rise to the product of two values. In the case of RISC, the data over which operation is to be performed, present in the memory is first loaded into the register by using separate instructions. Then the adequate command is used to perform the desired operation over the data in the registers. Lastly, the result of the operation is loaded back into the memory.

The CISC approach is quite different from RISC. Unlike RISC, in the case of CISC, there exists no need for loading the data from memory to the register for the operation to take place. Here simply, the data within the memory is directly used for the desired operation to take place. Suppose if we consider the storage scheme of a computer system that represents that the data over which operation is

to be performed resides within the memory locations

AMD Processor

AMD processors, short for Advanced Micro Devices processors, are a type of computer processor. They are an alternative to Intel processors and are known for their strong performance and competitive pricing. AMD processors are commonly used in desktop computers, laptops, and servers, offering a range of options to suit different needs and budgets.

AMD has gained significant popularity in recent years due

to its competitive performance and pricing. Their processors, such as the Ryzen series, offer strong multi-core performance, making them suitable for tasks like gaming, content creation, and productivity. AMD's processors also provide good value for money compared to Intel's offerings. However, it's always a good idea to consider your specific needs and do some research to determine which processor best suits your requirements. AMD processors serve as the central processing unit (CPU) in computers. They perform various tasks, such as executing instructions, performing calculations, and managing data. The CPU is responsible for running programs, handling system operations, and coordinating the overall functioning of the computer. In simpler terms, AMD processors are the brains of the computer, allowing it to perform tasks and run software efficiently.