Microprocessor Design (290402)
CSD IV SEM
Unit-5 (Notes)

Q1. Explain Flynns classification.

Flynn's taxonomy categorizes computer architectures based on the number of instruction streams and data streams that can be processed concurrently. Here's a breakdown of Flynn's classifications:

1. **Single Instruction Single Data :**

The original Von Neumann Architecture that does not employ any kind of parallelism. The sequential processor takes data from a single address in memory and performs a single instruction on the data. All single processor systems are SISD.

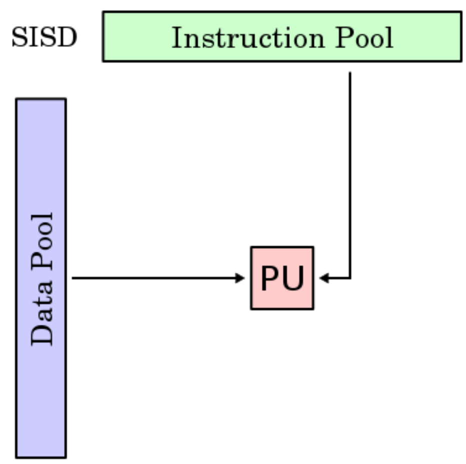

Fig1: SISD Architecture Diagram

Common usage

- Older Computers
- Microcontrollers

Advantages

- Low power requirements as only a single core
- Simpler architecture than others therefore cheaper and easier to manufacture

Disadvantages

- Speed of the system limited due to it being a single core

Characteristics

- Single Instruction Stream: Only one instruction is executed at a time.
- Single Data Stream: Operations are performed on a single set of data.
- Sequential Execution: Instructions are executed in a linear, sequential manner.

- Traditional von Neumann Architecture: Most general-purpose computers, where a central processing unit (CPU) fetches instructions and data from memory sequentially, fall under this category.

2. Single Instruction Multiple Data

A single instruction is executed on multiple different data streams. These instructions can be performed sequentially, taking advantage of pipelining, or in parallel using multiple processors. Modern GPUs, containing Vector processors and array processors, are commonly SIMD systems.

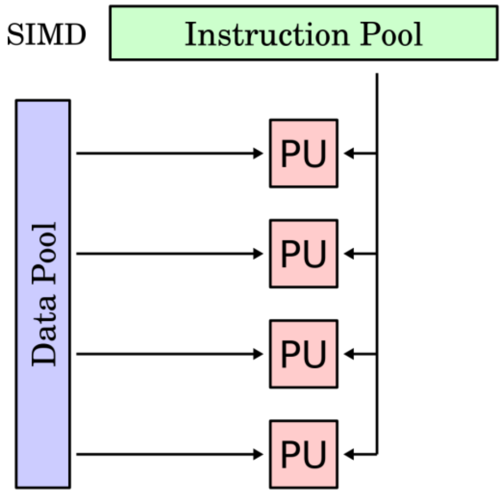

Fig 2: SIMD Architecture Diagram

Common usage

- Graphics Processing Units when performing vector and array operations.
- Scientific processing

Advantages

- Very efficient where you need to perform the same instruction on large amounts of data.

Characteristics

- Single Instruction Stream: All processing units execute the same instruction at the same time.
- Multiple Data Streams: Each processing unit operates on a different set of data simultaneously.
- Data Parallelism: SIMD architectures excel in exploiting data-level parallelism by applying the same operation to multiple data elements in parallel.
- Controlled by a Central Controller: Typically, a single control unit broadcasts instructions to all processing units.

3. Multiple Instruction Single Data

In this architecture multiple instructions are performed on a single data stream. An uncommon type commonly used for fault tolerance. Different systems perform operations on the data and all the results must agree. Used on flight control systems where fault detection is critical.

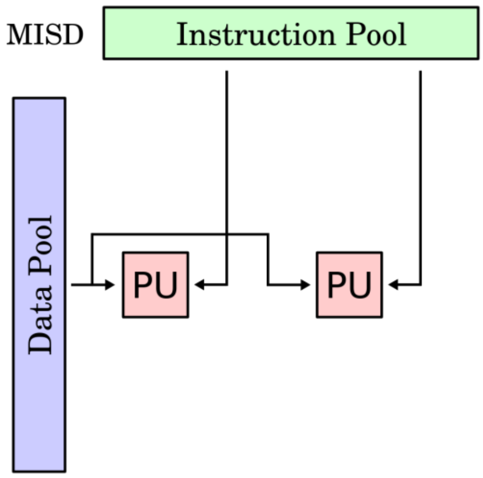

Fig.3 : MISD Architecture Diagram

Common Usage

- Not used commercially.
- Some specific use systems (space flight control)

Advantages

- Excellent for situation where fault tolerance is critical

Characteristics

- Multiple Instruction Streams: Multiple processing units execute different instructions on the same data.
- Single Data Stream: All instructions act on a single stream of data.
- Theoretical Concept: While theoretically possible, practical implementations of MISD architectures are rare.

4. Multiple Instruction Multiple Data

Multiple autonomous processors perform operations on difference pieces of data, either independently or as part of shared memory space. MIMD architecture involves multiple instruction streams operating on multiple data streams independently. This is the most complex and versatile category, allowing for true parallel processing with multiple processors executing different instructions on different data. Most modern parallel computers and distributed computing systems fall into this category.

Common Usage

- Most modern desktop / laptop / mobile processors are MIMD processors.

Advantages

- Great for situations where you need to perform a variety of processor and data intensive tasks (such as video editing, game rendering)

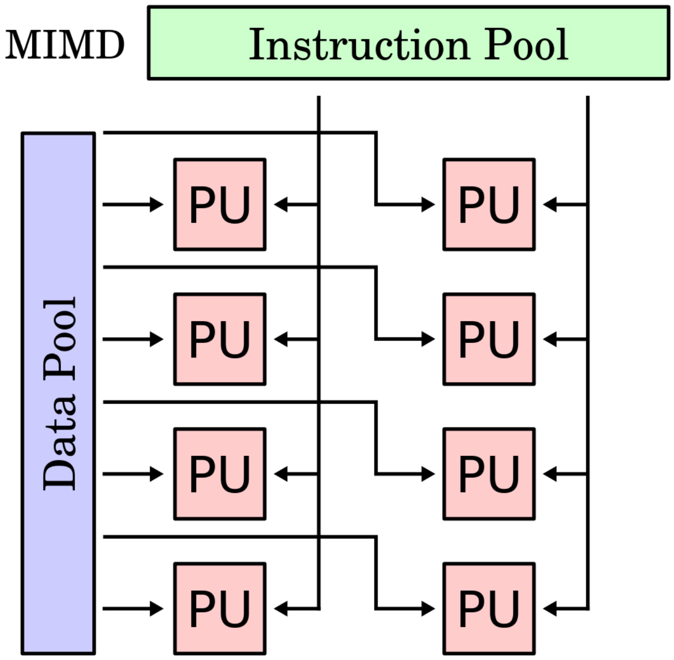

Fig. 4: MIMD Architecture Diagram

Characteristics

- Multiple Instruction Streams: Each processing unit executes its own set of instructions independently.
- Multiple Data Streams: Each processing unit operates on its own set of data independently.
- True Parallelism: Enables concurrent execution of different tasks or parts of a program.
- Distributed Control: Each processing unit may have its own control unit or operate autonomously.
- Examples: Clusters of computers, multi-core processors, and distributed computing systems like Hadoop and MPI (Message Passing Interface) applications.

QNO2 : Explain characteristics, advantages and disadvantages of RISC and CISC architecture

Reduced Instruction Set Computer(RISC)

Characteristics of RISC

- Simpler instruction, hence simple instruction decoding.
- Instruction comes undersize of one word.
- Instruction takes a single clock cycle to get executed.
- More general-purpose registers.
- Simple Addressing Modes.

- Fewer Data types.
- A pipeline can be achieved.

Advantages of RISC

- Simpler instructions: RISC processors use a smaller set of simple instructions, which makes them easier to decode and execute quickly. This results in faster processing times.
- Faster execution: Because RISC processors have a simpler instruction set, they can execute instructions faster than CISC processors.
- Lower power consumption: RISC processors consume less power than CISC processors, making them ideal for portable devices.

Disadvantages of RISC

- More instructions required: RISC processors require more instructions to perform complex tasks than CISC processors.
- Increased memory usage: RISC processors require more memory to store the additional instructions needed to perform complex tasks.
- Higher cost: Developing and manufacturing RISC processors can be more expensive than CISC processors.
-

Complex Instruction Set Computer (CISC)

Characteristics of CISC

- Complex instruction, hence complex instruction decoding.
- Instructions are larger than one-word size.
- Instruction may take more than a single clock cycle to get executed.
- Less number of general-purpose registers as operations get performed in memory itself.
- Complex Addressing Modes.
- More Data types.

Advantages of CISC

- Reduced code size: CISC processors use complex instructions that can perform multiple operations, reducing the amount of code needed to perform a task.
- More memory efficient: Because CISC instructions are more complex, they require fewer instructions to perform complex tasks, which can result in more memory-efficient code.
- Widely used: CISC processors have been in use for a longer time than RISC processors, so they have a larger user base and more available software.

Disadvantages of CISC

- Slower execution: CISC processors take longer to execute instructions because they have more complex instructions and need more time to decode them.
- More complex design: CISC processors have more complex instruction sets, which makes them more difficult to design and manufacture.
- Higher power consumption: CISC processors consume more power than RISC processors because of their more complex instruction sets.

Q3: Write a short note on multicomputer

A multicomputer system refers to a distributed computing system where multiple independent computers (nodes) are interconnected to work together towards a common goal. Each computer in a multicomputer system typically has its own memory and processor(s), and they communicate with each other over a network. The nodes in a multicomputer system can be homogeneous (similar hardware and software) or heterogeneous (differing hardware and software). Each node in a multicomputer system has its own local memory, and communication between nodes is achieved by message passing over the network. Multicomputer systems can be easily scaled by adding more nodes to the network, making them suitable for large-scale parallel computing tasks. Nodes in a multicomputer system can be added, removed, or replaced independently, allowing for flexible system configuration. Multiple nodes can work concurrently on different parts of a problem, which can lead to efficient parallel processing.

Q4: Write a short note o multiprocessor
A multiprocessor system refers to a shared-memory architecture where multiple processors (or cores) share a common memory space. In a multiprocessor system, all processors can access the same memory, which simplifies communication between processors. Multiprocessor systems can be symmetric multiprocessing (SMP) or asymmetric multiprocessing (AMP), depending on how processors are interconnected and managed. All processors in a multiprocessor system share a common memory space, allowing them to communicate by reading from and writing to shared memory locations. Processors in a multiprocessor system are tightly integrated and can communicate with each other directly through shared memory or interconnects. SMP systems have identical processors and a single operating system instance, while AMP systems may have different processors and/or operating systems.

Q5: Explain the key features of following processors: 8085, 8086, Intel i7 and AMD Ryzen 9 processors?

Intel 8085 (Released in 1976):
The 8085 was an 8-bit microprocessor, meaning it processed data in 8-bit chunks at a time. Its clock speeds is up to 3 MHz. It used a relatively simple instruction set, with around 74 instructions. 8085 processor has memory addressing up to 64 KB of memory directly. It fabricated using NMOS (N-channel Metal-Oxide-Semiconductor) technology. It has integrated support for basic input/output operations.
One notable feature of the Intel 8085 was its memory addressing capability, which allowed it to directly address up to 64 KB of memory. This made it suitable for handling memory-intensive applications of its time. The 8085 also supported basic arithmetic and logical operations, making it versatile for a range of applications, from embedded systems to early personal computers. Its architecture included various registers, such as accumulator, general-purpose registers, and special-purpose registers like program counter and stack pointer, enabling efficient data manipulation and control flow.
The Intel 8085 microprocessor was widely used in early computing systems and embedded devices due to its affordability, availability, and ease of integration. It played a key role in the development of home computers and industrial control systems during the late 1970s and early 1980s. Despite being superseded by more advanced microprocessors over time, the 8085 remains an important milestone in the history of computing, showcasing the transition from large-scale integrated circuits to single-chip microprocessors that revolutionized the electronics industry.

Intel 8086 (Released in 1978)

The 8086 introduced a 16-bit architecture, capable of processing 16-bit data and addressing 1 MB of memory. In 8086 microprocessor a segmented memory model is introduced, allowing efficient memory addressing beyond the 64 KB limit. It has clock speeds up to 10 MHz initially (later versions increased clock speeds). Expanded instruction set with more powerful and complex instructions compared to the 8085. It used HMOS (High-speed Metal-Oxide-Semiconductor) technology for manufacturing. It has enhanced peripheral support and more efficient input/output operations.

One of the key advancements introduced by the 8086 was its support for a more robust and comprehensive instruction set compared to its predecessors. The 8086 had a larger number of instructions and more complex addressing modes, enabling it to execute a wider range of operations with greater efficiency. This made the 8086 well-suited for multitasking and handling more sophisticated software applications, laying the foundation for modern operating systems.

The Intel 8086 microprocessor also featured a significant improvement in clock speed, running at frequencies up to 10 MHz. This higher clock speed, combined with its 16-bit architecture, resulted in substantial performance gains over previous generations of microprocessors. The 8086 was widely used in early personal computers, such as the IBM PC, and played a key role in the proliferation of x86 architecture in the computing industry.

Intel Core i7 (First Generation Released in 2008)

The Core i7 processors are 64-bit processors, supporting 64-bit data processing and addressing. The Core i7 series introduced multi-core processors, initially with quad-core designs, enabling parallel processing of tasks. It Supported Hyper-Threading, allowing each core to execute multiple threads simultaneously. Hyper-Threading technology further enhances multitasking capability by allowing each physical core to handle two threads simultaneously. It introduced Turbo Boost technology to dynamically increase clock speeds based on workload demands. It integrated memory controller for faster access to system memory. It Support advanced instruction set extensions like SSE (Streaming SIMD Extensions) for enhanced multimedia processing. It is fabricated using advanced CMOS (Complementary Metal-Oxide-Semiconductor) technology with smaller process nodes for improved efficiency and performance. Some Core i7 processors are integrated graphics processing units (GPUs) on the same die.

AMD Ryzen 9 Series Processors:

Ryzen 9 processors feature up to 16 cores and 32 threads, leveraging advanced multi-core architecture for high-performance computing.It is based on AMD's Zen microarchitecture (Zen 3 or Zen 2), offering significant improvements in IPC (Instructions Per Clock) and power efficiency compared to previous generations. It has high base and boost clock speeds for single-threaded and multi-threaded performance. It is fabricated using advanced 7nm process technology (Zen 2 and Zen 3), enhancing efficiency and performance. It is compatible with PCIe 4.0 for faster data transfer rates and improved connectivity. Ryzen 9 CPUs offer high base and boost clock speeds, allowing for fast single-threaded performance in addition to multi-core capabilities. Precision Boost technology dynamically adjusts clock speeds based on workload and thermal conditions for optimal performance.
AMD Ryzen 9 processors support SMT (Simultaneous Multi-Threading), allowing each core to handle two processing threads simultaneously. SMT improves overall efficiency by maximizing CPU utilization, especially in multi-threaded workloads. Ryzen 9 CPUs are compatible with PCIe 4.0 technology, offering faster data transfer rates for compatible PCIe devices such as SSDs and GPUs. Certain Ryzen 9 APUs (Accelerated Processing Units) feature integrated Radeon Vega graphics, suitable for systems without a discrete GPU or for light gaming and multimedia tasks.