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Parallel processing in processor organization

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Abstract*:* This paper reviews the coverage of parallel processing in processor organization. A parallel processing becomes more popular, the need for improvement in parallel processing in processor organization becomes even more important. Here compared each multiple processor organization, 1) SISD: single instruction single data, 2) SIMD: Single instruction multiple data 3) MISD: Multiple instruction single data and 4) MIMD: Multiple instruction multiple data

Keywords: Data, Instruction, IS: Instruction Set, CU: Control Unit, MU: Memory Unit PU: Processing Unit, LM: Local Memory, PE: Processing Element

I. INTRODUCTION

The taxonomy of computer systems proposed by M. J. Flynn in 1966 has remained the focal point in the field. This is based on the notion of instruction and data streams that can be simultaneously manipulated by the machine. Parallelism is to reduce the turnaround time but even increase the CPU time due to overhead and increase the required memory due to duplicate data and instructions. Writing and debugging a parallel program is much more complicated than a sequential program, at least an order-of-magnitude. Different architectures, different programming models are suitable for different applications and so the characteristics of the applications should make the decision for the selection of parallel hardware architecture and also the parallelization of the applications. A stream is just a sequence of items (instruction or data) SISD: A type of computer architecture in which there is a single instruction cycle, and operands are fetched in serial fashion into a single processing unit before execution. SIMD: A type of multiprocessor architecture in which there is a single instruction cycle, but multiple sets of operands may be fetched to multiple processing units and may be operated upon simultaneously within a single instruction cycle. MISD: s a type of parallel computing architecture where many functional units perform different operations on the same data. MIMD: A type of multiprocessor architecture in which several instruction cycles may be active at any given time, each independently fetching instructions and operands into multiple processing units and operating on them in a concurrent fashion.

II. Taxonomy of Parallel Processor Architectures

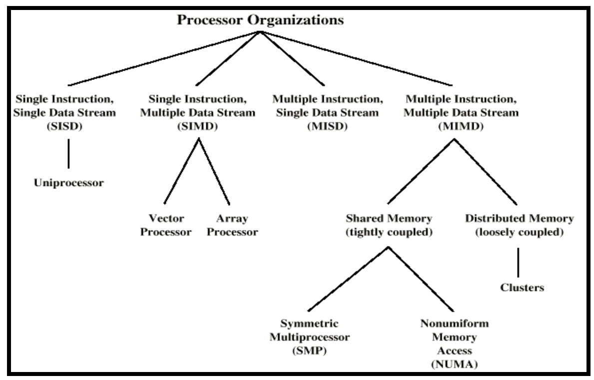

Figure 1: Taxonomy of Parallel Processor Architectures

1. SIS Model:

In computing, **SISD** (single instruction, single data) is a term referring to a computer architecture in which a Single processor, a uniprocessor, executes a single instruction stream, to operate on data stored in a single memory. SISD is one of the four main classifications. In this system classifications are based upon the number of concurrent instructions and data streams present in the computer architecture. SISD can have concurrent processing characteristics. Instruction fetching and pipelined execution of instructions are common examples found in most modern SISD computer

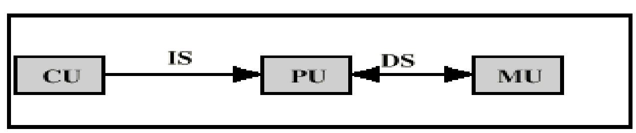

Figure 2 SISD model

- A serial (non-parallel) computer

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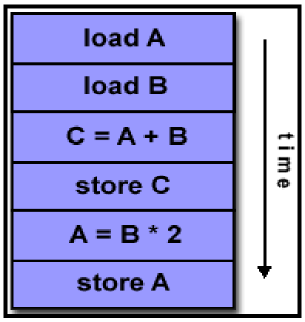
- Single Instruction: Only one instruction stream is being acted on by the CPU during any one clock cycle
- Single Data: Only one data stream is being used as input during any one clock cycle
- Deterministic execution
- This is the oldest and even today, the most common type of computer
- Examples: older generation mainframes, minicomputers and workstations; most modern day PCs.



2. SIMD Model: Single Instruction stream Multiple Data stream. is a class of Parallel computer. It describes computers with multiple processing elements that perform the same operation on multiple data points simultaneously. Thus, such machines exploit data level parallelism. SIMD is particularly applicable to common tasks like adjusting the contrast in a digital image or adjusting the volume of digital audio. Most modern CPU designs include SIMD instructions in order to improve the performance of multimedia use.

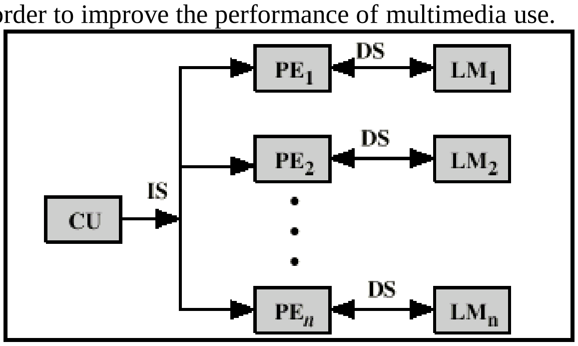


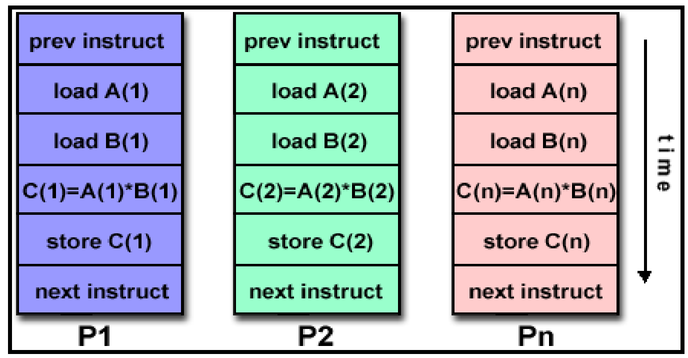
Figure 3 SIMD model

- A type of parallel computer

- **Single Instruction:** All processing units execute the same instruction at any given clock cycle
- **Multiple Data:** Each processing unit can operate on a different data element
- Best suited for specialized problems characterized by a high degree of regularity, such as graphics/image processing.
- Synchronous (lockstep) and deterministic execution
- Two varieties: Processor Arrays and Vector Pipelines
- Examples:

- Processor Arrays: Connection Machine CM-2, MasPar MP-1 & MP-2, ILLIAC IV
- Vector Pipelines: IBM 9000, Cray X-MP, Y-MP & C90, Fujitsu VP, NEC SX-2, Hitachi S820, ETA10

- Most modern computers, particularly those with graphics processor units (GPUs) employ SIMD instructions and execution units



2.1 Advantages

An application that may take advantage of SIMD is one where the same value is being added to (or subtracted from) a large number of data points, a common operation in many multimedia applications. One example would be changing the brightness of an image. Each pixel of an image consists of three values for the brightness of the red (R), green (G) and blue (B) portions of the color. To change the brightness, the R, G and B values are read from memory, a value is added to (or subtracted from) them, and the resulting values are written back out to memory.

With a SIMD processor there are two improvements to this process. For one the data is understood to be in blocks, and a number of values can be loaded all at once. Instead of a series of instructions saying "get this pixel, now get the next pixel", a SIMD processor will have a single instruction that effectively says "get n pixels" (where n is a number that varies from design to design). For a variety of reasons, this can take much less time than "getting" each pixel individually, as with traditional CPU design.

Another advantage is that SIMD systems typically include only those instructions that can be applied to all of the data in one operation. In other words, if the SIMD system works by loading up eight data points at once, the add operation

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being applied to the data will happen to all eight values at the same time. Although the same is true for any super-scalar processor design, the level of parallelism in a SIMD system is typically much higher.

3. MISD Model: In computing, MISD (multiple instruction, single data) is a type of parallel computing architecture where many functional units perform different operations on the same data. Pipeline architectures belong to this type, though a purist might say that the data is different after processing by each stage in the pipeline. Fault-tolerant computers executing the same instructions redundantly in order to detect and mask errors, in a manner known as task replication, may be considered to belong to this type. Not many instances of this architecture exist, as MIMD and SIMD are often more appropriate for common data parallel techniques. Specifically, they allow better scaling and use of computational resources than MISD does. However, one prominent example of MISD in computing are the Space Shuttle flight control computers.

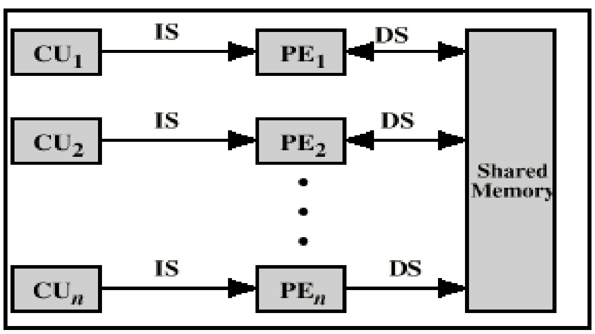
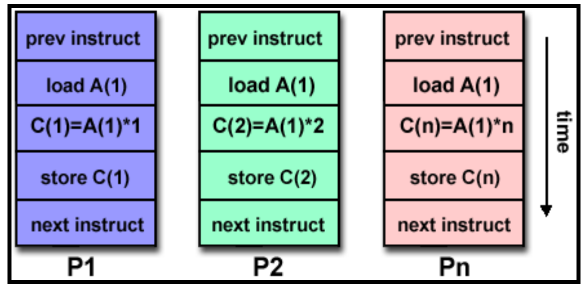


Figure 4 MISD model

- A type of parallel computer
- **Multiple Instructions:** Each processing unit operates on the data independently via separate instruction streams.
- **Single Data:** A single data stream is fed into multiple processing units.
- Few actual examples of this class of parallel computer have ever existed. One is the experimental Carnegie-Mellon C.mmp computer (1971).
- Some conceivable uses might be:
- multiple frequency filters operating on a single signal stream
- Multiple cryptography algorithms attempting to crack a single coded message.



4. MIMD Model: In computing, MIMD (multiple instructions, multiple data) is a technique employed to achieve parallelism. Machines using MIMD have a number of processors that function asynchronously and independently. At any time, different processors may be executing different instructions on different pieces of data. MIMD architectures may be used in a number of application areas such as computer-aided design/computer-aided manufacturing, simulation, modeling, and as communication switches. MIMD machines can be of either shared memory or distributed memory categories. These classifications are based on how MIMD processors access memory Shared memory machines may be of the bus-based, extended, or hierarchical type. Distributed memory machines may have hypercube or mesh interconnection schemes. A multi-core CPU is an MIMD machine.

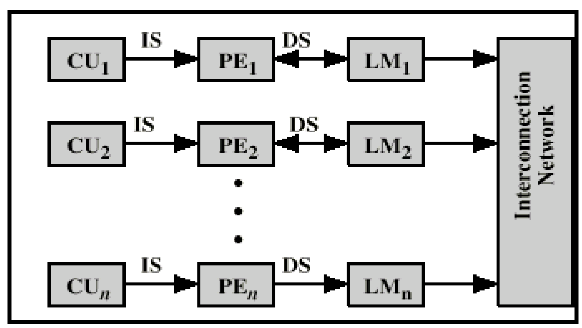


Figure 5 MIMD Model

- A type of parallel computer
- **Multiple Instruction:** Every processor may be executing a different instruction stream
- **Multiple Data:** Every processor may be working with a different data stream
- Execution can be synchronous or asynchronous, deterministic or non-deterministic
- Currently, the most common type of parallel computer - most modern supercomputers fall into this category.
- Examples: most current supercomputers, networked parallel computer clusters and "grids", multi-processor SMP computers, multi-core PCs.

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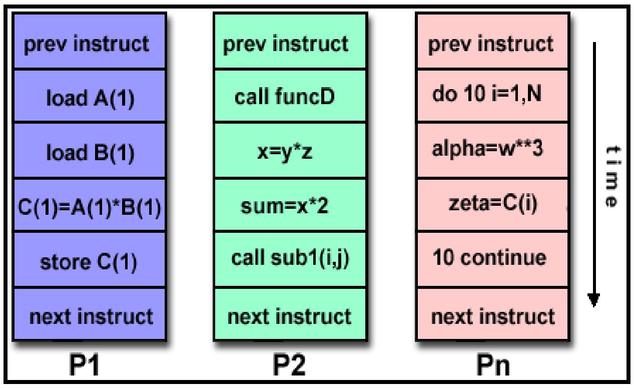
- Note: many MIMD architectures also include SIMD execution sub-components



Comparison of SIMD and MIMD

➢ SIMD computers require less hardware than MIMD computers because they have only one control unit.

➢ SIMD computers require less memory because only one copy of the program needs to be stored. In contrast, MIMD computers store the program and operating system at each processor.

➢ However, the relative unpopularity of SIMD processors as general purpose compute engines can be attributed to their specialized hardware architectures, economic factors, design constraints, product life-cycle, and application characteristics.

➢ In contrast, platforms supporting the SPMD paradigm can be built from inexpensive off-the-shelf components with relatively little effort in a short amount of time.

➢ SIMD computers require extensive design effort resulting in larger product development times. Since the underlying serial processors change so rapidly, SIMD computers suffer from fast obsolescence. Their regular nature of many applications also makes SIMD architectures less suitable

CONCLUSION

In this paper we have discussed about the Architectures of each parallel processing type in computer organization. We also described the types of parallel processing with example and advantages of Single Instruction Multiple Data and Comparison of SIMD and MIMD.

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BIOGRAPHY

Prabhudev S Irabashetti received his M.Tech. degree from Davangere University, Davangere in June 2012. He is presently working as Assistant Professor in Computer Department, Vishwabharati Academy's College of Engg Ahmednagar, Maharashtra, India. He is currently guiding B.E, M.E. students of VACOE Ahmedanagar. He has presented 2 papers in National Conference, and published 2 papers in International Journals