

# Chapter 8

## Introduction to parallel processing

# Parallel processing

- Parallel processing or parallel computing is a form of computation in which many calculations are carried out simultaneously, operating on the principle that large problems can often be divided into smaller ones, which are then solved concurrently (“in parallel”).
- Parallel processing/computing, uses multiple processing elements simultaneously to solve a problem.

# important points about parallel processing

- A parallel processing system is able to perform concurrent data processing to achieve faster execution time.
- The system may have two or more ALUs and be able to execute two or more instructions at the same time
- Also, the system may have two or more processors operating concurrently

# Parallel processing can be classified from:

- The internal organization of the processors
- The interconnection structure between processors
- The flow of information through the system
- The number of instructions and data items that are manipulated simultaneously

# Goal of parallel processing

- The Goal of parallel processing is to increase the throughput  
**instruction stream**
- Is The sequence of instructions read from memory.  
**data stream**
- is The operations performed on the data in the processor.
- Parallel processing may occur in the instruction stream, the data stream, or both

# Classification of Computer

Computer can be classified as:

- Single instruction stream, single data stream – SISD
- Single instruction stream, multiple data stream – SIMD
- Multiple instruction stream, single data stream – MISD
- Multiple instruction stream, multiple data stream – MIMD

# Pipelining

- Pipelining is an implementation technique where multiple instructions are overlapped in execution.
- Pipelining refers to the technique in which a given task is divided into a number of subtasks that need to be performed in sequence.
- Each subtask is performed by a given functional unit

# Arithmetic Pipeline

- Pipeline arithmetic units are usually found in very high speed computers.
- They are used to implement floating-point operations, multiplication of fixed-point numbers, and similar computations encountered in scientific problems.

# Instruction Pipeline:

- ▶ An instruction pipeline reads consecutive instructions from memory while previous instructions are being executed in other segments. Whenever there is space in the buffer, the control unit initiates the next instruction fetch phase. The following

# steps needed to process each instruction

1. Fetch the instruction from memory
2. Decode the instruction
3. Calculate the effective address
4. Fetch the operands from memory
5. Execute the instruction
6. Store the result in the proper place

# RISC Pipelines:

- A RISC (Reduced Instruction Set Computer) processor pipeline operates in much the same way, although the stages in the pipeline are different.
- While different processors have different numbers of steps, they have basically variations of these five steps:

# Cont...

1. fetch instructions from memory
2. read registers and decode the instruction
3. execute the instruction or calculate an address
4. access an operand in data memory
5. write the result into a register

# Vector Processing

- The part of a computer that carries out the instructions of various programs is the central processing unit (CPU).
- The CPU, also called a processor, receives a program's instructions; decodes those instructions, breaking them into individual parts; executes those instructions; and reports the results, writing them back into memory.
- The format for the processor comes in one of two primary types: vector and scalar.

# Cont...

- The difference between the two is that scalar processors operate on only one data point at a time, while vector processors operate on an array of data.
- Many scientific problems require arithmetic operations on large arrays of numbers.
- These numbers are usually formulated as vectors and matrices of floating point numbers.
- A vector is an ordered set of a one dimensional array of data items.
- A vector  $V$  of length  $n$  is represented as a row vector by  $V = [V_1, V_2, V_3, \dots, V_n]$ .