UTM

UNIVERSITI TEKNOLOGI MALAYSIA

SCSR3223 / SCSP3113 High Performance & Parallel Programming

Chapter 1: Introduction

Concept of Parallelism

- **Parallel Computer** - A multiple-processor computer system that supporting parallel programming and computation.

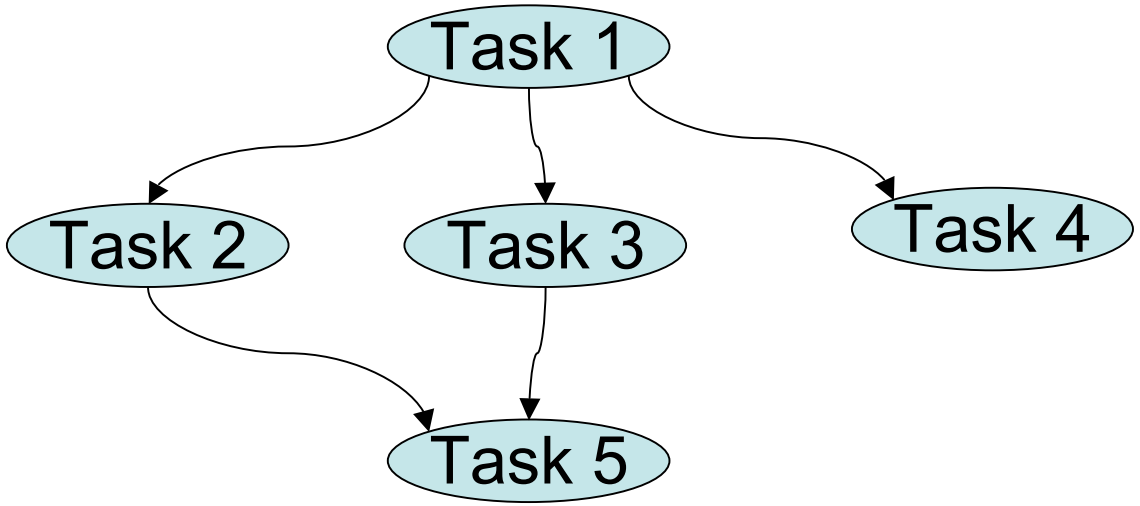
- **Parallel Computing** - The use of parallel computer to reduce the time needed to solve a single computational problem.

Concept of Parallelism

- **Parallel Programming** - Computer programming in a language that allows programmers to indicate how different portions of computation may be executed concurrently by different processors.

Overview of Seeking Concurrency

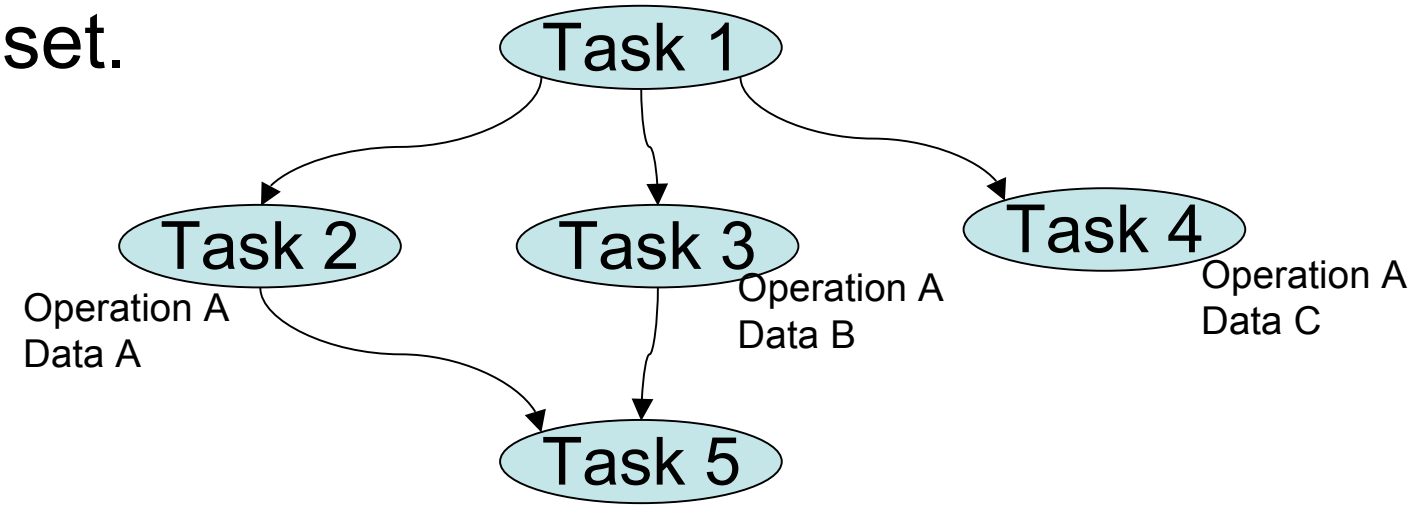
- Data Dependence Graph



  - Task 2,3 and 4 are dependent on Task 1
  - Task 2 and Task 3 are independent

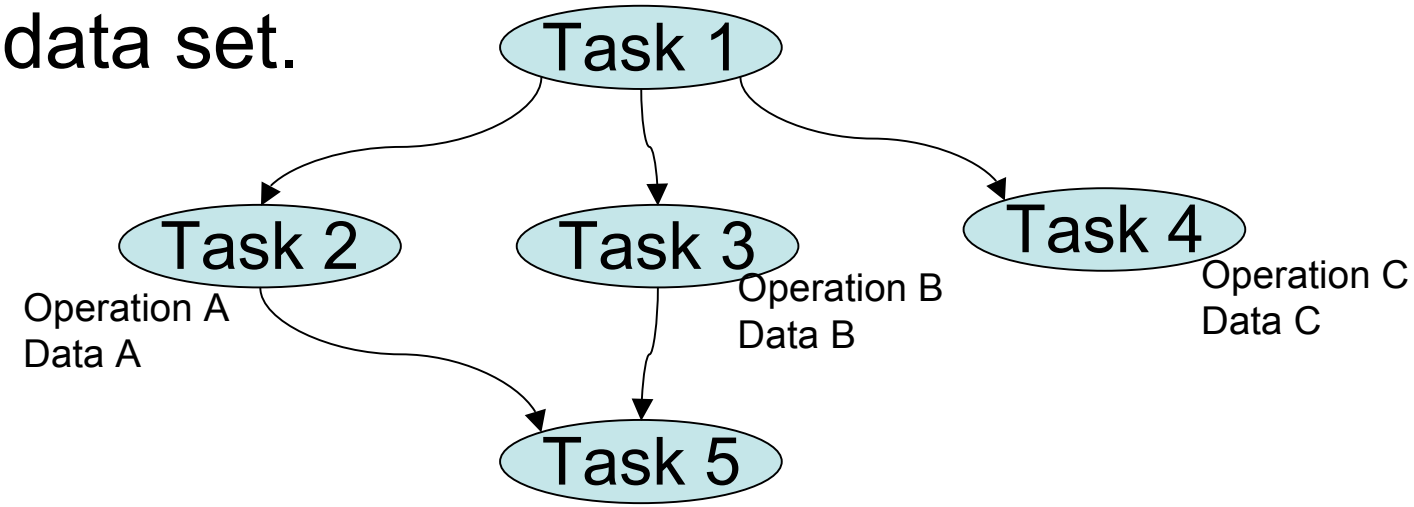
Seeking Concurrency

- Data Parallelism
  - **Independent tasks** applying the **same operation** to **different elements** of a data set.



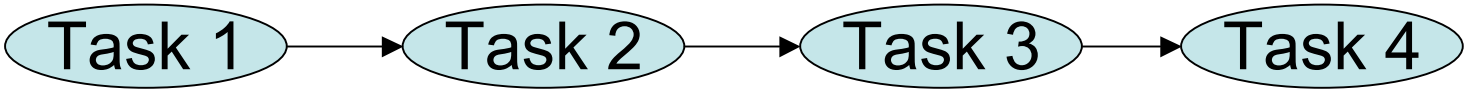
Seeking Concurrency

- Functional Parallelism
  - **Independent tasks** applying **different operations** to **different elements** of a data set.



Seeking Concurrency

- Pipelining
  - Only effective on multiple problem instances condition
  - If a single problem is divided into N stages, therefore, pipelining supports up to N concurrency
  - Ideally, each stage has equal computing period



Concept of Parallelism

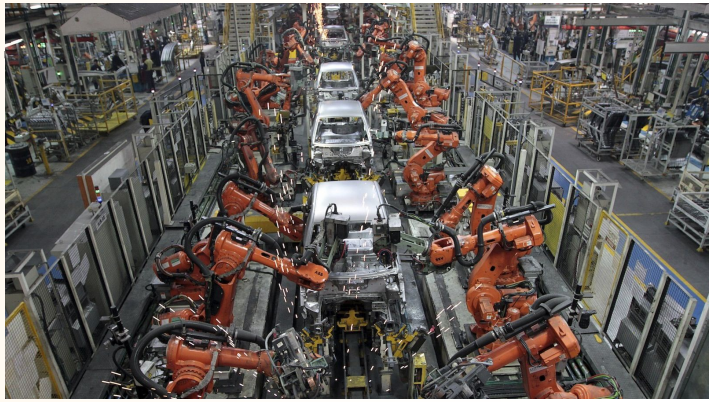
- Parallelism is not a new thing. Familiar concepts in human life, for example:
  - In juggling activity of a person
  - In construction of houses or buildings
  - In manufacturing
  - In customer service such as call center.

Concept of Parallelism

- Parallel activities in construction of houses or building
  - Wiring, Plumbing, framing, roofing and etc
  - Some tasks may be performed simultaneously
    - Eg: Wiring and plumbing
  - Some tasks need to be performed sequentially
    - Eg: Framing precedes roofing
  - Ordering requirement of tasks:
    - restrict the degree of parallelism.
    - Increase degree of interaction between workers

Concept of Parallelism

- Parallel activities in manufacturing
  - pipeline parallelism
  - Strict ordering requiremen
  - Each worker/stage do different tasks/routines.
  - Maximum degree of parallelism is equal to number of stages/workers in the pipeline.
  - Eg: Manufacturing of cars



Concept of Parallelism

- Parallel activities in call center
  - Calls are independent to other calls.
  - So the servers, therefore less degree of communication between workers.

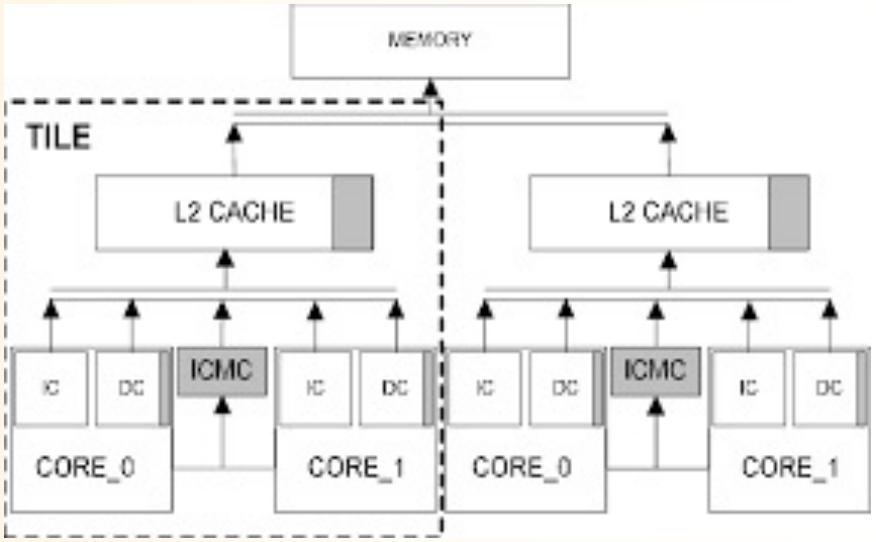
  - Maximum degree of parallelism is also equal to number of stage/workers in the call center.
  - All server/worker do common routine/procedures.

Concept of Parallelism

- Juggling
  - Event-driven parallelism
  - Occurring of an event then activates the execution of operations.
    - Event : falling ball
    - Operation executed: catching, throwing.

Parallelism Opportunities

- Existence of Multicore computers
  - Performance improvements of single chip processor has reached the limit.
  - Therefore multi-core architecture were developed.
  - Each core consists of instruction execution engine, cache memory.



Parallelism Opportunities

- Existence of Supercomputers
  - Commonly own by governments or large cooperation's.
  - Used to solve large computational problems.
  - Supercomputers have thousands of processors.
  - List of current supercomputers may be found at www.top500.org

Parallelism Opportunities

- Existence of Cluster Machine
  - Developed based on the idea of "combining many commodities machines/computers to produce a faster computer that can execute more instruction per unit time".
  - Commodities computers are connected using commodities interconnect such as Gigabit Ethernets, Myrinet, Fiber channel and etc.
  - Offers good ratio in term of of price/performance.

Parallelism Opportunities

- Availability of Connected Servers
  - Servers are connected on the networks/internet may be used to perform parallel computations.
  - These servers may belongs to an organizations or more.

Parallelism Opportunities

- Availability of Grid Computing
  - In grid computer, not just server machines are contributing as computing resources, in fact users/publics computers may also be linked and assign to perform parallel computing.
  - The computing nodes are from various range of specifications.

Benefits of Parallel Computing

- provide cost-effective solutions to meet the resource demand of big-scale computation problems.
- increase the utilization of existing resources.
- provide faster progress for industries that concern about how fast a progress is made).

In Scientific research (Grand Challenges)

- Modelling of human organs and bones, medicine
- Modelling of global weather and enironmental, Turbulence modelling
- Modelling of Enzyme activity, protein folding, gnome sequencing

In Commercial Area

- Web server
- Large scale transaction processing

In Computer Systems

- Intrusion detection and alert signaling
- Cryptography

In Embedded Systems

- Optimization of handling and performance of modern vehicles

END