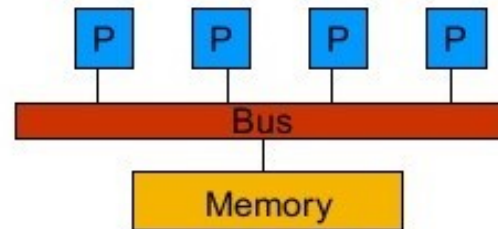# Parallel and Distributed Computing:
Introduction

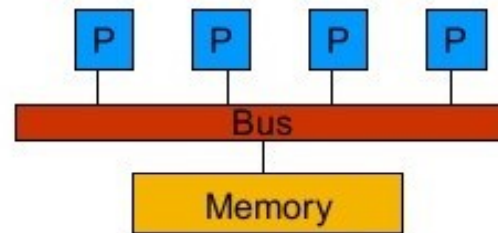# Parallel Computing vs. Distributed Computing

- **Parallel Computing** refers to a model in which the computation is divided among several processors sharing the same memory.

Parallel Computing vs. Distributed Computing

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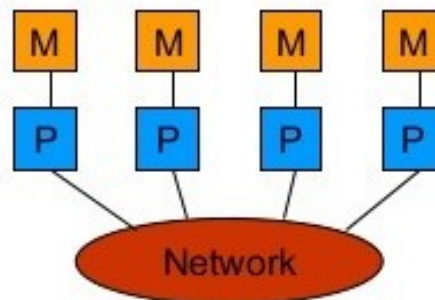

- **Distributed Computing** refers to the model in which each processor has its own private memory. Information is exchanged by passing messages between the processors.

Applications

➢ Complex problems require more computing power

- Climate Modeling (weather forecasting)

- Geophysics simulation (earthquake/tsunami prediction)

- Structure or flow simulation (crash test)

- Large data analysis (LHC)

- Military applications (crypto analysis)

Cluster Computing

- Distributed Computing

Characteristics:
- tightly coupled computers
- single system image
- Centralized Job management & scheduling system

Cluster Computing

- Distributed Computing

Characteristics:
- tightly coupled computers
- single system image
- Centralized Job management & scheduling system

+ Better performance and availability

Grid Computing

- Distributed Computing

Definition

Collection of resources owned by multiple organizations that is coordinated to allow them to solve a common problem.

Grid Computing

- Distributed Computing

Definition

   Collection of resources owned by multiple organizations that is coordinated to allow them to solve a common problem.

Characteristics
- loosely coupled
- no Single System Image
- distributed Job Management & scheduling

Cloud Computing

Definition

Cloud computing is the delivery of computing services over the Internet ("the cloud")

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Computing services

- Servers
- Storage
- Databases
- Networking
- Software
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- intelligence

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Advantages

- faster innovation
- flexible resources
- economies of scale

Supercomputing

- Thousands of processors
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Supercomputer

Syllabus

Course Outline:

Component	Unit	Lecture
Component 1	Unit 1	Introduction to PDC: Latency vs Bandwidth, Applications and Challenges, Types of architecture, Flynn's taxonomy, Basic concepts: cores, nodes, threads, processes, speedup, efficiency, overhead, strong and weak scaling (Amdahl's law, Gustafson's law), Cache, Principle of Locality, Programming Models.
	Unit 2	Distributed Computing: Distributed Memory, Message Passing Interface, Asynchronous/Synchronous computation/communication, concurrency control, fault tolerance, Distributed Programming with OpenMPI.
Component 2	Unit 3	Parallel Computing: shared memory, data and task parallelism, Synchronization, Concurrent Data Structures, Shared Memory Programming with available APIs: PThreads, OpenMP, TBB.
	Unit 4	GPU Programming: GPU Architecture, Programming Models: CUDA/OpenCL, Basic Concepts: Threads, Blocks, Grids, GPU memory hierarchy, Thread Scheduling, Warps and Control divergence, Memory Coalescing, Programming with CUDA, Using CUDA Libraries: CuBLAS, CuFFT

Books

Text Books and references

i.   The Art of Multiprocessor Programming by Maurice Herlihy and Nir Shavit, Morgan Kaufmann Publishers.

ii.   Principles of Parallel Programming, by Calvin Lin, Larry Snyder, Addison-Wesley.

iii.   Introduction to Parallel Computing, by Ananth Grama, Anshul Gupta, George Karypis, Vipin Kumar, Second Edition.

iv.   Wen-Mei W Hwu, David B Kirk, Programming Massively Parallel Processors A Hands-on Approach, Morgann Kaufmann, 3e

v.   Research Papers

Course Evaluation

Component	Marks
C1	30
C2	30
C3	40
Total	**100**

Course Evaluation

Component	Marks
C1	30
C2	30
C3	40
Total	**100**

Distribution	Marks
Review Tests	50%
Viva	
Assignments	20%
Project	20%
Class Participation	15%
Total	**100**

Important Points

- Kindly keep your camera and mic off during the lecture.
- Feel free to ask doubts anytime during the lecture
- Please feel free to contact me in case of any doubts/queries thereafter on my mail id: anshu@iiita.ac.in

Policy

- **Plagiarism in assignments/quiz/exams will not be tolerated and will be strictly dealt with**

- Absence in quiz/exams for genuine reasons will have to be informed in advance

- 15% weightage for class participation/interaction

- Attendance will be recorded for every lecture.

THANK YOU