Parallel Computing :

➢ ***Parallel Architectures***

➢ ***Parallel Algorithms***

➢ ***Parallel Programming***

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Abstract

Generally speaking, parallel computing deals with the parallel computer architectures, parallel algorithms and parallel programming. In this lecture we will discuss briefly them separately. In part I, we will discuss the contemporary parallel computer system architectures and memory access models, parallel system interconnections and parallel system performance evaluation. In part II, we will discuss the parallel computational models, the design methods, techniques and methodology of parallel algorithms, as well as some parallel numerical algorithms. In part III, we will discuss the parallel programming models, shared-memory, message-passing and data-parallel programming, as well as parallel programming environment and tools.

Outline

- **Part I : Hardware Platform for Parallel Computing**
  ------- ***Parallel Computer Systems***
  - System Architectures and Models
  - System Interconnections
  - Performance Evaluation

- **Part II : Theoretical Base for Parallel Computing**
  ------- ***Parallel Algorithms***
  - Computational Models
  - Design Methods
  - Design Techniques
  - Design Methodology
  - Parallel Numerical Algorithms

- **Part III : Software Support for Parallel Computing**
  ------- ***Parallel Programming***
  - Programming Models
  - Shared-Memory Programming
  - Message-Passing Programming
  - Data-Parallel Programming
  - Programming Environment and Tools

Part I : Hardware Platform

- **Parallel System Architectures and Models**
  - **Parallel Computer System Architectures**
    - *PVP : Parallel Vector Processors*
    - *SMP : Symmetric Multiprocessors*
    - *MPP : Massively Parallel Processors*
    - *DSM : Distributed Shared Memory*
    - *COW : Cluster Of Workstations*
  - **Parallel Computer Memory Access Models**
    - *UMA : Uniform Memory Access*
    - *NUMA : Non-Uniform Memory Access*
    - *COMA : Cache-Only Memory Access*
    - *NORMA : NO-Remote Memory Access*
- **Parallel System Interconnections**
  - **Network Environments**
    - *Intra-node Interconnections(Buses , Switches)*
    - *Inter-node Interconnections(SAN)*
    - *Inter-system Interconnections(LAN , MAN , WAN)*
  - **Interconnection Topologies**
    - *Static-Connection Networks(LA,RC,MC,TC,HC,CCC)*
    - *Dynamic-Connection Networks(Buses , Crossbar, MIN)*
  - **Wide-Band Networks**
    - *FDDI(Fiber Distributed Data Interface)*
    - *FE/GE(Fast Ethernet / Gigabit Ethernet)*
    - *ATM(Asynchronous Transfer Mode)*
    - *SCI(Scalable Coherence Interface)*
- **Parallel System Evaluation**
  - **Speed up of Systems**
    - *Amdahl's Law*
    - *Gustafson's Law*
    - *Sun and Ni's Law*
  - **Scalability of Systems**
    - *Iso-efficiency*
    - *Iso-speed*
    - *Average Latency*
  - **Performance of Systems : Benchmarks**
    - *LINPACK*
    - *SPEC*
    - *PARKBENCH*
    - *NAS etc.*

Part II : Theoretical Base

- **Parallel Computational Models**
  - PRAM : Parallel Random Access Machines
  - APRAM : Asynchronous PRAM
  - BSP : Bulk Synchronous Parallel
  - LogP : Latency , Overhead , Gap , Processors
  - C^3 : Computation , Communication , Congestion
- **Design Methods of Parallel Algorithms**
  - Parallelizing a Sequential Algorithm
  - Designing a new Parallel Algorithm
  - Borrowing Other Well-known Algorithm
- **Design Techniques of Parallel Algorithms**
  - Balanced Trees
  - Doubling Technique
  - Partitioning Strategy
  - Divide and Conquer
  - Pipelining
- **Design Methodology of Parallel Algorithms**
  - PCAM : Partitioning
  - PCAM : Communication
  - PCAM : Agglomeration
  - PCAM : Mapping
- **Parallel Numerical Algorithms**
  - Dense Matrix Algorithms
  - Solving Systems of Linear Equations
  - Fast Fourier Transform

Part III : Software Support

- **Parallel Programming Models**
  - **Implicit Model**
  - **Data-Parallel Model**
  - **Shared-Memory Model**
  - **Message-Passing Model**
- **Shared-Memory Programming**
  - **ANSI X3H5**
  - **POSIX Threads(Pthreads)**
  - **Shared-Variable Parallel Code to Compute** p
- **Message-Passing Programming**
  - **MPI : Message-Passing Interface**
  - **MPI Basics**
  - **Message-Passing Code to Compute** p
  - **PVM : Parallel Virtual Machine**
  - **PVM Program to Compute** p
- **Data-Parallel Programming**
  - **HPF : High-Performance Fortran**
  - **Gaussian Elimination in HPF**
- **Parallel Programming Environment and Tools**
  - **Parallelizing Compiler**
    - ***Two Ways to Parallelize Compiler***
    - ***SIMDizing : Vectoring***
    - ***MIMDizing : Parallelizing***
  - **Performance Analysis**
    - ***Data Collection***
    - ***Data Transformation and Visualization***
    - ***Performance Analysis Tools***
  - **Visualization of Scientific Data**
    - ***Definition , Goal and Concepts***
    - ***Characterization of Scientific Data***
    - ***Visualization Techniques***