

Distributed Systems

MSc: Prep. Year

Chapter 1

Introduction

Traditional Computer

- **Digital Computer System**

- A digital computer (traditional von Neumann sequential computer) is a computing machine comprises a **processor unit**, an associated **memory**, **input/output interfaces** and **various buses** connecting these devices.
- The digital computer is designed to be used by a single person, so its called **Personal Computer** (PC)
- The processor in this model is the single computational unit responsible for the functions of **fetching**, **decoding** and **executing** a program's instructions.

Traditional Computer

- **Operating Systems**

The operating system is a software program manages hardware resources of a personal/single computer to perform specific Process.

- **Principle of Processing in PC**

The principle of processing in the traditional computer is basically based on **sequential execution of the instructions** (statements or commands) that manipulate/solve a given job.

Traditional Computer

- The problem in the processing strategy of traditional computer

The problem is that, *the processing time for completing a job is relatively proportional with the size of the problem.*

As the problem size increases, as the processing time to finish the job increases.

Hence, ***at a time the PC will not sufficient to perform a large application.***

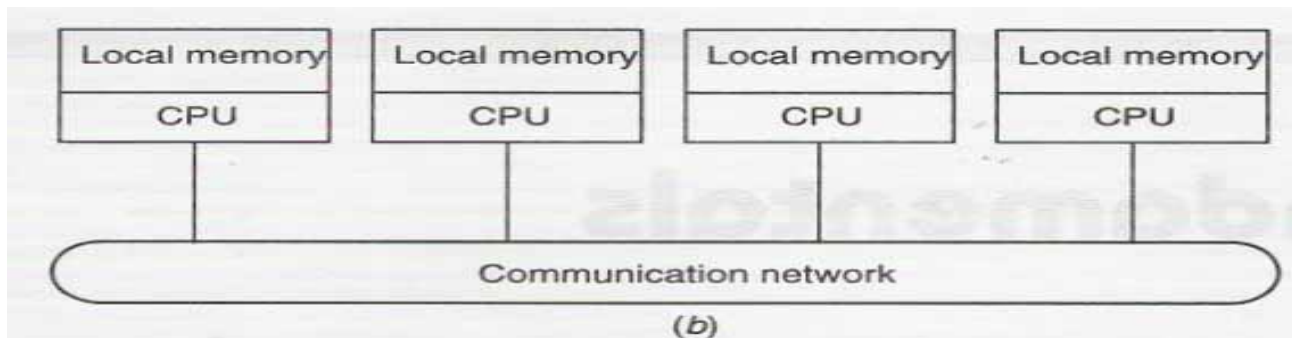
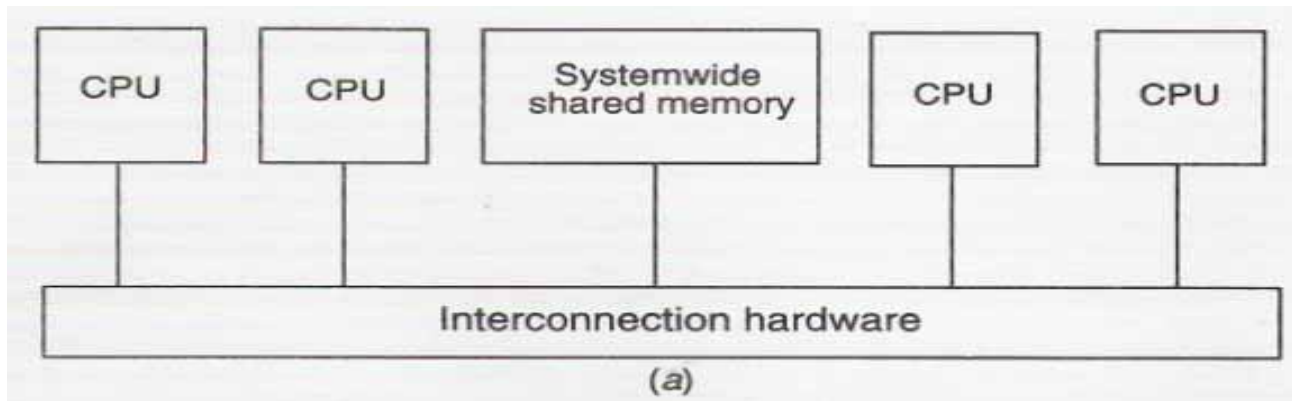
Traditional Computer

- **Solution of the problem**

- The solution is to process the given job on a ***multi-processor*** system or ***multi-computer*** system.
- ***Multi-processor system:*** a single computer system has many processors. There is SW manage the processors for processing a job.
- ***Multi-computer system:*** a set of computers interconnected by a computer network, each computer has its local processor and main memory. The computers are employed to do a specific process/job.

Hardware Concepts

- A Parallel and distributed system can be classified according to its distribution characteristics into two types: ***Tightly coupled*** and ***Loosely coupled***.



Hardware Concepts

- **Tightly coupled systems:**
 - There is a single system with primary memory (address space) that is shared by all the processors.
 - If any processor writes, for example, the value 100 to the memory location x, any other processor subsequently reading from location x will get the value 100.
 - Any communication between the processors usually takes place through the shared memory.

Hardware Concepts

- **Loosely coupled systems:**
 - The processors do not share memory, and each processor has its own local memory.
 - If a processor writes the value 100 to the memory location x, this write operation will only change the contents of its local memory and will not affect the contents of the memory of any other processor. Hence, if another processor reads the memory location x, it will get whatever value was there before in that location of its own local memory.
 - All physical communication between the processors is done by passing messages across the network that interconnects the processors.

Hardware Concepts

- **Loosely coupled systems** can be classified into: *homogeneous* and *heterogeneous*.
- ***Homogeneous multi-computer :***
 - *there is essentially only a single interconnection network that uses the same technology everywhere.*
 - *all processors are the same.*
- ***Heteromogeneous Distributed System:***
 - *a heterogeneous multicomputer system may contain a variety of different, independent computers,*
 - *The systems are connected through different networks.*

Definition of Distributed Systems [1]

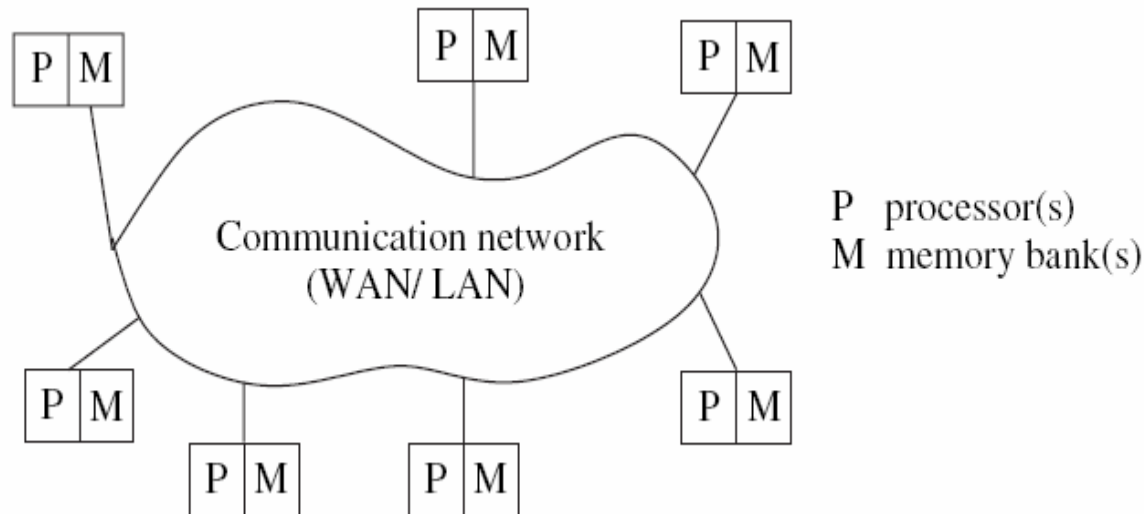
- A distributed system can be defined as:
 - “A collection of **autonomous computers** interconnected by a computer network and equipped with distributed system software to form an integrated computing facility”
 - “A system in which hardware or software components located at networked computers that communicate and coordinate their actions only by **message passing**”
 - “A system consists of a collection of two or more **independent computers** which coordinate their processing through the exchange of synchronous or asynchronous message passing”

Definition of Distributed Systems [2]

- *“A collection of autonomous computers linked by a network with software designed to produce an **integrated computing facility**”*
- *“A collection of independent computers that **appear to the users of the system as a single computer**”*
- *A **distributed system** is basically a collection of independent computers interconnected by a communication network and coordinate their actions only by message passing but appears to its users as a single coherent system.*

Definition of Distributed Systems [3]

- A typical distributed system would look as shown in the Figure. Each computer has a memory unit and a processing unit and the computers are connected by a communication network. Indeed, they interact to process a job.



Software Concepts

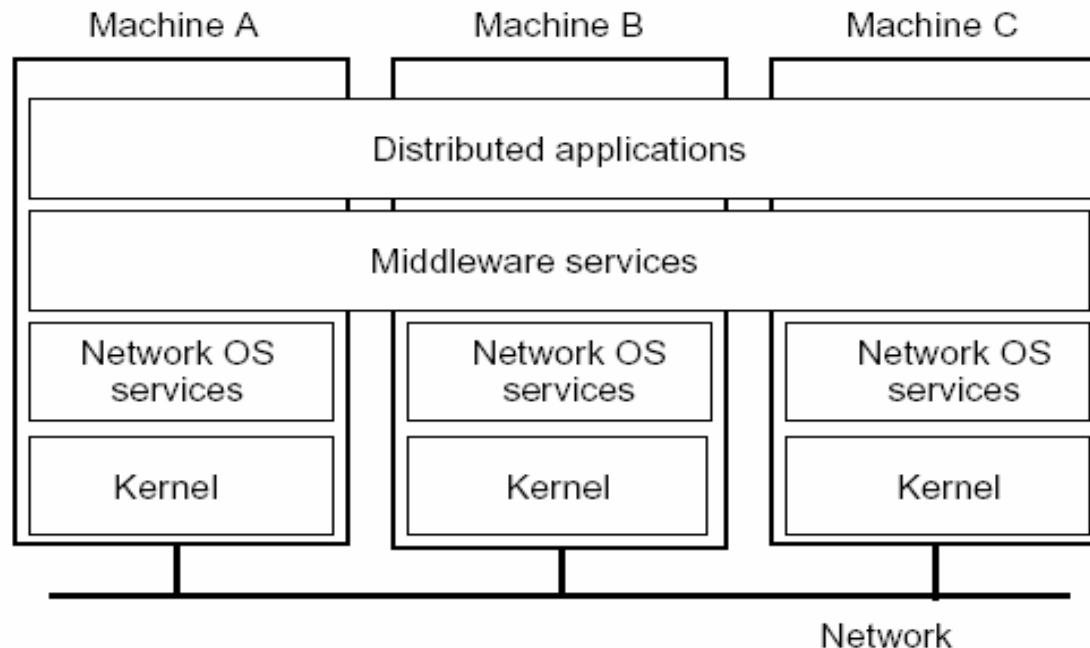
- **Categories of software of distributed systems**
 - ***Tightly coupled operating system:*** A tightly coupled operating system is generally referred to as a distributed operating system (DOS), and is used for *managing multiprocessors and homogeneous multicomputers*.
 - ***Loosely couple systems.*** The loosely-coupled network operating system (NOS, is used for for *managing multiprocessors of heterogeneous multicomputer systems*.

Software Concepts

- **Middleware layer**
- **Middleware layer** is additional layer of software between applications and the network operating system, offering a higher level of abstraction. This layer **hides the heterogeneity of the heterogeneous distributed system and appears the D.S to the user as a single machine (system imaging).**

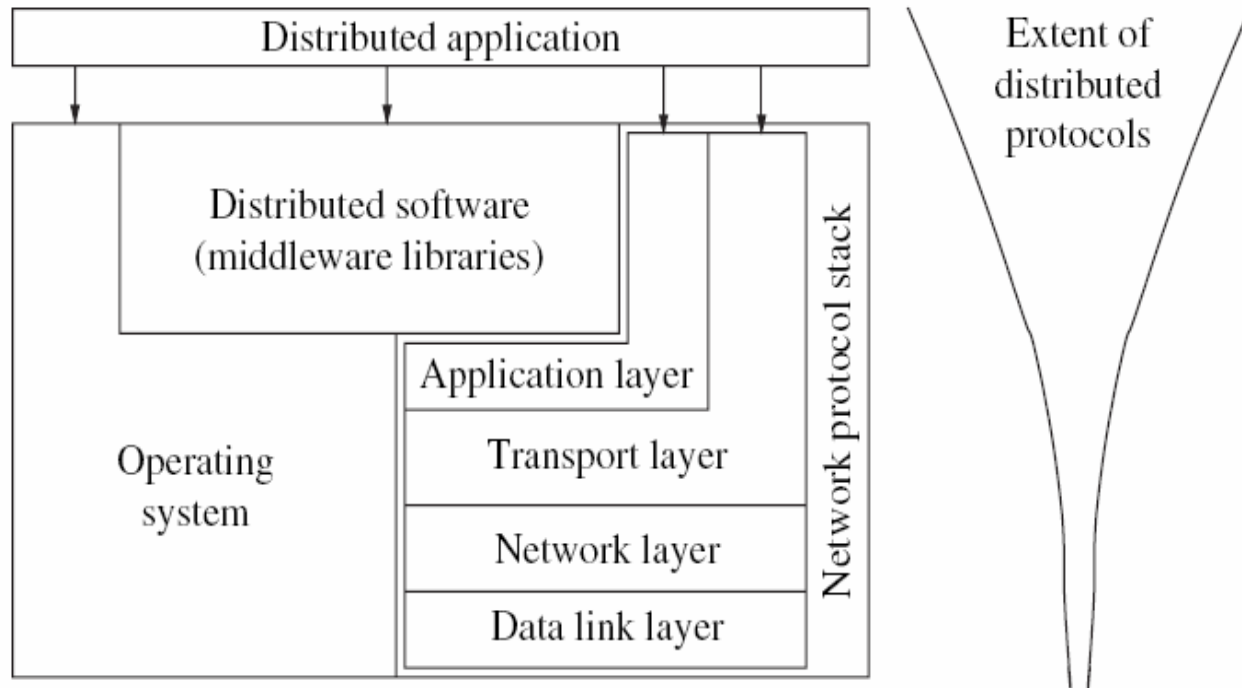
Software Concepts

- **positioning of middleware Layer**
- The middleware sits in the middle between applications and the network operating system as shown in the following Figure.



Software Concepts

- **The Interaction of the software components at each Computer**

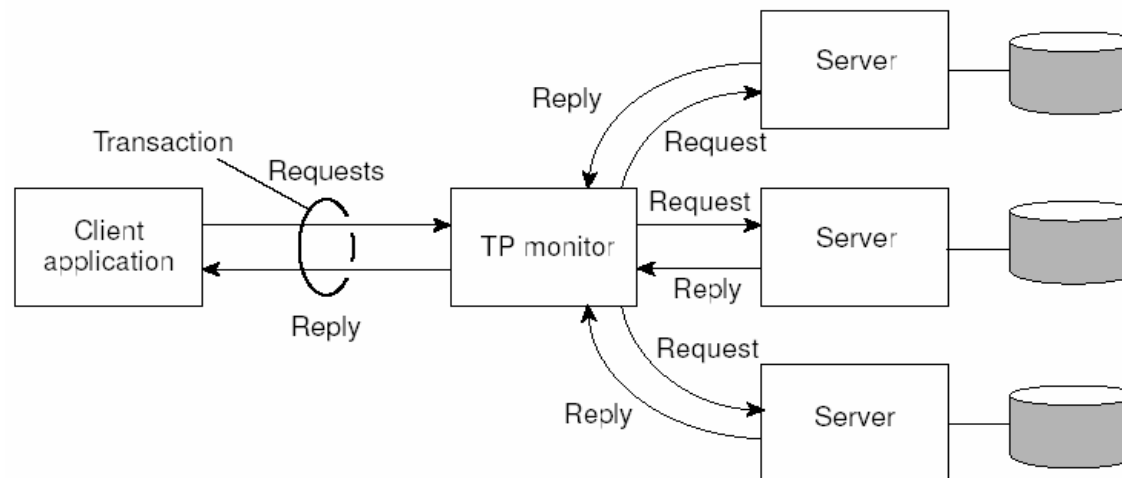


Types of Distributed Systems

- Various kinds of distributed systems operate today, each aimed at solving different kinds of problems:
 - *Cluster computing.*
 - *Grid computing.*
 - *Distributed information systems.*
 - *Distributed embedded systems.*
- ***Cluster computing:*** a collection of similar workstations or homogeneous computers (PCs) connected by a high speed local area network. Each node runs the same operating systems with the use of single management node. **(The computers have the same HW and SW)**

Types of Distributed Systems

- ***Grid computing***: a lot of heterogeneous computers dispersed across several organizations from everywhere in the wide-area network. Each system may fall under a different administration domain, and may be very different when it comes to hardware, software and deployed network technology.
- ***Distributed information system***: is a form of *traditional information systems* which integrate legacy systems, for example, Transaction Processing (TP) systems. **Retrieve information from the Internet.**



Types of Distributed Systems

- ***Distributed embedded systems:*** distributed systems in which the nodes are small, mobile, and often embedded as part of a larger system.

An Example: **Electronic health systems:**

Devices are physically close to a person: Where and how should monitored data be stored? How can we prevent loss of crucial data? What is needed to generate and propagate alerts? How can security be enforced? How can physicians provide online feedback?

Popularity of Distributed Computing Systems

- Inherently Distributed Applications
- Information Sharing among Users
- Resource Sharing
- Better Price-Performance Ratio
- Better Response Time and Throughput
- Higher Reliability
- Extensibility and Incremental Growth
- Better Flexibility in Meeting Users' Needs

Drawbacks of Distributed Computing Systems

- Software Shortage and Complexity:
- Dependency on Network reliability and Performance
- Security Weaknesses:
- Loss of Flexibility
- More complicated failure diagnosis.
- Data incompatibility.



