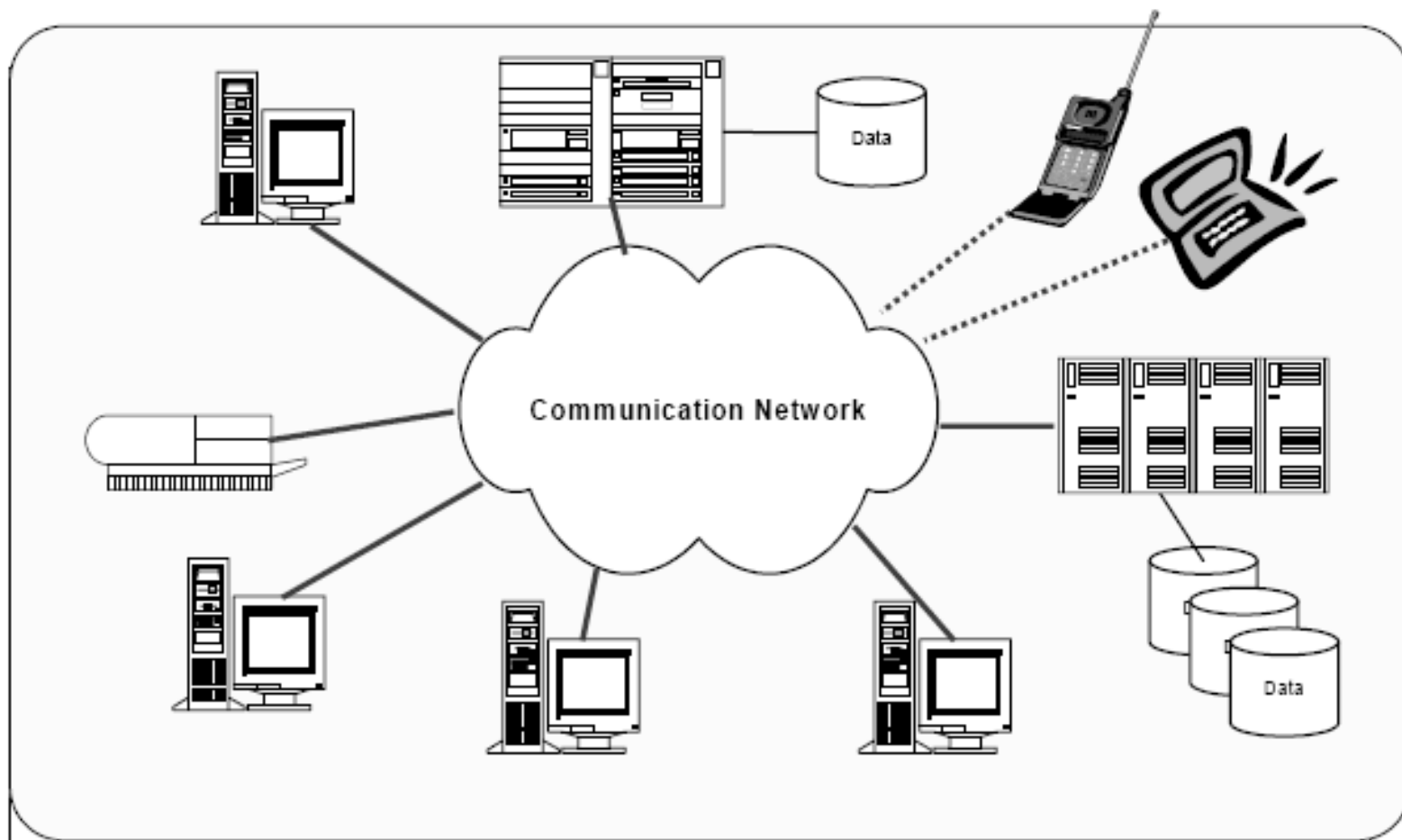


DISTRIBUTED COMPUTING SYSTEMS

An Introduction

A Distributed System



Examples

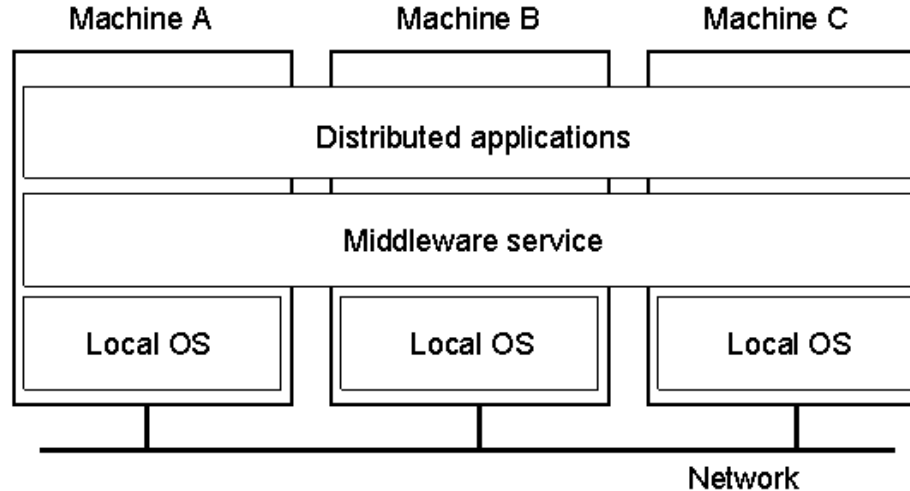
- The Internet : provides infrastructure for open communication
- Intranets : Close communication within community/organization
- Mobile and Ubiquitous Computing
- Computational Grids : provides more computational power
- The Word Wide Web : for information sharing

Definition(s)

- “A system in which hardware or software components located at networked computers communicate and coordinate their actions only by message passing.” [Coulouris]
- “A distributed system is a collection of independent computers that appear to the users of the system as a single computer.” [Tanenbaum]
- “A distributed system is a collection of **autonomous computers** linked by a **network** with **software** designed to produce an integrated computing facility.”

Three Concepts in DS

- **Hardware** : autonomous computers (Nodes/CPU's)
- **Network** : For communication between nodes
- **Software** : To manage the working of a system



Hardware Concepts

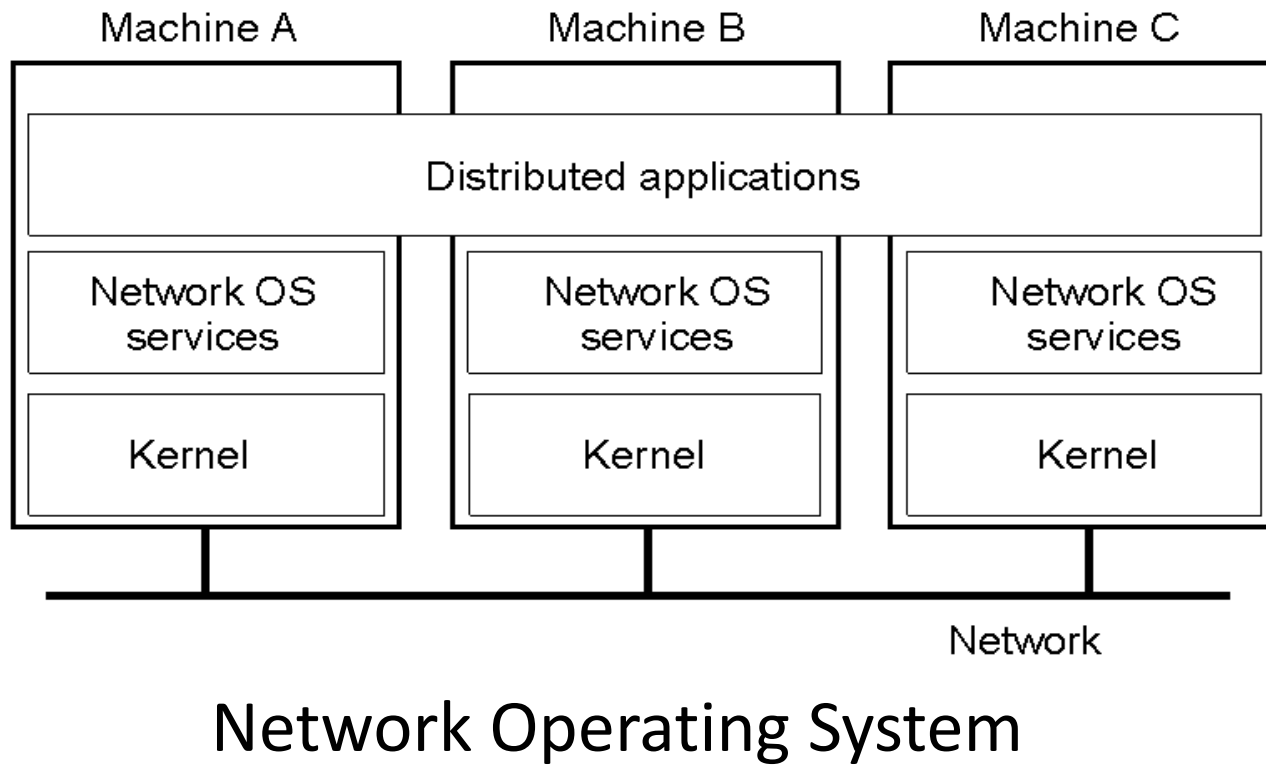
- Tightly Coupled Systems
 - Shared Memory
 - Short Delay
 - High Data rate
 - Usually, referred as parallel processing systems
- Loosely Coupled Systems
 - No Shared Memory
 - Long Delay
 - Low Data rate
 - Usually, referred as distributed computing systems

Software Concepts

- Loosely Coupled Software
 - Allows limited interaction between nodes
 - Each node can work independently
- Tightly Coupled Software
 - Allows full interaction between nodes
 - Coordinate each node to work towards same goal

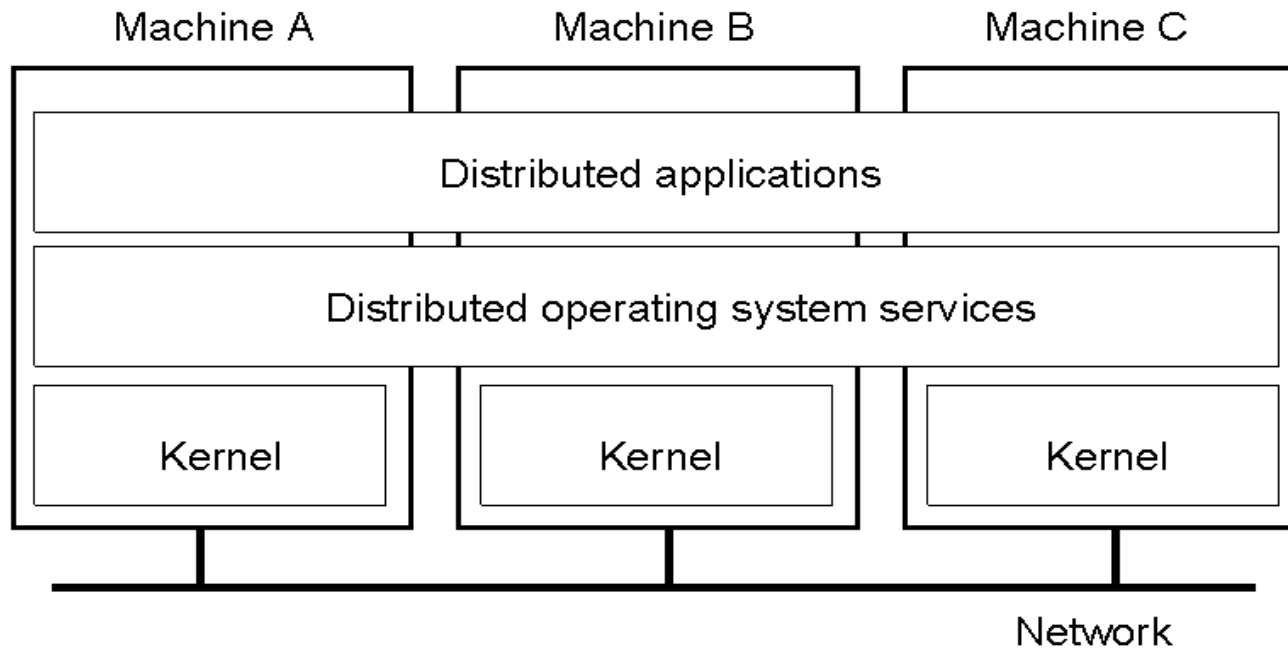
Hardware-Software Combination

- Loosely Coupled Hardware and Loosely Coupled Software



Hardware-Software Combination

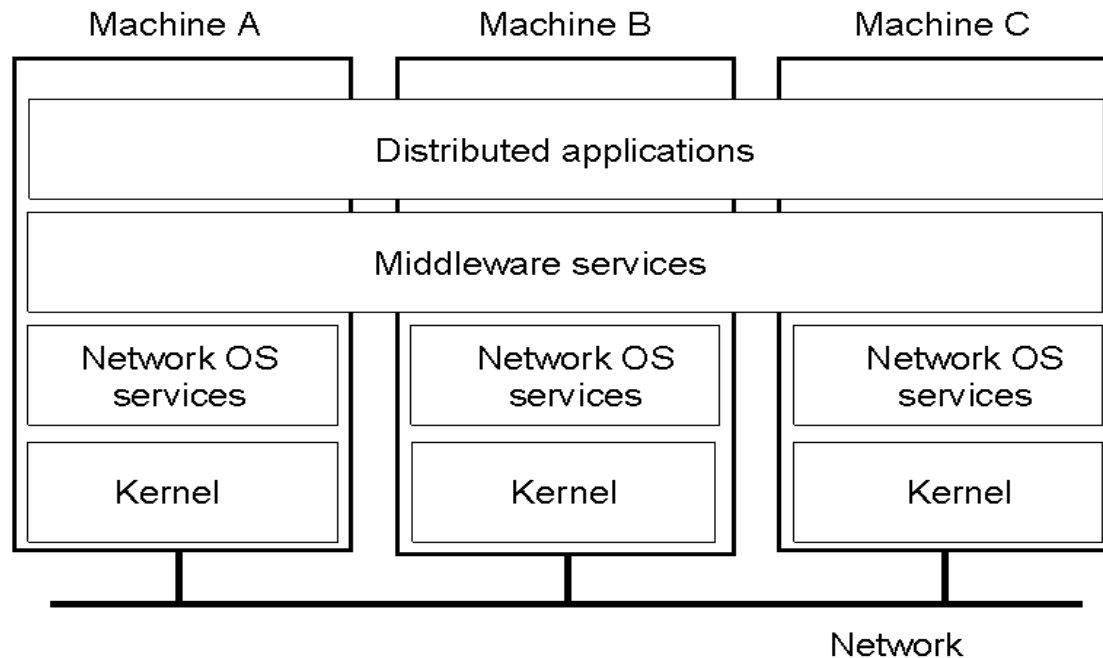
- Loosely Coupled Hardware and Tightly Coupled Software



Distributed Operating System

Hardware-Software Combination

- Difficult to design and implement a true DOS
- A special middleware layer is implemented on top of Network OS



Middleware based Operating System

Operating Systems in DS

System	Description	Main Goal
DOS	Tightly-coupled operating system for multi-processors and homogeneous multicomputers	Hide and manage hardware resources
NOS	Loosely-coupled operating system for heterogeneous multicomputers (LAN and WAN)	Offer local services to remote clients
Middleware	Additional layer atop of NOS implementing general-purpose services	Provide distribution transparency

Advantages

- Reliability
- Incremental Growth
- Resource sharing
- Flexibility
- Speed
- Performance

Disadvantages

- Software support
- Networking
- Security
- Troubleshooting

Centralized vs Distributed Systems

- **Centralized Systems**

- Centralized systems have non-autonomous components
- Centralized systems are often build using homogeneous technology
- Multiple users share the resources of a centralized system at all times
- Centralized systems have a single point of control and of failure

- **Distributed Systems**

- Distributed systems have autonomous components
- Distributed systems may be built using heterogeneous technology
- Distributed system components may be used exclusively
- Distributed systems are executed in concurrent processes
- Distributed systems have multiple points of failure

Distributed Computing System Models

- Minicomputer Model (E.g. ARPAnet)
- Workstation Model (E.g. The Sprite System)
- Workstation-Server Model (E.g. The V- System)
- Processor pool Model (E.g. Amoeba)
- Hybrid Model (Work-Station + Processor-Pool)