




Distributed Information Processing

1st Lecture

Eom, Hyeonsang (엄현상)
Department of Computer Science
& Engineering
Seoul National University



Outline

- Introduction to Distributed Systems
- Clock
- Q&A

Distributed Systems

■ Systems Where Components of Networked Computers Communicate and Coordinate Their Actions via Message Passing

□ Concurrency

□ No Global Clock

□ Independent Failures

- Sharing States
- Providing Services
- Having Global Properties
- Heterogeneity
- Unreliable, Insecure, Costly Comm.
- Scalability
- Autonomy

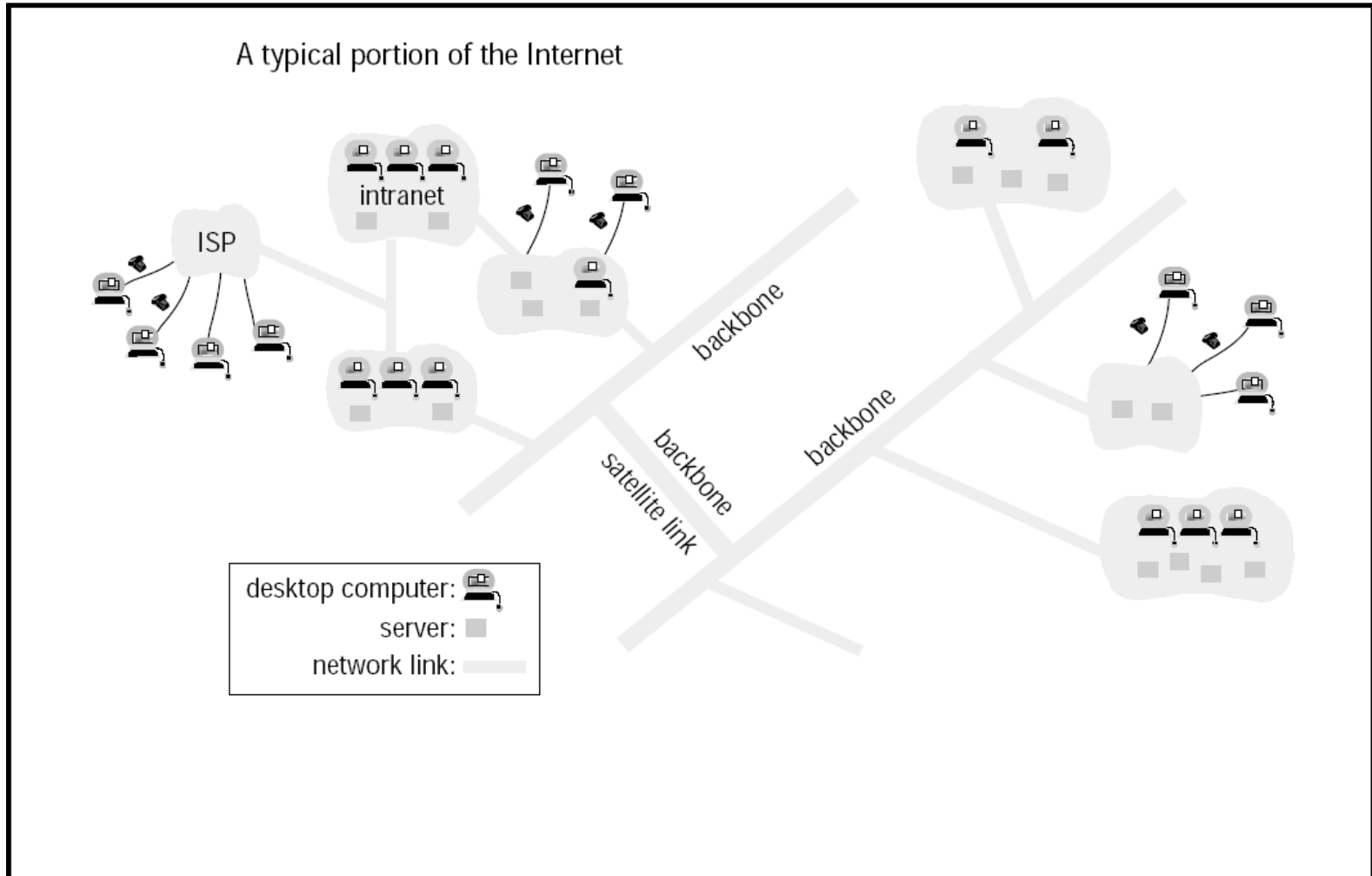
■ Systems Consisting of Collections of Spatially Separated Processes Communicating by Exchanging Messages

Different-Scale Systems

- Systems of Increasing Scale & Decreasing Integration

System Type	Heterogeneity, Geographic Distribution	Lack of Centralized Control	Exemplar Computational Model
End (Single) System			Multithreading
Cluster			Distributed Shared Memory
Intranet	○		Manager/Worker
Internet	○	○	Collaborative Systems

Example of Distributed Systems





Distributed System Goals

■ Accessibility

- As Connectivity and Sharing Increases, Security and Privacy Matter

■ Distribution Transparency

- Access: Regarding Data Representation & Access Method
- Location: Regarding Resource Location
- Migration: Regarding Resource Movement
- Relocation: Regarding Movement in Use
- Replication: Regarding Resource Replication

Distributed System Goals (Cont'd)

■ Distribution Transparency (Cont'd)

- Concurrency: Regarding Competitive Sharing
- Failure: Regarding Resource Failure and Recovery

Performance & Comprehensibility Issues

■ Openness:

Following Standard Rules That Describe the Syntax and Semantics of Services

- Interoperability

Distributed System Goals (Cont'd)

■ Openness (Cont'd)

- Portability
- Extensibility

Separating Policy from Mechanism

■ Scalability

- Limitations
 - Centralized services
 - Centralized data
 - Centralized algorithms
 - Synchronous communication

Distributed System Goals (Cont'd)

■ Scalability (Cont'd)

□ Decentralized Characteristics

- No local maintenance of global system state
- Decision making based only on local information
- Localized Failure
- No global clock

□ Scaling Techniques

- Asynchronous communication
- Client and Server load balancing
- Distribution: e.g., DNS & WWW
- Replication & caching



Distributed System Goals (Cont'd)


■ Pitfalls

- Network Reliability
- Network Security
- Network Homogeneity
- Static Topology
- Zero Latency
- Infinite Bandwidth
- Zero Transport Cost
- One Administrator



Technical Goals

- Heterogeneity
 - H/W, S/W, and Data Components
- Varying Component Size and Extent
- Network Connection
- Uniform Set of Services
- Certain Global Properties



Distributed Computing Approaches

- Grid
 - Addressing Infrastructure
- Peer-to-Peer
 - Addressing Failure
 - Self-organizing into network topologies
 - w/o a Global Server or Authority



Distributed System Types

- Distributed Computing Systems

- Cluster Computing Systems

- Collection of computers connected in a high-speed network

- Grid Computing Systems

- Federation of computer systems possibly in different administrative domains

- Distributed Information Systems

- Transaction Processing Systems

- Atomic, Consistent, Isolated, and Durable Transaction

Distributed System Types (Cont'd)

- Distributed Information Systems (Cont'd)
 - Enterprise Application Integration
 - Communicating Independent Components
 - Remote procedure call
 - Remote method invocation
 - Message-oriented middleware w/ logical contact points
 - Message queuing model
 - Message brokers as application-level gateway w/ subscription & publication
 - Distributed Pervasive Systems
 - Home Systems Possibly w/ UPnP
 - Electronic Health Care Systems in a BAN
 - Sensor Networks



Issues

- Problem

- No Global Clock

- Issues

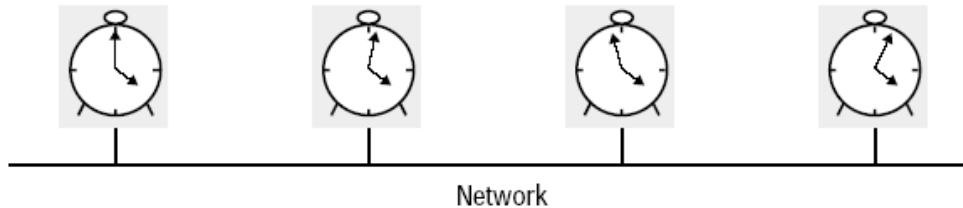
- How to Determine an Order of Events
 - How to Determine Global States
 - Consistency

Clock

■ Skew

- Difference between the Readings of Any Two Clocks

Skew between computer clocks in a distributed system



Coulouris, Dollimore and Kindberg Distributed Systems: Concepts and Design Edn. 4 © Pearson Education 2005

■ Drift

- Divergence of Clocks due to Counting Times at Different Rates

UTC (Coordinated Universal Time)

- International Time Standard
 - Formerly, Greenwich Mean Time or GMT
 - Zero hours UTC: midnight Greenwich (0 degrees longitude)
 - Based on Atomic Time (Drift Rate: $1/10^{13}$ Seconds/Second)
 - Signals synchronized and broadcast regularly
 - From land-based radio stations and satellites

Synchronous vs Asynchronous

■ Synchronous Systems

□ Known Bounds

- Drift rate of clocks
- Max message transmission delay
- Time to execute each step of a process

■ Asynchronous Systems

□ No Bounds