Distributed Information Processing

1st Lecture

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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

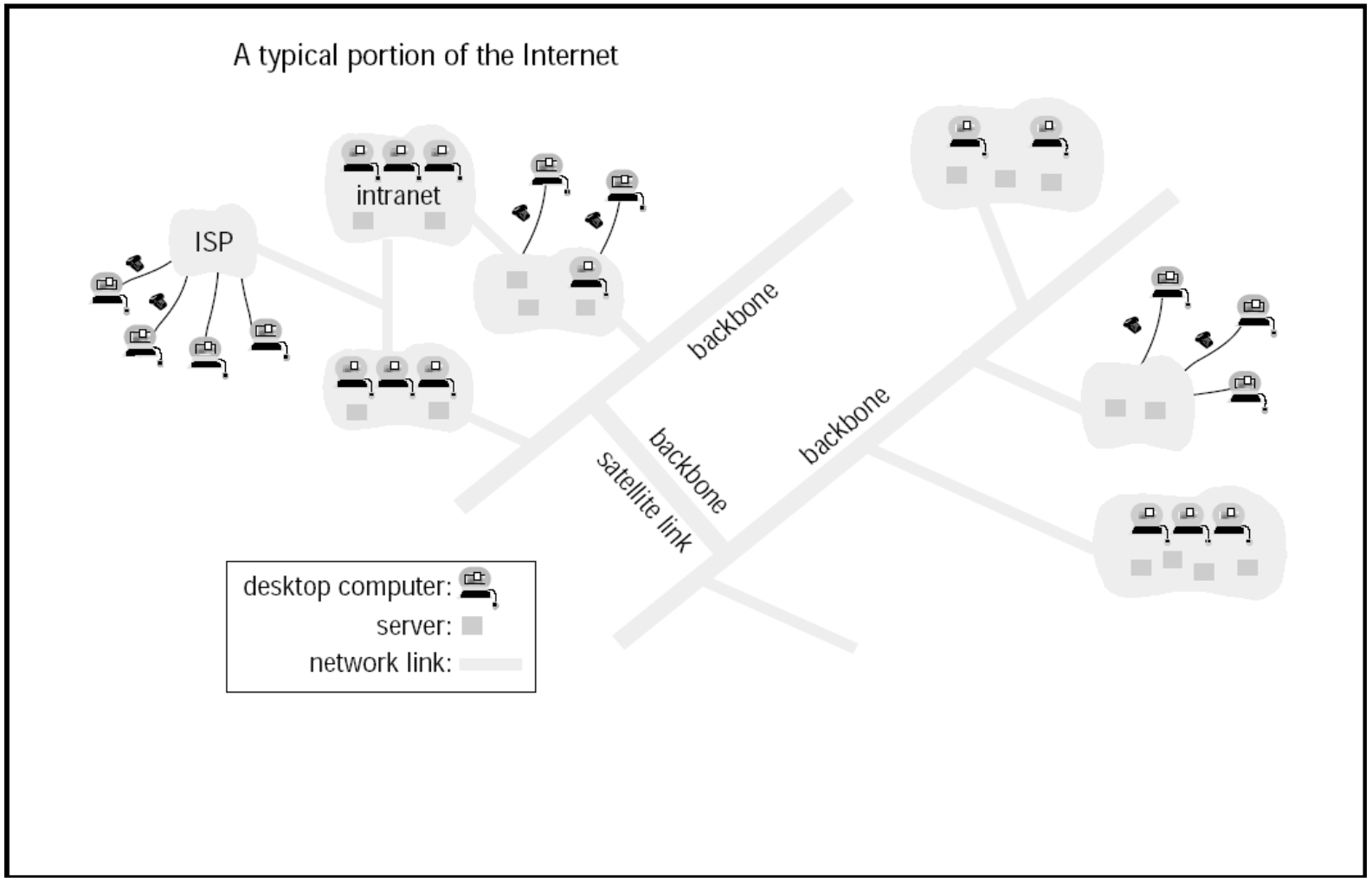
- Systems Consisting of Collections of Spatially Separated Processes Communicating by Exchanging Messages

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 Heath Care Systems in a BAN
    - Sensor Networks

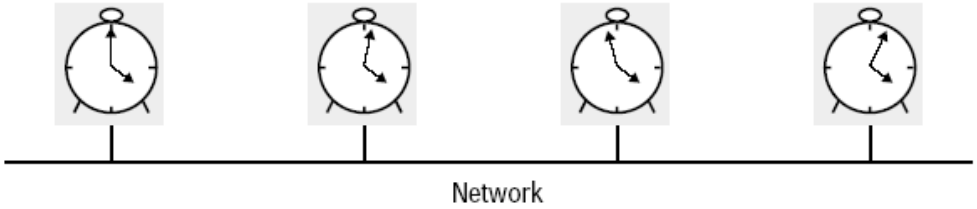
Issues

- 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