Outline

- Communication
  - Layered Protocols
  - Middleware Protocols
  - Types of Communication
- Communication Methods
- Q&A
Message Passing Requirements

- Agreements Needed at a Variety of Levels
  - Meaning of the Bits Being Sent
    - Character coding: e.g., EBCDIC and ASCII
  - Number of Volts for a 1-bit
  - Indication of the Last Bit of the Message
  - Detection of Damaged or Lost Messages
  - Lengths of Numbers, Strings, and Others
  - Representations

Agreements from the low-level details of bit transmission to the high-level details of how information is to be expressed
Layered Protocols

- ISO OSI (Open Systems Interconnection) Reference Model
  - Designed to Allow Open Systems to Communicate
    - Open system is prepared to communicate with any other by using standard rules that govern the format, contents, and meaning of messages
      - Protocols: such rules formalized
        - Connection oriented
        - Connectionless
  - Useful for Understanding Computer Networks

- Protocol Suite (or Stack)
  - Collection of Protocols Used in a System
**Illustration: Layered Protocols (1)**

**Layers, interfaces, and protocols in the OSI model**

Tanenbaum & Van Steen, Distributed Systems: Principles and Paradigms, 2e, (c) 2007 Prentice-Hall, Inc. All rights reserved
Illustration: Layered Protocols (2)

A typical message as it appears on the network.
Middleware Protocols

An adapted reference model for networked communication

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Types of Communication

- Persistent vs. Transient Communication
- Asynchronous vs. Synchronous Communication

Viewing middleware as an intermediate (distributed) service in application-level communication.
**Communication Methods**

- **RPC (Remote Procedure Call)**
  - Communication by Calling Remote Procedures
    - Definition of service interface
    - Lack of ability to create new object instances
    - Lack of support for remote object references

- **RMI (Remote Method Invocation)**
  - Communication by Calling Methods of a Remote Object
    - Implementation of a remote interface
    - Creation of new object instances
    - Support for remote object references
Communication Methods (Cont’d)

- **Socket**
  - Communication of Messages and Data between Processes
    - Use of a raw communication channel
    - Definition of a low-level message protocol
    - Definition of data transmission format

- **Distributed Event-Based Systems**
  - Communication via Event Subscription and Notification
    - Support for heterogeneity
    - Support for asynchronous communication
Middleware Approaches

- Location Transparency

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Method Invocation

- Local vs Remote Invocation
Distributed Object Model

A Remote Object and Its Remote Interface
Distributed Object Model (Cont’d)

- Instantiation of Remote Objects

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RMI Components

- **Proxy**
  - Forwarding Messages to a Remote Object and Receiving the Reply
    - Making RMI transparent to clients

- **Dispatcher**
  - Receiving the Request and Selecting the Appropriate Skeleton Method

- **Skeleton**
  - Implementing Methods in the Remote Interface
    - Unmarshalling arguments and invoking the method
RMI Components (Cont’d)

Illustration

Translating between Local and Remote Object References and Creating Remote Object References
RPC Components

Illustration

client process

client stub procedure

client program

Communication module

request

reply

server process

server stub procedure

service procedure

Communication module

dispatcher

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