Middleware

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Auxiliary Material

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Middleware

• Middleware== “A layer of software above the operating system but below the application program that provides a common programming abstraction across a distributed system”

• Middleware exists to help manage the complexity and heterogeneity inherent in distributed systems

• Middleware provides higher-level building blocks (“abstractions”) for programmers than the OS provides
  – Can make them much more productive
  – Can make the resulting code have fewer errors

• Middleware sometimes is called “plumbing”
  – Connects parts of a distributed application with “data pipes” and passes data between them
Middleware in Context

Host 1

Distributed Application – Part 1

Middleware API

Middleware

Operating System API

Operating System

Comm.  Processing  Storage

Network

Host 2

Distributed Application – Part 2

Middleware API

Middleware

Operating System API

Operating System

Comm.  Processing  Storage

Network
Middleware: Heterogeneity & Transparency

• Middleware’s programming building blocks mask heterogeneity
  – Makes programmer’s life much easier!!

• Kinds of heterogeneity masked by middleware
  – Heterogeneity in network technology always masked
  – Heterogeneity in host CPU always masked
  – Heterogeneity in operating system (or family thereof) usually masked
  – Heterogeneity in programming language usually masked
  – Heterogeneity in vendor implementations sometimes masked

• Middleware can provide transparency with respect to distribution:
  – Location transparency
  – Concurrency transparency
  – Replication transparency
  – Failure transparency
  – Mobility transparency

• Masking heterogeneity and providing transparency makes programming distributed systems much easier to do!
Kinds of Middleware

• Distributed Tuples: (a, b, c, d, e)
  – Relational databases, SQL, relational algebra
  – Linda and tuple spaces
  – Java Jini and JavaSpaces

• Remote procedure call (RPC)
  – make a function call look local even if non-local

• Message-Oriented Middleware (MOM)
  – messages and message queues

• Distributed Object Middleware
  – Make an object method look local even if non-local
  – CORBA
  – DCOM/SOAP/.NET
  – Java RMI
Middleware and Legacy Systems

- Middleware often called a “glue” technology: integrated “legacy” components
- Middleware’s abstractions are general enough to allow legacy systems to be “wrapped”
- Distributed objects model
Programming with Middleware

• Programming with Middleware
  – Do not have to learn a new programming language!
    (Usually)
  – Use an existing one already familiar with: C++, Java, Ada,
    (yuk) Visual Basic, (yuk) COBOL

• Ways to Program with Middleware
  1. Middleware system provides library of functions (Linda, others)
  2. **External Interface Definition Language (IDL) that “maps”
     to the language and generates local “proxy”
  3. Support directly in language from beginning (Java, RMI and JVM)