Project proposal assignment is open, due tonight by midnight

See instructions for CMS group formation
  do this first
• Message Brokers, EAI, Workflow
  • [ACKM04] Ch 3

• Web Technologies, J2EE Introduction
  • [ACKM04] Ch 4
Business Process

• A Supply Chain ...

• This is really a sequence of atomic transactions

• Some txns could happen concurrently ...
Business Process - Workflow

• Why do things this way on computer?
• Lots of reasons ...
  • Availability
    • need all the resources at once
  • Resource contention
    • hold only the subset of resources you needed now => better throughput
• Legacy systems
  • may not have distributed commit
ACID Properties?

- Clearly fails to provide Isolation
  - other txns can read state between committed steps
  - e.g. transfer funds by withdraw and deposit as separate txns
  - can view this as expanding set of “consistent” states
  - highly application dependent
ACID Properties?

• Atomicity?
  • not in short term -- same argument as for isolation!
  • long term -- to roll back a sequence of transactions, execute a *compensating transaction* for each committed step
• but this is not always possible
  • S1 makes deposit to bank acct
  • S2 makes withdrawal
• Later we try to compensate for S1’s deposit and find insufficient funds ...
• Inventory, ERP and Shipping are legacy apps
  • all run independent transactions

• New dispatcher app integrates them
With traditional MOM, integrating another application requires changing the dispatcher.

Is this really necessary?
Message Broker

- Message broker determines destinations
- based on sender identity, message type, message content
- Senders do not specify or know who the receivers are!

In basic MOM it is the sender who specifies the identity of the receivers.

With message brokers, custom message routing logic can be defined at the message broker level or at the queue level.
Publish / Subscribe

- **Publication:**
  - enqueue a message

- **Subscription:** specifies
  - message type (e.g. purchase order)
  - Boolean filter function on messages

- Message broker sends copy of each publication to each matching subscription

- Persistent?
Variant: Java Message Service

- Explicit *topic* takes place of message type
- Publication:
  - Publisher specifies a topic
- Subscription:
  - Subscriber specifies topic and filter predicate
• Add new application by altering routing specification in Message Broker ...

• Publish / Subscribe

• Fine as long as new application expects existing message type
More Precisely ...

- Dispatcher is new integrating application
- Legacy applications get adapters

- Integrating application (contains the composition logic)
- Message broker

- SmartQuotation adapter
- Database adapter
- SmartForecasting adapter
- E-mail adapter
- XYZ adapter
Recall: Business Process

- A Supply Chain of automated and manual steps
- WfMS supervises all steps
- Even the manual ones (using eMail)
Workflow Specification

- check if offered product
  - Offered=false
    - check if worth proceeding
    - Offered=true
      - else
        - GoAhead=true
  - else
    - get quote from quotation system
      - ContractExists=false
        - get quote from supplier
        - update quotation system
      - ContractExists=true
        - send quote to customer
        - enter quote in forecasting system

Variables:
- QuoteReferenceNumber: int
- Customer: String
- Item: String
- Quantity: int
- RequestedDeliveryDate: Date
- DeliveryAddress: String
- GoAhead: Bool
- ContractExists: Bool
- Offered: Bool
Workflow Specification

- Start Node
- Work Node
- Routing Node (decision)
- Routing Node (parallel)
- Work Nodes
- Completion Nodes
Workflow System

1. completed work items
2. workflow definitions
3. resource broker
4. workflow engine
5. outbound queues

- resource 1
- resource 2
- resource n

inbound queue
Error Conditions

• Deadline for step completion
  • WfMS takes corrective action

• Exception detected in application
  • Several mechanisms to raise exception
Error Conditions - Recovery

- **Forward Recovery**
  - State of workflow maintained by WfMS
  - Server fails => restart from that point
  - Like recovery from transactional RPC

- **Backward Recovery**
  - Execute compensating action to undo each previous action of workflow in reverse order

- Like rollback in Sagas
Combining - Integrating App is WfMS

Integrating App (Dispatcher)
HTTP is really simple

Request (GET/PUT/POST/OPTIONS/DELETE)
URI
Message

Status
Message

...
HTTP is really simple

- **URL**: think URL (host + path)
  - server.dnsname.com/file/path/name

- **Message**: think MIME encoded file
  - arbitrary sequence of bytes of identified type

- **Persistent connection**
Simple HTTP Connection

- Occasionally
  - if client and server are both behind the same firewall
  - And they trust one another!
HTTP Connection

- Server behind firewall and HTTP gateway
- More realistic
HTTP Connection

- Two firewalls, HTTP proxy, HTTP gateway
SSL

- Secure (encrypted) channel between client and server
- Server authenticated to client
- Client optionally authenticated to server
- Public Key certificates
HTTPS - SSL

HTTPS
client

HTTPS
server

Secure Sockets Layer (SSL)

TCP/IP

application layer

network layer
Recall 3-Tier

client ... client

middleware

server (resource manager)
Adapter to HTTP client

client

HTTP server

middleware

server (resource manager)

HTTP client
This also works 2-Tier

HTTP server

HTTP client

server
(resource manager)
Over the Web

client

HTTP server

middleware

server (resource manager)

firewall

HTTP client

wide area network (Internet)
Client is a browser

Web server sends HTML to browser

Web server is client of middle tier
Still Works 2-Tier

Web server

server (resource manager)

firewall

wide area network (Internet)

browser

Web server sends HTML to browser

Web server talks directly to database
Thin Client in Browser

- HTML forms
- cookies
Web Server is Client of Middleware

• Or maybe of the database!
• Technology to do this:
  • CGI
  • Servlets
• Ways to make web server execute code
- **CGI**
  - Create Process, run arbitrary program
  - But very expensive
Servlets

- JVM part of Web server
- No process creation
- Cache state
Application Server

- Middleware specialized for Web access
- Presentation layer plays more important role
Application Server - General

- **presentation layer**
- **application logic layer**
- **connection to resource mgmt layer**
- **application server**
- **resource management layer**

- Other servers (email, SOAP, ...)
- Web server

- Other protocols
- Client
- Browser

- Firewall
- Wide area network (Internet)

- HTTP

This is probably HTML data
J2EE Application Server Architecture

- Servlets
- JavaServer Pages (JSP)
- Java API for XML Processing (JAXP)
- JavaMail
- Java Authentication and Authorization Service (JAAS)
- Enterprise Java Beans (EJB)
- Java transaction API (JTA)
- Java Message Service (JMS)
- Java Naming/Directory Interface (JNDI)
- Java Database Connectivity (JDBC)
- Java 2 Connector Architecture (J2CA)

**support for communication and presentation**

**support for the application integration**

**support for access to resource managers**
J2EE Application Server Architecture - II

presentation layer

application logic layer

EJB
EJB
EJB
EJB container

JNDI

JMS

JDBC
J2CA resource adapter
J2CA resource adapter
other adapters

administration (management and security)

application server

DBMS
applications

enterprise system 1

enterprise system 2

enterprise system n

services
(load balancing, pooling, caching, transaction, persistence...)

application
server

application
logic
layer

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J2EE Application Server Architecture - III

- client
- servers for other connections (e.g., WAP)
- E-mail server
- Web server
- Servlets
- JSPs
- XML support
- multidevice content delivery
- personalization logic
- application logic layer
- connection to resource management layer
- resource management layer
- application server
- administration (management and security)
- services (load balancing, pooling, caching,...)
- Web services support
- XML support
- Web services support
- personalization logic
- presentation layer
Wide Area Integration

client

middleware

server (resource manager)

wide area network (Internet)

client

middleware

server (resource manager)
• Middleware instances need to communicate
Tunneling Through Firewalls

HTTP tunnel

client

Web server

firewall

Web server

client

middleware

remote-middleware protocol

WAN communication protocol

server (resource manager)

wide area network (Internet)

middleware

remote-middleware protocol

WAN communication protocol

server (resource manager)