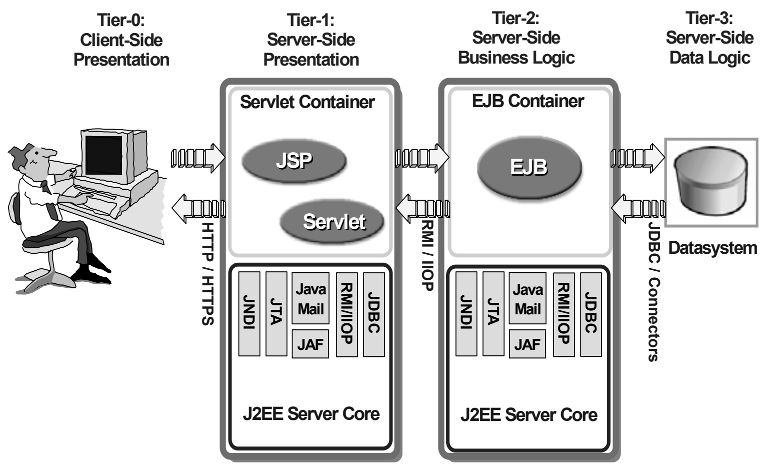
Web Services Support in Middleware Platforms (J2EE)

Workflows and Web Services
Kapitel 4

What is J2EE?

- Platform that enables solutions for developing, deploying and managing multi-tier server-centric applications.
- Defines a standard architecture that is delivered in the following elements
  - J2EE Application Programming Model - A standard programming model for developing multi-tier, thin-client applications
  - J2EE Platform - A standard platform for hosting J2EE applications, specified as a set of required APIs and policies
  - J2EE Compatibility Test Suite - A suite of compatibility tests for verifying that a J2EE platform product is compatible with the J2EE platform standard
  - J2EE Reference Implementation - A reference implementation for demonstrating the capabilities of J2EE and for providing an operational definition of the J2EE platform
- There are numerous vendor implementations of J2EE

4-Tier Distributed Computing



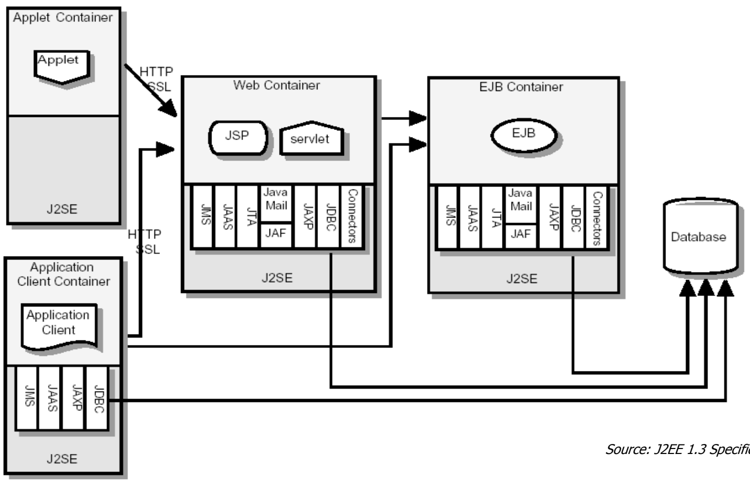
J2EE – Overview

- Component Technologies
  - Web components
    - Java Server Pages (JSP), Servlets
  - Enterprise JavaBeans
- Service Technologies
  - Java Transaction API (JTA)
  - Java DataBase Connectivity (JDBC)
  - Java Naming and Directory Service (JNDI)
  - Java Message Service (JMS)
  - JavaMail
  - Java Connector Architecture
  - Java Authentication and Authorization Service (JAAS)
- Communication Technologies
  - Internet protocols
    - HTTP, TCP/IP, SSL
  - Remote Object protocols
    - Java RMI, RMI/IIOP, Java IDL

J2EE – Overview (2)

- Containers
  - Types: web container, EJB container, client application container, applet container
  - Controls component life cycle
    - E.g., creates new instances of EJBs
  - Provides run-time services
    - Uniform access of technologies and APIs used by components
  - Routes (client) requests to (server) components
  - Declarative services
    - Service configuration during deployment
      - E.g., transactional behavior
- Deployment
  - Process of preparing a component for execution in a J2EE runtime environment
  - Involves declarative specification of technical aspects
    - Transactions, security, naming, …
  - Requires deployment descriptor
    - XML file

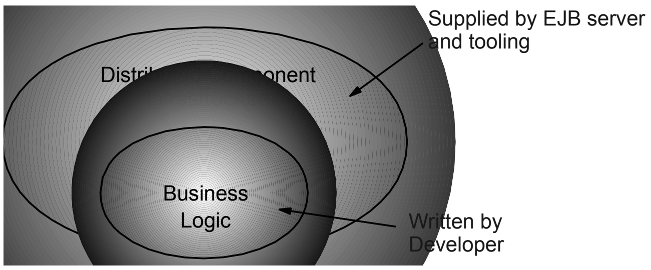
J2EE Architecture



Source: J2EE 1.3 Specification

Enterprise JavaBeans

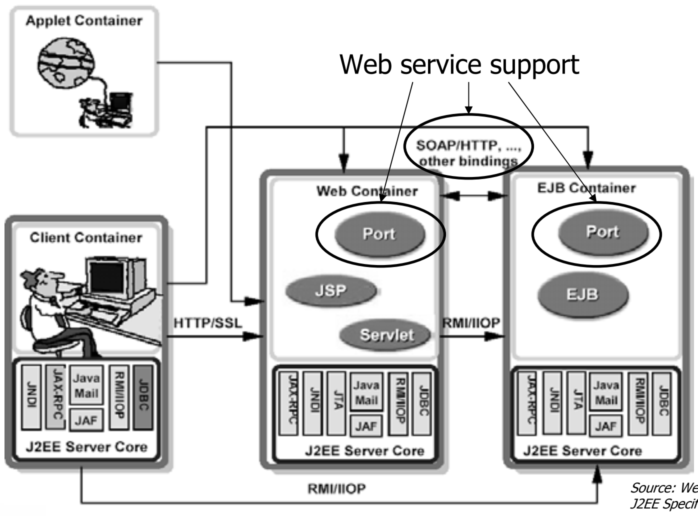
- Portable, server-side components written in Java
  - Transactional, Secure, etc.
- Widespread industry support
- Allow focus on business logic, not infrastructure



Types of EJBs

- Session beans contain information that will disappear after the user has closed the connection to the server (Internet Session ends).
  - Stateful session beans exist for the duration of a single client/server session.
  - Stateless session beans are pooled by the container to handle multiple requests from multiple clients.
  - Access databases using standard JDBC/SQLJ
    - obtain DB connection using JDBC data source (connection pooling)
- Entity beans contain persistent data that can be saved across sessions in various datastores.
  - Bean-Managed persistence (BMP): Entity beans that manage their own persistence (e.g., using JDBC, SQLJ)
  - Container-Managed persistence (CMP): Entity beans that delegate their persistence to the EJB container
- Message-driven Bean eases integration with existing applications
  - Asynchronous, message-oriented (JMS)

J2EE Architecture

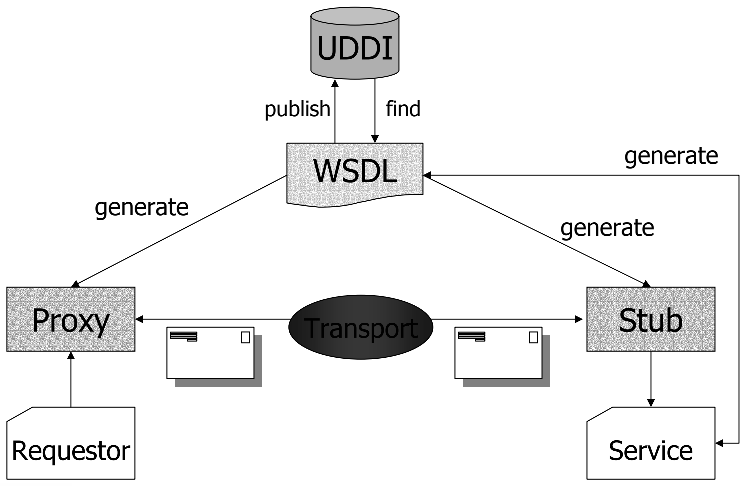


Source: Web services for J2EE Specification 1.0

SOAP w/Attachments API for Java (SAAJ)

- Enables production/consumption of messages that conform to the SOAP 1.1 specification and SOAP with Attachments note
  - "low-level" API
  - basis for JAX-RPC, JAXR
- API capabilities (javax.xml.soap package)
  - create a SOAP message
  - create an XML fragment
  - add content to the header of a SOAP message
  - add content to the body of a SOAP message
  - create attachment parts and add content to them
  - access/add/modify parts of a SOAP message
  - create/add/modify SOAP fault information
  - extract content from a SOAP message
- Simple request-response messaging (optional APIs)
  - create a point-to-point connection to a specified endpoint
  - send a SOAP request-response message
  - alternatively, other APIs can be used to send SOAP messages (JAXM, JMS)

Tooling Principles



Java API for XML-based RPCs (JAX-RPC)

- API for building web services and clients based on remote procedure calls and XML
  - Goal: hide all the complexities of SOAP message processing
  - APIs for supporting XML based RPC for the Java platform
    - Define web service
    - Use web service
  - Defines
    - WSDL/XML to Java mapping
    - Java to XML/WSDL mapping
    - Core APIs
    - SOAP support (including attachments)
    - Client and Server Programming models involving generated stub classes
- Client side invocation (standard programming model)
  - Application invokes web service through generated stub class
  - JAX-RPC runtime maps the invocation to SOAP, builds the SOAP message, processes the HTTP request
- Server side processing
  - JAX-RPC runtime processes HTTP, SOAP message, maps to RPC and dispatches to target (class implementing the web service)

Mapping WSDL <-> Java – Example

- WSDL port type definition

```
<!-- WSDL Extract -->
<message name="getLastTradePrice">
    <part name="tickerSymbol"
    type="xsd:string"/>
</message>
<message
    name="getLastTradePriceResponse">
    <part name="result"
                type="xsd:float"/>
</message>
<portType
    name="StockQuoteProvider">
    <operation
    name="getLastTradePrice"
      parameterOrder="tickerSymbol">
      <input message=
                "tns:getLastTradePrice"/>
      <output message=
         "tns:getLastTradePriceResponse"/>
    </operation>
</portType>
```

- Java service endpoint interface

```
//Java
public interface StockQuoteProvider
    extends java.rmi.Remote {
    float getLastTradePrice(
       String tickerSymbol)
       throws java.rmi.RemoteException;
}
```

Web Services for J2EE Specification (WS4J2EE)

- Sun specification (JSR109), included in J2EE 1.4
- Defines "a service architecture that leverages the J2EE component architecture to provide a client and server programming model which is
  - portable and interoperable across application servers,
  - provides a scalable secure environment, and yet
  - is familiar to J2EE developers"
- Objectives (among others)
  - Simple model for defining and implementing a new Web service and deploying this into a J2EE application server
  - Build on evolving industry standards (WSDL 1.1, SOAP 1.1, …)
  - Leverage existing J2EE technology
  - Inter-operability of vendor implementations
  - Minimize new concepts, interfaces, file formats, etc.
- WS4J2EE requires JAX-RPC support

Creating a Web Service

- Steps
  - Define service endpoint
    - Option 1: Start with WSDL, generate Java endpoint interface
    - Option 2: Start with Java endpoint interface, generate WSDL
  - Implement the service endpoint interface
    - J2EE Component Model
      - stateless session bean
      - servlet
  - Deploy the service on a server-side container-based runtime
    - specific to the runtime, deployment tool
    - deployment tool
      - configures one or more protocol bindings for the (abstract) service endpoint
        - e.g., SOAP/HTTP
      - creates one or more (concrete) endpoints with endpoint address
      - export the WSDL describing the service, so that clients can use it

Server Programming Model

- Two methods for implementing a web service
  - Java class running in a web container
    - Actually defined in the JAX-RPC specification
  - Stateless session EJB running in an EJB container
- Port Component
  - Defines server view of web service
  - Services
    - a location defined by WSDL port address
    - a set of operation requests defined by a WSDL PortType
  - Has a
    - Service Endpoint interface
      - Java mapping of the WSDL port type and binding
    - Service Implementation Bean
      - In general a Java class implementing the methods of the service endpoint interface
      - Differences based on the type of container (web or EJB)

Implementation Methods

- Stateless session bean used to implement a web service
  - EJB container takes care of multi-threaded access to web service
  - Requirements more or less as defined for stateless EJB by EJB specification
- Existing stateless EJB can be exposed as a web service
  - Service endpoint interface methods can be a subset of the EJB remote interface methods
  - Transaction attribute MANDATORY is not permitted
    - Existing transaction context will be suspended by container during execution of a web service
- Web container component
  - Implementation can be
    - single-threaded
      - Class implements servlet.singleThreadModel
      - Container responsible for synchronizing access
    - multi-threaded
  - Implementation class must be stateless

Container Responsibilities

- Listening on a well known port or on the URI of the Web service implementation (as defined in the service's WSDL after deployment) for SOAP/HTTP bindings.
- Parsing the inbound message according to the Service binding.
- Mapping the message to the implementation class and method according to the Service deployment data.
- Creating the appropriate Java objects from the SOAP envelope according to the JAX-RPC specification.
- Invoking the Service Implementation Bean handlers and instance method with the appropriate Java parameters.
- Capturing the response to the invocation if the style is request-response
- Mapping the Java response objects into SOAP message according to the JAX-RPC specification.
- Creating the message envelope appropriate for the transport
- Sending the message to the originating Web service client.

Client Programming Model

- Client can be
  - J2EE application client
  - Web component
  - EJB component
  - Another web service
- Client view of web service
  - Set of methods that perform business logic
    - Service endpoint interface
  - Stateless, i.e., there is not state information that persists across method invocations
- Uses the WS4J2EE runtime to access and invoke the methods of a web service
  - JNDI lookup to access a Service object
    - Factory to obtain a stub/proxy that implements the service endpoint interface
  - Invoke web service method on the stub object implementing the service endpoint interface

Client Programming Model (cont.)

- Client developer works only with the Service and Service endpoint interfaces, which may have been
  - supplied by the web service provider, or
  - generated using tools based on WSDL provided by WS provider
- Example

```
Context ctx = new InitialContext();
com.example.StockQuoteService sqs =
    ctx.lookup("java:comp/env/StockQuoteService");
com.example.StockQuoteProvider sqp =
    sqs.getStockQuoteProviderPort();
float quotePrice = sqp.getLastTradePrice("ACME");
```

service interface

logical service reference

service endpoint interface

- Developer can also use dynamic invocation interface (DII) of Service
  - Generic methods for invoking the web service methods
  - Useful if WS details are not known at development time
  - Supports one-way RPC in addition to request-response

Client Component Deployment

- Client developer does NOT generate stub/proxy class during development
  - Will be generated during deployment of the client component
  - Can be specific to the vendor runtime used on the client
- Web services client deployment descriptor contains additional information about web service supplied by developer
  - Service reference name used for JNDI lookup
  - Service interface name
- Deployer has to link the service reference to the actual service to be called
  - provide configuration info such as target endpoint address, protocol-specific properties, …

Additional Concepts

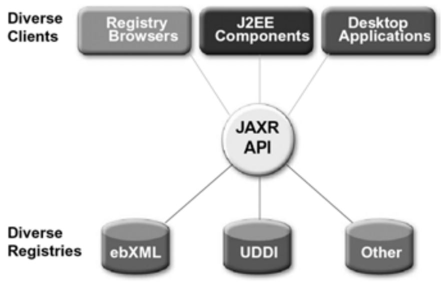
- Service Context
  - may carry information corresponding to SOAP headers
    - transactions, security, …
  - implicit context
    - managed and automatically propagated by the generated stubs and the JAX-RPC runtime
  - explicit context
    - passed as additional parameters of the method invocation
- Handlers
  - A means for intercepting and processing the raw SOAP request
  - Can examine and probably modify a request before it is processed by a web service component
    - Can also process/modify the response
  - May run on server as well as client side
  - Usage scenarios
    - Message logging
    - SOAP header processing/generation
    - Processing parts of the SOAP body

Additional Concepts (cont.)

- Security
  - Authentication: BASIC-AUTH, symmetric HTTPS
  - Authorization: J2EE container support
  - Integrity and confidentiality: HTTPS
  - Non-repudiation: recommended, but not defined
  - … a lot is left for future work
- Relationships to other Java specs for XML
  - JAX-M (JSR 00067): XML messaging and the Java language.
  - Java APIs for WSDL (JSR00110): APIs for manipulating WSDL documents.

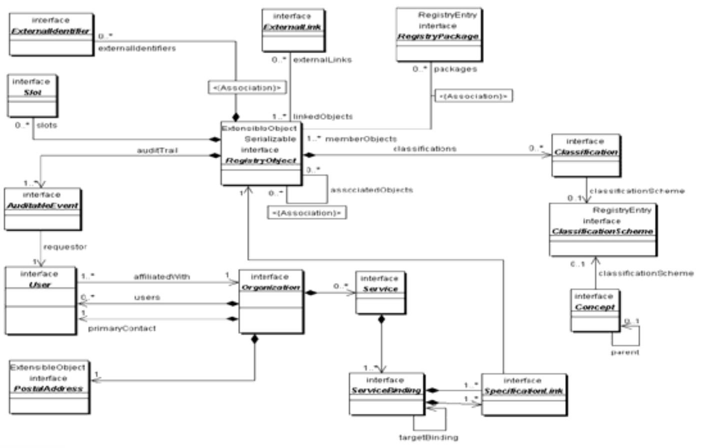
Java API for XML Registries (JAXR)

- Goals
  - Define a general purpose Java API for accessing business registries
  - Define a pluggable provider architecture
  - Support a union of the best features of dominant registry specifications
    - *JAXR is not a least common denominator API*
  - Ensure support for dominant registry specifications such as ebXML and UDDI



JAXR Information Model

- Largely based on the ebXML Registry Information model
  - extended to add concepts borrowed from UDDI



J2EE and Web Services - Summary

- Latest J2EE Version: 1.4 (Nov. 2003)
  - major focus on web service enhancements
- JAX-RPC and SAAJ APIs
  - basic web services interoperability support
- Web Services for J2EE specification
  - describes the packaging and deployment requirements for J2EE applications that provide and use web services
- EJB specification
  - extended to support implementing web services using stateless session beans.
- JAXR API
  - access to registries and repositories.
- JAXP API
  - processing XML documents
    - Java interfaces to XSLT, SAX, DOM-parsers