Basics of programming 3

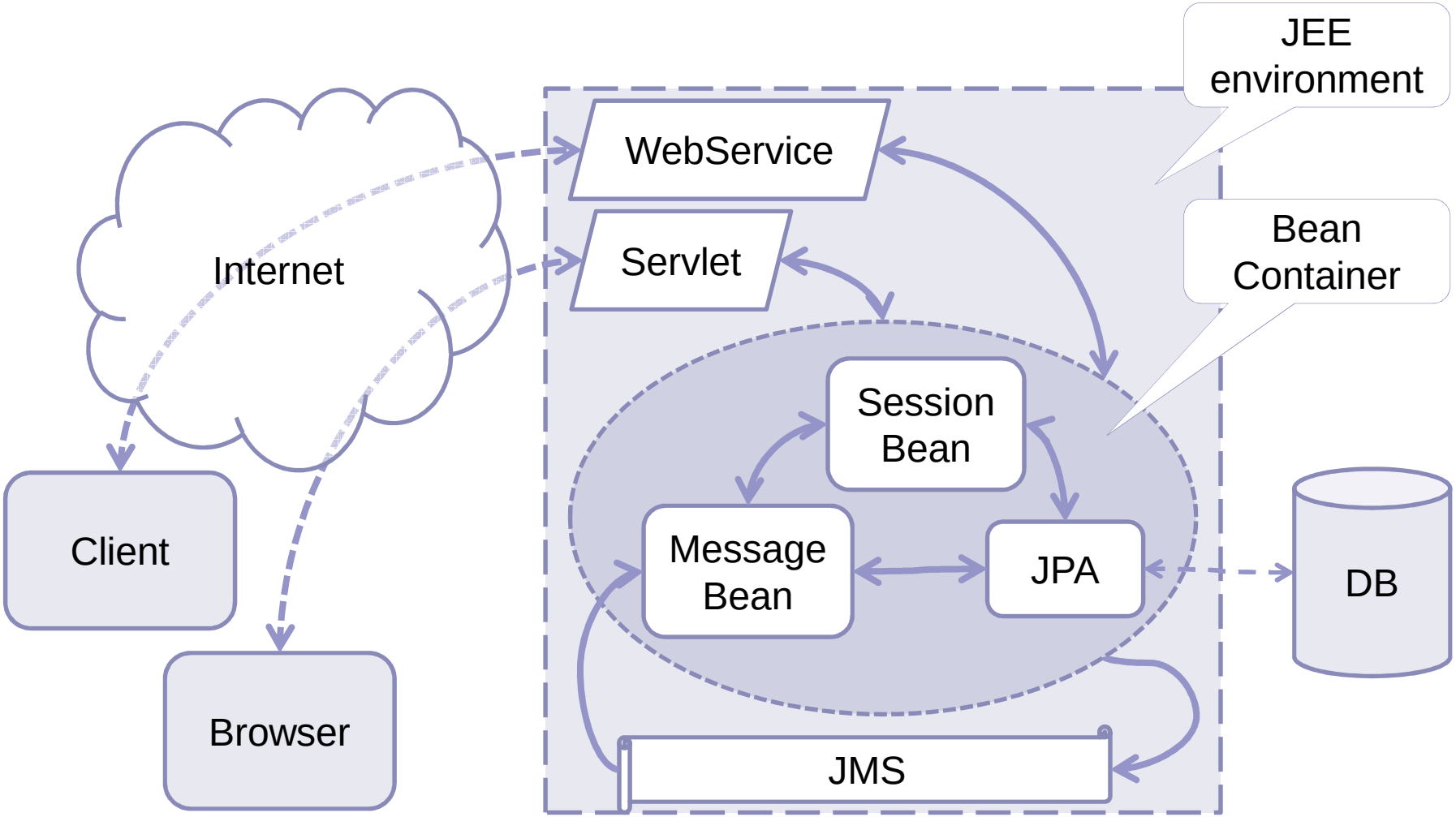
Java Enterprise Edition

Introduction

Enterprise environment

- Special characteristics
  - continuous availability
  - component based
    - component life-cycle support needed
  - massive network support
  - detailed configuration support
- Java Enterpise Edition (JEE)
  - Java based environment
  - more than Java...

JEE architecture



JEE components

- Business logic
  - Session beans
    - implement a core functionality
    - stateful, stateless or singleton
  - Message beans
    - react to messages
- Database connection
  - Entity beans
    - Java Persistent API
    - connect to relational or NoSQL databases

JEE components

- Interface
  - Web services
    - standardized interface
    - distributed communication
    - stateless
  - Servlets
    - connection to browsers
    - produce web pages
    - consume data from browsers
    - JSP and JSF for ease-of-use

JEE components

- Special connections
  - Java Messaging Service (JMS)
    - handles, stores, delivers messages
    - connects to message beans
  - Databases (DB)
    - usually relational
    - connection by JPA via hibernate etc.
    - OO – ER problems
      - associations
      - inheritance

JEE internals

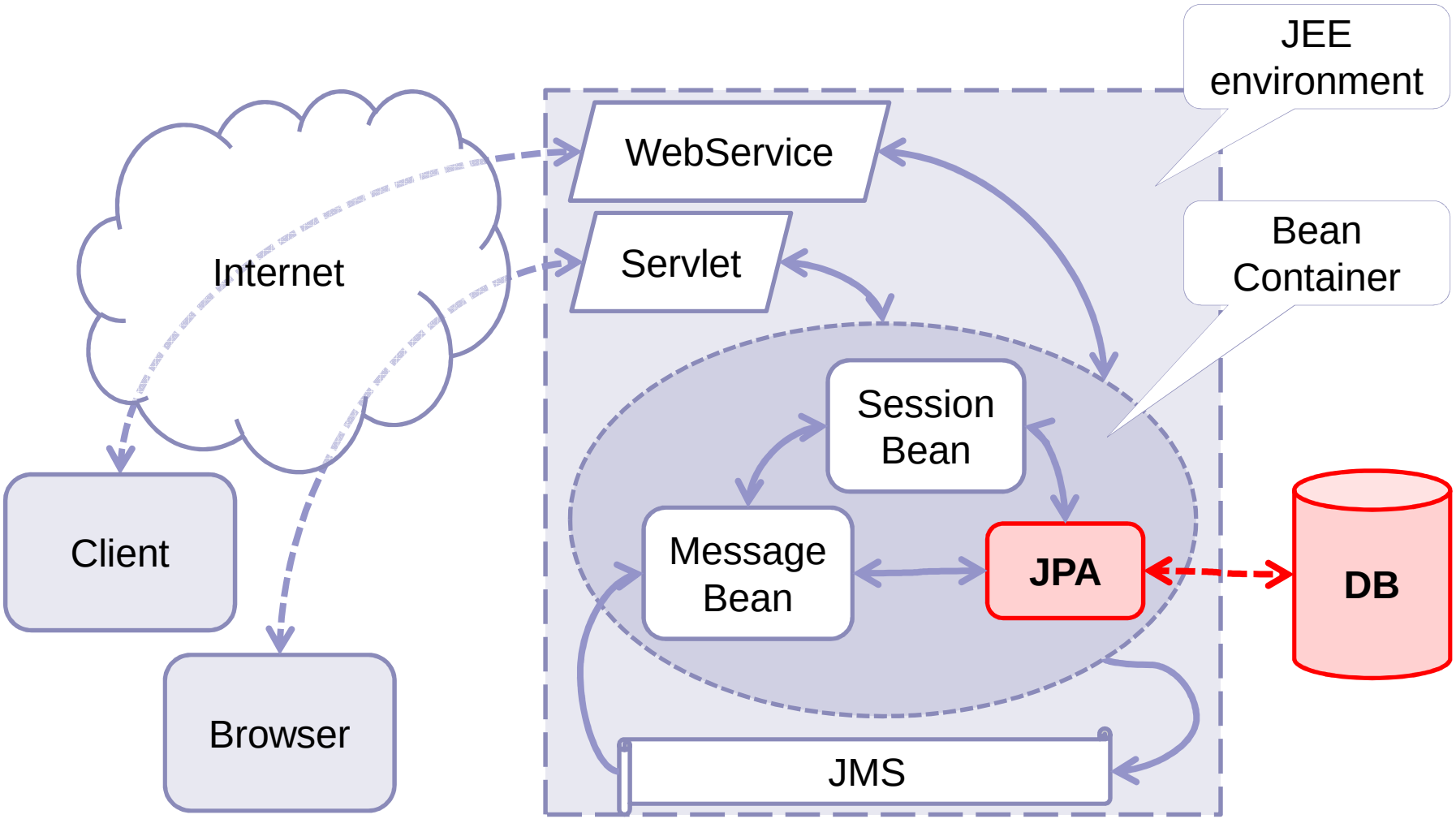
- Annotations rule
  - connections between internal components
    - beans only specify class of parties (injection)
    - resources specified via JNDI
  - business logic rules
    - concurrency
    - authorization
    - etc
  - persistency
    - JPA is annotation-based
  - web connections

JEE internals

- Runtime enablement by container
  - creates components on demand
  - connects elements on demand
  - establishes DB and net connections on demand
- Container settings via configurations
  - vendor-specific settings
  - component deployment and server configuration separately

DB access

JEE architecture



Database access

- Database is separate component
  - SQL or NoSQL
- OO vs DB
  - different approaches
  - different optimizations
- Mappings
  - JDBC, JDO, JPA, etc

Database connection

- JDBC (Java DataBase Connectivity)
  - relation-based
  - uniform OO view on SQL concepts
    - java.sql, javax.sql packages
    - connection (commit, statement, query, parameters)
    - db metadata
    - resultset (record + record metadata)
    - wrapping for types
  - drivers for accessing different DBs

Database connection

- JDO (Java Data Objects)
  - direct mapping from OO to DB
  - ease of use
    - focus on domain object model
  - portability
    - run on multiple implementations
    - metadata highly portable
  - database independence
    - support many different kinds of transactional data stores
  - high performance
    - implementation can optimize data access

Database connection

- JPA (Java Persistence API)
  - OO to relational mapping
    - support for NoSQL available
  - configurable
    - inheritance
    - associations (multiplicity)
    - etc
  - provider
    - implements actual mapping
    - Hibernate, EclipseLink, OpenJPA, etc

JPA example

```
@Entity
@Table(name = "children")
public class Child implements java.io.Serializable {
   private long id;
   private String name;
   private int age;
   private List<Mischief> ms = new ArrayList<Mischief>();
   public Child(){}
   @Id @GeneratedValue
   public long getId() { return id; }
   @Column(name = "NAME", nullable = false, length=80)
   public String getName() { return Name;}
   @ManyToMany @JoinTable(name = "child_mischief", joinColumns = {
        @JoinColumn(name = "mischief_id") },
        inverseJoinColumns = { @JoinColumn(name = "person_id") })
   public List<Mischief> getMischief() {
      return wishes;
   }
```

table specification

attributes (id is mandatory)

getters with column specs

association specs

JPA association mapping

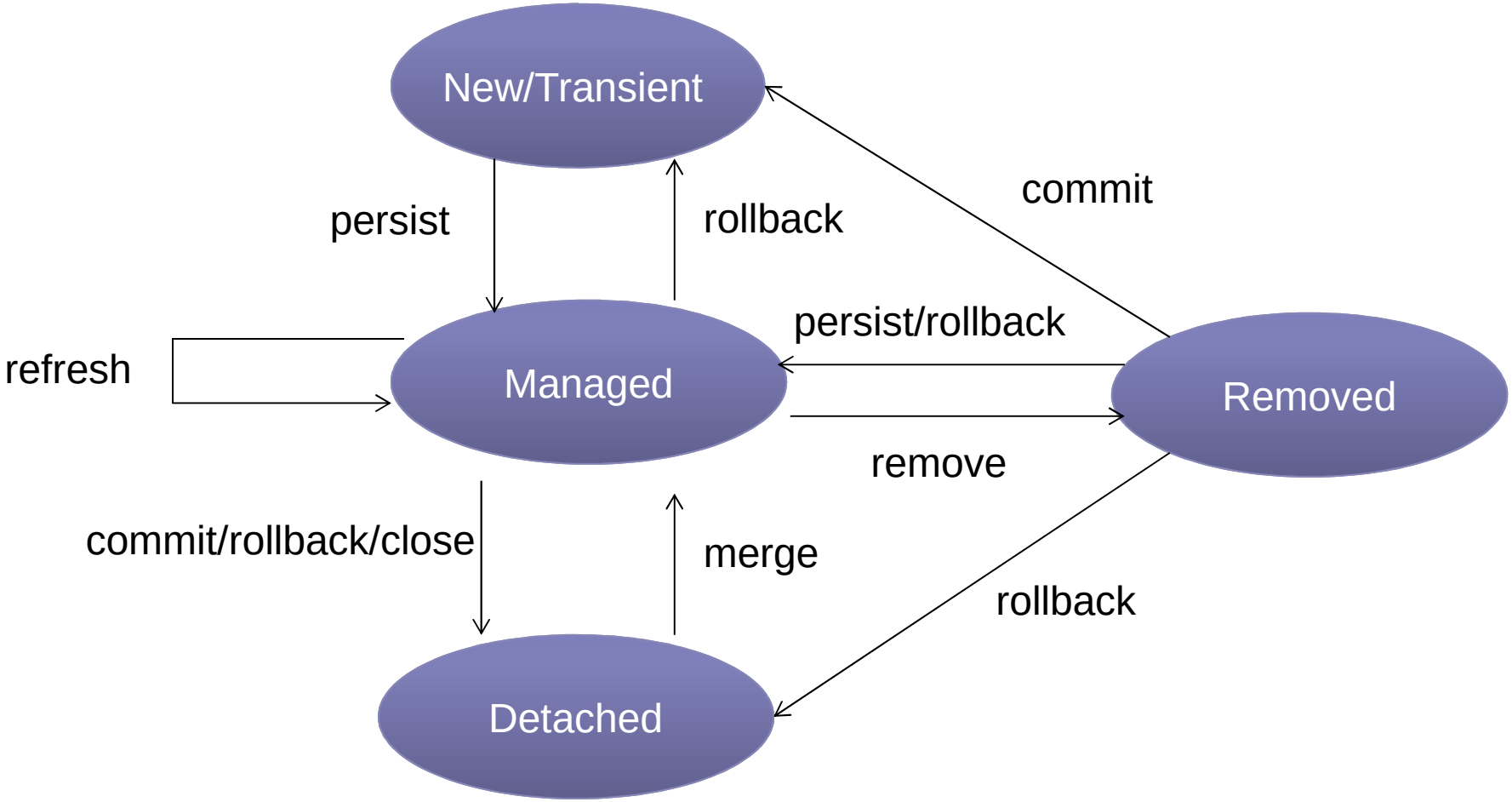
- ManyToOne

  OneToMany
  - stored usually on *Many* endpoint
  - reverse navigation needs calculation
- OneToOne
  - on either end
- ManyToMany
  - join table is needed

JPA inheritance mapping

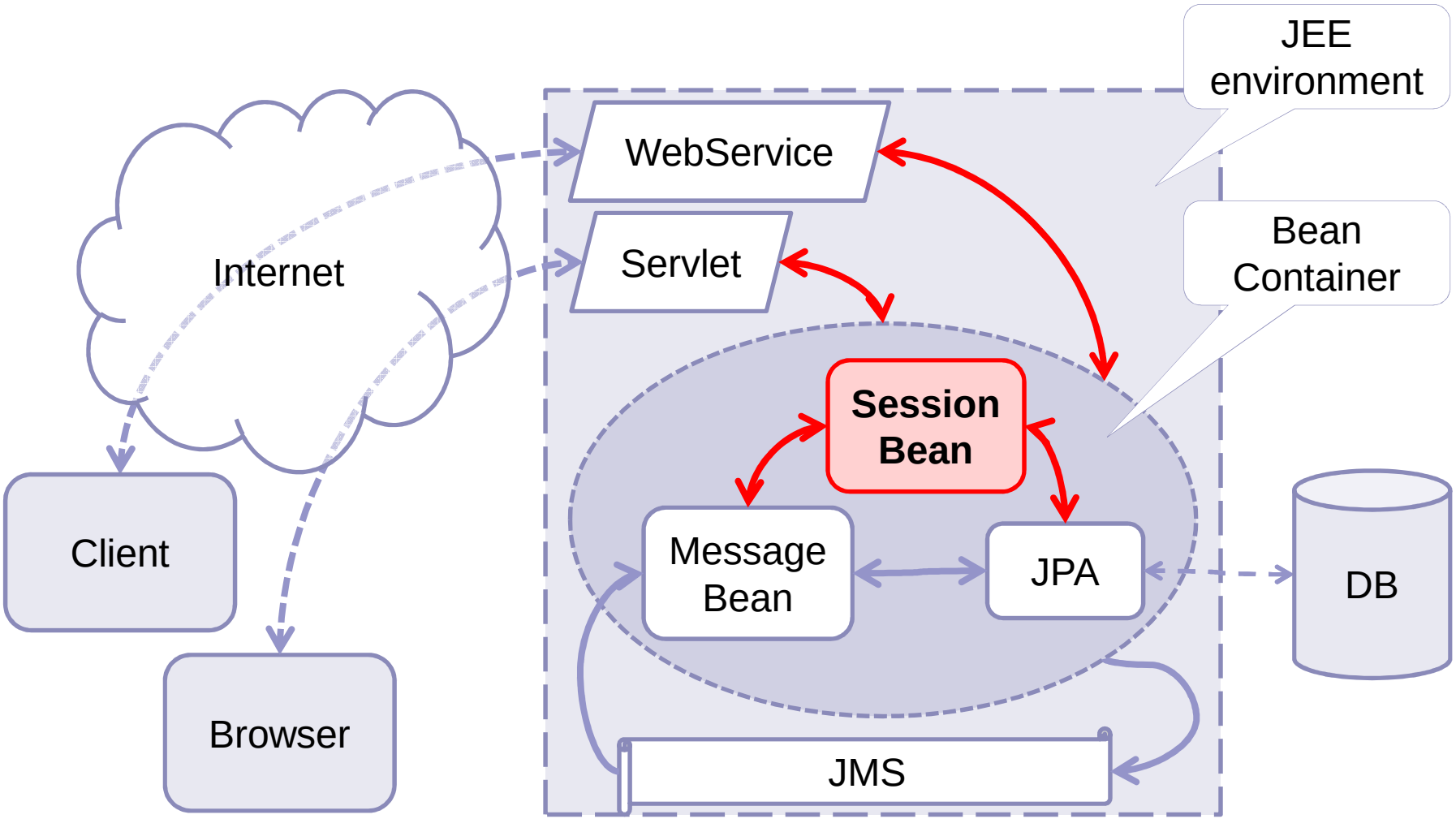
- Table Per Hierarchy
  - single table is required to map the whole hierarchy
  - extra column (discriminator) to identify the class
- Table Per Concrete class
  - tables only for concrete classes
  - duplicate column is added in subclass tables
- Table Per Subclass
  - tables are created for each class
  - inheritance by foreign key

JPA Object lifecycle



Session Beans

JEE architecture



Session Bean

- JavaBeans
  - are Java objects
  - public setter-getter methods
    - heavy use of reflection
- Session Beans
  - encapsulates business logic
  - can be invoked programmatically
  - can be stateful, stateless or singleton
  - non-persistent

Stateful beans

- Attributes represent the state of a unique client/bean session
  - this state is called the **conversational state**.
  - state is retained for the duration of the session
- Similar to an interactive session
  - are not shared
  - can have only one client
    - when the client terminates, its session bean appears to terminate
- Can implement a web service

Stateless beans

- Does not maintain a state with the client
  - attributes specific only during invocation
  - after invocation the client-specific state is not retained
  - stateless beans of the same type are considered similar
- Offers better scalability
  - no state, no state-maintaing overhead
- Can implement a web service
  - `@WebService, @WebMethod`

Singleton beans

- Instantiated once per application
  - exists for the lifecycle of the application
  - shared and concurrently accessed by clients
- Similar functionality to stateless session beans
  - but only single and continuous instance
- Can implement web service endpoints.
- Maintain their state between invocations
  - not across server crashes or shutdowns.

Session bean example

```
@Stateless
public class ElfServiceBean {
   private String message = "Naughty ";
   public void ElfServiceBean() {}
   public String sayHello(String name) {
      return message + name + ".";
   }
}
```

Stateless Session Bean

```
@Stateful
public class SantaBean {
   @EJB ElfServiceBean elf;
   int n;
   public void SantaBean() { n = 0; }
   public String sayMore(String name) {
      return "Hohoho, "+ elf.sayHello(name) + " #"+n;
   }
}
```

Stateful Session Bean

Refering a stateless bean

state maintained

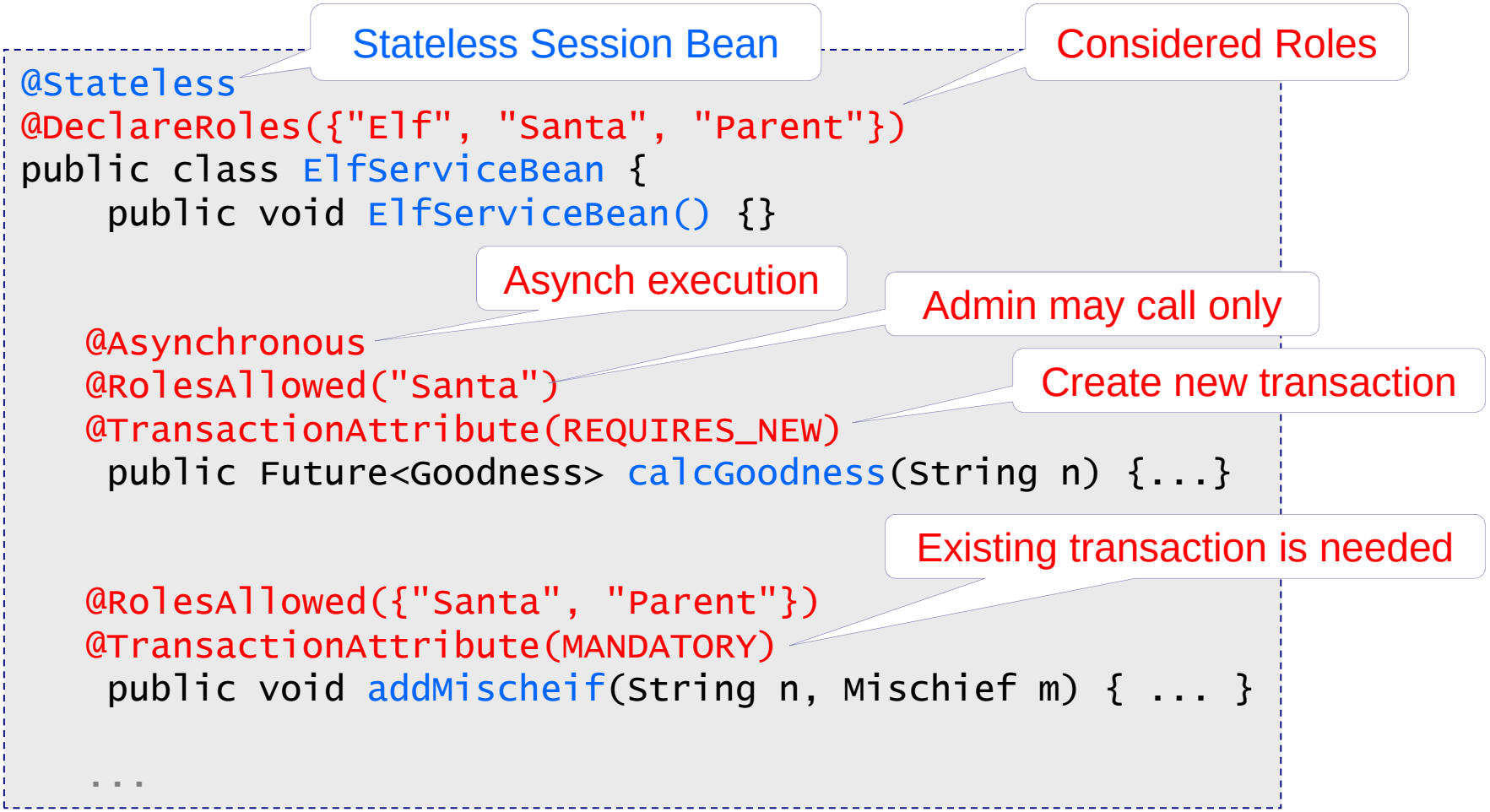
Further session bean features

- Asynchronous access
  - `@Asynchronous` (method or class)
  - special rules (returns *Future*<*T*>, etc)
- Transactions
  - `@TransactionAttribute(`*TYPE*`)`
    - `Required`: do in transaction, create if necessary
    - `RequiresNew` : do in transaction, create new
    - `Mandatory` : do in transaction, error if none
    - `Supports` : no transaction needed
    - `NotSupported` : do outside of transaction
    - `Never` : if in transaction throws exception

Further session bean features

- Security (authorization)
  - `@DeclareRoles` : specifies considered roles (class)
  - `@RolesAllowed` : how may call method
  - `@PermitAll` : no restriction
  - `@RunAs` : execute method with role
- Lifecycle management
  - `@PostConstruct, @PreDestroy`
    - execute method after construction / before deletion
  - `@PostActivate, @PrePassivate`
    - execute method after/before storing bean in secondary storage
  - `@Remove` : delete bean after executing annotated method

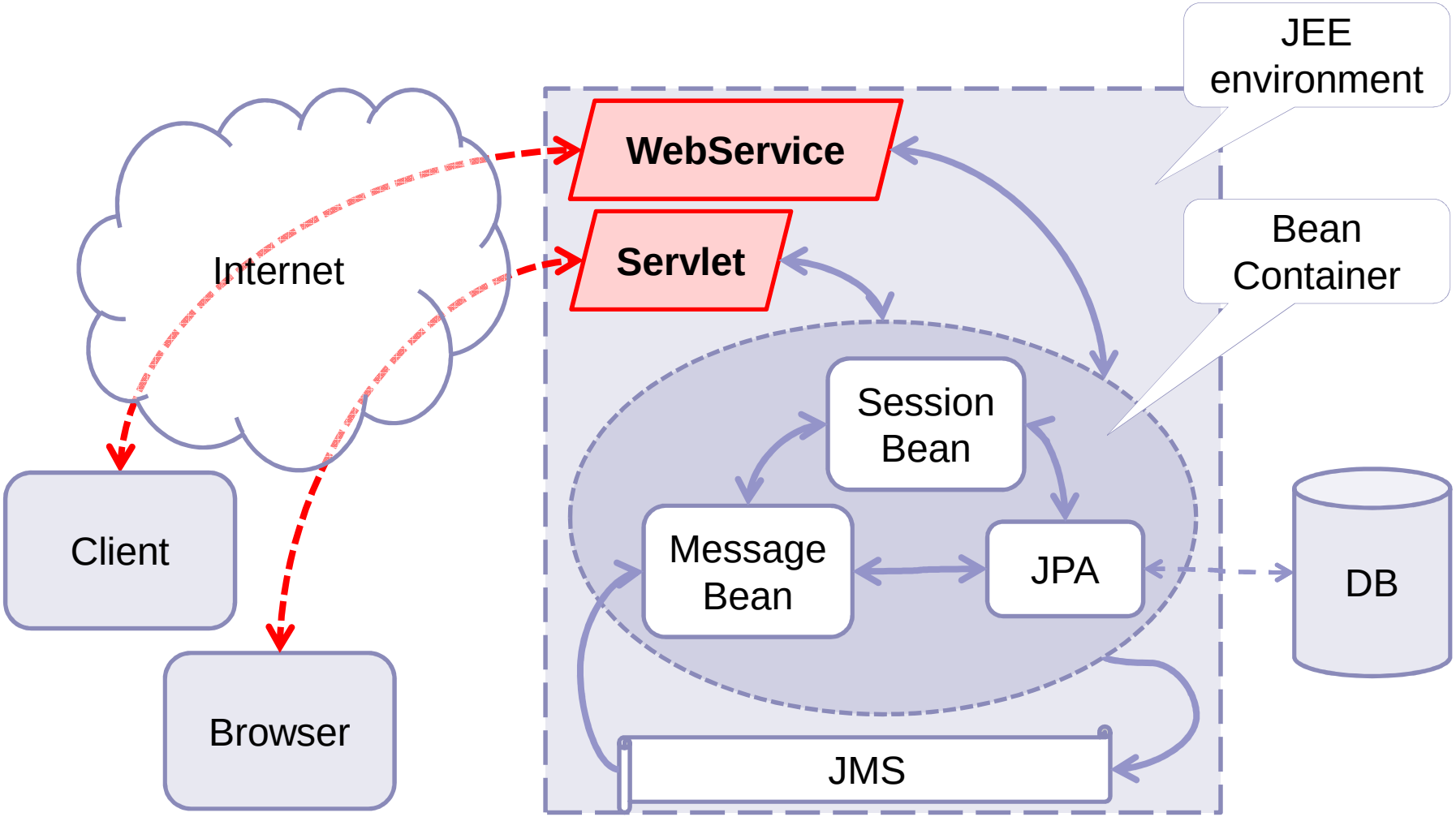
Complex session bean example




```
@Stateless
@DeclareRoles({"Elf", "Santa", "Parent"})
public class ElfServiceBean {
    public void ElfServiceBean() {}

   @Asynchronous
   @RolesAllowed("Santa")
   @TransactionAttribute(REQUIRES_NEW)
    public Future<Goodness> calcGoodness(String n) {...}

   @RolesAllowed({"Santa", "Parent"})
   @TransactionAttribute(MANDATORY)
    public void addMischeif(String n, Mischief m) { ... }

   ...
```

Web connection

JEE architecture



Web connection

- Web pages
  - for browsers on client side
  - Servlet, JSP, etc generates web page
  - session handling - cookies
- Web service
  - remote method call
  - well defined protocol
    - SOAP, REST
    - protocol extensions (WS-*)

Communicating with browsers

- Server to Client
  - HTML page, images, JavaScript, etc
  - generated by Servlet or JSP
    - servlet: Java code, output is content for browser
    - JSP: html-like code with commands
    - JSP is compiled to servlet internally
- Client to Server
  - HTTP/HTTPS protocol
    - get, post, put, delete, etc.
  - HTML-form input
  - AJAX, etc

Servlet

- Java object handling web communication
  - HTTPServlet for HTTP
    - *doGet*, *doPut*, *doUpdate*, *doDelete*, etc methods
  - access to session info
    - HTTPSession
  - everyhting in Java
    - even printouts, result generation, etc.
- Configured via XML
  - access path in URL

Servlet example

```
public class HelloWWW extends HttpServlet {


  public void doGet(HttpServletRequest   request,
                    HttpServletResponse response)
  throws ServletException, IOException {

        response.setContentType("text/html");
        PrintWriter out = response.getWriter();
        String docType = "<!DOCTYPE HTML PUBLIC \"-//W3C//DTD"
                       +" HTML 4.0 Transitional//EN\">\n";
        out.println(docType +
          "<HTML>\n<HEAD><TITLE>Santa's Page</TITLE></HEAD>\n" +
          "<BODY>\n<H1>Hohoho!</H1>\n</BODY></HTML>");
  }
}
```

HTTP protocol command (GET method)

HTML source

JSP

- HTML-like language for dynamic web-pages
  - JSP elements
    - *HTML tags* - layout
    - *taglet tags* - special layout or logic (e.g. loops)
    - *Java code* - special logic (no support in taglib)
- Connection to rest of app via *managed beans*
  - managed beans generated in Java
    - almost POJO
  - managed beans accessed in JSP
    - bean: getter/setter methods

JSP example

```
<%@ page language="java" contentType="text/html" %>
<%@ page import="java.util.*" %>
<%@ taglib prefix="c" uri="http://java.sun.com/jstl/core" %>
<html>
  <head><title>Santa's list</title></head>
  <body bgcolor="white">
    <h1>Children</h1>
    <table>
      <th>Name</th><th>Age</th><th>Goodness</th>
      <c:forEach items="${children}" var="current">
        <tr>
          <td><c:out value="${current.name}" /><td>
          <td><c:out value="${current.age}" /><td>
          <td><c:out value="${current.goodness}" /><td>
        </tr>
      </c:forEach>
    </table>
  </body>
</html>
```

basic structure in HTML

special tags for logic

Comparing Servlets and JSP

Characteristic	Servlet	JSP
Communication	same model	
Source lang	Java+println	HTML+tags
Auto recompilation	No	Yes
Approach	Imperative	Declarative
Readablity	Hard	Easier
Layout check	Hard	Easier
Business Logic check	Easier	Hard

Web services

- Connection between applications
  - no direct UI dependency
  - usually over HTTP/HTTPS
    - might use JMS or other
  - extended protocols
    - encryption, authentication, authorization
    - transaction handling, atomicity
    - big data
  - XML or JSON based message formats
    - interface description is important
    - common data format is needed

Web services in Java

- Common protocols are language independent
  - mostly SOAP or REST
- Java mapping
  - JAX-WS
    - Java interface to/from WSDL
    - SOAP protocol conversion
  - JAX-RS
    - REST methods in Java
  - JAXB
    - Java data to/from XML representation
  - etc.

Web service example

```
@WebService public class Santa {
   private String message = new String("Hohoho, ");
   public void Santa() { }
   @WebMethod public String sayHohoho(String name) {
      return message + name + ".";
   }
}
```

Webservice specification

Method with Java implementation

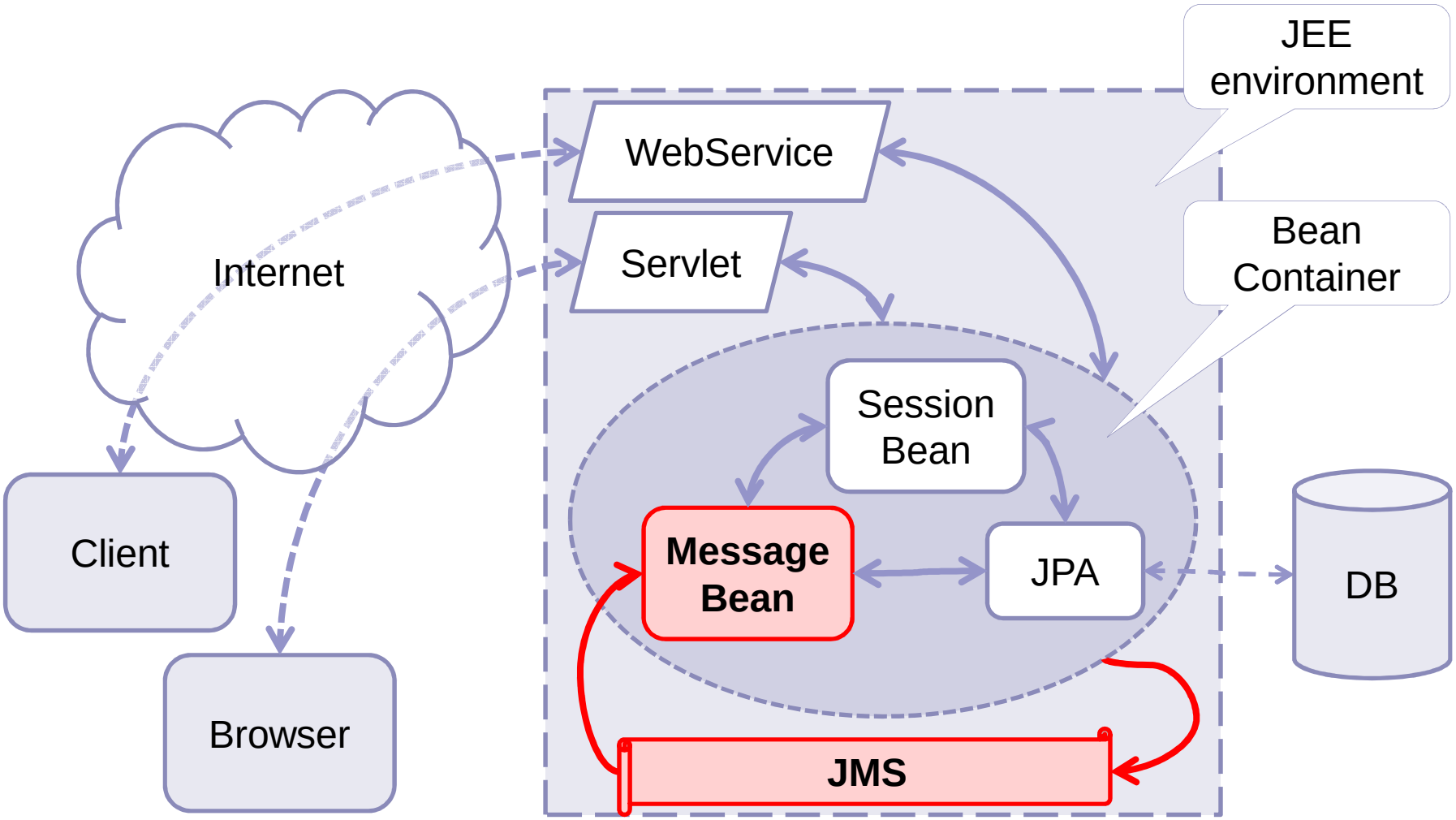
```
public class SantaClient {
   @WebServiceRef(wsdlLocation =
        "META-INF/wsdl/localhost_8080/hs/SantaService.wsdl")
   private static SantaService service;

   public static void main(String[] args) {
     hs.endpoint.Santa port = service.getSantaPort();
     return port.sayHello(arg0);
   }
}
```

Server URL

Calling server side

Messaging

JEE architecture

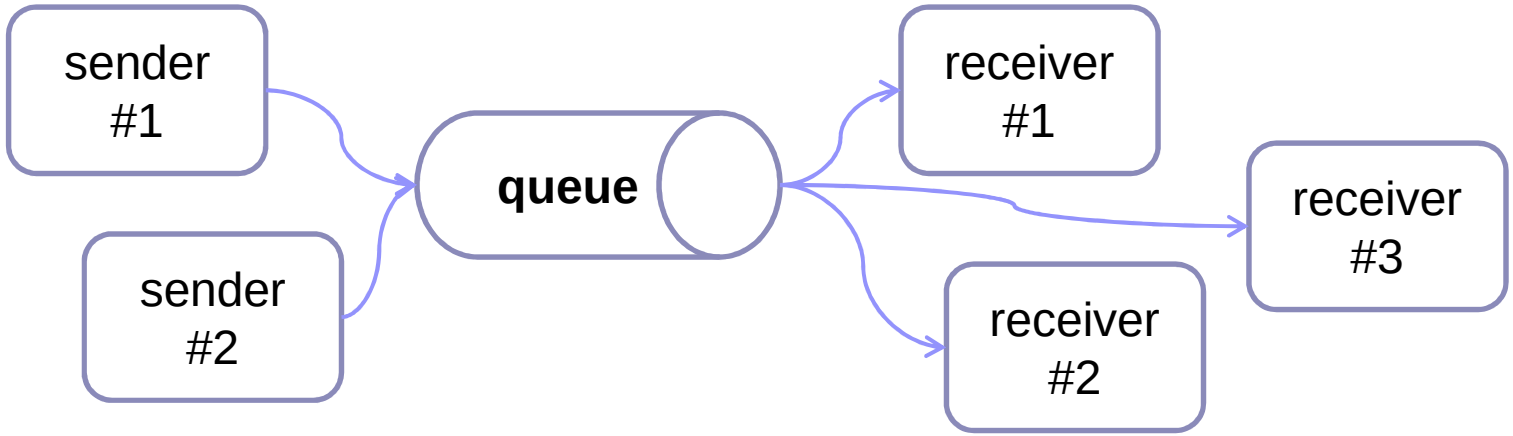


Java Messaging Service (JMS)

- Decoupled communication
  - Messages are sent between peers
    - via queue or topic
  - Producer (sender) creates message
  - Consumer (receiver) consumes message
- Messaging domains
  - describe message handling models
  - point-to-point: single recipient
  - publish-subscribe: multiple recipients

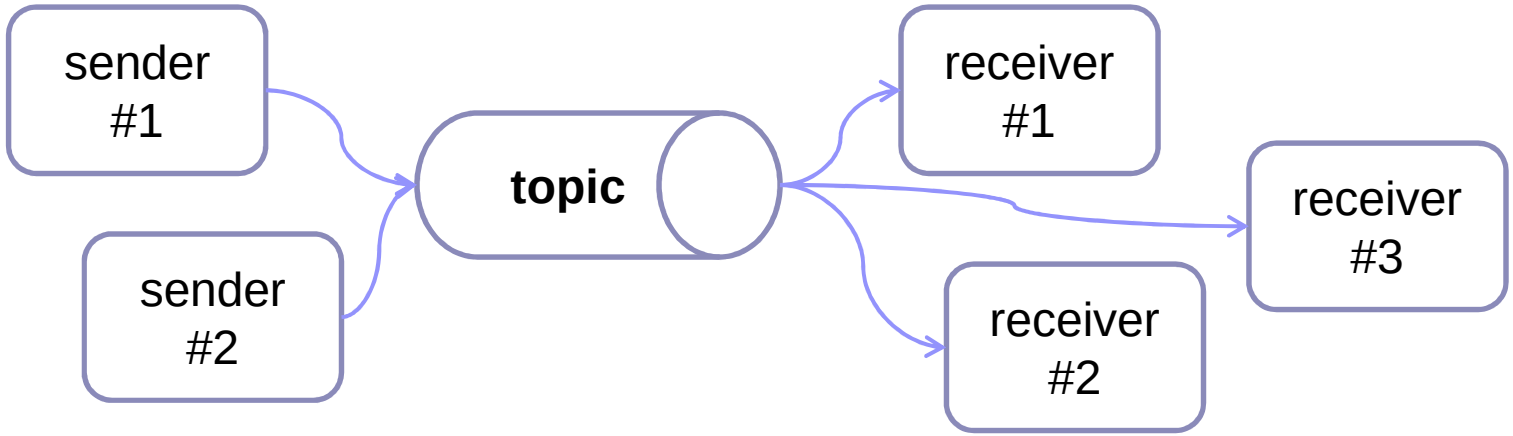
Point-to-point model

- Characteristics
  - each message has only one receiver
  - sender and receiver have no timing dependencies
  - receiver acknowledges successful processing



Publish-subscribe model

- Characteristics
  - each message can have multiple receivers
  - publishers and subscribers have timing dependency
    - messages can be consumed only after subscription
    - message predating subscription are lost to subscriber



Message consumptions

- Consumption is decoupled
  - senders and receivers don't wait for each other
- Timing models for consumers
  - Synchronous (pull)
    - explicit fetch by calling the *receive* method on queue/topic
    - block or time out
  - Asynchronous (push)
    - message listener is registered
    - JMS delivers by calling the listener's *onMessage* method

JMS example (receiver)

message bean

queue name

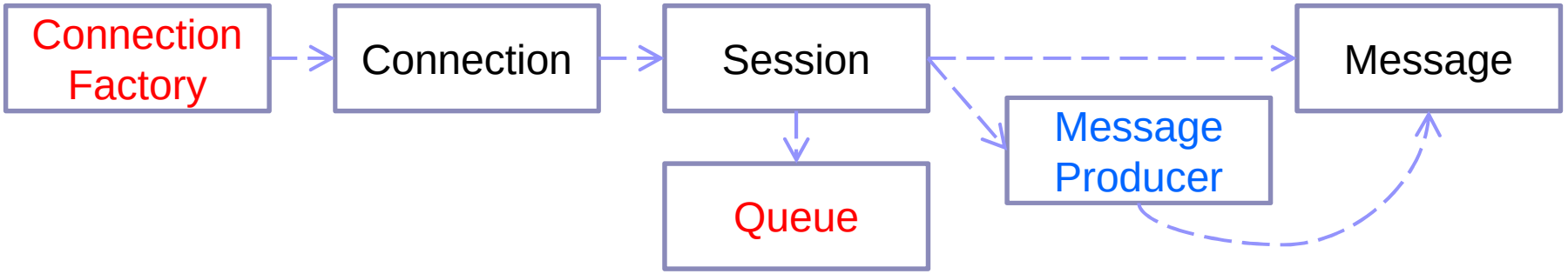
```
@MessageDriven(mappedName = "jms/deeds", activationConfig =  {
    @ActivationConfigProperty(propertyName = "acknowledgeMode",
                              propertyValue = "Auto-acknowledge"),
    @ActivationConfigProperty(propertyName = "destinationType",
                              propertyValue = "javax.jms.Queue")
    })
public class DeedMessage implements MessageListener {
    @EJB ElfServiceBean elf;
    public DeedMessage() {}
    public void onMessage(Message message) {
        try {
            TextMessage textMsg = (TextMessage)message;
            String text = textMsg.getText();
            storeReceipt(elf.addDeed(textMsg));
        } catch (Exception e) {e.printStackTrace();}
    }
}
```

business logic

comm model

push method

JMS example (sender)




```
@Resource(mappedName="jms/ConnectionFactory")
	private static ConnectionFactory connectionFactory;

@Resource(mappedName="jms/deeds") private static Queue queue;
```

```
connection = connectionFactory.createConnection();
session = connection.createSession(false, Session.AUTO_ACKNOWLEDGE);
messageProducer = session.createProducer(queue);

message = session.createTextMessage();
message.setText("Isidor broke the window");
messageProducer.send(message);
```

Configuration

Configuration

- Container manages resources
- Lookup
  - By name: *JNDI*
  - By type: *Dependecy injection*
- Setup
  - Annotations
  - Deployment descriptor
    - XML based
    - vendor specific features