Java™ 2 Platform, Enterprise Edition (J2EE™)

Overview for Web Application Development

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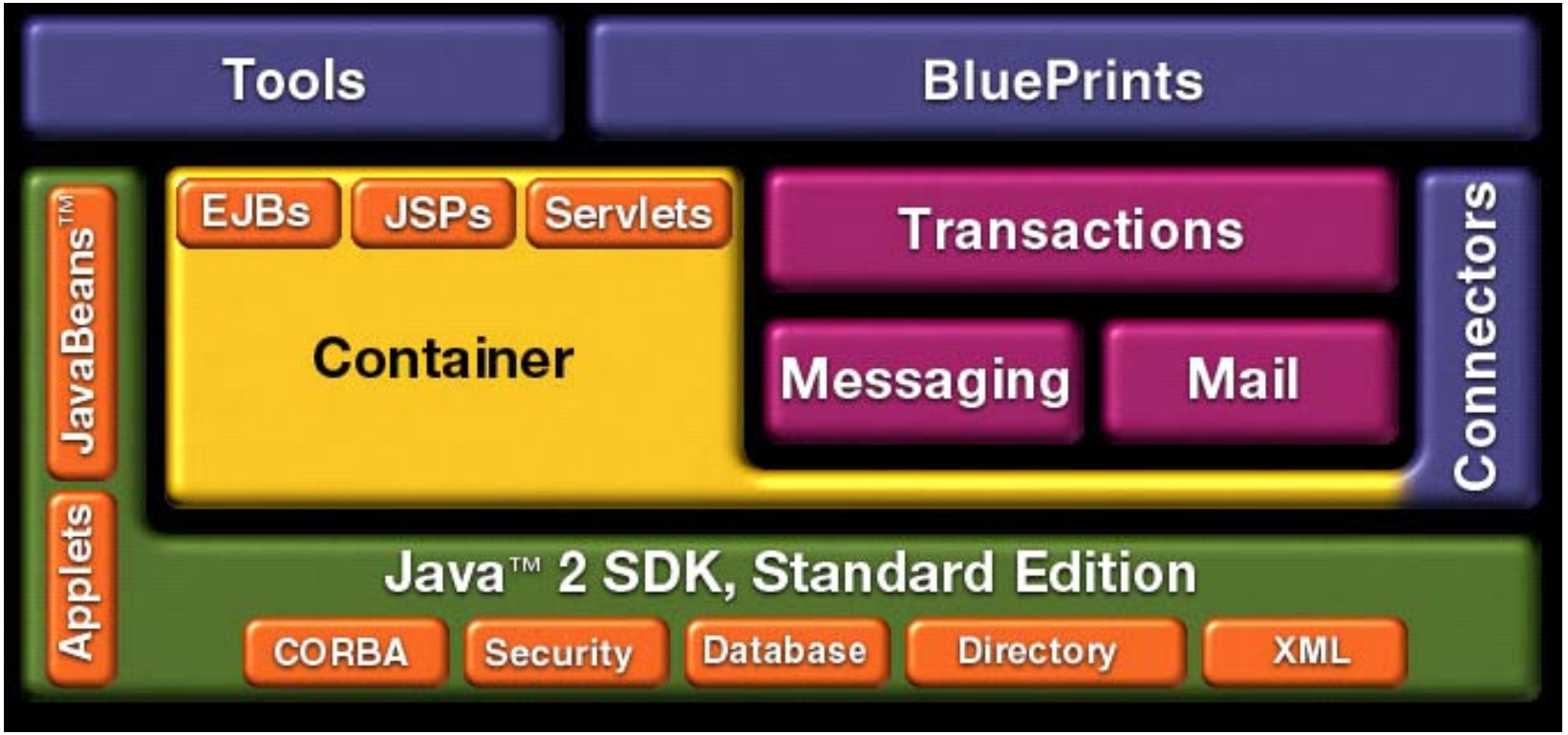
Agenda

- Introduction, Java Platforms
- J2EE Community and Future Directions
- Web Application Development in the J2EE World

Java: J2SE – J2ME – J2EE

- J2SE: WORA, new generation language
  - Additional APIs (AWT, SWING)
  - Core Language APIs
  - JVM
- J2ME: small JVM profiles
  - MIDP
  - CLDC
- J2EE: System Services, Middleware
  - Components
  - Containers
  - Services

J2EE Architecture



Good Overview of J2EE Architecture:
Designing Enterprise Applications with the J2EE Platform, 2nd Edition, Inderjeet Singh, Beth Stearns, Mark Johnson, Enterprise Team, 2002

Strength of Java™ Community

- 2.5 Million of registrations at Sun's Java™ Developer Connection
- 652 Java Community Process℠ members
  - 554 companies
  - 98 individuals
- 227 JSRs
  - 60% are led by Java™ partner companies
  - 40% are led by Sun

J2EE Success: Credit Suisse

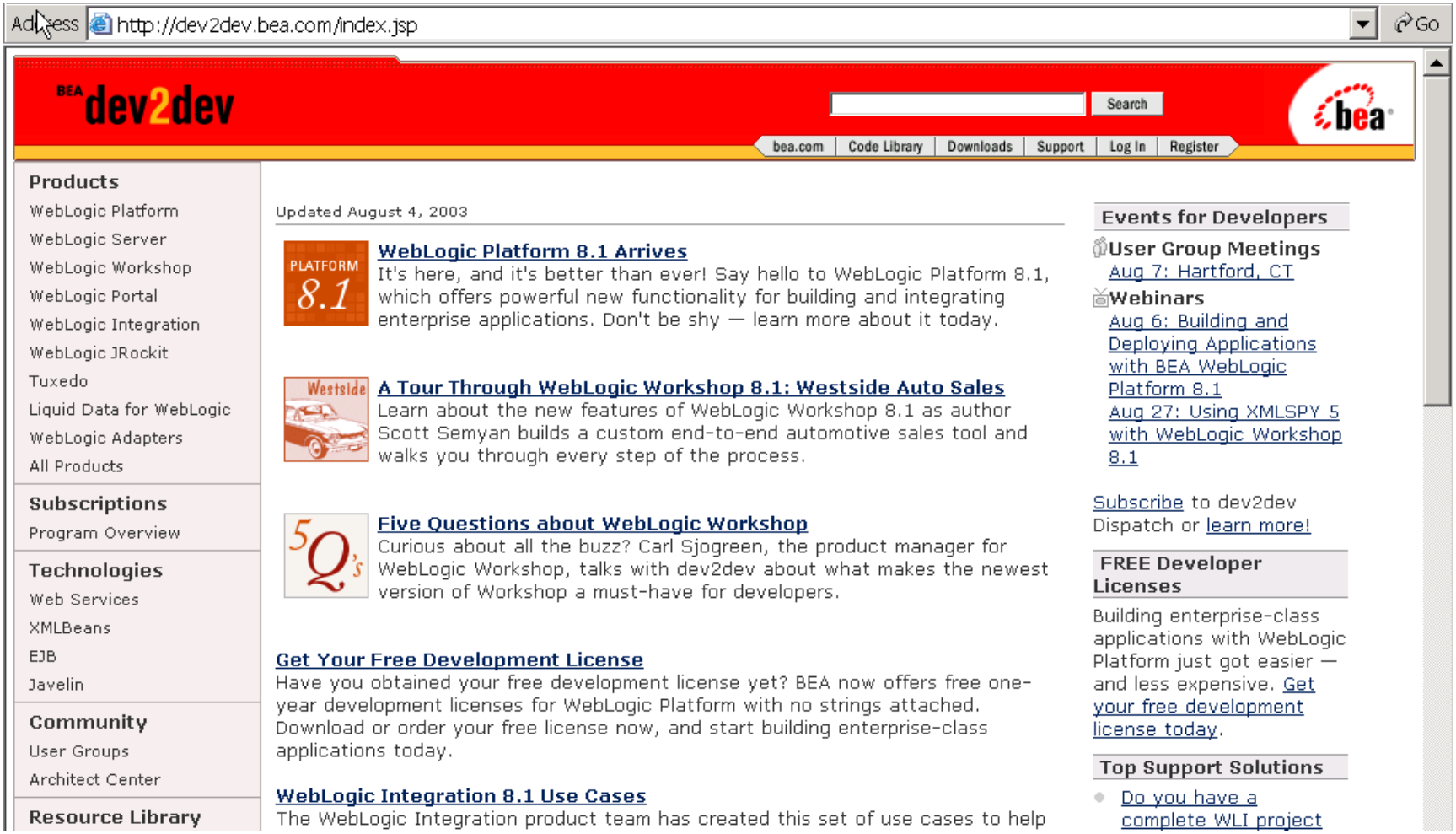
- Implemented SECOR Monitor, a monitoring tool for the bank's order routing system
  - Checks accuracy of trades
  - Expected to make 10% cost saving and improve efficiency
- Web Services based solution from Ergon Informatik
- Developed on J2EE™ Platform on the Server and J2SE™ Platform on the Client
- Credit Suisse Group employes 80,000 staff with $1.3 Trillion CHF under management

J2EE at Sun Microsystems

- **http://java.sun.com/j2ee**

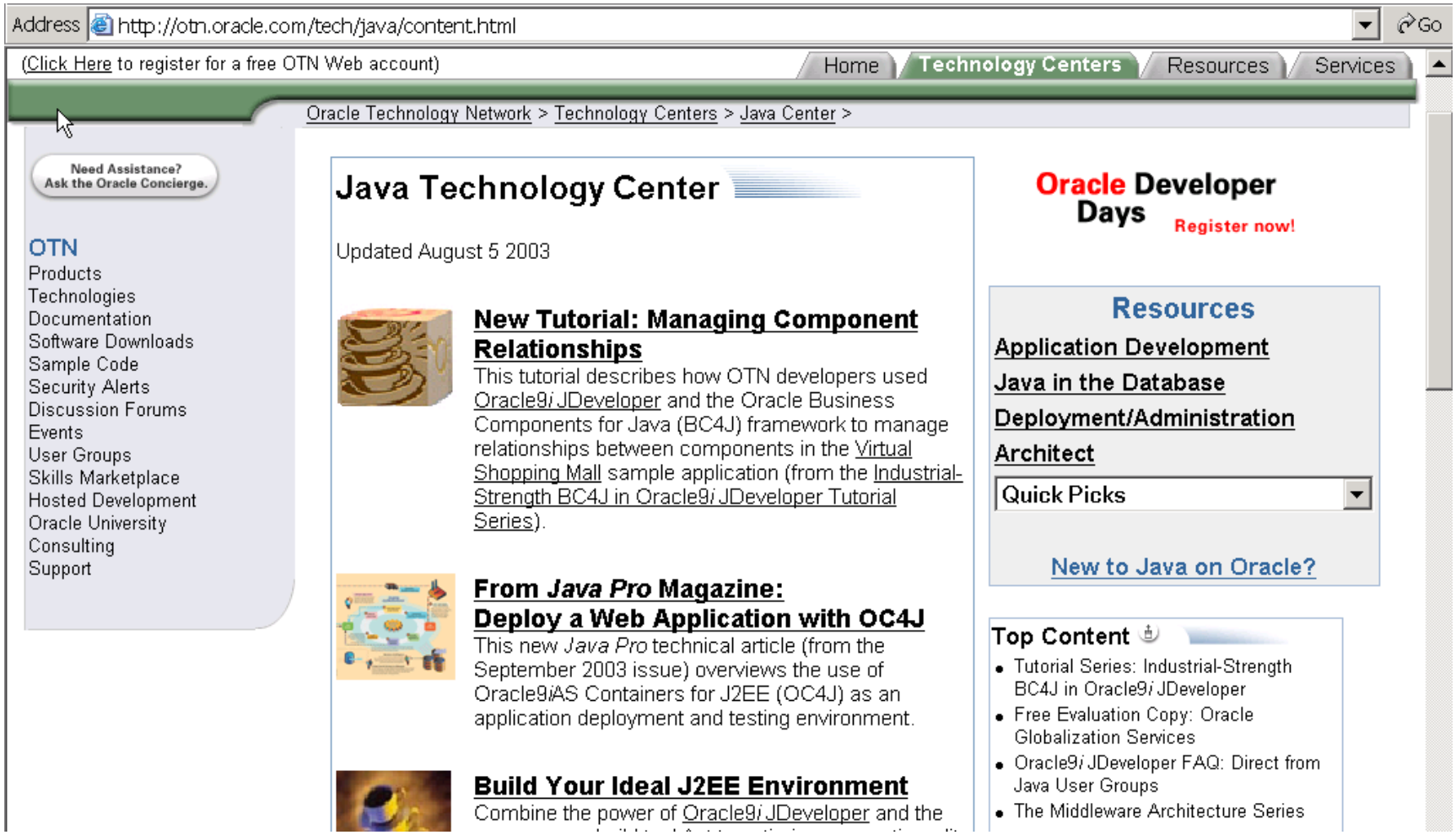
J2EE at BEA

- **http://dev2dev.bea.com**



J2EE at Oracle

- **http://otn.oracle.com/tech/java**



J2EE Development Tools

- Borland: http://www.borland.com/jbuilder/
  - JBuilder Personal (free)
  - JBuilder Developer, Enterprise (90 days eval)
- Sun: http://wwws.sun.com/software/sundev/
  - SunONE Studio
- BEA: http://www.bea.com/
  - Workshop 8.1 (12 months free development)
- Oracle: http://www.oracle.com/ip/develop/ids/
  - JDeveloper (free development license, OTN)

J2EE Development Runtime

- Borland:http://www.borland.com/besappserver/
  - Borland App Server (90 days eval)
- Sun:http://wwws.sun.com/software/products/appsrvr_pe/home_appsrvr_pe.html
  - SunONE App Server 7 PE (free)
- BEA: http://www.bea.com/
  - WebLogic 8.1 (12 months free development)
- Oracle: http://www.oracle.com/ip/deploy/ias/
  - Oracle 9iAS (free development license, OTN)

J2EE Deployment Runtime

- Sun:http://wwws.sun.com/software/products/appsrvr_pe/home_appsrvr_pe.html
  - SunONE App Server 7 PE (free)
- Sun:http://java.sun.com/webservices/webservicespack.html
  - Java Web Services Developer Pack 1.2 (free)
- Apache: http://jakarta.apache.org/tomcat/
  - Apache Tomcat 4.1 (free)
  - Apache Tomcat 5.0 (free)

Additional J2EE Links

- Java Community Process
  - http://www.jcp.org/
- J2EE Community/News
  - http://www.theserverside.com/
- J2EE hardcore Opensource
  - http://www.apache.org/foundation/mailinglists.html
- J2EE Technology Journal
  - http://www.sys-con.com/java/
- J2EE EJB Reference
  - Applying Enterprise JavaBeans 2.1: Development for the J2EE Platform (2nd edition) by Vlada Matena, Sanjeev Krishnan, Beth Sterns, Linda Demichiel (May 27, 2003)

J2EE and Microsoft

- J2EE is winning against .NET in the Enterprise (for now)
- J2EE interoperates with .NET
  - J2EE will support WS-I Basic Profile 1.0
- Allows to annotate fields, methods and classes with attribute-value pairs
  - JVM maps to CLR
  - Java maps to C#
  - J2EE maps to .NET
- J2EE provides a “safe harbor” against MSFT for software startups

J2EE Web Services in J2EE 1.4

- JAX-RPC 1.1
  - Implements WS-I Basic Profile 1.0
  - SOAP and WSDL based interoperability
  - Implements WSDL to Java mapping
  - Servlet based endpoint
  - Stateless session bean endpoint
- JAXR 1.0
  - Implements UDDI Registry protocol
- JSR 109 (Web Services for J2EE)
  - Deployment descriptors

Ease-of-Development in J2EE

- Main thrust for J2EE Platform going forward: **Ease-of-Development**
- J2EE Platform is designed to serve the needs of every developer:
  - Enterprise Developer
  - Corporate (Workgroup) Developer
  - Content (Web) Developer
- J2EE is becoming a ubiquitous platform for every type of application
  - Not just the Enterprise

Example: EJB Creation

Currently, to create an EJB:

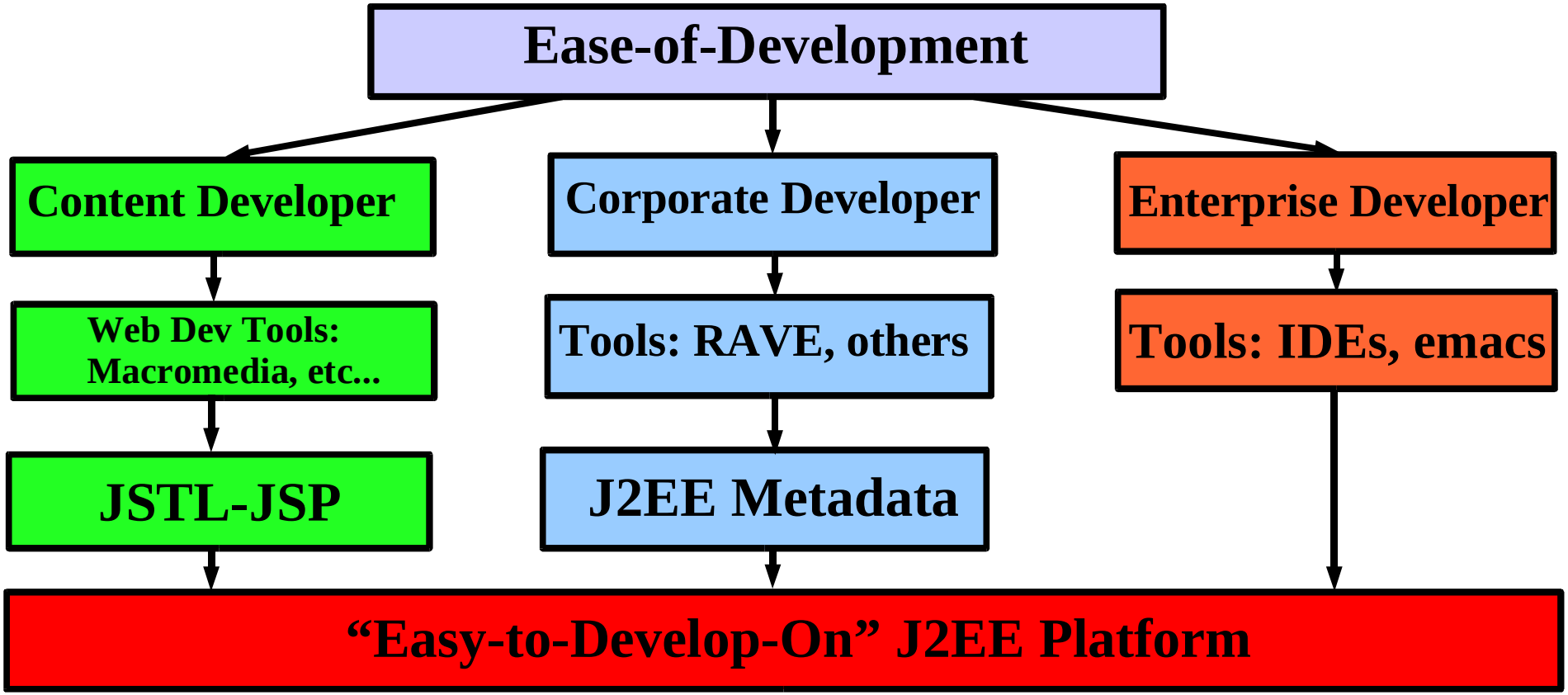
```
Context initial = new InitialContext();
Object objref = initial.lookup(java:comp/env/ejb/SimpleFoo”);
FooHome home = (FooHome)
       PortableRemoteObject.narrow(objref,FooHome.class);
Foo myFoo = home.create();
```

Wouldn't It be Nice, instead:

```
private @create Foo myFoo;
```

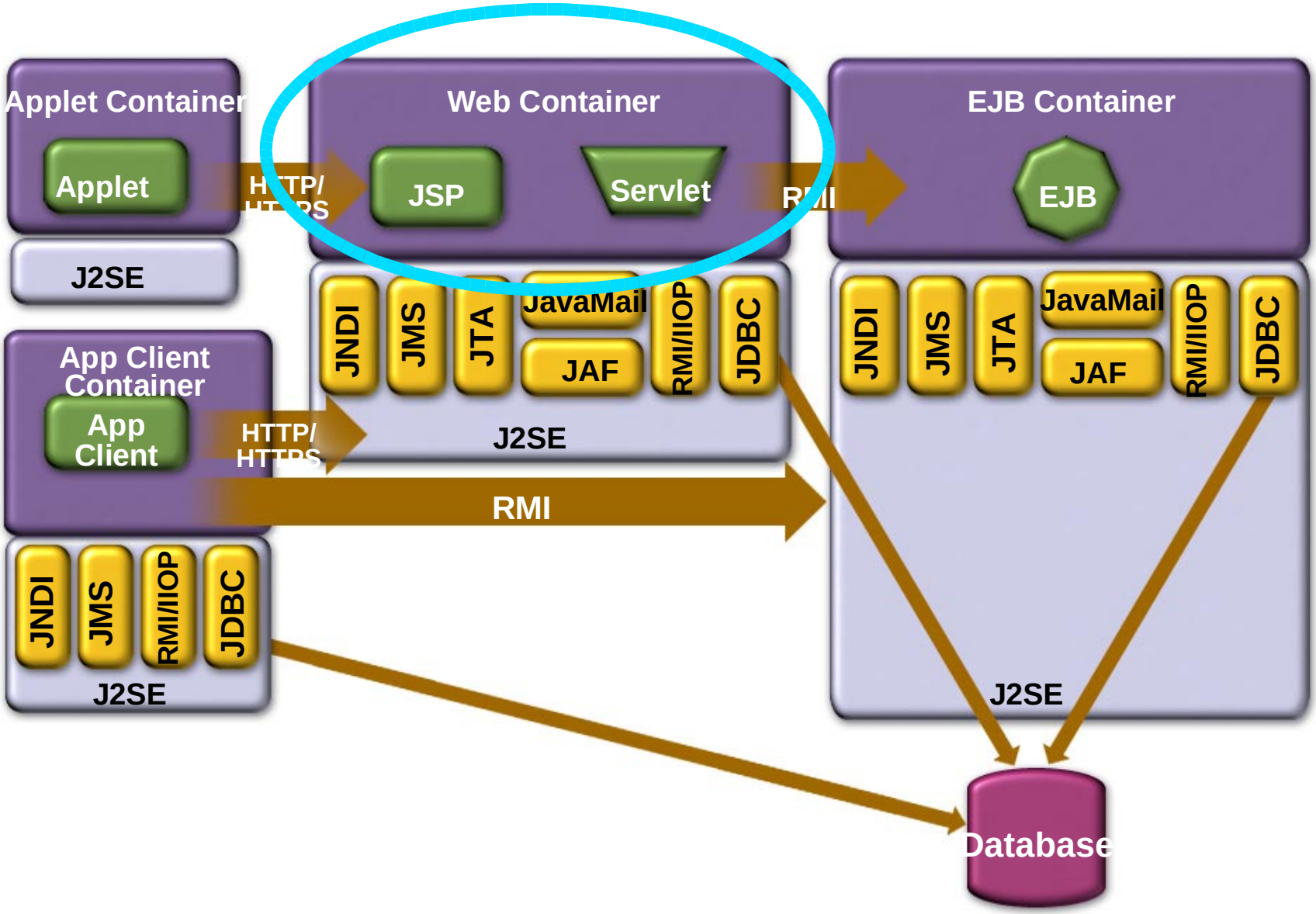
What is the Ease-of-Development?

- Tools are important, but...
- Code should be easy to write, understand and maintain as well



Web Application Development in the J2EE World

The Web Tier


Applet Container
Applet
J2SE
App Client Container
App Client
JNDI
JMS
RMI/IIOP
JDBC
J2SE
HTTP/ HTTPS
Web Container
JSP
Servlet
JNDI
JMS
JTA
JavaMail
JAF
RMI/IIOP
JDBC
J2SE
HTTP/ HTTPS
RMI
EJB Container
EJB
JNDI
JMS
JTA
JavaMail
JAF
RMI/IIOP
JDBC
J2SE
Database

What is a Web Application?

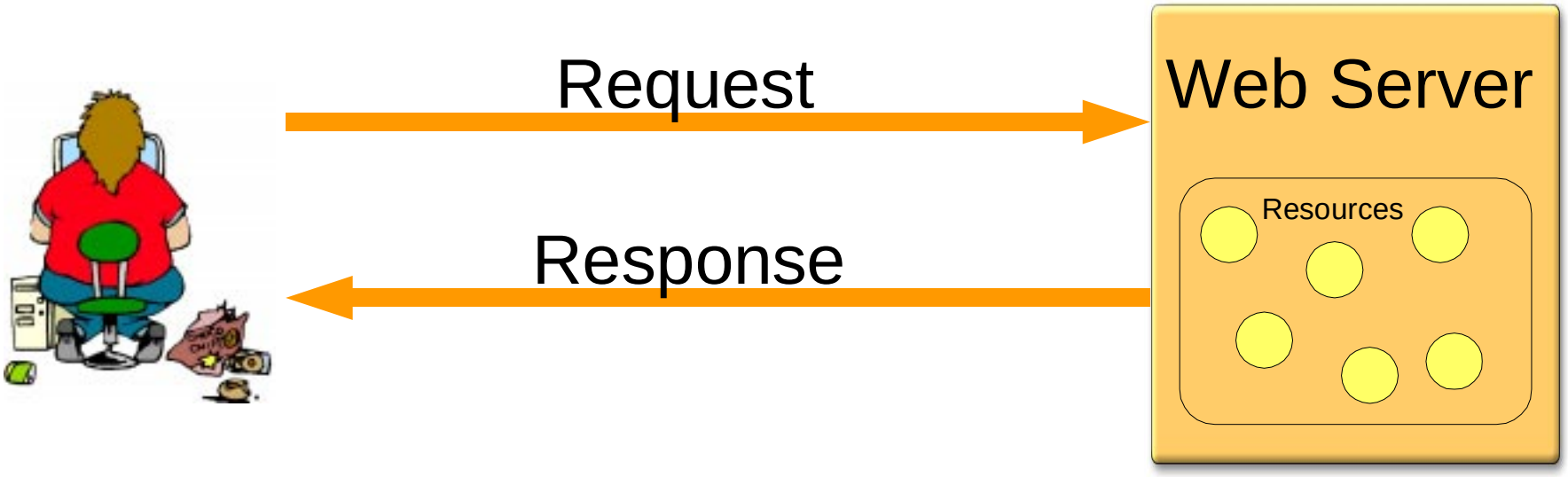
The WEB

Server

Application

HTTP

HTTP Communication Model



- Stateless
- No immediate feedback
- No details on how request is made

HTTP Request

```
GET /index.html HTTP/1.1          request line
```

```
Host: java.sun.com                request headers
User-Agent: Mozilla/4.5 [en]
Accept: image/gif, image/jpeg, image/pjpeg, */*
Accept-Language: en
Accept-Charset: iso-8859-1,*,utf-8
```

```
                                  optional request body
```

HTTP Response

```
HTTP/1.1 200 OK                                    status line
```

```
Last-Modified: Mon, Aug 4 2003 22:10:40 GMT
Date: Wed, Aug 8 2003 14:23:35 GMT
Status: 200
Content-Type: text/html
Content-Length: 59                          response headers
```

```
<html>                                  optional response body
  <body>
    <h1>Hello World!</h1>
  </body>
</html>
```

Request Parameters

- Request can also contain additional info in the form of parameters
  - In the URI itself as a query string
  - As part of the request body

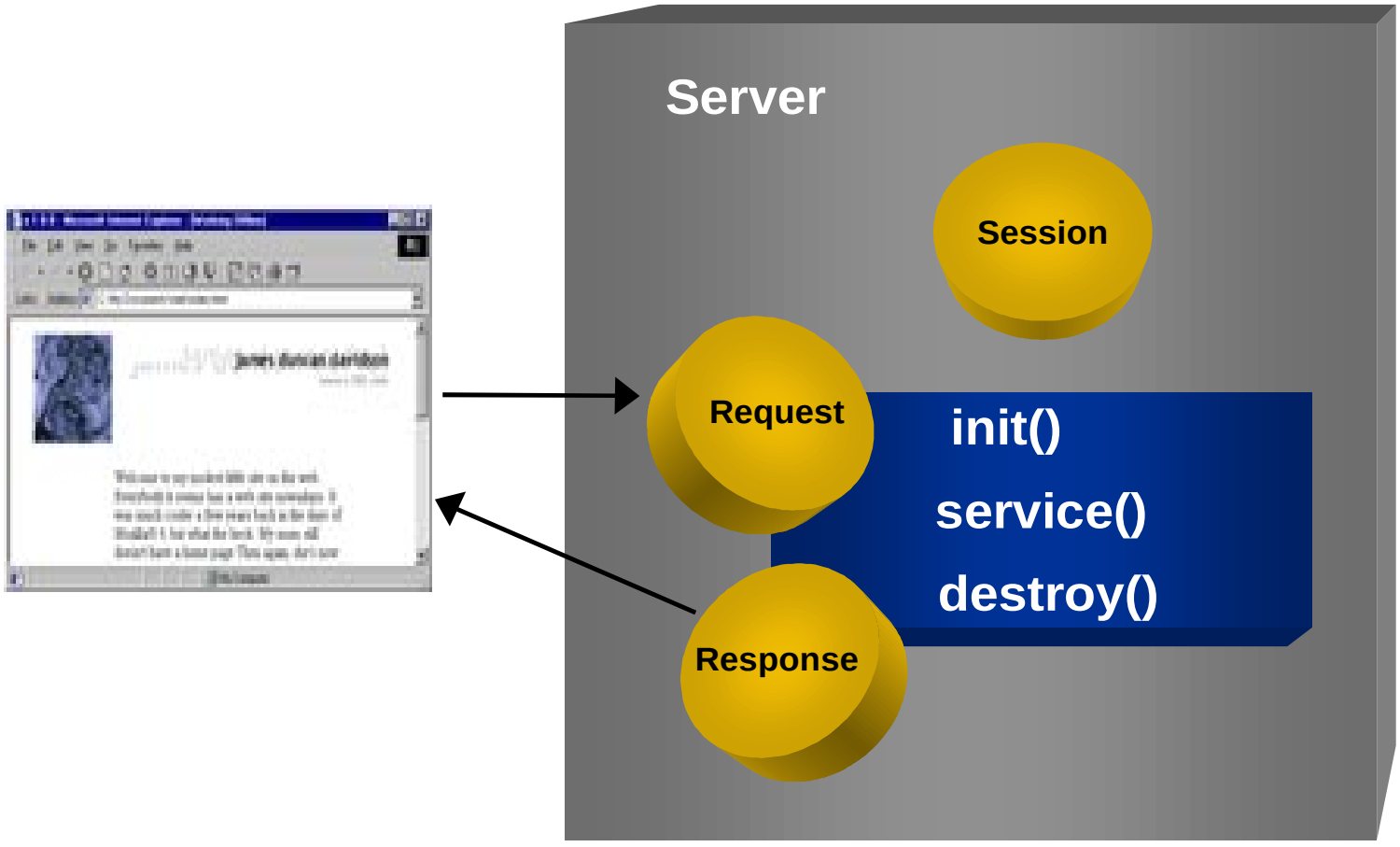
http://acme.com/register?name=Paul+Smith&state=CA

Servlets

What is a “Java Servlet”?

- Extension mechanism for dynamic content generation over HTTP, based on the Java™ Servlet API
- Simple architecture where the servlet container manages the lifecycle of servlets
- Extremely powerful
  - The full Java platform available to your web application

Servlet Invocation



Simple HTML example

```
public class HelloServlet extends HttpServlet {
  public void doGet(HttpServletRequest request,
                    HttpServletResponse response)
  {
    response.setContentType("text/plain");
    PrintWriter out = response.getWriter();
    out.println("Hello World!");
  }
}
```

Longer HTML Example

```
public class HelloServlet extends HttpServlet {
  public void doGet(HttpServletRequest request,
                    HttpServletResponse response)
  {
    response.setContentType("text/html");
    PrintWriter out = response.getWriter();
    out.println("<html>");
    out.println("Hello World!");
    out.println("<br>");
    JspCalendar clock = new JspCalendar();
    out.println("Today is");
    out.println("<ul>");
    out.println("<li>Day of month: ");
    out.println("clock.getDayOfMonth());
    out.println("</ul>");
    out.println("</html>");
  }
}
```

Servlets are great, but...

- Processing code and HTML elements are lumped together → BAD
  - Need to know Java to design HTML pages
  - Need to update servlet code to update L&F and support new types of clients
  - Hard to take advantage of web-page development tools when designing application interface

JavaServer Pages™

Servlet

```
public class HelloServlet extends HttpServlet {
  public void doGet(HttpServletRequest request,
                    HttpServletResponse response)
  {
    response.setContentType("text/plain");
    PrintWriter out = response.getWriter();
    out.println("<html>");
    out.println("Hello World!");
    out.println("<br>");
    JspCalendar clock = new JspCalendar();
    out.println("Today is");
    out.println("<ul>");
    out.println("<li>Day of month: ");
    out.println("clock.getDayOfMonth());
    out.println("</ul>");
    out.println("</html>");
  }
}
```

JSP

```
<jsp:useBean
   id="clock" class="calendar.JspCalendar" />

<html>
  Hello World!<br>
  Today is
  <ul>
    <li>Day of month: <%= clock.getDayOfMonth()%>
    <li>Year: <%= clock.getYear()%>
  </ul>
</html>
```

How does it work?

- JSP page
  - A textual document describing how to create a *response* from a *request*
  - Mixture of template data and dynamic content
  - “ Inside-Out” Servlet
- JSP engine
  - Compiles JSP page to Servlet
  - Executes servlet's service() method
- JSP page is
  - Compiled once
  - Executed many times

Key JSP concepts

- Directives
  - **<%@ *directive* %>**
- Scripting elements
  - **<%! *declaration* %>**
  - **<% *scriptlet* %>**
  - **<%= *expression* %>**
- Implicit objects
  - request, response, session, application, out, page, pageContext...
- Standard Actions
  - <jsp:useBean>, <jsp:getProperty>, <jsp:setProperty>
  - <jsp:include>, <jsp:forward>,

Example: Output Shopping Cart

```
<jsp:useBean id="cart" class="acme.com.bean.Cart"
             scope="request"/>

<html>
  <body>
    <table>
      <%
         for (int i=0; i<cart.size(); i++) {
            CartItem item = cart.getItem(i);
      %>
      <tr>
        <td><%= item.getName() %></td>
        <td><%= item.getPrice() %></td>
      </tr>
      <% } %>
    </table>
  </body>
</html>
```

Very nice, but who's the target audience?

Mike

Hard-core developer.
Handles all business logic and back-end matters.
Expert in Java, XML, databases, etc.

Ernie

Jack of all trades.
Not an expert in anything, but will eventually get the job done...

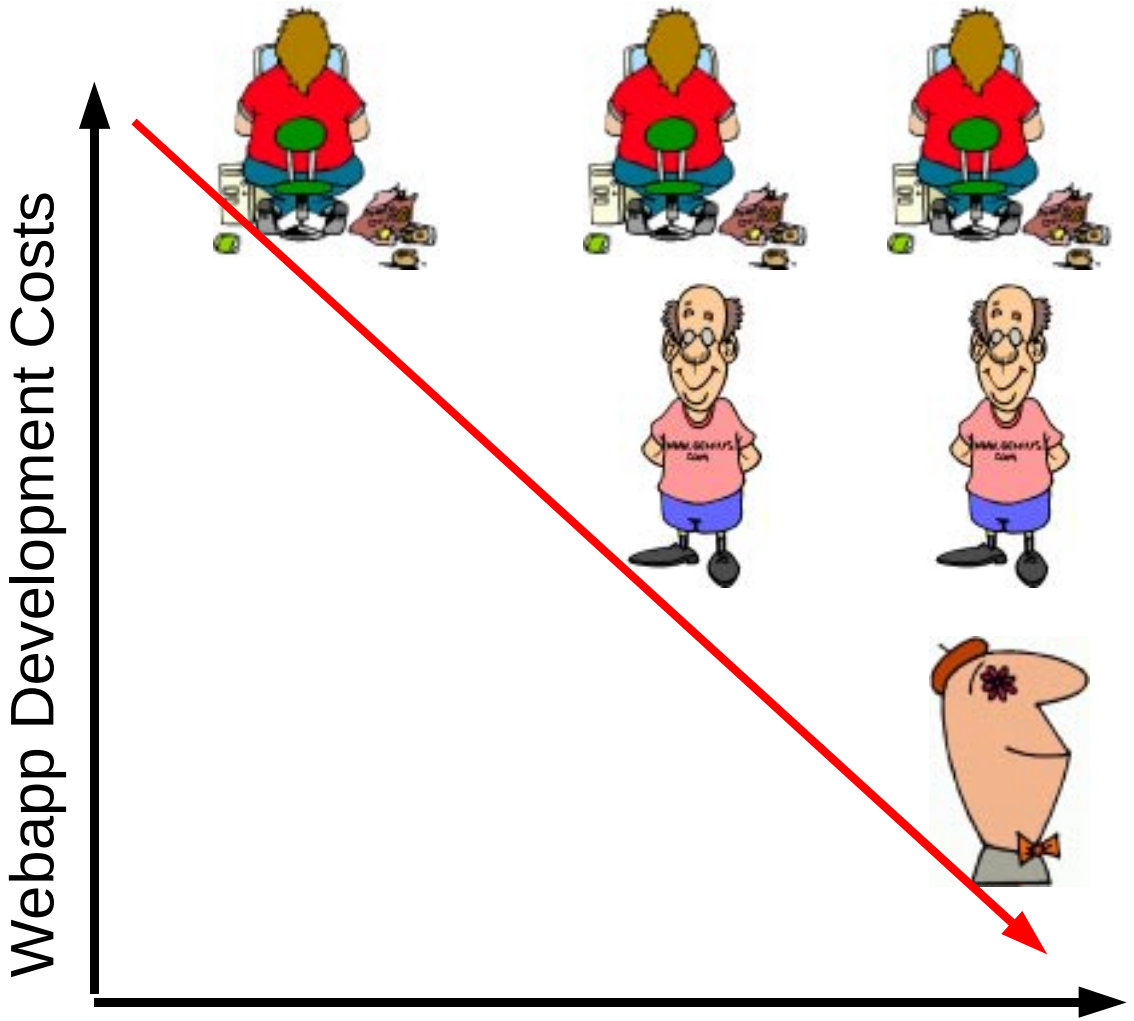
Philippe

Web site designer.
Knows how to make a website look really cool!
HTML/JavaScript expert

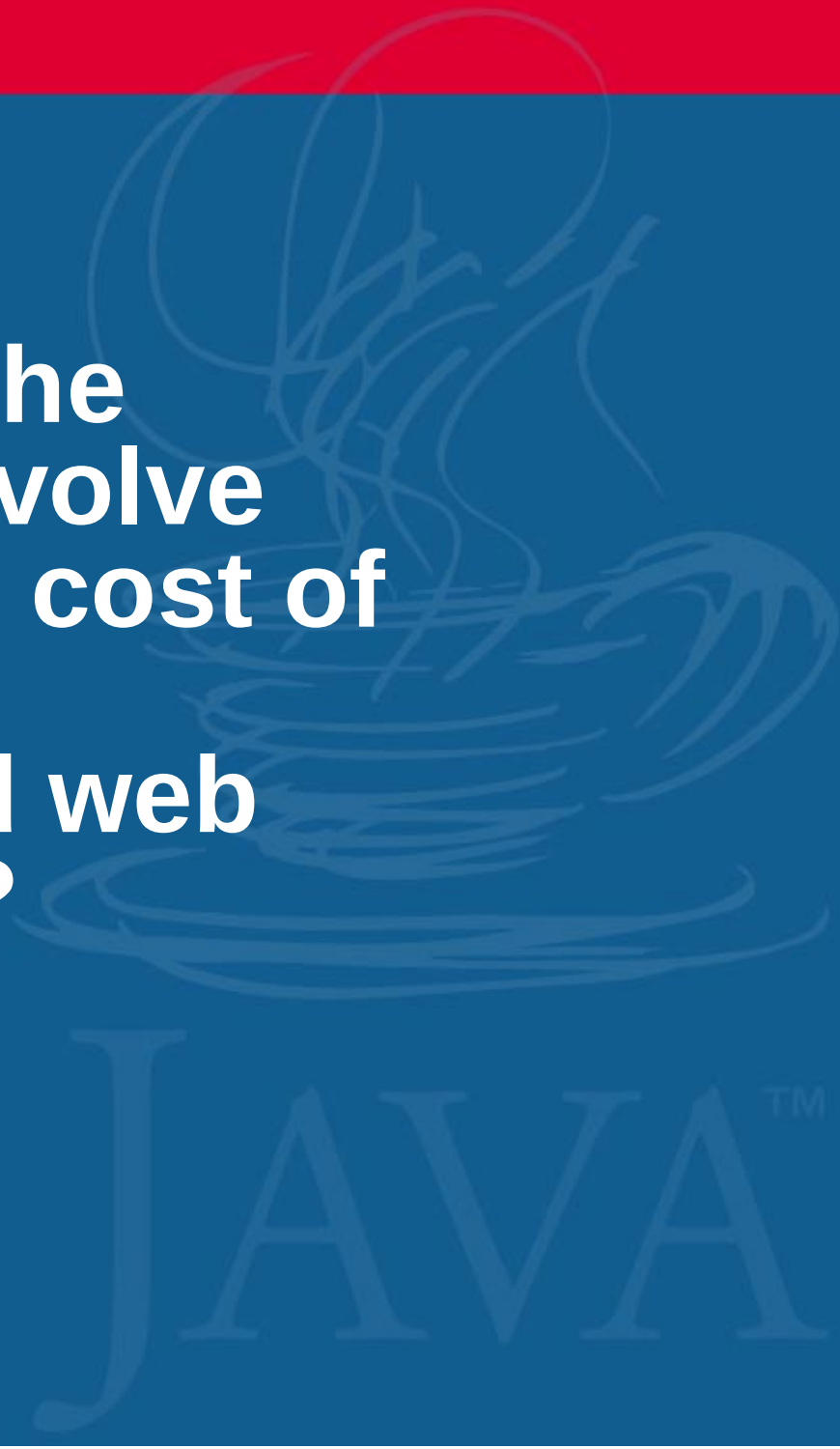
Cost rules...

Higher levels of abstraction make it easier to develop with JSPs:

- Less skills required
- Faster time to market



How should the technology evolve to reduce the cost of developping sophisticated web applications?



Custom Actions

- Design your own tags - Extremely powerful!
- Java code is executed when tag is encountered
- Easy to use by page authors
  - Look like HTML
- Encapsulate functionality
  - Reusable, maintainable
  - Keep Java Code off the JSP page
- Organizations can build a rich repository of tag libraries

Much easier...

```
<html>
  <body>
    <table>
      <acme:cart id=”item”>
        <tr>
          <td><%= item.getName() %></td>
          <td><%= item.getPrice() %></td>
        </tr>
      </acme:cart>
    </table>
  </body>
</html>
```

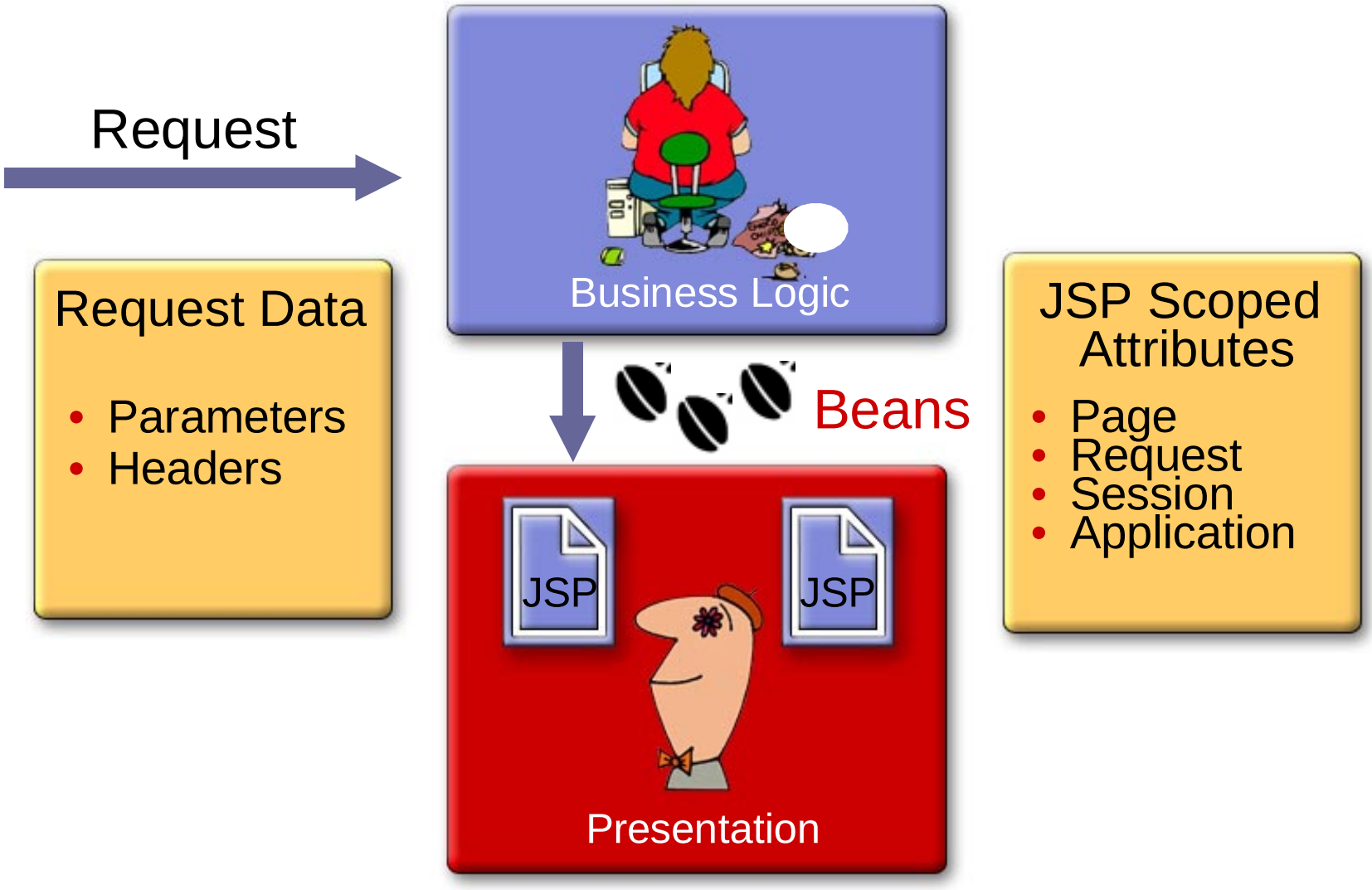
But...

Still need to refine...

- Tag Libraries
  - Should everyone reinvent the wheel?
  - Standard tag libraries → JSTL
- Java as the scripting language in JSP scares many people (e.g. Philippe)... can we simplify?
  - Expression Language: A language adapted for the web developer

Expression Language

Easy Access/Manipulation of Application Data



Before…

1. Must declare

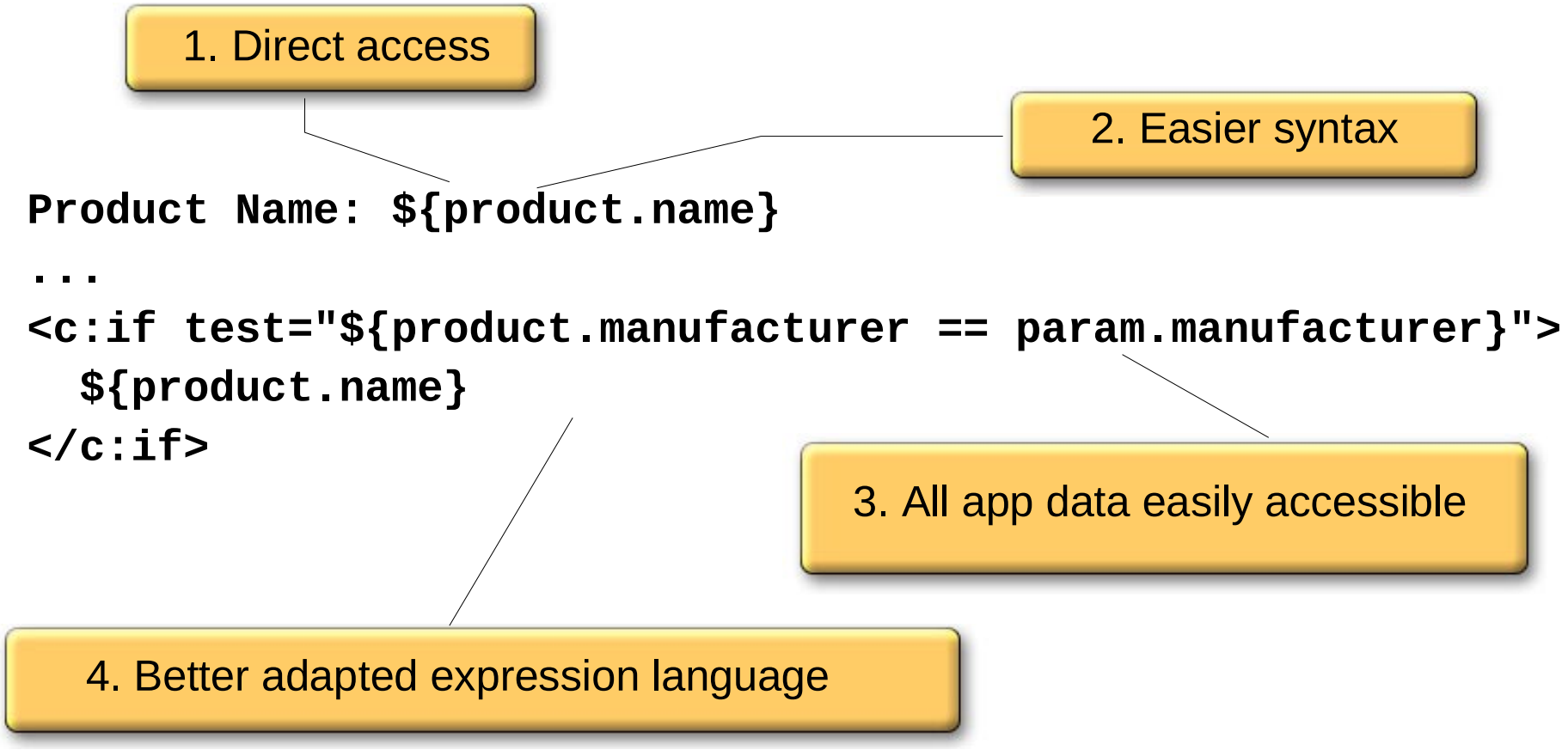
2. Must know type

```
<jsp:useBean id="product"
    type="acme.com.Product" scope="request"/>
...
Product Name: <%= product.getName() %>
...
<% if (product.getManufacturer().equals("ACME")) { %>
  ...
<% } %>
```

3. Awkward syntax

4. Knowledge of scripting language required even for simple manipulations

After


1. Direct access
2. Easier syntax
Product Name: ${product.name}
...
<c:if test="${product.manufacturer == param.manufacturer}">
${product.name}
</c:if>
3. All app data easily accessible
4. Better adapted expression language

Expression Language

1. Syntax

```
${expression}
value="product_${name}.${type}"
```

Expression Language

2. Application data directly accessible

```
${foo} -> pageContext.findAttribute("foo")
```

Implicit objects:

- `{page|request|session|application}Scope`
- `param/paramValues, initParam`
- `header/headerValues, cookie`
- `pageContext`

Expression Language

3. Beans and collections rule

```
${user.address.city}
${products[product.id]}
${products["DCR-PC100"]}
```

Expression Language

4. Operators

```
relational:
  ==, !=, <, >, <=, >=
arithmetic:
  +, -, *, /, %
binary:
  and, or, not
```

Expression Language

5. Automatic type conversions


```
begin="${request.beginValue}"
```

Expression Language

6. Default values

```
<c:set var="city"
       value="${user.address.city}"
       default="N/A"/>
```

Expression Language

7. Extensibility through functions

```
truncate name to 30 chars and display it
in uppercase

${fn:toUpperCase(fn:substring(name, 0, 30))}
```

EL Support Actions

- <c:out> – Display EL expression

```
<c:out value="${customer.address.city}"
       default="unknown"/>
```

- <c:set> – Set scoped variable

```
<acme:foo>
  <acme:bar>
    <x:atag>...</x:atag/>
  </acme:bar>
</acme:foo>
```

```
<c:set var="bar">
  <x:atag>...</x:atag/>
</c:set>
<acme:foo bar="${bar}"/>
```

- <c:remove> – Remove scoped variable

Conditional Actions

- Simple conditional execution

```
<c:if test="${user.visitCount == 1}">
    This is your first visit!
</c:if>
```

- Mutually exclusive conditional execution

```
<c:choose>
  <c:when test="${verbosityLevel == 'short'}>
    ${product.shortDescription}
  </c:when>
  <c:otherwise>
    ${product.longDescription}
  </c:otherwise>
</c:choose>
```

Iteration Actions

1. All J2SE collection types supported

```
<table>
  <c:forEach items="${customers}"
             var="customer"
             varStatus="status">
    <tr>
      <td>${status.count}</td>
      <td>${customer}</td>
    </tr>
  </c:forEach>
</table>
```

2. Current item

3. Iteration status

- begin, end, step
- **<c:forTokens delims="...">**

Standard Actions for Common Needs

URL related Actions

Hypertext Links

URL rewriting

```
<c:url url="/exec/add"
       var="myUrl">
  <c:param name="name" value="${param.name}"/>
  <c:param name="country" value="${param.country}"/>
</c:url>

<a href="${myUrl}">Add Member</a>
```

Parameter name and value automatically URL encoded

<jsp:include> —Webapp Centric

Web Application
Same Context

Relative URL

```
/foo/bar.jsp
bar.jsp
```

<jsp:include>

<c:import> —URL Centric

Internet Resources

Absolute URL

```
http://acme.com/foo
ftp://xyz.org/README
```

Web Application
Same Context

Relative URL

```
/foo/bar.jsp
bar.jsp
```

Web Application
Foreign Context

Relative URL

```
context="/global"
/copyright.html
```

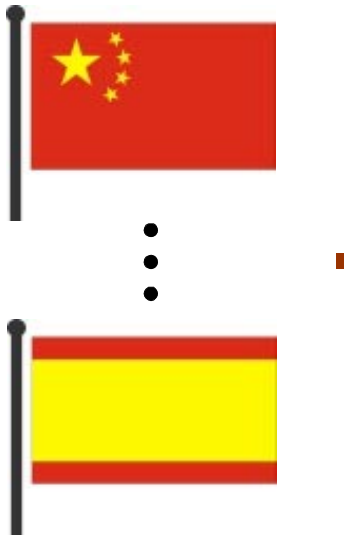
```
<c:import url="...">
```

Standard Actions
for Common Needs

Internationalization and Text Formatting

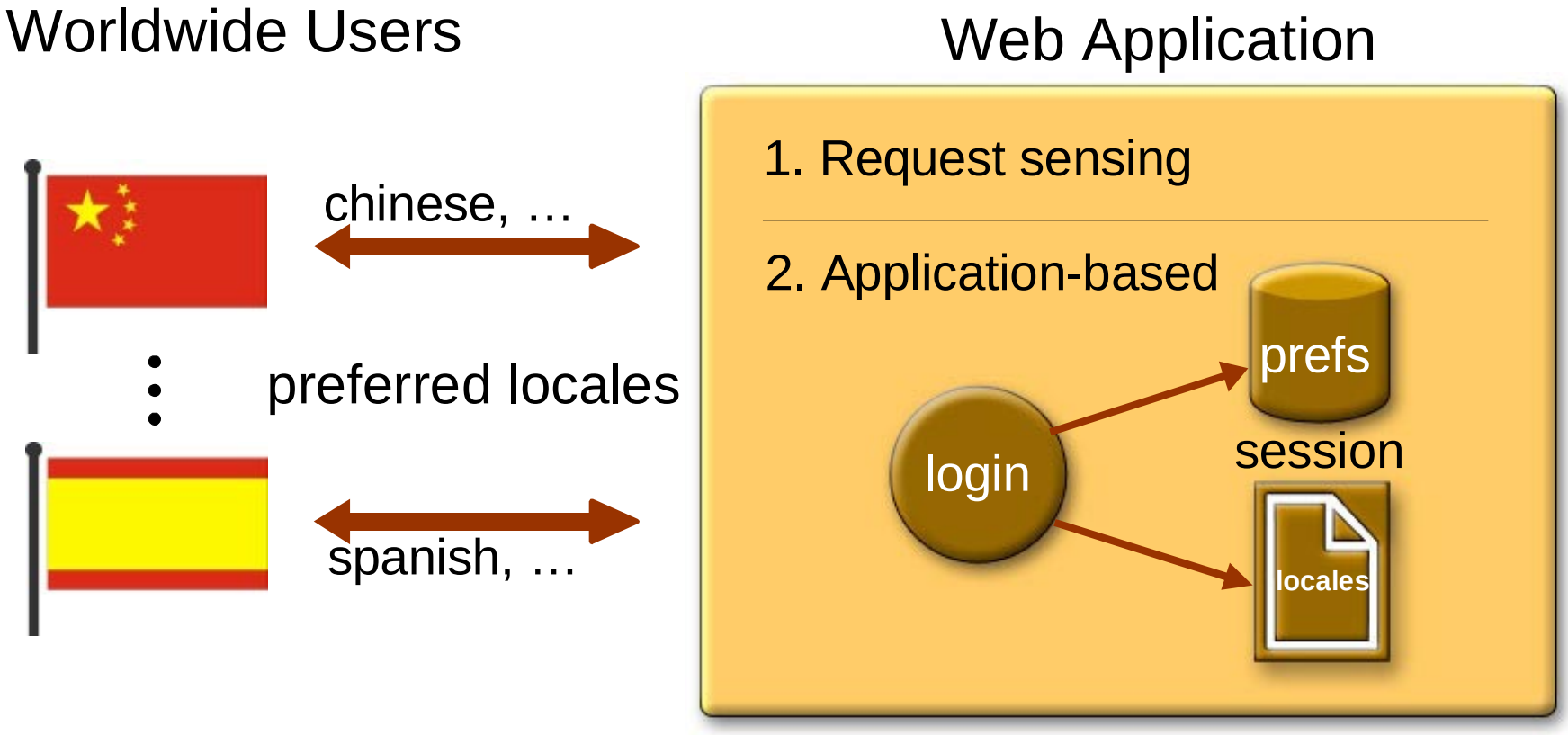
Webapp for Global Markets

Worldwide Users

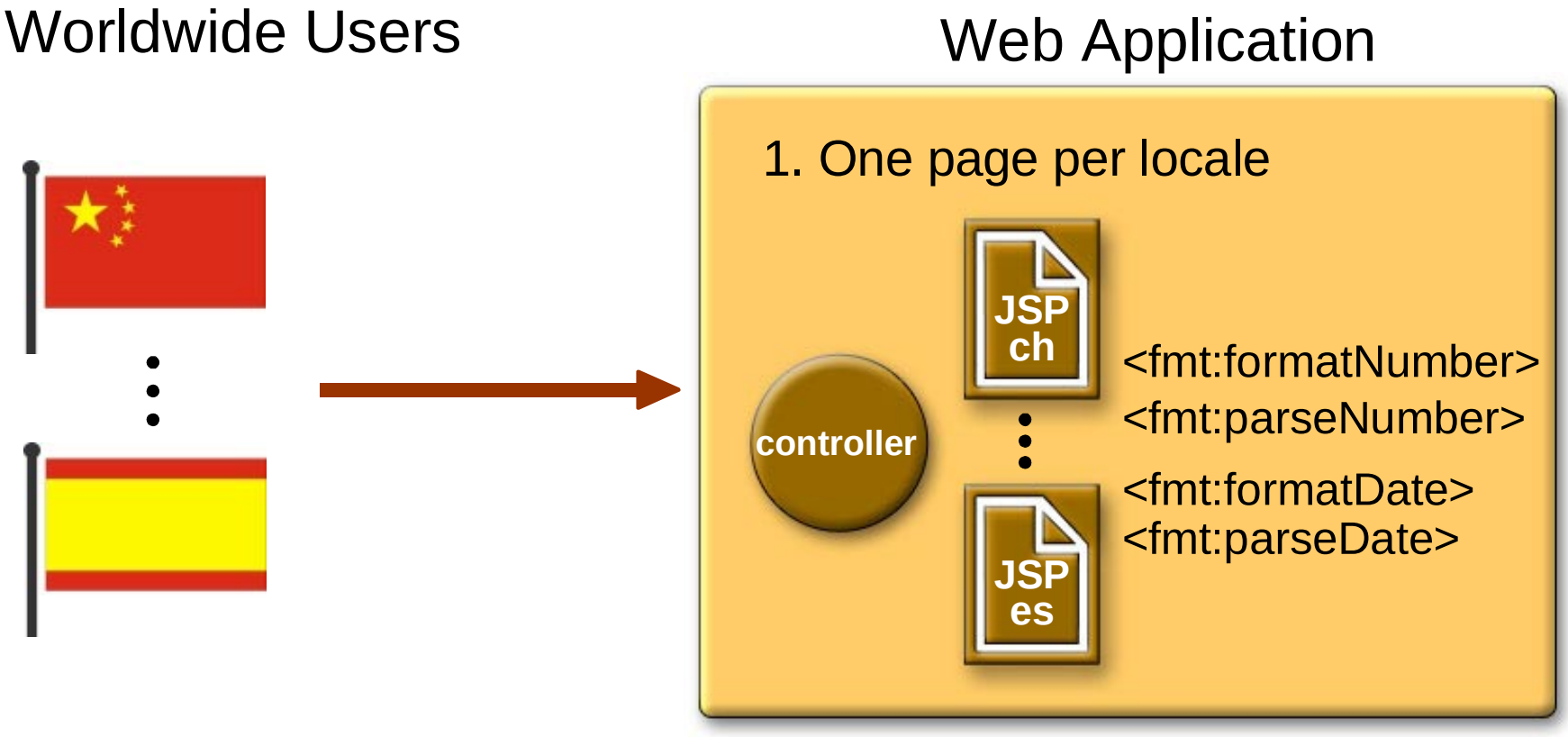


Web Application

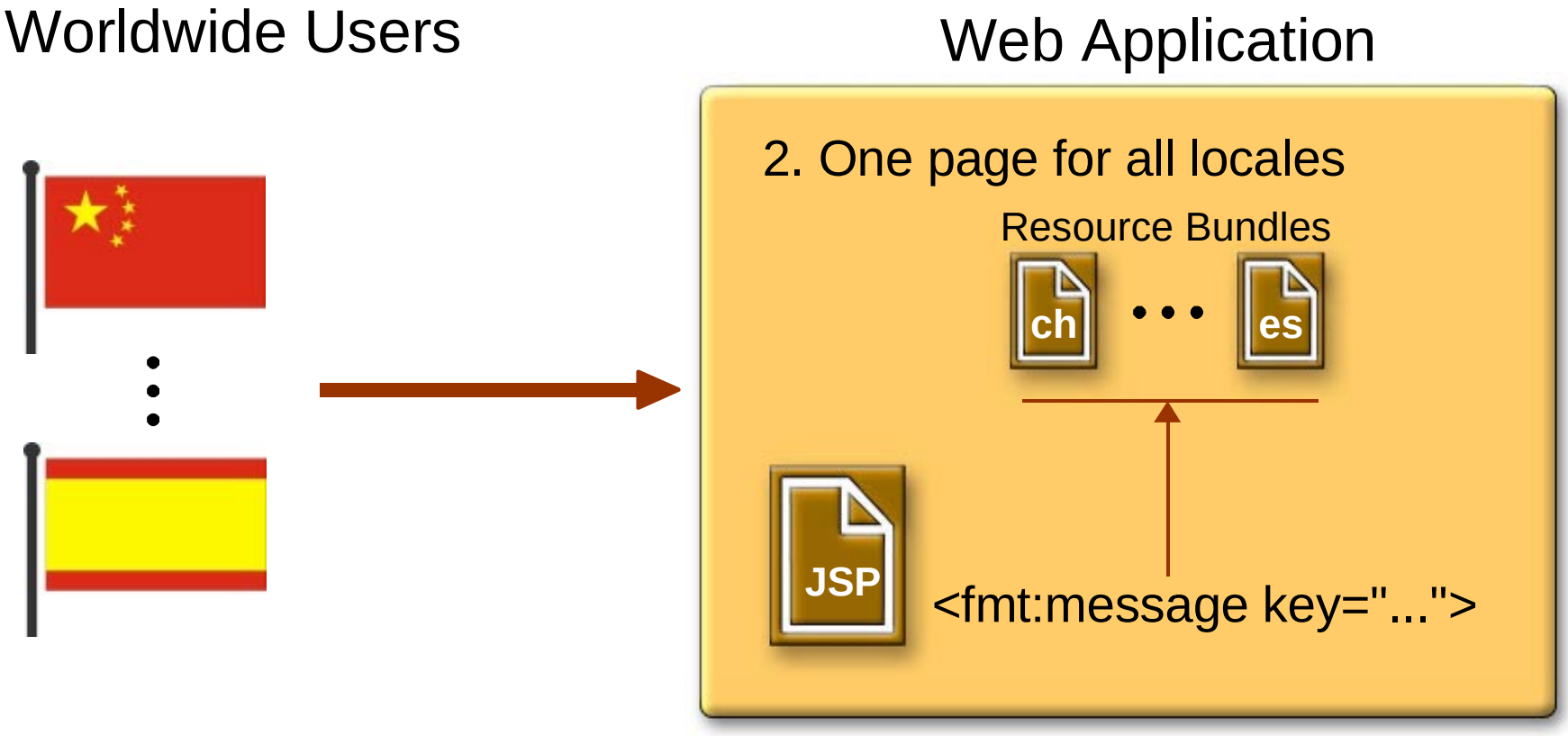
Locale


Worldwide Users
chinese, …
preferred locales
spanish, …
Web Application
1. Request sensing
2. Application-based
prefs
login
session
locales

I18N Architecture



I18N Architecture



How Easy to I18N a Webapp?

```
<fmt:message key="welcome"/>
```

How Easy to I18N a Webapp?

Uses Default Localization Context

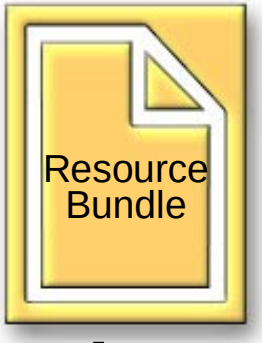
Request

Configuration parameter

1. Client's Locale preferences

2. Resource bundle basename

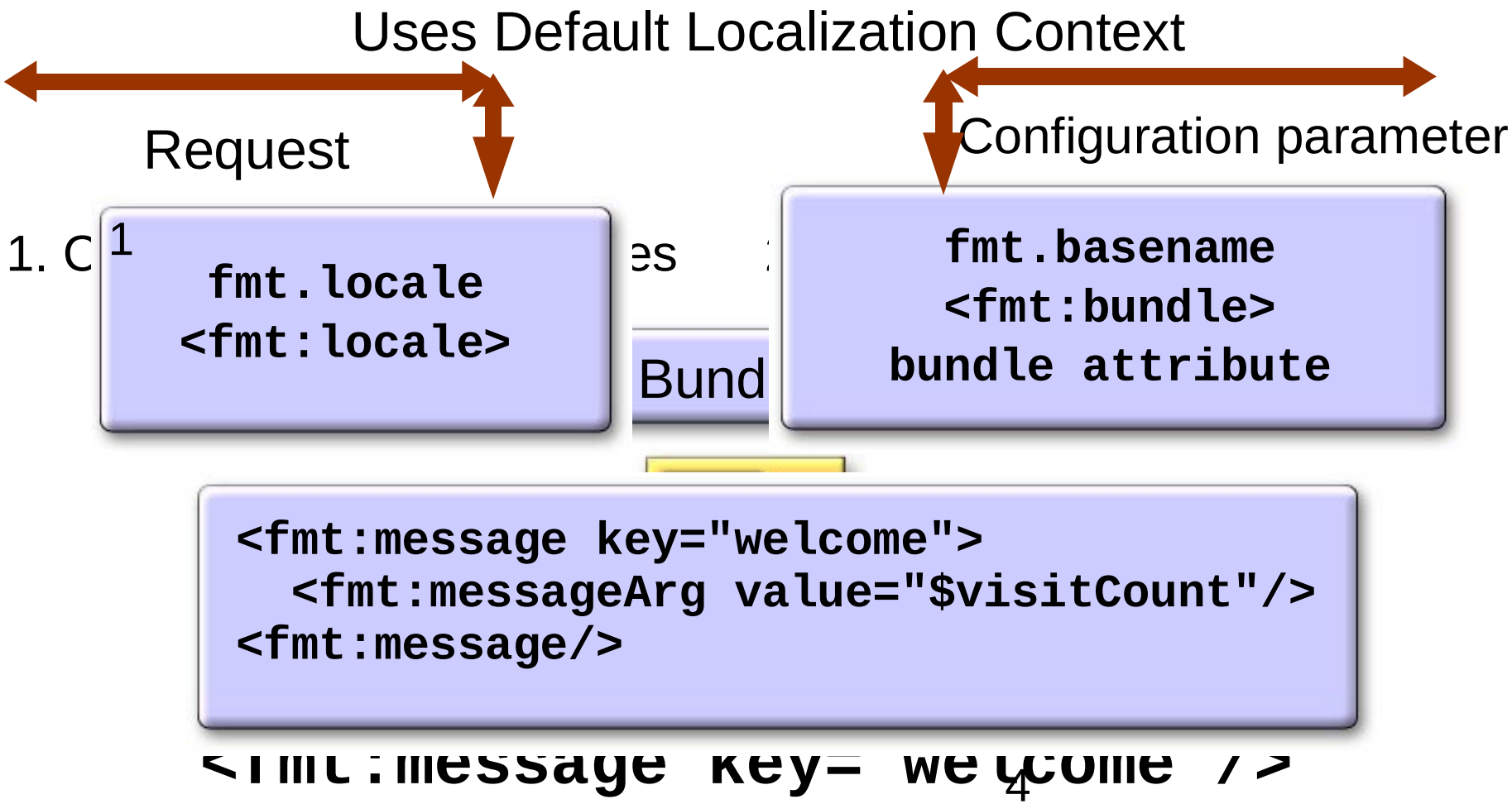
J2SE Resource Bundle Selection Algorithm




```
<fmt:message key="welcome"/>
```

3. Fallback Locale

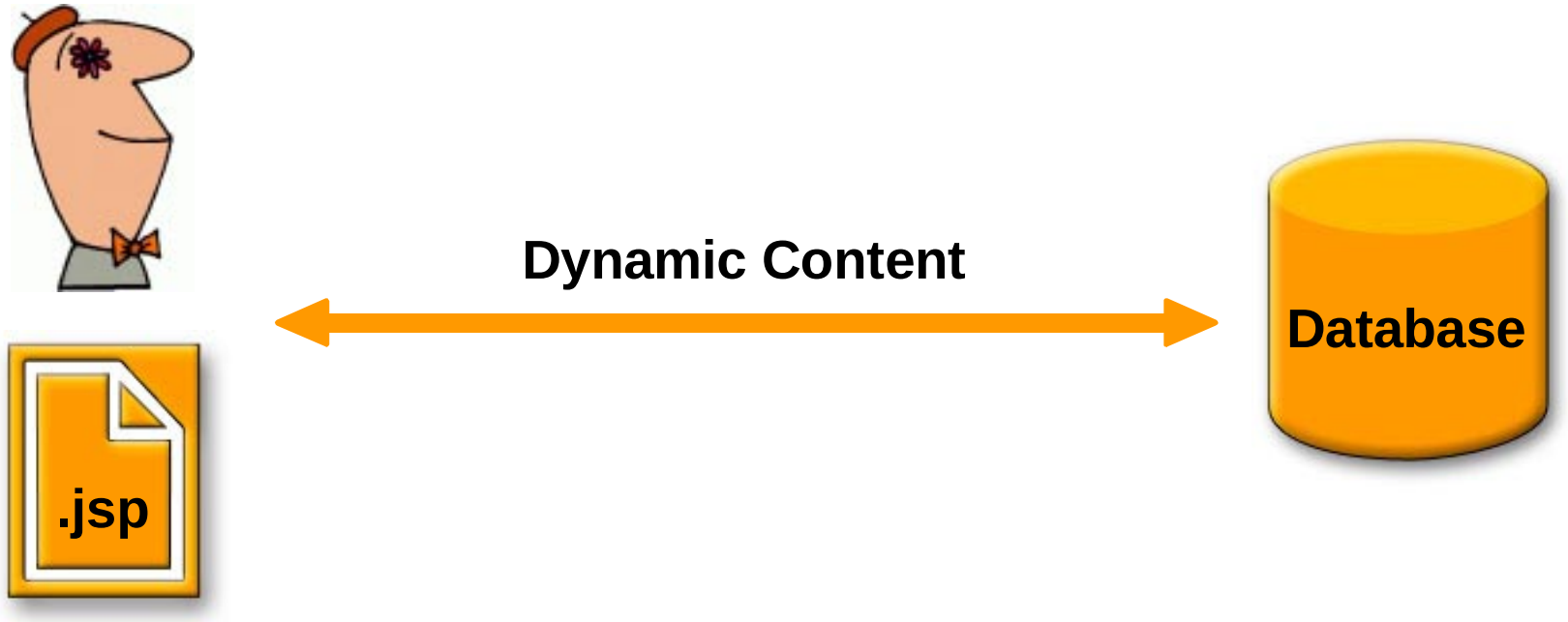
I18N Flexibility



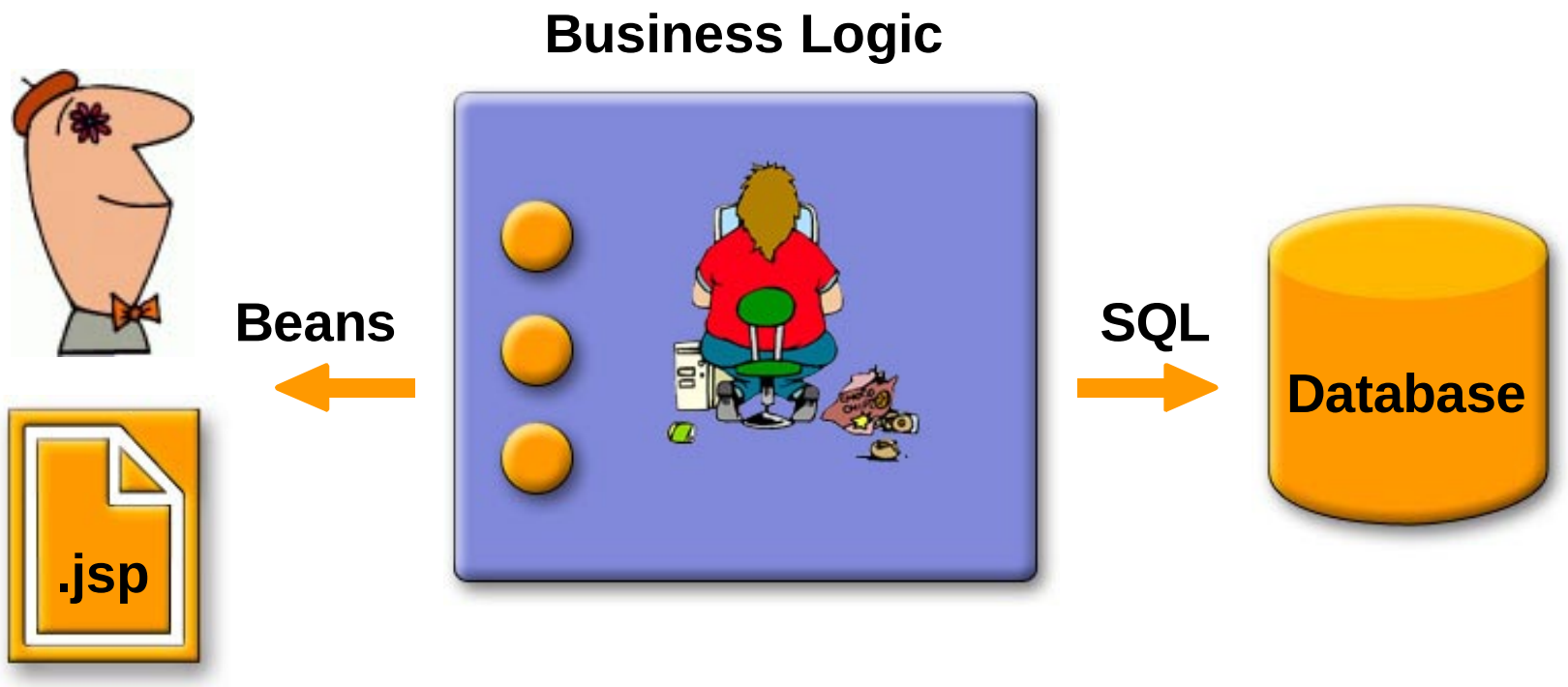
Standard Actions for Common Needs

Database Access

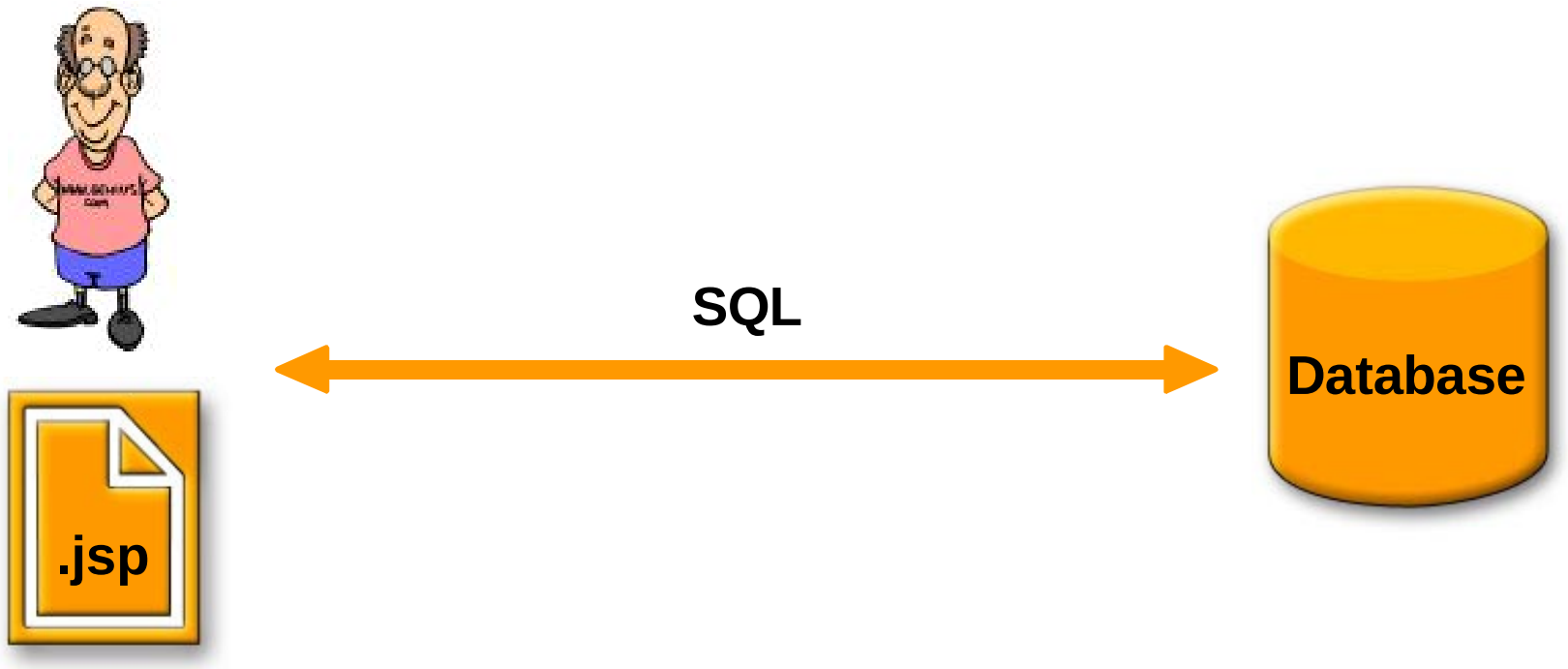
Database Access



MVC Architecture



RAD/Prototyping/Simple Apps



SQL Actions

.jsp

```
Query the database
  <sql:query>

Easy access to
result set
  Result
  ResultSupport


Update the database
  <sql:update>
  <sql:transaction>
```

Database

DataSource

- All DB actions operate on a DataSource
- Different ways to access a DataSource
  - Transparent collaboration
    - via configuration parameter **`sql.dataSource`**

```
<db:query query="..." />
```

  - Explicit collaboration
    - Object provided by application logic
    - Object provided by <sql:dataSource> action

```
<sql:dataSource var="dataSource"
     driver="org.gjt.mm.mysql.Driver"
     url="jdbc:..."/>
<sql:query dataSource="${dataSource}" .../>
```

Querying a Database

```
<sql:query var="customers" dataSource="${dataSource}">
   SELECT * FROM customers
   WHERE country = 'China'
   ORDER BY lastname
</sql:query>

<table>
<c:forEach var="row" items="${customers.rows}">
  <tr>
    <td><c:out value="${row.lastName}"/></td>
    <td><c:out value="${row.firstName}"/></td>
    <td><c:out value="${row.address}"/></td>
  </tr>
</c:forEach>
</table>
```

Updating a Database

```
<sql:transaction dataSource="${dataSource}">
  <sql:update>
    UPDATE account
    SET Balance = Balance - ?
    WHERE accountNo = ?
    <sql:param value="${transferAmount}">
    <sql:param value="${accountFrom}">
  </sql:update>
  <sql:update>
    UPDATE account
    SET Balance = Balance + ?
    WHERE accountNo = ?
    <sql:param value="${transferAmount}">
    <sql:param value="${accountTo}">
  </sql:update>
</sql:transaction>
```

Standard Actions for Common Needs

XML

XML Everywhere

1. Easy Access to XML Data

XPath

```
$doc/employee[@name=$param:name]
```

XPath variable bindings

1. Easy Access to XML Data

XPath – expression language for XML actions

`<x:out>`
`<x:set>`

`<x:if>`
`<x:choose>`
`<x:forEach>`

`select` attribute to specify XPath expression

2. Get the XML Data

```
<x:parse>
in    xmlUrl,xmlText,body content
out   var, varDom
perf  filter (org.xml.sax.XMLFilter)
```

3. XSLT Transformation

```
<x:transform>
in    xmlUrl,xmlText,body content
in    xsltUrl,xsltText
out   var,result,page
perf  transparent caching of Transformer objects possible
```

Demo / Q&A

Resources

- JSP home page
  http://java.sun.com/jsp
- JSTL home page
  http://java.sun.com/jstl
- Java Web Services Developer Pack
  http://java.sun.com/xml
- Books
  - JavaServer Pages, Hans Bergsten, O'Reilly
  - JSTL in Action, Shawn Bayern, Manning