Internet Applications

Chapter 7

Lecture Overview

- Internet Concepts
- Web data formats
  - HTML, XML, DTDs
- Introduction to three-tier architectures
- The presentation layer
  - HTML forms; HTTP Get and POST, URL encoding; Javascript; Stylesheets. XSLT
- The middle tier
  - CGI, application servers, Servlets, JavaServerPages, passing arguments, maintaining state (cookies)

Uniform Resource Identifiers

- Uniform naming schema to identify *resources* on the Internet
- A resource can be anything:
  - Index.html
  - mysong.mp3
  - picture.jpg
- Example URIs:

  http://www.cs.wisc.edu/~dbbook/index.html
  mailto:webmaster@bookstore.com

Structure of URIs

http://www.cs.wisc.edu/~dbbook/index.html

- URI has three parts:
  - Naming schema (http)
  - Name of the host computer (www.cs.wisc.edu)
  - Name of the resource (~dbbook/index.html)
- URLs are a subset of URIs

Hypertext Transfer Protocol

- What is a communication protocol?
  - Set of standards that defines the structure of messages
  - Examples: TCP, IP, HTTP
- What happens if you click on www.cs.wisc.edu/~dbbook/index.html?
- Client (web browser) sends HTTP request to server
- Server receives request and replies
- Client receives reply; makes new requests

HTTP (Contd.)

Client to Server:

```
GET ~/index.html HTTP/1.1
User-agent: Mozilla/4.0
Accept: text/html, image/gif,
    image/jpeg
```

Server replies:

```
HTTP/1.1 200 OK
Date: Mon, 04 Mar 2002 12:00:00 GMT
Server: Apache/1.3.0 (Linux)
Last-Modified: Mon, 01 Mar 2002
    09:23:24 GMT
Content-Length: 1024
Content-Type: text/html
<HTML> <HEAD></HEAD>
<BODY>
<h1>Barns and Nobble Internet
    Bookstore</h1>
Our inventory:
<h3>Science</h3>
<b>The Character of Physical Law</b>
...
```

HTTP Protocol Structure

HTTP Requests

- Request line: GET ~/index.html HTTP/1.1
  - GET: Http method field (possible values are GET and POST, more later)
  - ~/index.html: URI field
  - HTTP/1.1: HTTP version field
- Type of client: User-agent: Mozilla/4.0
- What types of files will the client accept:
  Accept: text/html, image/gif, image/jpeg

HTTP Protocol Structure (Contd.)

HTTP Responses

- Status line: HTTP/1.1 200 OK
  - HTTP version: HTTP/1.1
  - Status code: 200
  - Server message: OK
  - Common status code/server message combinations:
    - 200 OK: Request succeeded
    - 400 Bad Request: Request could not be fulfilled by the server
    - 404 Not Found: Requested object does not exist on the server
    - 505 HTTP Version not Supported
- Date when the object was created:
  Last-Modified: Mon, 01 Mar 2002 09:23:24 GMT
- Number of bytes being sent: Content-Length: 1024
- What type is the object being sent: Content-Type: text/html
- Other information such as the server type, server time, etc.

Some Remarks About HTTP

- HTTP is stateless
  - No "sessions"
  - Every message is completely self-contained
  - No previous interaction is "remembered" by the protocol
  - Tradeoff between ease of implementation and ease of application development: Other functionality has to be built on top
- Implications for applications:
  - Any state information (shopping carts, user login-information) need to be encoded in every HTTP request and response!
  - Popular methods on how to maintain state:
    - Cookies (later this lecture)
    - Dynamically generate unique URL's at the server level (later this lecture)

Web Data Formats

- HTML
  - The presentation language for the Internet
- Xml
  - A self-describing, hierarchal data model
- DTD
  - Standardizing schemas for Xml
- XSLT (not covered in the book)

HTML: An Example

```
<HTML>
  <HEAD></HEAD>
  <BODY>
  <h1>Barns and Nobble Internet
    Bookstore</h1>
  Our inventory:

  <h3>Science</h3>
  <b>The Character of Physical
    Law</b>
  <UL>
    <LI>Author: Richard
  Feynman</LI>
    <LI>Published 1980</LI>
    <LI>Hardcover</LI>
  </UL>

  <h3>Fiction</h3>
  <b>Waiting for the Mahatma</b>
  <UL>
    <LI>Author: R.K. Narayan</LI>
    <LI>Published 1981</LI>
  </UL>
  <b>The English Teacher</b>
  <UL>
    <LI>Author:  R.K. Narayan</LI>
    <LI>Published 1980</LI>
    <LI>Paperback</LI>
  </UL>

  </BODY>
</HTML>
```


HTML: A Short Introduction

- HTML is a markup language
- Commands are tags:
  - Start tag and end tag
  - Examples:
    - <HTML> … </HTML>
    - <UL> … </UL>
- Many editors automatically generate HTML directly from your document (e.g., Microsoft Word has an "Save as html" facility)

HTML: Sample Commands

- <HTML>:
- <UL>: unordered list
- <LI>: list entry
- <h1>: largest heading
- <h2>: second-level heading, <h3>, <h4> analogous
- <B>Title</B>: Bold

XML: An Example

```
<?xml version="1.0" encoding="UTF-8" standalone="yes"?>
<BOOKLIST>
  <BOOK genre="Science" format="Hardcover">
    <AUTHOR>
      <FIRSTNAME>Richard</FIRSTNAME><LASTNAME>Feynman</LASTNAME>
    </AUTHOR>
    <TITLE>The Character of Physical Law</TITLE>
    <PUBLISHED>1980</PUBLISHED>
  </BOOK>
  <BOOK genre="Fiction">
    <AUTHOR>
      <FIRSTNAME>R.K.</FIRSTNAME><LASTNAME>Narayan</LASTNAME>
    </AUTHOR>
    <TITLE>Waiting for the Mahatma</TITLE>
    <PUBLISHED>1981</PUBLISHED>
  </BOOK>
  <BOOK genre="Fiction">
    <AUTHOR>
      <FIRSTNAME>R.K.</FIRSTNAME><LASTNAME>Narayan</LASTNAME>
    </AUTHOR>
    <TITLE>The English Teacher</TITLE>
    <PUBLISHED>1980</PUBLISHED>
  </BOOK>
</BOOKLIST>
```


XML – The Extensible Markup Language

- Language
  - A way of communicating information
- Markup
  - Notes or meta-data that describe your data or language
- Extensible
  - Limitless ability to define new languages or data sets

XML – What's The Point?

- You can include your data and a description of what the data represents
  - This is useful for defining your own language or protocol
- Example: Chemical Markup Language

```
<molecule>
        <weight>234.5</weight>
        <Spectra>…</Spectra>
        <Figures>…</Figures>
</molecule>
```

- XML design goals:
  - XML should be compatible with SGML
  - It should be easy to write XML processors
  - The design should be formal and precise

XML – Structure

- XML: Confluence of SGML and HTML
- Xml looks like HTML
- Xml is a hierarchy of user-defined tags called elements with attributes and data
- Data is described by elements, elements are described by attributes

<BOOK genre="Science" format="Hardcover">…</BOOK>

attribute

open tag element name

attribute value

data

closing tag

XML – Elements

<BOOK genre="Science" format="Hardcover">…</BOOK>

attribute

open tag element name

attribute value

data

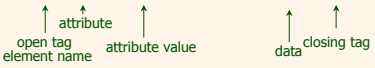
closing tag

- Xml is case and space sensitive
- Element opening and closing tag names must be identical
- Opening tags: "<" + element name + ">"
- Closing tags: "</" + element name + ">"
- Empty Elements have no data and no closing tag:
  - They begin with a "<" and end with a "/>"

<BOOK/>

XML – Attributes

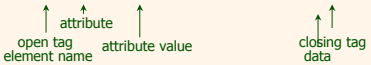
<BOOK genre="Science" format="Hardcover">…</BOOK>



- Attributes provide additional information for element tags.
- There can be zero or more attributes in every element; each one has the the form:
  attribute_name='attribute_value'
  - There is no space between the name and the "='"
  - Attribute values must be surrounded by " or ' characters
- Multiple attributes are separated by white space (one or more spaces or tabs).

XML – Data and Comments

<BOOK genre="Science" format="Hardcover">…</BOOK>



- Xml data is any information between an opening and closing tag
- Xml data must not contain the '<' or '>' characters
- Comments:
  <!- comment ->

XML – Nesting & Hierarchy

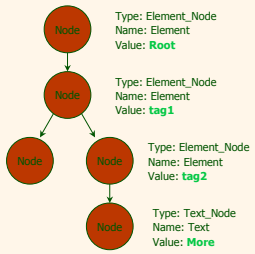
- Xml tags can be nested in a tree hierarchy
- Xml documents can have only one root tag
- Between an opening and closing tag you can insert:
  1. Data
  2. More Elements
  3. A combination of data and elements

```
<root>
  <tag1>
    Some Text
    <tag2>More</tag2>
  </tag1>
</root>
```

Xml – Storage

- Storage is done just like an n-ary tree (DOM)

```
<root>
  <tag1>
    Some Text
    <tag2>More</tag2>
  </tag1>
</root>
```



DTD – Document Type Definition

- A DTD is a schema for Xml data
- Xml protocols and languages can be standardized with DTD files
- A DTD says what elements and attributes are required or optional
  - Defines the formal structure of the language

DTD – An Example

```
<?xml version='1.0'?>
<!ELEMENT Basket (Cherry+, (Apple | Orange)*) >
    <!ELEMENT Cherry EMPTY>
        <!ATTLIST Cherry flavor CDATA #REQUIRED>
    <!ELEMENT Apple EMPTY>
        <!ATTLIST Apple color CDATA #REQUIRED>
    <!ELEMENT Orange EMPTY>
        <!ATTLIST Orange location 'Florida'>
```

```
<Basket>
    <Cherry flavor='good'/>
    <Apple color='red'/>
    <Apple color='green'/>
</Basket>
```

```
<Basket>
    <Apple/>
    <Cherry flavor='good'/>
    <Orange/>
</Basket>
```

DTD - !ELEMENT

<!ELEMENT Basket (Cherry+, (Apple | Orange)*) >

Name — Children

- !ELEMENT declares an element name, and what children elements it should have
- Content types:
  - Other elements
  - #PCDATA (parsed character data)
  - EMPTY (no content)
  - ANY (no checking inside this structure)
  - A regular expression

DTD - !ELEMENT (Contd.)

- A regular expression has the following structure:
  - exp_1, exp_2, exp_3, …, exp_k: A list of regular expressions
  - exp*: An optional expression with zero or more occurrences
  - exp+: An optional expression with one or more occurrences
  - exp_1 | exp_2 | … | exp_k: A disjunction of expressions

DTD - !ATTLIST

<!ATTLIST Cherry flavor CDATA #REQUIRED>

Element — Attribute — Type — Flag

<!ATTLIST Orange location CDATA #REQUIRED
color 'orange'>

- !ATTLIST defines a list of attributes for an element
- Attributes can be of different types, can be required or not required, and they can have default values.

DTD – Well-Formed and Valid

```
<?xml version='1.0'?>
<!ELEMENT Basket (Cherry+)>
   <!ELEMENT Cherry EMPTY>
        <!ATTLIST Cherry flavor CDATA #REQUIRED>
```

Not Well-Formed

```
<basket>
   <Cherry flavor=good>
</Basket>
```

Well-Formed but Invalid

```
<Job>
   <Location>Home</Location>
</Job>
```

Well-Formed and Valid

```
<Basket>
   <Cherry flavor='good'/>
</Basket>
```


XML and DTDs

- More and more standardized DTDs will be developed
  - MathML
  - Chemical Markup Language
- Allows light-weight exchange of data with the same semantics
- Sophisticated query languages for XML are available:
  - Xquery
  - XPath

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  - CGI, application servers, Servlets, JavaServerPages, passing arguments, maintaining state (cookies)

Components of Data-Intensive Systems

Three separate types of functionality:

- Data management
- Application logic
- Presentation

- The system architecture determines whether these three components reside on a single system ("tier) or are distributed across several tiers

Single-Tier Architectures

All functionality combined into a single tier, usually on a mainframe

- User access through dumb terminals

Advantages:

- Easy maintenance and administration

Disadvantages:

- Today, users expect graphical user interfaces.
- Centralized computation of all of them is too much for a central system

- GRAPHIC

Client-Server Architectures

Work division: Thin client

- Client implements only the graphical user interface
- Server implements business logic and data management

- Work division: Thick client
  - Client implements both the graphical user interface and the business logic
  - Server implements data management

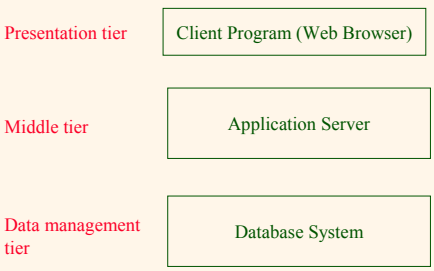
- GRAPHIC

Client-Server Architectures (Contd.)

Disadvantages of thick clients

- No central place to update the business logic
- Security issues: Server needs to trust clients
  - Access control and authentication needs to be managed at the server
  - Clients need to leave server database in consistent state
  - One possibility: Encapsulate all database access into stored procedures
- Does not scale to more than several 100s of clients
  - Large data transfer between server and client
  - More than one server creates a problem: x clients, y servers: x*y connections

The Three-Tier Architecture



The Three Layers

Presentation tier

- Primary interface to the user
- Needs to adapt to different display devices (PC, PDA, cell phone, voice access?)

Middle tier

- Implements business logic (implements complex actions, maintains state between different steps of a workflow)
- Accesses different data management systems

Data management tier

- One or more standard database management systems

Example 1: Airline reservations

- Build a system for making airline reservations
- What is done in the different tiers?
- Database System
  - Airline info, available seats, customer info, etc.
- Application Server
  - Logic to make reservations, cancel reservations, add new airlines, etc.
- Client Program
  - Log in different users, display forms and human-readable output

Example 2: Course Enrollment

- Build a system using which students can enroll in courses
- Database System
  - Student info, course info, instructor info, course availability, pre-requisites, etc.
- Application Server
  - Logic to add a course, drop a course, create a new course, etc.
- Client Program
  - Log in different users (students, staff, faculty), display forms and human-readable output

Technologies

Client Program *(Web Browser)*	*HTML Javascript XSLT*
Application Server *(Tomcat, Apache)*	*JSP Servlets Cookies CGI*
Database System *(DB2)*	*XML Stored Procedures*

Advantages of the Three-Tier Architecture

- Heterogeneous systems
  - Tiers can be independently maintained, modified, and replaced
- Thin clients
  - Only presentation layer at clients (web browsers)
- Integrated data access
  - Several database systems can be handled transparently at the middle tier
  - Central management of connections
- Scalability
  - Replication at middle tier permits scalability of business logic
- Software development
  - Code for business logic is centralized
  - Interaction between tiers through well-defined APIs: Can reuse standard components at each tier

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Overview of the Presentation Tier

- Recall: Functionality of the presentation tier
  - Primary interface to the user
  - Needs to adapt to different display devices (PC, PDA, cell phone, voice access?)
  - Simple functionality, such as field validity checking
- We will cover:
  - HTML Forms: How to pass data to the middle tier
  - JavaScript: Simple functionality at the presentation tier
  - Style sheets: Separating data from formatting

HTML Forms

- Common way to communicate data from client to middle tier
- General format of a form:
  - <FORM ACTION="page.jsp" METHOD="GET" NAME="LoginForm">
    …
    </FORM>
- Components of an HTML FORM tag:
  - ACTION: Specifies URI that handles the content
  - METHOD: Specifies HTTP GET or POST method
  - NAME: Name of the form; can be used in client-side scripts to refer to the form

Inside HTML Forms

- INPUT tag
  - Attributes:
    - TYPE: text (text input field), password (text input field where input is, reset (resets all input fields)
    - NAME: symbolic name, used to identify field value at the middle tier
    - VALUE: default value
  - Example: <INPUT TYPE="text" Name="title">
- Example form:

```
<form method="POST" action="TableOfContents.jsp">
   <input type="text" name="userid">
   <input type="password" name="password">
   <input type="submit" value="Login" name="submit">
   <input type="reset" value="Clear">
</form>
```


Passing Arguments

Two methods: GET and POST

- GET
  - Form contents go into the submitted URI
  - Structure:
    action?name1=value1&name2=value2&name3=value3
    - Action: name of the URI specified in the form
    - (name,value)-pairs come from INPUT fields in the form; empty fields have empty values ("name=")
  - Example from previous password form:
    TableOfContents.jsp?userid=john&password=johnpw
  - Note that the page named action needs to be a program, script, or page that will process the user input

HTTP GET: Encoding Form Fields

- Form fields can contain general ASCII characters that cannot appear in an URI
- A special encoding convention converts such field values into "URI-compatible" characters:
  - Convert all "special" characters to %xyz, were xyz is the ASCII code of the character. Special characters include &, =, +, %, etc.
  - Convert all spaces to the "+" character
  - Glue (name,value)-pairs from the form INPUT tags together with "&" to form the URI

HTML Forms: A Complete Example

```
<form method="POST" action="TableOfContents.jsp">
    <table align = "center" border="0" width="300">
    <tr>
        <td>Userid</td>
        <td><input type="text" name="userid" size="20"></td>
    </tr>
    <tr>
        <td>Password</td>
        <td><input type="password" name="password" size="20"></td>
    </tr>
    <tr>
        <td align = "center"><input type="submit" value="Login"
                name="submit"></td>
    </tr>
    </table>
</form>
```


JavaScript

- Goal: Add functionality to the presentation tier.
- Sample applications:
  - Detect browser type and load browser-specific page
  - Form validation: Validate form input fields
  - Browser control: Open new windows, close existing windows (example: pop-up ads)
- Usually embedded directly inside the HTML with the <SCRIPT> … </SCRIPT> tag.
- <SCRIPT> tag has several attributes:
  - LANGUAGE: specifies language of the script (such as javascript)
  - SRC: external file with script code
  - Example:
    <SCRIPT LANGUAGE="JavaScript" SRC="validate.js>
    </SCRIPT>

JavaScript (Contd.)

- If <SCRIPT> tag does not have a SRC attribute, then the JavaScript is directly in the HTML file.
- Example:

```
<SCRIPT LANGUAGE="JavaScript">
<!-- alert("Welcome to our bookstore")
//-->
</SCRIPT>
```

- Two different commenting styles
  - <!-- comment for HTML, since the following JavaScript code should be ignored by the HTML processor
  - // comment for JavaScript in order to end the HTML comment

JavaScript (Contd.)

- JavaScript is a complete scripting language
  - Variables
  - Assignments (=, +=, …)
  - Comparison operators (<,>,…), boolean operators (&&, ||, !)
  - Statements
    - if (condition) {statements;} else {statements;}
    - for loops, do-while loops, and while-loops
  - Functions with return values
    - Create functions using the function keyword
    - f(arg1, …, argk) {statements;}

JavaScript: A Complete Example

HTML Form:

```
<form method="POST"
  action="TableOfContents.jsp">
  <input type="text"
    name="userid">
  <input type="password"
    name="password">
  <input type="submit"
    value="Login"
    name="submit">
  <input type="reset"
    value="Clear">
</form>
```

Associated JavaScript:

```
<script language="javascript">
function testLoginEmpty()
{
 loginForm = document.LoginForm
 if ((loginForm.userid.value == "") ||
   (loginForm.password.value == ""))
 {
  alert('Please enter values for userid and
    password.');
  return false;
 }
 else return true;
}
</script>
```

Stylesheets

- Idea: Separate display from contents, and adapt display to different presentation formats
- Two aspects:
  - Document transformations to decide what parts of the document to display in what order
  - Document rending to decide how each part of the document is displayed
- Why use stylesheets?
  - Reuse of the same document for different displays
  - Tailor display to user's preferences
  - Reuse of the same document in different contexts
- Two stylesheet languages
  - Cascading style sheets (CSS): For HTML documents
  - Extensible stylesheet language (XSL): For XML documents

CSS: Cascading Style Sheets

- Defines how to display HTML documents
- Many HTML documents can refer to the same CSS
  - Can change format of a website by changing a single style sheet
  - Example:
    <LINK REL="style sheet" TYPE="text/css" HREF="books.css"/>

Each line consists of three parts:
selector {property: value}

- Selector: Tag whose format is defined
- Property: Tag's attribute whose value is set
- Value: value of the attribute

CSS: Cascading Style Sheets

Example style sheet:

```
body {background-color: yellow}
h1 {font-size: 36pt}
h3 {color: blue}
p {margin-left: 50px; color: red}
```

The first line has the same effect as:
<body background-color="yellow">

XSL

- Language for expressing style sheets
  - More at: http://www.w3.org/Style/XSL/
- Three components
  - XSLT: XSL Transformation language
    - Can transform one document to another
    - More at http://www.w3.org/TR/xslt
  - XPath: XML Path Language
    - Selects parts of an XML document
    - More at http://www.w3.org/TR/xpath
  - XSL Formatting Objects
    - Formats the output of an XSL transformation
    - More at http://www.w3.org/TR/xsl/

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Overview of the Middle Tier

- Recall: Functionality of the middle tier
  - Encodes business logic
  - Connects to database system(s)
  - Accepts form input from the presentation tier
  - Generates output for the presentation tier
- We will cover
  - CGI: Protocol for passing arguments to programs running at the middle tier
  - Application servers: Runtime environment at the middle tier
  - Servlets: Java programs at the middle tier
  - JavaServerPages: Java scripts at the middle tier
  - Maintaining state: How to maintain state at the middle tier. Main focus: Cookies.

CGI: Common Gateway Interface

- Goal: Transmit arguments from HTML forms to application programs running at the middle tier
- Details of the actual CGI protocol unimportant à libraries implement high-level interfaces

- Disadvantages:
  - The application program is invoked in a new process at every invocation (remedy: FastCGI)
  - No resource sharing between application programs (e.g., database connections)
  - Remedy: Application servers

CGI: Example

- HTML form:

```
<form action="findbooks.cgi" method=POST>
Type an author name:
<input type="text" name="authorName">
<input type="submit" value="Send it">
<input type="reset" value="Clear form">
</form>
```

- Perl code:

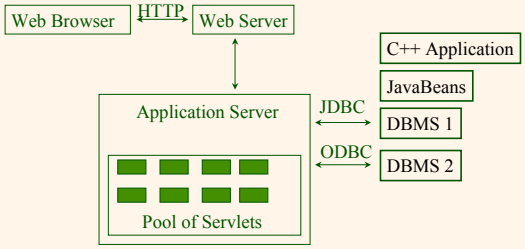
```
use CGI;
$dataIn=new CGI;
$dataIn->header();
$authorName=$dataIn->param('authorName');
print("<HTML><TITLE>Argument passing test</TITLE>");
print("The author name is " + $authorName);
print("</HTML>");
exit;
```


Application Servers

- Idea: Avoid the overhead of CGI
  - Main pool of threads of processes
  - Manage connections
  - Enable access to heterogeneous data sources
  - Other functionality such as APIs for session management

Application Server: Process Structure

Process Structure



Servlets

- Java Servlets: Java code that runs on the middle tier
  - Platform independent
  - Complete Java API available, including JDBC

Example:

```
import java.io.*;
import java.servlet.*;
import java.servlet.http.*;

public class ServetTemplate extends HttpServlet {
    public void doGet(HTTPServletRequest request,
                                    HTTPServletResponse response)
    throws SerletExpection, IOException {
        PrintWriter out=response.getWriter();
        out.println("Hello World");
    }
}
```


Servlets (Contd.)

- Life of a servlet?
  - Webserver forwards request to servlet container
  - Container creates servlet instance (calls init() method; deallocation time: calls destroy() method)
  - Container calls service() method
    - service() calls doGet() for HTTP GET or doPost() for HTTP POST
    - Usually, don't override service(), but override doGet() and doPost()

Servlets: A Complete Example

```
public class ReadUserName extends HttpServlet {
    public void doGet(          HttpServletRequest request,
                                HttpSevletResponse response)
        throws ServletException, IOException {
        reponse.setContentType("text/html");
        PrintWriter out=response.getWriter();
        out.println("<HTML><BODY>\n <UL> \n" +
                "<LI>" + request.getParameter("userid") + "\n" +
                "<LI>" + request.getParameter("password") + "\n" +
                "<UL>\n<BODY></HTML>");
    }
    public void doPost(         HttpServletRequest request,
                                HttpSevletResponse response)
        throws ServletException, IOException {
        doGet(request,response);
    }
}
```


Java Server Pages

- Servlets
  - Generate HTML by writing it to the "PrintWriter" object
  - Code first, webpage second
- JavaServerPages
  - Written in HTML, Servlet-like code embedded in the HTML
  - Webpage first, code second
  - They are usually compiled into a Servlet

JavaServerPages: Example

```
<html>
<head><title>Welcome to B&N</title></head>
<body>
    <h1>Welcome back!</h1>
    <% String name="NewUser";
        if (request.getParameter("username") != null) {
            name=request.getParameter("username");
        }
    %>
    You are logged on as user <%=name%>
    <p>
</body>
</html>
```

Maintaining State

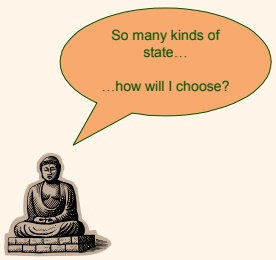
HTTP is stateless.

- Advantages
  - Easy to use: don't need anything
  - Great for static-information applications
  - Requires no extra memory space
- Disadvantages
  - No record of previous requests means
    - No shopping baskets
    - No user logins
    - No custom or dynamic content
    - Security is more difficult to implement

Application State

- Server-side state
  - Information is stored in a database, or in the application layer's local memory
- Client-side state
  - Information is stored on the client's computer in the form of a cookie
- Hidden state
  - Information is hidden within dynamically created web pages

Application State



Server-Side State

- Many types of Server side state:
- 1. Store information in a database
  - Data will be safe in the database
  - BUT: requires a database access to query or update the information
- 2. Use application layer's local memory
  - Can map the user's IP address to some state
  - BUT: this information is volatile and takes up lots of server main memory

5 million IPs = 20 MB

Server-Side State

- Should use Server-side state maintenance for information that needs to persist
  - Old customer orders
  - "Click trails" of a user's movement through a site
  - Permanent choices a user makes

Client-side State: Cookies

- Storing text on the client which will be passed to the application with every HTTP request.
  - Can be disabled by the client.
  - Are wrongfully perceived as "dangerous", and therefore will scare away potential site visitors if asked to enable cookies[1]
- Are a collection of (Name, Value) pairs

[1] http://www.webdevelopersjournal.com/columns/stateful.html

Client State: Cookies

- Advantages
  - Easy to use in Java Servlets / JSP
  - Provide a simple way to persist non-essential data on the client even when the browser has closed
- Disadvantages
  - Limit of 4 kilobytes of information
  - Users can (and often will) disable them
- Should use cookies to store interactive state
  - The current user's login information
  - The current shopping basket
  - Any non-permanent choices the user has made

Creating A Cookie

```
Cookie myCookie =
  new Cookie("username", "jeffd");
response.addCookie(userCookie);
```

- You can create a cookie at any time

Accessing A Cookie

```
Cookie[] cookies = request.getCookies();
String theUser;
for(int i=0; i<cookies.length; i++) {
  Cookie cookie = cookies[i];
  if(cookie.getName().equals("username"))  theUser =
  cookie.getValue();
}
// at this point theUser == "username"
```

- Cookies need to be accessed BEFORE you set your response header:

```
response.setContentType("text/html");
PrintWriter out = response.getWriter();
```

Cookie Features

- Cookies can have
  - A duration (expire right away or persist even after the browser has closed)
  - Filters for which domains/directory paths the cookie is sent to
- See the Java Servlet API and Servlet Tutorials for more information

Hidden State

- Often users will disable cookies
- You can "hide" data in two places:
  - Hidden fields within a form
  - Using the path information
- Requires no "storage" of information because the state information is passed inside of each web page

Hidden State: Hidden Fields

- Declare hidden fields within a form:
  - <input type='hidden' name='user' value='username'/>
- Users will not see this information (unless they view the HTML source)
- If used prolifically, it's a killer for performance since EVERY page must be contained within a form.

Hidden State: Path Information

- Path information is stored in the URL request:

```
http://server.com/index.htm?user=jeffd
```

- Can separate 'fields' with an & character:

```
index.htm?user=jeffd&preference=pepsi
```

- There are mechanisms to parse this field in Java. Check out the `javax.servlet.http.HttpUtils` `parserQueryString()` method.

Multiple state methods

- Typically all methods of state maintenance are used:
  - User logs in and this information is stored in a cookie
  - User issues a query which is stored in the path information
  - User places an item in a shopping basket cookie
  - User purchases items and credit-card information is stored/retrieved from a database
  - User leaves a click-stream which is kept in a log on the web server (which can later be analyzed)

Summary

We covered:

- Internet Concepts (URIs, HTTP)
- Web data formats
  - HTML, XML, DTDs
- Three-tier architectures
- The presentation layer
  - HTML forms; HTTP Get and POST, URL encoding; Javascript; Stylesheets. XSLT
- The middle tier
  - CGI, application servers, Servlets, JavaServerPages, passing arguments, maintaining state (cookies)