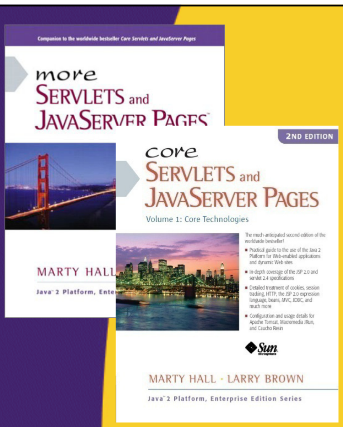
Declarative Web Application Security

Originals of Slides and Source Code for Examples:
http://courses.coreservlets.com/Course-Materials/msajsp.html



Agenda

- **Major security concerns**
- **Declarative vs. programmatic security**
- **Using form-based authentication**
  - Steps
  - Example
- **Using BASIC authentication**
  - Steps
  - Example

Major Issues

- **Preventing unauthorized users from accessing sensitive data.**
  - Access restriction
    - Identifying which resources need protection
    - Identifying who should have access to them
  - Authentication
    - Identifying users to determine if they are one of the authorized ones
- **Preventing attackers from stealing network data while it is in transit.**
  - Encryption (usually with SSL)

Declarative Security

- **None of the individual servlets or JSP pages need any security-aware code.**
  – Instead, both of the major security aspects are handled by the server.
- **To prevent unauthorized access**
  – Use the Web application deployment descriptor (*web.xml*) to declare that certain URLs need protection.
  – Designate authentication method that server uses to identify users.
  – At request time, the server automatically prompts users for usernames and passwords when they try to access restricted resources, automatically checks the results against a server-specific set of usernames and passwords, and automatically keeps track of which users have previously been authenticated. This process is completely transparent to the servlets and JSP pages.
- **To safeguard network data**
  – Use the deployment descriptor to stipulate that certain URLs should be accessible only with SSL. If users try to use a regular HTTP connection to access one of these URLs, the server automatically redirects them to the HTTPS (SSL) equivalent.

Programmatic Security

- **Protected servlets and JSP pages at least partially manage their own security.**
  – *Much* more work, but totally portable.
    - No server-specific piece. Also no web.xml entries needed and a bit more flexibility is possible.
- **To prevent unauthorized access**
  – Each servlet or JSP page must either authenticate the user or verify that the user has been authenticated previously.
- **To safeguard network data**
  – Each servlet or JSP page has to check the network protocol used to access it.
  – If users try to use a regular HTTP connection to access one of these URLs, the servlet or JSP page must manually redirect them to the HTTPS (SSL) equivalent.

Form-Based Authentication

- **When a not-yet-authenticated user tries to access a protected resource:**
  - Server automatically redirects user to Web page with an HTML form that asks for username and password
  - Username and password checked against database of usernames, passwords, and roles (user categories)
  - If login successful and role matches, page shown
  - If login unsuccesful, error page shown
  - If login successful but role does not match, 403 error given (but you can use error-page and error-code)
- **When an already authenticated user tries to access a protected resource:**
  - If role matches, page shown
  - If role does not match, 403 error given
  - Session tracking used to tell if user already authenticated

BASIC Authentication

- **When a not-yet-authenticated user tries to access a protected resource:**
  - Server sends a 401 status code to browser
  - Browser pops up dialog box asking for username and password, and they are sent with request in Authorization request header
  - Username and password checked against database of usernames, passwords, and roles (user categories)
  - If login successful and role matches, page shown
  - If login unsuccesful or role does not match, 401 again
- **When an already authenticated user tries to access a protected resource:**
  - If role matches, page shown
  - If role does not match, 401 error given
  - Request header used to tell if user already authenticated

Form-Based Authentication (Declarative Security)

- **1) Set up usernames, passwords, and roles.**
  - Designate a list of users and associated passwords and abstract role(s) such as normal user or administrator.
  - This is a completely server-specific process.
  - Simplest Tomcat approach: use *install_dir/conf/tomcat-users.xml*:

```
<?xml version="1.0" encoding="ISO-8859-1"?>
<tomcat-users>
  <user username="john" password="nhoj"
        roles="registered-user" />
  <user username="jane" password="enaj"
        roles="registered-user" />
  <user username="juan" password="nauj"
        roles="administrator" />
  <user username="juana" password="anauj"
        roles="administrator,registered-user" />
</tomcat-users>
```

Form-Based Authentication (Continued)

- **2) Tell server that you are using form-based authentication. Designate locations of login and login-failure page.**
  - Use the *web.xml* `login-config` element with `auth-method` of `FORM` and `form-login-config` with locations of pages.

```
<web-app> …
  <login-config>
    <auth-method>FORM</auth-method>
    <form-login-config>
      <form-login-page>/login.jsp</form-login-page>
      <form-error-page>/login-error.html</form-error-page>
    </form-login-config>
  </login-config>
  …</web-app>
```

Form-Based Authentication (Continued)

- **3) Create a login page (HTML or JSP)**
  - HTML form with ACTION of `j_security_check`, METHOD of POST, textfield named `j_username`, and password field named `j_password`.

```
<FORM ACTION="j_security_check" METHOD="POST">
  …
  <INPUT TYPE="TEXT" NAME="j_username">
  …
  <INPUT TYPE="PASSWORD" NAME="j_password">
  …
</FORM>
```

  - For the username, you can use a list box, combo box, or set of radio buttons instead of a textfield.

Form-Based Authentication (Continued)

- **4) Create page for failed login attempts.**
  - No specific content is mandated.
  - Perhaps just “username and password not found” and give a link back to the login page.
  - This can be either an HTML or a JSP document.

Form-Based Authentication (Continued)

- **5) Specify URLs to be password protected.**
  - Use `security-constraint` element of *web.xml*. Two subelements: the first (`web-resource-collection`) designates URLs to which access should be restricted; the second (`auth-constraint`) specifies abstract roles that should have access to the given URLs. Using `auth-constraint` with no `role-name` means no *direct* access is allowed.

```
<web-app ...>…
  <security-constraint>
    <web-resource-collection>
      <web-resource-name>Sensitive</web-resource-name>
      <url-pattern>/sensitive/*</url-pattern>
    </web-resource-collection>
    <auth-constraint>
      <role-name>administrator</role-name>
      <role-name>executive</role-name>
    </auth-constraint>
  </security-constraint>
  <login-config>...</login-config>…
</web-app>
```

Form-Based Authentication (Continued)

- **6) List all possible abstract roles (categories of users) that will be granted access to *any* resource**
  - Many servers do not enforce this, but technically required

```
<web-app ...>
  ...
  <security-role>
    <role-name>administrator</role-name>
  </security-role>
  <security-role>
    <role-name>executive</role-name>
  </security-role>
</web-app>
```

Form-Based Authentication (Continued)

- **7) Specify which URLs require SSL.**
  - If server supports SSL, you can stipulate that certain resources are available only through encrypted HTTPS (SSL) connections. Use the `user-data-constraint` subelement of `security-constraint`. Only full J2EE servers are *required* to support SSL.

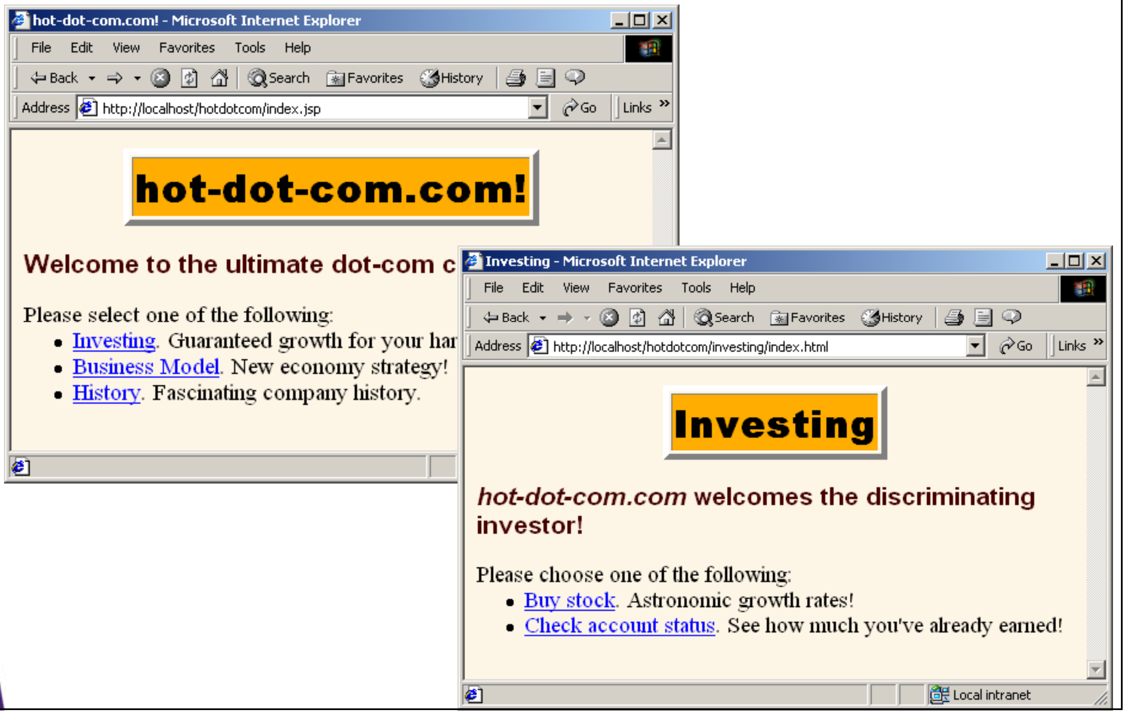
```
<security-constraint>
  …
  <user-data-constraint>
    <transport-guarantee>
      CONFIDENTIAL
    </transport-guarantee>
  </user-data-constraint>
</security-constraint>
```

Form-Based Authentication (Continued)

- **8) Turn off the invoker servlet.**
  - You protect certain URLs that are associated with registered servlet or JSP names. The *http://host/prefix/servlet/Name* format of default servlet URLs will probably not match the pattern. Thus, the security restrictions are bypassed when the default URLs are used.
  - Disabling it
    - In each Web application, redirect requests to other servlet by normal *web.xml* method

      ```
      <url-pattern>/servlet/*</url-pattern>
      ```
    - Globally
      - Server-specific mechanism (e.g. *install_dir/conf/server.xml* for Tomcat).

Example: Form-Based Security


hot-dot-com.com! - Microsoft Internet Explorer
File Edit View Favorites Tools Help
Back Search Favorites History
Address http://localhost/hotdotcom/index.jsp
Go Links

hot-dot-com.com!

Welcome to the ultimate dot-com c

Please select one of the following:
- Investing. Guaranteed growth for your har
- Business Model. New economy strategy!
- History. Fascinating company history.

Investing - Microsoft Internet Explorer
File Edit View Favorites Tools Help
Back Search Favorites History
Address http://localhost/hotdotcom/investing/index.html
Go Links
Local intranet

Investing

hot-dot-com.com welcomes the discriminating investor!

Please choose one of the following:
- Buy stock. Astronomic growth rates!
- Check account status. See how much you've already earned!

Example: Step 1

- Set up usernames, passwords, and roles.
  - *install_dir/conf/tomcat-users.xml*

```
<?xml version="1.0" encoding="ISO-8859-1"?>
<tomcat-users>
  <user username="john" password="nhoj"
        roles="registered-user" />
  <user username="jane" password="enaj"
        roles="registered-user" />
  <user username="juan" password="nauj"
        roles="administrator" />
  <user username="juana" password="anauj"
        roles="administrator,registered-user" />
  <!-- … -->
</tomcat-users>
```

Example: Step 2

- Tell server that you are using form-based authentication. Designate locations of login and login-failure page.

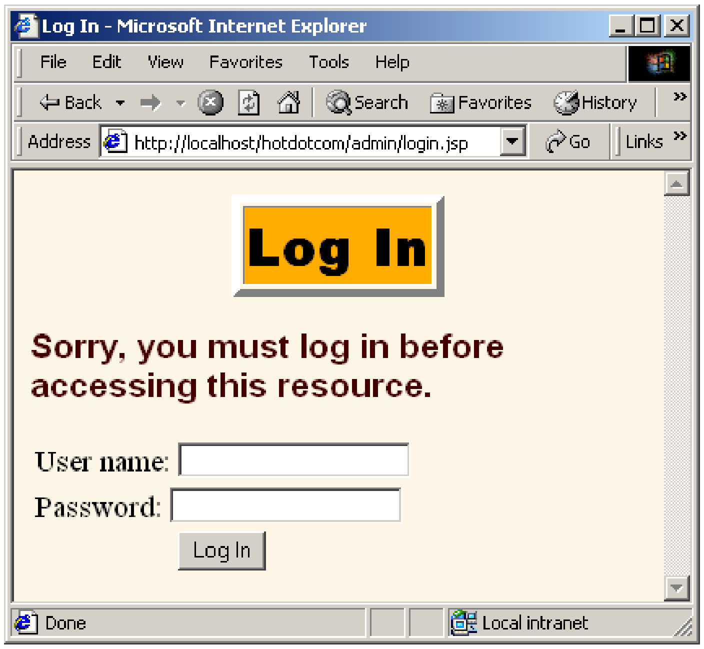
```
<login-config>
  <auth-method>FORM</auth-method>
  <form-login-config>
    <form-login-page>
      /admin/login.jsp
    </form-login-page>
    <form-error-page>
      /admin/login-error.jsp
    </form-error-page>
  </form-login-config>
</login-config>
```

Example: Step 3

- Create a login page

```
…
<BODY>
<TABLE BORDER=5 ALIGN="CENTER">
  <TR><TH CLASS="TITLE">Log In</TABLE>
<P>
<H3>Sorry, you must log in before
accessing this resource.</H3>
<FORM ACTION="j_security_check" METHOD="POST">
<TABLE>
<TR><TD>User name:
        <INPUT TYPE="TEXT" NAME="j_username">
<TR><TD>Password:
        <INPUT TYPE="PASSWORD" NAME="j_password">
<TR><TH><INPUT TYPE="SUBMIT" VALUE="Log In">
</TABLE>
</FORM></BODY></HTML>
```

Example: Step 3 (Result)


Log In - Microsoft Internet Explorer
File Edit View Favorites Tools Help
Back Search Favorites History
Address http://localhost/hotdotcom/admin/login.jsp
Go Links

Log In

Sorry, you must log in before accessing this resource.

User name:

Password:

Log In

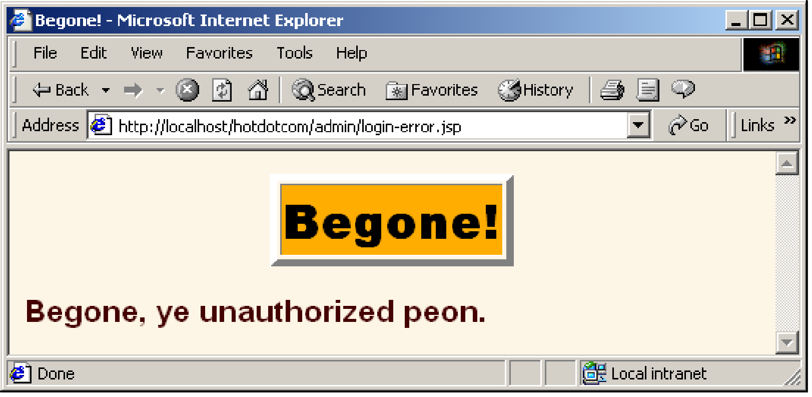
Example: Step 4

- Create page for failed login attempts.

```
…
<BODY>
<TABLE BORDER=5 ALIGN="CENTER">
  <TR><TH CLASS="TITLE">Begone!</TABLE>

<H3>Begone, ye unauthorized peon.</H3>

</BODY>
</HTML>
```


Begone! - Microsoft Internet Explorer
File Edit View Favorites Tools Help
Back Search Favorites History
Address http://localhost/hotdotcom/admin/login-error.jsp
Go Links

Begone!

Begone, ye unauthorized peon.

Example: Access Rules

- **Home page**
  – Anyone
- **Investing page**
  – Registered users
  – Administrators
- **Stock purchase page**
  – Registered users
  – Via SSL only
- **Delete account page**
  – Administrators

Example: Step 5

- **Specify URLs to be password protected.**

```
<!-- Protect everything within
     the "investing" directory. -->
<security-constraint>
  <web-resource-collection>
    <web-resource-name>Investing
    </web-resource-name>
    <url-pattern>/investing/*</url-pattern>
  </web-resource-collection>
  <auth-constraint>
    <role-name>registered-user</role-name>
    <role-name>administrator</role-name>
  </auth-constraint>
</security-constraint>
```

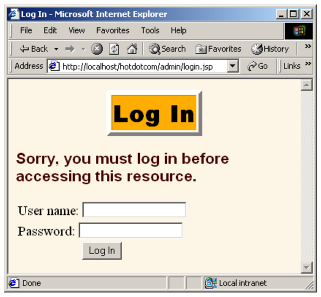
Example: Step 5 (Continued)

```
<!-- Only users in the administrator role
     can access the delete-account.jsp page
     within the admin directory. -->

<security-constraint>
  <web-resource-collection>
    <web-resource-name>Account Deletion
    </web-resource-name>
    <url-pattern>/admin/delete-account.jsp
    </url-pattern>
  </web-resource-collection>
  <auth-constraint>
    <role-name>administrator</role-name>
  </auth-constraint>
</security-constraint>
```

Example: Step 5 (Results)

- First attempt to access account status page


Log In - Microsoft Internet Explorer
File Edit View Favorites Tools Help
Back Search Favorites History
Address http://localhost/hotdotcom/admin/login.jsp Go Links
Done
Local intranet

Log In

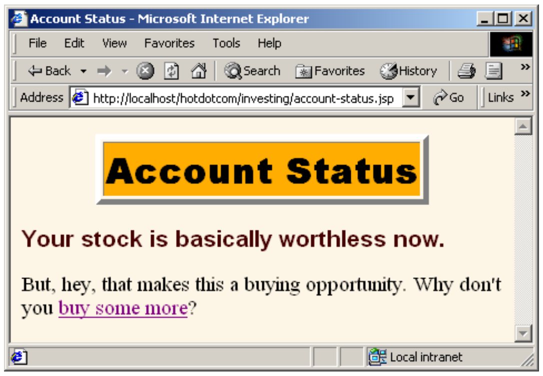
Sorry, you must log in before accessing this resource.

User name:

Password:

Log In

- Result of successful login and later attempts to access account status page


Account Status - Microsoft Internet Explorer
File Edit View Favorites Tools Help
Back Search Favorites History
Address http://localhost/hotdotcom/investing/account-status.jsp Go Links
Local intranet

Account Status

Your stock is basically worthless now.

But, hey, that makes this a buying opportunity. Why don't you buy some more?

Example: Step 6

- 6) List all possible abstract roles (types of users) that will be granted access to *any* resource

```
<web-app ...>
  ...
  <security-role>
    <role-name>registered-user</role-name>
  </security-role>
  <security-role>
    <role-name>administrator</role-name>
  </security-role>
</web-app>
```

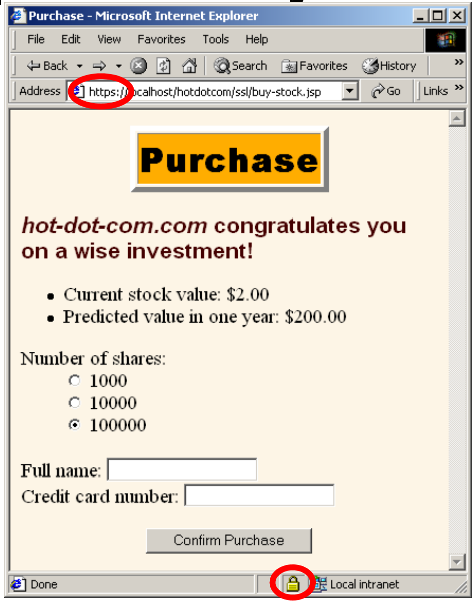
Example: Step 7

- Specify which URLs require SSL.

```
 <!-- URLs of the form
       http://host/webAppPrefix/ssl/blah
       require SSL and are thus redirected to
       https://host/webAppPrefix/ssl/blah. -->
<security-constraint>
  <web-resource-collection>
    <web-resource-name>Purchase
    </web-resource-name>
    <url-pattern>/ssl/*</url-pattern>
  </web-resource-collection>
  <auth-constraint>
    <role-name>registered-user</role-name>
  </auth-constraint>
  <user-data-constraint>
    <transport-guarantee>CONFIDENTIAL
    </transport-guarantee>
  </user-data-constraint>
</security-constraint>
```

Example: Step 7 (Results)

- http://host/prefix/ssl/buy-stock.jsp *or* https://host/prefix/ssl/buy-stock.jsp


Purchase - Microsoft Internet Explorer
File Edit View Favorites Tools Help
Back Search Favorites History
Address https://localhost/hotdotcom/ssl/buy-stock.jsp Go Links
Done
Local intranet

Purchase

hot-dot-com.com congratulates you on a wise investment!

- Current stock value: $2.00
- Predicted value in one year: $200.00

Number of shares:
- ○ 1000
- ○ 10000
- ● 100000

Full name:
Credit card number:

Confirm Purchase

Example: Step 8

- Turn off the invoker servlet

```
<!-- Turn off invoker. Send requests
     to index.jsp. -->

<servlet-mapping>
  <servlet-name>Redirector</servlet-name>
  <url-pattern>/servlet/*</url-pattern>
</servlet-mapping>
…
<welcome-file-list>
  <welcome-file>index.jsp</welcome-file>
  <welcome-file>index.html</welcome-file>
</welcome-file-list>
```

Example: Step 8 (Continued)

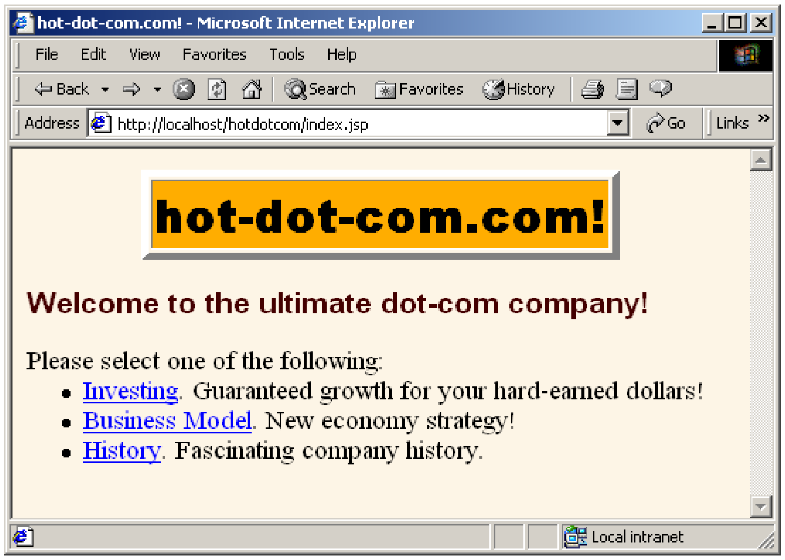
```
/** Servlet that simply redirects users to the
 *  Web application home page.
 */

public class RedirectorServlet extends HttpServlet {
  public void doGet(HttpServletRequest request,
                    HttpServletResponse response)
      throws ServletException, IOException {
    response.sendRedirect(request.getContextPath());
  }

  public void doPost(HttpServletRequest request,
                     HttpServletResponse response)
      throws ServletException, IOException {
    doGet(request, response);
  }
}
```

Example: Step 8 (Results)

- Attempt to access http://host/hotdotcom/servlet/Anything


hot-dot-com.com! - Microsoft Internet Explorer
File Edit View Favorites Tools Help
Back Search Favorites History
Address http://localhost/hotdotcom/index.jsp
Go Links
Local intranet

hot-dot-com.com!

Welcome to the ultimate dot-com company!

Please select one of the following:

- Investing. Guaranteed growth for your hard-earned dollars!
- Business Model. New economy strategy!
- History. Fascinating company history.

Form-Based vs. BASIC Authentication

- **Advantages of form-based**
  - Consistent look and feel
  - Fits model users expect from ecommerce sites
- **Disadvantage of form-based**
  - Can fail if server is using URL rewriting for session tracking. Can fail if browser has cookies disabled.
- **Advantages of BASIC**
  - Doesn't rely on session tracking
  - Easier when you are doing it yourself (programmatic)
- **Disadvantage of BASIC**
  - Small popup dialog box seems less familiar to most users
- **Other auth-method options**
  - CLIENT-CERT (X 509 certificates)
  - DIGEST (Not widely supported by browsers)

BASIC Authentication

1. **Set up usernames, passwords, and roles.**
   - Same as for form-based authentication. Server-specific.
2. **Tell the server that you are using BASIC authentication. Designate the realm name.**
   - Use the *web.xml* `login-config` element with an `auth-method` subelement of `BASIC` and a `realm-name` subelement (generally used as part of the title of the dialog box that the browser opens).

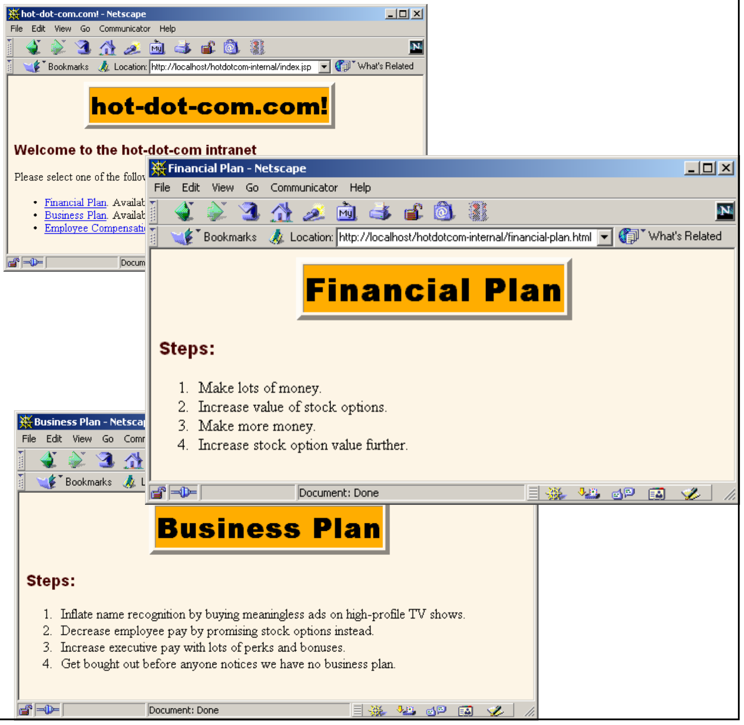
```
<login-config>
  <auth-method>BASIC</auth-method>
  <realm-name>Some Name</realm-name>
</login-config>
```

BASIC Authentication (Continued)

3. **Specify which URLs should be password protected.**
   – Same as with form-based authentication.
4. **List all possible roles (categories of users) that will access any protected resource**
   – Same as with form-based authentication
5. **Specify which URLs should be available only with SSL.**
   – Same as with form-based authentication.
6. **Turn off the invoker servlet.**
   – Same as with form-based authentication.

Example: BASIC Authentication

- **Home page**
  – Anyone
- **Financial plan**
  – Employees or executives
- **Business plan**
  – Executives only


hot-dot-com.com! - Netscape
File Edit View Go Communicator Help
Bookmarks
Location:
What's Related
Financial Plan - Netscape
Business Plan - Netscap
Document: Done

http://localhost/hotdotcom-internal/index.jsp

hot-dot-com.com!

Welcome to the hot-dot-com intranet

Please select one of the follov

- Financial Plan. Availat
- Business Plan. Availat
- Employee Compensati

http://localhost/hotdotcom-internal/financial-plan.html

Financial Plan

Steps:

1. Make lots of money.
2. Increase value of stock options.
3. Make more money.
4. Increase stock option value further.

Business Plan

Steps:

1. Inflate name recognition by buying meaningless ads on high-profile TV shows.
2. Decrease employee pay by promising stock options instead.
3. Increase executive pay with lots of perks and bonuses.
4. Get bought out before anyone notices we have no business plan.

Example: BASIC Authentication (Step 1)

- **Set up usernames, passwords, and roles.**

```
<?xml version="1.0" encoding="ISO-8859-1"?>
<tomcat-users>
  …
  <user username="gates" password="llib"
        roles="employee" />
  <user username="ellison" password="yrral"
        roles="employee" />
  <user username="mcnealy" password="ttocs"
        roles="executive" />
</tomcat-users>
```

  – Note: file that contains these passwords and those of declarative example is online at *http://archive.moreservlets.com/Security-Code/tomcat-users.xml*

Example: BASIC Authentication (Step 2)

- **Tell the server that you are using BASIC authentication. Designate the realm name.**

```
<login-config>
  <auth-method>BASIC</auth-method>
  <realm-name>Intranet</realm-name>
</login-config>
```

Example: BASIC Authentication (Step 3)

- Specify which URLs should be password protected.

```
<security-constraint>
  <web-resource-collection>
    <web-resource-name>
      Financial Plan
    </web-resource-name>
    <url-pattern>
      /financial-plan.html
    </url-pattern>
  </web-resource-collection>
  <auth-constraint>
    <role-name>employee</role-name>
    <role-name>executive</role-name>
  </auth-constraint>
</security-constraint>
```

Example: BASIC Authentication (Step 3 Continued)

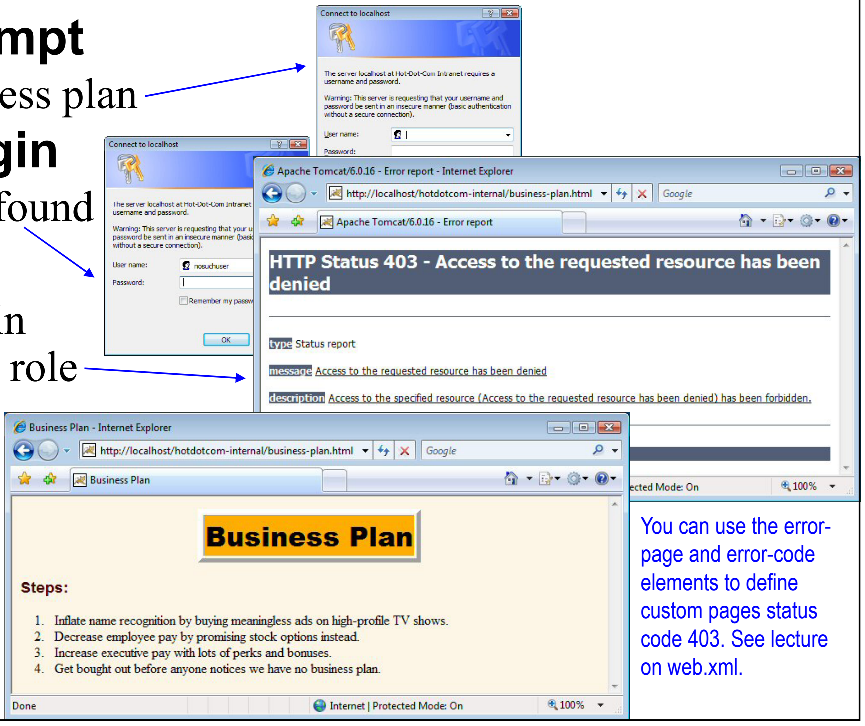
```
<security-constraint>
  <web-resource-collection>
    <web-resource-name>
      Business Plan
    </web-resource-name>
    <url-pattern>
      /business-plan.html
    </url-pattern>
  </web-resource-collection>
  <auth-constraint>
    <role-name>executive</role-name>
  </auth-constraint>
</security-constraint>
```

Example: BASIC Authentication (Step 4)

```
<web-app ...>
  ...
  <security-role>
    <role-name>employee</role-name>
  </security-role>
  <security-role>
    <role-name>executive</role-name>
  </security-role>
</web-app>
```

Example: BASIC Authentication (Results)

- **First attempt**
  - For business plan
- **Failed login**
  - User not found
- **Denied**
  - User not in executive role
- **Success**
  - User in executive role



Connect to localhost

The server localhost at Hot-Dot-Com Intranet requires a username and password.

Warning: This server is requesting that your username and password be sent in an insecure manner (basic authentication without a secure connection).

User name:

Password:

Connect to localhost

The server localhost at Hot-Dot-Com Intranet requires a username and password.

Warning: This server is requesting that your username and password be sent in an insecure manner (basic authentication without a secure connection).

User name: nosuchuser

Password:

Remember my password

OK

Apache Tomcat/6.0.16 - Error report - Internet Explorer

http://localhost/hotdotcom-internal/business-plan.html

HTTP Status 403 - Access to the requested resource has been denied

type Status report

message Access to the requested resource has been denied

description Access to the specified resource (Access to the requested resource has been denied) has been forbidden.

Business Plan - Internet Explorer

http://localhost/hotdotcom-internal/business-plan.html

Business Plan

Steps:

1. Inflate name recognition by buying meaningless ads on high-profile TV shows.
2. Decrease employee pay by promising stock options instead.
3. Increase executive pay with lots of perks and bonuses.
4. Get bought out before anyone notices we have no business plan.

Done

Internet | Protected Mode: On

You can use the error-page and error-code elements to define custom pages status code 403. See lecture on web.xml.

Summary

- **Main security issues**
  - Preventing access by unauthorized users
  - Preventing attackers from stealing network data
- **Declarative security**
  - Much less work than programmatic security
  - Requires server-specific password setup
- **Form-based authentication**
  - Attempts to access restricted resources get redirected to login page. HTML form gathers username and password. Session tracking tracks authenticated users.
- **BASIC authentication**
  - Attempts to access restricted resources results in dialog box. Dialog gathers username and password. HTTP headers track authenticated users.

Questions?