Declarative Web Application Security

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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 unsuccessful, 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 unsuccessful 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"氡?
   <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.

   ```
   <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>
   ```
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.

```html
<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.

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.

   ```xml
   <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

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

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

8) Turn off the invoker servlet.
   - You protect certain URLs that are associated with registered servlet or JSP names. The \texttt{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
       ```xml
       <url-pattern>/servlet/*</url-pattern>
       ```
     - Globally
       - Server-specific mechanism (e.g. \texttt{install_dir/conf/server.xml} for Tomcat).
Example: Form-Based Security

Welcome to the ultimate dot-com company!

Please select one of the following:
- Investing: Guaranteed growth for your bank.
- History: Fascinating company history.

Example: Step 1

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

```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.

```xml
<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

```html
...<BODY>
  <TABLE BORDER=5 ALIGN="CENTER">
    <TR><TH CLASS="TITLE">Log In</TH></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: </TD><TD>
        <INPUT TYPE="TEXT" NAME="j_username"></TD>
      </TR>
      <TR><TD>Password: </TD><TD>
        <INPUT TYPE="PASSWORD" NAME="j_password"></TD>
      </TR>
      <TR><TH><INPUT TYPE="SUBMIT" VALUE="Log In"></TH></TABLE>
  </FORM></BODY></HTML>
```
Example: Step 3 (Result)

![Image of login page]

Example: Step 4

- Create page for failed login attempts.

```html
...<BODY>
  <TABLE BORDER=5 ALIGN="CENTER">
    <TR><TH CLASS="TITLE">Begone!</TH>
  
  <H3>Begone, ye unauthorized peon.</H3>
</BODY>
</HTML>
```
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.**

```xml
<!-- 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

• Result of successful login and later attempts to access account status page
Example: Step 6

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

```xml
<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.

```xml
<!-- 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)


![Image of a web page with a Purchase button and a congratulatory message]

Example: Step 8

- Turn off the invoker servlet

```xml
<!-- 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>
```
/** 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

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).

   ```xml
   <login-config>
     <auth-method>BASIC</auth-method>
     <realm-name>Some Name</realm-name>
   </login-config>
   ```
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
Example: BASIC Authentication
(Step 1)

• Set up usernames, passwords, and roles.
  
```xml
<?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
  

Example: BASIC Authentication
(Step 2)

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

```xml
<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.

```xml
<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)

```xml
<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)

```xml
<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

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?

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