Need for Security in Web Applications

- Potentially large number of users
- Multiple user types
- No operating system to rely on

Web Application Security

Client 
\[\text{request} \rightarrow \text{Server}\]

Authentication
- who are you?
- username/password
- you're not authorized to access

Programmatic Security

- Security is implemented in the application code
- Example:
  - Login.jsp
  - Members.jsp

Pros?? Cons??

Connection Security

- Secure Socket Layer (SSL)
  - Server authentication
  - Client authentication
  - Connection encryption
- Transport Layer Security (TLS)
  - TLS 1.0 is based on SSL 3.0
  - IETF standard (RFC 2246)

HTTPS

- HTTP over SSL
Security by J2EE Application Server

- HTTP Basic
- HTTP Digest
- HTTPS Client
- Form-based

HTTP Basic

- HTTP 1.0, Section 11.1- http://www.w3.org/Protocols/HTTP/1.0/draft-ietf-http-spec.html

Request for a restricted page

Client → prompt for username/password

Server → resend request + username & password

HTTP Basic – Configuration

AuthType Basic
AuthName "Basic Authentication Example"
AuthUserFile /home/cysun/etc/htpasswords
Require user cs520

HTTP Basic – Request

GET /restricted/index.html HTTP/1.0
Host: sun.calstatela.edu
Accept: */*

Authorization: Basic Y3lzdW46YWJjZAo=

HTTP Basic – Server Response

HTTP/1.1 401 Authorization Required
Date: Tue, 24 Oct 2006 14:57:50 GMT
Server: Apache/2.2.2 (Fedora)
WWW-Authenticate: Basic realm="Restricted Access Area"
Content-Length: 484
Content-Type: text/html; charset=iso-8859-1

<!DOCTYPE HTML PUBLIC "-//IETF//DTD HTML 2.0//EN">
<html>
<head><title>401 Authorization Required</title></head>

HTTP Basic – Request Again

GET /restricted/index.html HTTP/1.0
Host: sun.calstatela.edu
Accept: */*

Authorization: Basic Y3lzdW46YWJjZAo=

Base64 Encoding of "cysun:abcd"

An online Base64 decoder is at http://www.opinionatedgeek.com/dotnet/tools/Base64Decoder/
Improve HTTP Basic (I)

HTTP Basic

Username and password are sent in plain text.

Encrypt username and password.

Cryptographic Hash Function...

- String of arbitrary length $\rightarrow n$ bits digest
- Properties
  1. Given a hash value, it's virtually impossible to find a message that hashes to this value
  2. Given a message, it's virtually impossible to find another message that hashes to the same value
  3. It's virtually impossible to find two messages that hash to the same value
- A.K.A.
  - One-way hashing, message digest, digital fingerprint

...Cryptographic Hash Function

- Common usage
  - Store passwords, software checksum ...
- Popular algorithms
  - MD5 (broken, partially)
  - SHA-1 (broken, sort of)
  - SHA-256 and SHA-512 (recommended)

Encrypting Password is Not Enough

- Why??

Improve HTTP Basic (II)

HTTP Basic

Username and password are sent in plain text.

Encrypt username and password.

HTTP Digest

Addition measures to prevent common attacks.

HTTP Digest

- RFC 2617 (Part of HTTP 1.1) - http://www.ietf.org/rfc/rfc2617.txt
  - request for a restricted page
  - prompt for username/password + nonce
  - resend request + message digest
HTTP Digest – Server Response

HTTP/1.1 401 Authorization Required
Date: Tue, 24 Oct 2006 14:57:50 GMT
Server: Apache/2.2.2 (Fedora)
WWW-Authenticate: Digest realm="Restricted Access Area",
   opaque="5ccc069c403ebaf9f0171e9517f40e41",
   algorithm="MD5",
   nonce="dcd98b7102dd2f0e8b11d0f600fb60c93",
   qop="auth,auth-int",
Content-Length: 484
Content-Type: text/html; charset=iso-8859-1
WWW-Authenticate: Digest realm="Restricted Access Area",
   opaque="5ccc069c403ebaf9f0171e9517f40e41",
   algorithm="MD5",
Content-Length: 484
Content-Type: text/html; charset=iso-8859-1

HTTP Digest – Request Again

GET /restricted/index.html HTTP/1.0
Host: sun.calstatela.edu
Accept: */*
Authorization: Digest username="cysun",
   realm="Restricted Access Area",
   opaque="5ccc069c403ebaf9f0171e9517f40e41",
   algorithm="MD5",
   nonce="dcd98b7102dd2f0e8b11d0f600fb60c93",
   qop="auth,auth-int",
   uri="/restricted/index.html",
   response="6629fae49393a05397450978507e4f1",
   opaque="5ccc069c403ebaf9f0171e9517f40e41",
   algorithm="MD5"

Hash value of the combination of username, password, realm, uri, nonce, cnonce, nc, qop

Form-based Security

- Unique to J2EE application servers
- Include authentication and authorization, but not connection security

Example – Users and Roles

```xml
<tomcat-users>
  <role rolename="admin"/>
  <role rolename="member"/>
  <user username="cysun" password="abcd" roles="admin,member"/>
  <user username="test" password="test" roles="member"/>
  <user username="guest" password="guest" roles="guest"/>
</tomcat-users>
```

Example – Directory Layout

```
/tomcat-users
  /admin
  /member
    index.html
    login.html
    logout.jsp
    error.html
    index.html
    /WEB-INF
      web.xml
```

Form-base Security using Tomcat

- `$TOMCAT/conf/tomcat-users.xml`
  - Users and roles
- `$APPLICATION/WEB-INF/web.xml`
  - Authentication type (FORM)
  - Login and login failure page
  - URLs to be protected
Example – Login Page

```html
<form action="j_security_check" method="post">
    <input type="text" name="j_username">
    <input type="password" name="j_password">
    <input type="submit" name="login" value="Login">
</form>
```

Example – web.xml ...

```xml
<login-config>
    <auth-method>FORM</auth-method>
    <form-login-config>
        <form-login-page>/login.html</form-login-page>
        <form-error-page>/error.html</form-error-page>
    </form-login-config>
</login-config>
```

... Example – web.xml

```xml
<security-constraint>
    <web-resource-collection>
        <web-resource-name>AdminArea</web-resource-name>
        <url-pattern>/admin/*</url-pattern>
    </web-resource-collection>
    <auth-constraint>
        <role-name>admin</role-name>
    </auth-constraint>
</security-constraint>
```

Declarative Security

- Security constraints are defined outside application code in some metadata file(s)
- Advantages
  - Application server provides the security implementation
  - Separate security code from normal code
  - Easy to use and maintain

Limitations of Declarative Security by App Servers

- Application server dependent
- Not flexible enough
- Servlet Specification only requires URL access control

Security Requirements of Web Applications

- Authentication
- Authorization (Access Control)
  - URL
  - Domain object
  - Method invocation
    - Access to service layer, e.g. DAO
    - Access to web services
Spring Security (SS)

- A security framework for Spring-based applications
- Addresses all the security requirements of web applications
- Formerly known as Acegi Security
  - ABCDEFGHI

How Does Spring Security Work

- Intercept request and/or response
  - Servlet filters
  - Spring handler interceptors
- Intercept method calls
  - Spring method interceptors

Servlet Filter

- Intercept, examine, and/or modify request and response

handler interceptors

Servlet Filter Example

- web.xml
  - <filter> and <filter-mapping>
- Modify request
- Modify response

Spring Handler Interceptor

- Serve the same purpose as servlet filter
- Configured as Spring beans, i.e. support dependency injection

Interceptor Request/Response

- Request
  - What can we do by intercepting the request??
  - Controller
    - /member/index.html
- Response
  - What can we do by intercepting the response??
Intercept Method Call

BeforeAdvice
What can we do in BeforeAdvice??

Method Invocation
User getUserById(1)

AfterAdvice
What can we do in AfterAdvice??

Authentication Processing Filter

Request
AuthenticationProcessingFilter

Login Form
Authentication Manager

Authenticated?
Y
Target URL
N
Default URL

Login Successful?
Y
Target URL
N
Has Target URL?

Configure Authentication Filter Beans

DelegatingFilterProxy in web.xml
In spring-security.xml
- springSecurityFilterChain
- authenticationProcessingFilter

Authentication Manager

Authentication Provider
... Authentication Provider

Authentication Sources
database LDAP Servlet Container

Authentication Sources Supported

- Database
- LDAP
- JAAS
- CAS
- OpenID
- SiteMinder
- X.509
- Windows NTLM

- Container-based
  - JBoss
  - Jetty
  - Resin
  - Tomcat
Authenticate Against a Database ...

What SS expects your tables look like:

```sql
create table users (
    username string primary key,
    password string, -- encrypted
    enabled boolean
);
create table authorities (
    username string references users(username),
    authority string -- role name
);
```

... Authenticate Against a Database ...

<table>
<thead>
<tr>
<th></th>
<th>username</th>
<th>password</th>
<th>enabled</th>
</tr>
</thead>
<tbody>
<tr>
<td>cysun</td>
<td>md5(abcd)</td>
<td>'t'</td>
<td></td>
</tr>
<tr>
<td>jdoe</td>
<td>md5(xyz)</td>
<td>'t'</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th></th>
<th>username</th>
<th>authority</th>
</tr>
</thead>
<tbody>
<tr>
<td>cysun</td>
<td>ROLE_ADMIN</td>
<td></td>
</tr>
<tr>
<td>cysun</td>
<td>ROLE_MEMBER</td>
<td></td>
</tr>
<tr>
<td>jdoe</td>
<td>ROLE_MEMBER</td>
<td></td>
</tr>
</tbody>
</table>

... Authenticate Against a Database ... Define your owner queries if your tables are different

- usersByUsernameQuery
- authoritiesByUsernameQuery

CSNS Example: Configure an Authentication Manager

Anonymous Authentication

An anonymous user has their own credentials

- AnonymousProcessingFilter
- AnonymousAuthenticationProvider

Access User Details in Application Code

User details –
http://static.springsource.org/spring-security/site/docs/2.0.x/apidocs/org/springframework/security/userdetails/UserDetails.html

- Username
- Password
- Authorities (Roles)

Example: SecurityUtils in CSNS
Authorization (Access Control)
- Secure URL access
- Secure method invocation
- Secure object access

Access Decision Manager

Types of Decision Managers
- Affirmative based
- Consensus based
- Unanimous based

How Decision Voter Works
- `AccessDecisionVoter` Interface
- Given
  - Object to be accessed
  - User information: username, roles
  - `Configuration attributes`, typically are roles names and/or access types like READ, WRITE etc.
- Return
  - `ACCESS_GRANTED`, or `ACCESS_DENIED`, or `ACCESS_ABSTAIN`

Secure URL Access
- `FilterSecurityInterceptor`
- CSNS Example:
  - Mapping from URL patterns to roles
  - `RoleVoter`

Secure Method Invocation
- `MethodSecurityInterceptor`
- CSNS Example
  - Mapping from method name patterns to roles
  - `RoleVoter`
Secure Object Access

- Implemented by checking the returned object of a method call
- Access decision is managed by `AfterInvocationManager`

Secure Object Access Example

- CSNS
  - `MethodSecurityInterceptor`
  - `AfterInvocationManager`
  - Customized `AfterInvocation` providers to provide application-specific access control
    - `SectionAccessVoter`
    - `AssignmentAccessVoter`
    - `SubmissionAccessVoter`
    - `FileAccessVoter`

Security Tag Library

- URI - `http://www.springframework.org/security/tags`
- `<authorize>`
  - `ifNotGranted`, `ifAllGranted`, `ifAnyGranted`
- `<authentication>`
  - `property`

Usage of the Security Tag Library

- CSNS Examples
  - `WEB-INF/jsp/surveys.jsp`
  - `WEB-INF/jsp/include/header.jspf`

Other Interesting Features of Spring Security

- Simplified namespace-based configuration syntax
- ACL based authorization

Conclusion

- Declarative security vs. Programmatic security
- Spring Security provides the best of both worlds
  - Declarative security framework
  - Portability and flexibility
  - Separate security code from regular code