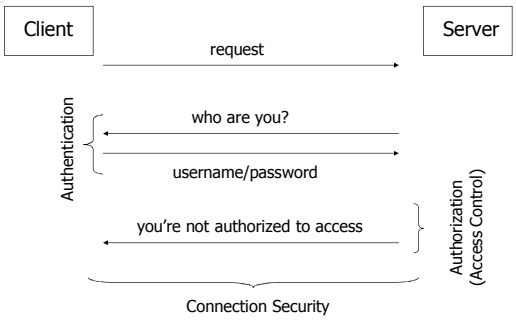
CS520 Web Programming
Declarative Security

Chengyu Sun
California State University, Los Angeles

Need for Security in Web Applications

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

Web Application Security



HTTP Secure (HTTPS)

- HTTP over SSL/TLS
- Configure SSL in Tomcat - http://tomcat.apache.org/tomcat-7.0-doc/ssl-howto.html

SSL and TLS

- 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)

Programmatic Security

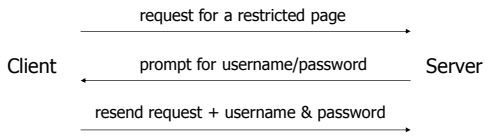
- Security is implemented in the application code
- Example:
  - `Login.jsp`
  - `Members.jsp`
- **Pros?? Cons??**

Security by Java EE 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



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: */*
```

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>
… …
</html>
```

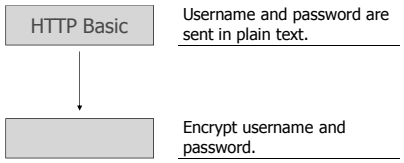
HTTP Basic – Request Again

```
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.base64decode.org/

Improve HTTP Basic (I)



Cryptographic Hash Function…

- String of arbitrary length → 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

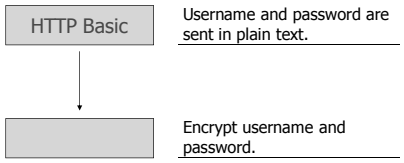
- Common usage
  - *Store passwords*, software checksum …
- Popular algorithms
  - MD5 (broken, partially)
  - SHA-1 (broken, sort of)
  - SHA-256 and SHA-512 (recommended)

Storing Passwords

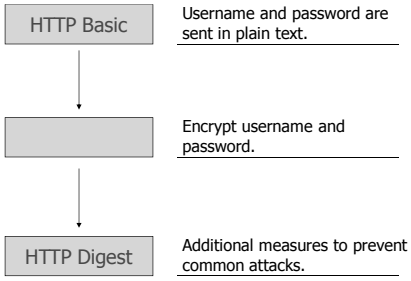
- Why encrypting stored password??
- Common attacks on encrypted passwords
  - Brute force and some variations
  - Dictionary
- Common defenses
  - Long and random passwords
  - Make cryptographic hash functions *slower*
  - Salt

Encrypting Password is Not Enough

- *Why??*



Improve HTTP Basic (II)



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",
                qop="auth,auth-int",
                nonce="dcd98b7102dd2f0e8b11d0f600bfb0c093",
                algorithm="MD5",
                opaque="5ccc069c403ebaf9f0171e9517f40e41"
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>
… …
</html>
```

HTTP Digest – Request Again

```
GET /restricted/index.html HTTP/1.0
Host: sun.calstatela.edu
Accept: */*
Authorization: Digest username="cysun",
        realm="Restricted Access Area",
        nonce="dcd98b7102dd2f0e8b11d0f600bfb0c093",
        uri="/restricted/index.html", qop=auth,
        nc=00000001, cnonce="0a4f113b",
        opaque="5ccc069c403ebaf9f0171e9517f40e41",
        algorithm="MD5"
        response="6629fae49393a05397450978507c4ef1"
```

Hash value of the combination of 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

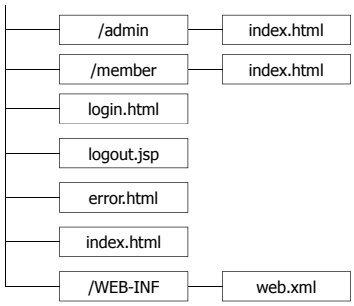
Form-base Security using Tomcat

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

Example – Users and Roles

```
<?xml version='1.0' encoding='utf-8'?>
<tomcat-users>
   <role rolename="admin"/>
   <role rolename="member"/>
   <user username="admin" password="1234"
         roles="admin,member"/>
   <user username="cysun" password="abcd"
         roles="member"/>
</tomcat-users>
```

Example – Directory Layout



Example – Login Page

```
<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 …

```
<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

```
<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
  - Method invocation
  - Domain object
  - View

Spring Security (SS)

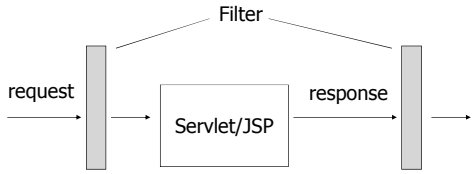
- A security framework for Spring-based applications
- Addresses all the security requirements of web applications

How Does Spring Security Work

- Intercept requests and/or responses
  - Servlet filters
  - Spring *handler interceptors*
- Intercept method calls
  - Spring *method interceptors*
- Modify views
  - *Spring Security Tag Library*

Servlet Filter

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

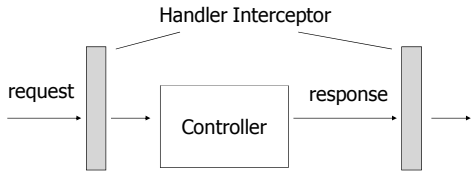


Servlet Filter Example

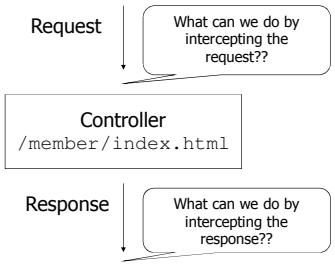
- web.xml
  - <filter> and <filter-mapping>
- Modify request
- Modify response

Spring Handler Interceptor

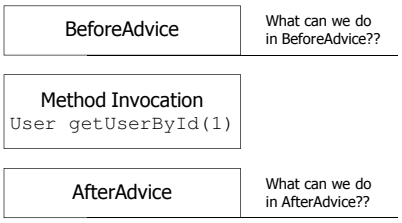
- Serve the same purpose as servlet filter
- Configured as Spring beans, i.e. support dependency injection



Intercept Request/Response



Intercept Method Call



Adding Spring Security to a Web Application …

- Dependencies
  - spring-security-config
  - spring-security-taglibs

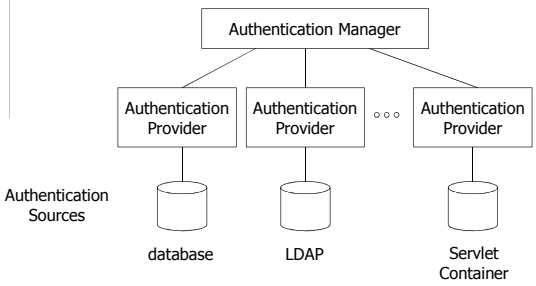
… Adding Spring Security to a Web Application

- web.xml

```
<filter>
   <filter-name>springSecurityFilterChain</filter-name>
   <filter-class>
      org.springframework.web.filter.DelegatingFilterProxy
   </filter-class>
</filter>

<filter-mapping>
   <filter-name>springSecurityFilterChain</filter-name>
   <url-pattern>/*</url-pattern>
</filter-mapping>
```

Authentication



Authentication Sources Supported

- Database
- LDAP
- JAAS
- CAS
- OpenID
- SiteMinder
- X.509
- Windows NTLM
- Container-based
  - JBoss
  - Jetty
  - Resin
  - Tomcat

Authenticate Against a Database – Configuration

- applicationContext.xml

```
<authentication-manager>
   <authentication-provider>
      <jdbc-user-service
         data-source-ref="dataSource" />
   <authentication-provider>
</authentication-manager>
```

Spring Security namespace:

http://www.springframework.org/schema/security
http://www.springframework.org/schema/security/spring-security.xsd

Authenticate Against a Database – Default Schema

```
create table users (
   username string primary key,
   password string,
   enabled boolean
);

create table authorities (
   username string references users(username),
   authority string -- role name
);
```

Authenticate Against a Database – Customization

- <jdbc-user-service>
  - users-by-username-query
  - authorities-by-username-query
- <authentication-provider>
  - <password-encoder>
  - user-service-ref

Customize <jdbc-user-service> …

```
class User {

   Integer id;

   String username;
   String password;
   boolean enabled;

   String email;

   Set<String> roles;
}
```

users

id
username
password
enabled
email

authorities

user_id
authority

… Customize <jdbc-user-service>

```
select u.username, a.authority
    from users u, authorities a
    where u.username = ? and u.id = a.user_id
```

```
<authentication-manager>
   <authentication-provider>
      <jdbc-user-service
         data-source-ref="dataSource"
         authorities-by-username-query="…"/>
   <authentication-provider>
</authentication-manager>
```

http://docs.spring.io/spring-security/site/docs/current/reference/htmlsingle/#nsa-jdbc-user-service

Implement Your Own User Service

- Example: CSNS2
  - `User` implements UserDetails interface
  - `UserDetailsServiceImpl` implements UserDetailsService interface
  - Use `UserDetailsServiceImpl` for the authentication provider

Access Authentication Inforamtion in Controller

```
SecurityContextHolder
      .getContext()
      .getAuthentication()
      .getPrincipal();
```

- See `SecurityUtils` in CSNS2 for more examples

What is Principal?

- `Principal` is an object representing the user who's currently logged in
- `Principal` implements the UserDetails interface – access to username, password, authorities etc.
- `Principal` is not your own `User` object unless you implement your own user service

Authentication – Login Form and More

```
<http auto-config="true" />
```

⬇

```
<http>
   <form-login />
   <http-basic />
   <logout />
</http>
```

Default Login URLs and Parameters

- `/j_spring_security_check`
- `/j_spring_security_logout`
- `j_username`
- `j_password`

Customize <form-login>

- login-page
- authentication-failure-url
- More at http://docs.spring.io/spring-security/site/docs/current/reference/htmlsingle/#nsa-form-login
- Example: CSNS2

Authorization Examples

- Users must log in to see the user list
- A user can only view/edit their own account
- An administrator can view/edit all accounts
- Only administrators can create new accounts
- Operations not available to a user should be hidden from the user

Example: URL Security

- Users must log in to see the user list

`ROLE_USER` is required to access `/user/list.html`

URL Security

- applicationContext.xml

```
<http auto-config="true" use-expressions="true">
   <intercept-url pattern="/user/viewUsers.html"
      access="hasRole('ROLE_USER')" />
</http>
```

Pattern for <intercept-url>

- Default to ANT path pattern, e.g.
  - `/user/list.html`
  - `/user/*`
  - `/user/**`
  - `/user/*/*.html`
  - `/**/*.html`
- Case-insensitive

Spring Expression Language (SpEL)

- http://docs.spring.io/spring/docs/current/spring-framework-reference/html/expressions.html

Security-Related SpEL Methods and Properties

- hasIpAddress()
- hasRole()
- hasAnyRole()
- permitAll
- denyAll
- anonymous
- authenticated
- rememberMe
- fullyAuthenticated

http://docs.spring.io/spring-security/site/docs/current/apidocs/org/springframework/security/web/access/expression/WebSecurityExpressionRoot.html

Example: Method Security

- A user can only edit their own account

A user may only invoke `userDao.saveUser()` if the `user` object to be saved has the same username.

Enable Method Security

- applicationContext.xml

```
<global-method-security
        pre-post-annotations="enabled" />
```

@PreAuthorize("SpEL expr")

- Allow method invocation if the SpEL expression evaluates to `true`
- Throw an `AccessDeniedException` if the expression evaluates to `false`

More Security-Related SpEL Properties

- `authentication`
- `principal`
- Method parameter: `#<param_name>`
- Method return value: `returnObject`

Method Security

```
@PreAuthorize ("principal.username == #user.username")
public User saveUser( User user )
```

- Exercise: implement the following security constraints
  - An administrator can edit all accounts
  - Only administrators can create new accounts

Example: Object Security

- A user can only view their own account

The `user` object returned by `userDao.getUser()` must have the same id as the user invoked the method

Object Security

```
@PostAuthorize ("principal.username == returnObject.username")
public User getUser( Integer id )
```

- Exercise: implement the following security constraints
  - An administrator can view all accounts

Example: View Security

- Operations not available to a user should be hidden from the user

ID	Name	Operations
1	admin	Details | Edit
2	cysun	Details | Edit
3	jdoe	Details | Edit

Security Tag Library

- http://docs.spring.io/spring-security/site/docs/current/reference/htmlsingle/#taglibs
- <authorize>
  - access
- <authentication>
  - property

View Security

```
<security:authorize access="hasRole('ROLE_ADMIN')
   or principal.username == '${user.username}'">
     <a href="viewUser.html?id=${user.id}">Details</a> |
     <a href="editUser.html?id=${user.id}">Edit</a>
</security:authorize>
```

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