CS520 Web Programming

Declarative Security

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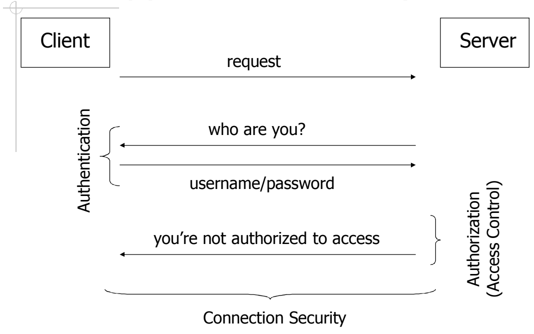
Need for Security in Web Applications

- 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`

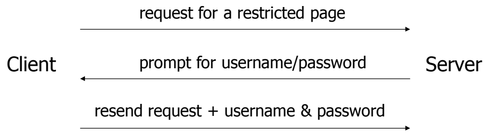
- **Pros?? Cons??**

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


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: */*
```

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>
```

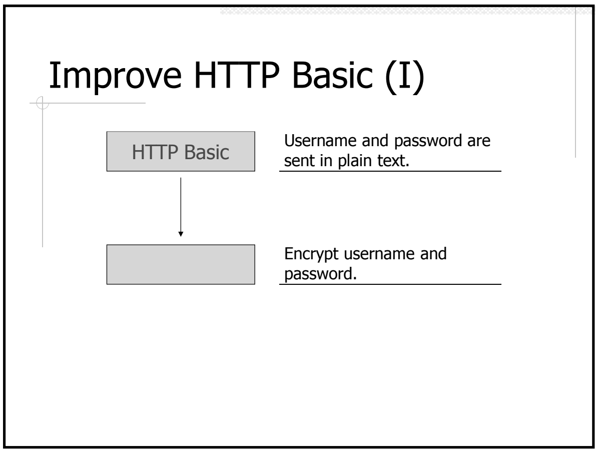
HTTP Basic – Request Again

```
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.opinionatedgeek.com/dotnet/tools/Base64Decode/

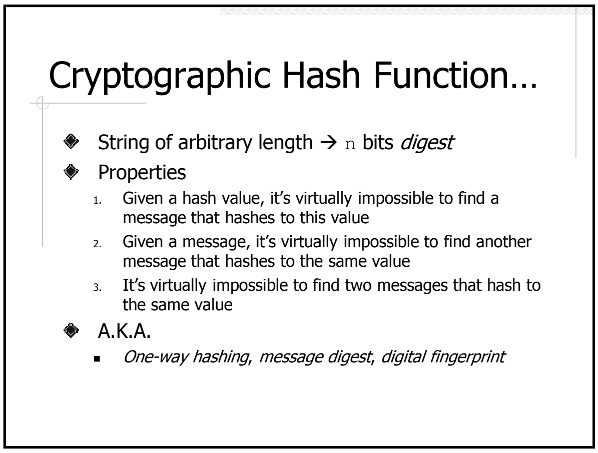


Improve HTTP Basic (I)

HTTP Basic

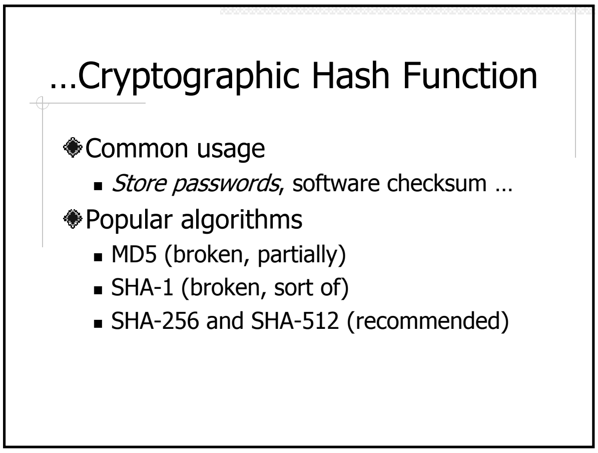
Username and password are sent in plain text.

Encrypt username and password.



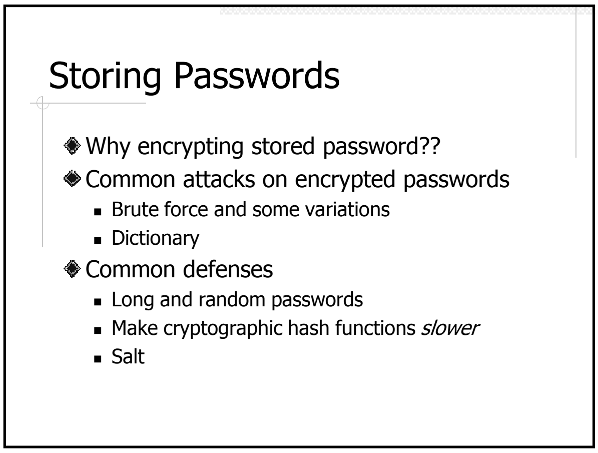
Cryptographic Hash Function…

- String of arbitrary length → 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*



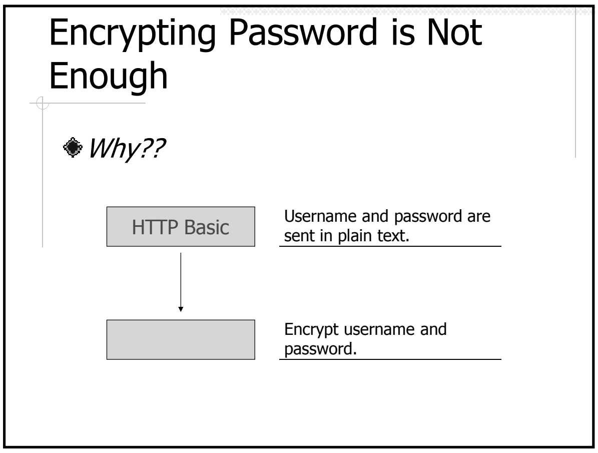
…Cryptographic Hash Function

- 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



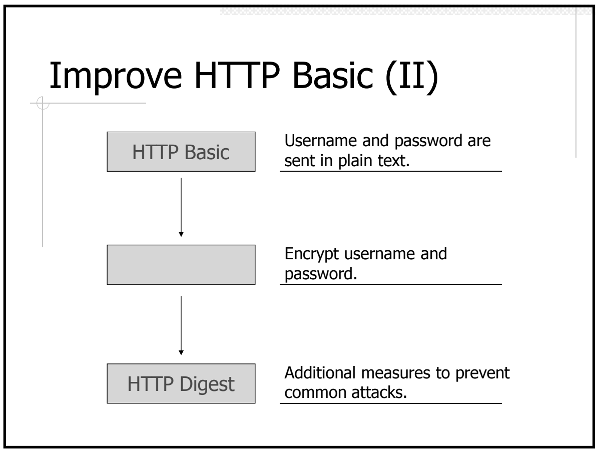
Encrypting Password is Not Enough

- *Why??*

HTTP Basic

Username and password are sent in plain text.

Encrypt username and password.



Improve HTTP Basic (II)

HTTP Basic

Username and password are sent in plain text.

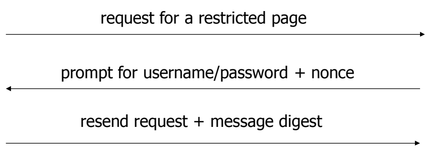
Encrypt username and password.

HTTP Digest

Additional 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",
                  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

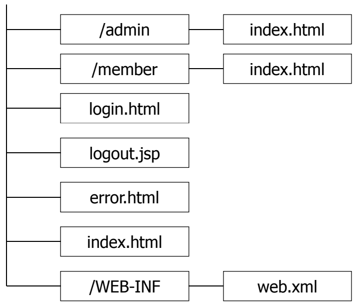
Form-base Security using Tomcat

- `$TOMCAT/conf/tomcat-users.xml`
  - Users and roles
- `$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)

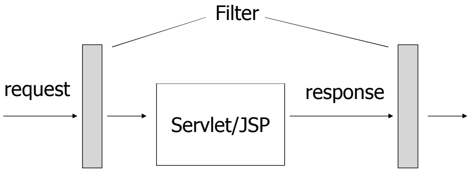
- A security framework for Spring-based applications
- Addresses all the security requirements of web applications

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



Filter

request

Servlet/JSP

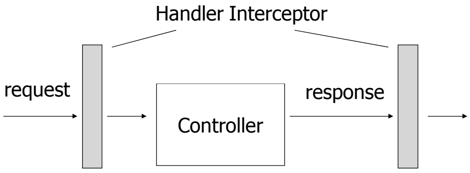
response

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



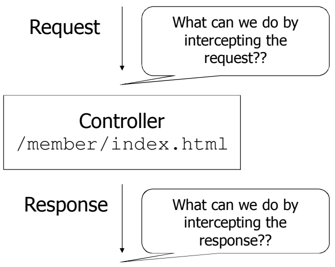
Handler Interceptor

request

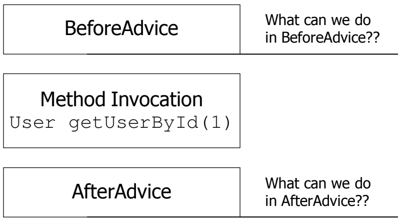
Controller

response

Intercept 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??

Adding Spring Security to a Web Application …

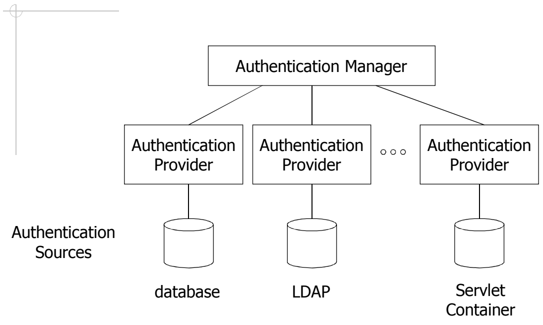
- Dependencies
  - spring-security-config
  - spring-security-taglibs
  - cglib

… Adding Spring Security to a Web Application

- web.xml

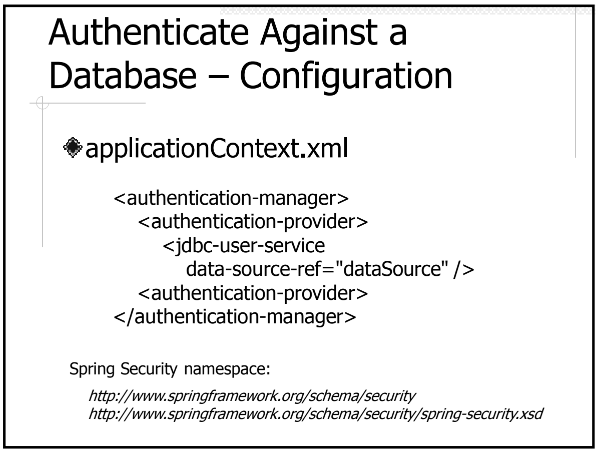
```
<filter>
   <filter-name>springSecurityFilterChain</filter-name>
   <filter-class>
      org.springframework.web.filter.DelegatingFilterProxy
   </filter-class>
</filter>

<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



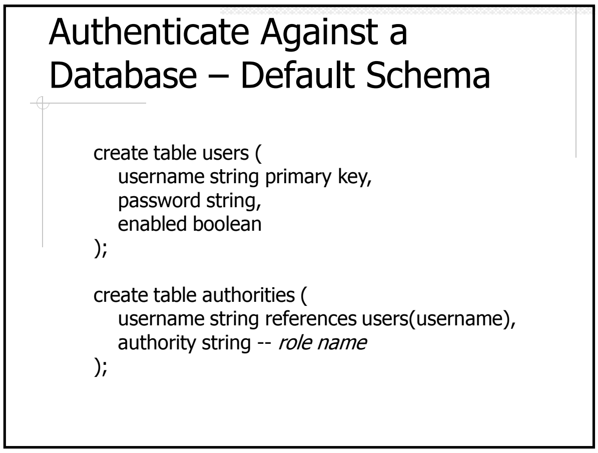
Authenticate Against a Database – Configuration

- applicationContext.xml

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

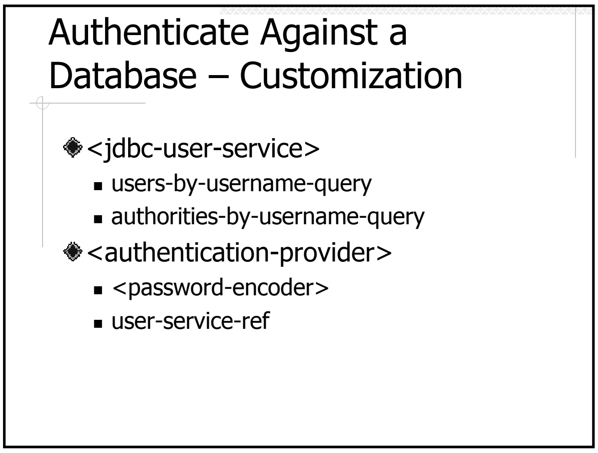
Spring Security namespace:

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



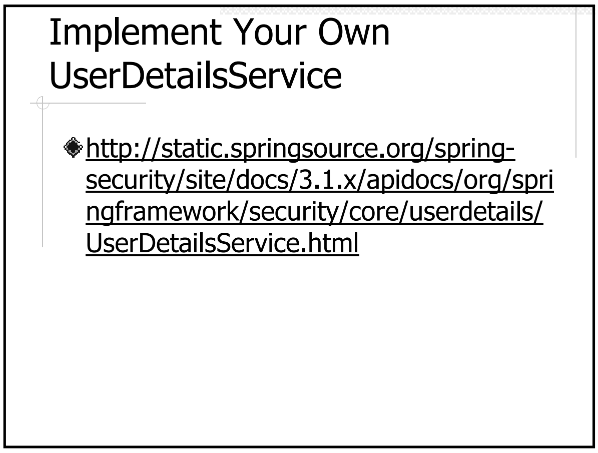
Authenticate Against a Database – Default Schema

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

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



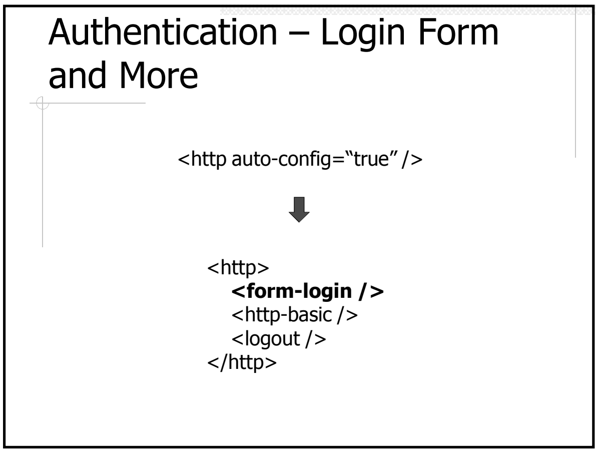
Authenticate Against a Database – Customization

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



Implement Your Own UserDetailsService

- http://static.springsource.org/spring-security/site/docs/3.1.x/apidocs/org/springframework/security/core/userdetails/UserDetailsService.html

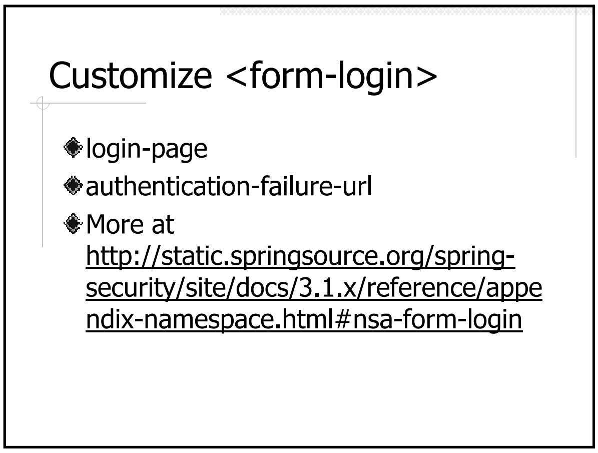


Authentication – Login Form and More

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

⬇

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



Customize <form-login>

- login-page
- authentication-failure-url
- More at http://static.springsource.org/spring-security/site/docs/3.1.x/reference/appendix-namespace.html#nsa-form-login

Default Login URLs and Parameters

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

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://static.springsource.org/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://static.springsource.org/spring-security/site/docs/3.1.x/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 id.

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`

About `authentication` and `principal`

- The `Authentication` interface - http://static.springsource.org/spring-security/site/docs/3.1.x/apidocs/org/springframework/security/core/Authentication.html
- Usually `principal` is an object that implements the `UserDetails` interface - http://static.springsource.org/spring-security/site/docs/3.1.x/apidocs/org/springframework/security/core/userdetails/UserDetails.html

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://static.springsource.org/spring-security/site/docs/3.1.x/reference/taglibs.html
- <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>
```

Access Authentication Inforamtion in Controller

- SecurityContextHolder
  - Access authentication information, e.g. username and roles
- AuthenticationTrustResolver
  - Determine if a user is authenticated or anonymous
- See `SecurityUtils` in CSNS2

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