XSS Attack & Defense

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RED HERRING EUROPE FINALIST 100

BLACKPOINT SME AWARDS FINALIST 2015

GARTNER'S MAGIC QUADRANT
Magic Quadrant for Global MSSPs

Gartner
Hype Cycle for Application security, 2015

What is XSS?

- Attacker driven JavaScript or JavaScript Injection
  - Most common web vulnerability
  - Easy vulnerability to find via auditing
  - Easy vulnerability to exploit
  - Certain types of XSS are very complex to fix
  - Significant business and technical impact potential

XSS Attack Payload Types

- Session hijacking
- Site defacement
- Network scanning
- Undermining CSRF defenses
- Site redirection/phishing
- Data theft
- Keystroke logging
- Loading of remotely hosted scripts

Input Example

Consider the following URL :

www.example.com/saveComment?comment=Great+Site!

```
6  <h3> Thank you for your comments! </h3>
7  You wrote:
8  <p/>
9  Great Site!
10 <p/>
```

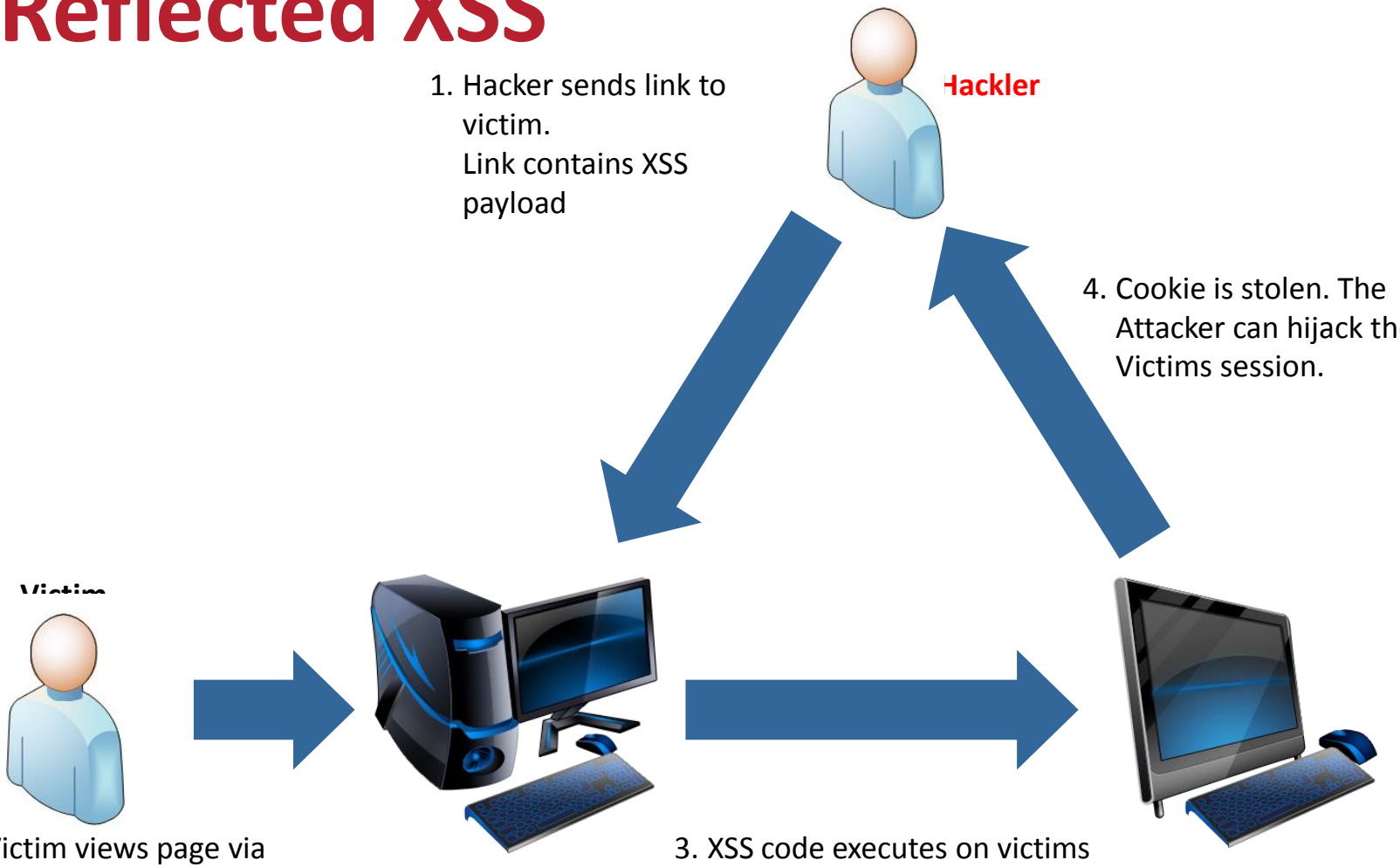
Source of resulting page displaying user input back to the browser

How can an attacker misuse this?

XSS Variants

Reflected/ Transient	■ Data provided by a client is immediately used by server-side scripts to generate a page of results for that user. ■ Search engines
Stored/ Persistent	■ Data provided by a client is first stored persistently on the server (e.g., in a database, filesystem), and later displayed to users ■ Bulletin Boards, Forums, Blog Comments
DOM based XSS	■ A page's client-side script itself accesses a URL request parameter and uses this information to dynamically write some HTML to its own page ■ DOM XSS is triggered when a victim interacts with a web page directly without causing the page to reload. ■ Difficult to test with scanners and proxy tools – why?

Reflected XSS



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Reflected XSS Code Sample

```
//Search.aspx.cs
public partial class _Default : System.Web.UI.Page
{
   Label lblResults;
   protected void Page_Load(object sender, EventArgs e)
   {
            //... doSearch();
            this.lblResults.Text = "You Searched For " +
                        Request.QueryString["query"];
   }
```

OK: http://app.com/Search.aspx?query=soccer

NOT OK: http://app.com/Search.aspx?query=<script>...</script>

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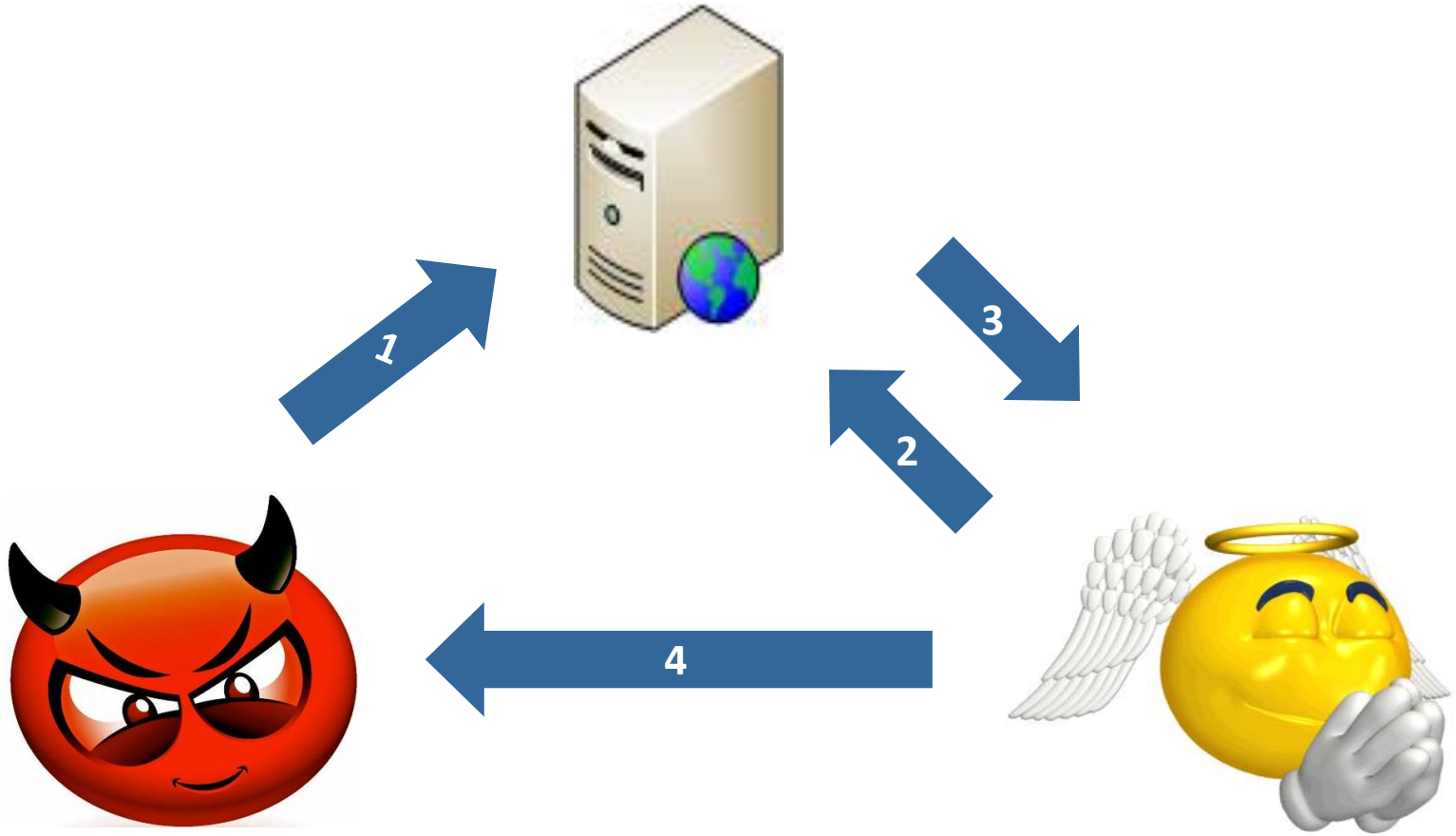
Persistent/Stored XSS



Persistent/Stored XSS Code Sample

```
<%
int id = Integer.parseInt(request.getParameter("id"));
String query = "select * from forum where id=" + id;
Statement stmt = conn.createStatement();
ResultSet rs = stmt.executeQuery(query);
if (rs != null) {
        rs.next ();
        String comment = rs.getString ("comment");
%>
User Comment : <%= comment %>
<%
}
%>
```

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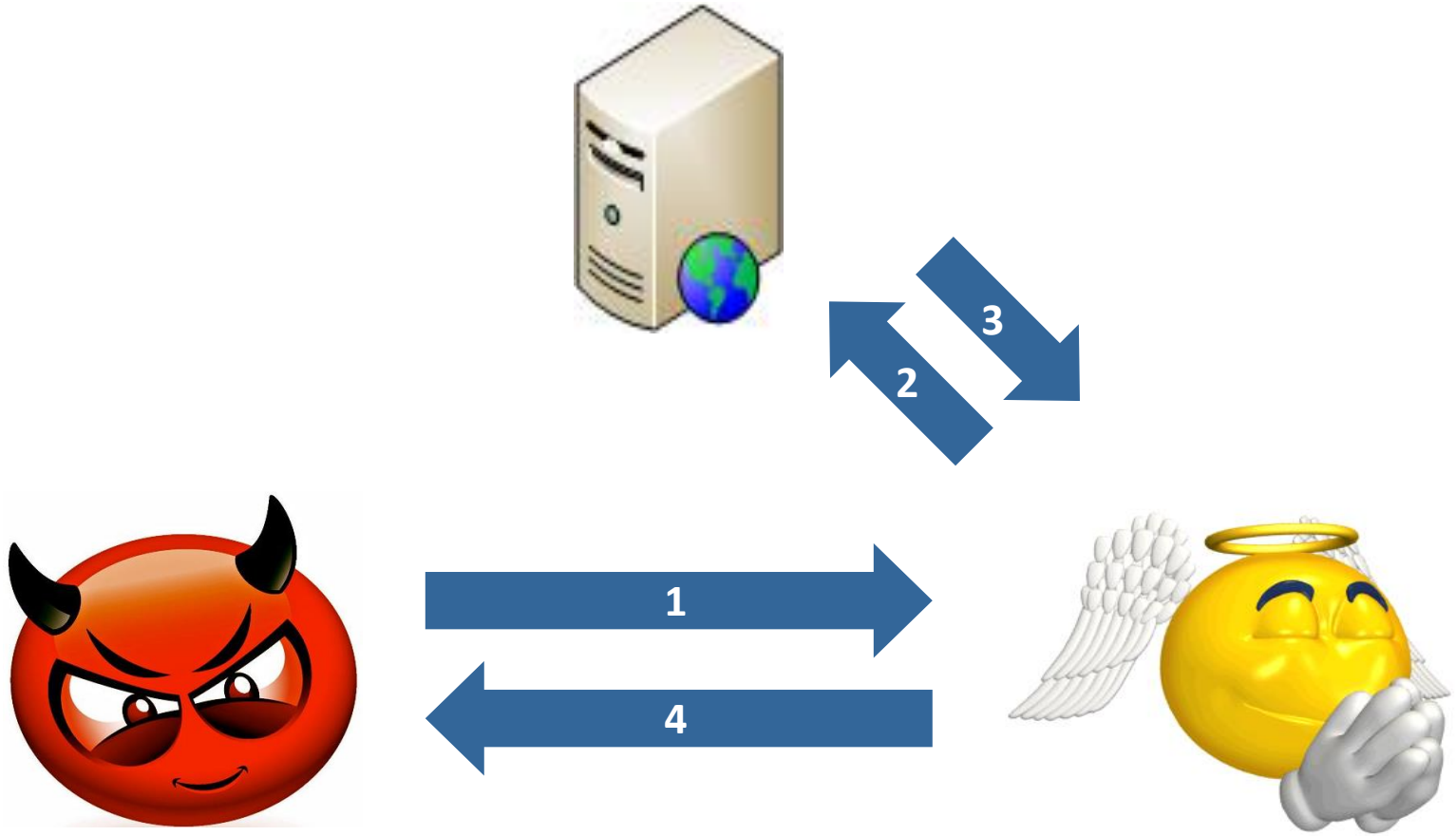
DOM-Based XSS (Client-side XSS)



DOM-Based XSS

http://www.com/index.jsp#name=<script>alert(document.cookie)<script>

```
<HTML>
  <TITLE>Welcome!</TITLE>
  Hi
  <SCRIPT>
  var pos=document.URL.indexOf("name=")+5;
  document.write(document.URL.substring(pos,document.URL.length));
  </SCRIPT>
  <BR>
  Welcome to our system
</HTML>
```

OK : http://a.com/page.htm#name=Joe

NOT OK: http://a.com/page.htm#name=<script>...</script>

In DOM XSS the attack is NOT embedded in the HTML

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Test for Cross-Site Scripting

- Make note of all pages that display input originating from current or other users
- Test by inserting malicious script or characters to see if they are ultimately displayed back to the user
- Examine code to ensure that application data is HTML encoded before being rendered to users
- Very easy to discover XSS via dynamic testing
- More difficult to discover via code review

Test for Cross-Site Scripting

- Remember the three common types of attacks:
  - Input parameters that are rendered directly back to the user
  - Server-Side
  - Client-Side
- Input that is rendered within other pages
- Hidden fields are commonly vulnerable to this exploit as there is a perception that hidden fields are read-only
- Error messages that redisplay user input

Test for Cross-Site Scripting

Each input should be tested to see if data gets rendered back to the user.

Break out of another tag by inserting "> before the malicious script

Bypass **<script>** "tag-hunting" filters

```
<IMG SRC="javascript:alert(document.cookie)">
<p style="left:expression(eval('alert(document.cookie)'))">
\u003Cscript\u003E
```

May not require tags if the input is inserted into an existing JavaScript routine **<- DOM XSS**

```
<SCRIPT> <%= userdata %> </SCRIPT>
```

Danger: XSS Weak Defense Used

- Getting rid of XSS is a difficult task
- How can we prevent XSS in our web application
  - Eliminate <, >, &, ", ' characters?
  - Eliminate all special characters?
  - Disallow user input? (not possible)
  - Global filter?
- Why won't these strategies work?

XSS Defense: The Solution?

Depends on the type of user input

- HTML, **Strings**, Uploaded Files

Depends on **where** user input is displayed in an HTML document

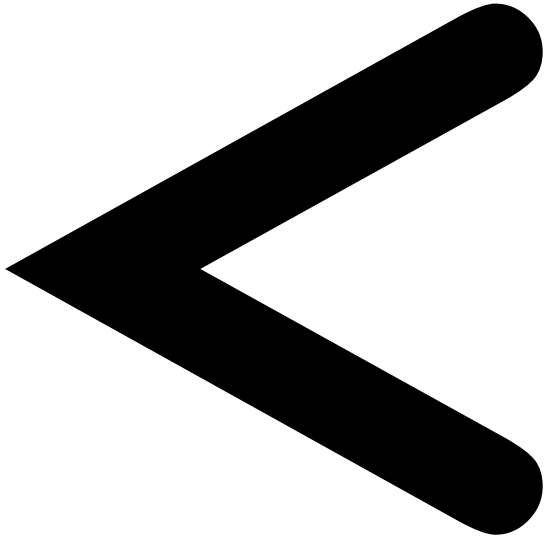
- HTML Body
- HTML Attribute
- JavaScript Variable Assignment

Several defensive techniques needed depending on context

- Input Validation (raw HTML input)
- Output Encoding (Strings)
- Sandboxing (3rd party JavaScript like ads)

Other Encoding Libraries

- **Ruby on Rails**
  - http://api.rubyonrails.org/classes/ERB/Util.html
- **PHP**
  - http://twig.sensiolabs.org/doc/filters/escape.html
  - http://framework.zend.com/manual/2.1/en/modules/zend.escaper.introduction.html
- **Java (Updated February 2014)**
  - https://www.owasp.org/index.php/OWASP_Java_Encoder_Project
- **.NET AntiXSS Library (v4.3 NuGet released June 2, 2014)**
  - http://www.nuget.org/packages/AntiXss/
- **Reform Project**
  - .NET v1/v2, Classic ASP, Python, Perl, JavaScript
  - https://www.owasp.org/index.php/Category:OWASP_Encoding_Project



<

HTML Entity Encoding: The Big 6

1.	&	&
2.	<	<
3.	>	>
4.	"	"
5.	'	'
6.	/	/

Output Encoding Code Sample

```
StringBuffer buff = new StringBuffer();
if ( value == null ) {
    return null;
}
for(int i=0; i<value.length(); i++) {
        char ch = value.charAt(i);
        if ( ch == '&' ) {
                buff.append("&amp;");
        } else if ( ch == '<') {
                buff.append("&lt;");
        } else if ( ch == '>') {
                buff.append("&gt;");
        } else if ( Character.isWhitespace(ch ) ) {
                buff.append(ch);
        } else if ( Character.isLetterOrDigit(ch) ) {
                buff.append(ch);
        } else if ( Integer.valueOf(ch).intValue() >= 20 &&
                        Integer.valueOf(ch).intValue() <= 126 ) {
                buff.append( "&#" + (int)ch + ";" );
        }
}
return buff.toString();
```

Simple HTML encoding method for HTML context

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Best Practice: Validate and Encode

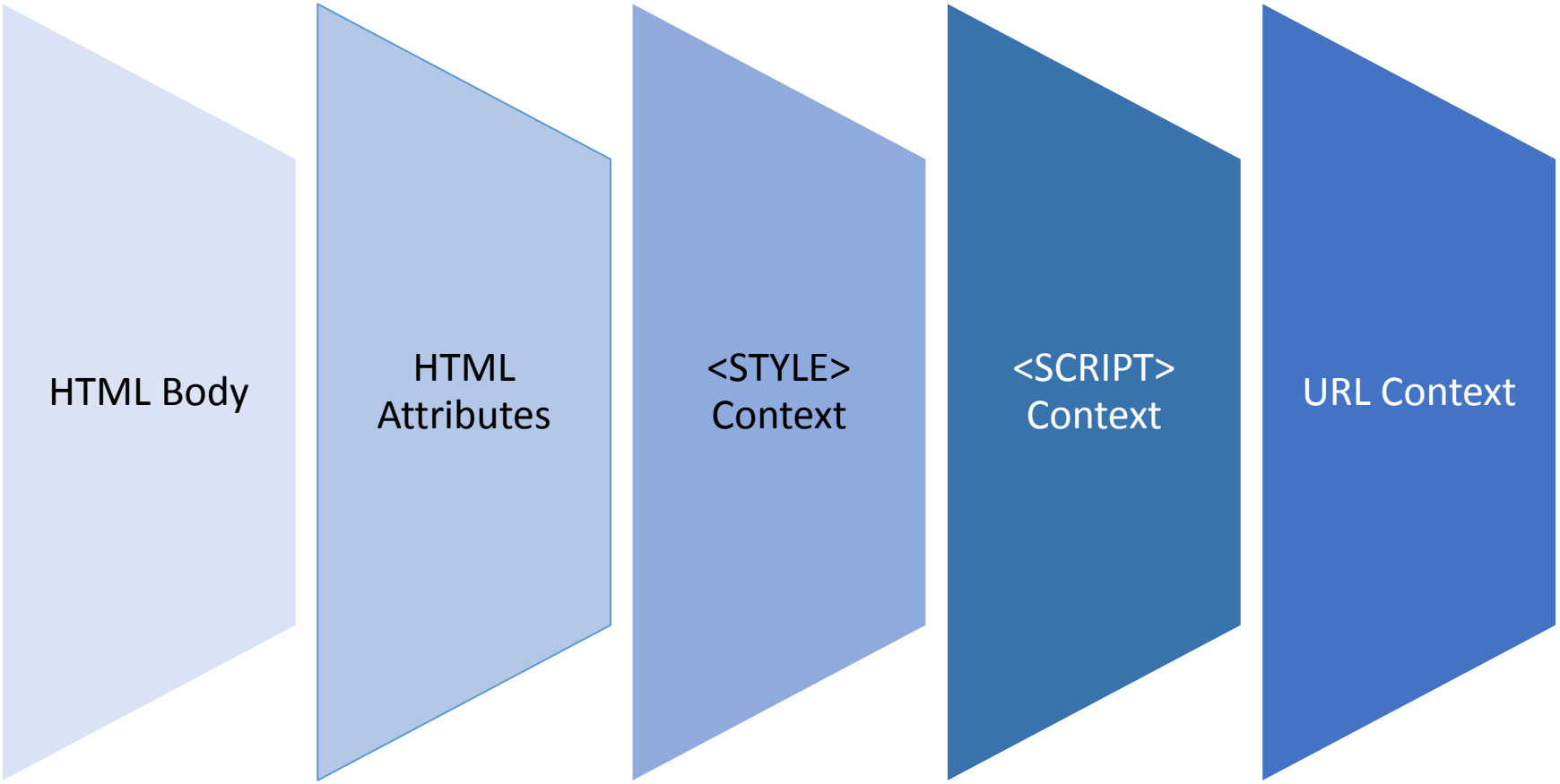
```
String email = request.getParameter("email");
out.println("Your email address is: " + email);
```

```
String email = request.getParameter("email");
String  expression =
"^\w+((-\w+)|(\.\w+))*\@[A-Za-z0-9]+((\.|-)[A-Za-z0-9]+)*\.[A-Za-z0-9]+$";

Pattern pattern = Pattern.compile(expression,Pattern.CASE_INSENSITIVE);
Matcher matcher = pattern.matcher(email);
if (macher.maches())
{
		out.println("Your email address is: " +  Encoder.HtmlEncode(email));
}
else
{
		//log & throw a specific validation exception and fail safely
}
```

Danger: Multiple Contexts

Different encoding and validation techniques needed for different contexts!



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HTML Encoding:
Certain sets of characters mean something special in HTML. For instance ‘<’ is used to open and HTML tag and ‘&’ is used to and the beginning of a sequence of characters to define special symbols like the copy write symbol. (htmlentities in PHP)

HttpUtility.HtmlEncode(“<script>alert(‘&’);</script>”)

<script>alert('&');</script>

Attribute Encoding:
Attribute encoding replaces three characters that are not valid to use inside attribute values in HTML. Those characters are ampersand ‘&’, less-than ‘<’, and quotation marks ‘”’

HttpUtility.HtmlAttributeEncode(“<script>alert(\”&\”);</script>”)

<script>alert("&");</script>

URL Encoding
URL encoding used when you have some data that you would like to pass in the URL and that data contains some reserved or invalid characters (&/<space>) – (urlencode() in php)

HttpUtility.UrlEncode(“Some Special Information / That needs to be in the URL”)

Some+Special+Information+%2f+That+needs+to+be+in+the+URL
OR
Some%20Special%20Information%20%2f%20That%20needs%20to%20be%20in%20the%20URL

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XSS Defense by Data Type and Context

Data Type	Context	Defense
String	HTML Body/Attribute	HTML Entity Encode/HTML Attribute Encoder
String	Java String	Java String Encoding
String	JavaScript Variable	JavaScript Hex Encoding
String	GET Parameter	URL Encoding
String	Untrusted URL	URL Validation, avoid javascript: URL's, Attribute encoding, safe URL verification
String	CSS Value	Strict structural validation, CSS Hex encoding, good design
HTML	HTML Body	HTML Validation (JSoup, AntiSamy, HTML Sanitizer)
Any	DOM	DOM XSS Cheat sheet
Untrusted JavaScript	Any	Sandboxing
JSON	Client parse time	JSON.parse() or json2.js

Safe HTML Attributes include: align, alink, alt, bgcolor, border, cellpadding, cellspacing, class, color, cols, colspan, coords, dir, face, height, hspace, ismap, lang, marginheight, marginwidth, multiple, nohref, noresize, noshade, nowrap, ref, rel, rev, rows, rowspan, scrolling, shape, span, summary, tabindex, title, usemap, valign, value, vlink, vspace, width

XSS Defense by Data Type and Context

Context	Encoding	OWASP Java Encoder
HTML Body	HTML Entity Encode	Encoder.forHtmlContent
HTML Attribute	HTML Entity Encode	Encoder.forHtmlAttribute
Java String	Java String Encoding	Encoder.forJava
JavaScript Variable	JavaScript Hex Encoding	Encoder.forJavaScript Encoder.forJavaScriptBlock Encoder.forJavaScriptAttribute
GET Parameter	URL Encoding	Encoder.forUriComponent
Untrusted URL	URL Validation, avoid javascript: URL's, attribute encoding, safe URL verification	Encoder.forUri
CSS Value	Strict structural validation, CSS Hex encoding, good design	Encoder.forCssString Encoder.forCssUrl

OWASP Java Encoder Project

https://www.owasp.org/index.php/OWASP_Java_Encoder_Project

- No third party libraries or configuration necessary.
- This code was designed for high-availability/high-performance encoding functionality. Redesigned for performance.
- Simple drop-in encoding functionality
- More complete API (uri and uri component encoding, etc) in some regards.
- This is a Java 1.5 project.
- Last updated February 4, 2014 (version 1.1.1)

OWASP Java Encoder Project

https://www.owasp.org/index.php/OWASP_Java_Encoder_Project

The Problem

Web Page built in Java JSP is vulnerable to XSS

The Solution

```
<%-- Basic HTML Context --%>
<body><b><%= Encode.forHtml(UNTRUSTED) %>" /></b></body>

<%-- HTML Attribute Context --%>
<input type="text" name="data" value="<%= Encode.forHtmlAttribute(UNTRUSTED) %>" />

<%-- Javascript Block context --%>
<script type="text/javascript">
var msg = "<%= Encode.forJavaScriptBlock(UNTRUSTED) %>"; alert(msg);
</script>

<%-- Javascript Variable context --%>
<button onclick="alert('<%= Encode.forJavaScriptAttribute(UNTRUSTED) %>');">click
me</button>
```

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OWASP Java Encoder Project

https://www.owasp.org/index.php/OWASP_Java_Encoder_Project

HTML Contexts

Encode#forHtml(String)
Encode#forHtmlContent(String)
Encode#forHtmlAttribute(String)
Encode#forHtmlUnquotedAttribute (String)

XML Contexts

Encode#forXml(String)
Encode#forXmlContent(String)
Encode#forXmlAttribute(String)
Encode#forXmlComment(String)
Encode#forCDATA(String)

CSS Contexts

Encode#forCssString(String)
Encode#forCssUrl(String)

JavaScript Contexts

Encode#forJavaScript(String)
Encode#forJavaScriptAttribute(String)
Encode#forJavaScriptBlock(String)
Encode#forJavaScriptSource(String)

URI/URL contexts

Encode#forUriComponent(String)

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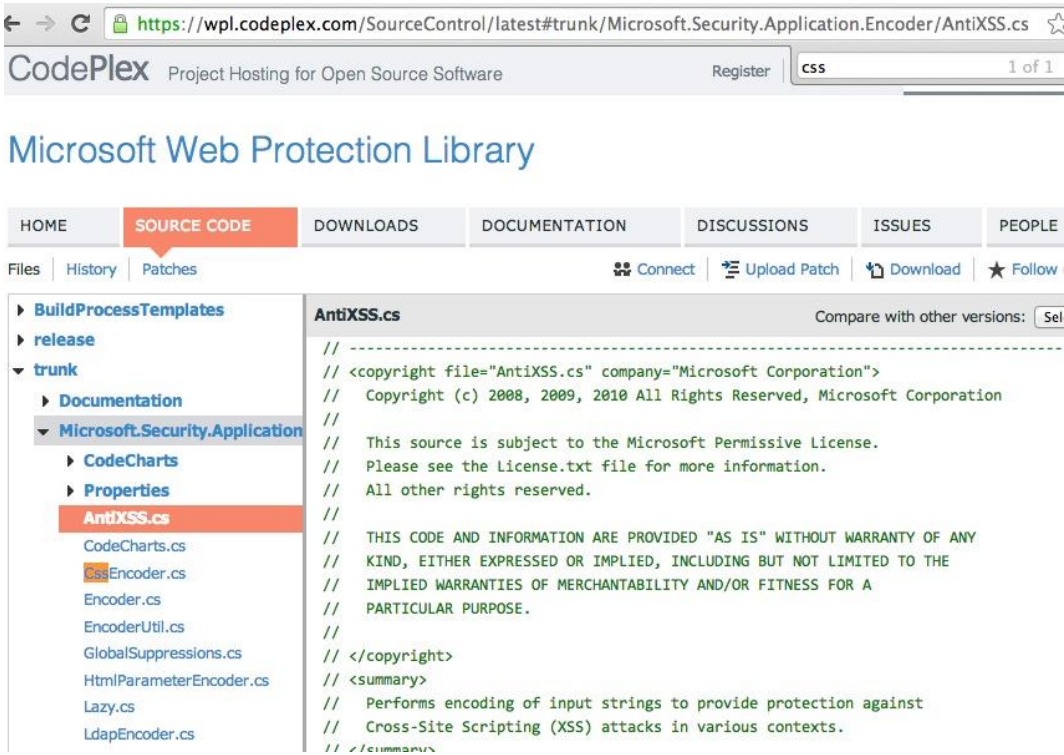
Microsoft Encoder and AntiXSS Library

- **System.Web.Security.AntiXSS**
- **Microsoft.Security.Application . AntiXSS**
- **Can encode for HTML, HTML attributes, XML, CSS and JavaScript.**
- **Native .NET Library**
- **Very powerful well written library**
- **For use in your User Interface code to defuse script in output**



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XSS in HTML Body

Reflective XSS attack example:

```
example.com/error?error_msg=You cannot access that file.
```

Untrusted data may land in a UI snippet like the following:

```
<div><%= request.getParameter("error_msg") %></div>
```

Sample test attack payload:

```
http://example.com/error? error_msg=
<script>alert(document.cookie)</script>
```

HTML Encoding stops XSS in this context!

HTML Body Escaping Examples

OWASP Java Encoder

```
<b><%= Encode.forHtml(UNTRUSTED)%></b>

<p>Title:<%= Encode.forHtml(UNTRUSTED)%></p>

<textarea name="text">
<%= Encode.forHtmlContent(UNTRUSTED) %>
</textarea>
```

AntiXSS .NET

```
Encoder.HtmlEncode(UNTRUSTED)
```

XSS in HTML Attributes

- Where else can XSS go?
  - <input type="text" name="comments" value="">
- What could an attacker put in here?
  - <input type="text" name="comments"
    - value="hello" onmouseover="/*fire attack*/">
- Attackers can add event handlers:
  - onMouseOver
  - onLoad
  - onUnLoad
  - etc…

HTML Attribute Context

- Aggressive escaping is needed when placing untrusted data into typical attribute values like width, name, value, etc.
- This rule is NOT ok for complex attributes likes href, src, style, or any event handlers like onblur or onclick.
- Escape all non alpha-num characters with the &#xHH; format
- This rule is so aggressive because developers frequently leave attributes unquoted
-

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) %> />
```

AntiXSS .NET

```
Encoder.HtmlAttributeEncode(UNTRUSTED)
```

URL Parameter Escaping

Escape **all** non alpha-num characters with the %HH format

<a href="/search?data=<%=DATA %>">

Be careful not to allow untrusted data to drive entire URL's or URL fragments

This encoding only protects you from XSS at the time of rendering the link

Treat DATA as untrusted after submitted

URL Parameter Escaping Examples

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)%>">
```

AntiXSS .NET

```
Encoder.UrlEncode(untrustedUrlFragment)
```

Handling Untrusted URL's

1) First validate to ensure the string is a valid URL
2) Avoid Javascript: URL's
3) Only allow HTTP or HTTPS only
4) Check the URL for malware inbound and outbound
5) Encode URL in the right context of display

```
<a href="UNTRUSTED URL">UNTRUSTED URL</a>
```

Escaping when managing complete URL's

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

OWASP Java Encoder

```
<a href="<%= Encode.forHTMLAttribute(untrustedURL) %>">
Encode.forHtmlContent(untrustedURL)
</a>
```

AntiXSS .NET

```
<a href="<%= Encoder.HtmlAttributeEncode(untrustedURL) %>">
Encoder.HtmlEncode(untrustedURL)
</a>
```

XSS in JavaScript Context

http://example.com/viewPage?name=Jerry

```
<script>
    //create variable for Jerry
    var name = "Jerry";
</script>
```

- What attacks would be possible?
- What would a %0d%0a in the name parameter do in the output?

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>
```

AntiXSS .NET

```
Encoder.JavaScriptEncode(alertMsg)
```

XSS in the Style Tag

Applications sometimes take user data and use it to generate presentation style

```
169 body {
170     font-size: 0.8em;
171     color: black;
172     font-family: Geneva, Verdana Arial, Helvetica, sans-serif;
173     background-color: white;
174     margin: 0;
175     padding: 0;
176 }
177
```

URL parameter written within style tag

Consider this example:

http://example.com/viewDocument?background=white

CSS Context: XSS Defense

Escape **all** non alpha-num characters with the \HH format

text</style>

Do not use any escaping shortcuts like \"

Strong positive structural validation is also required

If possible, design around this “feature”

- Use trusted CSS files that users can choose from
- Use client-side only CSS modification (font size)

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>
```

AntiXSS .NET

```
Encoder.CssEncode(value)
```

Dangerous Contexts

There are just certain places in HTML documents where you cannot place untrusted data

- Danger: <a $DATA> $DATA onblur="attack"

There are just certain JavaScript functions that cannot safely handle untrusted data for input

- Danger: <script>eval($DATA);</script>

XSS Defense by Data Type and Context

Data Type	Context	Defense
String	HTML Body/Attribute	HTML Entity Encode
String	JavaScript Variable	JavaScript Hex encoding
String	GET Parameter	URL Encoding
String	Untrusted URL	URL Validation, avoid javascript: URL's, Attribute encoding, safe URL verification
String	CSS	Strict structural validation, CSS Hex encoding, good design
HTML	HTML Body	HTML Validation (JSoup, AntiSamy, HTML Sanitizer)
Any	DOM	DOM XSS Cheat sheet
Untrusted JavaScript	Any	Sandboxing
JSON	Client parse time	JSON.parse() or json2.js

Safe HTML Attributes include: align, alink, alt, bgcolor, border, cellpadding, cellspacing, class, color, cols, colspan, coords, dir, face, height, hspace, ismap, lang, marginheight, marginwidth, multiple, nohref, noresize, noshade, nowrap, ref, rel, rev, rows, rowspan, scrolling, shape, span, summary, tabindex, title, usemap, valign, value, vlink, vspace, width

HTML Sanitization and XSS

What is HTML Sanitization

- HTML sanitization takes markup as input, outputs “safe” markup
  - Different from *encoding*
  - URLEncoding, HTMLEncoding, will not help you here!

- HTML sanitization is everywhere
  - TinyMCE/CKEditor Widgets
  - Web forum posts w/markup
  - Javascript-based Windows 8 Store apps
  - Outlook.com
  - Advertisements

This example displays all plugins and buttons that comes with the TinyMCE package.

Styles | Heading 1 | Font Family | Font Size

Welcome to the TinyMCE editor demo!

Feel free to try out the different features that are provided, please note that the MCImageManager and MCFileManager specific functionality is part of our commercial offering. The demo is to show the integration.

We really recommend Firefox as the primary browser for the best editing experience, but of course, TinyMCE is compatible with all major browsers.

Got questions or need help?

If you have questions or need help, feel free to visit our community forum! We also offer Enterprise support solutions. Also do not miss out on the documentation, its a great resource wiki for understanding how TinyMCE works and integrates.

Path: h1 » img Words:179

SUBMIT

Source output from post

Element	HTML
content	Welcome to the TinyMCE editor demo! Feel free to try out the different features that are provided, please note that the MCImageManager and MCFileManager specific functionality is part of our commercial offering. The demo is to show the integration. We really recommend Firefox as the primary browser for the best editing experience, but of course, TinyMCE is compatible with all major browsers. Got questions or need help? If you have questions or need help, feel free to visit our community forum! We also offer Enterprise support solutions. Also do not miss out on the documentation, its a great resource wiki for understanding how TinyMCE works and integrates. Found a bug? If you think you have found a bug, you can use the Tracker to report bugs to the developers. And here is a simple table for you to play with.

Why are HTML sanitization bugs important?

- **Worst case scenario**
  - Script running from a mail message executes within the security context of the mail application
  - …from the preview pane that appears automatically
  - Attacker could set up auto-forwarding, impersonate you, steal all your mail, etc.

- **Yet, HTML sanitization bugs are pervasive**
  - Fuzzing? Can be helpful, but difficult
  - Threat modeling? Not so relevant…
  - Smart hackers with some free time – very relevant

And the underlying platforms continue to change. All of them.

This is a <u>hard problem</u>.

HTML Sanitization Bug #1

- **Sanitizer Bypass in validator Node.js** Module by @NealPoole (https://t.co/5omk5ec2UD)
  - Nesting
  - **Input:** `<scrRedirecRedirect 302 302ipt type="text/javascript">prompt(1);</scrRedirecRedirect 302 302ipt>`
  - **Output:** `<script type="text/javascript">prompt(1);</script>`
- **Observation:** Removing data from markup can create XSS where it didn't previously exist!

HTML Sanitization Bug #2

- **CVE-2011-1252 / MS11-074**
  - SharePoint / SafeHTML (UnsafeHTMLWhenUsingIE(String))
  - Input:
    `<style>div{color:rgb(0,0,0)&a=expression(alert(1))}</style>`
  - & → & (HTML Encode)
  - Output:
    `<style>div{color:rgb(0,0,0)&a=expression(alert(1))}</style>`

- **Observations:**
  - Sanitizer created a delimiter (the semi-colon)
  - Legacy IE CSS expression syntax required to execute script
  - Sanitizer: “expression” is considered to be in a benign location
  - Browser: “expression” is considered to be the RHS of a CSS property set operation

HTML Sanitization Bug #3

- **Wordpress 3.0.3 (kses.php)**
  - Credit: Mauro Gentile (@sneak)
    - Thx @superevr!
  - Input and Output:
    `<a HREF="javascript:alert(0)">click me</a>`
- **Observations:**
  - No content modification required to trigger the vulnerability
  - Sanitizer: Only lower case "href" recognized as an attribute
  - Browser: HREF attribute recognized, javascript: URL executes on click
  - Sanitizer and browser don't agree on what constitutes an attribute name

OWASP HTML Sanitizer Project

https://www.owasp.org/index.php/OWASP_Java_HTML_Sanitizer_Project

- HTML Sanitizer written in Java which lets you include HTML authored by third-parties in your web application while protecting against XSS.
- This code was written with security best practices in mind, has an extensive test suite, and has undergone adversarial security review
- https://code.google.com/p/owasp-java-html-sanitizer/
- Very easy to use.
- It allows for simple programmatic POSITIVE policy configuration. No XML config.
- Actively maintained by Mike Samuel from Google's AppSec team!
- This is code from the Caja project that was donated by Google. It is rather high performance and low memory utilization.

Solving Real World Problems with the OWASP HTML Sanitizer Project

The Problem

Web Page is vulnerable to XSS because of untrusted HTML

The Solution

```
PolicyFactory policy = new HtmlPolicyBuilder()
   .allowElements("p")
   .allowElements(
       new ElementPolicy() {
         public String apply(String elementName, List<String> attrs) {
           attrs.add("class");
           attrs.add("header-" + elementName);
           return "div";
         }
       }, "h1", "h2", "h3", "h4", "h5", "h6"))
   .build();
String safeHTML = policy.sanitize(untrustedHTML);
```

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HTML Sanitizers by Language

- Pure JavaScript, client side HTML Sanitization with CAJA!
  - http://code.google.com/p/google-caja/wiki/JsHtmlSanitizer
  - https://code.google.com/p/google-caja/source/browse/trunk/src/com/google/caja/plugin/html-sanitizer.js
- Python
  - https://pypi.python.org/pypi/bleach
- PHP
  - ~~http://htmlpurifier.org/~~
  - http://www.bioinformatics.org/phplabware/internal_utilities/htmLawed/
- .NET AntiXSS Library (v4.3 released June 2, 2014)
  - http://www.nuget.org/packages/AntiXss/ (encoding)
  - https://github.com/mganss/HtmlSanitizer (HTML Sanitization)
- Ruby on Rails
  - https://rubygems.org/gems/loofah
  - http://api.rubyonrails.org/classes/HTML.html
- Java
  - https://www.owasp.org/index.php/OWASP_Java_HTML_Sanitizer_Project

DOM Based XSS Defense

DOM Based XSS is a complex risk

Suppose that x landed in …
<script>setInterval(x, 2000);</script>

For some Javascript functions, even JavaScript that is properly encoded will still execute!

Dangerous JavaScript Sinks

Direct execution	■ eval() ■ window.execScript()/function()/setInterval()/setTimeout(), requestAnimationFrame() ■ script.src(), iframe.src()
Build HTML/ JavaScript	■ document.write(), document.writeln() ■ elem.innerHTML = danger, elem.outerHTML = danger ■ elem.setAttribute("dangerous attribute", danger) – attributes like: href, src, onclick, onload, onblur, etc.
Within execution context	■ onclick() ■ onload() ■ onblur(), etc

Source: https://www.owasp.org/index.php/DOM_based_XSS_Prevention_Cheat_Sheet

Some Safe JavaScript Sinks

Setting a value	■ elem.innerText = "danger"; ■ formfield.value = "danger";
Safe JSON parsing	■ JSON.parse() (rather than eval())

Dangerous jQuery!

- jQuery will evaluate <script> tags and execute script in a variety of API's

```
$('#myDiv').html('<script>alert("Hi!");</script>');
$('#myDiv').before('<script>alert("Hi!");</script>');
$('#myDiv').after('<script>alert("Hi!");</script>');
$('#myDiv').append('<script>alert("Hi!");</script>');
$('#myDiv').prepend('<script>alert("Hi!");</script>');
$('<script>alert("Hi!");</script>').appendTo('#myDiv');
$('<script>alert("Hi!");</script>').prependTo('#myDiv');
```

http://tech.blog.box.com/2013/08/securing-jquery-against-unintended-xss/

jQuery API's and XSS

Dangerous jQuery 1.7.2 Data Types	
CSS	Some Attribute Settings
HTML	URL (Potential Redirect)

jQuery methods that directly update DOM or can execute JavaScript	
$() or jQuery()	.attr()
.add()	.css()
.after()	.html()
.animate()	.insertAfter()
.append()	.insertBefore()
.appendTo()	Note: .text() updates DOM, but is safe.

jQuery methods that accept URLs to potentially unsafe content	
jQuery.ajax()	jQuery.post()
jQuery.get()	load()
jQuery.getScript()	

Don't send untrusted data to these methods,
or properly escape the data before doing so

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jQuery – But there's more…

More danger

- jQuery(danger) or $(danger)
  - This immediately evaluates the input!!
  - E.g., $("<img src=x onerror=alert(1)>")
- jQuery.globalEval()
- All event handlers: .bind(events), .bind(type, [,data], handler()), .on(), .add(html)

Safe examples

- .text(danger), .val(danger)

Some serious research needs to be done to identify all the safe vs. unsafe methods

- There are about 300 methods in jQuery

Source: http://code.google.com/p/domxsswiki/wiki/jQuery

Client Side Context Sensitive Output Escaping

Context	Escaping Scheme	Example
HTML Element	(&, <, >, ") → &entity; (', /) → &#xHH;	$ESAPI.encoder().encodeForHTML()
HTML Attribute	All non-alphanumeric < 256 → &#xHH	$ESAPI.encoder().encodeForHTMLAttribute()
JavaScript	All non-alphanumeric < 256 → \xHH	$ESAPI.encoder().encodeForJavaScript()
HTML Style	All non-alphanumeric < 256 → \HH	$ESAPI.encoder().encodeForCSS()
URI Attribute	All non-alphanumeric < 256 → %HH	$ESAPI.encoder().encodeForURL()

Encoding methods built into a jquery-encoder:
https://github.com/chrisisbeef/jquery-encoder

JQuery Encoding with JQencoder

Contextual encoding is a crucial technique needed to stop all types of XSS

jqencoder is a jQuery plugin that allows developers to do contextual encoding in JavaScript to stop DOM-based XSS

- http://plugins.jquery.com/plugin-tags/security
- $('#element').encode('html', UNTRUSTED-DATA);

Should you trust all JSON?

```
"user":
  {
    "name": "Jameson",
    "occupation": "Distiller",
    "location": (function() { alert("XSS 1!"); return "somewhere"})(),
    "_location_comment": "Once parsed unsafely, the location XSS will run automatically, as a self-executing function. JSON.parse can help with this, and jQuery's $.parseJSON uses it by default (as do $.ajax, etc)",
    "bio": "<script type='text/javascript'>alert('XSS!');</script>",
    "_bio_comment": "This XSS will execute once it is added to the DOM, if not properly escaped  before adding it. This is more of a persistent kind of XSS attack."
  }
```

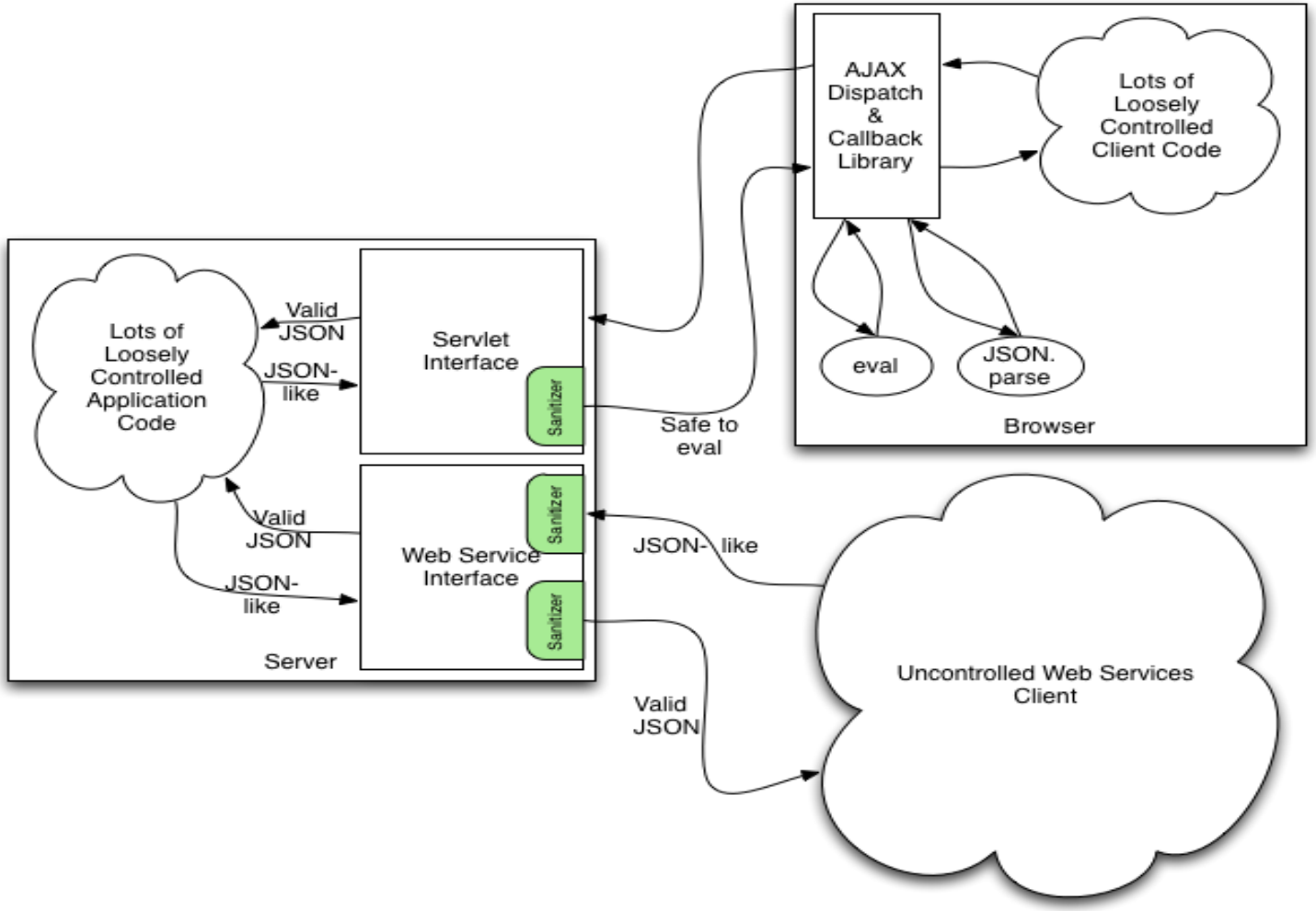
OWASP JSON Sanitizer Project

https://www.owasp.org/index.php/OWASP_JSON_Sanitizer

- Given JSON-like content, converts it to valid JSON.
- This can be attached at either end of a data-pipeline to help satisfy Postel's principle: *Be conservative in what you do, be liberal in what you accept from others.*
- Applied to JSON-like content from others, it will produce well-formed JSON that should satisfy any parser you use.
- Applied to your output before you send, it will coerce minor mistakes in encoding and make it easier to embed your JSON in HTML and XML.

OWASP JSON Sanitizer Project

https://www.owasp.org/index.php/OWASP_JSON_Sanitizer



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Server Side JSON Sanitization

The Problem

Web Page is vulnerable to XSS because of parsing of untrusted JSON incorrectly

The Solution

JSON Sanitizer can help with two use cases.

1) **Sanitizing untrusted JSON on the server that is submitted from the browser** in standard AJAX communication

2) Sanitizing potentially untrusted JSON server-side before sending it to the browser. The output is a valid Javascript expression, so can be parsed by Javascript's eval or by JSON.parse.

Best Practice: Sandboxing

JavaScript Sandboxing (ECMAScript 5)	iFrame Sandboxing (HTML5)
■ Object.seal(obj) ■ Object.isSealed(obj) ■ Sealing an object prevents other code from deleting, or changing the descriptors of, any of the object's properties	■ <iframe src="demo_iframe_sandbox.jsp" sandbox=""></iframe> ■ Allow-same-origin, allow-top-navigation, allow-forms, allow-scripts

More Later in HTML 5 considerations

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Best Practice: X-Xss-Protection

- Use the browser's built in XSS Auditor

- X-Xss-Protection:
  - [0-1] (mode=block)
- X-Xss-Protection:
  - 1; mode=block

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Best Practice: Content Security Policy

Anti-XSS W3C standard

CSP 2.0 Working Draft *Last Call* published July 2014

- http://www.w3.org/TR/CSP2/

Must move all inline script and style into external scripts

Add the Content-Security-Policy response header to instruct the browser that CSP is in use.

- The CSP standard and browser support is still emerging
- Do not depend on CSP yet
- True standard browser support is 1 years off

Best Practice: Content Security Policy

Externalize all Java-Script within web pages	■ No inline script tag ■ No inline JavaScript for onclick, onblur or other inline events handling ■ Push all JavaScript to formal .js files using event binding
Define Content Security Policy	■ Developers define which scripts/directories are valid ■ Browser will only execute supported scripts ■ Inline JavaScript code will be ignored

When should you apply CSP?

- It is a great ideas when building a new web application to apply CSP from day 1.
- CSP should be on 100% of html endpoints.
- It is often non-trivial to apply CSP to an existing app, so start from the beginning!

This is an unrealistic policy

default-src ‘self’; object-src ‘none’

XSS eliminated √
Flashed disabled √
Mixed content disallowed √
Third party content not allowed √

https://developer.mozilla.org/en-US/docs/Web/Security/CSP/CSP_policy_directives

The default-src directive defines the security policy for types of content which are not expressly called out by more specific directives.

This is a common policy

default-src ‘self’;
img-src https://mycdn.com;
script-src ‘unsafe-inline’ https://mycdn.com;
style-src ‘unsafe-inline’ https://mycdn.com
object-src ‘none’;

XSS eliminated X
Flash disabled √
Mixed content disallowed √
Third party content not allowed √

This is a useless policy

default-src *;
script-src * ‘unsafe-inline’ ‘unsafe-eval’;
style-src * ‘unsafe-inline’;

XSS eliminated X
Flash disabled X
Mixed content disallowed X
Third party content not allowed X