Top 10 Web Security Controls

(1) Query Parameterization (PHP PDO)

```
$stmt = $dbh->prepare("INSERT INTO
REGISTRY (name, value) VALUES
(:name, :value)");

$stmt->bindParam(':name', $name);
$stmt->bindParam(':value', $value);
```

Query Parameterization (.NET)

```
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()) { ...
```

Query Parameterization (Java)

```
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);

Query safeHQLQuery = session.createQuery("from
Inventory where productID=:productid");
safeHQLQuery.setParameter("productid",
userSuppliedParameter);
```

Query Parameterization (Ruby)

```ruby
# 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')
```

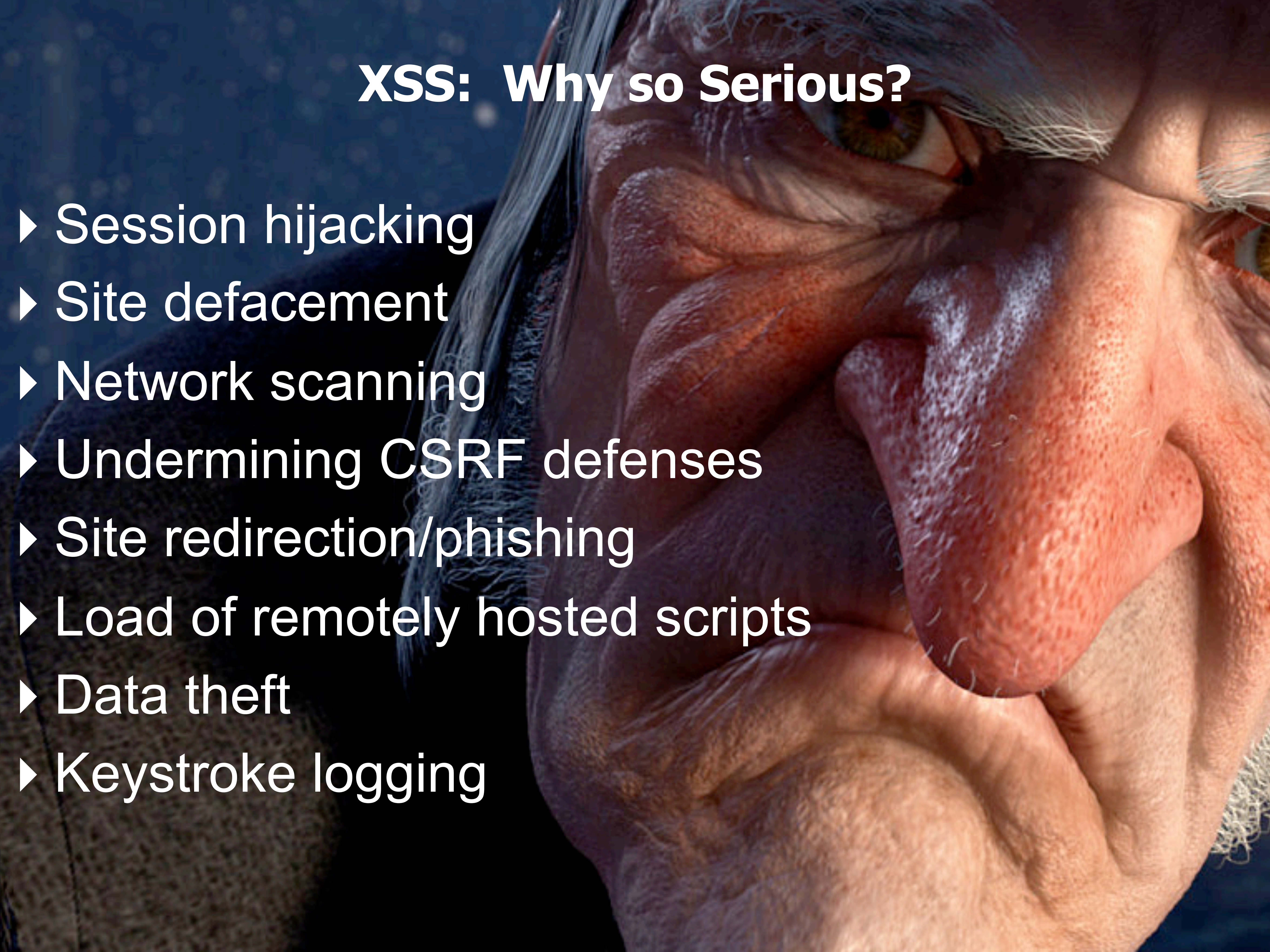
Query Parameterization (Cold Fusion)

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

Query Parameterization (PERL)

```
my $sql = "INSERT INTO foo (bar, baz) VALUES
( ?, ? )”;
my $sth = $dbh->prepare( $sql );
$sth->execute( $bar, $baz );
```

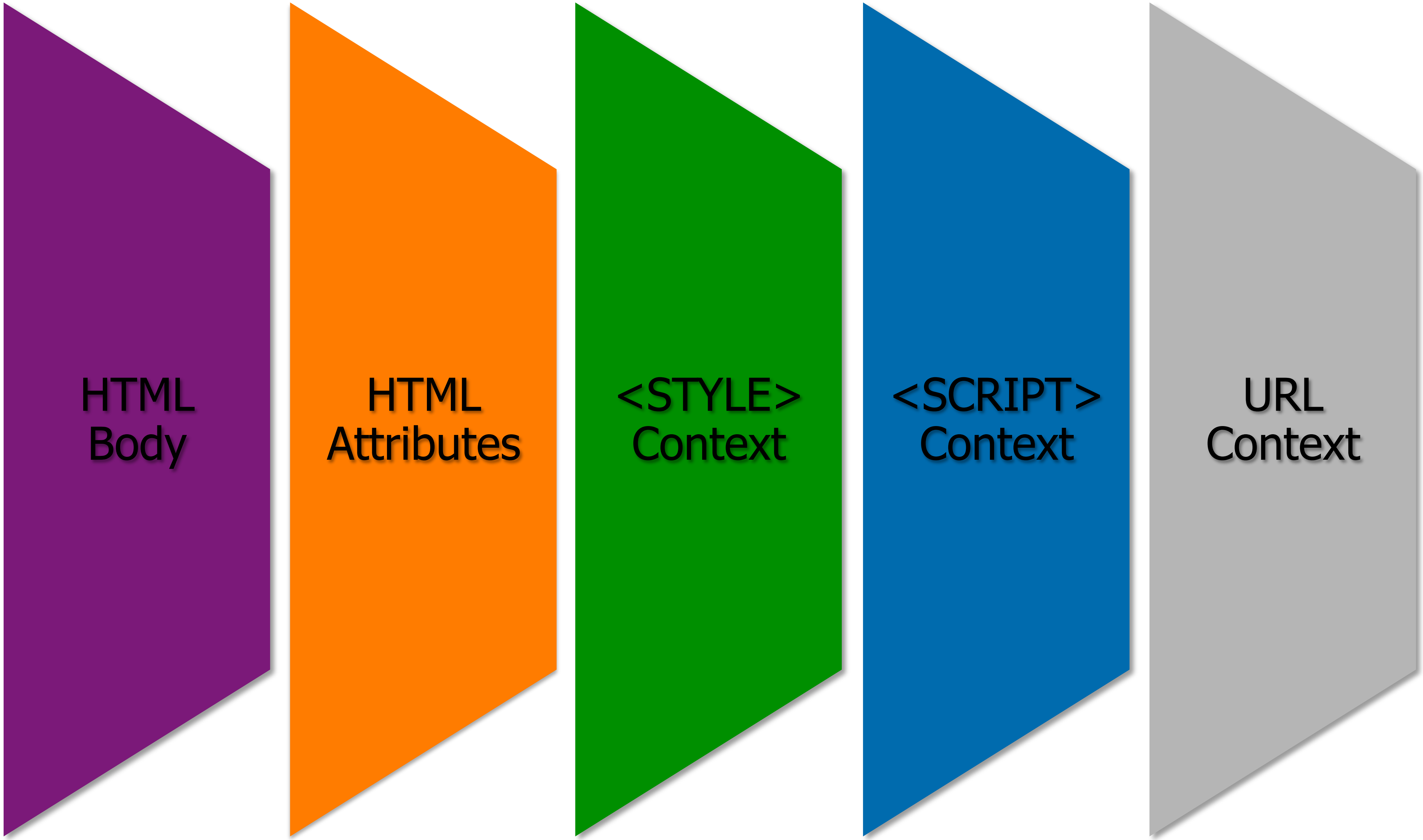
XSS: Why so Serious?



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

Danger: Multiple Contexts

Browsers have multiple contexts that must be considered!



HTML Body

HTML Attributes

<STYLE> Context

<SCRIPT> Context

URL Context

XSS in HTML Attributes

```
<input type="text" name="comments”
                    value="UNTRUSTED DATA">
```

```
<input type="text" name="comments"
                    value="hello" onmouseover="/*fire attack*/">
```

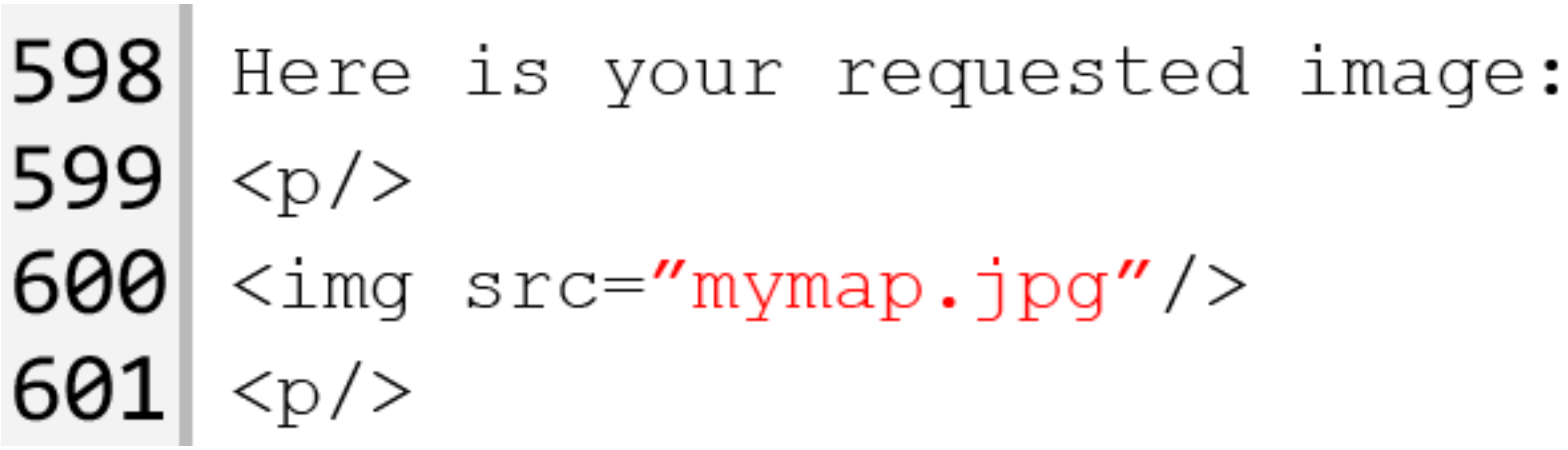
- Attackers can add event handlers:
  - onMouseOver
  - onLoad
  - onUnLoad
  - etc…

XSS in Source Attribute

- User input often winds up in src attribute
- Tags such as

  <img src="">

  <iframe src="">



```
Here is your requested image:
<p/>
<img src=”mymap.jpg”/>
<p/>
```

- Example Request:

  http://example.com/viewImage?imagename=mymap.jpg

- Attackers can use javascript:/*attack*/ in src attributes

URL Parameter Escaping

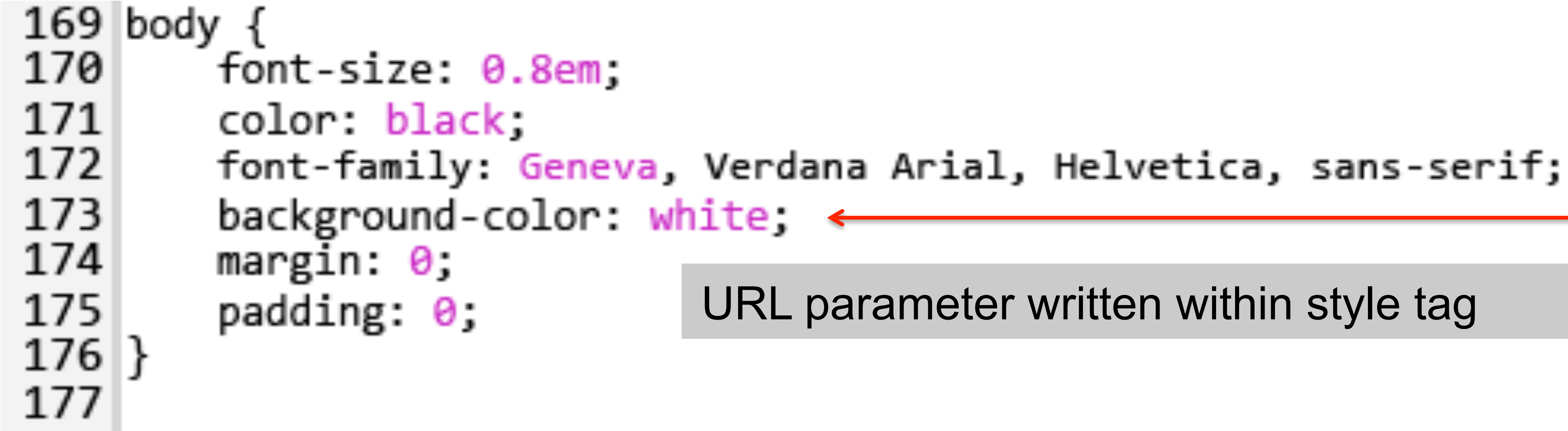
- Escape **all** non alpha-num characters with the %HH format

<a href=“/search?data=UNTRUSTED 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

XSS in the Style Tag

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



```
body {
    font-size: 0.8em;
    color: black;
    font-family: Geneva, Verdana Arial, Helvetica, sans-serif;
    background-color: white;
    margin: 0;
    padding: 0;
}
```

URL parameter written within style tag

- Consider this example:

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

CSS Pwnage Test Case

```
<div style="width: <%=temp3%>;"> Mouse over </div>
```

```
temp3 =
  ESAPI.encoder().encodeForCSS("expression(alert(String
  .fromCharCode (88,88,88)))");
```

```
<div style="width: expression\28 alert\28 String\2e
  fromCharCode\20 \28 88\2c 88\2c 88\29 \29 \29 ;">
  Mouse over </div>
```

- Pops in at least **IE6** and **IE7**.

lists.owasp.org/pipermail/owasp-esapi/2009-February/000405.html

Javascript Context

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

```
<script>var x='UNTRUSTED DATA';</script>
```

- You're now protected from XSS at the time data is assigned
- **What happens to x after you assign it?**

Best Practice: DOM Based XSS Defense

- Untrusted data should only be treated as displayable text
- JavaScript encode and delimit untrusted data as quoted strings
- Use document.createElement("…"), element.setAttribute("…","value"), element.appendChild(…), etc. to build dynamic interfaces
- Avoid use of HTML rendering methods
- Understand the dataflow of untrusted data through your JavaScript code. If you do have to use the methods above remember to HTML and then JavaScript encode the untrusted data
- Avoid passing untrusted data to eval(), setTimeout() etc.
- Don’t eval() JSON to convert it to native JavaScript objects. Instead use JSON.toJSON() and JSON.parse()
- Run untrusted scripts in a sandbox (ECMAScript canopy, HTML 5 frame sandbox, etc)

(2) XSS Defense by Data Type and Context

Data Type	Context	Defense
String	HTML Body	HTML Entity Encode
String	HTML Attribute	Minimal Attribute 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

Attacks on Access Control

- Vertical Access Control Attacks
  - A standard user accessing administration functionality
  - “Privilege Escalation”
- Horizontal Access Control attacks
  - Same role, but accessing another user's private data
- Business Logic Access Control Attacks
  - Abuse of workflow

Best Practice: Code to the Activity

```
if (AC.hasAccess(ARTICLE_EDIT, NUM)) {
   //execute activity
}
```

- Code it once, never needs to change again
- Implies policy is persisted/centralized in some way
- Requires more design/work up front to get right

Best Practice: Use a Centralized Access Controller

In Presentation Layer

```
if (ACL.isAuthorized(VIEW_LOG_PANEL))
{
        <h2>Here are the logs</h2>
        <%=getLogs();%/>
}
```

In Controller

```
try (ACL.assertAuthorized(DELETE_USER))
{
        deleteUser();
}
```

(3) Access Control Positive Patterns

- Code to the activity, not the role
- Centralize access control logic
- Design access control as a filter
- Fail securely (deny-by-default)
- Apply same core logic to presentation and server-side access control decisions
- Server-side trusted data should drive access control
- Provide privilege and user grouping for better management
- Isolate administrative features and access

Anatomy of an CSRF Attack

- Consider a consumer banking application that contains the following form

```
<form action=“https://bank.com/Transfer.asp” method=“POST” id=“form1”>
<p>Account Num: <input type=“text” name=“acct” value=“13243”/></p>
<p>Transfer Amt: <input type=“text” name=“amount” value=“1000” /></p>
</form>
<script>document.getElementById(‘form1’).submit(); </script>
```

(4) Cross Site Request Forgery Defenses

- Cryptographic Tokens
  - Primary and most powerful defense. Randomness is your friend.
- Request that cause side effects should use (and require) the POST method
  - Alone, this is not sufficient
- Require users to re-authenticate
  - Amazon.com does this *really* well
- Double-cookie submit
  - Decent defense, but no based on randomness, based on SOP

Authentication Dangers

- Weak password
- Login Brute Force
- Username Harvesting
- Session Fixation
- Weak or Predictable Session
- Plaintext or poor password storage
- Weak "Forgot Password” feature
- Weak "Change Password” feature
- Credential or session exposure in transit via network sniffing
- Session Hijacking via XSS

(5) Authentication Defenses

- 2FA
- Develop generic failed login messages that do not indicate whether the user-id or password was incorrect
- Enforce account lockout after a pre-determined number of failed login attempts
- Force re-authentication at critical application boundaries
  - edit email, edit profile, edit finance info, ship to new address, change password, etc.
- Implement server-side enforcement of credential syntax and strength

(6) Forgot Password Secure Design

- Require identity and security questions
  - Last name, account number, email, DOB
  - Enforce lockout policy
  - Ask one or more good security questions
    - http://www.goodsecurityquestions.com/

- Send the user a randomly generated token via out-of-band method
  - email, SMS or token

- Verify code in same web session
  - Enforce lockout policy

- Change password
  - Enforce password policy

(7) Session Defenses

- Ensure secure session ID's
  - 20+ bytes, cryptographically random
  - Stored in HTTP Cookies
  - Cookies: Secure, HTTP Only, limited path

- Generate new session ID at login time
  - To avoid *session fixation*

- Session Timeout
  - Idle Timeout
  - Absolute Timeout
  - Logout Functionality

(8) Clickjacking Defense

- Standard Option: X-FRAME-OPTIONS Header

```
// to prevent all framing of this content
response.addHeader( "X-FRAME-OPTIONS", "DENY" );

// to allow framing of this content only by this site
response.addHeader( "X-FRAME-OPTIONS", "SAMEORIGIN" );
```

- Frame-breaking Script defense:

```
<style id="antiClickjack">body{display:none}</style>
<script type="text/javascript">
if (self == top)  {
   var antiClickjack =
   document.getElementByID("antiClickjack");
   antiClickjack.parentNode.removeChild(antiClickjack)
} else {
  top.location = self.location;
}
</script>
```

(9a) Secure Password Storage

```
public String hash(String plaintext, String salt, int iterations)
     throws EncryptionException {
byte[] bytes = null;
try {
  MessageDigest digest = MessageDigest.getInstance(hashAlgorithm);
  digest.reset();
  digest.update(ESAPI.securityConfiguration().getMasterSalt());
  digest.update(salt.getBytes(encoding));
  digest.update(plaintext.getBytes(encoding));

  // rehash a number of times to help strengthen weak passwords
  bytes = digest.digest();
  for (int i = 0; i < iterations; i++) {
     digest.reset();  bytes = digest.digest(bytes);
   }
  String encoded = ESAPI.encoder().encodeForBase64(bytes,false);
  return encoded;
} catch (Exception ex) {
       throw new EncryptionException("Internal error", "Error");
}}
```

(9b) Password Security Defenses

- Disable Browser Autocomplete
  - <form AUTOCOMPLETE="off”>
  - <input AUTOCOMPLETE="off”>

- Password and form fields
  - Input type=password

- Additional password security
  - Do not display passwords in HTML document
  - Only submit passwords over HTTPS

(10) Encryption in Transit (TLS)

- Authentication credentials and session identifiers must me be encrypted in transit via HTTPS/SSL
  - Starting when the login form is rendered
  - Until logout is complete
  - All other sensitive data should be protected via HTTPS!

- https://www.ssllabs.com free online assessment of public facing server HTTPS configuration

- https://www.owasp.org/index.php/Transport_Layer_Protection_Cheat_Sheet for HTTPS best practices