DENIM GROUP

the leading secure software development firm

Benchmarking Web Application Scanners for YOUR Organization

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My Background

- Dan Cornell, founder and CTO of Denim Group
- Software developer by background (Java, .NET, etc)
- OWASP San Antonio, Global Membership Committee

Denim Group Background

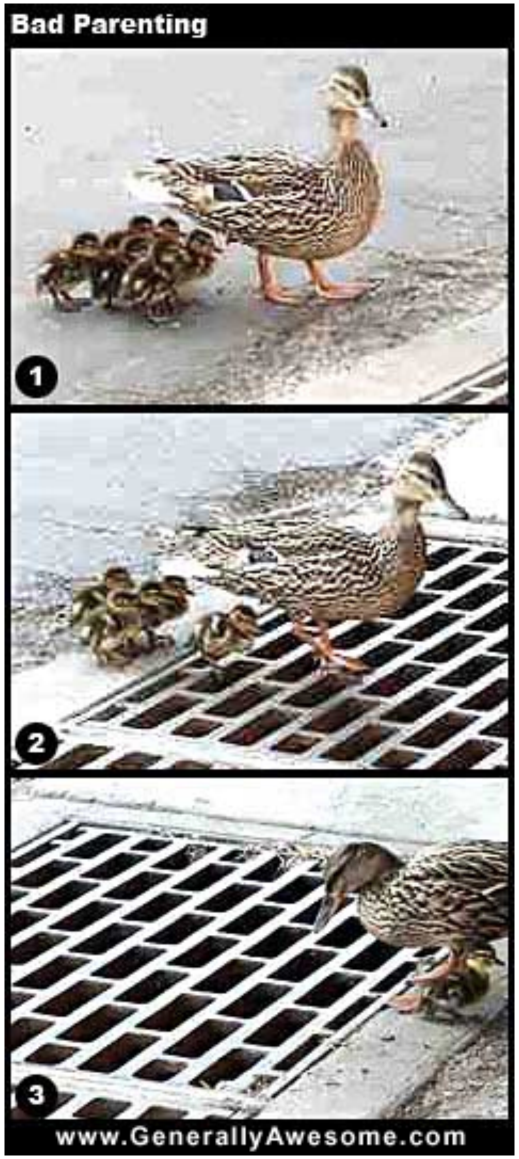
- Secure software services and products company
  - *Builds secure software*
  - *Helps organizations assess and mitigate risk of in-house developed and third party software*
  - *Provides classroom training and e-Learning so clients can build software securely*
- Software-centric view of application security
  - *Application security experts are practicing developers*
  - *Development pedigree translates to rapport with development managers*
  - ***Business impact: shorter time-to-fix application vulnerabilities***
- Culture of application security innovation and contribution
  - *Develops open source tools to help clients mature their software security programs*
    - *Remediation Resource Center, ThreadFix*
  - *OWASP national leaders & regular speakers at RSA, SANS, OWASP, ISSA, CSI*
  - *World class alliance partners accelerate innovation to solve client problems*

What Do You Want From a Scanner?

- Coverage
- Low False Positives
- Low False Negatives

Scanner Coverage

- You can't test what you can't see
- How effective is the scanner's crawler?
- How are URLs mapped to functionality?
  - *RESTful*
  - *Parameters*
- Possible issues:
  - *Login routines*
  - *Multi-step processes*
  - *Anti-CSRF protection*



Are You Getting a Good Scan?

Large financial firm: “Our 500 page website is secure because the scanner did not find any vulnerabilities!”

Me: “Did you teach the scanner to log in so that it can see more than just the homepage?”

Large financial firm: “…”

Can Your Scanner Do This?

- Two-step login procedure:
  - *Enter username / password (pretty standard)*
  - *Enter answer to one of several arbitrary questions*

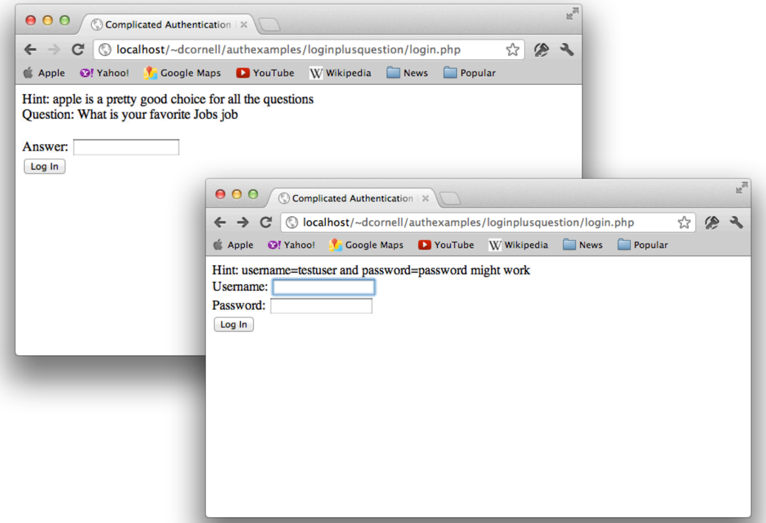
- Challenge was that the parameter indicating the question was dynamic
  - *Question_1, Question_2, Question_3, and so on*
  - *Makes standard login recording ineffective*

It All Started With A Simple Blog Post…

- Ran into an application with a complicated login procedure
- Wrote blog post about the toolchain used to solve the problem
  - *http://blog.denimgroup.com/denim_group/2012/04/automated-application-scanning-handling-complicated-logins-with-appscan-and-burp-suite.html*
- Other scanner teams responded:
  - *IBM Rational AppScan*
    - http://blog.denimgroup.com/denim_group/2012/04/automated-application-scanning-handling-complicated-logins-with-appscan-only.html
  - *HP WebInspect*
    - http://blog.denimgroup.com/denim_group/2012/05/handling-challengeresponse-logins-in-hp-webinspect.html
  - *Mavituna Security Netsparker*
    - http://blog.denimgroup.com/denim_group/2012/05/handling-challengeresponse-logins-in-mavituna-netsparker.html
  - *NTObjectives NTOSpider*
    - http://blog.denimgroup.com/denim_group/2012/05/handling-challengeresponse-logins-in-ntospider.html

Scanner Authentication Scenario Examples

- Built as a response to the previously-mentioned blog conversation
- Example implementations of different login routines
  - *How can different scanners be configured to successfully scan?*
- GitHub site:
  - *https://github.com/denimgroup/authexamples*


Complicated Authentication
localhost/~dcornell/authexamples/loginplusquestion/login.php
Apple
Yahoo!
Google Maps
YouTube
Wikipedia
News
Popular

Hint: apple is a pretty good choice for all the questions
Question: What is your favorite Jobs job

Answer:

Log In

Complicated Authentication
localhost/~dcornell/authexamples/loginplusquestion/login.php
Apple
Yahoo!
Google Maps
YouTube
Wikipedia
News
Popular

Hint: username=testuser and password=password might work
Username:
Password:
Log In

Did I Get a Good Scan?

- Scanner training is really important
  - *Read the Larry Suto reports…*
- Must sanity-check the results of your scans
- What URLs were accessed?
  - *If only two URLs were accessed on a 500 page site, you probably have a bad scan*
  - *If 5000 URLs were accessed on a five page site, you probably have a bad scan*
- What vulnerabilities were found and not found?
  - *Scan with no vulnerabilities – probably not a good scan*
  - *Scan with excessive vulnerabilities – possibly a lot of false positives*

Low False Positives

- Reports of vulnerabilities that do not actually exist
- How “touchy” is the scanner’s testing engine?
- Why are they bad?
  - *Take time to manually review and filter out*
  - *Can lead to wasted remediation time*

Low False Negatives

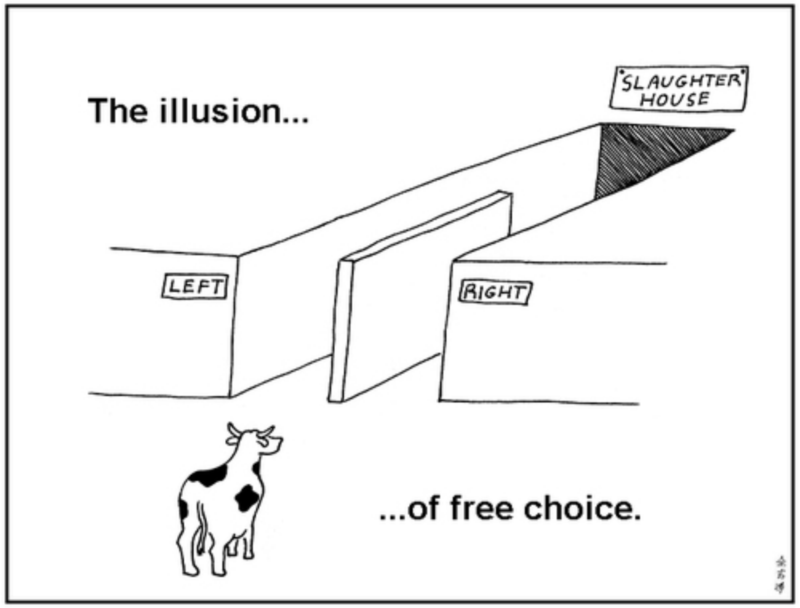
- Scanner failing to report vulnerabilities that do exist
- How effective is the scanner's testing engine?
- Why are they bad?
  - *You are exposed to risks you do not know about*
  - *You expect that the scanner would have found certain classes of vulnerabilities*
- What vulnerability classes do you think scanners will find?

Other Benchmarking Efforts

- Larry Suto's 2007 and 2010 reports
  - *Analyzing the Accuracy and Time Costs of Web Application Security Standards*
  - *http://ha.ckers.org/files/Accuracy_and_Time_Costs_of_Web_App_Scanners.pdf*
  - *Vendor reactions were … varied*
  - *[Ofer Shezaf attended this talk at AppSecEU 2012 and had some great questions and comments. See his reactions to the latest Larry Suto scanner report here : http://www.xiom.com/2010/02/09/wafs-are-not-perfect-any-security-tool-perfect]*
- Shay Chen's Blog and Site
  - *http://sectooladdict.blogspot.com/*
  - *http://www.sectoolmarket.com/*
- Web Application Vulnerability Scanner Evaluation Project (wavsep)
  - *http://code.google.com/p/wavsep/*

So I Should Just Buy the Best Scanner, Right?

- Or the cheapest?
- Well…
  - *What do you mean by “best”?*



- Follow-on questions
  - *How well do the scanners work on your organization’s applications?*
  - *How many false positives are you willing to deal with?*
  - *What depth and breadth of coverage do you need?*

ThreadFix - Overview

- ThreadFix is a software vulnerability aggregation and management system that helps organizations aggregate vulnerability data, generate virtual patches, and interact with software defect tracking systems.
- Freely available under the Mozilla Public License (MPL)
- Hosted at Google Code: http://code.google.com/p/threadfix/

ThreadFix

What is a Unique Vulnerability?

- (CWE, Relative URL)
  - *Predictable resource location*
  - *Directory listing misconfiguration*

- (CWE, Relative URL, Injection Point)
  - *SQL injection*
  - *Cross-site Scripting (XSS)*

- Injection points
  - *Parameters – GET/POST*
  - *Cookies*
  - *Other headers*

What Do The Scanner Results Look Like?

- Usually XML
  - *Skipfish uses JSON and gets packaged as a ZIP*
- Scanners have different concepts of what a “vulnerability” is
  - *We normalize to the (CWE, location, [injection point]) noted before*
- Look at some example files
- Several vendors have been really helpful adding additional data to their APIs and file formats to accommodate requests

Why Common Weakness Enumeration (CWE)?

- Every tool has their own "spin" on naming vulnerabilities
- OWASP Top 10 / WASC 24 are helpful but not comprehensive

- CWE is exhaustive (though a bit sprawling at times)
- Reasonably well-adopted standard
- Many tools have mappings to CWE for their results

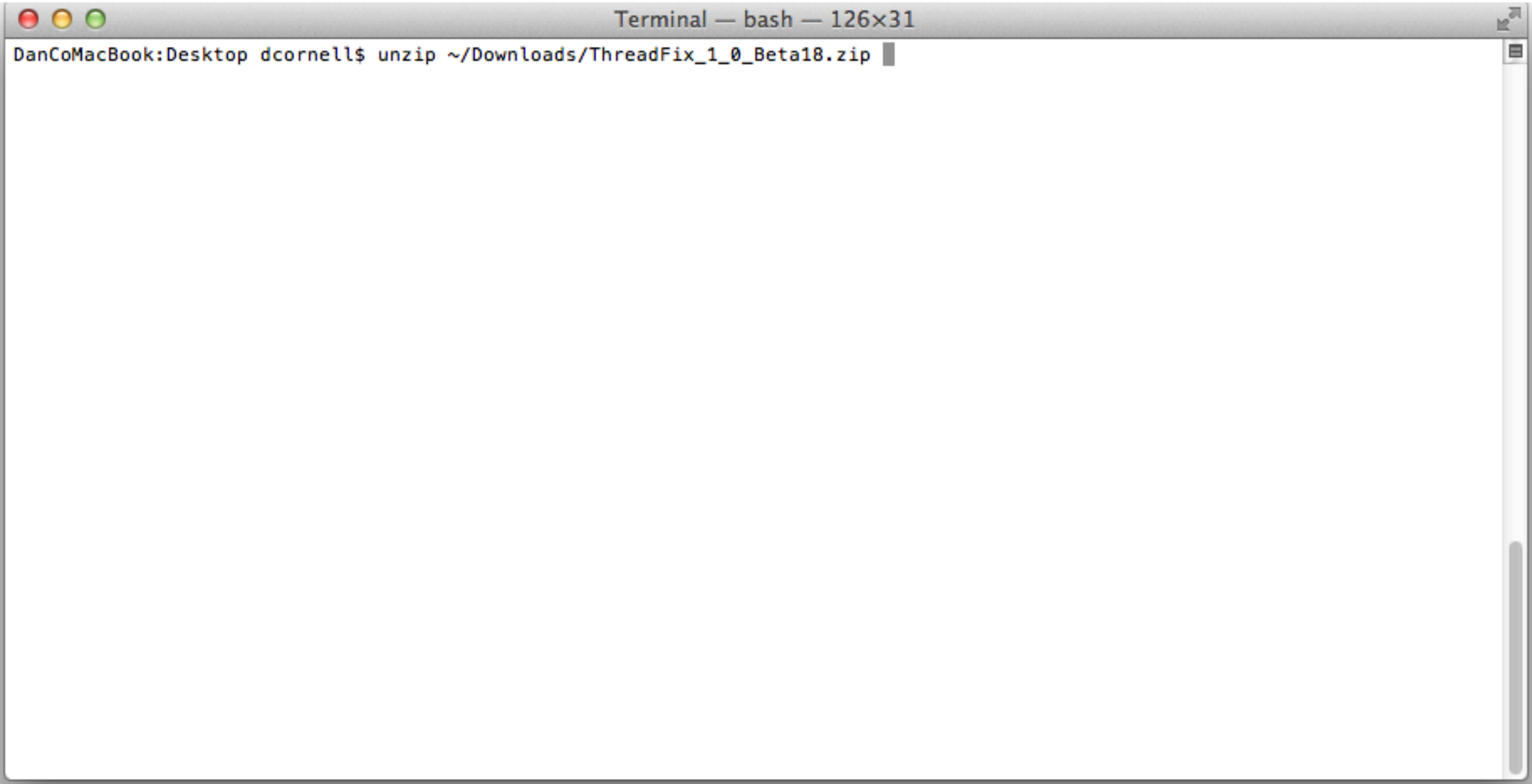
- Main site: http://cwe.mitre.org/

Demo

- Unpack and install ThreadFix
- Use ThreadFix to normalize and report on the use of multiple scanning technologies on a given application
- Import multiple scans and de-duplicate the results

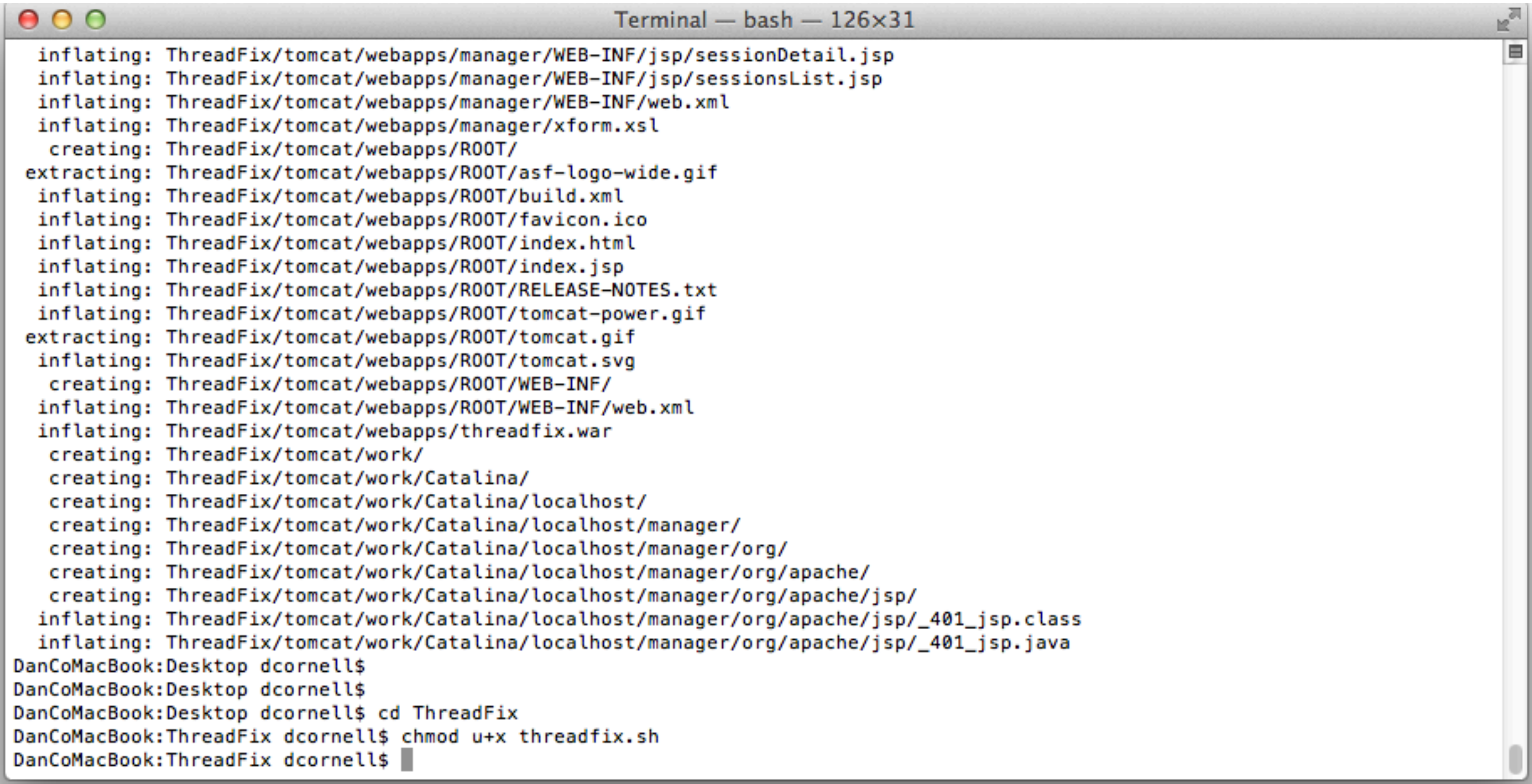
- **These screenshots are based on UNTUNED scans and are NOT meant to show a real benchmark of these scanners – only the process**

Unzip the ThreadFix Package (like WebGoat!)



```
DanCoMacBook:Desktop dcornell$ unzip ~/Downloads/ThreadFix_1_0_Beta18.zip
```

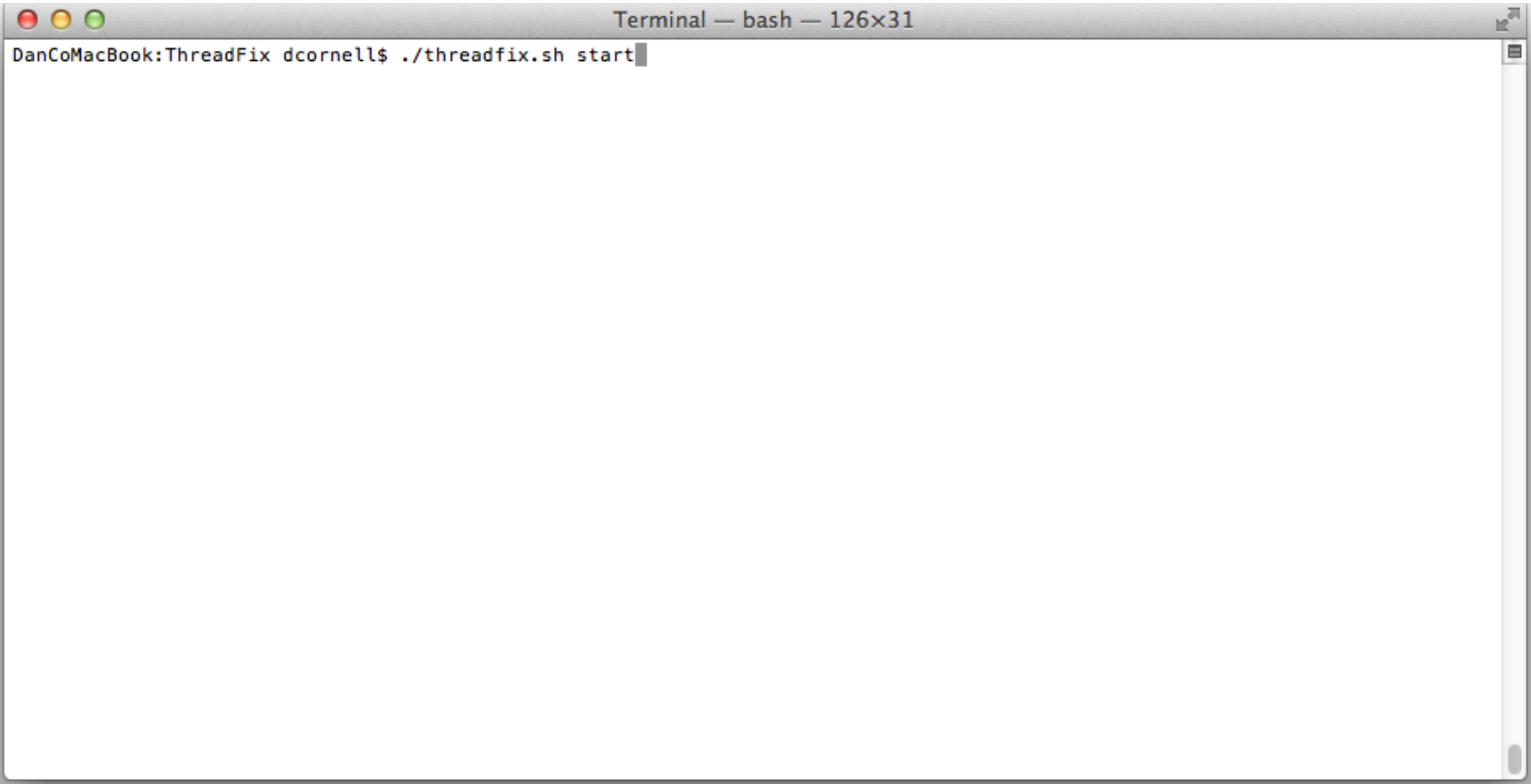
Make threadfix.sh Executable



Terminal — bash — 126×31

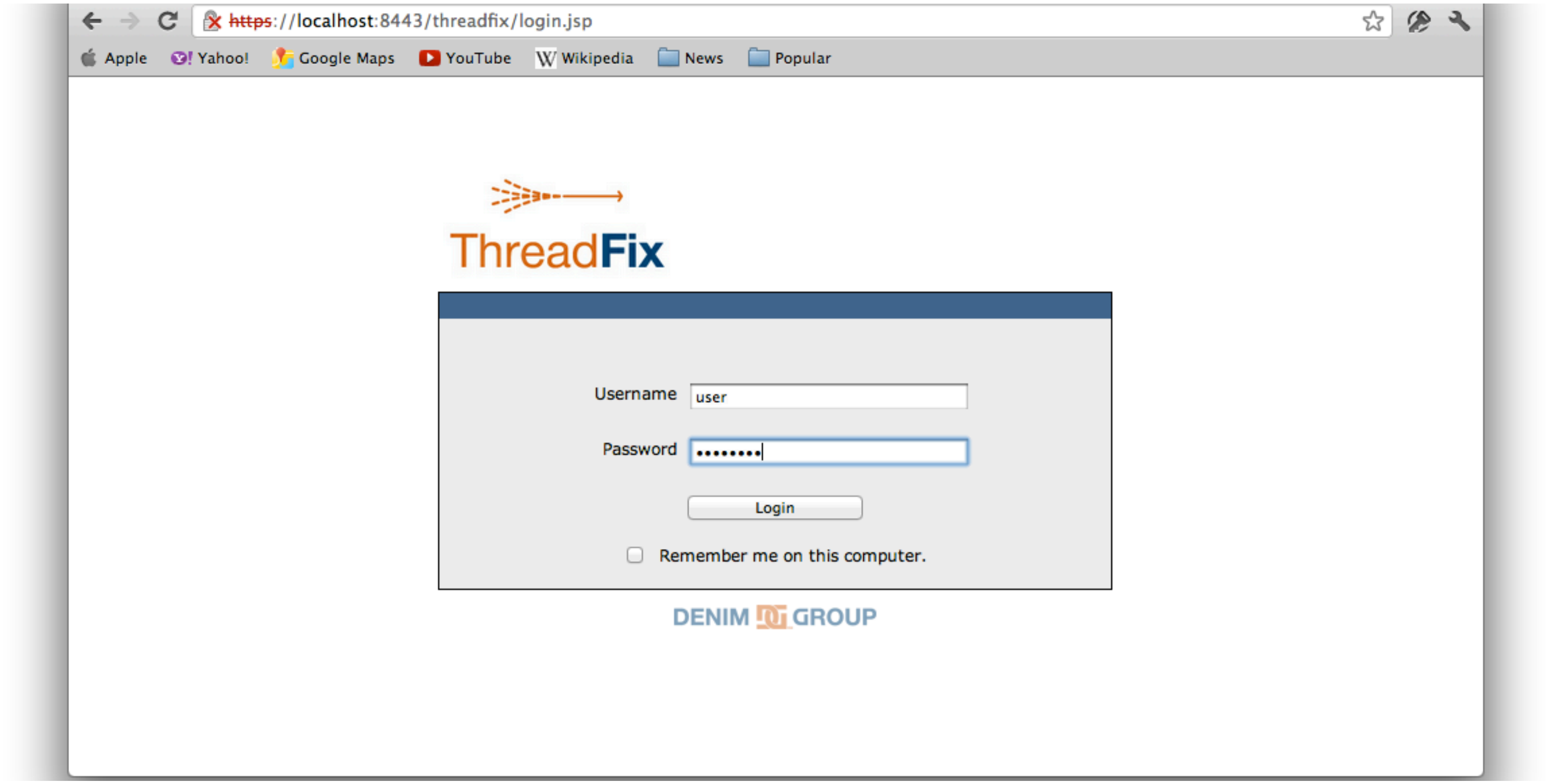
```
  inflating: ThreadFix/tomcat/webapps/manager/WEB-INF/jsp/sessionDetail.jsp
  inflating: ThreadFix/tomcat/webapps/manager/WEB-INF/jsp/sessionsList.jsp
  inflating: ThreadFix/tomcat/webapps/manager/WEB-INF/web.xml
  inflating: ThreadFix/tomcat/webapps/manager/xform.xsl
   creating: ThreadFix/tomcat/webapps/ROOT/
 extracting: ThreadFix/tomcat/webapps/ROOT/asf-logo-wide.gif
  inflating: ThreadFix/tomcat/webapps/ROOT/build.xml
  inflating: ThreadFix/tomcat/webapps/ROOT/favicon.ico
  inflating: ThreadFix/tomcat/webapps/ROOT/index.html
  inflating: ThreadFix/tomcat/webapps/ROOT/index.jsp
  inflating: ThreadFix/tomcat/webapps/ROOT/RELEASE-NOTES.txt
  inflating: ThreadFix/tomcat/webapps/ROOT/tomcat-power.gif
 extracting: ThreadFix/tomcat/webapps/ROOT/tomcat.gif
  inflating: ThreadFix/tomcat/webapps/ROOT/tomcat.svg
   creating: ThreadFix/tomcat/webapps/ROOT/WEB-INF/
  inflating: ThreadFix/tomcat/webapps/ROOT/WEB-INF/web.xml
  inflating: ThreadFix/tomcat/webapps/threadfix.war
   creating: ThreadFix/tomcat/work/
   creating: ThreadFix/tomcat/work/Catalina/
   creating: ThreadFix/tomcat/work/Catalina/localhost/
   creating: ThreadFix/tomcat/work/Catalina/localhost/manager/
   creating: ThreadFix/tomcat/work/Catalina/localhost/manager/org/
   creating: ThreadFix/tomcat/work/Catalina/localhost/manager/org/apache/
   creating: ThreadFix/tomcat/work/Catalina/localhost/manager/org/apache/jsp/
  inflating: ThreadFix/tomcat/work/Catalina/localhost/manager/org/apache/jsp/_401_jsp.class
  inflating: ThreadFix/tomcat/work/Catalina/localhost/manager/org/apache/jsp/_401_jsp.java
DanCoMacBook:Desktop dcornell$
DanCoMacBook:Desktop dcornell$
DanCoMacBook:Desktop dcornell$ cd ThreadFix
DanCoMacBook:ThreadFix dcornell$ chmod u+x threadfix.sh
DanCoMacBook:ThreadFix dcornell$ 
```

Run ThreadFix Pre-Configured Tomcat Server



```
DanCoMacBook:ThreadFix dcornell$ ./threadfix.sh start
```

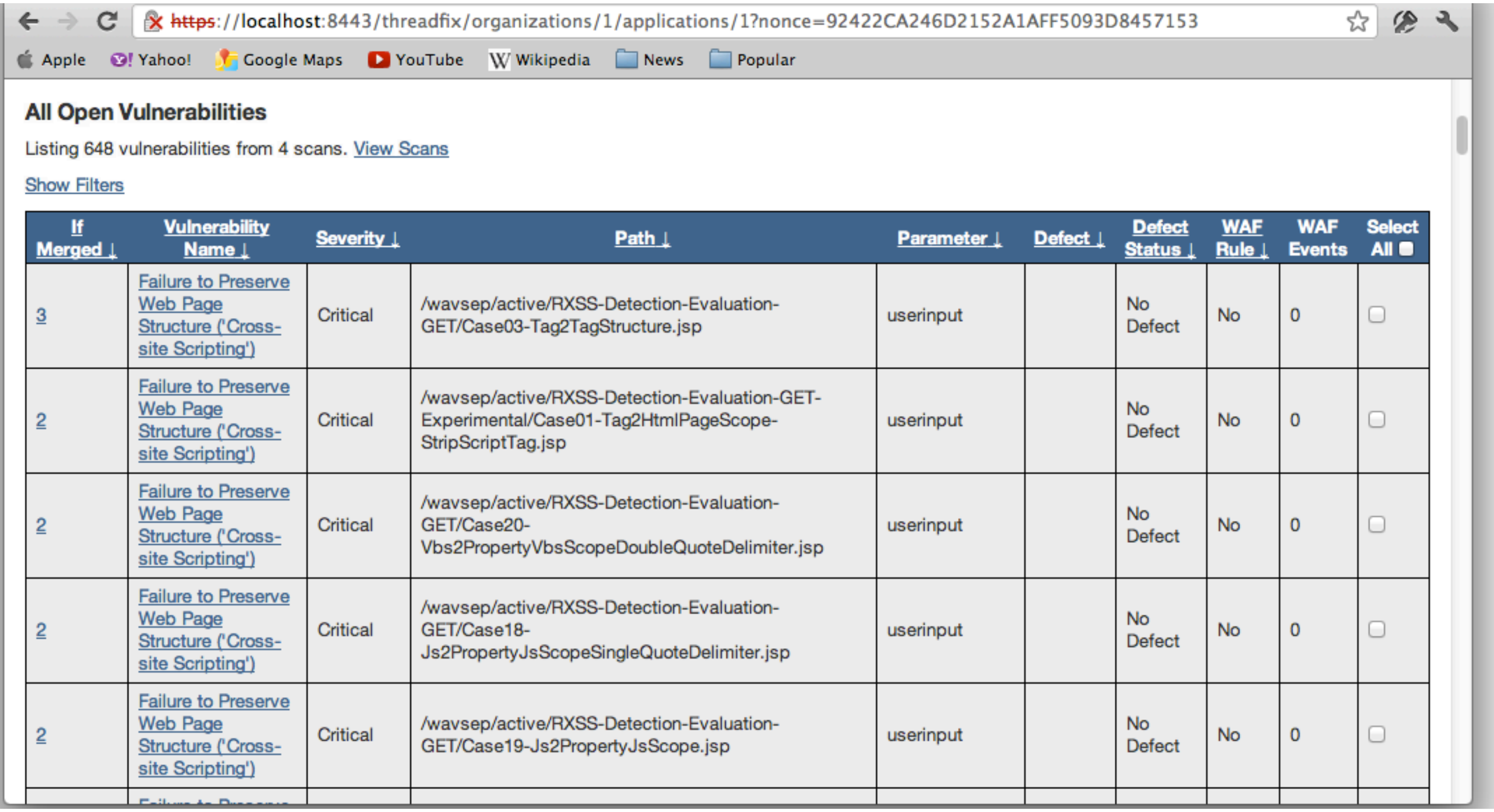
Login to ThreadFix ("user" and "password")


https://localhost:8443/threadfix/login.jsp

Username: user

Password: ••••••••

Upload Various Scan Results Files


https://localhost:8443/threadfix/organizations/1/applications/1?nonce=92422CA246D2152A1AFF5093D8457153

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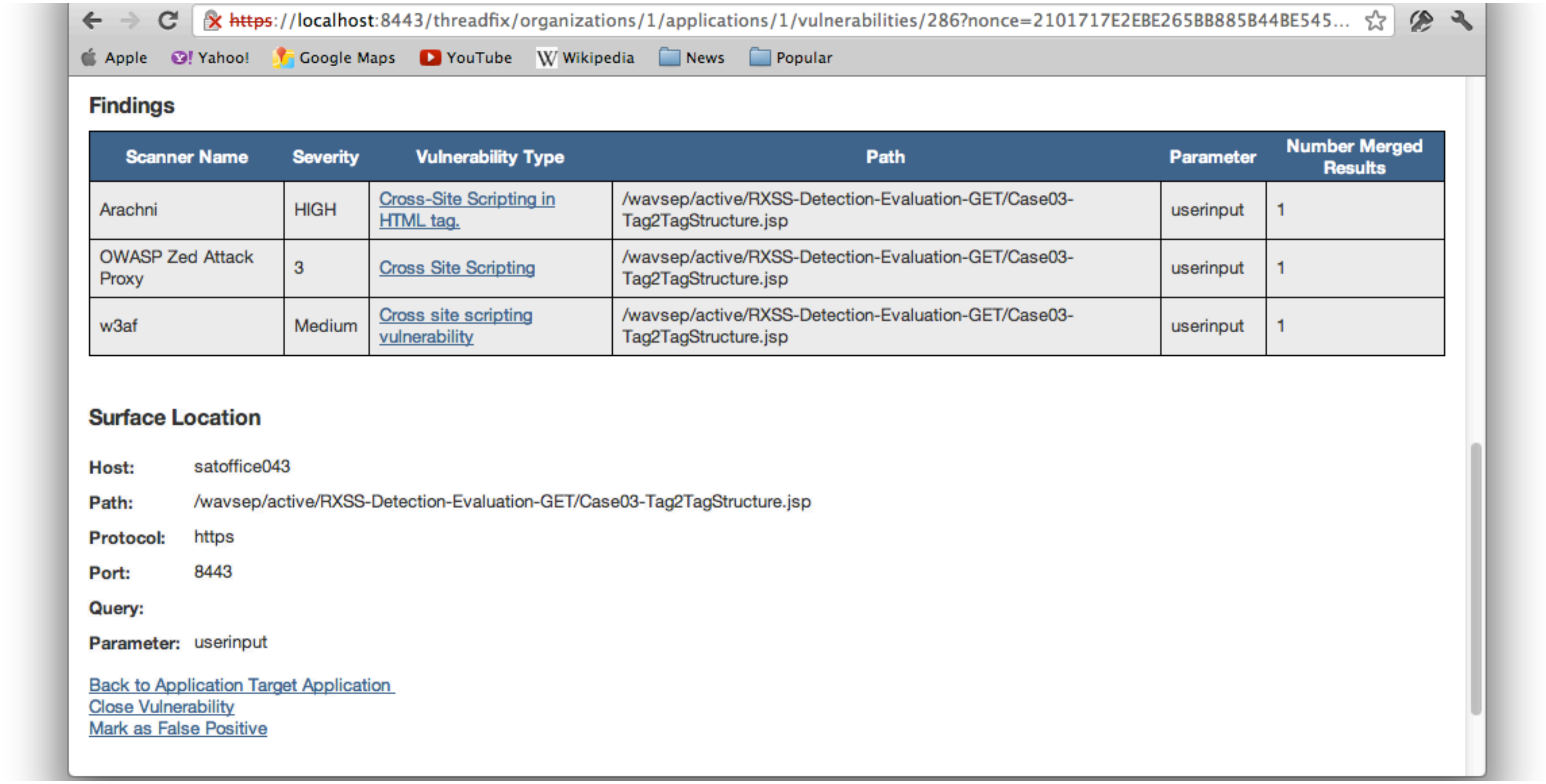
All Open Vulnerabilities

Listing 648 vulnerabilities from 4 scans. View Scans

Show Filters

If Merged	Vulnerability Name	Severity	Path	Parameter	Defect	Defect Status	WAF Rule	WAF Events	Select All
3	Failure to Preserve Web Page Structure ('Cross-site Scripting')	Critical	/wavsep/active/RXSS-Detection-Evaluation-GET/Case03-Tag2TagStructure.jsp	userinput		No Defect	No	0	☐
2	Failure to Preserve Web Page Structure ('Cross-site Scripting')	Critical	/wavsep/active/RXSS-Detection-Evaluation-GET-Experimental/Case01-Tag2HtmlPageScope-StripScriptTag.jsp	userinput		No Defect	No	0	☐
2	Failure to Preserve Web Page Structure ('Cross-site Scripting')	Critical	/wavsep/active/RXSS-Detection-Evaluation-GET/Case20-Vbs2PropertyVbsScopeDoubleQuoteDelimiter.jsp	userinput		No Defect	No	0	☐
2	Failure to Preserve Web Page Structure ('Cross-site Scripting')	Critical	/wavsep/active/RXSS-Detection-Evaluation-GET/Case18-Js2PropertyJsScopeSingleQuoteDelimiter.jsp	userinput		No Defect	No	0	☐
2	Failure to Preserve Web Page Structure ('Cross-site Scripting')	Critical	/wavsep/active/RXSS-Detection-Evaluation-GET/Case19-Js2PropertyJsScope.jsp	userinput		No Defect	No	0	☐

This Vulnerability Found By Three Scanners



https://localhost:8443/threadfix/organizations/1/applications/1/vulnerabilities/286?nonce=2101717E2EBE265BB885B44BE545...

Findings

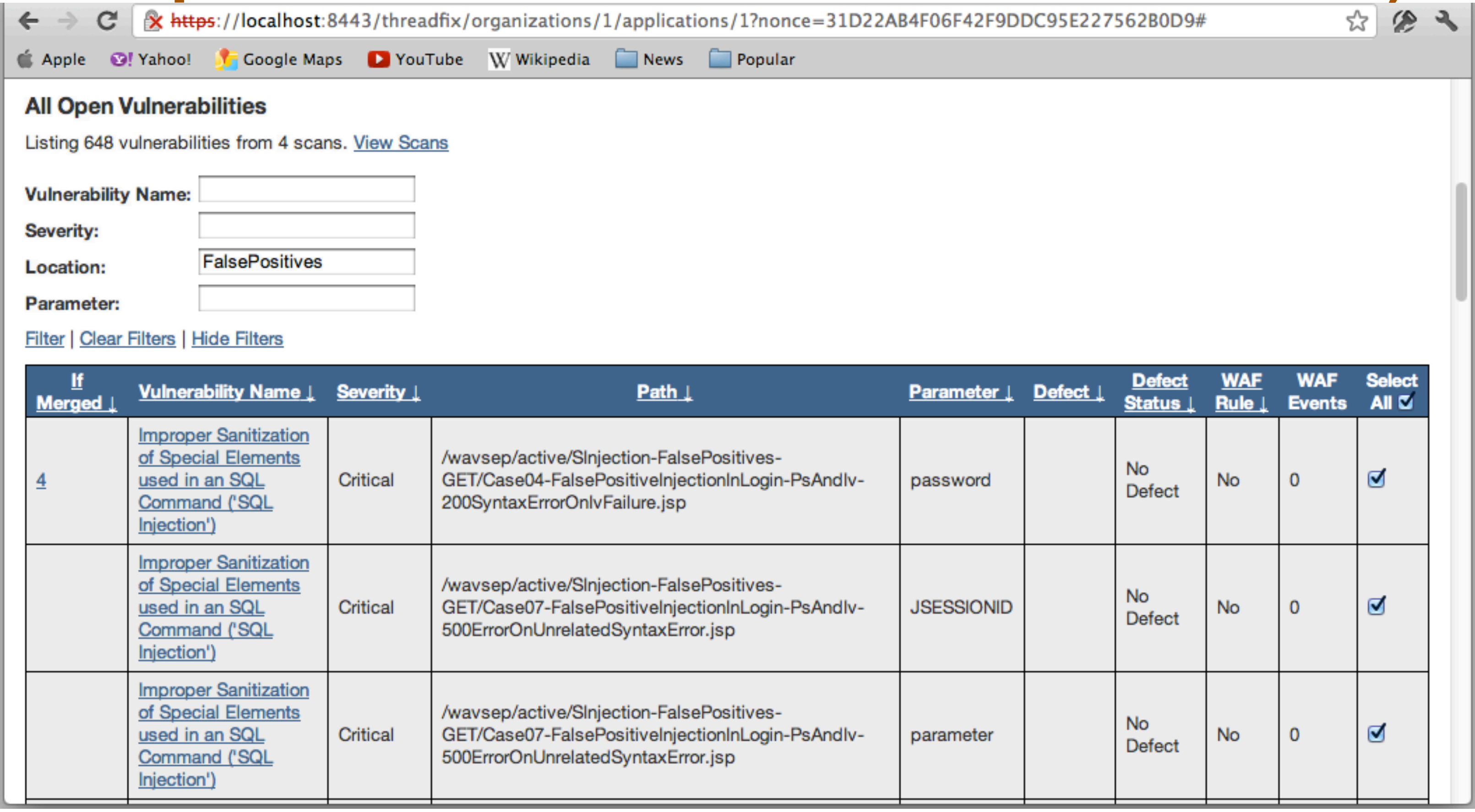
Scanner Name	Severity	Vulnerability Type	Path	Parameter	Number Merged Results
Arachni	HIGH	Cross-Site Scripting in HTML tag.	/wavsep/active/RXSS-Detection-Evaluation-GET/Case03-Tag2TagStructure.jsp	userinput	1
OWASP Zed Attack Proxy	3	Cross Site Scripting	/wavsep/active/RXSS-Detection-Evaluation-GET/Case03-Tag2TagStructure.jsp	userinput	1
w3af	Medium	Cross site scripting vulnerability	/wavsep/active/RXSS-Detection-Evaluation-GET/Case03-Tag2TagStructure.jsp	userinput	1

Surface Location

Host:	satoffice043
Path:	/wavsep/active/RXSS-Detection-Evaluation-GET/Case03-Tag2TagStructure.jsp
Protocol:	https
Port:	8443
Query:	
Parameter:	userinput

Back to Application Target Application
Close Vulnerability
Mark as False Positive

Mark False Positives (wavsep Uses "FalsePositives" In the URL…)


https://localhost:8443/threadfix/organizations/1/applications/1?nonce=31D22AB4F06F42F9DDC95E227562B0D9#

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All Open Vulnerabilities

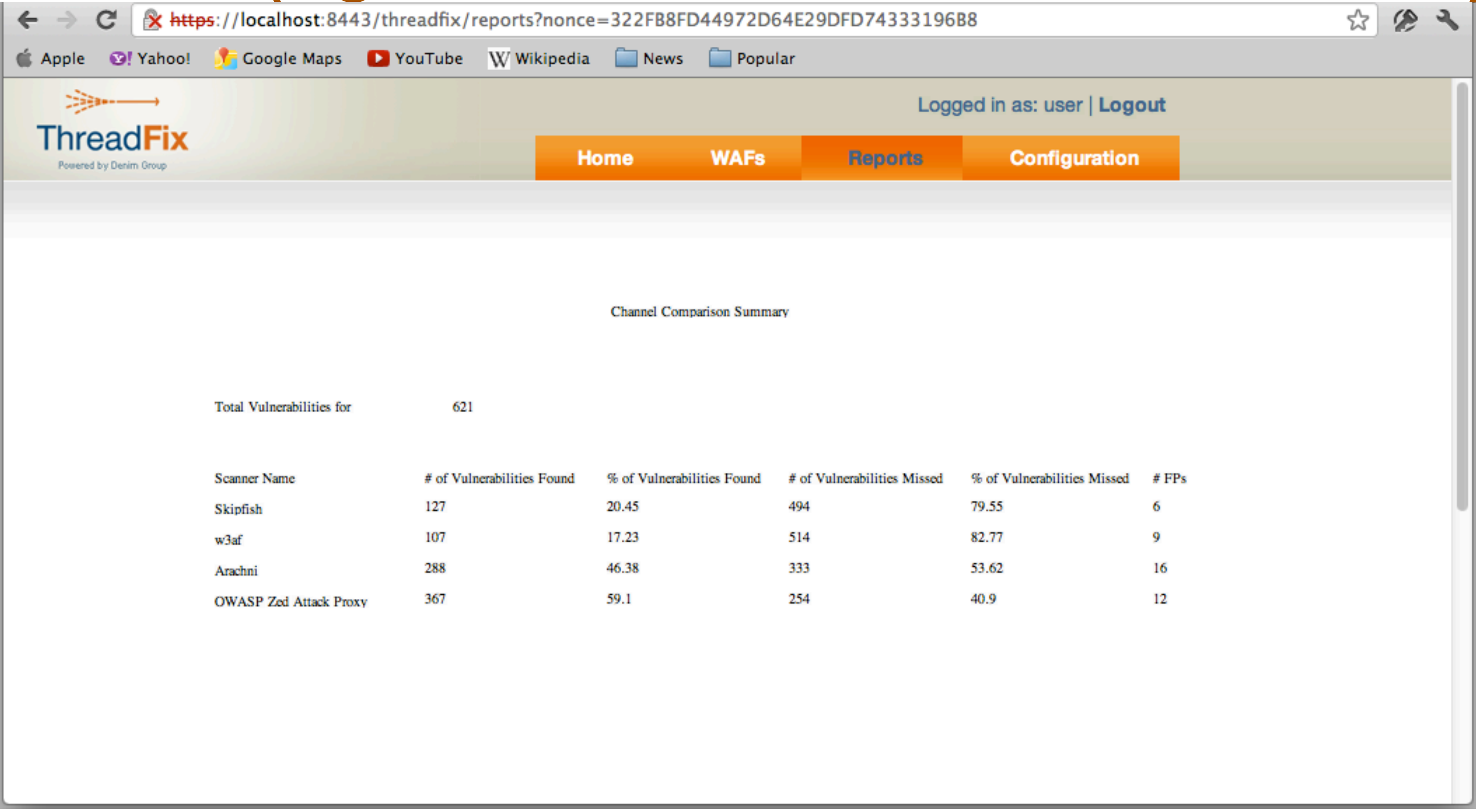
Listing 648 vulnerabilities from 4 scans. View Scans

Vulnerability Name:	
Severity:	
Location:	FalsePositives
Parameter:	

Filter | Clear Filters | Hide Filters

If Merged ↓	Vulnerability Name ↓	Severity ↓	Path ↓	Parameter ↓	Defect ↓	Defect Status ↓	WAF Rule ↓	WAF Events	Select All ✓
4	Improper Sanitization of Special Elements used in an SQL Command ('SQL Injection')	Critical	/wavsep/active/SInjection-FalsePositives-GET/Case04-FalsePositiveInjectionInLogin-PsAndIv-200SyntaxErrorOnlvFailure.jsp	password		No Defect	No	0	✓
	Improper Sanitization of Special Elements used in an SQL Command ('SQL Injection')	Critical	/wavsep/active/SInjection-FalsePositives-GET/Case07-FalsePositiveInjectionInLogin-PsAndIv-500ErrorOnUnrelatedSyntaxError.jsp	JSESSIONID		No Defect	No	0	✓
	Improper Sanitization of Special Elements used in an SQL Command ('SQL Injection')	Critical	/wavsep/active/SInjection-FalsePositives-GET/Case07-FalsePositiveInjectionInLogin-PsAndIv-500ErrorOnUnrelatedSyntaxError.jsp	parameter		No Defect	No	0	✓

Summary Report – Found, Not Found, False Positives (Again – NOT Based on Tuned Scans)

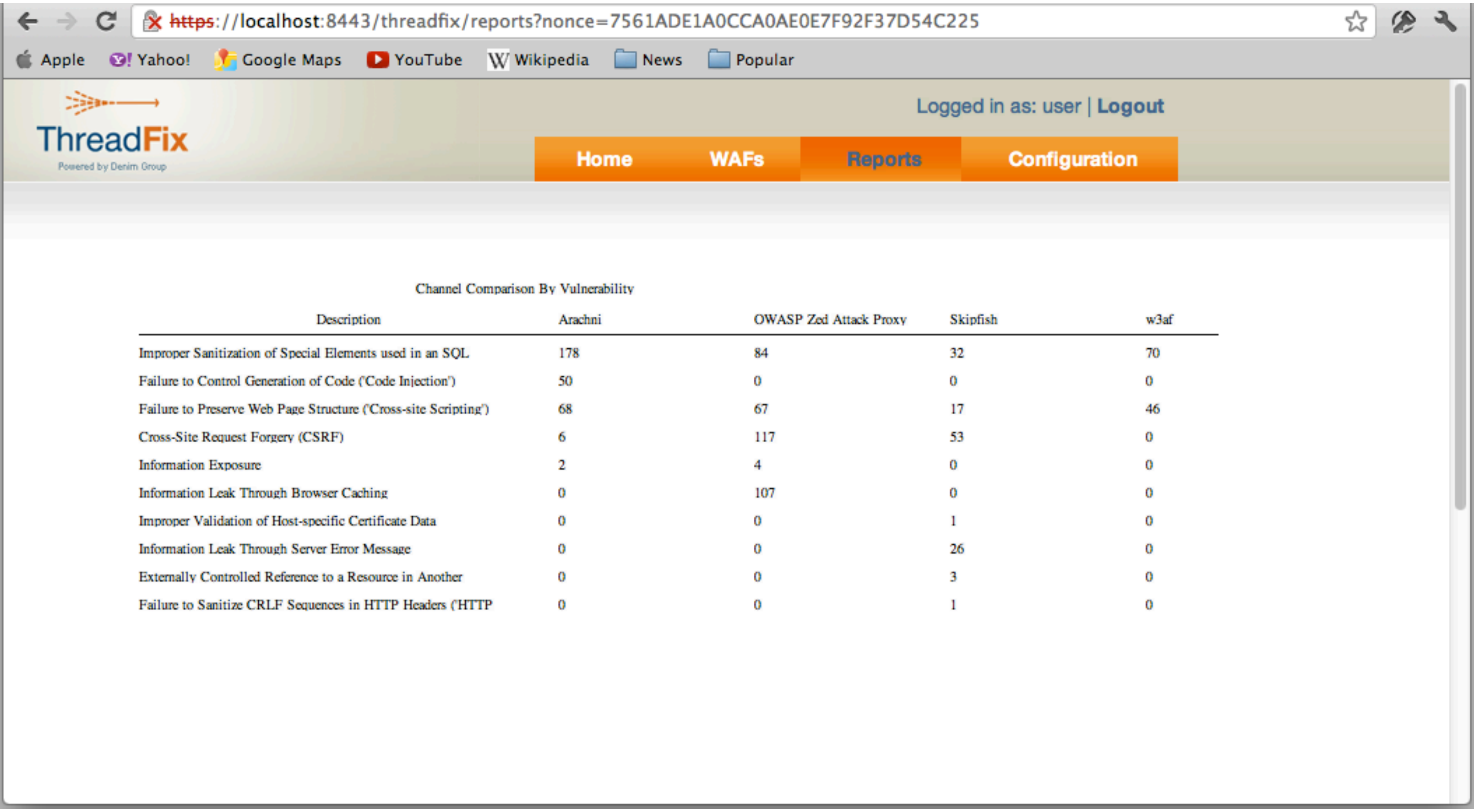


Channel Comparison Summary

Total Vulnerabilities for 621

Scanner Name	# of Vulnerabilities Found	% of Vulnerabilities Found	# of Vulnerabilities Missed	% of Vulnerabilities Missed	# FPs
Skipfish	127	20.45	494	79.55	6
w3af	107	17.23	514	82.77	9
Arachni	288	46.38	333	53.62	16
OWASP Zed Attack Proxy	367	59.1	254	40.9	12

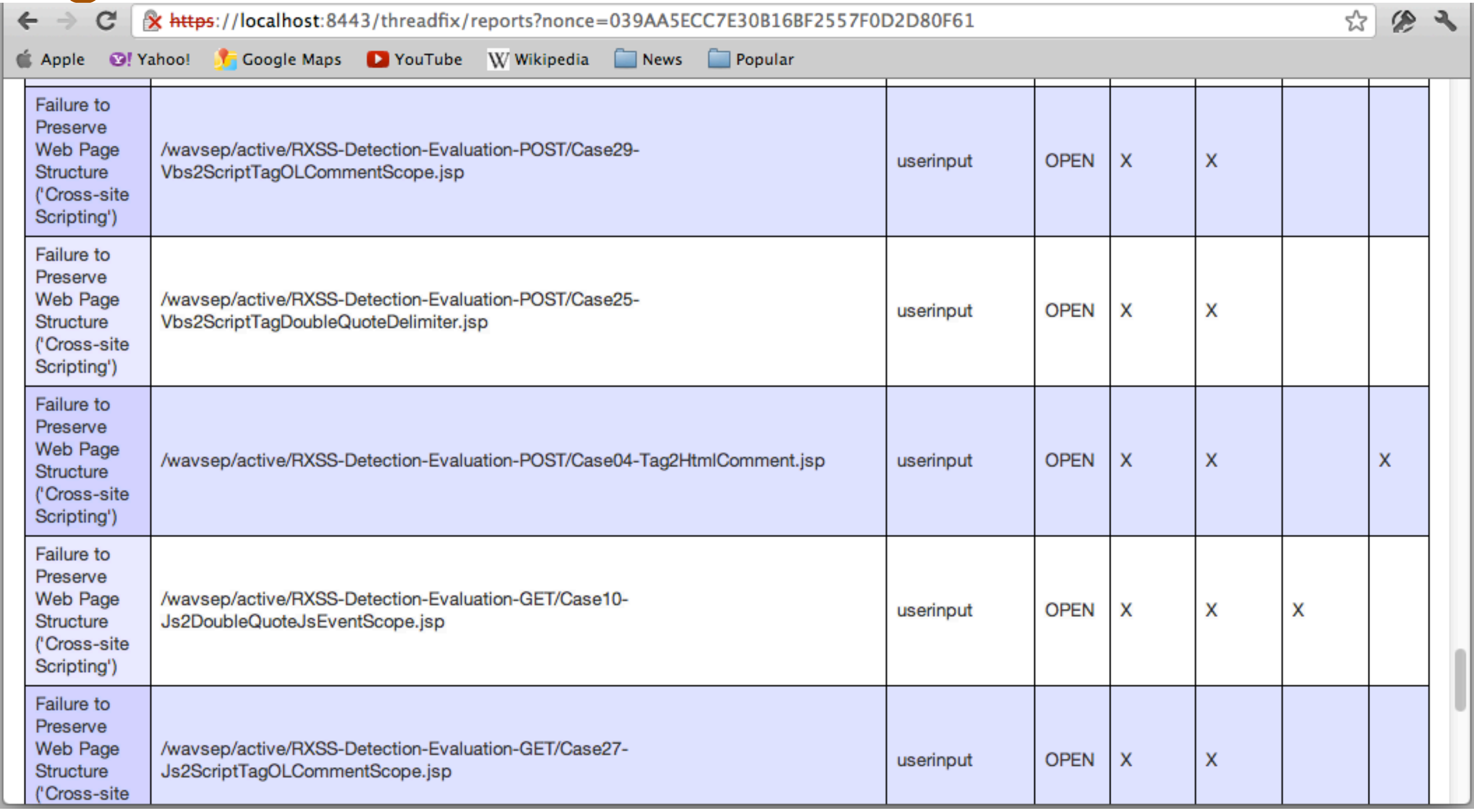
Report By Vulnerability Type



Channel Comparison By Vulnerability

Description	Arachni	OWASP Zed Attack Proxy	Skipfish	w3af
Improper Sanitization of Special Elements used in an SQL	178	84	32	70
Failure to Control Generation of Code ('Code Injection')	50	0	0	0
Failure to Preserve Web Page Structure ('Cross-site Scripting')	68	67	17	46
Cross-Site Request Forgery (CSRF)	6	117	53	0
Information Exposure	2	4	0	0
Information Leak Through Browser Caching	0	107	0	0
Improper Validation of Host-specific Certificate Data	0	0	1	0
Information Leak Through Server Error Message	0	0	26	0
Externally Controlled Reference to a Resource in Another	0	0	3	0
Failure to Sanitize CRLF Sequences in HTTP Headers ('HTTP	0	0	1	0

Detail Report Can Be Used To Error-Check Merge Process


https://localhost:8443/threadfix/reports?nonce=039AA5ECC7E30B16BF2557F0D2D80F61

Failure to Preserve Web Page Structure ('Cross-site Scripting')	/wavsep/active/RXSS-Detection-Evaluation-POST/Case29-Vbs2ScriptTagOLCommentScope.jsp	userinput	OPEN	X	X		
Failure to Preserve Web Page Structure ('Cross-site Scripting')	/wavsep/active/RXSS-Detection-Evaluation-POST/Case25-Vbs2ScriptTagDoubleQuoteDelimiter.jsp	userinput	OPEN	X	X		
Failure to Preserve Web Page Structure ('Cross-site Scripting')	/wavsep/active/RXSS-Detection-Evaluation-POST/Case04-Tag2HtmlComment.jsp	userinput	OPEN	X	X		X
Failure to Preserve Web Page Structure ('Cross-site Scripting')	/wavsep/active/RXSS-Detection-Evaluation-GET/Case10-Js2DoubleQuoteJsEventScope.jsp	userinput	OPEN	X	X	X	
Failure to Preserve Web Page Structure ('Cross-site	/wavsep/active/RXSS-Detection-Evaluation-GET/Case27-Js2ScriptTagOLCommentScope.jsp	userinput	OPEN	X	X		

Current Limitations

- Vulnerability importers are not currently formally vendor-supported
  - *Though a number have helped us test and refine them (thanks!)*
  - *After you get a good scan make sure you also got a good import*

- Summary report should show data by severity rating
  - *Make it easier to focus on vulnerabilities you probably care more about*
  - *But you can look at the data by vulnerability type*

Try This At Home, Kids

- Pick some applications to test
  - *Representative sample for your organization*
  - *Common languages, frameworks*
- Run scans with the targeted scanning technologies
  - *Make sure you get good scans: login, other state-based issues*
  - *If you train the scans (always a good idea) be consistent*
- Import the scans into ThreadFix
  - *Make sure you're happy with the import*
- Run some reports

You Know What Would Make All This Way Easier?

- Common data standards for scanning tools!
- Current efforts:
  - *MITRE Software Assurance Findings Expression Schema (SAFES)*
    - http://www.mitre.org/work/tech_papers/2012/11_3671/
  - *OWASP Data Exchange Format Project*
    - https://www.owasp.org/index.php/OWASP_Data_Exchange_Format_Project

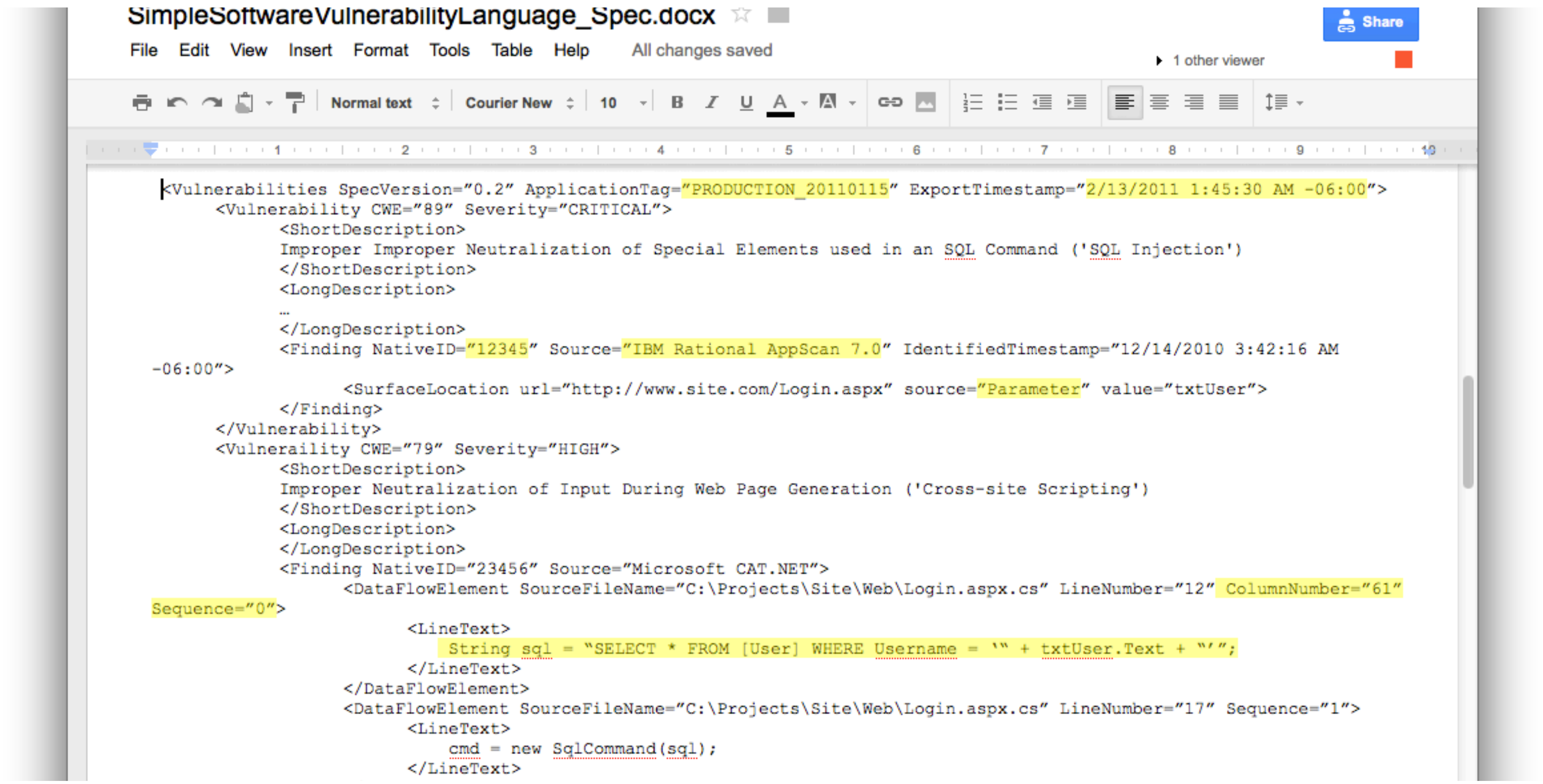
Simple Software Vulnerability Language (SSVL)

- Common way to represent static and dynamic scanner findings
- Based on our experience building importers for ThreadFix
  - *It "works" for real-world applications because we are essentially using it

- Love to hear feedback
  - *Send me a request and I can share the document for editing/annotation*

- Online:
  - *https://docs.google.com/document/d/1H5hWUdj925TtoZ7ZvnfHdFABe7hBCGuZtLUas29yBGI/edit?pli=1*
  - *Or http://tinyurl.com/cslqv47*

Simple Software Vulnerability Language (SSVL)


SimpleSoftwareVulnerabilityLanguage_Spec.docx
Share
File Edit View Insert Format Tools Table Help
All changes saved
1 other viewer
Normal text
Courier New
10

```
<Vulnerabilities SpecVersion="0.2" ApplicationTag="PRODUCTION_20110115" ExportTimestamp="2/13/2011 1:45:30 AM -06:00">
     <Vulnerability CWE="89" Severity="CRITICAL">
           <ShortDescription>
           Improper Improper Neutralization of Special Elements used in an SQL Command ('SQL Injection')
           </ShortDescription>
           <LongDescription>
           …
           </LongDescription>
           <Finding NativeID="12345" Source="IBM Rational AppScan 7.0" IdentifiedTimestamp="12/14/2010 3:42:16 AM
-06:00">
                 <SurfaceLocation url="http://www.site.com/Login.aspx" source="Parameter" value="txtUser">
           </Finding>
     </Vulnerability>
     <Vulneraility CWE="79" Severity="HIGH">
           <ShortDescription>
           Improper Neutralization of Input During Web Page Generation ('Cross-site Scripting')
           </ShortDescription>
           <LongDescription>
           </LongDescription>
           <Finding NativeID="23456" Source="Microsoft CAT.NET">
                 <DataFlowElement SourceFileName="C:\Projects\Site\Web\Login.aspx.cs" LineNumber="12" ColumnNumber="61"
Sequence="0">
                       <LineText>
                          String sql = "SELECT * FROM [User] WHERE Username = '" + txtUser.Text + "'";
                       </LineText>
                 </DataFlowElement>
                 <DataFlowElement SourceFileName="C:\Projects\Site\Web\Login.aspx.cs" LineNumber="17" Sequence="1">
                       <LineText>
                          cmd = new SqlCommand(sql);
                       </LineText>
```

Questions

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www.denimgroup.com

www.denimgroup.com/threadfix

code.google.com/p/threadfix

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