



Real World Web Service Testing For Web Hackers



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E M B E D D I N G S E C U R I T Y

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- » Senior SANS Instructor and Internet Storm Center Handler
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AGENDA

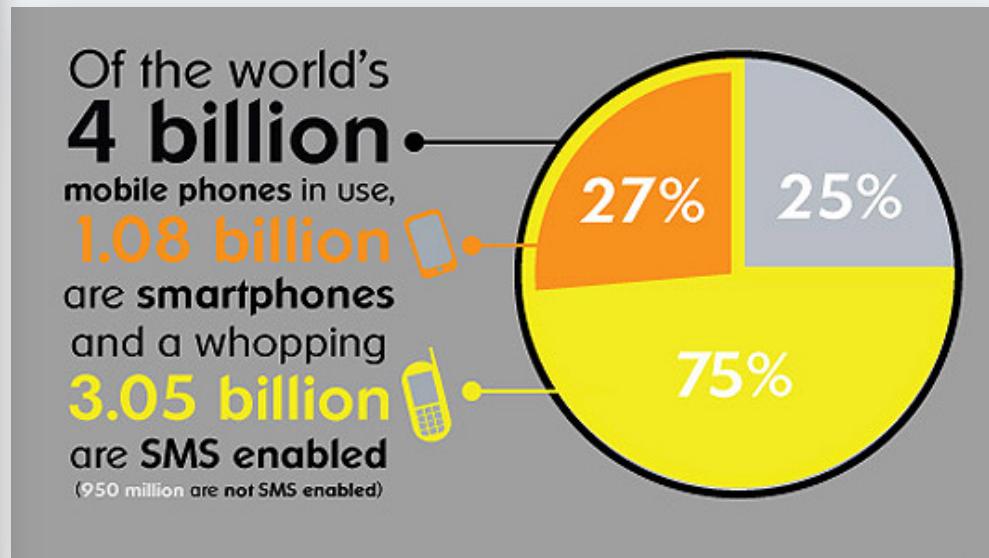
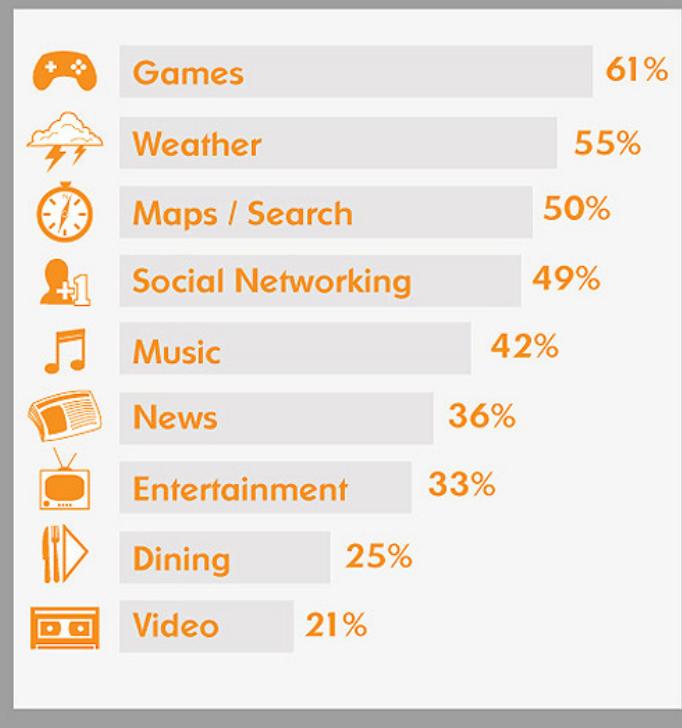
- » State of the Union for Web Services Testing
- » New Web Services threats and risks we need to address
- » Process Improvements Needed
 - Methodology, testing techniques
 - Tools and Lab Environments for Testing

WHY ATTACK WEB SERVICES?

- » Secondary attack vector
- » Ability to bypass controls in the application
- » Many developers don't implement proper security controls
- » Installed outside the protections within the web application
- » Assumed that the only client for a web service is another application
 - **You know what happens when we assume right?**

RECENT STATISTICS

» What do people use their mobile phones for?



» Statistics are from Microsoft Tag

WEB SERVICES STATE OF THE UNION

- » There are issues with:
 - Scoping
 - Tools
 - Testing Process
 - Methodology
 - Testing Techniques
 - Education
 - Testing Environments
- » Basically, it's all broken...

PENETRATION TESTERS DON'T KNOW WHAT TO DO WITH WEB SERVICES

- » How do you scope?
 - Do you even ask the right scoping questions?
- » Where do you begin?
- » How do I test this thing?
 - Automated vs. Manual Testing
 - Black vs. Grey vs. White Box Testing

WHY IS THE TESTING METHODOLOGY BROKEN?

» OWASP Web Service Testing Guide v3

- It's good for web application testing "in general"
- It's the "gold standard"
- It's outdated in regards to web service testing
- Missing full coverage based on a complete threat model
 - Examples: MiTM, Client-side storage, host based authentication
- Testing focused on old technology
 - Example: No mention of WCF services, how to test multiple protocols
- Most testing uses standard Grey Box techniques, fails to address unique web service requirements

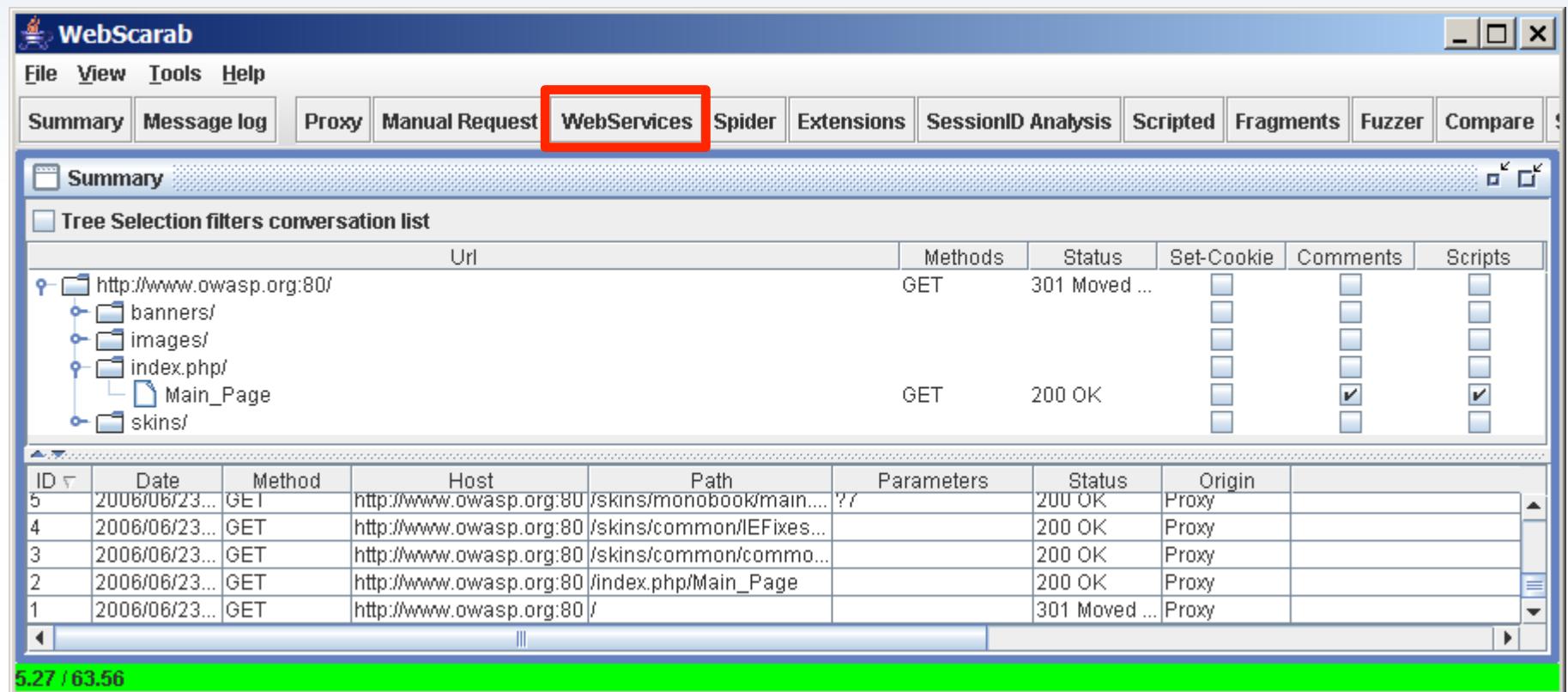
CURRENT TOOLS

- » They SUCK 😊
- » Mostly commercial tools (for developers, very little security focus)
 - soapUI, WCF Storm, SOA Cleaner
- » Very little automation
 - Tester's time is spent configuring tools and getting them running, less hacking!
 - Minimal amount of re-usability
- » Multiple tools built from the ground up
 - Missing features
 - Missing functionality (payloads)
 - Community support?

CURRENT TOOLS

- » What happened to WebScarab?
- » WS-Digger? No SSL?
- » There are other tools but many are hard to configure or just don't work properly
- » SOAP Messages written by-hand (THIS REALLY SUCKS!)
 - ~14 modules in Metasploit for web services

WEBSCARAB – WEB SERVICE MODULE



The screenshot shows the WebScarab application window. The title bar reads "WebScarab". The menu bar includes "File", "View", "Tools", and "Help". Below the menu is a toolbar with tabs: "Summary", "Message log", "Proxy", "Manual Request", "WebServices" (which is highlighted with a red box), "Spider", "Extensions", "SessionID Analysis", "Scripted", "Fragments", "Fuzzer", and "Compare". The main pane has a "Summary" tab selected, showing a tree view of a conversation list. The tree view shows a folder structure under "http://www.owasp.org:80/". The bottom part of the main pane is a table of captured requests:

ID	Date	Method	Host	Path	Parameters	Status	Origin	
5	2006/06/23...	GET	http://www.owasp.org:80	/skins/monobook/main....	?77	200 OK	Proxy	
4	2006/06/23...	GET	http://www.owasp.org:80	/skins/common/IEFixes...		200 OK	Proxy	
3	2006/06/23...	GET	http://www.owasp.org:80	/skins/common/commo...		200 OK	Proxy	
2	2006/06/23...	GET	http://www.owasp.org:80	/index.php/Main_Page		200 OK	Proxy	
1	2006/06/23...	GET	http://www.owasp.org:80	/		301 Moved ...	Proxy	

At the bottom of the window, a green progress bar indicates "5.27 / 63.56".

WSDIGGER

WS Digger

File Attacks Analysis Report Help

Foundstone | WSDigger™

WSDL Get Methods Clear Data

Service URL Invoke

Input

GoogleSearchService

- doGetCachedPage
- doSpellingSuggestion
- doGoogleSearch

doGoogleSearch

- String key =
- String q =
- Int32 start =
- Int32 maxResults =
- Boolean filter =
- String restrict =

Input Value

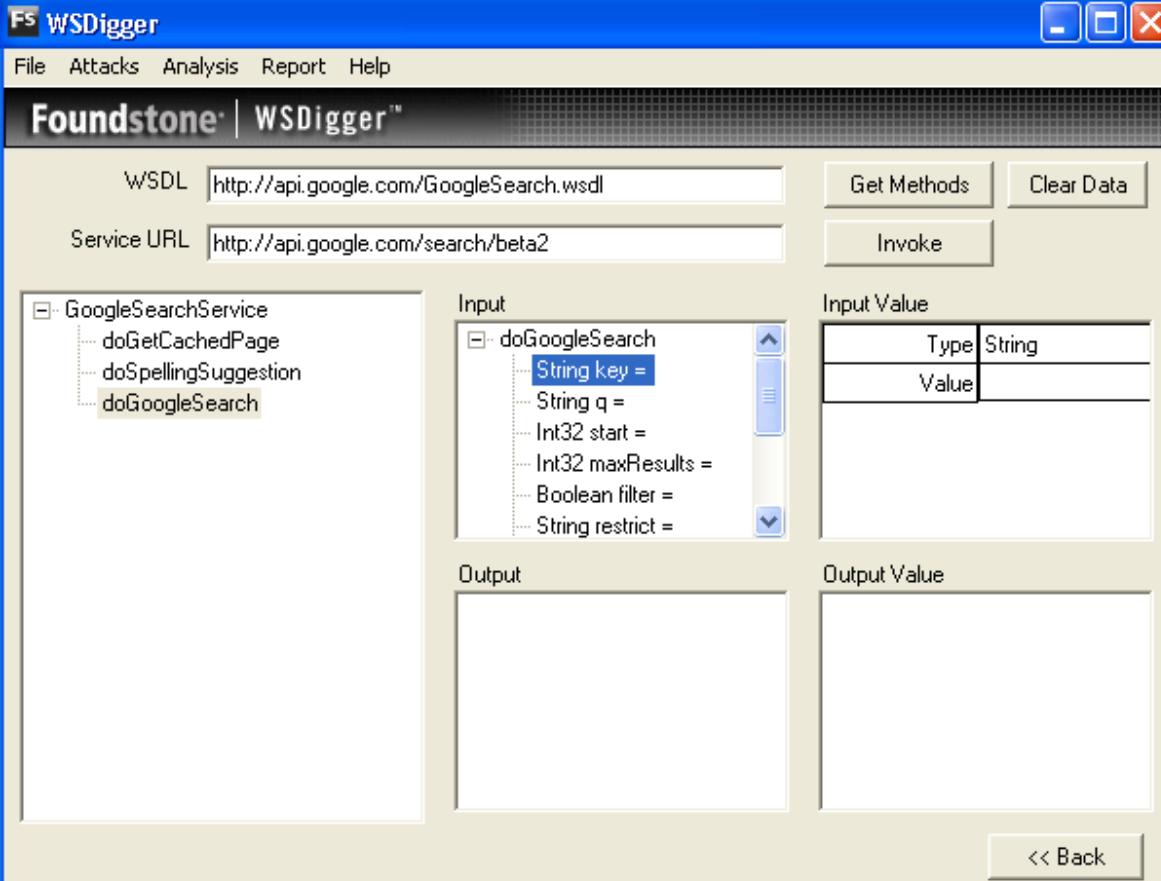
Type	String
Value	

Output

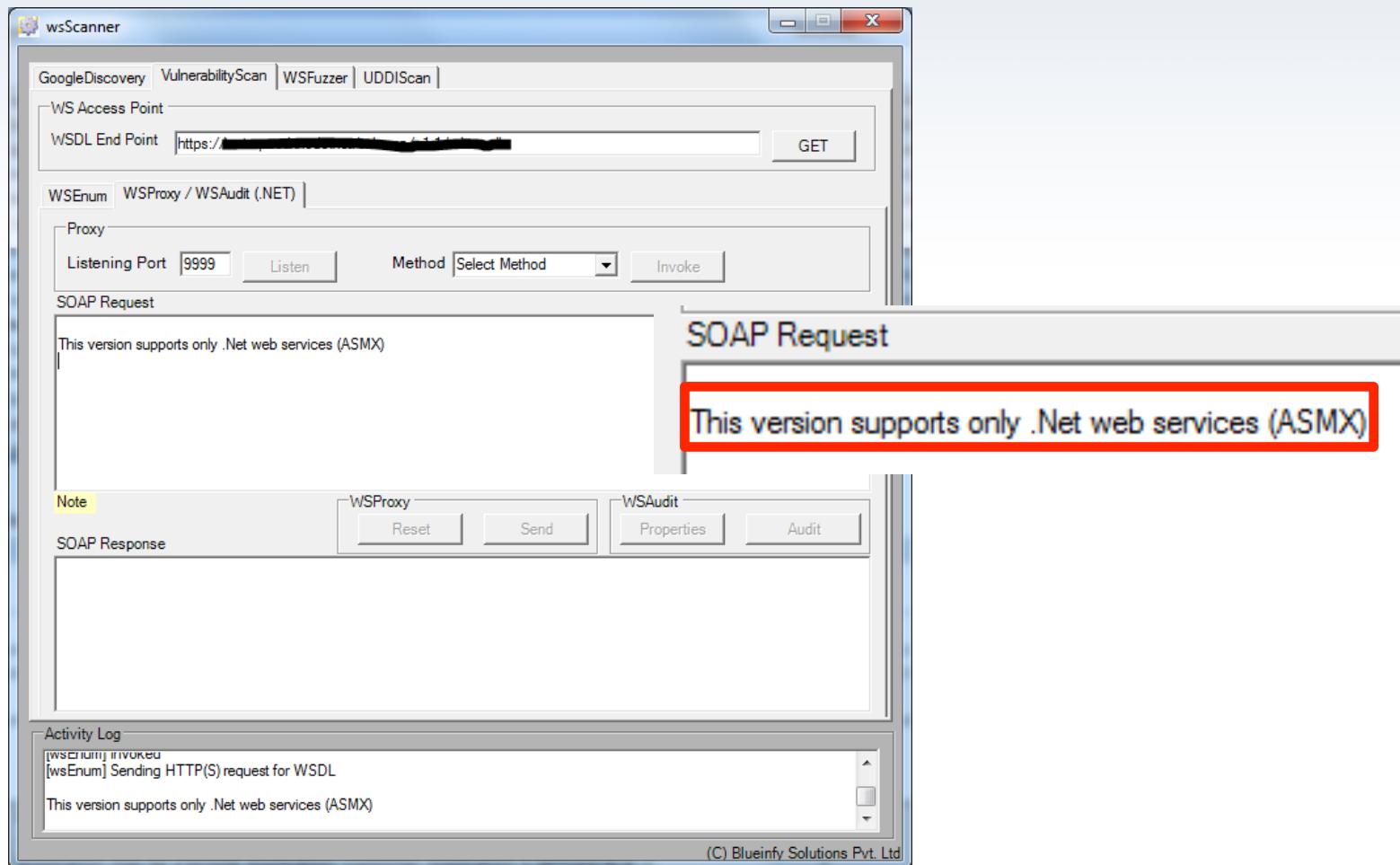
Output Value

<< Back

Proxy assembly loaded successfully from file: C:\DOCUME~1\DELTAU~1\IMPOST~1\Temp\1AC0F599EB2B3AD38DDE90C4



WSSCANNER

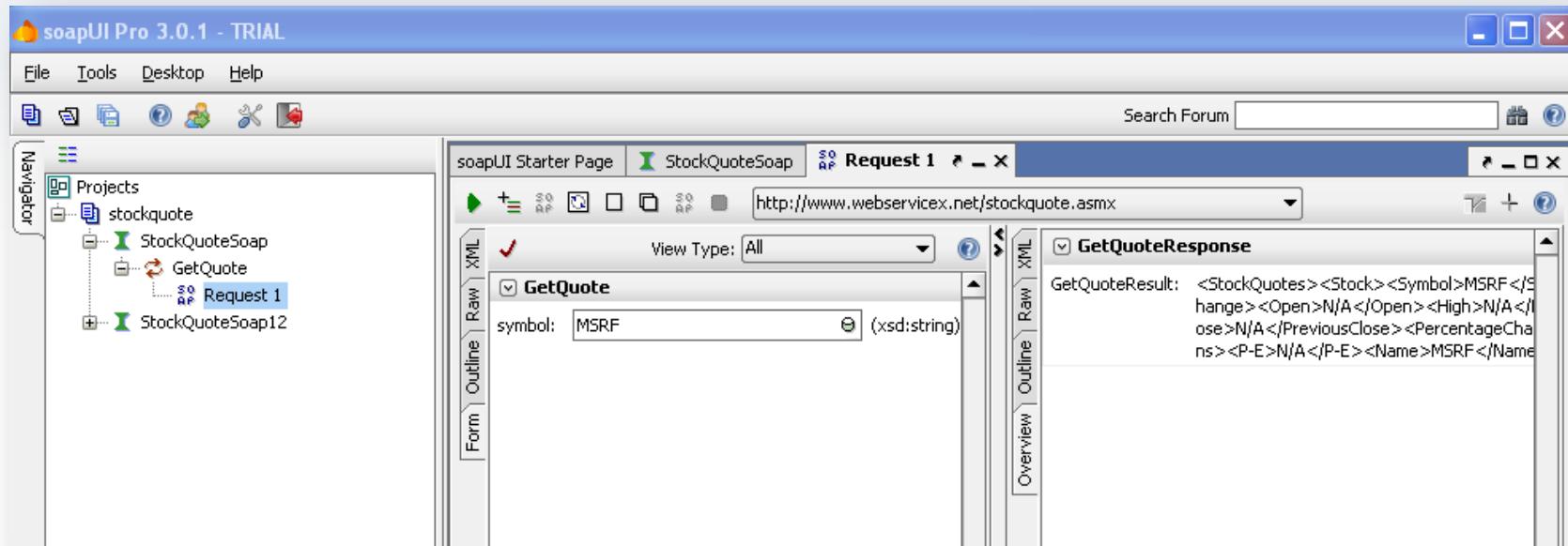


WHAT ARE WE USING?

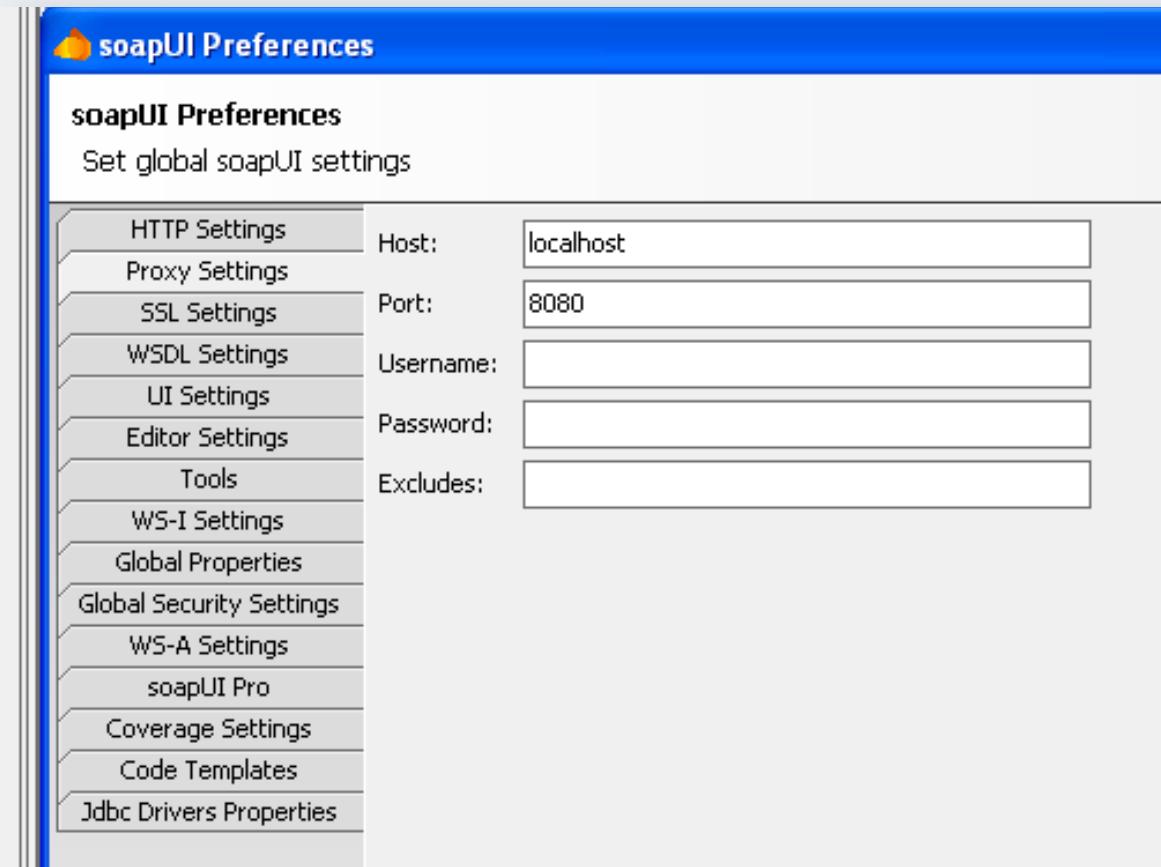
- » soapUI combined with BurpSuite are the bomb
 - Still could be better
- » There are very good BurpSuite Plugins by Ken Johnson as well:
<http://resources.infosecinstitute.com/soap-attack-1/>
- » Custom built scripts for specific engagements
 - Takes time and billable hours



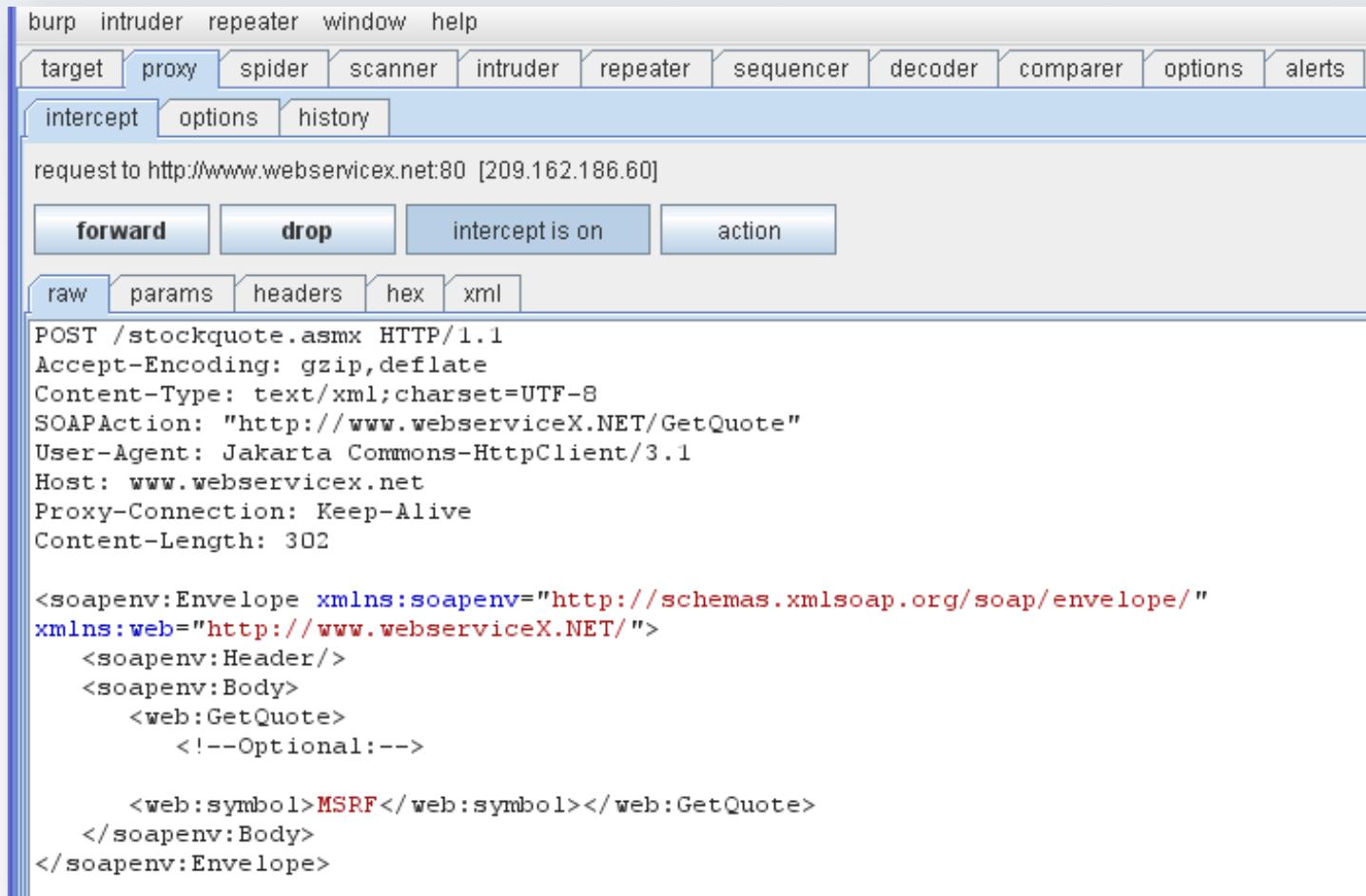
SCREEN SHOTS OF SOAPUI->BURP



SCREEN SHOTS OF SOAPUI->BURP (2)



SCREEN SHOTS OF SOAPUI->BURP (3)



The screenshot shows the Burp Suite interface with the following details:

- Menu Bar:** burp intruder repeater window help
- Toolbar:** target proxy spider scanner intruder repeater sequencer decoder comparer options alerts
- Sub-Toolbar:** intercept options history
- Status Bar:** request to http://www.webservicex.net:80 [209.162.186.60]
- Action Buttons:** forward drop intercept is on action
- Content View:** raw params headers hex xml
- Request Headers:**

```
POST /stockquote.asmx HTTP/1.1
Accept-Encoding: gzip,deflate
Content-Type: text/xml;charset=UTF-8
SOAPAction: "http://www.webserviceX.NET/GetQuote"
User-Agent: Jakarta Commons-HttpClient/3.1
Host: www.webservicex.net
Proxy-Connection: Keep-Alive
Content-Length: 302
```
- Request Body (Raw XML):**

```
<soapenv:Envelope xmlns:soapenv="http://schemas.xmlsoap.org/soap/envelope/"
xmlns:web="http://www.webserviceX.NET/">
    <soapenv:Header/>
    <soapenv:Body>
        <web:GetQuote>
            <!--Optional:-->

            <web:symbol>MSRF</web:symbol></web:GetQuote>
    </soapenv:Body>
</soapenv:Envelope>
```

LACK OF TESTING ENVIRONMENTS

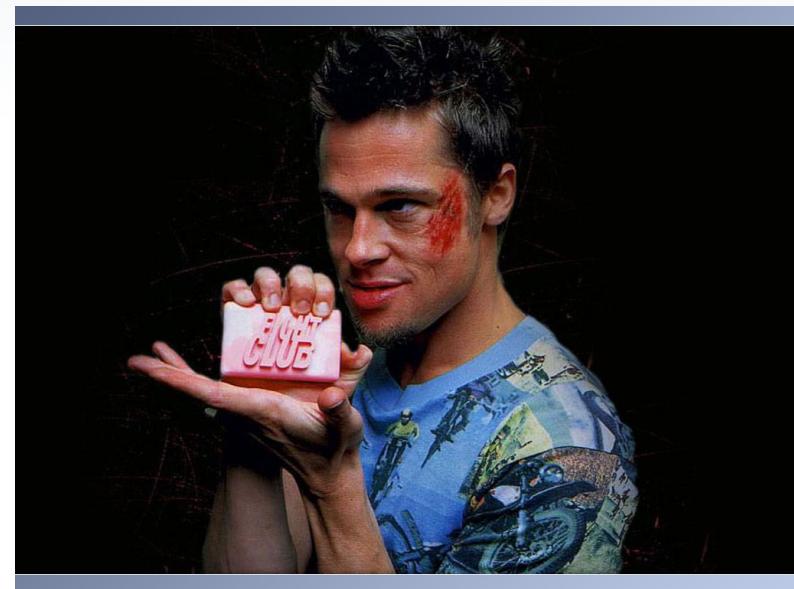
- » Great! I have a new tool/script..where can I test this?
- » Production systems will work....wait, what?
- » I'll just build my own testing environment...wait, what?



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WEB SERVICES AND THE OSI LAYERS

- » Implemented by adding XML into layer 7 applications (HTTP)
- » SOAP
 - Simple Object Access Protocol
- » Think of SOAP like you would with SMTP
 - It's a message/envelope and you need to get a response



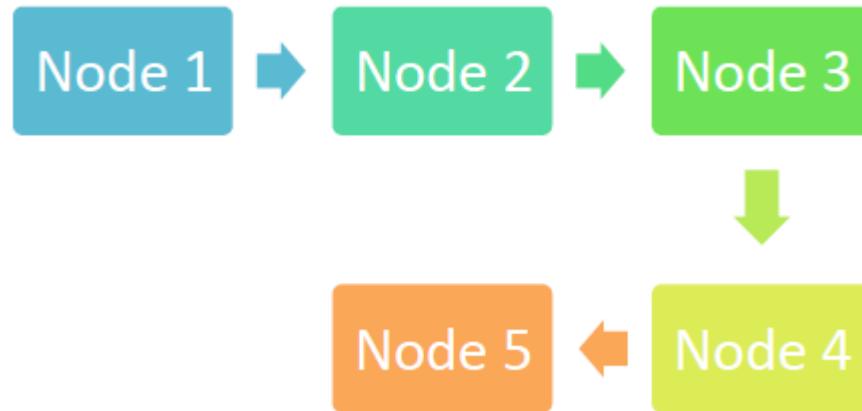
THE WEB SERVICE THREAT MODEL

- » Web Services in Transit
 - Is data being protected in transit?
 - SSL
 - What type of authentication is used?
 - BASIC Authentication != Secure
- » Web Services Engine
- » Web Services Deployment
- » Web Services User Code

* From “Hacking Web Services” by Shreeraj Shah

THE SOAP ENVELOPE AND TRANSPORT MECHANISM

- » Multiple endpoints become a problem
- » SSL only protects the data between nodes
- » What about the security of the message itself?



WEB SERVICES FINGERPRINTING

- » Google Hacking for exposed WSDLs
 - filetype:asmx
 - filetype:jws
 - filetype:wsdl
 - Don't forget about DISCO/UDDI directories
- » Searches for Microsoft Silverlight XAP files
- » Shodan search for exposed web service management interfaces

GOOGLE SEARCH

filetype:asmx

About 1,070,000 results (0.15 seconds)

inurl:asmx?wsdl

About 6,140,000 results (0.16 seconds)

inurl:jws?wsdl

About 1,610 results (0.17 seconds)

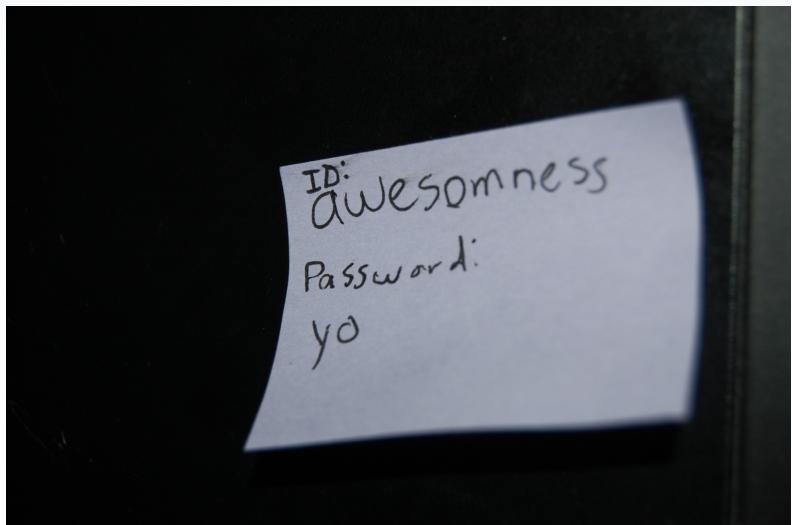
filetype:jws

About 2,210 results (0.13 seconds)

DIFFERENCES IN WEB SERVICE STANDARDS

- » Some developer departure from XML based SOAP to RESTful services like JSON
- » REST (Representational State Transfer) use HTTP methods (GET, POST, PUT, DELETE)
- » RESTful services are lightweight non-complex
- » However:
 - SOAP based services are complex for a reason!
 - Many custom applications use them in enterprise applications
- » Large services still use SOAP:
 - Amazon EC2, PayPal, Microsoft Azure are a few examples

THE IMPORTANCE OF WEB SERVICE MANAGEMENT INTERFACES



- » If these interfaces are exposed an attacker could:
 - Control the system that has the web services deployed
 - Why bother even testing the web services at this point??
- » How about weak or default passwords?
 - Most organization this is their biggest risk
 - Pass-the-Hash
- » Administration interfaces
 - Axis2 SAP BusinessObjects
 - 2010 Metasploit module created for this
 - <http://spl0it.org/files/talks/basc10/demo.txt>

GLASSFISH CURRENT ATTACKS

- » Web Application interface for managing web application and web services
- » Unique port: 4848
 - Enumeration easy
- » Sun Glassfish 2.x and Sun Application Server 9.x
 - Default credentials: admin / adminadmin
- » Known authentication bypass: CVE-2011-0807 (released in April)
 - Affects: Sun Glassfish 2.x, Sun Application Server 9.x and Glassfish 3.0

GLASSFISH 3.1 ATTACKS

- » Still unique port: 4848
 - Enumeration easy
- » Oracle GlassFish 3.0 and 3.1 use a default credential: (admin / *blank password*)



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ACLE Oracle GlassFish Server 3.1 Administration Guide

Technology Network Library PDF Print View Feedback Search

Information

of GlassFish Server Administration
Settings and Locations
Tasks
Configuration Tasks
Names Work for Configuration
Files
f Configuration Changes
erine Whether the DAS or an Instance
Restart
uration Changes That Require Restart
ic Configuration Changes
es That Affect Applications

stration Tools
stration Console
min Utility
terfaces
Tool
ool Utility

Administration Console

The Administration Console is a browser-based utility that features an easy-to-navigate graphical interface that includes extensive online help for the administrative tasks.

To use the Administration Console, the domain administration server (DAS) must be running. Each domain has its own DAS, which has a unique port number. When GlassFish Server was installed, you chose a port number for the DAS, or used the default port of 4848. You also specified a user name and password if you did not accept the default login (admin with no password).

When specifying the URL for the Administration Console, use the port number for the domain to be administered. The format for starting the Administration Console in a web browser is `http://hostname:port`. For example:

`http://kindness.example.com:4848`

If the Administration Console is running on the host where GlassFish Server was installed, specify `localhost` for the host name. For example:

`http://localhost:4848`

For Microsoft Windows, an alternate way to start the GlassFish Server Administration Console is by using the Start menu.

GLASSFISH ENUMERATION

Main Exploits Research

SHODAN glassfish Search

» Top countries matching your search

<u>United States</u>	1,390
<u>Germany</u>	316
<u>Brazil</u>	173
<u>France</u>	173
<u>Canada</u>	157

GLASSFISH 3.1 ATTACK

Administration Console

The Administration Console is a browser-based utility that features an easy-to-navigate graphical interface that includes extensive online help for the administrative tasks.

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http://kindness.example.com:4848
```

If the Administration Console is running on the host where GlassFish Server was installed, specify `localhost` for the host name. For example:

```
http://localhost:4848
```

For Microsoft Windows, an alternate way to start the GlassFish Server Administration Console is by using the Start menu.

Reference: http://download.oracle.com/docs/cd/E18930_01/html/821-2416/ggjxp.html#ablav

GLASSFISH 3.1 METASPLOIT DEMO

- » Auxiliary Scanner
- » Exploit Module
 - Thanks to Juan and Sinn3r for helping with the module
- » Works on :
 - Glassfish 3.1 (commercial and open source)
 - default credentials (admin / *blank password*)
 - Glassfish 3.0 (commercial and open source)
 - default credentials (admin / *blank password*) and auth bypass
 - Sun Glassfish 2.1 and Sun Application Server 9.1
 - Default credentials (admin / adminadmin) and auth bypass

THE IMPORTANCE OF WEB SERVICE MANAGEMENT INTERFACES

- » If these interfaces are exposed an attacker could:
 - Control the system that has the web services deployed
 - Why bother even testing the web services at this point??
- » How about weak or default passwords?
 - Example: Axis2 SAP BuisinessObjects
 - 2010 Metasploit module created for this (Josh you want to show an example?)

NEW WEB SERVICE THREATS

» Microsoft Silverlight

- Client side application that can use web services
- SOAP or REST
- Can use WCF (Windows Communication Foundation) services
- Attacker can directly interface with the web services...really no need for the client
- Security depends on the configuration of the services!

NEW WEB SERVICE ATTACKS



- » WS-Attacks.org by Andreas Flakenberg
 - Catalogs most (if not all) attacks for modern SOAP and BPEL web services
- » SOAP requests to web services that provide content to the web app
- » AJAX, Flash and Microsoft Silverlight add to the complexity

NEW ADVANCEMENTS

- » Client side applications like Microsoft Silverlight
- » Increased complexity with AJAX and Flash implementations
- » Multiple web services being used within applications
- » Organizations exposing web services for mobile applications



BPEL

» WS-BPEL

- Web Service Business Process Execution Language (BPEL)
- Separates the business process from the implementation logic
- Usually a White Box approach is required to understand the business logic fully

SCOPING A WEB SERVICE PENTEST

- » Pre-Engagement Scoping is **CRITICAL!**
- » Not only for pricing but for proper testing
- » Questions such as:
 - What type of framework being used? (WCF, Apache Axis, Zend)
 - Type of services (SOAP, REST, WCF)
 - What type of data do the web services provide
 - Provide all WSDL paths and endpoints
 - What type of authentication does the web service use?
 - SOAP attachment support?
 - Can you provide multiple SOAP requests that show full functionality?
- » There are MANY more questions. Our White Paper has the full list ☺

THE NEW WEB SERVICE TESTING METHODOLOGY

- » OWASP Testing Guide v3 was a great start
- » It's old, outdated and doesn't address new concerns
- » Our research will be included in OWASP Testing Guide v4
- » We are aligning the methodology with:
 - PTES: Penetration Testing Execution Standard
 - PTES provides a standard penetration testing methodology framework
 - Created with the help from information security practitioners from all areas of the industry (Example: Financial Institutions, Service Providers, Security Vendors)
 - Can be used by all penetration testers and outlines essential phases of ANY penetration test

PTES AND WEB SERVICE TESTING

- » Pre-Engagement Interactions
 - Scoping Questions and Goals
 - Assessment type (Black, Grey, White Box)
 - Rules of Engagement
- » Intelligence Gathering
 - Identify WSDLs and Enumerate
 - WS-Security Controls
 - Authentication Credentials
 - Sample SOAP requests
 - Identify Web Service Interfaces (GlassFish, Axis2)
- » Threat Modeling
 - What is most valuable from a business perspective?
 - Outline scenarios for realistic attack vectors



PTES AND WEB SERVICE TESTING

- » Vulnerability Analysis
 - Authentication Testing (Brute Force)
 - Transport Layer Testing
 - Web Service Interface Management Testing
 - Analyze Client Applications (Silverlight)
- » Exploitation
 - XML Structural, Content-Level Testing
 - Use new MSFWEBFUZZ module
 - Reply/MiTM Testing
 - BPEL Testing
- » Post Exploitation
 - Got shell?
 - Prepare and document
- » Reporting



* Full Methodology is included in our White Paper!

NEW WEB SERVICE TESTING MODULES FOR METASPLOIT

- » Two tools released today:
 - HTTP request repeater (msfwebrepeat)
 - HTTP fuzzer (msfwebfuzz)
- » Backend web services libs (alpha version)
 - Authentication support: BASIC/DIGEST and WS-Security
 - Ability to leverage existing payloads (php/java) thru native MSF libs

MSFWEBREPEAT - DEMO



MSFWEBFUZZ - DEMO



MSF WEB SERVICES MODULE - DEMO



DAMN VULNERABLE WEB SERVICES

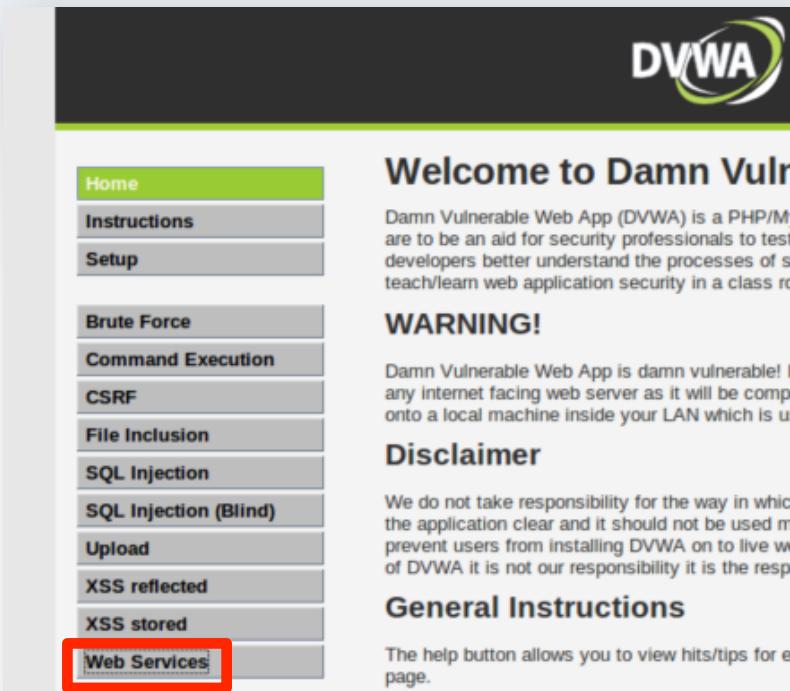
- » Damn Vulnerable Web Services (DVWS) is a series of vulnerable web services
- » Built within DVWA
- » Provides a series of services to test



The screenshot shows the DVWA homepage. At the top right is the DVWA logo. On the left is a vertical navigation menu with the following items: Home (highlighted in green), Instructions, Setup, Brute Force, Command Execution, CSRF, File Inclusion, SQL Injection, SQL Injection (Blind), Upload, XSS reflected, XSS stored, and Web Services (highlighted with a red box). The main content area has a title 'Welcome to Damn Vul...' and a warning message: 'Damn Vulnerable Web App (DVWA) is a PHP/M...'. It also contains sections for 'WARNING!', 'Disclaimer', and 'General Instructions'.

DVWS FEATURES

- » Uses DVWA authentication
- » High, medium and low difficulties
- » WSDL available for each services
- » Reflective and persistent vulnerabilities
- » Extendable



The screenshot shows the DVWA homepage. At the top right is the DVWA logo. Below it, the page title "Welcome to Damn Vulnerable Web App" is displayed. To the left is a sidebar menu with the following items: Home (highlighted in green), Instructions, Setup, Brute Force, Command Execution, CSRF, File Inclusion, SQL Injection, SQL Injection (Blind), Upload, XSS reflected, XSS stored, and Web Services (highlighted with a red box). The main content area contains a "WARNING!" section stating that DVWA is damn vulnerable and can be run on any internet-facing web server. It also includes a "Disclaimer" section and a "General Instructions" section.

Welcome to Damn Vulnerable Web App

Damn Vulnerable Web App (DVWA) is a PHP/MYSQL application designed to be an aid for security professionals to test their skills and for developers better understand the processes of security. It is intended to teach/learn web application security in a class room environment or at home.

WARNING!

Damn Vulnerable Web App is damn vulnerable! It can be run on any internet facing web server as it will be completely exposed onto a local machine inside your LAN which is useful for penetration testing.

Disclaimer

We do not take responsibility for the way in which you use this application. It is clear and it should not be used maliciously. We do not prevent users from installing DVWA on to live websites. If you do so, it is at your own risk. Of course, if DVWA is not our responsibility, it is the responsibility of the user.

General Instructions

The help button allows you to view hits/tips for each page.

WS-SQLI

- » Allows for the testing of SQL injection
- » Uses the DVWA database to be consistent
- » Difficulty levels are used for more challenge

sqlwsdl

View the [WSDL](#) for the service. Click on an operation name to view it's details.

sql

[Close](#)

Name: sql
Binding: sqlwsdlBinding
Endpoint: http://127.0.0.1/vulnerabilities/webservices/sql/index.php
SoapAction: urn:sqlwsdl#sql
Style: rpc
Input:
use: encoded
namespace: urn:sqlwsdl
encodingStyle: http://schemas.xmlsoap.org/soap/encoding/
message: sqlRequest
parts:
name: xsd:string
Output:
use: encoded
namespace: urn:sqlwsdl
encodingStyle: http://schemas.xmlsoap.org/soap/encoding/
message: sqlResponse
parts:
return: xsd:string
Namespace: urn:sqlwsdl
Transport: http://schemas.xmlsoap.org/soap/http
Documentation: Queries the database of contacts

WS-COMMANDINJ

- » Command injection allows for system commands delivered via SOAP
- » Filtering based on select DVWA difficulty
- » High level includes blind command injection

commandinjwsdl

View the [WSDL](#) for the service. Click on an operation name to view its details.

[commandinj](#)

[Close](#)

Name: commandinj
Binding: commandinjwsdlBinding
Endpoint: http://127.0.0.1/vulnerabilities/webservices/exec/index.php
SoapAction: um:commandinjwsdl#commandinj
Style: rpc
Input:
use: encoded
namespace: um:commandinjwsdl
encodingStyle: http://schemas.xmlsoap.org/soap/encoding/
message: commandinjRequest
parts:
name: xsd:string
Output:
use: encoded
namespace: um:commandinjwsdl
encodingStyle: http://schemas.xmlsoap.org/soap/encoding/
message: commandinjResponse
parts:
return: xsd:string
Namespace: um:commandinjwsdl
Transport: http://schemas.xmlsoap.org/soap/http
Documentation: Returns the results of a command

WS-XSS_P

- » Persistent XSS flaw
- » Service publishes content to the main web application
- » Difficult for automated testing due to the remote display

xss_pwsdl

View the [WSDL](#) for the service. Click on an operation name to view its details.

xss_p

Close

Name: xss_p
Binding: xss_pwsdlBinding
Endpoint: http://127.0.0.1/vulnerabilities/webservices/xss_p/index.php
SoapAction: um:xss_pwsdl#xss_p
Style: rpc
Input:
use: encoded
namespace: urn:xss_pwsdl
encodingStyle: <http://schemas.xmlsoap.org/soap/encoding/>
message: xss_pRequest
parts:
name: xsd:string
Output:
use: encoded
namespace: urn:xss_pwsdl
encodingStyle: <http://schemas.xmlsoap.org/soap/encoding/>
message: xss_pResponse
parts:
return: xsd:string
Namespace: urn:xss_pwsdl
Transport: <http://schemas.xmlsoap.org/soap/http>
Documentation: Injects content to display via the web application

CONCLUSIONS

- » Pay attention to new attack vectors and web service technology
- » Developers are ahead of the security community and we need to catch up
- » Our work is only the beginning. Get involved with OWASP, contribute to open source projects (get developers to do the same)



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