endava

COMMON WEBAPP SECURITY THREATS

… and what to do about them

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Content

- Introducing Web Security Threats & OWASP
- The OWASP Web Vulnerabilities List
- Useful Tools to Know About
- Reviewing Defences
- Summary

Introducing Web Security Threats

Web Security Threats

- We need systems that are **dependable** in the face of
  - Malice
  - Error
  - Mischance
- People are sometimes **bad**, **stupid** or just **unlucky**
- System security aims to **mitigate** these situations

Web Security Threats

- System threats are similar to **real-world threats**:
  - Theft
  - Fraud
  - Destruction
  - Disruption

- Anything of **value** may attract unwelcome attention

> *"I rob banks because that's where the money is"* – Willie Sutton

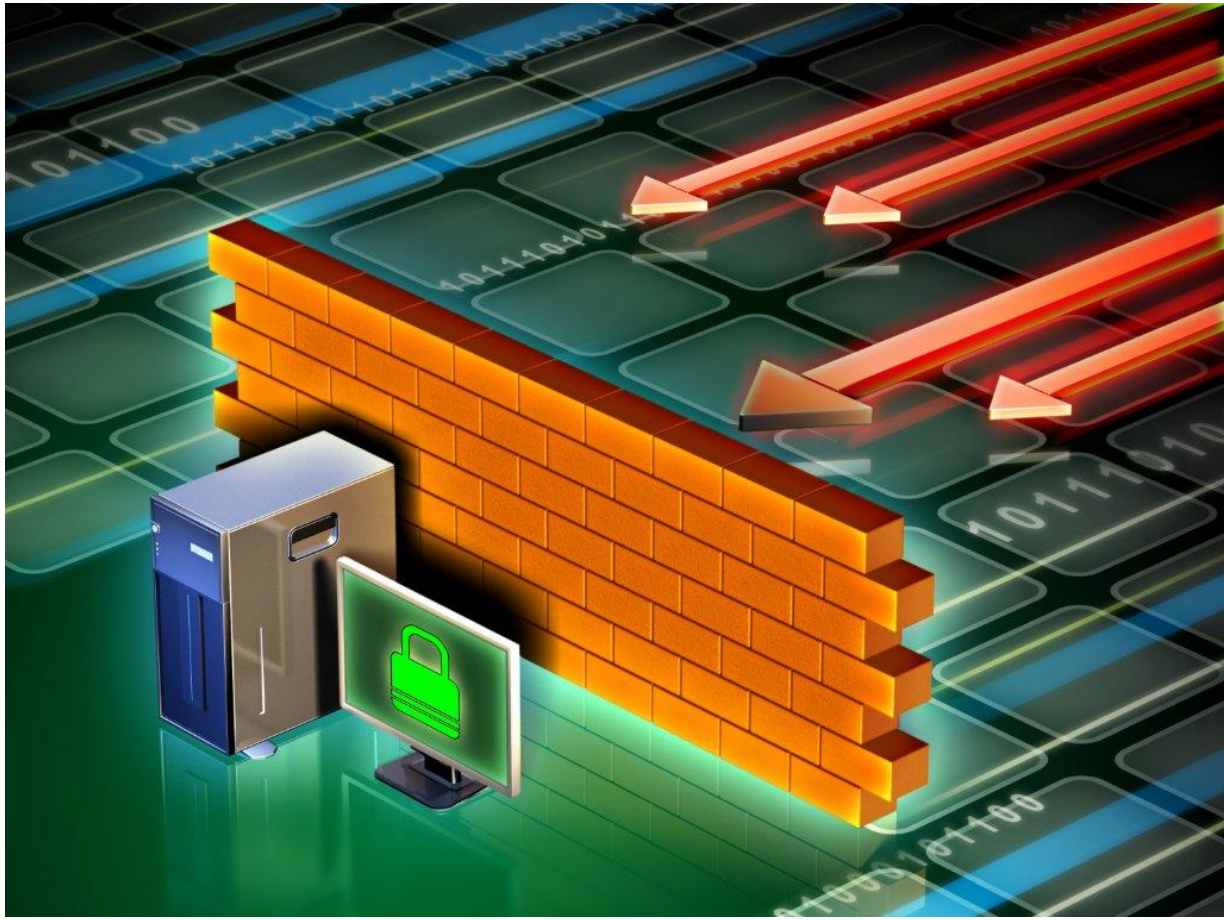
Web Security Threats

- Why do we **care** about these threats?
  - A threat is a **risk of a loss** of some sort
- Common types of **loss** are:
  - Time
  - Money
  - Privacy
  - Reputation
  - Advantage

Web Security Threats

- **Digital channels** need security
- **APIs** on the **Internet**
- **Introspection** of APIs
- Attacks being “**weaponised**”
- Today’s internal app is tomorrow’s “digital channel”

Security today mitigates tomorrow’s threat



Who are OWASP?

- The Open Web Application Security Project
  - Largely volunteer organisation, largely online
- Exists to improve the state of software security
  - Research, tools, guidance, standards
  - Runs local chapters for face to face meetings
- “OWASP Top 10” project lists top application security risks
  - Data-driven list of most significant threats to webapps
  - Referenced widely by MITRE, PCI DSS and similar
  - Updated as threats change (2003, 2004, 2007, 2010, 2013, 2017)

Other Important Security Organisations

- MITRE Corporation
  - Common Vulnerabilities and Exposures (CVE)
  - Common Weaknesses Enumeration (CWE)
- SAFECode
  - Fundamental Practices for Secure Software Development
  - Training

There are a lot of others too (CPNI, CERT, CIS, ISSA, …)

OWASP Web Vulnerabilities List

How was the 2017 List Produced?

- Project of the OWASP organisation
  - Group of ~75 volunteers create it
- Data set analysis
  - Data from 24 firms including Aspect Security, Checkmarx, MicroFocus, NCCST, Synopsis, TCS, Vantage Point, Veracode, …
  - Data represents ~114,000 applications
  - https://github.com/OWASP/Top10/2017/datacall
- Survey analysis
  - ~500 participants from the OWASP Top 10 mailing list

OWASP Top 10 - 2017

#1 Injection Attacks
#2 Broken Authentication
#3 Sensitive Data Exposure
#4 XML External Entities (XXE)
#5 Broken Access Control
#6 Security Misconfiguration
#7 Cross Site Scripting (XSS)
#8 Insecure Deserialisation
#9 Component Vulnerabilities
#10 Insufficient Logging and Monitoring

Some may look "obvious" but appear on the list year after year, based on real vulnerability data!

What Changed from 2013 to 2017?

OWASP 2013 Top 10	OWASP 2017 Top 10
A1 – Injection	A1 – Injection
A2 – Broken Authentication & Session Management	A2 – Broken Authentication
A3 – Cross-Site Scripting (XSS)	A3 – Sensitive Data Exposure
A4 – Insecure Direct Object References	A4 – XML External Entities (XEE) -- **NEW**
A5 – Security Misconfiguration	A5 – Broken Access Control
A6 – Sensitive Data Exposure	A6 – Security Misconfiguration
A7 – Missing Function Level Access Control	A7 – Cross Site Scripting (XSS)
A8 – Cross Site Request Forgery (CSRF)	A8 – Insecure Deserialisation -- **NEW**
A9 – Components with Known Vulnerabilities	A9 – Components with Known Vulnerabilities
A10 – Unvalidated Redirects & Forwards	A10 – Insufficient Logging and Monitoring -- **NEW**

#1 Injection Attacks

Exploitability	3
Prevalence	2
Detectability	3
Tech Impact	3

- Unvalidated input passed to any interpreter
  - Operating system and SQL are most common
  - Configuration injection often overlooked

```
SELECT * from table1 where name = '%1'
```

Set '%1' to **' OR 1=1 -- … this results in this query:**

```
SELECT * FROM table1 WHERE name = '' OR 1=1 --
```

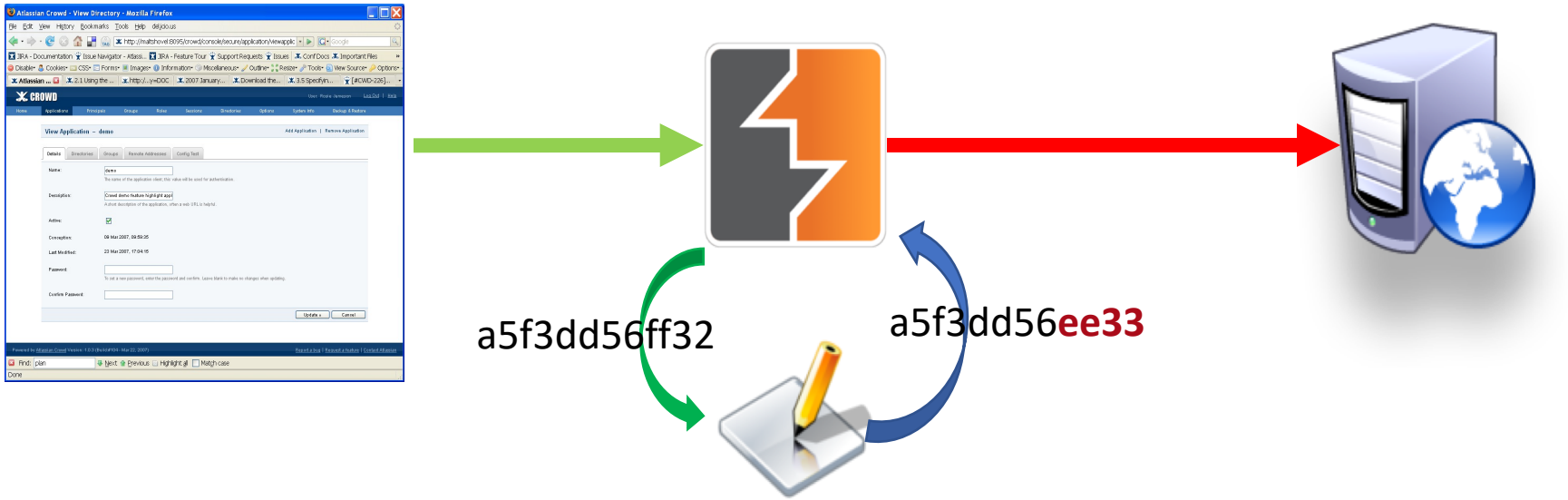
- Defences include "escaping" inputs, bind variables, using white lists, …

(See also #4 – XML External Entities …)

#2 Broken Authentication

Exploitability	3
Prevalence	2
Detectability	2
Tech Impact	3

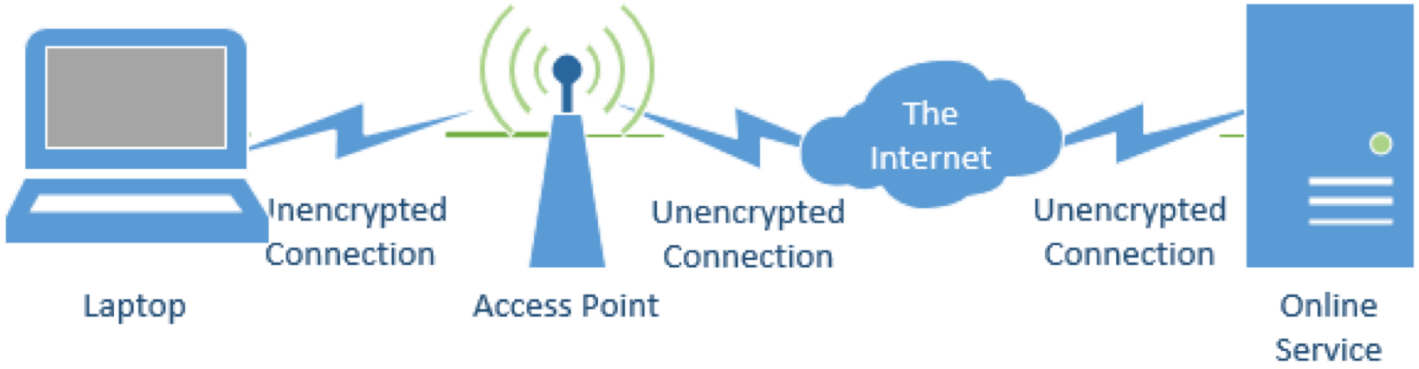
- Credential Stuffing - millions of usernames and passwords available
- Well known credentials often present
- Unprotected session IDs
- Session IDs not rotated after login or invalidated after use
- Mitigations include strong authentication and session management controls



#3 Sensitive Data Exposure

Exploitability	**2**
Prevalence	**3**
Detectability	**2**
Tech Impact	**3**

- Is sensitive data secured in transit?
  - TLS, message encryption
- Is sensitive data secured at rest?
  - Encryption, tokenisation, separation
- Impact can include loss of data or spoofing attacks
- Mitigation via threat analysis, encryption, limiting scope, crypto standardisation



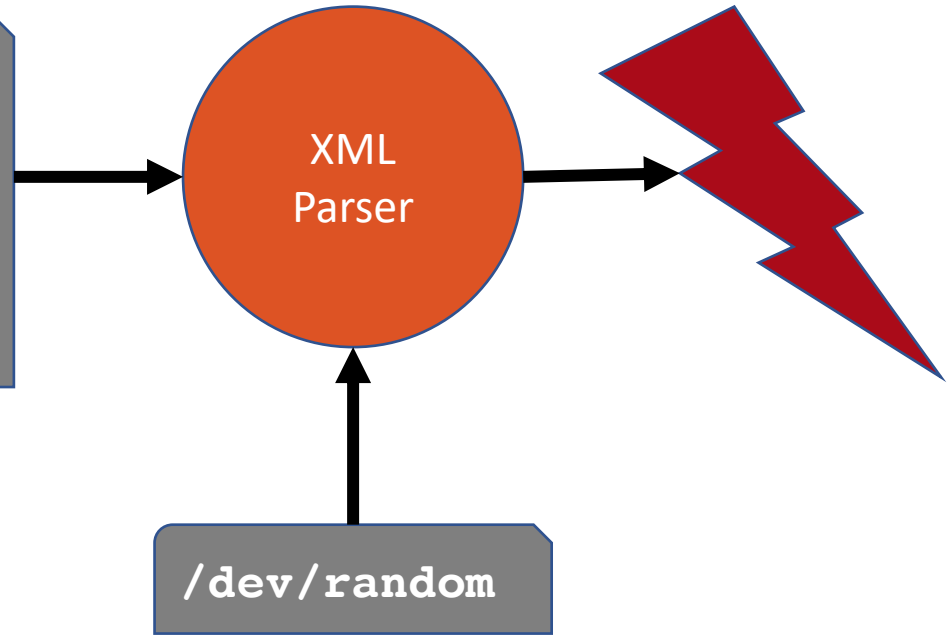
https://askleo.com

#4 XML External Entities (XXE)

Exploitability	2
Prevalence	2
Detectability	3
Tech Impact	3

- XML “external” entities cause XML parsers to retrieve external data
- Many XML parsers enable this by default (including Java’s standard library)

```
<?xml version="1.0" encoding="ISO-8859-1"?>
<!DOCTYPE danger [
   <!ELEMENT other ANY >
   <!ENTITY dos SYSTEM "file:///dev/random" >]>
 <foo>&xxe;</foo>
```



- Can expose sensitive data or provide DoS attack vector
- Mitigate by disabling external entities or removing XML

#5 Broken Access Control

Exploitability	2
Prevalence	2
Detectability	2
Tech Impact	3

- Directly referencing IDs in requests (filenames, accounts, …)
  - Not authenticating access to each on the server
  - Client can modify request and gain access to other objects
- Relying on UI or other client side code for access control
  - e.g. UI removing ”update” option & not validating action on the server

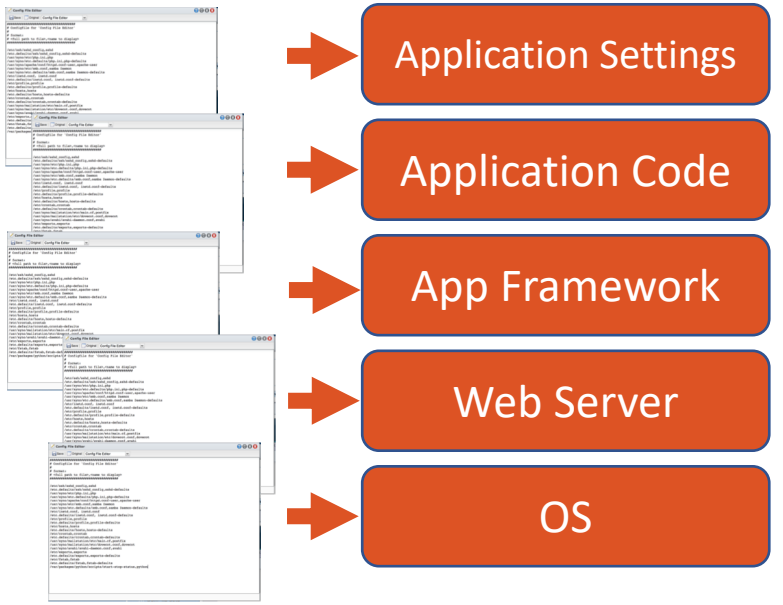
```
http://www.example.com/gettxn?txnid=4567
    → http://www.example.com/updttxn?tid=4567&value=100.00
```

- Not checking for tampering or replaying security meta data (e.g. JWT tokens)
- Mitigation through entity level access control, deny by default, strong and standardised authorisation technology and patterns, hide metadata

#6 Security Misconfiguration

Exploitability	**3**
Prevalence	**3**
Detectability	**3**
Tech Impact	**2**

- Security configuration is often complicated
  - Many different places to put it, complex & varying semantics
  - Layers from OS to application all need to be consistent



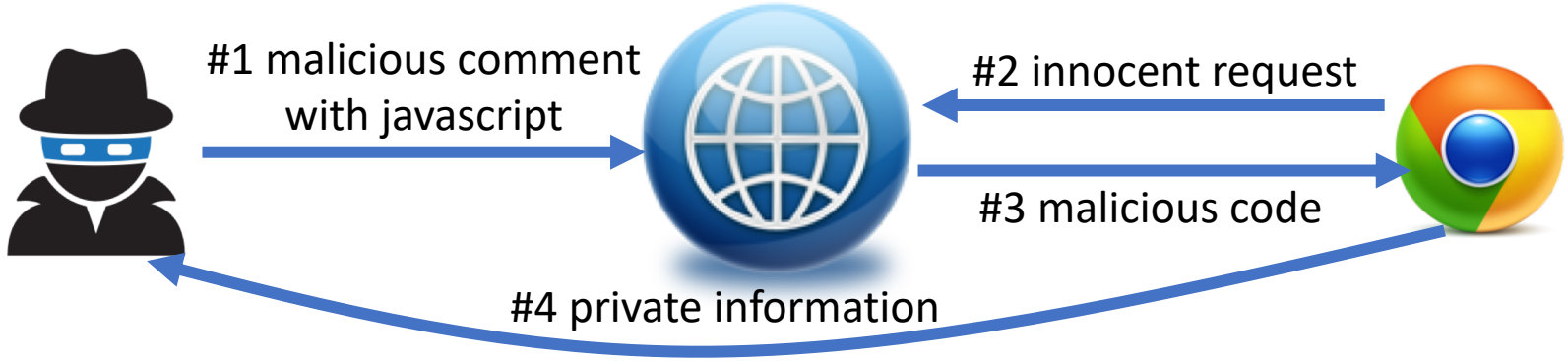
- It is easy to accidentally miss an important part
  - OS file permissions?
  - .htaccess files?
  - Shared credentials in test and production?
- Allows accidental access to or modification of resources

- Mitigation via scanning, standardisation, simplicity and automation

#7 Cross Site Scripting

Exploitability	3
Prevalence	3
Detectability	3
Tech Impact	2

- Occurs when script is injected into a user's web page
  - Reflected XSS attack – crafted link in email …
  - Stored XSS attack - database records, site postings, activity listings
  - DOM XSS attack - data inserted into the browser dom
- Allows redirection, session data stealing, page corruption, …



- Mitigations include validation and escaping data on the server-side

#8 Insecure Deserialisation

Exploitability	1
Prevalence	2
Detectability	2
Tech Impact	3

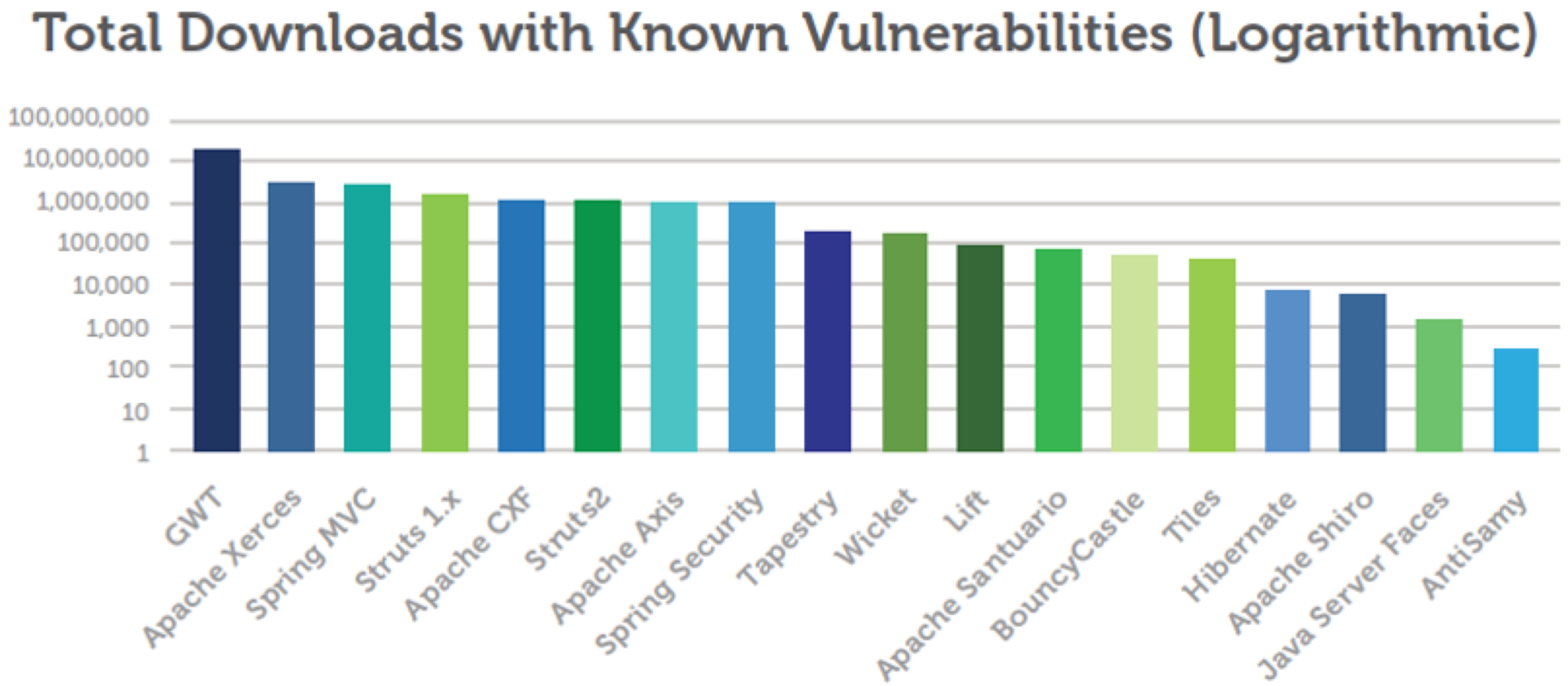
- Subverting de-serialisation mechanism
  - e.g. Java “gadgets” vulnerable to abuse with tampered objects
- De-serialising hostile code
  - e.g. serialised code that causes de-serialisation method to loop
- Mitigations include
  - only de-serialising from trusted sources
  - avoiding binary serialisation formats
  - signed serialisation data
  - whitelists of classes
  - platform security managers

```
public void loadSession(byte[] data) {
  ObjectInputStream ois = … ;
  …
  sess.adminUser = ois.readBoolean();
  return sess ;
}
```

```
public void resetUser(Session s,
                      String user, String pwd) {
  …
  if (s.adminUser) {
    user.setPassword(pwd) ;
    user.locked = false ;
  }
}
```

#9 Known Vulnerable Components

Exploitability	**2**
Prevalence	**3**
Detectability	**2**
Tech Impact	**2**

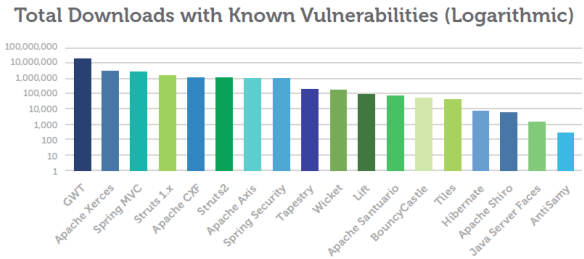


Source: “The Unfortunate Reality of Insecure Libraries”, Aspect Security & Sonartype, 2012

#9 Known Vulnerable Components

Exploitability	**2**
Prevalence	**3**
Detectability	**2**
Tech Impact	**2**

- Many commonly used components have vulnerabilities
  - See weekly US-CERT list for a frightening reality check!
  - Much OSS doesn't have well researched vulnerabilities



- Few teams consider security of their 3rd party components
  - And keeping everything up to date is disruptive

- Mitigations include automated scanning of 3rd party components, actively review vulnerability lists, keep components patched

#10 Insufficient Logging & Monitoring

Exploitability	**2**
Prevalence	**3**
Detectability	**1**
Tech Impact	**2**

- Poor logging and monitoring underpins many major exploits
- Common problems:
  - Not logging key events (failed login, high value transaction, …)
  - Poor messages, no actionable statements
  - Lack of log analysis

http://logio.org

- Centralise logging to provide better view and security of logs
  - Identify expected and unexpected log patterns (e.g OWASP coreruleset.org)
  - Know what to do when logs indicate unexpected situation

OWASP ModSecurity Core Rule Set
THE 1ST LINE OF DEFENSE

- Good test is to use OWASP ZAP, SQLMap and check for alerts
- Mitigations include standard log formats, key event logging, centralised logs, incident response plans, intrusion detection and SIEM systems

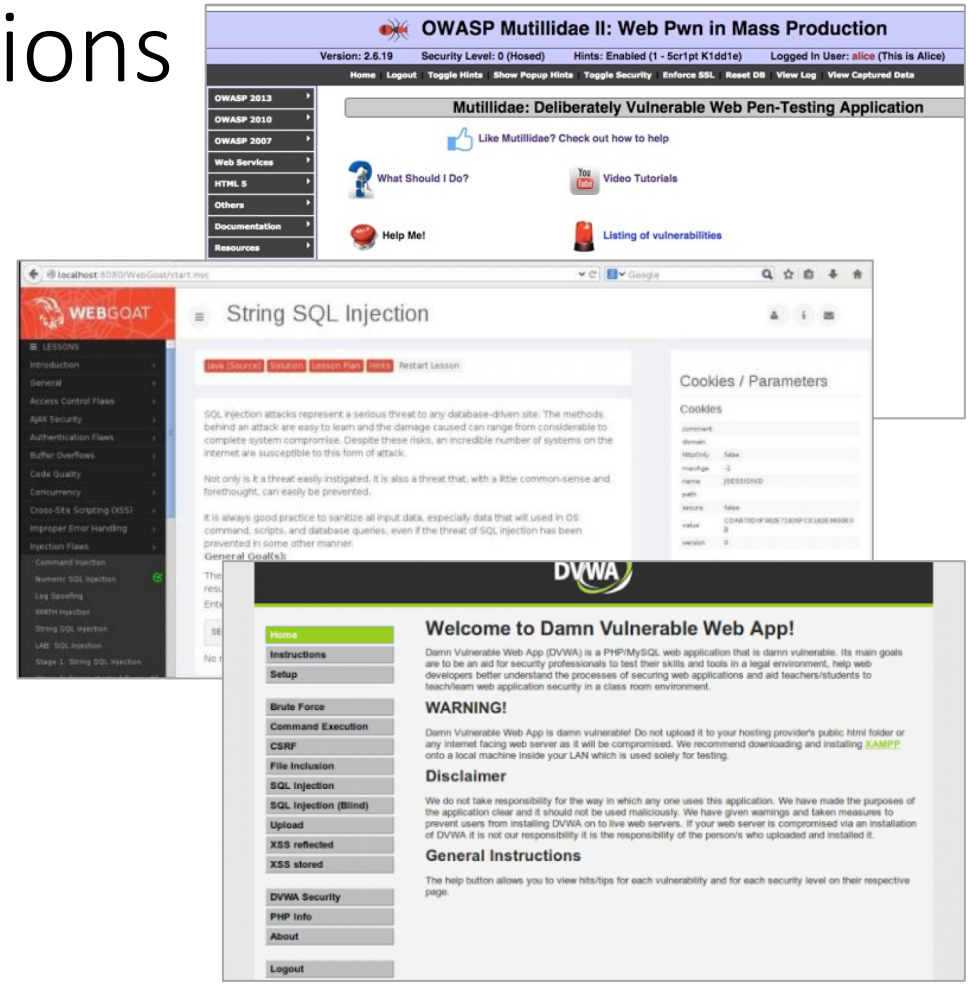
Summary of Main Vulnerability Types

- **Interpreter** and page **injections**
  - Operating System, SQL, XML, deserialization, XSS, …
- Lack of **validation**
  - trusting client side restrictions
  - allowing session IDs and cookies to be reused
  - not escaping and validating input data
  - parameter values directly in pages and links
- Missing **data protection**
  - Sensitive data exposure, deserialisation, configuration showing metadata, …
- **Complexity**
  - Misconfiguration, deserialization, XXE, known vulnerabilities

Useful Tools

Deliberately Vulnerable Applications

- Deliberately insecure webapps
  - So run in a VM!
- OWASP Top 10 in action
  - Mutillidae & DVWA in PHP
  - WebGoat in Java



http://sourceforge.net/projects/mutillidae/

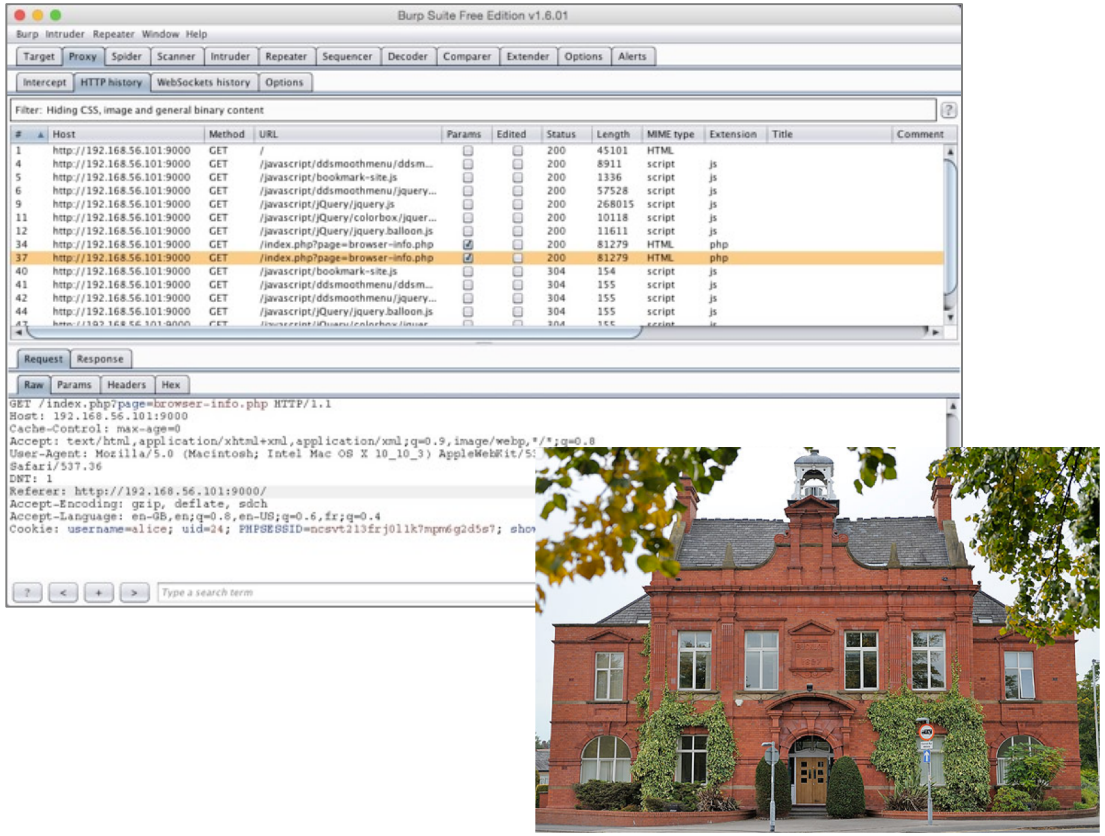
http://www.dvwa.co.uk/

https://github.com/WebGoat/WebGoat/wiki

https://github.com/eystsen/pentestlab

BurpSuite

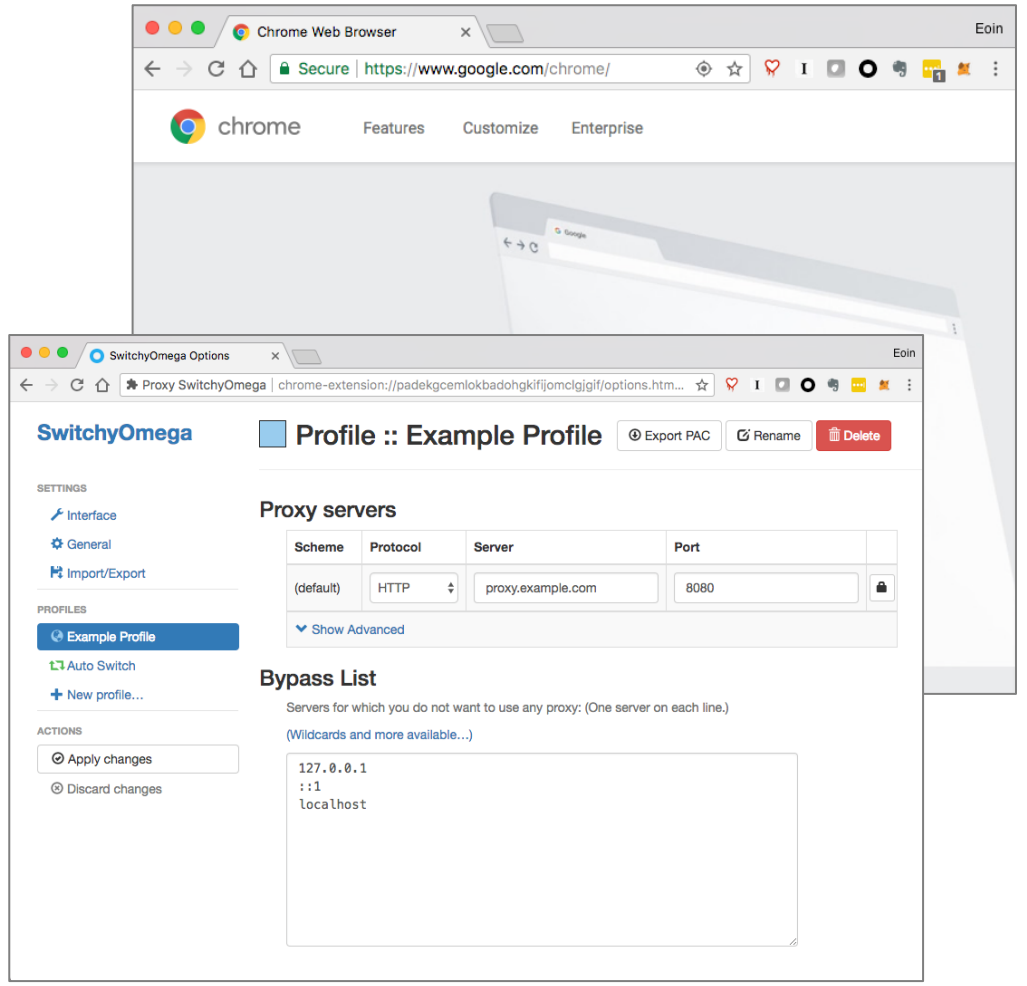
- Proxy, scanning, pentest tool
- Very capable free version
- Fuller commercial version available
- Inspect traffic, manipulate headers and content, replay, spider, …
- Made in Knutsford!



http://portswigger.net/burp

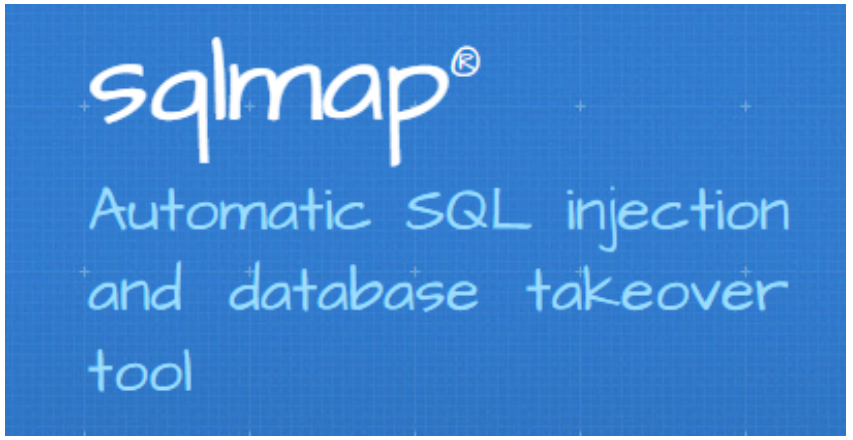
Browser and Proxy Switcher

- Chrome and Switchy Omega or other similar pairing
- Allows easy switching of proxy server to BurpSuite



sqlmap

- Automated SQL injection and database pentesting
- Open source Python command line tool
- Frighteningly effective!

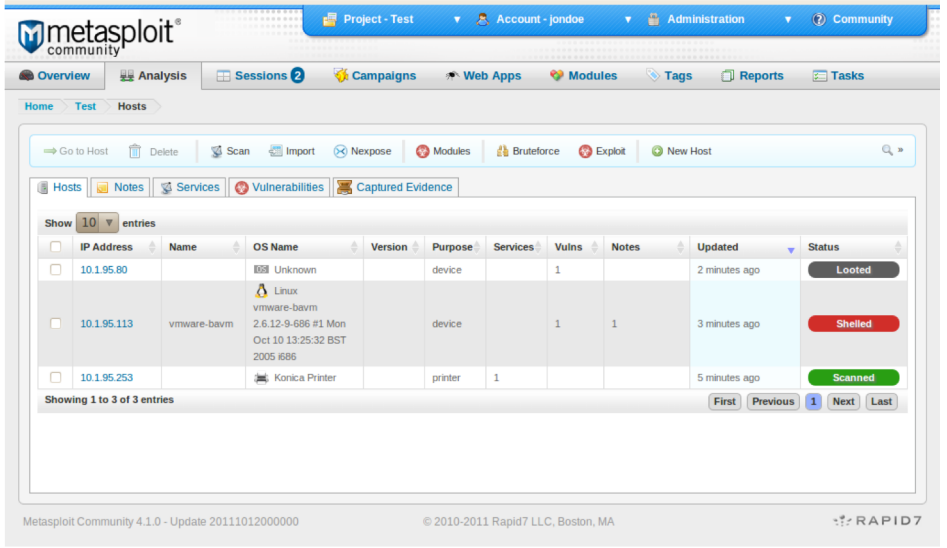



```
$ python sqlmap.py -u "http://debiandev/sqlmap/mysql/get_int.php?id=1" --batch
        ___
       __H__
 ___ ___[.]_____ ___ ___  {1.0.5.63#dev}
|_ -| . [.]     | .'| . |
|___|_  [.]_|_|_|__,|  _|
      |_|V...       |_|   http://sqlmap.org

[!] legal disclaimer: Usage of sqlmap for attacking targets without prior mutual consent i
s illegal. It is the end user's responsibility to obey all applicable local, state and fed
eral laws. Developers assume no liability and are not responsible for any misuse or damage
 caused by this program

[*] starting at 17:43:06

[17:43:06] [INFO] testing connection to the target URL
[17:43:06] [INFO] heuristics detected web page charset 'ascii'
[17:43:06] [INFO] testing if the target URL is stable
[17:43:07] [INFO] target URL is stable
[17:43:07] [INFO] testing if GET parameter 'id' is dynamic
[17:43:07] [INFO] confirming that GET parameter 'id' is dynamic
[17:43:07] [INFO] GET parameter 'id' is dynamic
[17:43:07] [INFO] heuristic (basic) test shows that GET parameter 'id' might be injectable
 (possible DBMS: 'MySQL')
```

http://sqlmap.org

Metasploit

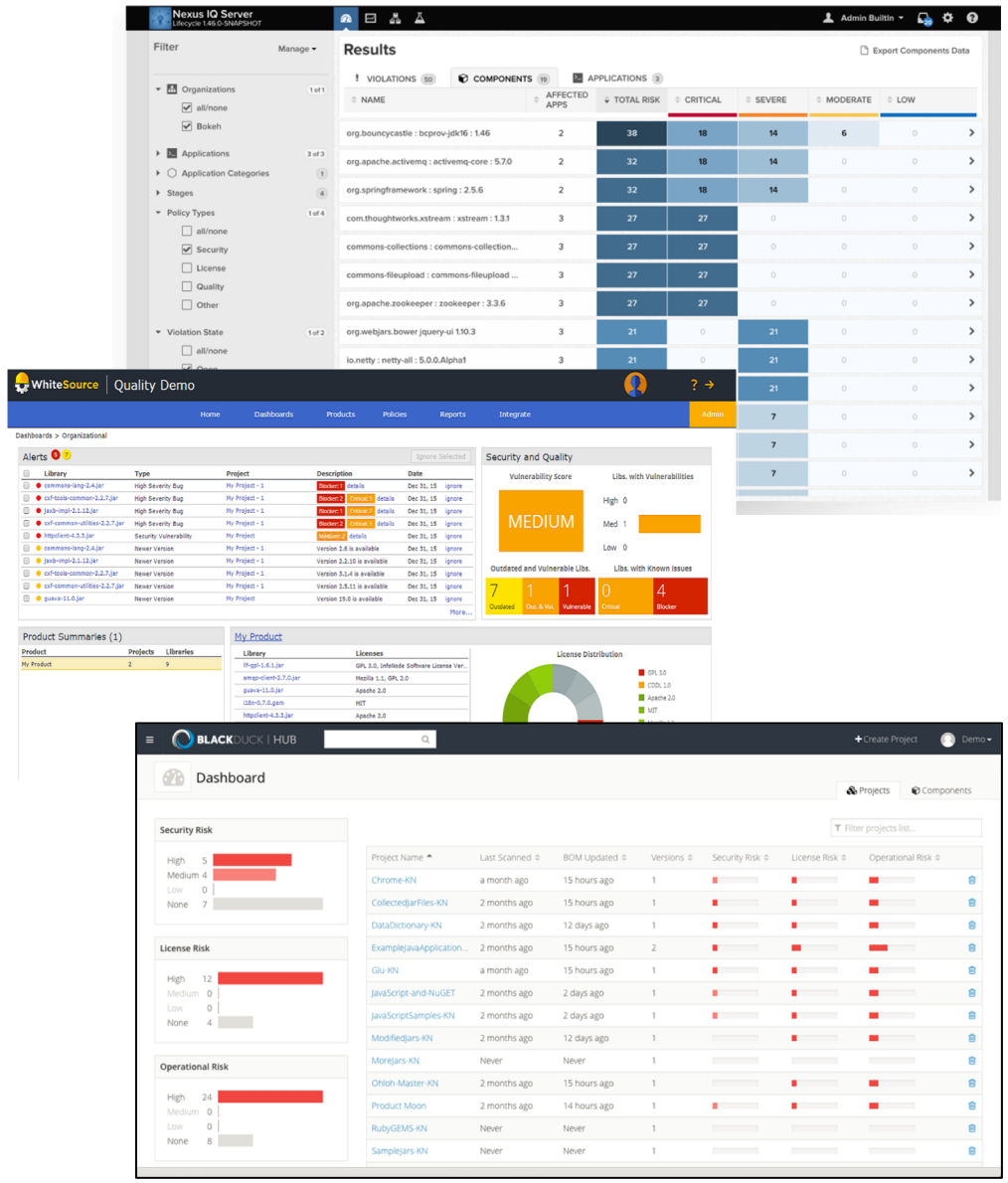
- The pentester’s ”standard” tool
- Very wide range of capabilities
- Commercial version available



https://www.metasploit.com

Open Source Scanning

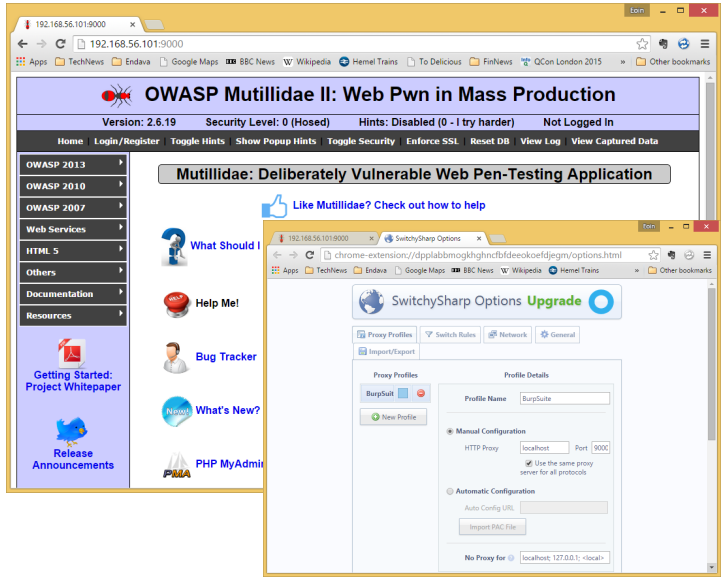
- Example commercial tools for open source security, audit & compliance:
  - BlackDuck
  - Whitesource
  - Sonatype LCM
- Scan builds identifying open source
- Checks for known vulnerabilities
- Alerts and dashboards for monitoring



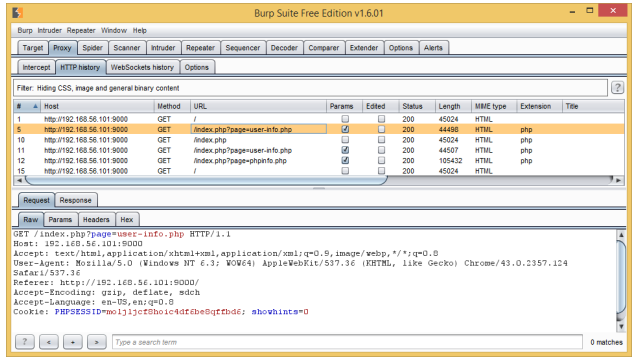
www.blackduck.com
www.whitesourcesoftware.com
www.sonatype.com/nexus-lifecycle

Demonstrations

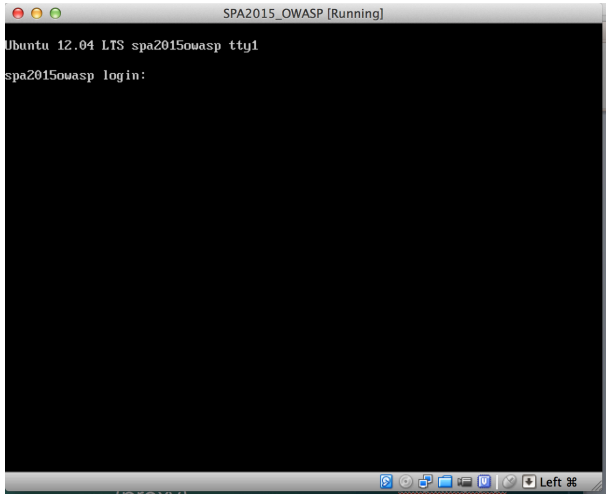
Mutillidae



Browser with proxy plugin



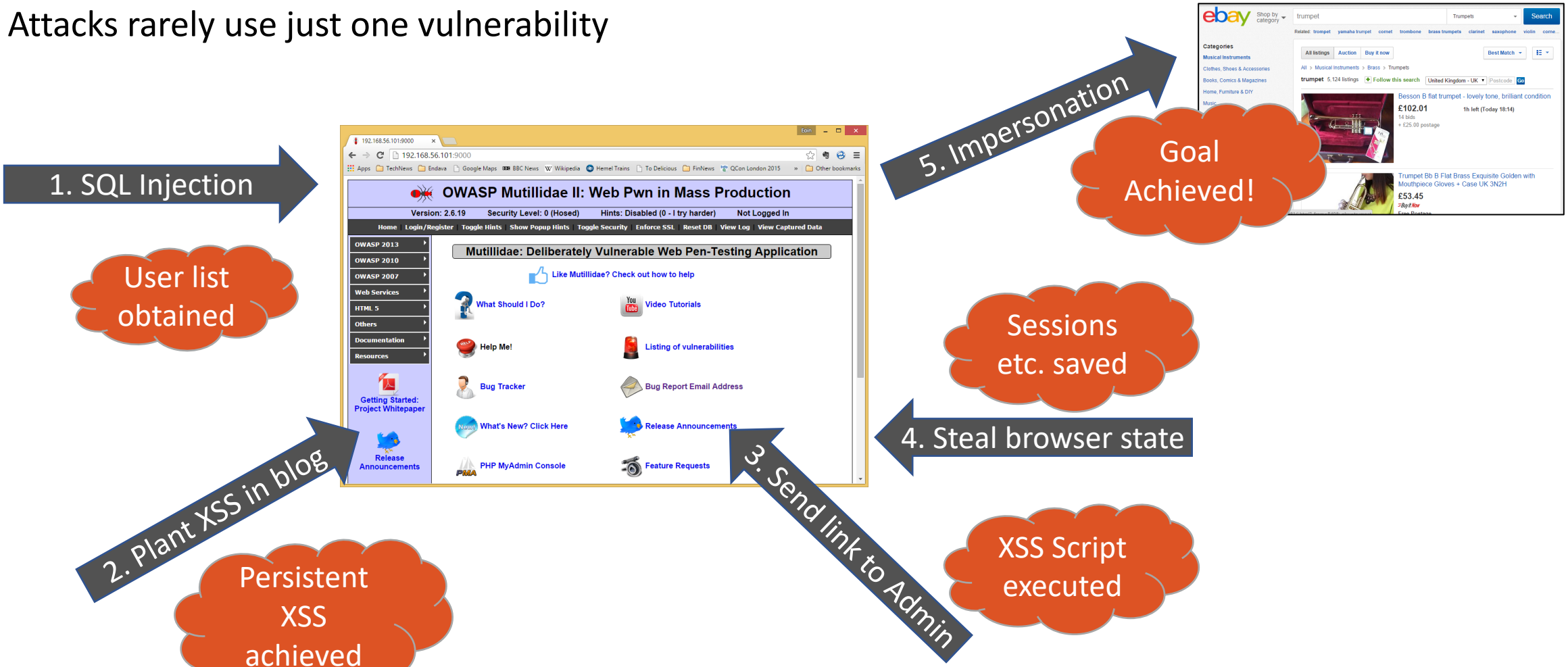
BurpSuite (proxy)



Mutillidae

An Example Multi-Step Attack - Impersonation

Attacks rarely use just one vulnerability



Practical Work

Practical Work

1. Install a XAMP stack (Apache, PHP, MySQL needed)
   - https://www.apachefriends.org
   - https://bitnami.com/stack/lamp
2. Install OWASP Mutillidae from Iron Geek
   - https://sourceforge.net/projects/mutillidae
3. Install a browser proxy (e.g. SwitchyOmega)
4. Install BurpSuite Community Edition
   - https://portswigger.net/burp/communitydownload
5. Git clone https://github.com/eoinwoods/webappsec

Defences

Key Web Vulnerability Defences

- Don’t trust clients (browsers)
  - Validation, authorisation, …
- Identify “interpreters”, escape inputs, use bind variables, …
  - Command lines, web pages, database queries, …
- Protect valuable information at rest and in transit
  - Use encryption judiciously
- Simplicity
  - Verify configuration and correctness
- Standardise and Automate
  - Force consistency, avoid configuration errors

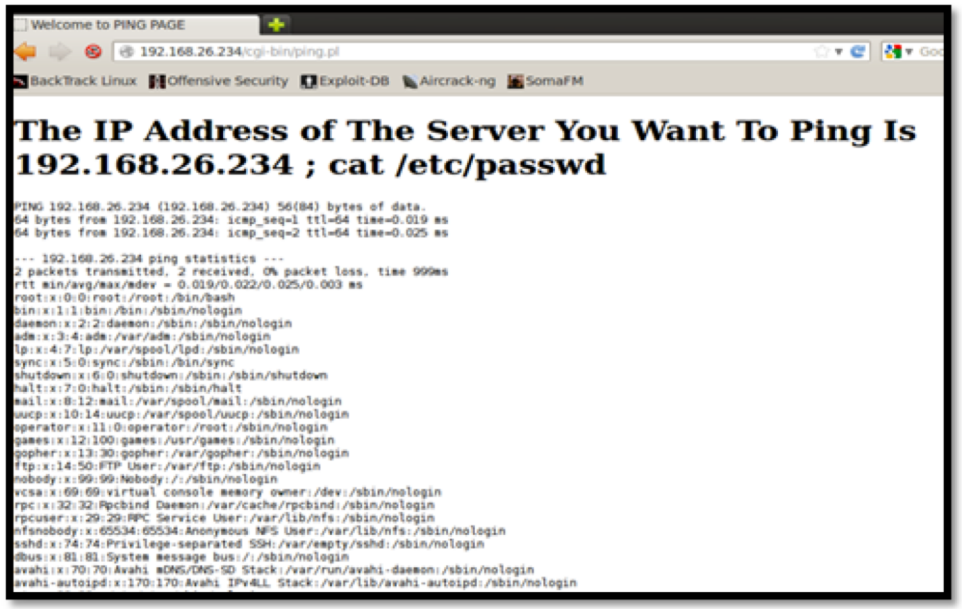
Don’t Trust Clients

- Be wary when trusting anything from a browser
  - You don’t control it
  - Sophisticated code execution (& injection) platform
  - Output can be manipulated
- Assume or prevent tampering
  - TLS connections to avoid 3rd party interception
  - Short lived sessions
  - Reauthenticate regularly & before sensitive operations
  - Consider multi-factor authentication
  - Use opaque tokens not real object references for params
  - Validate everything

Watch out for injection

- Many pieces of software act as interpreters
  - Browser for HTML and JavaScript
  - Operating system shells – system("mv $1 $2")
  - Databases – query languages
  - Configuration files
  - XML parsers

- Assume that someone will work it out!
  - Avoid creating commands using string manipulation
    - Use libraries and bind variables
  - Escape all strings being passed to an "interpreter"
    - Use a third party "escaping" library (e.g. OWASP)
  - Reject excessively long strings (e.g. username > 30 char)



Protect Valuable Information

- Defence in depth – assume perimeter breach
  - Encrypt messaging as standard
  - Consider database encryption
  - Consider file or filesystem encryption

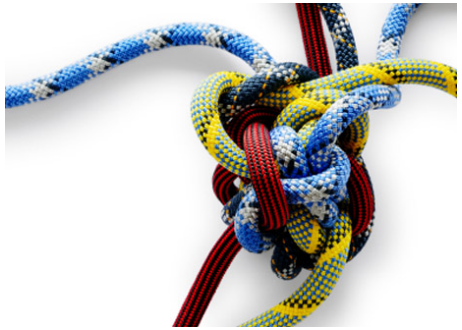
http://getacoder.com

- However encryption complicates using the data
  - Slows everything down
  - Can you query while encrypted? (Homomorphic encryption?)
  - Message routing on sensitive fields (in headers)
  - Managing and rotating the keys
  - What about restore on disaster recovery?

http://slate.com

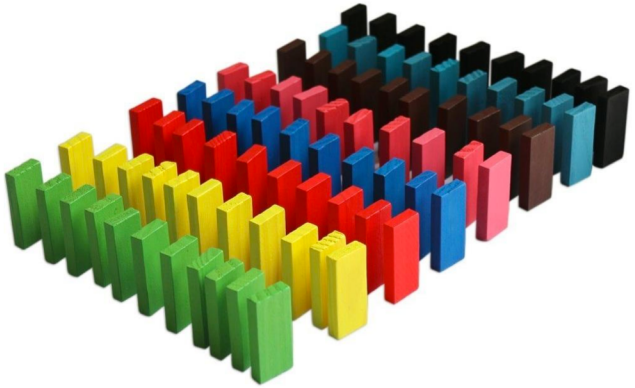
Simplicity & Standardisation

- Complexity is the enemy of security
  - "*You can't secure what you don't understand*" - Schneier
  - Special cases will be forgotten



http://innovationmanagement.se/

- Simplify, Standardise and Automate
  - Simpler things are easier to check and secure
  - Standardising an approach means there are no special cases to forget to handle
  - Automation eliminates human inconsistencies from the process so avoiding a type of risk



https://www.aliexpress.com

Summary

Summary

- Much of the technology we use is inherently insecure
  - Mitigation needs to be part of application development
- Attacking systems is becoming industrialised
  - Digital transformation is providing more valuable, insecure targets
- Fundamental attack vectors appear again and again
  - Injection, interception, page manipulation, validation, configuration, …
- Most real attacks exploit a series of vulnerabilities
  - Each vulnerability may not look serious, the combination is
- Most mitigations not difficult but need to be applied consistently
  - … and may conflict with other desirable qualities

Thank You

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