Intro to security 2

Malware

Vulnerabilities

Network attacks

Web attacks

Tools

Malware (malicious software)

A virus

It replicates itself:

- modifies other programs
- and inserts its own code into those programs

A worm

It actively transmits itself over a network to infect other computers and can copy itself without infecting files.

Creeper was the first computer worm, while **Reaper** was the first antivirus software, designed to eliminate Creeper.

https://en.wikipedia.org/wiki/Creeper_and_Reaper

Trojan horse

A Trojan horse misrepresents itself to masquerade as a regular, benign program or utility in order to persuade a victim to install it

Droppers are a sub-type of Trojans that solely aim to deliver malware upon the system that they infect with the desire to subvert detection through stealth and a light payload

Spyware

Programs designed to monitor users' web browsing, display unsolicited advertisements, or redirect affiliate marketing revenues are called spyware.

Spyware programs do not spread like viruses; instead they are generally installed by exploiting security holes.

They can also be hidden and packaged together with unrelated user-installed software.

Ransomware

Ransomware prevents a user from accessing their files until a ransom is paid.

Rootkits

Once malicious software is installed on a system, it is essential that it stays concealed, to avoid detection.

Software packages known as rootkits allow this concealment, by modifying the host's operating system so that the malware is hidden from the user.

Rootkits can prevent a harmful process from being visible in the system's list of processes, or keep its files from being read.

Vocabulary

Bug - An error only exist in source code

- When noticed easily correctable

Flaw - An error in the understanding or particularly in the design

- difficult and costly to correct

Vulnerability

A vulnerability is

- a weakness,
- flaw
- or software bug i

A vulnerability can be in

- an application
- a complete computer,
- an operating system,
- or a computer network that is exploited by malware to bypass defences or gain privileges it requires to run.

Common **V**ulnerabilities and **E**xposures

CVE created in 1999

Does NOT provide proof of concept (PoC) or exploit!

Common Weakness Enumeration

Common Weakness Enumeration

Some vulnerabilities and proof of concepts

Vx Underground

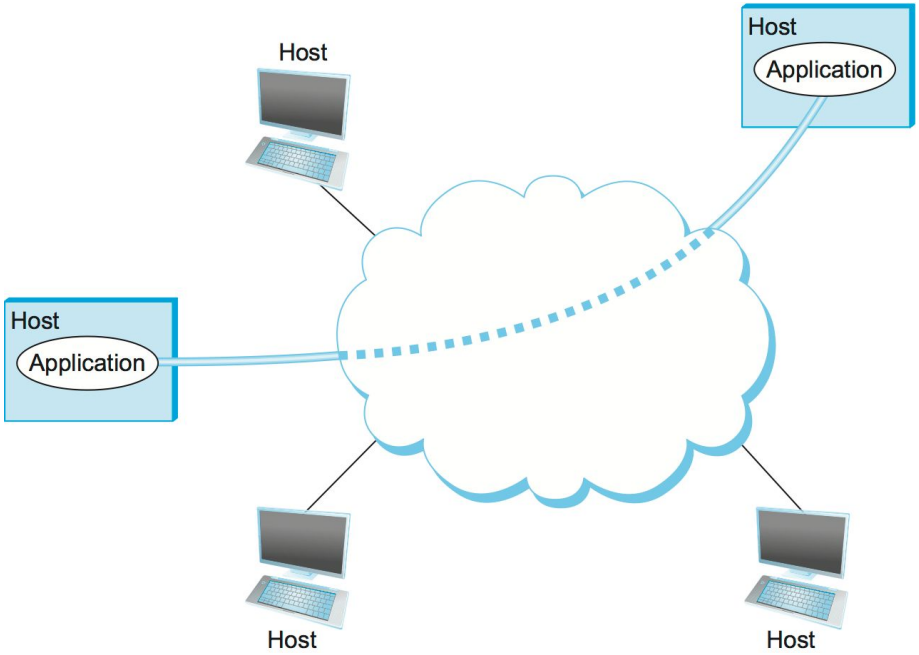
https://www.seebug.org/

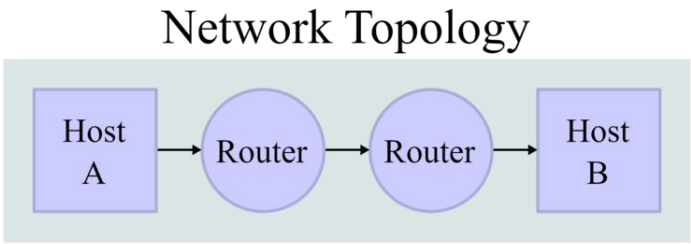
To search vulnerabilities in network and Iot devices

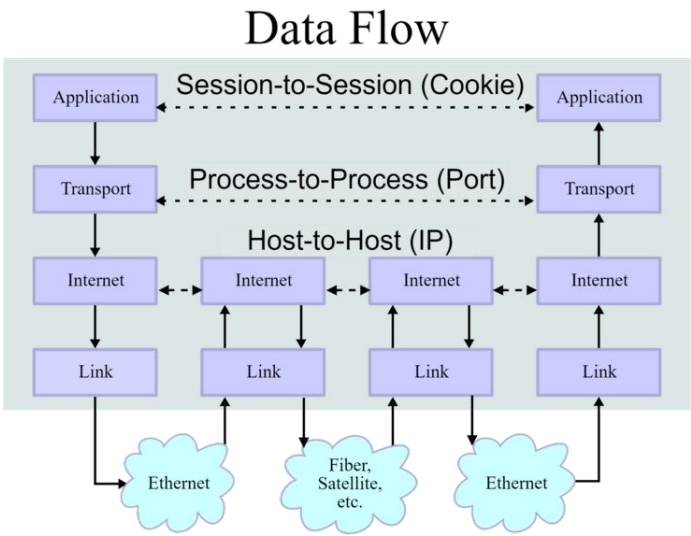
ZoomEye

Shodan

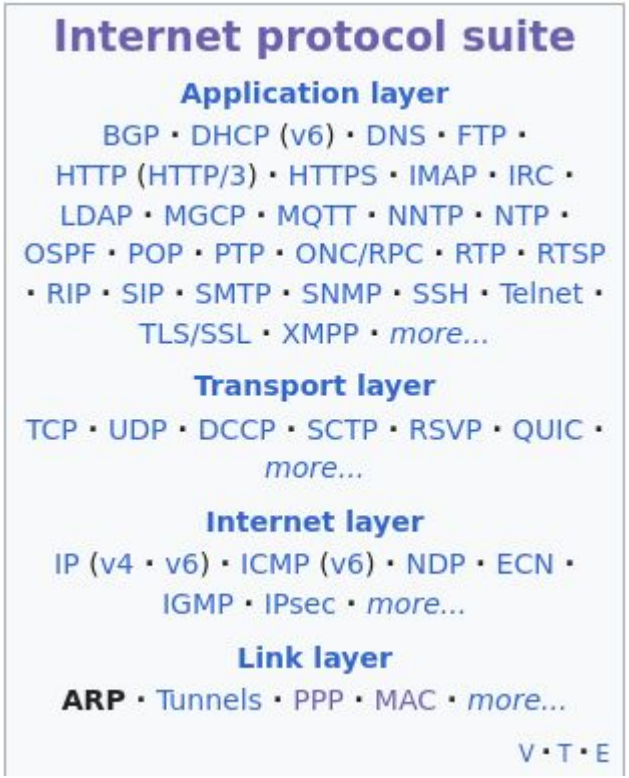
Reminder: Computer networks







Packet and protocols (encapsulation)



A packet contains implementation of used protocols in every layer

- Source&destination IP, port numbers, MAC address, TCP, HTTPS etc.

Address Resolution Protocol (ARP)

- IPv4 address
- + MAC address (medium access control address)
    - A unique identifier assigned to network interface card (NIC) for communications at the data link layer of a network segment

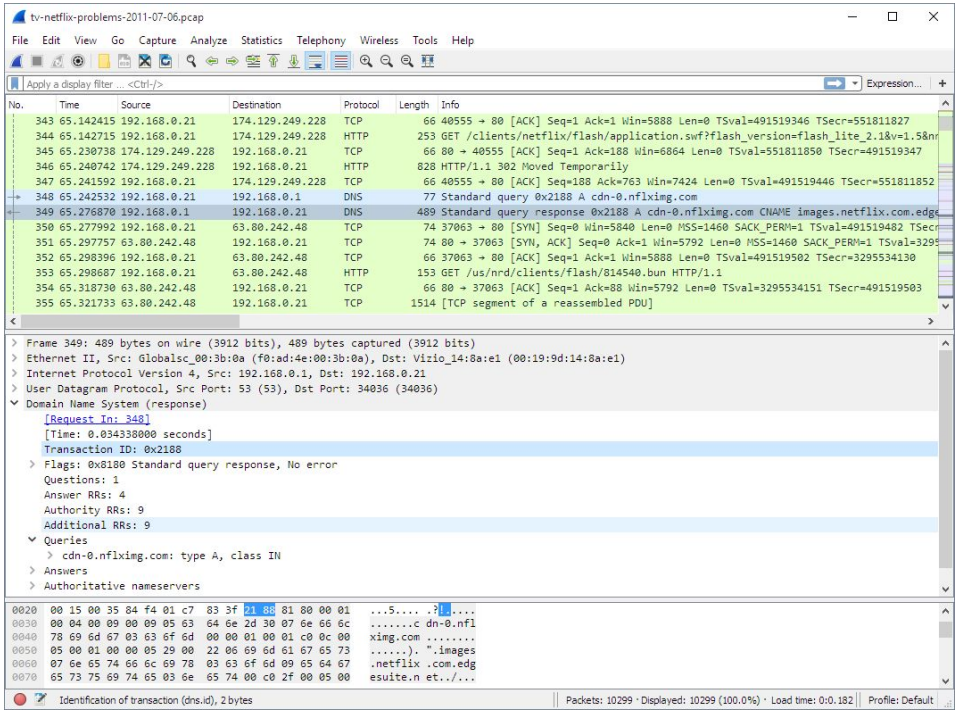
[Address Resolution Protocol - Wikipedia]

Tool wireshark

A popular network protocol analyzer

https://www.wireshark.org/

Wireshark captures packets and lets you examine their contents.

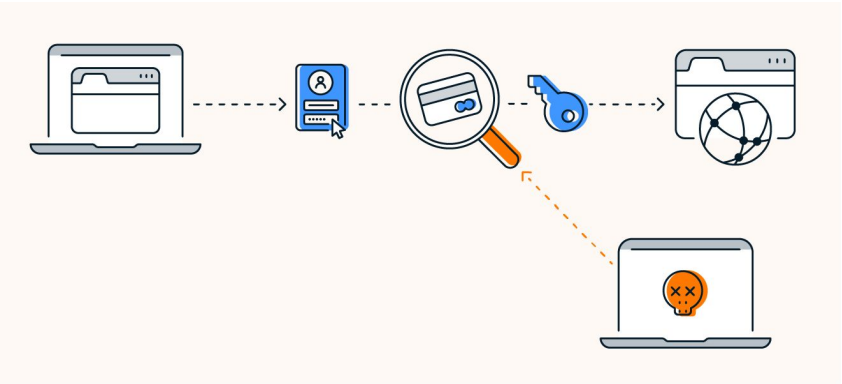


https://www.wireshark.org/docs/wsug_html_chunked/ChapterIntroduction.html#ChIntroPurposes

Attacking networks: network sniffing

Look at network traffic

Most of the traffic on a network is still unencrypted, plaintext ("in the clear")



Things you can do with network sniffing:

- Troubleshoot networking issues
- Record communications (e.g., email, voice, chat)
- Catch usernames and passwords, personal information, and other sensitive information

Image source: https://www.avast.com/c-packet-sniffing
https://cs116.org/slides/03_attacking_networks.pdf

Network sniffing tools

Ettercap and :: bettercap

Is not intended for network traffic analysis but has capabilities for:

- Capturing passwords
- Conducting man-in-the-middle (eavesdropping) attacks
- Hijacking sessions

dsniff | Kali Linux Tools

Suite of networking sniffing tools including

- dsniff - password sniffer
- webspy - intercepts URLs entered
- mailsnarf - intercepts POP or SMTP-based mail

https://cs116.org/slides/03_attacking_networks.pdf

How to prevent network sniffing

Use encryption and encrypted network protocols

E.g.

- Use HTTPS instead of HTTP
- Use SSH instead of RSH or Telnet
- Use SCP instead of FTP
- Use IMAP or POP3 over SSL
- Use a Virtual Private Network (VPN)

https://cs116.org/slides/06_web_security.pdf

Attacking networks: Network Scanning

Why? Network reconnaissance. Warfare 101

- What devices and computers are up?
- What ports are open on a computer?
- What services are running?
- Determine possible vulnerabilities?
- Still extremely relevant today
- Think poking holes, "ask questions”
- Poking holes: finding interesting and unwanted stuff on networks

Zoomeye and shodan can be used for this purpose

Fping: fping man-page ,

Nmap: Chapter 15. Nmap Reference Guide | Nmap Network Scanning

Netcat: nc(1): arbitrary TCP/UDP connections/listens - Linux man page

Shodan: Shodan

Zoomeye: ZoomEye

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Attacking networks: Distributed Denial of Service (DDoS) Attacks

The idea: to make a resource unavailable (the “A” in the CIA Triad) using many remote computing devices.

That is, overwhelm or flood a target (e.g., with so much network traffic)

• Imagine if an important service you use like Gmail, Google, Netflix, Twitter, GitHub is down

- Terabit scale Distributed Denial of Service (DDoS) attacks from September 2016 to late 2016
- How: using thousands of infected devices, mostly cameras. Devices infected via weak username:password hardcoded on device (e.g.,root:root, admin:admin)
- Results: took down Brian Kreb’s blog in September 2016; GitHub, Twitter, Netflix, and many major services were affected via DDoS on Dyn DNS in October 2016 (i.e., “all eggs in one basket”)
- Source code of Mirai botnet: GitHub - jgamblin/Mirai-Source-Code
- Rob Graham’s presentation on “Mirai and IoT Botnet Analysis” at RSA Conference 2017:
- https://vinceinthebay.files.wordpress.com/2017/02/rsac-slides-hta-w10-mirai-1.pdf

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DDOS flood Types

SYN Flood

- exhaust states in the TCP/IP stack

Ping of death

- violate the IP contract, send large packets to cause unexpected errors

And many others

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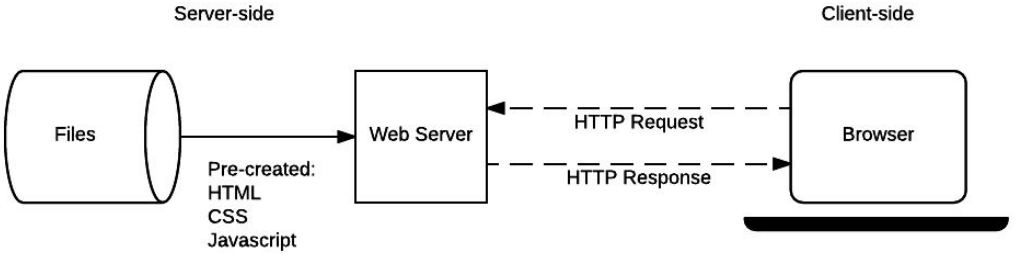
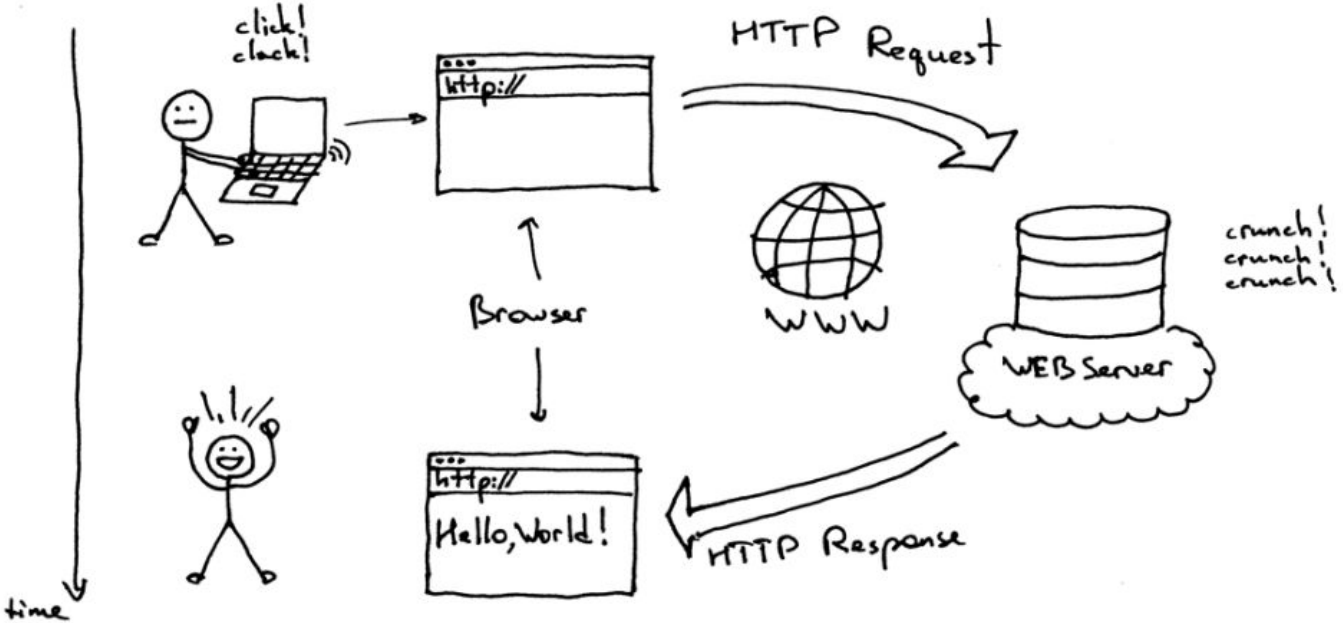
Web security and attacks





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Remember URL

Example: https://www.google.com/search?**q=grand+theft+auto**&**lr=lang_zh-TW**

(returns Google results on "Grand Theft Auto" in Chinese Traditional language)

- q => Google’s key in query string for “query”
- lr => Google’s key in query string for “language”

Notice example URL uses https. That is HTTP + Transport Layer Security (TLS)

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HTTP Request

header

- GET - Download data from server.
  - This is always the HTTP command used when you type in a URL into address bar
- POST - Sent to server from a form
- PUT - Upload
- DELETE

body

data to be sent to server including **query string key-value pairs**

Additional HTTP commands: HTTP - Wikipedia

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HTTP response

header

- 200 - OK
- 301 - Moved Permanently
- 302 - Found (the request was redirected to another URL/URI)
- 401 - Unauthorized
- 403 - Forbidden
- 404 - Not Found
- 500 - Internal Server Error

body

the content data (e.g., HTML, text, JSON, etc.)

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Web security

The Open Worldwide Application Security Project (OWASP) OWASP Foundation is a nonprofit foundation that works to improve the security of software. Our programming includes:

- Community-led open source projects including code, documentation, and standards
- Over 250+ local chapters worldwide
- Tens of thousands of members
- Industry-leading educational and training conferences

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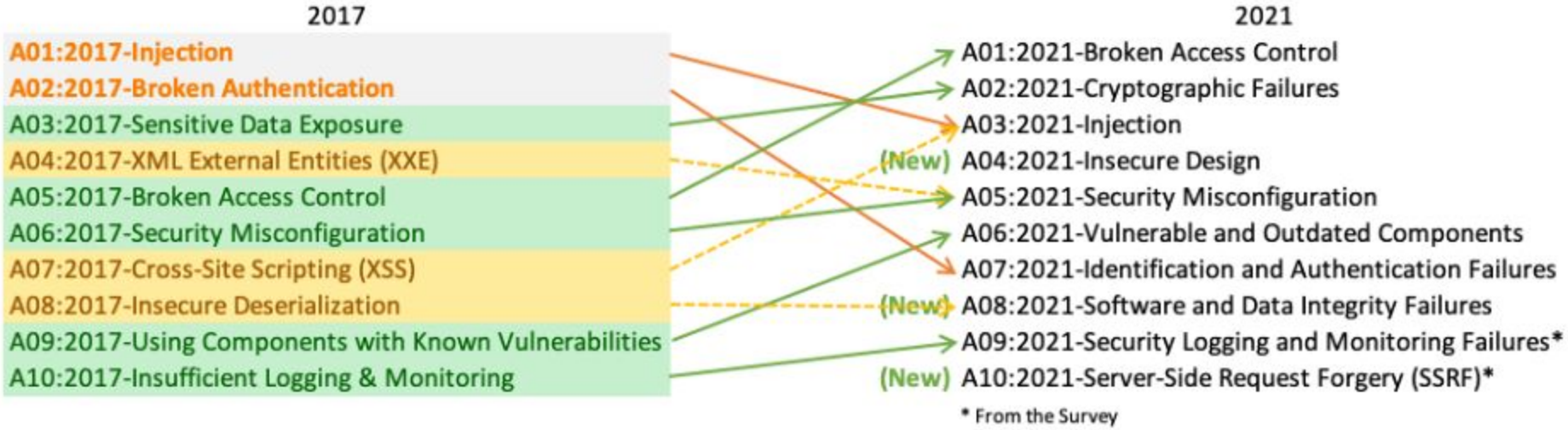
OWASP Top 10 Web Application Security Risks



2024 CWE Top 25 Most Dangerous Software Weaknesses

2024 CWE Top 25

Rank	ID	Name	Score	CVEs in KEV	Rank Change vs. 2023
1	CWE-79	Improper Neutralization of Input During Web Page Generation ('Cross-site Scripting')	56.92	3	+1
2	CWE-787	Out-of-bounds Write	45.20	18	-1
3	CWE-89	Improper Neutralization of Special Elements used in an SQL Command ('SQL Injection')	35.88	4	0
4	CWE-352	Cross-Site Request Forgery (CSRF)	19.57	0	+5
5	CWE-22	Improper Limitation of a Pathname to a Restricted Directory ('Path Traversal')	12.74	4	+3
6	CWE-125	Out-of-bounds Read	11.42	3	+1
7	CWE-78	Improper Neutralization of Special Elements used in an OS Command ('OS Command Injection')	11.30	5	-2
8	CWE-416	Use After Free	10.19	5	-4
9	CWE-862	Missing Authorization	10.11	0	+2
10	CWE-434	Unrestricted Upload of File with Dangerous Type	10.03	0	0
11	CWE-94	Improper Control of Generation of Code ('Code Injection')	7.13	7	+12
12	CWE-20	Improper Input Validation	6.78	1	-6
13	CWE-77	Improper Neutralization of Special Elements used in a Command ('Command Injection')	6.74	4	+3
14	CWE-287	Improper Authentication	5.94	4	-1
15	CWE-269	Improper Privilege Management	5.22	0	+7
16	CWE-502	Deserialization of Untrusted Data	5.07	5	-1
17	CWE-200	Exposure of Sensitive Information to an Unauthorized Actor	5.07	0	+13
18	CWE-863	Incorrect Authorization	4.05	2	+6
19	CWE-918	Server-Side Request Forgery (SSRF)	4.05	2	0
20	CWE-119	Improper Restriction of Operations within the Bounds of a Memory Buffer	3.69	2	-3
21	CWE-476	NULL Pointer Dereference			-9
22	CWE-798	Use of Hard-coded Credentials			-4
23	CWE-190	Integer Overflow or Wraparound			-9
24	CWE-400	Uncontrolled Resource Consumption			+13
25	CWE-306	Missing Authentication for Critical Function	2.73	5	-5

Notice the similarities with the OWASP Top 10 list

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Is There a Legal Way or Place to Practice Attacking Web Applications?

IMPORTANT: NEVER DEPLOY THESE WEB APPLICATIONS TO THE PUBLIC INTERNET OR ON A PRODUCTION SYSTEM!

- Damn Vulnerable Web Application (DVWA) - http://www.dvwa.co.uk/
- Mutillidae - https://sourceforge.net/projects/mutillidae/
- Hacme Casino - https://www.mcafee.com/us/downloads/freetools/hacme-casino.aspx (old; Ruby on Rails based)
- WebGoat - https://github.com/WebGoat/WebGoat/wiki; by OWASP
- A plethora deliberately vulnerable web applications to install and practice on

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Metasploitable 2

An **intentionally vulnerable Linux virtual machine (VM)**

https://sourceforge.net/projects/metasploitable/

- **Uses VMware by default; can run on VirtualBox**
- **Contains Damn Vulnerable Web Application, Mutillidae, phpMyAdmin, etc.**
- **Great practice environment**
- **References:**
- **https://community.rapid7.com/docs/DOC-1875**
- **https://www.offensive-security.com/metasploit-unleashed/requirements/**

https://cs116.org/slides/06_web_security.pdf

Some other tools

A web proxy will be an important tool for testing and breaking web applications

Many web proxie software available:

- Burp Suite
- OWASP Zed Attack Proxy (ZAP)
- Tamper Data for Firefox
- mitmproxy

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The vulnerabilities

The Principle of Least Privilege –Or Lack thereof

- **The issue1:** connecting to a database or system as root or as administrator -- which has the power to do anything

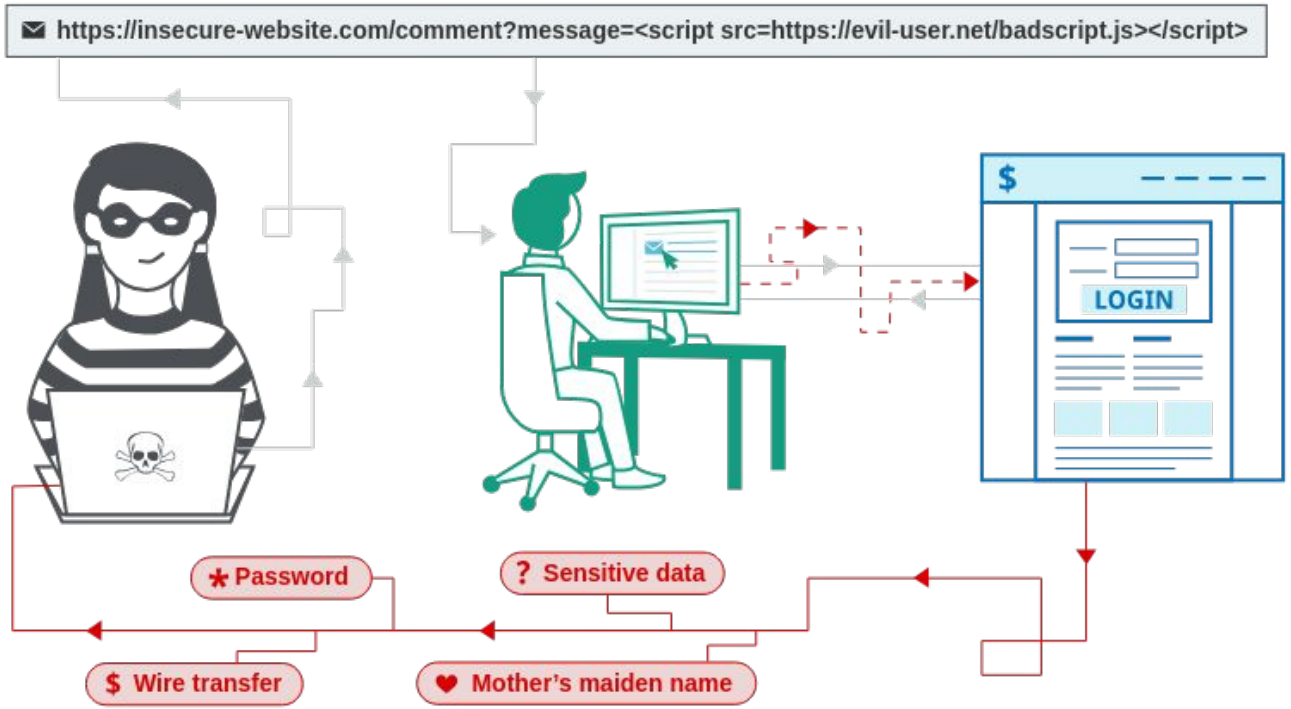
Hard-Coded Credentials

- **The issue2:** username and password or key are hard-coded in source code
- God forbid if you push source code with the credentials to GitHub

```
<?php
 $conn =mysql_connect( "127.0.0.1",
                                    "root",
                                    "pass");
?>
```

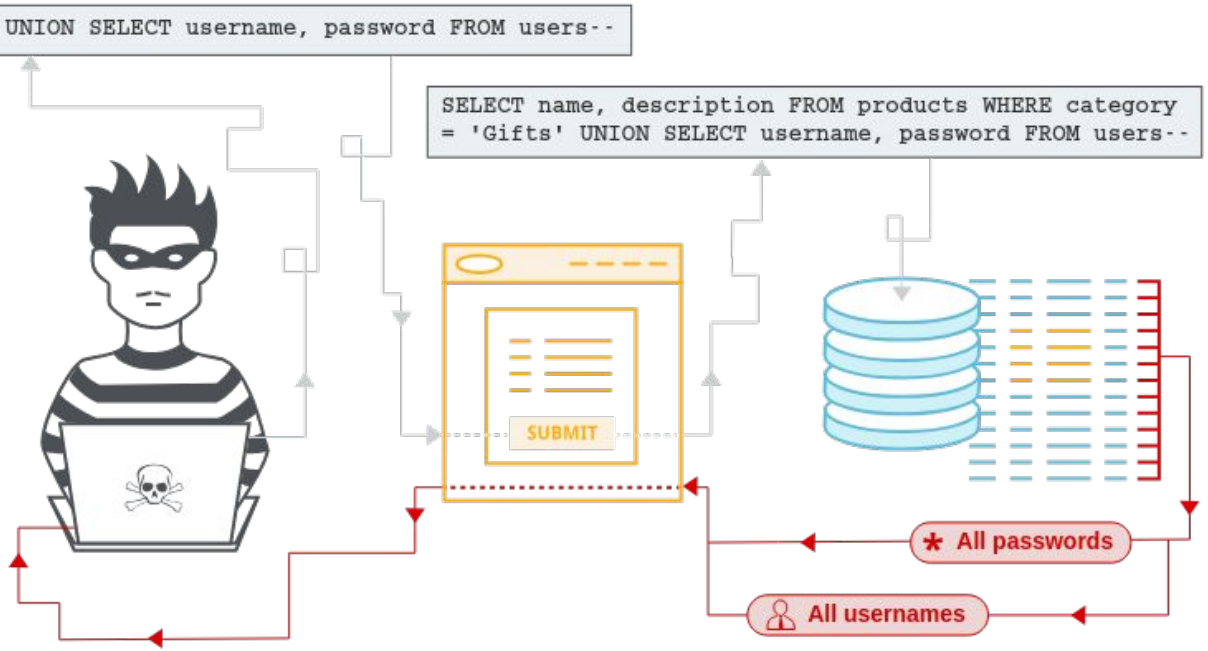
https://cs116.org/slides/06_web_security.pdf

cross-site scripting (XSS)



https://portswigger.net/web-security/cross-site-scripting, attacker's script executes in the user's browser

SQL Injection



https://portswigger.net/web-security/sql-injection

End of semester