



Greenbone

Test Automation & QA Strategy

for Short Iterations

Tim Steffens
Software / QA Engineer

these slides are licensed under a [Creative Commons Attribution 4.0 International license](#)

ABOUT ME

- Tim Steffens - tim.steffens@greenbone.net
- Father & husband
- ~20 years Software Engineering
- Quest
 - ✓ how to build software that "works well"?
- Fan of
 - ✓ clean code, TDD & functional programming
 - ✓ music (Metal)
 - ✓ outdoors & hiking



ABOUT GREENBONE

What sets us apart

Innovation: Leading in cybersecurity with scalable, cutting-edge solutions that identify and mitigate vulnerabilities.

Value Driven Culture: Work environment based on sincere appreciation, honoring individuality

Employee Empowerment: Recognizing our employees as the primary drivers of our success and committing to nurture growth through continuous learning and comprehensive benefits



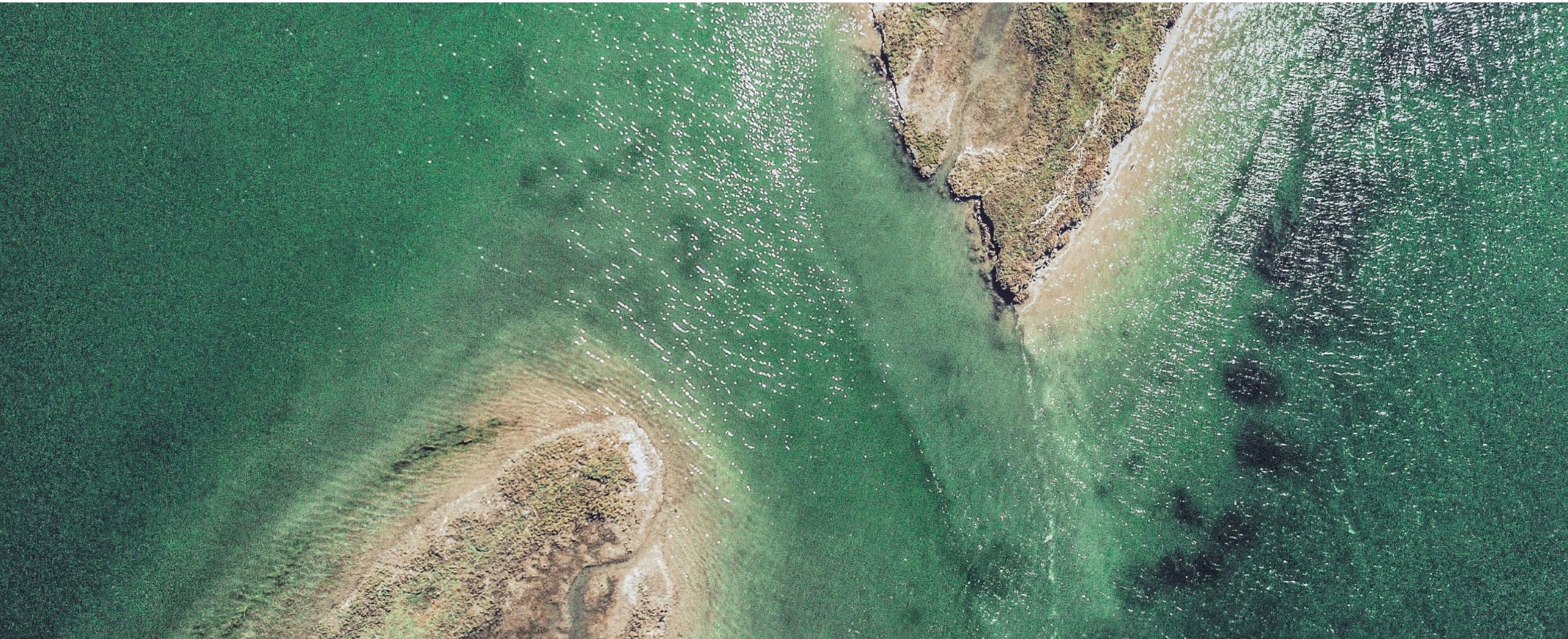
ABOUT YOU!

- Software Engineer?
- Testing Engineer?
- Architect?
- Project Lead?
- Non of those?

- Worked with test automation?

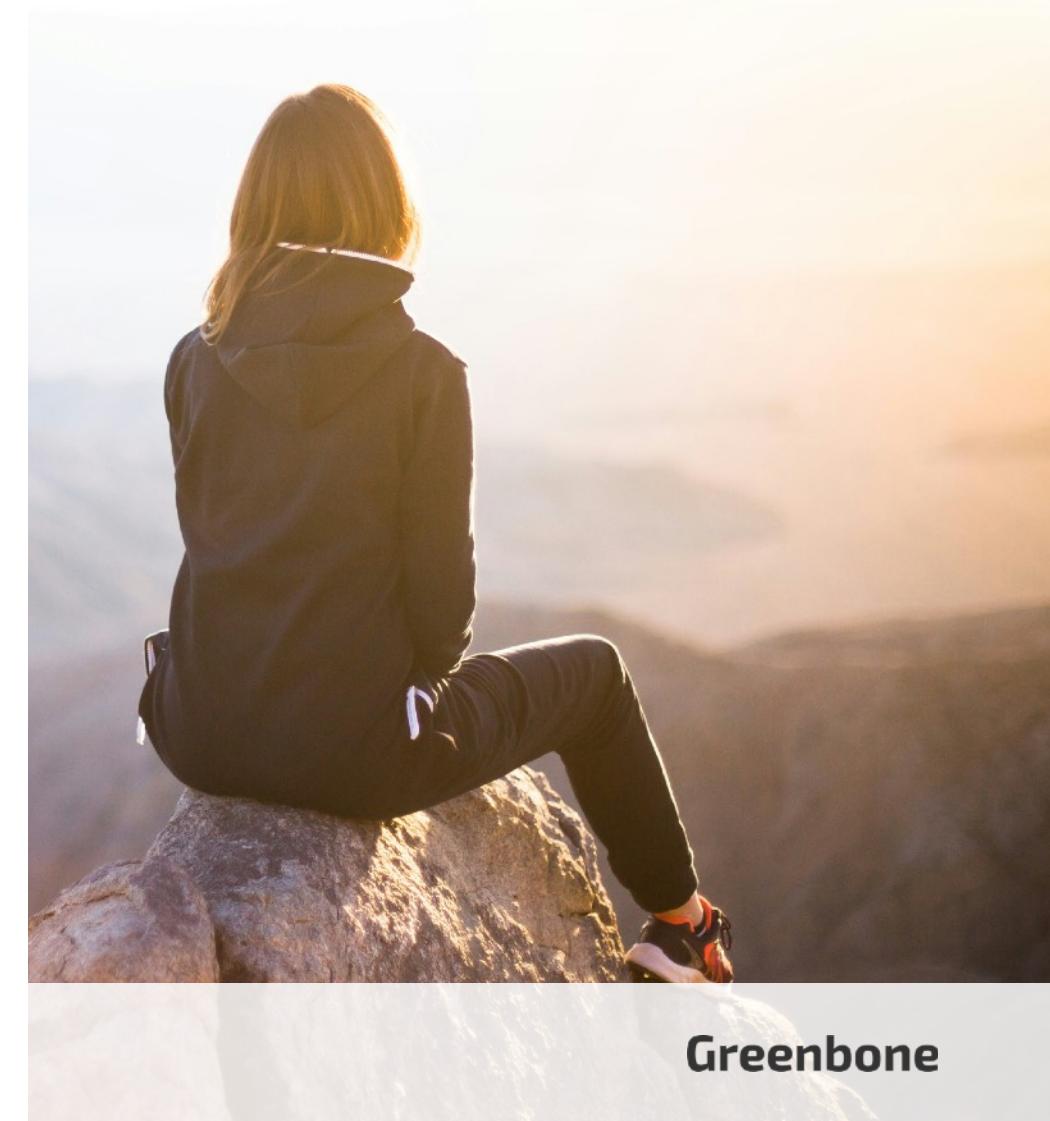


PLEASE INTERRUPT!



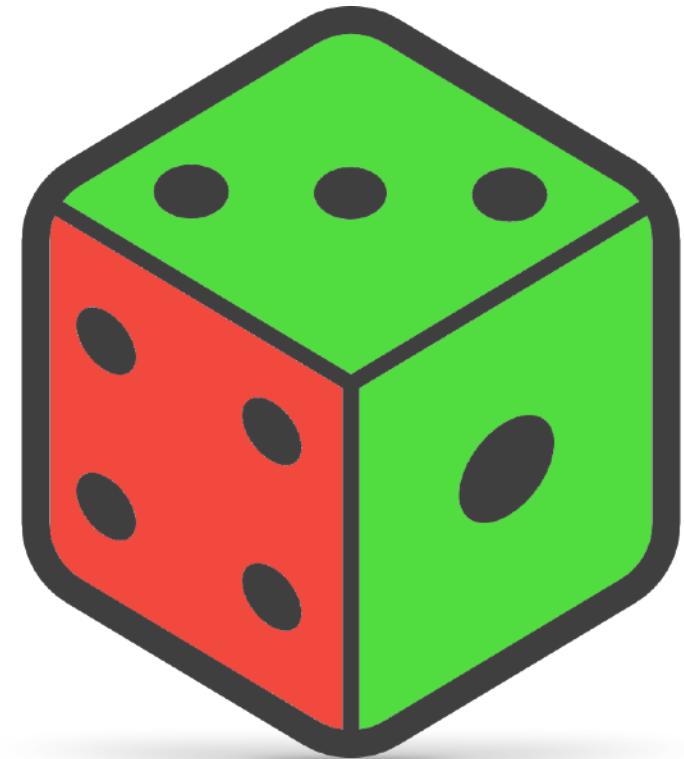
AGENDA

- Setting the Scene
- QA Strategy
- Implementation, Challenges & Learnings
- Outlook



DICE

- Recurring theme in Test Automation: "**the dice**"
 - ✓ AKA "**flaky tests**"
 - ✓ Two runs green, next red - despite no code change ...
- **Who** has already experienced **flaky tests**?

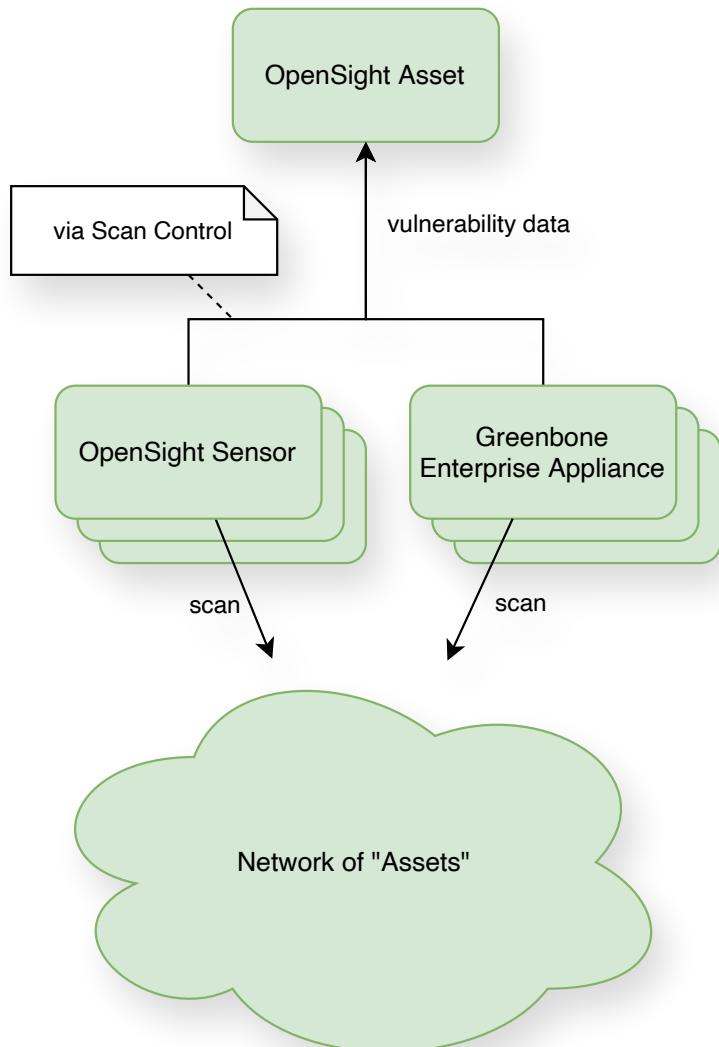


DISCLAIMER

- Out of scope:
 - NFA: Security Testing, Load Testing
 - Code Coverage
 - QA development practices (Pair Programming, Code Reviews)
 - Frontend Unit Tests



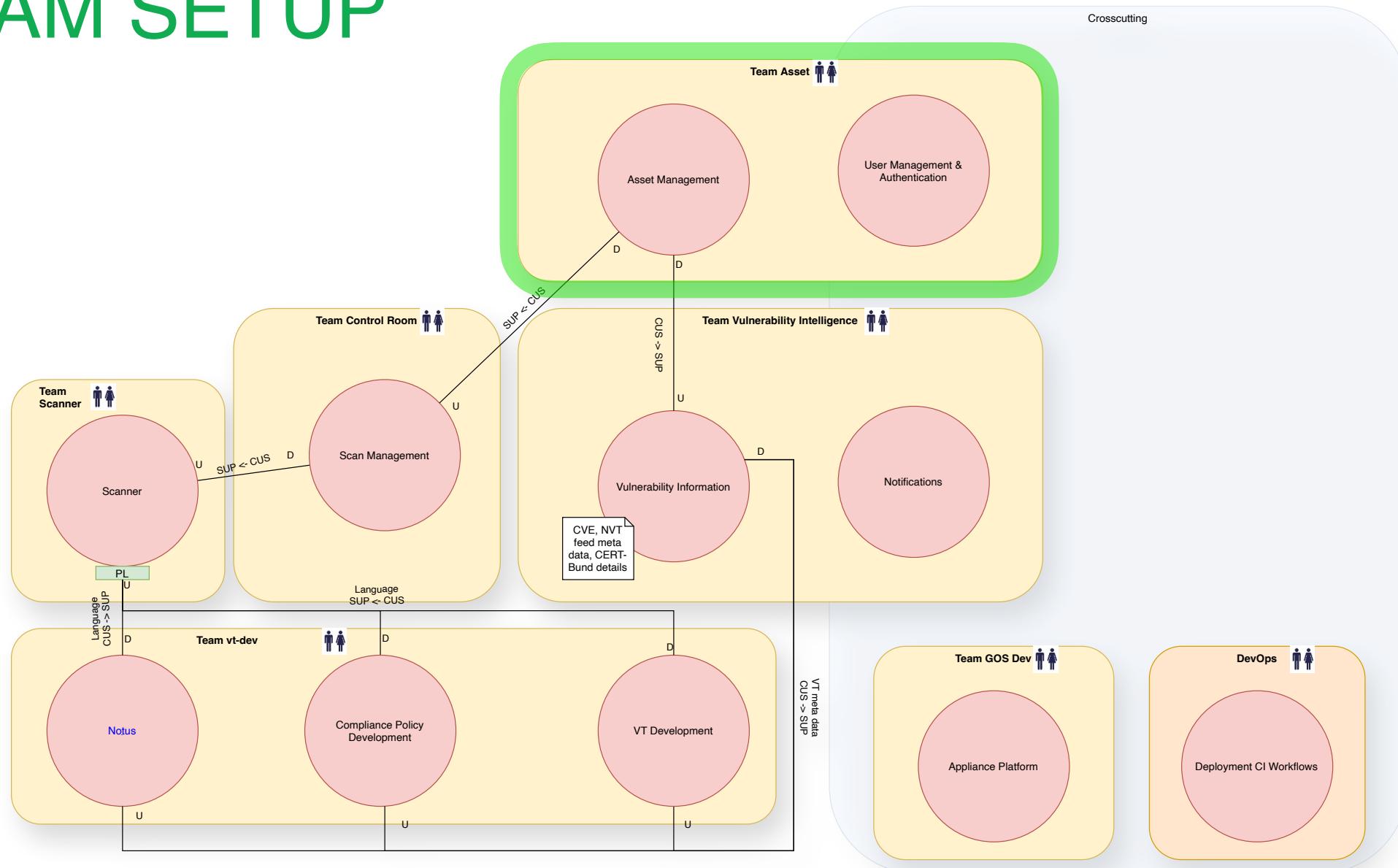
SETTING: PRODUCT



The screenshot shows the Greenbone Network Scanner interface. The top navigation bar includes "Analysis", "Dashboard" (which is selected), "Assets", "Vulnerabilities", and "Import". On the left, there's a sidebar with "Match All". The main area displays the following information:

- Number of assets:** 2,286
- Vulnerability trends:** A line chart showing the number of vulnerabilities over time (from April 10 to April 23). Three lines represent different severity levels: Critical (red), High (pink), and Medium (orange). The Medium line is consistently the highest, followed by High, then Critical.
- Top 10 vulnerabilities:** A table listing the top 10 vulnerabilities across three categories: Critical, High, and Medium. The critical section includes "mysql / mariadb default credentials (m...)" and "distcc rce vulnerability (cve-2004-2687)". The high section includes "postgreSQL default credentials (postgre...)" and "vnc brute force login". The medium section includes "twiki xss and command execution vuln..." and "ssh brute force logins w...".

TEAM SETUP



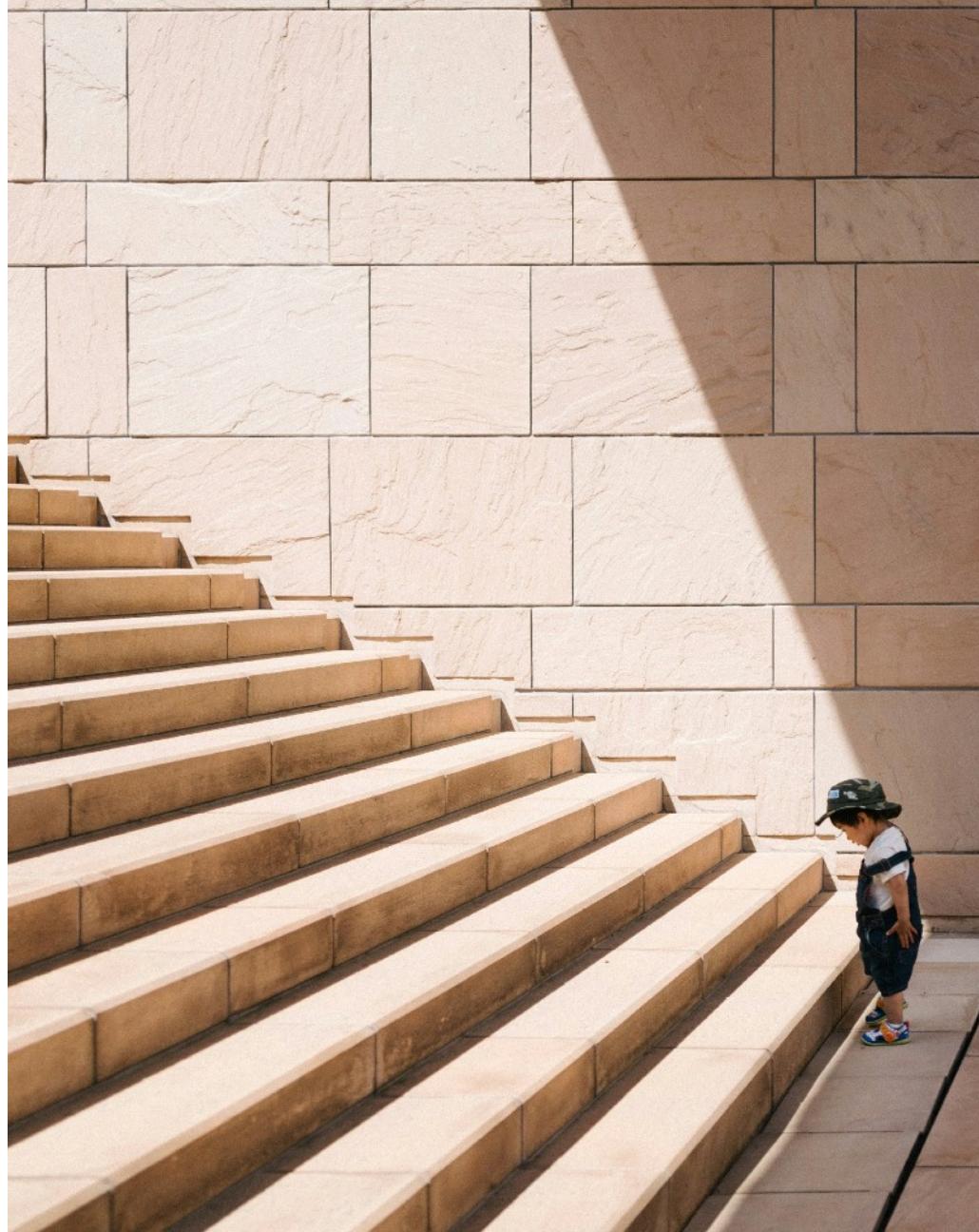
SETTING: AGILE

- Agile Approach
 - ✓ Scrum
 - ✓ short iterations: **2 week sprints**
 - ✓ multiple increments released per sprint
 - ✓ optimized for **fast feedback**



CHALLENGES

- Too few resources to **test everything manually**
- Especially **regression**
 - ✓ needs to be repeated **several times a week**
 - ✓ should be as **reliable** as possible
 - ✓ reasonable **effort**



THE ANSWER: TEST AUTOMATION



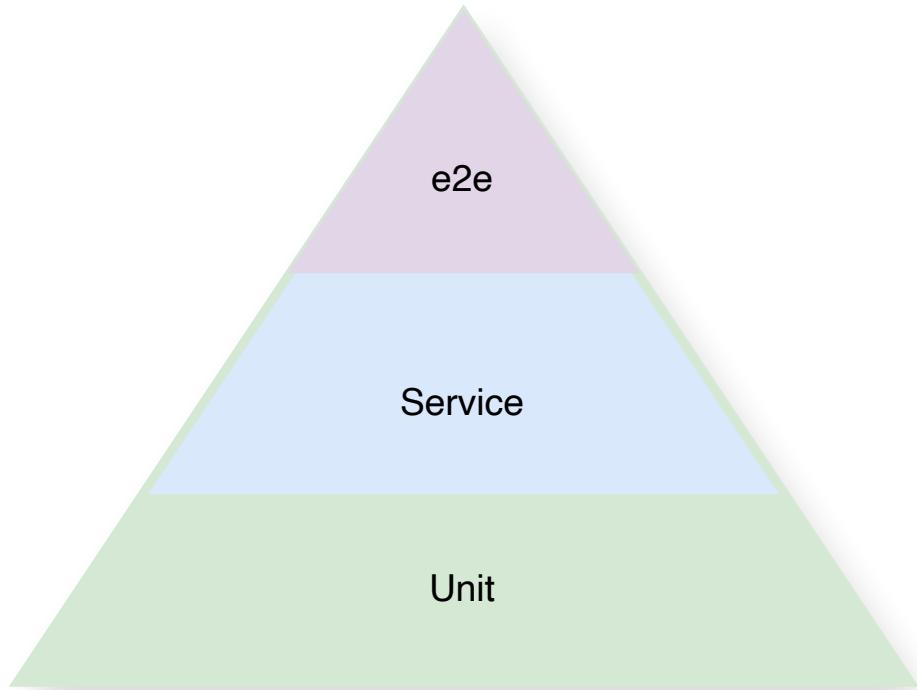
QA STRATEGY

- **automate as much as possible**
- test things on the **right level**

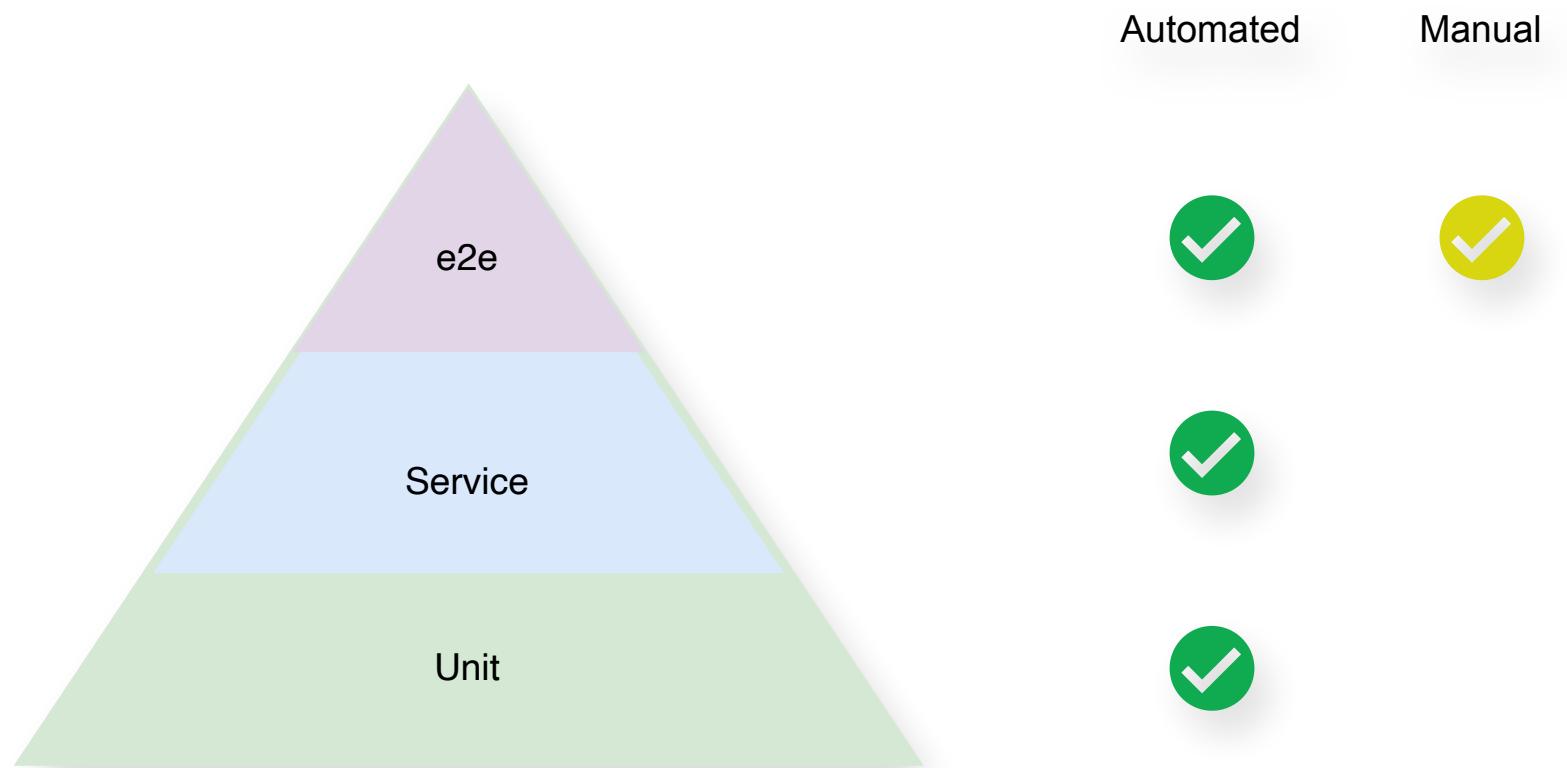
- **code reviews** are mandatory
- in case **manual tests** are needed for regression they must be **well-documented** and easily **reproducible**
- for each **bug** that is found a **test** must be created
- (...)



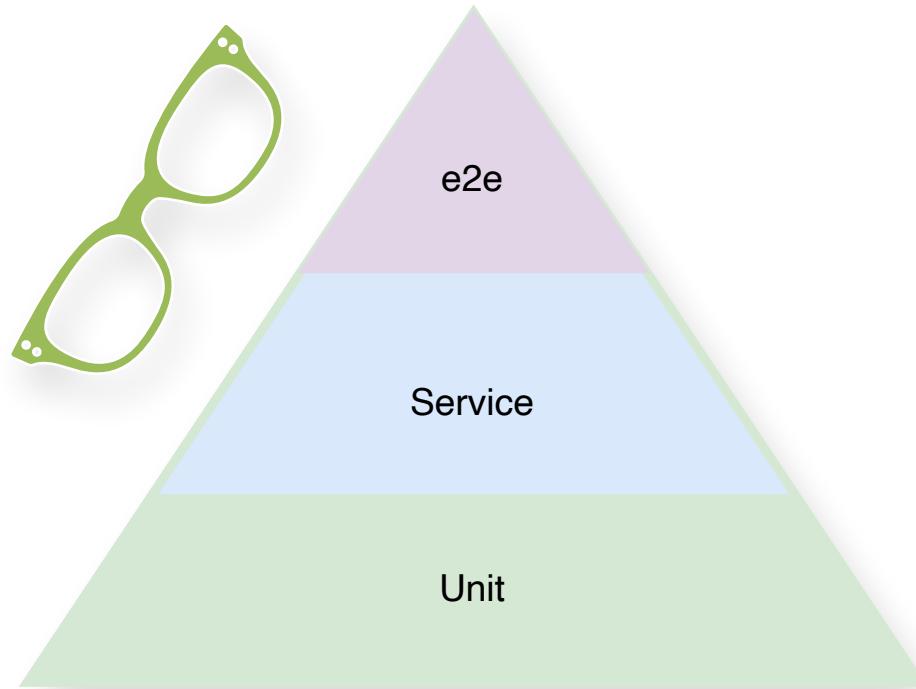
TEST LEVELS



TEST LEVELS



TEST LEVELS



TEST MATRIX

Use Case	Test Case	Unit Test	BE Service Test	FE Service Test	Full Service Test	e2e Test	manual test
Edit Appliance	edit appliance with missing fingerprint	+ for appliance controller + for appliance service	+ add test case (example test case for failure)	+ add test case (test case stops after receiving the fingerprint)	-	-	-
	edit appliance with correct fingerprint	+ for appliance controller + for appliance service	+ add test case (example test case for success)	+ add test case	-	-	-
	edit appliance with incorrect fingerprint	+ for appliance controller + for appliance service	-	+ add test case (test case stops after receiving the error)	-	-	-
	get appliance where the host key has changed and the fingerprint is no longer valid	+ for appliance controller + for appliance service + for import service(s)	(too difficult to simulate)	+ add test case	-	-	test manually

...

QA STRATEGY

Implementation

- **QA Strategy** workshop per team
- Dedicated **QA Engineer** per team
- **QA CoP**



E2E TESTS



E2E TESTS



E2E TESTS



```
1 import "cypress-wait-until"
2
3 ▷ describe('create a user and log in', () :void => {
4     after(() :void => {
5         cy.programmaticLogout()
6         cy.deleteUser(Cypress.env("new_user"))
7     })
8
9
10 ▷ it('Creating a user on operating system level should work', () :void => {
11     cy.createUser(Cypress.env("new_user"), Cypress.env("temp_password"))
12 }
13
14
15 ▷ it('Login via UI should work and lead to the landing page of OpenSight Asset', () :void => {
16     cy.visit(Cypress.env('redirect_uri'))
17     cy.waitForStableDOM()
18
19     cy.loginViaUI(Cypress.env("new_user"), Cypress.env("temp_password"))
20     cy.updatePassword(Cypress.env("password"))
21         .then(() :void => {
22             // check landing page for validation
23             cy.contains("✉ h2", "Dashboard")
24         })
25     })
26 }
```

E2E TESTS



```
1  name: e2e tests dev environment
2
3  on:
4    schedule:
5      - cron: '30 00 * * 1-5' # Mon-Fri at 01:30 UTC
6    workflow_dispatch:
7    pull_request:
8      branches: [ main ]
9
10 jobs:
11   e2e-tests:
12     name: Run e2e tests against the dev system
13     runs-on:
14       - self-hosted-generic
15       - self-hosted
16     container:
17       image: ghcr.io/greenbone/opensight-e2e:latest
18       options: --init
19     steps:
20       - name: Checkout
21         uses: actions/checkout@v4
22       - name: Install dependencies
23         run: chown -R root ./ && npm ci
24       - name: Run tests
25         env:
26           CYPRESS_ssh_pass: ${{ secrets.SSH_PASSWORD }}
27           CYPRESS_password: ${{ secrets.PASSWORD }}
28           CYPRESS_appliance_password: ${{ secrets.APPLIANCE_PASSWORD }}
29         run: make start-e2e-tests ENV=dev
30       - name: Upload report folder
31         if: always()
32         uses: actions/upload-artifact@v4
```

E2E TESTS



```
13 runs-on:
14   - self-hosted-generic
15   - self-hosted
16 container:
17   image: gher.io/greenbone/opensight-e2e:latest
18   options: --init
19 steps:
20   - name: Checkout
21     uses: actions/checkout@v4
22   - name: Install dependencies
23     run: chown -R root ./ && npm ci
24   - name: Run tests
25     env:
26       CYPRESS_ssh_pass: ${{ secrets.SSH_PASSWORD }}
27       CYPRESS_password: ${{ secrets.PASSWORD }}
28       CYPRESS_appliance_password: ${{ secrets.APPLIANCE_PASSWORD }}
29     run: make start-e2e-tests ENV=dev
30   - name: Upload report folder
31     if: always()
32     uses: actions/upload-artifact@v4
33     with:
34       name: e2e-test-dev-reports
35       path: cypress/reports/
36       retention-days: 4
37   - name: Upload screenshot folder
38     if: always()
39     uses: actions/upload-artifact@v4
40     with:
41       name: e2e-test-dev-screenshots
42       path: cypress/screenshots/
43       retention-days: 4
```

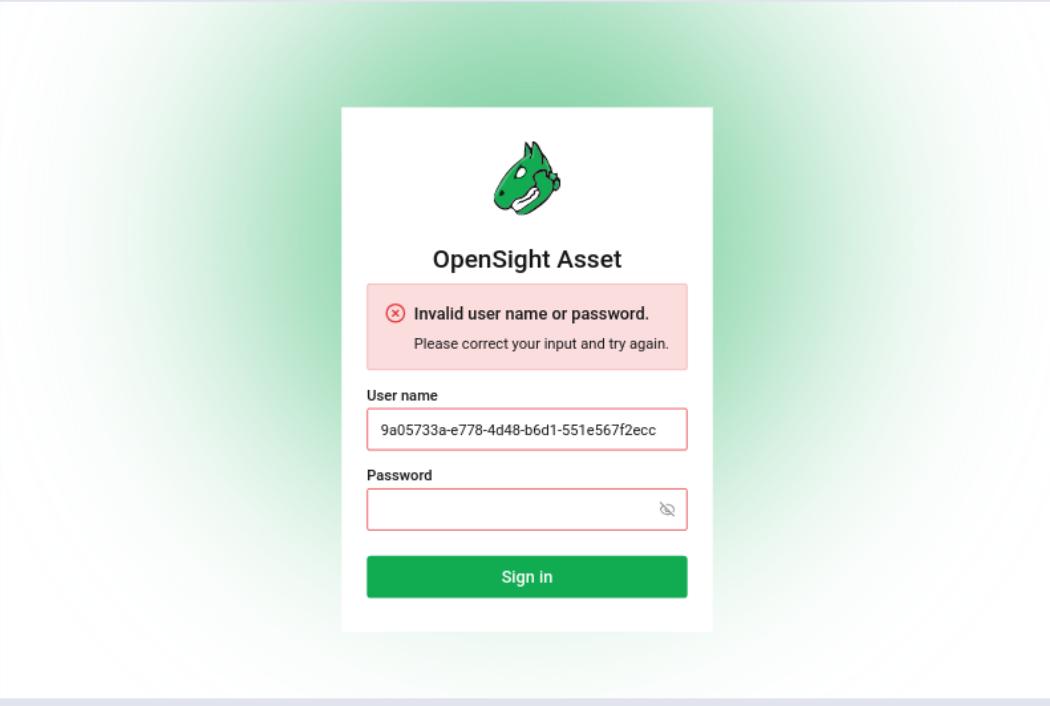
E2E TESTS

Specs 4 1 ⚡

login-logout-workflow.cy.ts 00:41

```
11 - type 8YWByCsMI/RHaW91D4rl2A==  
12 get input[id='kc-login'][name='login']  
13 - click  
  (form sub) --submitting form--  
  (page load) --page loaded--  
  (new url) https://asset-dev.opensight-  
    asset.greenbone.io/auth/realm.../login  
    -actions/authenticate?  
    session_code=xs7QQY0fgG_51jYKC...  
    B4dkEY...-lMw&execution=b674ef6e-d0ca-458d-  
    b11a-24441cbf180a&client_id=local-  
    web&tab_id=bkBsny0Je0I  
  (new url) https://asset-dev.opensight-  
    asset.greenbone.io/auth/realm.../login  
    -actions/authenticate?  
    execution=b674ef6e-d0ca-458d-  
    b11a-24441cbf180a&client_id=local-  
    web&tab_id=bkBsny0Je0I  
14 document  
15 log No changes detected for over interval  
  1400ms!  
16 log Continuing with test...  
17 wrap <document>  
18 get input[id='password-new'][name='password-new'] 0
```

https://asset-dev.opensight-asset.greenbone.io/auth/realm.../login
Electron 118 1000x660 (79%)



E2E TEST CHALLENGES

↳ Asynchronism ↳



- certain computations are done **asynchronously**
 - e.g. ui rendering, asynchronous messages
 - **time interval** before results are available **may vary**
strongly depending on system and load



E2E TEST CHALLENGES

↳ Asynchronism ↳



- certain **computations** are done
→ e.g. ui rendering, asynchronous requests
→ time interval before results are available
strongly depending on system and network

```
18 ▶  it('Creating a valid appliance should work and it should be displayed afterwards', () => {  
19    cy.enterPage("Import")  
20    cy.enterPage("Appliances")  
21    cy.get("span").contains("Add appliance").click()  
22    cy.get("form").find("input[name=name]").type(Cypress.env("appliance_name"))  
23    cy.get("form").find("input[name=gmpHost]").type(Cypress.env("appliance_ip"))  
24    cy.get("form")  
25      .find("input[name=gmpUsername]")  
26      .type(Cypress.env("appliance_user"))
```

- our approach @
- **wait for conditions with timeout** before checking assertions
- **cypress** has **built-in waits** with default timeouts!

27

The screenshot shows the Greenbone Network Scanner interface. The top navigation bar includes 'Analysis' (selected), 'Dashboard' (highlighted in green), 'Assets', 'Vulnerabilities', and 'Import'. The main dashboard area displays 'Number of assets' at 2,286 and 'Vulnerability trends'. Below this, there are two tables: 'Top 10 vulnerabilities' (critical) and 'Top 10 vulnerabilities' (high). The critical table lists:

Name	Assets
mysql / mariadb default credentials (mysql...)	68
distcc rce vulnerability (cve-2004-2687)	66
postgresql default credentials (postgresql ...)	59
vnc brute force login	52
twiki xss and command execution vulnera...	44
operating system (os) end of life (eol) date...	11

The high table lists:

Name
vsftpd compromised source code (vsftpd...)
distcc detection
the rlogin service is running (rlogin...)
phpinfo() output reporting (phpinfo...)
ssh brute force logins with password (ssh...)
php-cgi-based setups vulnerable to SSRF (php...)

Greenbone

E2E TEST CHALLENGES

↳ Changing Data ↳



- **data imported from real systems changes** throughout time
- ➡ **how many and which** entries will be there?

The screenshot shows the Greenbone Security Assistant web interface. The top navigation bar includes 'Analysis', 'Dashboard', 'Assets', and 'Vulnerabilities' (which is currently selected). Below the navigation is a search bar with 'Match All'. The main content area is titled 'Vulnerabilities' and lists 20 entries, each with a severity rating of 10. The entries are:

Severity	Name
10	The rexec service is running
10	PHP < 5.2.12 Multiple Vulnerabilities
10	Apache HTTP Server Multiple Security Vulnerabilities
10	Possible Backdoor: Ingreslock
10	Operating System (OS) End of Life (EOL) Detection
10	PHP End of Life (EOL) Detection - Linux
10	Distributed Ruby (dRuby/DRb) Multiple Remote Code Execution
10	Apache HTTP Server End of Life (EOL) Detection - Linux
10	PHP < 5.2.7 Multiple Vulnerabilities
10	phpMyAdmin End of Life (EOL) Detection - Linux
10	ISC BIND End of Life (EOL) Detection - Linux
10	OpenSSL End of Life (EOL) Detection - Linux
10	Mediawiki End of Life (EOL) Detection - Linux
10	Apache Log4j 2.0.x Multiple Vulnerabilities (Windows, Log4Shell)
10	Java RMI Server Insecure Default Configuration RCE Vulnerability
10	Nainx End of Life (EOL) Detection
10	TWiki XSS and Command Execution Vulnerabilities
10	MIT Kerberos5 Multiple Integer Underflow Vulnerabilities

E2E TEST CHALLENGES

↳ Changing Data ↳



- data imported from **real systems** throughout time
 - how many and which entries will be
- our approach @
- assert only what **you can know**
- validate **structure**

```
35 | Cypress.Commands.add("checkNumberOfImportedItems", (page: string) => {
36 |
37 |   cy.enterPage(page)
38 |   cy.deleteFilterTerms()
39 |   cy.enterFilterTerm(["Appliance ", "contains", Cypress.env("appliance_name")])
40 |   cy.waitForStableDOM()
41 |   cy.get("div[data-testid='pagination-container']", {timeout: 5000})
42 |     .contains("span", "items")
43 |     .invoke('text')
44 |     .then((text) => {
45 |       const regex = /(\d+) items/;
46 |       const matches = text.match(regex);
47 |       if (matches && matches.length === 2) {
48 |         cy.expect(parseInt(matches[1])).to.be.greaterThan(0)
49 |       }
50 |     })
51 |   cy.deleteFilterTerms()
52 | })
```

The screenshot shows the Greenbone Network Scanner interface. The left sidebar has tabs for Analysis, Dashboard, Assets, Vulnerabilities (which is selected), and Import. The main area is titled 'Vulnerabilities' with a 'Match All' button. It lists several findings:

- Severity: 10, Name: The reexec service is running
- Severity: 10, Name: PHP < 5.2.12 Multiple Vulnerabilities
- Severity: 10, Name: Java RMI Server Insecure Default Configuration RCE Vulnerability
- Severity: 10, Name: Nainx End of Life (EOL) Detection
- Severity: 10, Name: TWiki XSS and Command Injection Vulnerability
- Severity: 10, Name: MIT Kerberos5 Multiple Integer Underflow Vulnerabilities

The bottom right corner features the 'Greenbone' logo.

E2E TEST CHALLENGES

↳ Interference in Parallel Runs ↳



- **same resources** / entities / identifiers used for each run
 - e.g. same user
 - test data can be **influenced by another test run**

Version	Import status	Last import	Next import	Action
22.5	Done	Apr 19, 2024, 12:59:05 AM	Apr 20, 2024, 12:59:00 AM	⋮
22.5	Done	Apr 19, 2024, 06:30:03 AM	Apr 20, 2024, 06:30:00 AM	⋮
22.5	Done	Apr 19, 2024, 06:31:02 AM		⋮

Navigation: < 1 >

E2E TEST CHALLENGES

↳ Interference in Parallel Runs ↳



- same resources / entities / identifiers used for each run

- e.g. same user
- test data can be influenced by another test

- our approach @



- generate entities with random identifiers
- and delete them after each run

Version	Import status	Last import	Next import	Action
22.5	Done	Apr 19, 2024, 12:59:05 AM	Apr 20, 2024, 12:59:00 AM	⋮
22.5	Done	Apr 19, 2024, 06:30:03 AM	Apr 20, 2024, 06:30:00 AM	⋮
22.5	Done	Apr 19, 2024, 06:31:02 AM	Apr 19, 2024, 06:31:05 AM	⋮

```
1 ▶ #!/bin/bash
2
3 random_username=$(uuidgen)
4 export CYPRESS_new_user=$random_username
5
6 echo CYPRESS_new_user="$CYPRESS_new_user"
7
8 temp_password=$(head -c 16 /dev/urandom | base64)
9 export CYPRESS_temp_password=$temp_password
```

```
2
3 ▶ describe('create a user and log in', () :void => {
4     after(() :void => {
5         cy.programmaticLogout()
6         cy.deleteUser(Cypress.env("new_user"))
7     })
8
9
10 ▶ it('Creating a user on operating system level should work', () :void => {
11     cy.createUser(Cypress.env("new_user"), Cypress.env("temp_password"))
12 })
```

E2E TEST CHALLENGES

↳ Interference in Parallel Runs ↳



- same resources / entities / identifiers used for each run
 - e.g. same user
 - test data can be influenced by another test run
- our approach @
- generate entities with random identifiers
- and delete them after each run

Version ↑↓	Import status ↑↓	Last import ↑↓	Next import ↑↓	Action
22.5	Done	Apr 19, 2024, 12:59:05 AM	Apr 20, 2024, 12:59:00 AM	⋮
22.5	Done	Apr 19, 2024, 06:30:03 AM	Apr 20, 2024, 06:30:00 AM	⋮
22.5	Done	Apr 19, 2024, 06:31:02 AM		⋮

+ Add appliance

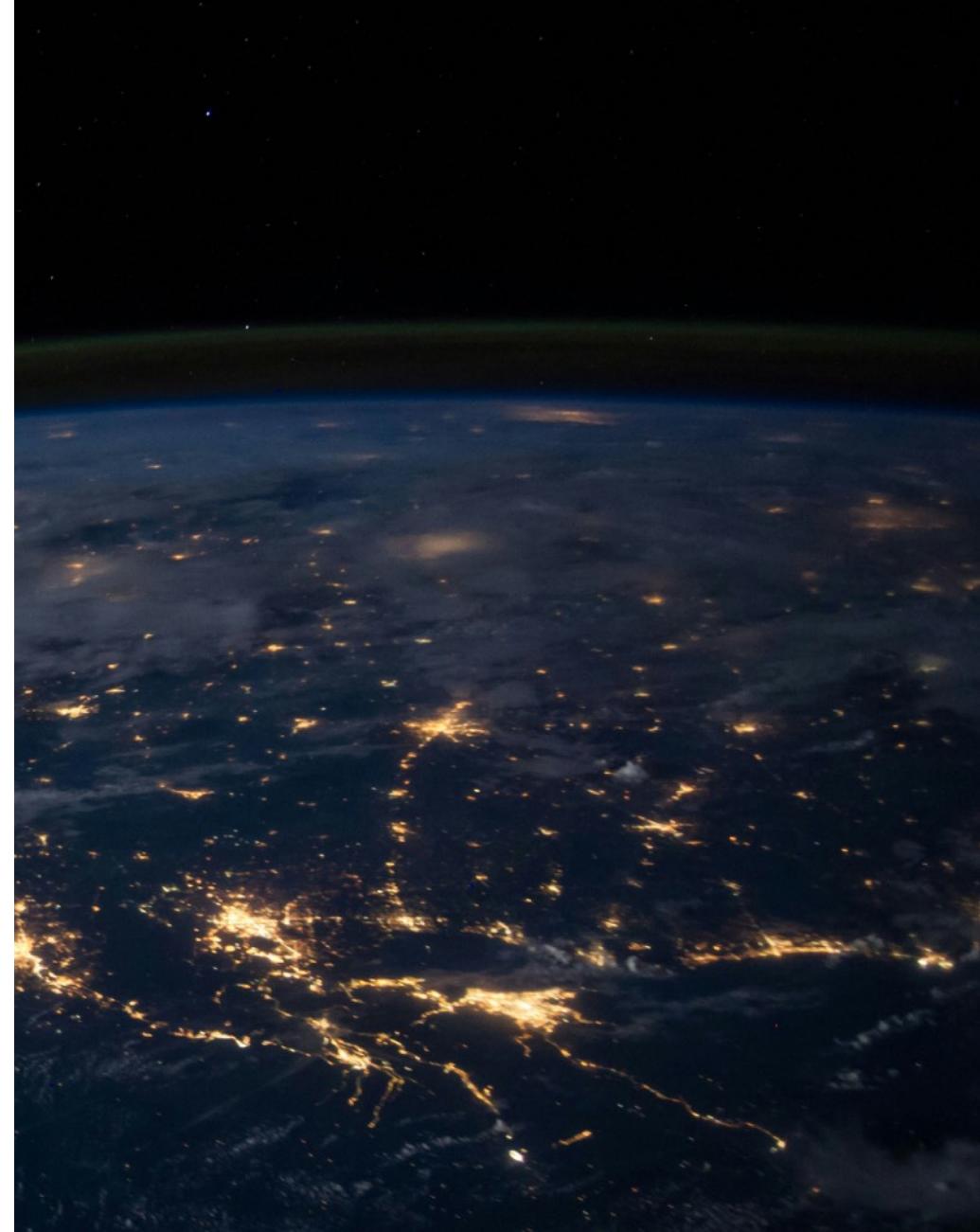
↳ unique resources ↳

- possible approaches
 - provide set and **lend instances to test runs**
 - write test that **adapt to situation** (e.g. start import if none is running)

E2E TESTS: WRAP-UP

- asynchronism: use **wait for** constructs
- no control of data: **validate structure**, assert what you can know
- parallel runs: **generate entities** with random identifiers, delete them after each run

- keep **test durations** low
 - e.g. use API calls for test setup
- **expect efforts** for maintenance



FRONTEND SERVICE TESTS



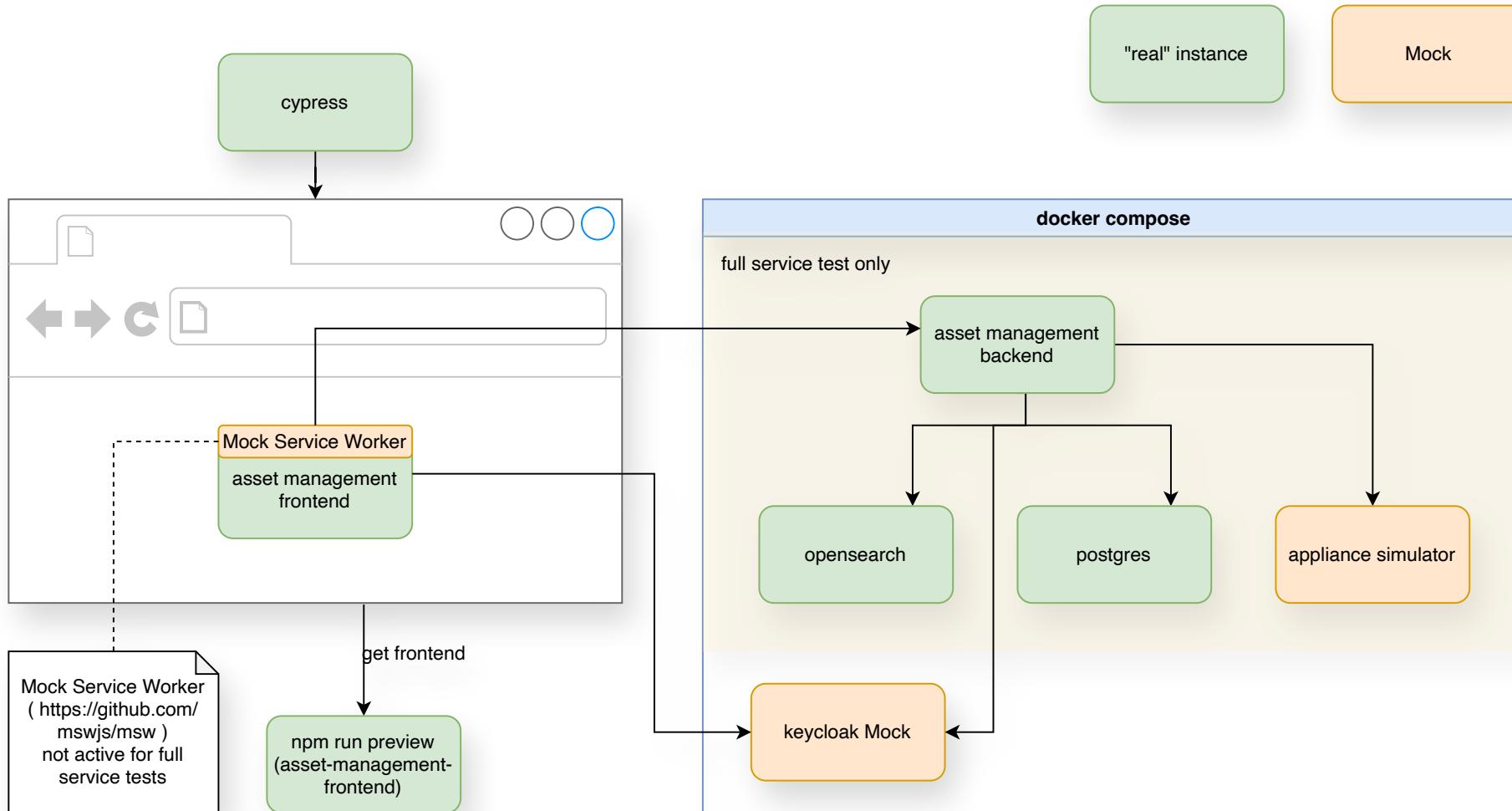
FRONTEND SERVICE TESTS



GitHub



FRONTEND SERVICE TESTS



FRONTEND SERVICE TESTS



Page Object Pattern

```
class VulnerabilityDetailsPage {
  elements = {
    breadcrumbCurrentPage: (text: string) =>
      cy.contains("div", `Vulnerability details: ${text}`),
    breadcrumbPreviousPage: () =>
      cy
        .contains("div", "Vulnerability details: ")
        .parent()
        .siblings("a"),
    vulnerabilityName: (text: string) => cy.contains("div", text),
    divContainer: () => cy.get("div"),
    linkToAffectedAssets: () => cy.contains("a", "here"),
  }

  verifyThatBreadcrumbContainsText(text: string) {
    this.elements.breadcrumbCurrentPage(text).should("exist")
  }

  verifyThatVulnerabilityNameContainsText(text: string) {
    this.elements.vulnerabilityName(text).should("exist")
  }
}
```

FRONTEND SERVICE TESTS



Page Object Pattern

```
1  describe("Frontend service tests for checking the vulnerabilities details page", () => {
2      const vulnerabilityDetailsPage = require("../pages/vulnerabilityDetailsPage")
3      const vulnerabilityOverviewPage = require("../pages/vulnerabilityOverviewPage")
4      const pageLayout = require("../pages/pageLayout")
5      const vulnerabilityName = "The rexec service is running"
6
7      before(() => {
8          pageLayout.visitRootPage()
9      })
10
11     beforeEach(() => {
12         pageLayout.enterPage("/vulnerabilities")
13         vulnerabilityOverviewPage.cleanFilterContainer()
14         vulnerabilityOverviewPage.navigateToVulnDetailsByIndex(0)
15     })
16
17     it("vulnerability details page should show correct information", () => {
18         vulnerabilityDetailsPage.verifyThatBreadcrumbContainsText(
19             vulnerabilityName
20         )
21         pageLayout.verifyThatPageTitleExists("Vulnerability details")
22         vulnerabilityDetailsPage.verifyThatVulnerabilityNameContainsText(
23             vulnerabilityName
24         )
25     })
26 })
```

FRONTEND SERVICE TESTS



```
10    jobs:
11      run-service-test:
12        runs-on: "ubuntu-latest"
13        strategy:
14          matrix:
15            node-version:
16              - 18.x
17              - 20.x
...
36      - name: setup service test environment
37        run: make start-service-test-environment
38
39      - name: run service tests
40        run: |
41          npm run preview&
42          sleep 5s
43          ./node_modules/.bin/cypress run --reporter mochawesome --spec "service-tests/cypress/tests/service-tests/*.cts"
...
45      - name: Upload report folder
46        if: always()
47        uses: actions/upload-artifact@v4
48        with:
49          name: FrontendServiceTestReports_${{ matrix.node-version }}
50          path: service-tests/cypress/reports/
51          retention-days: 1
...
```

FE S TEST CHALLENGES

↳ Changing Data ↳



- **data imported from real systems changes** throughout time
- ➡ **how many and which** entries will be there?

The screenshot shows the Greenbone Security Assistant web interface. The top navigation bar includes 'Analysis', 'Dashboard', 'Assets', and 'Vulnerabilities' (which is currently selected). Below the navigation is a search bar with 'Match All'. The main content area is titled 'Vulnerabilities' and lists 20 entries, each with a severity rating of 10. The entries are:

Severity	Name
10	The rexec service is running
10	PHP < 5.2.12 Multiple Vulnerabilities
10	Apache HTTP Server Multiple Security Vulnerabilities
10	Possible Backdoor: Ingreslock
10	Operating System (OS) End of Life (EOL) Detection
10	PHP End of Life (EOL) Detection - Linux
10	Distributed Ruby (dRuby/DRb) Multiple Remote Code Execution
10	Apache HTTP Server End of Life (EOL) Detection - Linux
10	PHP < 5.2.7 Multiple Vulnerabilities
10	phpMyAdmin End of Life (EOL) Detection - Linux
10	ISC BIND End of Life (EOL) Detection - Linux
10	OpenSSL End of Life (EOL) Detection - Linux
10	Mediawiki End of Life (EOL) Detection - Linux
10	Apache Log4j 2.0.x Multiple Vulnerabilities (Windows, Log4Shell)
10	Java RMI Server Insecure Default Configuration RCE Vulnerability
10	Nainx End of Life (EOL) Detection
10	TWiki XSS and Command Execution Vulnerabilities
10	MIT Kerberos5 Multiple Integer Underflow Vulnerabilities

Greenbone

FE S TEST CHALLENGES

↳ Changing Data ↳



- data imported from **real systems** changes throughout time
 - ➡ how many and which entries will be there?
- our approach @ 
 - ➡ **mock** external systems
 - ➡ simplifies test setup
 - ➡ makes test shorter & more stable (reliable testdata!)

The screenshot shows the Greenbone Security Assistant web interface. The top navigation bar includes 'Analysis', 'Dashboard', 'Assets', and 'Vulnerabilities' (which is currently selected). Below the navigation is a search bar with 'Match All'. The main content area is titled 'Vulnerabilities' and lists 20 entries, each with a severity rating of 10. The entries are:

Severity	Name
10	The rexec service is running
10	PHP < 5.2.12 Multiple Vulnerabilities
10	Apache HTTP Server Multiple Security Vulnerabilities
10	Possible Backdoor: Ingreslock
10	Operating System (OS) End of Life (EOL) Detection
10	PHP End of Life (EOL) Detection - Linux
10	Distributed Ruby (dRuby/DRb) Multiple Remote Code Execution
10	Apache HTTP Server End of Life (EOL) Detection - Linux
10	PHP < 5.2.7 Multiple Vulnerabilities
10	phpMyAdmin End of Life (EOL) Detection - Linux
10	ISC BIND End of Life (EOL) Detection - Linux
10	OpenSSL End of Life (EOL) Detection - Linux
10	Mediawiki End of Life (EOL) Detection - Linux
10	Apache Log4j 2.0.x Multiple Vulnerabilities (Windows, Log4Shell)
10	Java RMI Server Insecure Default Configuration RCE Vulnerability
10	Nainx End of Life (EOL) Detection
10	TWiki XSS and Command Execution Vulnerabilities
10	MIT Kerberos5 Multiple Integer Underflow Vulnerabilities

Greenbone

FE S TEST CHALLENGES

↳ Code Maintainability Decreases ↳

- code may become **difficult to read**
 - often selectors on the DOM are **not self-explanatory**
- code changes may become **cumbersome**
 - often **selectors are repeated** throughout the code
 - can be a **lot of effort** to change all locations

```
28     it("sorting assets by appliance name should work correctly", () => {
29       cy.contains("h4", "Appliance name").click()
30       cy.waitForStableDOM()
31       cy.get("tbody>tr")
32         .eq(0)
33         .should("contain", Cypress.env("appliance_name"))
34     cy.contains("h4", "Appliance name").click()
35     cy.waitForStableDOM()
36     cy.get("tbody>tr")
37       .eq(0)
38       .should("contain", Cypress.env("appliance_name"))
39   })
40
41   it("sorting assets by last scan should work correctly", () => {
42     cy.contains("h4", "Last scan").click()
43     cy.waitForStableDOM()
44     cy.get("tbody>tr").eq(0).should("contain", "Feb. 07, 2023 08:42:02am")
45     cy.contains("h4", "Last scan").click()
46     cy.waitForStableDOM()
47     cy.get("tbody>tr").eq(0).should("contain", "Feb. 07, 2023 09:36:46am")
48   })
49
50   it("the pagination should work for different sizes and pages", () => {
51     cy.contains("span", "1-10 of 15 items").should("exist")
52     cy.get("tbody>tr").then((rows) => {
53       cy.expect(rows.length).to.equal(10)
54     })
55     cy.get("input[data-testid='paging-step-select'][value='10']").should(
56       "exist"
57     )
58
59     // navigate to page 2
60     cy.get("div[data-testid='pagination-container']").within(() => {
61       cy.contains("button", "2").click().waitForStableDOM()
62     })
63     cy.contains("span", "11-15 of 15 items").should("exist")
64     cy.get("tbody>tr").then((rows) => {
65       cy.expect(rows.length).to.equal(5)
66     })
67     cy.get("tbody>tr").eq(0).should("contain", "192.168.123.36")
68
69   // change paging size to 20
70 }
```

FE S TEST CHALLENGES

↳ Code Maintainability Decreases ↳

- code may become **difficult to read**
 - ➡ often selectors on the DOM are **not self-explanatory**
- code changes may become **cumbersome**
 - ➡ often **selectors are repeated throughout the code**
 - ➡ can be a **lot of effort to change all locations**
- our approach @ 
 - ➡ **use page object pattern**

```
28     it("sorting assets by appliance name should work correctly", () => {
29       cy.contains("h4", "Appliance name").click()
30       cy.waitForStableDOM()
31       cy.get("tbody>tr")
32         .eq(0)
33         .should("contain", Cypress.env("appliance_name"))
34     cy.contains("h4", "Appliance name").click()
35     cy.waitForStableDOM()
36     cy.get("tbody>tr")
37       .eq(0)
38       .should("contain", Cypress.env("appliance_name"))
39   })
40
41   it("sorting assets by last scan should work correctly", () => {
42     cy.contains("h4", "Last scan").click()
43     cy.waitForStableDOM()
44     cy.get("tbody>tr").eq(0).should("contain", "Feb. 07, 2023 08:42:02am")
45     cy.contains("h4", "Last scan").click()
46     cy.waitForStableDOM()
47     cy.get("tbody>tr").eq(0).should("contain", "Feb. 07, 2023 09:36:46am")
48   })
49
50   it("the pagination should work for different sizes and pages", () => {
51     cy.contains("span", "1-10 of 15 items").should("exist")
52     cy.get("tbody>tr").then((rows) => {
53       cy.expect(rows.length).to.equal(10)
54     })
55     cy.get("input[data-testid='paging-step-select'][value='10']").should(
56       "exist"
57     )
58
59     // navigate to page 2
60     cy.get("div[data-testid='pagination-container']").within(() => {
61       cy.contains("button", "2").click().waitForStableDOM()
62     })
63     cy.contains("span", "11-15 of 15 items").should("exist")
64     cy.get("tbody>tr").then((rows) => {
65       cy.expect(rows.length).to.equal(5)
66     })
67     cy.get("tbody>tr").eq(0).should("contain", "192.168.123.36")
68
69   // change paging size to 20
70 }
```

FE S TEST CHALLENGES

↳ Code Maintainability Decreases ↳

- code duplication
 - often
- code repetition
 - often
- can't reuse
 - can't reuse
- Our application
 - uses

```
38 >     it("sorting assets by last scan should work correctly", () => {
39         affectedAssetsPage.tableController().sortHeader("Last scan")
40         affectedAssetsPage.verifyThatFirstRowsContainsText(
41             "Feb 07, 2023, 08:42:02 AM"
42         )
43         affectedAssetsPage.tableController().sortHeader("Last scan")
44         affectedAssetsPage.verifyThatFirstRowsContainsText(
45             "Feb 07, 2023, 09:36:46 AM"
46         )
47     })
48
49 >     it("the pagination should work for different sizes and pages", () => {
50         affectedAssetsPage.paginationTextEquals("1-10 of 15 items")
51         affectedAssetsPage.tableController().verifyRowAmountIsEqualTo(10)
52         affectedAssetsPage.tableController().verifySelectedPageSize(10)
53
54         affectedAssetsPage.tableController().gotoPage(2)
55         affectedAssetsPage.paginationTextEquals("11-15 of 15 items")
56         affectedAssetsPage.tableController().verifyRowAmountIsEqualTo(5)
57         affectedAssetsPage.verifyThatFirstRowsContainsText("192.168.123.36")
58
59         affectedAssetsPage.tableController().setPageSize(20)
60         affectedAssetsPage.paginationTextEquals("1-15 of 15 items")
61         affectedAssetsPage.tableController().verifySelectedPageSize(20)
```

```
28     it("sorting assets by appliance name should work correctly", () => {
29         cy.contains("h4", "Appliance name").click()
30         cy.waitForStableDOM()
31         cy.get("tbody>tr")
32             .eq(0)
33             .should("contain", Cypress.env("appliance_name"))
34         cy.contains("h4", "Appliance name").click()
35         cy.waitForStableDOM()
36         cy.get("tbody>tr")
37             .eq(0)
38             .should("contain", Cypress.env("appliance_name"))
39     })
40
41     it("sorting assets by last scan should work correctly", () => {
42         cy.contains("h4", "Last scan").click()
43         cy.waitForStableDOM()
44         cy.get("tbody>tr").eq(0).should("contain", "Feb. 07, 2023 08:42:02am")
45         cy.contains("h4", "Last scan").click()
46         cy.waitForStableDOM()
47         cy.get("tbody>tr").eq(0).should("contain", "Feb. 07, 2023 09:36:46am")
48     })
49
50     it("the pagination should work for different sizes and pages", () => {
51         cy.contains("span", "1-10 of 15 items").should("exist")
52         cy.get("tbody>tr").then((rows) => {
53             cy.expect(rows.length).to.equal(10)
54         })
55         cy.get("input[data-testid='paging-step-select'][value='10']").should(
56             "exist"
57         )
58
59         // navigate to page 2
60         cy.get("div[data-testid='pagination-container']").within(() => {
61             cy.contains("button", "2").click().waitForStableDOM()
62         })
63         cy.contains("span", "11-15 of 15 items").should("exist")
64         cy.get("tbody>tr").then((rows) => {
65             cy.expect(rows.length).to.equal(5)
66         })
67         cy.get("tbody>tr").eq(0).should("contain", "192.168.123.36")
68
69         // change paging size to 20
```

FE S TEST CHALLENGES

↳ time and translation varies ↳



- **i18n:** different time zones, date formats, translations
 - may differ between systems
 - tests may fail when checking for date, time or translations

Next import ↑

Apr 25, 2024, 06:30:00 AM

Action

Apr 25, 2024, 06:31:00 AM

⋮

Apr 25, 2024, 12:59:00 AM

⋮

← 1 →

Europe/Berlin ⚙

John Doe ⚙

+ Appliance hinzufügen

Nächster Import ↑

26.04.2024, 06:30:00

Aktion

25.04.2024, 18:31:00

⋮

26.04.2024, 00:59:00

⋮

Greenbone

← 1 →

FE S TEST CHALLENGES

↳ time and translation varies ↳



- i18n: different time zones, date formats, translations

→ may differ between

→ tests may fail when checking for date, time or translations

```
56 .PHONY: start-service-tests
57 start-service-tests:
58     TZ=UTC ./node_modules/.bin/cypress run --reporter mochawesome --spec ${SERVICE_TESTS_PATH}
```

← 1 →

- our approach @ 🦖

→ set time zone explicitly

→ select locale explicitly (or rely on default)

Next import ↑	Action
Apr 25, 2024, 06:30:00 AM	⋮
Apr 25, 2024, 06:31:00 AM	⋮
Apr 25, 2024, 12:59:00 AM	⋮

Europe/Berlin 🇩🇪 ☀️ John Doe ⚙

+ Appliance hinzufügen

Nächster Import ↑	Aktion
26.04.2024, 06:30:00	⋮
25.04.2024, 18:31:00	⋮
26.04.2024, 00:59:00	⋮

FE S TESTS: WRAP-UP

- consider **full service tests** (with backend)
- **mock** systems outside scope (except data stores)
- use **page object** pattern
- set **time zone / locale** explicitly

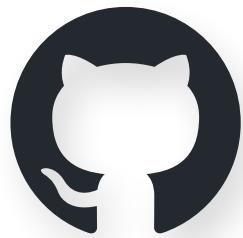
- like e2e
 - asynchronism: use **wait for** constructs
 - keep **test durations** low
 - **expect efforts** for maintenance



BACKEND SERVICE TESTS



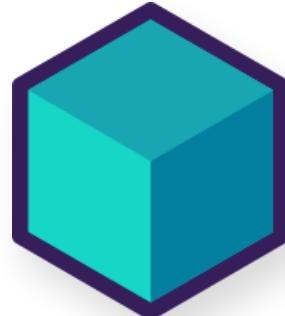
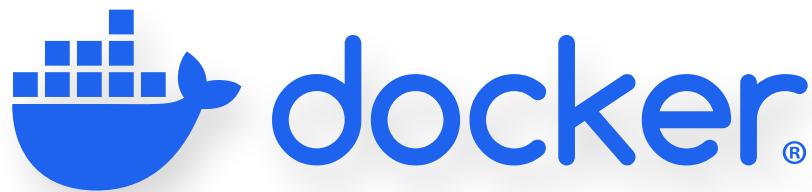
BACKEND SERVICE TESTS



GitHub

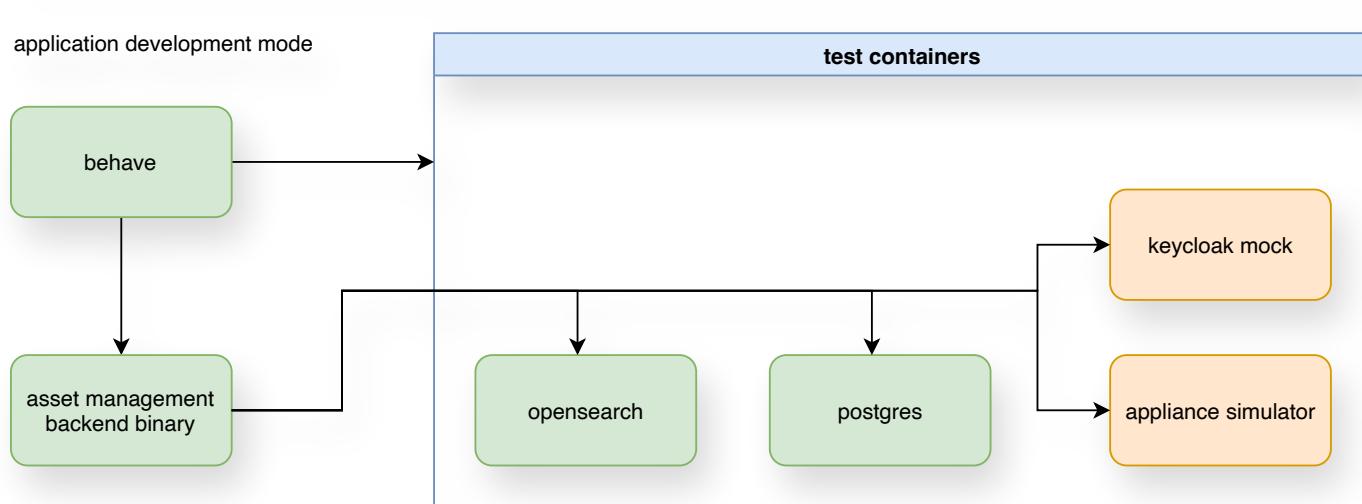
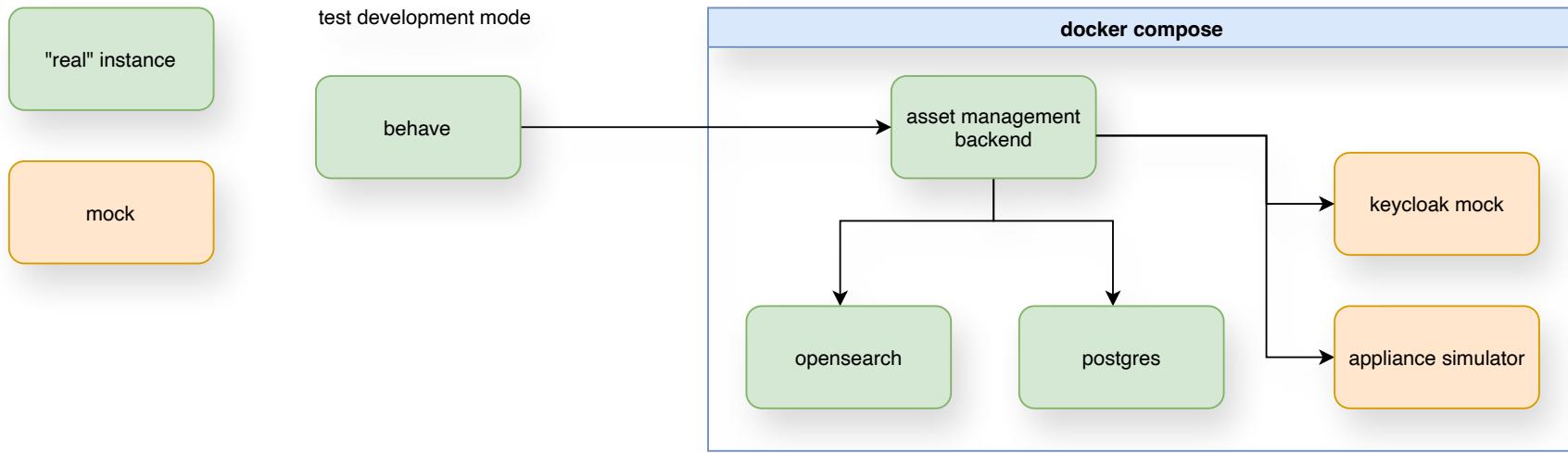


python™



Testcontainers

BACKEND SERVICE TESTS



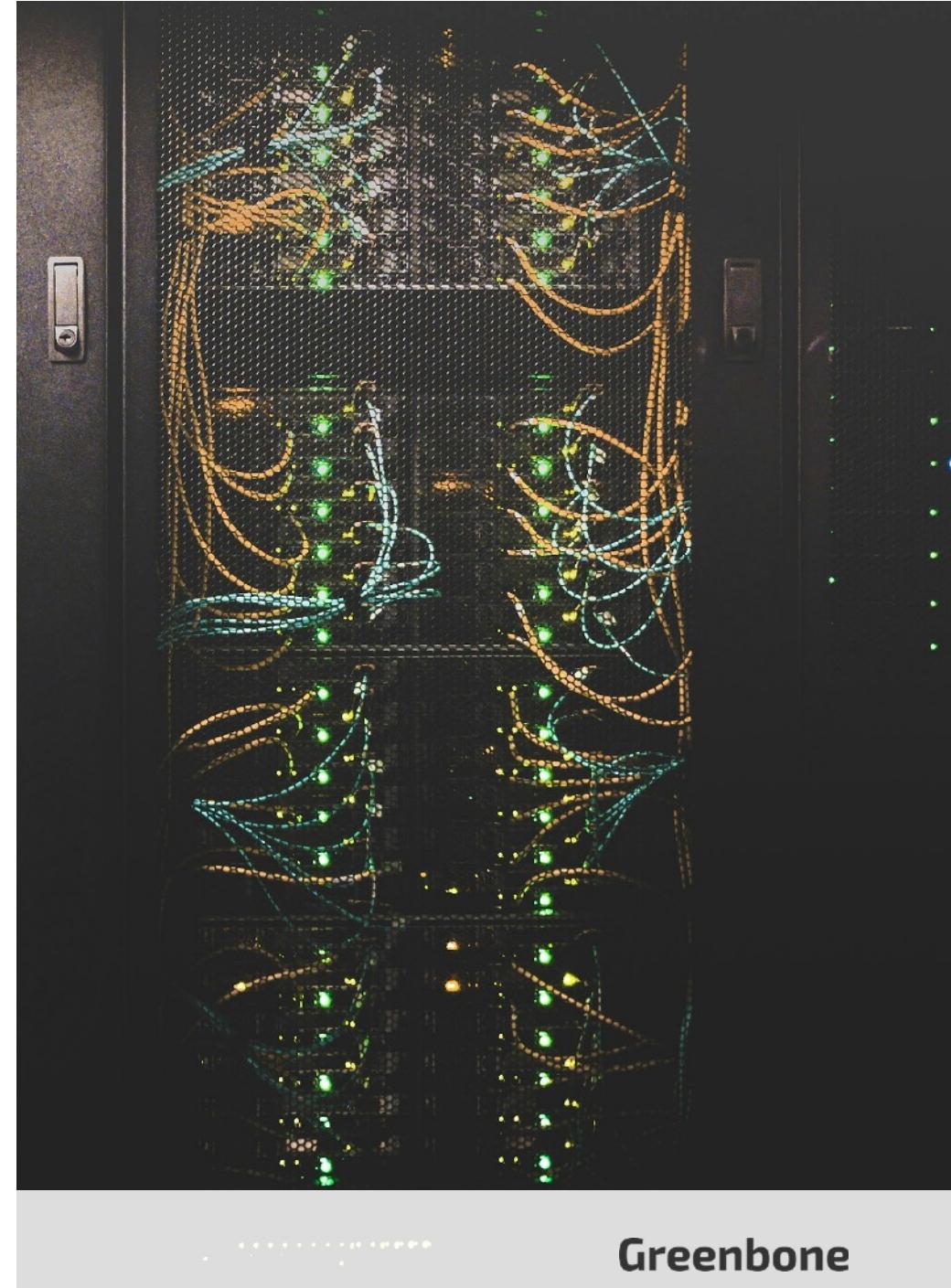
BACKEND SERVICE TESTS

```
98     @fixture.appliance.creation
99     @fixture.appliance.cleanup
100    Scenario: Updating an existing appliance with invalid ssh key fingerprint should deliver a 400 status and the expected error (via PUT /appliances/{applianceId})
101        Given the user is logged in
102        And the appliance 'Prepared Test Appliance' is available
103        When the existing appliance 'Prepared Test Appliance' is updated using invalid fingerprint
104        Then a 400 status is delivered
105        And the response has the text 'greenbone/asset/host-key-invalid' for the field 'type'
106        And the response has the text 'SHA256:yyq1KasQ622bc5Ez5nH/fh1Mcse2ZFhewcG4VH3Mir4' for the custom field 'retrievedSshFingerprint'
```

```
36     @step(u'a (?P<status_code>\\d+) status is delivered')
37     def step_check_error_code(context, status_code):
38         wait.wait_for_context_response(context, condition=lambda r: assert_that(r.status_code)
39                                         .is_equal_to(int(status_code)))
```

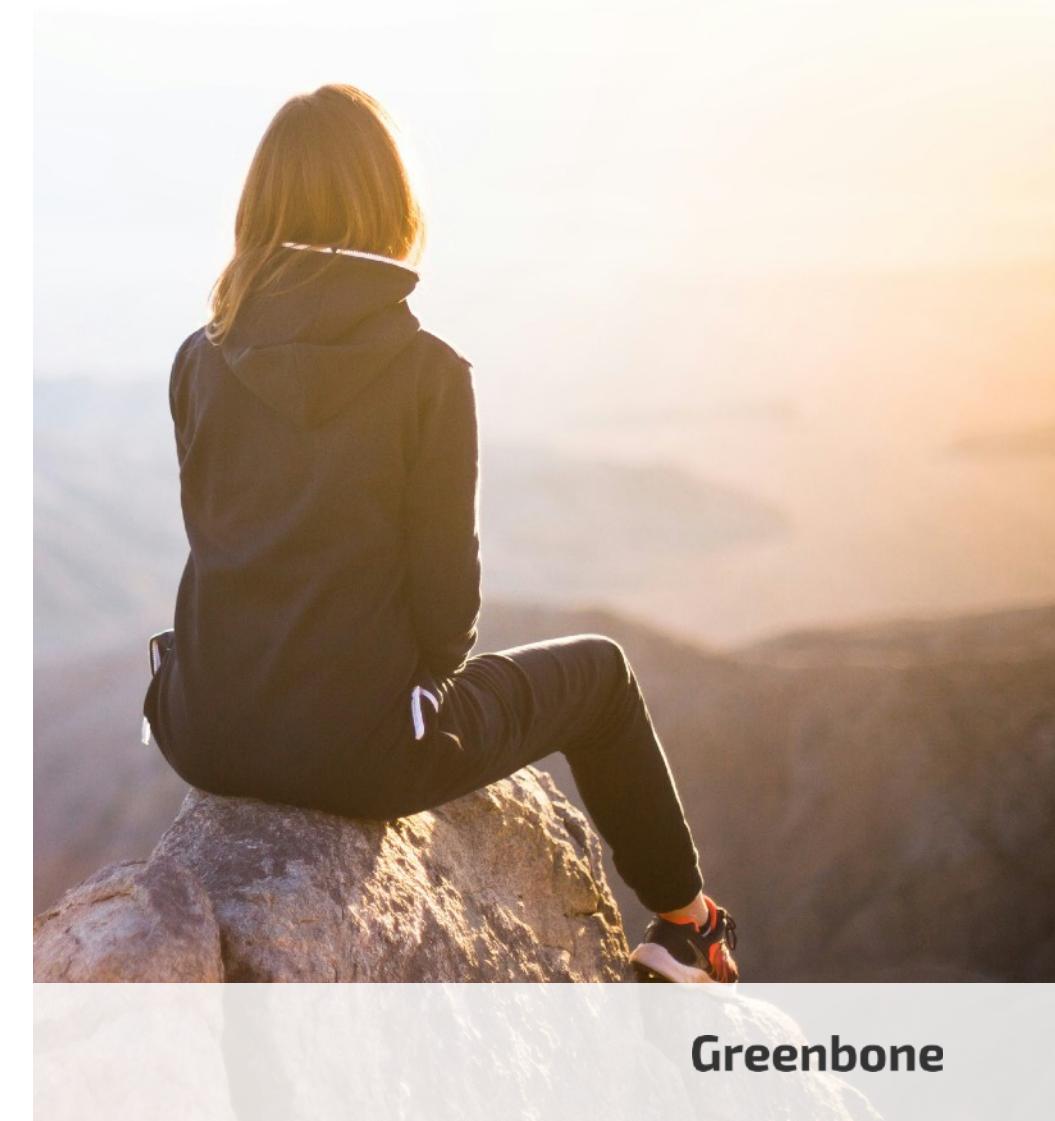
BE S TESTS: WRAP-UP

- like frontend service tests:
 - **mock systems** outside scope (except data stores)
 - asynchronous: use **wait for** constructs
 - keep **test durations** low
 - **expect efforts** for maintenance



OUTLOOK

- Sometimes we get "We detected that the **Electron** Renderer process just **crashed.**" in the CI
 - we need to investigate
- run e2e test after each deployment
- synchronize QA approach in whole company
- automated cross browser test
- contract driven testing (e.g. pact)
- metrics for quality (e.g. escaped bugs)



EXPLORATORY TESTING

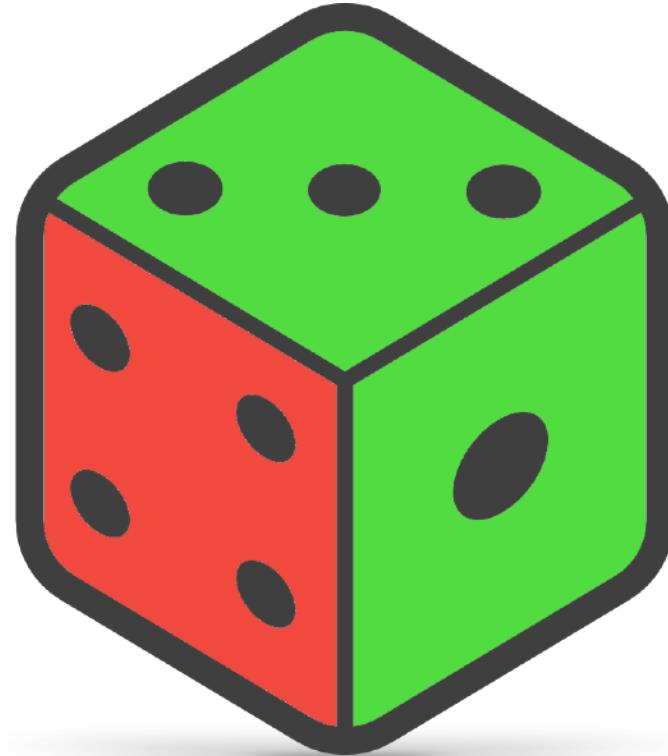
- **Scripted** (espec. automated) **testing is important**
e.g. for regression and possibly short feedback cycles
- But think of your scripted tests as **threads of a net**
- They catch whatever you thought of, but there are always **things** that are **not caught**
- Given the **unlimited space of possibilities** it is impossible to weave the net fine enough to catch every possibility
- This is where **exploratory testing** comes in handy!

<https://www.goodreads.com/book/show/15980494-explore-it>



BEWARE OF THE DICE

don't ignore flaky tests!



Thank You!

Greenbone

Questions?

LET'S CREATE A FUTURE TOGETHER

We are more than just a business: We are a team of creative thinkers, innovative problem solvers, dedicated professionals – and passionate humans.

Be part of the Solution: find our job postings here



Our key benefits:

Remote Work options: 100% remote work possible

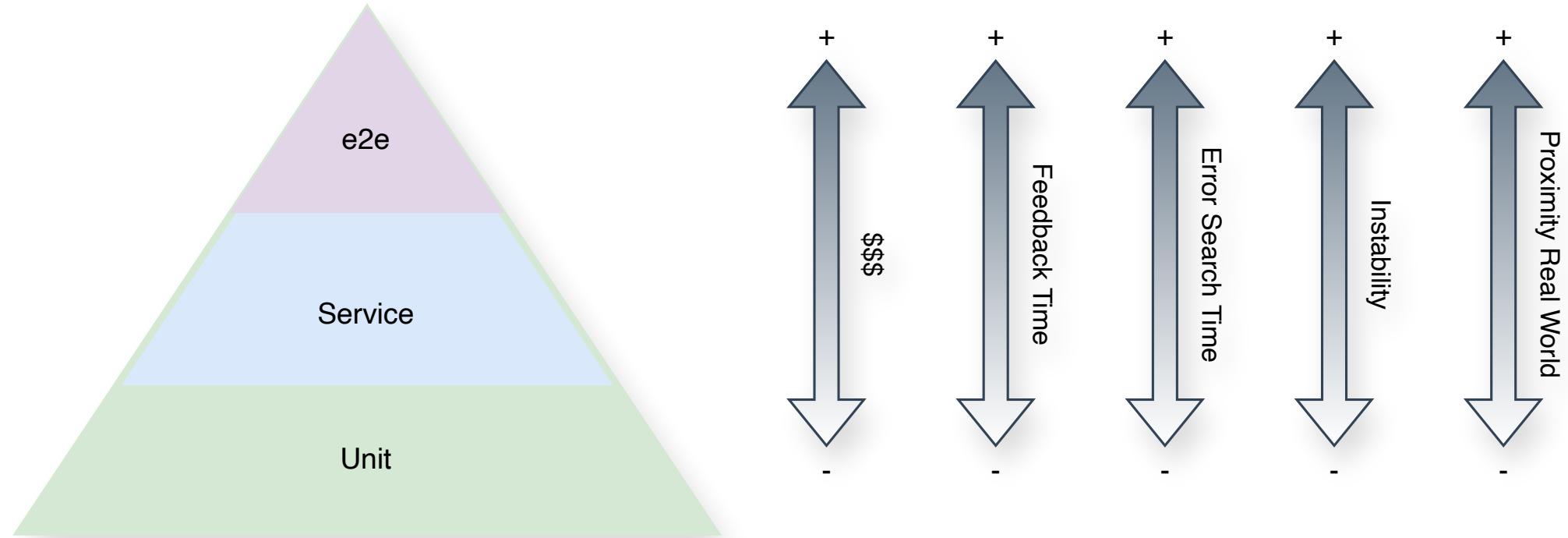
Flexible working hours

Opportunities for participation in company decisions

Backup

Greenbone

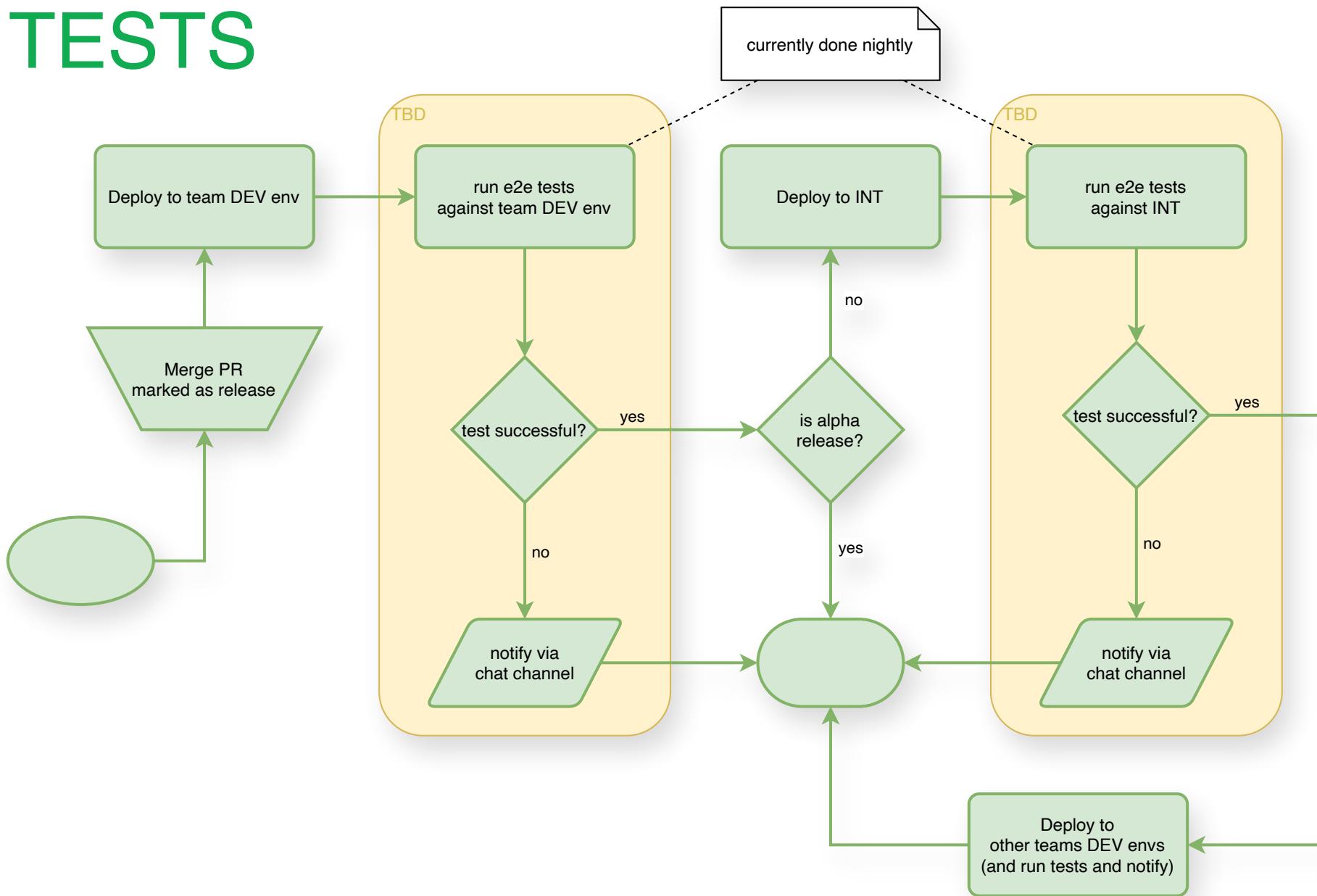
TEST PYRAMID



E2E TESTS



E2E TESTS

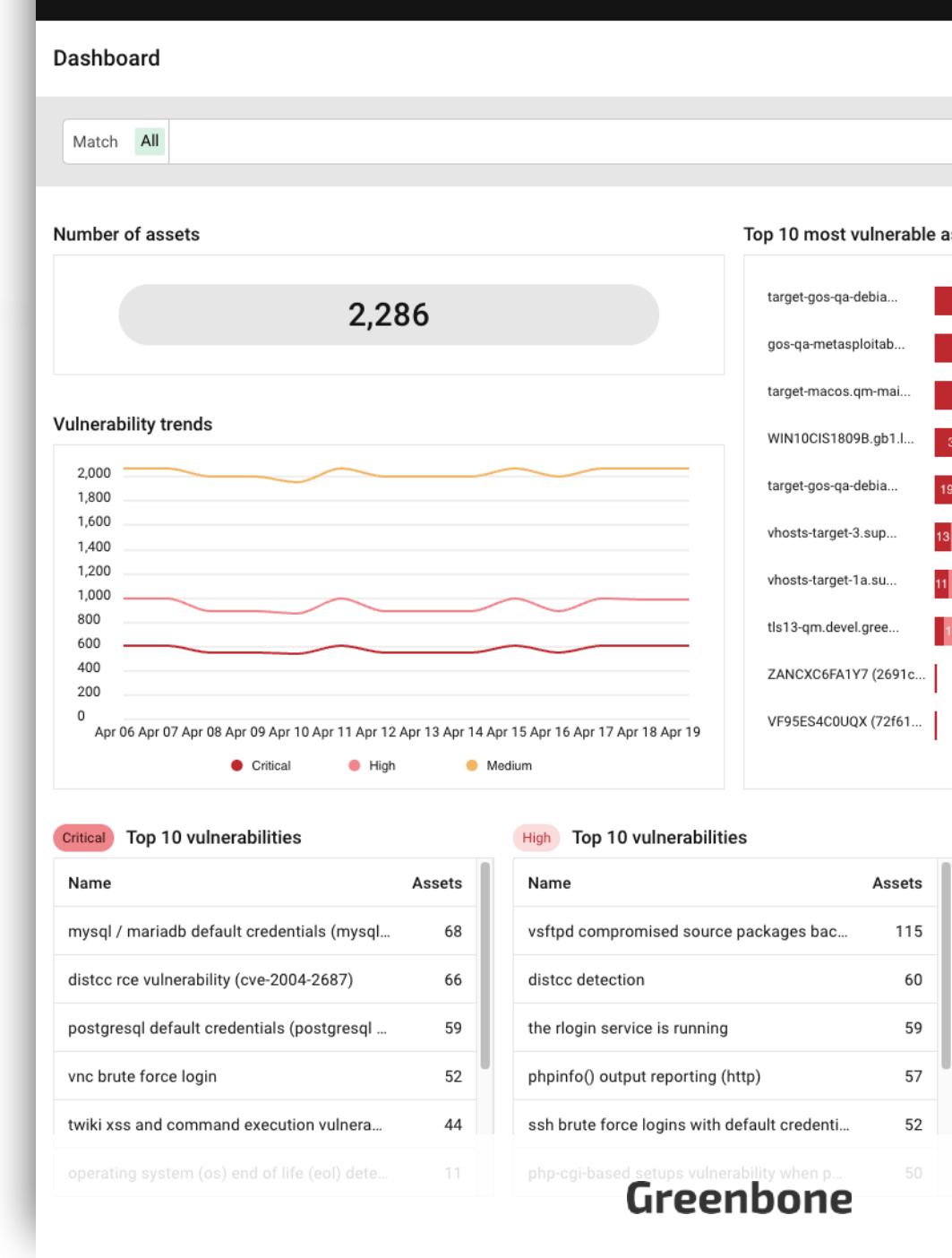


E2E TEST CHALLENGES

↳ Active Users on Test System ↳



- **test systems** are also used for **manual testing** and presentations
- test outcomes can be **influenced** by **user actions**



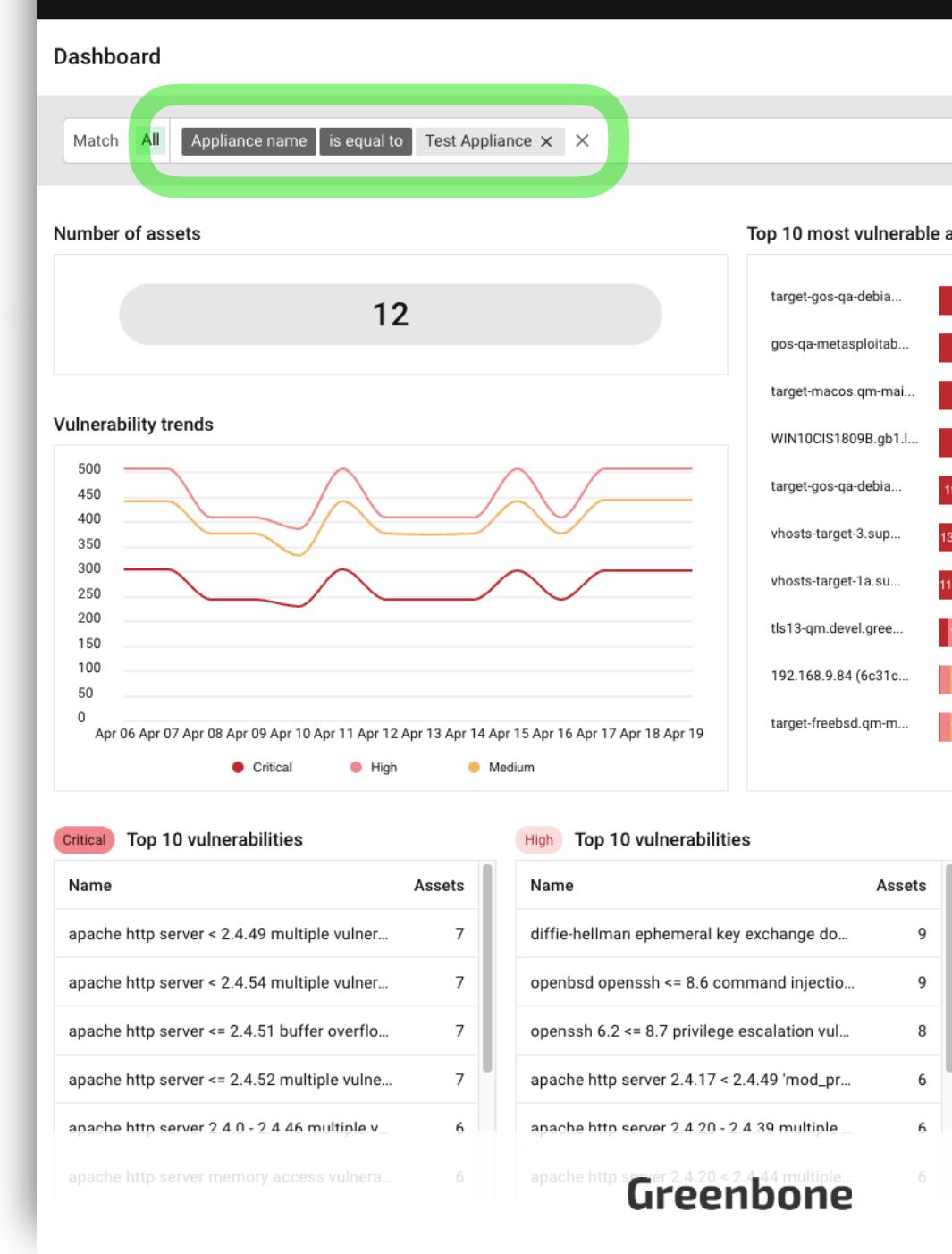
E2E TEST CHALLENGES

↳ Active Users on Test System ↳

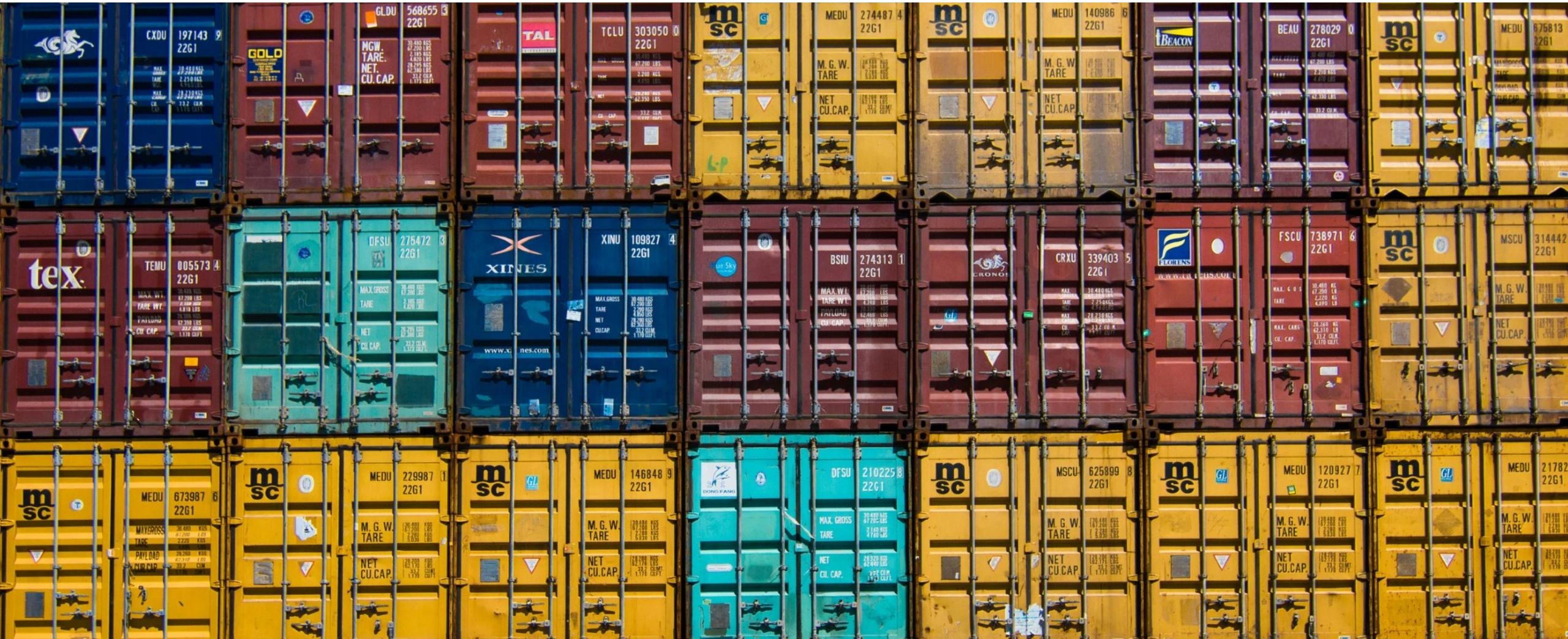


- **test systems** are also used for **manual testing** and presentations
 - test outcomes can be **influenced** by **user actions**
- our approach @

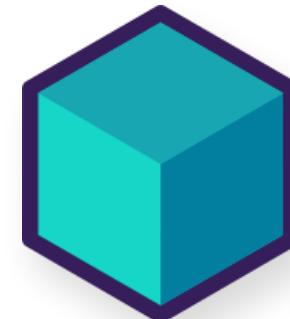
 - **label** test data and **filter** for it
 - conventions on **what (not) to change**
 - alternative: separate envs (\$\$\$), create separate accounts



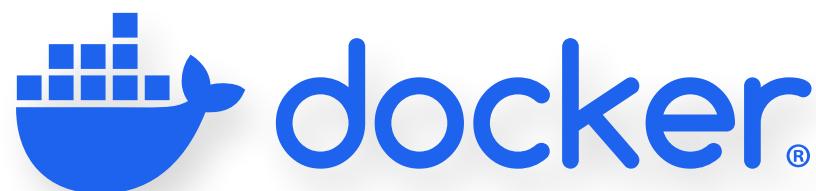
BACKEND UNIT TESTS



BACKEND UNIT TESTS



Testcontainers



BACKEND UNIT TESTS

```
327 func TestVulnerabilityExport(t *testing.T) {
328     testCases := map[string]testCase{
329         "happy path": {
330             acceptHeader:           "text/csv",
331             requestBody:          vulnerabilityRequest(),
332             expectedStatusCode:    http.StatusOK,
333             mockedVulnerabilitySearch: getMockedVulnerabilitySearch(t),
334             bodyValidation: func(mvc rest_test.MockMvc) {
335                 mvc.ExpectBody(`body: "Severity,Name,QoD,Total Assets,Solution type\n" +
336                               "7.5,FTP Brute Force Logins Reporting,95,1,Mitigation\n"`)
337             },
338         },
339         "invalid media type": {
340             acceptHeader:           "application/json",
341             expectedStatusCode:    http.StatusNotAcceptable,
342             bodyValidation: func(mvc rest_test.MockMvc) {
343                 mvc.ExpectJson(`json: "{\"title\":\"Invalid media type was specified in the Accept header (should be text/csv)\", \"type\":\"greenbone/generic-error\"}`)
344             },
345         },
346         "invalid body": {
```

BACKEND UNIT TESTS

```
for name := range testCases {
    t.Run(name, func(t *testing.T) {
        mockMvc := setupExport(testCases[name])
        mockMvc = mockMvc.
            Perform(t, rest_test.Post(url: "/api/asset-management/export/vulnerabilities").
                Header(key: "Accept", []string{
                    testCases[name].acceptHeader,
                }).
                Content(testCases[name].requestBody)).
                ExpectStatusCode(testCases[name].expectedStatusCode)
            testCases[name].bodyValidation(mockMvc)
    })
}
```

BACKEND UNIT TESTS - OPENSEARCH

```
56 ►  "paging and sorting": {
57     oid: "ba312986-9667-413a-95e8-030dcb039b37",
58     resultSelector: query.ResultSelector{
59         Filter: &filter.Request{},
60         Sorting: &sorting.Request{
61             SortColumn:    "name",
62             SortDirection: "asc",
63         },
64         Paging: &paging.Request{
65            PageIndex: 0,
66             PageSize:  2,
67         },
68     },
69     expectedRequest: string(readFile(t, name: "testJsons/vulnerabilityByAssetRequestWithPagingAndSorting.json")),
70     expectedResponse: string(readFile(t, name: "testJsons/vulnerabilityByAssetResponse.json")),
71     expectedResults: vulnerabilitiesByAssets(),
72     expectedTotalRowCount: 286,
73     expectedError: nil,
74 }
```

BACKEND UNIT TESTS - OPENSEARCH

```
56 ►  "paging and sorting": {
57     oid: "ba312986-9667-413a-95e8-030dcb039b37",
58     resultSelector: query.ResultSelector{
59         Filter: &filter.Request{},
60         Sorting: &sorting.Request{
61             SortColumn:    "name",
62             SortDirection: "asc",
63         },
64         Paging: &paging.Request{
65            PageIndex: 0,
66             PageSize:  2,
67         },
68     },
69     expectedRequest: string(readFile(t, name: "testJsons/vulnerability"),
70     expectedResponse: string(readFile(t, name: "testJsons/vulnerability"),
71     expectedResults: vulnerabilitiesByAssets(),
72     expectedTotalRowCount: 286,
73     expectedError:    nil,
74 }
```

```
1  {
2     "from": 0,
3     "query": {
4         "bool": {
5             "filter": [
6                 {
7                     "term": {
8                         "asset.id": {
9                             "value": "ba312986-9667-413a-95e8-030dcb039b37"
10                        }
11                    }
12                }
13            ]
14        }
15    },
16    "size": 2,
17    "sort": [
18        {
19            "vulnerabilityTest.name.keyword": {
20                "order": "asc"
21            }
22        }
23    ]
24 }
```

BE UNIT TESTS: WRAP-UP

- Make use of **data tables** / data driven testing
- make it possible to **verify test expectations**
- use **testcontainers** only where unavoidable
- like backend service tests:
 - **mock functions** outside scope (except data stores)
 - asynchronism: use **wait for** constructs
 - keep **test durations** low



IMAGE CREDITS



Foto von [Nicholas Green](#) auf Unsplash



Foto von [Jonathan Safa](#) auf Unsplash



Foto von [Denys Nevozhai](#) auf Unsplash



Foto von [Nicolas Hoizey](#) auf Unsplash



Foto von [Jukan Tateisi](#) auf Unsplash



Foto von [Aideal Hwa](#) auf Unsplash



Foto von [Dipesh Shrestha](#) auf Unsplash



Foto von [NASA](#) auf Unsplash



Foto von [Killian Cartignies](#) auf Unsplash

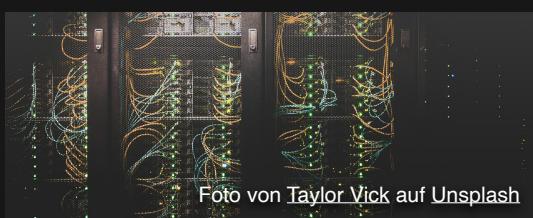


Foto von [Taylor Vick](#) auf Unsplash



Foto von [Guillaume Bolduc](#) auf Unsplash



Foto von [Jonas Jacobsson](#) auf Unsplash