

DOAG NextGen, 13.12.2019

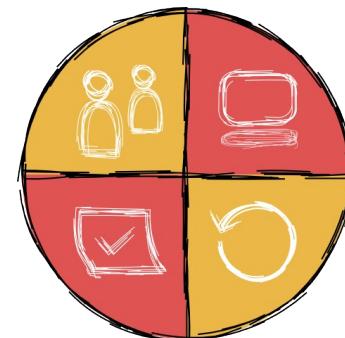
Testen von und mit Infrastruktur “Integration Testing Done Right” ☺

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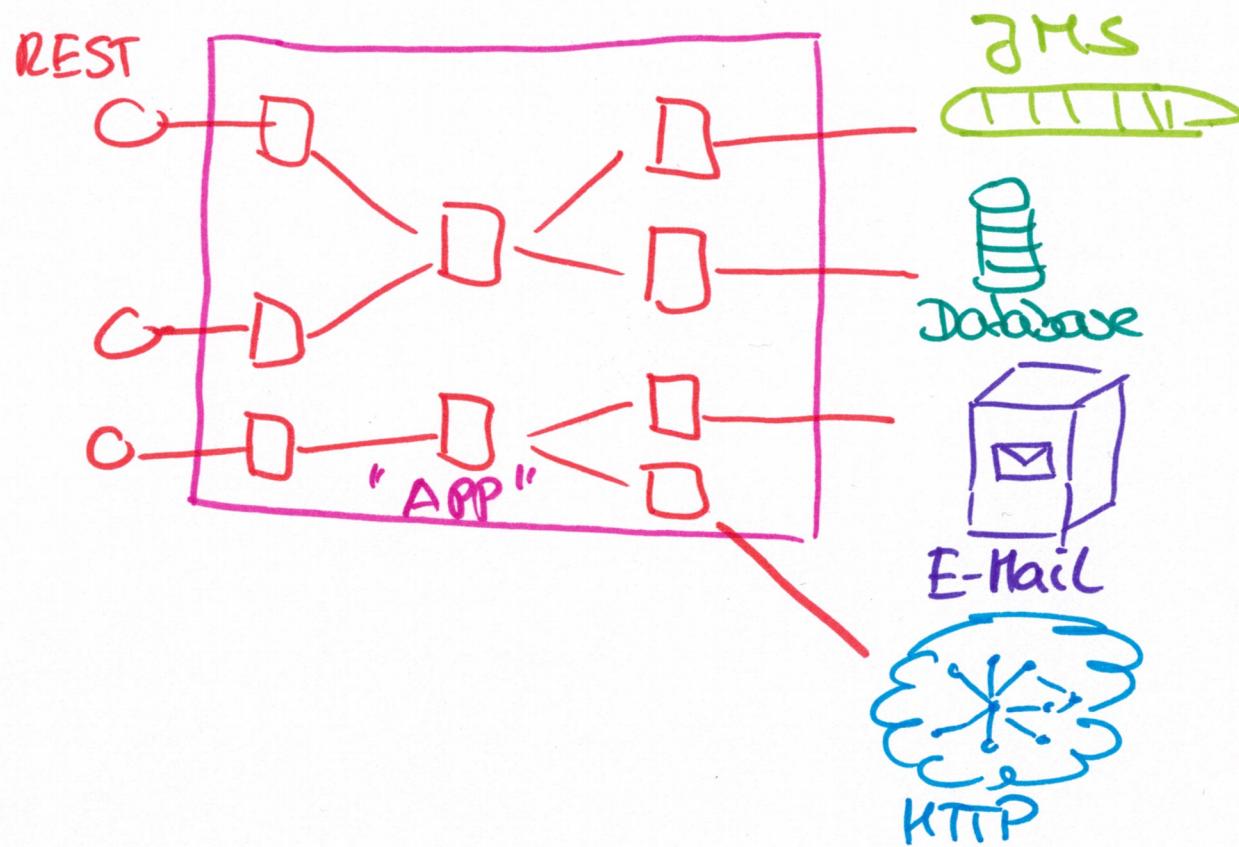
Zu meiner Person

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 - Agile Methoden
 - Software Craftmanship
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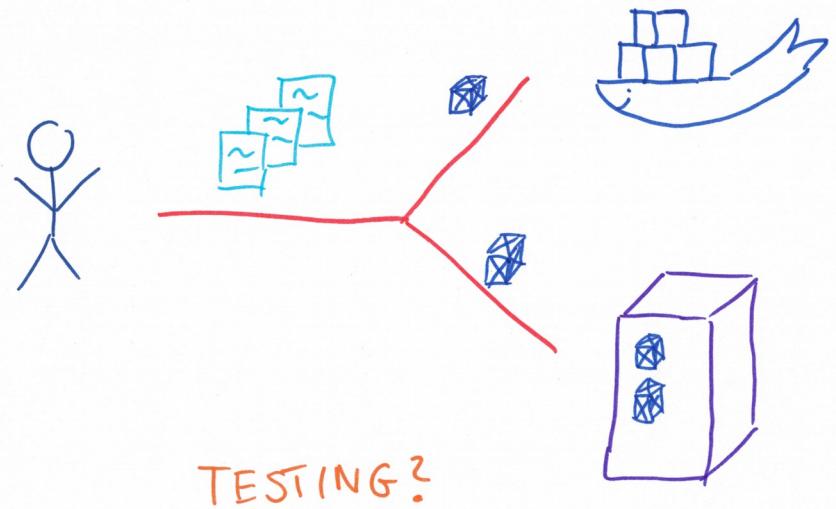
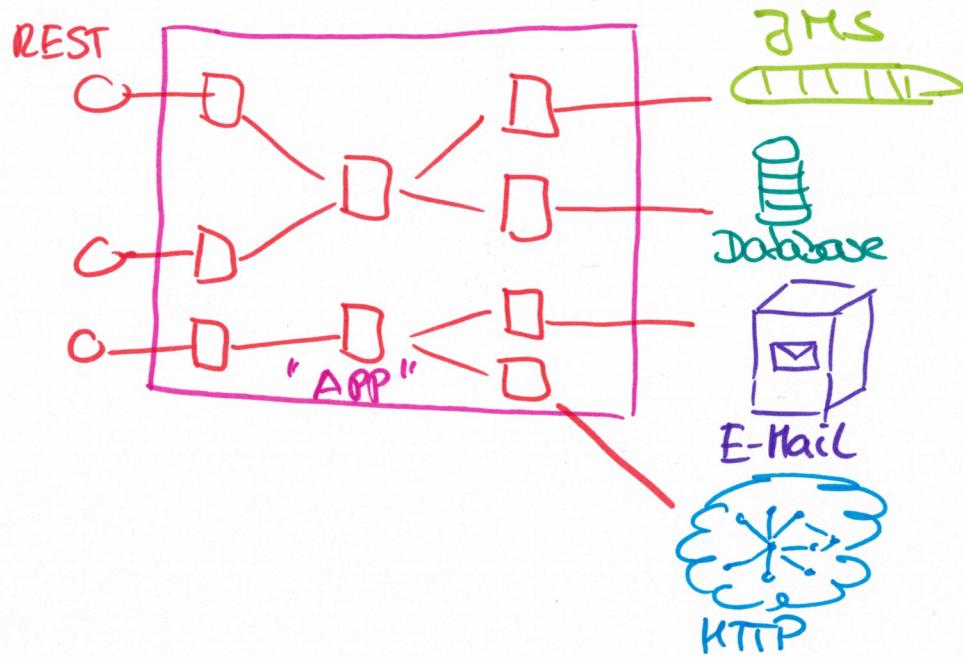


Motivation

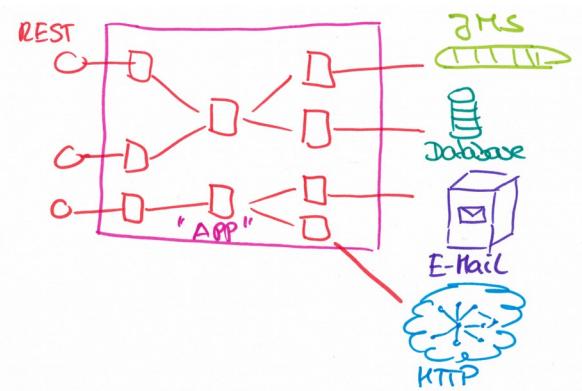








Testen mit Infrastruktur



Status Quo

- Interaktion mit Infrastruktur wird recht spät getestet
 - Feedback bei Fehlern recht spät
- Abhängig von einer bestimmten Infrastruktur
 - Manchmal auch schon beim Build (Bad smell)
 - False negative Fehlerquote recht hoch
 - Aufwändiges Setup
 - Testausführung langsam

Integration vs Integrated Tests

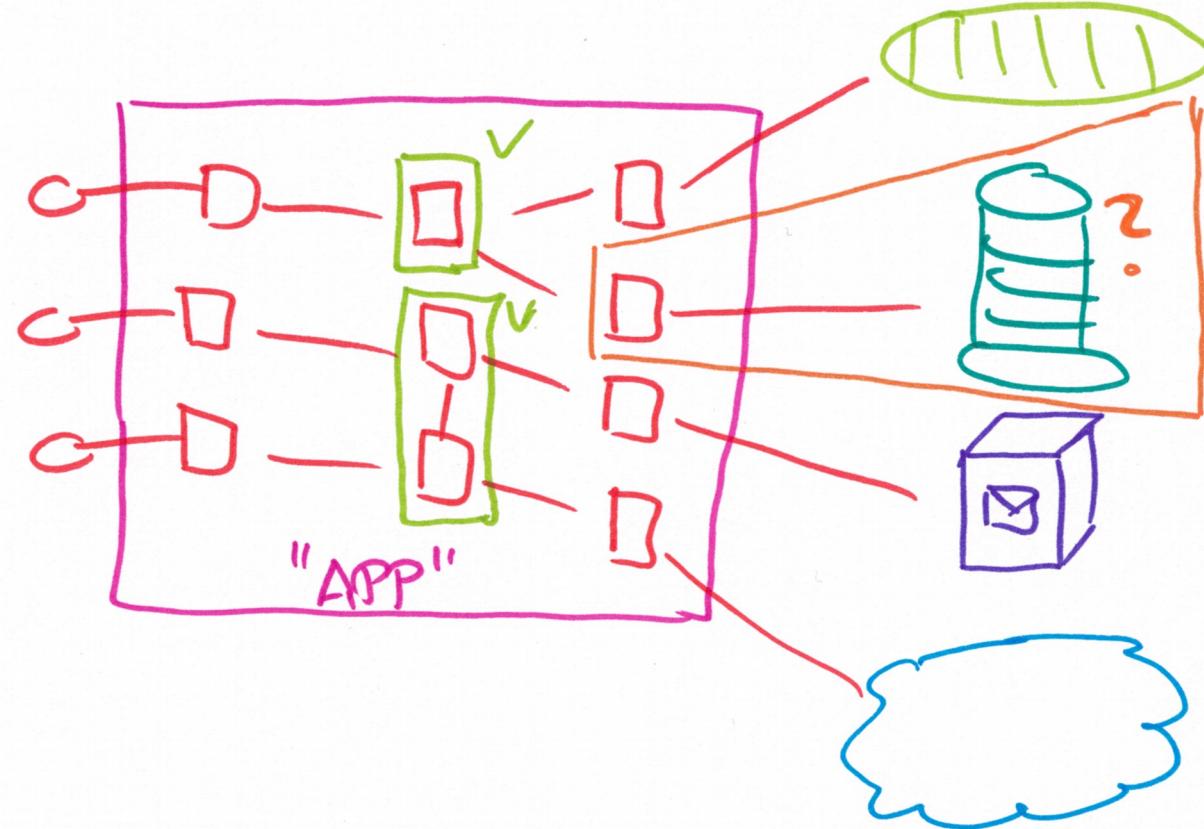
Integrated Tests

A test that will pass or fail based on the correctness of another system.

J.B.Rainsberger

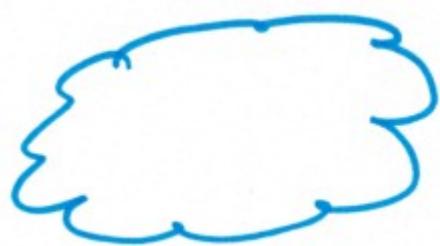
Signs for having Integrated Tests:

- We spin up other services in a local testing environment
- We test against other services in a shared testing environment
- Changes to your system breaks tests for other systems
from Spotify Blog Post



Anforderungen

- Build muss unabhängig von anderen Systemen sein
 - Minimierung der false negative Fehler
 - Entkopplung zwischen den Entwicklern
- Feedback bei Fehlern so schnell wie möglich
- Testausführung beschleunigen



HTTP



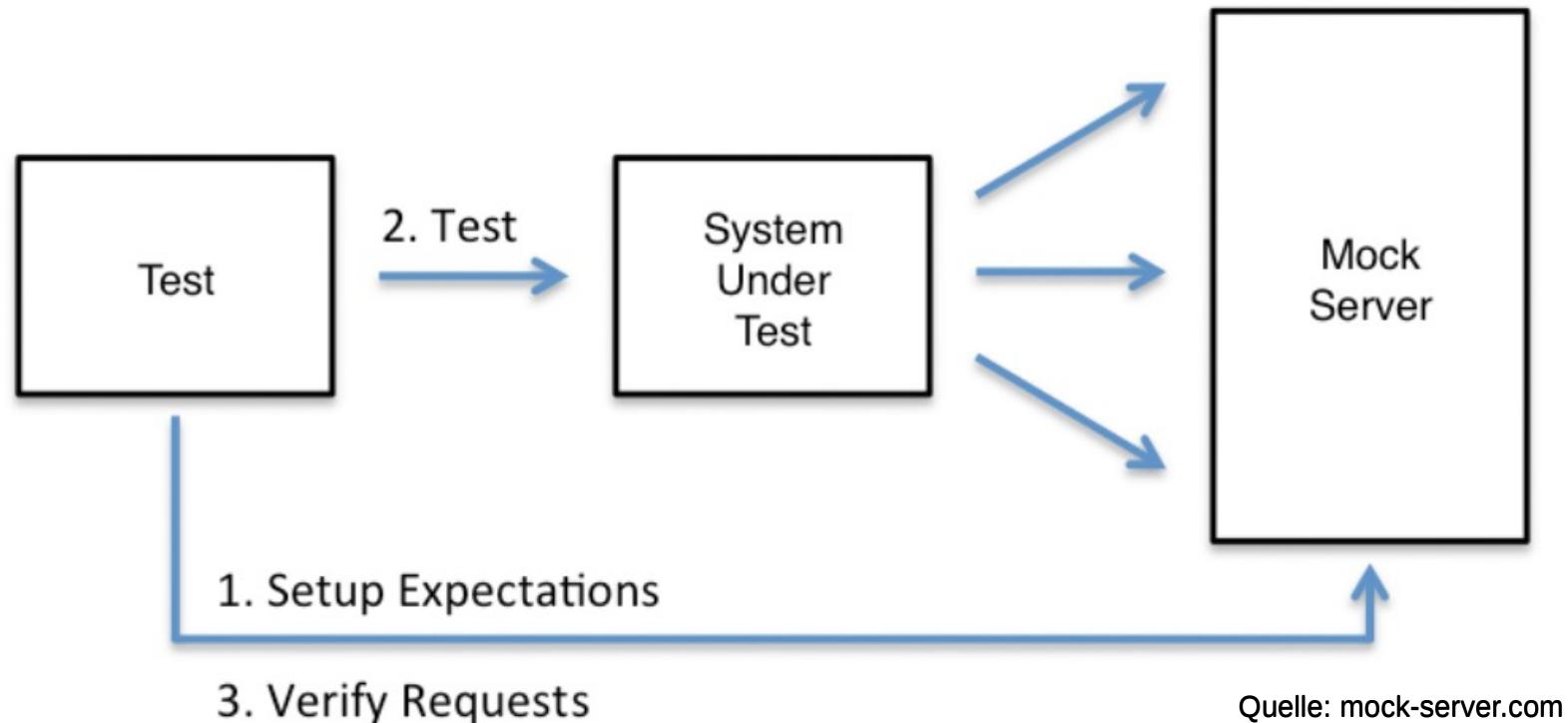
Datenbank

HTTP



Mocking HTTP Calls

- MockServer (<http://mock-server.com/>)
- WireMock (<http://wiremock.org/>)



MockServer

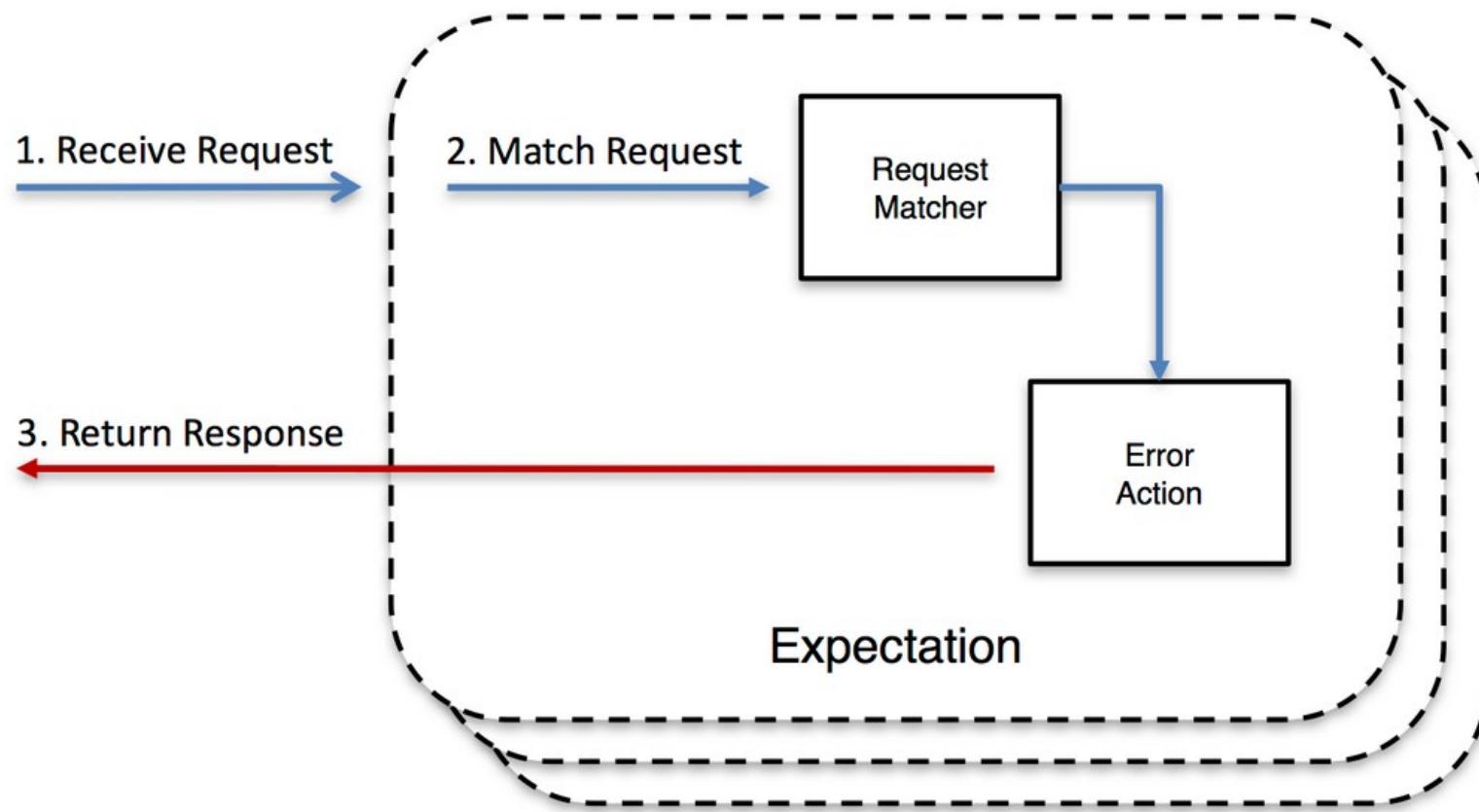
- Java und JavaScript API
- Java Rule / Extension
- Maven Plugin
- Npm Plugin
- Grunt Plugin
- Standalone (CLI)
- Docker Container

MockServer



Quelle: mock-server.com

MockServer



Quelle: mock-server.com

```
1 ▼ {
2   "count": 37,
3   "next": "https://swapi.co/api/starships/?page=2",
4   "previous": null,
5   "results": [
6     {
7       "name": "Executor",
8       "model": "Executor-class star dreadnought",
9       "manufacturer": "Kuat Drive Yards, Fondor Shipyards",
10      "cost_in_credits": "1143350000",
11      "length": "19000",
12      "max_atmosphering_speed": "n/a",
13      "crew": "279144",
14      "passengers": "38000",
15      "cargo_capacity": "2500000000",
16      "consumables": "6 years",
17      "hyperdrive_rating": "2.0",
18      "MGLT": "40",
19      "starship_class": "Star dreadnought",
20      "pilots": [],
21      "films": [
22        "https://swapi.co/api/films/2/",
23        "https://swapi.co/api/films/3/"
24      ],
25      "created": "2014-12-15T12:31:42.547000Z",
26      "edited": "2017-04-19T10:56:06.685592Z",
27      "url": "https://swapi.co/api/starships/15/"
28    },

```

<http://swapi.co/api/starships>

```
public class StarWarsClient {

    private final RestTemplate restTemplate;
    private final String baseUrl;

    public StarWarsClient(String baseUrl) {
        this.restTemplate = new RestTemplateBuilder().build();
        try {
            this.baseUrl = new URL(baseUrl).toString();
        } catch (MalformedURLException e) {
            throw new RuntimeException(e);
        }
    }

    public List<Starship> findAllStarships() {
        List<Starship> starships = new ArrayList<>();
        String nextPageUrl = baseUrl + "/api/starships";
        do {
            try {
                String forObject = restTemplate.getForObject(nextPageUrl, String.class);
                Map<String, Object> jsonMap = new GsonJsonParser().parseMap(forObject);
                nextPageUrl = (String) jsonMap.get("next");
                for (Map result : (List<Map>) jsonMap.get("results")) {
                    starships.add(Starship.from(result));
                }
            } catch (HttpClientErrorException.NotFound e) {
                // log error and finished grepping
                nextPageUrl = null;
            }
        }
        while (nextPageUrl != null);
        return starships;
    }
}
```

```
@ExtendWith(MockServerExtension.class)
public class StarWarsClientMockserverTest {

    private MockServerClient mockServerClient;
    private StarWarsClient clientUnderTest;

    public StarWarsClientMockserverTest(MockServerClient mockServerClient) { this.mockServerClient = mockServerClient; }

    @BeforeEach
    void setUp() {
        clientUnderTest = new StarWarsClient( baseUrl: "http://localhost:" + mockServerClient.remoteAddress().getPort());
    }

    @AfterEach
    void cleanUp() { mockServerClient.reset(); }
```

```
@Test
void findAllStarships() {
    mockServerClient
        .when(request())
            .withMethod("GET")
            .withPath("/api/starships")
    )
    .respond(response()
        .withBody(starshipTestData)
    );
    mockServerClient
        .when(request())
            .withMethod("GET")
            .withPath("/api/starships2")
    )
    .respond(response()
        .withBody(starshipTestData2)
    );
}

List<Starship> allStarships = clientUnderTest.findAllStarships();

assertThat(allStarships).hasSize(11);
}
```

Don't mock API you don't own

Verified Fakes

Tests, die die richtige API aufrufen und verifizieren ob die Test Doubles richtig sind

```
@ExtendWith(MockServerExtension.class)
@Tag("verifyFake")
public class StarWarsClientVerifiedFakeTest {

    private static Logger LOGGER = LoggerFactory.getLogger(StarWarsClientVerifiedFakeTest.class);

    @BeforeEach
    void setUp() {
        String baseUrl = "http://localhost:"+ mockServerClient.remoteAddress().getPort();

        if(System.getProperty("swapi.base.url") != null) {
            baseUrl = System.getProperty("swapi.base.url");
        }

        LOGGER.info("Used BaseURL: " + baseUrl);

        clientUnderTest = new StarWarsClient(baseUrl);
    }
}
```

```
<profiles>
    <profile>
        <id>verifyFakes</id>
        <build>
            <plugins>
                <plugin>
                    <artifactId>maven-surefire-plugin</artifactId>
                    <version>2.22.2</version>
                    <configuration>
                        <groups>verifyFake</groups>
                        <systemPropertyVariables>
                            <swapi.base.url>https://swapi.co</swapi.base.url>
                        </systemPropertyVariables>
                    </configuration>
                </plugin>
            </plugins>
        </build>
    </profile>
</profiles>
```

Call Verification

```
@Test
void verifyfindAllStarshipsRequest(){
    mockServerClient
        .when(request())
            .withMethod("GET")
            .withPath("/api/starships")
        )
        .respond(response()
            .withBody(starshipTestData)
        );
}

clientUnderTest.findAllStarships();

mockServerClient
    .verify(request()
        .withMethod("GET")
        .withPath("/api/starships"),
    VerificationTimes.once());
mockServerClient
    .verify(request()
        .withMethod("GET")
        .withPath("/api/starships2"),
    VerificationTimes.once());
}
```

Eigene HTTP Endpoints

- Jersey → JerseyTest
- Spring MVC → MockMvc
- Framework-unabhängig
 - REST Assured (<http://rest-assured.io/>)
 - „Killer“-Feature: JsonPath, XmlPath
 - Scala Support
 - Spring MVC Support
 - Given-when-then Struktur

Rest Assured - JsonPath

```
{  
  "lotto":{  
    "lottoId":5,  
    "winning-numbers":[2,45,34,23,7,5,3],  
    "winners":[{  
      "winnerId":23,  
      "numbers":[2,45,34,23,3,5]  
    }, {  
      "winnerId":54,  
      "numbers":[52,3,12,11,18,22]  
    }]  
  }  
}
```

```
get("/lotto").then().body("lotto.lottoId", equalTo(5));  
  
get("/lotto").then().body("lotto.winners.winnerId", hasItems(23, 54));
```

<http://localhost:8080/lotto>

Quelle: Rest Assured Doc

Rest Assured – Spring MVC

```
@Test
public void findAllMovies(){
    given().mockMvc(mockMvc).
    when().get( s: "/starwars/movies").
    then().statusCode(200)
        .body( s: "title", hasItems("A New Hope", "The Force Awakens"))
        .body( s: "findAll{ it.director == 'George Lucas'}.title", hasItem("A New Hope"));
}

@Test
public void findAllMovies_plainMockMvc() throws Exception {
    mockMvc.perform(get( urlTemplate: "/starwars/movies"))
        .andExpect(status().isOk())
        .andExpect(jsonPath( expression: "$..title").value(hasItems("A New Hope","The Force Awakens")))
        .andExpect(jsonPath( expression: "$[?(@.director == 'George Lucas')].title").value(hasItem("A New Hope")));
}
```

Unit Tests für Endpoints

```
@Controller
@RequestMapping("starwars")
public class StarWarsMovieController {

    @RequestMapping(value="movies", method = RequestMethod.GET, produces = "application/json")
    public @ResponseBody List<StarWarsMovie> findAllMovies(){
        return List.of(new StarWarsMovie( title: "A New Hope", director: "George Lucas"),
                      new StarWarsMovie( title: "The Force Awakens", director: "J. J. Abrams"));
    }
}
```

```
10 Q  class StarWarsMovieControllerTest {
11
12     @Test
13     void findAllMovies(){
14         StarWarsMovieController controllerUnderTest = new StarWarsMovieController();
15         List<StarWarsMovie> movies = controllerUnderTest.findAllMovies();
16
17         assertThat(movies)
18             .hasSize(2)
19             .extracting( propertyOrField: "director")
20             .containsExactlyInAnyOrder( "George Lucas","J. J. Abrams" );
21     }
22 }
```

Datenbanken



Datenbanken

- Embedded Datenbanken
 - H2, Derby
 - Nicht Produktionsnah
 - Nicht alles testbar
- Standalone Datenbanken
 - Abhangigkeit zur bestimmten Infrastruktur
- Shared Datenbanken
 - Abhangigkeiten zwischen Entwickler
 - Hohe false negative Fehlerrate



TESTCONTAINERS

```
@Testcontainers
class PersonRepositoryJUnit5Test {

    @Container
    private PostgreSQLContainer postgres = new PostgreSQLContainer();

    private PersonRepository repositoryUnderTest;

    @BeforeEach
    public void setup(){
        HikariConfig hikariConfig = new HikariConfig();
        hikariConfig.setJdbcUrl(postgres.getJdbcUrl());
        hikariConfig.setUsername(postgres.getUsername());
        hikariConfig.setPassword(postgres.getPassword());

        HikariDataSource ds = new HikariDataSource(hikariConfig);
        Flyway flyway = new Flyway();
        flyway.setDataSource(ds);
        flyway.migrate();

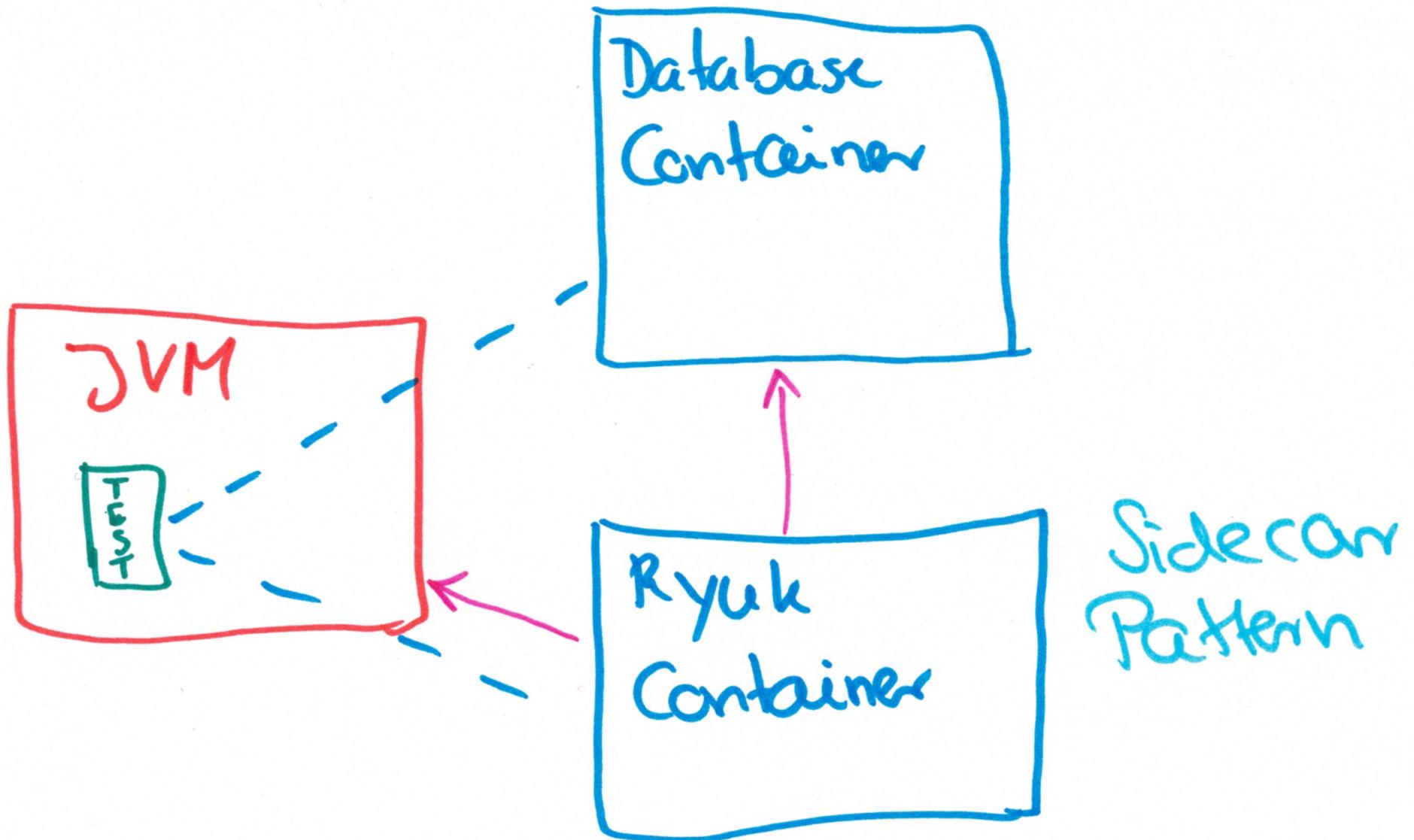
        repositoryUnderTest = new PersonRepository(ds);
    }

    @Test
    void saveAndFindAllPerson() {
        Person person = new Person();
        person.setFirstName("firstName");
        person.setLastName("lastName");
        person.setJobTitle("jobTitle");

        repositoryUnderTest.save(person);

        List<Person> persons = repositoryUnderTest.findAllPersons();
        assertThat(persons).hasSize(1).contains(person);
    }
}
```

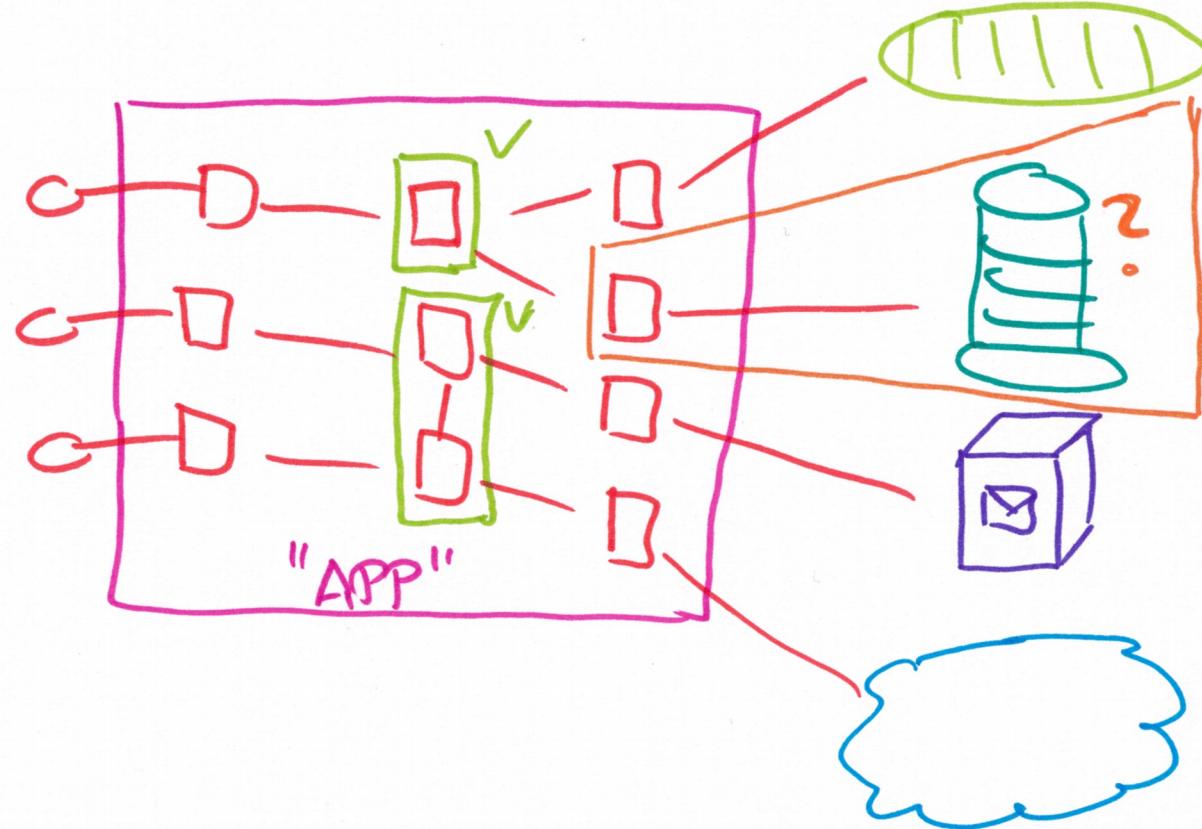
Funktionsweise

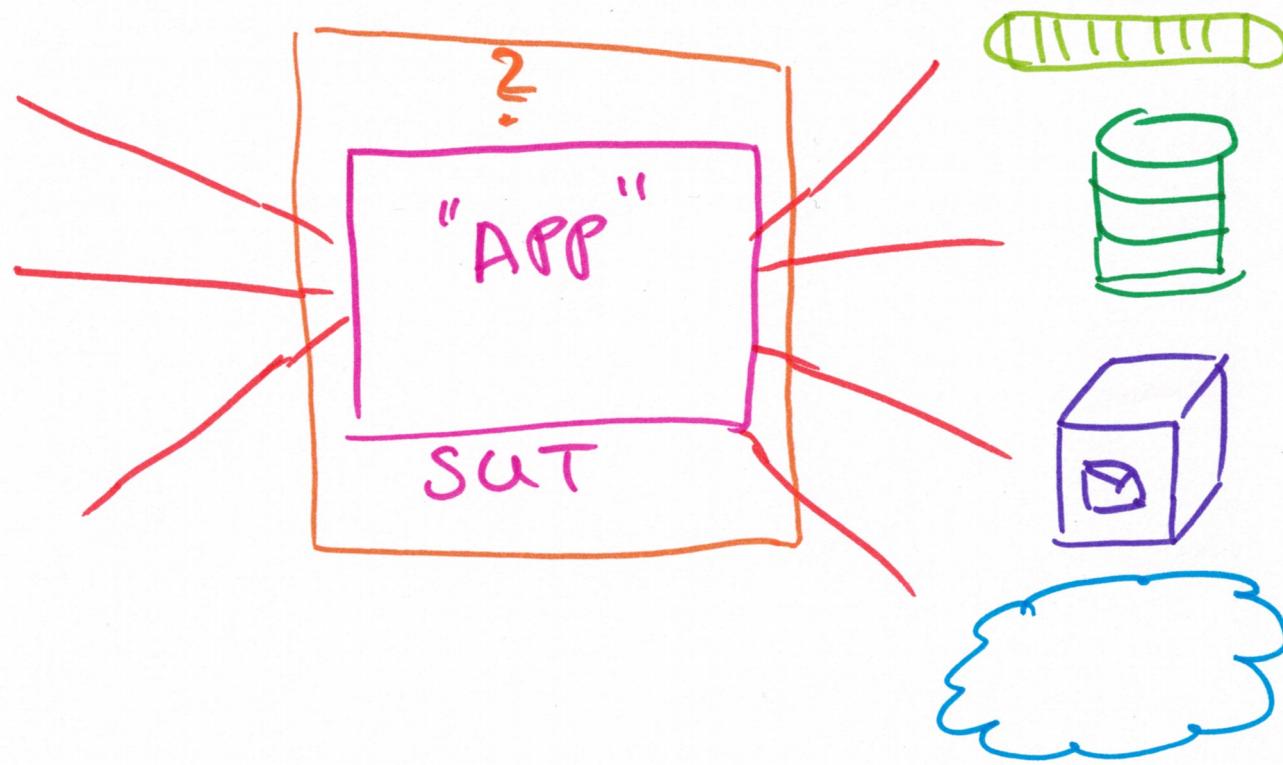


Testcontainers

- Temporary database containers - spezielle MySQL, PostgreSQL, DB2, Oracle XE und Virtuoso container
- Webdriver containers - Dockerized Chrome oder Firefox browser für Selenium/Webdriver Operationen mit automatischer Videoaufnahme
- Weitere spezifische Container – Elasticsearch, Kafka, Apache Pulsar, Mockserver, Toxiproxy, Nginx, RabbitMQ, Hashicorp Vault
- Generic containers – irgendein Docker Container
- Docker compose – Wiederverwendung von Docker Compose YAML Datei
- Dockerfile containers – Container direkt von einem Dockerfile

Was es noch so gibt





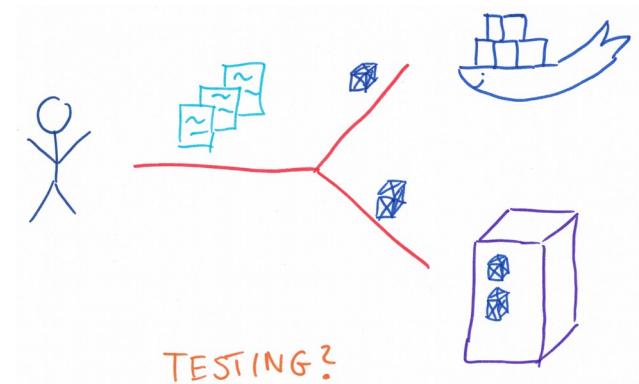
Citrus Integration Testing

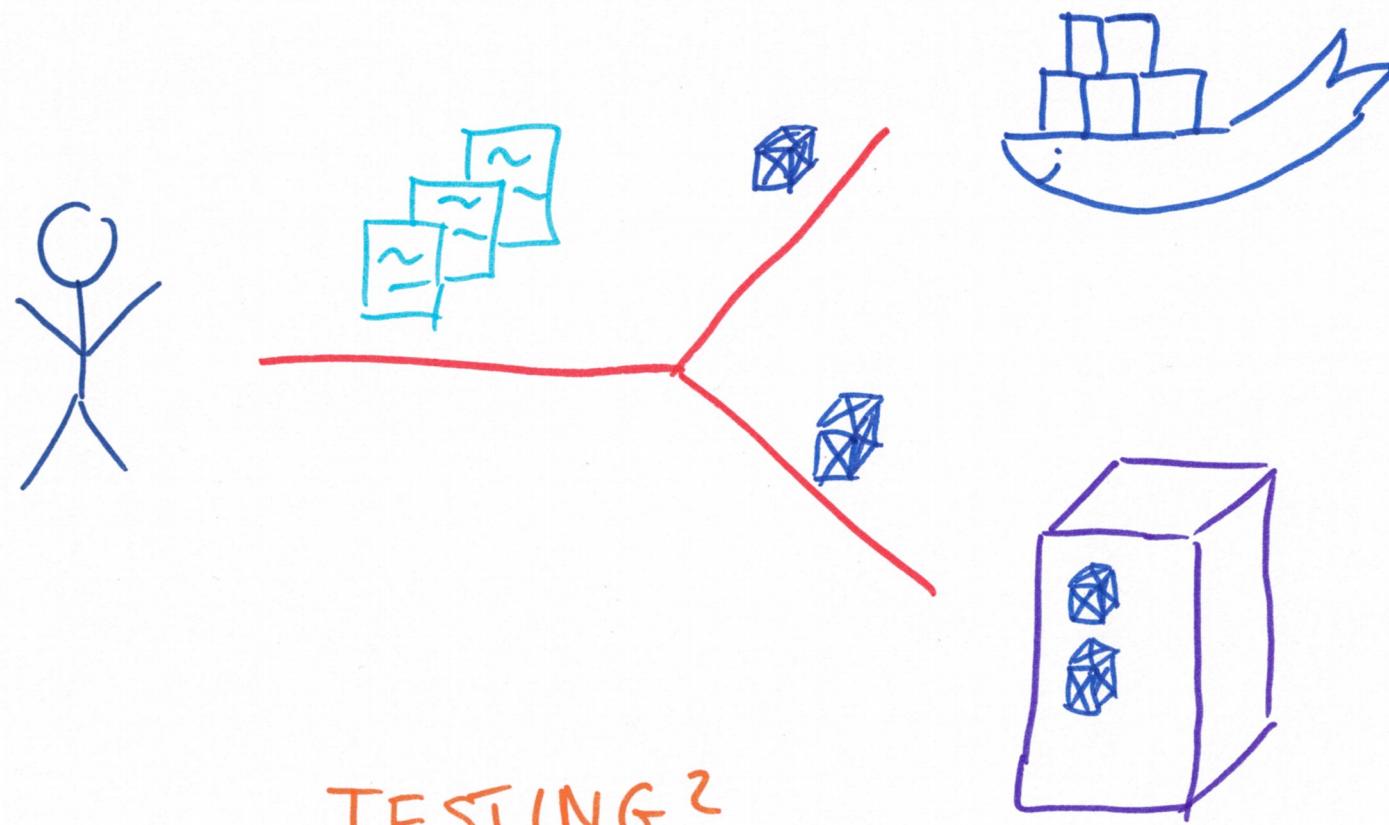


Resilience Tests

- ToxyProxy - framework for simulating network conditions (<http://toxiproxy.io/>)
 - NEW: Testcontainers Integration
- Chaos Monkey for Spring Boot – Chaos Engineering for Spring Boot Apps (<https://codecentric.github.io/chaos-monkey-spring-boot>)

Testen von Infrastruktur





Infrastructure as Code

- Shell Skripte
 - Bash, ksh, etc
- Provisionierungswerkzeuge
 - Puppet, Chef, Salt und Ansible
 - Terraform
- Container
 - Dockerfile

Provisionierungswerkzeuge (Beispiel Ansible)

- Codequalität
 - Ansible-lint
(<https://github.com/ansible/ansible-lint>)
 - yamllint (Yaml allgemein)
(<https://github.com/adrienverge/yamllint>)
- Funktionale Qualität
 - Serverspec (Tool unabh.)
(<https://serverspec.org/>)
 - Testinfra (Tool unabh.)
(<https://testinfra.readthedocs.io/en/latest/>)
 - Goss (Tool unabh.)
(<https://goss.rocks/>)

```
1   hosts: application-server
2   vars:
3     tomcat_version: 8.5.8
4     tomcat_base_name: apache-tomcat-{{ tomcat_version }}
5     #catalina_opts: "-Dkey=value"
6
7   tasks:
8     - name: install java
9       apt: name=openjdk-8-jdk state=present
10      become: yes
11      become_method: sudo
12
13     - name: Download current Tomcat 8 version
14       local_action: get_url url="http://archive.apache.org/dist/tomcat/tomcat-8/v{{ tomcat_version }}/bin/{{ tomcat_base_name }}.tar.gz" dest=/tmp
15
16     - name:
17       file: name=/opt mode=777
18       become: yes
19       become_method: sudo
20
21     - name: Install Tomcat 8
22       unarchive: src=/tmp/{{ tomcat_base_name }}.tar.gz dest=/opt creates=/opt/{{ tomcat_base_name }} owner=vagrant group=vagrant
23
24     - name: Set link to tomcat 8
25       file: src=/opt/{{ tomcat_base_name }} dest=/opt/tomcat state=link force=yes
26
27     - name: setup setenv.sh
28       template: dest="/opt/{{ tomcat_base_name }}/bin/setenv.sh" src="roles/tomcat8/templates/setenv.sh.j2" mode=755
29       when: catalina_opts is defined
30
31     - find: paths="/opt/{{ tomcat_base_name }}/bin" patterns="*.sh"
32       register: result
33
34     - name: ensure tomcat scripts are executable
35       file: name={{item.path}} mode=755
36       with_items: '{{ result.files }}'
37
38     - name: install tomcat as service
39       copy: src=roles/tomcat8/files/tomcat.service dest=/etc/systemd/system/
40       become: yes
41       become_method: sudo
42
```

Ansible-Lint

```
~/dev/workspace/infra-testing-talk/infrastructure-as-code-testing/ansible(master ✓) ansible-lint *.yml
[ANSIBLE0009] Octal file permissions must contain leading zero
setup-app.yml:16
Task/Handler: file name=/opt mode=777

[ANSIBLE0011] All tasks should be named
setup-app.yml:16
Task/Handler: file name=/opt mode=777

[ANSIBLE0009] Octal file permissions must contain leading zero
setup-app.yml:27
Task/Handler: setup setenv.sh

[ANSIBLE0011] All tasks should be named
setup-app.yml:31
Task/Handler: find patterns=*.sh paths=/opt/{{ tomcat_base_name }}/bin

[ANSIBLE0009] Octal file permissions must contain leading zero
setup-app.yml:34
Task/Handler: ensure tomcat scripts are executable

[ANSIBLE0002] Trailing whitespace
setup-db.yml:4
```

testinfra

```
def test_mysql_is_installed(host):
    mysql = host.package("mysql-server")
    assert mysql.is_installed

def test_mysql_service_is_running(host):
    mysql = host.service("mysql")
    assert mysql.is_enabled
    assert mysql.is_running

def test_mysql_config_parameter_exists(host):
    mysql_conf = host.file("/etc/mysql/mysql.conf.d/mysqld.cnf")
    assert mysql_conf.contains("bind-address = 0.0.0.0")
```



testinfra

```
1 def test_openjdk_is_installed(host):
2     openjdk = host.package("openjdk-8-jdk")
3     assert openjdk.is_installed
4
5 def test_tomcat_service_exists(host):
6     assert host.file("/etc/systemd/system/tomcat.service").exists
7
8 def test_tomcat_folder_exists(host):
9     assert host.file("/opt/tomcat").exists
```

testinfra



```
~/dev/workspace/infra-testing-talk/infrastructure-as-code-testing/ansible(master ✓) py.test --connection=ansible --  
ansible-inventory inventories/test -v tests/*.py  
===== test session starts =====  
platform linux2 -- Python 2.7.15rc1, pytest-3.6.3, py-1.5.4, pluggy-0.6.0 -- /usr/bin/python  
cachedir: .pytest_cache  
rootdir: /home/sparsick/dev/workspace/infra-testing-talk/infrastructure-as-code-testing/ansible, inifile:  
plugins: testinfra-1.14.1  
collected 6 items  
  
tests/test_app.py::test_openjdk_is_installed[ansible://192.168.33.10] PASSED [ 16%]  
tests/test_app.py::test_tomcat_service_exists[ansible://192.168.33.10] PASSED [ 33%]  
tests/test_app.py::test_tomcat_folder_exists[ansible://192.168.33.10] PASSED [ 50%]  
tests/test_db.py::test_mysql_is_installed[ansible://192.168.33.10] PASSED [ 66%]  
tests/test_db.py::test_mysql_service_is_running[ansible://192.168.33.10] PASSED [ 83%]  
tests/test_db.py::test_mysql_config_parameter_exists[ansible://192.168.33.10] PASSED [100%]  
  
===== 6 passed in 4.97 seconds =====
```

Container (Beispiel Docker)

- Codequalität
 - Dockerlint
(<https://github.com/RedCoolBeans/dockerlint>)
 - Haskell Dockerfile Linter – hadolint
(<https://github.com/hadolint/hadolint>)
- Funktionale Qualität
 - Testinfra
 - Serverspec
 - Goss
 - Container Structure Tests
(<https://github.com/GoogleContainerTools/container-structure-test>)

```
1 FROM ubuntu:18.04
2
3 RUN apt-get update -y && \
4     apt-get install openjdk-8-jre curl -y && \
5     curl http://archive.apache.org/dist/tomcat/tomcat-9/v9.0.10/bin/apache-tomcat-9.0.10.tar.gz -o
6     /opt/tomcat.tar.gz && \
7     tar -xf /opt/tomcat.tar.gz -C /opt && \
8     rm -f /opt/tomcat.tar.gz && \
9     ln -s /opt/apache-tomcat-9.0.10 /opt/tomcat && \
10    apt-get remove curl -y
11
12 ENV CATALINA_HOME /opt/tomcat
13 ENV PATH $CATALINA_HOME/bin:$PATH
14 WORKDIR $CATALINA_HOME
15
16 ENTRYPOINT [ "catalina.sh"]
17 CMD ["run"]
18 EXPOSE 8080
```

Hadolint

```
hadolint tomcat.df
tomcat.df:3 DL3008 Pin versions in apt get install. Instead of `apt-get install <package>` use `apt-get install <package>=<version>`
tomcat.df:3 DL3009 Delete the apt-get lists after installing something
tomcat.df:3 DL3015 Avoid additional packages by specifying `--no-install-recommends`
```

Container Structure Tests

```
1  # container structure tests
2  schemaVersion: "2.0.0"
3
4  metadataTest:
5    env:
6      - key: CATALINA_HOME
7        value: /opt/tomcat
8      exposedPorts: ["8080"]
9      entrypoint: ["catalina.sh"]
10     cmd: ["run"]
11     workdir: "/opt/tomcat"
12
13
14  fileExistenceTests:
15
16    - name: 'catalina.sh'
17      path: '/opt/tomcat/bin/catalina.sh'
18      shouldExist: true
19      permissions: '-rwxr-x---'
```

Container Structure Tests

```
container-structure-test test --image sparsick/tomcat9:latest --config tomcat-test.yaml

=====
===== Test file: tomcat-test.yaml =====
=====

INFO: File Existence Test: catalina.sh
--- RUN: File Existence Test: catalina.sh
--- PASS
--- RUN: Metadata Test
--- PASS

=====
===== RESULTS =====
=====

Passes:    2
Failures:  0
Total tests: 2

PASS
```

Vorher: docker build -t sparsick/tomcat9 -f tomcat.df .

Fazit

Fragen?

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<https://github.com/sparsick/infra-testing-talk>

Literatur

- <http://coding-is-like-cooking.info/2018/04/pre-tested-integration-back-to-the-basis-of-ci/>
- <http://blog.thecodewhisperer.com/permalink/integrated-tests-are-a-scam>
- <http://blog.thecodewhisperer.com/permalink/clearing-up-the-integrated-tests-scam>
- https://bee42.com/de/blog/The_dark_age_of_container_testing/
- <https://labs.spotify.com/2018/01/11/testing-of-microservices/>
- <https://martinfowler.com/bliki/IntegrationTest.html>
- <https://codewithoutrules.com/2016/07/31/verified-fakes/>

Literatur

- Infrastructure as Code: Managing Servers in the Cloud
von Kief Morris, O'Reilly Media