No API? No problem!

API mocking with WireMock

An open source workshop by …

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What are we going to do?

_Stubbing, mocking and service virtualization

_WireMock

_Exercises, examples, …

Preparation

_Install JDK (Java 17 or newer)

_Install IntelliJ IDEA (or any other IDE)

_Download or clone project

_Import Maven project in IDE

Section 0:

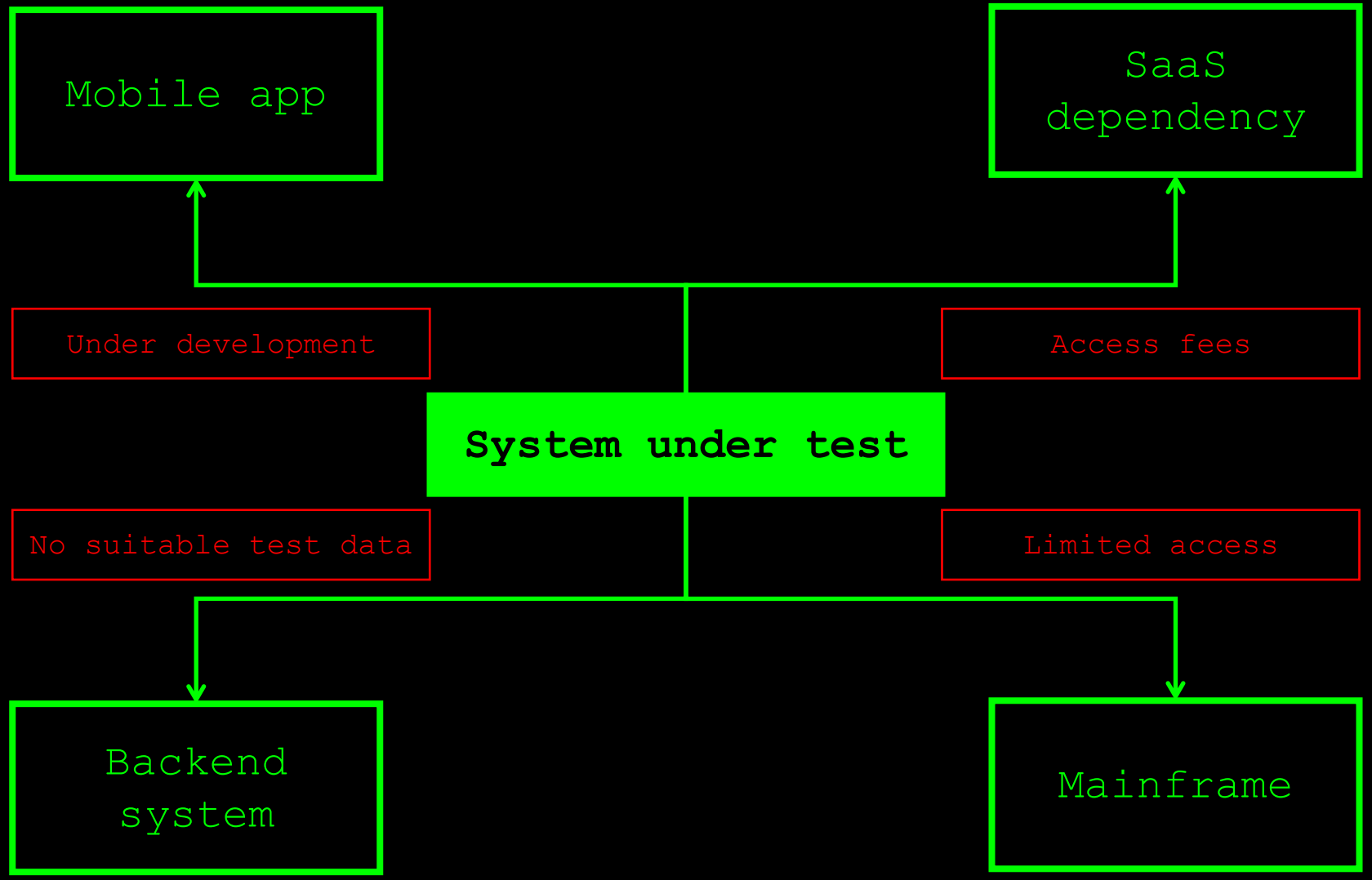
An introduction to service virtualization

Problems in test environments

- Systems are constructed out of of many different components

- Not all of these components are always available for testing
  - Parallel development
  - No control over test data
  - Fees required for using third party components
  - …

Problems in test environments

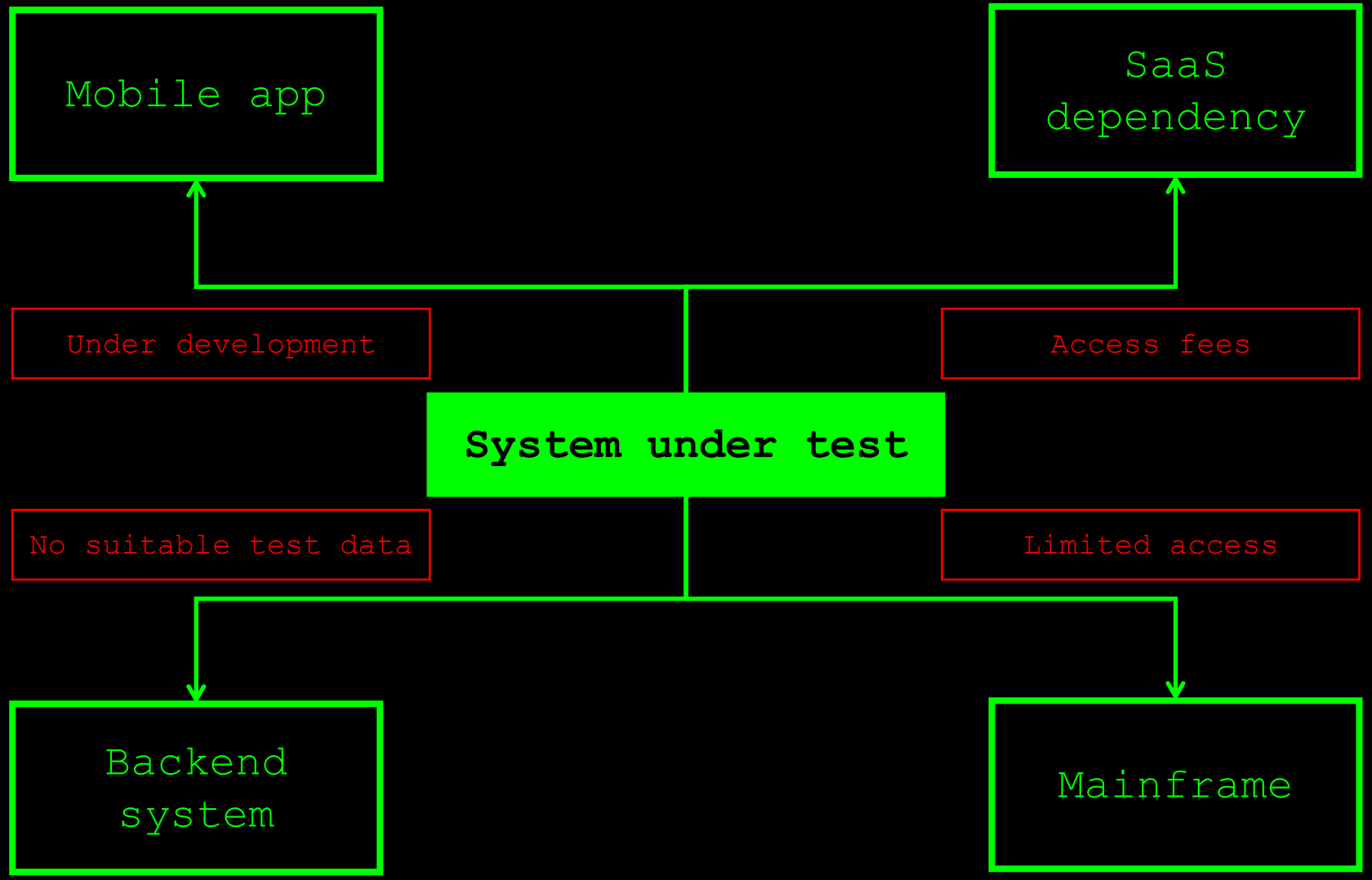


Simulation during test execution

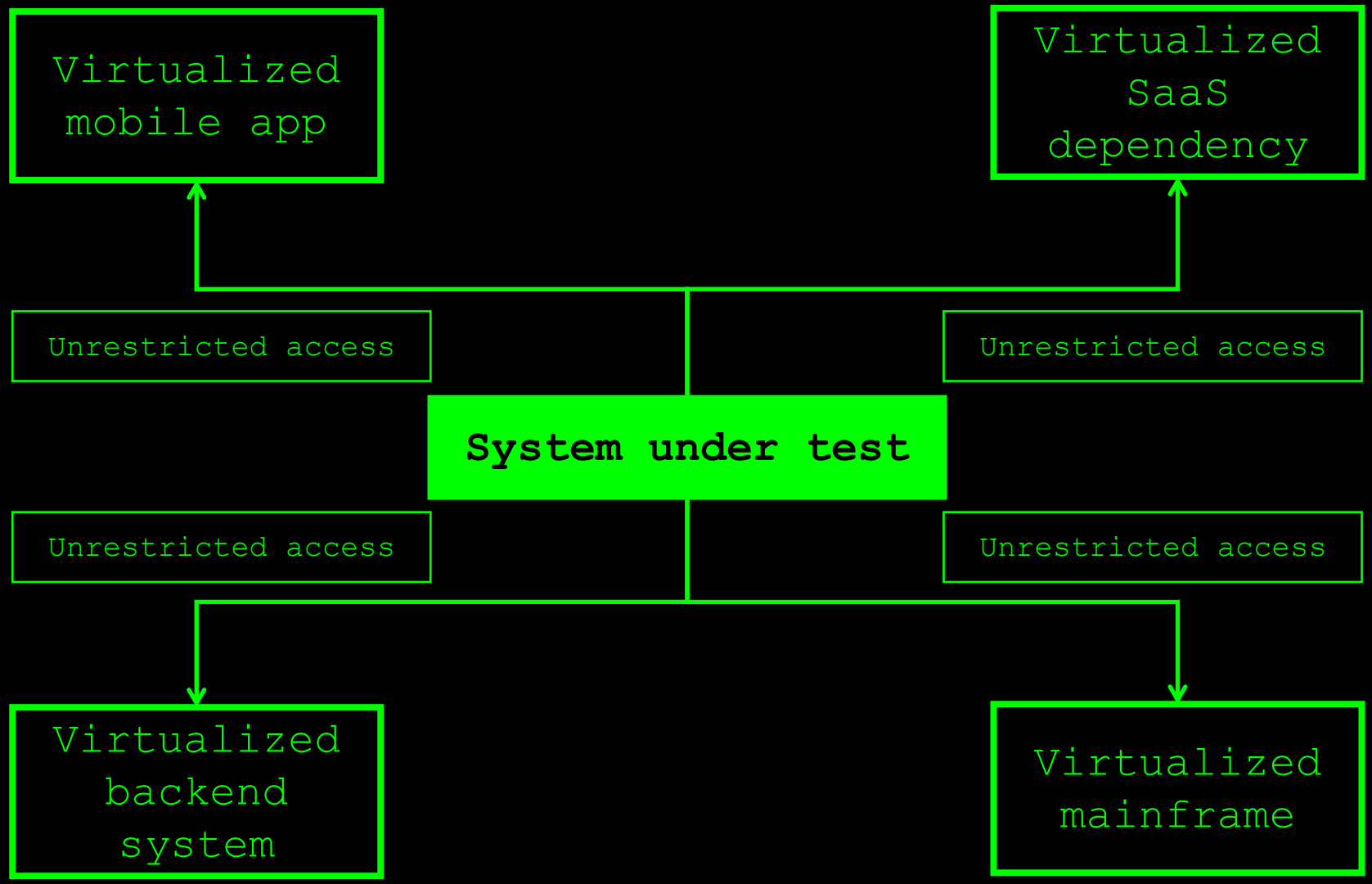
_Simulate dependency **behaviour**

_Regain control over test environment
  _Dependencies available on demand
  _Control over test data (edge cases!)
  _Eliminate third party component usage fees
  _…

Problems in test environments



Simulation in test environments



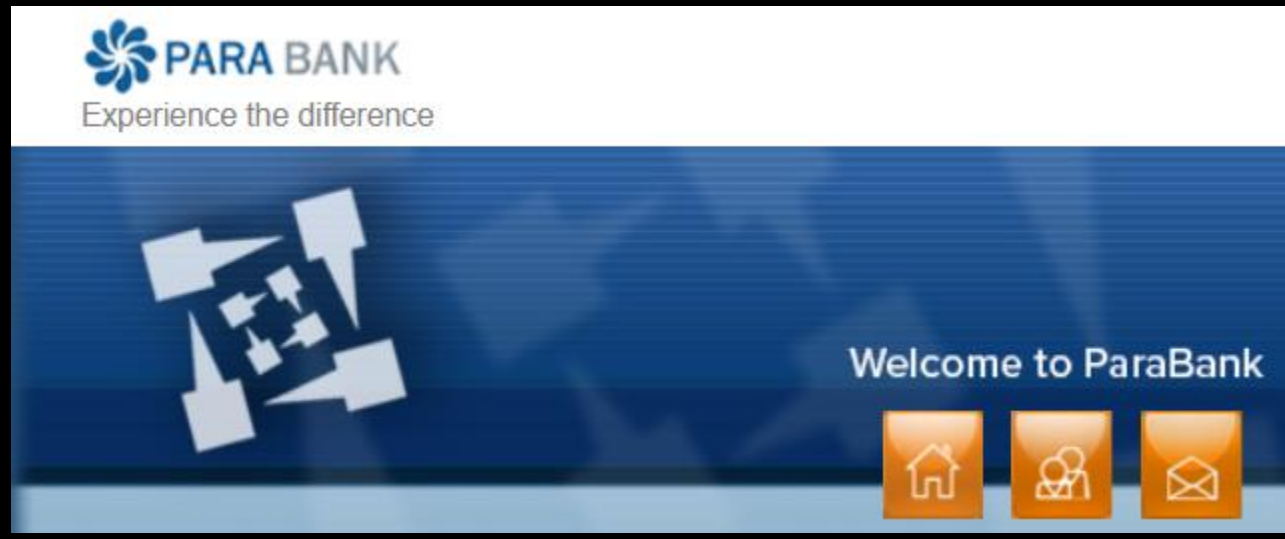
Our system under test

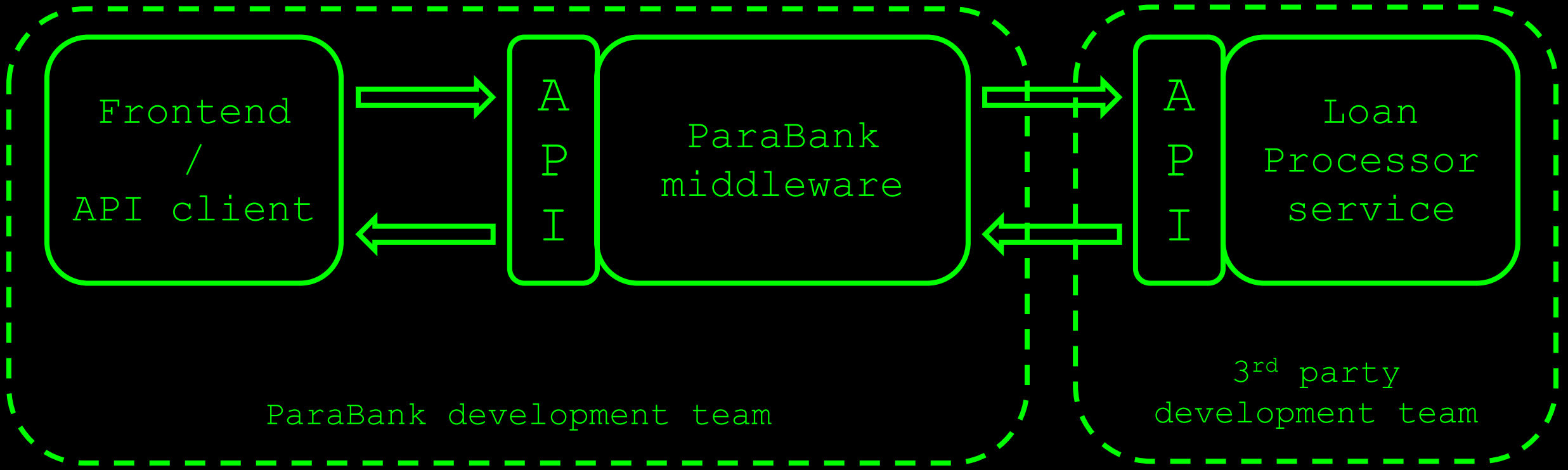
_ParaBank

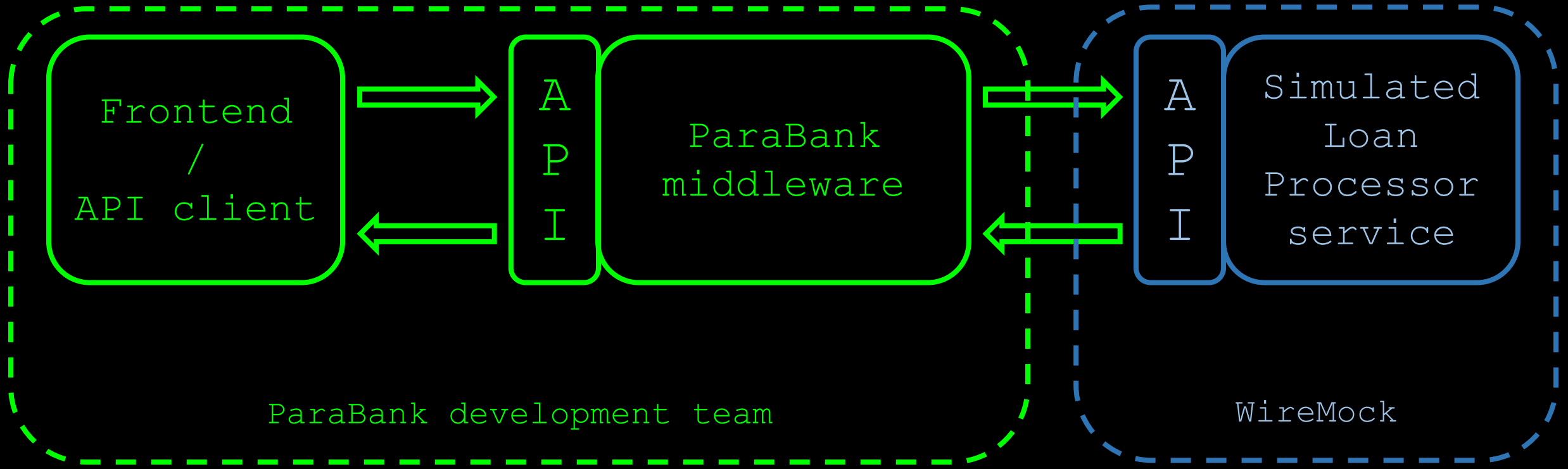
_The world's least safe online bank

_Request Loan process

_Loan application is processed by 3rd party loan provider component




Frontend
/
API client
API
ParaBank
middleware
API
Loan
Processor
service
ParaBank development team
3rd party
development team


Frontend
/
API client
API
ParaBank
middleware
API
Simulated
Loan
Processor
service
ParaBank development team
WireMock

Early testing against features under development

Easy setup of state for edge cases

What might we want to simulate?

Delays, fault status codes, malformatted responses, …

…

Section 1:

Getting started with WireMock

WireMock

- https://wiremock.org

- Java
  - ports and adapters are available for many other languages

- HTTP mock server
  - only supports HTTP(S)

- Open source

WireMock Cloud

https://www.wiremock.io

Install WireMock

_Maven

```
<dependency>
    <groupId>org.wiremock</groupId>
    <artifactId>wiremock</artifactId>
    <version>3.9.2</version>
    <scope>test</test>
</dependency>
```

Starting WireMock (JUnit 4)

Via JUnit 4 @Rule

```
@Rule
public WireMockRule wireMockRule = new WireMockRule( port: 9876);
```

Without using JUnit 4 @Rule

```
WireMockServer wireMockServer =
        new WireMockServer(new WireMockConfiguration().port(9876));

wireMockServer.start();
```

Starting WireMock (JUnit 5)

_Uses the JUnit 5 Jupiter extension mechanism

_Via @WireMockTest class annotation (basic configuration)

```
@WireMockTest(httpPort = 9876)
public class WireMockAnswers1Test {
```

_Using @RegisterExtension (full configuration)

```
@RegisterExtension
static WireMockExtension wiremock = WireMockExtension.newInstance()
        .options(wireMockConfig().port(9876).globalTemplating(true))
        .build();
```

Starting WireMock (standalone)

_Useful for exploratory testing purposes

_Allows you to share WireMock instances between teams

_Long-running instances

_Download the .jar first

java -jar wiremock-standalone-3.9.2.jar --port 9876

Configure responses

_In (Java) code

_Using JSON mapping files

An example mock defined in Java

```
public void helloWorld() {

    stubFor(
        get(
            urlEqualTo( testUrl: "/helloworld")
        )
            .willReturn(
                aResponse()
                    .withHeader( key: "Content-Type",  ...values: "text/plain")
                    .withStatus(200)
                    .withBody("Hello world!")));
}
```

Some useful WireMock features

- Verification
  - Verify that certain requests are sent by application under test
- Record and playback
  - Generate mocks based on request-response pairs (traffic)
- Fault simulation
- …
- Full documentation at https://wiremock.org/docs/

Now it's your turn!

_exercises > WireMockExercises1Test.java

_Create a couple of basic mocks
  _Implement the responses as described in the comments

_Verify your solution by running the tests in the same file

_Answers are in answers > WireMockAnswers1Test.java

_Examples are in examples > WireMockExamples1Test.java

Section 2:

Request matching strategies and fault simulation

Request matching

- Send a response only when certain properties in the request are matched

- Options for request matching:
  - URL
  - HTTP method
  - Query parameters
  - Headers
  - Request body elements
  - …

Example: URL matching

```
public void setupStubURLMatching() {

    stubFor(get(urlEqualTo( testUrl: "/urlmatching"))
        .willReturn(aResponse()
            .withBody("URL matching")
        ));
}
```

_Other URL options:

- _urlPathEqualTo (matches only path, no query parameters)
- _urlMatching (using regular expressions)
- _urlPathMatching (using regular expressions)

Example: header matching

```
public void setupStubHeaderMatching() {

    stubFor(get(urlEqualTo( testUrl: "/headermatching"))
        .withHeader( s: "Content-Type", containing( value: "application/json"))
        .withHeader( s: "DoesntExist", absent())
        .willReturn(aResponse()
            .withBody("Header matching")
        ));
}
```

_absent(): check that header is **not** in request

Example: using logical AND and OR

```
public void setupStubLogicalAndHeaderMatching() {

    stubFor(get(urlEqualTo( testUrl: "logical-or-matching"))
        .withHeader( s: "my-header",
            matching( regex: "[a-z]+").and(containing( value: "somevalue"))
        )
        .willReturn(aResponse()
            .withBody("Logical AND matching"))
    );
}
```

- ‘somevalue’ is matched
- ‘bananasomevaluebanana’ is matched
- ‘banana’ is not matched (does not contain ‘somevalue’)
- ‘123somevalue’ is not matched (contains numeric characters)

Some more examples…

```
public void setupStubLogicalAndHeaderMatchingMoreVerbose() {

    stubFor(get(urlEqualTo( testUrl: "logical-or-matching"))
        .withHeader( s: "my-header", and(
            matching( regex: "[a-z]+"),
            containing( value: "somevalue"))
        )
        .willReturn(aResponse()
            .withBody("Logical AND matching, a little more verbose"))
    );
}
```

Same behaviour as the previous example, using a slightly different syntax

```
public void setupStubLogicalOrHeaderMatching() {

    stubFor(get(urlEqualTo( testUrl: "logical-or-matching"))
        .withHeader( s: "Content-Type",
            equalTo( value: "application/json").or(absent()))
        )
        .willReturn(aResponse()
            .withBody("Logical OR matching"))
    );
}
```

Matching on request body elements

```
public void setupStubRequestBodyValueMatching() {

    stubFor(post(urlEqualTo( testUrl: "/request-body-matching"))
            .withRequestBody(
                    matchingJsonPath( value: "$.fruits[?(@.banana == '2')]")
            )
            .willReturn(aResponse()
                    .withBody("Request body matched successfully"))
    );
}
```

Matching only those request bodies that have a root level element *fruits* with a child element *banana* with value *2*

{"fruits": {"banana": "2", "apple": "5"} } ➔ **MATCH**

{"fruits": {"apple": "5"} } ➔ **NO MATCH**

{"fruits": {"banana": "3", "apple": "5"} } ➔ **NO MATCH**

Matching using date/time properties

```
public void setupStubAfterSpecificDateMatching() {

    stubFor(get(urlEqualTo( testUrl: "date-is-after"))
        .withHeader( s: "my-date",
            after( dateTimeSpec: "2021-07-01T00:00:00Z")
        )
        .willReturn(aResponse()
            .withBody("Date is after midnight, July 1, 2021"))
    );
}
```

Matching all dates after midnight of July 1, 2021

```
public void setupStubRelativeToCurrentDateMatching() {

    stubFor(get(urlEqualTo( testUrl: "date-is-relative-to-now"))
        .withHeader( s: "my-date",
            beforeNow().expectedOffset( amount: 1, DateTimeUnit.MONTHS)
        )
        .willReturn(aResponse()
            .withBody("Date is at least 1 month before current date"))
    );
}
```

Matching all dates at least 1 month before the current date

Other matching strategies

- Authentication (Basic, OAuth(2))
- Query parameters
- Multipart/form-data
- You can write your own matching logic, too

Fault simulation

_Extend test coverage by simulating faults

_Often hard to do in real systems

_Easy to do using stubs or mocks

_Used to test the exception handling of your application under test

Example: HTTP status code

```
public void setupStubReturningErrorCode() {

    stubFor(get(urlEqualTo( testUrl: "/errorcode"))
        .willReturn(aResponse()
            .withStatus(500)
            .withStatusMessage("Status message goes here")
        ));
}
```

_Some often used HTTP status codes:

Consumer error	Provider error
403 (Forbidden)	500 (Internal server error)
404 (Not found)	503 (Service unavailable)

Example: timeout

```
public void setupStubFixedDelay() {

    stubFor(get(urlEqualTo( testUrl: "/fixeddelay"))
        .willReturn(aResponse()
            .withFixedDelay(2000)
        ));
}
```

- Random delay can also be used
  - Uniform, lognormal distribution

- Can be configured on a per-stub basis as well as globally

Example: bad response

```
public void setupStubBadResponse() {

    stubFor(get(urlEqualTo( testUrl: "/badresponse"))
        .willReturn(aResponse()
            .withFault(Fault.MALFORMED_RESPONSE_CHUNK)
        ));
}
```

- HTTP status code 200, but garbage in response body

- Other options:
  - RANDOM_DATA_THEN_CLOSE (as above, without HTTP 200)
  - EMPTY_RESPONSE (does what it says on the tin)
  - CONNECTION_RESET_BY_PEER (close connection, no response)

Now it's your turn!

- exercises > WireMockExercises2Test.java
- Practice fault simulation and different request matching strategies
  - Implement the responses as described in the comments
- Verify your solution by running the tests in the same file
- Answers are in answers > WireMockAnswers2Test.java
- Examples are in examples > WireMockExamples2Test.java

Section 3:

Creating stateful mocks

Statefulness

- Sometimes, you want to simulate stateful behaviour
- Shopping cart (empty / containing items)
- Database (data present / not present)
- Order in which requests arrive is significant

Stateful mocks in WireMock

- Supported through the concept of a Scenario
- Essentially a finite state machine (FSM)
  - States and state transitions
- Combination of current state and incoming request determines the response being sent
  - Before now, it was only the incoming request

Stateful mocks: an example

```
public void setupStubStateful() {

    stubFor(get(urlEqualTo( testUrl: "/order")).inScenario( s: "Order processing")
        .whenScenarioStateIs(Scenario.STARTED)
        .willReturn(aResponse()
            .withBody("Your shopping cart is empty")
        )
    );

    stubFor(post(urlEqualTo( testUrl: "/order")).inScenario( s: "Order processing")
        .whenScenarioStateIs(Scenario.STARTED)
        .withRequestBody(equalTo( value: "Ordering 1 item"))
        .willReturn(aResponse()
            .withBody("Item placed in shopping cart")
        )
        .willSetStateTo("ORDER_PLACED")
    );

    stubFor(get(urlEqualTo( testUrl: "/order")).inScenario( s: "Order processing")
        .whenScenarioStateIs("ORDER_PLACED")
        .willReturn(aResponse()
            .withBody("There is 1 item in your shopping cart")
        )
    );
}
```

Responses are grouped by scenario name

Response depends on both the incoming request as well as the current state

The initial state should always be Scenario.STARTED

Incoming requests can trigger state transitions

State names other than Scenario.STARTED are yours to define

Now it's your turn!

- exercises > WireMockExercises3Test.java
- Create a stateful mock that exerts the described behaviour
  - Implement the responses as described in the comments
- Verify your solution by running the tests in the same file
- Answers are in answers > WireMockAnswers3Test.java
- Examples are in examples > WireMockExamples3Test.java

Section 4:

Response templating

Response templating

- Often, you want to reuse elements from the request in the response
  - Request ID header
  - Unique body elements (client ID, etc.)
  - Cookie values

- WireMock supports this through response templating

Setup response templating (JUnit 4)

_In code: through the JUnit @Rule

```
@Rule
public WireMockRule wireMockRule =
    new WireMockRule(wireMockConfig().
        port(9876).
        extensions(new ResponseTemplateTransformer( global: true))
    );
```

_Global == false: response templating transformer has to be enabled for individual stubs

Setup response templating (JUnit 5)

_In code: through the JUnit @RegisterExtension

```
@RegisterExtension
static WireMockExtension wiremock = WireMockExtension.newInstance()
        .options(wireMockConfig().port(9876).globalTemplating(true))
        .build();
```

_Argument == false: response templating has to be enabled for individual stubs

Enable/apply response templating

_This template reads the HTTP request method (GET/POST/PUT/…) using *{{request.method}}* and returns it as the response body

```
public void setupStubResponseTemplatingHttpMethod() {

    wiremock.stubFor(any(urlEqualTo( testUrl: "/template-http-method"))
        .willReturn(aResponse()
            .withBody("You used an HTTP {{request.method}}")
            .withTransformers("response-template")
        ));
}
```

This call to *withTransformers()* is only necessary when response templating isn't activated globally

One thing to keep in mind…

```
@RegisterExtension
static WireMockExtension wiremock = WireMockExtension.newInstance()
        .options(wireMockConfig().port(9876).globalTemplating(true))
        .build();
```

Because we're explicitly initializing a WireMock instance here…

```
public void setupStubResponseTemplatingHttpMethod() {

    wiremock.stubFor(any(urlEqualTo( testUrl: "/template-http-method"))
        .willReturn(aResponse()
            .withBody("You used an HTTP {{request.method}}")
            .withTransformers("response-template")
        ));
}
```

… we need to explicitly assign our stub definition to that instance here, or else the stub definition will not be picked up!

Request attributes

- Many different request attributes available for use
  - `request.method` : HTTP method (example)
  - `request.pathSegments.[<n>]` : n^{th} path segment
  - `request.headers.<key>` : header with name *key*
  - …

- All available attributes listed at

https://wiremock.org/docs/response-templating/

Request attributes (cont'd)

_Extracting and reusing body elements

_In case of a JSON request body:

{{jsonPath request.body '$.path.to.element'}}

_In case of an XML request body:

{{xPath request.body '/path/to/element/text()'}}

JSON extraction example

_When sent this JSON request body:

```
{
    "book": {
        "author": "Ken Follett",
        "title": "Pillars of the Earth",
        "published": 2002
    }
}
```

_This stub returns a response with body “Pillars of the Earth”:

```
public void setupStubResponseTemplatingJsonBody() {

    stubFor(post(urlEqualTo( testUrl: "/template-json-body"))
            .willReturn(aResponse().
                    withBody("{{jsonPath request.body '$.book.title'}}").
                    withTransformers("response-template")
            ));
}
```

Again, this call to *withTransformers()* is only necessary when response templating isn’t activated globally

Now it's your turn!

_exercises > WireMockExercises4Test.java

_Create mocks that use response templating
  _Implement the responses as described in the comments

_Verify your solution by running the tests in the same file

_Answers are in answers > WireMockAnswers4Test.java

_Examples are in examples > WireMockExamples4Test.java

Section 5:

Verification

Verifying incoming requests

- Apart from returning responses, you might also want to verify that incoming requests have certain properties
  - Fail a test if these verifications aren't met

- You can do this with WireMock in a way very similar to mocking frameworks for unit tests (e.g., Mockito for Java)

Verifying incoming requests

```
public void setupHelloWorldStub() {

    stubFor(
        get(
            urlEqualTo( testUrl: "/hello-world")
        )
            .willReturn(
                aResponse()
                    .withHeader( key: "Content-Type", ...values: "text/plain")
                    .withStatus(200)
                    .withBody("Hello world!"))
    );
}
```

Given this simple 'hello world' stub

```
@Test
public void helloWorldVerificationTest() {

    setupHelloWorldStub();

    given().
            spec(requestSpec).
    when().
            get( s: "/hello-world").
    then().

    and().
            body(org.hamcrest.Matchers.equalTo( operand: "Hello world!"));
```

When we have this test that should invoke that stub exactly once

Then this verification can be added to the test to ensure that indeed, an HTTP GET to '/hello-world' has been made exactly once

```
verify(exactly( expected: 1), getRequestedFor(urlEqualTo( testUrl: "/hello-world")));
```

```
verify(exactly( expected: 1), getRequestedFor(urlEqualTo( testUrl: "/hello-world")));
```

Some more verification examples

```
verify(getRequestedFor(urlEqualTo( testUrl: "/hello-world")));
```

The same as the above, but less verbose

```
verify(lessThan( expected: 5), postRequestedFor(urlEqualTo( testUrl: "/requestLoan")));
```

Verify that less than 5 HTTP POSTs were made to /requestLoan

```
verify(
        moreThanOrExactly( expected: 10),
        postRequestedFor(urlEqualTo( testUrl: "/requestLoan"))
                .withHeader( key: "Content-Type", containing( value: "application/json"))
);
```

Verify that 10 or more HTTP POSTs with a 'Content-Type' header value containing 'application/json' were made to /requestLoan

Now it's your turn!

_exercises > WireMockExercises5Test.java

_Add WireMock verifications to the tests
  _Verify request properties as described in the comments

_Verify your solution by running the tests

_Answers are in answers > WireMockAnswers5Test.java

_Examples are in examples > WireMockExamples5Test.java

Section 6:

Extending WireMock

Extending WireMock

- In some cases, the default WireMock feature set might not fit your needs
- WireMock is open to extensions
- Allows you to create even more powerful stubs
- Several options available

Section 6.1:

Filtering incoming requests

Request filtering

- Modify incoming requests (or halt processing)

- This has a variety of use cases:
  - Checking authentication details
  - Request header injection
  - URL rewriting

- Created by implementing the *StubRequestFilterV2* interface

Request filtering - build

```
public class HttpDeleteFilter implements StubRequestFilterV2 {

    @Override
    public RequestFilterAction filter(Request request, ServeEvent serveEvent) {
        if (request.getMethod().equals(RequestMethod.DELETE)) {

            return RequestFilterAction.stopWith(ResponseDefinition.notPermitted("HTTP DELETE is not allowed!"));
        }

        return RequestFilterAction.continueWith(request);
    }

    @Override
    public String getName() { return "http-delete-filter"; }
}
```

If the HTTP verb used equals DELETE…

Return an HTTP 403 and stop processing the request

Else continue processing the request

Request filtering - use

```
@RegisterExtension
static WireMockExtension wiremock = WireMockExtension.newInstance().
        options(wireMockConfig().
                port(9876).
                extensions(new HttpDeleteFilter())
        ).build();
```

An extension can be registered using:
- its class name (“*com.example.HttpDeleteFilter*”)
- the class (*HttpDeleteFilter.class*)
- an instance (*new HttpDeleteFilter()*)

Now it's your turn!

- exercises > extensions > BasicAuthFilter.java

- Implement a custom request filter that filters out all requests that do not have the proper basic authentication credentials

- Verify your solution by running the tests in exercises > WireMockExercises6dot1Test.java

- Answers are in answers > extensions > BasicAuthFilter.java

- Examples are in examples > extensions > HttpDeleteFilter.java

Section 6.2:

Building a custom request matcher

Custom request matchers

- Add custom request matching logic to WireMock
- Can be combined with existing standard matchers
- Done by extending RequestMatcherExtension class

Custom request matcher - build

```
public class BodyLengthMatcher extends RequestMatcherExtension {

    @Override
    public String getName() {
        return "body-too-long";
    }

    @Override
    public MatchResult match(Request request, Parameters parameters) {
        int maxLength = parameters.getInt( key: "maxLength");
        return MatchResult.of(request.getBody().length > maxLength);
    }
}
```

Get the value of the *maxLength* matcher parameter

Compare the request body length to the *maxLength* parameter value and return the result as a *MatchResult*

Custom request matcher – use

```
@RegisterExtension
static WireMockExtension wiremock = WireMockExtension.newInstance().
        options(wireMockConfig().
                port(9876).
                extensions(new BodyLengthMatcher())
        ).build();
```

Register the extension

Use custom matcher in a stub definition using its name (can be combined with existing matchers)

Specify desired parameter value

```
stubFor(get(urlEqualTo( testUrl: "/custom-matching")).
        andMatching( "body-too-long", Parameters.one( name: "maxLength", value: 20)).
        willReturn(aResponse().withStatus(400))
);
```

Now it's your turn!

- exercises > extensions > RejectedHttpVerbsMatcher.java

- Implement a custom matcher that reads a list of rejected HTTP verbs and matches the HTTP verb used in the incoming request against it

- Verify your solution by running the tests in exercises > WireMockExercises6dot2Test.java

- Answers are in answers > extensions > RejectedHttpVerbsMatcher.java

- Examples are in examples > extensions > BodyLengthMatcher.java

Section 6.3 is waiting on

https://github.com/wiremock/wiremock/issues/2525

to be resolved

https://wiremock.org/docs/extending-wiremock/

Appendix A:

JSON equivalents for the Java examples

Our Hello world! mock

```
{
    "request": {
        "method": "GET",
        "url": "/helloworld"
    },
    "response": {
        "status": 200,
        "body": "Hello world!",
         "headers": {
            "Content-Type": "text/plain"
        }
    }
}
```

URL matching

```
{
    "request": {
        "method": "GET",
        "url": "/urlmatching"
    },
    "response": {
        "status": 200,
        "body": "URL matching"
    }
}
```

Request header matching

```
{
    "request": {
        "method": "GET",
        "headers": {
            "headerName": {
                "equalTo": "headerValue"
            }
        }
    },
    "response": {
        "status": 200,
        "body": "Header matching"
    }
}
```

Simulating a delay

```
{
    "request": {
        "method": "GET",
        "url": "/fixeddelay"
    },
    "response": {
        "status": 200,
        "fixedDelayMilliseconds": 2000
    }
}
```

Returning a fault response

```
{
    "request": {
        "method": "GET",
        "url": "/badresponse"
    },
    "response": {
        "fault": "MALFORMED_RESPONSE_CHUNK"
    }
}
```

Creating a stateful mock

```
{
  "mappings": [
    {
      "scenarioName": "Order processing",
      "requiredScenarioState": "Started",
      "request": {
        "method": "GET",
        "url": "/order"
      },
      "response": {
        "status": 200,
        "body" : "Your shopping cart is empty"
      }
    },

    {
      "scenarioName": "Order processing",
      "requiredScenarioState": "Started",
      "newScenarioState": "ORDER_PLACED",
      "request": {
        "method": "POST",
        "url": "/order",
        "bodyPatterns": [
          { "equalTo": "Ordering 1 item" }
        ]
      },
      "response": {
        "status": 200,
        "body": "Item placed in shopping cart"
      }
    },

    {
      "scenarioName": "Order processing",
      "requiredScenarioState": "ORDER_PLACED",
      "request": {
        "method": "GET",
        "url": "/order"
      },
      "response": {
        "status": 200,
        "body" : "There is 1 item in your shopping cart"
      }
    }
  ]
}
```

Use response templating

```
{
    "request": {
        "url": "/template-http-method"
    },
    "response": {
        "status": 200,
        "body": "You used an HTTP {{request.method}}",
        "transformers": ["response-template"]
    }
}
```

Use response templating

_When sent this JSON request body:

```
{
    "book": {
        "author": "Ken Follett",
        "title": "Pillars of the Earth",
        "published": 2002
    }
}
```

_This stub returns a response with body “Pillars of the Earth”:

```
{
  "request": {
    "method": "POST",
    "urlPath": "/template-json-body"
  },
  "response": {
    "body": "{{jsonPath request.body '$.book.title'}}",
    "transformers": ["response-template"]
  }
}
```

Using WireMock extensions

```
{
    "request" : {
        "customMatcher" : {
            "name" : "body-too-long",
            "parameters" : {
                "maxLength" : 2048
            }
        }
    },
    "response" : {
        "status" : 422
    }
}
```

Using a custom matcher

```
{
    "request": {
        "method": "GET",
        "url": "/local-transform"
    },
    "response": {
        "status": 200,
        "body": "Original body",
        "transformers": ["my-transformer", "other-transformer"]
    }
}
```

Registering a local transformer

Specifying transformer parameters

```
{
    "request" : {
        "url" : "/transform",
        "method" : "GET"
    },
    "response" : {
        "status" : 200,
        "transformerParameters" : {
            "paramName" : "value"
        }
    }
}
```