Tiger User Manual

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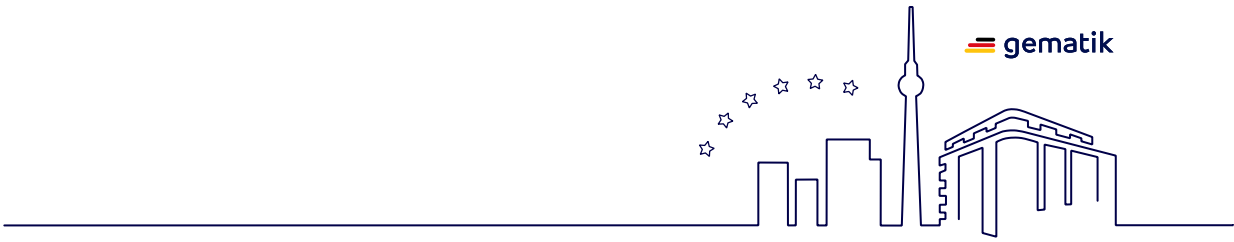

Contents

Chapter 1. Overview

To get a quick introduction to the core concepts and features of the Tiger test framework check out our video at
https://youtu.be/eJJZDeuFlyI?autoplay

Figure 1. Tiger product pitch video

Tiger is a framework for interface-driven BDD black-box-testing.

Tiger is a toolbox that supports and guides you when writing test suites. It lets you focus on writing the tests and solves typical problems that every team encounters (configuration, setting up the test environment, parametrization, result reporting, test running). How, you ask?

- Tiger does not focus on components but on the interactions between them. The Tiger Proxy captures the traffic between components.
- Tiger Proxy parses the traffic and builds a tree-structure which abstracts away the encoding (XML, JSON…) and lets you focus on the data.
- The Tiger test environment manager handles dockers, helm charts, JARs and external servers, boots the configured setup and routes the traffic, all with zero lines of Java, all in YAML only.
- A complete configuration toolkit, which combines multiple source and supports custom configuration of your testsuite as well, again with zero lines of Java.
- Common tasks (JSON-validation, message-filtering, scenario configuration, configuration of simulators…) can be performed with the Tiger test library, which can be seamlessly imported into BDD test suites.
  This allows you to build mighty test suites with zero lines of java.
- If you want to write custom steps and glue code our Java-API has got you covered by supporting common tasks (crypto, serialization…) for you. So the little lines you have to write are be powerful and descriptive?!

1.1. Use cases

In our first dive we focused on what Tiger should stand for and how we could improve the situation of test teams.

Core business use cases

- Fast and easy set up of test environments
- Uncomplicated automated execution of IOP tests
- Explicit analysis of test failures
- Reuse of cases/steps from existing test suites
- (non Java test automation support is not implemented yet)

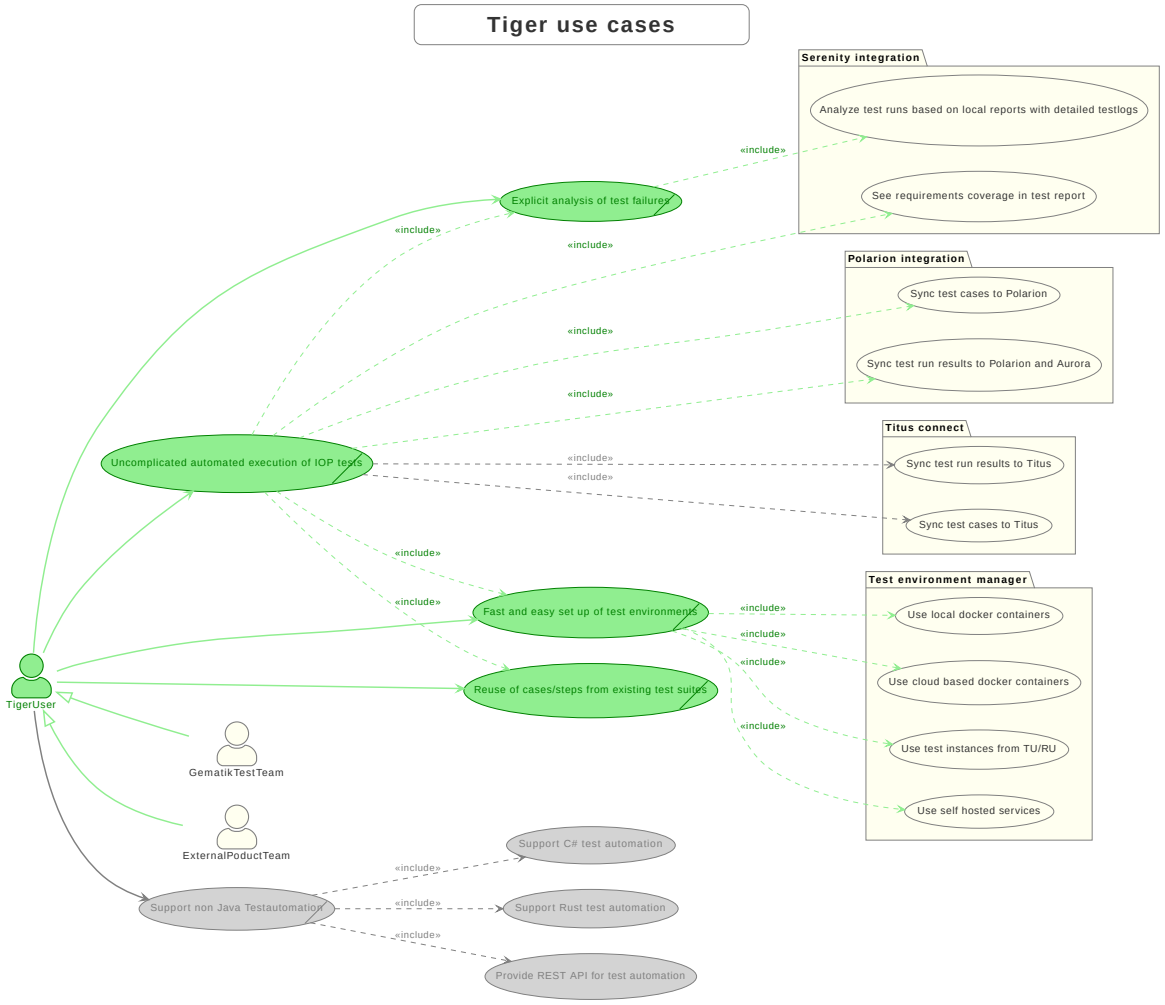

Figure 2. Tiger use cases

1.2. Components

Tiger has a clear separation in three components, each of them having a clear purpose, described in the next subsections:

- Tiger Proxy
- Tiger Testenvironment Manager
- Tiger Test library

1.2.1. Tiger Proxy

The Tiger Proxy at its core is an extended Mock server, that has the following additional core feature set:

- **Rerouting** - allows rerouting requests based on a configured lookup table
- **Modifications** - allows modifying the content of requests / responses on the fly
- **Mesh set up** - allows forwarding traffic data from one proxy to another for aggregated validations
- **TLS man in the middle** - allows tracing TLS encrypted traffic
- **RBel logging** - breaks up and parses each request / response received. This includes decryption of VAU and encrypted JWT.
  Structured data like JSON, XML, JWT is displayed in a sophisticated HTML report.

1.2.2. Tiger test environment manager

The Tiger test environment manager provides methods to configure and instantiate multiple server nodes in your test environment and offers the following core feature set:

- **Instantiating test nodes** - docker containers, docker compositions, helm charts, external Jars** and
  accessing server instances via external URL configurations
- **Instantiating preconfigured server nodes** - for common test scenarios like ePA, ERp, IDP, Demis
- **Automatic shutdown** - on tear down of test run, all the instantiated test nodes are ended
- **Highly configurable** - Multitude of parameters and configuration properties
- **Flexible environment management** - exporting and importing environment variables and system properties to other test nodes
- **Customizing configuration properties** - via command line system properties or environment variables

1.2.3. Tiger test library

The Tiger test library provides the following core features:

- **Validation** - BDD steps to filter requests and validate responses
- **Workflow UI** - BDD steps to support tester guidance in test workflows
- **Content assertion** - BDD steps to assert JSON / XML data structures
- **Product Integration** - Synchronisation with Polarion, Serenity BDD and screenplay pattern

1.2.4. Working together

The Testenvironment Manager instantiates all test nodes configured in the `tiger.yaml` config file.

It also instantiates one local Tiger Proxy for the current test suite.
This Tiger Proxy instance (and others created in the test environment if using a mesh setup) traces all requests and responses
forwarded via this proxy and provides them to the test suite for further validation.

For each server node instantiated, the local Tiger Proxy adds a route so that the instantiated server node
can be reached by the test suite via HTTP and the configured server hostname.

Each Tiger Proxy can be configured in a multitude of ways: as reverse or forward proxy with special routing features and
modifications of content easily configurable, or in a mesh setup as proxy forwarding traffic to other Tiger Proxies…

The BDD or JUnit test suite can integrate the Tiger test library to validate messages (requests and responses) sent/received
over Tiger Proxies using features such as RBelPath, VAU decryption, JSON checker and XML checker.

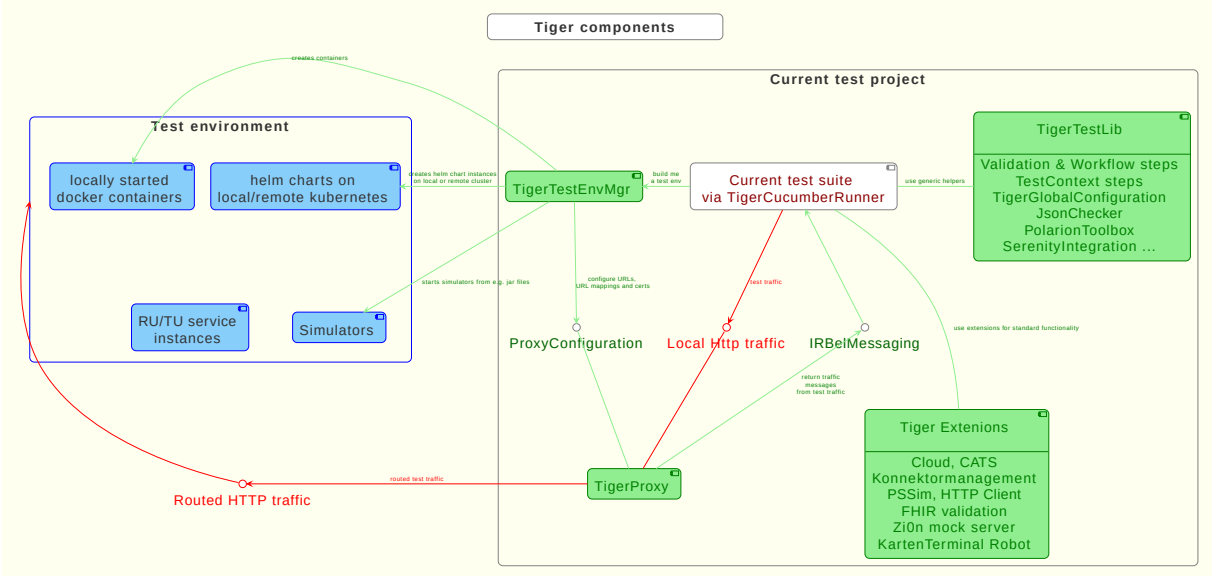

Figure 3. Tiger components

1.2.5. Tiger extensions

As Tiger evolves we have implemented quite a nice set of extensions that eases your job as tester in areas not directly fitting the core of Tiger. The currently or soon available extensions are:

- **Cloud** extension provides the docker, docker compose and helm chart server types for the Tiger test environment mgr
- **CATS** extension provides BDD steps to configure and interact with the Cats Card Terminal simulator of gematik
- **Konnektormanagement** extension provides BDD steps to administer Konnektors
- **PSSim** extension provides BDD steps to simulate a Primärsystem
- **HTTP Client** extension follows the zero code philosophy and provides BDD

steps to perform http requests without having to write any line of code

- **FHIR validation** extension provides BDD steps to perform FHIR scheme based / FHIRPath based validations (planned release early spring 2023)
- **Kartenterminal Robot** extension provides BDD steps to control the card terminal robot currently constructed at gematik labs (release mid 2023)

Chapter 2. Getting started

Tiger is based on Java, Maven and Serenity BDD - so saddle the horses, check the operating system requirements and hit the road.

We do not at the moment have any plans to support gradle or other build environments.
But if you are using it in your projects feel free to contact us, and we might find a way to support your specific build environment.

If you don't have time right now to look through the whole documentation, you can directly jump to our Example project section.

2.1. Requirements

Operating system requirements

- Open JDK >= 17
- Maven >= 3.6
- IntelliJ >= 2021.2.3

On Windows please refrain from using Powershell or DOS command line windows but stick with GitBash

2.2. Maven in a nutshell

In order to use Tiger with your BDD/Cucumber/Serenity based test suite you need to add a few dependencies to integrate with Tiger

- Current version of Tiger test library
- Current version of Tiger test library as test-jar artefact

The second dependency is needed so that the IntelliJ Cucumber plugin detects the Steps/Glue code provided by the Tiger test library.

And to trigger the test suite's execution, you will need to add these plugins

- Tiger maven plugin
- Maven FailSafe plugin

Listing 1. Simple Tiger Maven pom.xml

```
<?xml version="1.0" encoding="UTF-8"?>
<!--
  ~ ${GEMATIK_COPYRIGHT_STATEMENT}
  -->

<project xmlns="http://maven.apache.org/POM/4.0.0"
    xmlns:xsi="http://www.w3.org/2001/XMLSchema-instance"
    xsi:schemaLocation="http://maven.apache.org/POM/4.0.0 http://maven.apache.org/xsd/maven-
4.0.0.xsd">
    <modelVersion>4.0.0</modelVersion>
```

```
    <groupId>de.gematik.test.tiger.examples</groupId>
    <artifactId>TigerTestBDD</artifactId>
    <version>1.2.0-SNAPSHOT</version>

    <properties>
        <maven.compiler.source>17</maven.compiler.source>
        <maven.compiler.target>17</maven.compiler.target>

        <version.junit5>5.9.3</version.junit5>
        <version.maven.failsafe>3.1.2</version.maven.failsafe>
        <!-- please adapt Tiger version property to the most current one obtained from -->
        <!-- maven central:
          https://mvnrepository.com/artifact/de.gematik.test/tiger-test-lib
          or from gematik internal Nexus
          https://nexus.prod.ccs.gematik.solutions/#browse/search=keyword%3Dtiger-test-lib
        -->
        <version.tiger>2.1.4-SNAPSHOT</version.tiger>
    </properties>

    <!-- tag::dependencies[] -->
    <dependencies>
        <dependency>
            <groupId>de.gematik.test</groupId>
            <artifactId>tiger-test-lib</artifactId>
            <version>${version.tiger}</version>
        </dependency>
        <!-- for Junit5 Driver classes you need these dependencies -->
        <!-- needed for support of junit5  driver classes -->
        <dependency>
            <groupId>org.junit.platform</groupId>
            <artifactId>junit-platform-suite</artifactId>
            <version>1.9.2</version>
            <scope>test</scope>
        </dependency>
        <dependency>
            <groupId>io.cucumber</groupId>
            <artifactId>cucumber-junit-platform-engine</artifactId>
            <version>7.11.2</version>
            <scope>test</scope>
        </dependency>
        <!-- Optional if you have JUnit5 dependencies
        but use the JUnit4 based template for your driver classes
        <dependency>
            <groupId>org.junit.vintage</groupId>
            <artifactId>junit-vintage-engine</artifactId>
            <version>${version.junit5}</version>
        </dependency>-->
    </dependencies>
    <!-- end::dependencies[] -->

    <build>
        <plugins>
            <!-- tag::generator-plugin[] -->
            <!-- optional plugin to dynamically create JUnit driver classes on the fly.
            You may omit this plugin if you have written your driver classes manually.
            -->
            <plugin>
                <groupId>de.gematik.test</groupId>
                <artifactId>tiger-maven-plugin</artifactId>
                <version>${version.tiger}</version>
                <executions>
                    <execution>
                        <configuration>
                            <!-- mandatory -->
                            <glues>
                                <glue>de.gematik.test.tiger.glue</glue>
                                <!-- add your packages here -->
                            </glues>
                            <!-- optional -->
                            <featuresDir>
```

```
${project.basedir}/src/test/resources/features</featuresDir>
                        <!-- optional -->
                        <includes>
                            <include>**/*.feature</include>
                        </includes>
                        <!-- optional -->
                        <driverPackage>
                            de.gematik.test.tiger.examples.bdd.drivers
                        </driverPackage>
                        <!-- optional -->
                        <!--suppress UnresolvedMavenProperty -->
                        <driverClassName>Driver${ctr}IT</driverClassName>
                        <!-- optional, defaults to the templated located at
                        /src/main/resources/driver4ClassTemplate.jtmpl
                        in the tiger-maven-plugin module.
                        This template will create a junit4 compliant driver class.
                        Use separate template file if you have spring boot apps to test
                        or need to do some more fancy set up stuff.
                        <templateFile>${project.basedir}/..../XXXX.jtmpl</templateFile>
                        -->
                        <!-- optional -->
                        <skip>false</skip>
                        <junit5Driver>true</junit5Driver>
                    </configuration>
                    <phase>generate-test-sources</phase>
                    <id>generate-tiger-drivers</id>
                    <goals>
                        <goal>generate-drivers</goal>
                    </goals>
                </execution>
                <execution>
                    <id>generate-tiger-report</id>
                    <goals>
                        <goal>
                            generate-serenity-reports
                        </goal>
                    </goals>
                </execution>
            </executions>
        </plugin>
        <!-- end::generator-plugin[] -->

        <!-- tag::failsafe-plugin[] -->
        <!-- Runs the tests by calling the JUnit driver classes -->
        <!-- To filter features / scenarios use the system property
             -Dcucumber.filter.tags -->
        <plugin>
            <groupId>org.apache.maven.plugins</groupId>
            <artifactId>maven-failsafe-plugin</artifactId>
            <version>${version.maven.failsafe}</version>
            <executions>
                <execution>
                    <goals>
                        <goal>integration-test</goal>
                        <goal>verify</goal>
                    </goals>
                </execution>
            </executions>
            <configuration>
                <includes>
                    <!-- adapt to the class names of your driver classes -->
                    <include>**/Driver*IT.java</include>
                </includes>
            </configuration>
        </plugin>
        <!-- end::failsafe-plugin[] -->
    </plugins>
</build>
</project>
```

For a successful startup you also need a minimum Tiger test environment configuration yaml file in your project root:

Listing 2. Minimum Test environment configuration

```
# minimum viable test environment specification
# default local Tiger Proxy
tigerProxy:
# no server nodes
servers: {}
```

and finally a minimal feature file under src/test/resources/features:

Listing 3. Minimum Cucumber feature file

```
Feature: Test Tiger BDD

  Scenario: Dummy Test
    Given TGR set global variable "key01" to "value01"
    When TGR assert variable "key01" matches "v.*\d\d"
```

With these three files in place you can run the simple dummy test scenario defined in the feature file by issuing

```
mvn verify
```

2.3. Maven plugin details

This section is for the ones that love to know all the details. If you are happy that everything works and
don't bother to understand all the bits / properties and settings just skip this section and head over to the Example project section.

2.3.1. Tiger maven plugin

This plugin allows to dynamically generate the JUnit driver classes that are then used in the Surefire plugin to start the test runs. And replaces the serenity maven plugin to generate Serenity BDD test reports.

Generate Drivers goal

You may decide to manually write your own JUnit driver classes in which case you can omit this plugin.

To activate this feature in your maven project add the following plugin block to your <build><plugins> section:

```
            <!-- optional plugin to dynamically create JUnit driver classes on the fly.
            You may omit this plugin if you have written your driver classes manually.
            -->
            <plugin>
                <groupId>de.gematik.test</groupId>
                <artifactId>tiger-maven-plugin</artifactId>
                <version>${version.tiger}</version>
```

```
                <executions>
                    <execution>
                        <configuration>
                            <!-- mandatory -->
                            <glues>
                                <glue>de.gematik.test.tiger.glue</glue>
                                <!-- add your packages here -->
                            </glues>
                            <!-- optional -->
                            <featuresDir>
${project.basedir}/src/test/resources/features</featuresDir>
                            <!-- optional -->
                            <includes>
                                <include>**/*.feature</include>
                            </includes>
                            <!-- optional -->
                            <driverPackage>
                                de.gematik.test.tiger.examples.bdd.drivers
                            </driverPackage>
                            <!-- optional -->
                            <!--suppress UnresolvedMavenProperty -->
                            <driverClassName>Driver${ctr}IT</driverClassName>
                            <!-- optional, defaults to the templated located at
                            /src/main/resources/driver4ClassTemplate.jtmpl
                            in the tiger-maven-plugin module.
                            This template will create a junit4 compliant driver class.
                            Use separate template file if you have spring boot apps to test
                            or need to do some more fancy set up stuff.
                            <templateFile>${project.basedir}/..../XXXX.jtmpl</templateFile>
                            -->
                            <!-- optional -->
                            <skip>false</skip>
                            <junit5Driver>true</junit5Driver>
                        </configuration>
                        <phase>generate-test-sources</phase>
                        <id>generate-tiger-drivers</id>
                        <goals>
                            <goal>generate-drivers</goal>
                        </goals>
                    </execution>
                    <execution>
                        <id>generate-tiger-report</id>
                        <goals>
                            <goal>
                                generate-serenity-reports
                            </goal>
                        </goals>
                    </execution>
                </executions>
            </plugin>
```

Mandatory configuration properties

- **List[glue] glues** (mandatory)
  list of packages to be included as glue or hooks code

Optional configuration properties or properties with default values

- List[include] includes (mandatory)
  list of include patterns for feature files in Ant format (directory/**.feature)
- String featuresDir (default: local working directory)
  root folder from where to apply includes and excludes
- List[exclude] excludes (default: empty)
  list of exclusion patterns for feature files in Ant format (directory/**.feature)
- boolean skip (default: false)

flag whether to skip the execution of this plugin

- String driverPackage (default: de.gematik.test.tiger.serenity.drivers)
  package of the to be generated driver class
- String driverClassName (default: Driver${ctr})
  Name of the to be generated driver class.

The ctr token ${ctr} is mandatory! For more details see section below

- String templateFile (default: null which means that the plugin will use the built-in template file)
  Optional path to a custom template file to be used for generating the driver Java source code file.
  - The plugin currently supports the following list of tokens:
    - ${ctr}
      counter value that is unique and incremented for each feature file.
    - ${package}
      will be replaced with package declaration code line of the driver class. Either empty or of the pattern "package xxx.yyy.zzz;" where xxx.yyy.zzz is replaced with the configured driverPackage configuration property.
    - ${driverClassName}
      name of the driver class (with the ctr token already being replaced with the incrementing counter value).
    - ${feature}
      path to the feature file(s).
    - ${glues}
      comma separated list of glue/hook packages as specified by the glues configuration property in curly braces.
    - ${gluesCsv}
      comma separated list of glue/hook packages without curly braces.

Manually creating driver classes

For each feature (or use wildcards / directories for single driver class) you can implement a driver class based on the example code below.

```
package de.gematik.test.tiger.integration.YOURPROJECT;

import io.cucumber.junit.CucumberOptions;
import io.cucumber.junit.TigerCucumberRunner;
import org.junit.runner.RunWith;

@RunWith(TigerCucumberRunner.class)
@CucumberOptions(
    features = {"src/test/resources/features/YOURFEATURE.feature"},
    plugin = {"json:target/cucumber-parallel/1.json"},
    monochrome = false,
    glue = {"de.gematik.test.tiger.glue",
        "ANY ADDITIONAL PACKAGES containing GLUE or HOOKS code"})
public class Driver1IT {
```

```
}
```

Generate Reports goal

The second execution block in the example XML section above will trigger the report creation. There are no properties for configuration at the moment.
Two reports will be generated under target/site/serenity:

- A simple HTML single page report for emailing (serenity-summary.html)
- A fancy detailed overall report (index.html)

Start Tiger test environment in stand alone mode

Adding the plugin as shown below will allow you to start a test enviroment in standalone mode by starting mvn as follows: `mvn tiger:setup-testenv`.
Please be aware that this is a blocking call, you may specify a timeout configuration property `autoShutdownAfterSeconds` with timeout in seconds. To prematurely stop the process either press Ctrl+C in your console or kill it with operating system specific kill commands / tools. In order to customize the tiger yaml to be used either set the environment variable `TIGER_TESTENV_CFGFILE` or set the system property `tiger.testenv.cfgfile`.

```
            <plugin>
                <groupId>de.gematik.test</groupId>
                <artifactId>tiger-maven-plugin</artifactId>
                <version>${version.tiger}</version>
             </plugin>
```

2.3.2. FailSave plugin

The failsafe plugin will trigger the test run.
It is important to activate the **testFailureIgnore** property, to ensure that even if the test fails, the serenity report is created.

To filter the scenarios/features to be run you may pass in the Java system property cucumber.filter.tags. You can do so either within the <systemPropertyVariables> tag or via the command line using -Dcucumber.filter.tags

The "not @Ignore" is the default setting for maven verify as well as for IntelliJ, therefore scenarios that should be ignored are to be tagged with @Ignore. If the user uses the cucumber option "-Dcucumber.options" to set own tags then the default setting of "not @Ignore" is overridden. The same counts for own tag settings in the IntelliJ run configuration.

For more details about how to use filter tags see https://cucumber.io/docs/cucumber/api/#tags

```
            <!-- Runs the tests by calling the JUnit driver classes -->
            <!-- To filter features / scenarios use the system property
                 -Dcucumber.filter.tags -->
            <plugin>
                <groupId>org.apache.maven.plugins</groupId>
                <artifactId>maven-failsafe-plugin</artifactId>
```

```
                <version>${version.maven.failsafe}</version>
                <executions>
                    <execution>
                        <goals>
                            <goal>integration-test</goal>
                            <goal>verify</goal>
                        </goals>
                    </execution>
                </executions>
                <configuration>
                    <includes>
                        <!-- adapt to the class names of your driver classes -->
                        <include>**/Driver*IT.java</include>
                    </includes>
                </configuration>
            </plugin>
```

We do not recommend the parallel test execution with Tiger at the moment.

Reason is that when using Tiger Proxies with the Tiger test library validation feature parallel execution may lead to messages
from different threads / forked processes ending up in the wrong listening queue making it very complicated to make sure your validations are working as expected in different timing situations.

2.4. Example project

In the /doc/examples/tigerOnly` folder of this project you will find an example for a minimum configured maven project that

- embedds Tiger
- allows to use its Cucumber steps and
- allows to easily configure your test environment

All you need is to set up three files:

- a Maven `pom.xml` file to declare the dependencies and the plugins needed
- a `tiger.yaml` to declare your test environment (servers needed, proxy routes,…). This is currently "empty".
- a `test.feature` file containing a test scenario and dummy test steps to be performed.

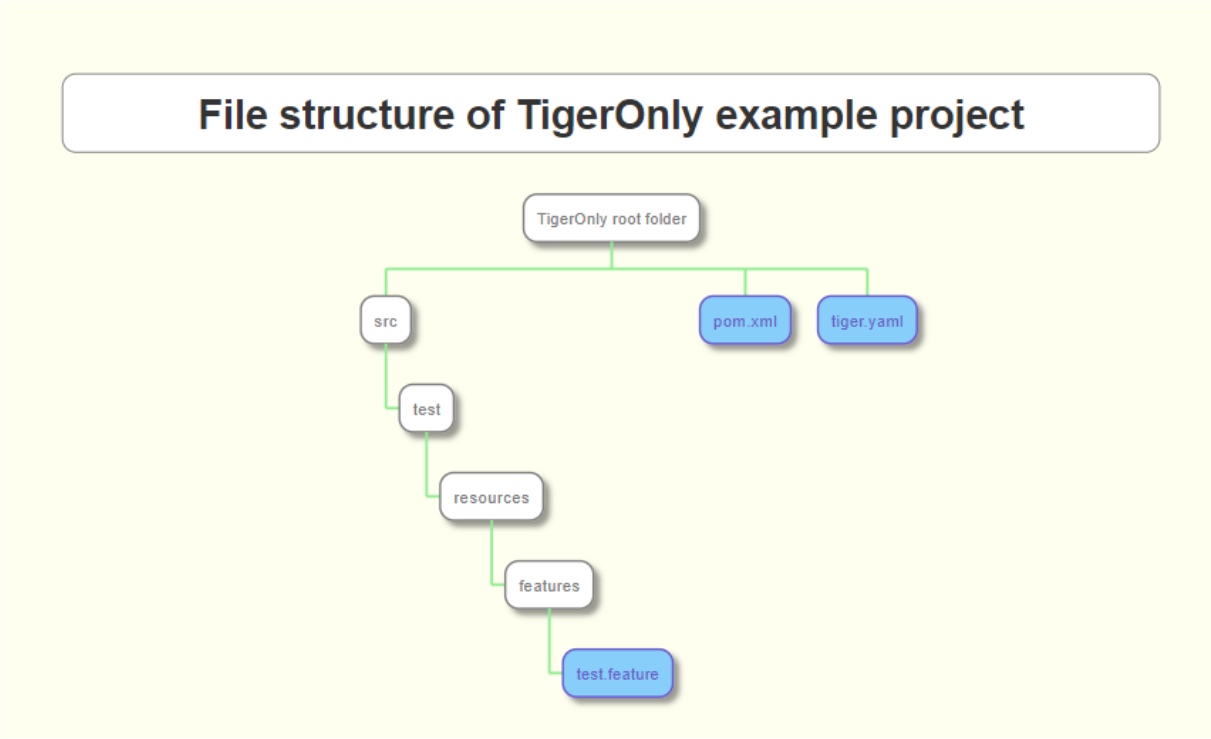

Figure 4. File structure of TigerOnly example project

2.5. How to contact the Tiger team

You can reach us via

- GitHub https://github.com/gematik/app-Tiger
- or email TIGER@gematik.de

2.6. IntelliJ

We recommend to use latest version of IntelliJ at least version 2021.1.

2.6.1. Run/Debug settings

To be able to successfully start scenarios/features you first need to configure the Run/Debug settings of your project:

Run/Debug settings for Java Cucumber template

- Main class: io.cucumber.junit.TigerCucumberRunner
- Glue:
  - de.gematik.test.tiger.glue
  - net.serenitybdd.cucumber.actors
    if you are using the screenplay pattern (PREFERRED!)
  - additional packages specific to your test suite
- VM Options:
  - Java proxy system properties (see Proxy configuration below)
- Environment variables:
  - Proxy environment variables (see Proxy configuration below)

Best is to add these settings to the **Configuration Templates** for Cucumber Java.
Depending on the version of IntelliJ these settings are located either on the top icon bar or at the bottom left as link.

Else you would have to apply these settings to any new Debug/Run Configuration, like when you start a new scenario, which was never executed before.

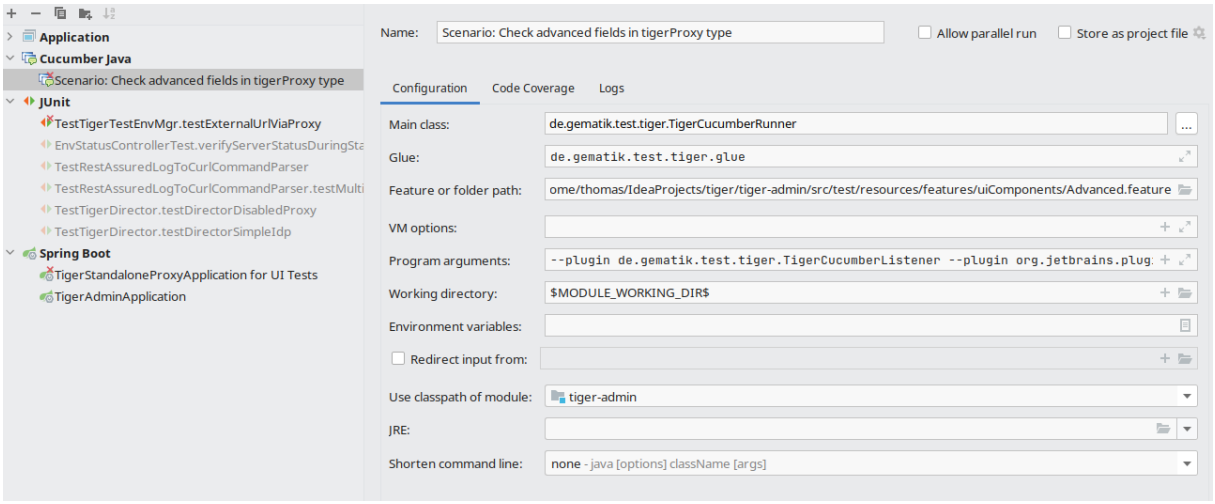

Figure 5. Run/Debug settings for IntelliJ

2.6.2. Proxy configuration

If you are located behind a proxy please make sure to set the environment variables HTTPS_PROXY and HTTP_PROXY as well as
the Java system properties http.proxyHost, http.proxyPort, https.proxyHost and https.proxyPort appropriately so that the internet connections are routed properly through your **company proxy**.

Please also make sure IntelliJ has its proxy settings configured appropriately for HTTP and HTTPS so that it can download the dependencies for the IntelliJ build environment too.

BOTH settings (environment variables and system properties) are required as Maven and Java code and HTTP client libraries use both settings.

Chapter 3. Tiger test environment manager

As outlined in the overview section the test environment manager is one of the three core components of the Tiger test framework.
Its main task is to start various test server nodes configured in the `tiger.yaml` configuration file and initialize the local Tiger Proxy for the test suite.
To choose a different test environmental configuration file you may set the environment variable `TIGER_TESTENV_CFGFILE`.

The test environment manager first checks if the env variable is set and tries to load the configuration file from this value.
If this file does not exist the test environment manager tries to load the configuration from `tiger.yaml`.
If none of these files exist it will fail the start-up.

If the environment variable is not set it searches for files named `tiger.yaml` or `tiger.yml`.
If none of these files exist it will fail the start-up.

It then loads further yaml-files:

- `tiger-${hostname}.yaml` and `tiger-${hostname}.yml` are read and give the possibility to make computer-dependent configuration.
  The hostname is the of your own computer in the network (on Windows-machines typically the computername).
- The list given under `tiger.additionalYamls` is read.
  Each list-entry has two properties:
  - `filename` pointing to the file to be read.
    This can be relative to the tiger.yaml (primary) or relative to the working-directory (secondary).
    Keep in mind that placeholders can be used in the filename!
  - `baseKey`, an optional attribute, which gives you the chance to prefix every property from the given file with this key (keep in mind that the `tiger.yaml` has a baseKey of `tiger`)

In the start-up phase it also informs the local Tiger Proxy about the hostnames each node has configured, so that the local Tiger Proxy can create appropriate routing entries in its own configuration.

To configure your test environment you can compose the `tiger.yaml` file manually.

The nodes configured in the yaml file will be started asynchronously unless the dependsUpon property is set.

3.1. Supported server nodes and their configuration

The Tiger testenvironment manager currently supports the following list of server nodes.

- **Docker container** is a node based on instantiating a specific docker image that is either locally available or downloaded from a remote docker repo configured in the source property.
- **Docker compose** is a node that you can use to start a group of services

defined in one to several compose yaml files configured in the source list.

- **Helm charts** is a node that installs/updates a given helm chart on a local or remote kubernetes cluster (configuring a local context for remote clusters has to be done outside of Tiger)
- **External jar** is a node that is started by running `java -jar XXXX.jar` after downloading a Jar archive from the configured source URL.
- **External URL** is a symbolic node that is actually maintained outside the realm of the test environment manager.
  The main purpose is to allow the test suite to access this external server via a constant URL, regardless of what the actual access URL of the server is.
  So if you change the location of the external server has no adaptations effect on the test suite.
- **Tiger Proxy** is a specialized external Jar node that allows you to instantiate standalone Tiger Proxy nodes in your test environment in several locations to track, log and validate traffic between any two nodes.
  For this to work, you must either be able to force a proxy on the nodes or use a reverse proxy set up scenario.
- **Helm Chart** is a node that will be added to tiger via a plugin mechanism that starts a helm chart within a kubernetes environment.
- **httpbin** is a node mainly useful for testing purposes.
  It starts a httpbin server which provides mock endpoints.

3.1.1. YAML configuration files in a nutshell

Before you start writing your own `tiger.yaml` configuration files, make sure you have worked with yaml files before and know its syntax and structure.
If unsure take a 20 minutes primer, although not everything in the video is relevant, it gives a good introduction to indenting properties and structures and specifying values in a yaml file.

3.1.2. General properties

The general properties apply to each node type.

Listing 4. General properties

```
serverKey_xxx:
  # OPTIONAL hostname of this node when accessing it via the test suite
  # (rerouted via the local test suite Tiger Proxy).
  # Defaults to the server name (serverKey_xxx)
  # For docker compose and helm chart this property must NOT be set!
  hostname: string
  # MANDATORY one of [tigerProxy|docker|compose|externalJar|externalUrl]
  type: string
  # OPTIONAL name of a template to apply.
  # Default value is empty
  template: string
  # OPTIONAL comma separated list of keys of server nodes that must be started
  # before this node is set up.
  # Default value is empty
  dependsUpon: csv string
  # OPTIONAL duration in seconds to wait for a successful start-up of the server node
  # Default value is 20
  startupTimeoutSec: int
  # MANDATORY type specific property in that for some types it's a list,
  # for some others it's a single URL
```

```
  source:
    - source entry 1
    - source entry 2
  # used by all node types, for external URL this property is OPTIONAl and fallback is the source
URL
  healthcheckUrl: string
  # OPTIONAL only declare the server healthy once the specified return code
  # is given
  healthcheckReturnCode: int
  # type specific property for Tiger Proxy and docker container nodes
  version: string
  # OPTIONAL the logs of the server are also written to a file, if no logFile is
  # specified a default name will be used (default is "./target/serverLogs/[key of server in
tiger.yaml].log")
  logFile: ./target/serverLogs/serverKey_xxx.log

  # OPTIONAL list of pki certs and keys to initialize
  # the local Tiger Proxy of the test suite with
  # Default value is empty array
  # For more details see "PKI configuration" section below
  pkiKeys: []
  # OPTIONAL type specific list of environmental variable assignments to be used
  # when starting the server node.
  # Each entry has to have the format ENV_VAR_NAME=VALUE
  # Has NO EFFECT on external Url nodes.
  # Default value is empty array
  environment:
    - ENV_VAR1=VALUE1
    - ENV_VAR2=VALUE2
    - http://tsl --> https://download-ref.tsl.ti-dienste.de
  # OPTIONAL list of routes to be added to the local Tiger Proxy of the test suite.
  # Default value is empty array
  urlMappings:
    - https://www.orf.at --> https://eitzen.at
  # OPTIONAL list of system properties that will be provided to following nodes.
  # Each entry has to have the format system.property.name=VALUE
  # Default value is empty array
  exports:
    - systemProp1=Value1
    - systemProp2=Value2
```

Here is a little example how the server names are set and used and how there server is reachable via the Tiger Proxy.

Listing 5. Example with three external jar servers

```
servers:
  # here the server name is "identityServer" and
  # the server is reachable under "identityServer" via the Tiger Proxy
  identityServer:
    type: externalJar
    source:
      - local:../octopus-identity-service/target/octopus-identity-service-1.0-SNAPSHOT.jar
    healthcheckUrl: http://localhost:${tiger.ports.identity}/status
    externalJarOptions:
      options:
        - -Dhttp.proxyHost=127.0.0.1
        - -Dhttp.proxyPort=${tiger.ports.proxyPort}
      arguments:
        - --server.port=${tiger.ports.identity}
        - --services.shopping=http://myShoppingServer

  # here the server name is "shoppingServer"
  # but the server is reachable under "myShoppingServer" via the Tiger Proxy because hostname is set
  shoppingServer:
    hostname: myShoppingServer
    type: externalJar
```

```
    source:
      - local:../octopus-shopping-service/target/octopus-shopping-service-1.0-SNAPSHOT.jar
    healthcheckUrl: http://localhost:${tiger.ports.shopping}/inventory/status
    externalJarOptions:
      options:
        - -Dhttp.proxyHost=127.0.0.1
        - -Dhttp.proxyPort=${tiger.ports.proxyPort}
      arguments:
        - --server.port = ${tiger.ports.shopping}
        - --services.identity=http://identityServer

  testClient:
    type: externalJar
    source:
      - local:../octopus-example-client/target/octopus-example-client-1.0-SNAPSHOT.jar
    healthcheckUrl: http://localhost:${tiger.ports.client}/testdriver/status
    externalJarOptions:
      options:
        - -Dhttp.proxyHost=127.0.0.1
        - -Dhttp.proxyPort=${tiger.ports.proxyPort}
      arguments:
        - --server.port=${tiger.ports.client}
        # here are the examples how the servers are reachable
        - --services.shopping=http://myShoppingServer
        - --services.identity=http://identityServer
```

The general properties are followed by the type specific substructures, which configure specific aspects of each node type.
Their meaning and format are explained in the related section.

Listing 6. Type specific properties

```
  # type specific sub structure for external jar, Tiger Proxy, docker and helm chart nodes
  externalJarOptions:
    # used by external jar and Tiger Proxy nodes
    workingDir: string
    # only used by external jar nodes
    options: []
    # used by external jar and Tiger Proxy nodes
    arguments: []
    # flag whether to forward log output from external jar processes to the workflow UI
    activateWorkflowLogs : true
    # flag whether to forward log output from external jar processes to workflow UI and console
    activateLogs: true

  # type specific sub structure for Tiger Proxy nodes
  tigerProxyConfiguration:
    # Here a normal Tiger Proxy configuration can be used.
    # This is explained in more depth down below
    adminPort: int
    proxiedServer: string
    proxiedServerProtocol: [HTTP|HTTPS]
    proxyRoutes:
        # defines a forward-proxy-route from this server
      - from: http://foobar
        # to this server
        to: https://cryptic.backend/server/with/path

  # type specific sub structure for docker container and compose nodes
  dockerOptions:
    # all properties below only used by docker container nodes
    proxied: boolean
    oneShot: boolean
    entryPoint: string
  # type specific sub structure for helm charts
  helmChartOptions:
    # context to install the helm chart to
```

```
    context:
    # name for the helm chart
    podName:
    # working directory for local helm and kubectl calls
    workingDir:
    # name sapce to install the helm chart to
    nameSpace:
    # flag whether to show more detailed infos about
    # the helm chart installation in the console
    debug:
    # list of regex names for pods to be running to signal
    # successful startup of helm chart **/
    healthcheckPods:
    # list of key value pairs to be used by the helm chart
    values:
    # comma separated list of port forwardings
    # Entries can be either "podNameRegex:xxxx", which is shorthand for
    # "podNameRegex:xxxx:xxxx or
    # "podNameRegex:xxxx:yyyy" where xxxx is the local port
    # and yyyy is the port in the pod
    exposedPorts:
    # list of regex for pod names logs should be shown
    logPods:
```

The configuration of the Tiger Proxy is explained in detail in the section Configuring the local test suite Tiger Proxy

3.1.3. PKI configuration in pkiKeys

The pkiKeys property contains a list of certificates and keys to be provided to the local Tiger Proxy of the test suite.
Each entry has to provide a unique id, type and pem property.

Listing 7. PKI configuration

```
pkiKeys:
    # MANDATORY unique key/certificate id
  - id: disc_sig
    # MANDATORY one of [Certificate|Key]
    type: Certificate
    # MANDATORY base64 encoded multiline string representing the certificate / key.
    pem: "MIICsTCCAligAwIBAgIHA61I5ACUjTAKBggqhkjOPQQDAjCBhDELMAkGA1UEBhMC
REUxHzAdBgNVBAoMFmdlbWF0aWsgR21iSCBOT1QtVkFMSUQxMjAwBgNVBAsMKUtv
.....
xiKK4dW1R7MD334OpOPTFjeEhIVV"
  - id: disc_enc
    type: Key
    pem: "ISUADOGBESBXEZOBXWEDHBXOU..."
```

3.1.4. Configuring PKI identities in Tiger Proxy's tls section

PKI identities can be supplied in a number of ways (JKS, BKS, PKCS1, PKCS8).
In every place a string can be given.
It could be one of

- "my/file/name.p12;p12password"
- "p12password;my/file/name.p12"
- "cert.pem;key.pkcs8"
- "rsaCert.pem;rsaKey.pkcs1"

- "key/store.jks;key"
- "key/store.jks;key1;key2"
- "key/store.jks;jks;key"

Not supported pathname strings:

- "D:\\myproject\\key\\store.jks;key"

Supported pathname string on all platforms:

- "myproject/key/store.jks;key"

Please notice, that double backslashes ("\\") are not supported as file separators, since they are not accepted on all platforms.
Invalid pathname strings will also produce an exception.

Each part can be one of:

- filename
- password
- store-type (accepted are P12, PKCS12, JKS, BKS, PKCS1 and PKCS8)

PKI identity passwords

Tiger will attempt to decrypt a given P12 file with a list of common passwords.

```
"00", "123456", "gematik", "changeit"
```

Users can insert additional passwords by configuring the `tiger.yaml` as follows

```
lib:
    additionalKeyStorePasswords: ["foo", "bar", "baz"]
```

3.1.5. Docker Container node

The docker container node allows to instantiate a local docker container from the configured image.
The exposed port of the docker container is available as a special token in the substitution process of the exports entries (`${PORT:xxxx}` where xxxx is the port being exposed inside the container).

To customize the docker container you may alter the entry point command line and add the Tiger Proxy certificate to the container's operating system list of trusted certificates.
For containers that should exit after a single command you may enable the oneShot property.

If there is no health check configured inside the docker image, Tiger will try to guess a healthcheck url by assuming the first exposed port as a get request to localhost to check for a successful startup of the docker container (e.g. http://127.0.0.1:xxxx).

If no port is exposed at all, the startupTimeoutSec property will determine the wait period, after which Tiger assumes the container is up and running.

If you have your local docker environment set up hosting the docker containers on a remote docker hub server, you may set the environment variable `TIGER_DOCKER_HOST` to allow the health check url determined on runtime to point to the remote host instead of localhost.

To use this server type you must include the tiger-cloud-extension dependency!

Listing 8. Docker container configuration

```
dockerContainer_001:
  hostname: myDockerContainer
  type: docker
  dependsUpon: csv string
  startupTimeoutSec: int

  # MANDATORY URL from where to download the docker image.
  source:
    - dockerhubrepo.somewhere.org/repo/project/docker.image
  # OPTIONAL version of the docker image to download.
  version: 0.1.2
  # OPTIONAL the logs of the docker container are also written to a file, if no logFile is
  # specified a default name will be used
  logFile: ./target/serverLogs/dockerContainer_001.log

  dockerOptions:
    # OPTIONAL Flag whether the container shall be modified by
    # o adding the Tiger Proxy certificate to the container operating system.
    # o adding docker.host.internal to the container's /etc/hosts file.
    # Default value is true.
    proxied: true
    # OPTIONAL Flag whether the container is a one shot container or not.
    # One shot meaning it will execute a command and then stop.
    # Default value is false.
    oneShot: false
    # OPTIONAL The entry point command line to be used to start up this container
    # overwriting any configured entry point in the docker image.
    # Default value is empty meaning to use the configured entry point command line.
    entryPoint: chmod a+x /startup.sh && /startup.sh

  # The following properties are explained in the General properties section above
  pkiKeys: []
  environment: []
  urlMappings: []
  exports: []
```

3.1.6. Docker Compose node

The docker compose node is a very tricky type of node because we use testcontainer library, which is not exactly up to date in terms of docker compose support.
So many of the yaml compose files will need to be modified to work with the testcontainer library.

For now, we support the ePA2 FD module and the DEMIS Meldeportal.

If you want to use your own compose files, please note that Tiger copies and processes your yml files to the target/tiger-testenv-mgr/${serverId} folder,

replacing all variable/property expressions (for details check this chapter).

The processing/copying flattens the file hierarchy, thus you must not depend on any additional file resources in your docker compose files.
Each copied compose file will have a random UUID appended to its filename.

To use this server type you must include the tiger-cloud-extension dependency!

Listing 9. Docker compose configuration

```
  type: compose
  dependsUpon: csv string
  startupTimeoutSec: int
  # OPTIONAL the logs of the docker compose are also written to a file, if no logFile is
  # specified a default name will be used
  logFile: ./target/serverLogs/dockerCompose.log

  # MANDATORY list of yaml files to use to start up the services.
  # The entries can either be file paths or if starts with
  # classpath:....  a reference to a yaml file contained in the class path
  # (it could also be located inside a jar that is in the class path)
  source:
    - classpath:/de/gematik/test/tiger/testenvmgr/epa/titus-epa2.yml
    - classpath:/de/gematik/test/tiger/testenvmgr/epa/titus-epa2-local.yml
```

Listing 10. Demis docker compose example

```
demis_001:
  type: compose
  source:
    - classpath:/de/gematik/test/tiger/testenvmgr/demis/demis_localhost.yml
  startupTimeoutSec: 180
```

3.1.7. External Jar node

The External Jar node is along with the Docker container node the most important/used node for test environments.
Any Jar archive executable which can be started with the `java -jar` command can be configured as an external Jar node.

The options list are arguments added immediately after the java executable, while the arguments list is appended after the -jar argument.

The working directory is the place where the jar file is downloaded to and executed from.
So if your jar archive expects some configuration files make sure to choose the folder appropriately.

If using the `local:` prefix you can also use wildcards to find any matching jar-files.
Tiger will use the following order to try to find a matching file:

- In the working directory a file with the filename contained in the source
- From the working directory a file with a relative path equal to the source
- In the working directory a file with a filename matching the source (eg. `app-`

`*.jar`)

- From the working directory a file with a relative path equal and matching the filename of the source (eg. `../target/app-*.jar`)

```
java ${options} -jar externalJar.jar ${arguments}
```

Listing 11. External jar configuration

```
externalJar_001:
  hostname: mySpecialJar
  type: externalJar
  dependsUpon: csv string
  startupTimeoutSec: int

  # MANDATORY SINGLE ENTRY URL from where to download the Jar archive.
  # If the entry starts with "local:" followed by a file path the jar archive
  # is expected to be available at that location and no download is performed.
  # Only one entry is expected for this node type. Additional entries are silently ignored.
  source:
    - http://myjars.download.org/myproject/myjar.jar
  # MANDATORY URL to check for the successful startup of this node.
  # A successful start is indicated by ANY answer on this URL.
  # Any status is accepted as long as there is an answer.
  # If set to "NONE" no check is performed and
  # the test environment manager will wait for the startup timeout.
  healthcheckUrl: http://127.0.0.1:8080
  # OPTIONAL only declare the server healthy once the specified return code
  # is given
  healthcheckReturnCode: int
  # OPTIONAL the logs of the externalJar are also written to a file, if no logFile is
  # specified a default name will be used
  logFile: ./target/serverLogs/externalJar_001.log

  externalJarOptions:
    # OPTIONAL folder from where to start the external jar.
    # The downloaded jar file will be stored and executed from here
    # The default value is empty, which means that the operating-system-specific
    # temporary folder will be used.
    # hint: when the jar file is taken from a local directory and is set in source
    # and the workingDir is set then the workingDir has to be the directory where
    # the jar file is located
    workingDir: /home/user/test/myspecificjar
    # OPTIONAL Options to pass in to the java executable call.
    options: []
    # OPTIONAL provide additional arguments to the jar archive call.
    # Default value is empty.
    arguments:
      - --testarg1
      - -singledasharg2
      - --paramarg3=testvalue1

  # The following properties are explained in the General properties section above
  pkiKeys: []
  environment: []
  urlMappings: []
  exports: []
```

By default, the JVM used to start the JAR-File is the taken from the `java.home` system property, thus using the same JVM with which Tiger was started.
To change the JVM used you can set the property `tiger.lib.javaHome` (e.g. by setting `-Dtiger.lib.javaHome`, by setting `TIGER_LIB_JAVAHOME` in the environment or by setting `lib.javaHome` in the `tiger.yaml`).

3.1.8. External URL node

The symbolic node type that will not start a server instance, but simply allows external services to be used via the configured hostname.
This is achieved by the test environment manager instructing the local Tiger Proxy to provide a route for the symbolic hostname to the external URL of the service.

So, in the following example, the test suite can send HTTP(S) requests to the server "http://myExternalServer" via the local Tiger Proxy, which will be rerouted to the external URL "https://www.medizin.de".
If it is ever necessary to change the external URL, the test suite does not have to be modified, only the routing configuration for the node has to be changed.

Given the nature of this type, the environment section has no effect and is not to be used.

Listing 12. External URL configuration

```yaml
externalUrl_001:
  hostname: myExternalServer
  type: externalUrl
  dependsUpon: csv string
  startupTimeoutSec: int

  # MANDATORY URL of the external server
  source:
    - https://www.medizin.de

  # OPTIONAL URL to check for successful startup of this node.
  # A successful start is indicated by ANY answer on this URL.
  # Any status is accepted as long as there is an answer.
  # If the value is not set, then no health check is carried out
  # in the startup phase, instead the startupTimeout is waited for.
  # After this timeout it is assumed that the server is up.
  healthcheckUrl: https://www.medizin.de/healthyState.jsp
  # OPTIONAL only declare the server healthy once the specified return code
  # is given
  healthcheckReturnCode: int
  # OPTIONAL the logs of the externalUrl are also written to a file, if no logFile is
  # specified a default name will be used
  logFile: ./target/serverLogs/externalUrl_001.log

  # The following properties are explained in the General properties section above
  pkiKeys: []
  # IGNORE for this type as it has no effect
  environment: []
  urlMappings: []
  exports: []
```

3.1.9. Helm Chart node

The helm chart node allows to start a helm chart from the configured source (local helm chart file / folder or remote helm chart).
The helm chart is started and the server is ready when all pods are up and running, if port-forward is used (if exposedPorts are set), then port-forwarding is also done and the startup is finished and the service can be used for testing.

To use this server type you must include the tiger-cloud-extension dependency!

Listing 13. Helm chart configuration

```yaml
servers:
  testHelmChart_Nginx:
    type: helmChart
    startupTimeoutSec: 50
    # MANDATORY repository from where to download the docker image
    # if the helm chart is stored on the local file system that the
    # workingDir should be set.
    source:
      - bitnami/nginx
    # OPTIONAL version of the image
    version: 1.1.0
    helmChartOptions:
      # The kubernetes context
      context:
      # OPTIONAL if no working directory is set the default . is used.
      # if the helm chart is stored on the local file system the workingDir
      # should be set.
      workingdir:
      # OPTIONAL prints out debug messages if set to true, default is false.
      debug: true
      # OPTIONAL override the POD_NAMESPACE environment variable if set.
      # if not set, "default" will be used.
      nameSpace: buildslaves
      # MANDATORY pod name of the helm chart
      podName: test-tiger-nginx
      # OPTIONAL key-value pairs that will be used for starting the helm chart
      values:
      # OPTIONAL should contain a list of pods for the health check, regex can be used.
      healthcheckPods:
        - test-tiger-nginx-.*
      # OPTIONAL contains a list of regex to identify the pods whose logs
      # should be forwarded to the console and Tiger Workflow UI.
      logPods:
        - test-tiger-nginx.*
      # OPTIONAL contains a list that will be used for the port forwarding,
      # if empty no port forwarding is done. The syntax is:
      # <POD_NAME_OR_REGEX>,<LOCAL_PORT>:<FORWARDING_PORT>[,<LOCAL_PORT>:<FORWARDING_PORT>]*
      exposedPorts:
        - test-tiger-nginx.*,8080:80
```

3.1.10. Tiger Proxy node

The most complex and versatile node type.
The Tiger Proxy will be started as an embedded spring boot application.
This way the start-up time can be minimized, and it is always guaranteed to start the current version.

Listing 14. Tiger Proxy configuration

```yaml
tigerProxy_001:
  hostname: myTigerProxy
  type: tigerProxy
  dependsUpon: csv string
  startupTimeoutSec: int

  tigerProxyConfiguration:
    # OPTIONAL port of the web user interface and the proxy management
    # (e.g. rbel-message forwarding)
    # Default value is empty, which means a random port will be used.
    # The chosen port is stored with the key tiger.internal.localproxy.admin.port in
    # the TigerGlobalConfiguration
    adminPort: 8080
    # OPTIONAL server name of the node this proxy shall be used as reverse proxy for.
```

```
    # If set the routes will be configured appropriately.
    # Default value is empty.
    proxiedServer: externalJar_001
    # OPTIONAL port of the proxy, where the proxy expects to receive proxy requests
    # Default value is empty, which means a random port will be used.
    proxyPort: 3128
    # OPTIONAL protocol the proxy is expecting requests in. One of [http|https]
    # Default value is http
    proxiedServerProtocol: http
    # configures the proxy itself. For more details
    # please check the chapter about the local test suite Tiger Proxy below
    ...
    proxyRoutes:
      - from: http://foobar
        # defines a forward-proxy-route from this server...
        to: https://cryptic.backend/server/with/path
        # to this server
    ...

  # The following properties are explained in the General properties section above
  pkiKeys: []
  environment: []
  urlMappings: []
  exports: []
```

The configuration of the Tiger Proxy is explained in detail in the section Configuring the local test suite Tiger Proxy

3.1.11. httpbin node

The httpbin simply starts a httpbin server.
This provides several endpoints against which you can perform all kinds of http requests.
The server port on which the server starts can be configured.

Listing 15. httpbin configuration

```
httpbin:
    type: httpbin
    serverPort: ${free.port.0}
    healthcheckUrl: http://localhost:${free.port.0}/status/200
```

3.2. Provided node templates

Besides these basic nodes we also support tailored templates for nodes like IDP, ePA, ERp and DEMIS.
This should allow you to bring up project specific test environments very fast.

All currently supported templates can be found in the tiger-testenv-mgr modul in the yaml file at /src/main/resources/de/gematik/test/tiger/testenvmgr/templates.yaml

To use such a template, just use the template attribute:

```
myPersonalTestIDPInTheRU:
  template: idp-rise-ru
```

or if you want to have an environment with a local reference implementation of

the ERezept Fachdienst

```
myLocalTestIDP:
  template: idp-ref
  hostname: idp

myLocalTestERp:
  template: erzpt-fd-ref
  dependsUpon: myLocalTestIDP
```

3.2.1. Local IDP reference nodes

This template provides the reference implementation of the IDP server as a local docker container.
The docker image is loaded from a gematik internal docker registry server.

The system property IDP_SERVER is set to the URL of the Discovery Document end point and is available for all subsequently initiated test environment nodes.

3.2.2. External IDP RISE instance nodes

The idp-rise-ru template provides the RU instance of RISE's IDP server as an "external URL".
The system properties IDP_SERVER and GEMATIK_TESTCONFIG are set to the URL of the Discovery Document end point and a config-file for the IDP test suite respectively.
They are available for all subsequently initiated test environment nodes.

The idp-rise-tu template provides the TU instance accordingly.

3.2.3. Local ERp reference nodes

This template provides the reference implementation of the eRezept server as a local docker container.
The docker image is loaded from a gematik internal docker registry server.
Make sure that an IDP server node is instantiated before the ERp FD is started and that it is available under http://idp or adapt the environment variable configuration.

A large list of environment variables is set.
But don't worry, it is just the server that uses them.

3.2.4. Local ePA2 reference nodes

This template provides the gematik reference Aktensystem simulation as docker compose.

3.2.5. Local PSSim node

This template provides a Primärsystem simulation (as a jar), usable for ePA.
See https://wiki.gematik.de/display/PTP/epa-ps for more information.

3.2.6. Local KonSim node

This template provides a Konnektor simulation (as external jar).
See https://wiki.gematik.de/display/PTP/KonSim for more information.

3.2.7. Local ePA FdV Sim

This template provides FdV simulation, usable for ePA.

3.2.8. Local DEMIS reference nodes

This template provides the DEMIS Meldeportal as local docker compose.

3.3. Configuring the local test suite Tiger Proxy

The local Tiger Proxy for the test suite can be configured by using the following section(s) in the `tiger.yaml` file.
For more information about what the Tiger Proxy is and how it works see the chapter Tiger Proxy basics

```yaml
# Flag whether to activate the local Tiger Proxy. The local tiger proxy field will be null if this
property is set to false
# Default value is true
localProxyActive: true

# Specifiy additional yaml-files to read in during startup
additionalYamls:
  -
    # the path to the file to read
    filename: specialEnvironment.yaml
    # the key to which to map the given file. "tiger" is the base-key for the tiger.yaml-file
    baseKey: tiger

# the block where all the Tiger Proxy configuration properties are located
tigerProxy:
  # the port under which the server will be booted
  adminPort: 7777
  # logLevel of the proxy-server. DEBUG and TRACE will print traffic, so use with care!
  proxyLogLevel: TRACE
  # section to configure whether and where the proxy should dump
  # a traffic HTML report on shutdown
  fileSaveInfo:
    # should the cleartext http-traffic be logged to a file?
    writeToFile: true
    # configure the file name
    filename: "foobar.tgr"
    # default false
    clearFileOnBoot: true
    # filter messages read from file (JEXL expression)
    readFilter: "message.statusCode == '200'"
  # a list of routing entries the proxy should apply to traffic
  proxyRoutes:
      # defines a forward-proxy-route from this server...
    - from: http://foobar
      # to this server
      to: https://cryptic.backend/server/with/path
      # reverse proxy-route. http://<tiger-proxy>/blub will be forwarded
    - from: "/blub"
      to: "https://another.de/server"
      # the traffic for this route will NOT be logged (default is false)
      disableRbelLogging: true

  # a list of modifications that will be applied to every proxied request and response
```

```
  modifications:
    # a condition that needs to be fulfilled for the modification to be applied
    # (uses JEXL grammar)
  - condition: "isRequest"
    # which element should be targeted?
    targetElement: "$.header.user-agent"
    # the replacement string to be filled in.
    # This modification will replace the entire "user-agent" in all requests
    replaceWith: "modified user-agent"

  - condition: "isResponse && $.responseCode == 200"
    targetElement: "$.body"
    # The name of this modification.
    # This can be used to identify, alter or remove this modification.
    name: "body replacement modification"
    # This will replace the body of every 200 response completely with the given json-string
    # (This ignores the existing body. For example this could be an XML-body.
    # Content-Type-headers will NOT be set accordingly).
    replaceWith: "{\"another\":{\"node\":{\"path\":\"correctValue\"}}}"
  - targetElement: "$.body"
    # The given regex will be used to target only parts of targeted element.
    regexFilter: "ErrorSeverityType:((Error)|(Warning))"
    # This modification has no condition,
    # so it will be applied to every request and every response
    replaceWith: "ErrorSeverityType:Error"

  # can be used if the target-server (to) is behind another proxy
  forwardToProxy:
    hostname: 192.168.110.10
    port: 3128
    # for https based traffic you will have to adapt the type to HTTPS
    type: HTTP
  # The Tiger Proxy will route google.com to google.com even if no route is set.
  # The traffic routed via this "forwardAll"-routing will be logged by default
  # (meaning it will show up in the Rbel-Logs and be forwarded to tracing-clients)
  # This can be deactivated by setting this flag to false
  activateForwardAllLogging: true
  # Limits the rbel-Buffer to approximately this size.
  # Note: When Rbel debugging is activated the size WILL vastly exceed this limit!
  rbelBufferSizeInMb: 1024
  # If set to false disables traffic-analysis by Rbel.
  # Deactivating will not impede proxy-forwarding nor
  # the traffic-endpoints.
  activateRbelParsing: true
  # While parsing the Tiger Proxy can block the communication from completing.
  # The end answer from the Tiger Proxy is only transmitted when parsing is completed
  # (and the message pair can be seen in the log). When 'false' the parsing is done
  # asynchronous.
  # Default is true ONLY for the local Tiger Proxy, otherwise default is false!!
  parsingShouldBlockCommunication: false
  # This will share the WebUI-Resources (various CSS-files) from the Tiger Proxy
  # locally, thus enabling usage when no internet connection exists
  localResources: true
  # When active the host-headers are rewritten even for a reverse-proxy-route
  rewriteHostHeader: true

  tls:
    # Can be used to define a CA-Identity to be used with TLS. The Tiger Proxy will
    # generate an identity when queried by a client that matches the configured route.
    # If the client then in turn trusts the CA this solution will provide you with a seamless
    # TLS experience. It however requires access to the private-key of a trusted CA.
    serverRootCa: "certificate.pem;privateKey.pem;PKCS8"
    # Alternative solution: now all incoming TLS-traffic will be handled using this identity.
    # This might be easier but requires a certificate
    # which is valid for the configured routes
    serverIdentity: "certificateAndKeyAndChain.p12;Password"
    # Defines which SSL-Suites are allowed. This will delete all default-suites and only add the one
    # defined here. This configures the server-side of the proxy. Available values can be found
here:
    # https://docs.oracle.com/javase/7/docs/technotes/guides/security/SunProviders.html
```

```
    serverSslSuites:
      - "TLS_ECDHE_RSA_WITH_AES_256_CBC_SHA"
    # This configures the SSL-Suites for the client-side. Available values can be found here:
    # https://docs.oracle.com/javase/7/docs/technotes/guides/security/SunProviders.html
    clientSslSuites:
      - "TLS_ECDHE_RSA_WITH_AES_256_CBC_SHA"
    # Define which TLS protocols the server will allow/use. Available values can be found here:
    # https://docs.oracle.com/javase/7/docs/technotes/guides/security/SunProviders.html
    clientSupportedGroups:
      - "brainpoolP256r1"
      - "brainpoolP384r1"
      - "prime256v1"
      - "secp384r1"
    # Define the groups to be offered in the "client hello" message. More information can be found
here:
    # https://datatracker.ietf.org/doc/html/rfc8446#section-4.2.7
    serverTlsProtocols:
      - "TLSv1.2"

    # This identity will be used as a client-identity for mutual-TLS when forwarding to
    # other servers. The information string can be
    # "my/file/name.p12;p12password" or
    # "p12password;my/file/name.p12" or
    # "cert.pem;key.pkcs8" or
    # "rsaCert.pem;rsaKey.pkcs1" or
    # "key/store.jks;key" or
    # "key/store.jks;key1;key2" or
    # "key/store.jks;jks;key"
    #
    # Each part can be one of:
    # * filename
    # * password
    # * store-type (accepted are P12, PKCS12, JKS, BKS, PKCS1 and PKCS8)
    forwardMutualTlsIdentity: "directory/where/another/identityResides.jks;changeit;JKS"
    # domain which will be used as the server address in the TLS-certificate
    domainName: deep.url.of.server.de
    # Alternate names to be added to the TLS-certificate
    # (localhost and 127.0.0.1 are added by default)
    alternativeNames:
      - localhost
      - 63.54.54.43
      - foo.bar.server.com

  # the given folders are loaded into RBel for analysis. This is only necessary to decrypt
  # traffic when analyzing it. It has no effect on the proxy-functions themselves.
  keyFolders:
  - .

  # Filter out any messages larger from parsing (saving performance)
  skipParsingWhenMessageLargerThanKb: 8000
  # Filter out any messages (or message parts) from displaying
  skipDisplayWhenMessageLargerThanKb: 512

  # A list of upstream Tiger Proxies. This proxy will try to connect to all given sources to
  # gather traffic via the STOMP-protocol. If any of the given endpoints are not accessible
  # the server will not boot. (fail fast, fail early)
  trafficEndpoints:
    - http://another.tiger.proxy:<proxyPort>
  trafficEndpointConfiguration:
    # the name for the traffic Endpoint. can be any string, which will be
    # displayed at /tracingpoints
    name: "tigerProxy Tracing Point"
```

3.4. Standalone mode vs. implicit startup with test suite

If your test environment is very "expensive" to start or if you are developing your test suite scenarios thus starting many test runs in short time, you might want to

keep your test environment running and not shut it down after each run.
To do so, you can simply use the tiger maven plugin to start your test environment in standalone mode.

First prepare a standalone test environment configuration file (call it for example tiger-standalone.yaml) containing all the server nodes needed and with a deactivated the local Tiger Proxy section.

Now set the env var TIGER_TESTENV_CFGFILE or the Java system property tiger.testenv.cfgfile to point to this file.

And add the plugin block to your pom.xml

```
<plugin>
    <groupId>de.gematik.test</groupId>
    <artifactId>tiger-maven-plugin</artifactId>
    <version>${version.tiger}</version>
</plugin>
```

If you start the test environment manager standalone, it will keep the nodes running until you enter quit into the console or kill the process with Ctrl + C or the operating equivalent commando to the UNIX command kill ${PROCESS_ID}.
In the latter case it is not guaranteed that all processes are cleanly shut down.
Please check your process list with operating system specific tools.

```
export TIGER_TESTENV_CFGFILE=...../tiger-standalone.yaml
mvn tiger:setup-testenv
```

In case you also need cloud extension server types (docker, helmchart) make sure to add the Tiger cloud extensions as dependency to the **plugin block**.

Now before starting your test suite scenarios you need to

- disable / remove the test nodes in your default `tiger.yaml` (either by setting the property active to false or remove the server node entry completely).
  If you forget to do this, two nodes will be instantiated (one from the standalone test environment manager and the second during test run from the test environment manager started via the test suite hooks).
- and add routes for each node to the local Tiger Proxy.
  If you forget to do this, your test suite will not be able to access the test nodes under their configured hostname as this configuration is only known to the standalone test environment manager and NOT to the local tiger proxy started by the test suite hooks.

Best practice is to have three test environment configuration files:

- tiger-standalone.yaml to enable a persistent test environment during the development of test suite scenarios
- tiger-nonodes.yaml for the test suite that will instantiate no nodes but only configure the routes to the nodes from the standalone test environment manager
- `tiger.yaml` a complete configuration that can be used in CI or after the test

suite development is completed.

The first and the latter most of the time are identical besides the root level flag localProxyActive.
So you may skip the first and just use it with two different values being set.

3.5. Using Environment variables and system properties

3.5.1. Token/variable substitution

Entries in the exports list of a node will be parsed and specific tokens will be substituted:

- ${PORT:xxxx} will be replaced with the port on the docker host interface
- ${NAME} will be replaced with the hostname of the node

All exports entries of a node will be present when subsequent nodesare instantiated and can be used in the following properties:

Docker node:

- source list
- environment list

Tiger Proxy node:

- from/to route URLs

External URL node:

- source list

External Jar node:

- options list

Chapter 4. Tiger Proxy

4.1. Excurse: What are proxies, reverse, forward

There are a lot of different kind of proxies.
Here we talk only about HTTP and HTTPS proxies!

4.1.1. Forward proxies

Forward proxies work like a switch-station: You send a packet to your destination, via proxy.
The proxy receives the packet, sees the address and can send that packet to wherever he sees fit.
To use a forward proxy the sender has to be aware of it and send the packet accordingly.

This allows the creation of virtual domains, something we use extensively in tiger.

A forward proxy can always read the entire content of your communication, something we also use heavily.

Lastly a forward proxy acts as a man-in-the-middle, enabling the penetration of TLS-traffic.
We also use this, but we will explain it in more depth later.

4.1.2. Reverse proxies

Reverse proxies also receive traffic and may reroute them at their own discretion.
But unlike a forward proxy a reverse proxy is invisible to the sender.
Reverse proxies act like normal servers and are addressed as such.
They then send the received packet to its actual destination and return the answer to the original caller.

The reverse proxy can also read the complete traffic.

The eventual destination is opaque to the original caller.
This also enables path-rewriting (for example the GET http://reverse.proxy.de/my/deep/url might be mapped to http://gematik.de/deep/url, eliminating the /my)

A reverse proxy also terminates https, always.
This is less of a problem with a reverse proxy since it is technically not a man-in-the-middle attack, due to the traffic being addressed to the reverse proxy.

4.2. Tiger Proxy basics

The Tiger Proxy is a proxy-server.
It comes in two flavours: Tiger Proxy and Tiger Standalone Proxy.
The standalone tiger proxy is started from a JAR-file.
The test environment manager boots the main tiger proxy (local tiger proxy) and also any additional ones (normal tiger proxy, not standalone).

Both types have a proxy-port (configurable via `tigerProxy.proxyPort`), which

supports both http- and https-traffic, (so you do not have to differentiate between the two).
Additionally, they have an admin-port (configurable via `tigerProxy.adminPort`).
This provides a WebUI to monitor the traffic (described in detail here), a rest-interface to customize the behavior (add/delete route, add/delete modifications) and a web-socket interface to stream rbel-messages between multiple Tiger Proxies.

4.3. Understanding routes

Routes are the fundamental mechanic of how the Tiger Proxy handles traffic.
They can be for a forward- or reverse-proxy.
A route has the following properties:

4.3.1. from

From where should the traffic be collected?
This can either be an absolute URL (e.g. http://foobar), which defines a forward-proxy route, or relative (e.g. /blub), defining a reverse-proxy-route.
Please note: You can freely add parts (e.g. http://foobar/extra/part) to further specify the mapping.

4.3.2. to

The target of the mapping.
This has to be an absolute URL.
The Tiger Proxy will, upon receiving a request to this mapping, execute a matching request to the defined host.

An example.
Consider the following route:

```
tigerProxy:
    proxyRoutes:
      - from: http://my.domain/
        to: http://orf.at/
```

The "http://" in the **from property** indicates that we have a forward-proxy route defined.
So when we execute: (assuming the Tiger Proxy is started locally under the port 1234)

```
curl -x http://localhost:1234 http://my.domain/news
```

The result will match the following curl

```
curl http://orf.at/news
```

Additional headers are kept and just patched through.
The same goes for the body and the HTTP-Method.

Added parts of the from-URL are stripped when forwarding.
Meaning: If you have a mapping

```
tigerProxy:
    proxyRoutes:
      - from: http://my.domain/deep/
        to: http://orf.at/blub/
```

and you execute GET http://my.domain/deep/deeper, you will get the result of GET http://orf.at/blub/deeper (the /deep in between has been eliminated along with my.domain).

4.3.3. disableRbelLogging

You can deactivate the rbel-Logging on a per-Route basis.
Rbel is a versatile and powerful tool, but the analysis of individual messages consumes a lot of both CPU and memory.
Deactivating it for routes in which it is not needed is therefore a good idea.

4.3.4. basicAuth

You can add optional basic-auth configuration which will be added to the forwarded message.
Theoretically this could also be done via modifications, but this a more convenient approach.

```
tigerProxy:
    proxyRoutes:
      - from: http://my.domain/deep/
        to: http://orf.at/blub/
        basicAuth:
          username: "test1"
          password: "pwd2"
```

4.4. TLS, keys, certificates a quick tour on proxies

A fundamental part of a proxy setup is TLS.
Since a proxy is a constant man-in-the-middle attack TLS is designed to make this exact scenario (eavesdropping while forwarding) impossible.
Since a lot of the traffic in the gematik context is security-relevant and thus TLS-secured this point is a very relevant one.

Fundamentally breaking into TLS requires two things:

- A certificate which the server can present which is valid for the given domain
- The certifying CA (or a CA reachable via a certification path) has to be part of the client truststore

There a different ways to reach these two requirements.
Which one should be taken is dependent on the setting and the client used (most importantly, of course: can you alter the truststore for the test-setup?)

Here are a few things to know and ways in which to enable TLS:

4.4.1. TLS and HTTPS-Proxy

TLS can be done via a http- or a https-proxy.
The proxy-protocol does NOT equate to the client-server-protocol.
To minimize the headache in configuration it is therefore strongly recommended to simply always use the http-proxy (sidenote: using a http-proxy does NOT reduce the security of the overall protocol.
The security still relies on server-certificate-verification.)

If, however, you can not avoid using the https-proxy you have to make sure that you add the given certificate to your truststore.
In class TigerProxy.java in Tiger there are methods such as SSLContext getConfiguredTigerProxySslContext(), X509TrustManager buildTrustManagerForTigerProxy() and KeyStore buildTruststore() which can help you configure the SSLContext in your case, if you use HTTP 3rd party libraries (Unirest, okHttp, RestAssured, etc.) as well as vanilla Java.
If you encounter any problems, please contact us.

4.4.2. Dynamic server identity

For successfully breaking into TLS traffic the Tiger Proxy needs to present a certificate which features the domain-name of the server.
Since the domain-names are known only at runtime, we generate the needed certificate on-the-fly during the first connection.

For a forward-proxy this is easy: The client sends not only the path, but the complete URL to the proxy, letting him handle DNS-resolution.
So when the Tiger Proxy receives a new request the necessary domain-name is given by the client.
A new, matching, certificate is generated (these are cached) and presented.
To complete the setup the client-truststore needs to be patched.
The CA used by the Tiger Proxy is dynamically generated on each startup.

For a reverse-proxy the domain name, which should be used, is unknown to the Tiger Proxy (DNS-resolution is done on the client-side).
Thus, a domain-name needs to be provided, which should be used for certificate-generation:

```
tigerProxy:
    tls:
        domainName: deep.url.of.server.de
```

4.4.3. Client-sided truststore modification

When using a non-default certificate (which will almost always be the case for the Tiger Proxy) the modification of the client-truststore is necessary.
For cases where the client is running in the same JVM as the target Tiger Proxy (which is the typical case for a tiger-based testsuite) there exists helper method to make this task easier.

Depending on your HTTP- or REST- or SOAP-API you will need to choose the exact way yourself.
The following two examples might give you some idea of what to do.

```
Unirest.config().sslContext(tigerProxy.buildSslContext());
```

```
 OkHttpClient client = new OkHttpClient.Builder()

    .proxy(new Proxy(
        Proxy.Type.HTTP,
        new InetSocketAddress(
            "localhost",
            tigerProxy.getPort())))

    .sslSocketFactory(
        tigerProxy.getConfiguredTigerProxySslContext().getSocketFactory(),
        tigerProxy.buildTrustManagerForTigerProxy())

    .build();
```

4.4.4. Custom CA

If you can not or don't want to alter the client-truststore you have two choices: You can either provide a custom CA to be used (and trusted by the client) or you can give the certificate to be used by the Tiger Proxy.
To set a custom CA to be used for certificate generation simply specify it:

```
tigerProxy:
    tls:
        serverRootCa: "certificate.pem;privateKey.pem;PKCS8"
# for more information on specifying PKI identities in tiger see "Configuring PKI identities"
```

4.4.5. Fixed server identity

The final, easiest and most unflexible way to solve TLS-issues is to simply give a fixed server-identity.
This identity will be used for all routes.

```
tigerProxy:
    tls:
      serverIdentity: "certificateAndKeyAndChain.p12;Password"
```

4.4.6. OCSP stapling

If you want the Tiger Proxy to use OCSP stapling you can directly specify the OCSP-Signer to use in the configuration.

```
tigerProxy:
    tls:
      ocspSignerIdentity: "myOcspSigner.p12;Password"
```

The server will then use this OCSP-Signer to create a fake OCSP-Response during the TLS-handshake.

4.5. Modifications

Modifications are a powerful tool to alter messages before forwarding them.
They can be applied to requests and responses, to routes in forward- and reverse-proxy-mode.
You can choose to modify only specific parts of the message and only alter messages, if certain conditions are met.
Response messages support so called "reason phrases" which are small text explanations to the response code, e.g. "200 OK", ("OK" is a reason phrase).
You can add, modify and remove reason phrases.

Below is a sample configuration giving insight into how modifications are organized:

```
tigerProxy:
    modifications:
    # a list of modifications that will be applied to every proxied request and response

        # The following modification will replace the entire "user-agent" in all requests
      -
        condition: "isRequest"
        # a condition that needs to be fullfilled for the modification to be applied (JEXL grammar)
        targetElement: "$.header.user-agent"
        # which element should be targeted?
        replaceWith: "modified user-agent"
        # the replacement string to be filled in.

        # The following modification will replace the body of every 200 response completely with the
given json-string
        # (This ignores the existing body. For example this could be an XML-body. Content-Type-
headers will NOT be set accordingly)
      -
        condition: "isResponse && $.responseCode == 200"
        targetElement: "$.body"
        name: "body replacement modification"
        # The name of this modification. This can be used to identify, alter or remove this
modification. A name is optional
        replaceWith: "{\"another\":{\"node\":{\"path\":\"correctValue\"}}}"

        # The following modification has no condition, so it will be applied to every request and
every response
      -
        targetElement: "$.body"
        regexFilter: "ErrorSeverityType:((Error)|(Warning))"
        # The given regex will be used to target only parts of targeted element.
        replaceWith: "ErrorSeverityType:Error"
```

4.6. Mesh set up

One of the fundamental features of the Tiger Proxy is mesh set up AKA rbel-message forwarding.
This transmits the information about the messages, which the proxy has logged, to other Tiger Proxies (where they will be logged as well).
This enables the creation of "proxy-meshes", staggered Tiger Proxies.

In a mesh set up the "remote tiger proxy" is the one which intercepts the traffic and sends the information.
Conversely, the "receiving tiger proxy" receives the information about the message from the remote tiger proxy.
The "local tiger proxy" is the main tiger proxy booted by the testsuite.

If you configured it to receive traffic from another tiger proxy (which should always be the case when you are doing a mesh set up) then it is also a receiving tiger proxy.

Common scenario for this approach might be the use of multiple reverse-proxies on the root level (e.g. when the client only allows the configuration of the server IP or domain, but no path-prefix) or the aggregation of traffic across machine-boundaries (e.g. one constantly running Tiger Proxy which is used by a testsuite on another machine).

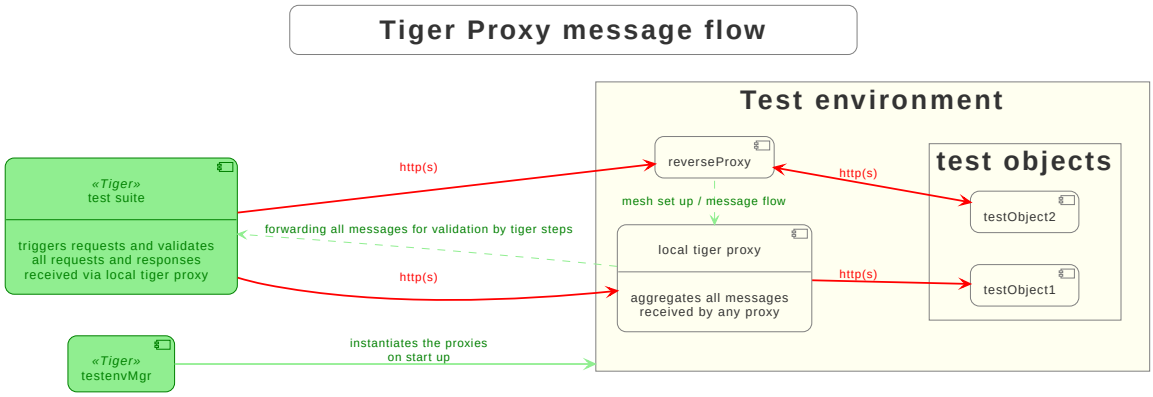

Figure 6. Tiger Proxy message flow

In the above picture the test object 2 would not be accessible directly by the test suite, thus using the reverse proxy allows circumventing network restrictions.
The reverse proxy could either be started by the test environment manager or as standalone process.

```
tigerProxy:
    proxyId: IBM
    trafficEndpoints:
      - http://another.tiger.proxy:<adminPort>
    # A list of upstream Tiger Proxies. This proxy will try to connect to all given sources to
    # gather traffic via the STOMP-protocol.
    skipTrafficEndpointsSubscription: false
    # If false then the subscription is tested at the beginning and if any of the given endpoints
are not accessible the
    # server will not boot. (fail fast, fail early)
    # default of skipTrafficEndpointsSubscription is false
    downloadInitialTrafficFromEndpoints: true
    # Should the traffic currently available (cached) in the remote be download upon initial
connection?
```

Please be advised to use the server-port (`server.port`) here, not the proxy-port (`tigerProxy.proxyPort`).
The traffic from routes with `disableRbelLogging: true` will not show up here.

If you are setting up a Tiger Proxy to run constantly and simply forward traffic to a testsuite that is booted ad-hoc you might run into performance-problems.
This is due to the Rbel-Logger being a very hungry beast.
To stop Rbel from parsing all message simply add `tigerProxy.activateRbelParsing: false`.
This will vastly reduce memory and CPU consumption of the

application, while still forwarding logged traffic.

4.6.1. Mesh API

The Tiger Proxies use STOMP a simple/streaming text oriented messaging protocol via web socket to forward received traffic.
For an external client to receive these traffic data, it must subscribe to the traces topic reachable at the subscription path /topic/traces.
To do so the client must connect to the traffic endpoint URL of the Tiger Proxy.
This is answered with HTTP status 100 and then redirected to web socket protocol via the same port.
For each received traffic data pair (request/response) the Tiger Proxy will push a web socket message to all subscribed clients.

This JSON encoded message consists of:
* UUID string * http request as base64 encoded data * http response as base64 encoded data * hostname and port of sender (if retrievable, worst case only IP address or empty) * hostname and port of receiver (if retrievable, worst case only IP address or empty)

```
{
    "uuid": "UUID string",
    "request": "base64 encoded http request",
    "response": "base64 encoded http response",
    "sender": {
      "hostname": "hostname/ip address of sender",
      "port": portAsInt
    },
    "reveiver": {
      "hostname": "hostname/ip address of receiver",
      "port": portAsInt
    }
}
```

4.7. Understanding RBelPath

RBeL-Path is a XPath or JSON-Path inspired expression-language enabling the quick traversal of captured RBeL-Traffic (navigation of the RbelElement-tree).

A simple example:

```
assertThat(convertedMessage.findRbelPathMembers("$.header"))
    .containsExactly(convertedMessage.getFacetOrFail(RbelHttpMessageFacet.class).getHeader());
```

or

```
assertThat(convertedMessage.findElement("$.header"))
    .get()
    .isSameAs(convertedMessage.getFacetOrFail(RbelHttpMessageFacet.class).getHeader());
```

(The first example executes the RbelPath and returns a list of all matching element, the second one returns an Optional containing a single result.
If there are multiple matches an exception is given.)

RBeL-Path provides seamless retrieval of nested members.

Here is an example of HTTP-Message containing a JSON-Body:

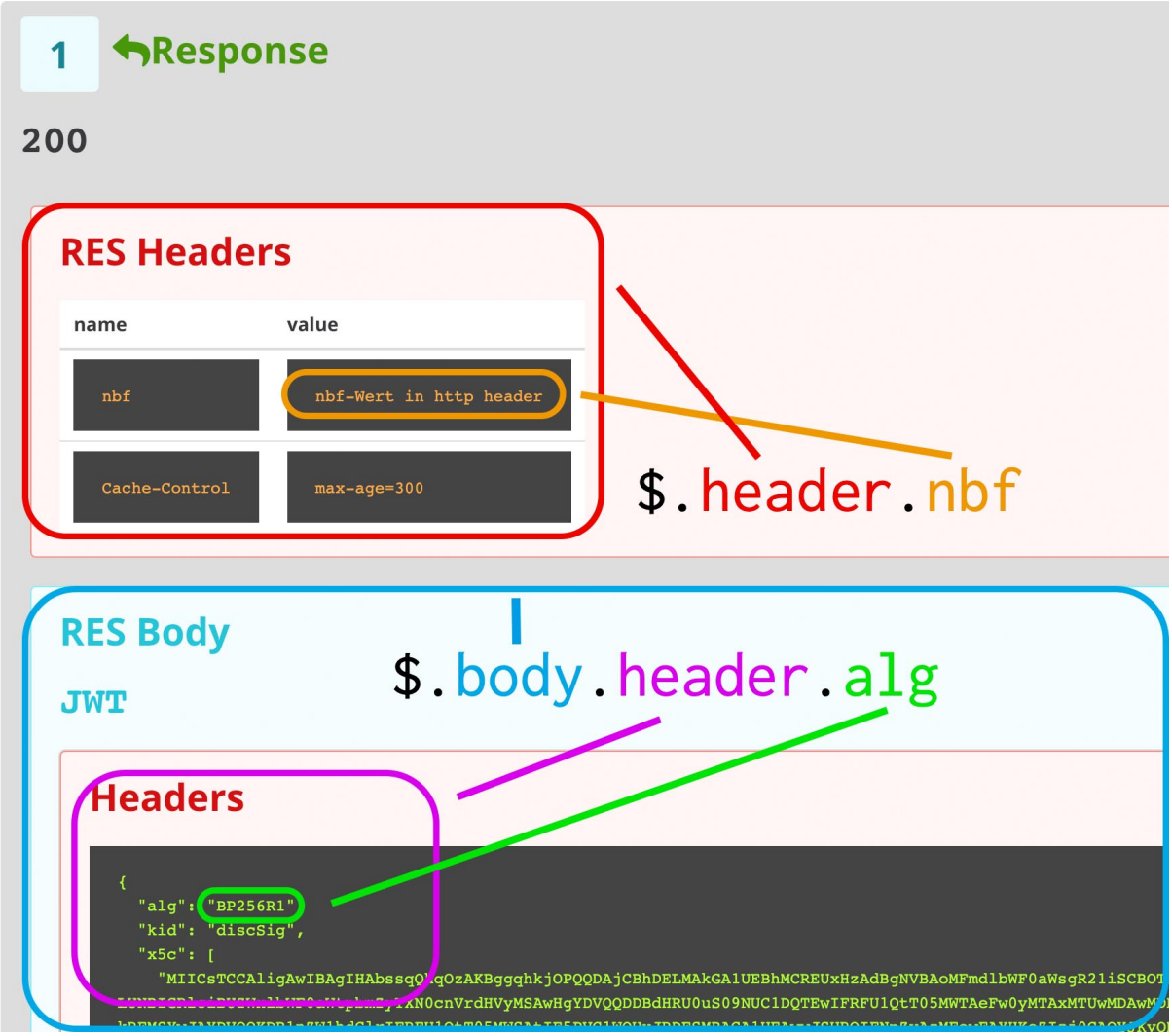

Figure 7. Rbel-Path expression in a HTTP-Response

The following message contains a JWT (Json Web Token, a structure which contains of a header, a body and a signature).
In the body there is a claim (essentially a Key/Value pair represented in a JSON-structure) named `nbf` which we want to inspect.

Please note that the RBeL-Path expression contains no information about the types in the structure.
This expression would also work if the HTTP-message contained a JSON-Object with the corresponding path, or an XML-Document.

```
assertThat(convertedMessage.findRbelPathMembers("$.body.body.nbf"))
    .containsExactly(convertedMessage.getFirst("body").get()
    .getFirst("body").get()
    .getFirst("nbf").get()
    .getFirst("content").get());
```

(The closing .getFirst("content") in the assertion is due to a fix to make RbelPath in JSON-Context easier: If the RbelPath ends on a JSON-Value-Node the

corresponding content is returned.)

Figure 8. Multiple body references

You can also use wildcards to retrieve all members of a certain level:

```
$.body.[*].nbf
```

Alternatively you can recursively descend and retrieve all members:

```
$..nbf
```

and

```
$.body..nbf
```

will both return the same elements (maybe amongst other elements).

To use keys containing spaces, escape them via `['foo bar']`, like so:

`$.body.['foo bar'].key`

Please note that the keys in the bracket are URL unescaped.
So to use special characters please URL encode them (Space is a special case since + and ' ' are allowed, depending on the exact position).

4.7.1. Alternate keys

To find alternating values, concatenate them using the pipe symbols, like so:
`$.body.['foo'|'bar'].key`

This expression will explore both subtrees to try to find the following nodes `$.body.foo.key` and `$.body.bar.key`.
Please note that only elements that are present are returned.
So if only always one of the two elements is present, only a single element will be returned.

4.7.2. JEXL expressions

RBeL-Path can be integrated with JEXL-expression, giving a much more powerful and flexible tool to extract certain element.
This can be done using the syntax from the following example:

```
$..[?(key=='nbf')]
```

The expression in the round-brackets is interpreted as JEXL.
The available syntax is described in more detail here or https://commons.apache.org/proper/commons-jexl/reference/syntax.html

Please note that these Jexl-Expression can not be nested inside each other deeper then one level (You can write a RbelPath that contains a Jexl-Expression.
And this Jexl-Expression can even contain a RbelPath.
But the inner RbelPath can not contain another Jexl-Expression).

The variables that can be used are listed below:

- `element` contains the current RBeL-Element
- `parent` gives direct access to the parent element of the current element.
  Is `null` if not present
- `message` contains the HTTP-Message under which this element was found.
  It contains:
  - `method` is the HTTP-Method (or null if it is a response)

    - `url` is the request URL (or null if it is a response)
    - `statusCode` is the status response code (or null if it is a request)
    - `request` is a boolean denoting whether this message is a request
    - `response` is a boolean denoting whether this message is a response
    - `header` is a map containing all headers (as `Map<String, List<String>>`)
    - `bodyAsString` is the body of the message as a raw string, or null if none given
    - `body` is the RbelElement of the message-body, or null if none given
- `request` is the corresponding HTTP-Request.
  If `message` is a response, then the corresponding Request will be returned.
  If `message` is a request, then the `message` itself will be returned.
- `response` is the corresponding HTTP-Response.
  If `message` is a request, then the corresponding Response will be returned.
  If `message` is a response, then the `message` itself will be returned.
- `key` is a string containing the key that the current element can be found under in the parent-element.
- `path` contains the complete sequence of keys from `message` to `element`.
- `type` is a string containing the class-name of `element` (eg `RbelJsonElement`).
- `content` is a string describing the content of `element`.
  The actual representation depends heavily on the type of `element`.

Additionally you can always reference the current element (via @.) or the root element (via $.) in any JEXL-expression.
Lets explain this using an example.

For more detailed information on JEXL expressions please refer to Detailed JEXL-expressions.

4.7.3. Nested RbelPath expressions

Consider the following rbel tree:

Figure 9. Nested RBel tree with array

At `$.body.body.idp_entity` we have an array with potentially multiple entries (here there is only one, entry `0`).
We want to select an entry where the `iss`-claim matches our expectation.
We can achieve this with using a nested Rbel-Path inside the JEXL-Expression:

```
$.body.body.idp_entity.[?(@.iss.content=='https://idpsek.dev.gematik.solutions')]
```

Here the `@.` references the current element: For each array entry the expression is tested, with `@.` always referring to the current entry.
To access elements starting from the root you can use `$.` like so:

```
$.body.body.idp_entity.[?(@.iss.content==$.body.body.idp_entity.0.iss.content)]
```

You can use recursive descent here as well:
`$.body.[?(@..content == 'ES256')]` would yield `$.body.header`.
Let's unpack this expression:

- `$.body` selects the http body
- `.` then selects a child (of the http-body, meaning either `header`, `body` or `signature`)
- The JEXL-selector `[?(@..content == 'ES256')]` is then tested on each of the candidates.
  - In turn `@..` executes a recursive descent, meaning it will select all child nodes individually

    - `content` selects only the elements which have a key matchin `content`.
      So we end up with all nodes in the respective subtrees that are named `content`.
    - The JEXL-expression `* == 'ES256''` is then selected for every member of the subtree (so for the header it will test `$.body.header.typ.content`, `$.body.header.kid.content` and `$.body.header.alg.content`).
      The individual results are then reduced using (so the overall expression matches if there is ANY matching element)
- Since only one of the subtrees does fulfill the expression only this subtree is returned (and NOT the element itself, i.e. `$.body.header.alg.content`)

Please note that since the RbelPath-expressions are executed prior to the JEXL-expression the negation might yield unexpected results.
Currently it is not recommended to use these. (e.g. `$.body.[?(not (@.. == 'ES256'))]`)

4.7.4. Debugging Rbel-Expressions

To help users create RbelPath-Expressions there is a Debug-Functionality which produces log message designed to help.
These can be activated by `RbelOptions.activateRbelPathDebugging();`.
Please note that this is strictly intended for development purposes and will flood the log with quite a lot of messages.
Act accordingly!

When you want to debug RbelPath in BDD test suites, you can add a `tiger.yaml` file to your project root and add the following property (for more details see this chapter):

```
lib:
    rbelPathDebugging: true
```

To get a better feel for a RbelElement (whether it being a complete message or just a part) you can print the tree with the `RbelElementTreePrinter`.
It brings various options:

```
RbelElementTreePrinter.builder()
    .rootElement(this) //the target element
    .printKeys(printKeys) // should the keys for every leaf be printed?
    .maximumLevels(100) // only descend this far into the three
    .printContent(true) // should the content of each element be printed?
    .build()
    .execute();
```

4.8. Running Tiger Proxy as standalone JAR

If you only want to run a Tiger Proxy instance without test environment manager or test library you may do so (e.g. in certain tracing set-ups).
A spring boot executable JAR is available via maven central.

Supplying an application.yaml file allows you to configure the standalone proxy just like an instance started by the test environment manager.

All properties can be used the same way as described in this chapter.
There is however one additional property for the standalone proxy specifically:

```
# flag whether to load all resources (js,css) locally or via CDN/internet.
# useful if you have no access to the internet in your environment
localResources: false
```

4.9. Additional configuration

There are some additional configuration-flags in the Tiger Proxy:

4.9.1. Performance

Below some properties along with their respective default values:

```
tigerProxy:
    activateRbelParsing: true
    activateAsn1Parsing: false
    activateEpaVauAnalysis: false
    parsingShouldBlockCommunication: false
    activateTrafficLogging: true
```

activateRbelParsing

Deactivating this flag turns off all Rbel-Analysis of the incoming traffic.
This is a huge deal in terms of memory- and CPU-consumption but you will loose all benefit of performing Rbel-Analysis.

activateAsn1Parsing

This is off by default.
ASN.1 objects are very common in crypto applications.
While parsing them will enable you to directly have a look inside certificates it comes with a penalty in performance and also clutters the object-tree.
Often it's enough to know that there is a certificate, only in some scenarios is the content of interest.
If the latter is of interest to you activate ASN.1 parsing.

activateEpaVauAnalysis/activateErpVauAnalysis

VAU-Analysis adds information about the current session to every single VAU-message.
If you are not trying to analyze ePA-VAU messages leave this option turned off.
If you do, enabling it will give you additional information about the messages.

parsingShouldBlockCommunication

If blocking is enabled the Tiger Proxy will only return the response when message parsing is completed.
This is inadvisable in high-speed scenarios.
It, however, greatly simplifies the test suite (after the communication is concluded the parsed message appears in the log).
Therefore, the blocking is deactivated by default.

The only exception is the local Tiger Proxy, which WILL block communication until parsing is completed.
For all Tiger Proxies this default behavior can be changed.

directReverseProxy

To enable the use of the TigerProxy for non-HTTP scenarios you can use the option `directReverseProxy`:

```
tigerProxy:
    directReverseProxy:
        hostname: 127.0.0.1
        port: 3858
```

This will directly forward any request to the given host.
This is a form of reverseProxy, only also applicable for non-http-traffic.
HTTP traffic will still be forwarded through use of a global reverse proxy.
Other traffic will be directly forwarded, rerouted directly on the TCP layer.
Messages transmitted can still be parsed via RBel.

4.9.2. activateTrafficLogging

This flag controls whether the Tiger Proxy will log all traffic. If activated every request and response is noted in the log. This can lead to a verbose and bloated log. If you are not interested in the traffic log, but only in the Rbel-Analysis, you can deactivate this flag. Default is true.

4.9.3. rewriteHostHeader

This flag activates the rewriting of the host-header. If activated the host-header will be rewritten to the target host (only applicable for reverse proxy routes). Default is false.

4.9.4. rewriteLocationHeader

This flag activates the rewriting of the location-header for 3xx responses. If activated the location-header will be modified so the client will still use the proxy to reach the new location. Default is true.

4.10. Understanding filtering

The filtering of messages in the tiger proxy consists of three main stages.
These are:

- Traffic filter (trafficEndpointFilterString / readFilter, Determines which messages are accepted into the tiger proxy)
- WebUI filter (Which messages are displayed in the WebUI?)
- Pagination (Look around in smaller pages of messages)

Lets dive a bit deeper!

4.10.1. Traffic filter

At the core of the Tiger Proxy sits a RbelLogger instance.
Here the messages are parsed and stored.
Three sources feed into the RbelLogger:

- Messages intercepted in the Tiger Proxy
- Messages relayed using a mesh setup
- Messages imported from a file

Messages that are intercepted are automatically stored (the exception being the `tigerProxy.activateForwardAllLogging`-property, which can deactivate the logging of traffic not specifically forwarded via a route).
For messages in a mesh setup and from a source file filter expressions can be defined to limit the messages that are actually stored.
These can be defined using the `tigerProxy.trafficEndpointFilterString` (for mesh setups) and `tigerProxy.fileSaveInfo.readFilter` (for tgr-files) respectively.

When messages pass the filter, partner messages (request/response pairs) are kept intact.
So when you filter for messages that have a return code of 200 the corresponding requests do not match the filter expression.
They are however kept in memory since the partner, the response in that case, do match.

Filter expressions are JEXL-expressions.

4.10.2. WebUI filter

When you display the messages on the WebUI you have the ability to filter out certain messages to be displayed exclusively.
The messages, which are filtered out, do still remain stored in the Tiger Proxy.
Consequently, this has no effect if you store a TGR file (be it via the WebUI or the YAML).

The menu on the right side will only show the messages being filtered out to avoid confusion.
However, the messages numbers do reference the order in the main Tiger Proxy store.
This way they are consistent across different WebUI filters (message #10 will always refer to the same message, regardless of the WebUI filter being applied).

Filter expressions are JEXL-expressions.

4.10.3. Pagination

Finally, pagination is applied in the WebUI.
This comes after the WebUI-Filter has been applied.
So when would filter out every second message via a WebUI-Filter every page would still contain 20 (or whatever page size you have set) messages.

Chapter 5. Tiger Test library

As outlined in the overview section the Tiger test library is one of the three core components of the Tiger test framework.
Its main goal is to provide extensive support for BDD/Cucumber testing and integrating the local Tiger Proxy with the test environment manager and the started test environment.

As of now we do not support multithreaded / parallel test runs.

5.1. Tiger test lib configuration

In the root folder of your test project you may place a *tiger.yaml* configuration file to customize the Tiger test library integration and activate / deactivate certain features.

```
lib:
    # Flag to activate tracing at the Rbel Path Executor.
    # If activated the Executor will dump all evaluation steps of all levels to the console
    # when traversing through the document tree
    # Deactivated by default
    rbelPathDebugging: false
    # Flag whether the Executor's dump shall be in ANSI color.
    # If you are working on operating systems (Windows) that do not support
    # Ansi color sequences in their console you may deactivate the coloring with this flag.
    # Activated by default.
    rbelAnsiColors: true
    # Flag whether to start a browser window to display
    # the current steps / banner messages / rbel logs
    # when executing the test suite.
    # This feature can be used to instruct the tester to follow
    # a specific test workflow for manual tests.
    # Deactivated by default
    activateWorkflowUi: false
    # Flag whether to add a curl command details button to
    # SerenityRest Restassured calls
    # in the Serenity BDD report
    addCurlCommandsForRaCallsToReport: true
    # Flag whether to create the RBEL HTML reports during
    # a testsuite run, activated by default
    createRbelHtmlReports: true
    # maximum amount of seconds to wait / pause execution via pop up in the workflow ui, default is
5 hours.
    pauseExecutionTimeoutSeconds: 18000
    # Customize your Rbel-Logs with your own logo. Must be PNG format.
    # Path should be relative to execution-location
    rbelLogoFilePath: "myLogo.png"

# flag whether to start the local Tiger Proxy (default) or to omit it completely.
# if you have the local Tiger Proxy deactivated you will NOT be able to
# validate / log any traffic data from test requests / responses.
localProxyActive: true

# section to allow adapting the logging levels of packages/class loggers similar to spring boot
logging:
  level:
    # activate tracing for a specific class
    de.gematik.test.tiger.testenvmgr.TigerTestEnvMgr: TRACE
    # activate tracing for all classes and subpackages of a package
    de.gematik.test.tiger.proxy: TRACE
    # activate tracing for the local Tiger Proxy. This logger has a special name due to its
importance in the tiger test framework
```

```
    localTigerProxy: TRACE
```

5.2. Cucumber and Hooks

As Tiger focuses on BDD and Cucumber based test suites all the setup and tear down as well as steps based actions are performed.

That's why it is mandatory to use the TigerCucumberRunner, which internally registers the plugin `io.cucumber.core.pluginTigerSerenityReporterPlugin` to the plugins list.

The LocalProxyRbelMessageListener class initializes a static single RBelMessage listener to collect all messages received by the local Tiger Proxy and provides those messages via a getter method to the Tiger filter and validation steps.

At startup of the TigerCucumberRunner the TigerDirector gets called once to initiate the Tiger test environment manager, the local Tiger Proxy (unless it's configured to be not active) and optionally the workflow UI.
It adds a RbelMessage Listener once to the local Tiger proxy and also clears the RbelMessages queue before each scenario / scenario outline variant.
Utilizing the close integration of SerenityBDD and RestAssured at startup also a Restassured request filter, which parses the details and adds a curl Command details button to the Serenity BDD report, is registered.
The curl command shown in that section in the report allows to repeat the performed REST request, for manual test failure analysis.

After each scenario / data variant all collected RbelMessages are saved as HTML file to the `target/rbellogs` folder, and attached to the SerenityBDD report as test evidence.
The current test run state (success/failed rate) is logged to the console.

5.3. Using the Cucumber Tiger validation steps

The Tiger validation steps are a set of Cucumber steps that enable you to search for requests and associated responses matching certain criteria.
All of that without need to write your own code.
Basic knowledge about RBelPath and regular expressions are sufficient.
In order to use these steps you must ensure that the relevant traffic is routed via the local Tiger Proxy of the test suite or construct a Tiger Proxy mesh set up.

5.3.1. Filtering requests

Core features

- Filter for server, method, path, RBelPath node existing / matching given value in request
- Find first / next / last matching request
- Find absolute last request (no path input needed)
- Find first / next / last request containing a RBelPath node
- Clear all recorded messages
- Specify timeout for filtering request

With the `TGR find next request …` steps you can validate a complete workflow of requests to exist in a specific order and validate each of their responses (see next chapter).

5.3.2. Validating responses

Core features

- Assert that the body of the response matches regex
- Assert that a given RBelPath node exists
- Assert that a given RBelPath node matches regex
- Assert that a given RBelPath node does not match regex
- Assert that a given RBelPath node matches a JSON struct using the JSONChecker feature set
- Assert that a given RBelPath node matches an XML struct using the XMLUnit difference evaluator

Listing 16. Tiger response validation steps example

```
Feature Tiger validation steps

  Scenario: Example steps

    Given TGR clear recorded messages
    And TGR filter requests based on host "testnode.example.org"
    And TGR filter requests based on method "POST"
    And TGR set request wait timeout to 20 seconds
    When TGR find request to path "/path/path/blabla" with "$..tag.value.text" matching "abc.*"
    And TGR find request to path "/path/path/blabla" containing node "$..tag"
    Then TGR current response with attribute "$..answer.result.text" matches "OK.*"
    But TGR current response with attribute "$..answer.reason.text" does not match "REQUEST.*"
    And TGR current response body matches:
    """
         body content
        """
    And TGR current response at "$..tag" matches as JSON:
    """
          {
            "arr1": [
              "asso", "bsso"
            ]
          }
        """
    And TGR current response at "$..tag" matches as XML:
    """
          <arr1>
            <entry index="1">asso</entry>
            <entry index="2">bsso</entry>
          </arr1>
        """
```

5.4. Modifying RbelObjects (RbelBuilder)

5.4.1. Introduction

Tiger supports modifying JSON, XML and several token formats.
After loading in an object from a string or a file the RbelObject can be modified in multiple ways:

- Changing a primitive value at a certain path
- replacing a primitive node by an object node and vice versa
- adding new nodes and primitive values as child path of an existing path
- adding new nodes to an array/list

After the adjustments the values of the modified RbelElements can be asserted.
The object can be serialised back to a string.
Jexl Expressions are implemented, as for reading a file or for serializing:
`'!{rbelObject:serialize("myRbelObject")}'`

5.4.2. List of all possible Steps

TGR erstellt ein neues Rbel-Objekt {tigerResolvedString} mit Inhalt {tigerResolvedString}

TGR creates a new Rbel object {tigerResolvedString} with content {tigerResolvedString}

Using the Rbel builder steps

Creates a new Rbel object with a given key and string content; the string can be a jexl
expression

param name key of Rbel object
param content content of Rbel object, or jexl expression resolving to one

TGR erstellt ein neues leeres Rbel-Objekt {tigerResolvedString} mit Typ {rbelContentType}

TGR creates a new empty Rbel object {tigerResolvedString} of type {rbelContentType}

Creates a new empty Rbel object

param name key of Rbel object

TGR setzt Rbel-Objekt {tigerResolvedString} an Stelle {tigerResolvedString} auf Wert {tigerResolvedString}

TGR sets Rbel object {tigerResolvedString} at {tigerResolvedString} to new value {tigerResolvedString}

Sets a value of an object at a specified path; newValue is of type String

param objectName name of object in rbelBuilders
param rbelPath path which is to be set
param newValue new value to be set

TGR ergänzt Rbel-Objekt {tigerResolvedString} an Stelle {tigerResolvedString} um {tigerResolvedString}

TGR extends Rbel object {tigerResolvedString} at path {tigerResolvedString} by a new entry {tigerResolvedString}

Adds a new entry to an array or a list of a Rbel object at a specific path

param objectName name of Rbel object
param rbelPath path of array/list
param newEntry new entry

TGR prüft, dass Rbel-Objekt {tigerResolvedString} an Stelle {tigerResolvedString} gleich {tigerResolvedString} ist

TGR asserts Rbel object {tigerResolvedString} at {tigerResolvedString} equals {tigerResolvedString}

Asserts whether a string value at a given path of the rootTreeNode of a RbelBuilder is a
certain value

param objectName name of RbelBuilder in rbelBuilders Map
param rbelPath Path to specific node
param expectedValue value to be asserted

TGR prüft, dass {tigerResolvedString} gleich {tigerResolvedString} mit Typ {rbelContentType} ist

TGR asserts {tigerResolvedString} equals {tigerResolvedString} of type {rbelContentType}

Asserts, if 2 Rbel object serializations are equal

param jexlExpressionActual actual value
param jexlExpressionExpected expected value
param contentType type of Rbel object content for comparison

5.4.3. Usage examples

Listing 17. Tiger Rbel Builder steps example

```
Feature Tiger validation steps

  Scenario: Example steps

    Given TGR clear recorded messages
    And TGR filter requests based on host "testnode.example.org"
    And TGR filter requests based on method "POST"
    And TGR set request wait timeout to 20 seconds
    When TGR find request to path "/path/path/blabla" with "$..tag.value.text" matching "abc.*"
    And TGR find request to path "/path/path/blabla" containing node "$..tag"
    Then TGR current response with attribute "$..answer.result.text" matches "OK.*"
    But TGR current response with attribute "$..answer.reason.text" does not match "REQUEST.*"
    And TGR current response body matches:
    """
         body content
        """
    And TGR current response at "$..tag" matches as JSON:
    """
          {
            "arr1": [
```

```
              "asso", "bsso"
            ]
          }
        """
    And TGR current response at "$..tag" matches as XML:
    """
          <arr1>
            <entry index="1">asso</entry>
            <entry index="2">bsso</entry>
          </arr1>
        """
```

5.5. Using the HTTP client steps

The Tiger HTTP client steps are a set of Cucumber steps that enable you to perform simple HTTP requests, with bodies, default and custom headers.

Listing 18. Tiger response validation steps example

```
Feature: HTTP/HTTPS GlueCode Test feature

  Background:
    Given TGR clear recorded messages

  Scenario Outline:  Test <color> with <inhalt>
    And TGR show <color> text "${my.string}"
    Examples: We use this data only for testing data variant display in workflow ui, there is no
deeper sense in it
      | color  | inhalt |
      | red    | Dagmar |
      | blue   | Nils   |
      | green  | Tim    |
      | yellow | Sophie |

  Scenario Outline: Test <color> with <text> again
    Given TGR show <color> banner "<text>"
    And TGR clear recorded messages
    Then TGR clear recorded messages
    Examples:
    # Test comment
      | color | text |
      | green | foo  |
      | red   | bar  |

  Scenario: Simple Get Request
    When TGR send empty GET request to "http://httpbin/"
    Then TGR find last request to path ".*"
    And TGR assert "!{rbel:currentRequestAsString('$.method')}" matches "GET"
    And TGR assert "!{rbel:currentRequestAsString('$.path')}" matches "\/?"

  Scenario: Get Request to folder
    When TGR send empty GET request to "http://httpbin/get"
    Then TGR find last request to path ".*"
    And TGR assert "!{rbel:currentRequestAsString('$.method')}" matches "GET"
    And TGR assert "!{rbel:currentRequestAsString('$.path')}" matches "\/get\/?"

  Scenario: PUT Request to folder
    When TGR send empty PUT request to "http://httpbin/put"
    Then TGR find last request to path ".*"
    And TGR assert "!{rbel:currentRequestAsString('$.method')}" matches "PUT"
    And TGR assert "!{rbel:currentRequestAsString('$.path')}" matches "\/put\/?"

  Scenario: PUT Request with body to folder
    When TGR send PUT request to "http://httpbin/put" with body "{'hello': 'world!'}"
    Then TGR find last request to path ".*"
    And TGR assert "!{rbel:currentRequestAsString('$.method')}" matches "PUT"
```

```
    And TGR assert "!{rbel:currentRequestAsString('$.path')}" matches "\/put\/?"
    And TGR assert "!{rbel:currentRequestAsString('$.body.hello')}" matches "world!"

  Scenario: PUT Request with body from file to folder
    When TGR send PUT request to "http://httpbin/put" with body "!{file('pom.xml')}"
    Then TGR find last request to path ".*"
    And TGR assert "!{rbel:currentRequestAsString('$.method')}" matches "PUT"
    And TGR assert "!{rbel:currentRequestAsString('$.path')}" matches "\/put\/?"
    And TGR assert "!{rbel:currentRequestAsString('$.body.project.modelVersion.text')}" matches
"4.0.0"
    # application/octet-stream is used since no rewriting is done, so unknown/default MIME-type is
assumed
    And TGR assert "!{rbel:currentRequestAsString('$.header.Content-Type')}" matches
"application/octet-stream.*"

  Scenario: DELETE Request without body
    When TGR send empty DELETE request to "http://httpbin/delete"
    Then TGR find last request to path ".*"
    And TGR assert "!{rbel:currentRequestAsString('$.method')}" matches "DELETE"
    And TGR assert "!{rbel:currentRequestAsString('$.path')}" matches "\/delete\/?"

  Scenario: Request with custom header
    When TGR send empty GET request to "http://httpbin/get" with headers:
      | foo    | bar |
      | schmoo | lar |
    Then TGR find last request to path ".*"
    And TGR assert "!{rbel:currentRequestAsString('$.header.foo')}" matches "bar"
    And TGR assert "!{rbel:currentRequestAsString('$.header.schmoo')}" matches "lar"

  Scenario: Request with default header
    Given TGR set default header "key" to "value"
    When TGR send empty GET request to "http://httpbin/get"
    Then TGR find last request to path ".*"
    And TGR assert "!{rbel:currentRequestAsString('$.header.key')}" matches "value"
    When TGR send POST request to "http://httpbin/post" with body "hello world"
    Then TGR find last request to path ".*"
    And TGR assert "!{rbel:currentRequestAsString('$.header.key')}" matches "value"
    And TGR assert "!{rbel:currentRequestAsString('$.body')}" matches "hello world"

  Scenario: Request with custom and default header, check headers
    Given TGR set default header "key" to "value"
    When TGR send empty GET request to "http://httpbin/get" with headers:
      | foo | bar |
    Then TGR find last request to path ".*"
    And TGR assert "!{rbel:currentRequestAsString('$.header.foo')}" matches "bar"
    And TGR assert "!{rbel:currentRequestAsString('$.header.key')}" matches "value"

  Scenario: Get Request with custom and default header, check body, application type url encoded
    Given TGR set local variable "configured_state_value" to "some weird $value§"
    Given TGR set local variable "configured_param_name" to "my_cool_param"
    When TGR send GET request to "http://httpbin/get" with:
      | ${configured_param_name} | state                      | redirect_uri        |
      | client_id                | ${configured_state_value} | https://my.redirect |
    Then TGR find last request to path ".*"
    And TGR assert "!{rbel:currentRequestAsString('$.path.state.value')}" matches
"${configured_state_value}"
    And TGR assert "!{rbel:currentRequestAsString('$.path.state')}" matches
"state=!{urlEncoded('some weird $value§')}"
    And TGR assert "!{rbel:currentRequestAsString('$.path.my_cool_param')}" matches
"${configured_param_name}=client_id"
    And TGR assert "!{rbel:currentRequestAsString('$.header.Content-Type')}" matches "application/x-
www-form-urlencoded.*"

  Scenario: Post Request with custom and default header, check body, application type url encoded
    Given TGR set local variable "configured_state_value" to "some weird $value§"
    Given TGR set local variable "configured_param_name" to "my_cool_param"
    When TGR send POST request to "http://httpbin/post" with:
      | ${configured_param_name} | state                      | redirect_uri        |
      | client_id                | ${configured_state_value} | https://my.redirect |
    Then TGR find last request to path ".*"
```

```
    And TGR assert "!{rbel:currentRequestAsString('$.body.state')}" matches "!{urlEncoded('some
weird $value§')}"
    And TGR assert "!{rbel:currentRequestAsString('$.body.my_cool_param')}" matches "client_id"
    And TGR assert "!{rbel:currentRequestAsString('$.header.Content-Type')}" matches "application/x-
www-form-urlencoded.*"
    And TGR assert "!{rbel:currentRequestAsString('$.body.redirect_uri')}" matches
"!{urlEncoded('https://my.redirect')}"

  Scenario: Request with custom and default header, check application type json
    Given TGR set default header "Content-Type" to "application/json"
    When TGR send POST request to "http://httpbin/post" with:
      | ${configured_param_name} |
      | client_id                |
    Then TGR find last request to path ".*"
    And TGR assert "!{rbel:currentRequestAsString('$.header.Content-Type')}" matches
"application/json"

  Scenario Outline: JEXL Rbel Namespace Test
    Given TGR send empty GET request to "http://httpbin/html"
    Then TGR find request to path "/html"
    Then TGR current response with attribute "$.body.html.body.h1.text" matches
"!{rbel:currentResponseAsString('$.body.html.body.h1.text')}"

    Examples: We use this data only for testing data variant display in workflow ui, there is no
deeper sense in it
      | txt   | txt2 | txt3 | txt4 | txt5 |
      | text2 | 21   | 31   | 41   | 51   |
      | text2 | 22   | 32   | 42   | 52   |

  Scenario: Simple first test
    Given TGR send empty GET request to "http://httpbin/html"
    Then TGR find request to path "/html"
    Then TGR current response with attribute "$.body.html.body.h1.text" matches "Herman Melville -
Moby-Dick"

  Scenario: Test Find Last Request
    Given TGR send empty GET request to "http://httpbin/anything?foobar=1"
    Then TGR send empty GET request to "http://httpbin/anything?foobar=2"
    Then TGR find last request to path "/anything"
    Then TGR current response with attribute "$.responseCode" matches "200"
    Then TGR current response with attribute "$.body.url.content.foobar.value" matches "2"

  Scenario: Test find last request with parameters
    Given TGR send empty GET request to "http://httpbin/anything?foobar=1"
    Then TGR send empty GET request to "http://httpbin/anything?foobar=1&xyz=4"
    Then TGR send empty GET request to "http://httpbin/anything?foobar=2"
    Then TGR find last request to path "/anything" with "$.path.foobar.value" matching "1"
    Then TGR current response with attribute "$.body.url.content.xyz.value" matches "4"

  Scenario: Test find last request
    Given TGR send empty GET request to "http://httpbin/anything?foobar=1"
    Then TGR send empty GET request to "http://httpbin/anything?foobar=2"
    Then TGR send empty GET request to "http://httpbin/anything?foobar=3"
    Then TGR send empty GET request to "http://httpbin/status/404?other=param"
    Then TGR find the last request
    Then TGR current response with attribute "$.responseCode" matches "404"
    Then TGR assert "!{rbel:currentRequestAsString('$.path.other.value')}" matches "param"

  Scenario: Get Request to folder and test param is url decoded when access via $.path and ..value
is url decoded
    When TGR send empty GET request to "http://httpbin/get?foo=bar%20and%20schmar"
    Then TGR find last request to path ".*"
    And TGR assert "!{rbel:currentRequestAsString('$.path.foo.value')}" matches "bar and schmar"
    And TGR assert "!{rbel:currentRequestAsString('$.path.foo')}" matches "foo=bar%20and%20schmar"

  Scenario: Test deactivate followRedirects
    When TGR disable HttpClient followRedirects configuration
    And TGR send empty GET request to "http://httpbin/redirect-
to?url=!{urlEncoded('http://httpbin/status/200')}"
    Then TGR find the last request
```

```
    Then TGR current response with attribute "$.responseCode" matches "302"
    And TGR current response with attribute "$.header.Location" matches "http://httpbin/status/200"
    When TGR reset HttpClient followRedirects configuration
    And TGR send empty GET request to "http://httpbin/redirect-
to?url=!{urlEncoded('http://httpbin/status/200')}"
    Then TGR find the last request
    Then TGR current response with attribute "$.responseCode" matches "200"
```

5.5.1. XMLUnit Diff Builder

Using the validation steps `TGR current response at {string} matches as XML:` or `TGR current response at {string} matches as XML and diff options {string}:` you are able to compare the content of any RbelPath node in the response.
The latter method even allows passing in the following options to the XMLUnit's DiffBuilder:

- "nocomment" for DiffBuilder::ignoreComments
- "txtignoreempty" for DiffBuilder::ignoreElementContentWhitespace
- "txttrim" for DiffBuilder::ignoreWhitespace
- "txtnormalize" for DiffBuilder::normalizeWhitespace

Per default the comparison algorithm will ignore mismatches in namespace prefixes and URIs.
Comparison is also performed on similarity and not equal content.

For more detailed explanation about the XMLUnit difference evaluator we refer to the online documentation of the XMLUnit project.

5.5.2. JSONChecker

Using the validation step `TGR current response at {string} matches as JSON:` you are able to compare the content of any RbelPath node in the response to the doc string beneath the step, with the help of the JSONChecker comparison algorithm.

The purpose of JSONChecker class is to compare JSON structures, including checking for the integrity of the whole RbelPath node, as well as matching values for particular keys.

To make sure all the attributes in your JSON RbelPath structure are present, such features as ${json-unit.ignore}, $NULL, optional attributes, regular expressions and lenient mode can come in handy.

${json-unit.ignore} is a parameter which allows ignoring certain values in your RbelPath node while comparing, and the result of such comparison always returns true.
It also works when ${json-unit.ignore} is used in a JSON array or nested JSON object.
This parameter should be placed as a value of a key.
To ignore some attributes in the JSON structure, you can set a boolean value checkExtraAttributes as false.
In this case if you miss one attribute in your doc string, the comparison will still be equal to true.

To check whether the value for a particular key is null, you can either use null or

parameter $NULL at the place of the value.
Checking whether a nested key is null also works with JSONChecker.

Four underscores "__" before the JSON keys indicate that these keys are optional and will be checked for the value ONLY if the value exists in the test JSON RBelPath node.
Please note that checking whether a nested key is optional, is not yet possible with JsonChecker.

JSON Arrays are compared in lenient mode, meaning that the order of elements in JSON array doesn't matter.

Identifying missing keys is made easy in JSONChecker with the help of parameter $REMOVE.

If you specify the name of the key and then $REMOVE parameter as its value, the comparison will result in true, if the key is indeed missing and false, if the key is present.
It is worth noting that even if the value of the key is null, the key doesn't count as missing.

Last but not least, regular expressions, which can be used for matching the whole JSON element, as well as particular values.
It will be first checked, whether the expected value is equal to the actual one, and only afterwards, if the actual value matches a regular expression.

It should also be noted, that although JSONChecker can match multilevel JSON objects at a high level, it is not yet possible to access nested attributes out of the box.
We are working on it :)

Listing 19. Simple adapted example from the IDP test suite

```
{
  "alg": "dir",
  "enc": "A256GCM",
  "cty": "$NULL",
  "exp": "[\\d]*",
  "____kid": ".*",
  "dummyentry": "${json-unit.ignore}",
  "dummyarray": [ "entry1", "entry2" ],
  "dummyarray2":  "${json-unit.ignore}"
}
```

The example above shows three main features of the JSONChecker.

- Value specified as $NULL, meaning this value of this key is equal to null.
- Usage of regular expression (e.g. ".*" and "[\\d]*") to match values.
- Usage of "__" preceeding a json key: This indicates that the entry is optional but if it exists it must match the given value.
- if a value is specified as "${json-unit.ignore}", there is no check performed at all.
  This applies also to objects and arrays as seen in the dummyarray2 entry.
- if we match key dummyEntry2 to the value of $REMOVE, it will return true, because this key does not exist.

5.5.3. Regex matching

When comparing values (e.g. in the `TGR current response body matches:`) generally the algorithms check for equality and only check for regex matches if they were not equal.

5.5.4. Complete set of steps in validation glue code

TGR setze Anfrage Timeout auf {int} Sekunden

TGR set request wait timeout to {int} seconds

Specify the amount of seconds Tiger should wait when filtering for requests / responses before
reporting them as not found.

TGR lösche aufgezeichnete Nachrichten

TGR clear recorded messages

clear all validatable rbel messages. This does not clear the recorded messages later on
reported via the rbel log HTML page or the messages shown on web ui of tiger proxies.

TGR filtere Anfragen nach Server {tigerResolvedString}

TGR filter requests based on host {tigerResolvedString}

filter all subsequent findRequest steps for hostname. To reset set host name to empty string
"".

param hostname host name (regex supported) to filter for

TGR filtere Anfragen nach HTTP Methode {tigerResolvedString}

TGR filter requests based on method {tigerResolvedString}

filter all subsequent findRequest steps for method.

param method method to filter for

TGR lösche den gesetzten HTTP Methodenfilter

TGR reset request method filter

reset filter for method for subsequent findRequest steps.

TGR warte auf eine Nachricht, in der Knoten {tigerResolvedString} mit {tigerResolvedString} übereinstimmt

TGR wait for message with node {tigerResolvedString} matching {tigerResolvedString}

Wait until a message is found in which the given node, specified by a RbelPath-Expression,
matches the given value. This method will NOT alter currentRequest/currentResponse!!

param rbelPath rbel path to node/attribute
param value value to match at given node/attribute

TGR warte auf eine neue Nachricht, in der Knoten {tigerResolvedString} mit {tigerResolvedString} übereinstimmt

TGR wait for new message with node {tigerResolvedString} matching {tigerResolvedString}

Wait until a NEW message is found in which the given node, specified by a RbelPath-Expression,
matches the given value. NEW in this context means that the step will wait and check only
messages which are received after the step has started. Any previously received messages will
NOT be checked. Please also note that the currentRequest/currentResponse used by the find /
find next steps are not altered by this step.

param rbelPath rbel path to node/attribute
param value value to match at given node/attribute

TGR finde die erste Anfrage mit Pfad {string}

TGR find request to path {string}

find the first request where the path equals or matches as regex and memorize it in the {**link**
#rbelValidator} instance

param path path to match

TGR finde die erste Anfrage mit Pfad {string} und Knoten {string} der mit {string} übereinstimmt

TGR find request to path {string} with {string} matching {string}

find the first request where path and node value equal or match as regex and memorize it in the
{**link** #rbelValidator} instance.

param path path to match
param rbelPath rbel path to node/attribute
param value value to match at given node/attribute

TGR finde die nächste Anfrage mit dem Pfad {string}

TGR find next request to path {string}

find the NEXT request where the path equals or matches as regex and memorize it in the {**link**
#rbelValidator} instance.

param path path to match

TGR finde die nächste Anfrage mit Pfad {string} und Knoten {string} der mit {string} übereinstimmt

TGR find next request to path {string} with {string} matching {string}

find the NEXT request where path and node value equal or match as regex and memorize it in the
{**link** #rbelValidator} instance.

param path path to match
param rbelPath rbel path to node/attribute
param value value to match at given node/attribute

TGR finde die erste Anfrage mit Pfad {string} die den Knoten {string} enthält

TGR find request to path {string} containing node {string}

find the first request where path matches and request contains node with given rbel path and
memorize it in the {**link** #rbelValidator} instance.

param path path to match
param rbelPath rbel path to node/attribute

TGR finde die nächste Anfrage mit Pfad {string} die den Knoten {string} enthält

TGR find next request to path {string} containing node {string}

find the NEXT request where path matches and request contains node with given rbel path and
memorize it in the {**link** #rbelValidator} instance.

param path path to match
param rbelPath rbel path to node/attribute

TGR finde die letzte Anfrage mit dem Pfad {string}

TGR find last request to path {string}

find the LAST request where the path equals or matches as regex and memorize it in the {**link**
#rbelValidator} instance.

param path path to match

TGR finde die letzte Anfrage mit Pfad {string} und Knoten {string} der mit {string} übereinstimmt

TGR find last request to path {string} with {string} matching {string}

find the LAST request where path and node value equal or match as regex and memorize it in the
{**link** #rbelValidator} instance.

param path path to match
param rbelPath rbel path to node/attribute
param value value to match at given node/attribute

TGR finde die letzte Anfrage

TGR find the last request

find the LAST request.

TGR finde eine Nachricht mit Knoten {tigerResolvedString} der mit {tigerResolvedString} übereinstimmt

TGR any message with attribute {tigerResolvedString} matches {tigerResolvedString}

assert that there is any message with given rbel path node/attribute matching given value. The
matching will NOT perform regular expression matching but only checks for identical string
content The result (request or response) will not be stored in the {**link** #rbelValidator}
instance.

param rbelPath rbel path to node/attribute
param value value to match at given node/attribute
deprecated

TGR speichere Wert des Knotens {tigerResolvedString} der aktuellen Antwort in der Variable {tigerResolvedString}

store given rbel path node/attribute text value of current response.

param rbelPath path to node/attribute
param varName name of variable to store the node text value in

TGR ersetze {tigerResolvedString} mit {tigerResolvedString} im Inhalt der Variable {tigerResolvedString}

replace stored content with given regex

param regexPattern regular expression to search for

param replace string to replace all matches with
param varName name of variable to store the node text value in

TGR prüfe aktuelle Antwort stimmt im Body überein mit:

assert that response body of filtered request matches.

param docString value / regex that should equal or match

TGR prüfe aktuelle Antwort enthält Knoten {tigerResolvedString}

assert that response of filtered request contains node/attribute at given rbel path.

param rbelPath path to node/attribute

TGR prüfe aktuelle Antwort stimmt im Knoten {tigerResolvedString} überein mit {tigerResolvedString}

assert that response of filtered request matches at given rbel path node/attribute.

param rbelPath path to node/attribute
param value value / regex that should equal or match as string content with MultiLine and
DotAll regex option

TGR prüfe aktuelle Antwort stimmt im Knoten {tigerResolvedString} nicht überein mit {tigerResolvedString}

assert that response of filtered request does not match at given rbel path node/attribute.

param rbelPath path to node/attribute
param value value / regex that should NOT BE equal or should NOT match as string content with
MultiLine and DotAll regex option

TGR prüfe aktuelle Antwort im Knoten {tigerResolvedString} stimmt überein mit:

assert that response of filtered request matches at given rbel path node/attribute.

param rbelPath path to node/attribute
param docString value / regex that should equal or match as string content with MultiLine and
DotAll regex option supplied as DocString

TGR prüfe aktuelle Antwort im Knoten {tigerResolvedString} stimmt nicht überein mit:

assert that response of filtered request does not match at given rbel path node/attribute.

param rbelPath path to node/attribute
param docString value / regex that should equal or match as string content with MultiLine and
DotAll regex option supplied as DocString

TGR prüfe aktuelle Antwort im Knoten {tigerResolvedString} stimmt als {modeType} überein mit:

assert that response of filtered request matches at given rbel path node/attribute assuming its
JSON or XML

param rbelPath path to node/attribute
param mode one of JSON|XML
param oracleDocStr value / regex that should equal or match as JSON or XML content
see JsonChecker#compareJsonStrings(String, String, boolean)

TGR prüfe aktuelle Antwort im Knoten {tigerResolvedString} stimmt als XML mit folgenden diff Optionen {tigerResolvedString} überein mit:

assert that response of filtered request matches at given rbel path node/attribute assuming its
XML with given list of diff options.

param rbelPath path to node/attribute
param diffOptionsCSV a csv separated list of diff option identifiers to be applied to
comparison of the two XML sources

nocomment … {**link** DiffBuilder#ignoreComments()}
txtignoreempty … {**link** DiffBuilder#ignoreElementContentWhitespace()}
txttrim … {**link** DiffBuilder#ignoreWhitespace()}
txtnormalize … {**link** DiffBuilder#normalizeWhitespace()}

param xmlDocStr value / regex that should equal or match as JSON content
see More on DifferenceEvaluator

TGR gebe aktuelle Response als Rbel-Tree aus

Prints the rbel-tree of the current response to the System-out

TGR gebe aktuelle Request als Rbel-Tree aus

Prints the rbel-tree of the current request to the System-out

TGR liest folgende .tgr Datei {tigerResolvedString}

Read # TGR file and sends messages to local Tiger proxy

5.5.5. Complete set of steps in HTTP client glue code

TGR send empty {requestType} request to {tigerResolvedUrl}

TGR eine leere {requestType} Anfrage an {tigerResolvedUrl} sendet

TGR sende eine leere {requestType} Anfrage an {tigerResolvedUrl}

Sends an empty request via the selected method. Placeholders in address will be resolved.

param method HTTP request method (see {**link** Method})
param address target address
see TigerGlobalConfiguration#resolvePlaceholders(String)

TGR send empty {requestType} request to {tigerResolvedUrl} without waiting for the response

TGR sende eine leere {requestType} Anfrage an {tigerResolvedUrl} ohne auf Antwort zu warten

Sends an empty request via the selected method. Placeholders in address will be resolved.

This method is NON-BLOCKING, meaning it will not wait for the response before continuing the
test.

param method HTTP request method (see {**link** Method})
param address target address
see TigerGlobalConfiguration#resolvePlaceholders(String)

TGR send empty {requestType} request to {tigerResolvedUrl} with headers:

TGR eine leere {requestType} Anfrage an {tigerResolvedUrl} und den folgenden Headern sendet:

TGR sende eine leere {requestType} Anfrage an {tigerResolvedUrl} mit folgenden Headern:

Sends an empty request via the selected method and expands the list of default headers with the
headers provided by the caller. Placeholders in address and in the data table will be resolved.
Example:

```
When ##### TGR send empty GET request to "${myAddress}" with headers:
 | name | bob |
 | age  | 27  |
```

This will add two headers (name and age) with the respective values "bob" and "27" on top of
the headers which are used by default.

param method HTTP request method (see {**link** Method})
param address target address
param customHeaders Markdown table of custom headers and their values
see TigerGlobalConfiguration#resolvePlaceholders(String)

TGR send empty {requestType} request to {tigerResolvedUrl} without waiting for the response with headers:

TGR sende eine leere {requestType} Anfrage an {tigerResolvedUrl} ohne auf Antwort zu warten mit folgenden Headern:

Sends an empty request via the selected method and expands the list of default headers with the
headers provided by the caller. Placeholders in address and in the data table will be resolved.

This method is NON-BLOCKING, meaning it will not wait for the response before continuing the
test.

param method HTTP request method (see {**link** Method})
param address target address
param customHeaders Markdown table of custom headers and their values
see TigerGlobalConfiguration#resolvePlaceholders(String)

TGR send {requestType} request to {tigerResolvedUrl} with body {string}

TGR eine leere {requestType} Anfrage an {tigerResolvedUrl} und dem folgenden body {string} sendet

TGR sende eine {requestType} Anfrage an {tigerResolvedUrl} mit Body {string}

Sends a request containing the provided body via the selected method. Placeholders in the body
and in address will be resolved.

param method HTTP request method (see {**link** Method})
param body to be included in the request
param address target address
see TigerGlobalConfiguration#resolvePlaceholders(String)

TGR send {requestType} request to {tigerResolvedUrl} with body {string} without waiting for the response

TGR sende eine {requestType} Anfrage an {tigerResolvedUrl} mit Body {string} ohne auf Antwort zu warten

Sends a request containing the provided body via the selected method. Placeholders in the body
and in address will be resolved.

This method is NON-BLOCKING, meaning it will not wait for the response before continuing the
test.

param method HTTP request method (see {**link** Method})
param body to be included in the request
param address target address
see TigerGlobalConfiguration#resolvePlaceholders(String)

TGR send {requestType} request to {tigerResolvedUrl} with:

TGR eine {requestType} Anfrage an {tigerResolvedUrl} mit den folgenden Daten sendet:

TGR sende eine {requestType} Anfrage an {tigerResolvedUrl} mit folgenden Daten:

Sends a request via the selected method. The request is expanded by the provided key-value
pairs. Placeholders in keys and values will be resolved. The values must not be URL encoded, as
this is done by the step. Example:

```
When Send POST request to "http://my.address.com" with
 | ${configured_param_name}   | state                     | redirect_uri        |
 | client_id                  | ${configured_state_value} | https://my.redirect |
```

NOTE: This Markdown table must contain exactly 1 row of headers and 1 row of values.

param method HTTP request method (see {**link** Method})
param address target address
param parameters to be sent with the request
see RequestSpecification#formParams(Map)
see TigerGlobalConfiguration#resolvePlaceholders(String)

TGR send {requestType} request to {tigerResolvedUrl} with multiline body:

TGR eine {requestType} Anfrage an {tigerResolvedUrl} mit den folgenden mehrzeiligen Daten sendet:

TGR sende eine {requestType} Anfrage an {tigerResolvedUrl} mit folgenden mehrzeiligen Daten:

Sends a request via the selected method. For the given request's body placeholders in keys and

values will be resolved. This step is meant to be used for more complex bodys spanning multiple
lines.

Example:

```
When ##### TGR send POST request to "http://my.address.com" with multiline body:
 """
   {
        "name": "value",
        "object": { "member": "value" },
        "array" : [ 1,2,3,4]
   }
 """
```

param method HTTP request method (see {**link** Method})
param address target address
param body body content of the request
see TigerGlobalConfiguration#resolvePlaceholders(String)

TGR send {requestType} request to {tigerResolvedUrl} without waiting for the response with:

TGR sende eine {requestType} Anfrage an {tigerResolvedUrl} ohne auf Antwort zu warten mit folgenden Daten:

Sends a request via the selected method. The request is expanded by the provided key-value
pairs. Placeholders in keys and values will be resolved. The values must not be URL encoded, as
this is done by the step.

This method is NON-BLOCKING, meaning it will not wait for the response before continuing the
test.

param method HTTP request method (see {**link** Method})
param address target address
param parameters to be sent with the request
see RequestSpecification#formParams(Map)
see TigerGlobalConfiguration#resolvePlaceholders(String)

TGR set default header {tigerResolvedString} to {tigerResolvedString}

TGR den default header {tigerResolvedString} auf den Wert {tigerResolvedString} setzen

TGR setze den default header {tigerResolvedString} auf den Wert {tigerResolvedString}

Expands the list of default headers with the provided key-value pair. If the key already
exists, then the existing value is overwritten by the new value. Placeholders in the header

name and in its value will be resolved.

param header key
param value to be stored under the given key
see TigerGlobalConfiguration#resolvePlaceholders(String)

TGR set default headers:

TGR setze folgende default headers:

TGR folgende default headers gesetzt werden:

Expands the list of default headers with the provided key-value pairs. If the key already
exists, then the existing value is overwritten by the new value. Placeholders in the header
names and in their values will be resolved.

param docstring multiline doc string, one key value pair per line
see TigerGlobalConfiguration#resolvePlaceholders(String)

TGR clear all default headers

TGR lösche alle default headers

Clear all default headers set in previous steps.

TGR disable HttpClient followRedirects configuration

TGR HttpClient followRedirects Konfiguration deaktiviert

Modifies the global configuration of the HttpClient to not automatically follow redirects. All
following requests will use the modified configuration.

TGR reset HttpClient followRedirects configuration

TGR HttpClient followRedirects Konfiguration zurücksetzt

Resets the global configuration of the HttpClient to its default behaviour of automatically
following redirects.

5.5.6. Exemplaric scenario Konnektorfarm EAU validation

The EAU Konnektorfarm scenario is a scenario where customers can use their Primärsystem to test signing and verifying documents via a set of Konnektoren and that this works interoperable.
For this purpose a phalanx of local Tiger Proxies is set up as reverse proxies for each Konnektor being hosted at the gematik location.
Any message that is forwarded by any of these proxies is forwarded to an aggregating Tiger Proxy which in turn forwards all the received messages to the local Tiger Proxy for assertion via the validation test suite.

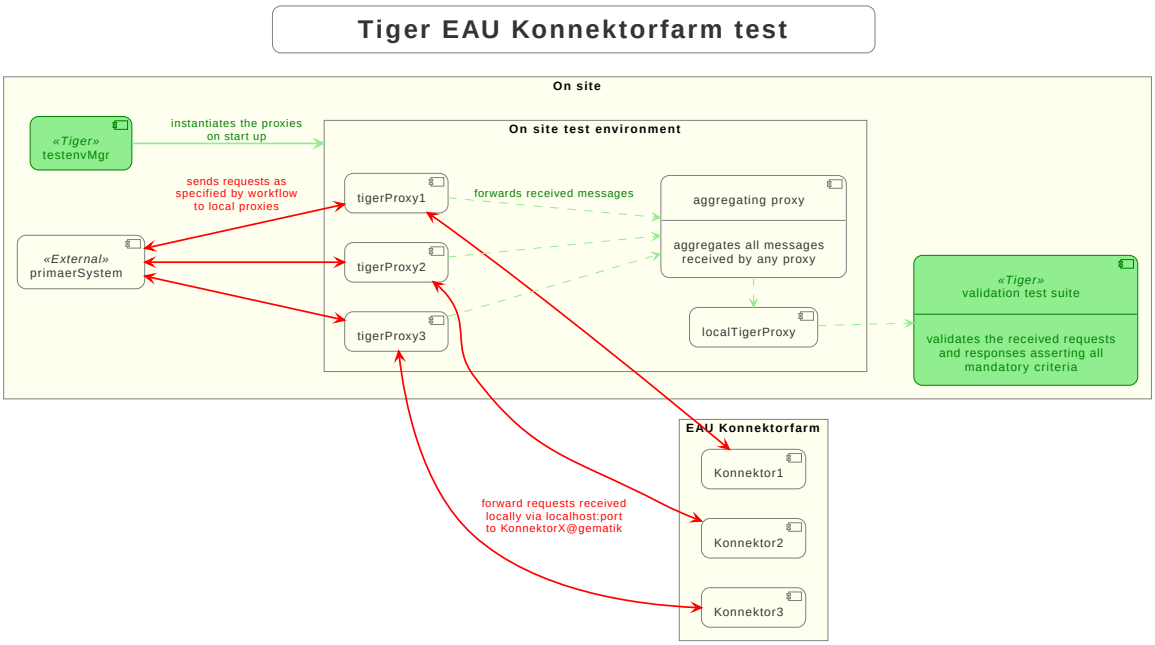

Figure 10. Tiger EAU Konnektorfarm test environment

So after starting the validation test suite (and the test environment), the customer / Primärsystem manufacturer must perform the specified workflow.
The test suite meanwhile will wait for a given order of requests/responses matching specified criteria to appear.
If all is well, at the end the test report JSON files will be packed into a zip archive and can be uploaded to the Titus platform for further certification steps.

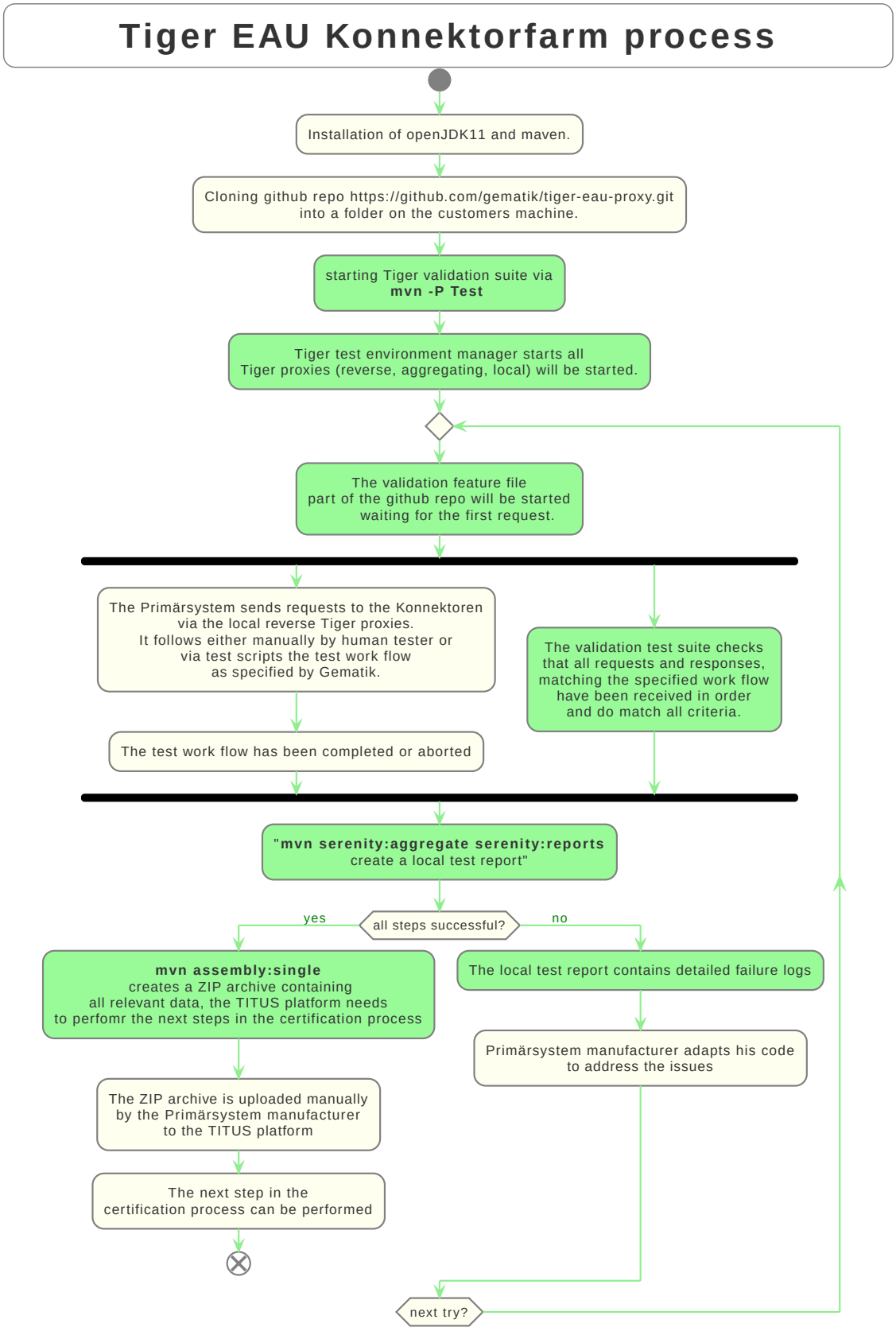

Figure 11. Tiger EAU Konnektorfarm process

TGR setze globale Variable {tigerResolvedString} auf {tigerResolvedString}

TGR set global variable {tigerResolvedString} to {tigerResolvedString}

Current message steps for Workflow UI

Sets the given key to the given value in the global configuration store. Variable substitution
is performed.

param key key of the context
param value value for the context entry with given key

TGR setze lokale Variable {tigerResolvedString} auf {tigerResolvedString}

TGR set local variable {tigerResolvedString} to {tigerResolvedString}

Sets the given key to the given value in the global configuration store. Variable substitution
is performed. This value will only be accessible from this exact thread.

param key key of the context
param value value for the context entry with given key

TGR prüfe Variable {tigerResolvedString} stimmt überein mit {tigerResolvedString}

asserts that value with given key either equals or matches (regex) the given regex string.
Variable substitution is performed. This checks both global and local variables!

param key key of entry to check
param regex regular expression (or equals string) to compare the value of the entry to

TGR prüfe Variable {tigerResolvedString} ist unbekannt

asserts that value of context entry with given key either equals or matches (regex) the given
regex string. Variable substitution is performed.

Special values can be used:

param key key of entry to check

TGR zeige {word} Banner {tigerResolvedString}

TGR show {word} banner {tigerResolvedString}

TGR zeige {word} Text {tigerResolvedString}

TGR show {word} text {tigerResolvedString}

TGR zeige Banner {tigerResolvedString}

TGR show banner {tigerResolvedString}

TGR wait for user abort

TGR warte auf Abbruch

TGR pause test run execution

TGR pausiere Testausführung

TGR pause test run execution with message {string}

TGR pausiere Testausführung mit Nachricht {string}

TGR pause test run execution with message {tigerResolvedString} and message in case of error {tigerResolvedString}

TGR pausiere Testausführung mit Nachricht {tigerResolvedString} und Meldung im Fehlerfall {tigerResolvedString}

TGR show HTML Notification:

TGR zeige HTML Notification:

TGR assert {tigerResolvedString} matches {tigerResolvedString}

TGR prüfe das {tigerResolvedString} mit {tigerResolvedString} überein stimmt

TGR gebe variable {tigerResolvedString} aus

Prints the value of the given variable to the System-out

The pause steps allow to pause the validation test suite.
Please note, these steps are only modified for the Workflow UI and don't work on a regular console (no failure, there is just no pause).
The step "wait for user abort" allows to pause the validation test suite and is mainly used in demo scenarios allowing the manual tester to perform demo transactions that will be logged and saved to HTML reports but are not validated.
This step subsequently terminates the test execution.

5.6. Using Tiger test lib helper classes

If you don't want to use the Tiger test framework but only pick a few helper classes the following classes might be of interest to you:

All classes listed here are part of the tiger-common module

5.6.1. Banner

If you want to use large ASCII art style log banners you may find this class very helpful.

Supports ANSI coloring and a set of different fonts.
Furthermore, all banner messages are displayed and highlighted in the Workflow UI For more details please check the code and its usages in the Tiger test framework.

5.6.2. TigerSerializationUtil

This class supports you in converting String representation of YAML and JSON data to an Java JSONObject or extract that or other loaded data to Java Maps.
If you are planning to implement test data management or configuration sets, we propose to use the TigerGlobalConfiguration class described in detail here.

5.6.3. TigerPkiIdentityLoader, TigerPkiIdentity

The loader class allows to easily instantiate PKI identities from given files.
For more details on the format and the supported file types please check this section in the test environment chapter.

5.6.4. Performing REST calls with Tiger

Tiger is closely integrated with SerenityBDD, which in turn has integrated the RestAssured library, so if you use the `SerenityRest` helper class, you will get detailed information about each call inside the test report.
The Tiger test library configuration also provides a flag to add curl command details to each of these calls, so that you can easily reproduce the REST call manually in case of test failure analysis.

For more information about REST testing in Tiger/SerenityBDD please check these two documents:

- Serenity REST
- Serenity Screenplay REST

5.7. Synchronizing BDD scenarios with Polarion test cases (Gematik only)

Within gematik we maintain test cases via feature files being committed to git repositories.
To keep traceability to the requirements maintained in Polarion we have a Tiger sub project that synchronizes test cases in Polarion with the scenarios in our feature files.
It is a one way synchronisation, where the master are the feature files.

To use this feature the scenarios need a minimal set of mandatory annotations:

- **@TCID:xxx** - a unique test case identifier, where 'xxx' matches the value of the custom field "cfInternalId" in Polarion
- **@PRODUKT:p,p,p** - reference to the custom field "cfProductType".
  You add this annotation above each feature, not each scenario. 'p' is a product, one is mandatory but it can be a list.

And following optional annotations exist:

- @AFO-ID:xxx - a link to a defined requirement (Anforderung) in Polarion, where 'xxx' matches the custom field "cfAfoId"
- @AF-ID:xxx - a link to a defined requirement (Anwendungsfall) in Polarion, where 'xxx' matches the custom field "cfAfId"
- @AK-ID:xxx - a link to a defined requirement (Akzeptanzkriterium) in Polarion, where 'xxx' matches the work item id
- @PRIO:n - priority number (1-4), default is '1'
- @MODUS:xxx - describes the way of testing, default is 'automatisch'
- @STATUS:xxx - describes the status of the test, default is 'implementiert'
- @TESTFALL:n - describes if the test case is a negative testcase or positive one, default is 'positiv'
- @TESTSTUFE:n - describes the test type, default is '3' (which is E2E-Test)
- @DESCRIPTION - if your test case has a description, and you use this annotation, the description will be parsed.
  If not, the description stays empty and won't overwrite the one already existing in Polarion

If a scenario is identified that has no test case with a matching TCID, it will be created automatically in the sync run.
Background blocks will be merged to each scenario before exporting its steps to Polarion.

For more details on how to perform the synchronisation, all choices for the annotations and how to upload generated test run reports to Polarion and Aurora, please check the README.md in the PolarionToolbox project on the Gematik GitLab.

Chapter 6. Tiger Configuration

Configuration is an integral part of testing.
To make this task easier for you and to make configuration the various parts of the system as easy as possible Tiger has a central configuration store: TigerGlobalConfiguration.
It combines properties from multiple source and feeds into various parts of the system.

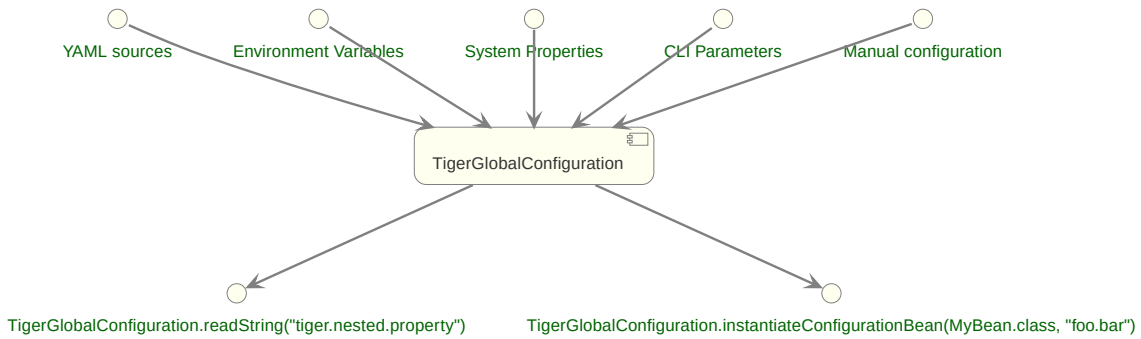

Figure 12. The TigerGlobalConfiguration with inlets and outlets

This allows a vastly simplified retrieval and configuration of nearly all aspects of the system.
It is therefore recommended reusing this system for your own testsuite as well.

6.1. Inlets

The following inlets are considered in the TigerGlobalConfiguration (ordered from most to least important, meaning if a property occurs in multiple sources the one at the top is considered first):

- Exports from ScopedExecutor
- Thread-local exports
- Exports done in glue code
- Exports during runtime (`TigerGlobalConfiguration.putValue()`)
- Command-line properties
- System-Properties (System.setProperty)
- Environment-Variables (export "FOO_BAR" = 42)
- Full-text YAML file (value of `tiger.yaml` configuration key)
- Additional YAML-Files (`additionalYamls:`)
- Host YAML-File (`tiger-<hostname>.yaml`)
- Main YAML-File (`tiger.yaml`)
- Interne Defaults

6.2. Key-translation

To easily convert between the multiple sources the TigerGlobalConfiguration

offers key-translation:

`tiger.foo.bar` is equal to `TIGER_FOO_BAR` is equal to `tIgER.fOO.BaR`

- When the key consists only of letters and underscores then the underscores are converted to points.
- Names are compared without considering the case.
- Keys that contain '{', '}' or '|' are forbidden.
  To allow a clean startup on systems that have values like this configured the given characters are replaced by '_'.

6.3. Thread-based configuration

To enable execution of multiple tests simultaneously some data has to be stored in a thread-based manner (the first step could for example store the result of a request in a variable, the second step could read it from that variable).

To enable this simply reference the Thread-context when storing a variable:

```
TigerGlobalConfiguration.putValue("foo.value", "bar", SourceType.THREAD_CONTEXT);
```

When retrieving the variable you could simply ask for `foo.value`: Only when you are in the thread that stored this variable you will find it again.

6.4. Placeholders

The TigerGlobalConfiguration supports the use of placeholders.
Say for example you have a test-environment with two servers, "A" and "B".
For the server "A" you have two choices: Either a real URL in the internet or a locally booted server.
The use can choose which to activate by setting "active" of the server to use.
The server "B" should now use the activated server, without having to set it manually while booting.

You could achieve this by exporting the URL (`servers.myServer.exports`) and referencing it in an argument which is passed into server "B" (`serverAUrl=${serverA.url}`.
The first part here before the equal is the name of the environment variable passed into server "B" while booting, the second part behind the equal is the name of the property. compare this to the exports in the two serverA-options):

Listing 20. Configuring using placeholders and exports

```
servers:
  serverAInternet:
    active: true
    type: externalUrl
    source:
      - https://my.real.server/api
    exports:
# The string SERVERA_URL is split internally into SERVERA and URL, which are then considered
# as lowercase keys
      - SERVERA_URL=https://my.real.server/api
  serverALocal:
    active: false
```

```
    type: externalUrl
    source:
      - https://localhost:8080/api
    exports:
      - SERVERA_URL=https://localhost:8080/api
  serverB:
    type: externalJar
    source:
      - http://nexus/download/server.jar
    healthcheckUrl: http://127.0.0.1:19307
    externalJarOptions:
      arguments:
# The second part is the placeholder which will be resolved using the internal value store.
# The string "serverA.url" is split into "serverA" and "url", again considered as lowercase,
# which then matches to "SERVERA_URL",
        - --serverAUrl=${serverA.url}
```

Placeholders which can not be resolved will not lead to errors but rather they will simply not be replaced.

6.5. RbelPath-style retrieval

The placeholders also support RbelPath-style expressions to allow for more flexible, dynamic retrieval of properties.
Consider for example the following YAML:

```
myMap:
  anotherLevel:
    key1:
      value: foobar
      target: schmoo
    key2:
      value: xmas
      target: blublub
  hidden:
    treasure:
      buried: deep
```

To retrieve values from this map you can use the following expressions:

- `${myMap.anotherLevel.[?(@.value=='foobar')].target}` will resolve to "schmoo", retrieving the node `myMap.anotherLevel.key.target`.
- The same value can be retrieved via `${..[?(@.target=='schmoo')].target}`.
  This expression uses the recursive descent mechanic of RbelPath.
- `${..buried}` will resolve to "deep", retrieving the node `myMap.hidden.treasure.buried`.

6.6. Fallback values

Sometimes a default value is desired when a given key is not set.
To define such a value, just use the pipe (|) after the key, like so:

`${foo.bar|orThisValue}`

This will first test for the presence of "foo.bar" as a configuration key.
If that key is not found, the fallback value "orThisValue" will be used.

6.7. Localized configuration

Sometimes scope-creep can be a concern: Say you want to add a bunch of values right for one specific call but want to avoid that those values can be seen from everywhere else.
By default, TigerGlobalConfiguration does not honor scope, which is a deliberate design-choice.
To give you greater control over scope-behavior use the `.localScope()`-method:

```
TigerGlobalConfiguration.localScope()
    .withValue("local.key", "localValue")
    .withValue("another.key", "anotherValue")
    .execute(() -> assertThat(TigerGlobalConfiguration.readString("local.key"))
        .isEqualTo("localValue"));
```

Bear in mind that this does not work with threading: The values are added to the global store and will remain in the store for the duration of the execution of the given runnable.
If you execute multiple tests in parallel you should look into the `TigerThreadScopedConfigurationSource` (which comes with other drawbacks, threading is not an easy problem to solve).

6.8. Examples

Some examples to clarify:

6.8.1. Example 1

Say you have an environment configured in your testenv.yaml.
You want the Tiger Proxy to forward traffic on one route to your backend-server.
This will normally be a local server, but on the build-server you want to address another host.
You can simply set an environment variable to do the job for you.
Below are the relevant snippets:

Listing 21. tiger.yaml with the Tiger Proxy routing everything to the local server

```
tigerProxy:
    proxyRoutes:
        - from: /
          to: http://127.0.0.1:8080
```

In the buildserver you can now simply overwrite the "to"-part of this route like so:

```
export TIGERPROXY_PROXYROUTES_0_TO = "http://real.server"
```

6.8.2. Example 2

In the above example let’s say you only want to customize the port.
This can be done by using placeholders:

Listing 22. tiger.yaml with the Tiger Proxy routing everything to the local server

```
tigerProxy:
    proxyRoutes:
        - from: /
          to: http://127.0.0.1:${backend.server.port}
```

This time we don't overwrite the complete to-url but only the port like so:

```
export BACKEND_SERVER_PORT = "8080"
```

6.8.3. Example 3

Now we want to assert that the reply coming from the server has the correct backend-url in the XML that is returned to the sender.
To do this we have to reference the configured URL from above, since the value could be different on every execution.
We can solve this using placeholders:

Listing 23. The testsuite

```
    TGR current response with attribute "$.body.ReplyStructure.Header.Sender.url" matches
"http://127.0.0.1:${backend.server.port}"
```

The glue-code in Tiger automatically resolves the placeholders.

6.9. Pre-Defined values

Tiger adds some pre-defined values to make your life easier configuring the environment.
Currently these are:

- `free.port.0` - `free.port.255`: Free ports that are randomly determined at startup but stay fixed during the execution.
  This enables side effect free execution of the testsuite.

6.10. Inline JEXL

In addition to the `${foo.bar}` syntax allowing the retrieval of configuration values there exists the `!{'foo' != 'bar'}` syntax allowing the execution of JEXL expressions.
The JEXL-syntax is described in more depth here: https://commons.apache.org/proper/commons-jexl/reference/syntax.html

To give you more power and flexibility when creating inline-JEXL-expression you can access several namespaces from inside the JEXL expression.
You will find two predefined namespaces and also the ability to add your own, allowing further customization.

6.10.1. The default namespace

The default-namespace of the inline JEXL-expression carries the following functions:

- `file(<filename>)` loads the given file and returns it as a UTF-8 parsed string.
- `sha256` returns the HEX-encoded SHA256-value of the given string.
- `sha256Base64` returns the Base64-encoded SHA256-value of the given string.
- `sha512` returns the HEX-encoded SHA512-value of the given string.
- `sha512Base64` returns the Base64-encoded SHA512-value of the given string.
- `md5` returns the HEX-encoded MD5-value of the given string.
- `md5Base64` returns the Base64-encoded MD5-value of the given string.
- `base64Encode` returns the Base64-Encoding of the given string (non-url safe).
- `base64UrlEncode` returns the Base64-URL-Encoding of the given string.
- `base64Decode` decodes the given Base64-String (URL and non-url) and converts it into a UTF-8 string.

An example of a function-invocation in the default namespace:

```
!{file('src/test/resources/testMessage.json')}
```

This will load the given file and replace any placeholders found in it.

6.10.2. The rbel namespace

To give you direct access to the messages sent please use the rbel-namespace:

- `currentResponse` returns the current response, optionally filtered by a given Rbel-path
- `currentResponseAsString` returns the string-representation of the current response, optionally filtered by a given Rbel-path
- `currentRequest` returns the current request, optionally filtered by a given Rbel-path
- `currentRequestAsString` returns the string-representation of the current request, optionally filtered by a given Rbel-path

This can be done like so

```
!{rbel:currentResponseAsString('$.body.html.head.link.href')}
```

This will immediately return the `href`-attribute of the link in question as a string.

6.10.3. Adding custom namespaces

You can easily register additional namespaces by calling `TigerJexlExecutor.registerAdditionalNamespace(<namespace-prefix>, <namespace class or object)`.

6.11. Configuration Editor

The configuration editor allows to view and edit the tiger configuration during a

test run.
The editor is part of the Workflow UI and can be opened by clicking the gears icon in the sidebar (Figure 13).

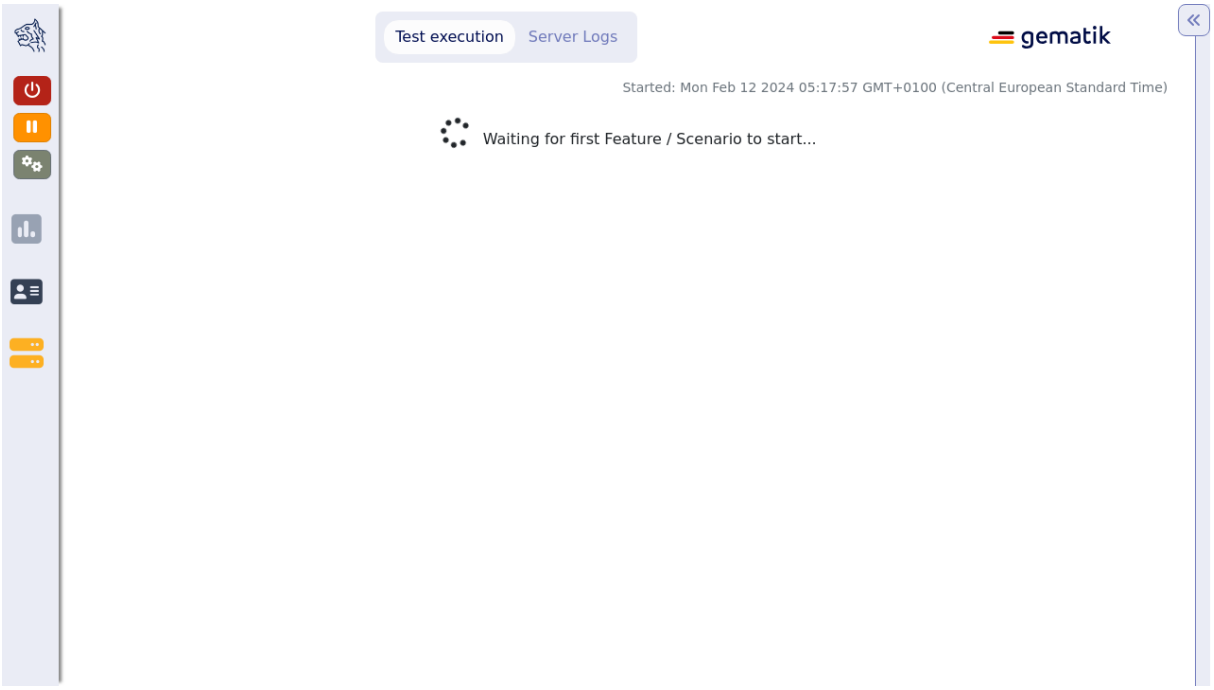

Figure 13. Open the configuration editor by clicking the gears icon in the sidebar.

The configuration editor displays a table where you can view the current configuration properties loaded in the Tiger global configuration (Figure 14).
This includes properties from all inlet sources.
If a property is defined multiple times in different sources, only the one with higher importance is displayed.

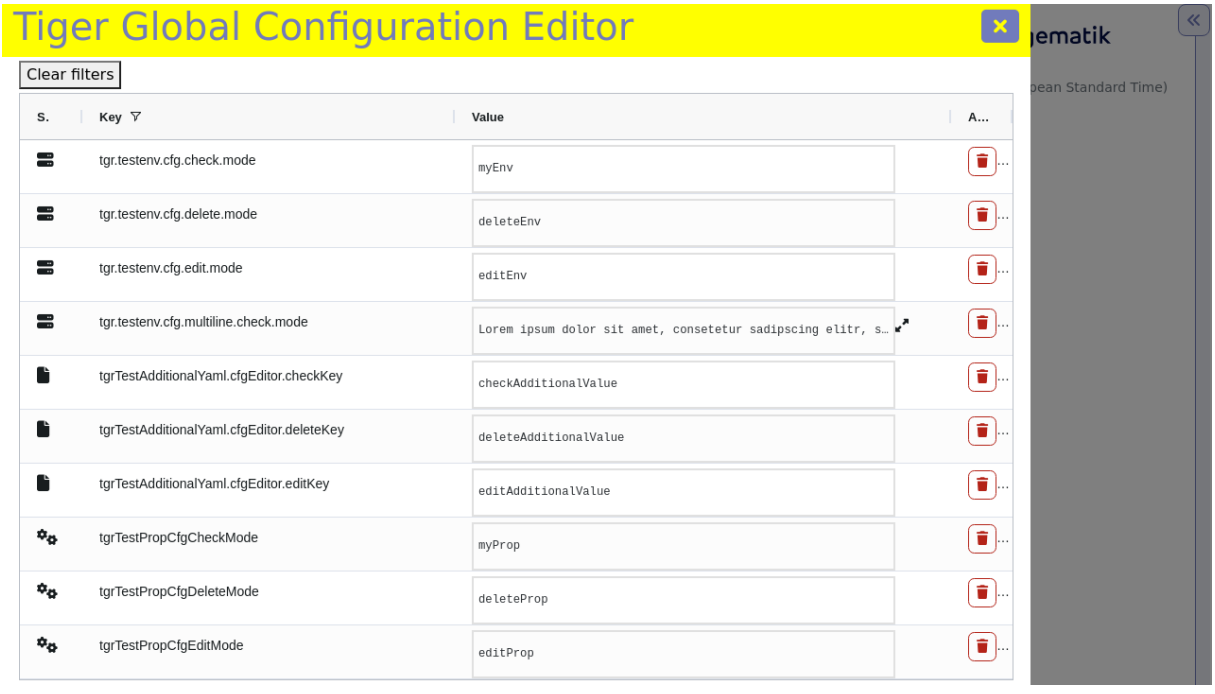

Figure 14. The Tiger global configuration editor

The editor allows sorting and filtering each column so that you can easily find a specific property (Figure 15).

Given that the Tiger global configuration includes many environment variables and system properties which are not directly relevant to Tiger, the filtering functionally proves to be especially useful.

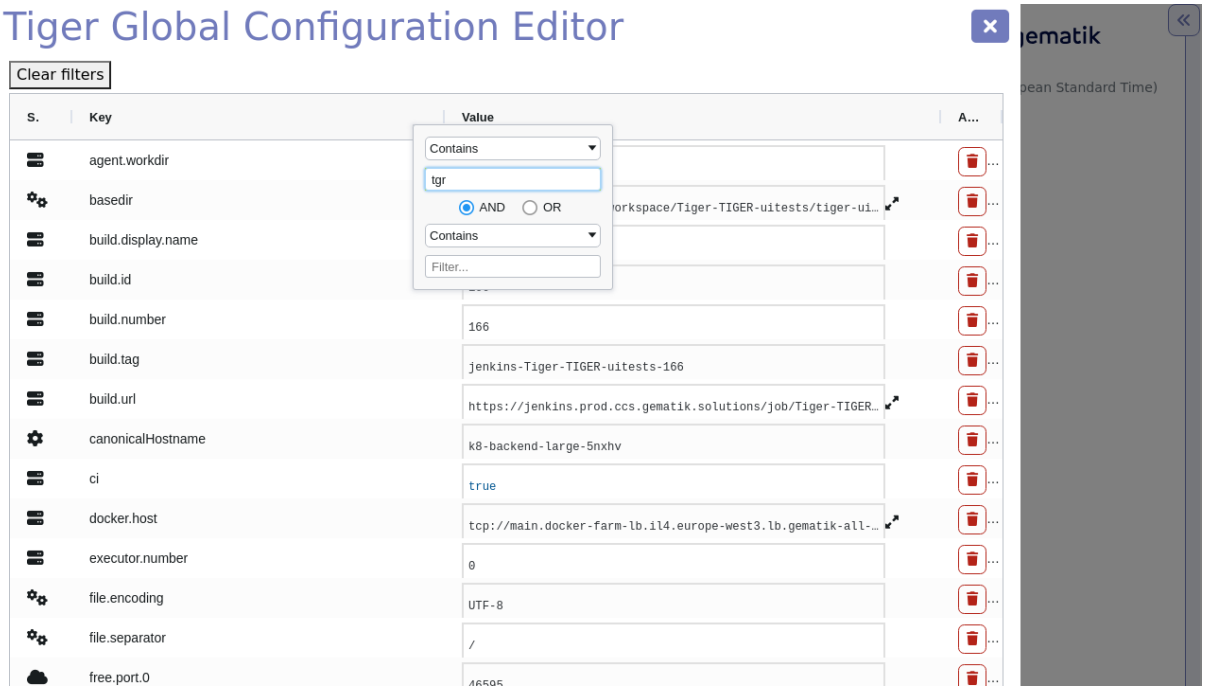

Figure 15. Example of filtering the column key by the text 'tgr'

The values of existing configuration properties can be edited by double-clicking the value cells.
This opens an input field where you can input a new value (Figure 16).

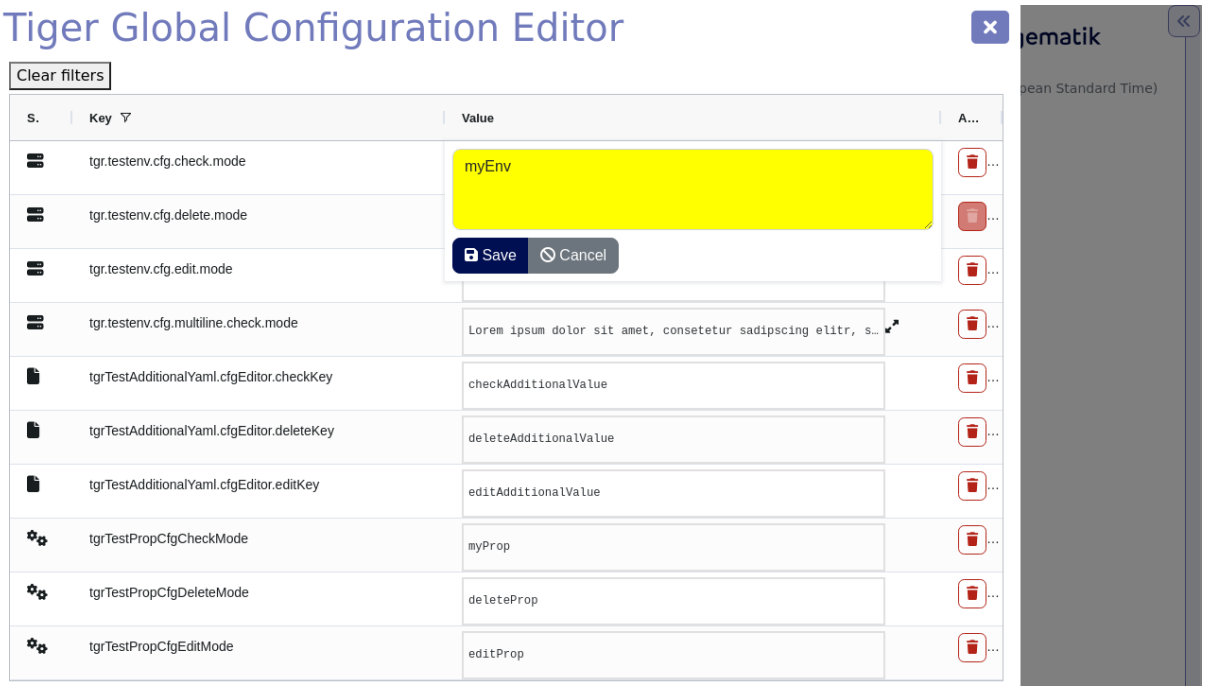

Figure 16. Double clicking a value cell opens the cell editor.

Additionally, you can remove existing configuration properties by clicking the delete button (Figure 17)

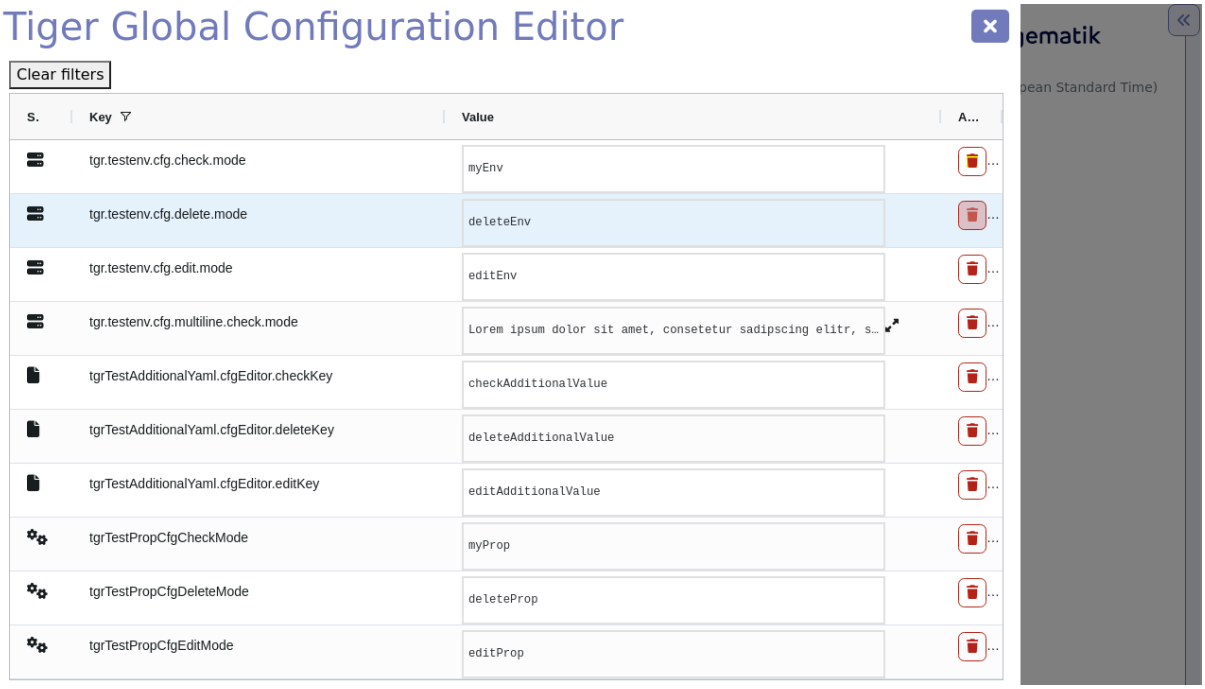

Figure 17. Clicking the delete button removes the property from the Tiger global configuration.

Editing or removing configuration properties will not affect already ran tests.
If you want to use edited properties in a specific test, then you should pause the test before editing the configuration.
In Workflow UI you can see how to use custom steps to pause the test suite.

Some variables in the table have multiline values, causing the text to appear truncated initially.
These cells are equipped with an expand icon (Figure 18), indicating the availability of additional content.

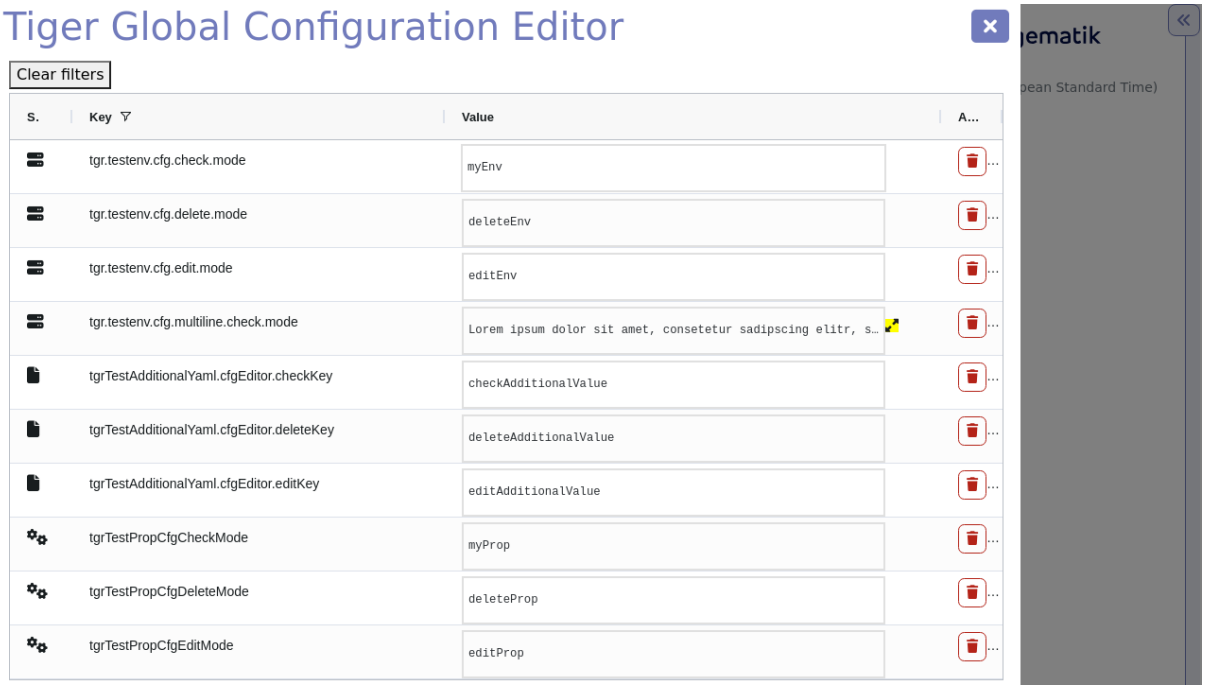

Figure 18. Clicking on the expand icon reveals the full multiline content.

Clicking the expand icon uncover the complete multiline content, ensuring it is fully visible within the cell.

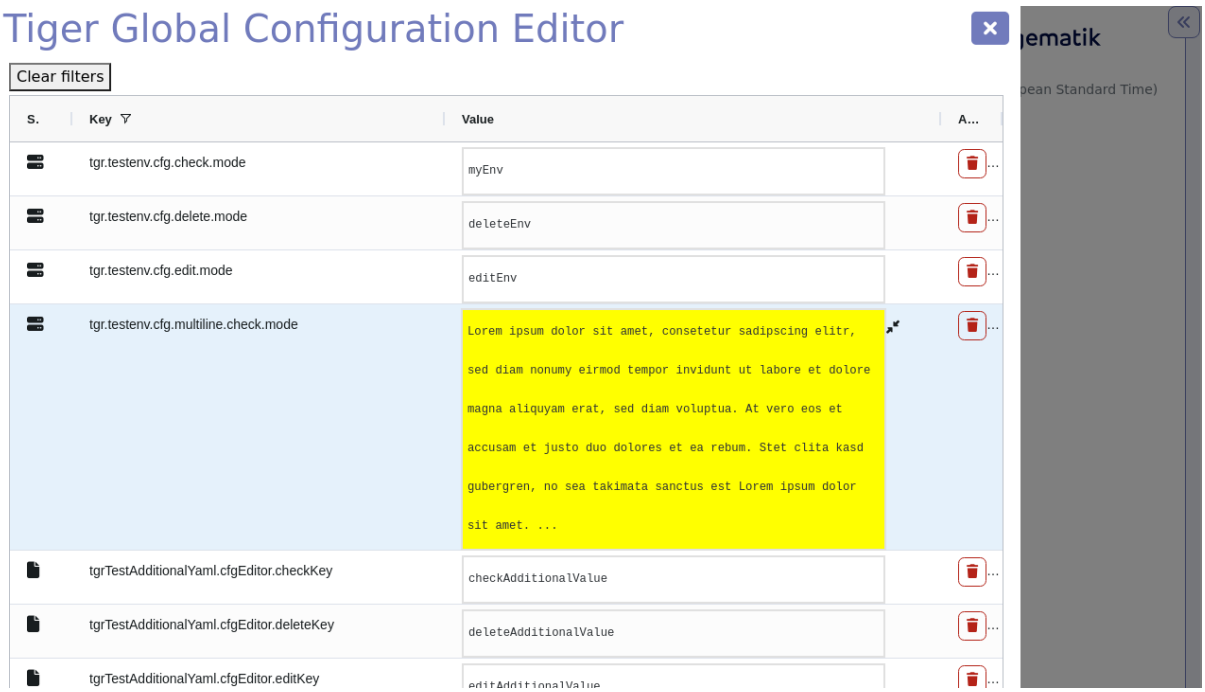

Figure 19. Click the expand icon to view the full multiline content.

To hide the multiline content and return to a truncated view, simply click on the collapse icon.
This action collapses the multiline content, returning the text to its truncated state.

Chapter 7. Tiger User interfaces

7.1. Workflow UI

The Workflow UI is a feature for a better user experience during the test run of feature file(s).

If activated via the `tiger.yaml` configuration file, the Workflow UI will be opened in the current browser window during the test run and shows the status and logs of the servers as well as the results and request calls of the scenarios and feature files during the test run.
If no browser is open at the time a new instance will be launched.

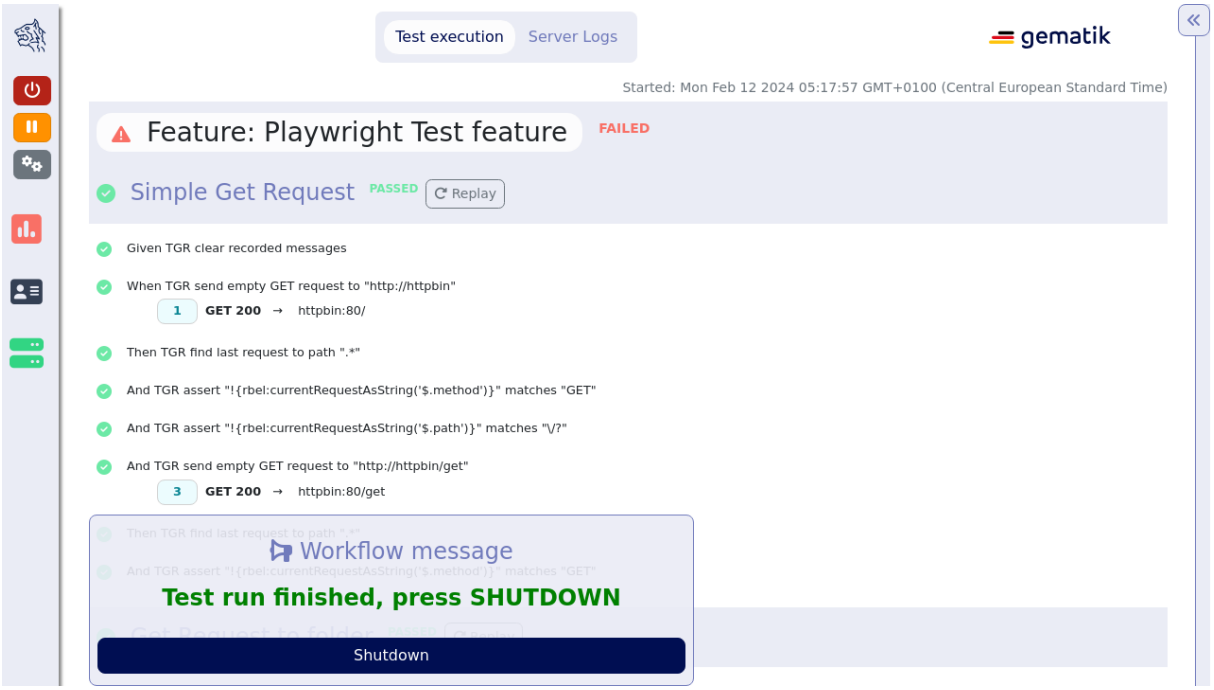

Figure 20. Workflow UI

The image above shows the initial startup of the Workflow UI.
The Workflow UI is divided into three sections: the status bar, the main window with test execution and server logs and the Rbel log details (a slimmed down version of the WebUI).

7.1.1. Status Bar

The section on the left is called status bar as shown in the picture below.

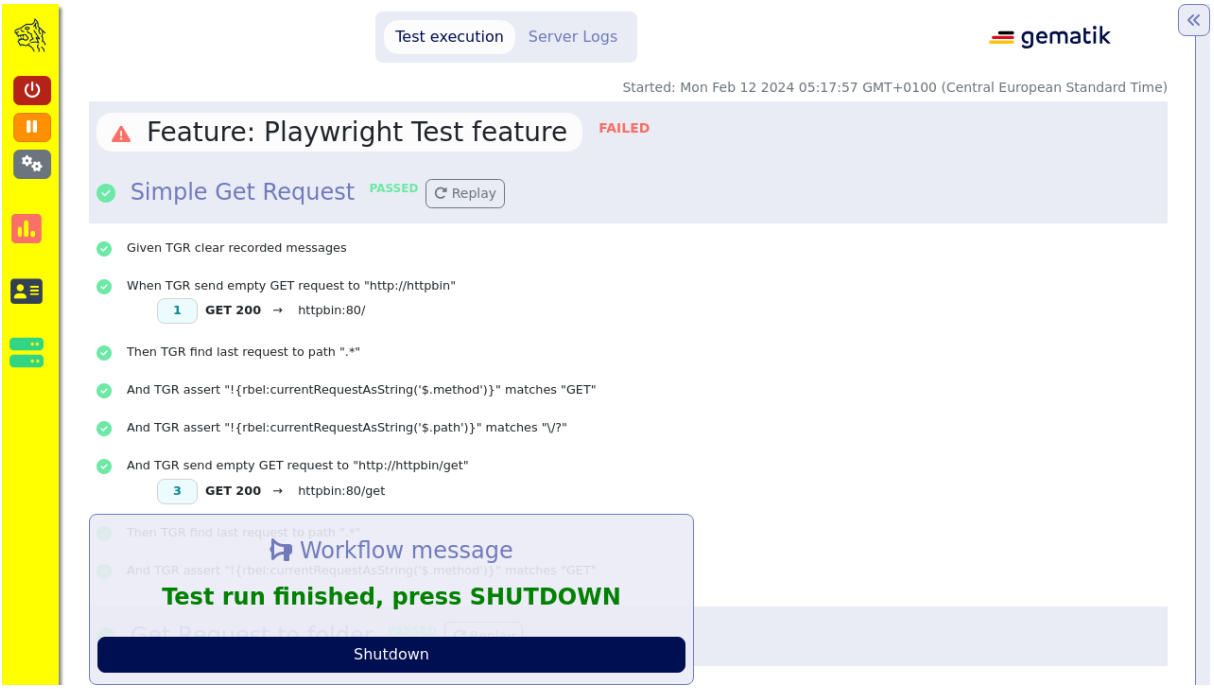

Figure 21. the status bar is situated on the left

When the user clicks on the tigers head on the top left the status bar slides open as shown below.

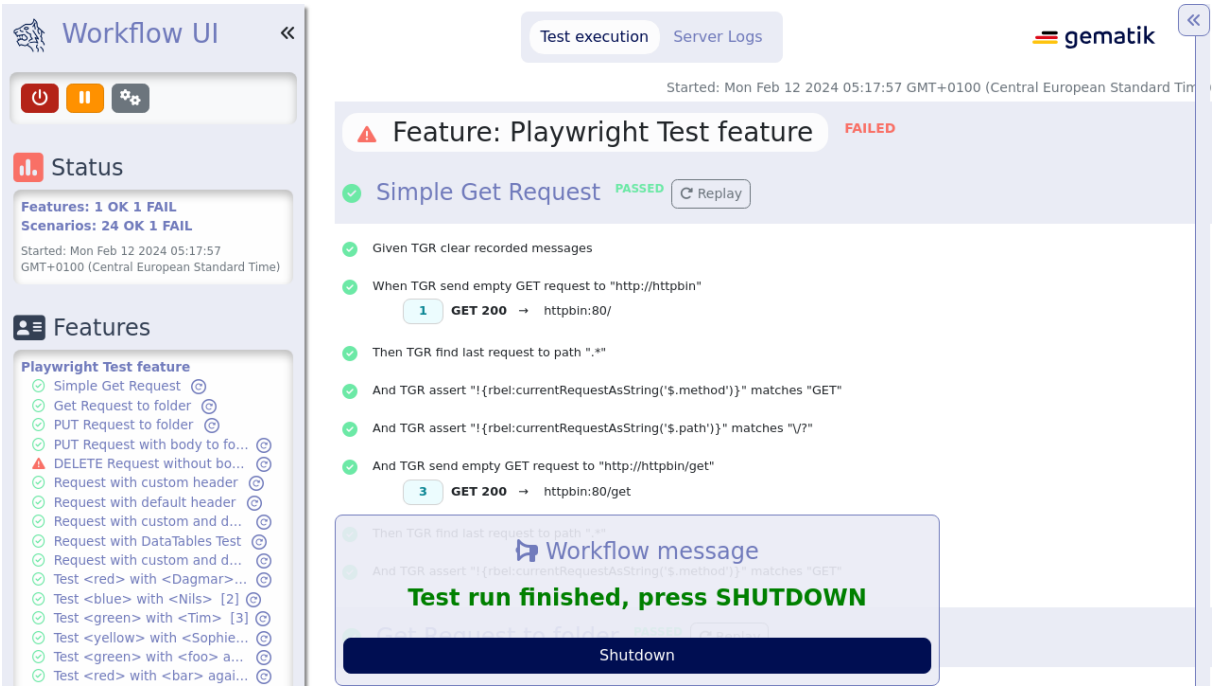

Figure 22. open status bar

Figure 23. status bar buttons: abort, pause, configuration editor

The first button stops the test execution and terminates the servers.
As seen in the following screenshot the background color of the status bar changed to red and at a banner is shown that tells the user that the test execution has been aborted.

Once the Workflow UI has quit, searches and filtering on the Rbel log details as well as on the Web UI are no longer possible.

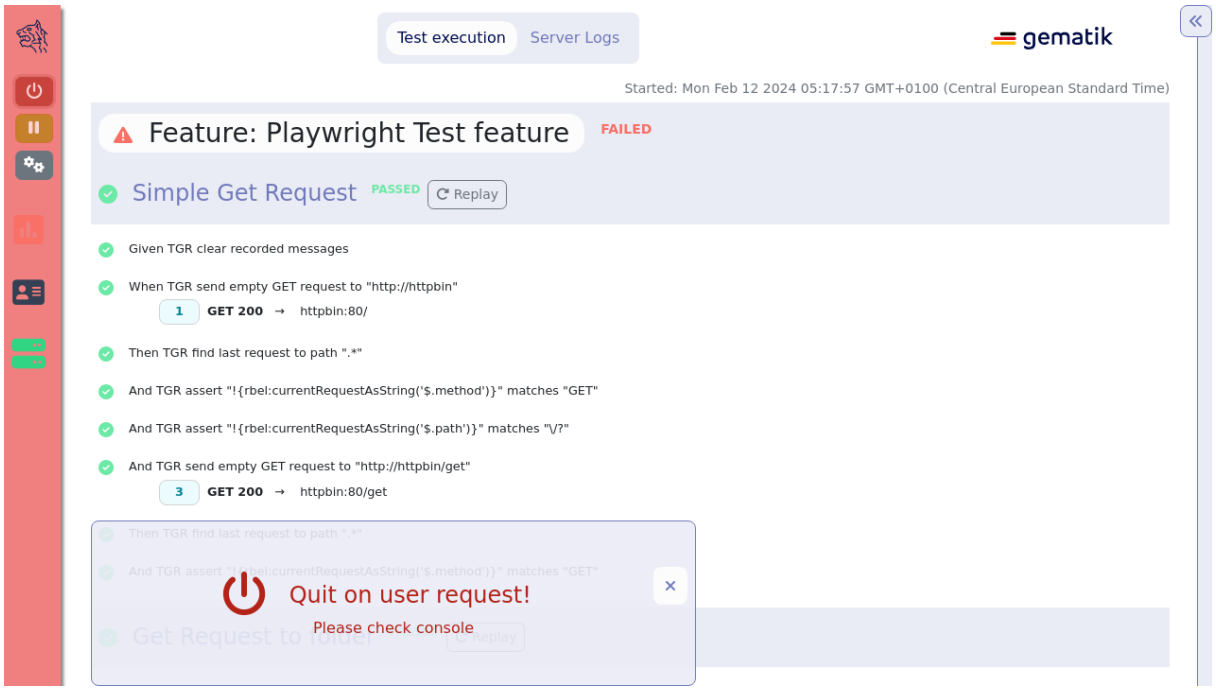

Figure 24. test execution has stopped on user request

By clicking on the second button the test execution pauses.
The background color of the status bar and the pause button change to indicate the pause as shown in the following picture.

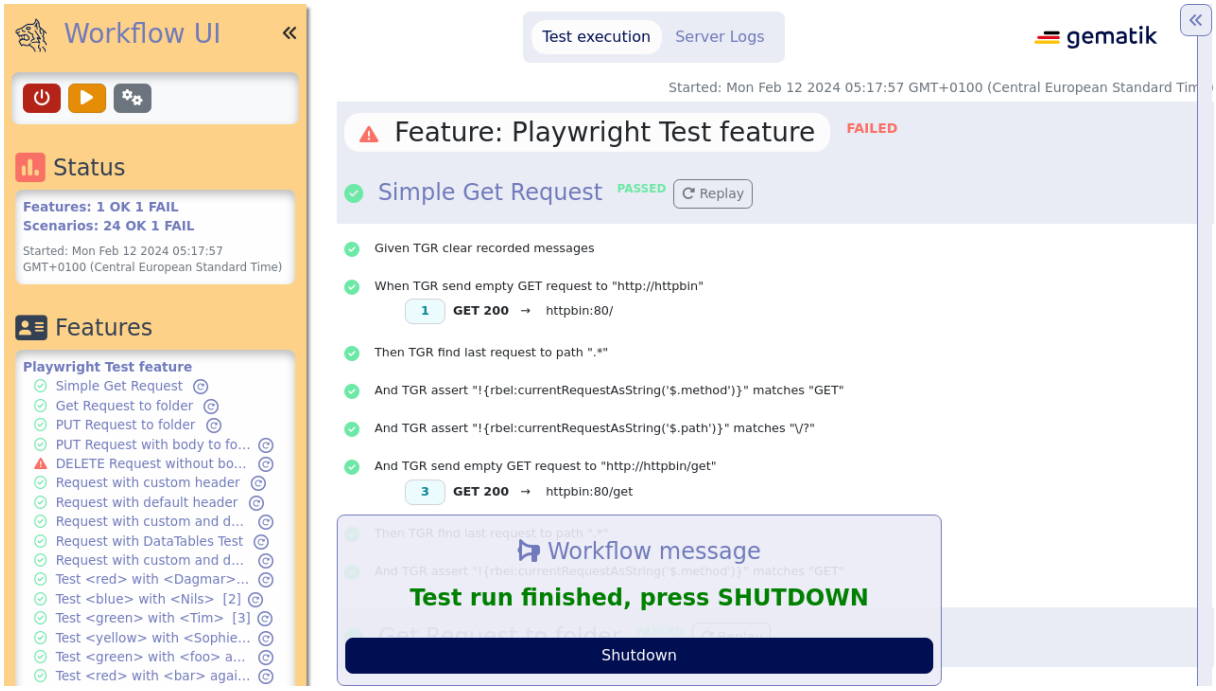

Figure 25. test execution is paused

The test execution will be resumed once the user clicks on the green play button.
The third button opens the Configuration Editor which is explained in detail in this section.

Below the buttons the status box shows how many feature files and how many

scenarios were executed and also the amount of failed tests are shown.

Figure 26. status box

In the feature box below each scenario name is displayed.
The names are linked to the test and when the user clicks on the scenario the test is shown in the test execution on the main section.
The green icon in front of the name indicates a passed scenario, the red exclamation mark indicates a failed scenario.
The numbers in square brackets indicate that this is part of an outline scenario, meaning a test scenario that is run multiple times with different test data.

Figure 27. feature box

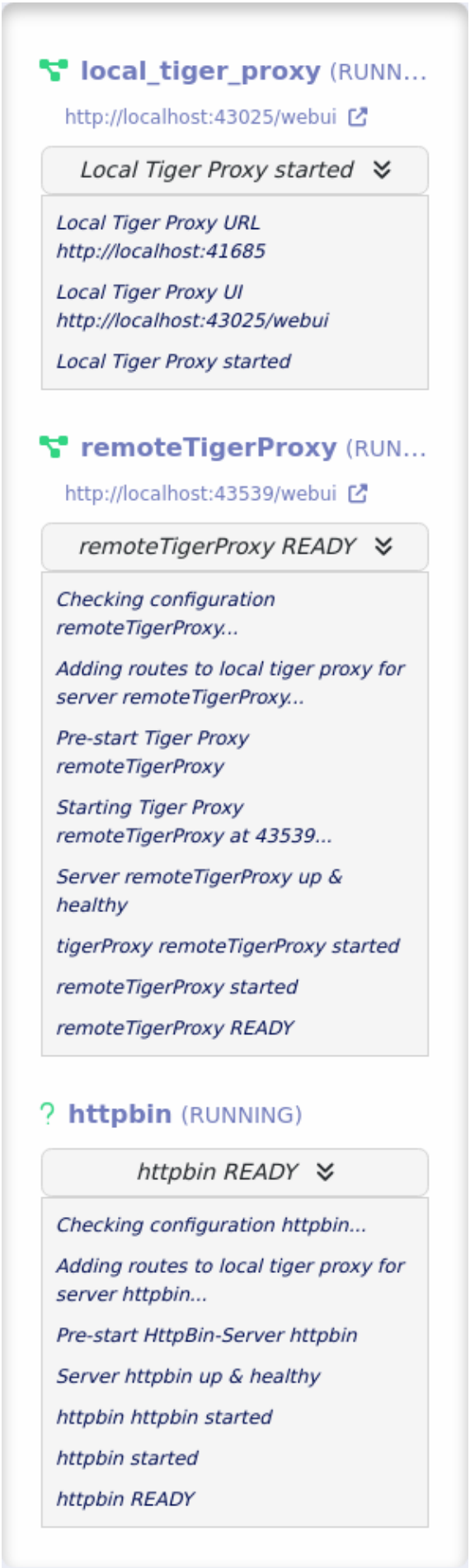

Figure 28. server box

The server box above displays the configured servers, its status (e.g. STARTING, RUNNING, STOPPED) and some outputs of its logs.
When the icon color before the server name is green then the server is up and running correctly.

Below the server box the version number and the build date of the currently used tiger release is displayed.

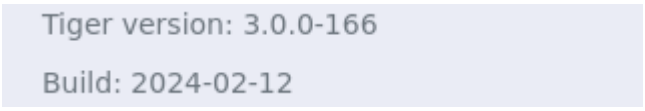

Figure 29. tiger version and build

The status bar can be minimized by clicking on the double arrow or by clicking on any of the icons in the status bar (e.g. status box icon, feature box icon, server box icon, tiger head icon).

7.1.2. Main window

The main window of the Workflow UI has two sections: the test execution and the server logs which can be selected by the two buttons on top of the Workflow UI as seen in the picture below.

Server logs

By clicking on the server logs button on top of the main window the user can have a look at the log files of each server.
There the user can use several filter options to search in the log files.
There are the following server buttons: you can see all logs of all servers, or only the logs of one or more servers by clicking on the corresponding buttons.
The user can also search via text input after a certain text phrase.
It is also possible to distinguish between the different log levels.
In the picture below only the httpbin server is selected.

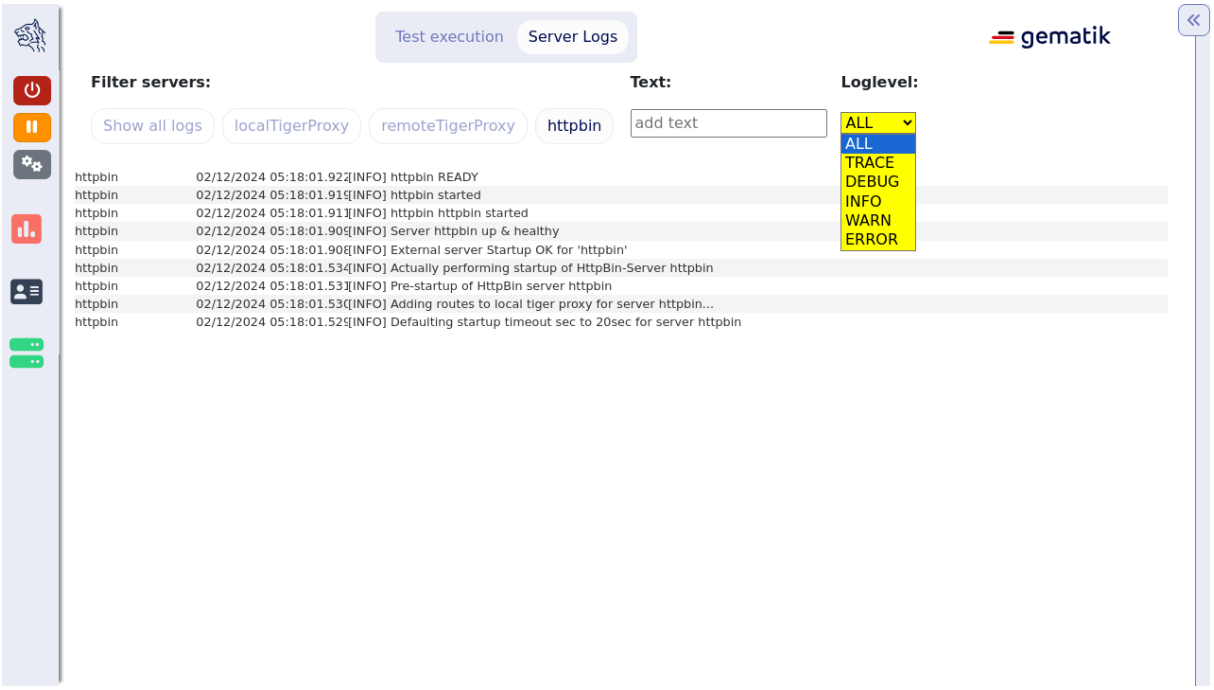

Figure 30. Server Logs with httpbin server and all log levels selected

Test execution

In the test execution tab the user sees the executed features and their scenarios as well as their execution status.
A test can be either passed or failed.
In the example below the scenario has passed but the feature itself has failed, which means that at least one of the scenarios of the feature has failed.

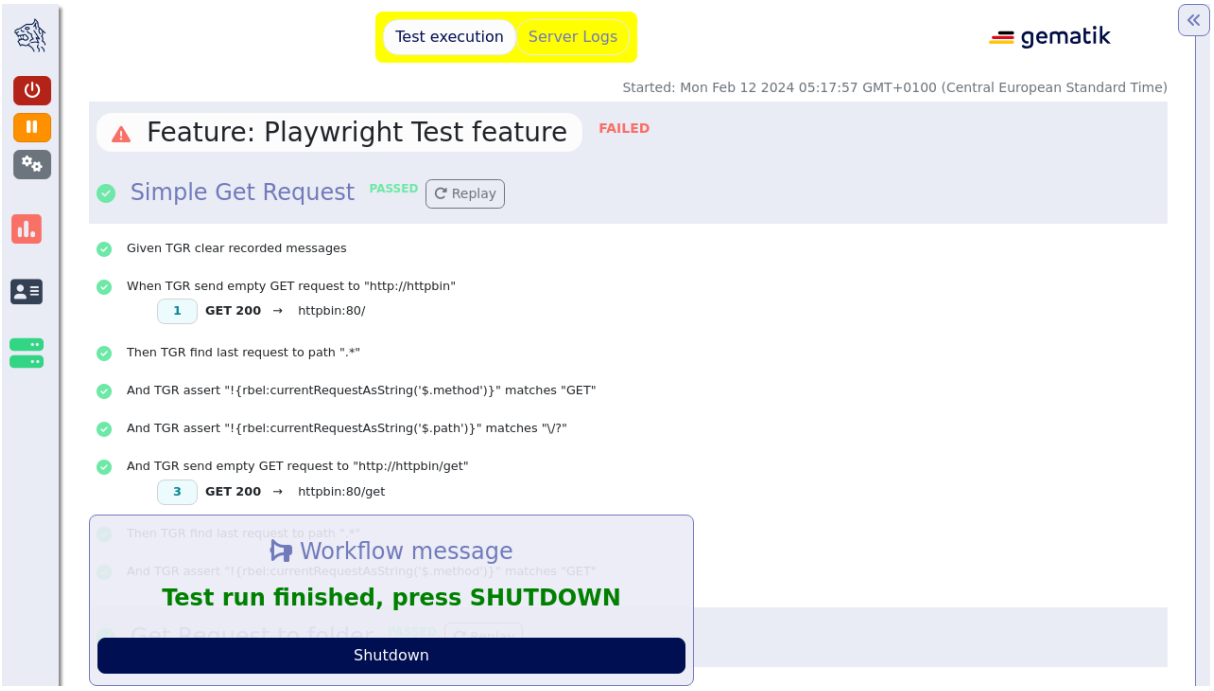

Figure 31. Test execution

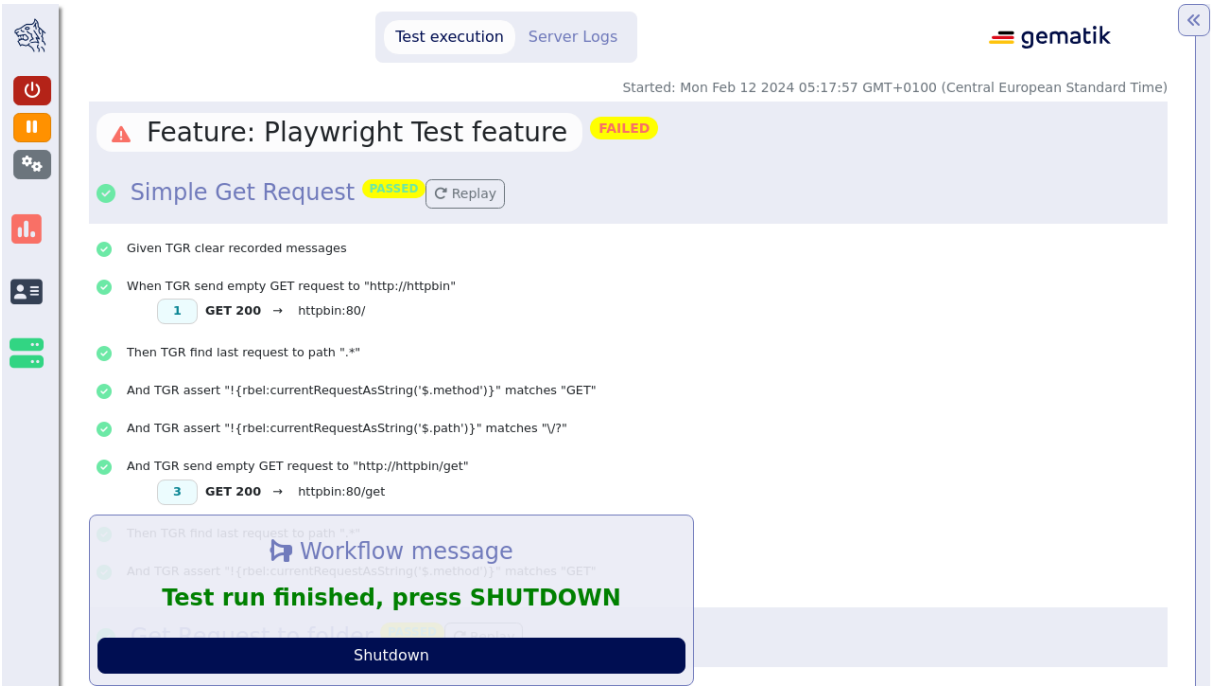

Figure 32. execution status for scenarios and features

Beside the status at the end of the feature/scenario name the user can also see the status at the icon before the name.
During text execution or while pausing the Workflow UI there is a third status the feature/scenario can have which is "pending".

The icon before the name would be a spinner icon to indicate that status.

TGR banner step will be displayed at the bottom of the Workflow UI and will stay there till the next banner step replaces the message.
This way you can instruct manual testers to follow a specified test workflow.
This feature is used in the EAU Konnektorfarm validation test suite to guide the Primärsystem manufacturers through the interoperability combinations of signing/verifying documents against all Konnektors available.

Additionally, a test scenario can be replayed.
When clicking the replay button next to the scenario name, the scenario will be rerun again.
If placeholder variables were modified with the configuration editor, the new values will be used when replaying the scenario.

Figure 33. The replay button

Alternatively, a scenario can be replayed by clicking the small replay button in the feature box in the sidebar.

Figure 34. Small replay buttons in the sidebar

The communication requests that are called during the step execution are displayed beneath the step that initiated the request.
When the user clicks on the light blue rectangle with the number (whereas uneven numbers are requests, even number are responses) of the request then the Rbel Log view opens on the right hand side of the Workflow UI as shown on the screenshot below.

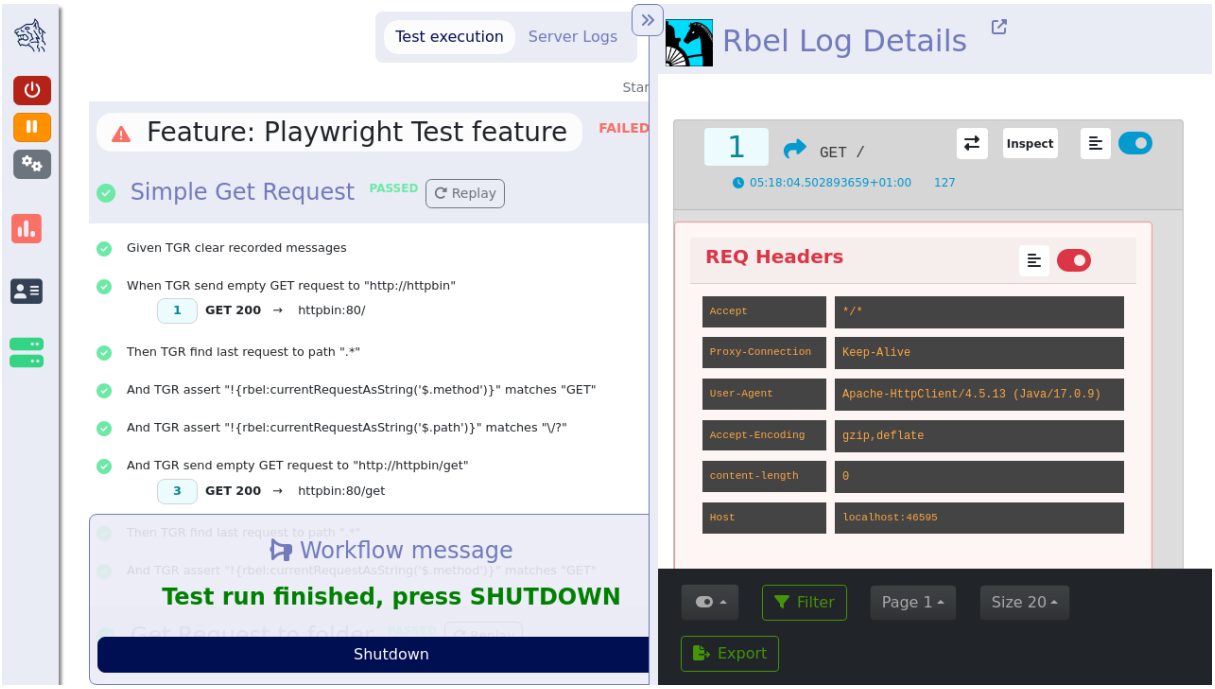

Figure 35. Rbel Log Details

In the Rbel Log Details view the RbelMessages are displayed that are also saved as HTML files as described in the Cucumber and Hooks section.
Next to the headline there is a link to the WebUI (aka Tiger Proxy UI) which opens the WebUI in a new tab as shown in the picture below.

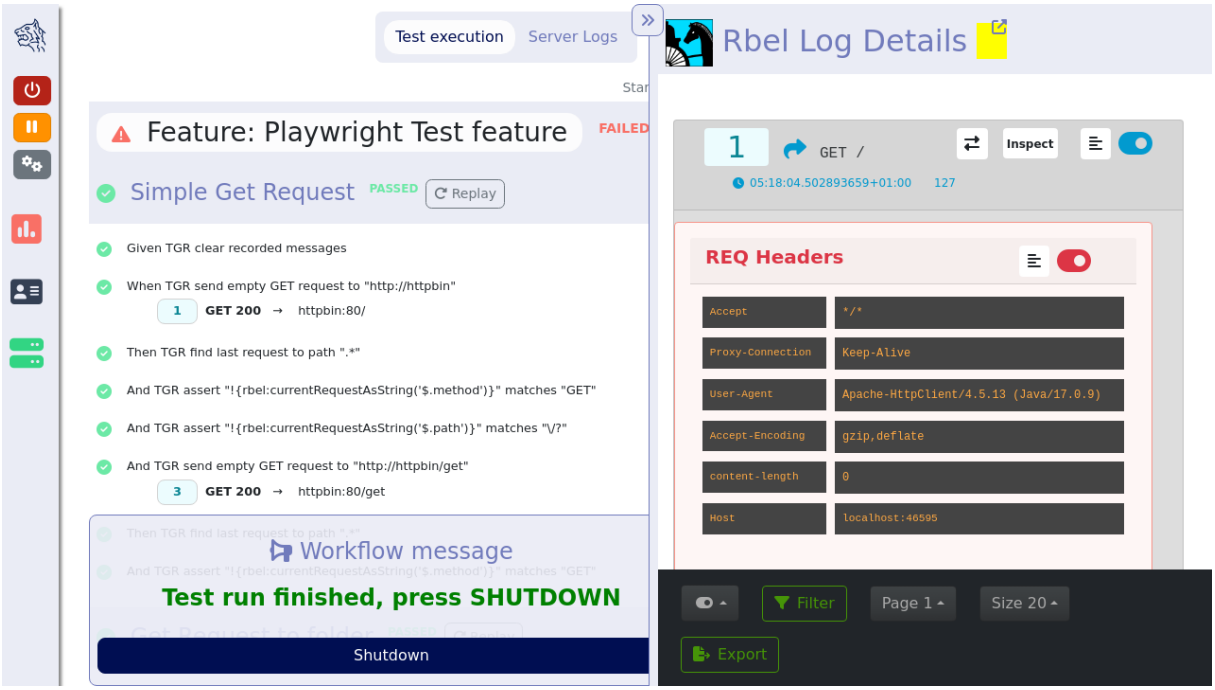

Figure 36. Link to open the WebUI

The Rbel Log Details view is described in the WebUI section as it is a slimmed down version of the WebUI.
In order to increase/decrease the width of the Rbel Log Details view the user can drag the border between the main window and the Rbel Log Details view.
The Rbel Log Details can be minimized by clicking on the double arrow on the top left of the Rbel Log Details section.

7.1.3. Traffic Visualization

An additional feature of the Workflow UI is the traffic visualization.
This feature allows to visualize the traffic between the servers under test in a sequence diagram.
The feature needs to be explicitly enabled in the `tiger.yaml` configuration file.

```
lib:
  trafficVisualization: true
```

This will enable a third section in the main window of the Workflow UI where a sequence diagram is displayed.

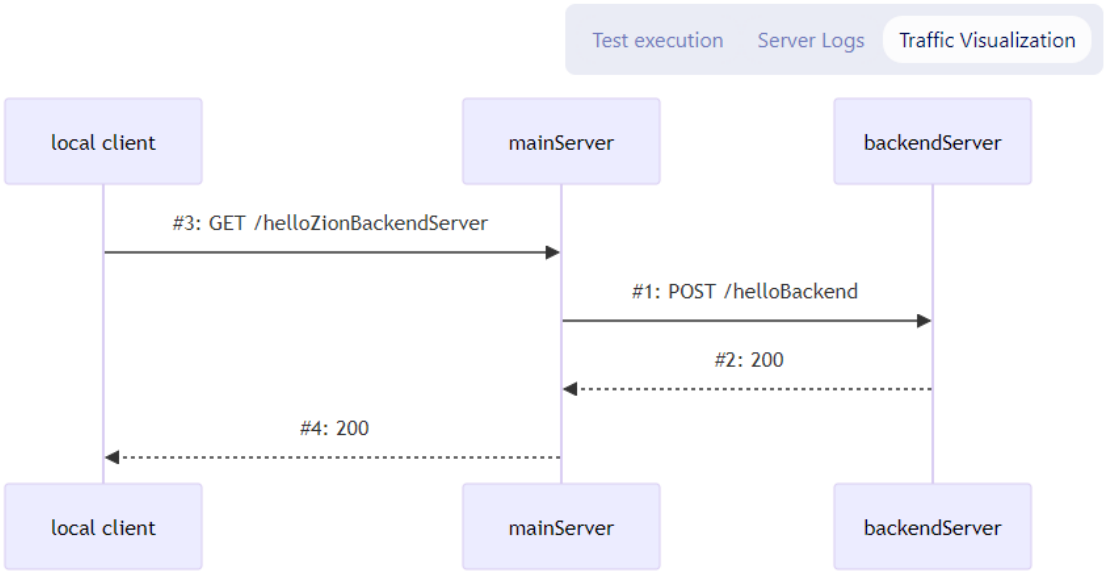

Figure 37. Traffic Visualization

The sequence diagram shows the messages that were exchanged between the servers under test.
By clicking on a message in the sequence diagram, the corresponding Rbel Log Details will be displayed in the Rbel Log Details section.

The traffic visualization currently supports the following server types: `externalJar`, `externalUrl`, `zion`, `docker` and `compose`.

For messages to show up in the sequence diagram they need to be routed through the Tiger Proxy.
This is the case for all the messages originating in the local tiger client and their responses.
If there are additional messages originating on one the servers under test, they need to be routed through the Tiger Proxy as well.
In Zion servers this is automatically configured.
For external jars this can be achieved by configuring the servers with the following VM options:

```
externalJarOptions:
  options:
    - -Dhttp.proxyHost=127.0.0.1
```

```
    - -Dhttp.proxyPort=${tiger.tigerProxy.proxyPort}
```

For the server types docker and compose, we do not yet support the visualization of messages originating on a client port of these servers.

7.2. Standalone Tiger Proxy UI (WebUI)

To watch the recorded messages and to be able to analyze issues at test run time already you can visit the Tiger Proxy web user interface at:

```
http://127.0.0.1:${SERVERPORT}/webui
```

With `ADMINPORT` being the configured server port of the Tiger Proxy.

When the user works with the Workflow UI the Tiger Proxy UI can be opened via a link in the Rbel Log Details view in a new browser tab.

7.2.1. Overview

The following screenshot shows the WebUI.
On the left side the request/response pairs are displayed.
The user can see the request type and the error code of the response as well as the timestamp of the request.

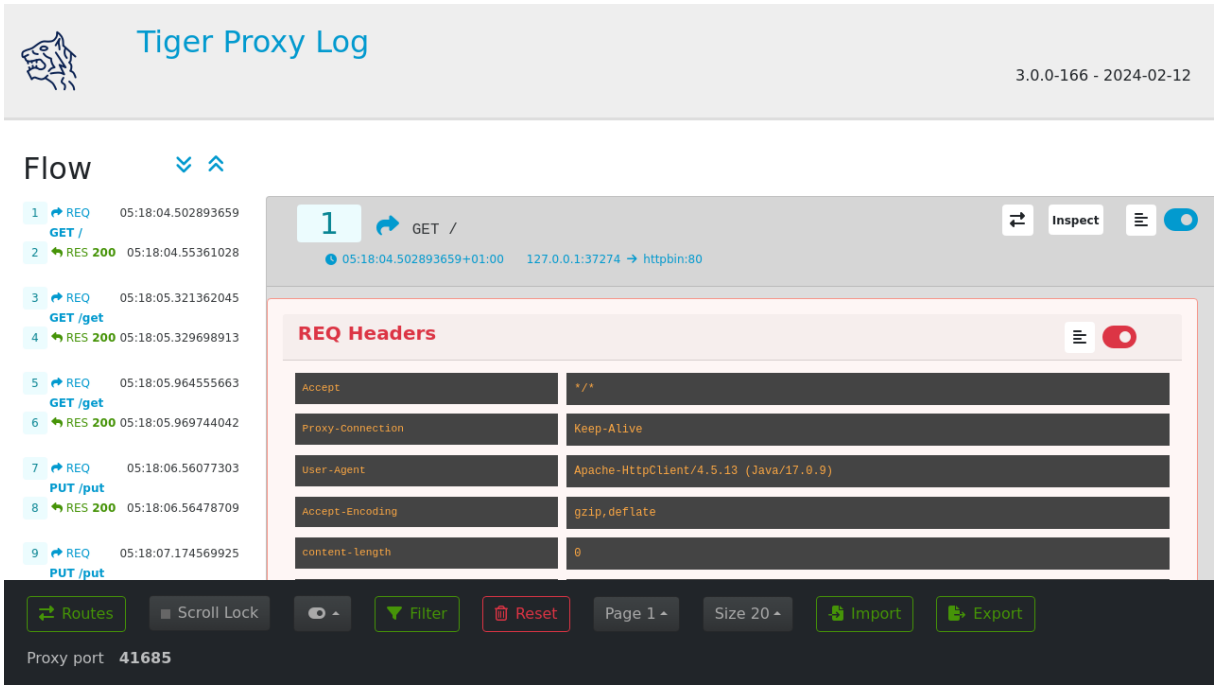

Figure 38. Tiger Proxy UI / WebUI

On the top right the tiger version and the build date are displayed.
In the middle the full request and response messages are shown with detailed header and body.

7.2.2. Bottom menu bar

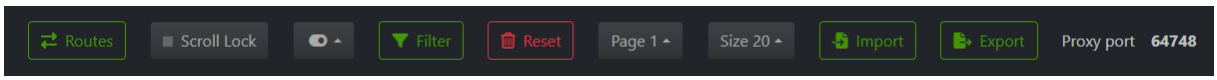

Figure 39. Tiger Proxy UI bottom menu bar

The displayed buttons can trigger the following actions:

- **Routes** … allows you to modify and add the routes configured on this Tiger Proxy
- **Scroll Lock** … allows you to lock the scroll position.
  Incoming messages will still be added to the list at the bottom of the page.
- **Toggle Button** … has two possibilities (hide headers and hide details) which collapses either all headers (request headers as well as response headers) or all the detailed information of the requests and responses.
- **Filter** … allows you to filter the received messages with a RbelPath or a JEXL expression.
  You can also search for text or a regex in this input field, but then you need to place the search text inside quotation marks (").
- **Reset** … allows you to delete all recorded messages so far.
  This will delete all messages on the Tiger Proxy!
- **Export** … allows you to export all or the currently filtered received messages as an HTML page or as a machine-readable tgr file.
- **Page** … allows pagination of the messages.
- **Size** … changes the size of the messages.
- **Import** … allows you to import the previously stored traffic file.
- **Quit** … allows you to quit the Tiger Proxy instance

Some modals are explained in more detail in the following sections.

Filter Modal

When a lot of messages are recorded, it is sometimes hard to find the message you are looking for.
Therefore, the user can filter the messages with a Rbel-Path or a regex using either the filter modal as shown in the picture below or the JEXL Debugging modal described here.

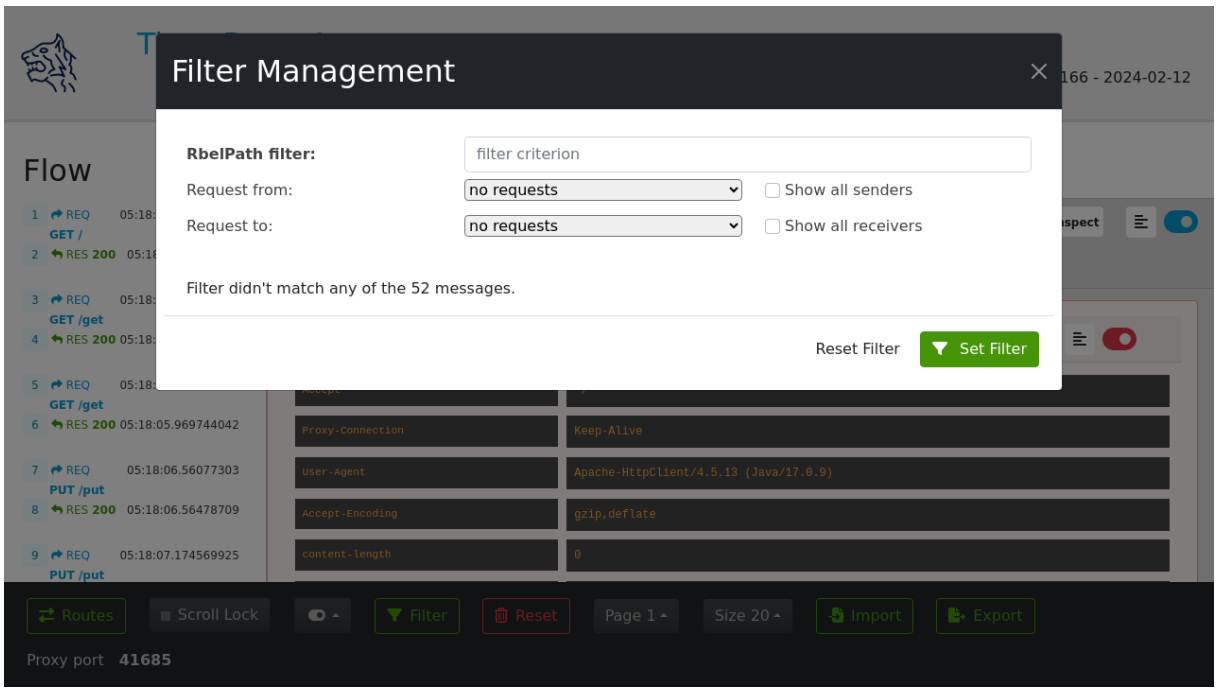

Figure 40. Filter Managment

RBel-Path/JEXL Debugging Modal

When the user wants to inspect a Rbel-Path or have a look at some JEXL expressions, the user can click on the corresponding button in the top right corner of the request or the response that is highlighted in the following screenshot.

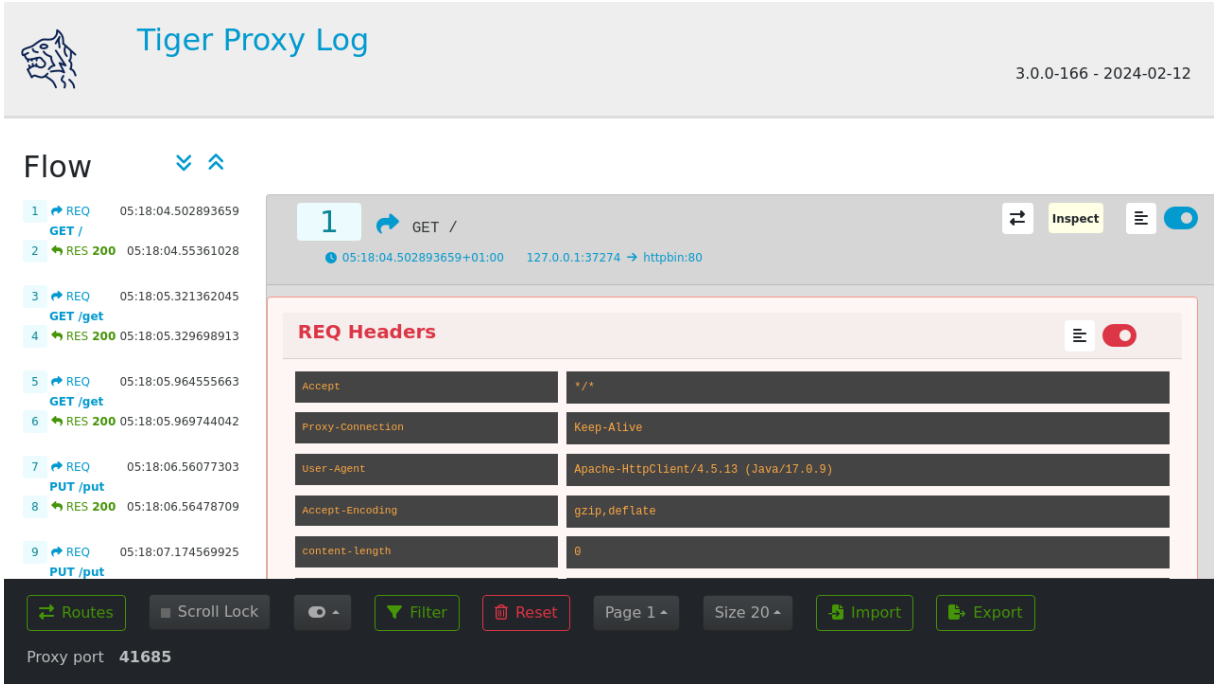

Figure 41. Access RBel-Path/JEXL Debugging

The picture below shows the RBel-Path tab.
The user can execute the RBel-Path on the request or the response and the result is displayed in the bottom part of the modal.

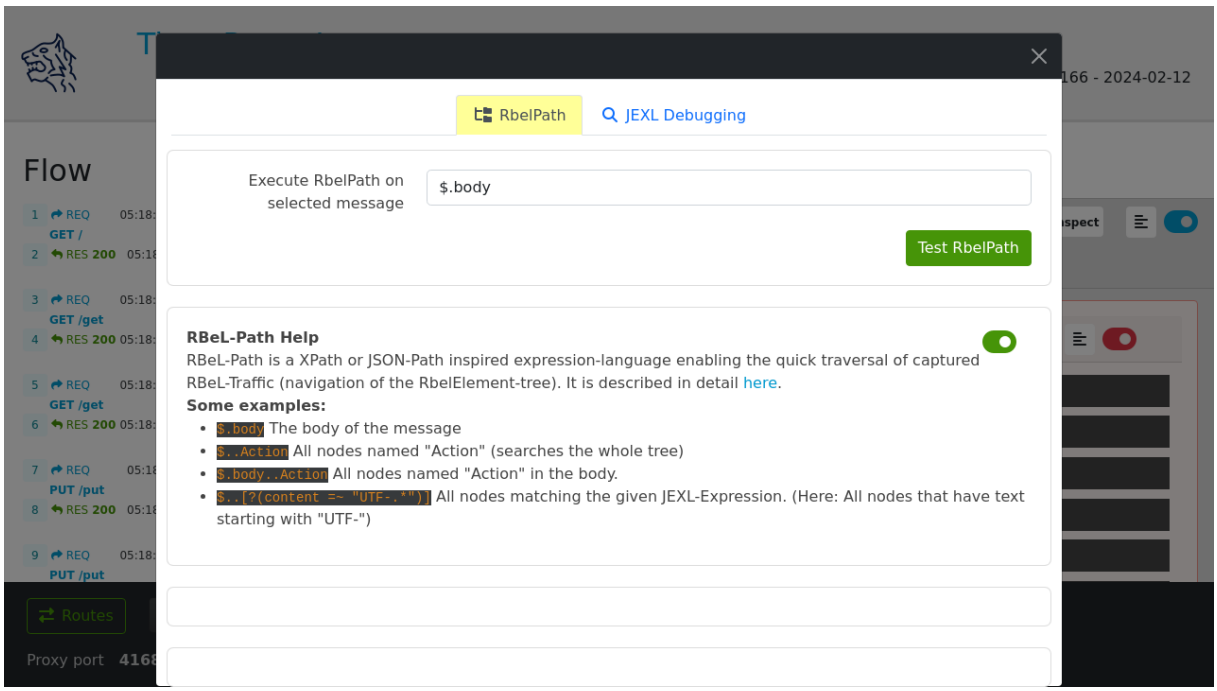

Figure 42. RBel-Path

For more information in the Rbel-Path check out this section.

The picture below shows the JEXL Debugging tab.
The user can execute the JEXL expression on the request or the response and the result is displayed in the bottom part of the modal.
Further information on JEXL expressions can be found in Explanation of JEXL Expressions.

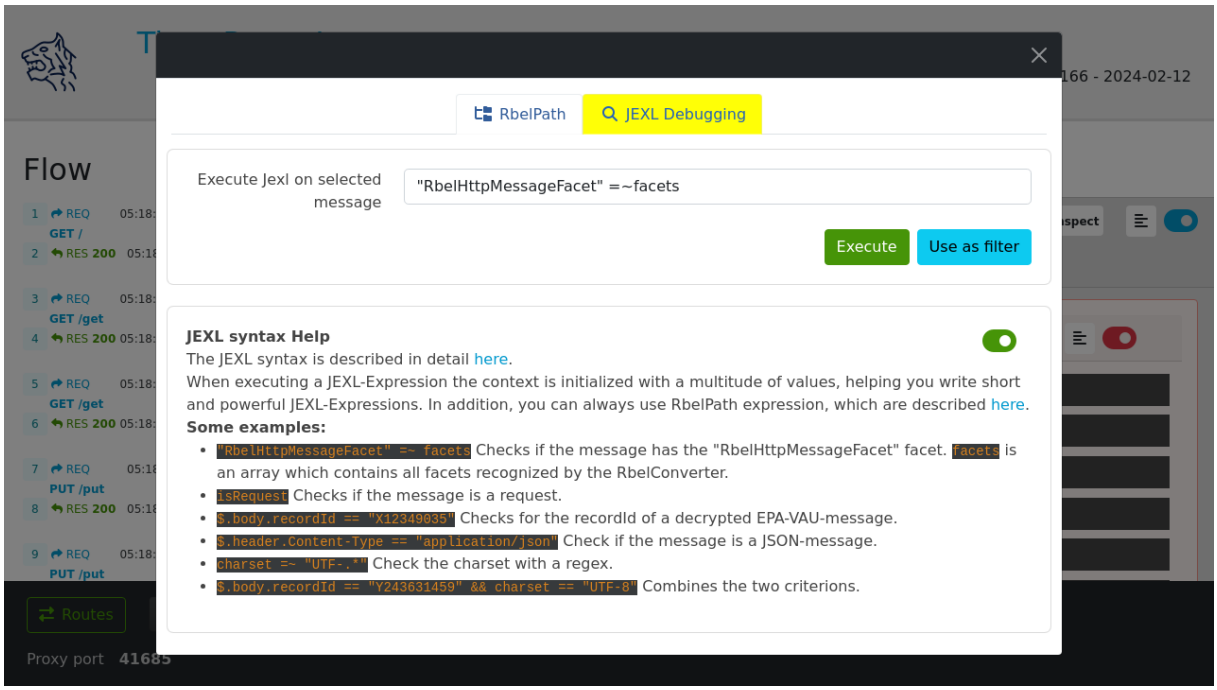

Figure 43. JEXL Debugging

When the user wants to filter the messages with a JEXL expression, the user can click on the "Use as filter" button in the modal.

Routing Modal

The user can add/delete routes in the routing modal which is shown in the following screenshot.

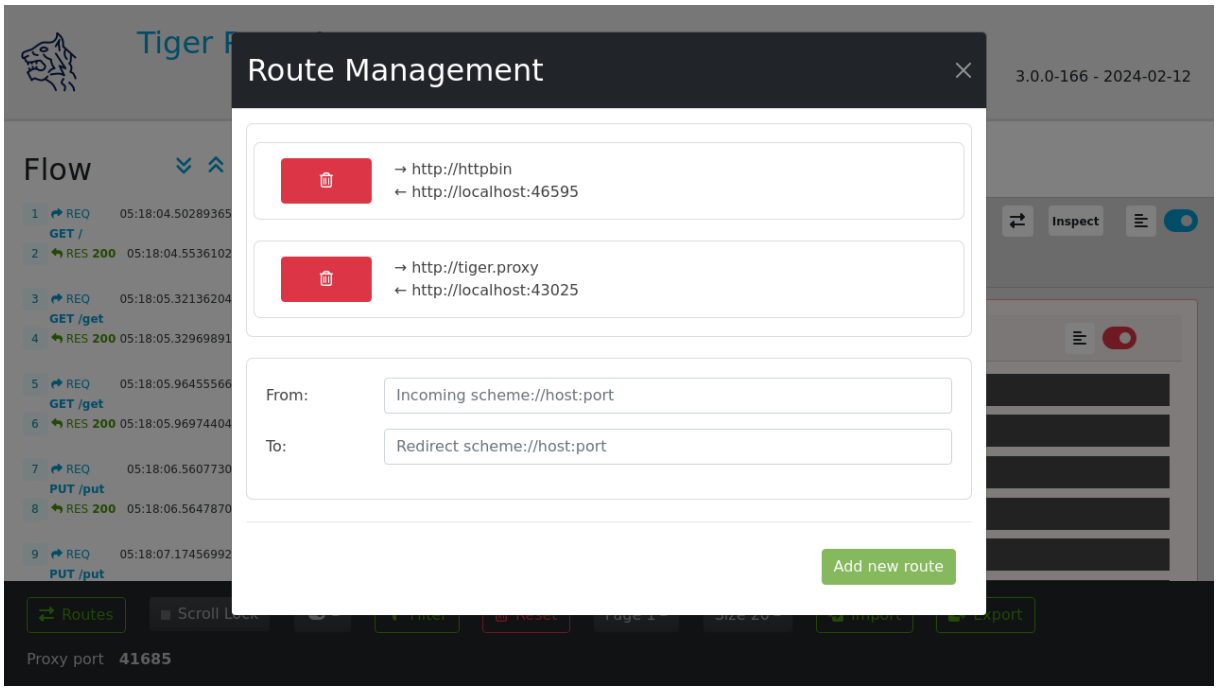

Figure 44. Route Managment

Message Content

The user can have a look at the request/response message content of the header, body or both by clicking on the corresponding button in the top right corner of the request or the response that is highlighted in the following screenshot.

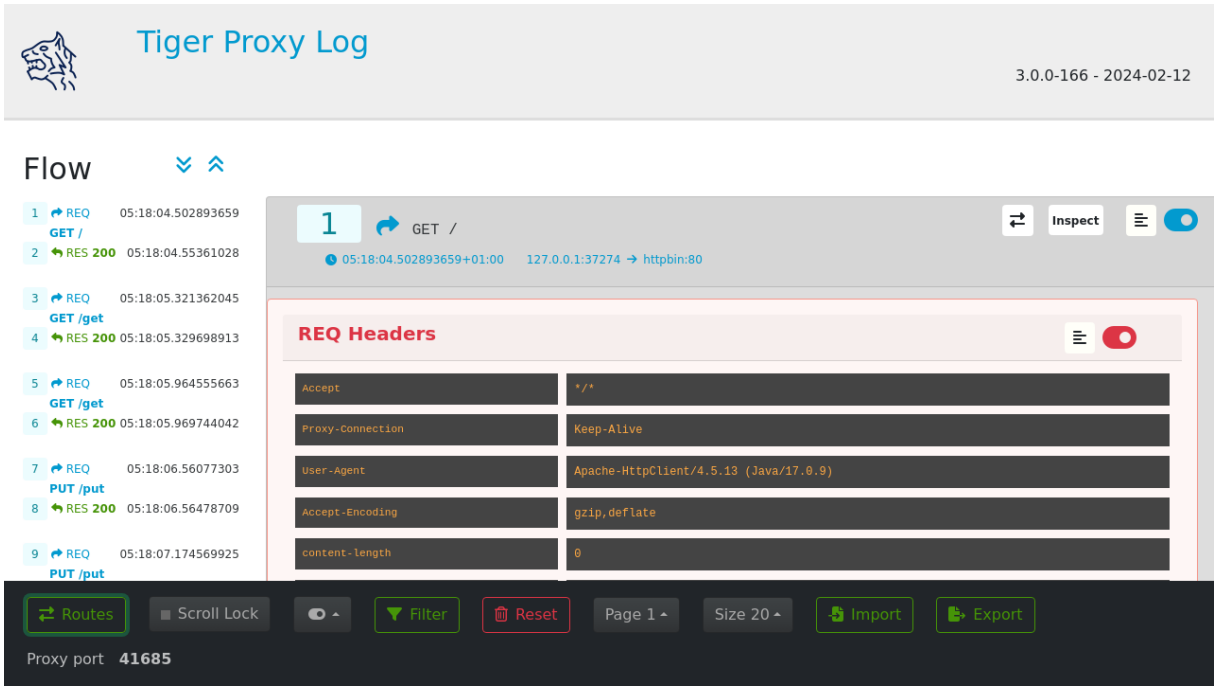

Figure 45. Buttons to show message content

The picture below shows the content of the whole response.

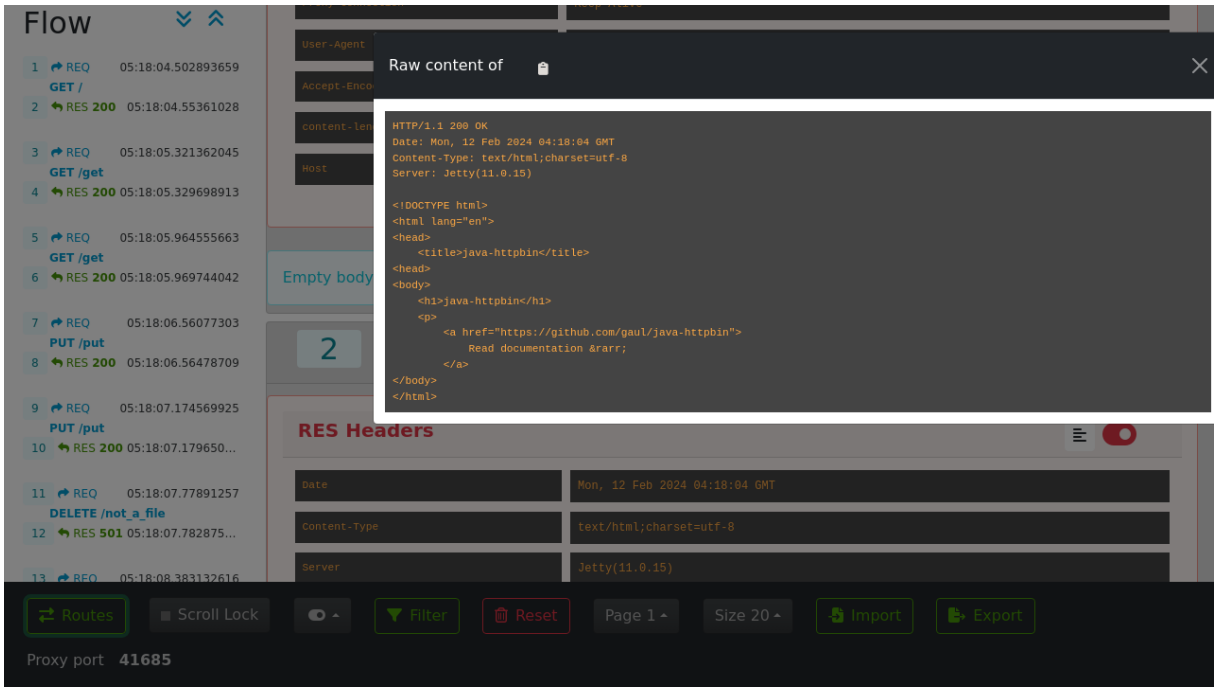

Figure 46. Example of the content of a response

Switching between request/response

Since the order in the list is based upon the reception of the corresponding message it can be hard to find the corresponding request or response to a given message. To make this easier the user can switch between the request and the response by clicking on the corresponding button in the top right corner of the request or the response that is highlighted in the following screenshot.

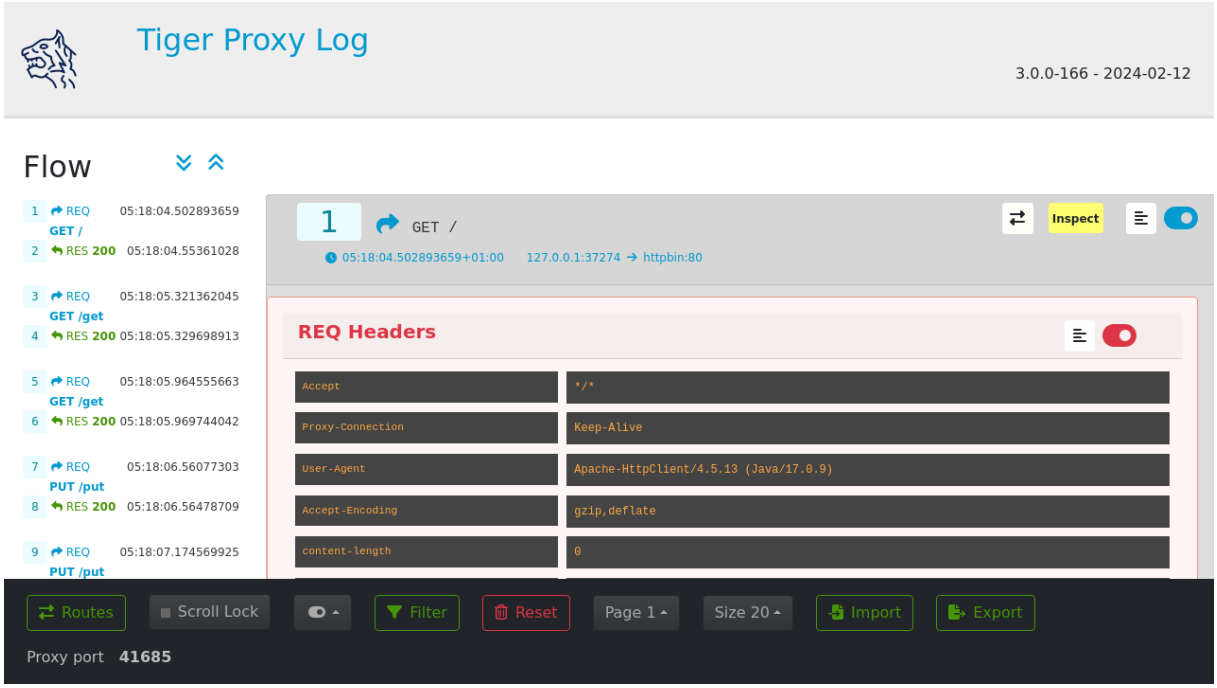

Figure 47. Buttons to switch between request and response

7.3. Explanation of JEXL Expressions

In the Workflow UI and in the WebUI you can inspect the requests and response messages.
For that you can use RbelPath and/or JEXL expressions. This section should give you a brief review on the JEXL expressions.

Important to know is that an JEXL expression is usually a "condition1 operator condition2" expression which is compared.
Therefor the following operators could be used.

7.3.1. Operators

Operator	Description
and | &&	cond1 *and* cond2 and cond1 *&&* cond2 are equivalent
or | ||	cond1 *or* cond2 and cond1 || cond2 are equivalent
not | !	The ! operator can be used as well as the word *not*, e.g. !cond1 and not cond1 are equivalent
==	Equality, e.g. cond1 == cond2 *null* is only ever equal to null, that means when you compare null to a non-null value, the result is false.
!=	Inequality
>	Greater than
<	Less than
>=	Greater than or equal
☐	Less than ot equal
=~	In or match, can be used to check that a string matches a regular expression. For example "abcdef" =~ "abc.* returns true. It also checks whether any collection, set or map contains a value or not; in that case, it behaves as an "in" operator. "a" =~ ["a","b","c","d","e",f"] returns true.
!~	Not in or not-match, can be used to check that a string does not match a regular expression. For example "abcdef" !~ "abc.* returns false. It also checks whether any collection, set or map does not contain a value. "a" !~ ["a","b","c","d","e",f"] returns false.
=^	startsWith, for example "abcdef" =^ "abc" returns true
!^	startsNotWith, "abcdef" !^ "abc" returns false
=$	endsWith, for example "abcdef" =$ "def" returns true

Operator	Description
!$	endsNotWith, for example "abcdef" !$ "def" returns false
Empty	The unary empty operator behaves like the corresponding function empty().
size	The unary size operator behaves like the corresponding function size().

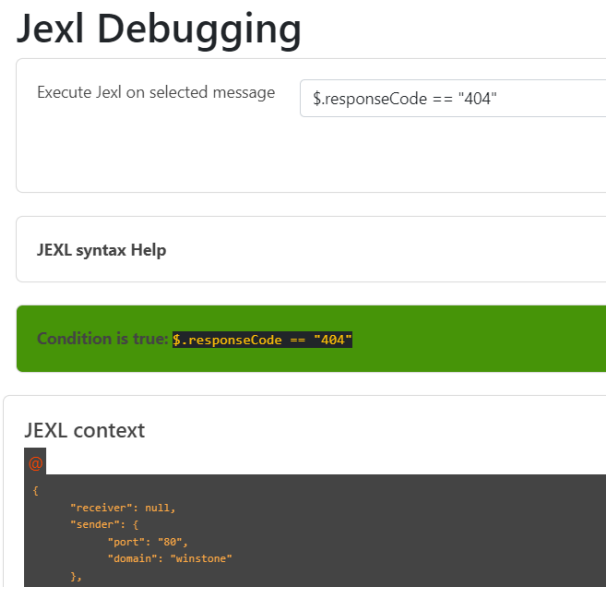

Figure 48. Rbel Path Expression

7.3.2. Access on Array, Lists and Maps

To access maps in JEXL/RbelPath the point notations is used. In case of lists use the number of the list entry you want to access, starting with 0, 1, 2 and so on.

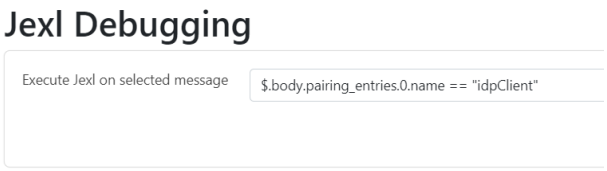

Figure 49. The access of the elements of a list is done with the number, starting with 0. For maps the point notation is used.

7.3.3. Access JEXL contexts

There are predefined JEXL contexts which can be used for the query, for example `isRequest`, `isResponse`, `charset`, `content` or also more complex contexts like `response.statuscode`, `request.url`, `message.method` etc.
For more details check the InlineJexlToolbox

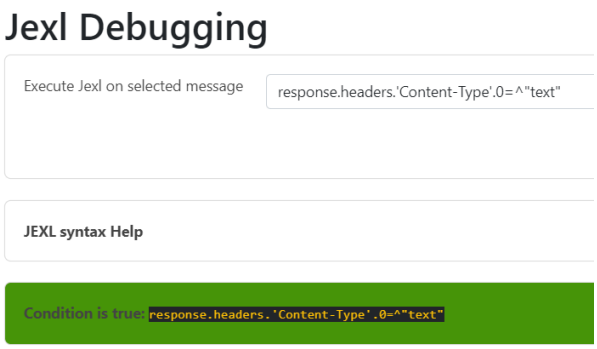

Figure 50. Use single quotes when using JEXL contexts with a hyphen.

7.3.4. More Examples

`message.headers.'content-length'.0 == "0"` ☐ Use single quotes when using JEXL contexts with a hyphen.

`@.body.0.name.content =^ "Jasmin"` ☐ check whether the content starts with "Jasmin"

`$.body.recordId == "X12349035"` ☐ checks for the recordId of a decrypted EPA-VAU-message

`$.header.Content-Type == "application/json"` ☐ check if the message is a JSON-message

`request.method == "GET"` ☐ check if request is da GET request

`charset =~ "UTF-.*"` ☐ check the charset with a regex

`empty(response.url)==true` oder auch `empty(response.url)` ☐ url is not set

`$.body.recordId == "Y243631459" && charset == "UTF-8"` ☐ combines the two criterions

7.3.5. POST Form / GET parameters

When accessing parameters POST and GET are handled differently.
POST form data requests contain the data as Url encoded query string in the body of the request.
There is no easy way to decode this data generically within Rbel/JEXL.
To help you ease the situation for POST we do have a helper JEXL inline method: `!{urlEncoded('value')}`
To access POST form data you may use `$.body.paramname` which will return the URL encoded value.

For GET requests you have two options:

- `$.path.paramname` which will return the string "paramaname=URLENCODED_VALUE" or
- `$.path.paramname.value` which will return the URL decoded original value.

For further help on JEXL please check out the offical website (https://commons.apache.org/proper/commons-jexl).

Chapter 8. Tiger Zion

Tiger Zion is a server that is highly customizable.
It serves as a stand-in, an interactive, Zero-Line mock for more complicated servers.

It can be stateful, do backend-requests, give conditional answers (allowing for error cases, edge cases).
It can return JSON, XML, JWT, JWE and many more, nest these formats into each other.
The underlying templating language supports loops and conditions.
It can be used both as a standalone server or as a server directly inside of tiger.

8.1. Simple canned response

To start lets write a server that has one endpoint: Return a simple JSON.
We do this as part of a tiger testsuite.

Listing 24. tiger.yaml

```yaml
servers:
  zionServer:
    type: zion
    zionConfiguration:
      # define the server port.
      # In a real setup you would leave this empty (then a random port will be used)
      serverPort: 8080
      mockResponses:
      # a map with all the responses
        helloWorld:
        # the name is arbitrary. It can be used to alter the response later on
          requestCriterions:
          # This is a list of JEXL expressions. Only when all expressions are met is this response
considered
            - message.method == 'GET'
            - message.path == '/helloWorld'
          response:
            statusCode: 200
            body: '{"Hello":"World"}'
```

This will give us:

```
$ curl localhost:8080/helloWorld
{"Hello": "World"}
```

8.2. Looping (tgrFor)

Let's now make this a bit more interactive: Return a map of all given HTTP headers.
And please return it as an XML!

Because XMLs are large and get complicated easily we don't want to write it directly inside the `tiger.yaml`.
So we reference an external file, where we do the heavy lifting:

Listing 25. tiger.yaml

```yaml
servers:
  zionServer:
    type: zion
    zionConfiguration:
      serverPort: 8080
      mockResponses:
        helloWorld:
          requestCriterions:
            - message.method == 'GET'
            - message.path == '/helloWorld'
          response:
            statusCode: 200
            bodyFile: complicatedResponse.xml
```

Listing 26. complicatedResponse.xml

```
<?xml version="1.0" encoding="utf-8" ?>
<requestDescription>
    <headers>
        <header>
            <tgrFor>header : request.headers.entrySet()</tgrFor>
            ${header}
        </header>
    </headers>
</requestDescription>
```

Lets try it out:

```
$ curl localhost:8080/helloWorld
<?xml version="1.0" encoding="UTF-8"?>

<requestDescription>
  <url>http://localhost:8080/helloWorld</url>
  <path>/helloWorld</path>
  <headers>
    <header>host=[localhost:8080]</header>
    <header>accept=[*/*]</header>
    <header>user-agent=[curl/7.88.1]</header>
  </headers>
</requestDescription>
```

Here you see a `tgrFor` construct. As the name leads on, it is used for looped rendering.
It reside WITHIN the element which needs to be considered, which is a bit different compared to other templating languages.
It just has to be beneath the element in the logical tree of the document.
So the `tgrFor` can be a tag within `<header>`, but it also could have been an attribute.
It can also be used in a JSON-fragment: The tgrFor then has to be a field in the object that you want looped.

The `tgrFor` must consist of three parts: The name of the loop-variable (here: `header`), followed by colon and then the loop expression to be evaluated.
The loop expression must yield a Java-Collection as a result.
Some examples:

```
1..42
```

```
{ 'one' , 2, 'more'}
```

```
{ 'one' : 1}.entrySet()
```

The loop-variable will be set for every iteration in the TigerConfiguration.
So to access it directly, use `${myLoopVariable}`.
You can then also combine the loop-variable with JEXL like so:

Listing 27. complicatedResponse.xml

```
<?xml version="1.0" encoding="utf-8" ?>
<requestDescription>
    <headers>
        <header>
            <tgrFor>header : {1,2,3}</tgrFor>
            ${header} and !{ ${header} + 1}
        </header>
    </headers>
</requestDescription>
```

will lead to

```
<?xml version="1.0" encoding="UTF-8"?>

<requestDescription>
  <headers>
    <header>1 and 2</header>
    <header>2 and 3</header>
    <header>3 and 4</header>
  </headers>
</requestDescription>
```

8.3. Conditional rendering (tgrIf)

To make the presence of elements conditional you can use the `tgrIf` statement. Consider the following example:

Listing 28. complicatedResponse.xml

```
<?xml version="1.0" encoding="utf-8" ?>
<requestDescription>
    <checkIf tgrIf="1 &lt; 5" logic="still applies" />
</requestDescription>
```

This will give us

```
<?xml version="1.0" encoding="UTF-8"?>

<requestDescription>
  <checkIf logic="still applies"></checkIf>
```

```
</requestDescription>
```

The tgrIf statement just consist of one single JEXL expression.
The result must be of type boolean. Please note that the tgrIf-statement, like the tgrFor, has to be beneath the target element in the document tree. This can be done via an attribute in XML, but it can also be done using a tag:

Listing 29. complicatedResponse.xml

```
<?xml version="1.0" encoding="utf-8" ?>
<requestDescription>
    <checkIf logic="still applies">
        <tgrIf>1 &lt; 5</tgrIf>
    </checkIf>
</requestDescription>
```

Here are some examples for other possible criteria:

```
$.header.connection == 'Keep-Alive'
```

This will only be true if the matching header is present.

```
$.header.host =~ 'local.*'
```

You can also use the more complex JEXL operators (here `=~`, comparing using a regex).

8.4. Backend request

To simulate complex interactions you can execute backend requests.
The following example should clarify the mechanism:

We want measure the length of the response by google to a query:

Listing 30. tiger.yaml

```
servers:
  zionServer:
    type: zion
    zionConfiguration:
      serverPort: 8080
      mockResponses:
        helloWorld:
          requestCriterions:
            - message.method == 'GET'
            - message.path == '/helloWorld'
          backendRequests:
            tokenCheck:
              url: "https://google.com/!{$.path.myParam.value}"
# the method is optional. GET is the default, POST if a body is present
              method: GET
              assignments:
                length: "$.header.Content-Length"
          response:
            statusCode: 200
            body: "{'responseLength':'${length}', 'testedPath':'?{$.path.myParam.value}'}"
```

To test, we sent:

```
$ curl "localhost:8080/helloWorld?myParam=dsfds"
{"responseLength": "1566","testedPath": "dsfds"}
```

The request is sent, the path is taken from the `myParam` query-parameter of the initial request.
Afterwards, the value of the `Content-Length`-Header is stored in the variable named `length` in the TigerGlobalConfiguration.
We then sent a response with status-code 200 and json-body.
Here we first reference the measured `length` variable from the backend-request and next we return the testedPath, taking the parameter from the initial request.

8.5. Nested response

To reduce the overhead when simulating conditional responses you can use the `nestedResponses` mechanism.
This allows subdividing responses.
Consider the following example, where we check the password of the calling party (which is given in cleartext in the request header).

Listing 31. tiger.yaml

```yaml
servers:
  zionServer:
    type: zion
    zionConfiguration:
      serverPort: 8080
      mockResponses:
        passwordCheckResponse:
          requestCriterions:
            - message.method == 'GET'
            - message.path == '/helloWorld'
          nestedResponses:
            correctPassword:
              importance: 10
              requestCriterions:
                - "'?{$.header.password}' == 'geheim'"
              response:
                statusCode: 200
                body: '{"Hello":"World"}'
            wrongPassword:
              importance: 0
              response:
                statusCode: 405
                body: '{"Wrong":"The password !{$.header.password} is not correct"}'
```

The two answers are both considered.
Since they are stored in the YAML as a map, the order in the YAML is of no significance.
Rather you have to specify the importance of a response, with a higher number meaning a higher importance meaning the response will be considered first.

8.6. Matching path variables

In many REST-Apis it is usual to include variables as part of the resource path. Zion allows to configure a response that will match a path and extract the given

variables. The assigned values can then be used in the response or be used in additional matching criteria. Here is an example:

Listing 32. tiger.yaml

```yaml
servers:
  zionServer:
    type: zion
    zionConfiguration:
      serverPort: 8080
      mockResponses:
        users:
          request:
            path: "/users/{userId}"
            method: "GET"
            additionalCriterions:
              - "'${userId}' == '123'"
          response:
            statusCode: 200
            body: "{'id':'${userId}', 'username': 'Tiger'}"
```

The matching of the response is made with the new configuration entry `request`.Here we defined the `path` and `method` that should match and `additionalCriterions`.In the path we can see a variable defined with `{userId}`.

When making the following request:

```
$ curl "localhost:8080/users/123"
{'id':'123', 'username': 'Tiger'}
```

the variable `userId` will be matched with the requested url and be assigned the value of `"123"`. This value can then be used in the `additionalCriterions` and in the `body`.

The matching of paths using the `request` configuration can also be made using nested responses. The path to match will combine paths specified in the different levels of the nested response. For example:

Listing 33. tiger.yaml

```yaml
servers:
  zionServer:
    type: zion
    zionConfiguration:
      serverPort: 8080
      mockResponses:
        users:
          request:
            path: "/users"
          nestedResponses:
            getSpecificUser:
              request:
                path: "/{userId}"
                method: "GET"
                additionalCriterions:
                  - "'${userId}' == '123'"
              response:
                statusCode: 200
                body: "{'id':'${userId}', 'username': 'Tiger'}"
            addUser:
              request:
```

```
                method: "POST"
                path: ""
              response:
                statusCode: 201
                headers:
                  Location: "/users/456"
```

Here we have two nested responses in the `/users` path. One will match GET requests to the path `/users/+{userId}+` and the other will match POST-Requests to the path `/users`.

8.7. tgrEncodeAs

One of the core capabilities of Zion is the ability to switch between media types.
You can return XML, JSON, JWT and many more types.
You can also embed one into the other.

As an example we want to return a JSON containing a freshly signed JWT (JSON Web Token).
For this we use the following response body file:

Listing 34. complicatedResponse.json

```
{
  "myToken": {
    "tgrEncodeAs": "JWT",
    "header": {
      "alg": "BP256R1",
      "typ": "JWT"
    },
    "body": {
      "name": "Max Power",
      "iat": {
        "tgrAttributes": ["jsonNonStringPrimitive"],
        "value": "!{currentTimestamp()}"
      }
    },
    "signature": {
      "verifiedUsing": "idpEnc"
    }
  }
}
```

will lead to

```
{
  "myToken":
"eyJhbGciOiJCUDI1NlIxIiwidHlwIjoiSldUIn0.eyJuYW1lIjogIk1heCBQb3dlciIsImlhdCI6IDE2ODg2MzQ5MjR9.aOnFMx
Skzvo9fJjnDSFCeX0G5-IP3XFQPZCRyZFBOEyBAgV2Dy3ImEjz_DpFRqSqtkHdkCcV-T_e6aBejN_A2g"
}
```

We see the keyword `tgrEncodeAs` being used here. Currently the following values are supported: `XML, JSON, JWT, JWE, URL, BEARER_TOKEN`.
A JWT consists of three parts: header, body, signature. The given nodes are searched and taken. The description of the JWT also could have been done in XML.

We then see another mode-switch being done in the `iat`-claim in the body of the

JWT: `iat` is the Unix-Timestamp at which the token was issued. For our faked ad-hoc token we of course want to use the current time for this claim. Unfortunately the `iat` claim is a number, which precludes the direct use of a JEXL-expression. To solve this problem make the claim complex, add the `"jsonNonStringPrimitive"` attribute to the resulting node and set the value to the desired value. This also works for floating-point and boolean values.

8.8. RbelWriter content structures

In this paragraph we'll take a look at the various structures that can be serialized with the RbelWriter, which sits at the core of the Zion-Server. The following examples are kept in JSON (apart from the Bearer token example). Please note that the same result can be achieved from XML (or any other format for that matter).

8.8.1. JWT

```
{
  "tgrEncodeAs": "JWT",
  "header": {
    "alg": "BP256R1",
    "typ": "JWT"
  },
  "body": {
    "claim": "value"
  },
  "signature": {
    "verifiedUsing": "idpEnc"
  }
}
```

The three parts denote the different part of a JWT: The header claims (header), body claims (body) and signature properties (signature). RbelWriter will automatically try to sign the given JWT. For this the key at `$.signature.verifiedUsing` is consulted and a matching key is searched in the tiger key-database. This will be filled at start-time by digging through the root-directory of the application recursively and trying to open all found key-files with various default passwords.

Please note that the header-claims have to match the given key, otherwise the signing operation can't be completed successfully.

8.8.2. JWE

```
{
  "tgrEncodeAs": "JWE",
  "header": {
    "alg": "ECDH-ES",
    "enc": "A256GCM"
  },
  "body": {
    "some_claim": "foobar",
    "other_claim": "code"
  },
  "encryptionInfo": {
    "decryptedUsingKeyWithId": "idpEnc"
  }
```

```
}
```

As with the JWT, for the JWE all relevant claims are to be found in the appropriate sections.
The signature has been replaced by the `encryptionInfo`-section. Here you need to specify the key to be used for the encryption. Here in this example we are using a public/private key-pair (with the same name as before). Again the header claims have to match the key used.

Apart from a public/private key-pair you can also use direct keys to encrypt your JWE. Here is an example:

```
{
  "tgrEncodeAs": "JWE",
  "header": {
    "alg": "dir",
    "enc": "A256GCM"
  },
  "body": {
    "some_claim": "foobar",
    "other_claim": "code"
  },
  "encryptionInfo": {
    "decryptedUsingKey": "YVI2Ym5wNDVNb0ZRTWFmU1Y1ZTZkRTg1bG9za2tscjg"
  }
}
```

As we are using a AES 256 bit key the supplied key has to exactly carry 256 bits, Base64 encoded.

8.8.3. URL

To generate a URL you can also use the RbelWriter. Consult the following structure:

```
{
  "tgrEncodeAs": "url",
  "basicPath": "http://blub/fdsa",
  "parameters": {
    "foo": "bar"
  }
}
```

The parameters will be added as query-parameters. This can be rather useful to construct more complex parameters, for example
a dynamically generated JWT.

8.8.4. Bearer Token

A Bearer token can also be serialized directly via RbelWriter. This is very relevant if you want to, for example, generate a JWT on the fly and use it as the Bearer token. The straight-forward way would be to directly write the Bearer token like so:

```
Bearer {
```

```
    "tgrEncodeAs":"JWT",
    "header":{
      "alg": "BP256R1",
      "typ": "JWT"
    },
    "body":{
      "claim": "value",
    },
    "signature":{
      "verifiedUsing":"idpEnc"
    }
  }
```

Here the whole arrangement will be parsed as a Bearer token (Which is essentially the Word `Bearer`, followed by a space and any string). The value of the Bearer token will be parsed as a JSON. When the result is then serialized, the `tgrEncodeAs` is interpreted and the JSON will be written as a Base64-encoded JWT.

The following example will produce the same result. However the overall structure is a JSON, which will be written as a Bearer token (`"tgrEncodeAs": "BEARER_TOKEN"`). The content of the token is taken from the child-node with the name `BearerToken`.

```
{
  "tgrEncodeAs": "BEARER_TOKEN",
  "BearerToken": {
    "tgrEncodeAs": "JWT",
    "header": {
      "alg": "BP256R1",
      "typ": "JWT"
    },
    "body": {
      "claim": "value",
    },
    "signature": {
      "verifiedUsing": "idpEnc"
    }
  }
}
```

Chapter 9. Links to test relevant topics

- 3-Amigos
  - presumably first mentioned in George Dinwiddie's blog (2009)
  - John Ferguson's Blog about 3 Amigos
- Cucumber
  - Product website
  - Guru99's Intro to Gherkin
  - Cucumbers Gherkin reference
- Serenity BDD
- SOLID
  - Explaining all five concepts with simple Geometry
  - In depth discussion of the 5 principles
- Separation of concerns principle
- Screenplay Pattern
  - Nice overview of what the screenplay pattern is about
  - From Page Objects to SOLID Screenplay
- FIRST principle for Unit tests
  - AgileOtters Blog

Unresolved directive in tiger_user_manual.adoc - include::../../../FAQ.adoc[leveloffset=+1]