FH University of Applied Sciences TECHNIKUM WIEN

CONINT Semester Project

S4-CONINT

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FH University of Applied Sciences TECHNIKUM WIEN

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CONINT Semester Project

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Brief description of used technology stack:

Backend: Node.js application with Fastify

Frontend: Static webserver with nginx

Source control: GitHub

Cloud-hosted CI: GitHub Actions

Self-hosted CI: Jenkins on AWS

Task	Assigned person
Frontend – Implementation & Dockerization & tests	Nick Müllner
Backend – Implementation & Dockerization & tests	Rene Rumetshofer
E2E & performance testing setup	Sophie Peirl
GitHub Actions pipeline setup	Rene Rumetshofer
AWS infrastructure setup	Rene Rumetshofer
PostHog setup & Frontend – A/B integration	Amelia Maier
Sonarqube setup	Rene Rumetshofer
Jenkins setup	Nick Müllner
Jenkins pipeline setup	Nick Müllner
Blue/Green Deployment setup	Sophie Peirl
Snyk setup	Rene Rumetshofer
Documentation polishing	Amelia Maier

1. Applications + Docker Files

- Explanation of the chosen frameworks (Vue, React, or Express)
- Dockerfile instructions, ports, environment variables

1.1 Backend

Used packages and technologies:

- Docker compose for development
- Prettier for formatting code
- Postgrator for DB migrations

Database credentials are stored in the local docker.env file at the project root level. The variables are loaded by the docker-compose file. Because the setup on development and on production is the same, there is no need to split up the environment:

```
"scripts": {
  "eslint": "eslint src/",
  "sonar-scanner": "sonar-scanner -Dsonar.host.url=$SONAR_HOST_URL -Dsonar.login=$SONAR_TOKEN",
  "snyk-auth": "snyk auth --auth-type=token $SNYK_TOKEN",
  "snyk": "snyk test",
  "jest": "jest --coverage",
  "start-compose-v1": "docker-compose -f ../docker-compose.yaml up -d --build backend",
  "start-compose-v2": "docker compose -f ../docker-compose.yaml up -d --build backend"
},
```

Testing is set up by first installing the following packages as dev dependencies:

- "@eslint/js": "^9.31.0",
- "@babel/core": "^7.28.0",
- "@babel/preset-env": "^7.28.0",
- "eslint": "^9.31.0",
- "babel-jest": "^30.0.4",
- "globals": "^16.3.0",
- "jest": "^30.0.4",
- "jest-environment-node": "^30.0.4",
- "prettier": "^3.6.2",
- "snyk": "^1.1297.3",
- "supertest": "^7.1.3",
- "sonar-scanner": "^3.1.0"

Setup of jest.config.js:

```
export default {  no usages  Rene Rumetshofer +1
  testEnvironment: 'node',
  testMatch: ['<rootDir>/test/jest/*.spec.js'],
  transform: {
    '^.+\\.(js|jsx)$': 'babel-jest',
  },
};
```

Setup of babel.config.js:

```
backend > babel.config.js > ...
1   export default {
2     presets: ['@babel/preset-env'],
3     plugins: ['@babel/plugin-transform-modules-commonjs'],
4   };
```

Setup of eslint.config.mjs:

```
import js from '@eslint/js';
import globals from 'globals';
import { defineConfig } from 'eslint/config';

export default defineConfig( args: [  no usages
  {
    files: ['**/*.{js,mjs,cjs}'],
    plugins: { js },
    extends: ['js/recommended'],
    languageOptions: {
      globals: {
        ...globals.browser,
        process: 'readonly',
        Buffer: 'readonly',
      },
    },
  },
  {
    files: ['**/*.spec.js'],
    languageOptions: {
      globals: globals.jest,
    },
  },
]);
```

Integration testing is being setup by installing the dev dependeny “supertest” and executed through jest. Unit tests (spec files) and integration tests are specified under the folder “tests/jest”.

The application first runs migrations via the migration service and only afterwards starts Fastify by listening on all interfaces. Before starting, all routes and the database connector are registered.

```
import Fastify from 'fastify';
import cors from '@fastify/cors';
import dbConnector from './db/postgres-connector.js';
import notesRoutes from './routes/notes.routes.js';
import migrate from './db/migration.service.js';

try {
  await migrate();
} catch (err) {
  console.error('Migrations failed with error; ', err);
  process.exit(1);
}

const fastify = Fastify({
  logger: true,
});

await fastify.register(cors, {
  origin: '*',
  methods: ['GET', 'POST', 'PUT', 'DELETE'],
});

fastify.register(dbConnector);
fastify.register(notesRoutes);

fastify.listen({ port: 3000, host: '0.0.0.0' }, function (err, address) {
  if (err) {
    fastify.log.error(err);
    process.exit(1);
  }
});
```

Routes are stored under the directory “routes”, database services including migration files under “db” and general services under “services”. Please see the repository for details.

The migration service establishes a DB connection by using the environment variables and then runs all SQL files under the sub-directory “migrations”:

```
import pg from 'pg';
import Postgrator from 'postgrator';
import path from 'node:path';
import { fileURLToPath } from 'url';
import { dirname } from 'path';

async function migrate() {
  const client = new pg.Client({
    host: process.env.DB_HOST,
    port: process.env.DB_PORT,
    database: process.env.DB_NAME,
    user: process.env.DB_USER,
    password: process.env.DB_PASSWORD,
  });

  await client.connect();

  const __filename = fileURLToPath(import.meta.url);
  const __dirname = dirname(__filename);
  const postgrator = new Postgrator({
    migrationPattern: path.join(__dirname, '/migrations/*'),
    driver: 'pg',
    database: process.env.DB_NAME,
    schemaTable: 'migrations',
    currentSchema: 'public', // Postgres and MS SQL Server only
    execQuery: (query) => client.query(query),
  });

  const result = await postgrator.migrate();

  if (result.length === 0) {
    console.log(
      'No migrations run for schema "public". Already at the latest one.'
    );
  }

  console.log('Migration done.');

  await client.end();
}

export default migrate;
```

There is only one route file called ”notes.routes.js”. The functionality of such files can be explained via the first routes:

```
import {
  encryptNote,
  generateUUID,
  decryptNote,
} from '../services/crypto.service.js';

async function routes(fastify, options) {
  fastify.get('/notes', async (request, reply) => {
    fastify.pg.query(
      'SELECT notes_uuid, title FROM notes',
      function onResult(err, result) {
        reply.send(err || result?.rows);
      }
    );

    return reply;
  });

  const getNoteOpts = {
    schema: {
      params: {
        type: 'object',
        required: ['uuid'],
        properties: {
          key: { type: 'string' },
        },
      },
      query: {
        type: 'object',
        required: ['key'],
        properties: {
          key: { type: 'string' },
        },
      },
    },
  };
  fastify.get('/notes/:uuid', getNoteOpts, async (request, reply) => {
    console.log(request.query);
    fastify.pg.query(
      'SELECT content FROM notes WHERE notes_uuid = $1',
      [request.params.uuid],
      function onResult(err, result) {
        if (err) {
          reply.code(500).send('Error while fetching note');
          return;
        }
        if (result.rows.length === 0) {
          reply.code(404).send('Note not found');
          return;
        }

        try {
          reply.send(decryptNote(request.query.key, result.rows[0].content));
        } catch (err) {
          reply.code(403).send('Key is invalid');
        }
      }
    );

    return reply;
```

The first route simply fetches all notes and returns the UUIDs and titles only. The second GET route takes a path parameter and a query variable to select a specific note by UUID and provide a key (request.query.key).

The Dockerfile uses node version 24, installs all packages, copies all files from src and starts the backend. The environment file is not specified here as the env variables will later be passed by using Docker compose environment variables.

```
FROM node:24-alpine

WORKDIR /app

COPY package*.json ./
RUN npm ci --omit=dev --ignore-scripts
COPY src .

EXPOSE 3000

CMD ["node", "index.js"]
```

1.2 Frontend

The Frontend is pretty similar to the Backend: also using jest for unit testing, docker compose for deployment and a Dockerfile for a custom Docker Image. There is no env file necessary, since the Frontend is a basic nginx container which serves a static website. Compared to the Backend, the Frontend also contains e2e testing through playwright and performance testing through k6:

```
"scripts": {
  "eslint": "eslint src/",
  "sonar-scanner": "sonar-scanner -Dsonar.host.url=$SONAR_HOST_URL -Dsonar.login=$SONAR_TOKEN",
  "snyk-auth": "snyk auth --auth-type=token $SNYK_TOKEN",
  "snyk": "snyk test",
  "jest": "jest --coverage",
  "playwright": "playwright test",
  "k6": "k6 run test/k6/load-test.js",
  "start-compose-v1": "docker-compose -f ../docker-compose.yaml up -d --build frontend",
  "start-compose-v2": "docker compose -f ../docker-compose.yaml up -d --build frontend"
},
```

The following development dependencies are necessary for testing:

- "@eslint/js": "^9.31.0",
- "@jest/globals": "^30.0.4",
- "@playwright/test": "^1.54.1",
- "eslint": "^9.31.0",
- "globals": "^16.3.0",
- "jest": "^30.0.4",
- "jest-environment-jsdom": "^30.0.4",
- "k6": "^0.0.0",
- "playwright": "^1.54.1",
- "snyk": "^1.1297.3",
- "sonar-scanner": "^3.1.0"

Setup of jest.config.js:

```
module.exports = {
  testEnvironment: "jsdom",
  testMatch: ["<rootDir>/test/jest/*.spec.js"],
};
```

Setup of playwright.config.js:

```
const { defineConfig :{…} } = require("@playwright/test");

module.exports = defineConfig({
  use: {
    browserName: "chromium",
    headless: true,
    launchOptions: {
      args: ["--no-sandbox", "--disable-setuid-sandbox"],
    },
  },
  testDir: "./test/playwright",
});
```

Setup of eslint.config.mjs:

```
import js from "@eslint/js";
import globals from "globals";
import { defineConfig } from "eslint/config";

export default defineConfig( args: [  no usages
  {
    files: ["**/*.{js,mjs,cjs}"],
    plugins: { js },
    extends: ["js/recommended"],
    languageOptions: {
      globals: {
        ...globals.browser,
      },
    },
  },
  {
    files: ["**/tests/jest/*.js"],
    languageOptions: {
      globals: globals.jest,
    },
  },
]);
```

Tests are found under the following directory:

- test/jest → Unit testing
- test/k6 → performance testing
- test/playwright → e2e testing

A simple structured index.html provides a clean interface for creating, viewing and deleting notes. Furthermore, index.js and posthog.js are linked within the file. To ensure Eventlisteners are created after the DOM has loaded, a small check is also included:

```
<h2>Alle Notizen</h2>
<div id="notes"></div>

<h2>Neue Notiz erstellen</h2>
<form id="newNoteForm">
  <label for="newTitle">Titel</label>
  <input id="newTitle" placeholder="Titel" required type="text" />
  <label for="newContent">Inhalt</label>
  <textarea id="newContent" placeholder="Inhalt" required></textarea>
  <label for="newKey">Verschlüsselungs-Key</label>
  <input id="newKey" placeholder="Verschlüsselungs-Key" required type="text" />
  <button id="createNote" type="submit">Erstellen</button>
</form>

<script src="posthog.js"></script>
<script src="index.js"></script>
<script>
  if (document.readyState === "loading") {
    document.addEventListener("DOMContentLoaded", () => {
      initializeDOMInteractions(true);
    });
  } else {
    initializeDOMInteractions(true);
  }
</script>
```

To enable several environments (local, staging, production, Jenkins), a workaround was used which relies on the URL, which is set on the used browser, dynamically determining the API address:

```
const API_HOSTS :{…} = {
  localhost: "http://localhost:3000/api",
  "staging.conint-securenotes.online":
    "https://staging.conint-securenotes.online/api",
  "prod.conint-securenotes.online":
    "https://prod.conint-securenotes.online/api",
  "frontend-green": "http://backend-green:3000/api",
};

const hostname :string = window.location.hostname;
const API = API_HOSTS[hostname];
```

Viewing and deleting notes are defined in own methods, creating notes is defined as an Eventlistener which is added after DOM loaded:

```
async function loadNotes() : Promise<void> {...}

async function loadNote(uuid) : Promise<void> {...}

async function deleteNote(uuid) : Promise<void> {...}

async function initializeDOMInteractions(isLoadNotes) : Promise<void> { Show usages  Ni
  document
    .getElementById( elementId: "newNoteForm")
    .addEventListener( type: "submit", listener: async (e : SubmitEvent ) : Promise<void> => {
      e.preventDefault();
      const title = document.getElementById( elementId: "newTitle").value;
      const content = document.getElementById( elementId: "newContent").value;
      const key = document.getElementById( elementId: "newKey").value;

      const res : Response = await fetch( input: `${API}/notes`, init: {
        method: "POST",
        headers: { "Content-Type": "application/json" },
        body: JSON.stringify( value: { title, content, key }),
      });

      if (res.ok) {
        alert("Notiz erstellt!");
        document.getElementById( elementId: "newNoteForm").reset();
        await loadNotes();
      } else {
        alert("Fehler beim Erstellen der Notiz.");
      }
    });
```

Testing with jest, k6 and playwright was a challenge, since all of them need URLs to Frontend and Backend, but they differ in environment passed variable handling. Jest exports the methods from the index.js and mocks the fetches to the API:

```
const {
  initializeDOMInteractions,
  loadNotes,
  loadNote,
  deleteNote,
} = require("../../src/index.js");

beforeEach(() : void  => {  Nick Müllner
  document.body.innerHTML = `
    <form id="newNoteForm">
      <input id="newTitle" />
      <input id="newContent" />
      <input id="newKey" />
      <button type="submit">Submit</button>
    </form>
    <div id="notes">
      <div class="note">
        <strong>Test Note 3</strong><br>
        UUID: 789<br>
        <input type="text" placeholder="Key eingeben" id="key-789">
        <button id="show-789">Anzeigen</button>
        <button id="del-789">Löschen</button>
        <pre id="content-789"></pre>
      </div>
    </div>
  `;

  global.fetch = jest.fn() : any | Promise<...>  =>
    Promise.resolve( value: {
      json: () : any | Promise<...>  => Promise.resolve( value: []),
    }),
  );

  initializeDOMInteractions( isLoadNotes: false);
});
```

```
test("loadNotes should load notes and display them", async () : Promise<void>  => {
  fetch.mockResolvedValueOnce({
    ok: true,
    json: async () : Promise<[{notes_uuid: string, title: s...>  => [
      { notes_uuid: "123", title: "Test Note 1" },
      { notes_uuid: "456", title: "Test Note 2" },
    ],
  });

  await loadNotes();

  expect(document.querySelectorAll( selectors: ".note").length).toBe( expected: 2);
  expect(document.querySelector( selectors: ".note").textContent).toContain(
    expected: "Test Note 1",
  );
});
```

K6 is using its own environment, making it necessary to pass variables in a specific way:

```
const BASE_URL = __ENV.BACKEND_GREEN || "http://localhost:3000/api";

export default function () : void  {  no usages  Sophie Peirl +2
  group("Notiz erstellen → abrufen → löschen", () : void  => {
    // 1. Notiz erstellen
    const payload : string  = JSON.stringify( value: {
      title: `Titel ${__VU}-${__ITER}`,
      content: "Dies ist ein Loadtest-Inhalt",
      key: "kótestkey",
    });

    const headers : {Content-Type: string}  = { "Content-Type": "application/json" };

    const postRes = http.post(`${BASE_URL}/notes`, payload, { headers });

    check(postRes, {
      "Notiz erfolgreich erstellt": (res) : boolean  => res.status === 200,
    });

    let uuid = postRes.json().notes_uuid;
```

Finally, we have playwright:

```
const BASE_URL : string  = process.env.FRONTEND_GREEN || "http://localhost:80";

test.beforeEach( inner: async ({ page : Page  }) : Promise<void>  => {  Sophie Peirl
  await page.goto(BASE_URL);
});

test( title: "1. Seite lädt und zeigt Notizliste an (auch wenn leer)", body: async ({
  page : Page ,
}) : Promise<void>  => {
  const notesContainer : Locator  = page.locator( selector: "#notes");
  const count : number  = await notesContainer.locator( selectorOrLocator: ".note").count();
  expect(count).toBeGreaterThanOrEqual( expected: 0);
});
```

Summarized, we use either dynamically or “passed via environment variables” URLs to Frontend and Backend to ensure correct paths on different environments. Like this, local development and testing is still possible while CICD tools can manipulate URLs for their needs.

A simple Dockerfile is used for creating the image. Using nginx 1.29, copying the src folder and exposing on port 80:

```
FROM nginx:1.29-alpine

COPY src /usr/share/nginx/html

EXPOSE 80
```

2. Version Control

- Branching strategy (main, feature branches, deploy/production branch)

For version control, GitHub is used. https://github.com/ReneRumetshofer/CONINT

Trunk-based development is used, so feature branches should be short lived and often rebased on main. Merges back into main are only allowed via pull requests. The main branch is protected from direct pushes.

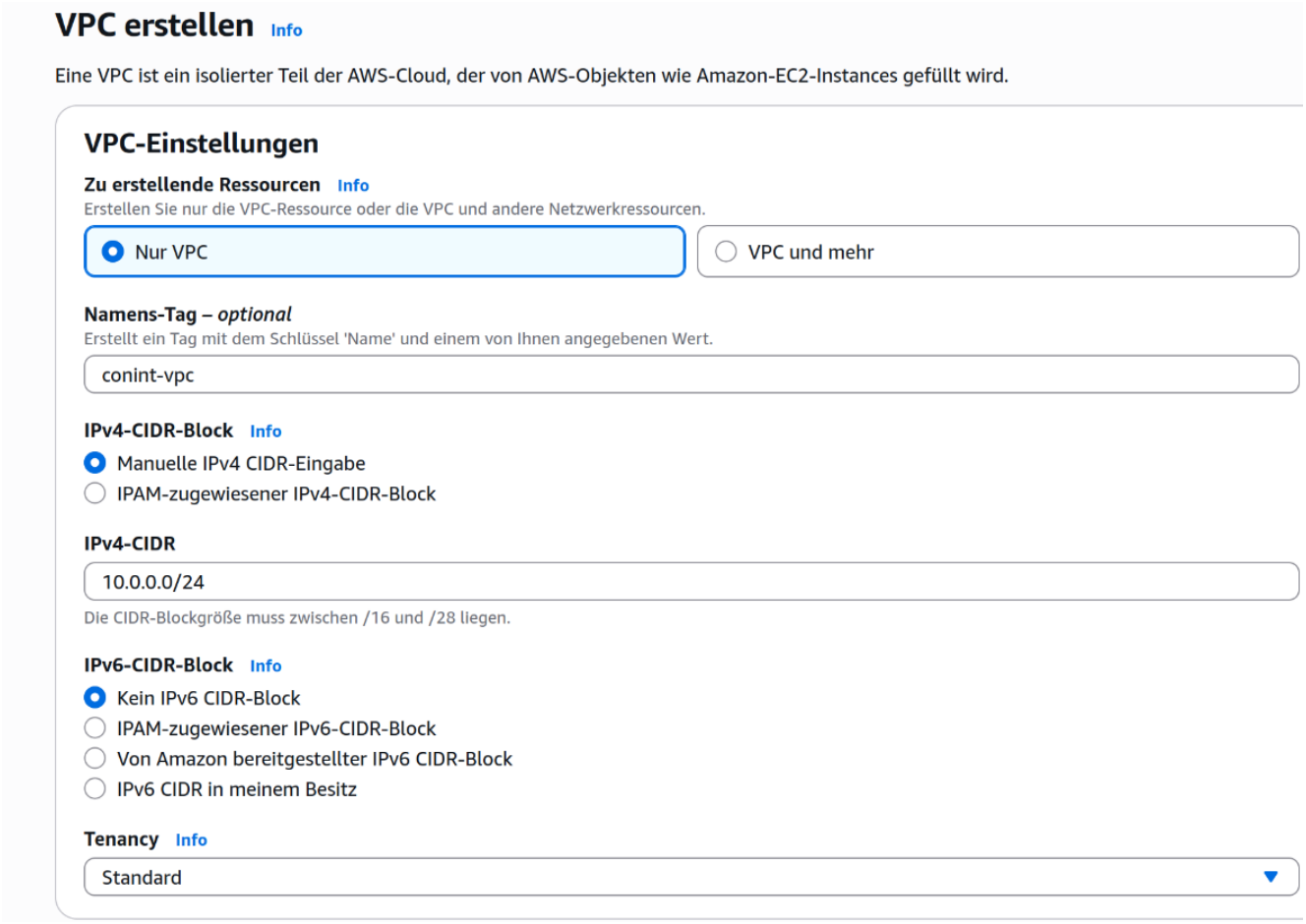
As it's a requirement for this project, deployments to the staging and prod environments, as well as steps leading up to this, will only take place when a commit is pushed onto the branch called "production". This branch should not have direct commits and can only be updated via pull requests. This is also enforced via a branch protection rule.

3. Infrastructure (AWS)

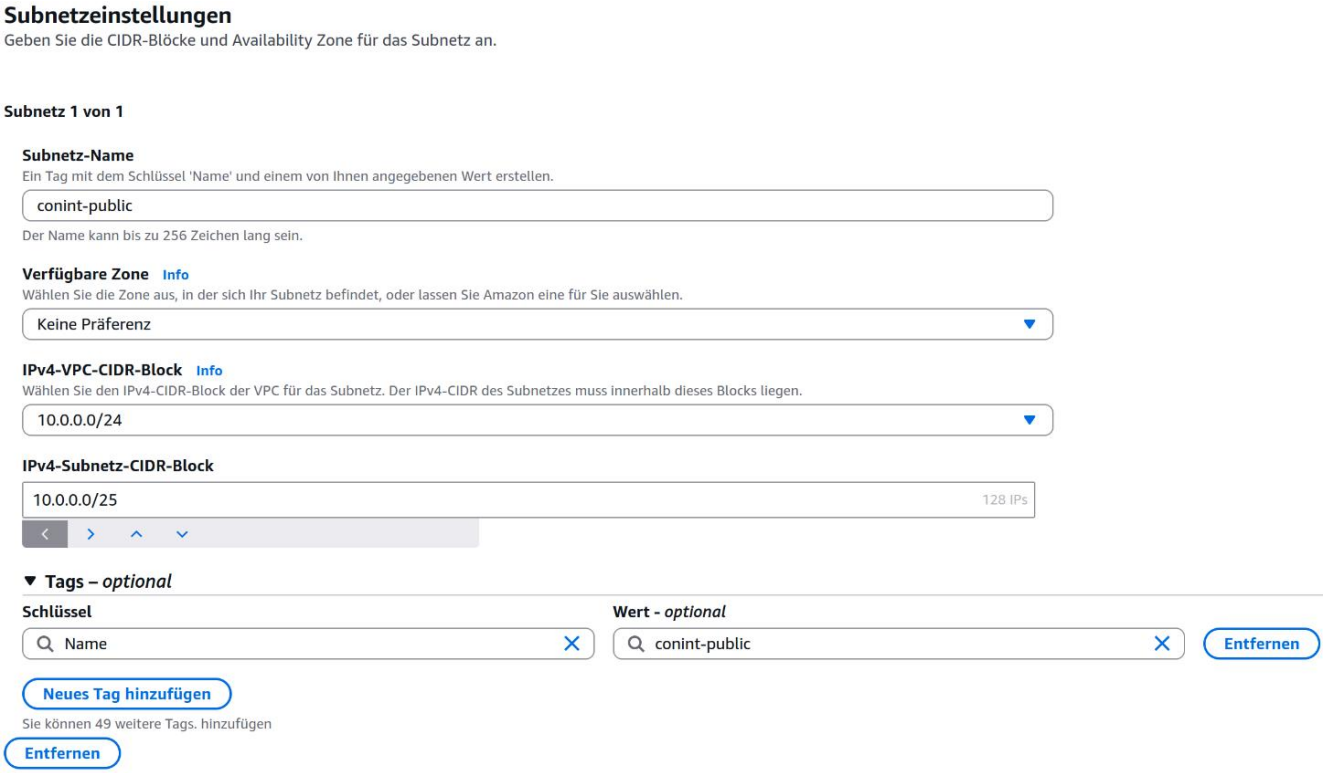
- EC2 instance configuration
- RDS configuration for PostgreSQL
- Network details and security groups

3.1 Network setup

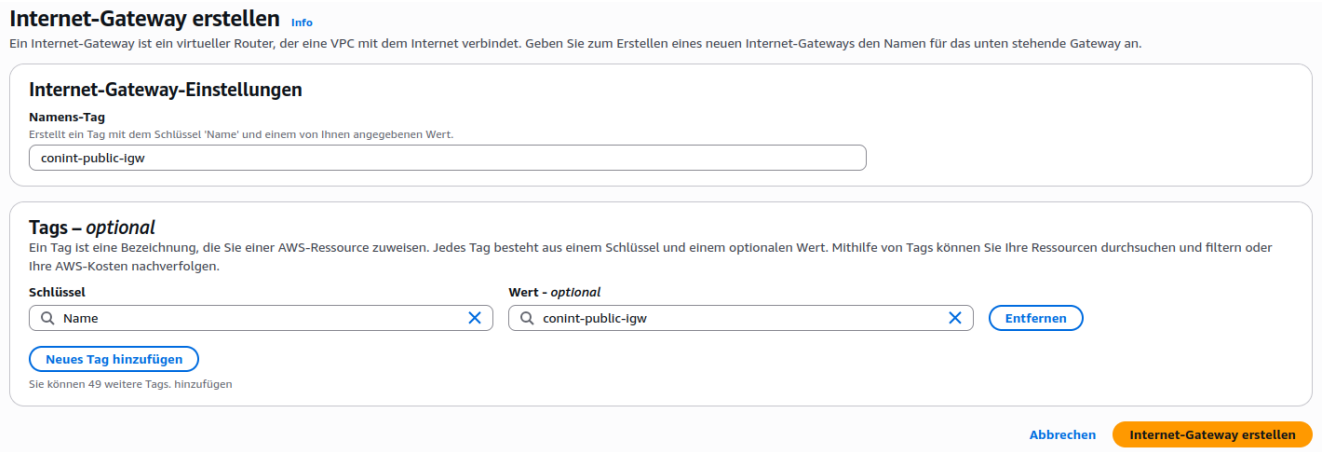
Setup VPC as 10.0.0.0/24 virtual network:



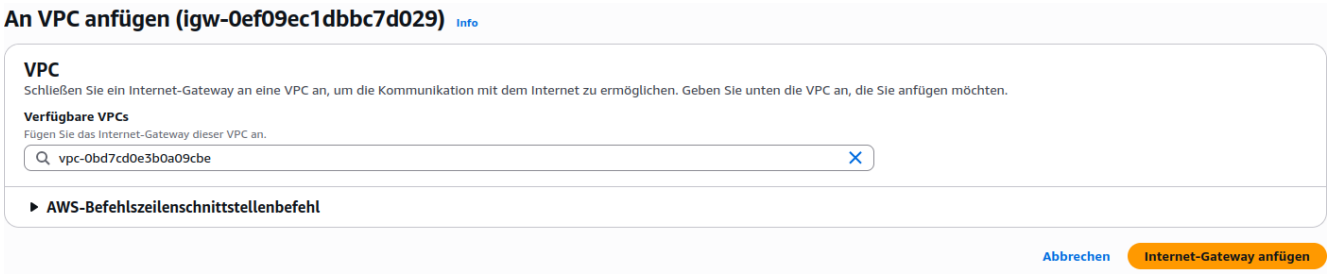
A public subnet is added which gets half of all IPs, therefore using network mask 10.0.0.0/25:



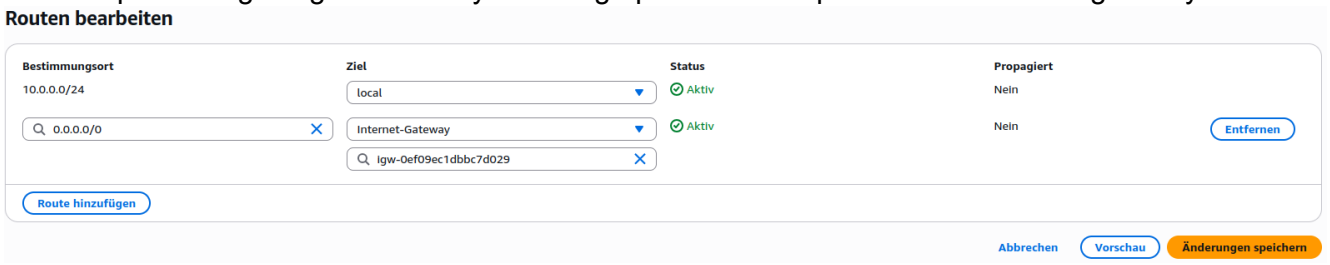
Creating a internet gateway for internet connectivity:



This IGW is now being attached to the VPC:

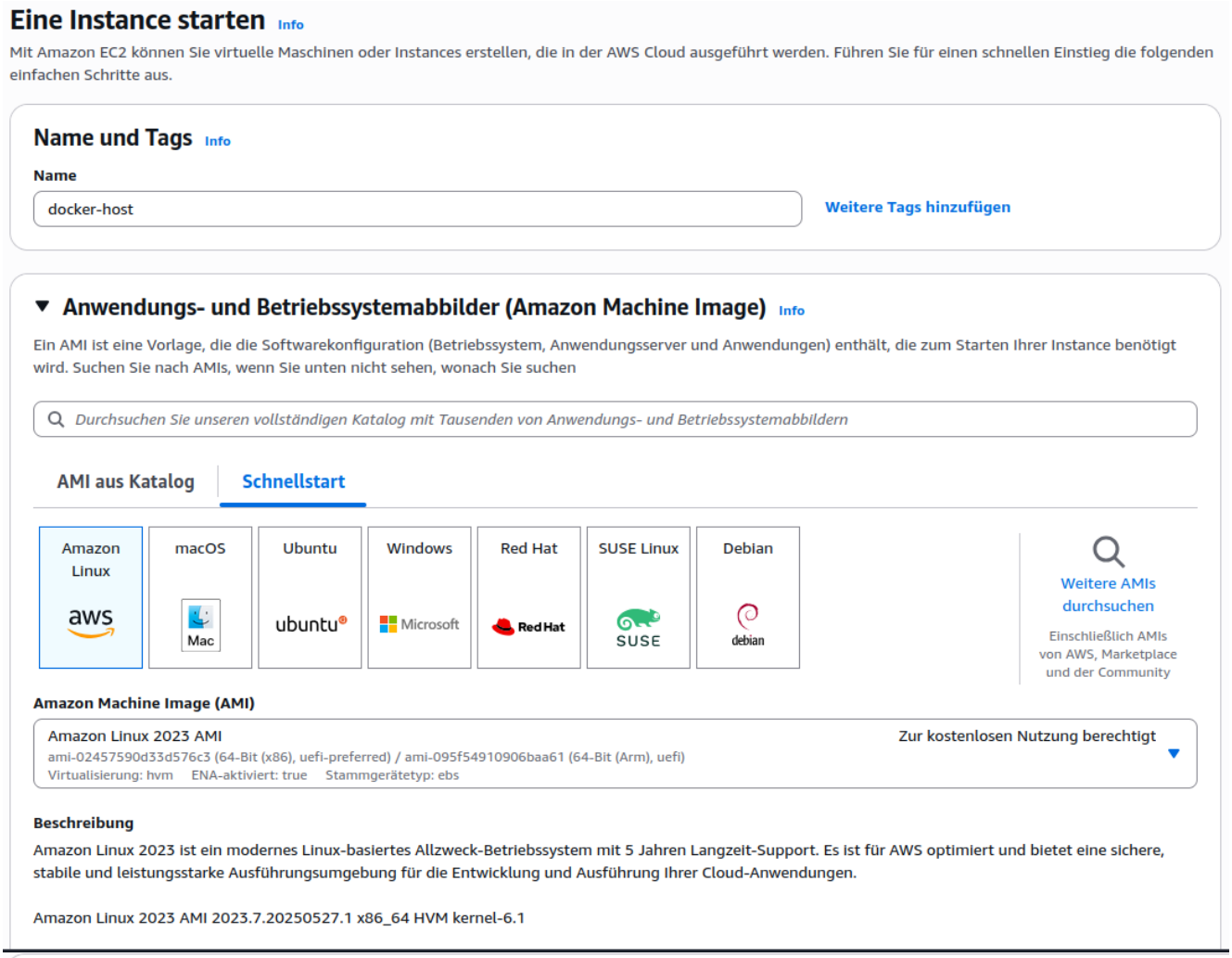


The last piece for getting connectivity is setting up a route that points to the internet gateway:



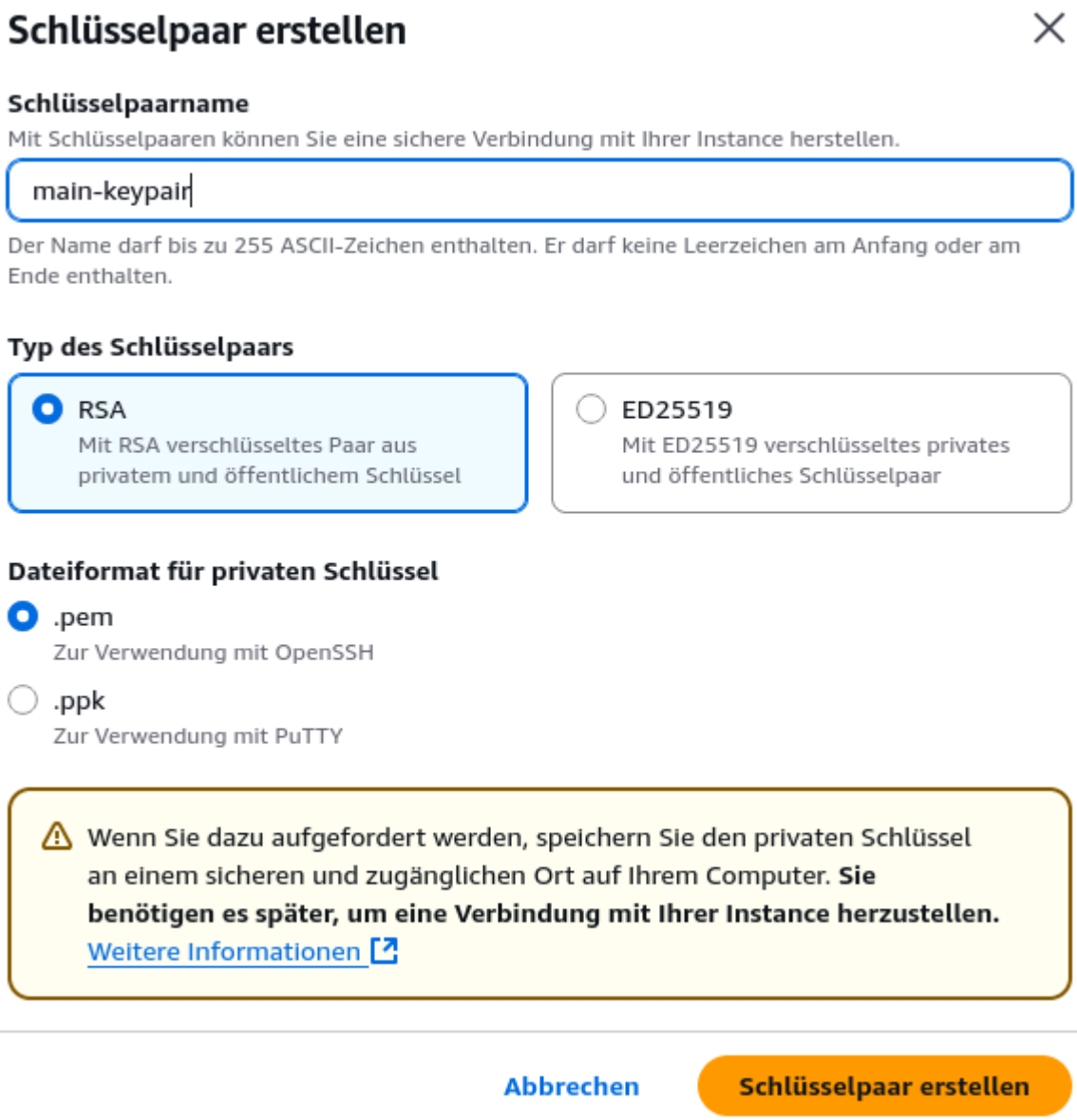
3.2 EC2 setup

A new EC2 instance is created that will be used for hosting docker all needed docker containers for this project.

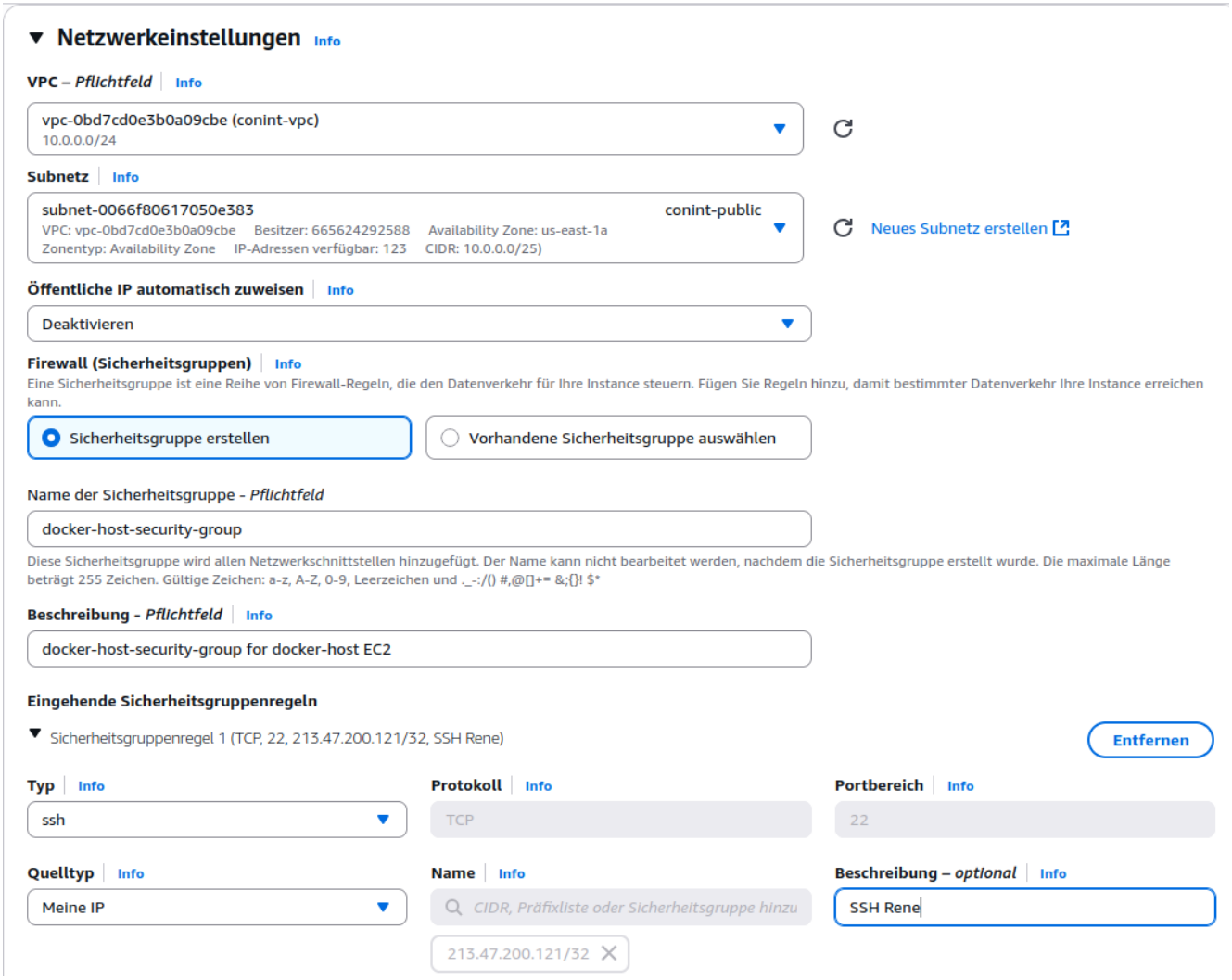


“t2.medium” is used as instance type, as this brings 2 vCPU cores with 4 GiB of RAM which should suffice for running a bunch of docker containers fluidly.

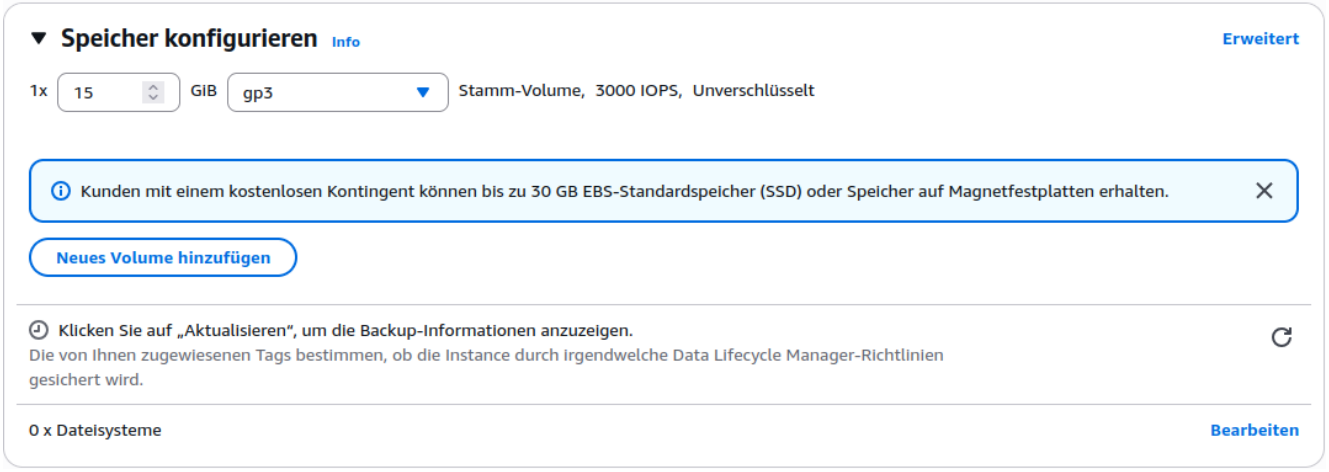
A new keypair is created for SSH access:



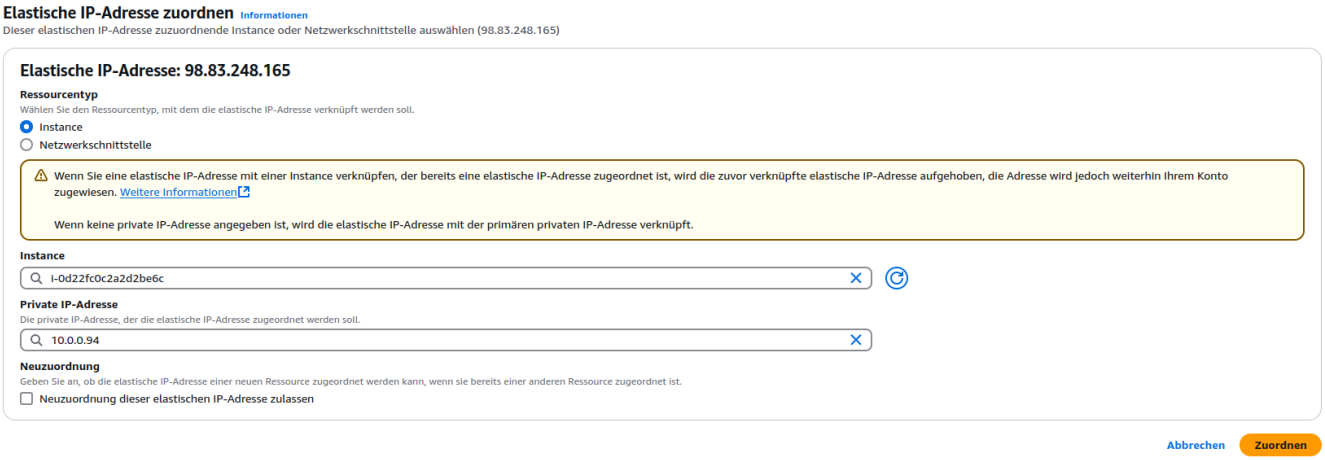
Networking is configured to use the previously created VPC and public subnet. A new security group is being created that for configuring the instance contains one incoming SSH rule for the IP address of the configuring user:



16 GiB of disk space get used. It was deliberately chosen to be higher than the default of 8 GiB to have enough space for docker images.



After starting the instance, an elastic IP address is created and bound to the EC2 instance:



The started instance is now reachable via SSH. It is important to mention that the file permissions of the previously created keypair in .pem file format must be changed to ”700” for SSH to accept the key.

```
[rene@rene Downloads]$ chmod 700 main-keypair.pem
[rene@rene Downloads]$ ssh -i main-keypair.pem ec2-user@98.83.248.165
   ,     #_
   ~\_  ####_        Amazon Linux 2023
  ~~  \_#####\
  ~~     \###|
  ~~       \#/ ___   https://aws.amazon.com/linux/amazon-linux-2023
   ~~       V~' '->
    ~~~         /
      ~~._.   _/
         _/ _/
       _/m/'
Last login: Mon Jun  9 13:18:19 2025 from 213.47.200.121
[ec2-user@ip-10-0-0-94 ~]$
```

3.3 Docker host configuration

First things first, docker is installed via “sudo yum install docker”. Afterwards the engine is started and the default user “ec2-user” added to the docker group. The installation can be verified by running a container of the hello-world image:

```
[ec2-user@ip-10-0-0-94 ~]$ sudo systemctl enable --now docker
[ec2-user@ip-10-0-0-94 ~]$ sudo usermod -aG docker $USER
[ec2-user@ip-10-0-0-94 ~]$ newgrp docker
[ec2-user@ip-10-0-0-94 ~]$ docker run hello-world

Hello from Docker!
This message shows that your installation appears to be working correctly.

To generate this message, Docker took the following steps:
 1. The Docker client contacted the Docker daemon.
 2. The Docker daemon pulled the "hello-world" image from the Docker Hub.
    (amd64)
 3. The Docker daemon created a new container from that image which runs the
    executable that produces the output you are currently reading.
 4. The Docker daemon streamed that output to the Docker client, which sent it
    to your terminal.

To try something more ambitious, you can run an Ubuntu container with:
 $ docker run -it ubuntu bash

Share images, automate workflows, and more with a free Docker ID:
 https://hub.docker.com/

For more examples and ideas, visit:
 https://docs.docker.com/get-started/

[ec2-user@ip-10-0-0-94 ~]$
```

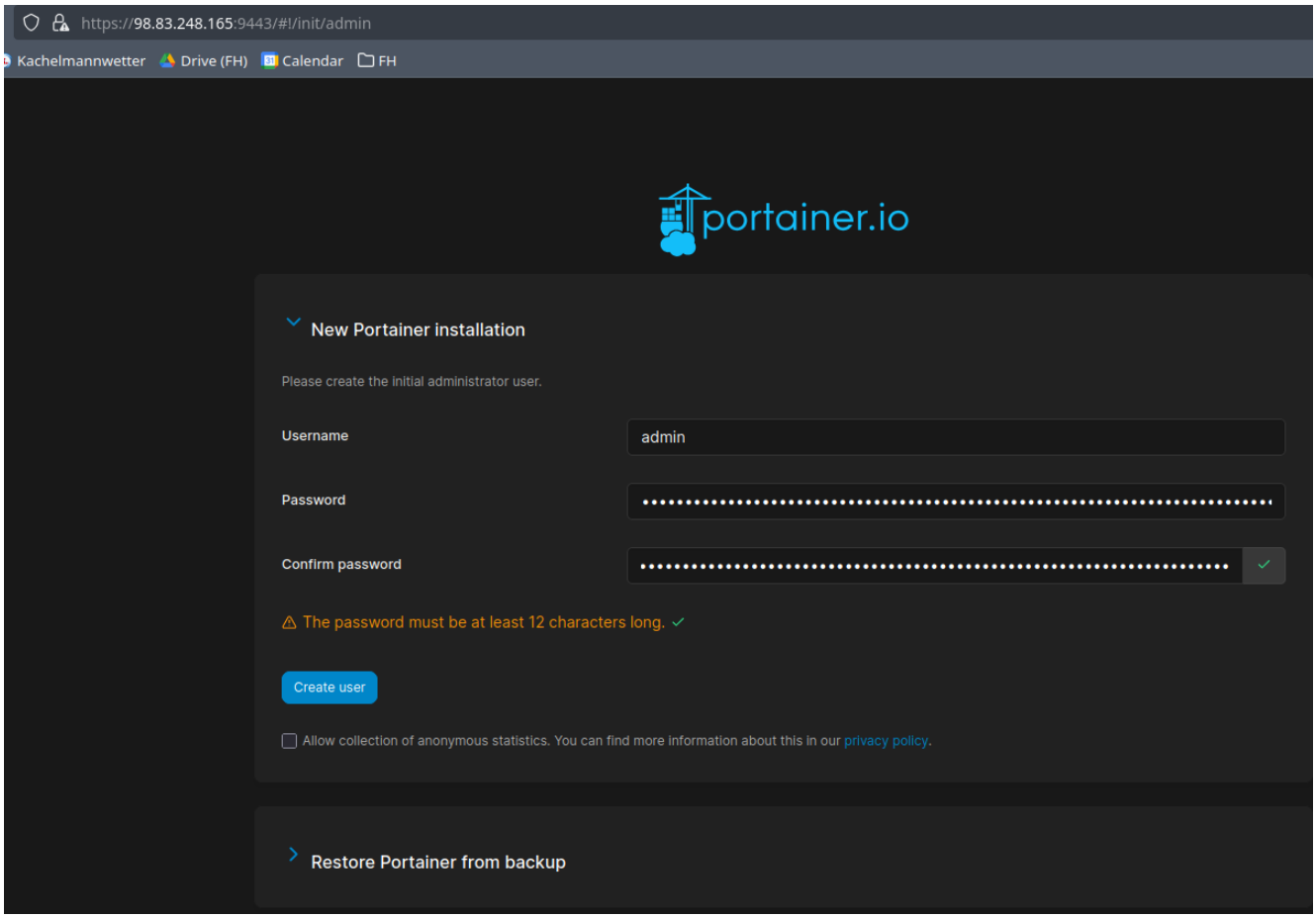
We also install docker compose:

```
[ec2-user@ip-10-0-0-94 deployment]$ sudo curl -L https://github.com/docker/compose/releases/latest/download/docker-c
ompose-$(uname -s)-$(uname -m) -o /usr/local/bin/docker-compose
sudo chmod +x /usr/local/bin/docker-compose
  % Total    % Received % Xferd  Average Speed   Time    Time     Time  Current
                                 Dload  Upload   Total   Spent    Left  Speed
  0     0    0     0    0     0      0      0 --:--:-- --:--:-- --:--:--     0
  0     0    0     0    0     0      0      0 --:--:-- --:--:-- --:--:--     0
100 71.5M  100 71.5M    0     0  86.9M      0 --:--:-- --:--:-- --:--:-- 86.9M
[ec2-user@ip-10-0-0-94 deployment]$
```

For graphical management of the docker environment on this server, we use Portainer that can be spun up as a container. First, a volume is created. Then the Portainer container can be created.

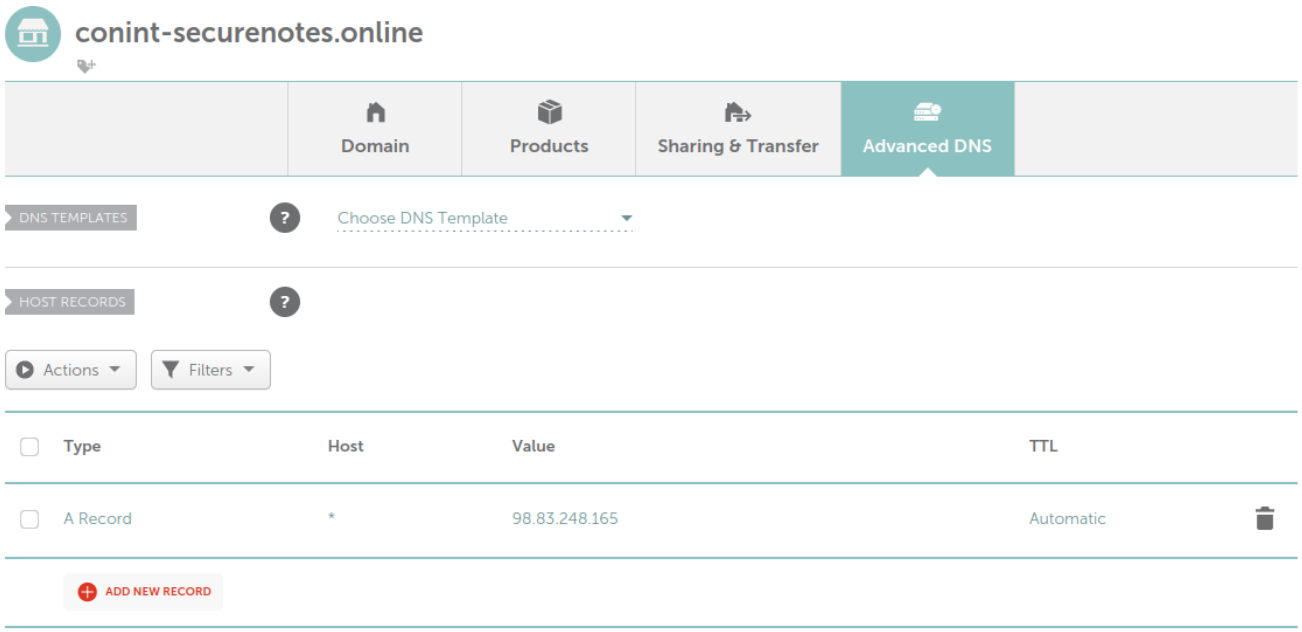
```
[ec2-user@ip-10-0-0-94 ~]$ docker volume create portainer_data
portainer_data
[ec2-user@ip-10-0-0-94 ~]$ docker run -d -p 8000:8000 -p 9443:9443 --name portainer --restart=always -v /var/run/doc
ker.sock:/var/run/docker.sock -v portainer_data:/data portainer/portainer-ce:lts
Unable to find image 'portainer/portainer-ce:lts' locally
lts: Pulling from portainer/portainer-ce
c02951246260: Pull complete
b7c5ecc05946: Pull complete
04de093ad5ed: Pull complete
a9ff7abff372: Pull complete
e09df2601140: Pull complete
54675ba571ac: Pull complete
886c883b7538: Pull complete
93b4ed907f92: Pull complete
f126cb2940fd: Pull complete
4f4fb700ef54: Pull complete
Digest: sha256:ebead33595e425f88b1d02a74e4cc65a6d295e96c3643bb176dca7cb64bc36b0
Status: Downloaded newer image for portainer/portainer-ce:lts
c461956e68a8276b1b23fd2e8ccd21422fab16e3315330dc6c972b2117662c70
[ec2-user@ip-10-0-0-94 ~]$
```

After creating an incoming rule in the security group of the EC2 instance, Portainer is reachable via the internet. Upon first connection, an admin password must be set.



3.4 NGINX Proxy manager

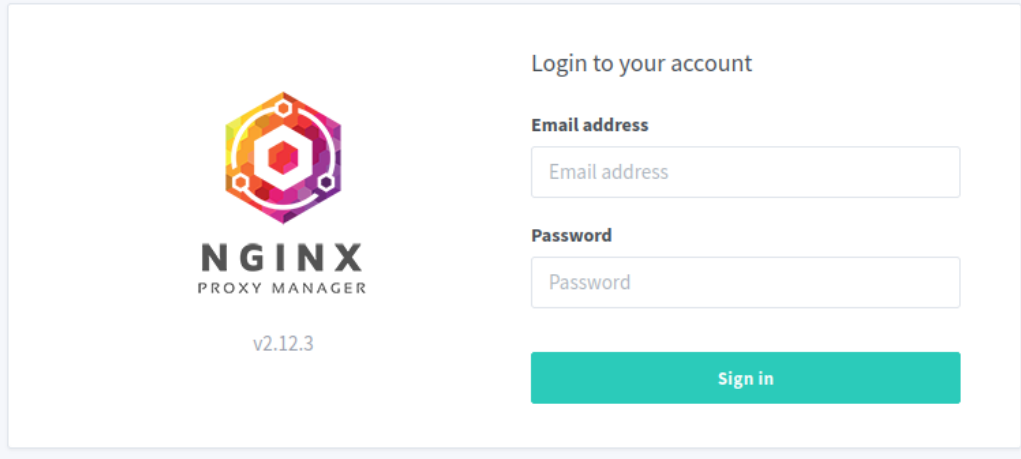
NGINX Proxy Manager will be used for managing TLS termination including certificates via Letsencrypt. A domain has been bought for this project: conint-securenotes.online. DNS is set up in a way, that all subdomains get routed to the AWS instance (98.83.248.165):



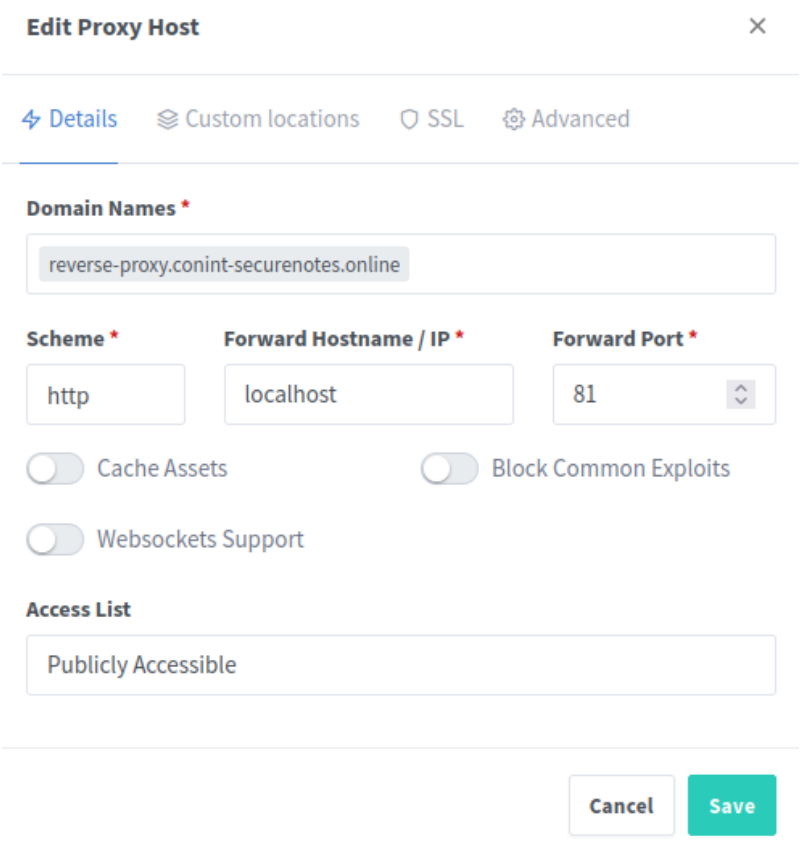
A new stack (docker compose stack) can be added in Portainer containing configuration for the NGINX proxy manager container which will use a custom docker compose in the repository:

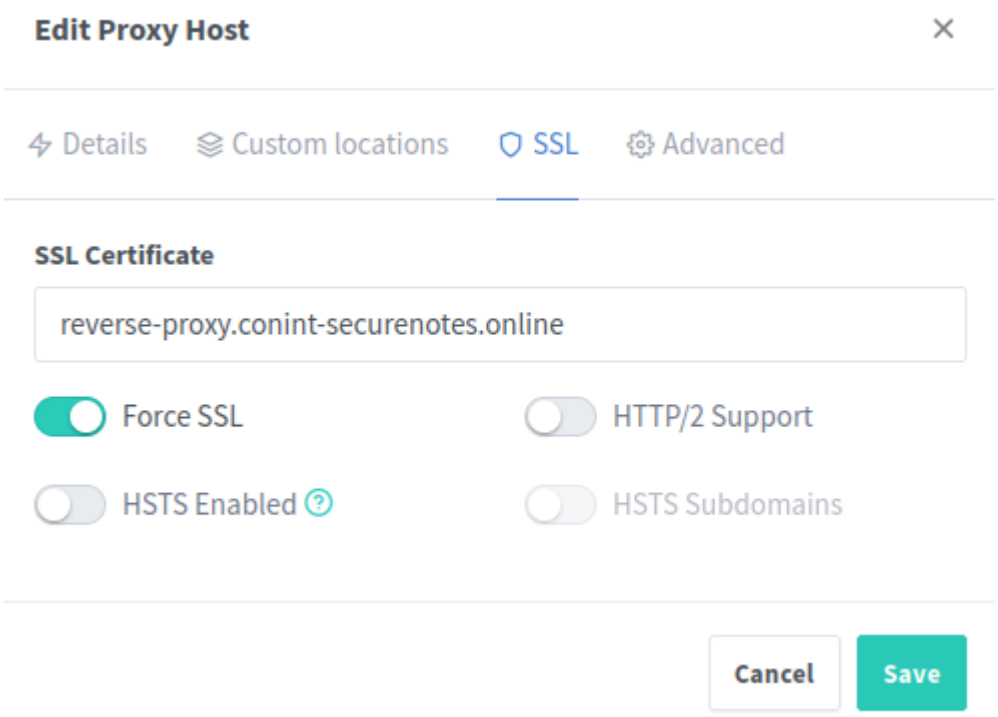
```yaml
services:
  nginx-proxy-manager:
    image: jc21/nginx-proxy-manager:2
    container_name: nginx-proxy-manager
    restart: unless-stopped
    ports:
      - "80:80"
      - "81:81"
      - "443:443"
    volumes:
      - ./data:/data
      - ./letsencrypt:/etc/letsencrypt
    networks:
      - jenkins_jenkins_network
      - portainer_portainer_network
      - sonarqube_sonarqube_network
      - proxy_network
```

Port 81 must be used for the initial setup. After adding an inbound rule in AWS for the administrator's IP only and port 81, NGINX proxy manager can be reached via internet. The initial credentials are "admin@example.com" with password "changeme".



A proxy host can be setup to move away from the insecure port 81.

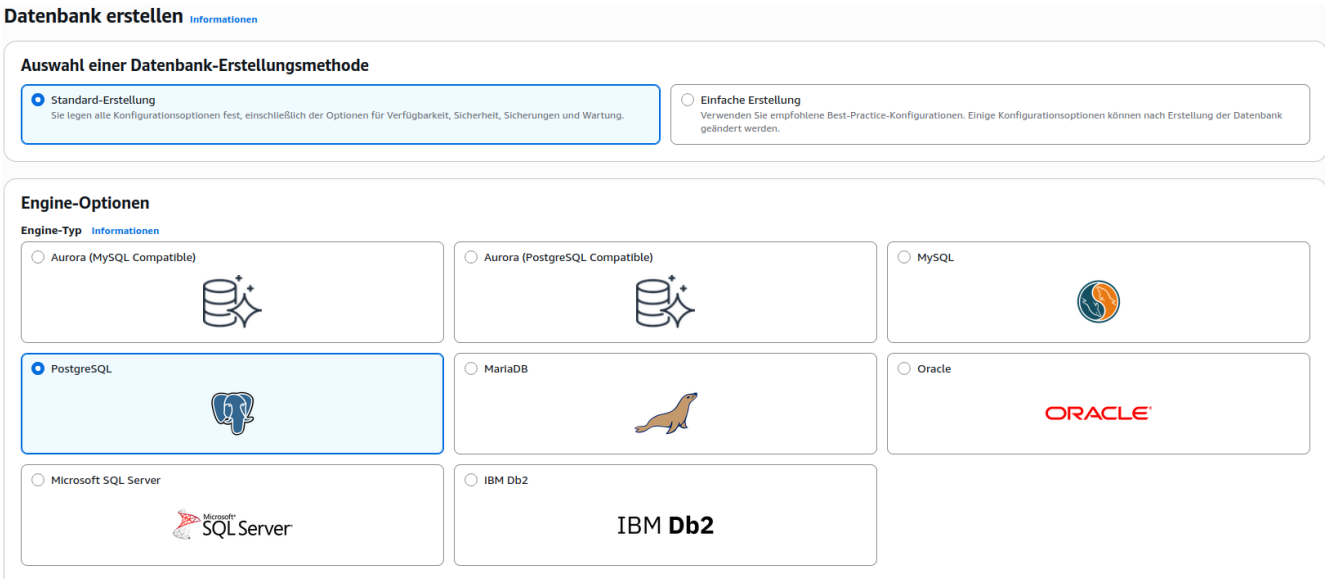




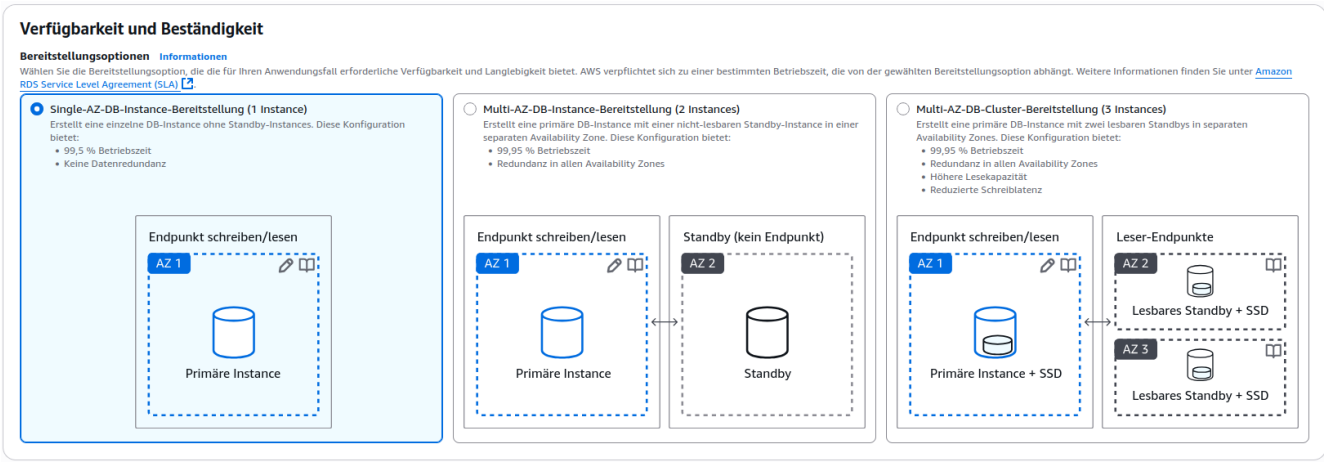
After this, port 81 can be removed again from the Portainer stack aswell as the inbound rule in AWS.

3.5 RDS setup

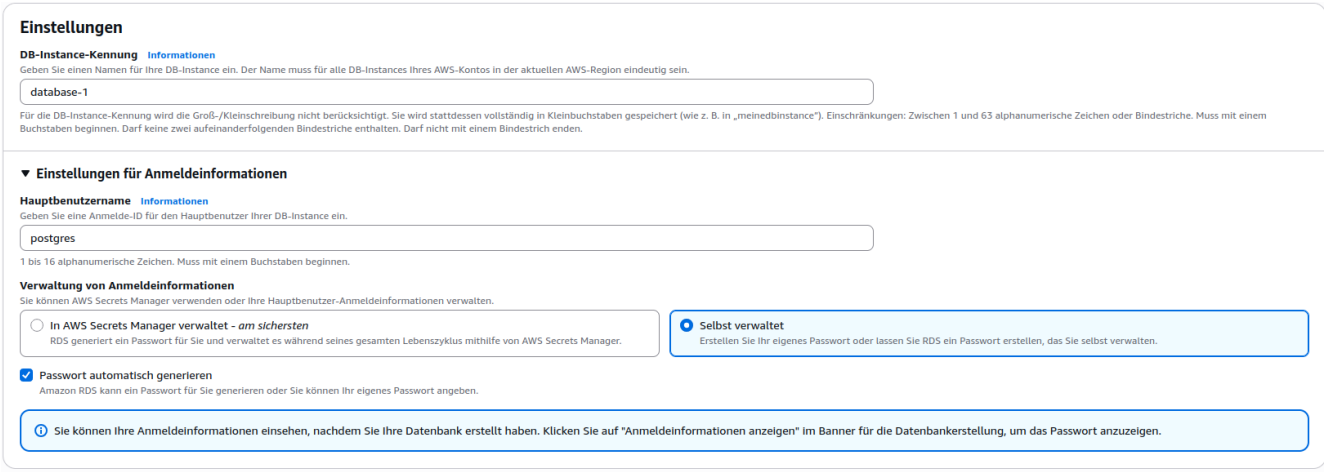
Creating a new RDS postgres database:



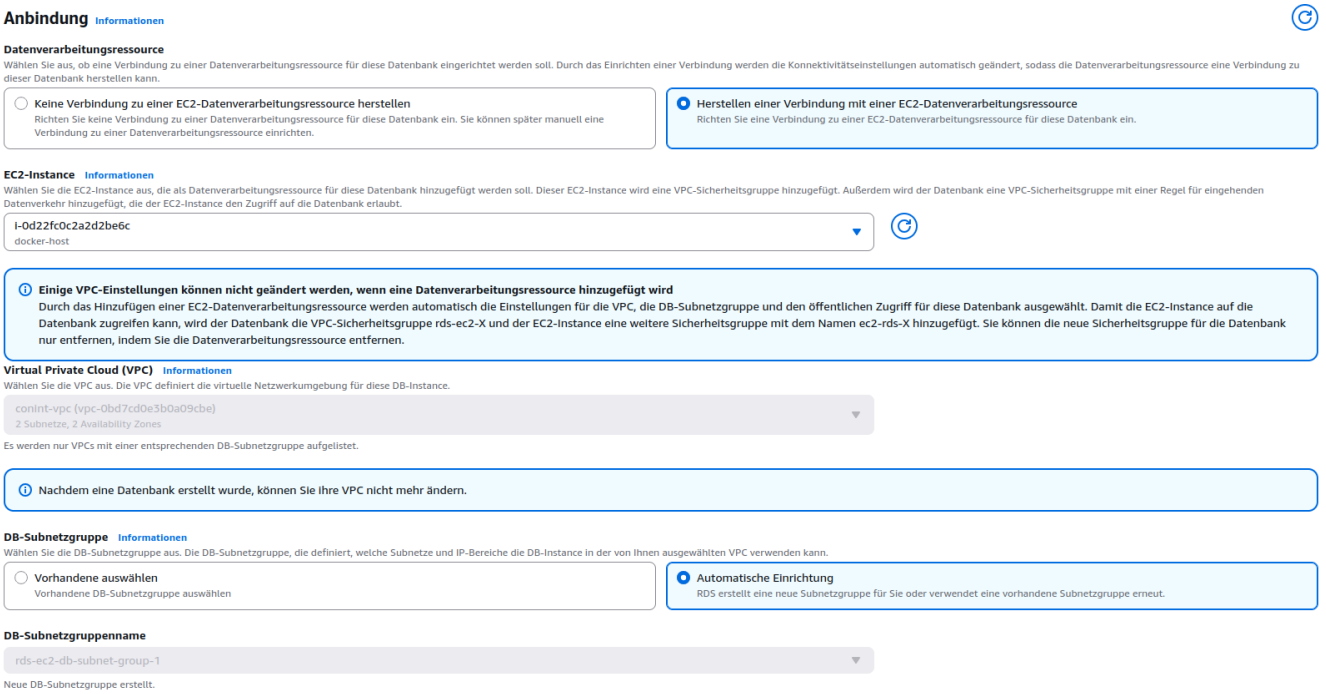
Selecting a single AZ database instance:



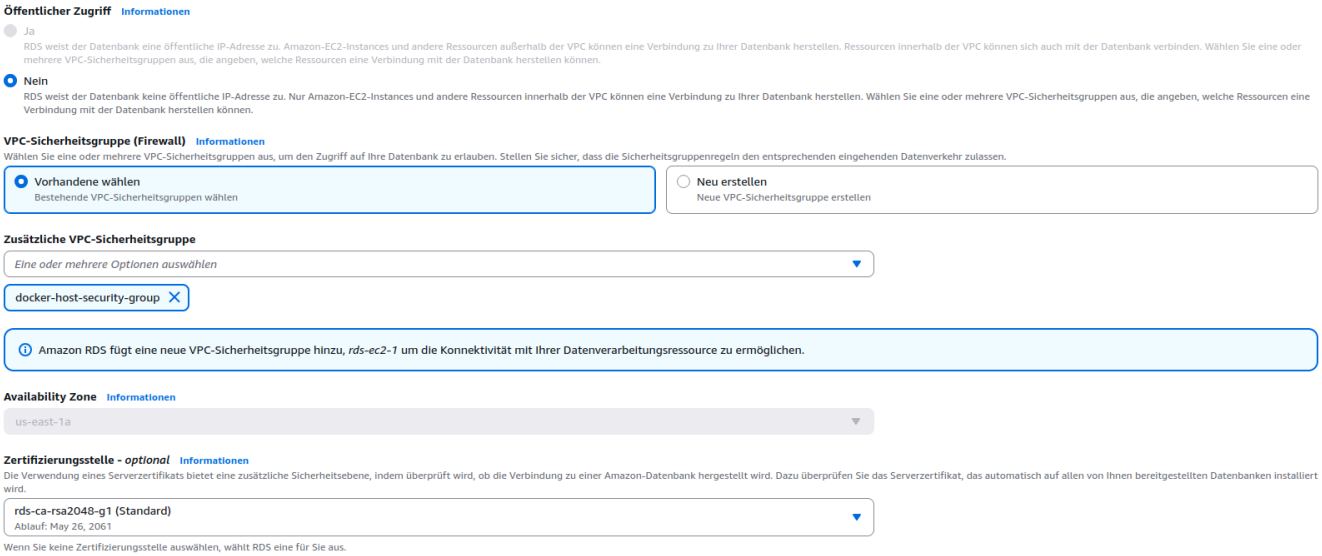
Using a generated password and not using AWS secrets manager as this would add cost:



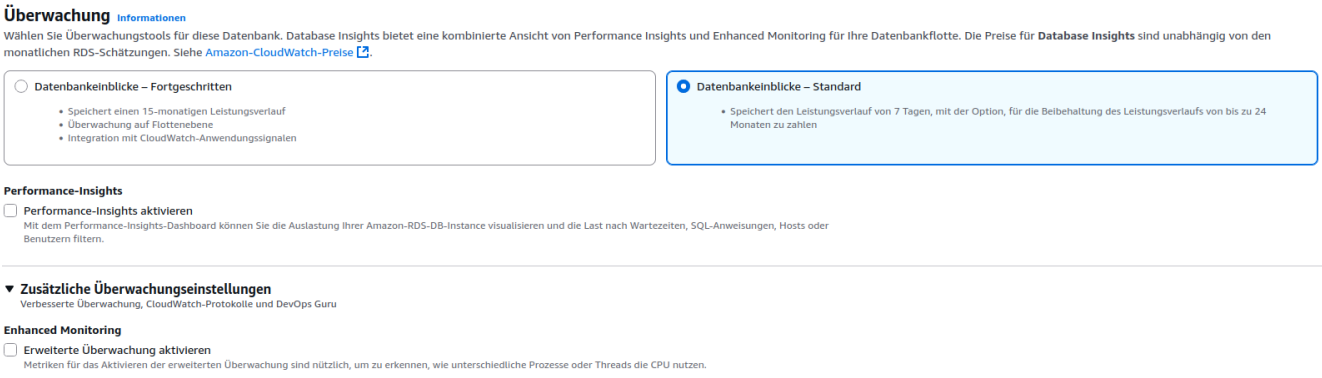
Establishing a connection to the docker host EC2 instance. We let AWS create a subnet for the database.



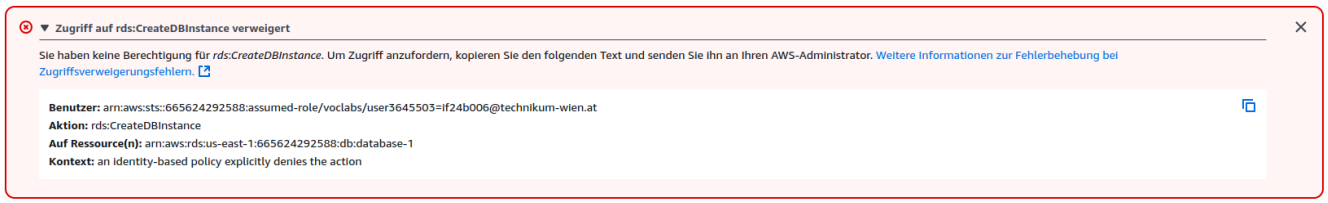
Using the security group of the EC2 instance for the connection rules:



Setting logging and monitoring to basic settings to save cost:



Unfortunately, an error occurs while trying to create a RDS instance:



The problem is that the lab user does not have sufficient permissions to use this AWS service. As a workaround, it was decided to host a Postgres instance on our Docker host. For this, a network called ”deployment-network” was created. The proxy manager was added to this network. A new stack is set up running a Postgres instance:

```yaml
services:
  db:
    image: postgres:17-alpine
    container_name: db
    restart: unless-stopped
    env_file:
      - docker.env
    expose:
      - 5432
    volumes:
      - secret_notes_postgres:/var/lib/postgresql/data
    networks:
      - secret_notes_network
```

4. Docker Hub

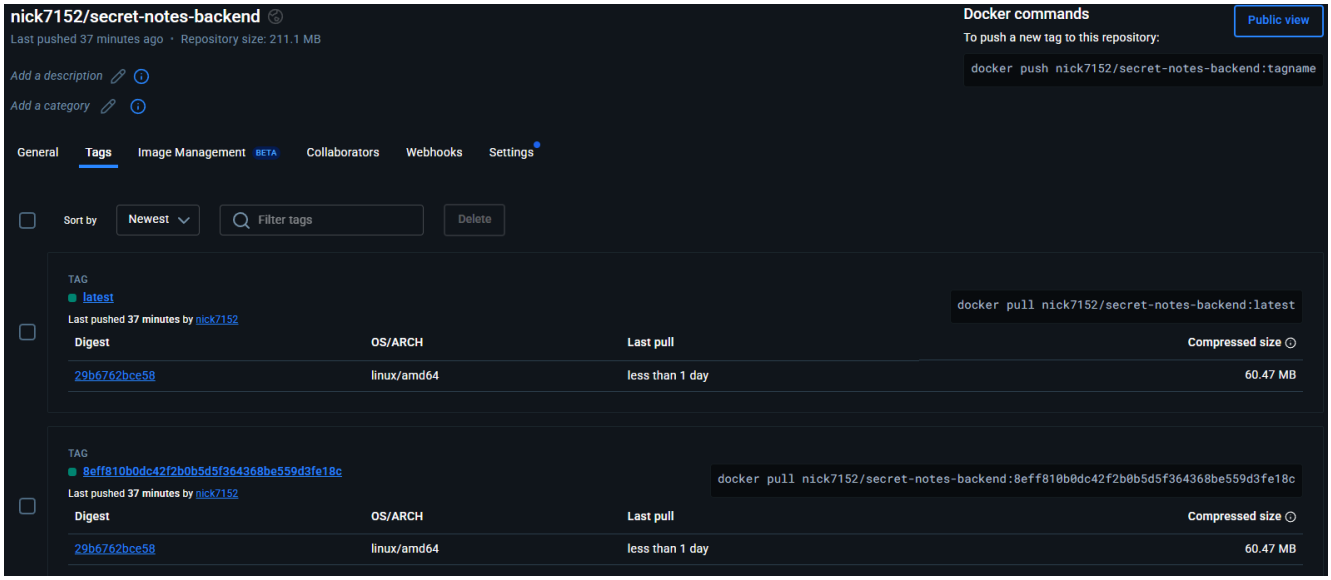
- Repository setup and naming conventions
- Image tagging strategy

Two publicly visible Docker Hub repositories are set up:

Name	Last Pushed	Contains	Visibility	Scout
nick7152/secret-notes-backend	36 minutes ago	IMAGE	Public	Inactive
nick7152/secret-notes-frontend	36 minutes ago	IMAGE	Public	Inactive

Both are named with the prefix ”secret-notes-” and get discriminated by the layer (frontend / backend).

Images built in a CI pipeline will be tagged with the latest full commit SHA digest. The newest image will additionally carry the tag “latest”. An example:



Here the latest tag refers to the newest image ”8eff810b0dc42f2b0b5d5f364368be559d3fe18c".

5. CI Servers

- Details of both pipelines (cloud-hosted and self-hosted)
- Screenshots or logs showing successful and failing runs

5.1 GitHub Actions

Enabling CI/CD functionality to a GitHub repository can be done by specifying workflow files in YAML format in the directory “.github/workflows” in the repository.

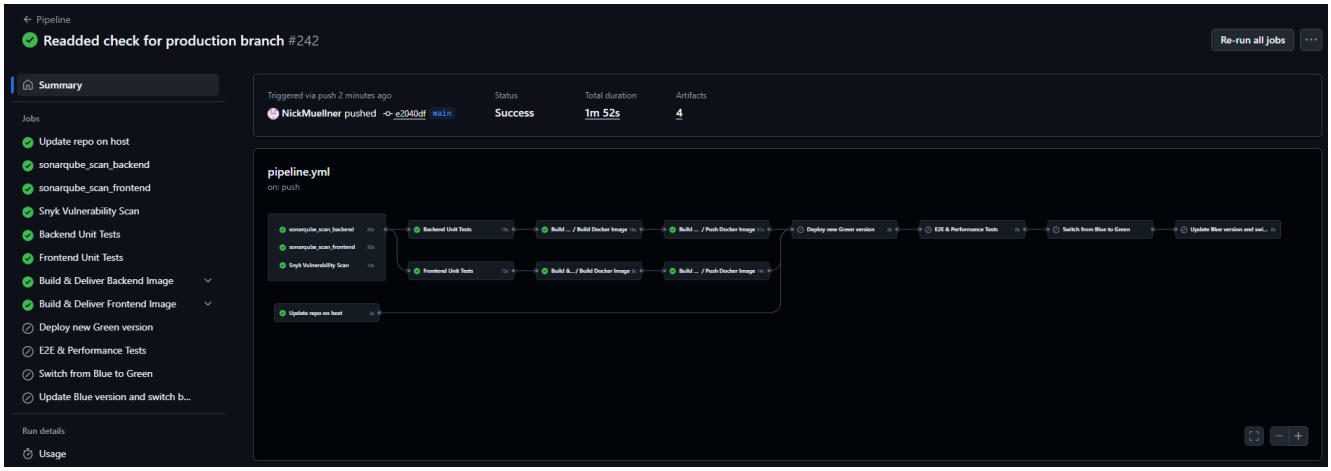
The main pipeline is defined as “pipeline.yml”. The long steps of building and delivering docker images has been oustourced to a second workflow file “build-and-deliver.yml" that can be called in the main workflow multiple times. This mechanism can be compared to functions in code as we can pass input variables to the sub-workflow.

As GitHub does not support the concept of stages like GitLab does, stage-like behavior can be simulated using “needs” directives that control the flow. Additionally, if clauses can be used to determine if a job should run.

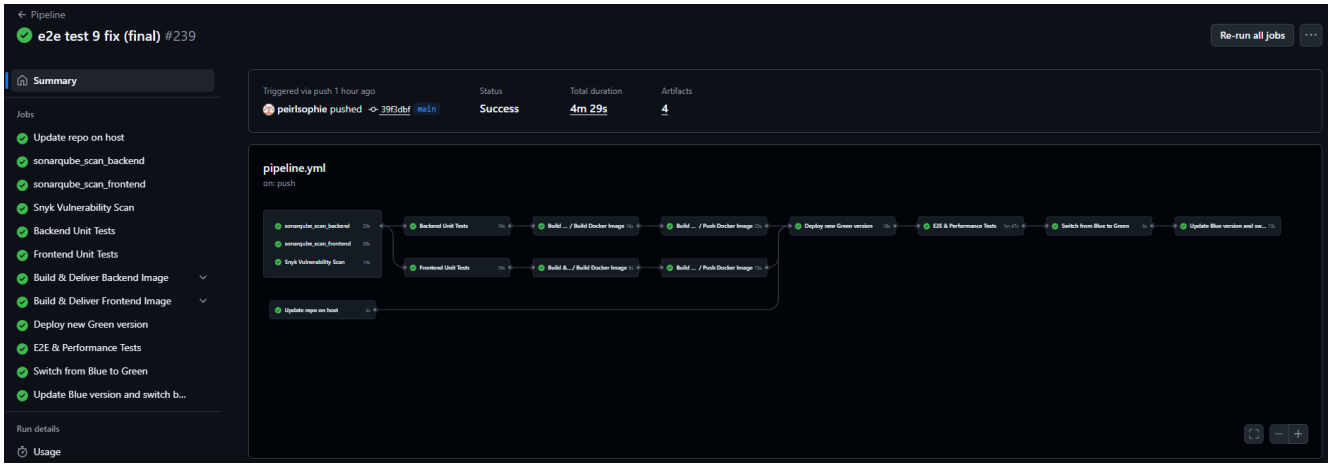
From left to right the following stages are contained:

- Linting: Contains SAST scanning with SonarQube, vulnerability scanning with Snyk and eslint
- Unit testing
- Build: Building Docker images
- Deliver: Pushing Docker images to Docker Hub
- Deploy: Uses the latest images and deploys to staging (green) environment
- E2E & Performance testing: conducting tests to assure stability of newly deployed staging environment (playwright, k6)
- Go-live: switch traffic to the verified green environment in the first step, update blue and switch back in the second step.

The stages Deliver, Deploy, E2E & Performance and Go-live only run when the triggering commit was made on the branch “production”. This is controlled via if clauses on the relevant jobs. The first stages are run when a commit is made to the main branch:



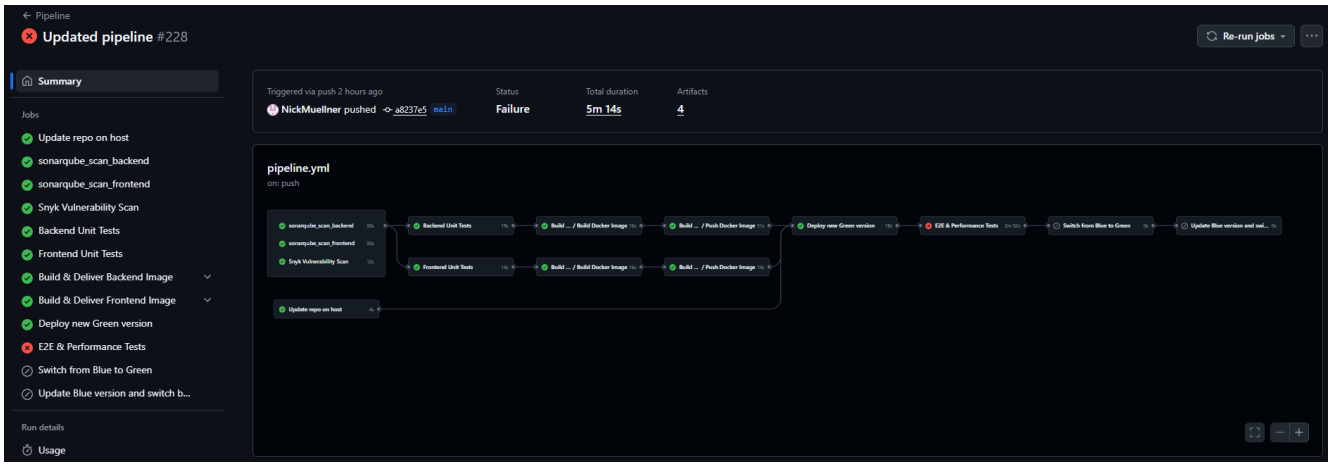
Without branch check for testing purposes:



The pipeline halts when a stage is unsuccessful. The following stages will not be executed in the event of failure.

Details of each stage are explained in chapter 9.

An example of a failed run:



E2E testing failed. This causes following stages to not be executed at all.

5.2 Jenkins

The setting with Jenkins is very similar to GitHub Actions. Instead of a pipeline.yml, a Jenkinsfile with groovy language is defined. But before we can start writing our stages, the setup for a Jenkins container is needed. Jenkins is available on Docker Hub as a container which we will use since we are using Docker on our host anyway. To address additional steps to have a container with Jenkins and project-related dependencies, a Dockerfile was created:

```
FROM jenkins/jenkins:lts

USER root

RUN groupadd -g 992 docker && usermod -aG docker jenkins

RUN gpg -k && gpg --no-default-keyring --keyring /usr/share/keyrings/k6-archive-keyring.gpg \
     --keyserver hkp://keyserver.ubuntu.com:80 --recv-keys C5AD17C747E3415A3642D57D77C6C491D6AC1D69 && \
    echo "deb [signed-by=/usr/share/keyrings/k6-archive-keyring.gpg] https://dl.k6.io/deb stable main" | tee /etc/apt/sources.list.d/k6.list

RUN apt-get update && \
    apt-get install -y k6

RUN curl -fsSL https://deb.nodesource.com/setup_22.x | bash - && \
    apt-get update && \
    apt-get install -y docker.io nodejs

RUN curl -L https://npmjs.org/install.sh | sh

RUN npx playwright install-deps

RUN curl -L "https://github.com/docker/compose/releases/latest/download/docker-compose-linux-x86_64" -o /usr/local/bin/docker-compose && \
    chmod +x /usr/local/bin/docker-compose

USER jenkins

RUN npx playwright install
```

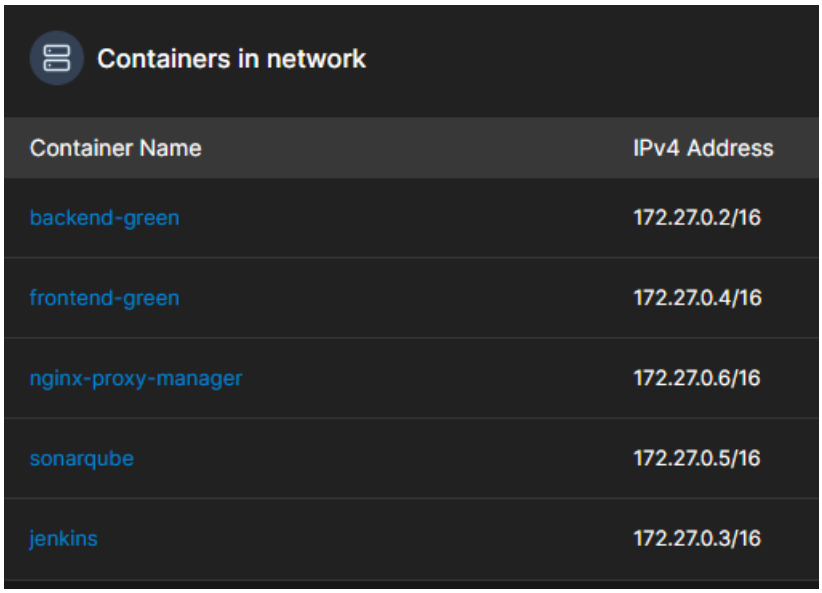
This creates a Jenkins container with:

- Jenkins assigned to the Docker group (needed for Docker socket access)
- Installed k6, docker, docker-compose nodejs, npm and playwright packages

Portainer is again used to deploy the container on the host with this compose file:

```
services:
  jenkins:
    build:
      dockerfile: Dockerfile
    container_name: jenkins
    user: jenkins
    restart: unless-stopped
    expose:
      - 8080
    volumes:
      - jenkins_home:/var/jenkins_home
      - /var/run/docker.sock:/var/run/docker.sock
    networks:
      - jenkins_network

volumes:
  jenkins_home:

networks:
  jenkins_network:
```

As Jenkins is responsible for local rollouts and tests, the network Jenkins_home is added to most of the other containers.



Containers in network

Container Name	IPv4 Address
backend-green	172.27.0.2/16
frontend-green	172.27.0.4/16
nginx-proxy-manager	172.27.0.6/16
sonarqube	172.27.0.5/16
jenkins	172.27.0.3/16

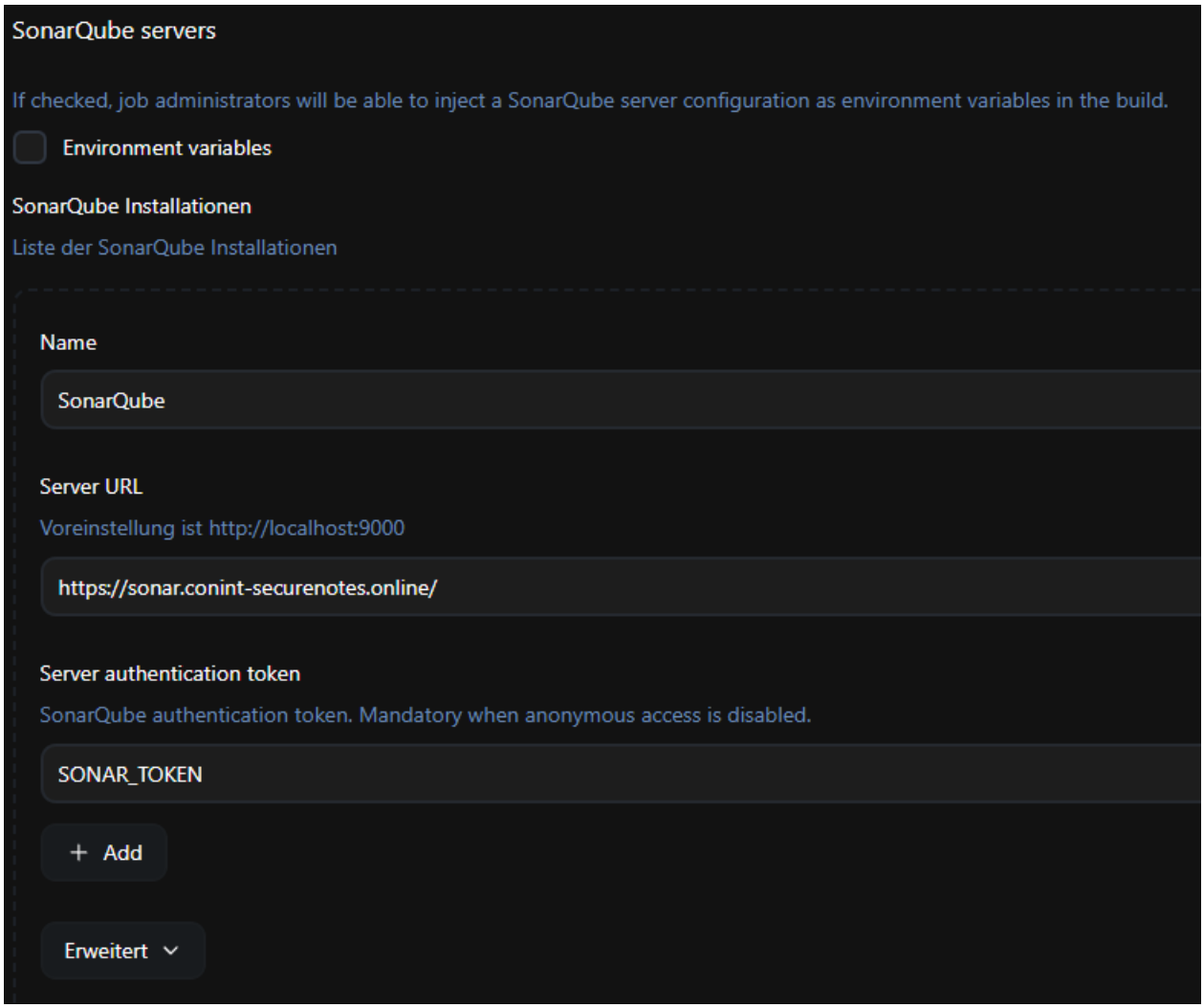
Now we can create a new Pipeline on the server with our Jenkinsfile with nearly 300 lines. Variables are either set or retrieved when starting a new run in the UI:

```
pipeline {
    agent any

    parameters {
        booleanParam(name: 'STATIC_TESTS', defaultValue: true, description: 'Statische Code Analyse durchführen? (lint, snyk, sonar, jest)')
        booleanParam(name: 'DYNAMIC_TESTS', defaultValue: true, description: 'Dynamische Tests durchführen? (playwright, kó)')
        booleanParam(name: 'BUILD_FRONTEND', defaultValue: false, description: 'Frontend bauen und pushen?')
        booleanParam(name: 'BUILD_BACKEND', defaultValue: false, description: 'Backend bauen und pushen?')
        booleanParam(name: 'DEPLOY', defaultValue: false, description: 'Erzeugten Build deployen und testen?')
        string(name: 'IMAGE_TAG', defaultValue: 'latest', description: 'Tag unter dem das Docker image gepushed wird')
    }

    environment {
        SONAR_HOST_URL = 'http://sonarqube:9000'
        FRONTEND_GREEN = 'http://frontend-green:80'
        BACKEND_GREEN = 'http://backend-green:3000/api'
        FRONTEND_IMAGE = 'nick7152/secret-notes-frontend'
        BACKEND_IMAGE = 'nick7152/secret-notes-backend'
    }

    stages {

        stage('Install Dependencies') {
            parallel {
                stage('Install Frontend Dependencies') {
                    steps {
                        dir('frontend') {
                            echo 'Installing frontend dependencies...'
                            sh 'npm ci'
                        }
                    }
                }
```

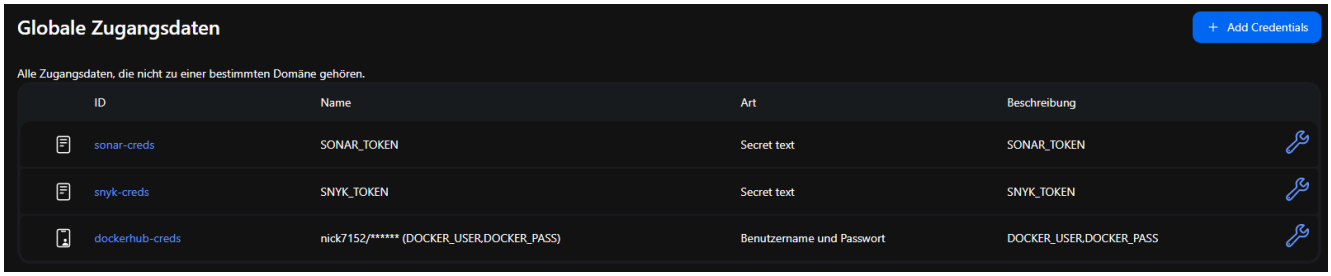
Jenkins comes with handy plugins for everything, but since we installed nearly everything on the host (e.g. nodejs, npm, etc.) we just added some graphical plugins and a plugin for SonarQube to the already installed default plugins:

- Blue Ocean → Huge overall UI enhancement
- Pipeline: Stage View Plugin → Summary of the last runs with stage detail
- Rebuilder → Easily rebuild a run with the same parameters
- SonarQube Scanner for Jenkins → Retrieves SonarQube scan results

Additional setup is needed for SonarQube:

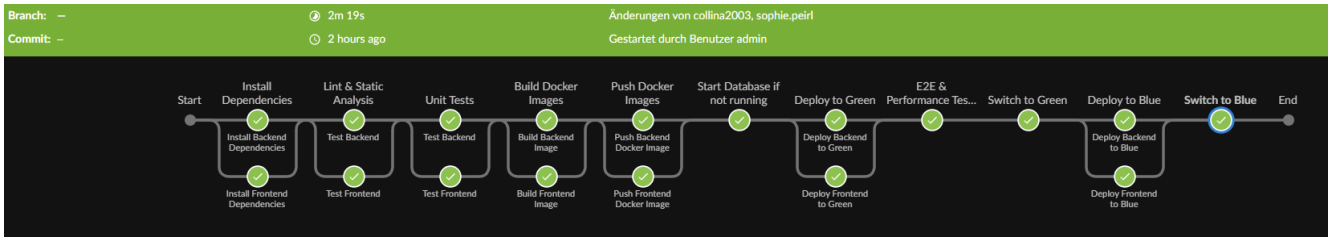


Also, credentials are needed for the Pipeline:



With everything set up, the pipeline can be manually triggered. To see a summary of some of the last runs we can easily look into the Pipeline and take use of the Pipeline: Stage View Plugin:

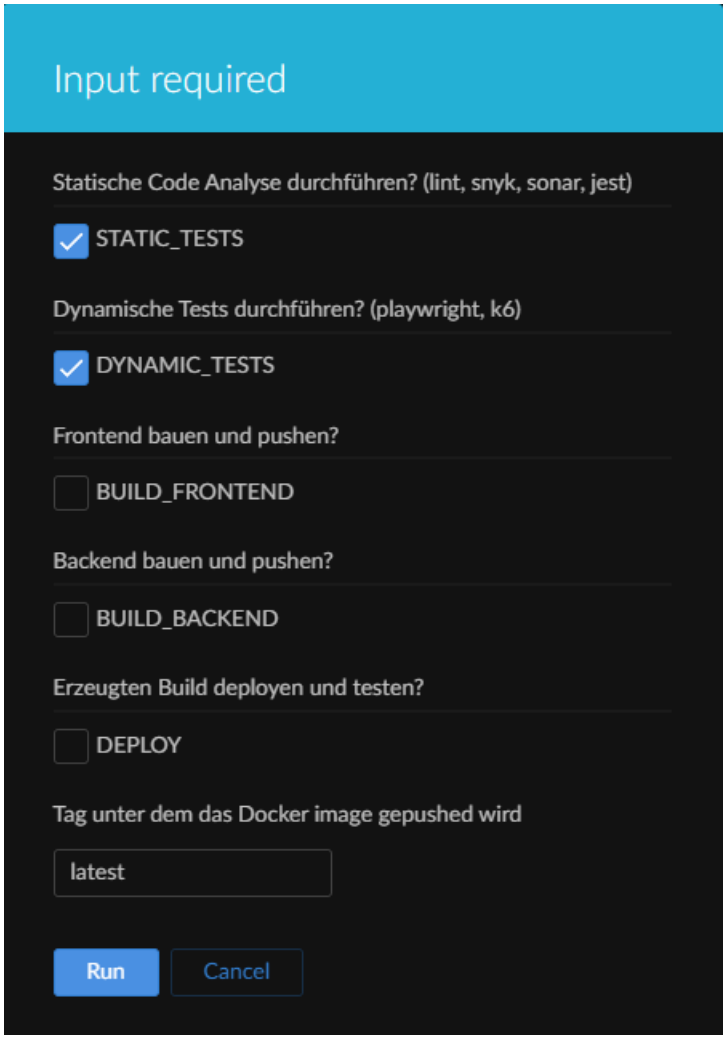
Here we see the last 10 runs and also which of them were successful. Because of the usage of parallel stages, unfortunately this view is not good for a detailed view of the stages. However, it is very nice to get a quick overview of the past runs. Therefore, we have Blue Ocean where we can inspect a specific run and also see parallel stages:



The following stages are run:

- Install dependencies
- Lint & Static Analysis
  - Eslint
  - SonarQube
  - Snyk
- Unit Tests
- Build Docker Images
- Push Docker Images
- Start Database if not running (for first deployment)
- Deploy to Green
- E2E & Performance Tests
- Switch to Green
- Deploy to Blue
- Switch to Blue

If a new run of the pipeline is started in the UI, several variables can be passed:



They have the following effects:

- STATIC_TESTS (default: true) → Executes stage “Lint & Static Analysis” and “Unit Tests”
- DYNAMIC_TESTS (default: true) → Executes stage “E2E & Performance Testing”
- BUILD_FRONTEND (default: false) → Executes stage “Build Docker Images: Build Frontend Image” and “Push Docker Images: Push Frontend Docker Image”
- BUILD_BACKEND (default: false) → Executes stage “Build Docker Images: Build Backend Image” and “Push Docker Images: Push Backend Docker Image”
- DEPLOY (default: false) → Executes stage “Start Database if not running”, “Deploy to Green”, “Switch to Green”, “Deploy to Blue” and “Switch to Blue”
- IMAGE_TAG (default: “latest”) → Defines which Image tag should be build/pushed and deployed

6. Code Quality Server

- SonarQube setup, including typical metrics collected

6.1 SonarQube container setup

A SonarQube server will be spun up on the EC2 docker host instance as a docker container. A problem occurs where the max map count of the system is set too low. The output of the error is visible when starting the SonarQube container. To fix, the file “/etc/sysctl.conf” needs to be edited with the needed map count. The configuration can be applied via “sudo sysctl –p".

```
[ec2-user@ip-10-0-0-94 ~]$ cat /etc/sysctl.conf
# sysctl settings are defined through files in
# /usr/lib/sysctl.d/, /run/sysctl.d/, and /etc/sysctl.d/.
#
# Vendors settings live in /usr/lib/sysctl.d/.
# To override a whole file, create a new file with the same in
# /etc/sysctl.d/ and put new settings there. To override
# only specific settings, add a file with a lexically later
# name in /etc/sysctl.d/ and put new settings there.
#
# For more information, see sysctl.conf(5) and sysctl.d(5).
vm.max_map_count=262144
[ec2-user@ip-10-0-0-94 ~]$ sudo sysctl -p
vm.max_map_count = 262144
[ec2-user@ip-10-0-0-94 ~]$
```

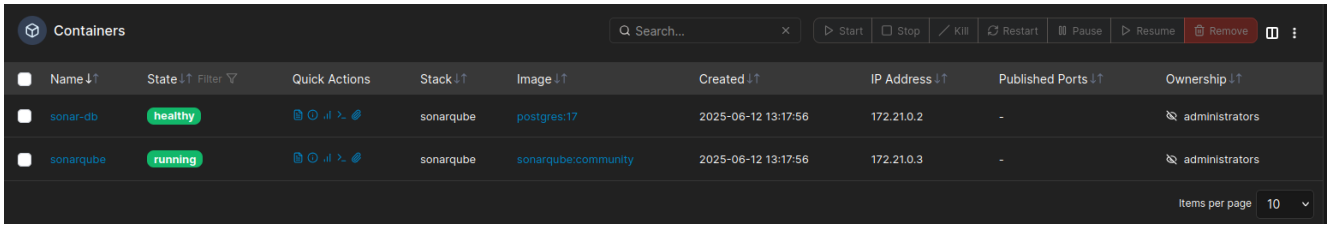
A docker compose stack can be set up in Portainer. It uses SonarQube itself and a Postgres database for storing data. Sonar and Postgres need a couple of volumes to keep configurations and data persisted. An external network is created and used in both containers:

```
sonarqube:
  image: sonarqube:25.7.0.110598-community
  container_name: sonarqube
  restart: unless-stopped
  depends_on:
    - db
  expose:
    - 9000
  environment:
    SONAR_JDBC_URL: jdbc:postgresql://sonarqube_db:5432/sonarqube
    SONAR_JDBC_USERNAME: sonar
    SONAR_JDBC_PASSWORD: sonarpassword
  volumes:
    - sonarqube_data:/opt/sonarqube/data
    - sonarqube_extensions:/opt/sonarqube/extensions
    - sonarqube_logs:/opt/sonarqube/logs
    - sonarqube_temp:/opt/sonarqube/temp
  networks:
    - sonarqube_network
    - jenkins_jenkins_network
```

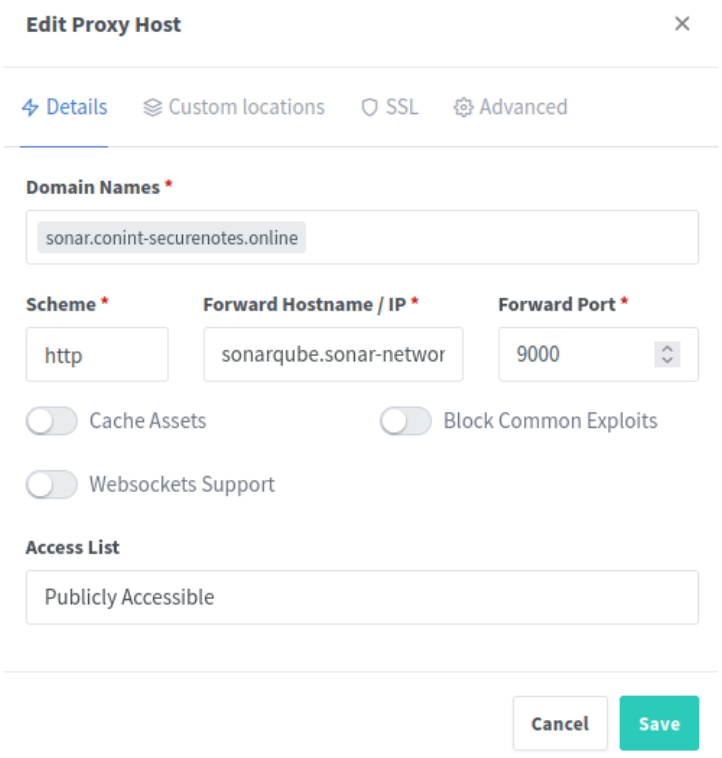
And the database:

```
db:
  image: postgres:17-alpine
  container_name: sonarqube_db
  restart: unless-stopped
  environment:
    POSTGRES_USER: sonar
    POSTGRES_PASSWORD: sonarpassword
    POSTGRES_DB: sonarqube
  volumes:
    - postgresql_data:/var/lib/postgresql/data
  networks:
    - sonarqube_network
```

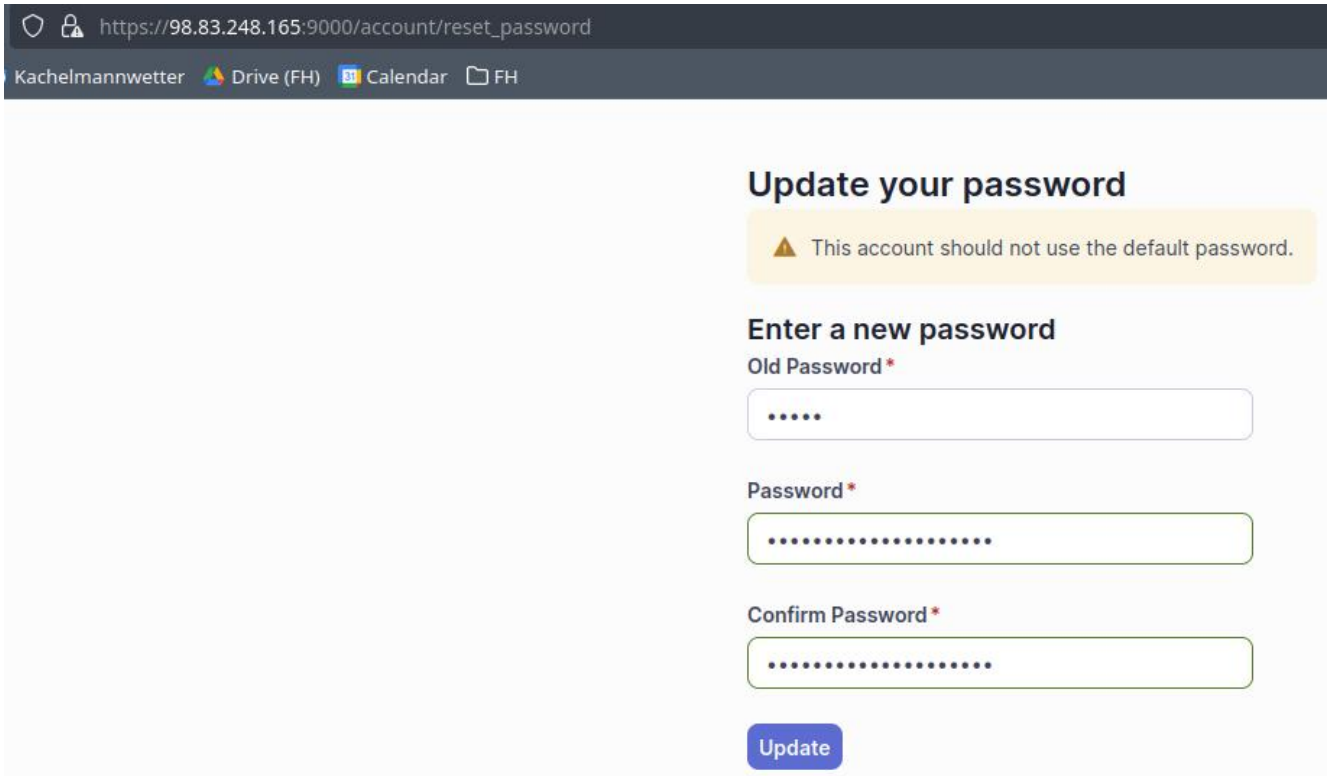
After saving, the containers are up and running.



A new proxy host is also added in NGINX proxy manager for the sonar instance (for TLS termination). The forward hostname can be specified as follows: container.network; in this case: ”sonarqube.sonar-network”. A SSL certificate is also requested via LetsEncrypt.

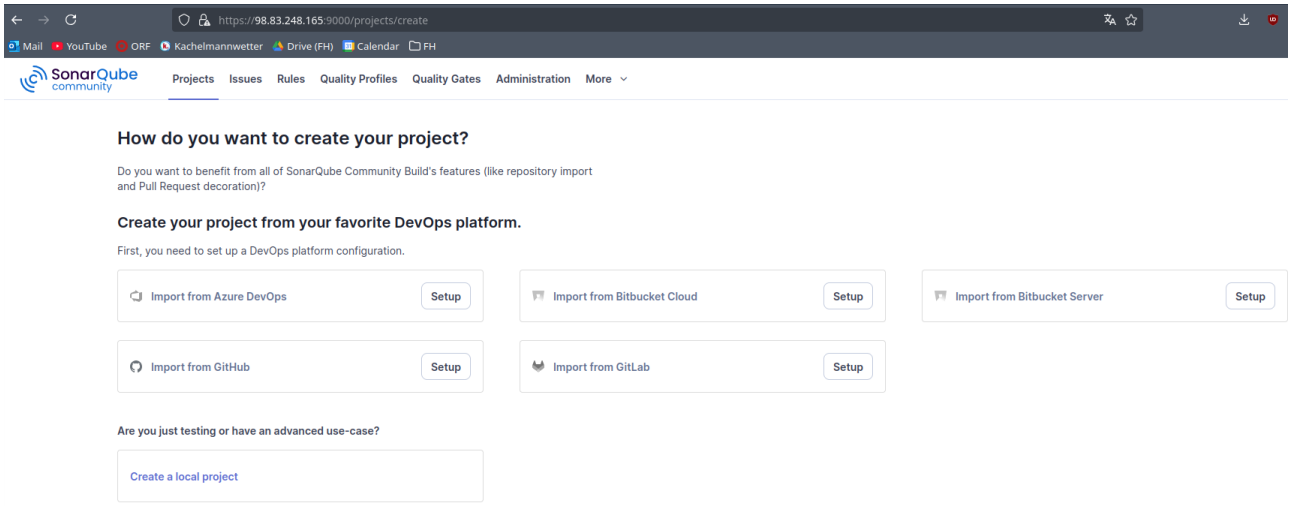


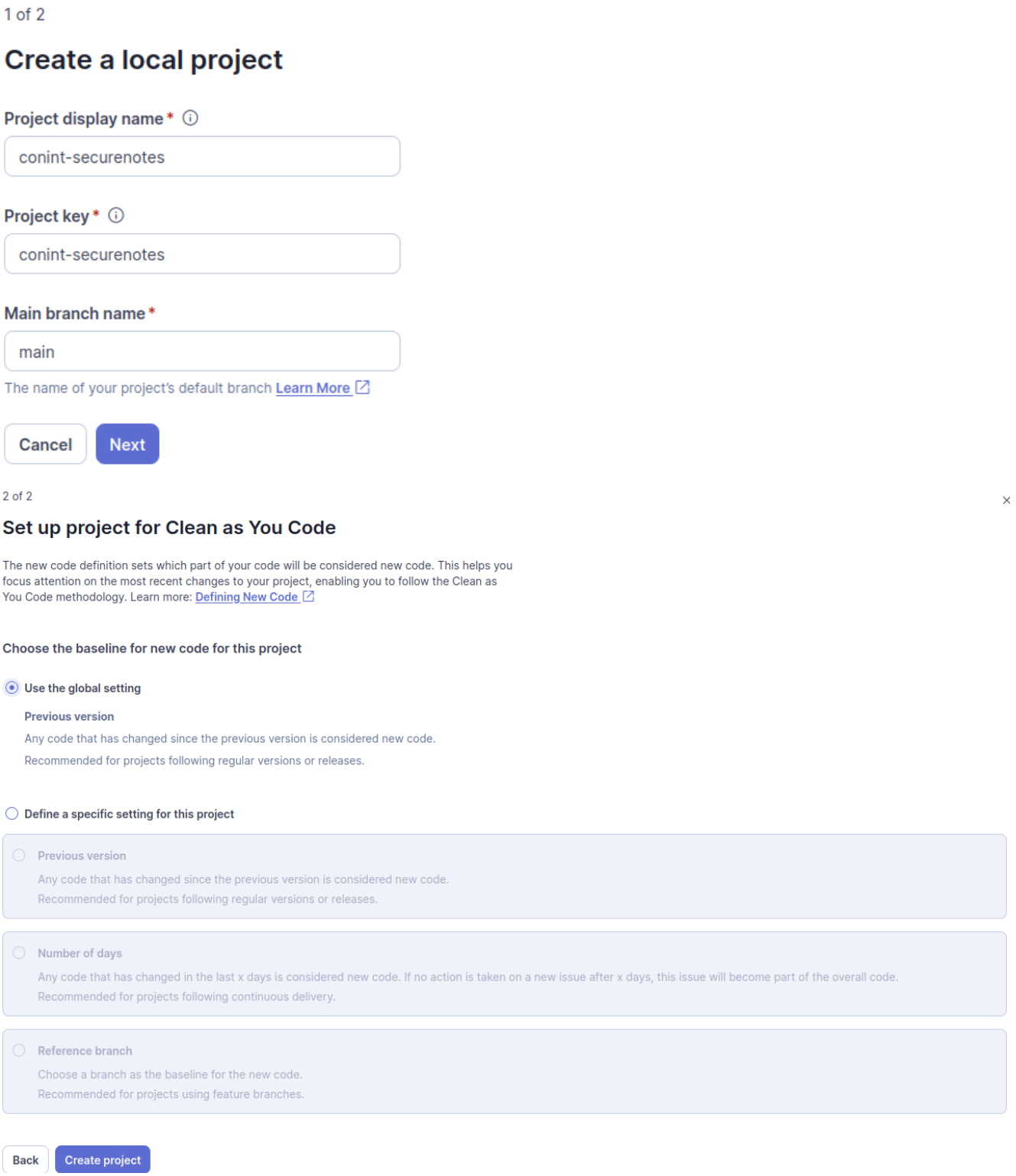
Sonar’s interface is now accessible via https://sonar.conint-securenotes.online (a rule for incoming traffic has already been setup). Upon first login with credentials ”admin” and password ”admin”, a new password must be entered.



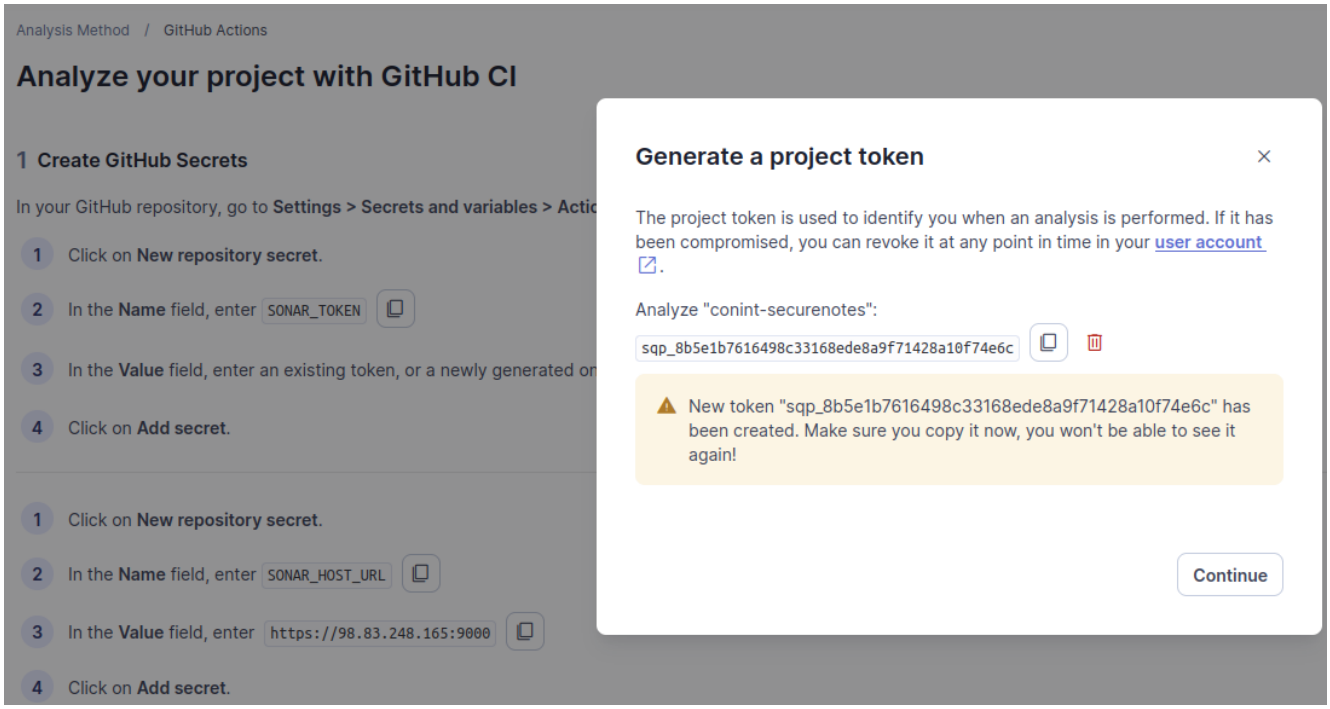
6.2 SAST configuration

Two new “local project” are configured in the Sonar interface, one for the backend and one for the frontend:

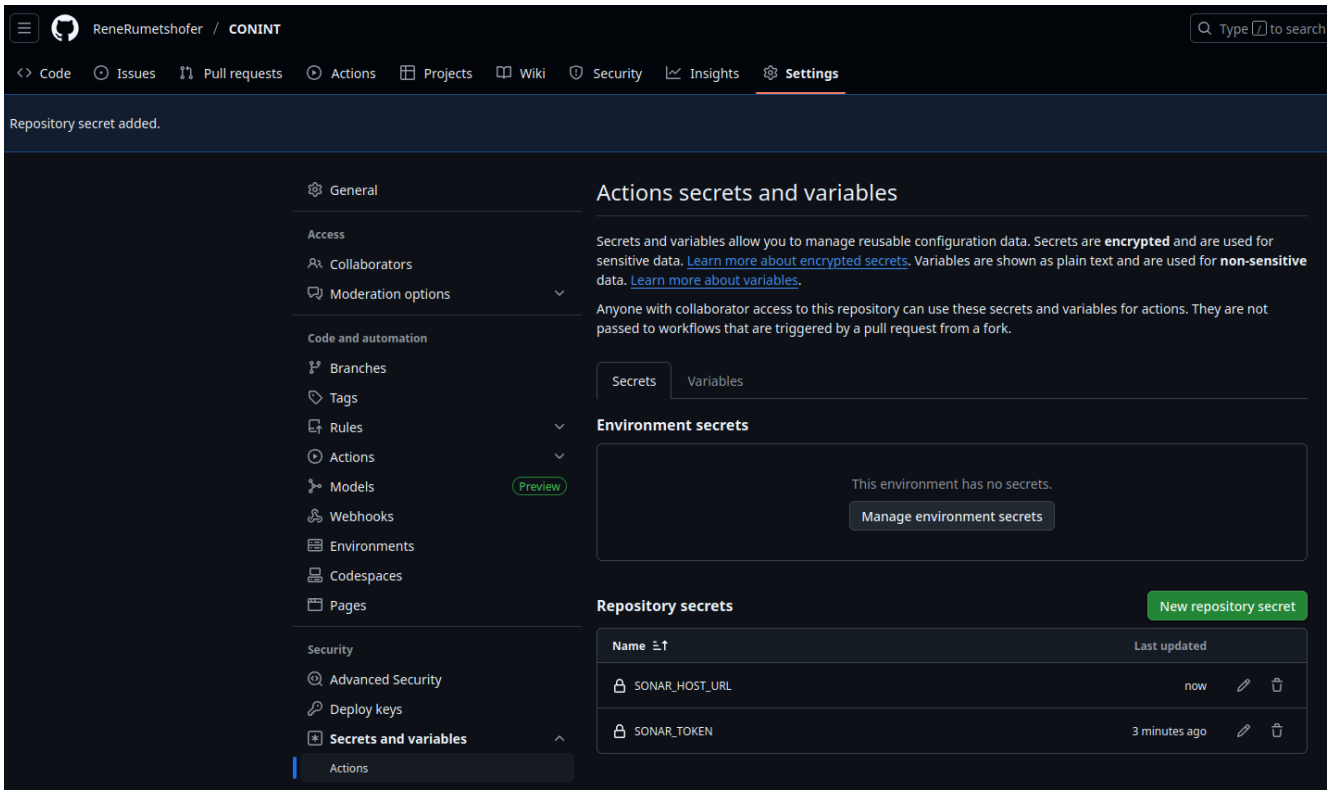




"GitHub actions" is selected for setup. Sonar provides detailed directions on how to add needed config to a GitHub repo. Firstly, a project token must be generated.



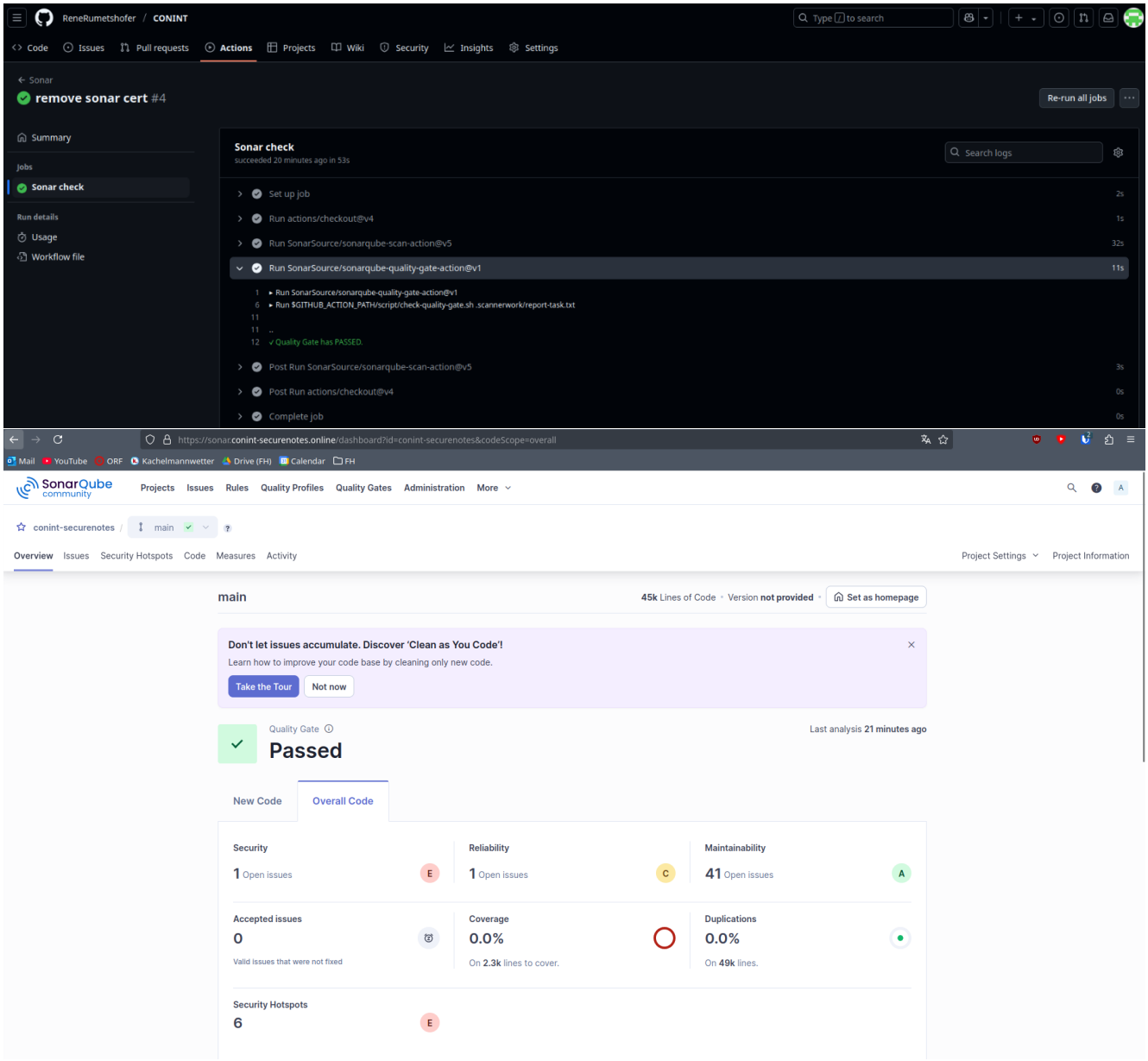
This token is then entered in the GitHub repo's settings under "Secrets and variables" -> "Actions" as a repository secret called "SONAR_TOKEN". Another secret "SONAR_HOST_URL" has to be created that contains the URL of Sonar.



Next, a file called ”sonar-project.properties” with content ”sonar.projectKey=conint-securenotes" is added to the root of the repository and committed. A test workflow is added under ”.github/workflows/sonar.yml” for trying sonar connectivity:

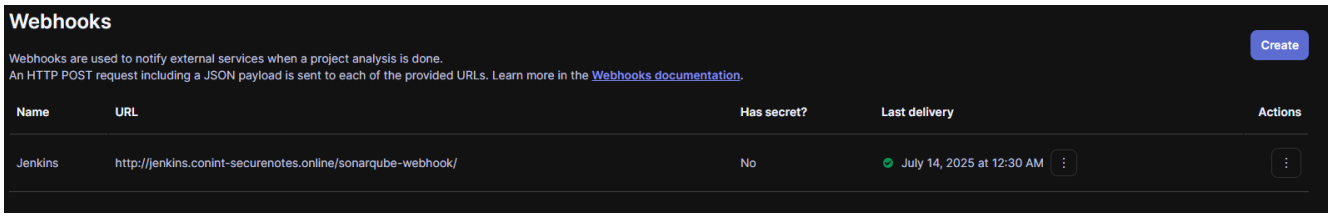
```yaml
sonarqube_scan_backend:
  runs-on: ubuntu-latest
  steps:
    - uses: actions/checkout@v4
    - uses: SonarSource/sonarqube-scan-action@v5
      with:
        args: -Dsonar.projectBaseDir=backend
      env:
        SONAR_TOKEN: ${{ secrets.SONAR_TOKEN }}
        SONAR_HOST_URL: ${{ secrets.SONAR_HOST_URL }}
    - uses: SonarSource/sonarqube-quality-gate-action@v1
      with:
        scanMetadataReportFile: backend/.scannerwork/report-task.txt
      timeout-minutes: 5
      env:
        SONAR_TOKEN: ${{ secrets.SONAR_TOKEN }}

sonarqube_scan_frontend:
  runs-on: ubuntu-latest
  steps:
    - uses: actions/checkout@v4
    - uses: SonarSource/sonarqube-scan-action@v5
      with:
        args: -Dsonar.projectBaseDir=frontend
      env:
        SONAR_TOKEN: ${{ secrets.SONAR_TOKEN }}
        SONAR_HOST_URL: ${{ secrets.SONAR_HOST_URL }}
    - uses: SonarSource/sonarqube-quality-gate-action@v1
      with:
        scanMetadataReportFile: frontend/.scannerwork/report-task.txt
      timeout-minutes: 5
      env:
        SONAR_TOKEN: ${{ secrets.SONAR_TOKEN }}
```

After committing the workflow a pipeline runs through and conducts a check via our Sonar server:



In Jenkins we also need preparation:

1. Install and configure associated plugin as mentioned in 5.2
2. Configure credentials (same token as used in GitHub Actions)
3. Set up webhook in SonarQube to let Jenkins know when it has finished



Now Jenkins executes the scan and aborts if there was found something:

```
echo 'SonarQube & Snyk Frontend...'
withCredentials([string(credentialsId: 'sonar-creds', variable: 'SONAR_TOKEN')]) {
    withSonarQubeEnv('SonarQube') {
        sh 'npm run sonar-scanner'
    }
}
timeout(time: 1, unit: 'MINUTES') {
    waitForQualityGate abortPipeline: true
}
```

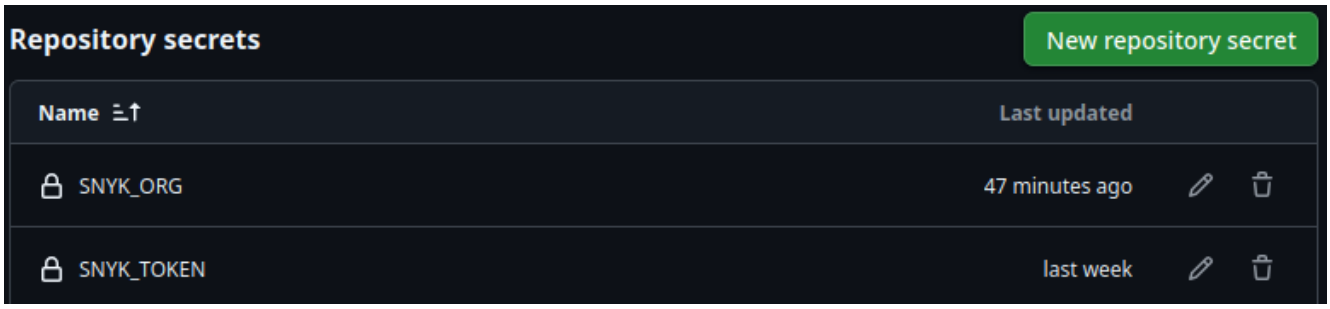
```
true  — Wait for SonarQube analysis to be completed and return quality gate status
1   Checking status of SonarQube task '9e55994b-efe3-4f28-84a6-d99418ecad44' on server 'SonarQube'
2   SonarQube task '9e55994b-efe3-4f28-84a6-d99418ecad44' status is 'IN_PROGRESS'
3   SonarQube task '9e55994b-efe3-4f28-84a6-d99418ecad44' status is 'SUCCESS'
4   SonarQube task '9e55994b-efe3-4f28-84a6-d99418ecad44' completed. Quality gate is 'OK'
```

7. Security Scan Server

- Snyk usage, how to interpret and fix vulnerabilities found

On Snyk a new organization “CONINT-securenotes” is used, the ID can be obtained via choosing to add a new project via “CLI”. For authentication, a token will be used. This can be obtained in the the personal settings of Snyk in the “General” section.

Both the organization ID and the authentication token are stored as repository secrets in GitHub:

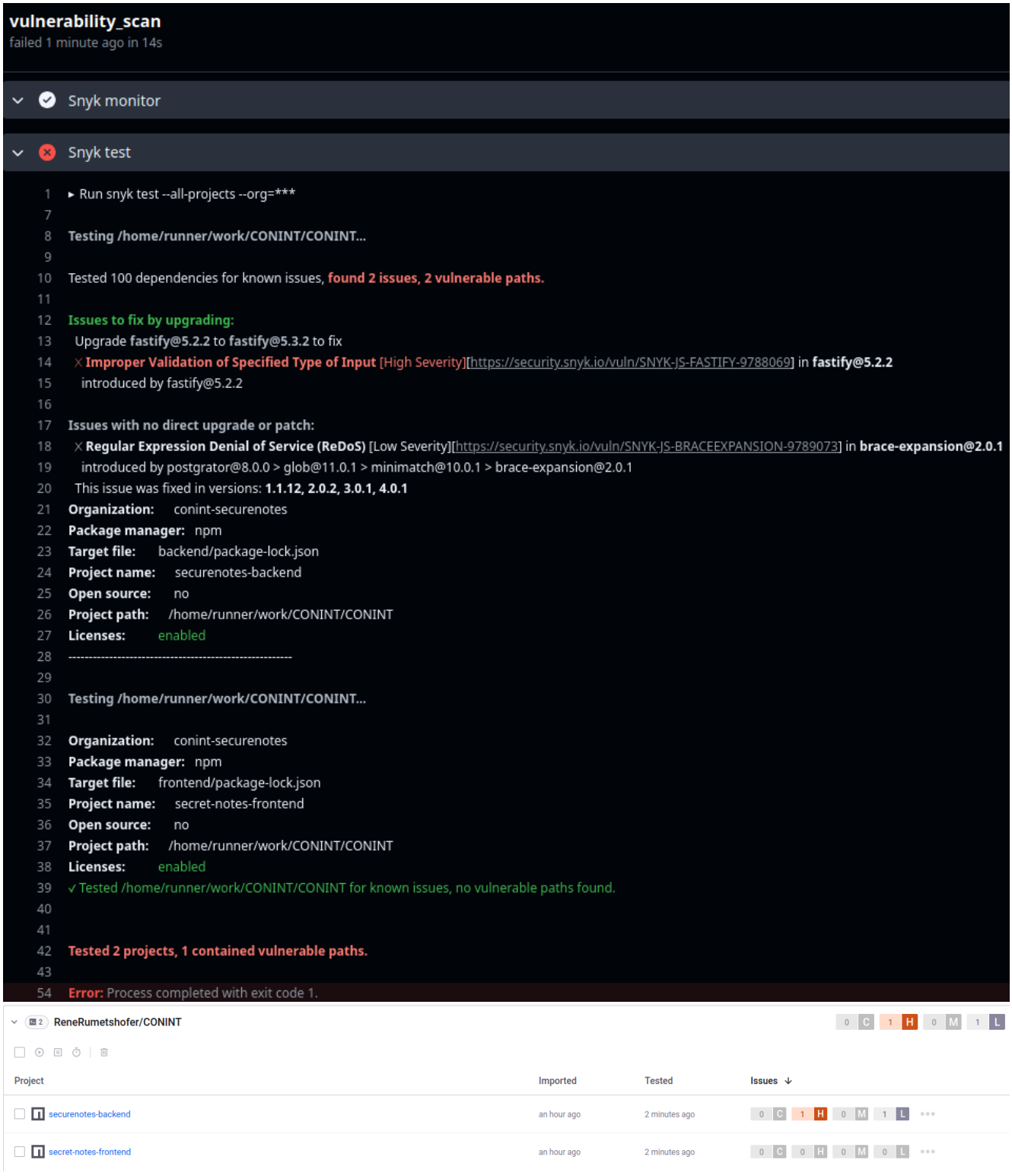


A new job is added to the GitHub workflow:

```yaml
vulnerability_scan:
  runs-on: ubuntu-latest
  steps:
    - uses: actions/checkout@main
    - uses: snyk/actions/setup@master
    - uses: actions/setup-node@v4
    - name: Snyk monitor
      run: snyk monitor --all-projects --org=${{ secrets.SNYK_ORG }}
      env:
        SNYK_TOKEN: ${{ secrets.SNYK_TOKEN }}
    - name: Snyk test
      run: snyk test --all-projects --org=${{ secrets.SNYK_ORG }}
      env:
        SNYK_TOKEN: ${{ secrets.SNYK_TOKEN }}
```

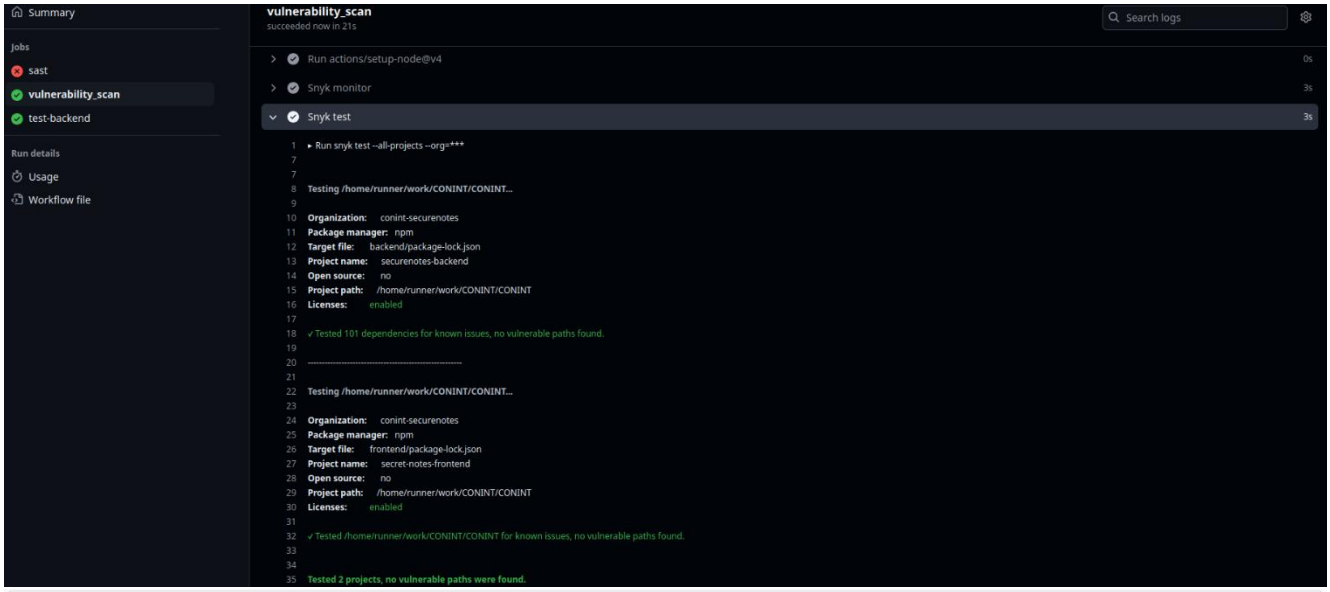
No dependencies are specified as the job should run in the first “stage”. It was decided to use the monitoring function to show vulnerabilities in Snyk’s dashboard and to get notified via email when new vulnerabilities should occur. The problem with this is that the pipeline does not fail if vulnerabilities are discovered. Therefore, we opted to run a Snyk test as well.

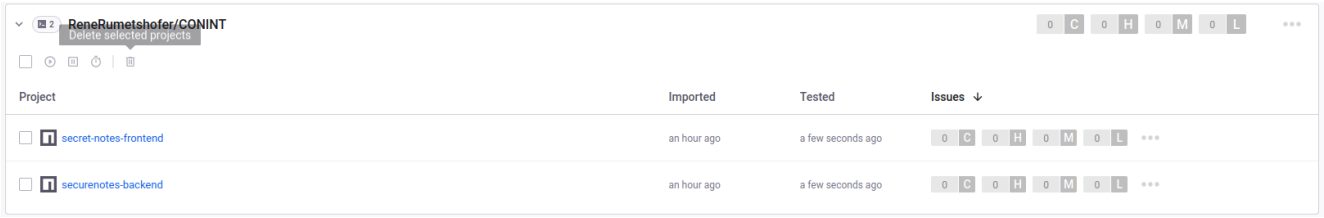
Running the pipeline for the first time resulted in a finding:



In order to fix the high severity issue, an update of NPM packages was done by running ”npm update”.

After committing the change, the new pipeline passes the scan:

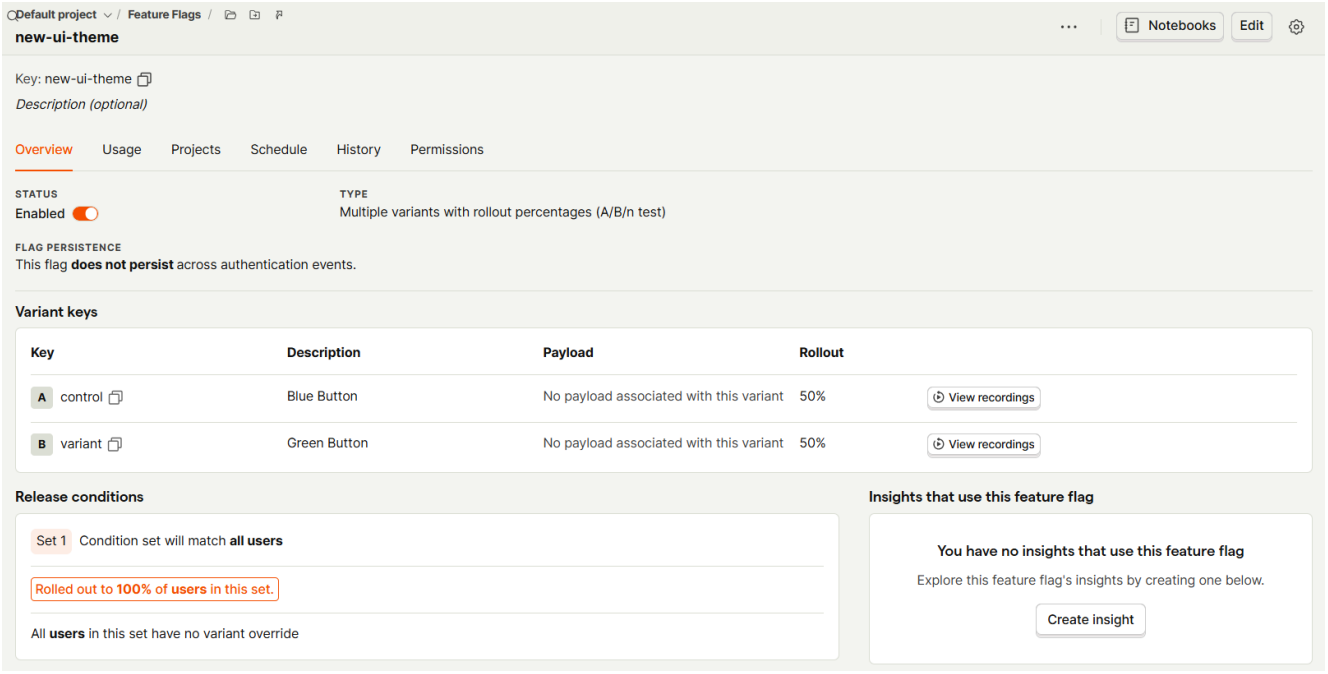

Summary
Jobs
sast
vulnerability_scan
test-backend
Run details
Usage
Workflow file
vulnerability_scan
succeeded now in 21s
Search logs
Run actions/setup-node@v4
0s
Snyk monitor
3s
Snyk test
3s
▸ Run snyk test --all-projects --org=***
Testing /home/runner/work/CONINT/CONINT...
Organization: conint-securenotes
Package manager: npm
Target file: backend/package-lock.json
Project name: securenotes-backend
Open source: no
Project path: /home/runner/work/CONINT/CONINT
Licenses: enabled
✓ Tested 101 dependencies for known issues, no vulnerable paths found.
Testing /home/runner/work/CONINT/CONINT...
Organization: conint-securenotes
Package manager: npm
Target file: frontend/package-lock.json
Project name: secret-notes-frontend
Open source: no
Project path: /home/runner/work/CONINT/CONINT
Licenses: enabled
✓ Tested /home/runner/work/CONINT/CONINT for known issues, no vulnerable paths found.
Tested 2 projects, no vulnerable paths were found.


ReneRumetshofer/CONINT
Delete selected projects
Project
Imported
Tested
Issues
secret-notes-frontend
an hour ago
a few seconds ago
securenotes-backend
an hour ago
a few seconds ago

8. Feature Toggle & A/B Test Server

- PostHog setup for toggles and experiments
- Example toggles with instructions on how to enable/disable them

PostHog setup for toggles and experiments



Loading PostHogs tracking library:

```
s.api_host.replace( searchValue: ".i.posthog.com", replaceValue: "-assets.i.posthog.com") +
"/static/array.js"),
```

Initalizing PostHog:

```
posthog.init( i: "phc_ASQ4jxULA4BuJQfLNnCH974PkeqxcLGfzQl2DyYXCjh", s: {
  api_host: "https://eu.i.posthog.com",
  defaults: "2025-05-24",
  person_profiles: "always",
});
```

Creating stub functions to allow calling PostHog methods before the library loads

Example toggles with instructions on how to enable/disable them

In PostHogs' feature flags interface, you can toggle the feature flag with ease by pushing the button underneath status showcasing its current status. An advantage PostHog offers is that you don't have to restart the server when toggling the feature flag to apply its effects.

The screenshot below shows a PostHog feature flag to toggle the UI style of the create note button.

9. Each Stage of the Pipeline

- Detailed explanation of Lint, Test, Build, Deliver, Deploy, E2E/Performance Testing
- What happens if a stage fails (notification)

9.1 GitHub actions

The main pipeline is defined as “pipeline.yml”. As mentioned in chapter 5, stages are not directly supported by GitHub actions. They are however simulated by controlling the flow of jobs via defining needed jobs with the “needs” keyword.

Before running the script, a git pull is executed on the EC2 host, because some files are needed locally like the nginx.conf for the blue-green-proxy or the blue/green compose files:

```yaml
update-local-repo:
  name: Update repo on host
  runs-on: ubuntu-latest
  steps:
    - uses: appleboy/ssh-action@v1
      with:
        host: ${{ secrets.DEPLOY_HOST }}
        username: ${{ secrets.DEPLOY_HOST_USERNAME }}
        key: ${{ secrets.DEPLOY_HOST_SSH_KEY }}
        script: |
          cd /opt/CONINT && \
          sudo git pull
```

The linting stage runs two jobs: “sonarqube_scan_backend/sonarqube_scan_frontend” and “vulnerability_scan”. Existing actions are used for running SonarQube (SAST) and Snyk tests. The latter runs two snyk commands separately. The first “monitor” command only updates Snyk’s state of the repostitory (to manage in Snyk’s dashboard and get notified on new vulnerabilities) and does not fail the pipeline. This is why the consequent “snyk test” command is also used.

```yaml
vulnerability_scan:
  name: Snyk Vulnerability Scan
  runs-on: ubuntu-latest
  steps:
    - uses: actions/checkout@main
    - uses: snyk/actions/setup@master
    - uses: actions/setup-node@v4
    - name: Snyk monitor
      run: snyk monitor --all-projects --org=${{ secrets.SNYK_ORG }}
      env:
        SNYK_TOKEN: ${{ secrets.SNYK_TOKEN }}
    - name: Snyk test
      run: snyk test --all-projects --org=${{ secrets.SNYK_ORG }}
      env:
        SNYK_TOKEN: ${{ secrets.SNYK_TOKEN }}
```

And SonarQube (first scanning and then retrieving results):

```yaml
sonarqube_scan_backend:
  runs-on: ubuntu-latest
  steps:
    - uses: actions/checkout@v4
    - uses: SonarSource/sonarqube-scan-action@v5
      with:
        args: -Dsonar.projectBaseDir=backend
      env:
        SONAR_TOKEN: ${{ secrets.SONAR_TOKEN }}
        SONAR_HOST_URL: ${{ secrets.SONAR_HOST_URL }}
    - uses: SonarSource/sonarqube-quality-gate-action@v1
      with:
        scanMetadataReportFile: backend/.scannerwork/report-task.txt
      timeout-minutes: 5
      env:
        SONAR_TOKEN: ${{ secrets.SONAR_TOKEN }}

sonarqube_scan_frontend:
  runs-on: ubuntu-latest
  steps:
    - uses: actions/checkout@v4
    - uses: SonarSource/sonarqube-scan-action@v5
      with:
        args: -Dsonar.projectBaseDir=frontend
      env:
        SONAR_TOKEN: ${{ secrets.SONAR_TOKEN }}
        SONAR_HOST_URL: ${{ secrets.SONAR_HOST_URL }}
    - uses: SonarSource/sonarqube-quality-gate-action@v1
      with:
        scanMetadataReportFile: frontend/.scannerwork/report-task.txt
      timeout-minutes: 5
      env:
        SONAR_TOKEN: ${{ secrets.SONAR_TOKEN }}
```

The test stage follows the linting stage by defining order via the needs keyword, where the jobs wait on all jobs of the previous stage. Both jobs checkout the code base, setup node, install packages and run linting and the jest tests.

```yaml
test-backend:
  name: Backend Unit Tests
  runs-on: ubuntu-latest
  needs: [ sonarqube_scan_backend, sonarqube_scan_frontend, vulnerability_scan ]
  defaults:
    run:
      working-directory: backend
  steps:
    - uses: actions/checkout@v4
    - uses: actions/setup-node@v4
    - run: npm ci
    - run: npm run eslint
    - run: npm run jest
    - name: Archive code coverage results
      uses: actions/upload-artifact@v4
      with:
        name: backend-coverage-report
        path: backend/coverage/lcov-report

test-frontend:
  name: Frontend Unit Tests
  runs-on: ubuntu-latest
  needs: [ sonarqube_scan_backend, sonarqube_scan_frontend, vulnerability_scan ]
  defaults:
    run:
      working-directory: frontend
  steps:
    - uses: actions/checkout@v4
    - uses: actions/setup-node@v4
    - run: npm ci
    - run: npm run eslint
    - run: npm run jest
    - name: Archive code coverage results
      uses: actions/upload-artifact@v4
      with:
        name: frontend-coverage-report
        path: frontend/coverage/lcov-report
```

The next stage is the building and delivering stage. Here, a separate workflow is being called to avoid repeating large sections of steps (between backend and frontend). The definition of “secrets: inherit” is important for the call to access GitHub actions secrets in the called workflow. Variables are passed via “with”.

```yaml
build-deliver-backend-image:
  name: Build & Deliver Backend Image
  needs: test-backend
  secrets: inherit
  uses: ./.github/workflows/build-and-deliver.yml
  with:
    working-directory: backend
    dockerhub-repository: secret-notes-backend
    image-artifact-name: backend-image

build-deliver-frontend-image:
  name: Build & Deliver Frontend Image
  needs: test-frontend
  secrets: inherit
  uses: ./.github/workflows/build-and-deliver.yml
  with:
    working-directory: frontend
    dockerhub-repository: secret-notes-frontend
    image-artifact-name: frontend-image
```

The workflow file “build-and-deliver.yml” starts with defintions of variables that can be passed.

```yaml
name: Build and Push Docker Image

on:
  workflow_call:
    inputs:
      working-directory:
        required: true
        type: string
      dockerhub-repository:
        required: true
        type: string
      image-artifact-name:
        required: true
        type: string

env:
  DOCKERHUB_USERNAME: nick7152
```

The jobs build an image using the Git commit SHA as the image tag. The image gets pushed to Docker Hub. Additionally, the image is also pushed under the tag “latest”. The username for DockerHub is simply defined as an environment variable here, as it is not secret. The built image gets passed from the build to the deliver job via an artifact.

```yaml
build-image:
  name: Build Docker Image
  runs-on: ubuntu-latest
  outputs:
    image-tag: ${{ steps.tag.outputs.image-tag }}
  steps:
    - name: Checkout code
      uses: actions/checkout@v4
    - name: Set Docker image tag
      id: tag
      run: echo "image-tag=${GITHUB_SHA}" >> "$GITHUB_OUTPUT"
    - name: Build Docker image
      run: |
        docker build -t ${{ env.DOCKERHUB_USERNAME }}/${{ inputs.dockerhub-repository }}:${{ steps.tag.outputs.image-tag }} ${{ inputs.working-directory }}
    - name: Save Docker image to file
      run: |
        docker save ${{ env.DOCKERHUB_USERNAME }}/${{ inputs.dockerhub-repository }}:${{ steps.tag.outputs.image-tag }} -o image.tar
    - name: Upload image artifact
      uses: actions/upload-artifact@v4
      with:
        name: ${{ inputs.image-artifact-name }}
        path: image.tar
```

```yaml
push-backend-image:
  name: Push Docker Image
  needs: build-image
  runs-on: ubuntu-latest
  steps:
    - name: Download image artifact
      uses: actions/download-artifact@v4
      with:
        name: ${{ inputs.image-artifact-name }}
        path: .
    - name: Load Docker image
      run: |
        docker load -i image.tar
    - name: Log in to Docker Hub
      uses: docker/login-action@v3
      with:
        username: ${{ env.DOCKERHUB_USERNAME }}
        password: ${{ secrets.DOCKERHUB_TOKEN }}

    - name: Push Docker image
      run: |
        docker tag ${{ env.DOCKERHUB_USERNAME }}/${{ inputs.dockerhub-repository }}:${{ needs.build-image.outputs.image-tag }} \
                   ${{ env.DOCKERHUB_USERNAME }}/${{ inputs.dockerhub-repository }}:latest
        docker push ${{ env.DOCKERHUB_USERNAME }}/${{ inputs.dockerhub-repository }}:${{ needs.build-image.outputs.image-tag }}
        docker push ${{ env.DOCKERHUB_USERNAME }}/${{ inputs.dockerhub-repository }}:latest
```

The next stage is “deploy-green”. Here a job connects to the docker host EC2 instance via SSH (using an marketplace action). Secrets, such as the username or SSH private key, are stored in the repository’s action’s secrets. On the host, the .env file is updated with the Git commit SHA of the newly built images followed by the Docker deployment of the green branch.

```yaml
deploy-green:
  name: Deploy new Green version
  runs-on: ubuntu-latest
  needs: [ build-deliver-backend-image, build-deliver-frontend-image, update-local-repo ]
  if: github.ref == 'refs/heads/production'
  outputs:
    image-tag: ${{ steps.tag.outputs.image-tag }}
  steps:
    - name: Get commit SHA
      id: tag
      run: echo "image-tag=${GITHUB_SHA}" >> "$GITHUB_OUTPUT"
    - name: Deploy new green version
      uses: appleboy/ssh-action@v1
      env:
        GREEN_BACKEND_TAG: ${{ steps.tag.outputs.image-tag }}
        GREEN_FRONTEND_TAG: ${{ steps.tag.outputs.image-tag }}
      with:
        host: ${{ secrets.DEPLOY_HOST }}
        username: ${{ secrets.DEPLOY_HOST_USERNAME }}
        key: ${{ secrets.DEPLOY_HOST_SSH_KEY }}
        envs: GREEN_BACKEND_TAG,GREEN_FRONTEND_TAG
        script: |
          cd /opt/CONINT && \
          echo 'Deploying Frontend to green...' && \
          docker-compose -f stacks/secret_notes/docker-compose-secret-notes-green.yml down frontend-green && \
          IMAGE_TAG=${GREEN_FRONTEND_TAG} docker-compose -f stacks/secret_notes/docker-compose-secret-notes-green.yml up -d --build frontend-green && \
          echo 'Deploying Backend to green...' && \
          docker-compose -f stacks/secret_notes/docker-compose-secret-notes-green.yml down backend-green && \
          IMAGE_TAG=${GREEN_BACKEND_TAG} docker-compose -f stacks/secret_notes/docker-compose-secret-notes-green.yml up -d --build backend-green
```

Now that the green environment is re-deployed, the E2E test can be conducted.

```yaml
e2e-and-performance-tests:
  name: E2E & Performance Tests
  runs-on: ubuntu-latest
  needs: deploy-green
  defaults:
    run:
      working-directory: frontend
  steps:
    - uses: actions/checkout@v4

    - name: Set up Node.js
      uses: actions/setup-node@v4
      with:
        node-version: 18

    - name: Install Dependencies
      run: npm ci

    - name: Install Playwright Browsers
      run: npx playwright install --with-deps

    - name: Run Playwright E2E Tests
      run: npm run playwright
      env:
        FRONTEND_GREEN: https://staging.conint-securenotes.online

    - name: Install k6
      run: |
        sudo gpg -k
        sudo gpg --no-default-keyring --keyring /usr/share/keyrings/k6-archive-keyring.gpg --keyserver hkp://keyserver.ubuntu.com:80 --recv-keys C5AD17C747E3415A3642D57D77C6C491D6AC1D69
        echo "deb [signed-by=/usr/share/keyrings/k6-archive-keyring.gpg] https://dl.k6.io/deb stable main" | sudo tee /etc/apt/sources.list.d/k6.list > /dev/null
        sudo apt update
        sudo apt install -y k6

    - name: Run k6 Performance Tests
      env:
        BACKEND_GREEN: https://staging.conint-securenotes.online/api
      run: BACKEND_GREEN=${BACKEND_GREEN} npm run k6
```

In the E2E and performance test stage, the tests are executed against the green environment to validate its functionality before switching traffic to it. It starts with setting up Node.js version 18 as the runtime environment. It installs all frontend dependencies using npm ci and then installs all necessary browsers for Playwright. The Playwright E2E tests are executed with the Base URL set to the staging Url. After the E2E tests, the performance testing tool k6 is installed and the tests are executed.

Only if this stage succeeds, does the pipeline continue with the blue-green switch. This is again accomplished by using an SSH action where the NGINX configs get changed and executing a NGINX reload.

```yaml
switch-green-blue:
  name: Switch from Blue to Green
  runs-on: ubuntu-latest
  needs: e2e-and-performance-tests
  steps:
    - name: Switch from Blue to Green
      uses: appleboy/ssh-action@v1
      with:
        host: ${{ secrets.DEPLOY_HOST }}
        username: ${{ secrets.DEPLOY_HOST_USERNAME }}
        key: ${{ secrets.DEPLOY_HOST_SSH_KEY }}
        script: |
          docker exec blue-green-proxy sh -c "
          sed -i \
            -e 's|set \\$active_frontend http://frontend-blue:80;|set \\$active_frontend http://frontend-green:80;|' \
            -e 's|set \\$active_backend http://backend-blue:3000;|set \\$active_backend http://backend-green:3000;|' \
            /etc/nginx/conf.d/blue-green.conf && \
          nginx -s reload"
```

After this was successful, the blue environment is updated silently to the new images. A switch back to blue is made at last.

```yaml
update-blue:
  name: Update Blue version and switch back to Blue
  runs-on: ubuntu-latest
  needs: switch-green-blue
  outputs:
    image-tag: ${{ steps.tag.outputs.image-tag }}
  steps:
    - name: Get commit SHA
      id: tag
      run: echo "image-tag=${GITHUB_SHA}" >> "$GITHUB_OUTPUT"
    - name: Update Blue version
      uses: appleboy/ssh-action@v1
      env:
        BLUE_BACKEND_TAG: ${{ steps.tag.outputs.image-tag }}
        BLUE_FRONTEND_TAG: ${{ steps.tag.outputs.image-tag }}
      with:
        host: ${{ secrets.DEPLOY_HOST }}
        username: ${{ secrets.DEPLOY_HOST_USERNAME }}
        key: ${{ secrets.DEPLOY_HOST_SSH_KEY }}
        envs: BLUE_BACKEND_TAG,BLUE_FRONTEND_TAG
        script: |
          cd /opt/CONINT && \
          echo 'Deploying Frontend to blue...' && \
          docker-compose -f stacks/secret_notes/docker-compose-secret-notes-blue.yml down frontend-blue && \
          IMAGE_TAG=${BLUE_FRONTEND_TAG} docker-compose -f stacks/secret_notes/docker-compose-secret-notes-blue.yml up -d --build frontend-blue && \
          echo 'Deploying Backend to blue...' && \
          docker-compose -f stacks/secret_notes/docker-compose-secret-notes-blue.yml down backend-blue && \
          IMAGE_TAG=${BLUE_BACKEND_TAG} docker-compose -f stacks/secret_notes/docker-compose-secret-notes-blue.yml up -d --build backend-blue
```

```yaml
- name: Switch back to Blue
  uses: appleboy/ssh-action@v1
  with:
    host: ${{ secrets.DEPLOY_HOST }}
    username: ${{ secrets.DEPLOY_HOST_USERNAME }}
    key: ${{ secrets.DEPLOY_HOST_SSH_KEY }}
    script: |
      docker exec blue-green-proxy sh -c "
      sed -i \
        -e 's|set \\$active_frontend http://frontend-green:80;|set \\$active_frontend http://frontend-blue:80;|' \
        -e 's|set \\$active_backend http://backend-green:3000;|set \\$active_backend http://backend-blue:3000;|' \
        /etc/nginx/conf.d/blue-green.conf && \
      nginx -s reload"
```

If the GitHub actions pipeline fails, the triggering user (usually the issuer of a commit if not triggered manually) gets notified via email automatically.

9.2 Jenkins

While the GitHub Actions Pipeline is triggered through pushes to main or production, Jenkins must be triggered manual. Otherwise, they would conflict with each other. However, Jenkins provides a brighter variety of input variables for our run and a better control of which stages are executed.

A huge benefit compared to GitHub Actions is that the workspace and build results are persistent as well as the Jenkins container was built with predefined dependencies in the Dockerfile. This leads to a faster run since not everything has to be installed every run. Most of the stages are parallel, meaning that Backend and Frontend tasks are executed at the same time to increase efficiency.

Because Jenkins runs as a container on the host and not on the internet, there are some changes in the pipeline configuration like different base URLs for Frontend and Backend or test environments. We use inputs through UI and fixed environment variables. We also define on which agents/nodes we run the pipeline (in our case they are run in the Jenkins container itself):

```
pipeline {
    agent any

    parameters {
        booleanParam(name: 'STATIC_TESTS', defaultValue: true, description: 'Statische Code Analyse durchführen? (lint, snyk, sonar, jest)')
        booleanParam(name: 'DYNAMIC_TESTS', defaultValue: true, description: 'Dynamische Tests durchführen? (playwright, kó)')
        booleanParam(name: 'BUILD_FRONTEND', defaultValue: false, description: 'Frontend bauen und pushen?')
        booleanParam(name: 'BUILD_BACKEND', defaultValue: false, description: 'Backend bauen und pushen?')
        booleanParam(name: 'DEPLOY', defaultValue: false, description: 'Erzeugten Build deployen und testen?')
        string(name: 'IMAGE_TAG', defaultValue: 'latest', description: 'Tag unter dem das Docker image gepushed wird')
    }

    environment {
        SONAR_HOST_URL = 'http://sonarqube:9000'
        FRONTEND_GREEN = 'http://frontend-green:80'
        BACKEND_GREEN = 'http://backend-green:3000/api'
        FRONTEND_IMAGE = 'nick7152/secret-notes-frontend'
        BACKEND_IMAGE = 'nick7152/secret-notes-backend'
    }
```

The variables are already explained in 5.2 and won't be explained again here. Quick recap: depending on the variables stages are either executed or skipped. This can be seen through the initial "when" condition in every stage, e.g.:

```
stage('Unit Tests') {
    when {
        expression { return params.STATIC_TESTS }
    }
```

The first stage ensures that all npm dependencies are installed (compared to npm install, npm ci always reinstalls which is ideal for CICD tools like Jenkins since it ensures to handle with the same condition in every run. Because the workspace is consistent, node_modules is also consistent):

```
stage('Install Dependencies') {
    parallel {
        stage('Install Frontend Dependencies') {
            steps {
                dir('frontend') {
                    echo 'Installing frontend dependencies...'
                    sh 'npm ci'
                }
            }
        }
        stage('Install Backend Dependencies') {
            steps {
                dir('backend') {
                    echo 'Installing backend dependencies...'
                    sh 'npm ci'
                }
            }
        }
    }
}
```

Now the Lint & Static Analysis can be done (Eslint, SonarQube and Snyk). The credentials which are configured in Jenkins are passed for authentication:

```
stage('Lint & Static Analysis') {
    when {
        expression { return params.STATIC_TESTS }
    }
    parallel {
        stage('Test Frontend') {
            steps {
                dir('frontend') {
                    echo 'Linting Frontend...'
                    sh 'npm run eslint'

                    echo 'SonarQube & Snyk Frontend...'
                    withCredentials([string(credentialsId: 'sonar-creds', variable: 'SONAR_TOKEN')]) {
                        withSonarQubeEnv('SonarQube') {
                            sh 'npm run sonar-scanner'
                        }
                    }
                    timeout(time: 1, unit: 'MINUTES') {
                        waitForQualityGate abortPipeline: true
                    }
                    withCredentials([string(credentialsId: 'snyk-creds', variable: 'SNYK_TOKEN')]) {
                        sh 'npm run snyk-auth'
                    }
                    sh 'npm run snyk'
                }
            }
        }
```

```
        stage('Test Backend') {
            steps {
                dir('backend') {
                    echo 'Linting Backend...'
                    sh 'npm run eslint'

                    echo 'SonarQube & Snyk Backend...'
                    withCredentials([string(credentialsId: 'sonar-creds', variable: 'SONAR_TOKEN')]) {
                        withSonarQubeEnv('SonarQube') {
                            sh 'npm run sonar-scanner'
                        }
                    }
                    timeout(time: 1, unit: 'MINUTES') {
                        waitForQualityGate abortPipeline: true
                    }
                    withCredentials([string(credentialsId: 'snyk-creds', variable: 'SNYK_TOKEN')]) {
                        sh 'npm run snyk-auth'
                    }
                    sh 'npm run snyk'
                }
            }
        }
    }
}
```

In a separate stage, the unit tests via Jest are executed:

```
stage('Unit Tests') {
    when {
        expression { return params.STATIC_TESTS }
    }
    parallel {
        stage('Test Frontend') {
            steps {
                dir('frontend') {
                    echo 'Testing Frontend...'
                    sh 'npm run jest'
                }
            }
        }
        stage('Test Backend') {
            steps {
                dir('backend') {
                    echo 'Testing Backend...'
                    sh 'npm run jest'
                }
            }
        }
    }
}
```

If everything succeeded until here the Docker Image is built and tagged with latest and the written tag in the UI through IMAGE_TAG:

```
stage('Build Docker Images') {
    when {
        expression { return params.BUILD_FRONTEND || params.BUILD_BACKEND }
    }
    parallel {
        stage('Build Frontend Image') {
            when {
                expression { return params.BUILD_FRONTEND }
            }
            steps {
                dir('frontend') {
                    echo 'Building Frontend...'
                    sh "docker build -t $FRONTEND_IMAGE:$IMAGE_TAG -t $FRONTEND_IMAGE:latest ."
                }
            }
        }
        stage('Build Backend Image') {
            when {
                expression { return params.BUILD_BACKEND }
            }
            steps {
                dir('backend') {
                    echo 'Building Backend...'
                    sh "docker build -t $BACKEND_IMAGE:$IMAGE_TAG -t $BACKEND_IMAGE:latest ."
                }
            }
        }
    }
}
```

With the configured credentials they are sent to Docker Hub:

```
stage('Push Docker Images') {
    when {
        expression { return params.BUILD_FRONTEND || params.BUILD_BACKEND }
    }
    parallel {
        stage('Push Frontend Docker Image') {
            when {
                expression { return params.BUILD_FRONTEND }
            }
            steps {
                withCredentials([usernamePassword(credentialsId: 'dockerhub-creds', usernameVariable: 'DOCKER_USER', passwordVariable: 'DOCKER_PASS')]) {
                    sh "echo $DOCKER_PASS | docker login -u $DOCKER_USER --password-stdin"
                    echo 'Pushing Frontend...'
                    sh "docker push $FRONTEND_IMAGE:latest"
                    sh "docker push $FRONTEND_IMAGE:$IMAGE_TAG"
                }
            }
        }
        stage('Push Backend Docker Image') {
            when {
                expression { return params.BUILD_BACKEND }
            }
            steps {
                withCredentials([usernamePassword(credentialsId: 'dockerhub-creds', usernameVariable: 'DOCKER_USER', passwordVariable: 'DOCKER_PASS')]) {
                    sh "echo $DOCKER_PASS | docker login -u $DOCKER_USER --password-stdin"
                    echo 'Pushing Backend...'
                    sh "docker push $BACKEND_IMAGE:latest"
                    sh "docker push $BACKEND_IMAGE:$IMAGE_TAG"
                }
            }
        }
    }
}
```

Since the following tasks are only responsible for blue/green deployment for Frontend and Backend, a quick stage was included to ensure a running database for the first deploy:

```
stage('Start Database if not running') {
    when {
        expression { return params.DEPLOY }
    }
    steps {
        echo 'Starting database...'
        sh "docker-compose -f stacks/secret_notes/docker-compose-secret-notes-green.yml up -d db"
    }
}
```

The method of blue/green deployment is the same as in GitHub Actions, a local docker compose green file which comes from the repository is executed. Here the IMAGE_TAG is passed once again and is included in the docker compose green file:

```
stage('Deploy to Green') {
    when {
        expression { return params.DEPLOY }
    }
    parallel {
        stage('Deploy Frontend to Green') {
            steps {
                echo 'Deploying Frontend to green...'
                sh "docker-compose -f stacks/secret_notes/docker-compose-secret-notes-green.yml down frontend-green"
                sh "IMAGE_TAG=${IMAGE_TAG} docker-compose -f stacks/secret_notes/docker-compose-secret-notes-green.yml up -d --build frontend-green"
            }
        }
        stage('Deploy Backend to Green') {
            steps {
                echo 'Deploying Backend to green...'
                sh "docker-compose -f stacks/secret_notes/docker-compose-secret-notes-green.yml down backend-green"
                sh "IMAGE_TAG=${IMAGE_TAG} docker-compose -f stacks/secret_notes/docker-compose-secret-notes-green.yml up -d --build backend-green"
            }
        }
    }
}
```

If the deployment on green was successful, we can start with final testing. As mentioned, Jenkins was already built with most of the dependencies, therefore we do not need to install playwright or k6. Because playwright accesses the Frontend and k6 the Backend, environment variables need to be passed. For playwright it's enough to declare the URL in the beginning of the Jenkinsfile as an environment variable, but for k6 we need to pass it on:

```
stage('E2E & Performance Testing') {
    when {
        expression { return params.DYNAMIC_TESTS }
    }
    steps {
        dir('frontend') {
            echo 'Testing Frontend on green...'
            sh 'npm run playwright'
            sh "BACKEND_GREEN=${BACKEND_GREEN} npm run k6"
        }
    }
}
```

The last stages are the same as in GitHub Actions: switch to green, deploy to blue, switch to blue:

```
stage('Switch to Green') {
    when {
        expression { return params.DEPLOY }
    }
    steps {
        echo 'Switching from blue to green deployment...'
        sh '''
        docker exec blue-green-proxy sh -c "
          sed -i \
              -e 's|set \\$active_frontend http://frontend-blue:80;|set \\$active_frontend http://frontend-green:80;|' \
              -e 's|set \\$active_backend http://backend-blue:3000;|set \\$active_backend http://backend-green:3000;|' \
              /etc/nginx/conf.d/blue-green.conf && \
          nginx -s reload
        "
        '''
    }
}
```

```
stage('Deploy to Blue') {
    when {
        expression { return params.DEPLOY }
    }
    parallel {
        stage('Deploy Frontend to Blue') {
            steps {
                echo 'Deploying Frontend to blue...'
                sh "docker-compose -f stacks/secret_notes/docker-compose-secret-notes-blue.yml down frontend-blue"
                sh "docker-compose -f stacks/secret_notes/docker-compose-secret-notes-blue.yml up -d --build frontend-blue"
            }
        }
        stage('Deploy Backend to Blue') {
            steps {
                echo 'Deploying Backend to blue...'
                sh "docker-compose -f stacks/secret_notes/docker-compose-secret-notes-blue.yml down backend-blue"
                sh "docker-compose -f stacks/secret_notes/docker-compose-secret-notes-blue.yml up -d --build backend-blue"
            }
        }
    }
}
```

```
stage('Switch to Blue') {
    when {
        expression { return params.DEPLOY }
    }
    steps {
        echo 'Switching green to blue deployment...'
        sh '''
        docker exec blue-green-proxy sh -c "
          sed -i \
            -e 's|set \\$active_frontend http://frontend-green:80;|set \\$active_frontend http://frontend-blue:80;|' \
            -e 's|set \\$active_backend http://backend-green:3000;|set \\$active_backend http://backend-blue:3000;|' \
            /etc/nginx/conf.d/blue-green.conf && \
          nginx -s reload
        "
        '''
    }
}
```

The result of the run can be seen in Jenkins either on the pipeline dashboard with the Pipeline: Stage View Plugin or in the Blue Ocean view, where also parallel stages are shown correctly.

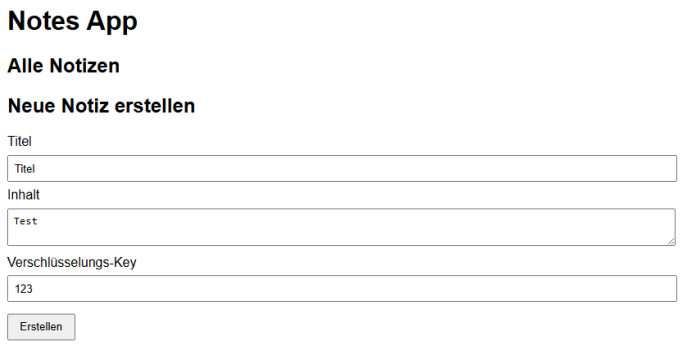
10. Features and Refined User Stories

- Detailed acceptance criteria
- Implementation details

Detailed acceptance criteria and implementation details

User story 1:

The user enters text and a key/passphrase



The note is encrypted on the server and stored in the database

```
export function encryptNote(secretKey, plaintext) {  Show usages   Rene Rumetshofer
  const salt = crypto.randomBytes(16);
  const key = deriveKey(secretKey, salt);

  const iv = crypto.randomBytes(12);
  const cipher = crypto.createCipheriv('aes-256-gcm', key, iv);

  const encrypted = Buffer.concat( strings: [
    cipher.update(plaintext, 'utf8'),
    cipher.final(),
  ]);
  const authTag = cipher.getAuthTag();

  // Data = salt + iv + authTag + cipher text
  return Buffer.concat( strings: [salt, iv, authTag, encrypted]).toString('base64');
}
```

```
fastify.post('/api/notes', postNoteOpts, async (request, reply) : Promise<any>  => {
  const encryptedContent = encryptNote(
    request.body.key,
    request.body.content
  );
  const noteUuid = generateUUID();
  return fastify.pg.transact( callback: async (client) : Promise<void>  => {
    await client.query(
      'INSERT INTO notes(notes_uuid, title, content) VALUES($1, $2, $3)',
      [noteUuid, request.body.title, encryptedContent]
    );
    reply.code(200).send({ notes_uuid: noteUuid });
  });
});
```

UI confirms that the note is created securely

User Story 2:

The user enters the same key used to encrypt

The system decrypts the note if the key is valid, returning the plaintext to the user

```
export function decryptNote(secretKey, encryptedData) {  Show usages
  const data = Buffer.from(encryptedData, 'base64');

  const salt = data.subarray(0, 16);
  const iv = data.subarray(16, 28);
  const authTag = data.subarray(28, 44);
  const ciphertext = data.subarray(44);

  const key = deriveKey(secretKey, salt);
  const decipher = crypto.createDecipheriv('aes-256-gcm', key, iv);
  decipher.setAuthTag(authTag);

  const decrypted = Buffer.concat( strings: [
    decipher.update(ciphertext),
    decipher.final(),
  ]);
  return decrypted.toString('utf8');
}
```

The system rejects or returns an error if the key is invalid

User Story 3:

A toggle in PostHog allows enabling or disabling a second UI

```
if (typeof posthog !== "undefined") {
  /* eslint-disable no-undef */
  posthog.onFeatureFlags(() : void => {
    const variant = posthog.getFeatureFlag("new-ui-theme");
    /* eslint-enable no-undef */
    const button : HTMLElement = document.getElementById( elementId: "createNote");
    if (button) {
      button.style.backgroundColor = variant === "variant" ? "green" : "blue";
    }
  });
}
```

A/B testing splits users into at least two groups with distinct experiences

As seen in the screenshot above, users are split into two groups and their UI is different, although just the button colour.

11. A/B Testing

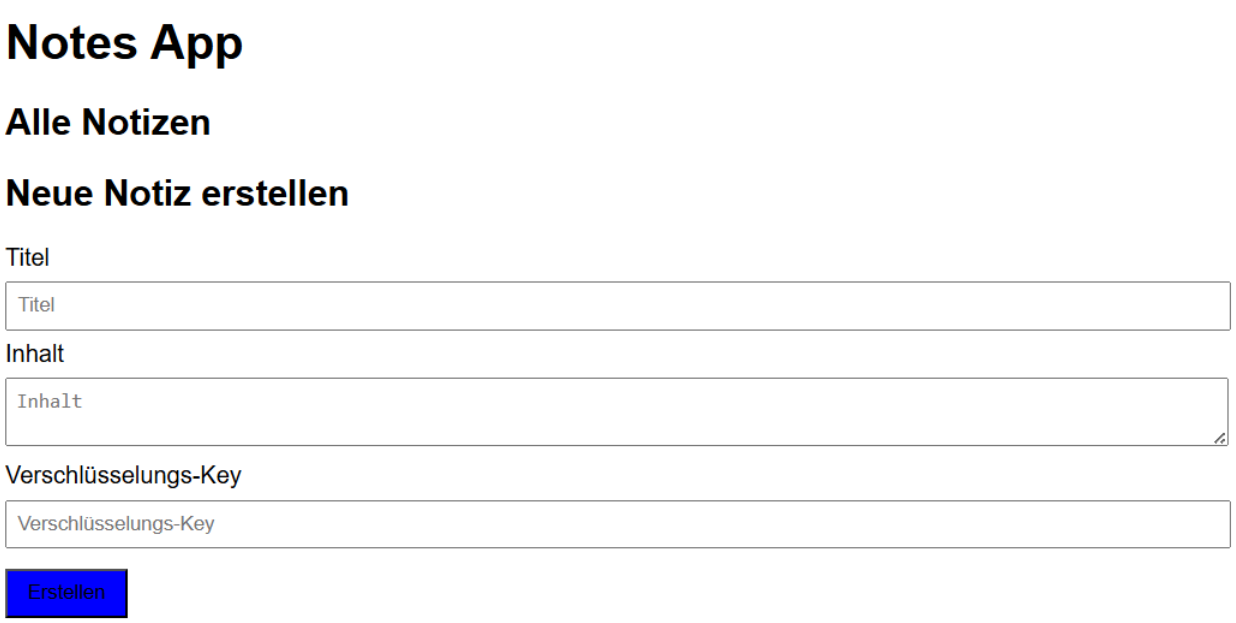
- How to set up a new split test for a different UI feature or encryption flow

The feature flag is of type “Multiple variants with rollout percentages” and contains the variant keys “control” and “variant”, both of which have an equal rollout of 50%, randomly determined. “Control” version has a blue button and “variant” has a green button.

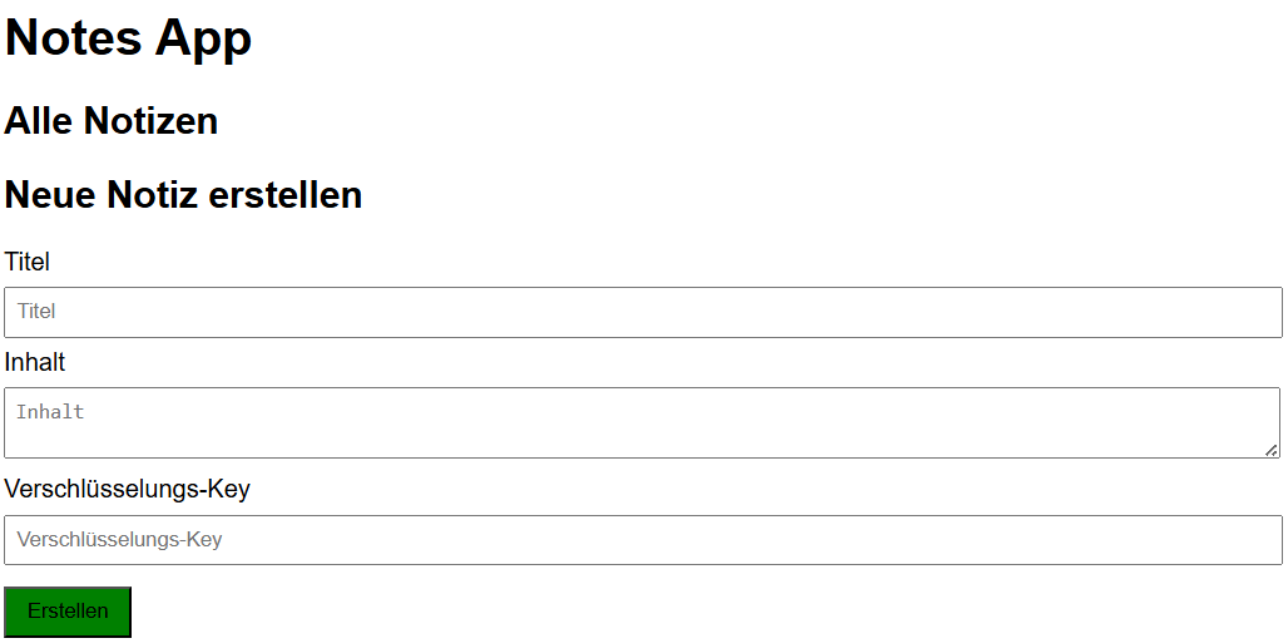
Here, the respective version is determined.

```
if (typeof posthog !== "undefined") {
  posthog.onFeatureFlags(() => {
    const variant = posthog.getFeatureFlag("new-ui-theme");

    const button = document.getElementById("createNote");
    if (button) {
      button.style.backgroundColor = variant === "variant" ? "green" : "blue";
    }

    window._variant = variant;
  });
}
```

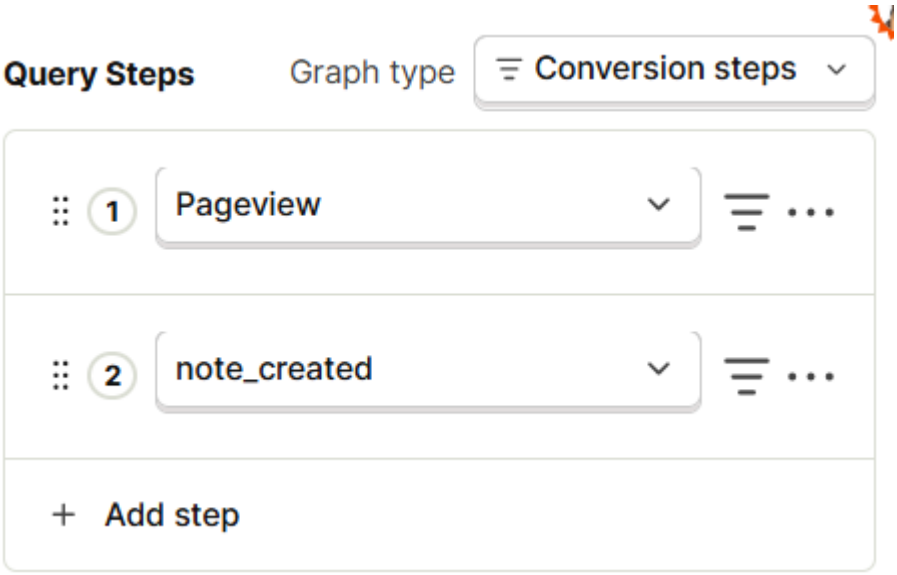
Example for “control”



Example for “variant”



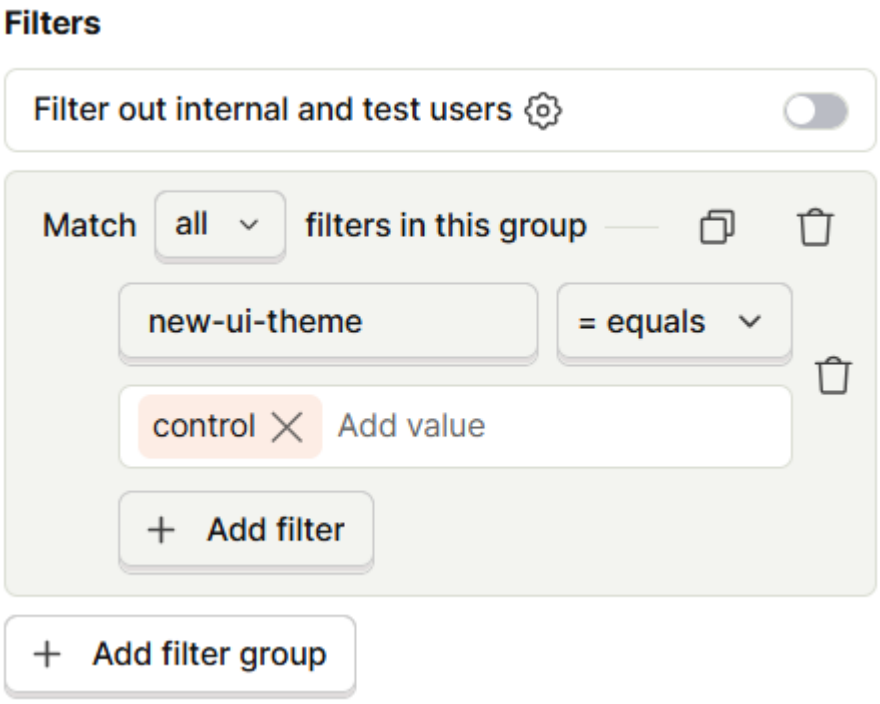
With the help of funnels created in PostHog, we decided that a good user conversion rate is determined by how many users create a note upon entering the website. The funnel's query steps were chosen to be Pageview --> "note_created".



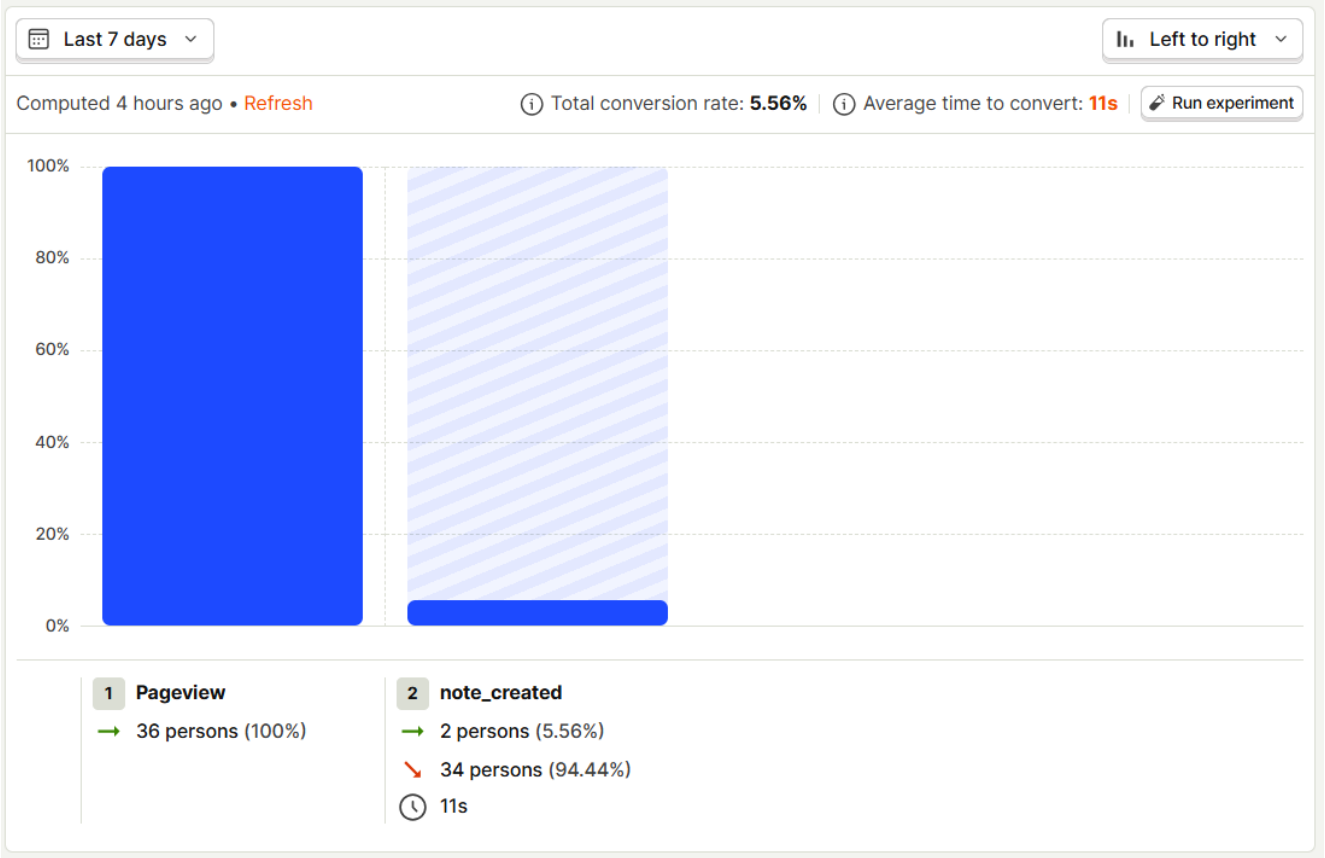
"note_created" is an event that was created to track when a user has clicked on "Erstellen". In it, an event property that is used as a filter to distinguish between both user groups is created.

```
if (typeof posthog !== "undefined") {
  posthog.capture("note_created", {
    "new-ui-theme": window._variant || "unknown"
  });
}
```

In filters, you can further specify which funnel of the versions you want to investigate.



However, due to complications, PostHog was not able to read the event property “new-ui-theme" that is tracked by the capture function. This is why the funnel below is showing each query step, with all users combined, instead of each user group in comparison to each other.



12. Blue/Green Deployment

- How you implement it on AWS (e.g., Docker Compose definitions swapped behind a load balancer)

Blue/Green deployment is implemented in a manner that only the Docker host is used for hosting. The following routes have been defined:

- “staging.conint-securenotes.online” is always routed to the green environment
- “prod.conint-securenotes.online” is routed to blue or green, depending on the current state of a deployment.

Incoming traffic is routed as follows: The first responding service is NGINX Proxy Manager which handles TLS certification. Traffic is forwarded to another NGINX instance called “blue-green-proxy" which handles routing between blue and green, and in the case of the staging route to green:

```
blue-green-proxy:
  image: nginx:1.29-alpine
  container_name: blue-green-proxy
  restart: unless-stopped
  expose:
    - 80
  volumes:
    - /opt/CONINT/stacks/reverse_proxy/nginx/conf.d/:/etc/nginx/conf.d/
    - /opt/CONINT/stacks/reverse_proxy/nginx/nginx.conf:/etc/nginx/nginx.conf
  networks:
    - secret_notes_secret_notes_network
    - proxy_network
```

Routing for “prod”

```
server {
  listen 80;
  server_name prod.conint-securenotes.online;

  set $active_frontend http://frontend-blue:80;
  set $active_backend http://backend-blue:3000;

  location / {
    proxy_pass $active_frontend;
    proxy_set_header Host $host;
    proxy_set_header X-Real-IP $remote_addr;
    proxy_set_header X-Forwarded-For $proxy_add_x_forwarded_for;
    proxy_set_header X-Forwarded-Proto $scheme;
  }

  location /api {
    proxy_pass $active_backend;
    proxy_set_header Host $host;
    proxy_set_header X-Real-IP $remote_addr;
    proxy_set_header X-Forwarded-For $proxy_add_x_forwarded_for;
    proxy_set_header X-Forwarded-Proto $scheme;
  }
}
```

Routing for “staging”:

```
server {
  listen 80;
  server_name staging.conint-securenotes.online;

  set $frontend http://frontend-green:80;
  set $backend http://backend-green:3000;

  location / {
    proxy_pass $frontend;
    proxy_set_header Host $host;
    proxy_set_header X-Real-IP $remote_addr;
    proxy_set_header X-Forwarded-For $proxy_add_x_forwarded_for;
    proxy_set_header X-Forwarded-Proto $scheme;
  }

  location /api {
    proxy_pass $backend;
    proxy_set_header Host $host;
    proxy_set_header X-Real-IP $remote_addr;
    proxy_set_header X-Forwarded-For $proxy_add_x_forwarded_for;
    proxy_set_header X-Forwarded-Proto $scheme;
  }
}
```

To modify the routing for prod to point to either green or blue, the file is modified during the CICD run:

```
docker exec blue-green-proxy sh -c "
  sed -i \
      -e 's|set \$active_frontend http://frontend-blue:80;|set \$active_frontend http://frontend-green:80;|' \
      -e 's|set \$active_backend http://backend-blue:3000;|set \$active_backend http://backend-green:3000;|' \
      /etc/nginx/conf.d/blue-green.conf && \
  nginx -s reload
```

The stack of containers needed for running blue/green frontend and backend as well as the proxy is managed in a docker compose file on the server:

```
backend-blue:
  image: nick7152/secret-notes-backend:${IMAGE_TAG}
  container_name: backend-blue
  restart: unless-stopped
  env_file:
    - docker.env
  expose:
    - 3000
  networks:
    - secret_notes_network
frontend-blue:
  image: nick7152/secret-notes-frontend:${IMAGE_TAG}
  container_name: frontend-blue
  restart: unless-stopped
  expose:
    - 80
  networks:
    - secret_notes_network
```

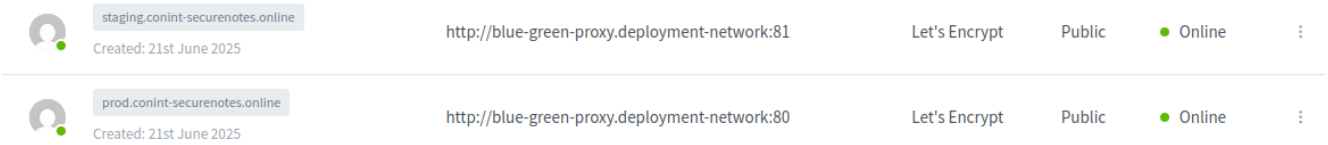
```yaml
backend-green:
  image: nick7152/secret-notes-backend:${IMAGE_TAG}
  container_name: backend-green
  restart: unless-stopped
  env_file:
    - docker.env
  expose:
    - 3000
  networks:
    - secret_notes_network
    - jenkins_jenkins_network
frontend-green:
  image: nick7152/secret-notes-frontend:${IMAGE_TAG}
  container_name: frontend-green
  restart: unless-stopped
  expose:
    - 80
  networks:
    - secret_notes_network
    - jenkins_jenkins_network
```

All containers, including the NGINX proxy manager, are part of an external network “proxy_network” for enabling communication between them.

When new tags of images are available, they will replace the old tag during the rollout process. This is done via environment variables which are passed on through GitHub Actions or Jenkins directly in the shell. Either the tag was entered in the UI (Jenkins) or auto generated (GitHub Actions)

```
parallel {
    stage('Deploy Frontend to Green') {
        steps {
            echo 'Deploying Frontend to green...'
            sh "docker-compose -f stacks/secret_notes/docker-compose-secret-notes-green.yml down frontend-green"
            sh "IMAGE_TAG=${IMAGE_TAG} docker-compose -f stacks/secret_notes/docker-compose-secret-notes-green.yml up -d --build frontend-green"
        }
    }
    stage('Deploy Backend to Green') {
        steps {
            echo 'Deploying Backend to green...'
            sh "docker-compose -f stacks/secret_notes/docker-compose-secret-notes-green.yml down backend-green"
            sh "IMAGE_TAG=${IMAGE_TAG} docker-compose -f stacks/secret_notes/docker-compose-secret-notes-green.yml up -d --build backend-green"
        }
    }
}
```

Two proxy hosts have been set up on the NGINX proxy manager instance:



The mapping to port 81 for the staging route can be seen here.

13. Logging and Monitoring (Outlook)

- Proposed approach for logging, analytics, and potential monitoring solutions (e.g., CloudWatch, Splunk, ELK)

Logging

For centralized logging, we would integrate the ELK Stack to collect and visualize application logs from both frontend and backend. This would allow us to track errors and debug issues more efficiently.

Analytics

For user analytics we would use PostHog on the frontend to track the user behaviour, feature usage and conversion metrics. Backend events such as note creation or authentication can be logged in a structured format for analysis.

Monitoring

To monitor system performance and availability, we would use CloudWatch for system-level and custom application metrics.