# Project APAQ&E

AP HOGESCHOOL ANTWERPEN

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# Agenda

- Introduction of the team
- Introduction of the project
- Purpose of the project
- The goal of the project
- Composition of the project

# The team

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- 8 cybersecurity
- 2 IoT
- 1 AI
- 1 Software
- 1 IT & Business

# The project

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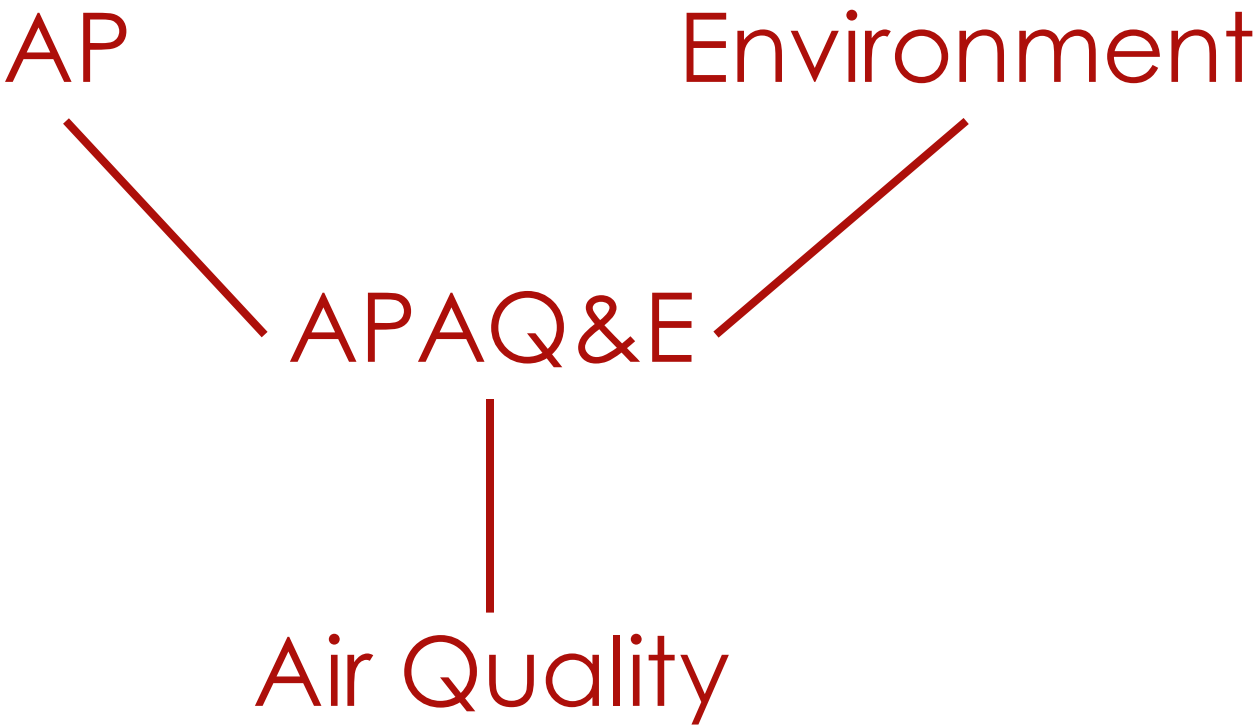
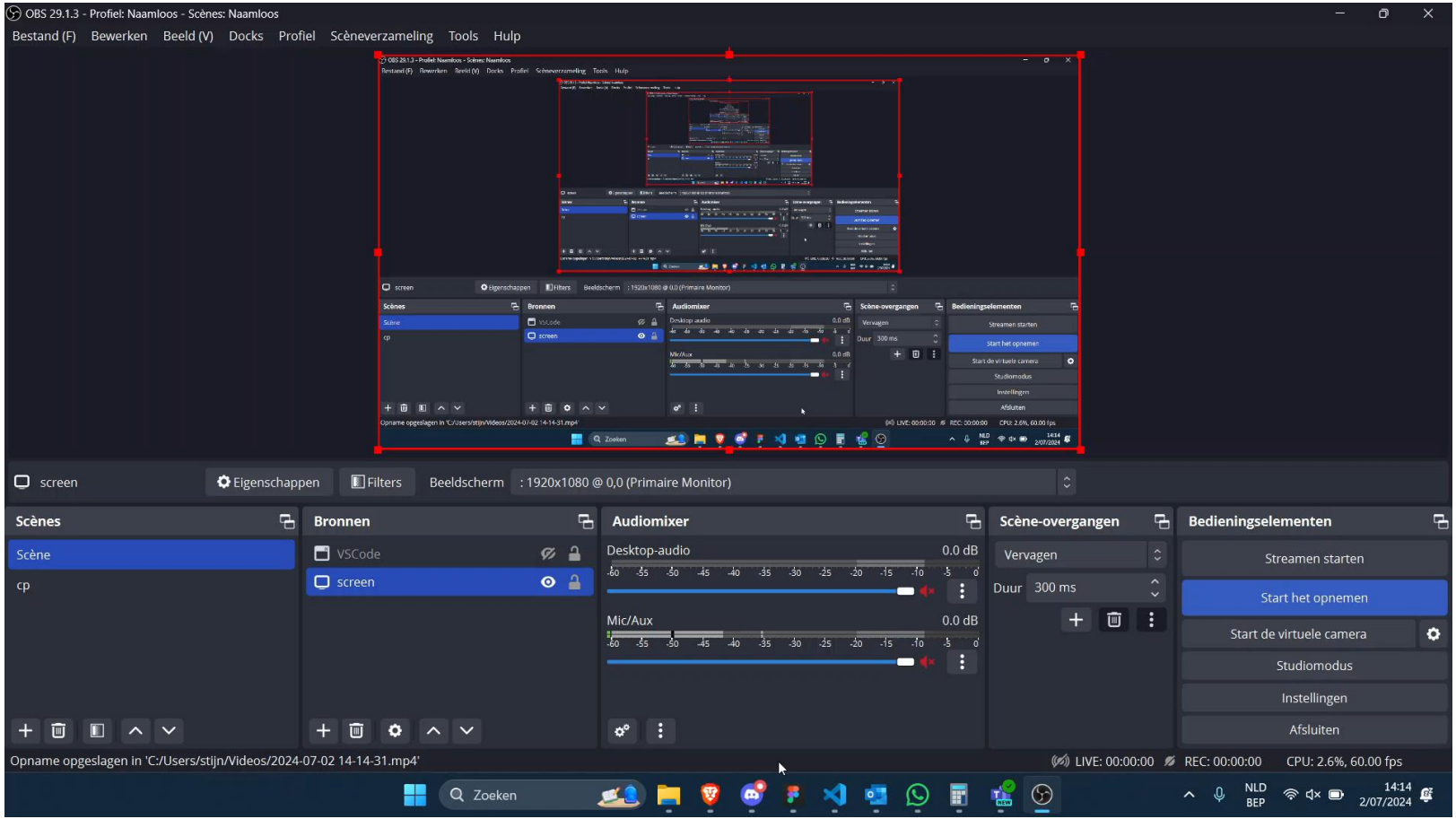

AP
Environment
APAQ&E
Air Quality


OBS 29.1.3 - Profiel: Naamloos - Scènes: Naamloos
Bestand (F) Bewerken Beeld (V) Docks Profiel Scèneverzameling Tools Hulp
screen
Eigenschappen
Filters
Beeldscherm
: 1920x1080 @ 0,0 (Primaire Monitor)
Scènes
Scène
cp
Bronnen
VSCode
screen
Audiomixer
Desktop-audio
0.0 dB
Mic/Aux
0.0 dB
Scène-overgangen
Vervagen
Duur
300 ms
Bedieningselementen
Streamen starten
Start het opnemen
Start de virtuele camera
Studiomodus
Instellingen
Afsluiten
Opname opgeslagen in 'C:/Users/stijn/Videos/2024-07-02 14-14-31.mp4'
LIVE: 00:00:00
REC: 00:00:00
CPU: 2.6%, 60.00 fps
Zoeken
NLD
BEP
14:14
2/07/2024

# The purpose of the project

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# The purpose

- Insights concerning environmental factors
- Comprehensible Platform / dashboard that offers detailed information
- Enables organizations / to make informed decisions based on concrete data.

# The goal of the project

# The goal

*The goal of the project is to measure air quality and other environmental properties and make this data available for local organizations and governments to aid in decision-making.*

# But how do we get all this to work ?

# Composition of the project

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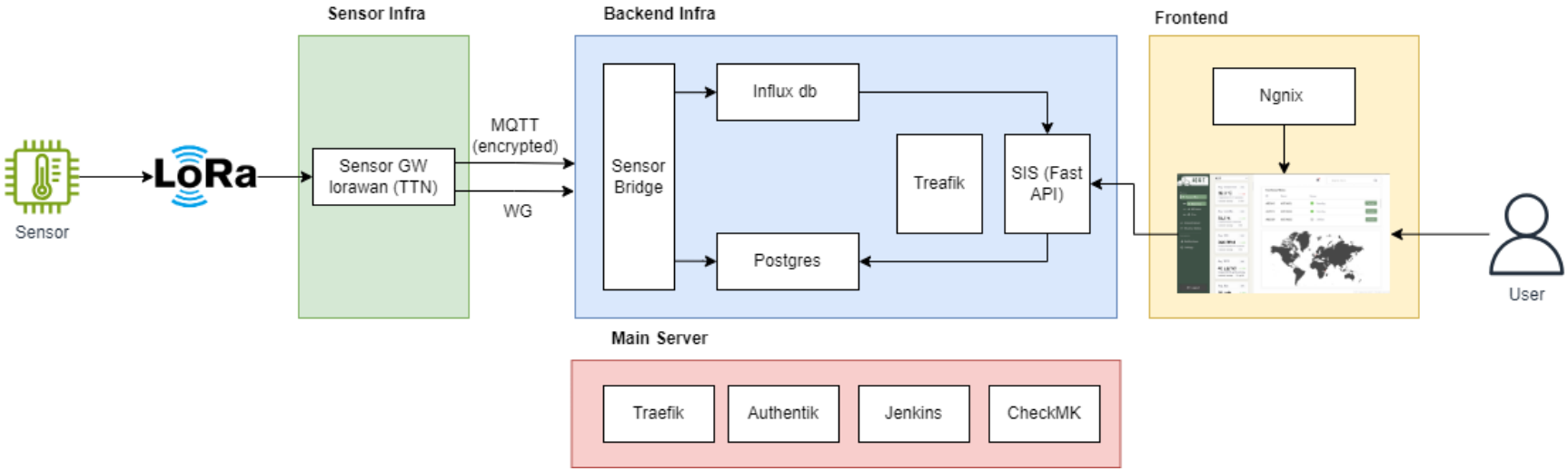
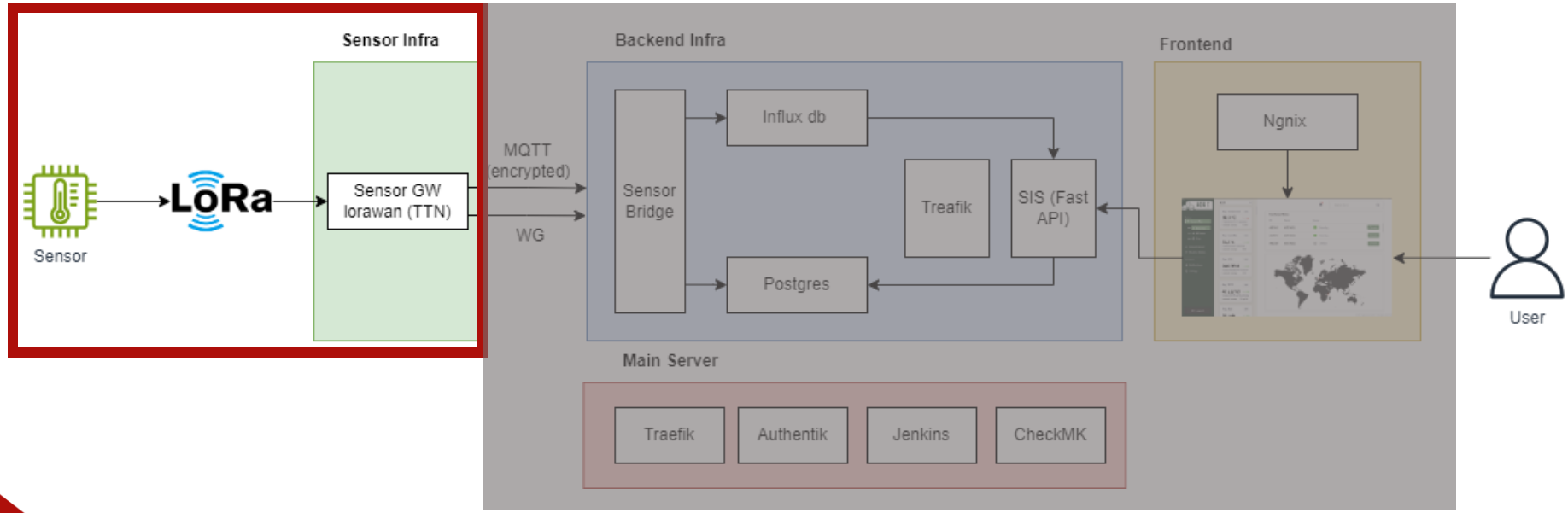
# Agenda

- The Sensor
- Backend Infrastructure
  - Backend Components
- Main Server
  - Main Server Components
- Frontend Infrastructure
  - Frontend Components

# Composition



# Composition



# The sensor

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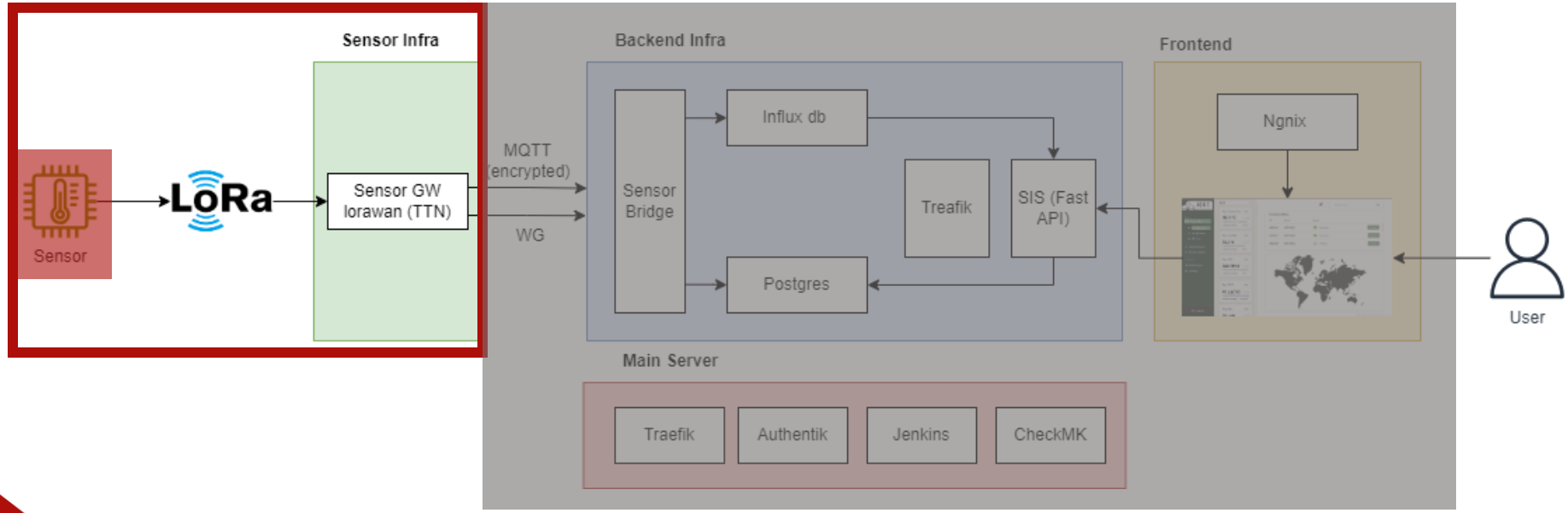
# Overview


Sensor Infra
Sensor
LoRa
Sensor GW
lorawan (TTN)
MQTT
(encrypted)
WG
Backend Infra
Sensor
Bridge
Influx db
Treafik
SIS (Fast
API)
Postgres
Frontend
Ngnix
User
Main Server
Traefik
Authentik
Jenkins
CheckMK

Jesse Zaenen [IoT]

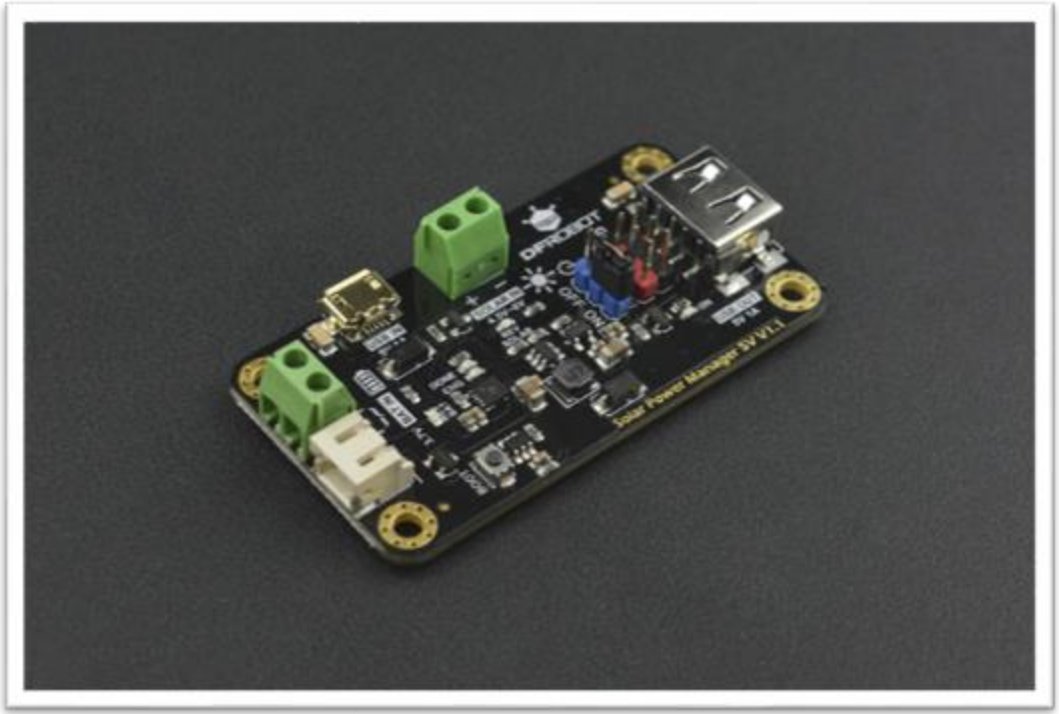
Lorik Qerkezi[CSC]

Kobe Nevelsteen [IoT]

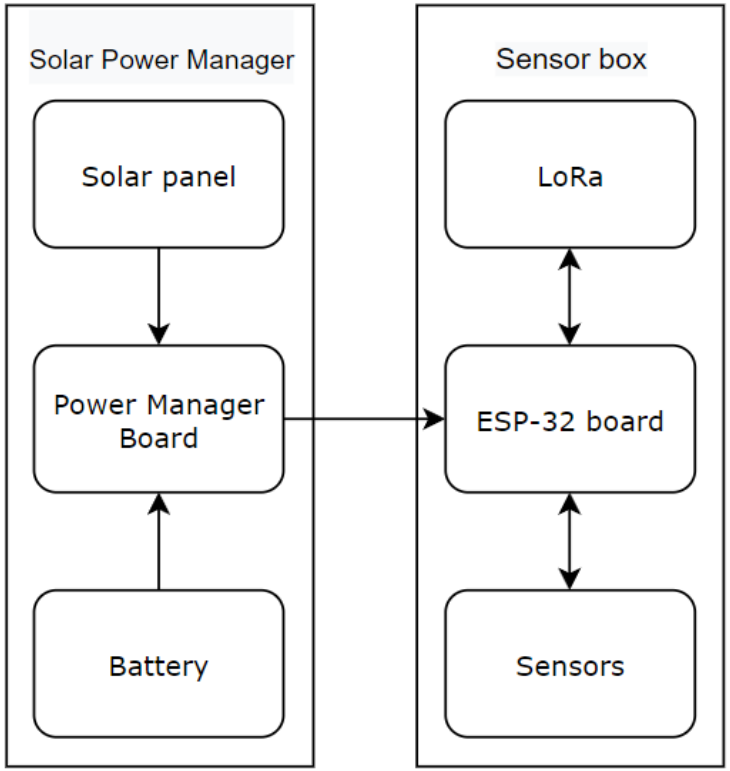
# Market research

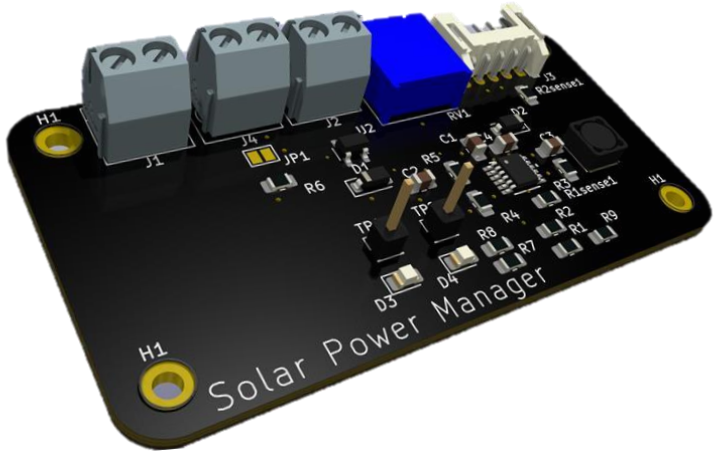
- Sparkfun
- Adafruit
- DFRobot

Open-source

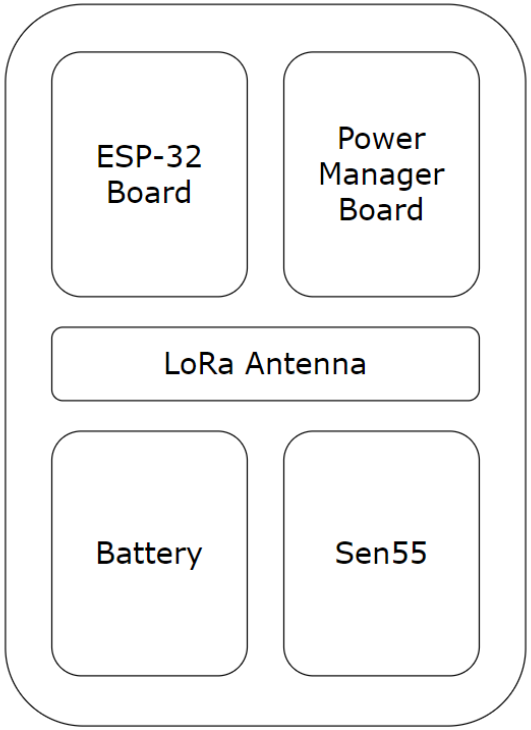


# Overview

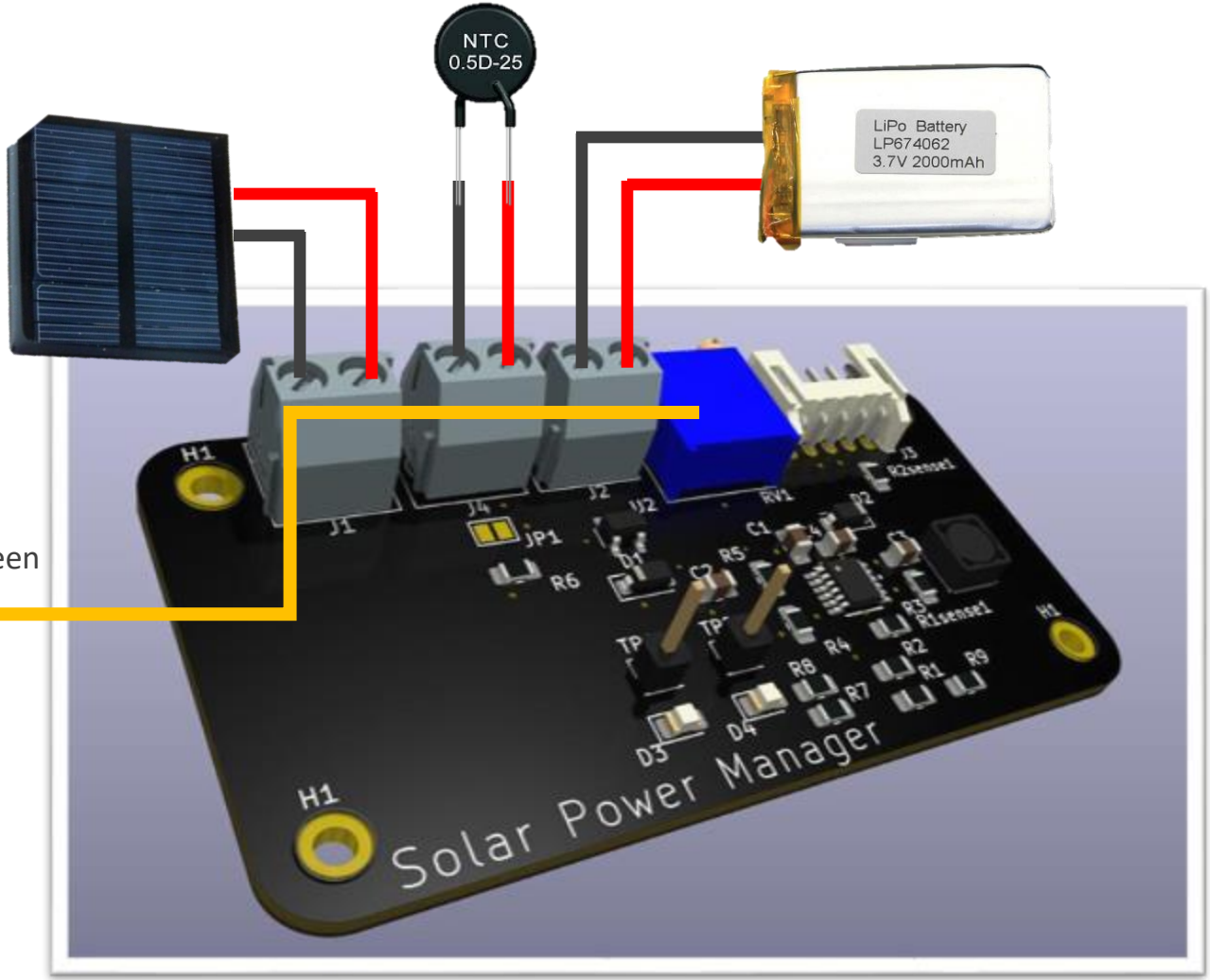

Solar Power Manager
Solar panel
Power Manager Board
Battery
Sensor box
LoRa
ESP-32 board
Sensors


Solar Power Manager

# Component placement sensor box




# Usage




Adjust for MTTP until green light shines in full sun

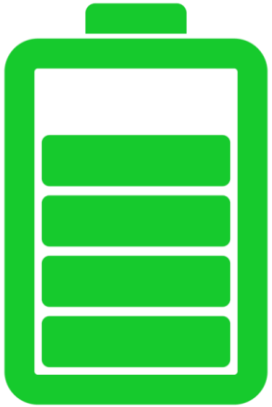
# Autonomy

Practical

- Long duration test had some setbacks due to hardware errors

Theoretical

- 72 hours of battery life
- Charging time +- 4 hours using the solar panel



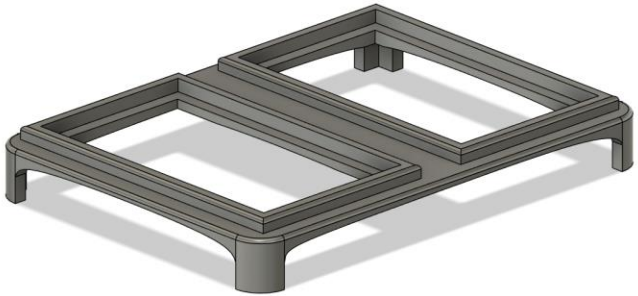
# Measuring environmental factors

- Humidity
- Temperature
- $No_x$
- TVOC
- PPM (parts per million)
- …

# Final product

## Old design

## New design

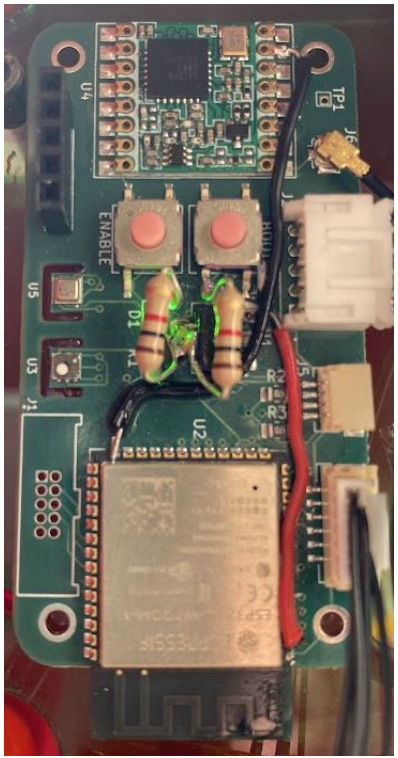


# Obstacles We Faced

- Problems with the sensor-board
  - boot and enable are changed
  - rx and tx were already swapped
  - LoRa chip didn’t have all connections
- Voltage integration problem

# Adaptations Overview

- Hardware
  - Rewired the second LoRa communication cable (black)
  - Put a wire straight from the 3.3V to the ESP-32 voltage input and erased the previous connection (red)
- Software
  - Added the current sensing capabilities
  - fold and charge indicators
  - BME280 readings



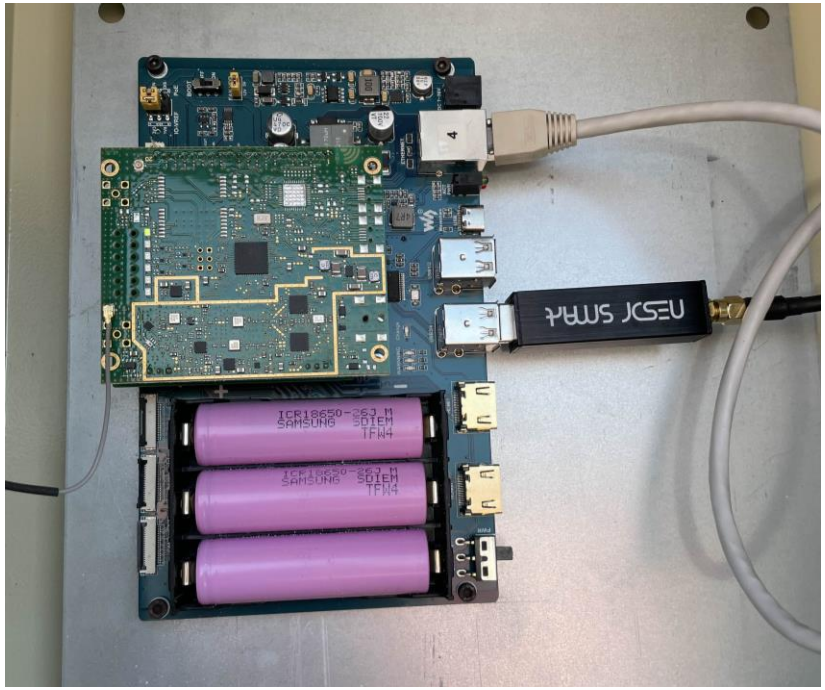
# Future adjustments

- esp-idf adaptation
- Current sensing OPAMP
- reconsider the voltage input and outputs
- LoRa GPS map
- brown out detection

# The gateway

# Gateway

- Sensors
- The things network
- Gateway



# Gateway parts

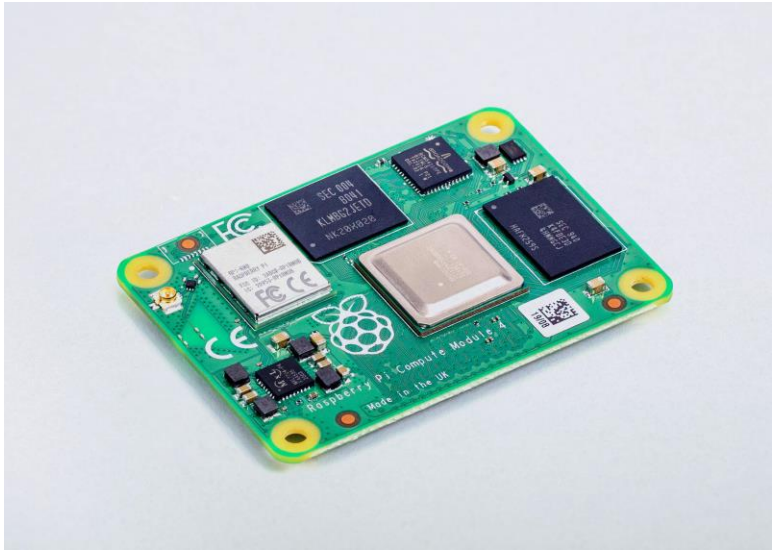
## cm4-poe-ups-base

## iC880A-SPI LoRa® Concentrator

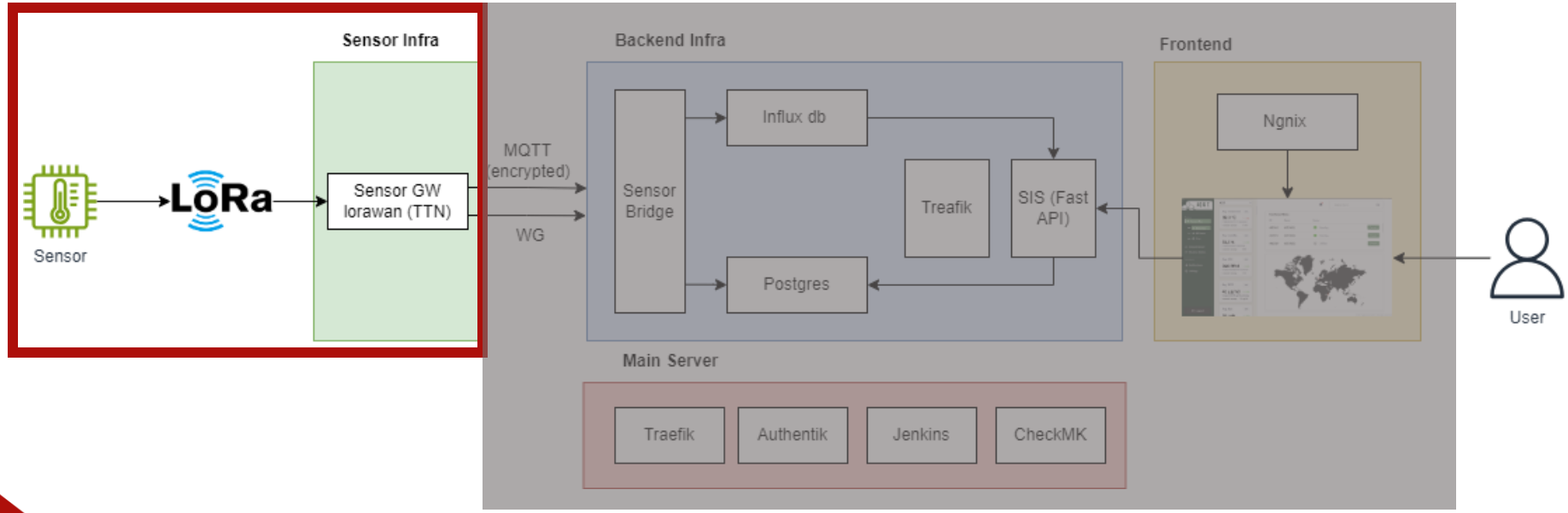
# Gateway parts

## samsung icr18650


## raspberry pi compute module 4

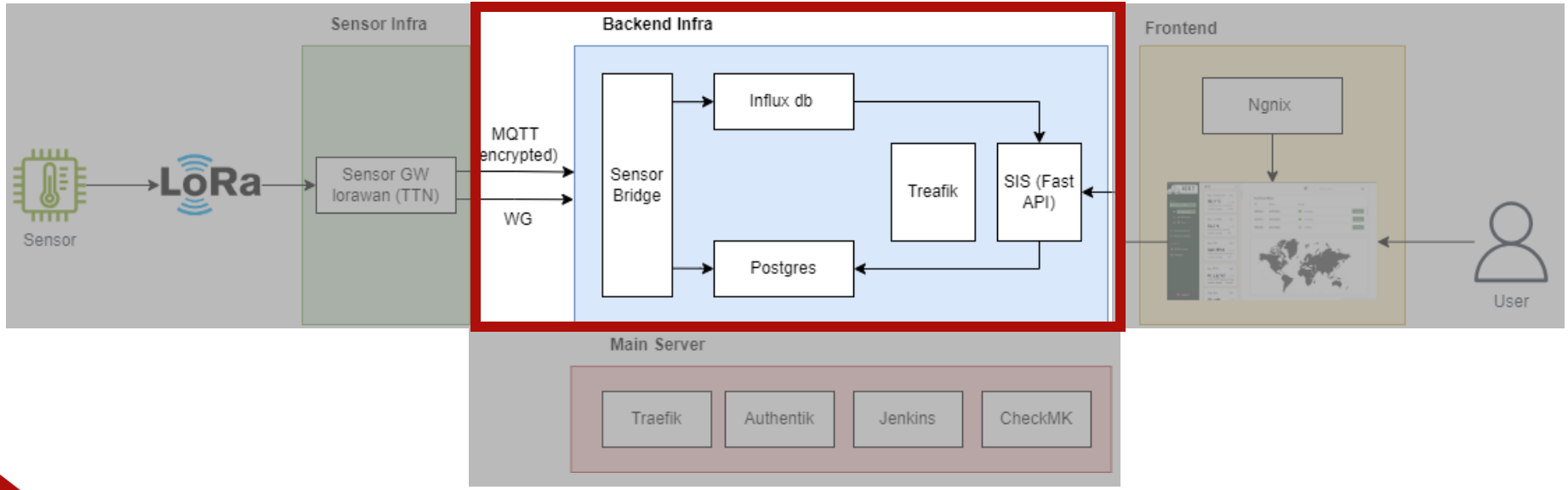


# Composition



# Backend infrastructure

# Composition



# Backend Components

- WireGuard
- Sensor Bridge
- Data Storage
  - Influx DB
  - PostgreSQL
- Traefik
- SIS – API with FastAPI

# Wireguard Gateway

## Backend Components

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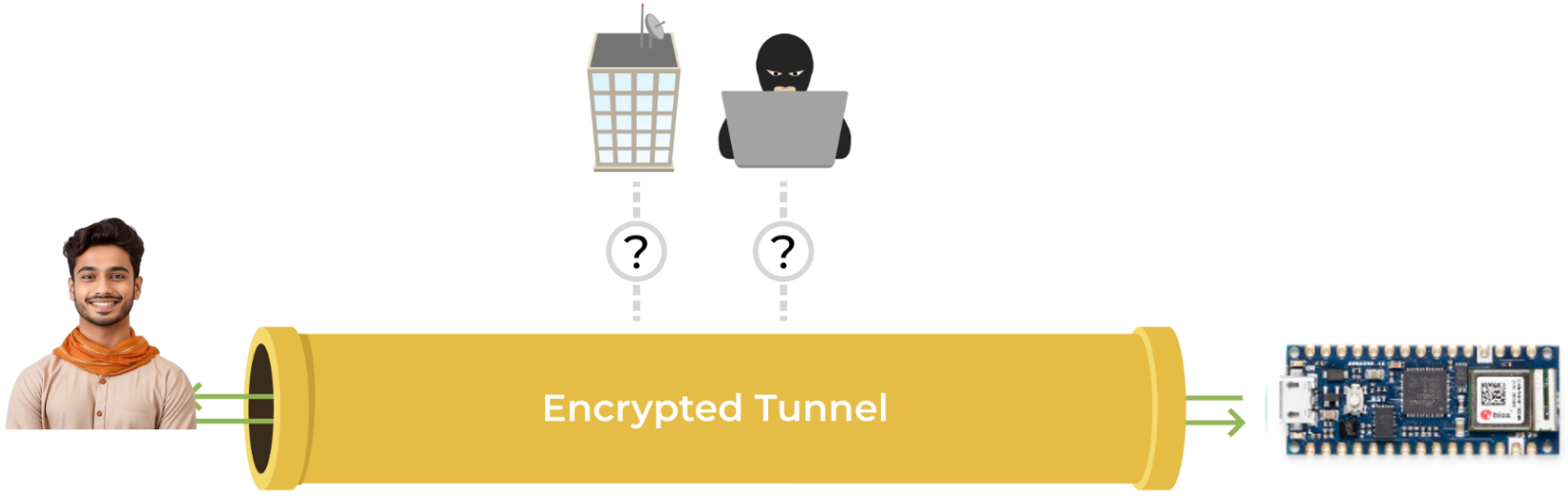
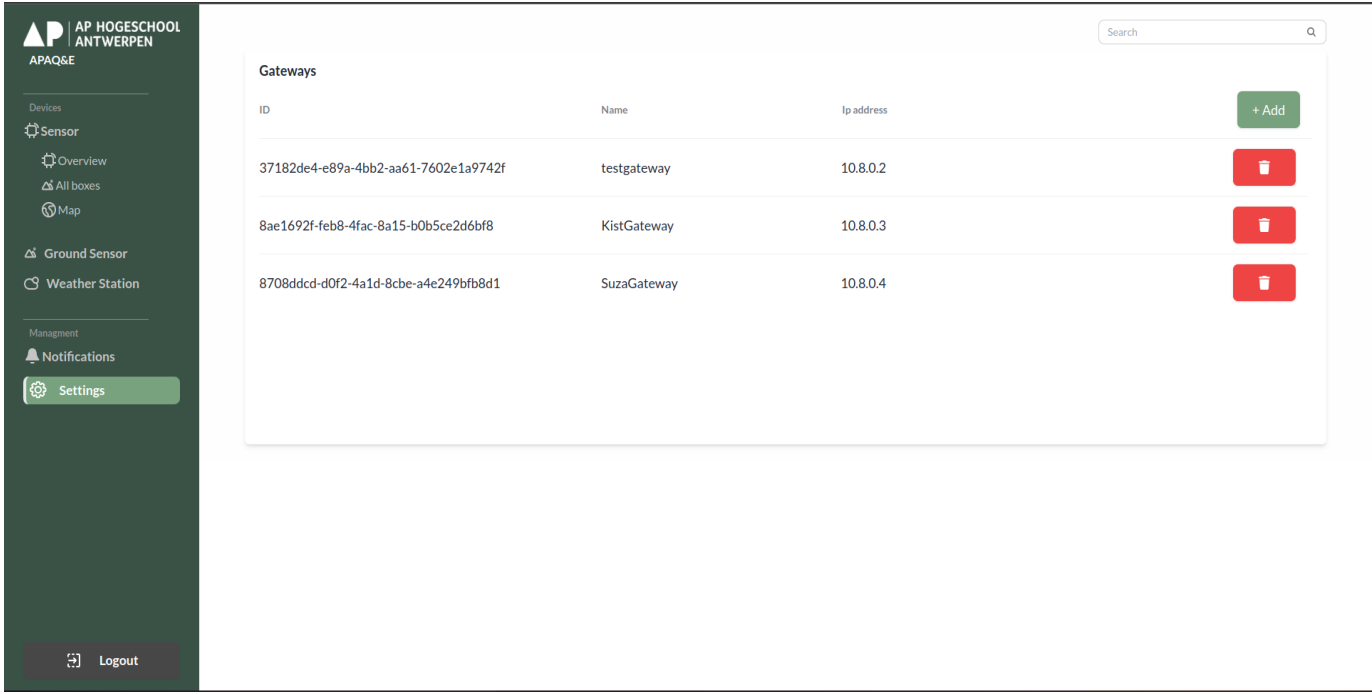
# WireGuard




WIREGUARD®
FAST, MODERN, SECURE VPN TUNNEL

# WireGuard

- Why WireGuard?
- WGEasy



# Sensor Bridge

## Backend Components

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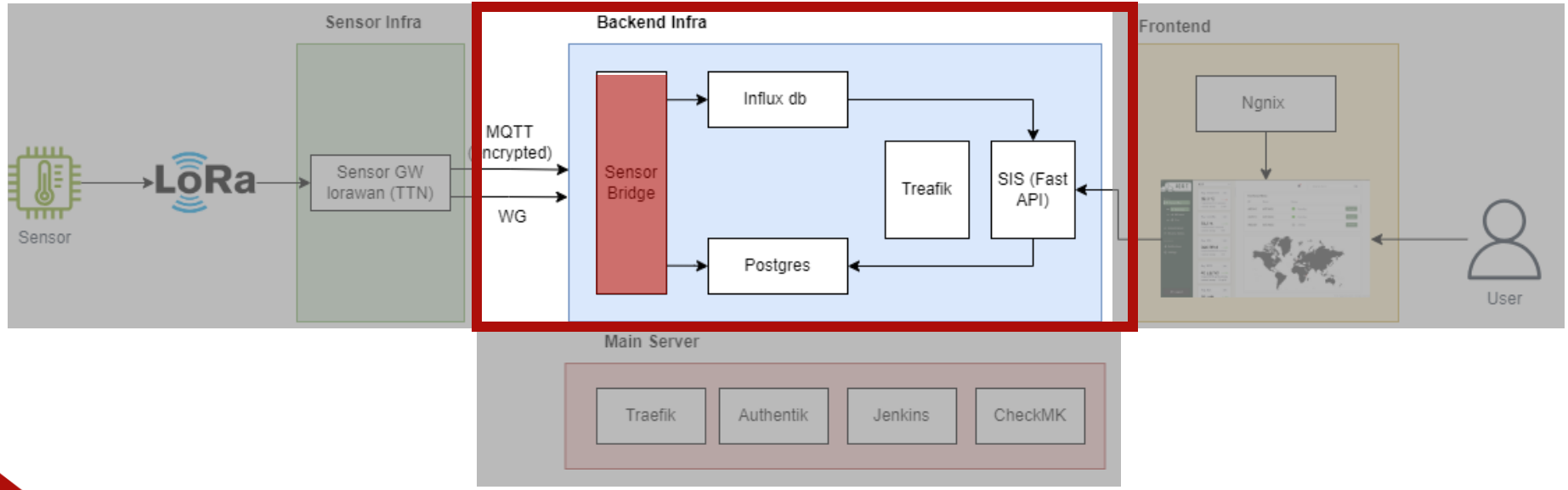
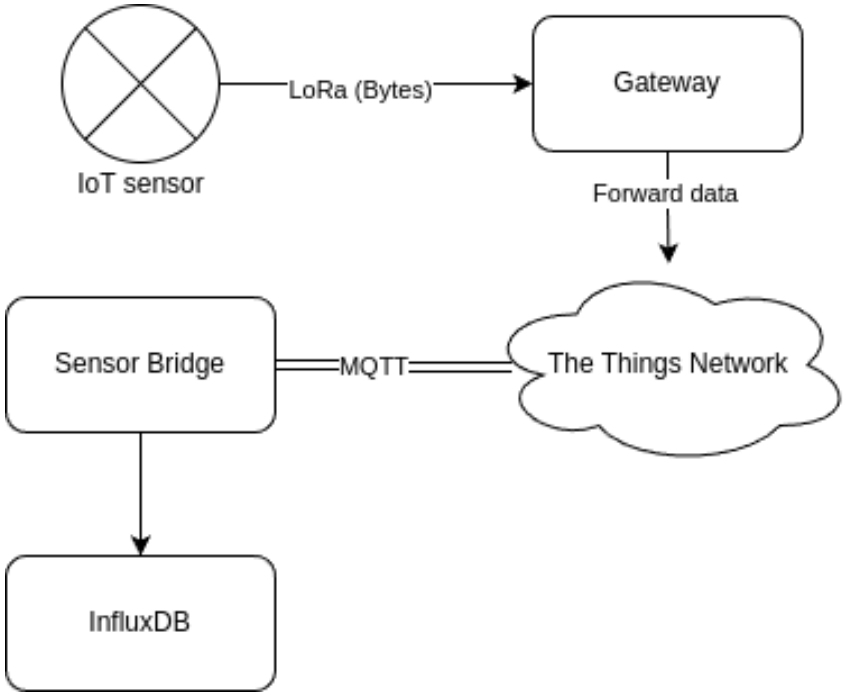
# Sensor Bridge Overview



# Sensor Bridge Overview



# Sensor Bridge – The payload

- The Things Network ID
- Recieve timestamp
- Data
  - Base64 encoded
  - 11 parameters

# Data Storage

## Backend Components

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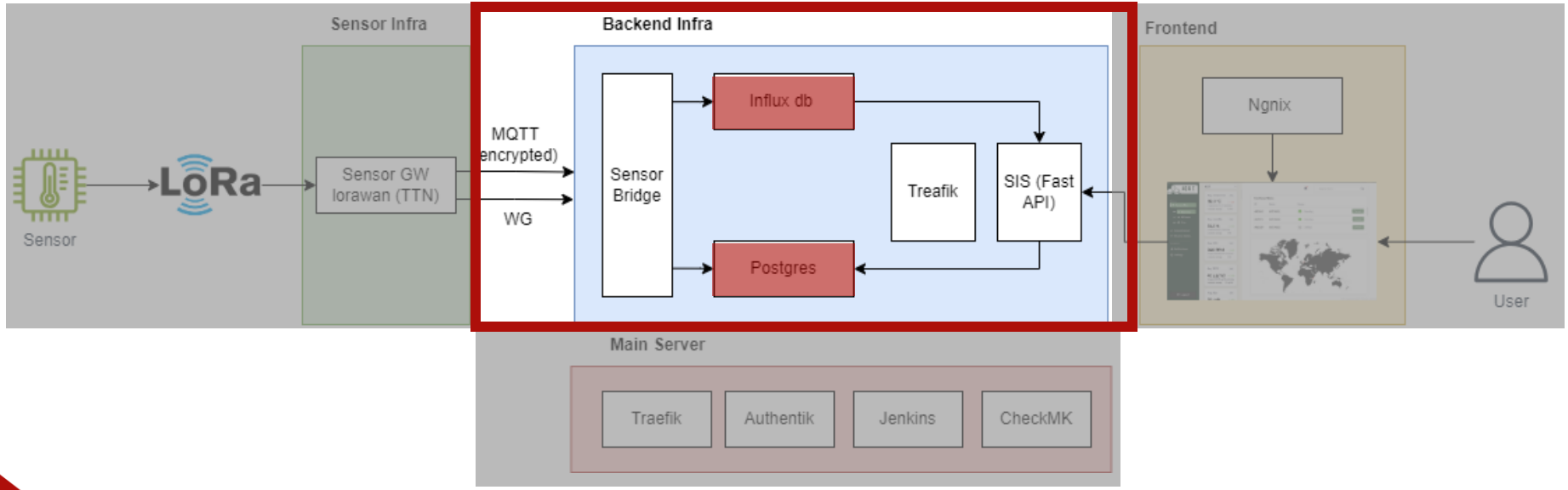
# Data Storage Overview



# Data storage

- Different kinds of data


- Sensor data
  - Timeseries database
- Relational data
  - Relational database

# Data Storage – InfluxDB

- The Things Network ID
- Recieve timestamp
- Data
  - Base64 encoded
  - 11 parameters

# Data Storage – InfluxDB

- The Things Network ID
- Recieve timestamp
- Data
  - Base64 encoded
  - 11 parameters

# SIS/API with FastAPI

## Backend Components

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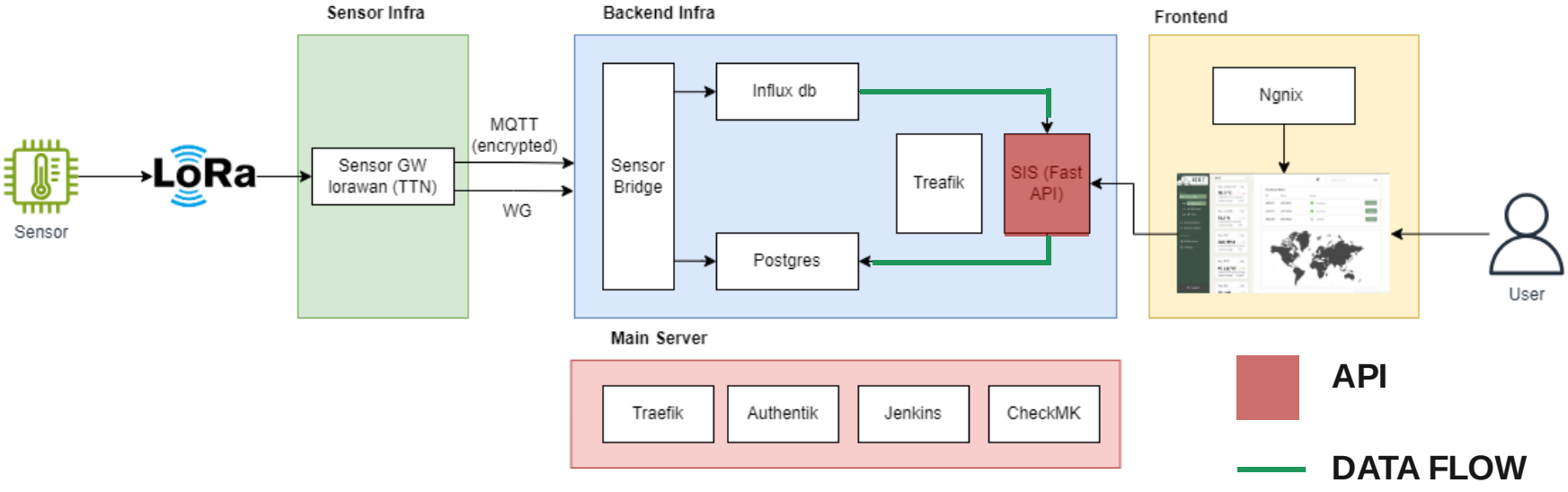
# API OVERVIEW



# API

## PREVIOUS YEAR

- NodeRuby
- 2 routes
  - Sensor.js
  - Weatherstation.js
- Script.js & app.js

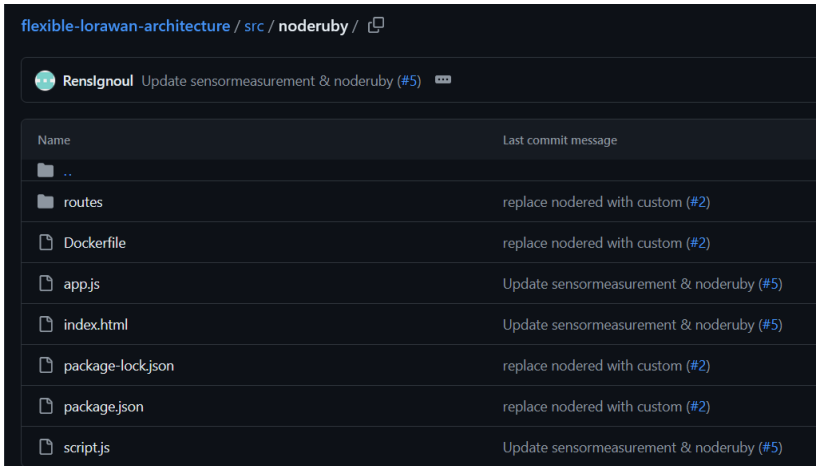
## THIS YEAR

- FastAPI
- 8 routes
- 7 models (classes)
- 2 utils
- Main.py
- In-depth readme

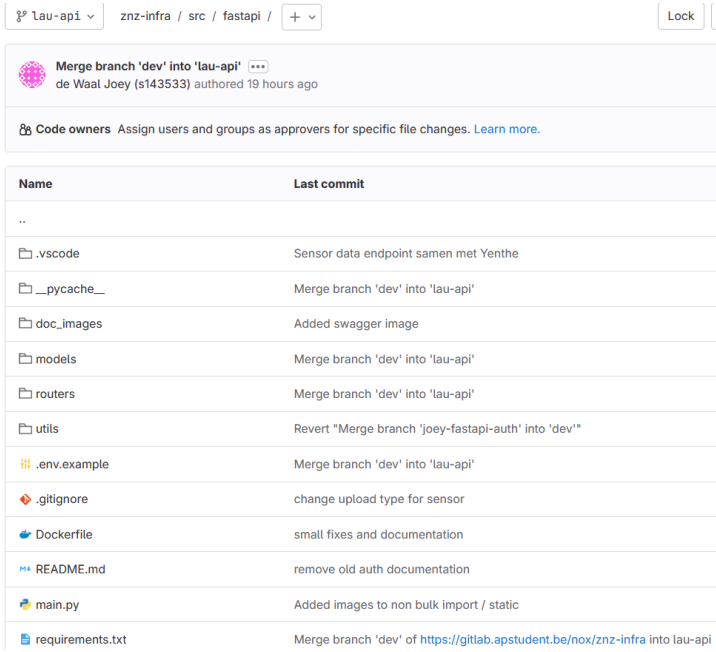
# Why do we use FASTAPI?

- Included in IT@AP classes
- Smooth handover to next year students
- Python is a very accesible programming language
- Extensive documentation available

# PREVIOUS YEAR

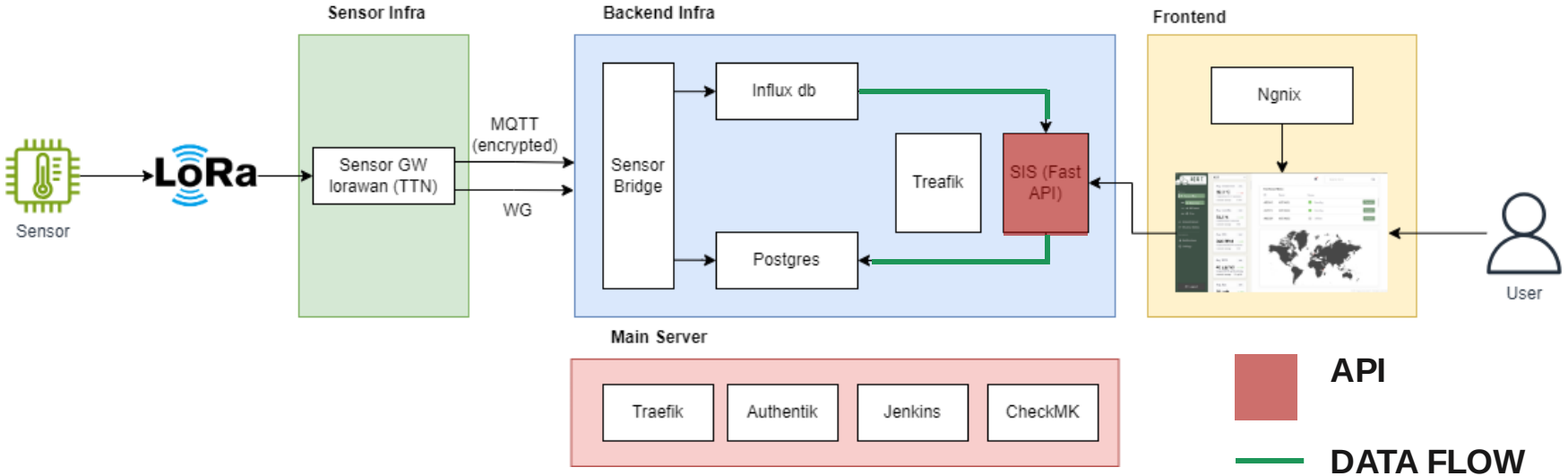



# THIS YEAR



# Why do we need an API ?

- Data flow between components
- Acts as a middleman



# What is **our** API doing ?

- Database - PostgreSQL - connection
- Database – InfluxDB - connection
- Frontend (website) integration
  - Frontend user interaction with backend → **API**


# FASTAPI FEATURES

## SIS/API with FastAPI

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# FASTAPI FEATURES

- VPN management
- Sensor data handling
- Sensor registration
- Auth with authentik
- Notifications
- Export data in csv


# VPN management

- Manage WG gateways
  - Create gateway
  - Delete gateway
  - Get gateway stats
  - Get configuration

# Sensor data handling

- Retrieve specific sensor data
- Retrieve all sensor data
- Retrieve specific data
- Retrieve data between dates
- Retrieve aggregated sensordata

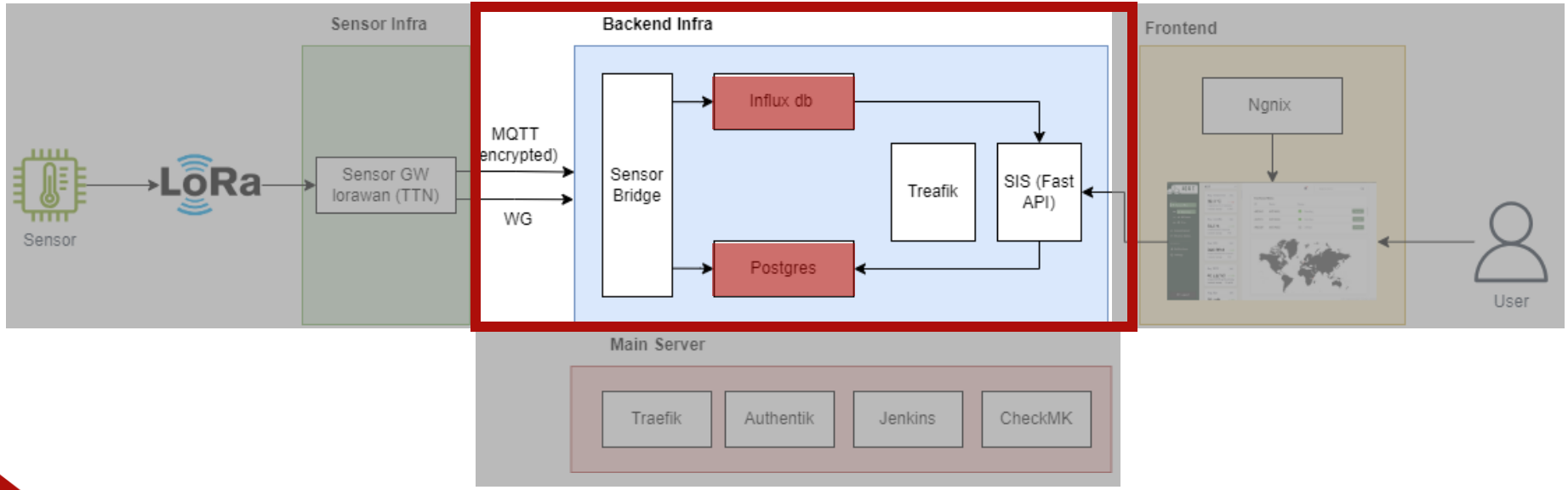
# Sensor registration

- Register new sensor
- Register batch of sensors
- Modify sensor
- Register sensor group
- Add sensor to sensor group
- Delete sensor group

# Authentication

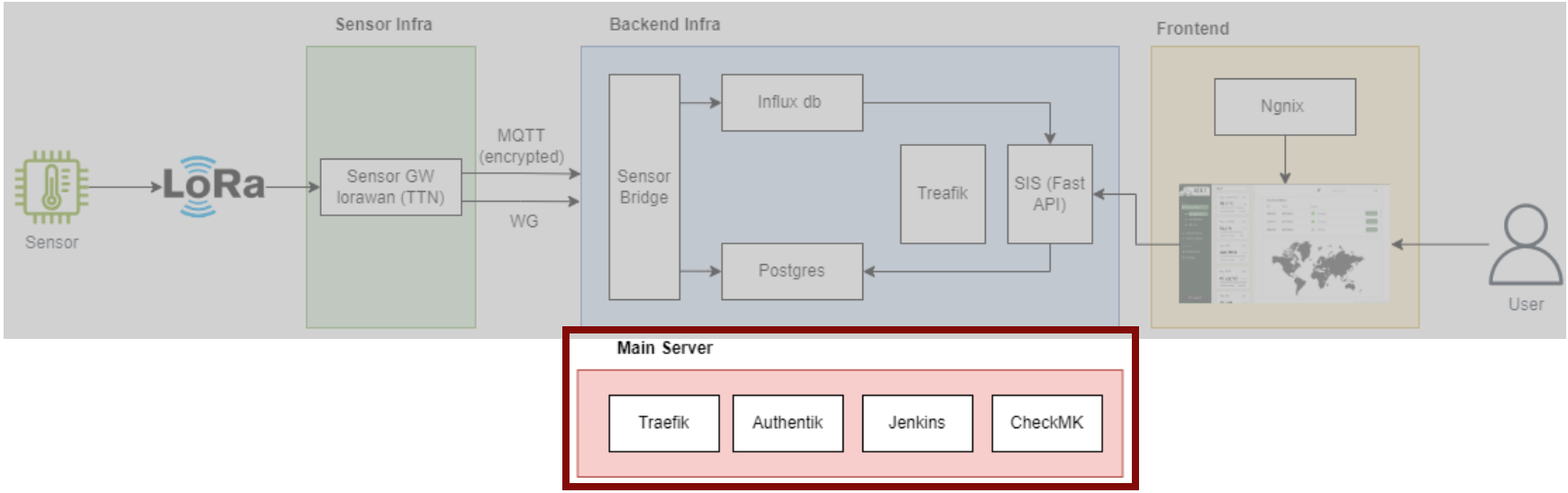

- Authentik as OIDC provider
- FastAPI middleware to control sessions
- JWT tokens in Cookies

# Composition



# Main Server

# Main Server Overview



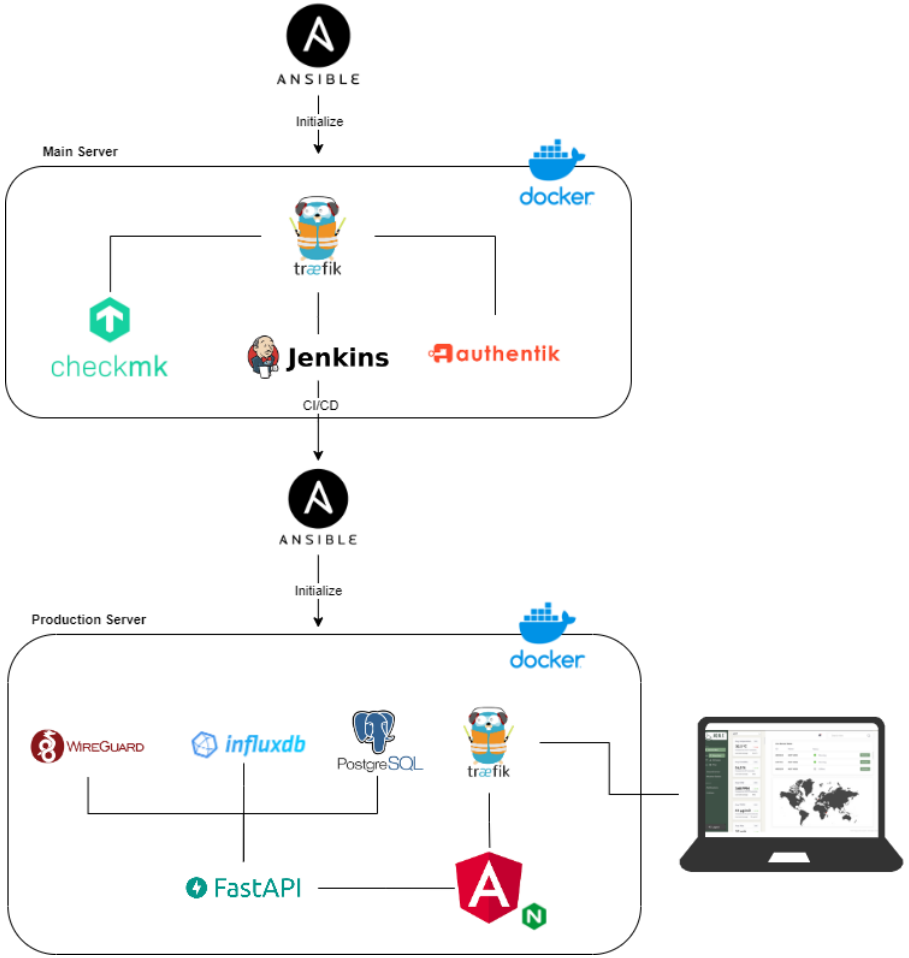
# Main Server Components

Traefik

Authentik

Jenkins

CheckMK



# Traefik & Authentik

## Main Server Components

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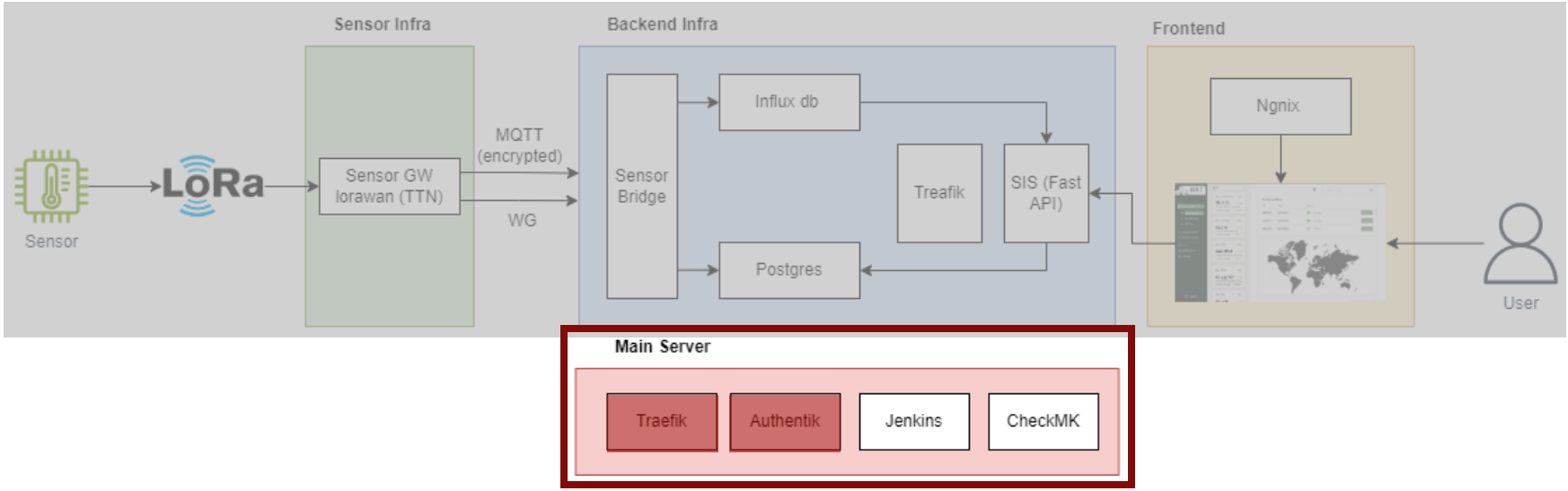
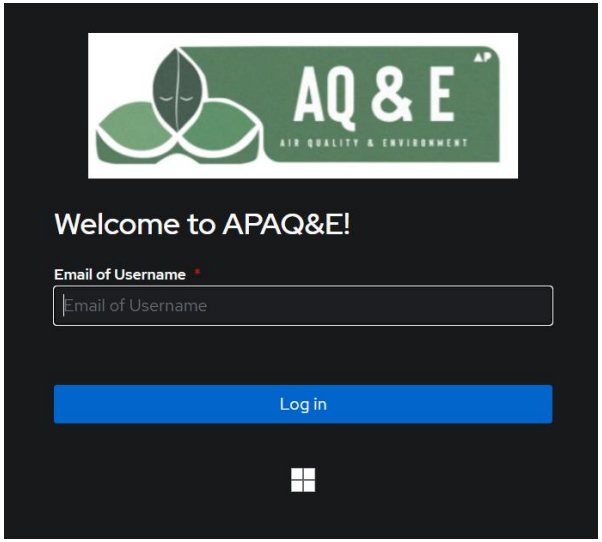
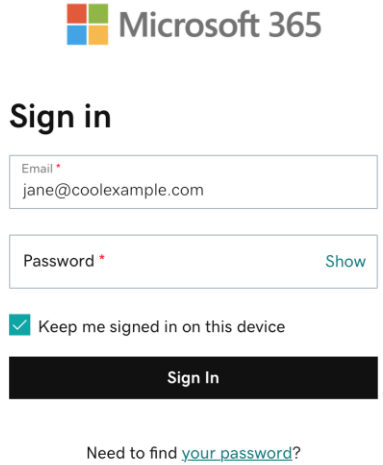
# Traefik & Authentik Overview



# Authentication



# AUTHENTIK

- Open-source identiteitsprovider and authenticationsystem
- Acts as oauth2-provider
- Easily integrated in applications and services
- Identity management
- Single Sign-On (SSO)
- LDAP for integrated services

# Reverse Proxy

# Traefik

- Open-source reverse proxy
- Load balancer
- SSL-certificates

# Jenkins

## Main Server Components

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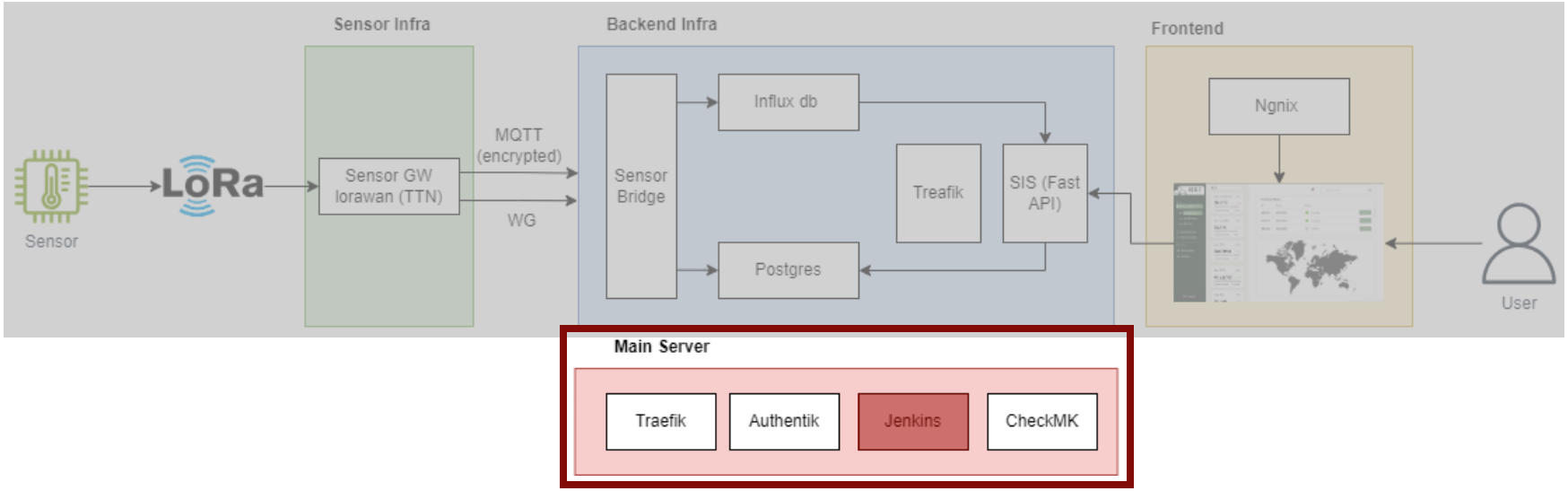
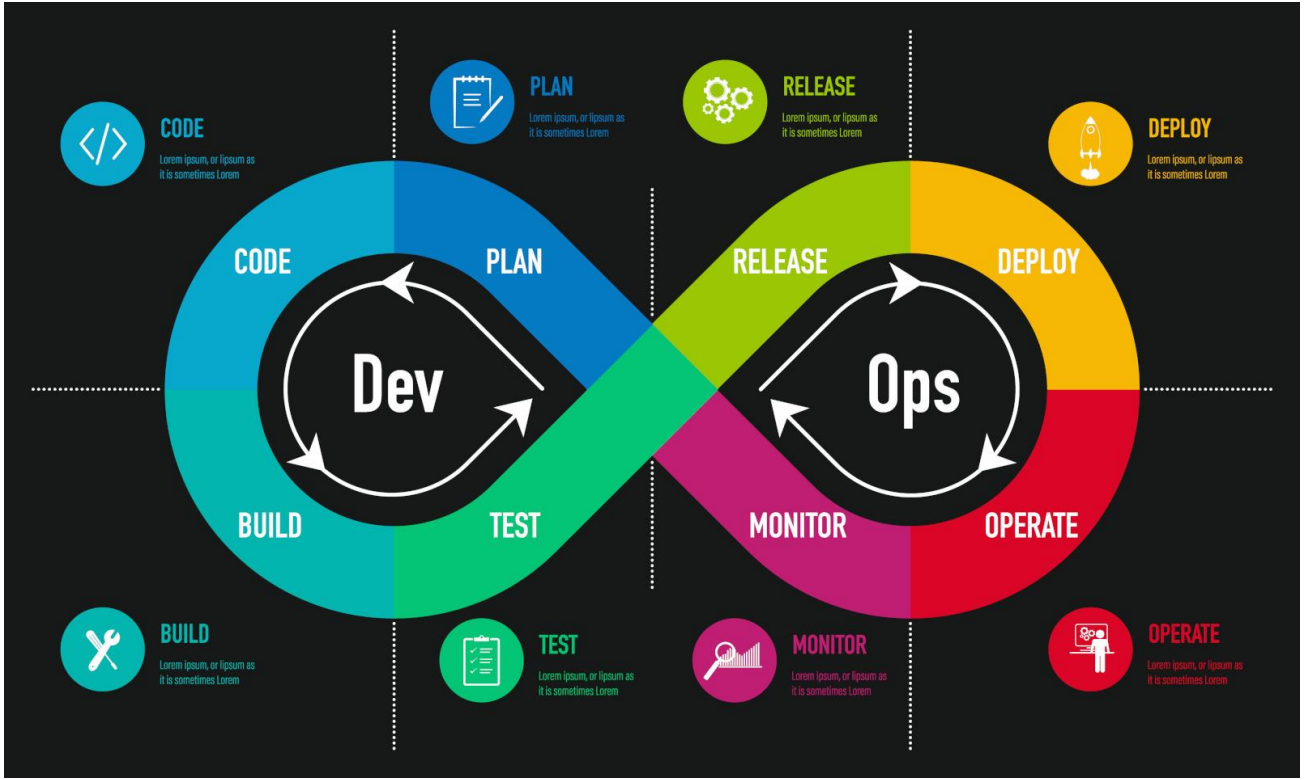
# Jenkins Overview



# Jenkins Basic



# Jenkins

| S | W | Name ↓ | Laatste geslaagd | Laatst mislukte | Duur laatste project uitvoer |
|---|---|---|---|---|---|
| ✓ | ☁ | Backups | 1 minuut 28 seconden #105 | 42 minuten #104 | 12 seconden ▷ |
| ✓ | ☁ | ProductieOmgeving | 1 dag 20 uur #5 | 4 dagen 19 uren #3 | 8 minuten 2 seconden ▷ |
| ⊘ | ☁ | Testomgeving | 2 dagen 19 uren #22 | 2 dagen 19 uren #21 | 4 minuten 53 seconden ▷ |

# CheckMK

## Main Server Components

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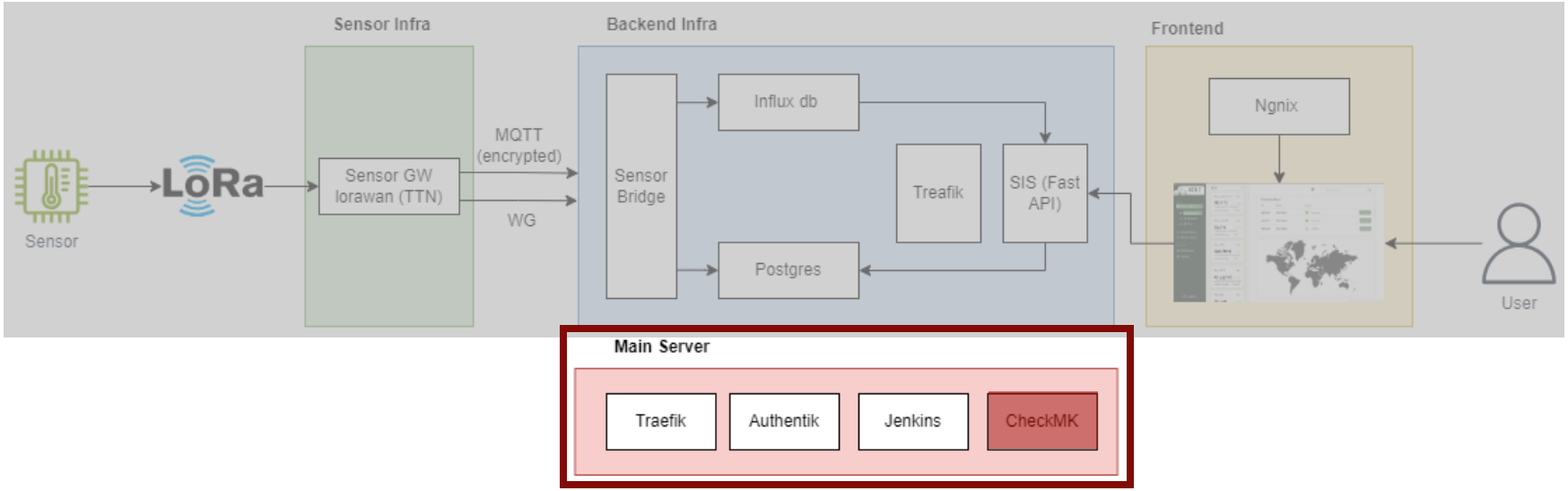
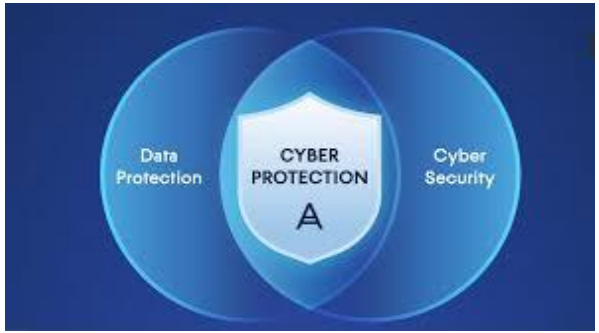
# CheckMK Overview

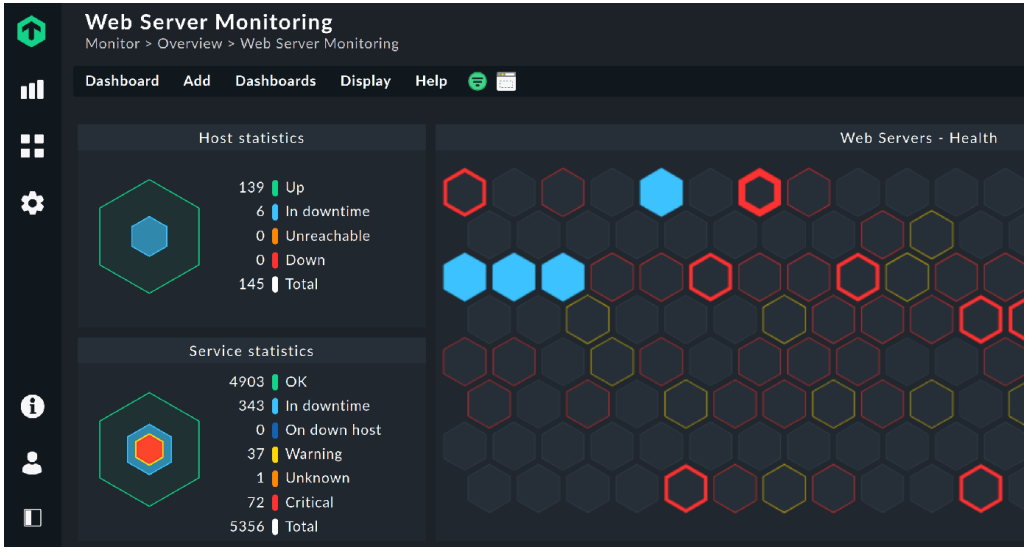


# Cybersecurity

## MONITORING

checkmk



# CheckMK – IN DEPTH

- Server status
- Server logins
- Service status
- Docker containers
  - Status
  - Services inside container

# Ansible

## Server preperation

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# Automation

ANSIBLE

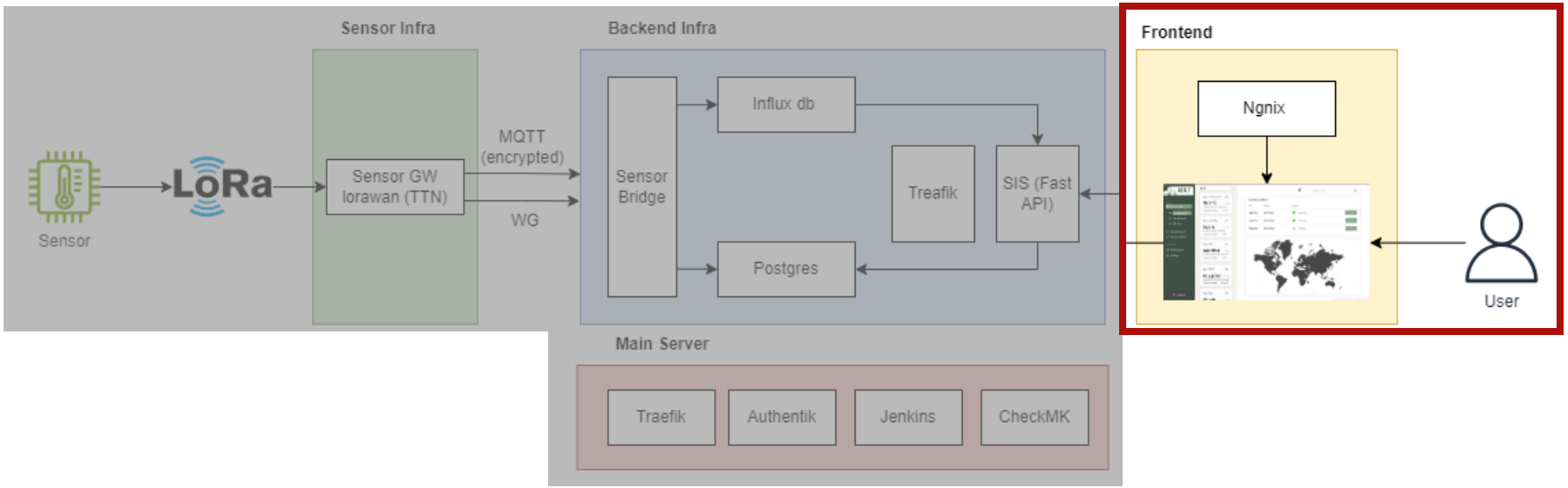
# Ansible – IN DEPTH

- Preparing the server
- Deploying the infrastructure
- Adding checkmk agents - monitoring

- Changing servers
- Changing provider

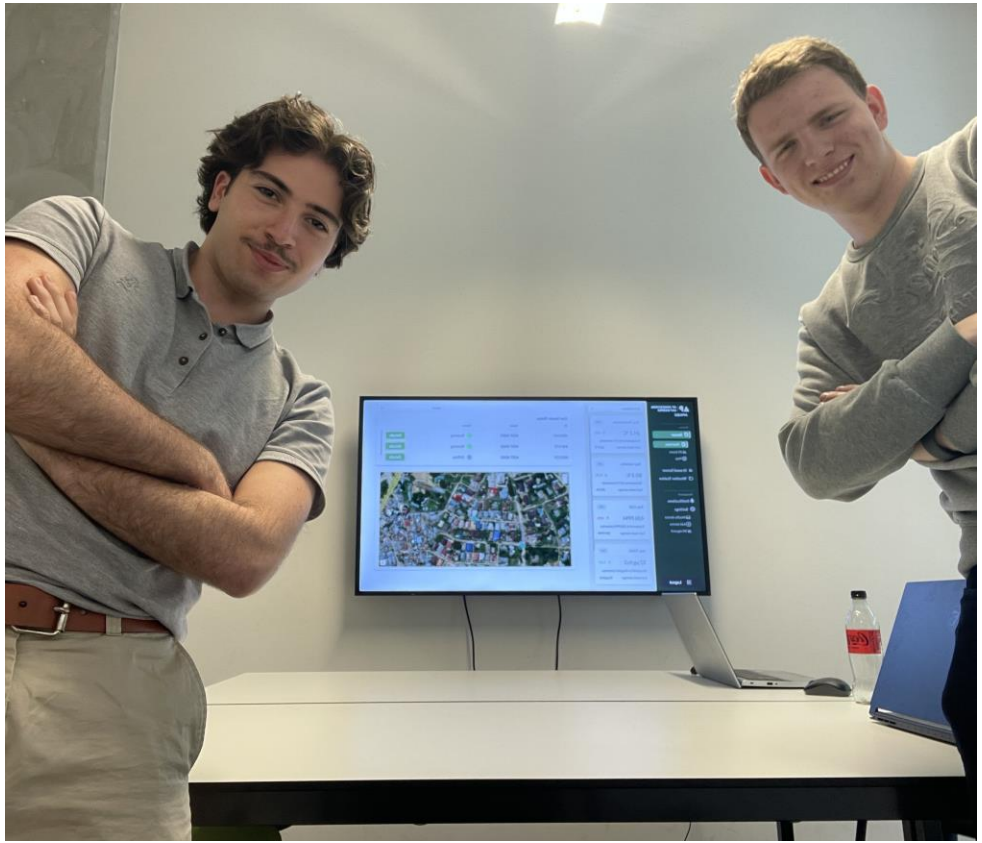
# Frontend

# Composition



Stijn Voeten, [SOFT] right

Hakim Ghanoudi, [ITBUS] left



# Frontend Components

- Nginx
- Dashboard

# Dashboard

## Frontend Components

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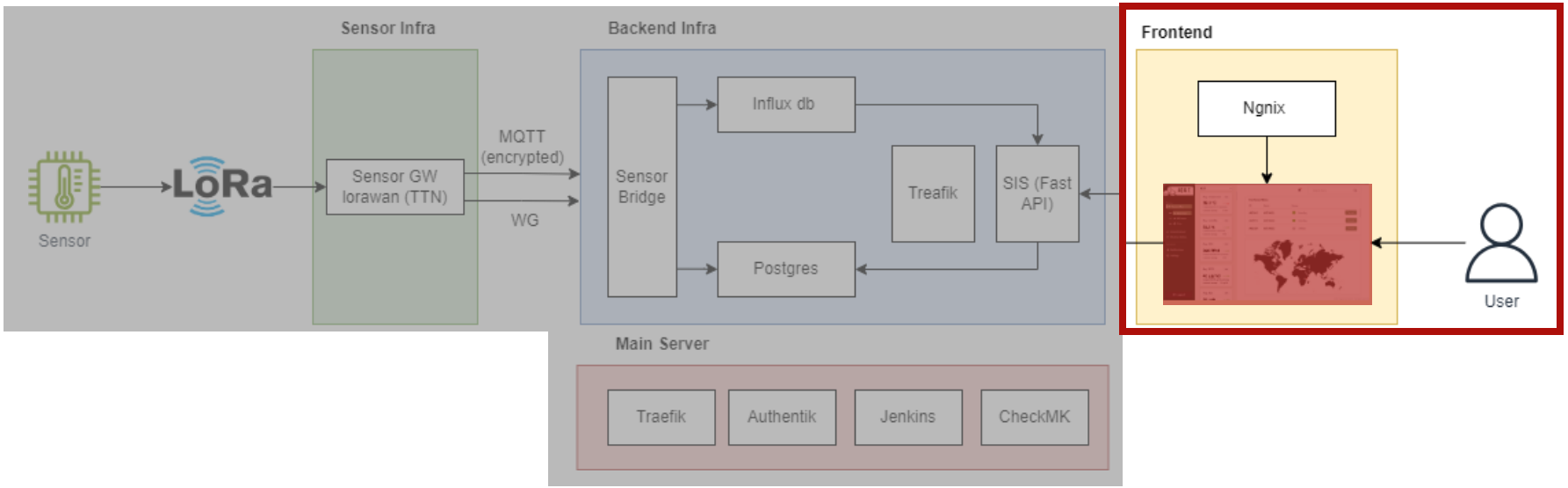
# Dashboard Overview



# Rome wasn't built in a day…

neither was this dashboard.

# Why first designing ?
# Instead of building


Adobe Stock | #310701218

# Sensor Dashboard

Alerts

Exit

x stations selected

Go

## Weatherstation location


## Station Information

**Weather station**
{STATION_NAAM}

**Last data**
11/03/2024 @ 15:07

**Sensor health**
Voltage: 4.2V
Power: 10mW
Uptime: 10d05h13min

## Mean values (24h)

| | |
|---|---|
| Temp: ... | TVOC: ... |
| CO2: ... | NOx: ... |
| Humidity: ... | Air pressure: ... |
| PM: ... | Gust: ... |


## Weatherstation location


## Station Information

**Weather station**
{STATION_NAAM}

**Last data**
11/03/2024 @ 15:07

**Sensor health**
Voltage: 4.2V
Power: 10mW
Uptime: 10d05h13min

## Mean values (24h)

| | |
|---|---|
| Temp: ... | TVOC: ... |
| CO2: ... | NOx: ... |
| Humidity: ... | Air pressure: ... |
| PM: ... | Gust: ... |

AP HOGESCHOOL ANTWERPEN
APAQ&E

Devices

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KIST

Search here

**Avg. temperature** 24H

**32.3 °C** ↑ 1.5%

Compared to 31,8 °C yesterday

Last week average 32.3 °C

**Avg. humidity** 24H

**56,5 %** ↓ 2.5%

Compared to 60 % yesterday

Last week average 53%

**Avg. CO2** 24H

**368 PPM** ↓ 2.5%

Compared to 350 PPM yesterday

Last week average 53%

**Avg. TVOC** 24H

**41 µg/m3** ↓ 2.5%

Compared to 45 µg/m3 yesterday

Last week average 31 µg/m3

**Avg. Nox** 24H

**55 ppb** ↓ 2.5%

**Live Sensor Status**

| ID | Name | Status | |
|---|---|---|---|
| #ED543 | KIST A001 | Running | Details |
| #AF472 | KIST A002 | Running | Details |
| #RD539 | KIST A003 | Offline | Details |

AP HOGESCHOOL ANTWERPEN

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# (9) - Sensor Boxes

Search here


#ED543

KIST A001

Details

#AF472

KIST A002

Details

#AF472

KIST A003

Details

#AF472

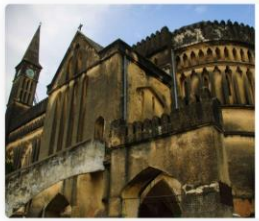
KIST A004

Details

#AF763

STNTWN A001

Details



#AF733

STNTWN A002

Details

#AF753

STDHSE A001

Details

#AF753

STDHSE A002

Details

AP HOGESCHOOL ANTWERPEN

Devices

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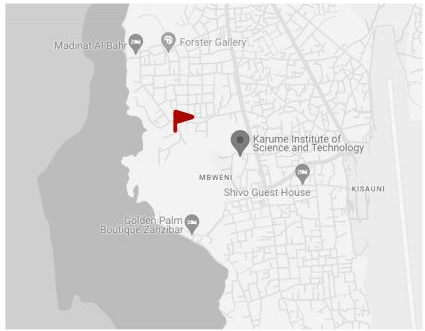
# #AF472 - KIST A003

Running

Search here



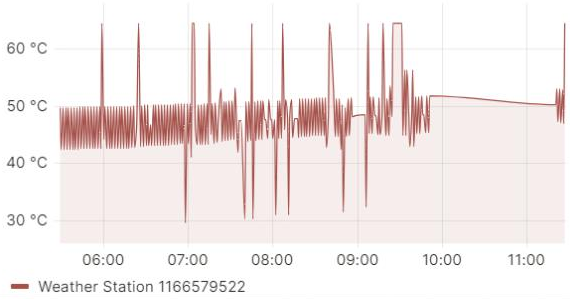

Selecteer datum Selecteer bereik

46.5 °C

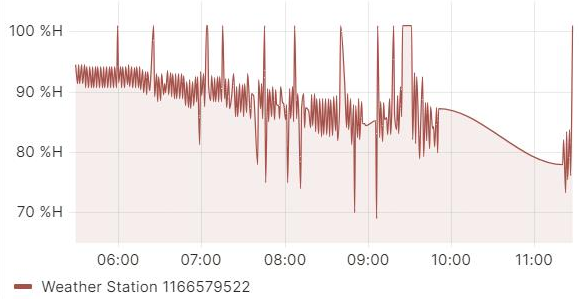
91.8 %H

46.5 °C

## Temperature

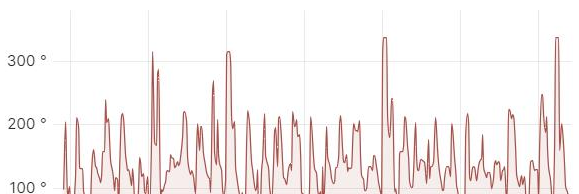



## Humidity




## Rain


## Wind Direction



AP HOGESCHOOL ANTWERPEN

# APAQ&E - MAP

Search here

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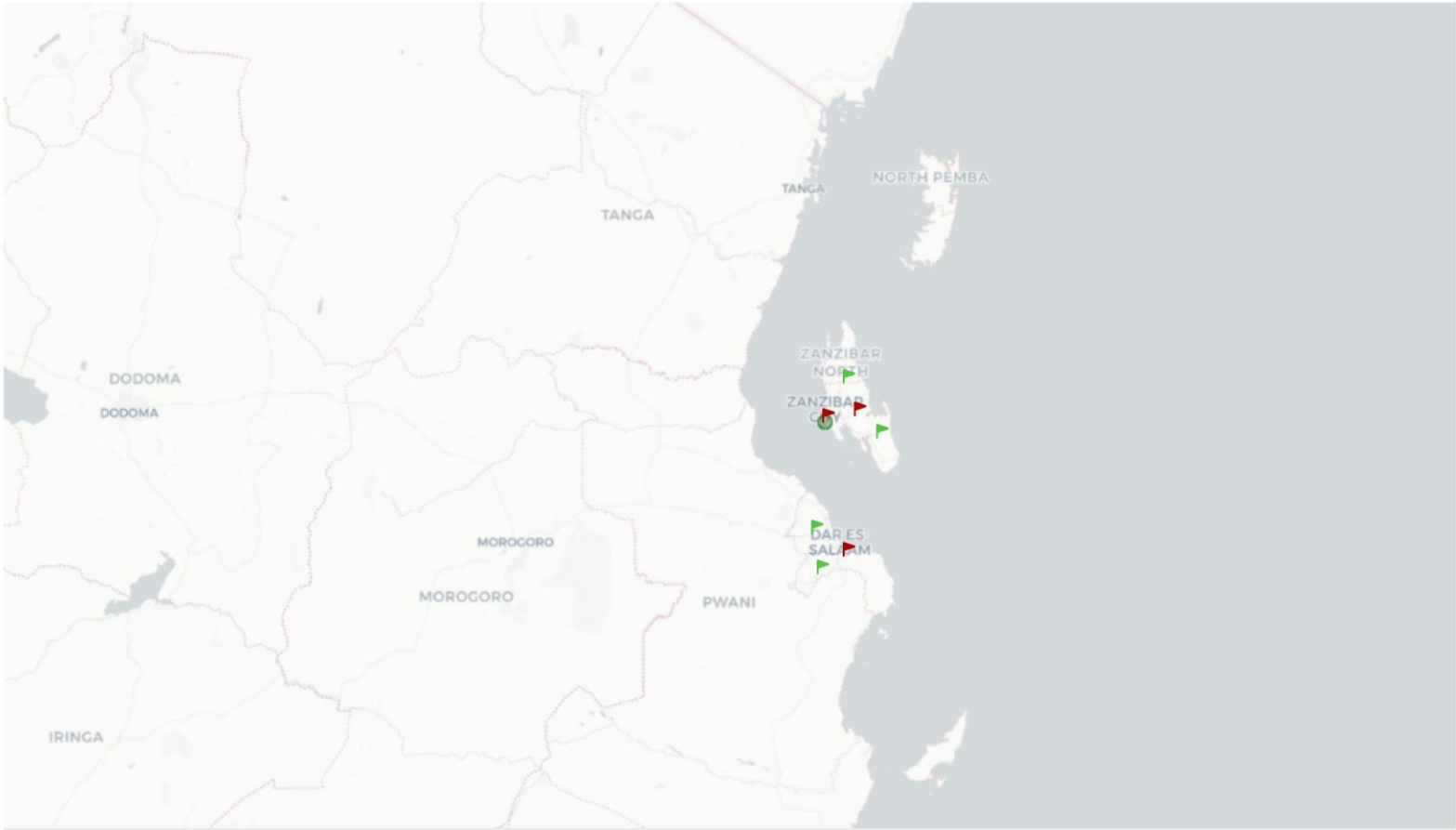
Offline Online



AQ & E
AIR QUALITY & ENVIRONMENT

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KIST

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### Live Sensor Status

| ID | Name | Status | |
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| #AF472 | KIST A002 | Running | Details |
| #RD539 | KIST A003 | Offline | Details |

AQ & E
AIR QUALITY & ENVIRONMENT

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- Settings

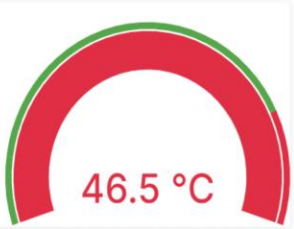
Logout

# #AF472 - KIST A003

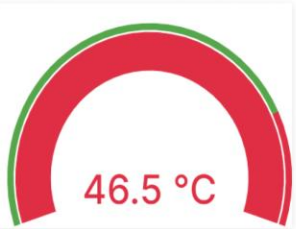
Running

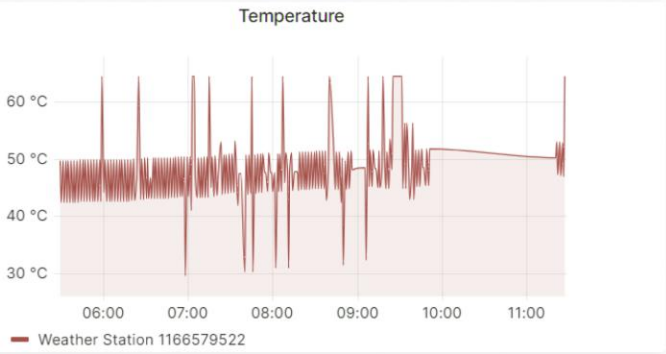
Search here

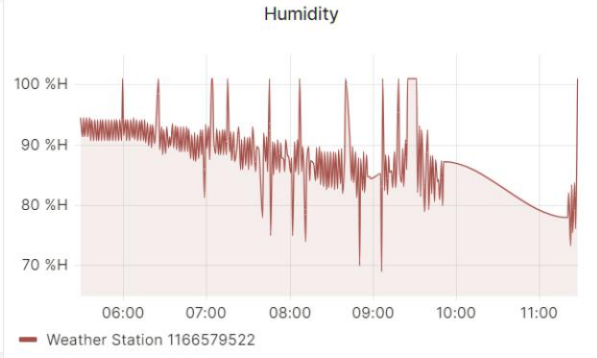

Selecteer datum  Selecteer bereik



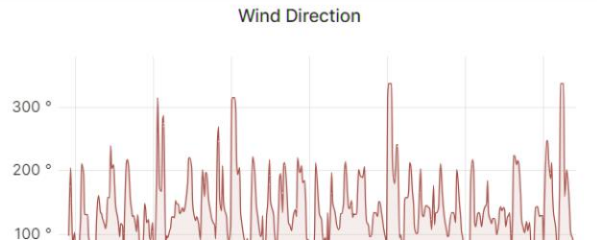








AQ & E
AIR QUALITY & ENVIRONMENT

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# (9) - Sensor Boxes

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#ED543

KIST A001

Details


#AF472

KIST A002

Details

#AF472

KIST A003

Details

#AF472

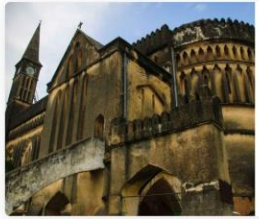
KIST A004

Details

#AF763

STNTWN A001

Details



#AF733

STNTWN A002

Details

#AF753

STDHSE A001

Details

#AF753

STDHSE A002

Details

# APAQ&E - MAP

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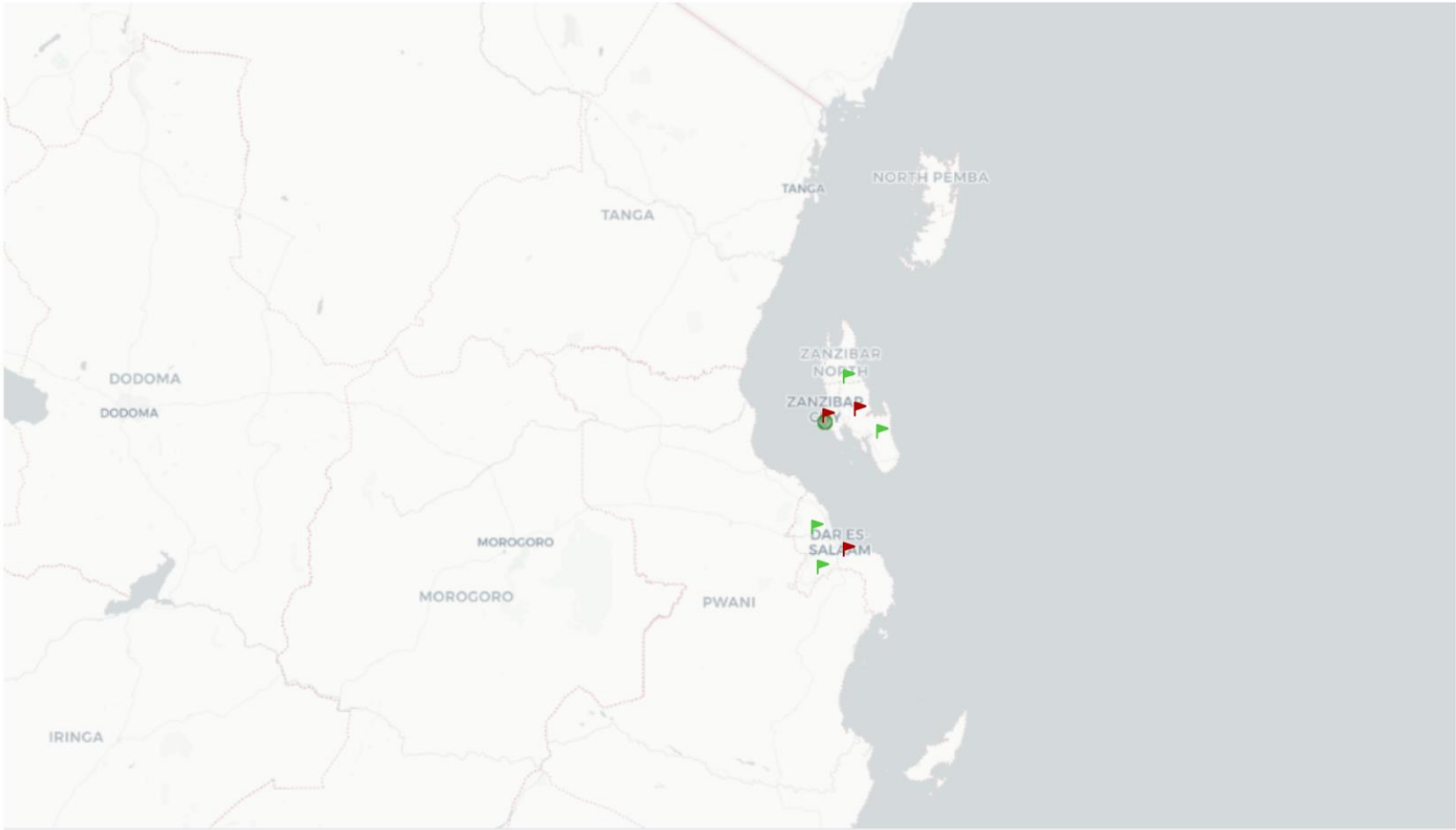
Offline Online




# User Management

Search here

Devices

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Managment

- Notifications
- Settings

Logout

| ID | Name | Role | |
|---|---|---|---|
| 1 | Lawrence D. Alessi | Administrator | Edit |
| 2 | Shari M. Krebs | User | Edit |
| 3 | Doris P. Santos | User | Edit |
| 4 | Kenneth L. Leger | User | Edit |

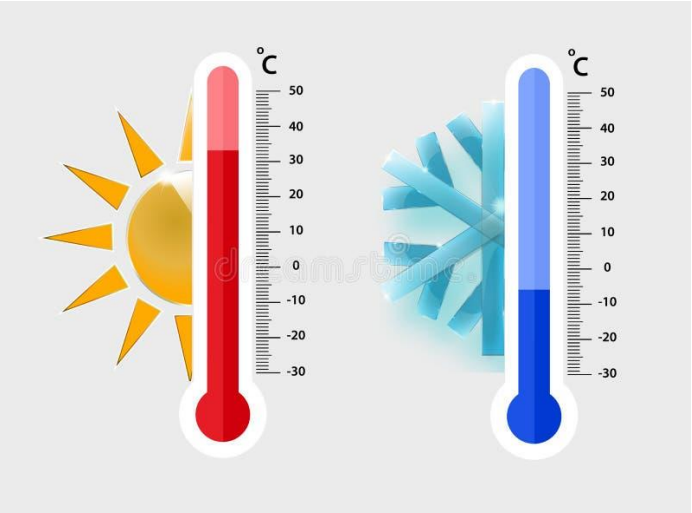
# Anomaly detection - AI

# Anomaly detection - Technologies

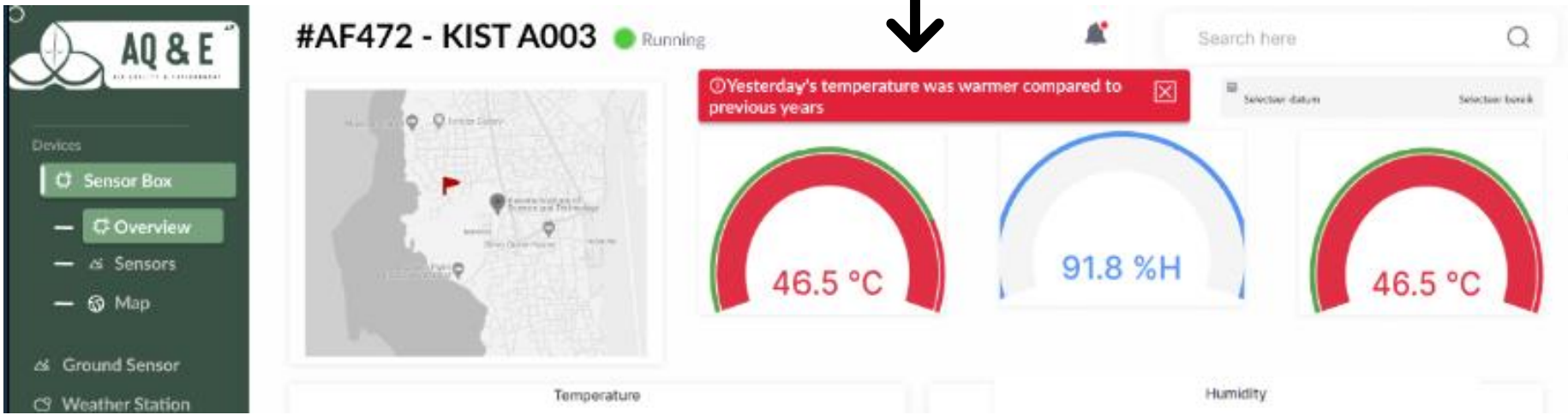


# Anomaly detection - Goal

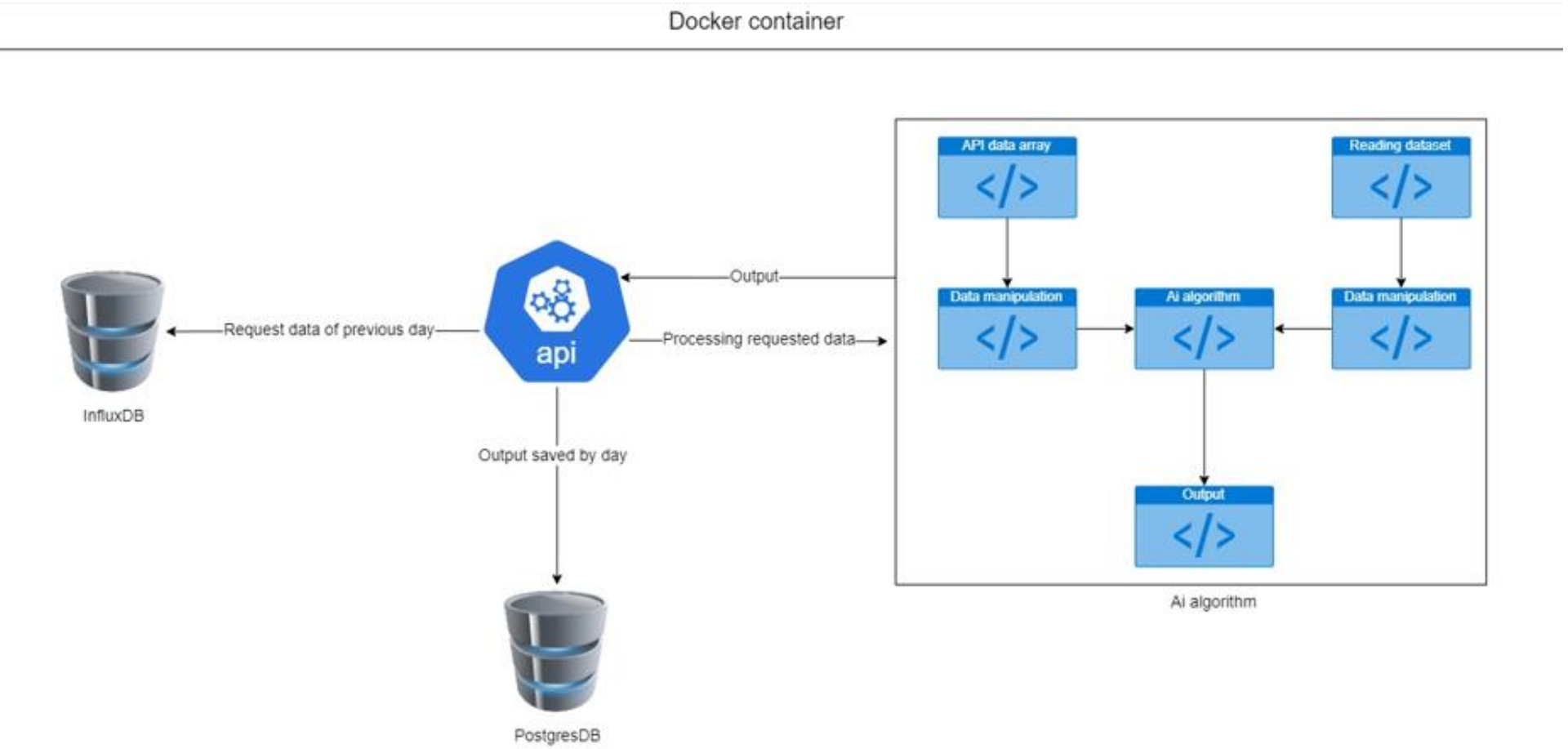
- Finding anomaly's in temperature
- Abnormal high/low temperatures would be calculated
- Dashboard displays message



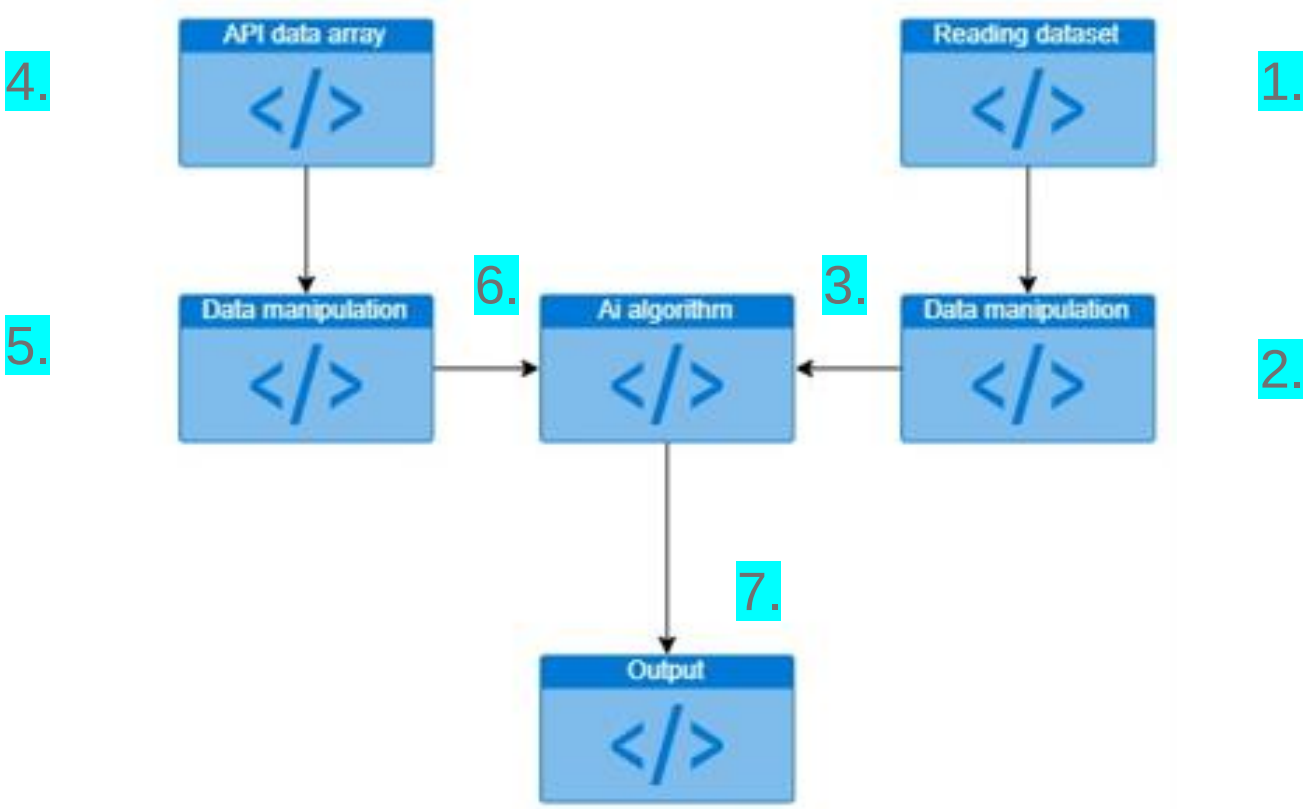
# Anomaly detection - Example message



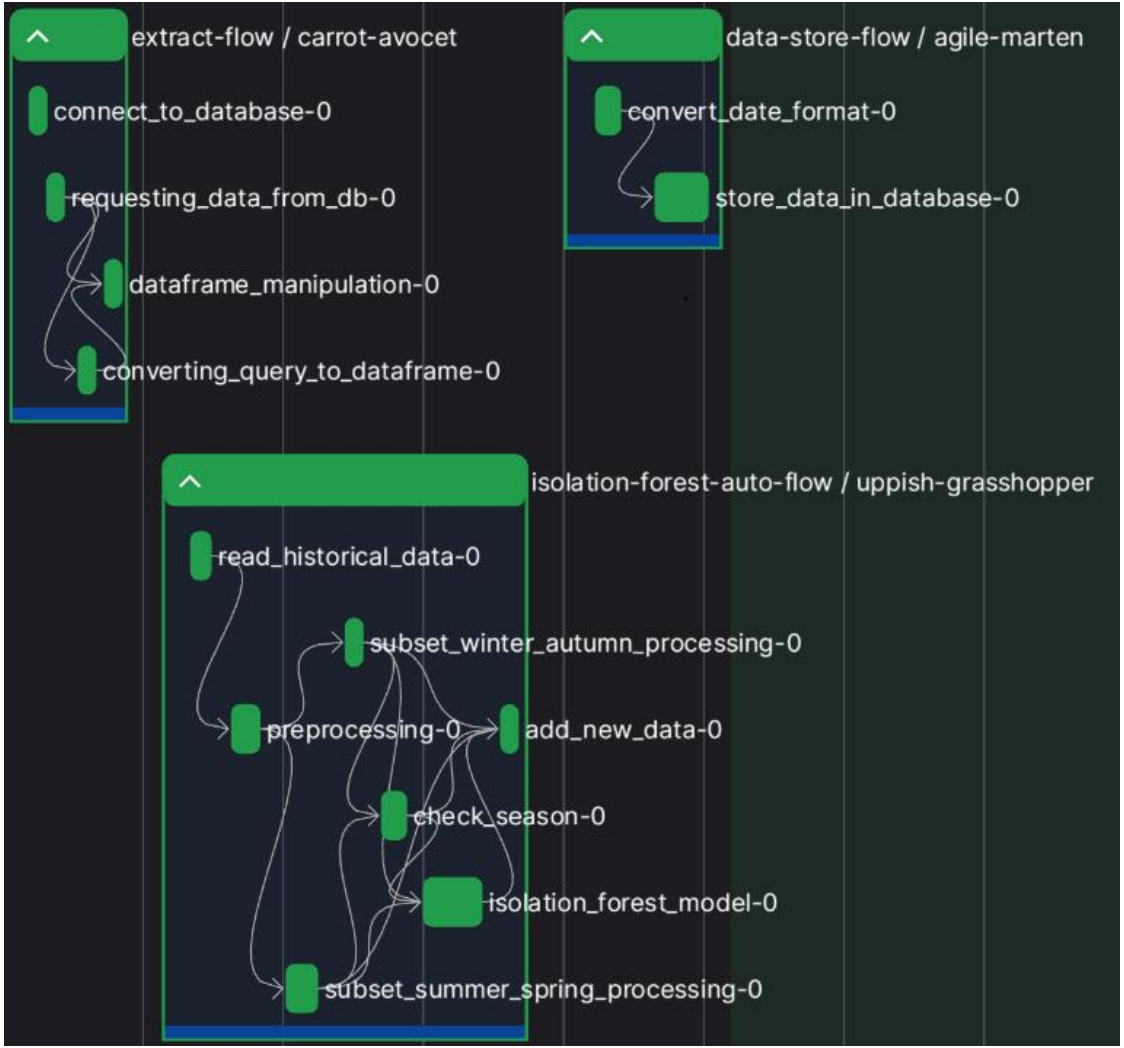
# Anomaly detection - Flow



# Anomaly detection - Algorithm Flow



# Anomaly detection - Algorithm Flow



# Anomaly detection - What kind of algorithm?

- Created 2 algorithms
- Why?
  - Compare results
  - Selecting the best algorithm

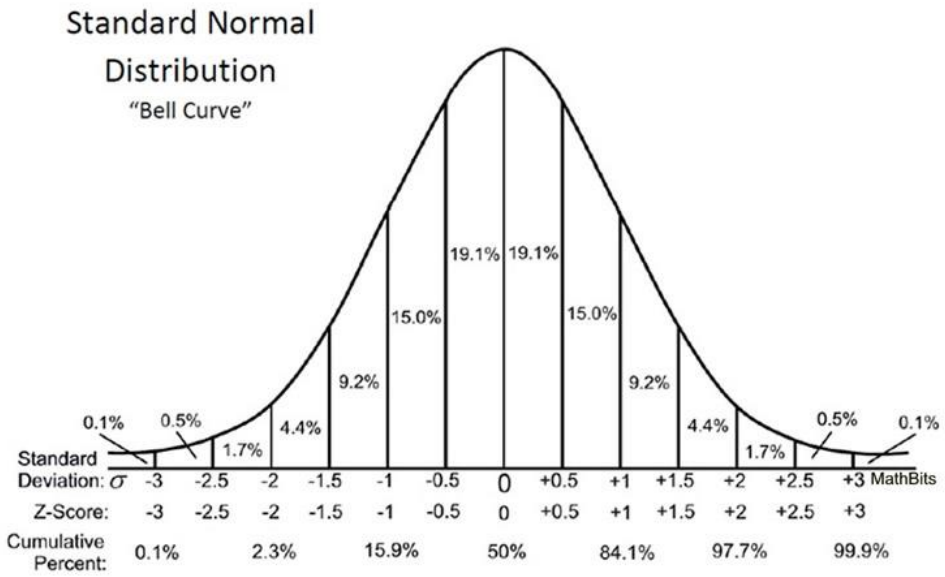
# Anomaly detection - What kind of algorithm?

- Based on the Gaussian Equation
- Isolation Forest (ML Algorithm)

# Anomaly detection - What kind of algorithm?

Option 1:

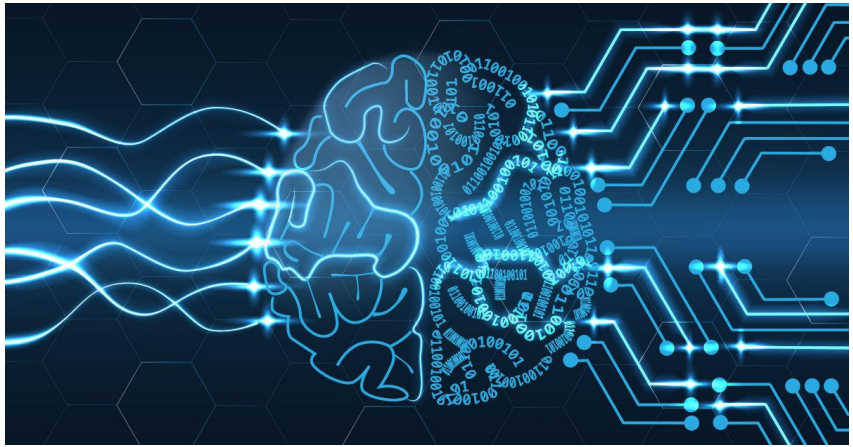
- Simple Ai algorithm
- Custom made
- Based on the Gaussian Equation



# Anomaly detection - What kind of algorithm?

Option 2:

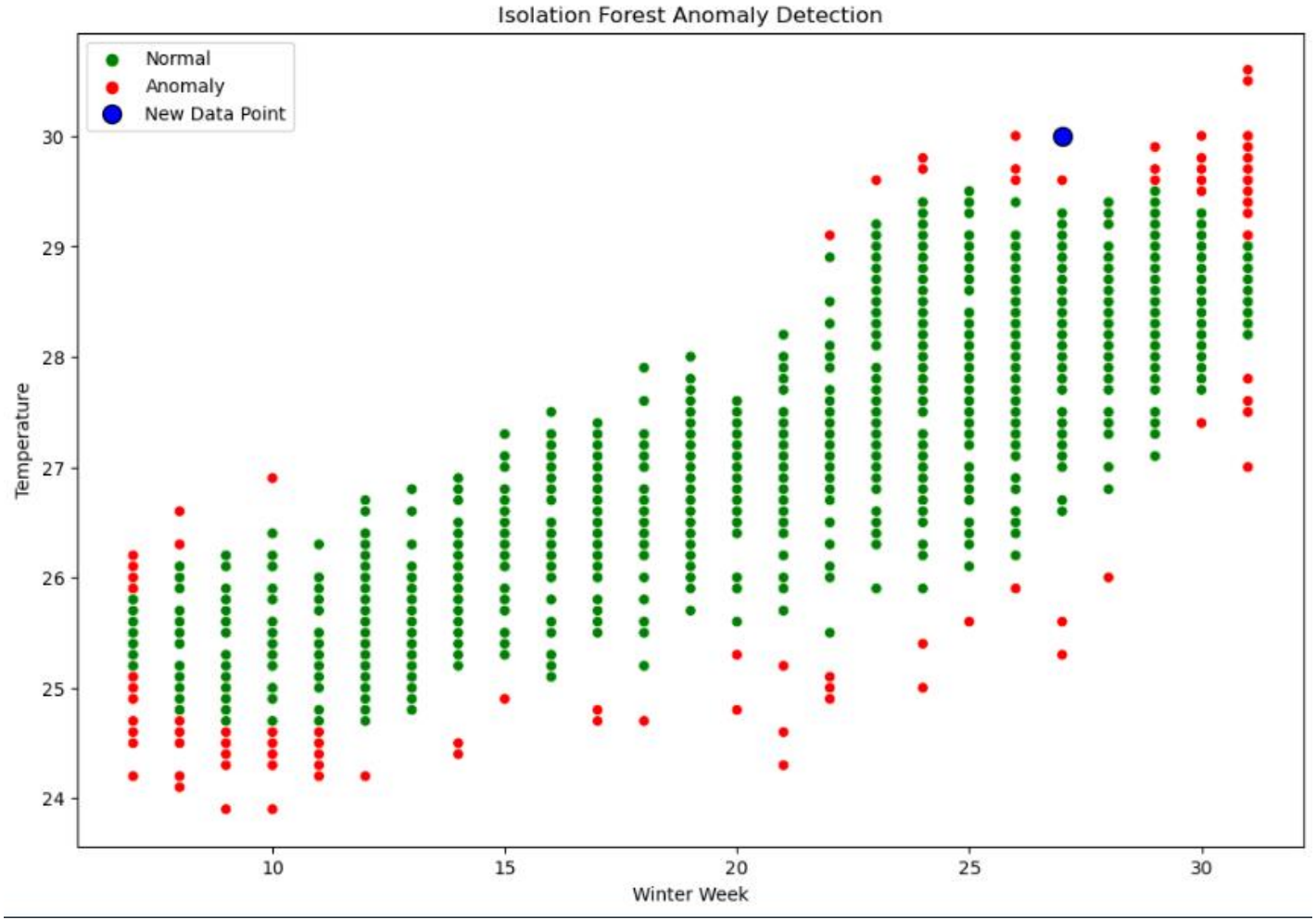
- Isolation Forest
- Machine Learning Algorithm
- More stable



# Anomaly detection - What kind of algorithm?

- Decision based on monitoring
- Isolation Forest had best prestations

# Anomaly detection - Output example



# Planning and projectmanaging

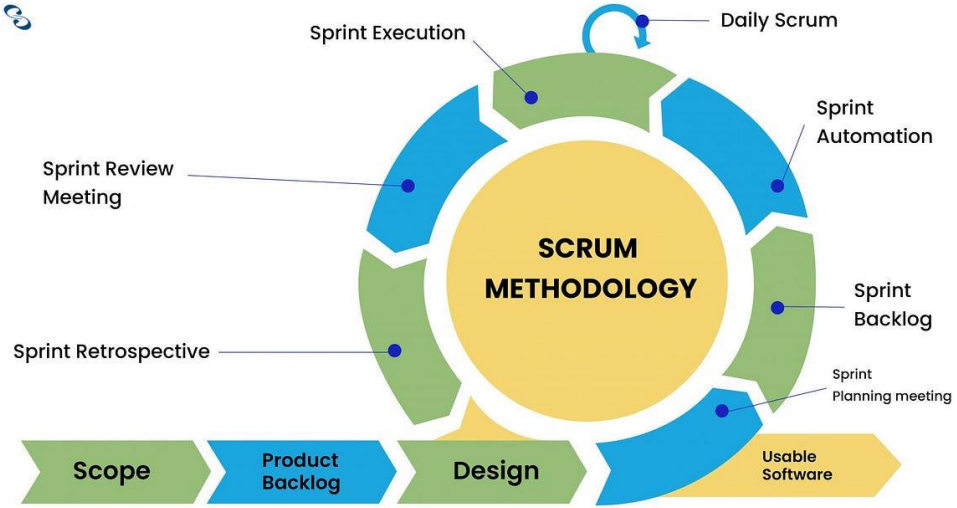
AP HOGESCHOOL ANTWERPEN

AP.BE

# Hakim Ghanoudi, [ITBUS]

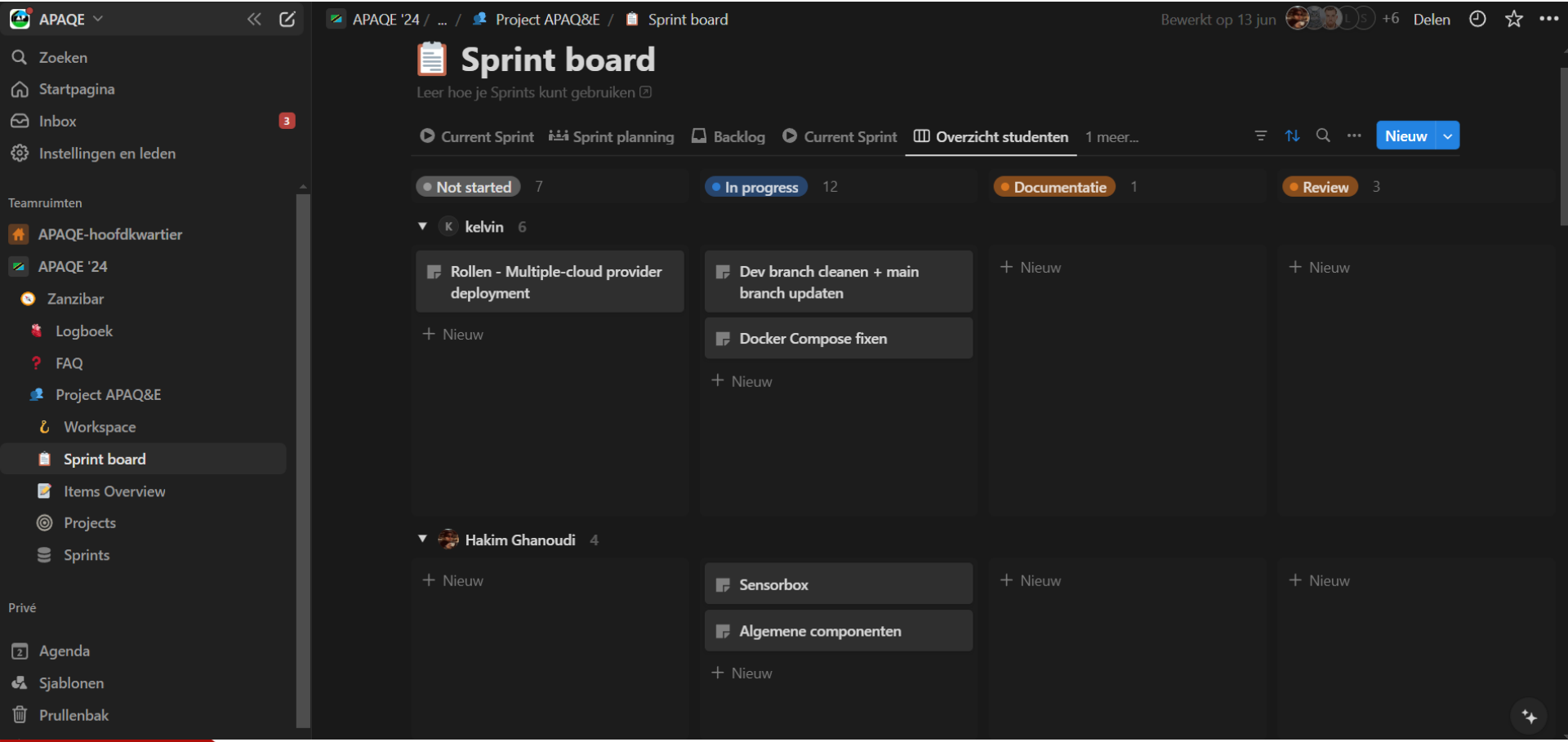
# Business

## Planning




Notion

# Notion

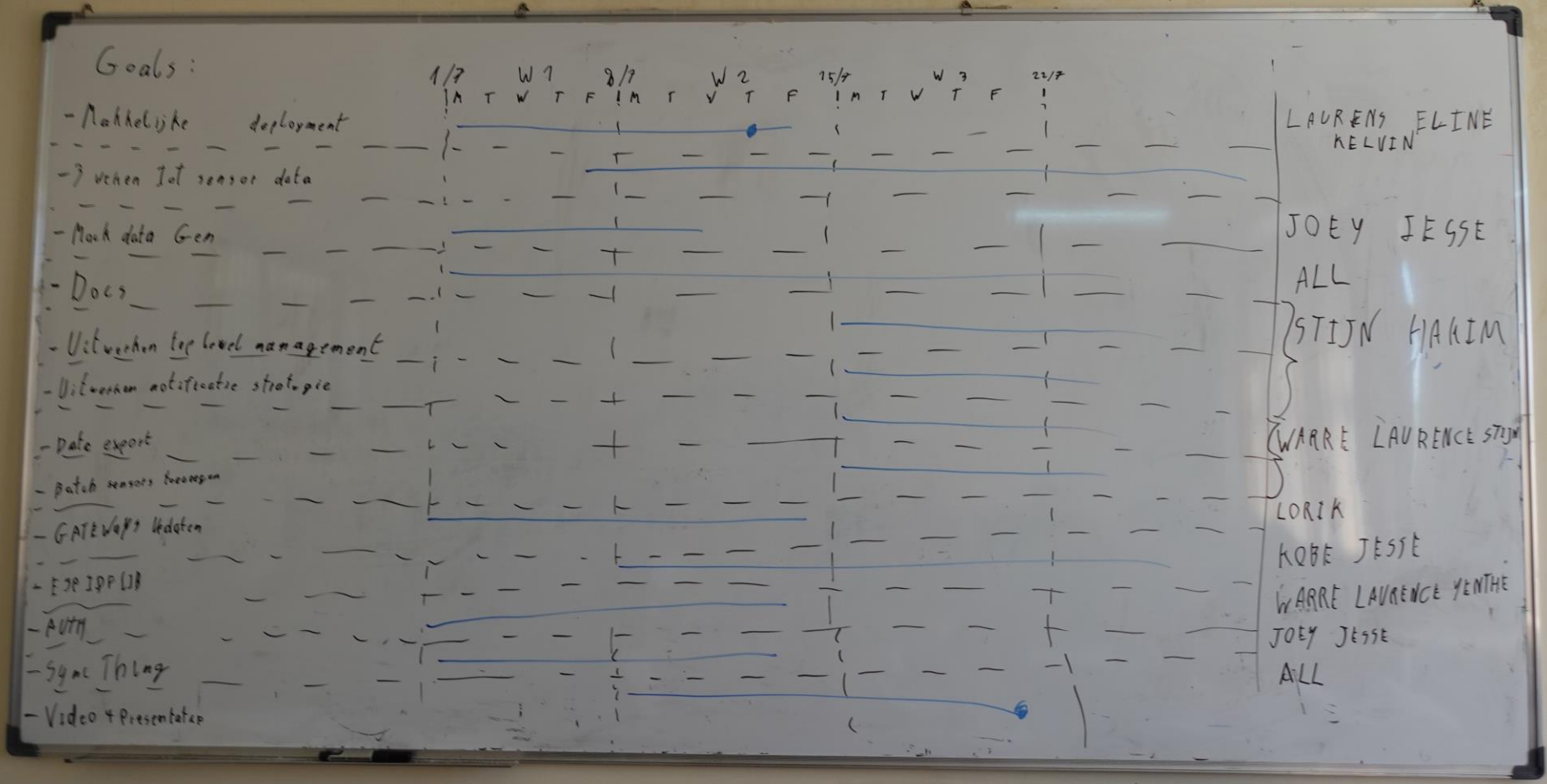

APAQE
Zoeken
Startpagina
Inbox
3
Instellingen en leden
Teamruimten
APAQE-hoofdkwartier
APAQE '24
Zanzibar
Logboek
FAQ
Project APAQ&E
Workspace
Sprint board
Items Overview
Projects
Sprints
Privé
Agenda
Sjablonen
Prullenbak
APAQE '24 / ... / Project APAQ&E / Sprint board
Bewerkt op 13 jun
+6
Delen
Sprint board
Leer hoe je Sprints kunt gebruiken
Current Sprint
Sprint planning
Backlog
Current Sprint
Overzicht studenten
1 meer...
Nieuw
Not started 7
In progress 12
Documentatie 1
Review 3
kelvin 6
Rollen - Multiple-cloud provider deployment
Dev branch cleanen + main branch updaten
Docker Compose fixen
Nieuw
Hakim Ghanoudi 4
Sensorbox
Algemene componenten

# Weekly standup?

# Scrum?

*Scrum is a management framework that teams use to self-organize and work towards a common goal. It describes a set of meetings, tools, and roles for efficient project delivery.*

- Worked a whole semester for a good base.
- This for 6 hours a week per student
- Tickets per student
- Sprints
- Weekly standup


Goals:
1/7
W1
8/7
W2
15/7
W3
22/7
M T W T F M T W T F M T W T F
- Makkelijke deployment
- 3 weken IoT sensor data
- Mock data Gen
- Docs
- Uitwerken top level management
- Uitwerken notificatie strategie
- Data export
- patch sensors toevoegen
- GATEWAY's klaarzetten
- ESP IDF [J]
- AUTH
- Sync Thing
- Video + Presentatie
LAURENS ELINE KELVIN
JOEY JESSE
ALL
STIJN HAKIM
WARRE LAURENCE STIJN
LORIK
KOBE JESSE
WARRE LAURENCE YENTHE
JOEY JESSE
ALL

# Thank you KIST!