

UNIVERSIDADE DE AVEIRO
LICENCIATURA EM ENGENHARIA DE
COMPUTADORES E INFORMÁTICA

M2 - ELABORATION

Recolha e Visualização de Dados 5G num Ambiente Smart City - Grupo 1

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Context

5G is the fifth generation of cellular networks, and it's used in the ATCLL Project environment.

The importance of the exposure of data from multiple devices that are connected to the network.

Visualization of this data in an easier way of understanding.



State of Art



Related work to our
Technical Projects

ATCLL

Large-scale smart city infrastructure spread across Aveiro. It supports research, testing, and development in areas like data collection, connected vehicles, and advanced networks.

OPEN5GS

Open-source project that implements the core network components needed for 5G and LTE networks. Its modular design allows for customization and the replacement of specific network functions to suit particular use cases.

NETWORK SURVEY

The Network Survey App is a tool designed to collect and analyze data on network performance and coverage. It allows users to gather information on parameters like signal strength, bandwidth, and latency.



Objectives

1

Develop an intuitive visualization platform.

2

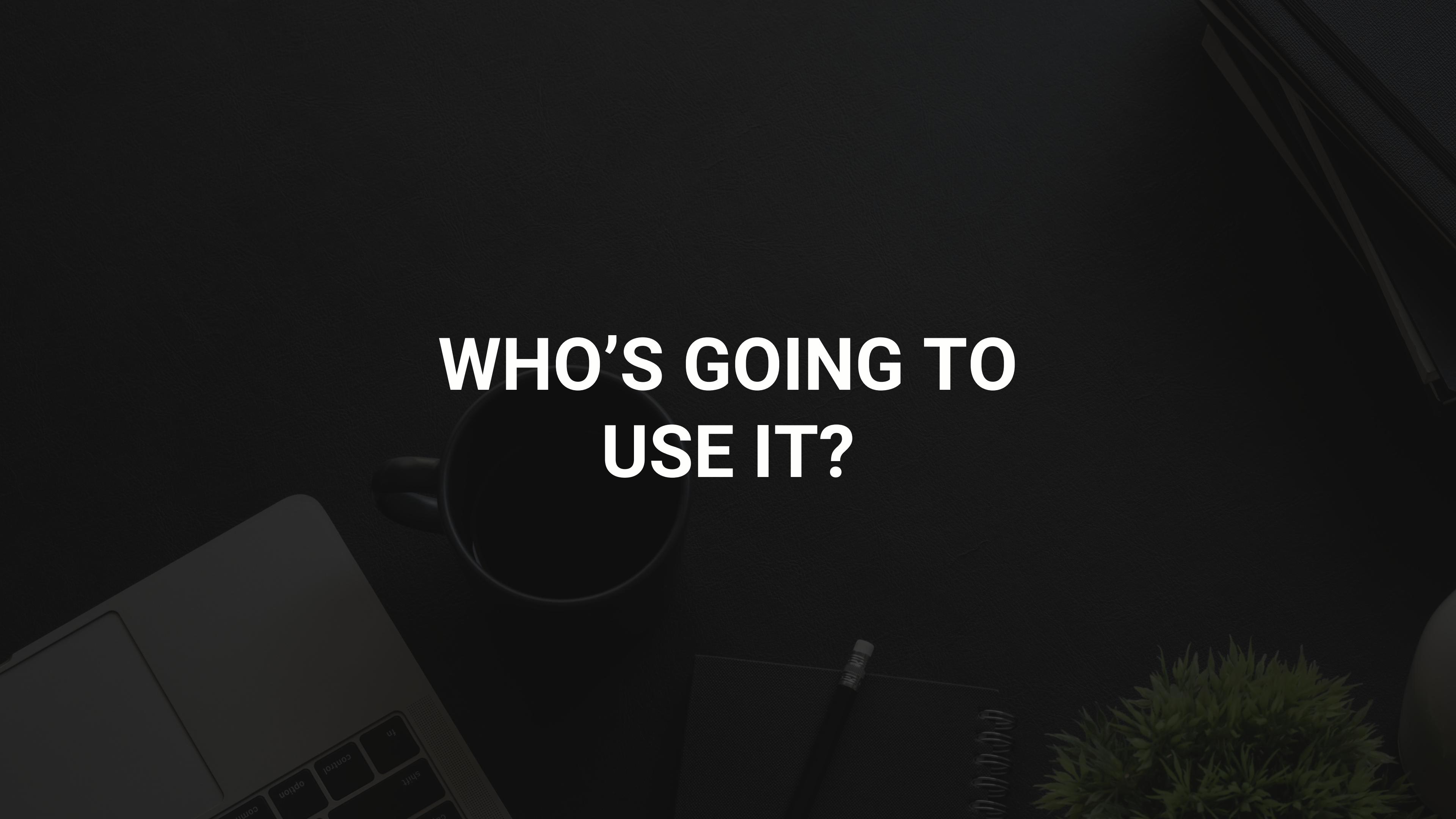
Incorporate collected data in a simpler way.

3

Perform real-time analysis of network performance.

4

Estimate the location of mobile devices on the network.



WHO'S GOING TO USE IT?

Personas



Manuel

Age: 27 years

Job: Researcher in IT Aveiro

Problem: Struggles with the current mobile applications for running quality tests on 5G networks. Most tools are either too complex, lack the specific features he needs, or don't integrate correctly with the current technologies used, causing delays in his research work.

Goal: Aim to streamline his research process by finding a reliable mobile app that allows him to run quality tests on 5G networks efficiently. He seeks a solution that provides accurate results quickly, giving him more time to focus on his analysis.



Personas

Matilde

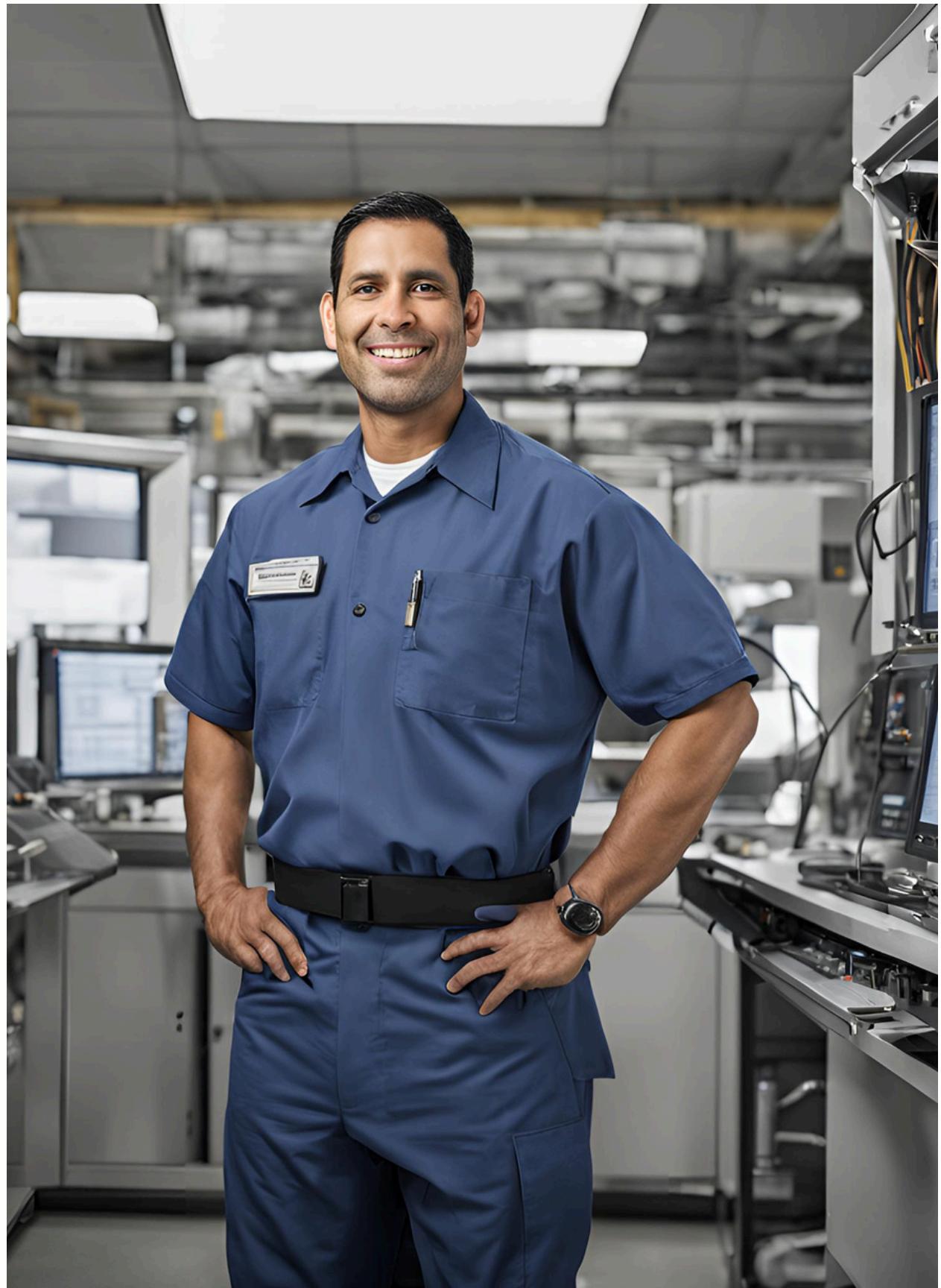
Age: 23 years

Job: Enthusiast citizen of Aveiro

Problem: Struggles with frequent disruptions during video calls and streaming due to unreliable network coverage. This not only affects her productivity but also her mood and overall quality of life.

Goal: Wants to achieve reliable internet coverage in her area, allowing her to work efficiently and enjoy her online hobbies without interruptions. She is determined to take control of her network quality and understand its nuances.

Personas



Carlos

Age: 34 years

Job: Technician in the telecommunications industry

Problem: Identifying malfunctioning antennas quickly and accurately. His current tools are either outdated or don't provide the real-time data he needs to address issues proactively, which adds to his workload and stress.

Goal: Achieve seamless and reliable monitoring of antenna performance, allowing him to respond swiftly to issues and enhance service delivery. His ultimate goal is to ensure uninterrupted connectivity for clients and maintain a high standard of service.



Use Cases

1. Conduct Network Test
2. Monitor Live Metrics
3. View Network Coverage
4. Analyze Network Performance

Android App

Functional Requirements

Collect network metrics related to signal quality and operator data and publish them to the broker

Perform network tests (Iperf and speedtest)

Make data collected in tests available in various forms

Non-Functional Requirements

Provide several options for each test

Be simple and intuitive

Web App

Functional Requirements

Agent who subscribes a broker and populates the database

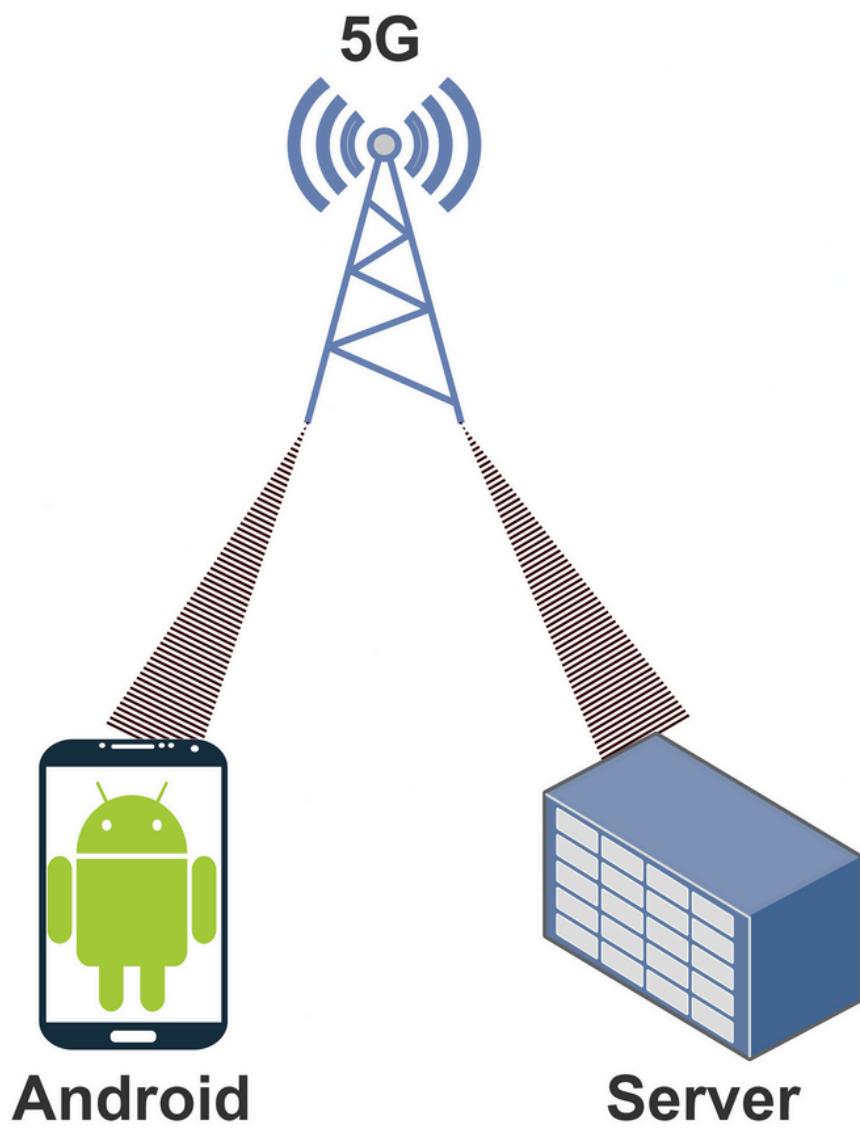
Agent consumes persistent data from the database and real time data from the broker

Treat the collected data and present it graphically

Non-Functional Requirements

Data has to be presented in a simpler, more efficient, and non-redundant way.

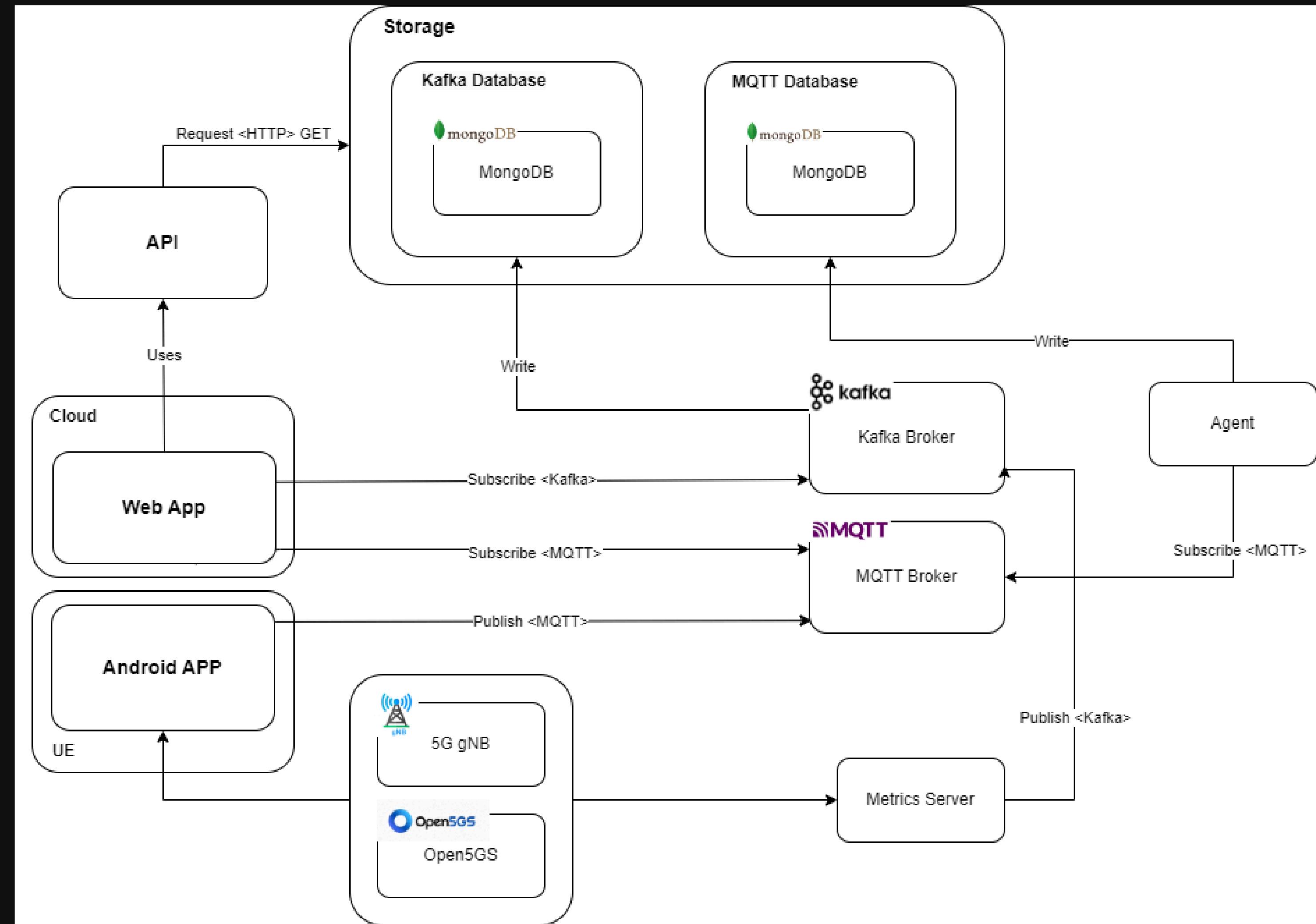
Dynamic real-time data



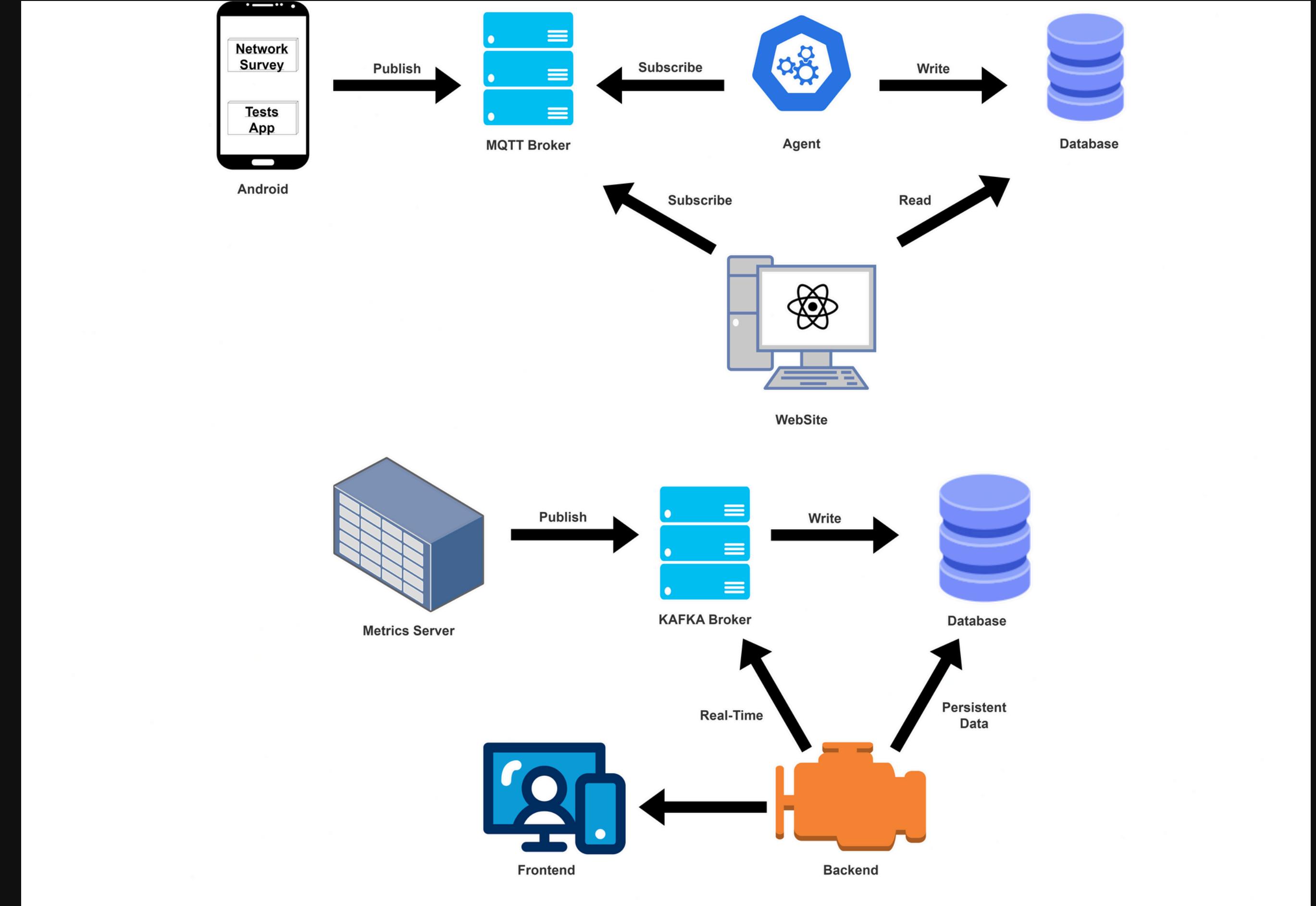
System Architecture

The 5G antenna is going to send different types of data either to a smartphone, using an Android system, or to a metrics server. This data is collected and through the subscription of brokers data can be visualized in real time or stored to a database to later be requested for persistent data.

System Architecture



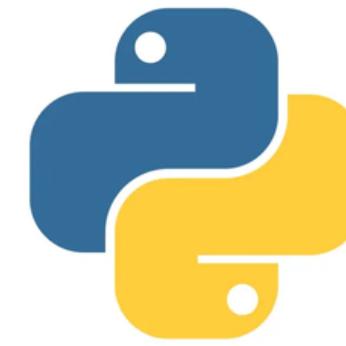
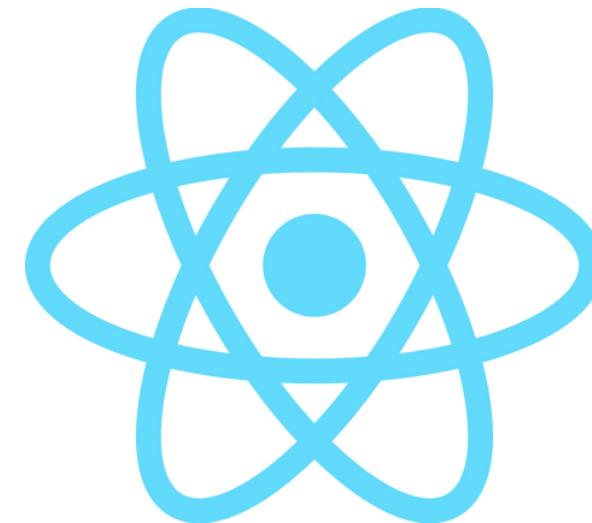
System Architecture



Technologies



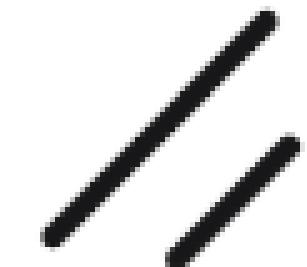
~~NEXT~~.JS



MQTT



APACHE
kafka



shadcn-ui

**AVEIRO
TECH City
living lab** Mobility Smart Parking Road Safety Network

Historic Data

Realtime

Jan 20, 2023 - Feb 09, 2023

 Chart**Area Chart - Stacked**

Showing total visitors for the last 6 months



Trending up by 5.2% this month ↗

January - June 2024

 Chart**Area Chart - Stacked Expanded**

Showing total visitors for the last 6months



Trending up by 5.2% this month ↗

January - June 2024

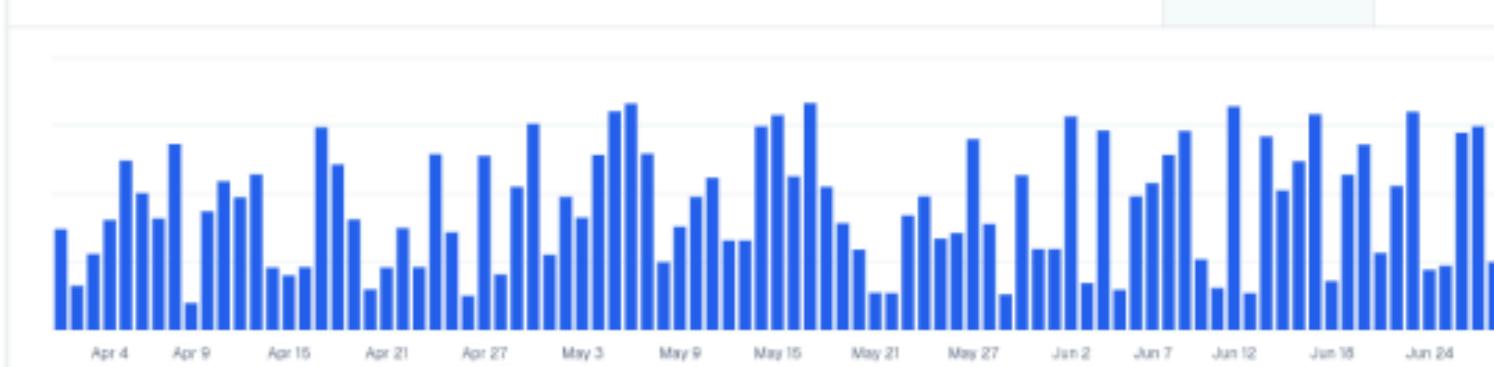
 Chart**Bar Chart - Interactive**

Showing total visitors for the last 3 months

Desktop

24,828

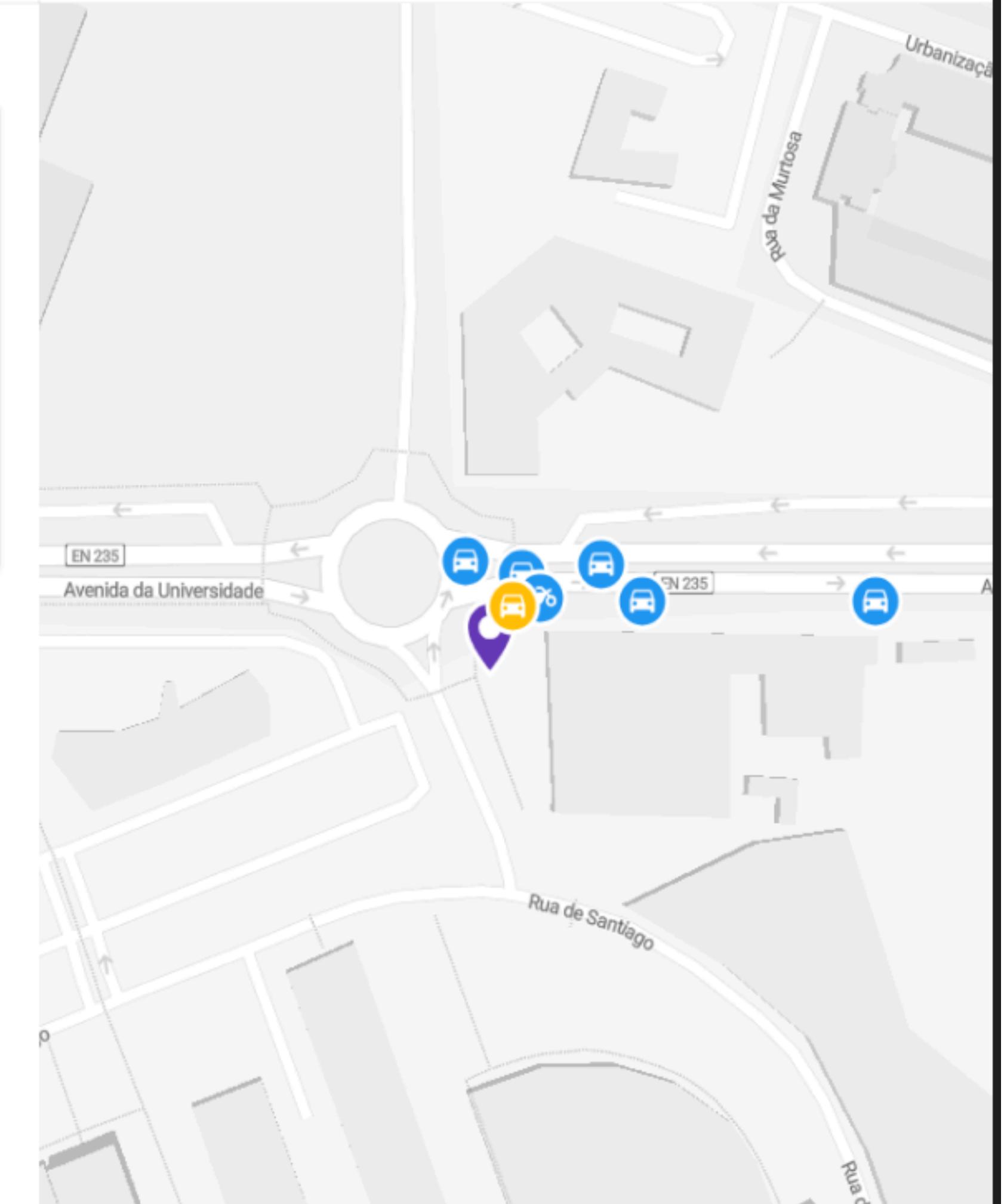
Mobile

25,010 Chart View Code**Pie Chart - Donut**

January - June 2024

 Chart View Code**Pie Chart - Donut Active**

January - June 2024





John Doe

Network >

AVEIRO TECH CITY living lab

Mobility

Smart Parking

Road Safety

Network

[Historic Data](#) [Realtime](#)[Jan 20, 2023 - Feb 09, 2023](#)

gNB

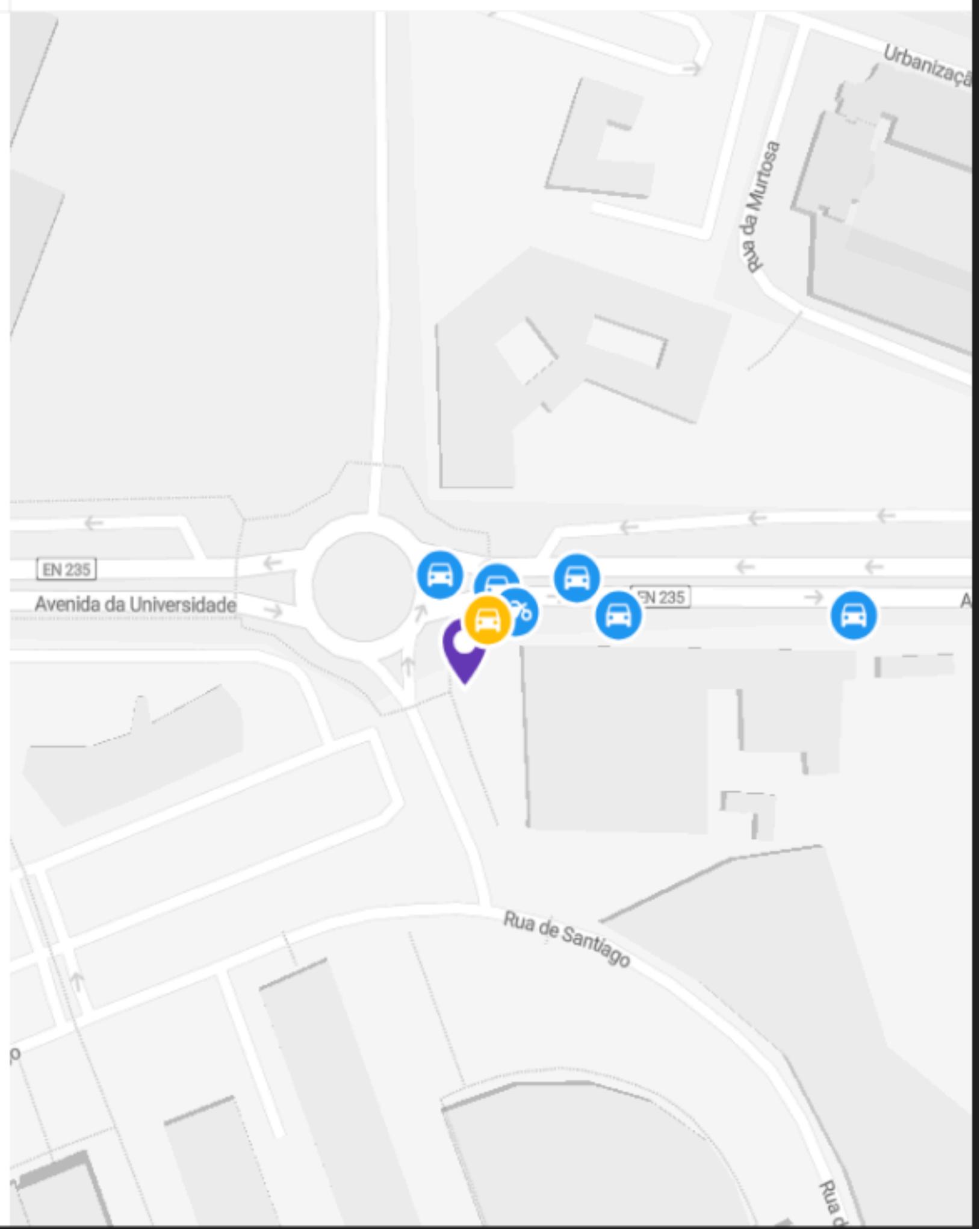
Search bar

Details

 Location
1111,-111Fabricante
XXXXXXTAC
xxxxxxPCI
xxxxxxx

UE

Search bar



**AVEIRO
TECH CITY
living lab**

Mobility

Smart Parking

Road Safety

Network

Historic Data Realtime

gNB

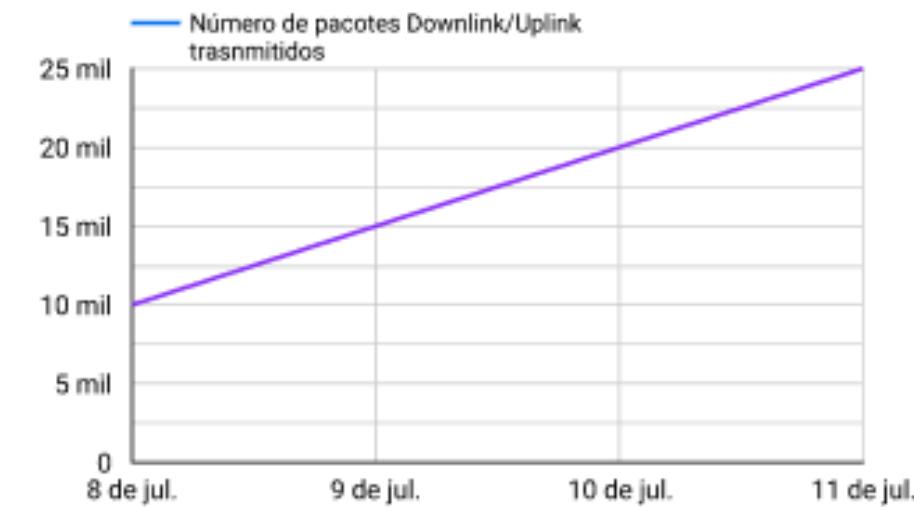
Search bar

Connected UE's

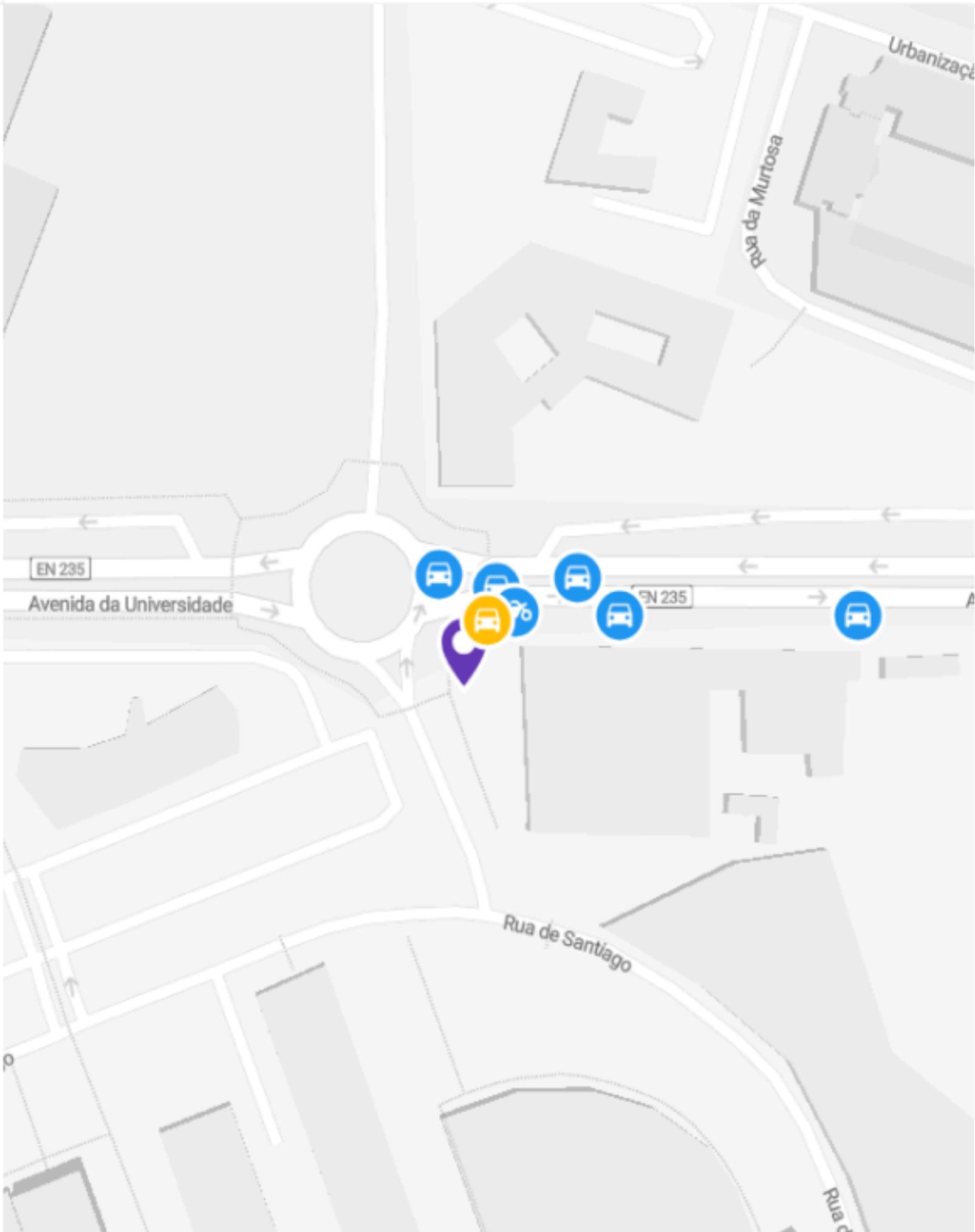
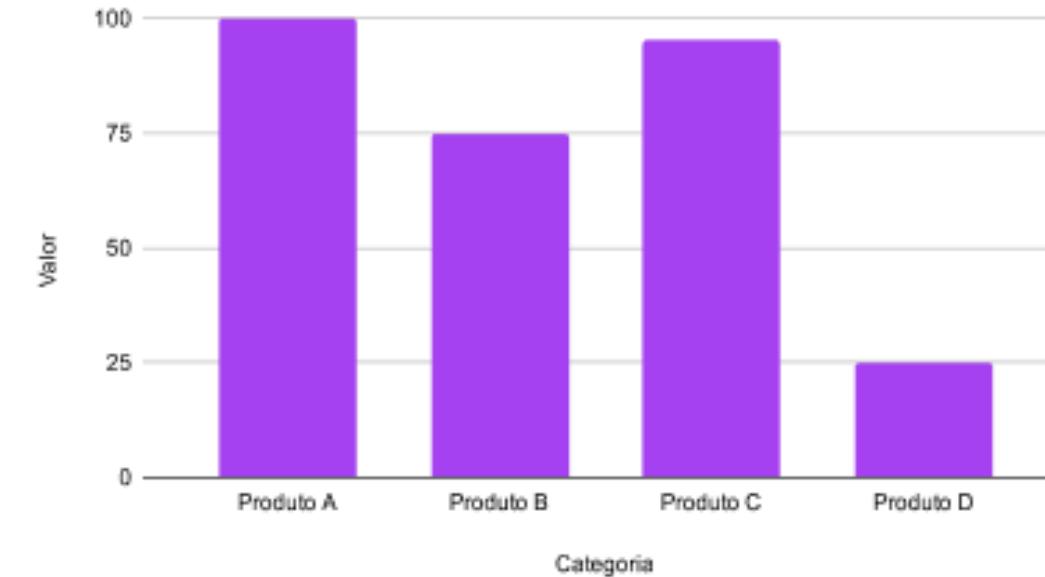
5

UE

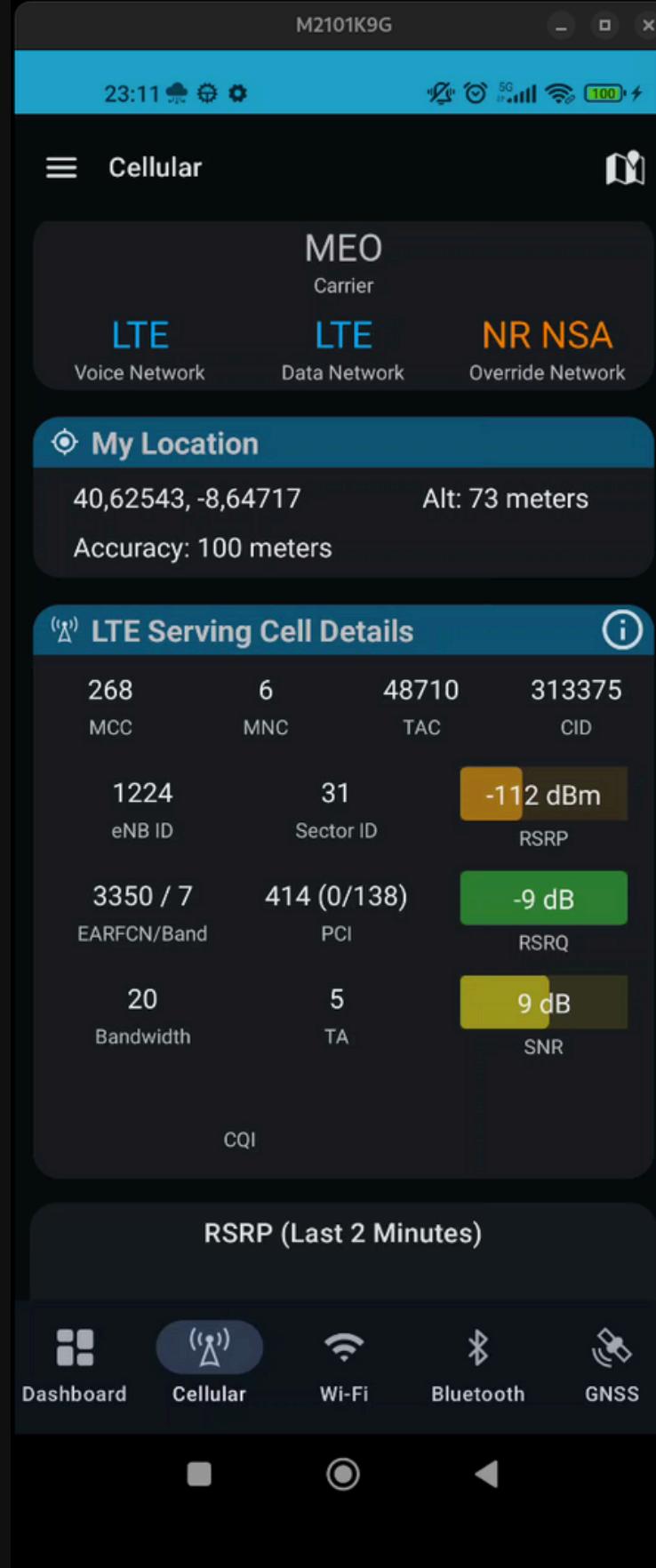
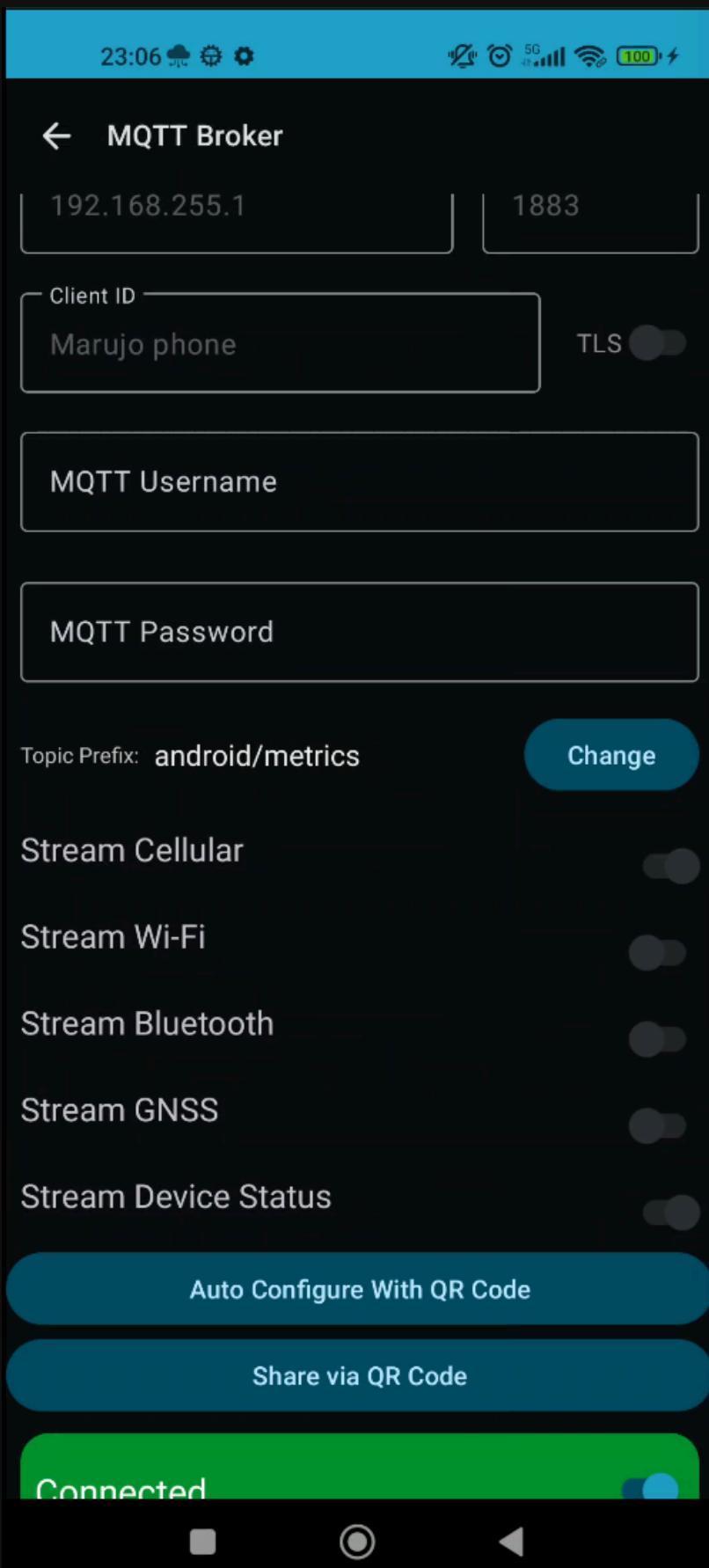
Search bar



Pacotes transmitidos com sucesso



Functional Testing - Collecting metrics from MQTT server



This screenshot shows a terminal window with the command `python test_mqtt.py` running. The output indicates successful connection to an MQTT broker at localhost:1883 and receipt of several 'LteRecord' messages. The messages contain detailed cellular location and serving cell information, such as device serial number, latitude, longitude, altitude, mission ID, record number, group number, accuracy, MCC, MNC, TAC, CID, RSRP, RSRQ, PCI, TA, and SNR.

This screenshot shows a terminal window displaying the status of the Mosquitto MQTT Broker service using the command `systemctl status mosquitto.service`. The service is listed as 'Mosquitto MQTT Broker' and is currently active (running) since 2024-11-28 22:49:46 WET. It has been running for 14 minutes. The service file is located at `/usr/lib/systemd/system/mosquitto.service`, which is a drop-in for `/usr/lib/systemd/system/service.d/10-timeout-abort.conf` and `50-keep-warm.conf`.

Functional Testing - Collecting metrics from Kafka server

The image shows two terminal windows side-by-side. The left terminal window is titled 'Terminal' and contains the following text:

```
(venv) marujo@yoga7i:~/PECI/web-dev$ python kafka_consumer.py
Tópicos disponíveis:
0 - RANPeciTest
1 - RANdata

Escolha o tópico que deseja ouvir: 0
Conectado ao broker 10.0.23.112:31662 e a ouvir o tópico "RANPeciTest"...
Mensagem recebida: b'Hello, Kafka!'
```

The right terminal window is also titled 'Terminal' and contains the following text:

```
(venv) marujo@yoga7i:~/PECI/web-dev$ python kafka_producer.py
(venv) marujo@yoga7i:~/PECI/web-dev$ █
```

Functional Testing - API to collect persistent data from KafkaDB

```
(venv) marujo@yoga7i:~/PECI/web-dev$ python test_api.py
```

Menu:

1. List all UEs
2. List all gNBs
3. List all attributes
4. Get gNB by ID
5. Get UE by ID
6. Get Measurement
7. Exit

Enter your choice: 4

```
1 - 6734e23fef72dcc004d19733
```

```
2 - 6734e3c8ef72dcc004d19734
```

Enter gNB: 2

Do you want to see the output as pretty-printed JSON? (yes/no):

```
{
  "_id": "6734e3c8ef72dcc004d19734",
  "band": 78,
  "channel_bandwidth": 20,
  "manufacturer": "srsRAN",
  "pci": 10,
  "plmn": "PLMN",
  "position": [
    "40.639138, -8.643084"
  ],
  "tac": 1
}
```

Functional Testing - API to collect persistent data from KafkaDB

GET /measurement/gnb/{gnb_id}/attr/{attr_name} Get a set of Traffic Measurements of gNB

returns a set of traffic measurements

Cancel

Parameters

Name	Description
gnb_id * required	ID of gNB to query string (path)
attr_name * required	name of the attribute to query string (path)
dateFrom	Lower date limit string (query)
dateTo	Upper date limit string (query)

6734e3c8ef72dcc004d19734

ul_brate

2024-11-13T14:50:00.000Z

2024-11-13T14:51:00.000Z

Execute Clear

Responses

Curl

```
curl -X 'GET' \
'http://10.0.23.112:30051/measurement/gnb/6734e3c8ef72dcc004d19734/attr/ul_brate?dateFrom=2024-11-13T14%3A50%3A00.000Z&dateTo=2024-11-13T14%3A51%3A00.000Z'
-H 'accept: application/json'
```

Request URL

```
http://10.0.23.112:30051/measurement/gnb/6734e3c8ef72dcc004d19734/attr/ul_brate?dateFrom=2024-11-13T14%3A50%3A00.000Z&dateTo=2024-11-13T14%3A51%3A00.000Z
```

```
{ "timestamp":  
  1731509435.1230001,  
  "ue_list": [ {  
    "ue_container": {  
      "ul_brate": 4352.0 } } ] }, {  
  "timestamp":  
  1731509436.1230001,  
  "ue_list": [ {  
    "ue_container": {  
      "ul_brate": 13056.0 } } ] }
```

Any doubts?

