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Developing a Sustainable and Transferable Visitor Information System 2.0 with the Internet of Things – A Prototype

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Dominik Visca received his master`s degree in Geoinformatics from the Mainz University of Applied Sciences, Germany in 2021. He is currently a research associate working in the project RAFVINIERT at the University of Applied Sciences Mainz focusing on data processing and information tools for spatial planning. His research interests include digitization, open data as well as spatial data infrastructures and geo-government.

Max Hoppe received his master`s degree in Human Geography from the Johannes Gutenberg University Mainz, Germany in 2018. He is currently a research associate working in the project RAFVINIERT at the University of Applied Sciences Mainz focusing on transfer and communication with project partners. His research interests include new governance arrangements in rural areas due to processes of the digital transformation.

Prof. Dr. rer. nat. Pacal Neis was appointed as Endowed Professor for Geo-Government at Mainz University of Applied Sciences in the winter semester of 2018. For some years now, the digital workflows of administrative processes at the national or even European level have been influencing administrative actions more and more. Professor Neis' research is dedicated to these challenges and takes place on different levels. In addition to emerging issues and opportunities around Open Government, current and forward-looking topics such as Open Data in the context of Geo-Government will be addressed in particular.

Goals

- Monitoring of visitor numbers and movement flows in order to comply with hygiene concepts
- Based on connected sensors, i.e., use of smartphones, tablets and wearables, among others
- Visualization in a live web dashboard for university management but also visitors

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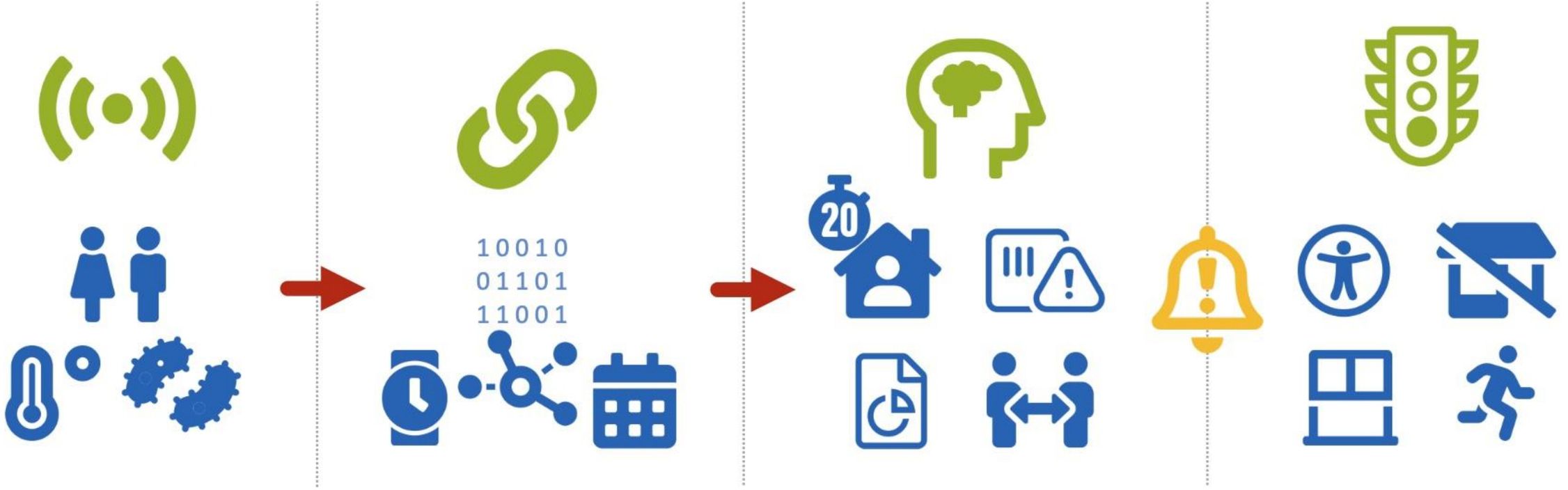
- Sustainable and affordable components, i.e., use of FOSS (Free and open-source software) and open standards, as well as low-cost single-board computers

Workflow



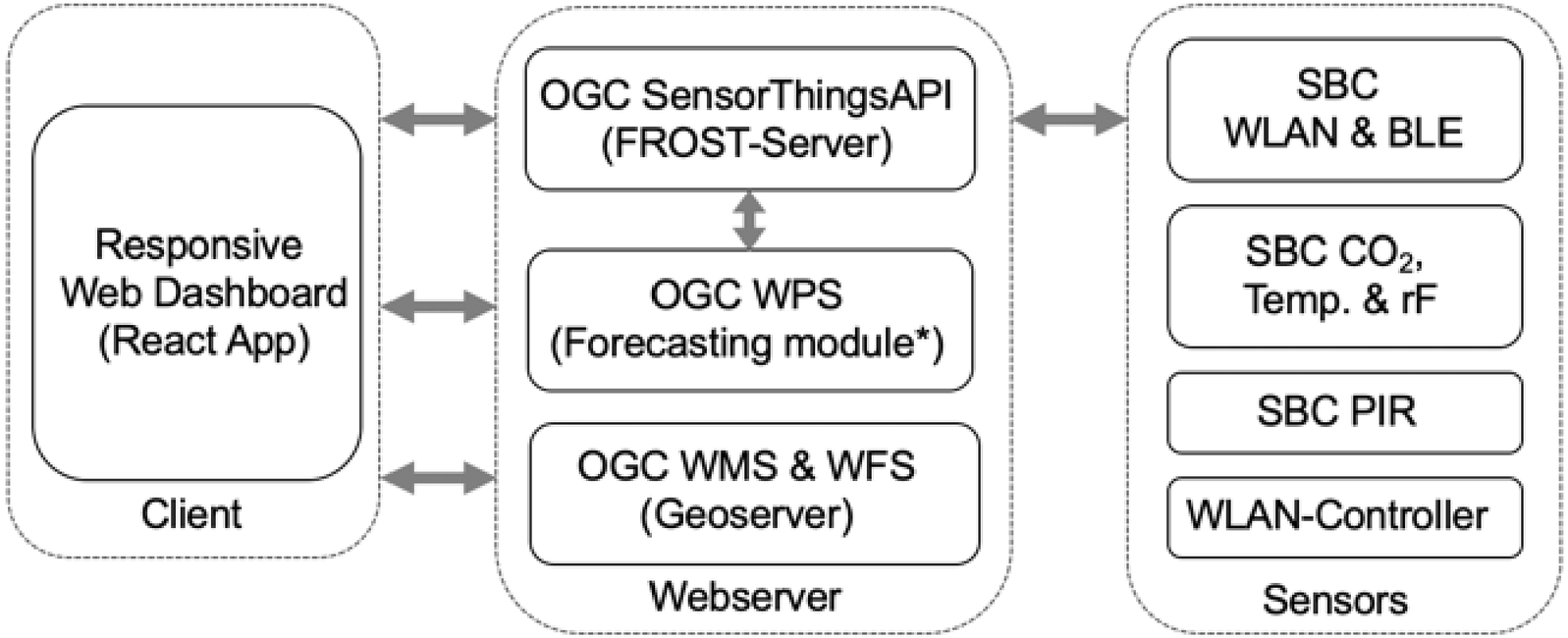
Tracing & Measuring via Sensors

Data Fusion

Analysis using AI & Machine Learning

Real-time Monitoring & Forecasts

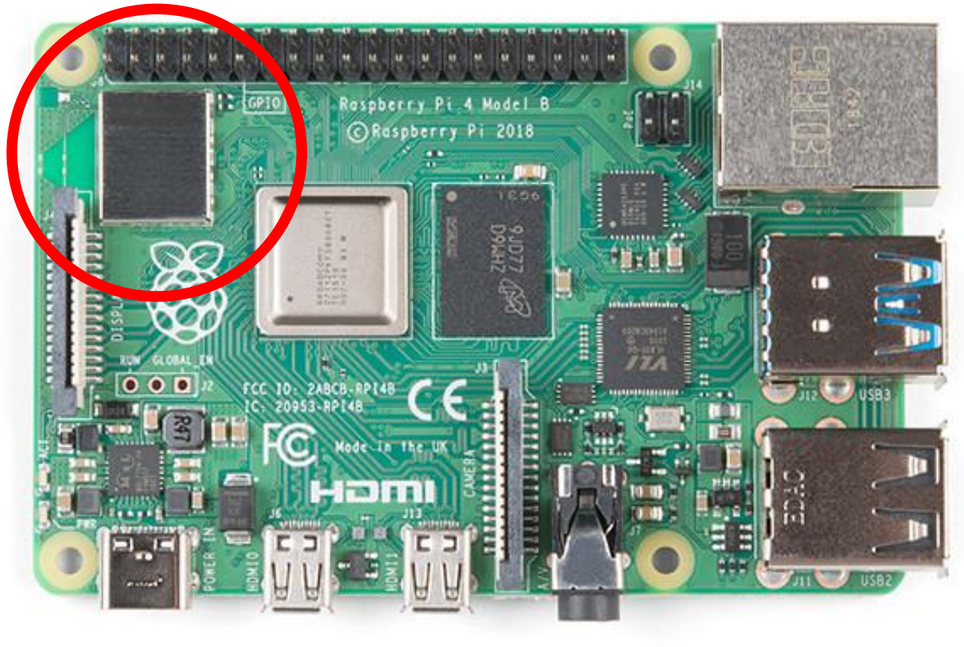
Architecture



Architecture of the visitor information system

Sensors

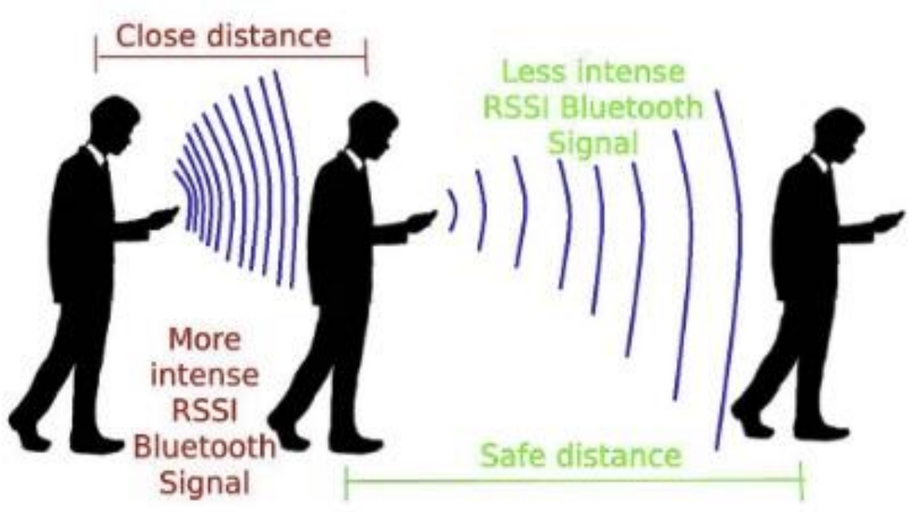
- Raspberry Pi 4 Model B
  - WLAN and Bluetooth module
- Second WLAN module
- Other Sensors



© Raspberry Pi 4 Model B

- WLAN module in **monitor mode**
  - receives data packages from nearby, transmitting devices
  - filtering of known devices (MAC-address)
- Received signal strength as an indicator for distance (RSSI = Received signal strength indication)
- Second WLAN module for data transmission

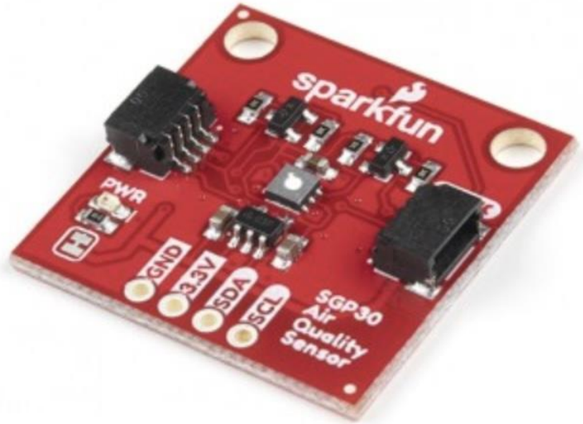
+ Bluetooth



Received signal strength as an indicator for the distance of devices or people to each other (RSSI)

Source: Narvarez & Guerra (2021)

- ~~Camera~~
  - Data privacy!
- (Passive) Infrared
- Temperature, air pressure, humidity
- Air quality (CO_2 level)



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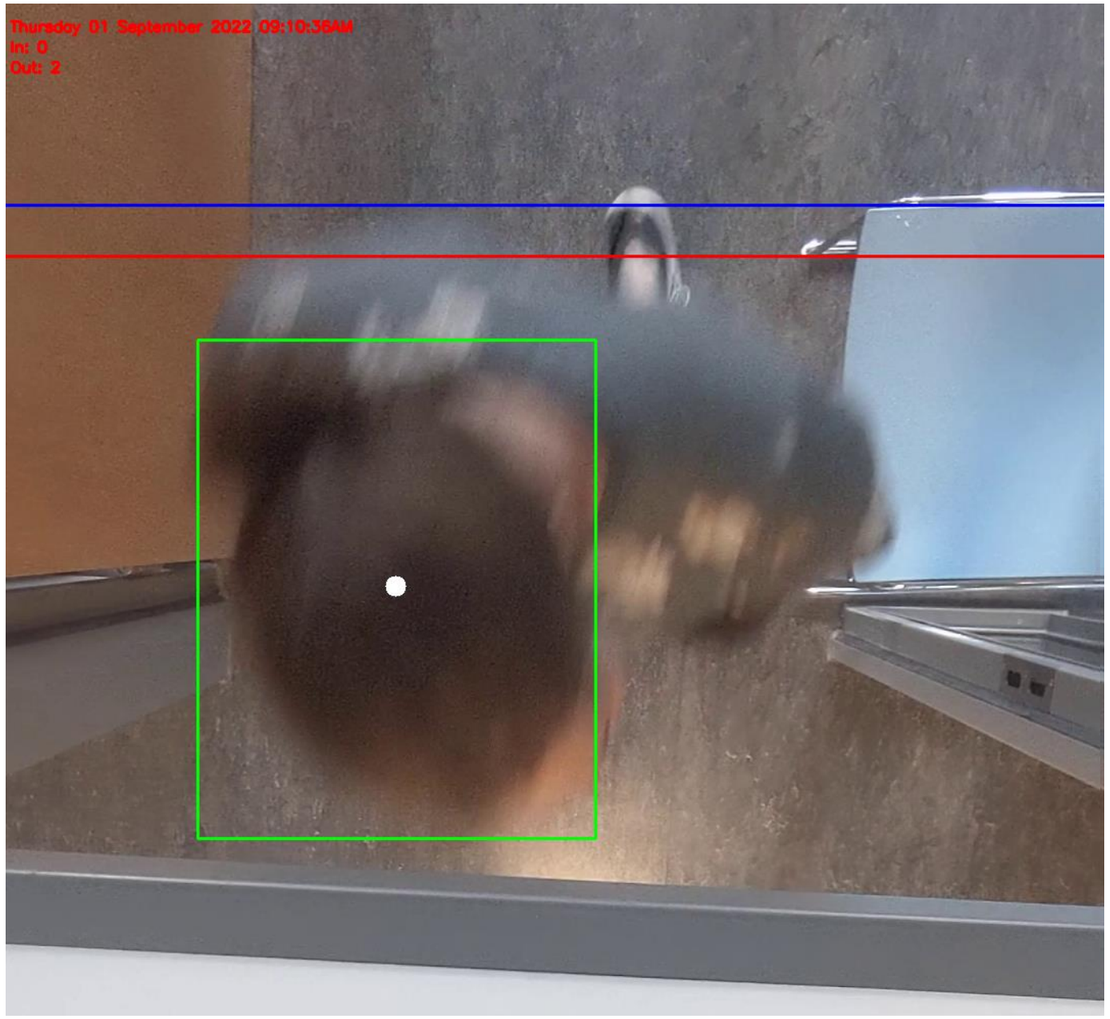
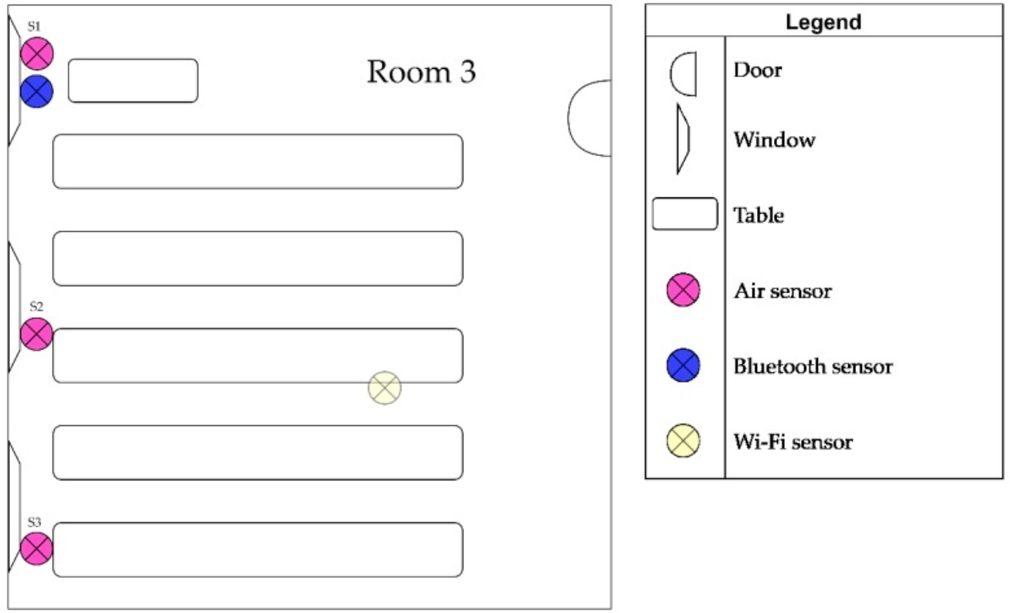


- Sensors required for each room
  - WLAN sensors centered in the room
  - Power supply often a problem
  - Existing IT (access points) can be used if necessary
  - PIR sensors installed at each room entrance



Example of distribution of sensors

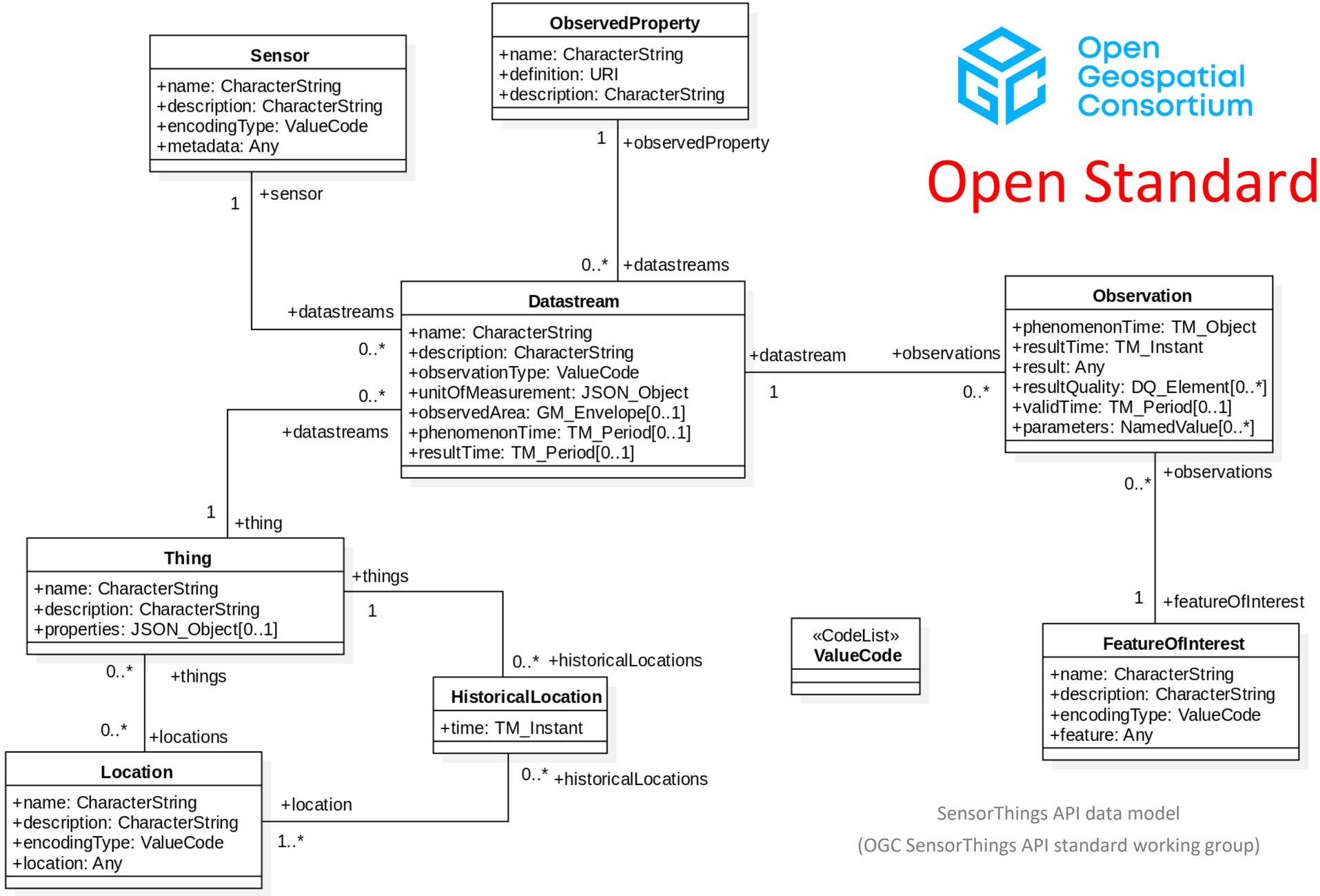
Source: Roussel, Böhm, Neis (2022)

~~Web~~server

Open Geospatial Consortium

i3 mainz

Open Standard



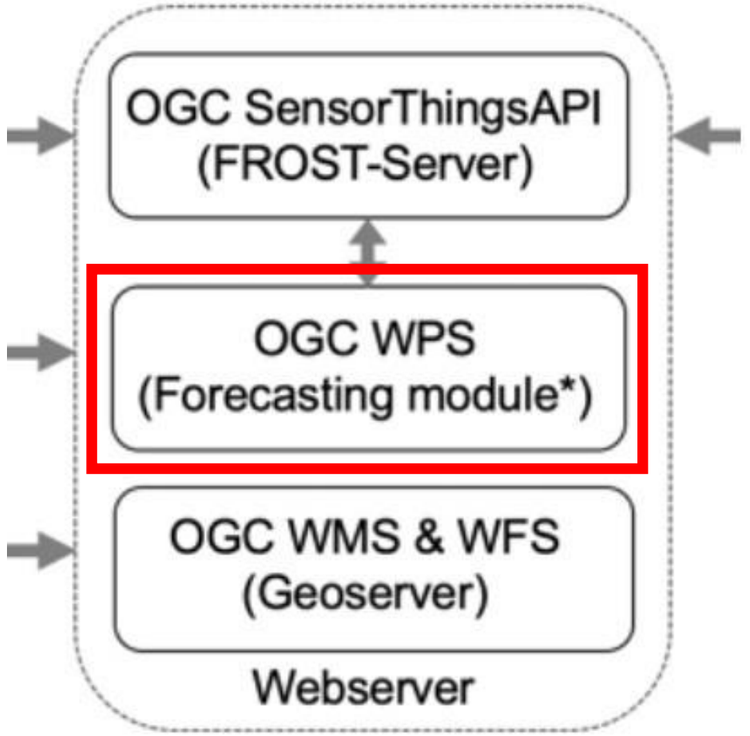
SensorThings API data model

(OGC SensorThings API standard working group)

- **FR**aunhofer Open Source SensorThings API Server for concrete implementation
- Access to Raspberry Pi measured values
- Processing for aggregated spatial data
  - with machine learning methods, among others
- Output standardized for the client or presentation layer

- GeoServer for standardized output of geodata, especially background map and spatial plans

- Forecasting module using collected data sets and machine learning methods
  - largely online teaching in the last semesters
  - minimal room usage, i.e. few data
  - focus on upcoming semesters



Client

Crowd Monitoring

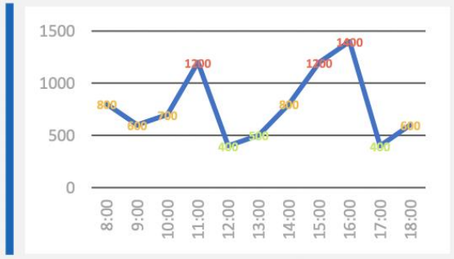
Ein Überblick verschiedener Räume der Hochschule Mainz

Dashboard

Statistik

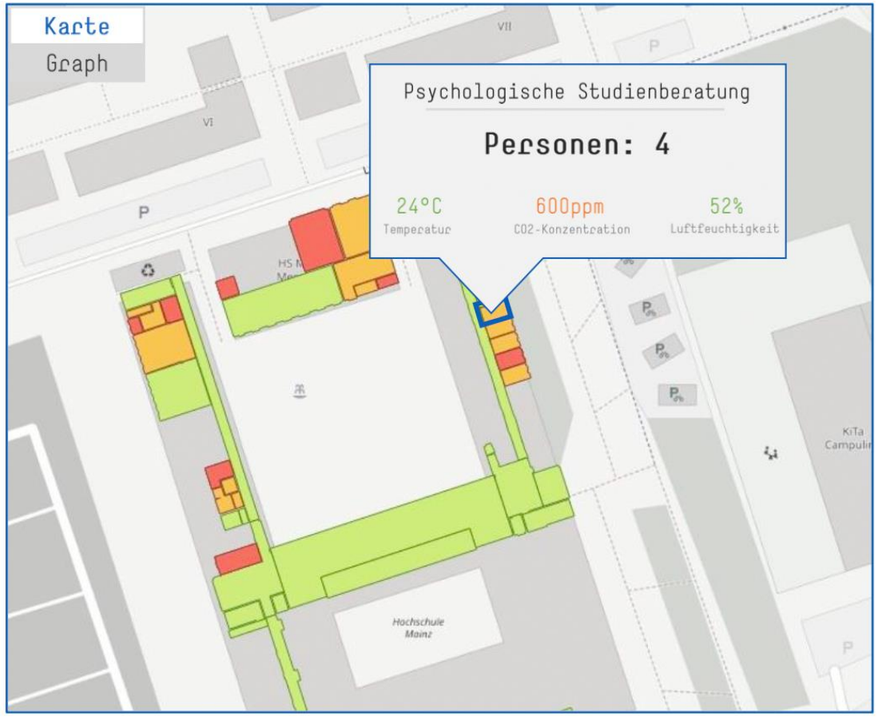
Personenanzahl

Luftqualität



Temperatur

Feuchtigkeit



14.07.2022

18:00 Uhr

Etage

Alle Etagen

Einzelne Etage

Etage EG

Räume

Alle Räume

Einzelner Raum

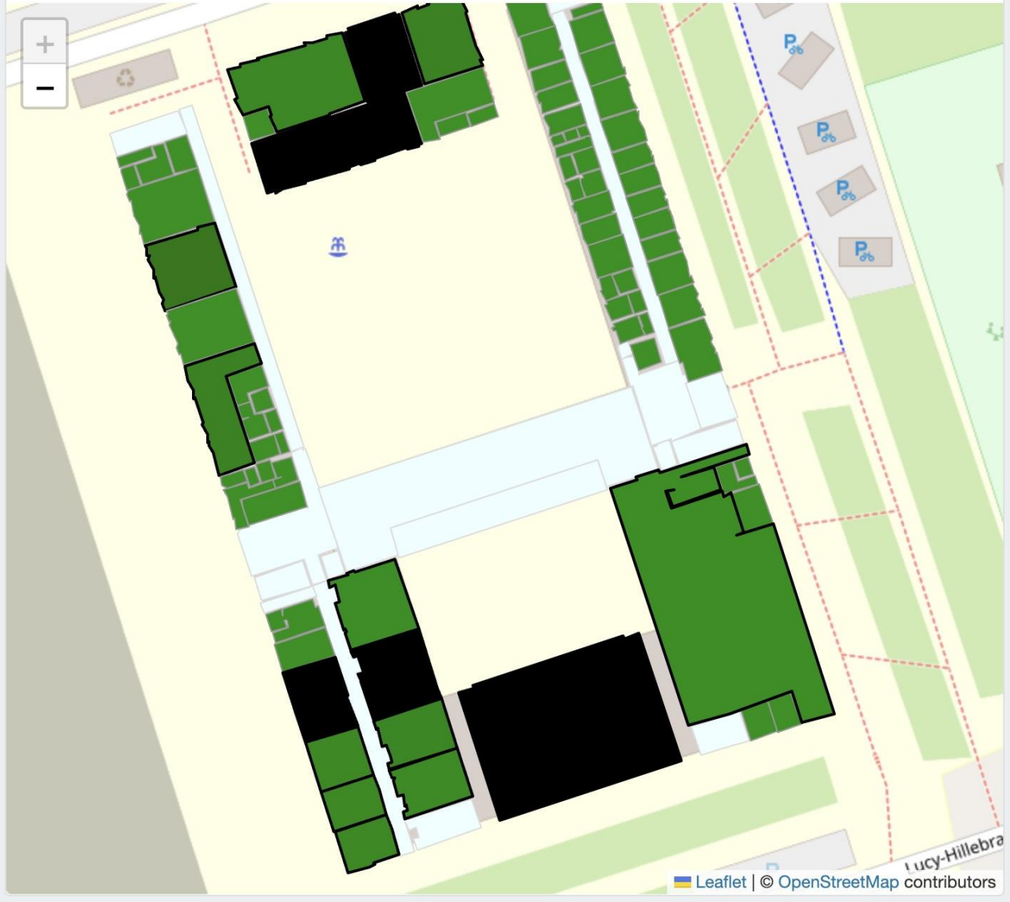
Raum a0.16

Suche:

Results

Suchen..

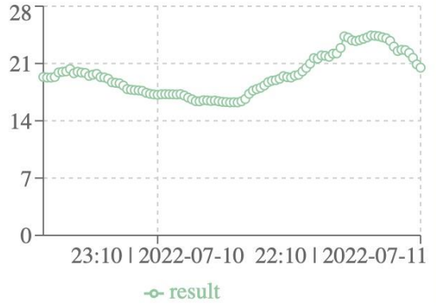
Karte | Gebäude



Überblick

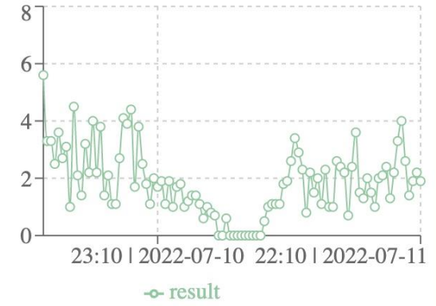
- Anzahl der Personen im Gebäude: 56
- Anzahl der überbelegten Räumen: 0

Temperatur



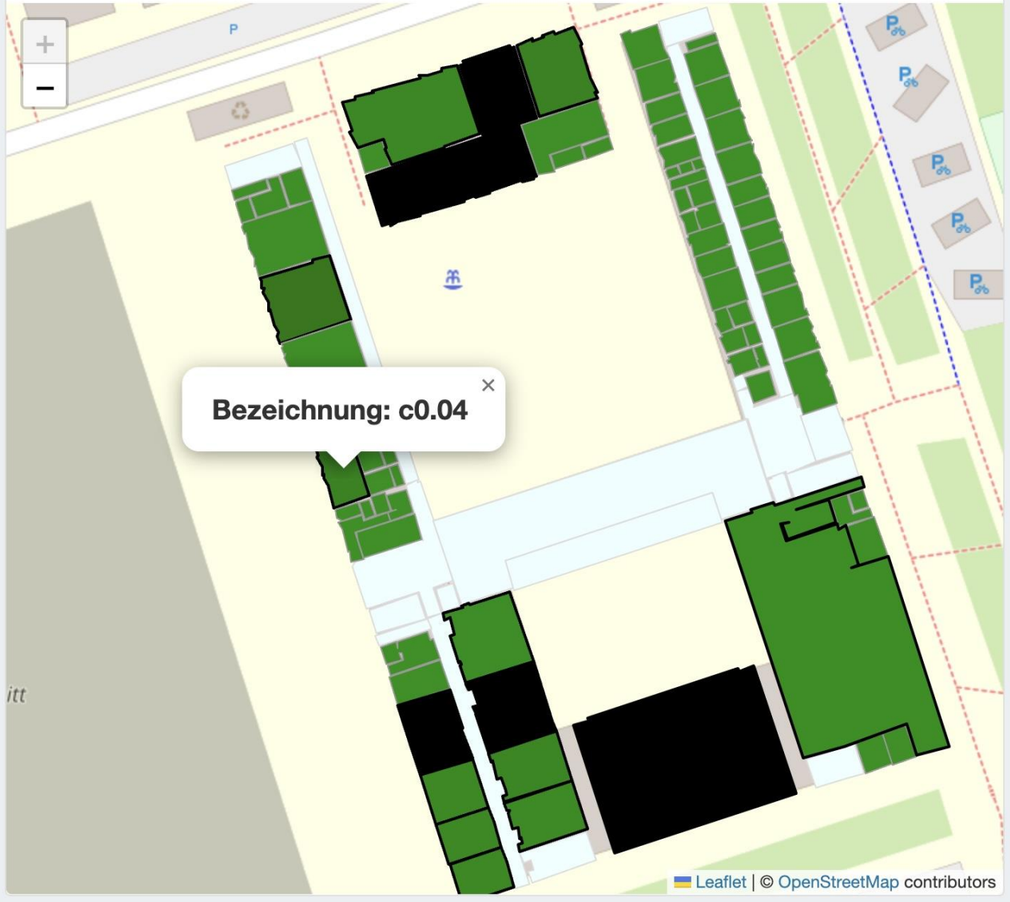
Luftfeuchtigkeit

Windstärke



Suchen..

Karte | Gebäude



Raum: C0.04

Bezeichnung: CA-0J15
Kapazität: 11
Verbundene Geräte: 1

Outlook

- Forecasting module
- Simulation of visitor flows
- Integration of schedules

Evacuation scenarios

Facility Management /
Smart Campus

Controlling

Contact

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