

Smart Emission Data Platform

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RIVM - Bijeenkomst
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Intro

**“project EU en gemeenschappelijke voorzieningen,
onderdeel van het programma INSPIRE in Nederland”**

- **2014/2015 - SOSPilot - RIVM**

- <http://sensors.geonovum.nl>

- **2015-2016**

- 1. Smart Emission Nijmegen**

- <http://data.smartemission.nl>

- 2. AirSenseEUR**

- 3. OGC SensorThings API (SensorUp, Steve Liang)**

- 4. FIWARE**

- 5. LoRa - TheThingsNetwork**

Smart Emission

Inclusive Citizen Sensing

- Citizen-sensor-networks for fine-grained measurements, with new low-cost sensing devices
- Transparency and democracy of pollution monitoring, 'making the externalities (e.g. noise, air pollution) visible'
- Cost-effective environmental monitoring, Open Data.

The smart residents

well-informed residents create solutions themselves



Case: Environmental health in Nijmegen



Nijmegen is located on the River Waal in the eastern part of the Netherlands, near the German border.

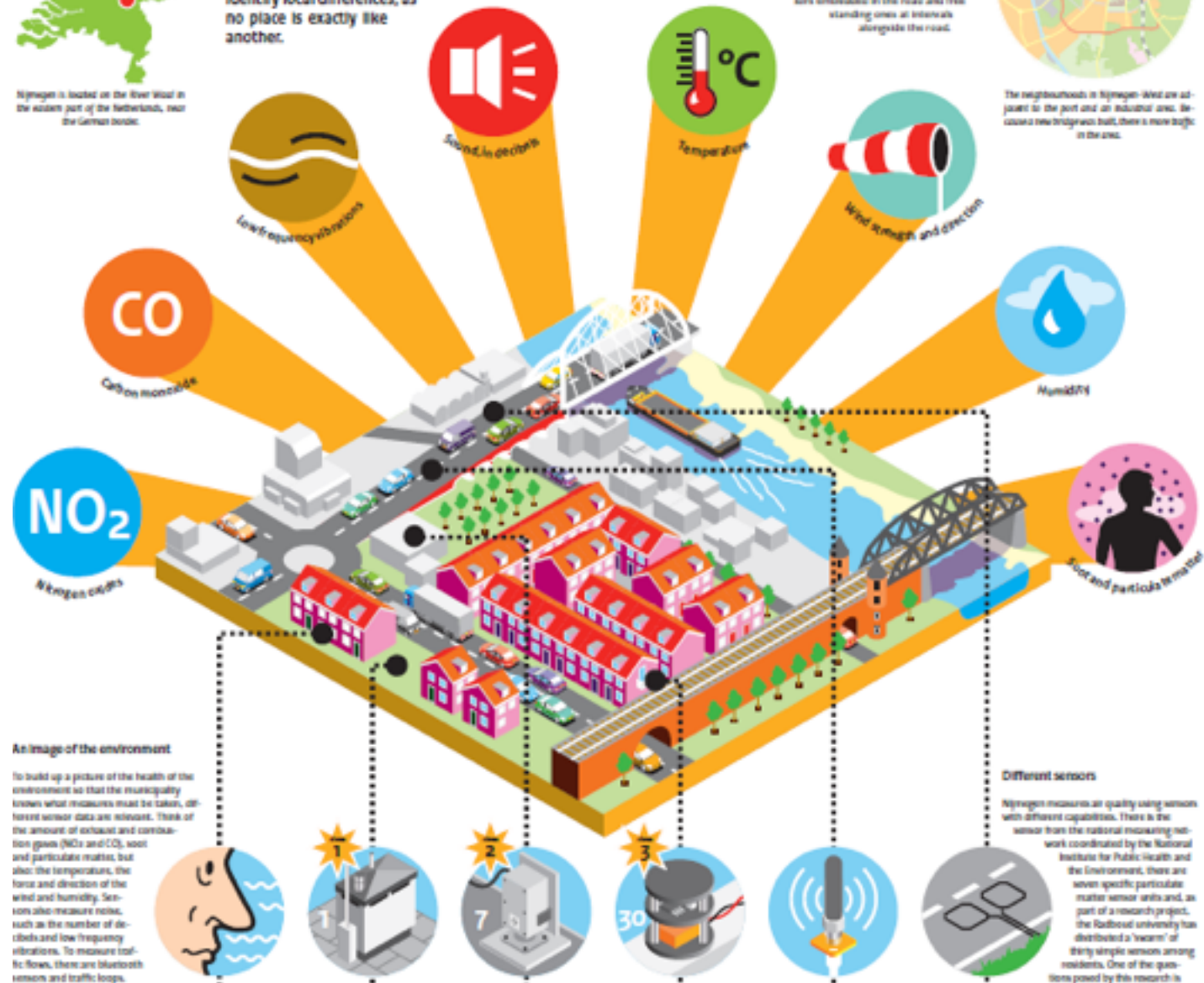
The environment is very important for people's health. That's why standards are set for the concentrations of pollutants. Sensors measure whether we keep within these standards using national monitoring networks. In addition, several municipalities and regions have their own sensors to identify local differences, as no place is exactly like another.

Nijmegen also monitors local environmental quality. With the advent of a new bridge and the construction of a ring road, the traffic situation in the western part of Nijmegen has changed. Developments in the port and the industrial area by the River Waal have been made, and residents in the nearby neighbourhood are worried about the health of their environment. The municipality is taking their concerns seriously and has placed sensors in the neighbourhood to measure the air quality and noise level.

Nijmegen also wants to collate reports about bad odours. To monitor traffic flows, the municipality uses sensors embedded in the road and free-standing ones at intervals alongside the road.



The neighbourhoods in Nijmegen-West are adjacent to the port and an industrial area. Because a new bridge was built, there is more traffic in the area.



Issues and questions to deal with

1. Deployment of a local air quality network using low-cost sensors

- What is the quality of low-cost sensors in general?
- Which type of low cost sensors to deploy?
- ***How to calibrate the low-cost sensors?***
- How many and at what locations (spatial pattern) to deploy the sensors?
- ***What data platform for data collection and distribution?***
- ***Which standards for data acquisition and distribution?***
- ***Which (interpolation) models for further processing air quality data?***
- ***How to visualize the results?***

2. Involvement of citizens in the deployment and maintenance of the sensor network

- Which method to use for citizen engagement?
- Do we need to train citizens to deploy and maintain the sensor?

3. Involvement of citizens in the analysis of the results of local air quality monitoring

- How to engage citizens?
- How to preprocess and visualize the data for citizens?
- How to interact with citizens?
- How and when to meetup with citizens?
- What applications will the citizens need?

Which type of low cost sensors to deploy?

Quality and price

National Air Quality
stations



Aireas
“Airbox”



Smart Emission
“Jose”



“Smart Citizen Kit”



Number of sensors applied in a city

Jose Multi-Purpose Sensor Station - Intemo



Open Data!

Data open available for citizens, researchers, students, government, companies, ...

Data available for download in tabular and (OGC) geospatial formats:

WMS-Time

WFS

SOS

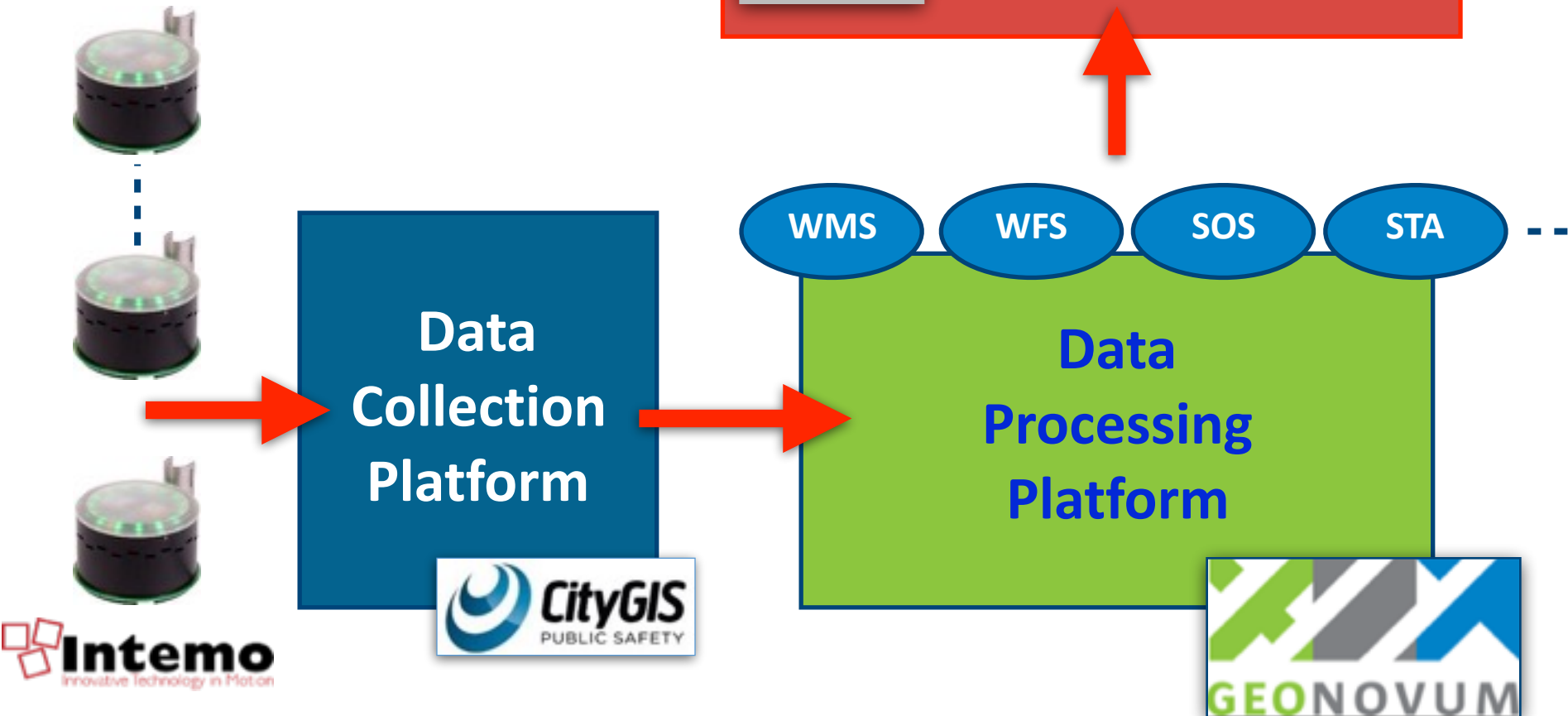
STA

Radboud Universiteit



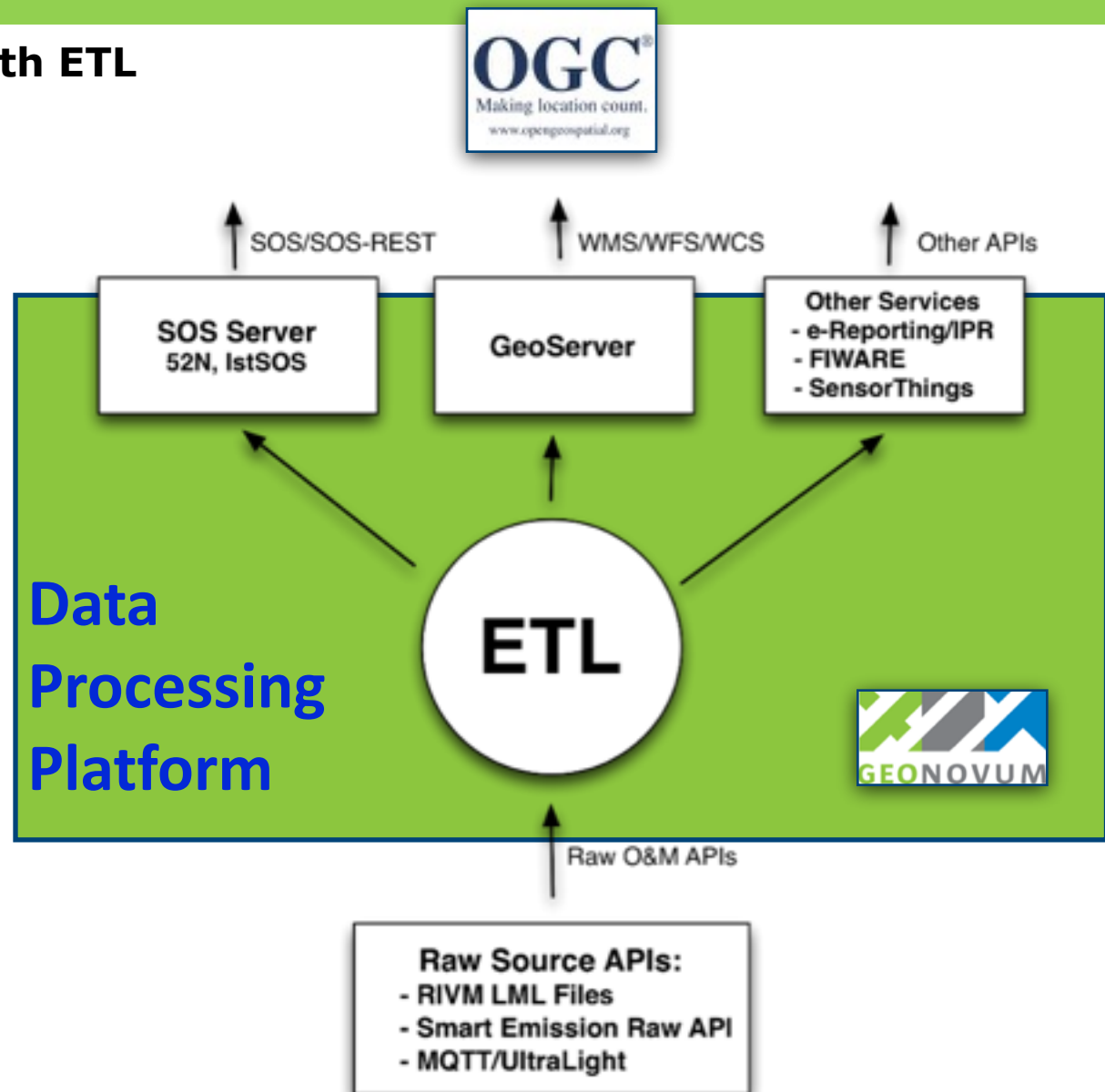
Data Platform

Data Infrastructure The Big Picture

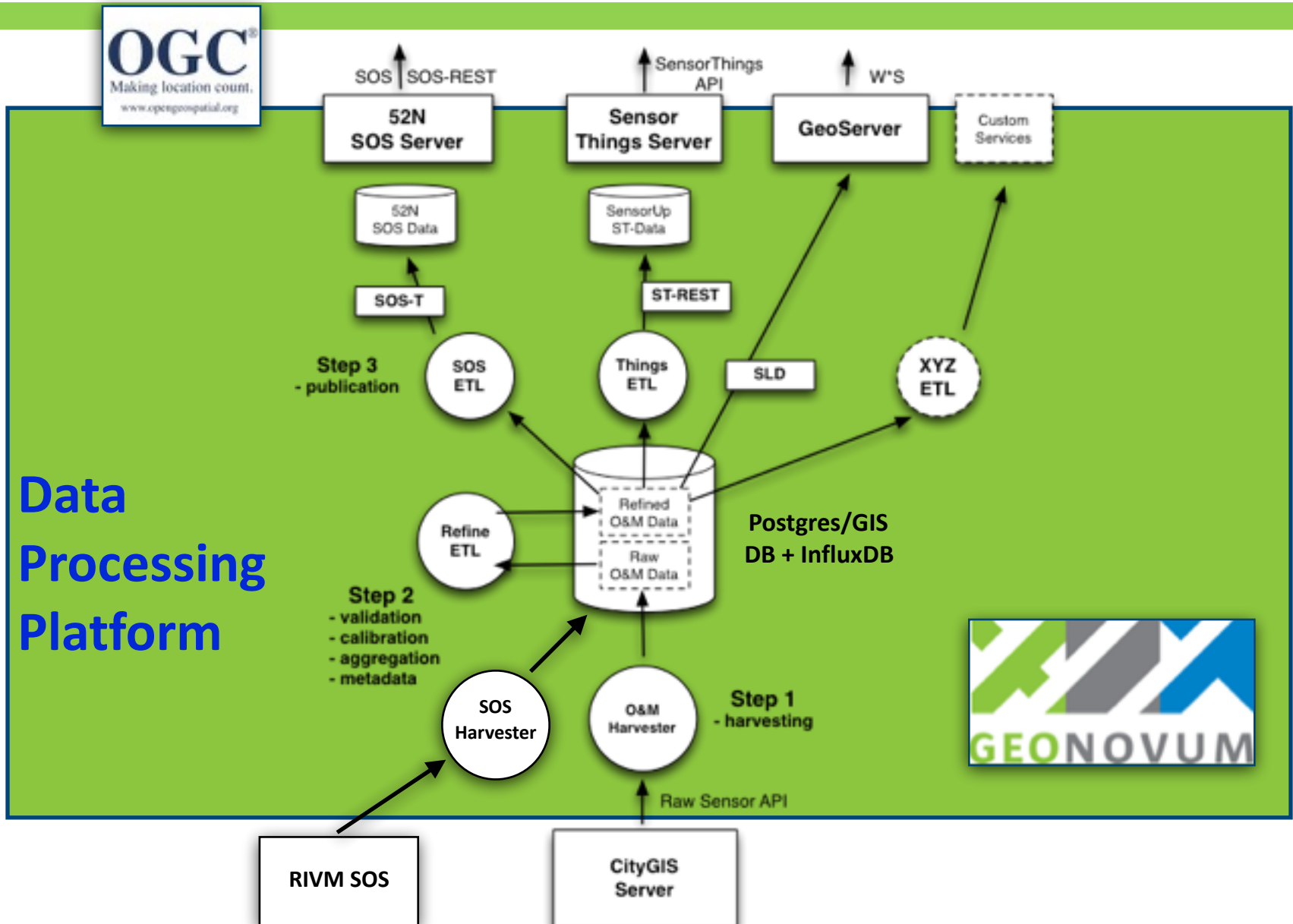


Data Architecture with ETL

ETL =
Extract Transform Load



Data Architecture with 3-Step ETL



Platform Functioneel: Lagen



Web

Heron
Viewer

Smart
App

Grafana

52North
SOSViewer

Website
data.smartemission.nl

Beheer

AppServers

GeoServer

52North
SOS

SensorUp
STA

Processing
(ETL)

Calibrator

Refiner

SOS
Publisher

STA
Publisher

Databases

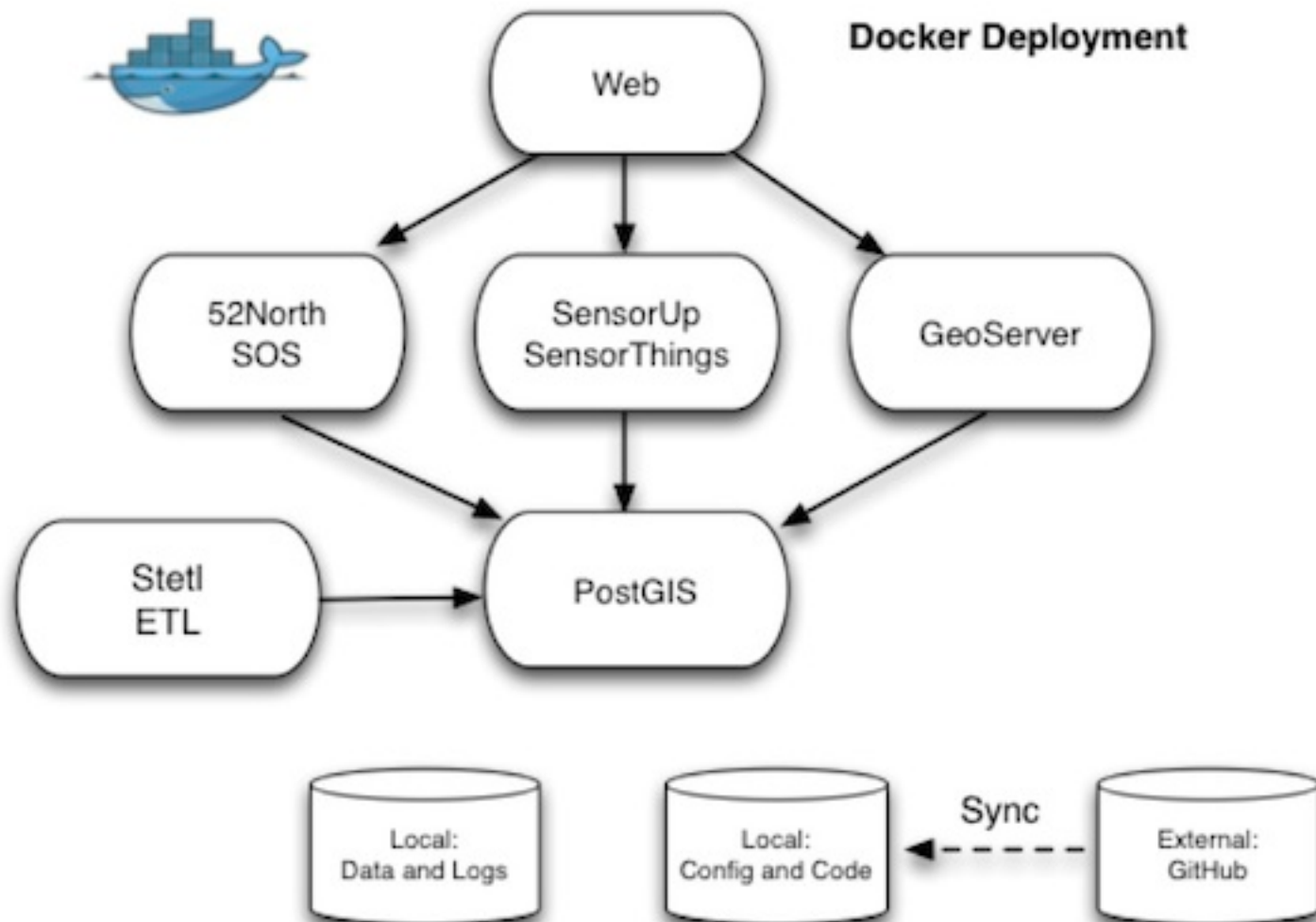
PostGIS

InfluxDB

Harvesters

CityGIS
Harvester

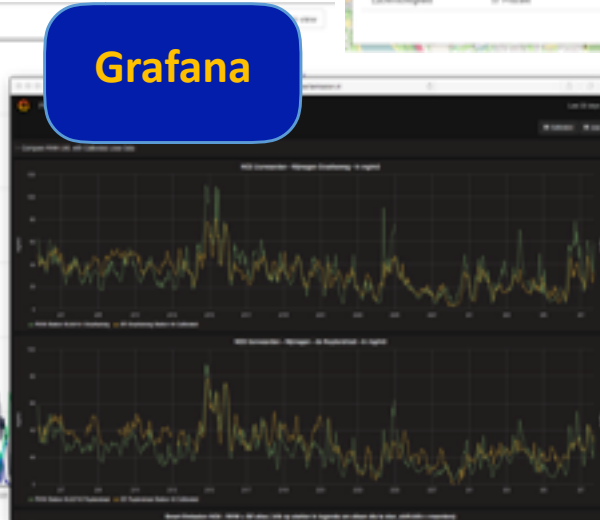
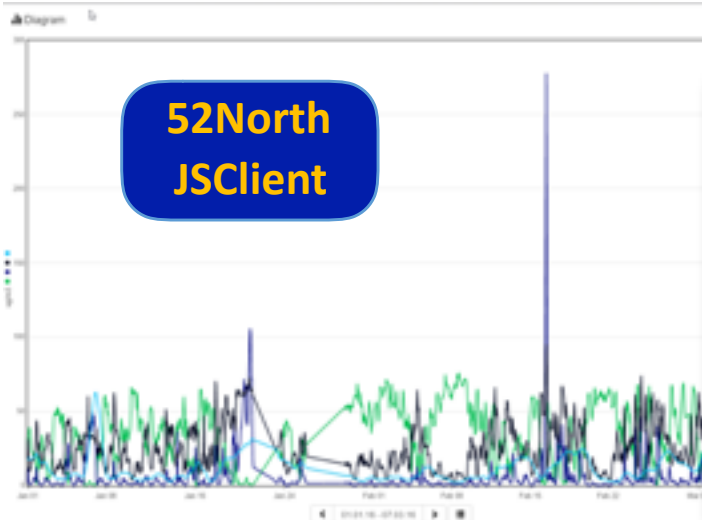
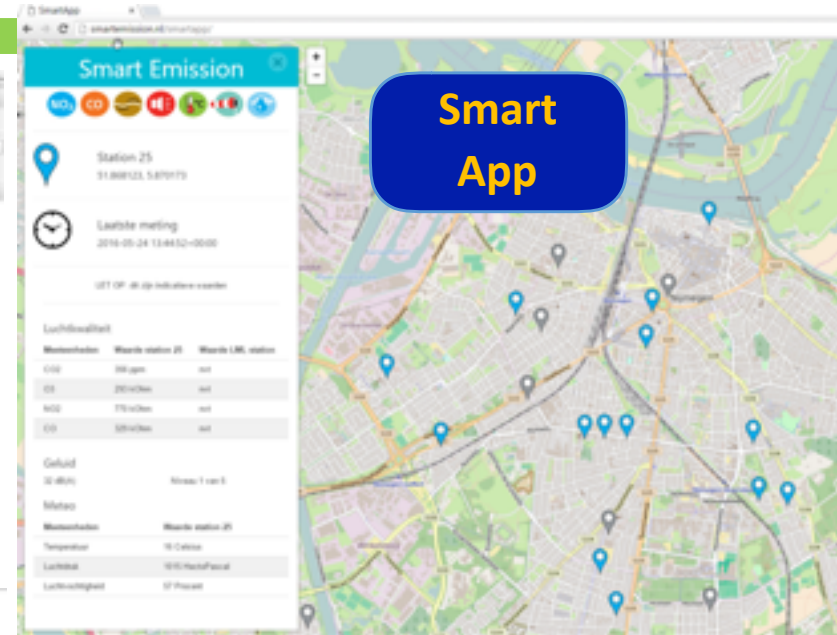
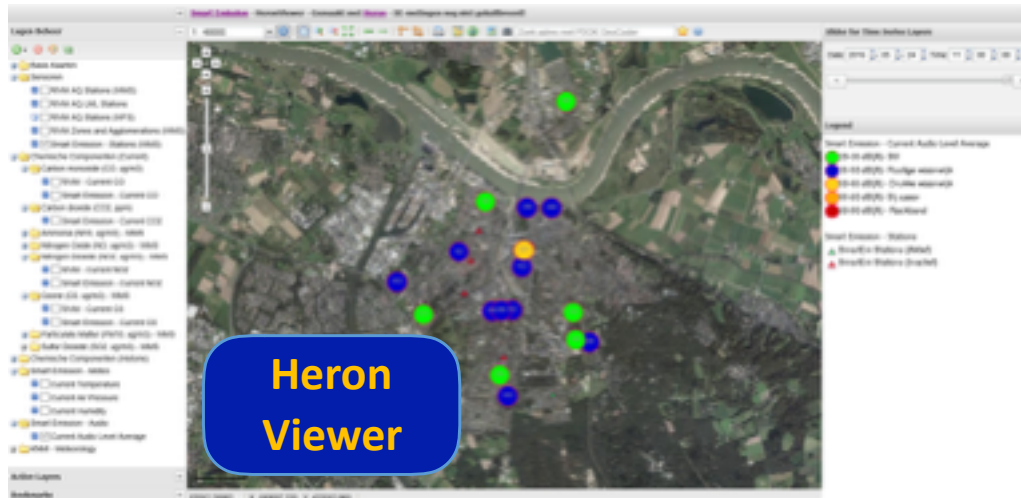
SOS
Harvester



Viewers



In SE
Platform



Extern



<http://data.smartemission.nl> (data platform)

Kalibratie ETL

How to calibrate the low-cost sensor for air quality?

Calibration at two national air quality locations by and in the City of Nijmegen and in laboratory setting at the National Institute of Environment and Health (RIVM)

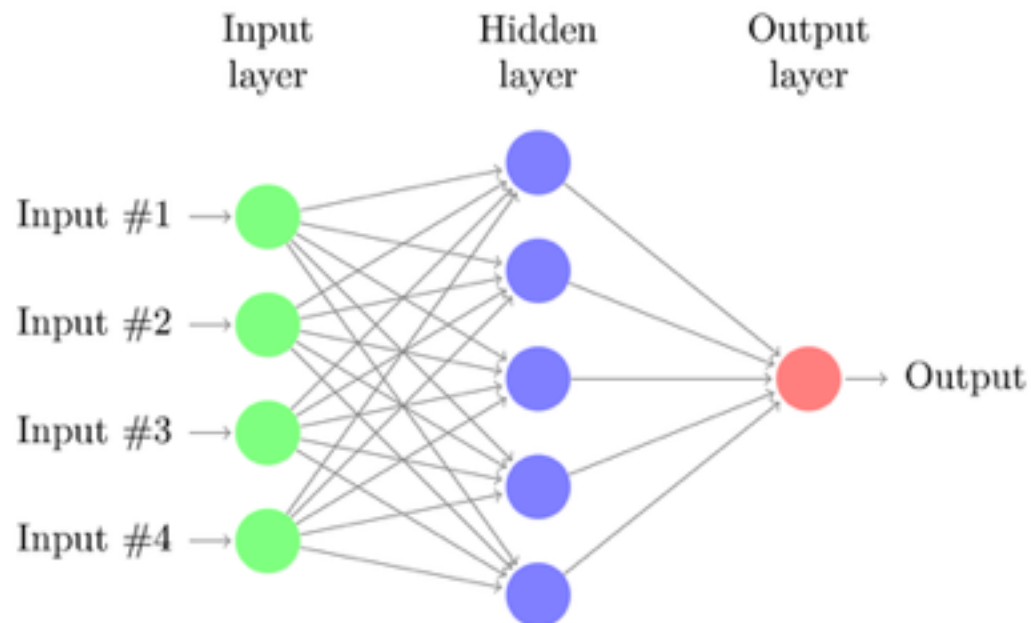


Rijksinstituut voor Volksgezondheid
en Milieu
Ministerie van Volksgezondheid,
Welzijn en Sport



ETL Implementation Details

- **Python**
- **Stetl** “Streaming ETL” - base ETL framework: <http://stetl.org>
- **Docker** deployment
- **Crontab** scheduling
- **Open Source**: <https://github.com/Geonovum/smartermission/tree/master/etl>
- **Artificial Neural Networks (ANN)** for Gas Calibration (by Pieter Marsman)
 - R (preprocessing)
 - sklearn <http://scikit-learn.org>



Calibration ETL

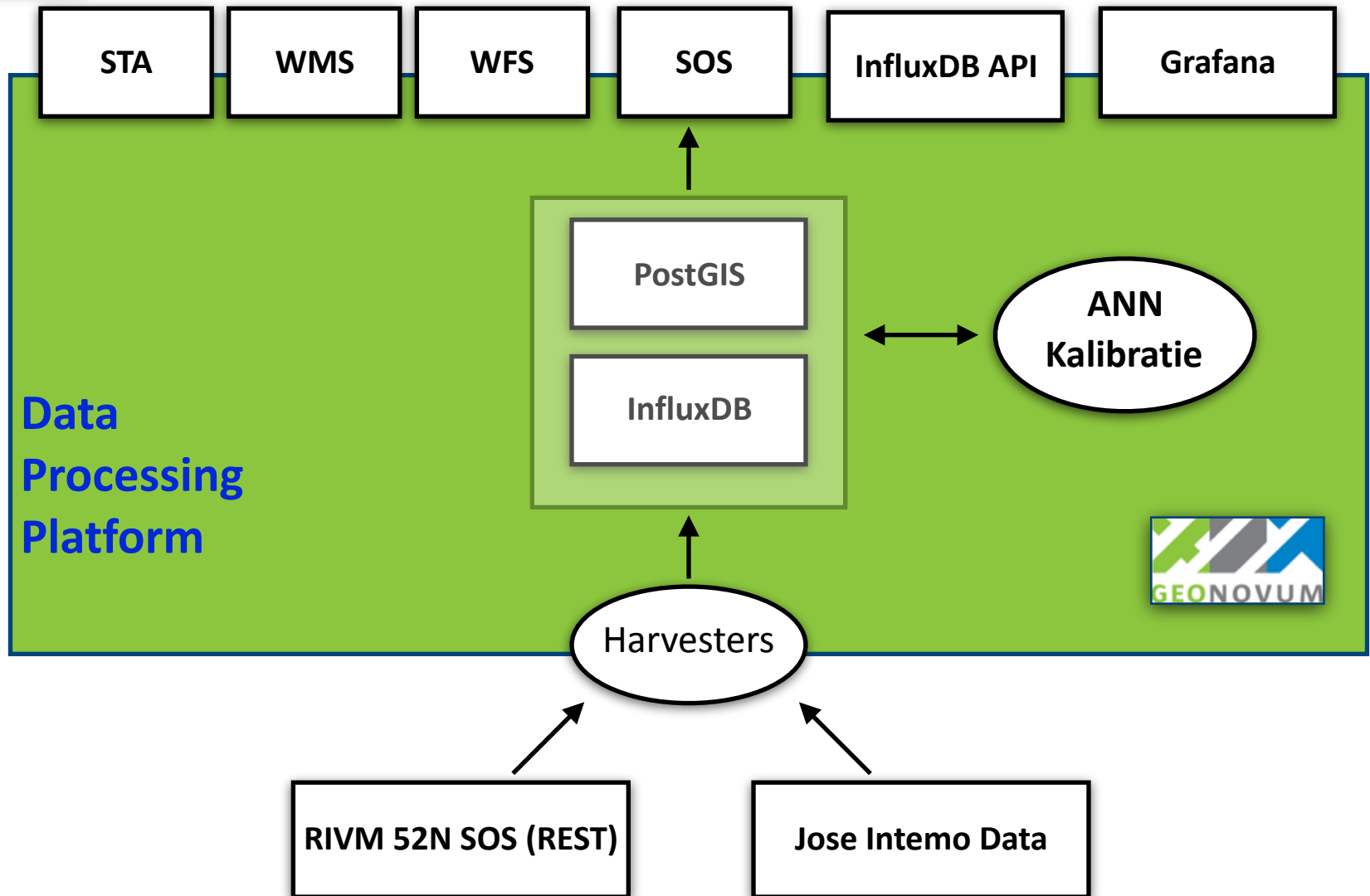
Componenten

- InfluxDB - timeseries database
- Grafana - Dashboard voor visualisatie

Functioneel

- Harvesting van RIVM LML data uit RIVM SOS
- Kalibratie via ETL met ANN Models in PostGIS
- Publicatie vanuit AirSenseEUR naar InfluxDB
- Ruwe en gekalibreerde data beschikbaar via InfluxDB en Grafana

Datastroom Kalibratie



RIVM LML in InfluxDB



Grafana - FirstRIVM x InfluxDB - Admin interface x Just

test.smartemission.nl/influxdb/7

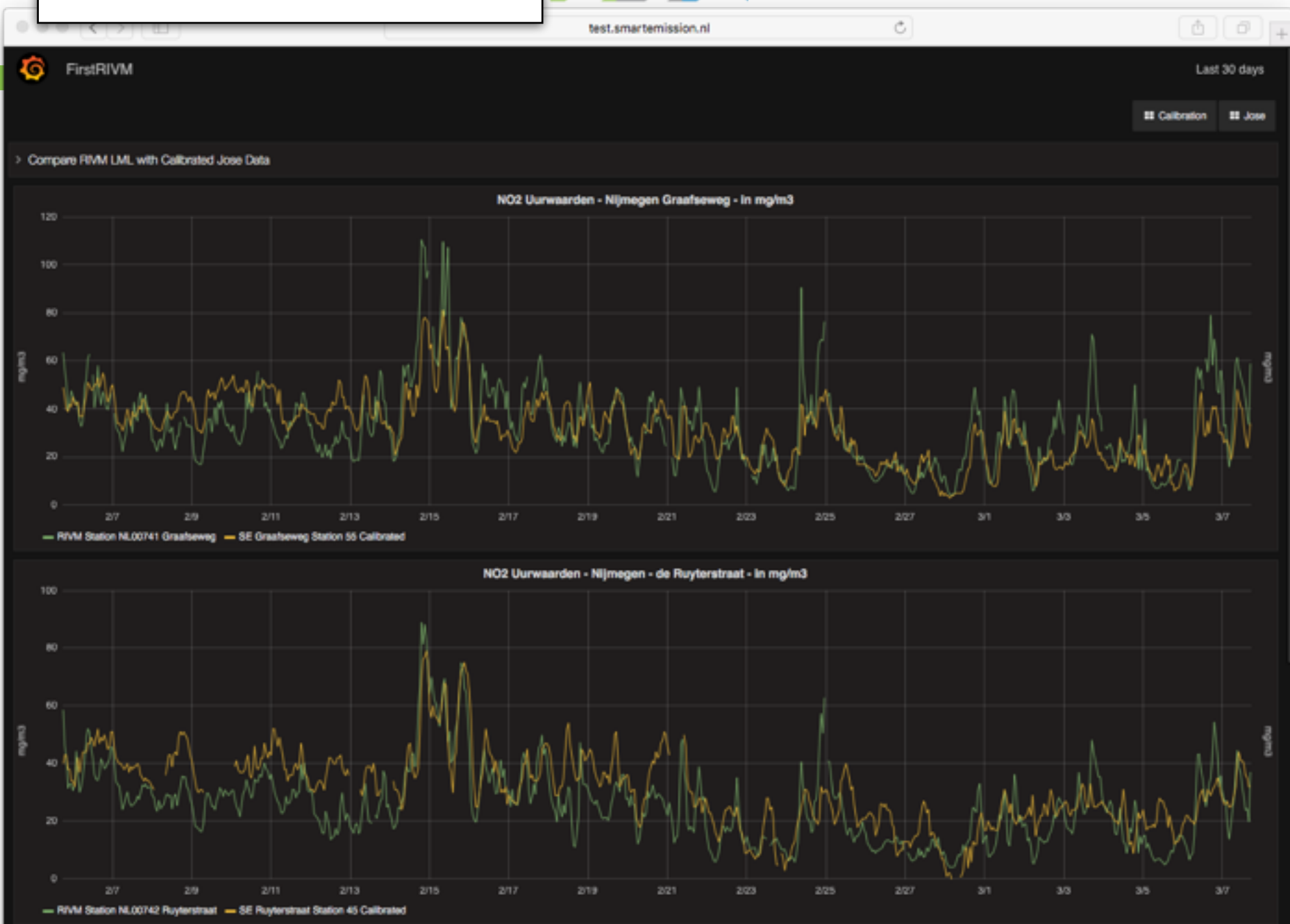
InfluxDB Write Data Documentation Database: smartemission +

Query: `SELECT "value" FROM "rivm" WHERE "component" = 'nitrogen_dioxide__air_' AND "station" = 'nijmegen_grasfleweg'` Generate Query URL Query Templates ▾

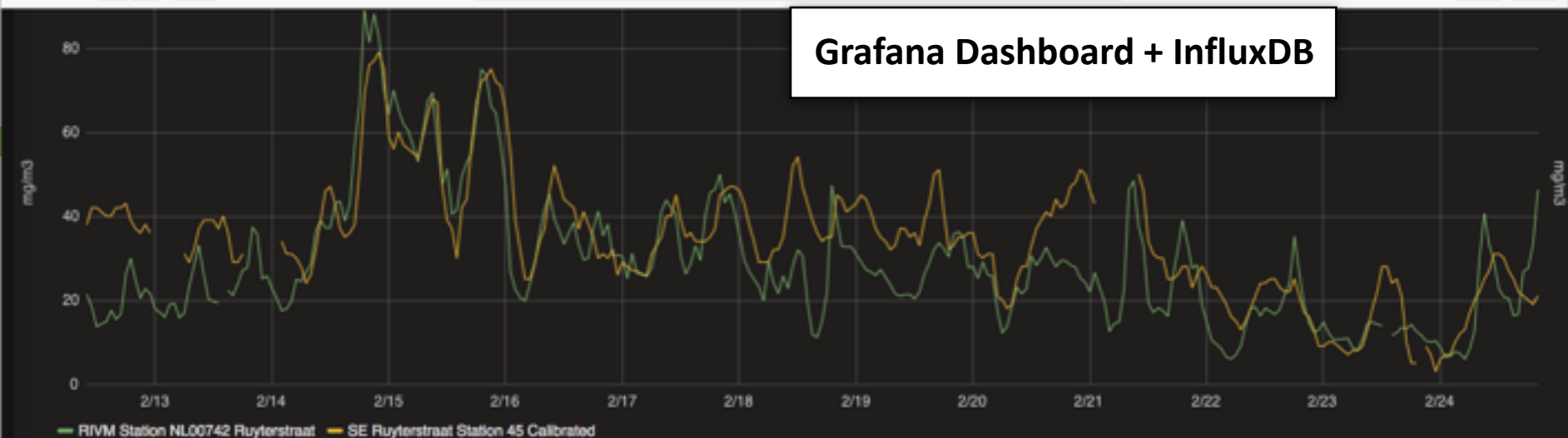
rivm

time	value
2015-08-21T04:00:00Z	56.65
2015-08-21T05:00:00Z	38.28
2015-08-21T06:00:00Z	42.89
2015-08-21T07:00:00Z	41.82
2015-08-21T08:00:00Z	63.64
2015-08-21T09:00:00Z	55.39
2015-08-21T10:00:00Z	35.88
2015-08-21T11:00:00Z	37.37
2015-08-21T12:00:00Z	27.08
2015-08-21T13:00:00Z	26.72
2015-08-21T14:00:00Z	27
2015-08-21T15:00:00Z	26.45
2015-08-21T16:00:00Z	72.45
2015-08-21T17:00:00Z	42.79
2015-08-21T18:00:00Z	20.26
2015-08-21T19:00:00Z	25.48
2015-08-21T20:00:00Z	29.54
2015-08-21T21:00:00Z	38.67
2015-08-21T22:00:00Z	60.8
2015-08-21T23:00:00Z	53.8
2015-08-22T00:00:00Z	42.29

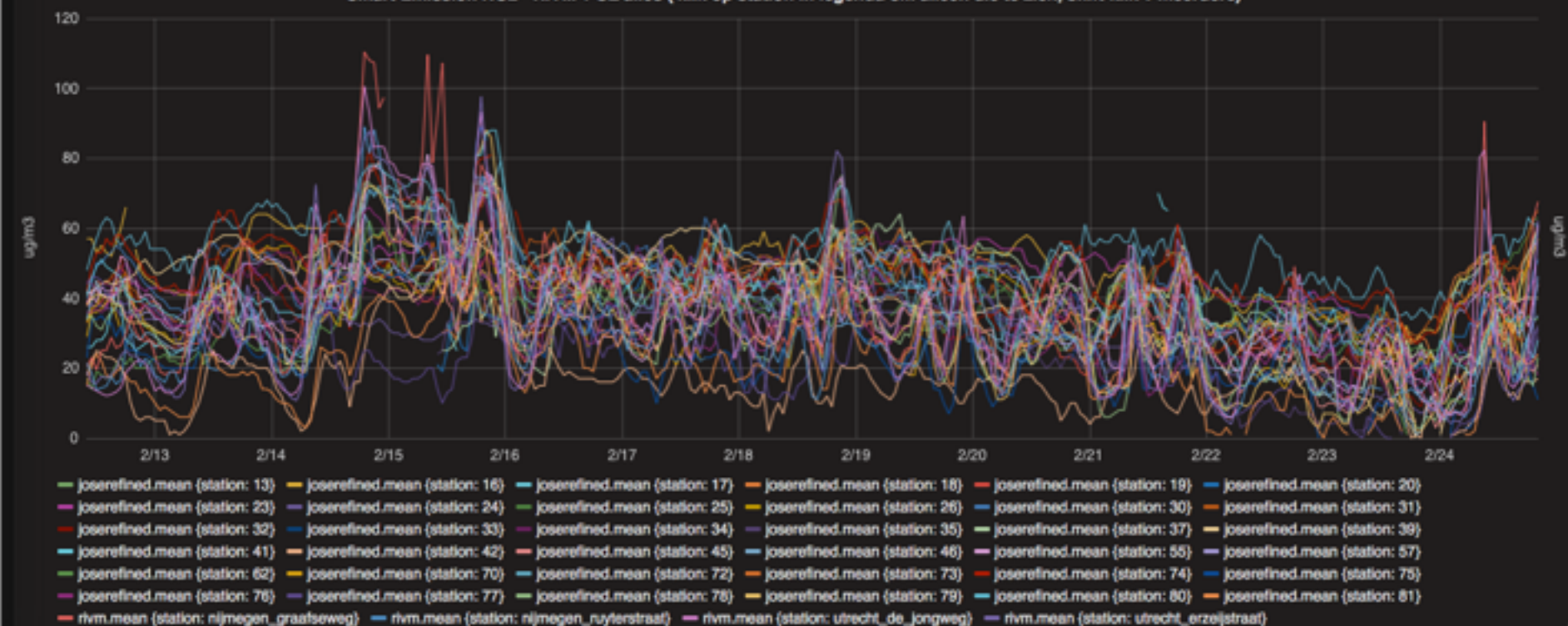
Grafana Dashboard + InfluxDB



Grafana Dashboard + InfluxDB



Smart Emission NO2 - RIVM + SE alles (klik op station in legenda om alleen die te zien, shift-klik v meerdere)



OGC SensorThings API

OGC SensorThings API

Showcase Modern Standard

(REST) API-based: HTTP Verbs

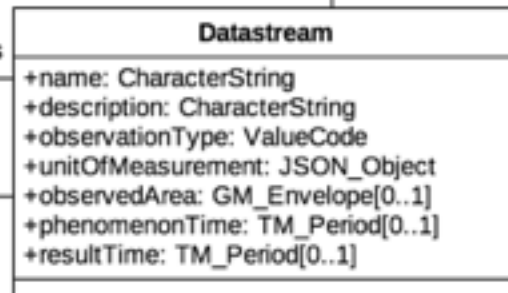
Data Model First Class Citizen

JSON Encoding

Public Versioning (GitHub)

API Implementation Examples

SensorThings API Model

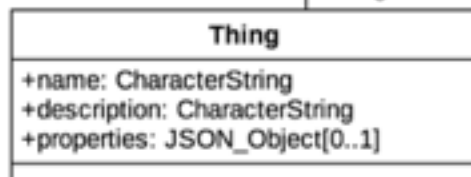


0..*

0..*

+datastreams

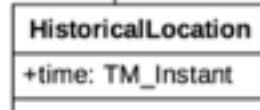
1 +thing



+things

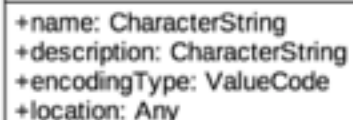
1

0..* +historicalLocations



0..* +historicalLocations

Location



+location

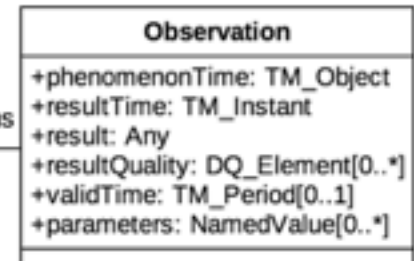
1..*

+datastream

1

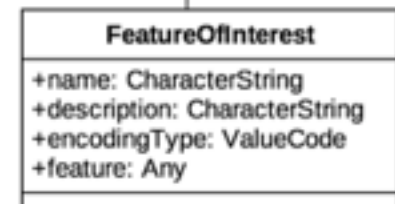
+observations

0..*



0..* +observations

1 +featureOfInterest



«CodeList»
ValueCode

Bevindingen

- Probeer online community te faciliteren
- Onderschat kalibratie niet
- Ontsluit met meerdere standaarden: WMS-Time, WFS en SOS, STA (WCS)
- Faciliteer bulk download in meerdere formaten: GML, JSON, CSV, Excel etc
- Bulk download prima via WFS
- SOS verbleekt bij STA
- Docker maakt deployment eenvoudig

Dank U!

Links:

Smart Emission

<http://www.smartemission.nl> (website)

<http://data.smartemission.nl> (data platform)

<https://github.com/Geonovum/smartemission> (broncode)

<http://smartplatform.readthedocs.io> (documentation)

Making Sense for Society

<http://www.geonovum.nl/onderwerpen/sensor-geo-informatie/algemeen-living-lab-internet-everything>

We would like to acknowledge for their valuable input:

All partners of the Smart Emission Consortium

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