



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 - SOS Pilot - RIVM (oa Hans Berkhout)**

<http://sensors.geonovum.nl>

- **2015-2017**

1. **Smart Emission Nijmegen**

<http://data.smartemission.nl>

2. **AirSenseEUR Workshop Ispra**

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

- **2017-2018**

4. **Smart City Living Lab (Intemo, Hans Nouwens)**

5. **Placing 5 AirSenseEURs in NL en connect to SE (EU JRC, RIVM)**

6. **SE Platform Migratie naar PDOK**

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.

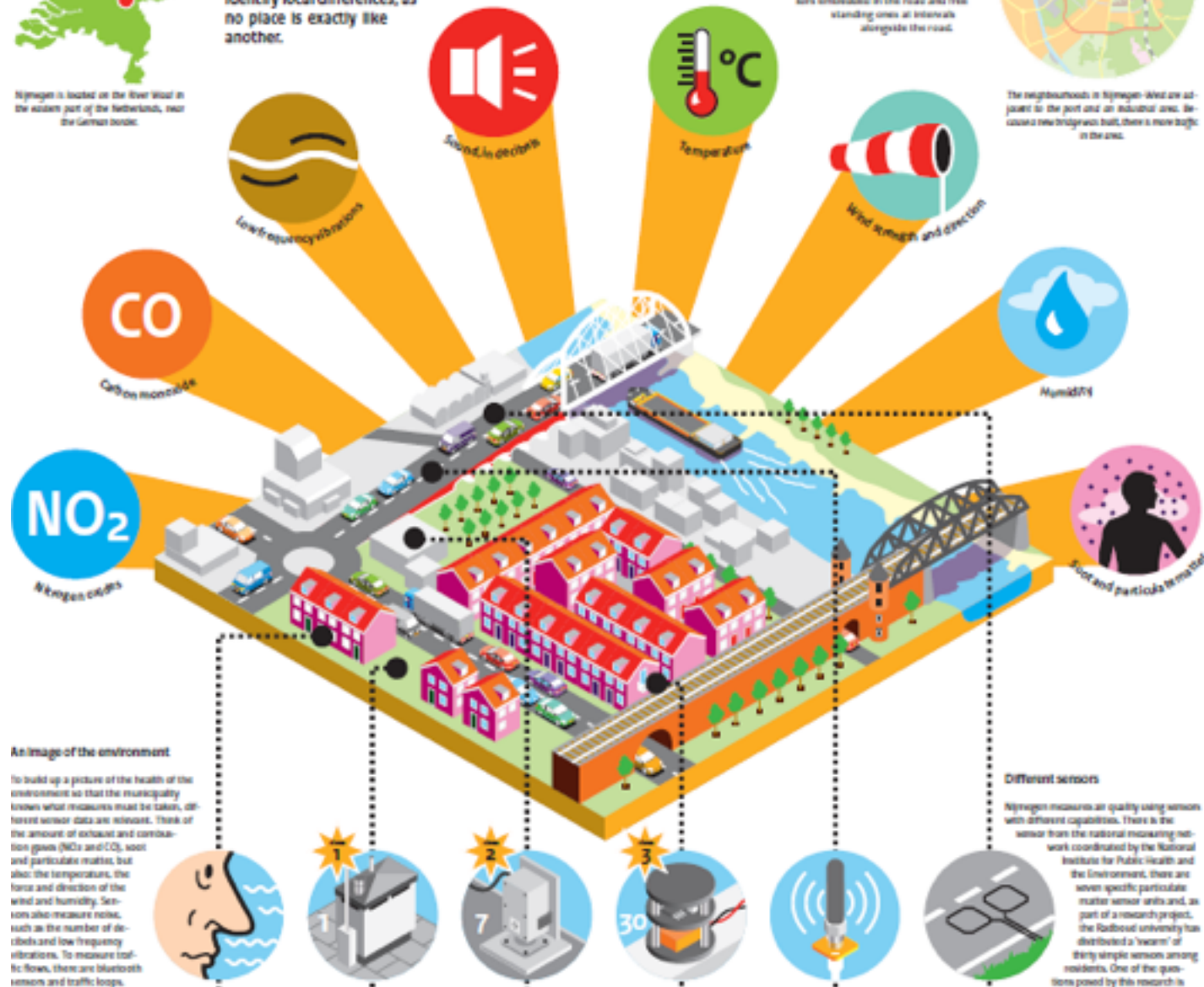
The environment is very important for people's health. That's why standards are set for the concentrations of pollutants. Sensors measure whether we keep within these standards using national monitoring networks. In addition, several municipalities and regions have their own sensors to identify local 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 collect 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.



An image of the environment

To build up a picture of the health of the environment so that the municipality knows what measures must be taken, different sensor data are relevant. Think of the amount of exhaust and combustion gases (NO_x and CO₂), soot and particulate matter, but also the temperature, the force and direction of the wind and humidity. Sensors also measure noise, such as the number of decibels and low-frequency vibrations. To measure traffic flows, there are Bluetooth sensors and traffic loops.

Different sensors

Nijmegen measures air quality using sensors with different capabilities. There is the sensor from the national monitoring network coordinated by the National Institute for Public Health and the Environment, there are seven specific particulate matter sensor units and, as part of a research project, the Radboud university has distributed a 'swarm' of thirty simple sensors among residents. One of the questions posed by this research is

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

Geolocation



Temperature



Humidity



Sound pressure



Air pressure



Rainfall



Tilting (x-y-z)



Open Data!

Radboud Universiteit



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

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

WMS-Time

WFS

SOS

STA



Data Platform

SE Platform The Big Picture



**Client
Apps/Viewers**



sensors



web-APIs

- WMS
- WFS
- SOS
- STA
- ...



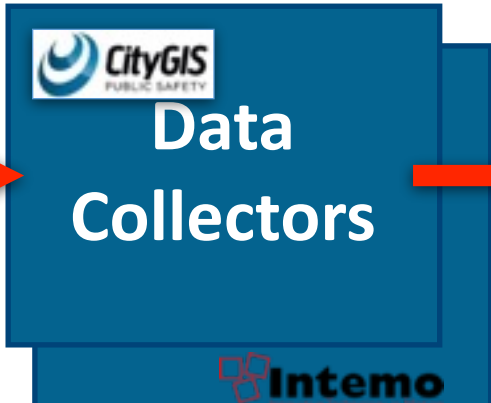
**Data
Management**

Collector APIs



SE Platform The Big Picture

Decoupling, data push & pull via Data Collectors



Data Collectors

CityGIS
PUBLIC SAFETY

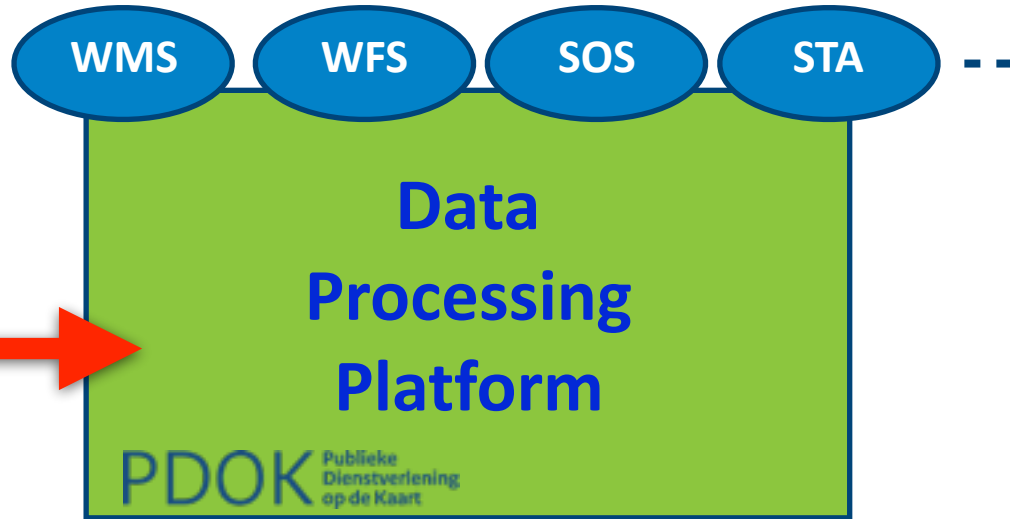
Intemo



Client Apps

luchtradar

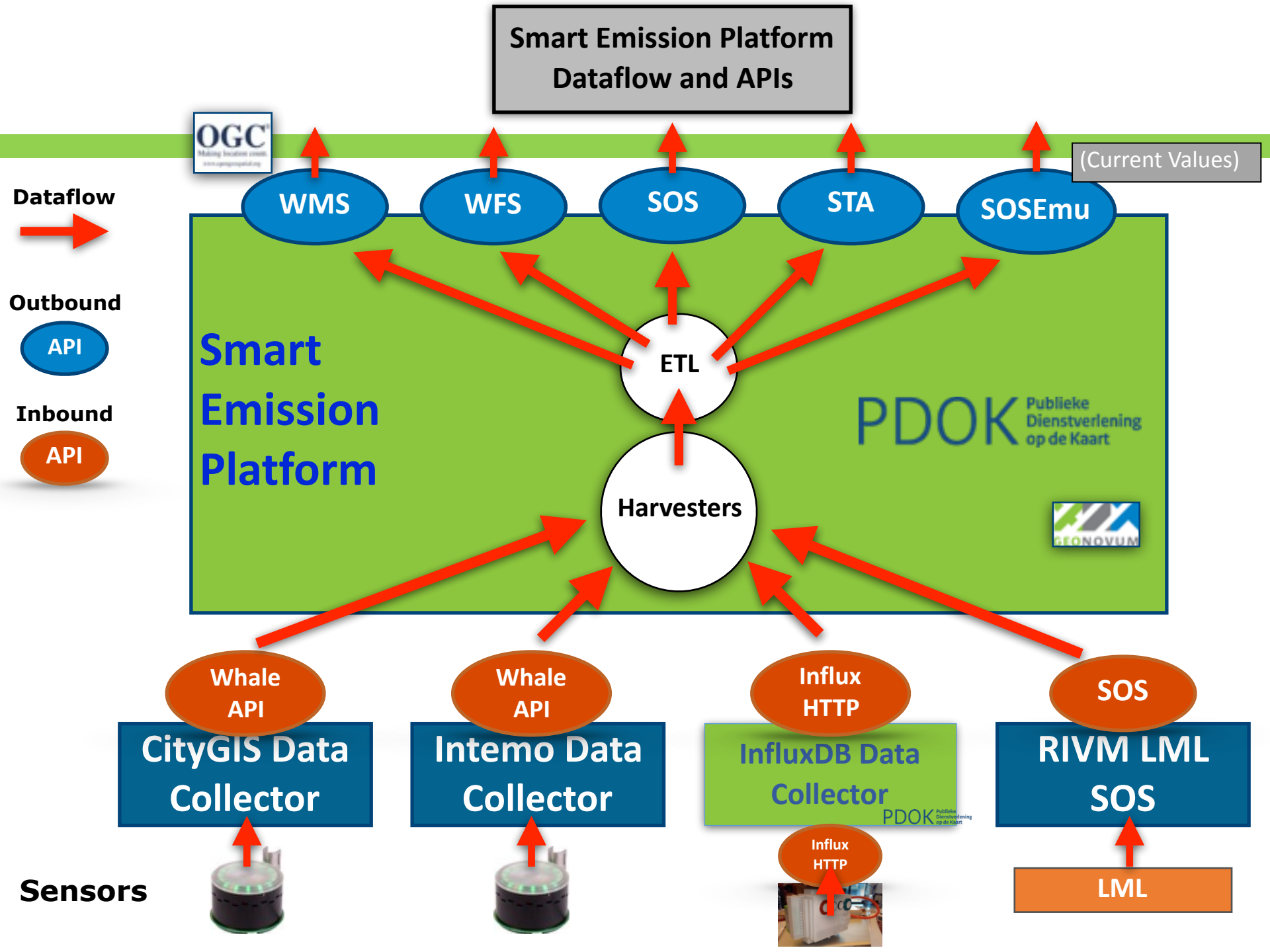
IMAGEM



WMS WFS SOS STA ...

Data Processing Platform

PDOK
Publieke Dienstverlening op de Kaart

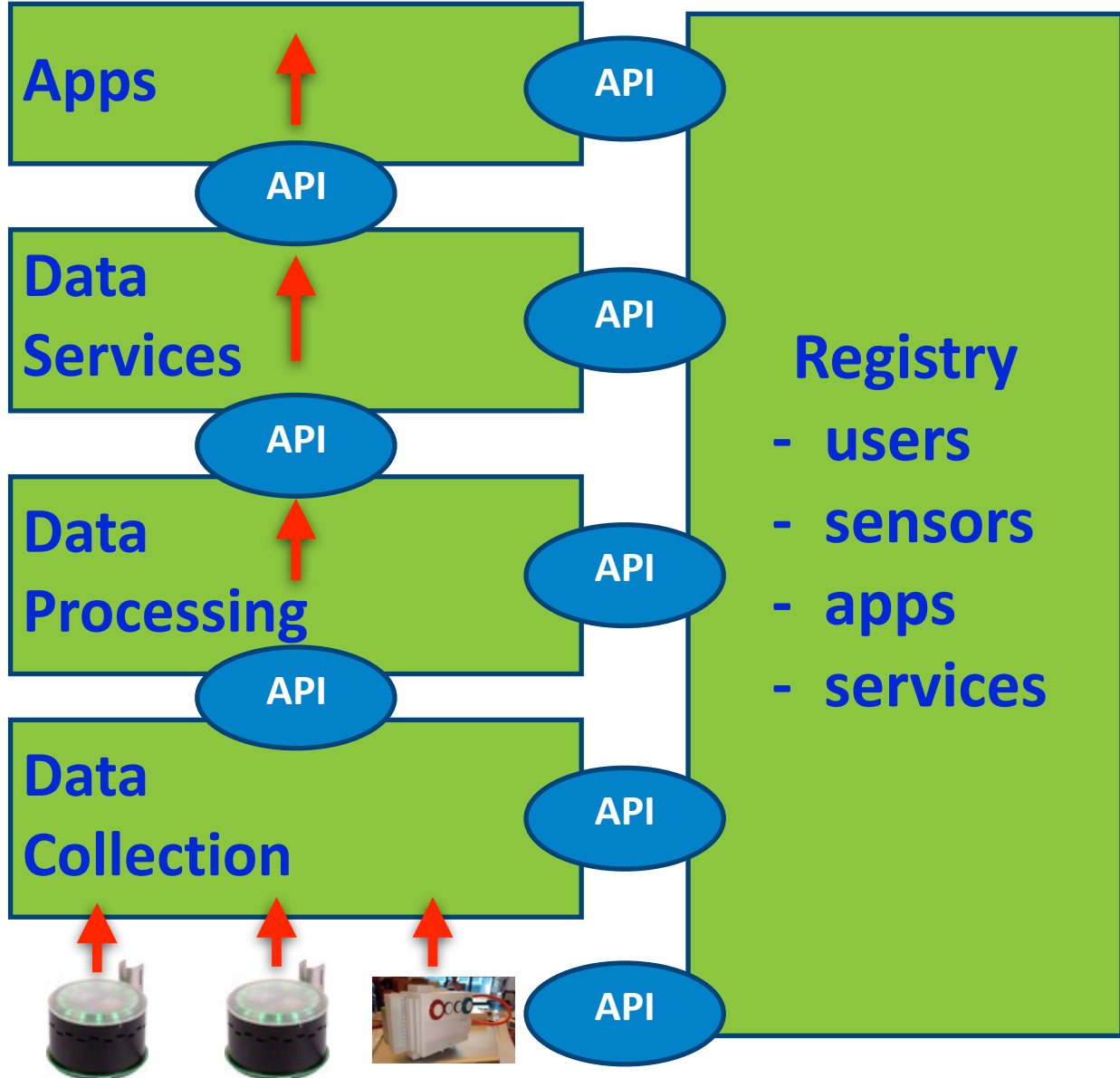




Dataflow



APIs



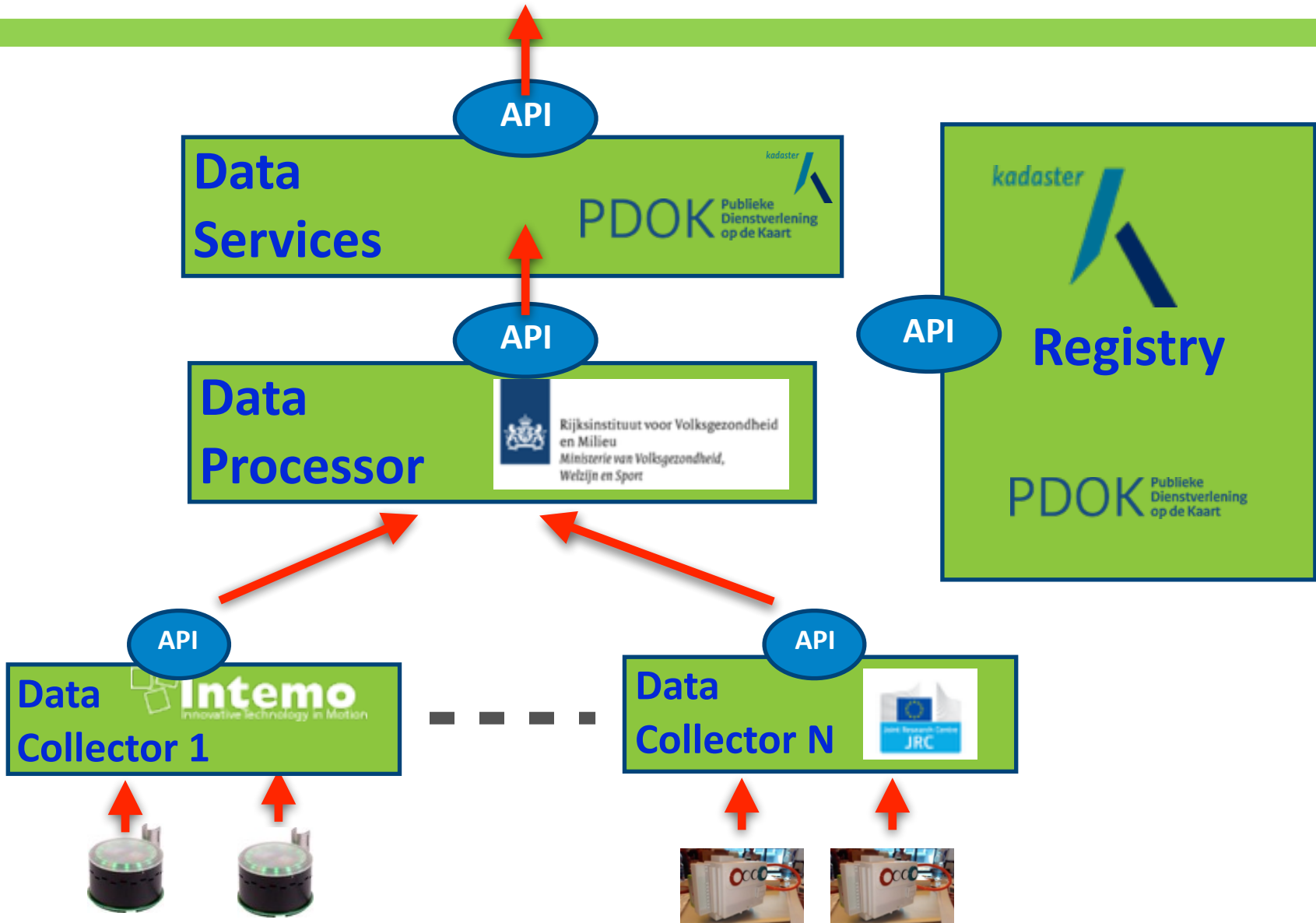
Sensors



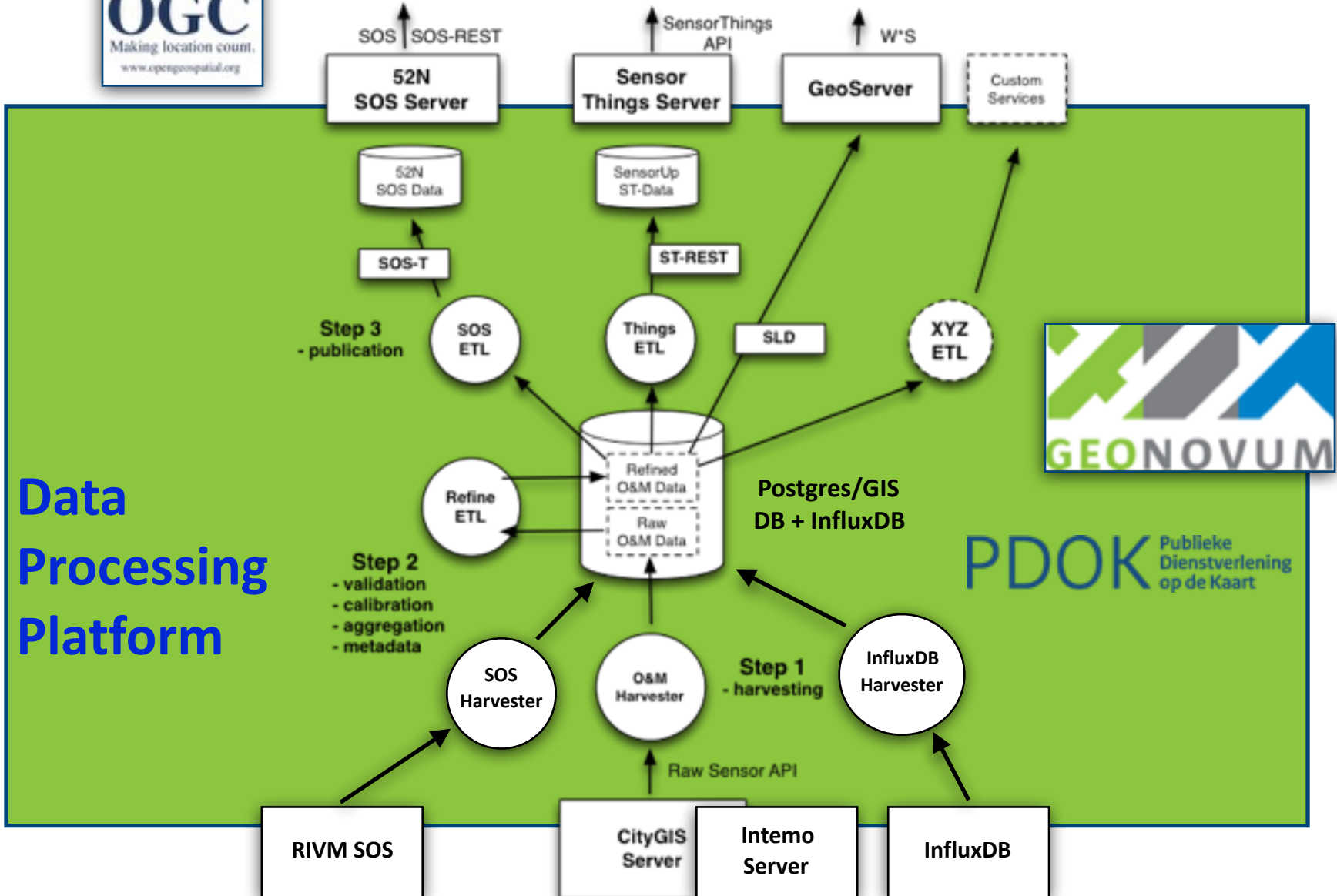
Dataflow



APIs



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

GOST
STA

Processing
(ETL)

Calibrator

Refiner

SOS
Publisher

STA
Publisher

Databases

PostGIS

InfluxDB

Harvesters

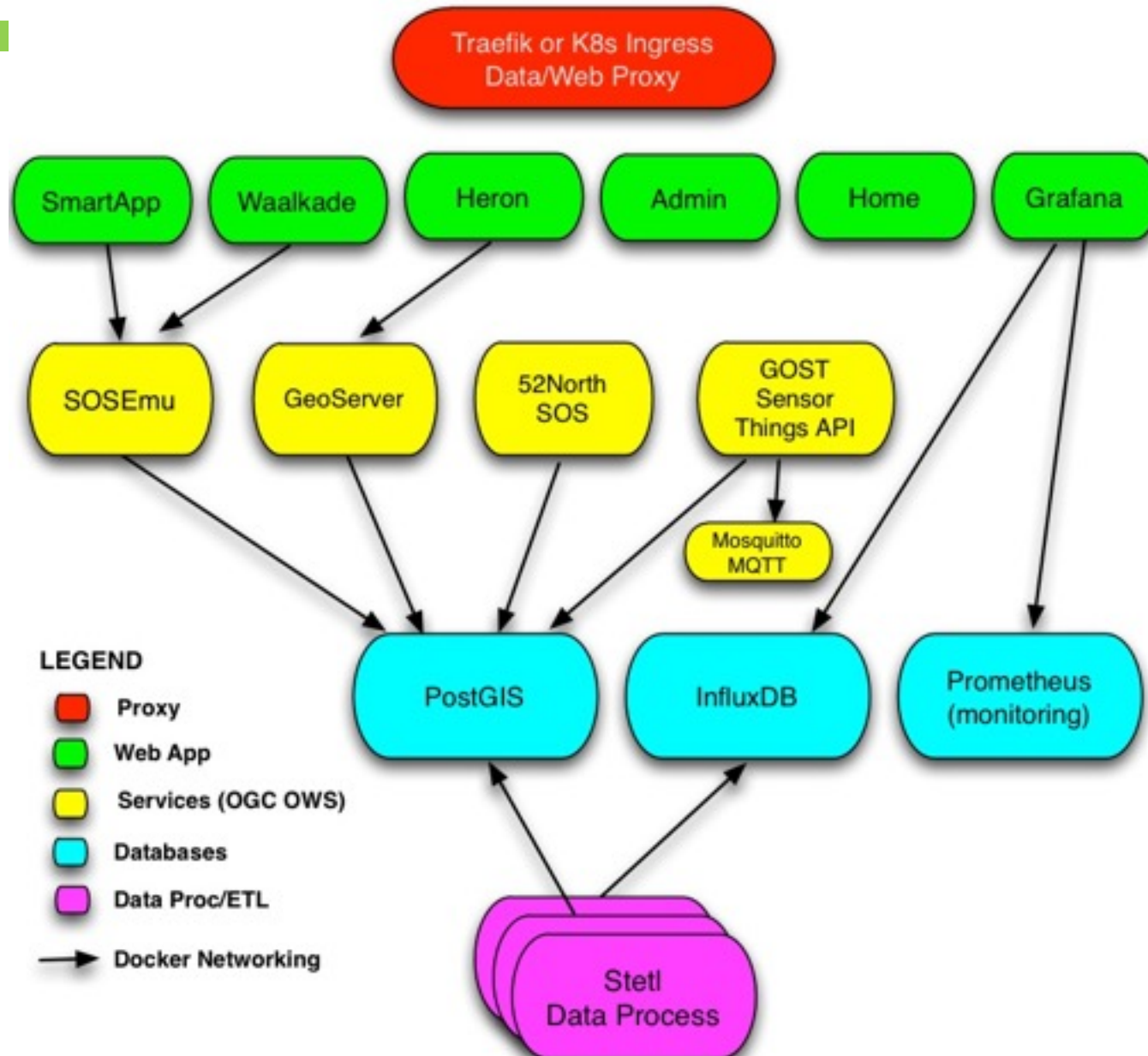
CityGIS
Harvester

SOS
Harvester

InfluxDB
Harvester



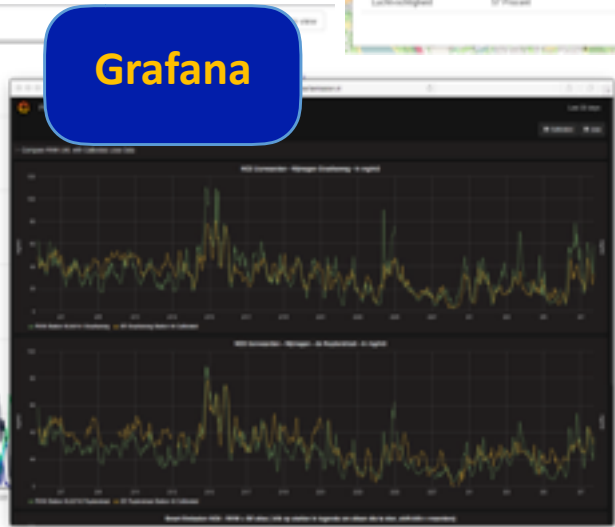
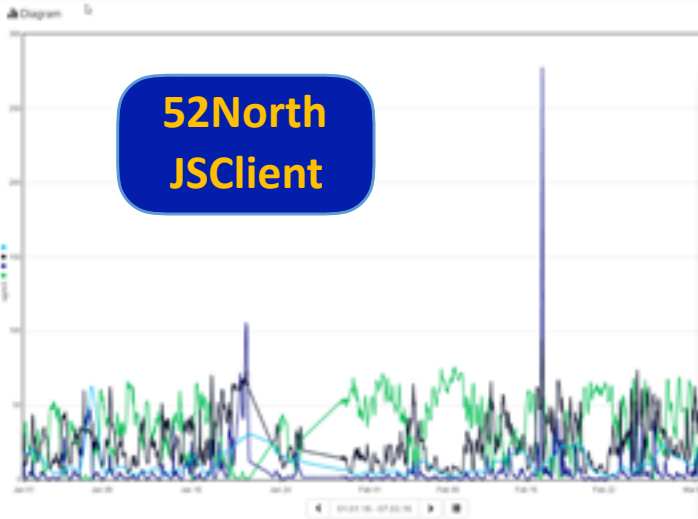
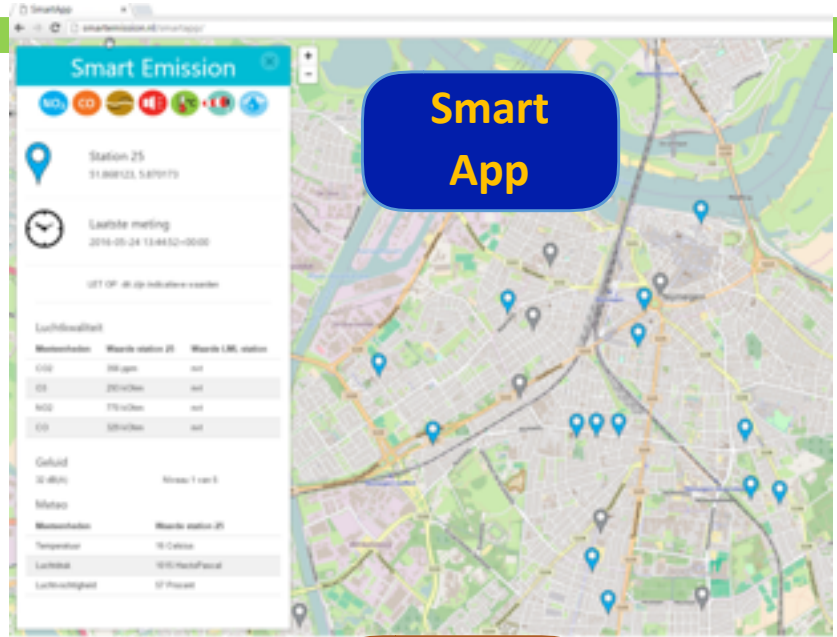
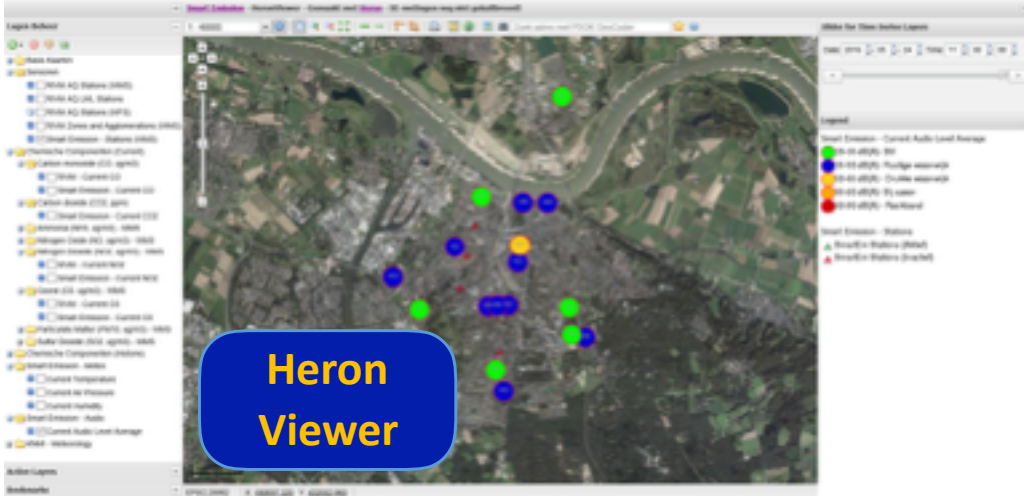
Smart Emission Docker Deployment



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)

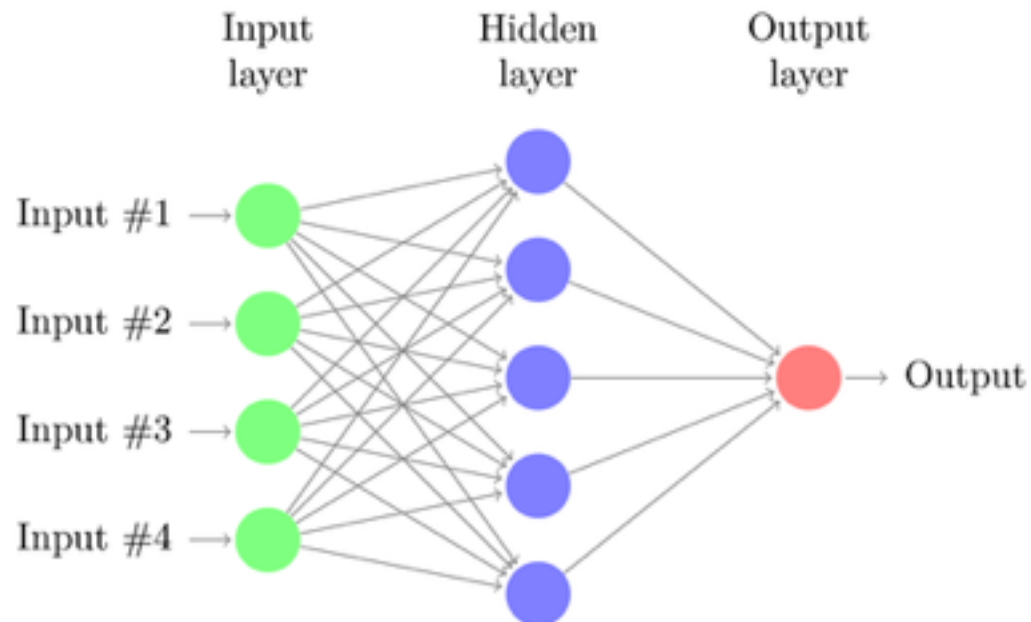


Rijksinstituut voor Volksgezondheid
en Milieu
Ministerie van Volksgezondheid,
Welzijn en Sport



ETL Implementation Details

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



Calibration ETL

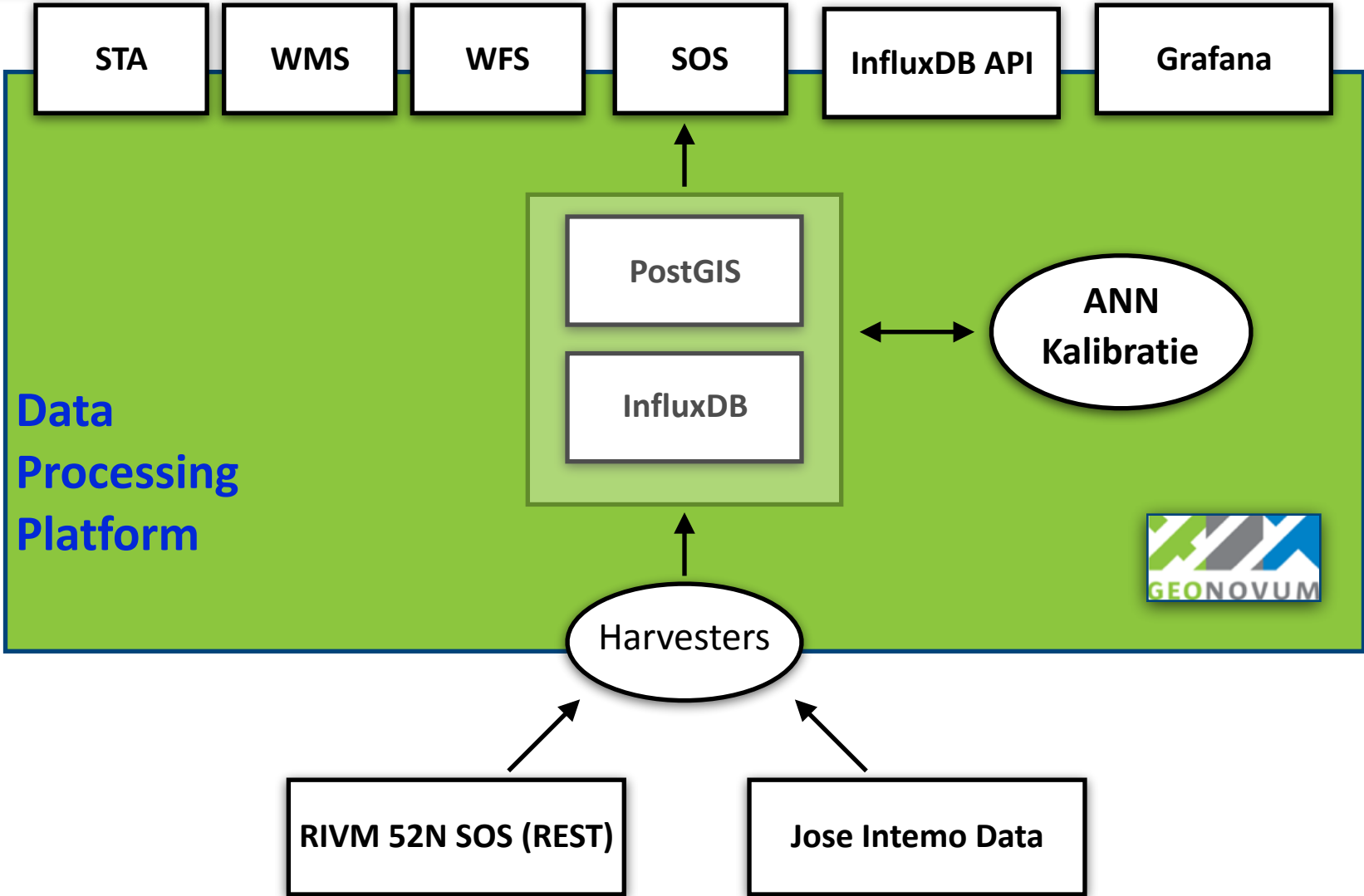
Componenten

- 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 Calibratie



RIVM LML in InfluxDB



The screenshot shows the InfluxDB Admin Interface. At the top, there are browser tabs for 'Grafana - FirstRIVM' and 'InfluxDB - Admin Interface'. The address bar shows the URL 'test.smartemission.nl/influxdba?'. The InfluxDB logo and navigation links 'Write Data' and 'Documentation' are visible. The database name 'smartemission' is shown in the top right. A query is entered in the main field: `SELECT "value" FROM "rivm" WHERE "component" = "nitrogen_dioxide_air_" AND "station" = "rijmegen_grasfleweg"`. Below the query field are buttons for 'Generate Query URL' and 'Query Templates'. The results are displayed as a table with two columns: 'time' and 'value'. The data shows a decreasing trend in values from approximately 56.65 at 00:00Z to 42.29 at 22:00Z.

time	value
2015-08-21T04:00:00Z	56.65
2015-08-21T05:00:00Z	38.26
2015-08-21T06:00:00Z	42.69
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



test.smartemission.nl

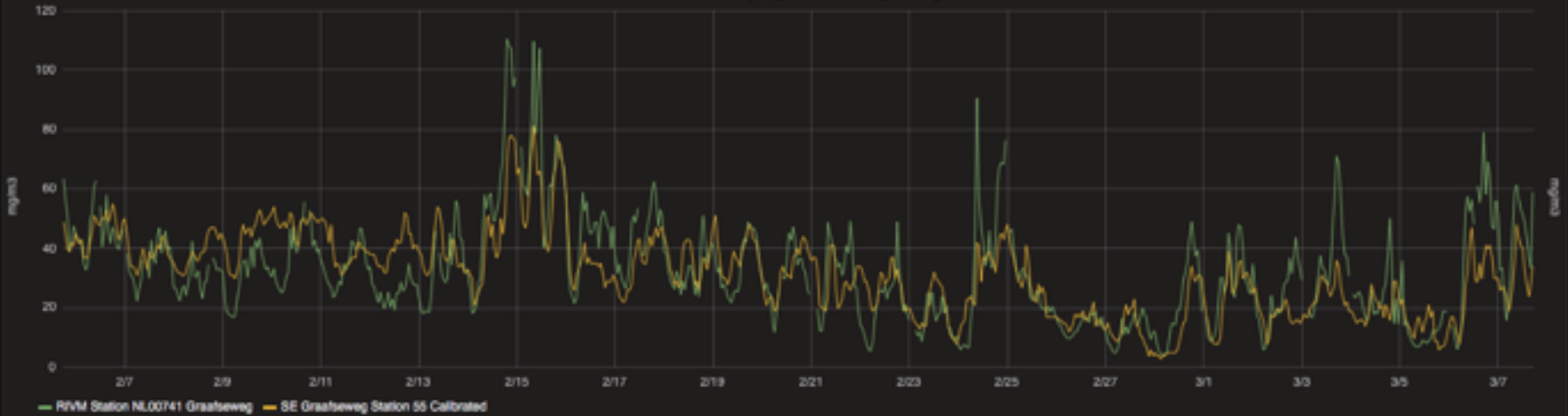
FirstRIVM

Last 30 days

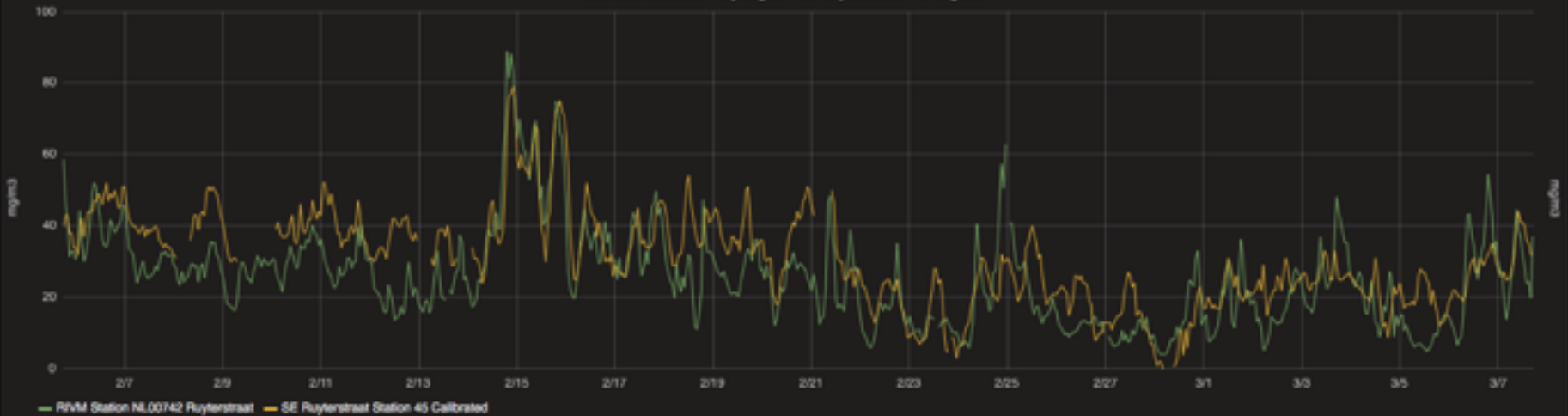
Calibration Jose

> Compare RIVM LML with Calibrated Jose Data

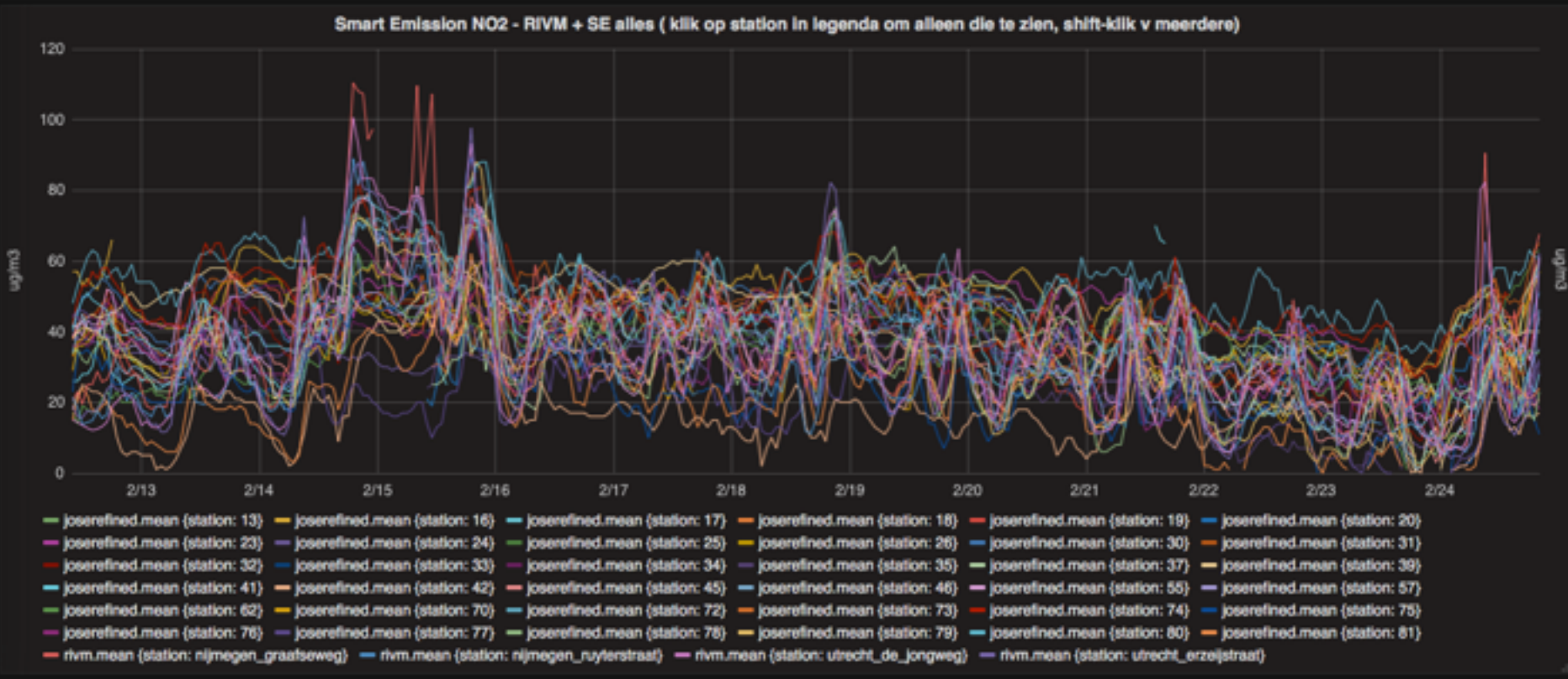
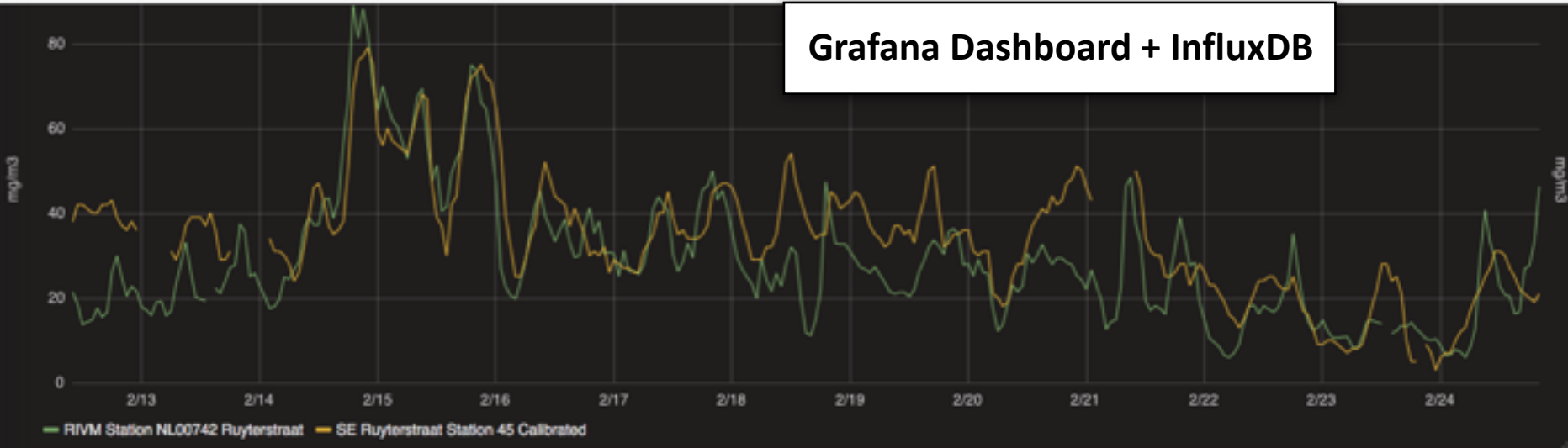
NO2 Uurwaarden - Nijmegen Graafseweg - In mg/m3



NO2 Uurwaarden - Nijmegen - de Ruyterstraat - In mg/m3



Grafana Dashboard + InfluxDB



OGC SensorThings API

OGC SensorThings API Showcase Modern Standard

(REST) API-based: HTTP Verbs

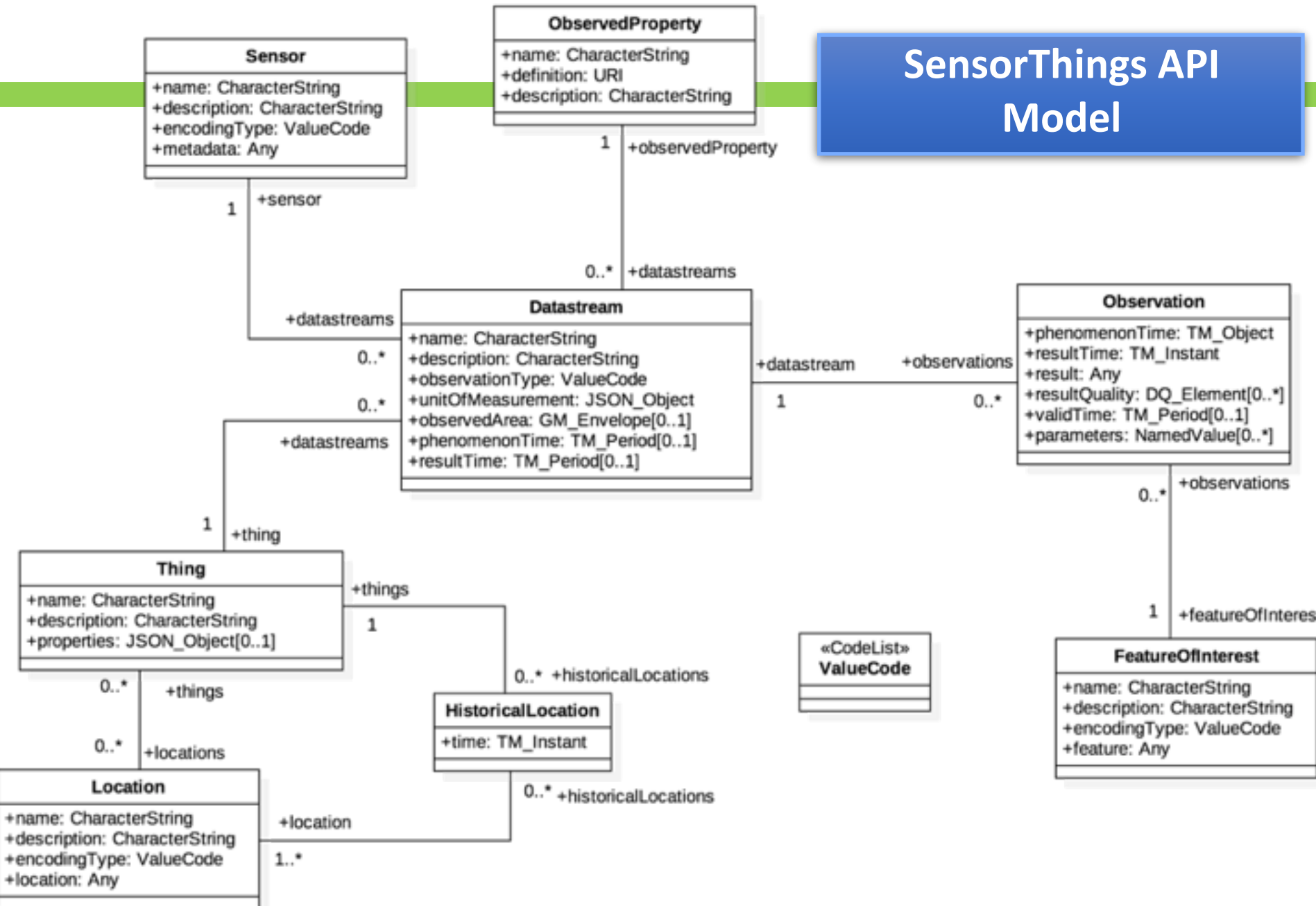
Data Model First Class Citizen

JSON Encoding

Public Versioning (GitHub)

API Implementation Examples

SensorThings API Model



SensorThings API Entity Mapping

Data records produced by the *Refiner* are mapped to STA Entities by the *STA Publisher*.

SE Artefact	STA Entity	Example
Station	<i>Thing</i>	Intemo station AirSenseEUR Box
Station point location	<i>Location</i>	AirSenseEUR Box location at 4.982, 52.358 lon/lat
Sensor Type/Metadata	<i>Sensor</i>	AlphaSense NO2B43F
Type and unit (uom)	<i>ObservedProperty</i>	NO2 in ug/m3
Value and time	<i>Observation</i>	42 ug/m3 on 1 aug 2018 13:42:45
Combination of above	<i>Datastream</i>	Combines T, S, OP and O
Station time+location	<i>HistoricalLocation</i>	AirSenseEUR Box at lat/lon 52.35,4.92 on on 1 aug 2018 13:43:26
Station Area	<i>FeatureOfInterest</i>	Location of Station 11820004

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

Contact



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