

Sensor networks for public (and regulatory) information

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Air pollution: WHO (2015)

<http://www.who.int/mediacentre/news/releases/2015/wha-26-may-2015/en/>

26 MAY 2015 ; GENEVA – The World Health Assembly closed today, with Director-General Dr Margaret Chan noting that it had passed several “landmark resolutions and decisions”. Three new resolutions were passed today: one on air pollution, one on epilepsy and one laying out the next steps in finalizing a framework of engagement with non-State actors.

Air pollution

Delegates at the World Health Assembly adopted a resolution to address the health impacts of **air pollution – the world’s largest single environmental health risk**. Every year 4.3 million deaths occur from exposure to indoor air pollution and **3.7 million deaths are attributable to outdoor air pollution**. This was the first time the Health Assembly had debated the topic.

Legislative efforts - air quality

EU

(Council) Directives:

80/779/EEC AQ limits SO₂

...

96/62/EC, 2008/50/EC

on ambient air quality Sources
regulations:

- National emission ceiling directive
- Traffic emissions (EURO standard)
- Fuel quality directive
- Waste incineration directive
-

UN ECE CLRTAP

1979 [Convention on Long-range Transboundary Air Pollution](#)

Protocols:

- 1999/2012 Acidification, Eutrophication and Ground-level Ozone
- 1998/2009 Persistent Organic Pollutants
- 1998/2012 Heavy Metals
- 1994 Sulphur emissions
- 1991 Volatile Organic Compounds
- 1998 Nitrogen Oxides transboundary fluxes
- 1985 Sulphur emissions reduction

The resulting AQ monitoring

Based on scientific consensus achieved through a broad stakeholder involvement (research, policy, corporate/collective stakeholders)

Standardization



Comparability

Information systems



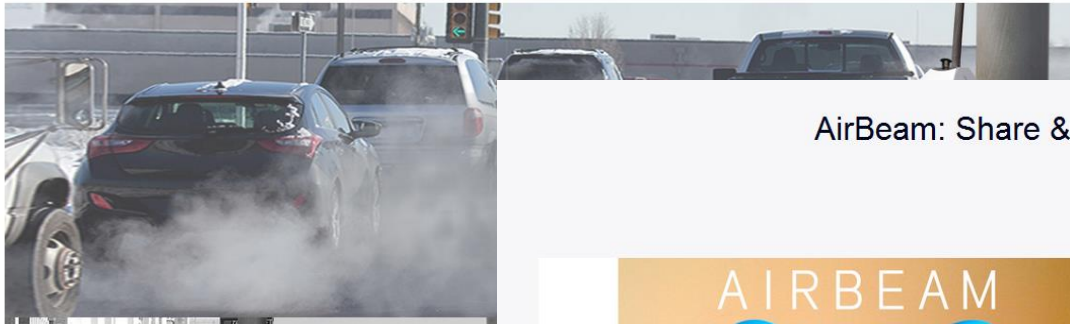
1979-2017: technologies change



A revolution in air quality monitoring

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Vaisala Air Quality Transmitter

Overview Technical Specifications Documents

Overview

Vaisala Air Quality Transmitter AQT410 measures the most common pollutants: nitrogen dioxide (NO₂), sulphur dioxide (SO₂), carbon monoxide (CO) and carbon dioxide (CO₂). Measurement performance is based on proprietary advanced algorithms and is supported by regular calibration measurements at an affordable price using electrochemical sensors.

AQT410 has been specifically designed for air quality monitoring networks or around industrial sites and airports. Thanks to its small weight and compact size it is ideally suited for deployment even in large air quality networks.



AirBeam: Share & Improve Your Air



AirBeam is a wearable air monitor that maps, graphs & crowdsources your pollution exposures in real-time.

Buy Now

Created by

HabitatMap

333 backers pledged \$55,833 to help bring this project to life.

Make your home healthier, your office more productive

Uncover the simple solutions. Just place a small, stylish, cordless and connected Cube in each room.

Cubes are SOLD OUT!



Meet Flow, your smart mobile air quality tracker

For the past two years, Plume Labs has had one mission: helping you stay ahead of air pollution to improve your environmental health.

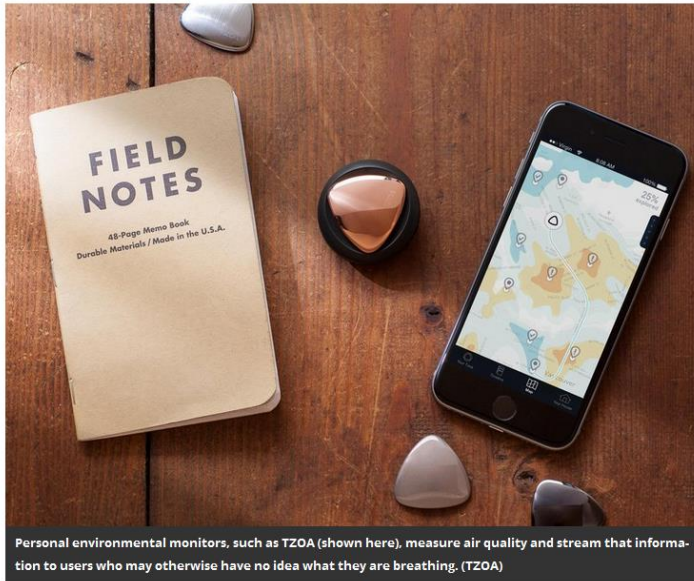
Today we are incredibly proud to unveil the design of Flow by Plume Labs.



..... technologies change

With Wearable Devices That Monitor Air Quality, Scientists Can Crowd-source Pollution Maps

Emerging technology means anyone with a smartphone can become a mobile environmental monitoring station



By [Brian Handwerk](#)
SMITHSONIAN.COM




Pigeon Air Patrol to the rescue! Birds with backpacks track air pollution

By [Sheena McKenzie](#), CNN
Updated 1415 GMT (2215 HKT) March 16, 2016



The Pigeon Air Patrol measures nitrogen dioxide in London, which has a high level of air pollution.

Top stories

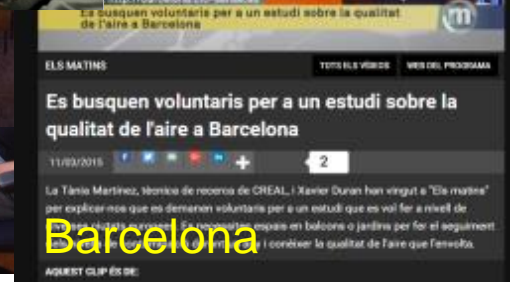
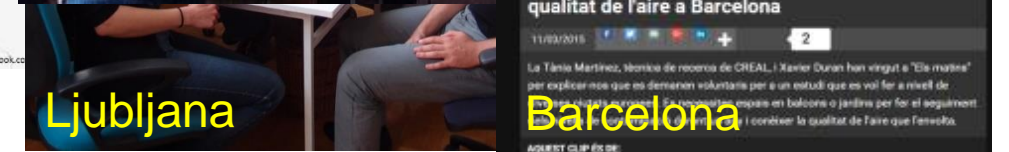
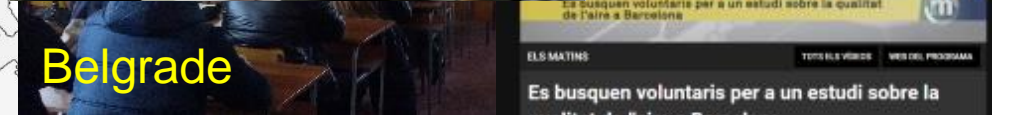
-  There's something amiss with this inauguration photo
-  Australia: Actor fatally shot while filming music video



Les mer Prisant: 7 900 000 kr
P-rom: 77m² 

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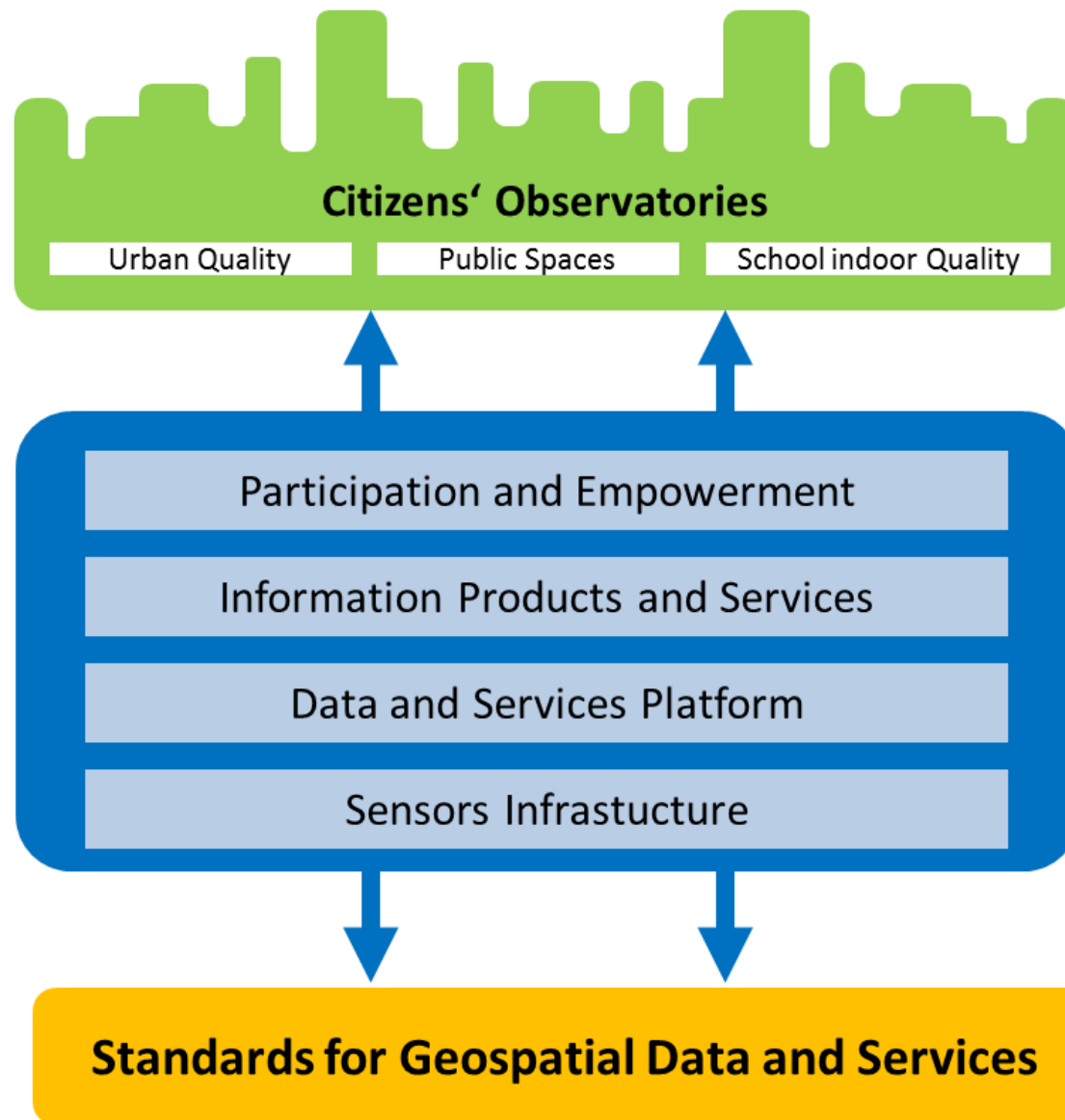
CITI-SENSE 2012-2016 in 9 European cities



The people behind CITI-SENSE



CITI-SENSE Implementation





9 tenants associations

EUROPE

3 universities

7 secondary schools

17 elementary schools

54 kindergartens

9 cities

**9,4 million observations
(9/2015-9/2016)**

>1.200 CityAir-app-users

2036 reported perceptions, app still running!

**324 air sensor units in network at
one time**

Additional sensor clusters

**>50 public places
volunteers**

**327 LEO-
volunteers**

1530 answers to AQ questionnaire

>300 evaluations of products



Challenges

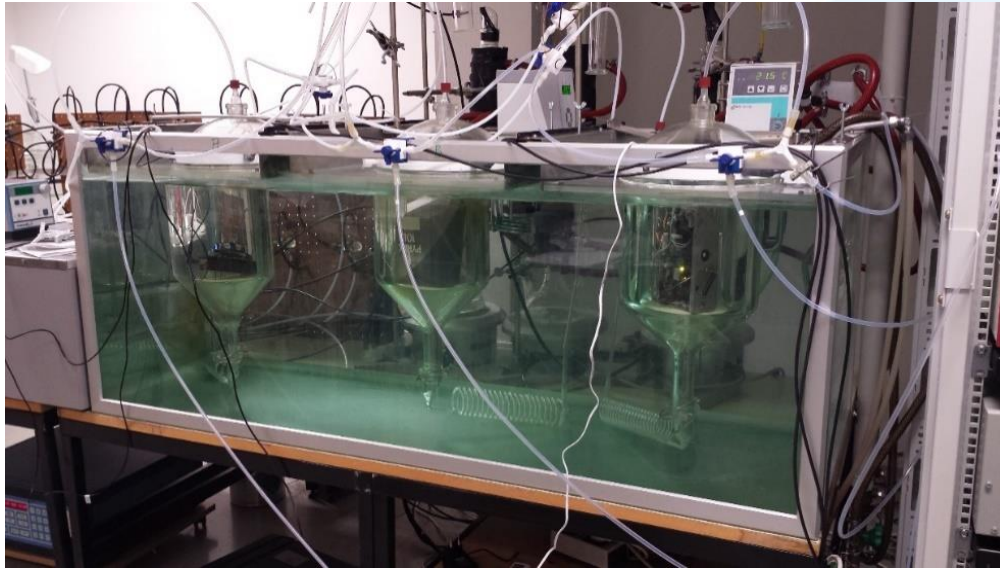
Technology: low-cost sensor systems challenges

Technology: connectivity

User issues: deployment

User issues: value proposition

Data quality: calibration in the laboratory and in the field



Science of The Total Environment

Volume 575, 1 January 2017, Pages 639–648

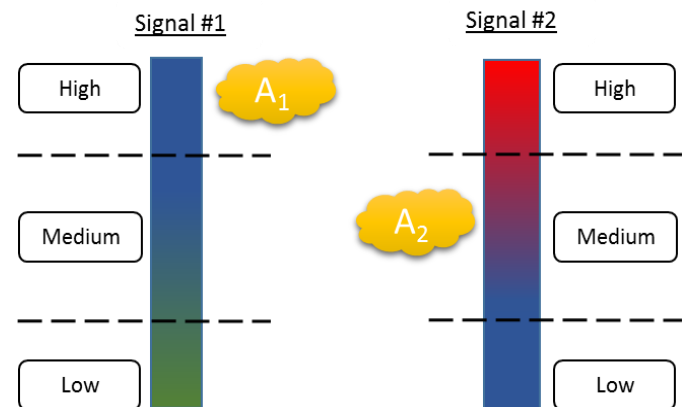


An evaluation tool kit of air quality micro-sensing units

Barak Fishbain^{a, 1}, Uri Lerner^{a, 1}, Nuria Castell^b, Tom Cole-Hunter^{c, d}, Olalekan Popoola^a, David M. Broday^a, Tania Martinez Iniguez^{c, d}, Mark Nieuwenhuisen^c, Milena Jovasevic-Stojanovic^c, Dusan Topalovic^{c, d}, Roderic L. Jones^a, Karen S. Galea^b, Yael Etzion^a, Fadi Kizel^a, Yaela N. Golumbic^{a, 1}, Ayelet Baram-Tsabari^a, Tamar Yacobi^a, Dana Drahtler^a, Johanna A. Robinson^{d, m}, David Kocman^a, Milena Horvat^a, Vlasta Svecova^a, Alexander Arpacı^a, Alena Bartonova^b

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^b Norwegian Institute for Air Research (NILU), Kjeller, Norway



$A_1(t)$ & $A_2(t)$ in the same segment \rightarrow Match score = 1

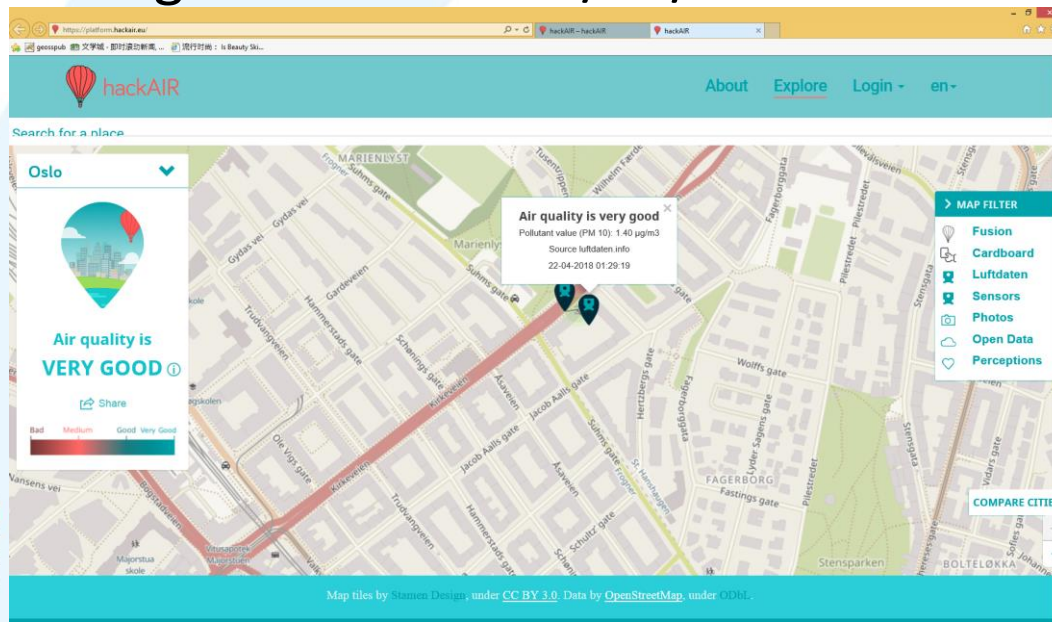
$A_1(t)$ & $A_2(t)$ not in the same segment \rightarrow Match score = 0

Typical deployment

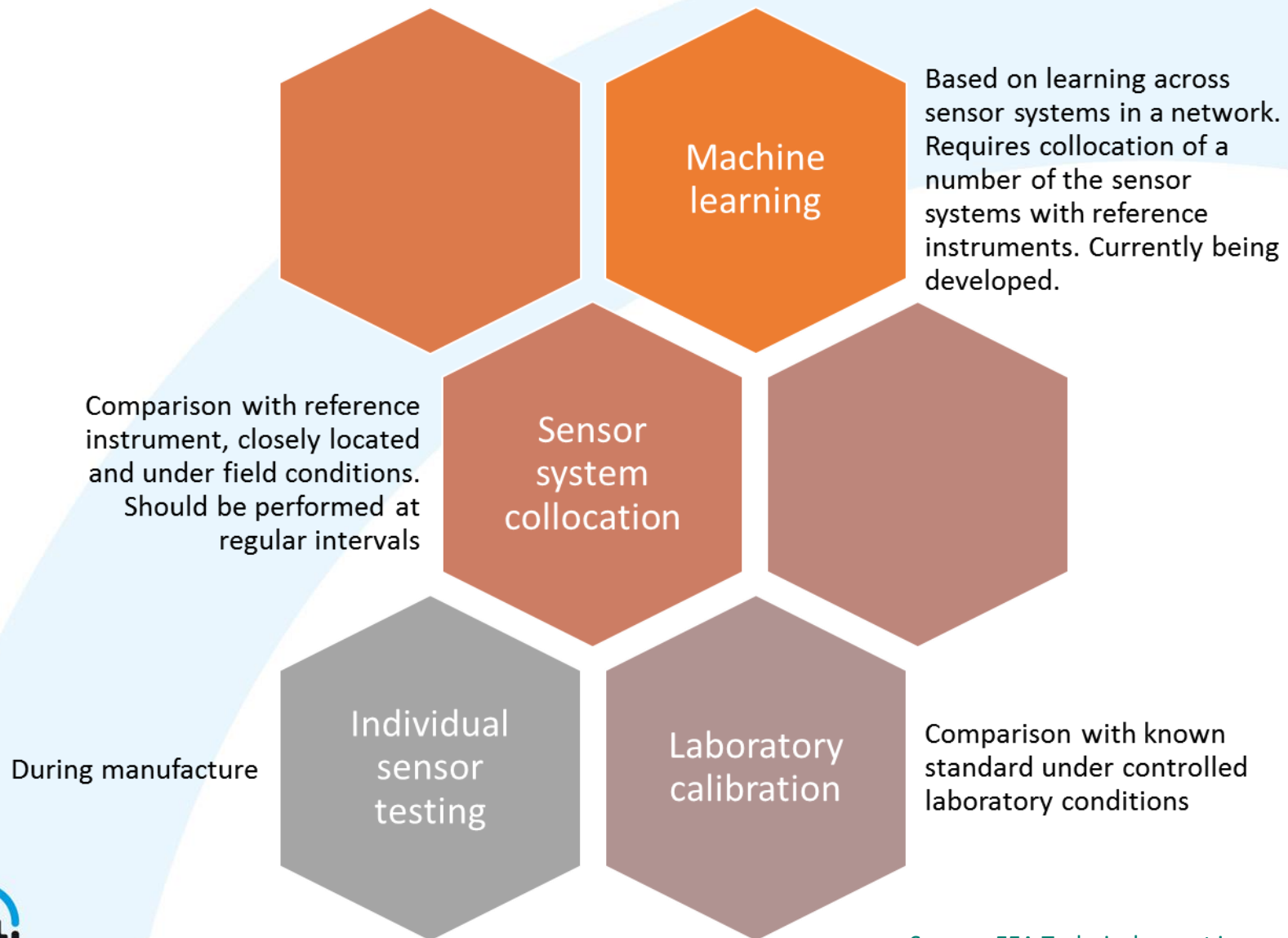


Performance assessment of hackAIR PM sensors

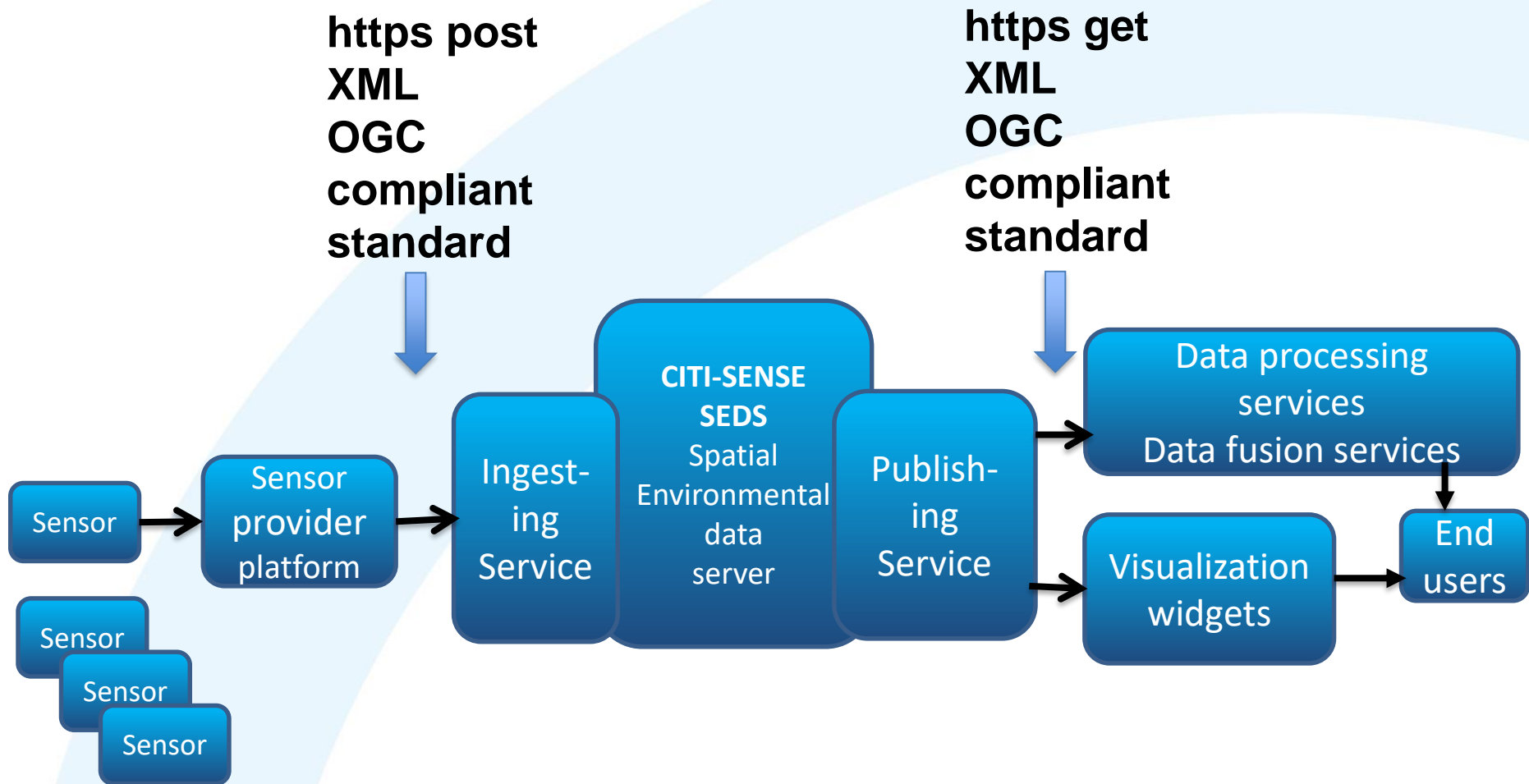
- Co-locating three hackAIR PM sensor at an air quality monitoring station (Kirkeveien, Oslo).
- Dense traffic area
- Road transport is major emission source of PM
- Data registered from 24/11/2017 to now



Large deployments require smart calibration



Connectivity: simplified platform



Data processing infrastructure

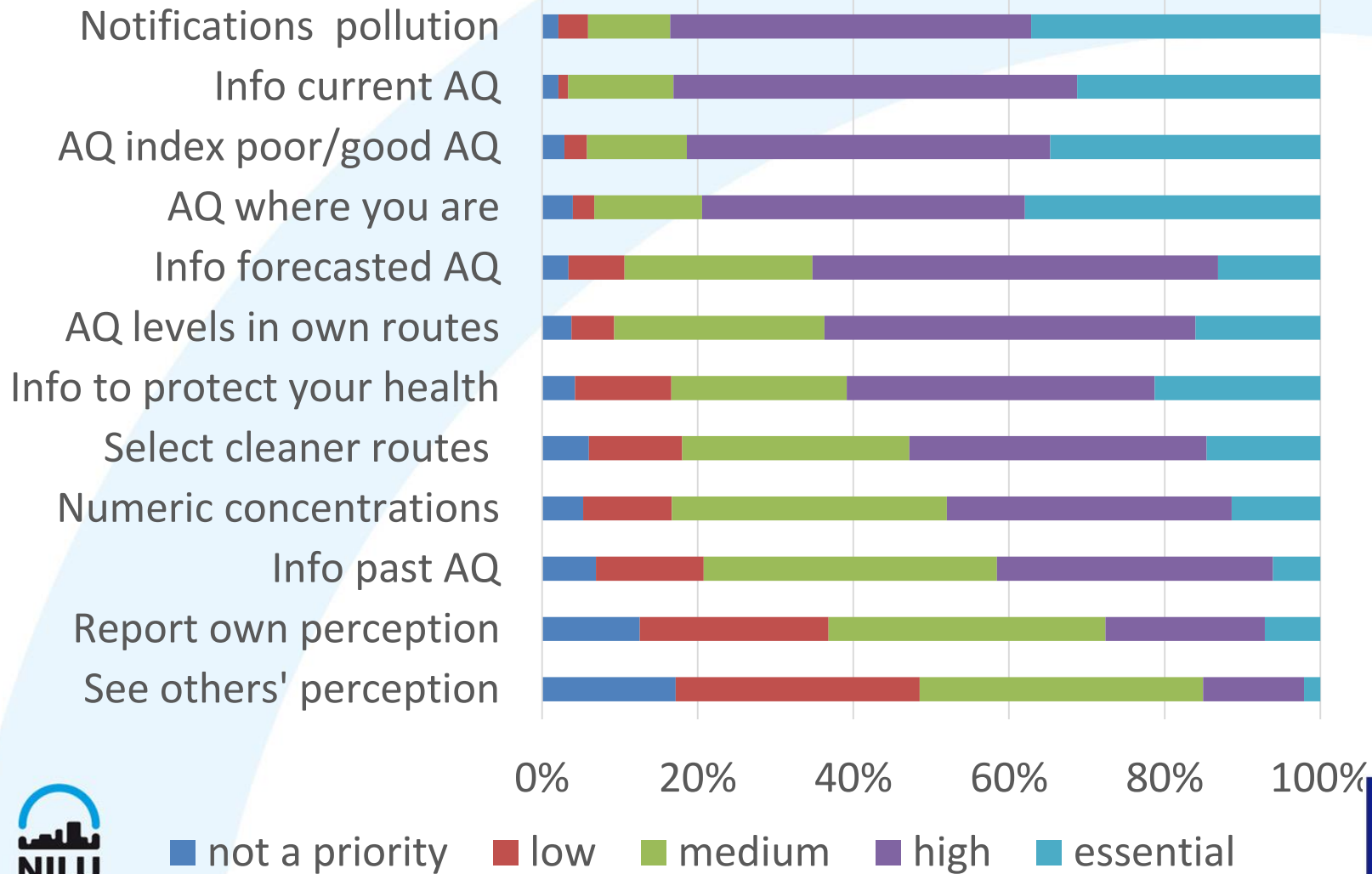
From raw data to processed/quality assured data

Research questions:

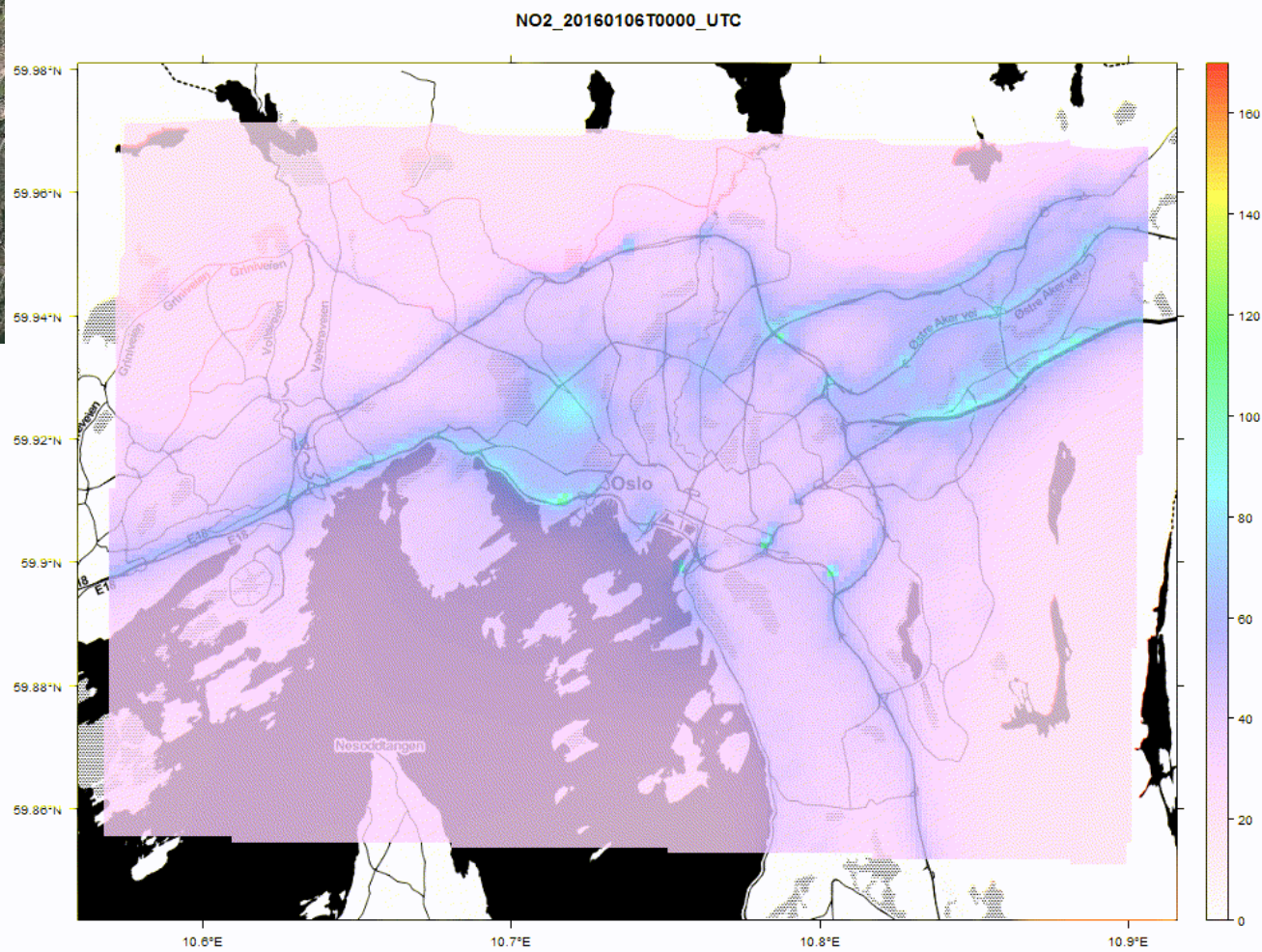
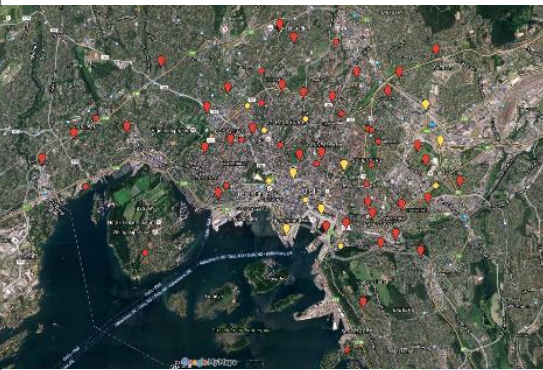
- Calibration routines (individual instrument - CEN; network -?)
- Sensor network properties
- Visualisation methodologies
- Underlying technologies and connectivity/datasharing

What people want to know on AQ

What would you like to see on an app?



Real time air quality map



Air quality on a map

The screenshot displays the CITI-SENSE Outdoor Data Portal for Barcelona. The browser address bar shows the URL: `srv.dunavnet.eu/new/citisen/OutdoorDataPortal/#Barcelona`. The page features a search bar and a navigation menu on the left with options like 'LOCATION' (set to Barcelona), 'TIME PERIOD', 'LAYERS', 'FILTERS', and 'FOR LEO USERS'. A central map shows air quality data for the Barcelona region, with a color-coded legend for 'Air Pollution Indication' ranging from 'Very low' (green) to 'High' (red). The legend also includes symbols for 'Static sensor units' (circles), 'Mobile sensor units' (triangles), and 'User perception' (stick figures). The map shows various sensor locations and pollution levels across the area, including locations like Rubí, Sant Joan Despi, and L'Hospitalet de Llobregat. The bottom of the image shows a Windows taskbar with various application icons and a system tray displaying the time as 17:37 on 25.05.2016.

Are low cost sensors really low-cost?

Public monitoring networks:

- High investment cost
- Rigorous QA/QC
- (High) operating costs
- Benefit: comparability in time and space

Sensor systems:

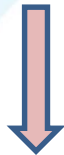
- Low investment costs for monitoring technology
- Unclear QA/QC
- High operating costs for sustained operation
- Benefit: local and spatial resolution high

Way forward:

low-cost sensor system network

Sensor system unit is not a miniature reference station (low public literacy in metrology)

Siting: natural variability and large gradients of air quality within an urban area



Strength is in numbers: the network

Way forward

Sensor systems network infrastructure

- Heterogeneous sensor system deployment
- ICT infrastructure for data harvesting
- Requires new funding mechanisms

Data processing infrastructure

- On the fly calibration and correction
- Connectivity to other systems
- Real time products
- Service provided by the municipality/EPA

www.nilu.no

www.hackair.eu

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