3M4city 2014: Modelling, Mining, Managing smart city data flows

Smart Cities Data Streams Integration: experimenting with Internet of Things and social data flows

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PRESENTATION ABSTRACT

Smart cities are nowadays expanding and flourishing worldwide with **Internet of Things (IoT),** i.e. smart things like sensors and actuators, and mobile devices applications and installations which change the **citizens'** and **authorities' everyday life**.

Smart cities produce daily huge streams of sensors data while citizens interact with Web and/or mobile devices utilizing social networks.

- New approaches to integrate big data streams from both sensors and social networks are needed to exploit big data production and circulation towards offering innovative solutions and applications.

- This presentation outlines its research and industrial perspective and potential impact under the EADIC (Archimedes) and SmartSantander infrastructure (EU FP7) projects.

PRESENTATION OUTLINE

- The EADIC project and opportunities
- Smart City experimenting : concepts, motivation and ideas;
- SEN2SOC platform overview;
- SEN2SOC Architecture Specification and Components Design;
- SEN2SOC experiment : setting the requirements;
- EADIC and SEN2SOC audience and impact.

todays SMART cities...

sensor networks: accurate measurements of physical parameters and phenomena (impact on citizens' life)

1. identify phenomena

(traffic congestion or atmospheric pollution at a particular area/time period)

2. take short-term actions

(inform/alert citizens and especially vulnerable social groups)

3. plan long-term actions

(understanding the progress of the phenomena and trying to address them)

...and SMART users

so far, smart sensor networks provide information about some parameters of a given phenomenon

OPEN QUESTIONS :

what are the effects on humans?

what knowledge can various social groups offer?

how can we utilize users' social response?

The EADIC project principles (I)

Various forms of smart cities are being developed around the world since 1990:

- Web or Virtual Cities such as the America on Line cities (USA) and the **digital city** of Kyoto (Japan);
- the **Knowledge Based Cities** the Copenhagen base and the knowledge democracy of Blacksbourg (Scotland);
- the **Broadband Cities** such as Beijing (China), Hull (UK), Amsterdam (Holland) etc.; Digital Democracies and Nework Cities such as Eurocities (Europe) and Smart Communities;
- **Smart Cities** such as Malta and Dubai; Wireless Cities such as New York and Chicago; Ubiquitous Cities such as New Songdo (South Korea) and Osaka (Japan).
- All apply different ICT solutions or they apply the same solutions in different manner in order to achieve their particular targets.
- face common challenges : improvement of everyday life in their local communities, the development of the local market, new job opportunities, access to information and knowledge etc.

The EADIC project principles (II)

Enterprise Architecture for Digital Cities (**EADIC**) project, which is funded by the Greek Ministry of Education and investigates the smart city domain for viability features.

- **Enterprise Architecture** is an important knowledge base, which describes the strategic mission of an organization, the information and the technologies which are necessary to succeed in the strategic targets, and the migration procedure to handle technological change.
- the EA supports the organization's **stakeholders** (managers, ICT staff, marketing etc.) providing them with the standards for the development of new infrastructure and of new services; and for the process re-engineering that is necessary for the development of **new products and services**, and for the <u>change</u> management, which accompanies the new products and services

SEN2SOC concept

SEN2SOC: *bridging SENsor measurements and SOCial networks interactions via natural language generation for supporting smart city services*

❖ Internet of Things (IoT)

❖ smart city infrastructures

❖ smart living: "a mastered continuum of people, computers and things"

❖ **objective**: build apps that exploit IoT data streams (e.g., sensor data) and capture social pulse (e.g., Twitter)

SEN2SOC

sensor data → social network users

social interaction
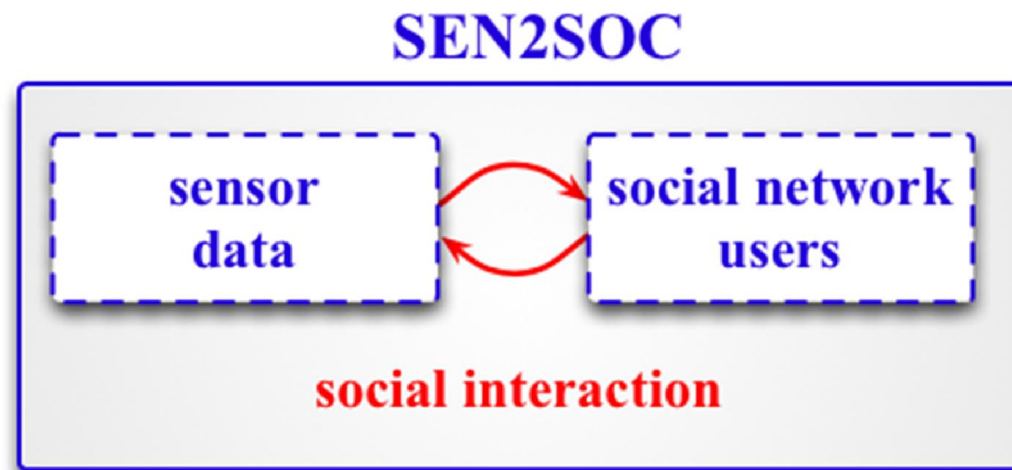
SEN2SOC motivation

current Internet of Things (IoT) and Internet of Services (IoS) apps:
opportunities to test services/infrastructures

...*but* offer merely quantitative solutions (data from devices/sensors)

SEN2SOC: let's go *beyond quantitative outcomes*

...people are interested in qualitative human-oriented solutions

new design framework for integrating:
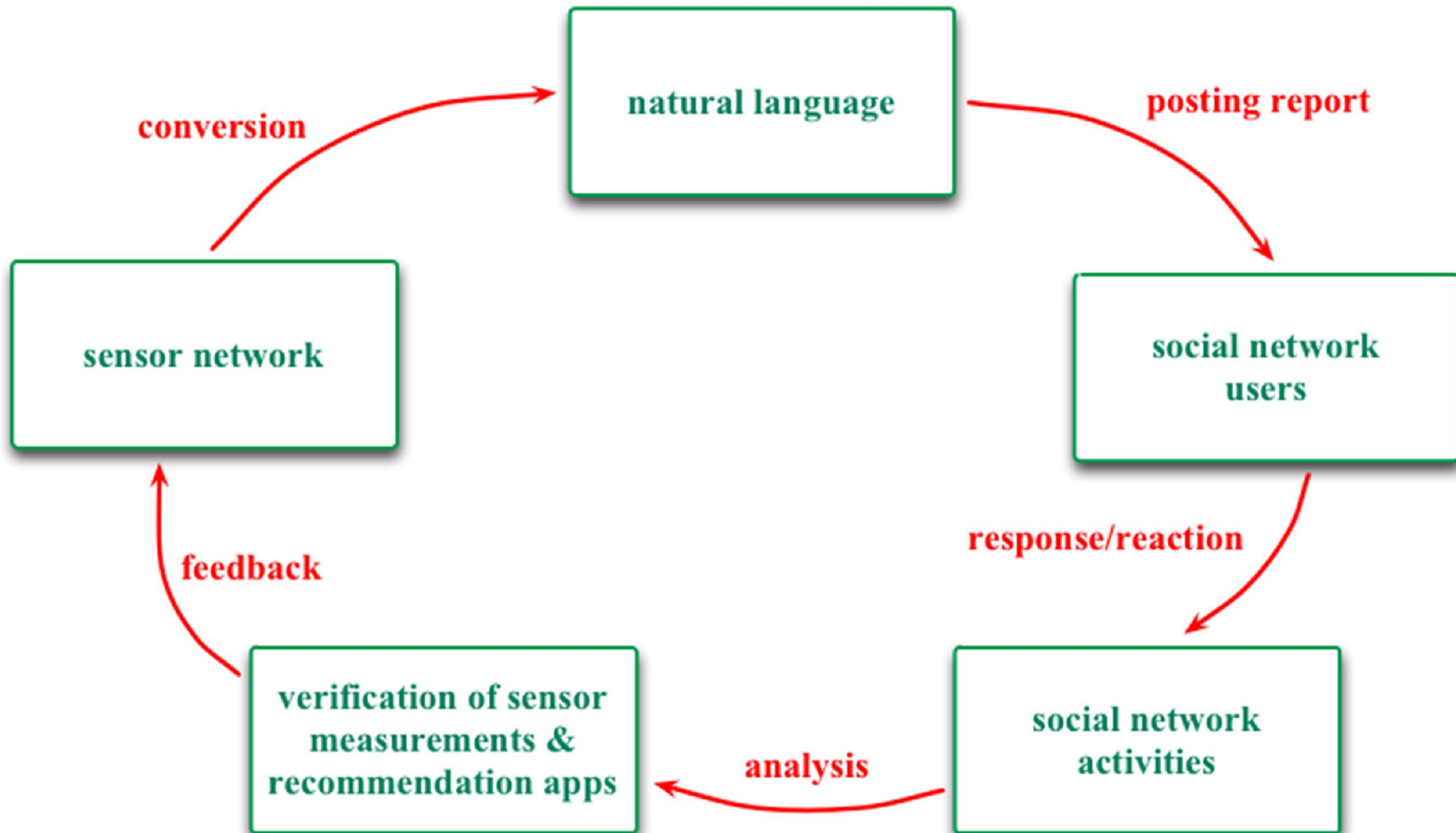
quantitative sensor-generated data

+

qualitative human-generated data

SEN2SOC = sensor-to-social reciprocal relationship

the SEN2SOC experiment

SEN2SOC will exploit and enhance SmartSantander testbed
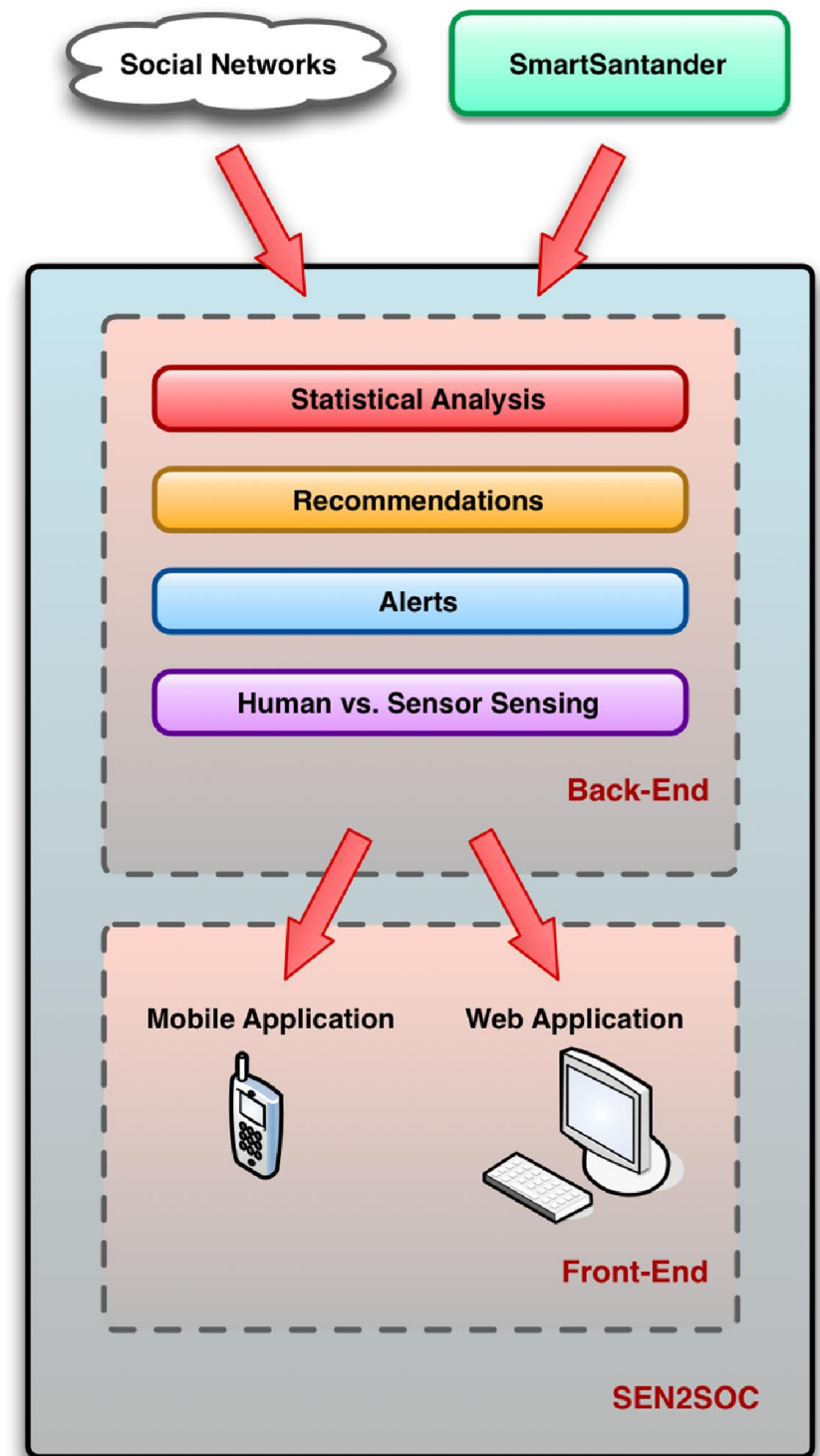
1. utilize sensor measurements

interpreted in natural language postings & uploaded in social networks

2. follow social network activities around *sensor postings* and capture "*human sensing*" and crowd observations

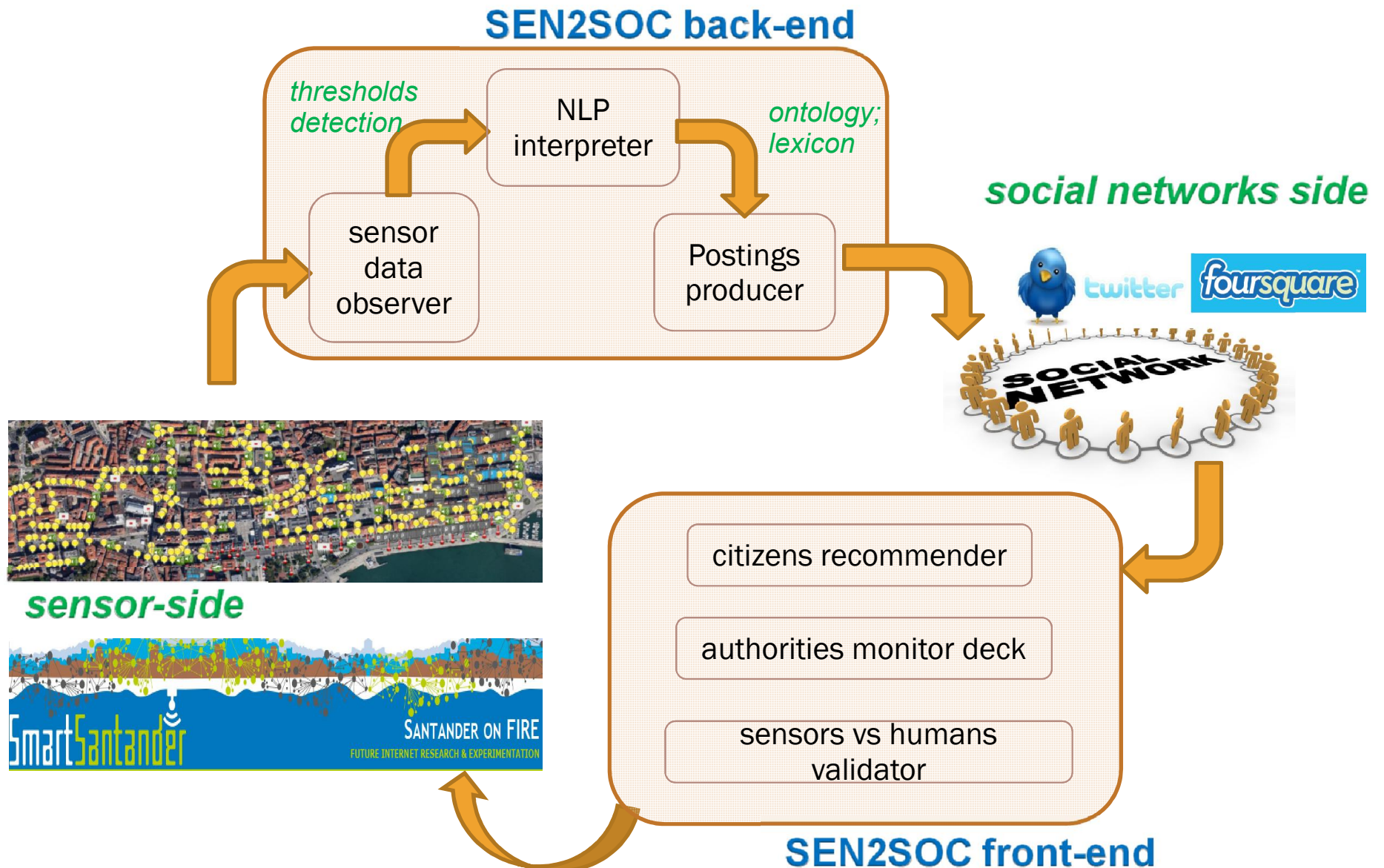(traffic conditions, pollution, temperature, humidity, etc.)

Note: user info provided either by explicit postings or indirectly via social network actions
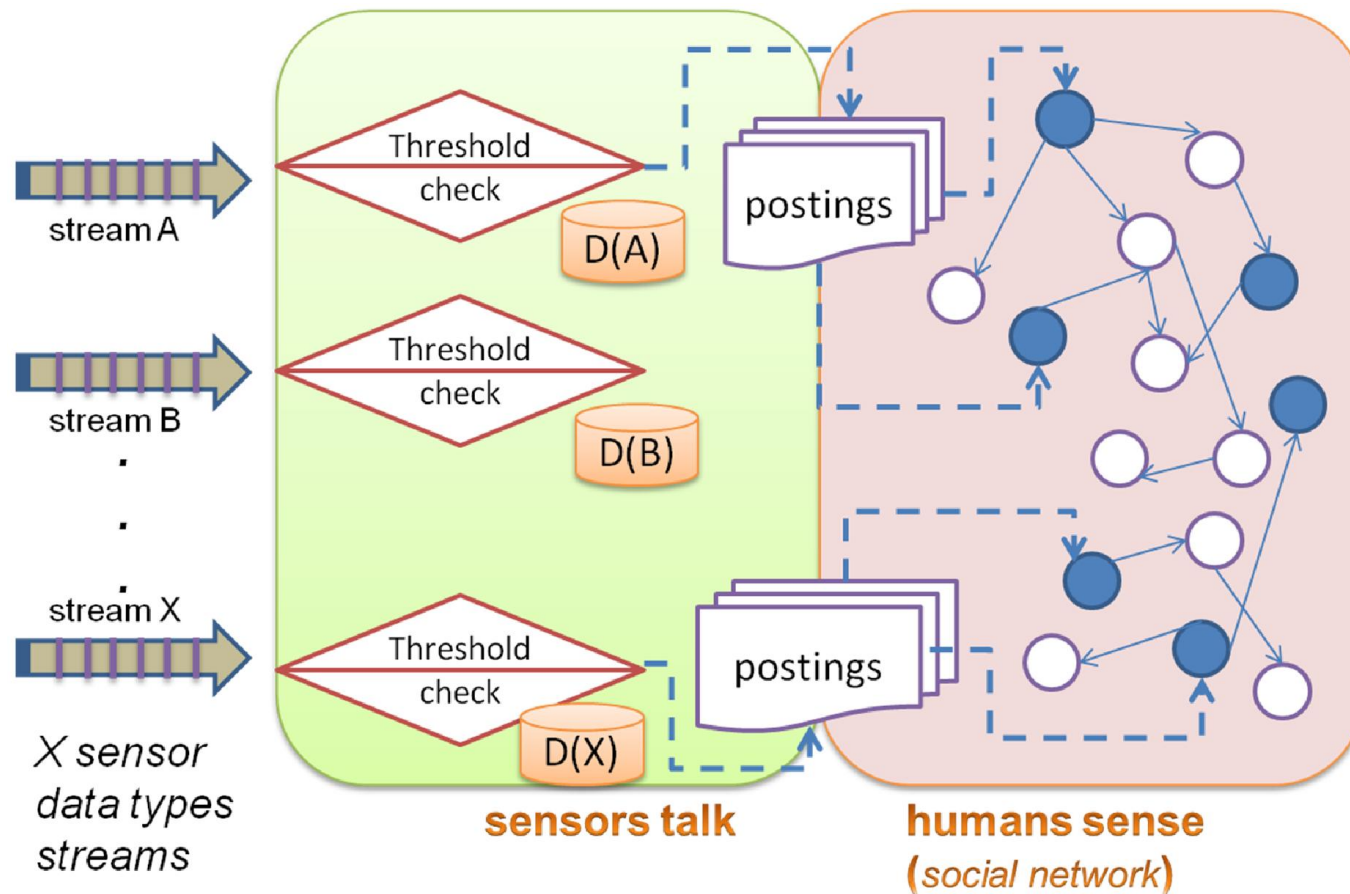
SEN2SOC platform principles

1. *back-end module:* retrieves and analyzes sensor data, and detects extreme sensor measurements

2. *sensor-to-social interpretation mechanism:* generates alerts (social media postings or mobile application alert messages) when extreme environmental conditions are observed

3. *front-end module:* monitors and analyzes social networking activity and provides services to Santander citizens, visitors, and city authorities

Social Networks

SmartSantander

Statistical Analysis

Recommendations

Alerts

Human vs. Sensor Sensing

Back-End

Mobile Application

Web Application

Front-End

SEN2SOC

SEN2SOC platform overview

SEN2SOC back-end

thresholds detection → NLP interpreter → ontology; lexicon

sensor data observer

Postings producer

social networks side

twitter foursquare

SOCIAL NETWORK

sensor-side

SmartSantander

SANTANDER ON FIRE
FUTURE INTERNET RESEARCH & EXPERIMENTATION

citizens recommender

authorities monitor deck

sensors vs humans validator

SEN2SOC front-end

SEN2SOC innovation

SEN2SOC extends current SmartSantander sensor network with *"human-sensors"*

SmartSantander users: not only passive information consumers, but *active producers of information* themselves (info sharing)

14

SEN2SOC architecture & components

SEN2SOC architecture is component-based with :

- a stateless orchestrator component called Interface, which is accountable for service provision and data exchange among the SEN2SOC components.

- Sensor Data Monitoring constitutes the linking component between SEN2SOC and SmartSantander platforms, and its primary responsibility is to retrieve and store SmartSantander sensor data.
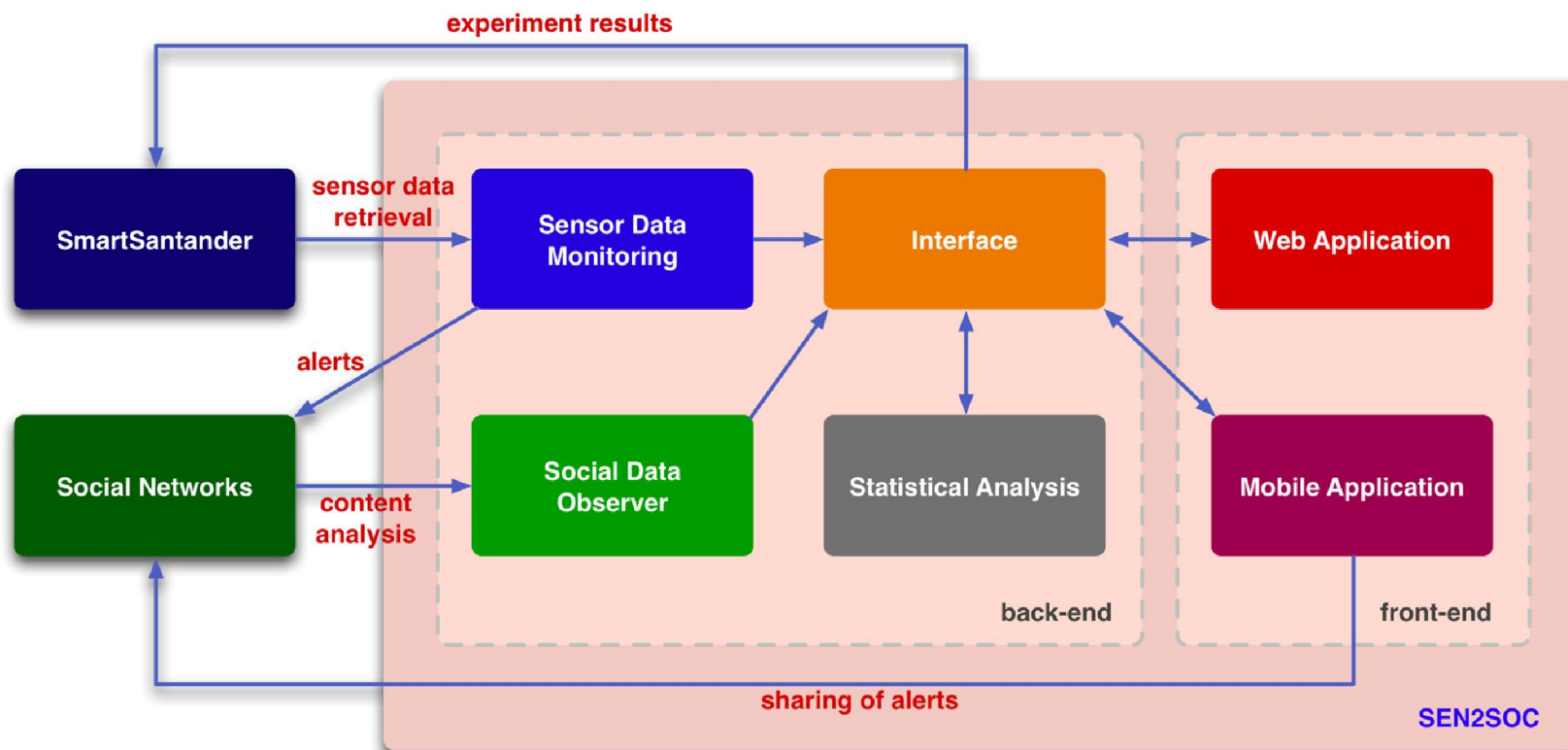
SEN2SOC challenges

| demanding data processing	improving the SmartSantander infrastructure	qualitative requirements
continuous sensor data recording	evaluation & validation of the SEN2SOC services	SEN2SOC user-friendly mobile and web apps
real-time processing	SmartSantander data availability	anonymity and privacy preservation
heterogeneous data (sensors, humans, apps)	measurement of SmartSantander platform responsiveness	collective activity capturing

SEN2SOC experiment control flow
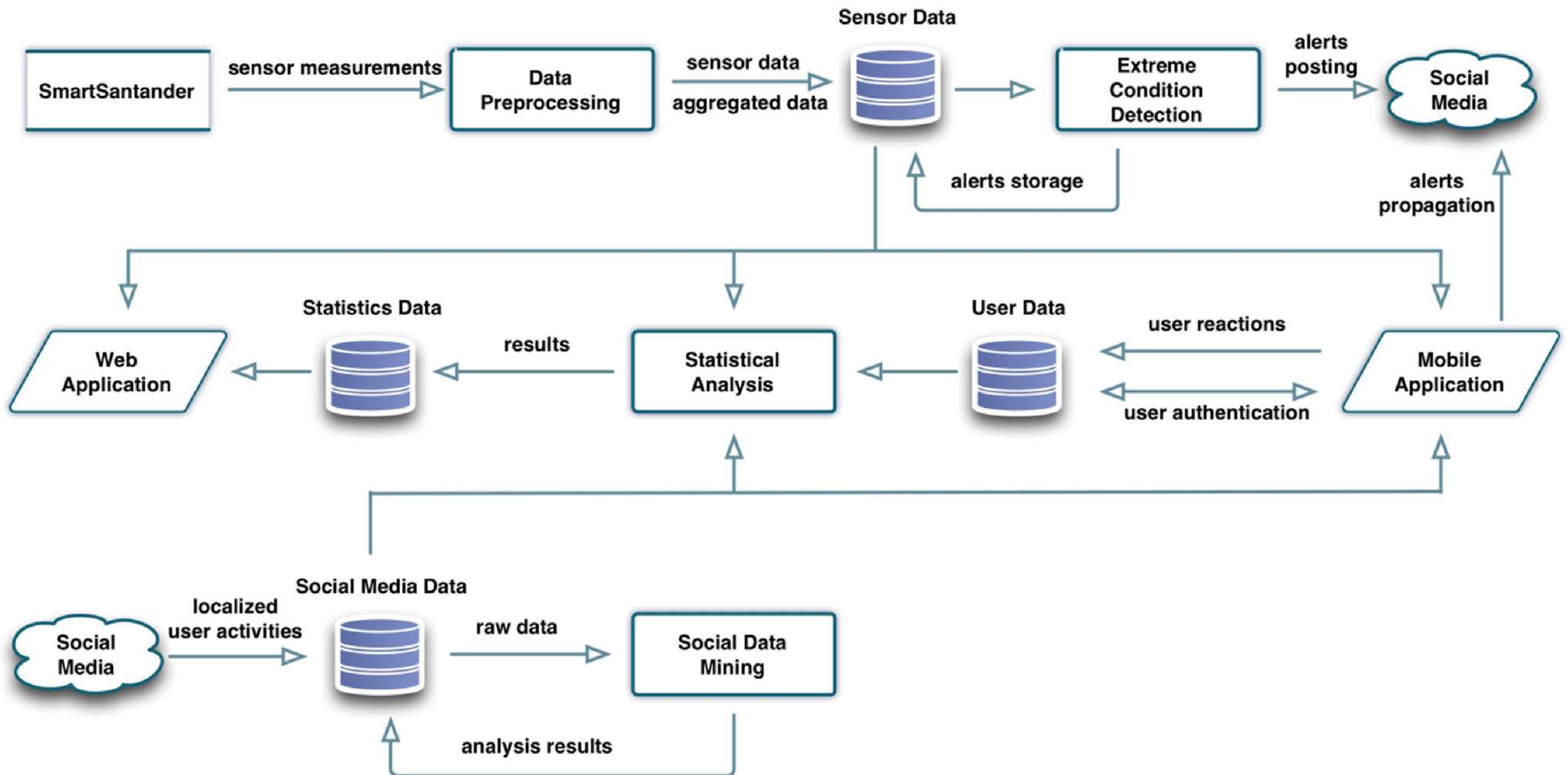
APPLICATIONS UTILIZING SENSOR AND SOCIAL DATA INTEGRATION
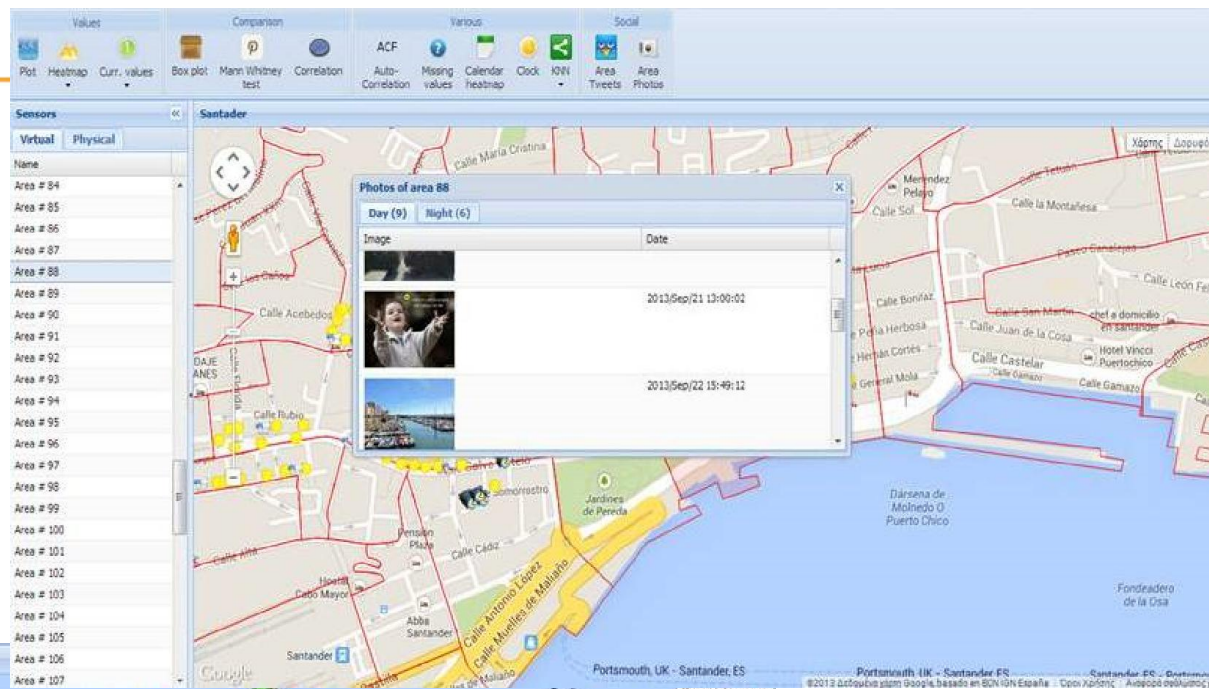
Santander area statistics out of Flickr activity
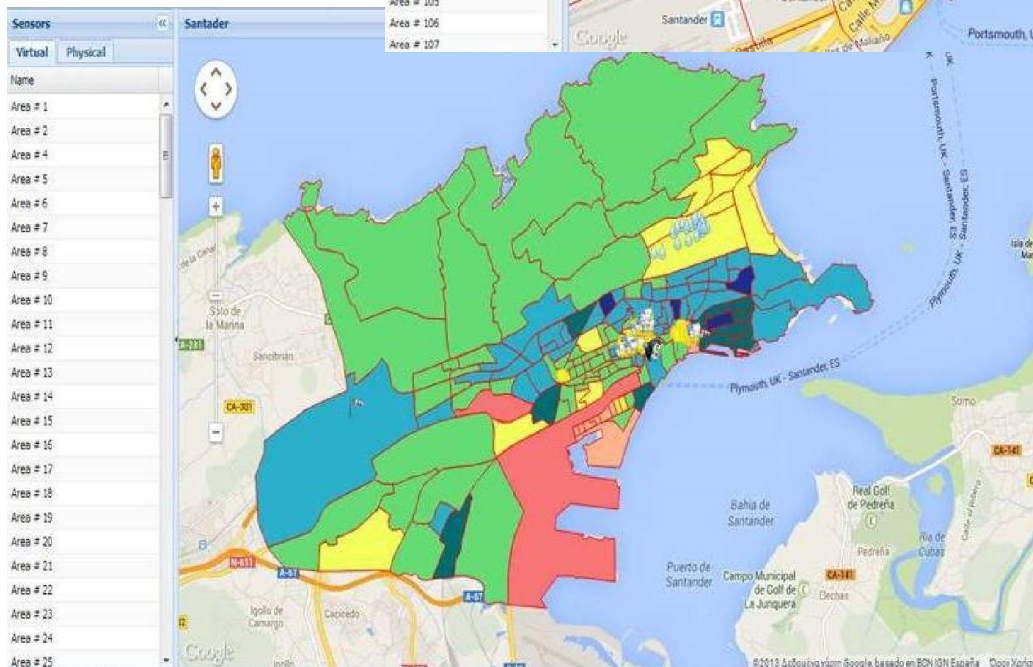
Heat map for CO metric
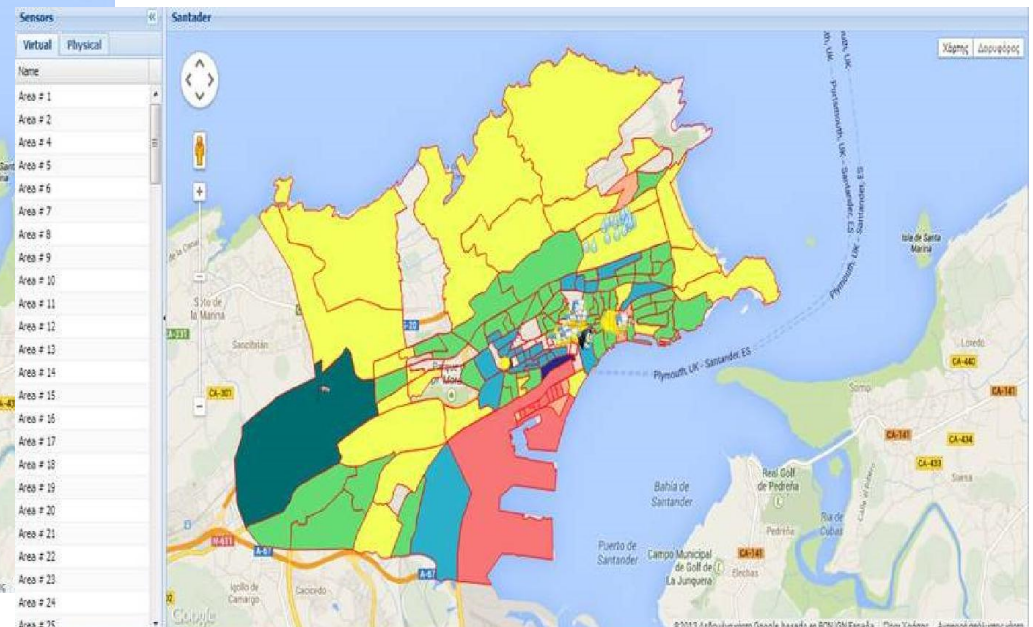
Heat Map for Temperature metric

citizens & visitors

real-time adaptive recommendations:

- city navigation
- Points of Interest (POIs) visiting

sensor network: distance, CO level, noise level, public transport routes and schedules, free parking spots

social network: qualitative characterization (for weather, parking availability, pollution rates), POIs highly evaluated by users, tourists' observations

19

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authorities

(city council, city's policy makers, emergency agencies, police, etc.)

city's major "variables" monitoring (e.g., noise, temperature, CO levels) via a user-friendly visualization interface

detection of problematic geographic areas (over-threshold sensor measurements)

broadcasting alert reports to citizens via social networks

SmartSantander project consortium

SEN2SOC experiment :

validates and complements sensor measurements

utilizes the public's responsiveness (opinions and reactions on sensor postings & alerts)

reveals areas of problematic sensor functionality or of poor measurements

SENSOR AND SOCIAL DATA INTEGRATION: INDUSTRIAL EXPLOITATION

commercial exploitation potential of these services is huge and the companies are approaching it from different perspectives.

- In Smart Santander, large companies like Telefonica and Ericsson provided the key components of the platform enabling storage and semantic annotation of the sensor data and a repository of semantic descriptions of all available sensors in the system thus enabling their dynamic discovery (Resource Directory).

- Ericsson collaborates actively with the cities on promotion of smart city solutions and has already deployed the ekobus service, a combination of public bus fleet management and environment monitoring service in the city of Pancevo where the Resource Directory is used as one of the key enablers.

- In collaboration with the city of Novi Sad, a participatory sensing application has been released.

- A number of small companies are specializing in development and deployment of various hardware components that can be used in the cities, while large companies like Intel and ARM are creating the enablers for development of small, cost and energy efficient hardware components