# Air Pollution Monitoring based on Participatory Sensing

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Motivation for Participatory Sensing

- **Participation** of cellular phones users in a **cooperative way**.

- The **spatial resolution** that a PS system provides can replace the traditional measuring approach.

- To measure, detect and analyze events that occur at different **spatial scales**.

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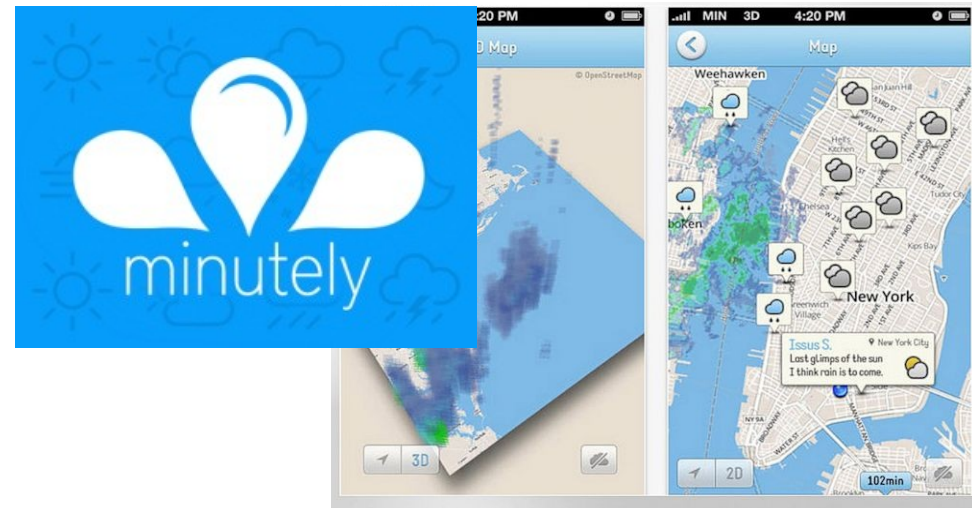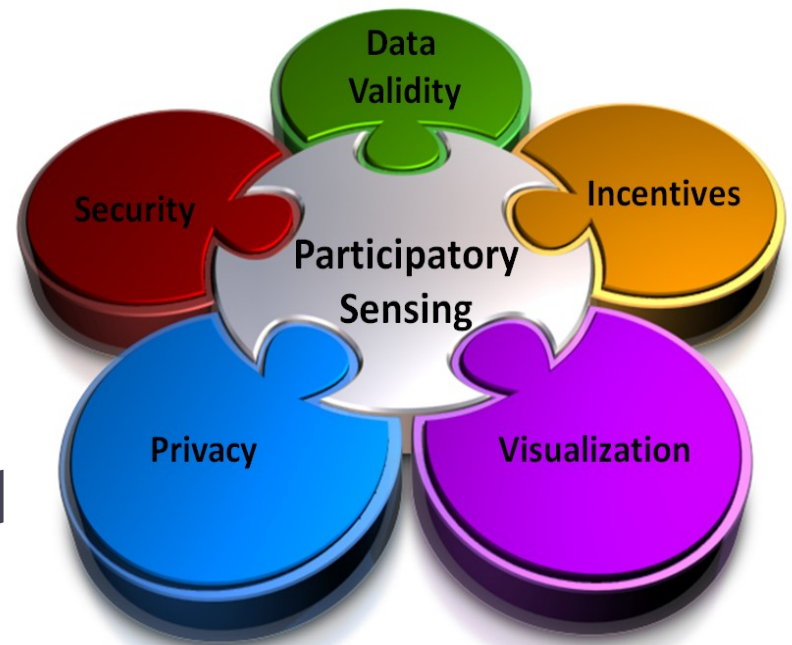
Pollution Monitoring
Traditional vs. PS approach

▸ Pollution monitoring is important because:

- ▸ Government officials: monitor the Air Quality Index (AQI)
- ▸ Doctors: correlate respiratory problems to AQI.
- ▸ County officials: where to build a new school or hospital.

Traditional Approach	Participatory Sensing
Expensive stations	Cheap cellphones and sensors
High accuracy	Low accuracy
Low failure rate	High failure rate
One or two stations per county	Massive amount of users
Static stations	Mobile users

But there are Challenges!!!
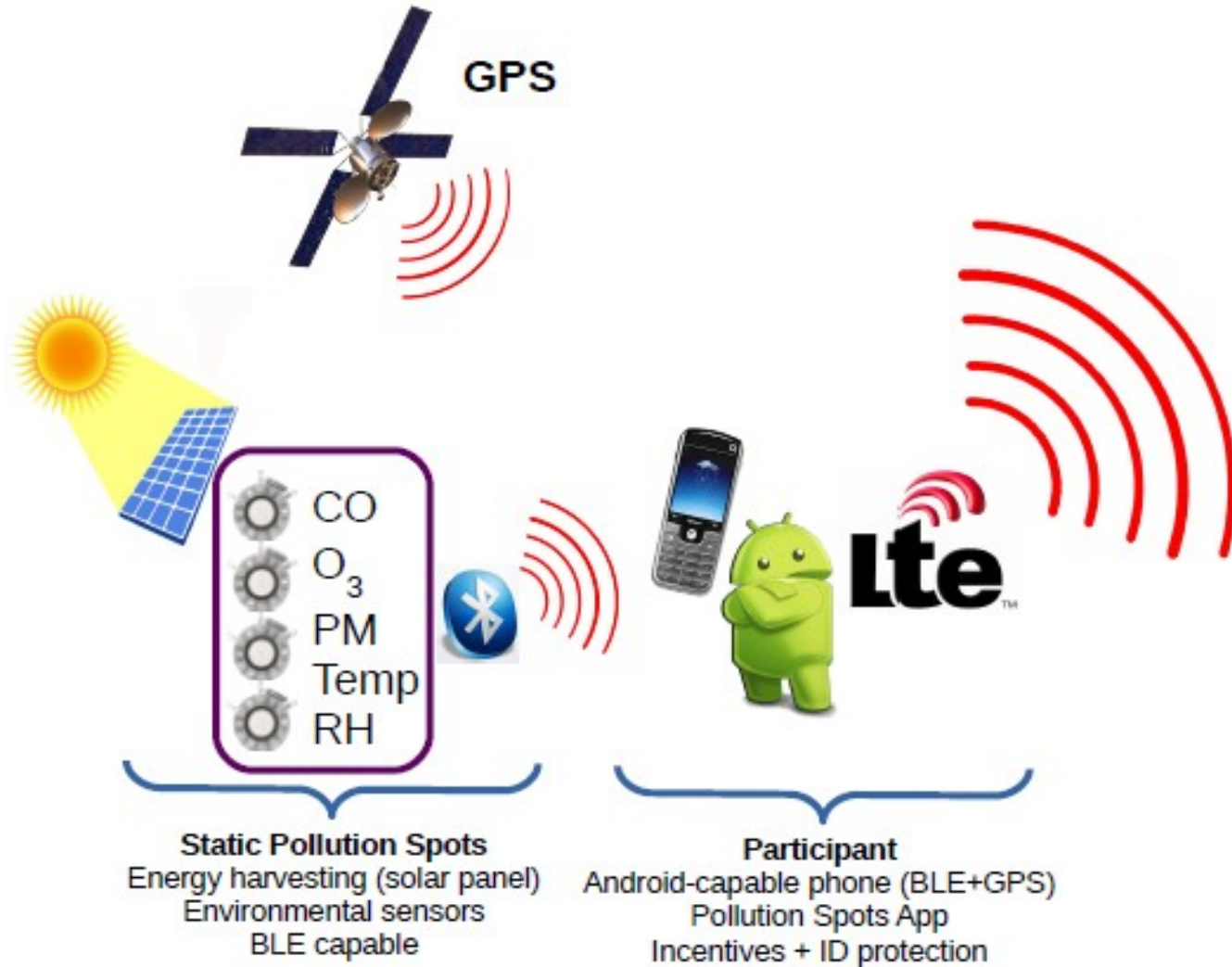
Since the devices are cheaper and in the hands of the users:

▶ Sensor's accuracy is lower.

▶ Sensors may fail more frequently.

▶ Malicious users.

▶ Incentives to participate.

▶ Protect users' identity and information.

Pollution Monitoring @PUJ

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Spot Architecture

GPS

CO
O_3
PM
Temp
RH

Static Pollution Spots
Energy harvesting (solar panel)
Environmental sensors
BLE capable

Participant
Android-capable phone (BLE+GPS)
Pollution Spots App
Incentives + ID protection

lte

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The General Architecture

Pollution Spots + Participants

GPS

Internet

Servers

IP Transport Network

Servers

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Initial Results

pollution spots

Variable Contaminante:
- ◉ Monóxido de Carbono
- ○ Ozono
- ○ Material Particulado
- ○ Temperatura
- ○ Humedad Relativa
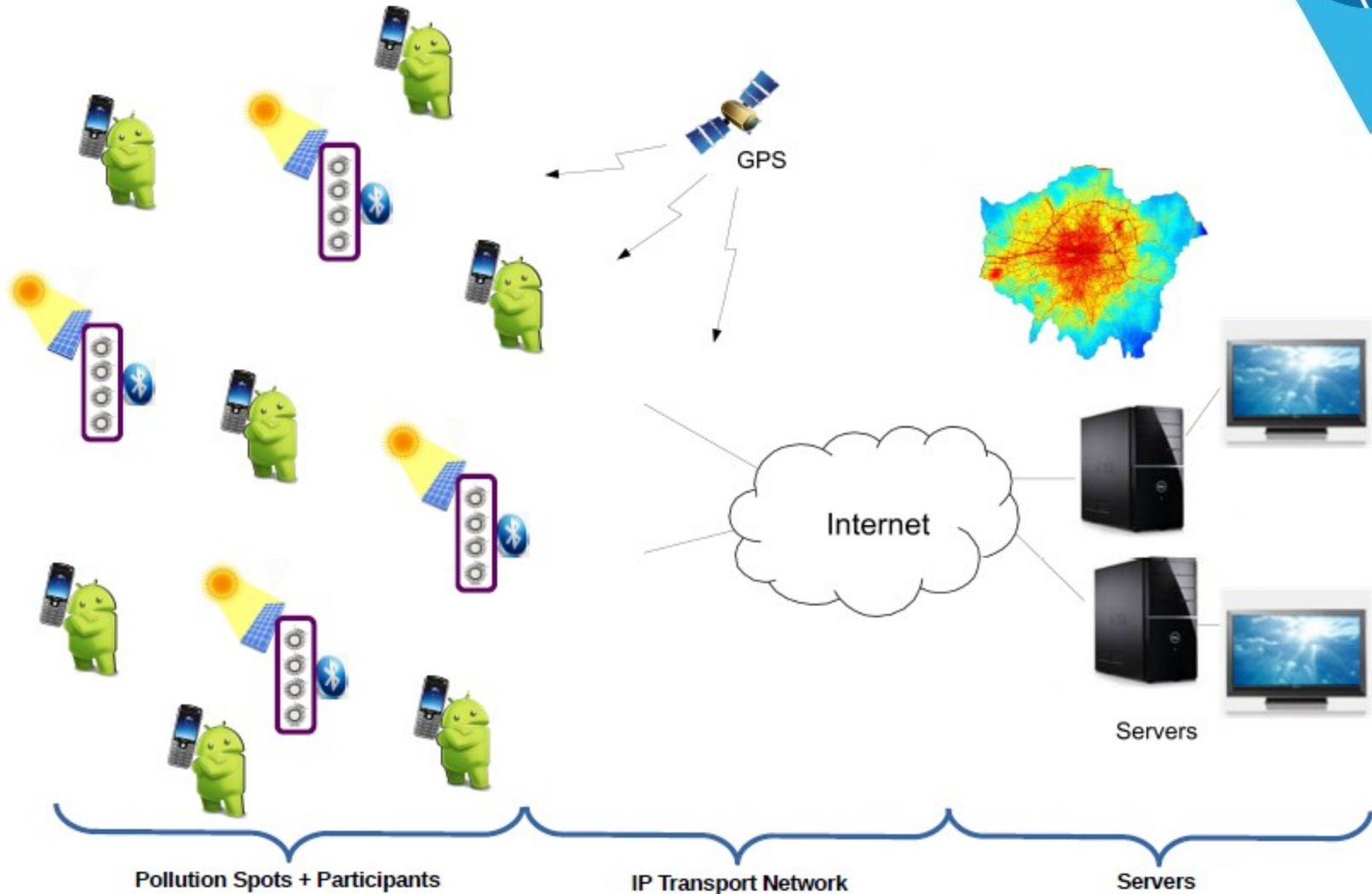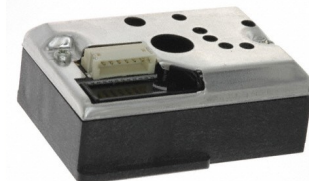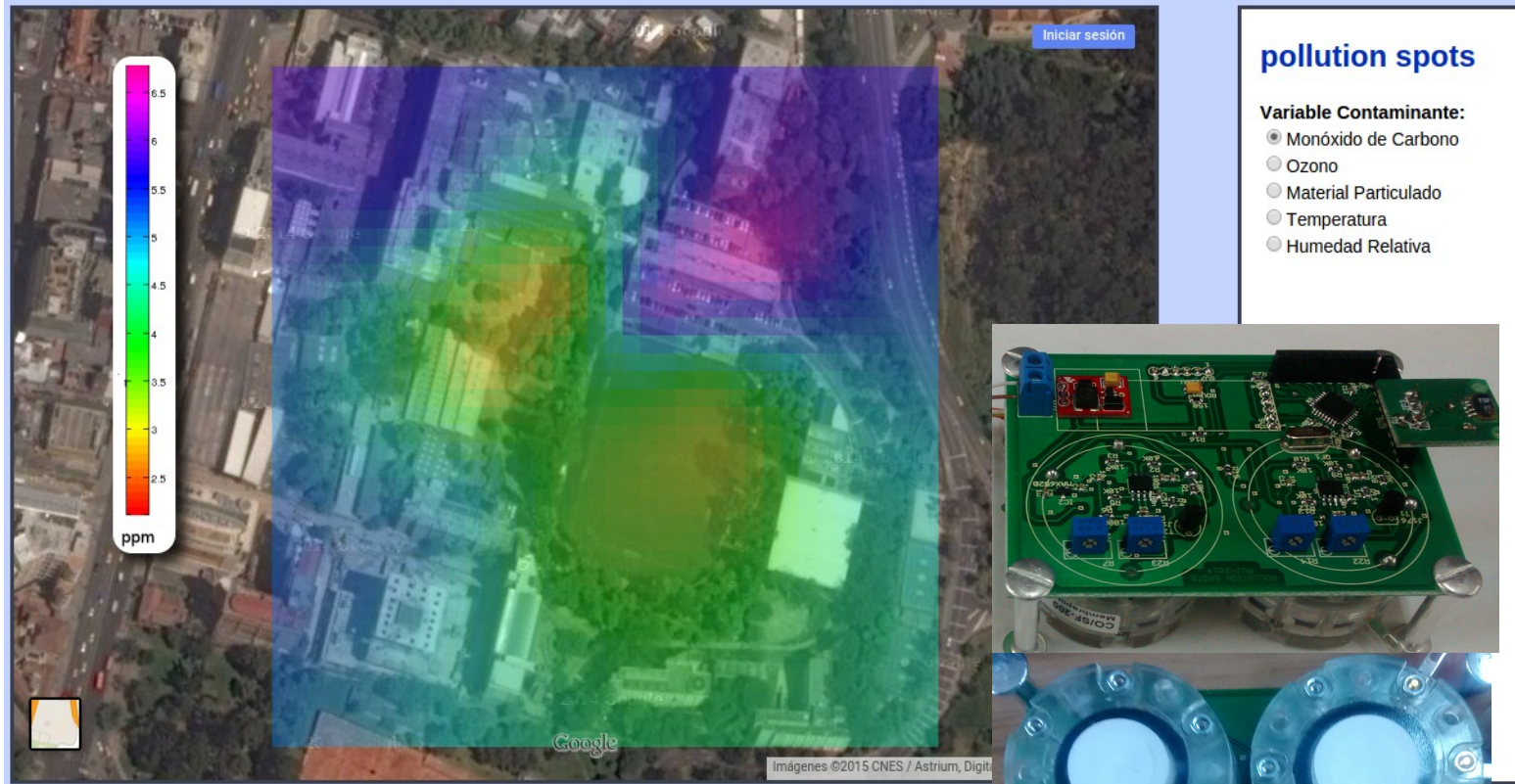
Ongoing work:
- Sensor calibration
- Incentives mechanisms

Related Publications

GENERAL ISSUES
- **Pollution Spots: A Novel Method for Air Pollution Monitoring.** RODRÍGUEZ, Laura; MÉNDEZ, Diego. To appear on Air Pollution proceedings. Valencia, Spain. June. **(2015)**
- **A General Framework for Participatory Sensing Systems.** MÉNDEZ, Diego; LABRADOR, Miguel. Journal of Networks. Volume 9, No 11. November. Pages 2994-3004. **(2014)**
- **Density Maps: Determining Where to Sample in Participatory Sensing Systems.** MÉNDEZ, Diego; LABRADOR, Miguel. Proceedings of the 3rd FTRA International Conference on Mobile, Ubiquitous, and Intelligent Computing (MUSIC'12). Vancouver, Canada. June 26-28. **(2012)**
- **P-sense: A Participatory Sensing System for Air Pollution Monitoring and Control.** MÉNDEZ, Diego; PEREZ, Alfredo; LABRADOR, Miguel; MARRON Juan. PerCom WiP Session. Proceedings of IEEE International Conference on Pervasive Computing and Communications (PerCom 2011). Seattle, USA. **(2011)**

PRIVACY & SECURITY
- **Privacy, Quality of Information, and Energy Consumption in Participatory Sensing Systems.** VERGARA-LAURENS, Idálides; MÉNDEZ, Diego; LABRADOR, Miguel. Proceedings of IEEE International Conference on Pervasive Computing and Communications (PerCom 2014). Budapest, Hungry. March. **(2014)**
- **On the Interactions between Privacy-Preserving, Incentive, and Inference Mechanisms in Participatory Sensing Systems.** VERGARA-LAURENS, Idálides; MÉNDEZ, Diego; LABRADOR, Miguel. The 7th International Conference on Network and System Security (NSS), Madrid Spain, June 2013. Lecture Notes in Computer Science (LNCS). Volume 7873. Pages: 614-620. **(2013)**

DATA VISUALIZATION
- **Data Interpolation for Participatory Sensing Systems.** MÉNDEZ, Diego; LABRADOR, Miguel; RAMACHANDRAN, Kandethody. Pervasive and Mobile Computing journal. Volume 9, Issue 1. February. Pages 132-148. **(2013)**

DATA VERIFICATION
- **On Sensor Data Verification for Participatory Sensing Systems.** MÉNDEZ, Diego; LABRADOR, Miguel. Journal of Networks. Volume 8, No 3. March. Pages 576-587. **(2013)**
- **Removing Spatial Outliers in PS Applications.** MÉNDEZ, Diego; LABRADOR, Miguel. Proceedings of the International Conference on Selected Topics in Mobile and Wireless Networking (iCOST). Avignon, France. July 2-4. **(2012)**

Some other research initiatives

- Center of Excellence on the Internet of Things
  - Technological Leaders: IBM, Intel, Microsoft
  - Academic institutions: Universidad Javeriana, Universidad Tecnológica de Bolívar, Universidad Autónoma de Bucaramanga.
  - Companies: Colombian Coffee Growers Federation, Javeriana's University Hospital, Totto, Logyca.
  - Funded by: Colciencias and Colombian ICT Ministry
- Auto-configurable, self-healing distributed wireless sensor networks supporting high dependability for critical applications.
  - Colombian institutions: Universidad Javeriana and Univiersidad del Norte.
  - German institutions: BTU Cottbus, Universitat Erlangen-Nürnberg
  - Funded by: Colciencias (Colombia) and DFG (Germany)
- Low-cost capacitive sensors and NFC energy harvesting for water monitoring.
  - Universidad Javeriana and Univiersidad de los Andes.
  - Funded by: Colciencias

Grazie!

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