



# Sensor Networks and “Smart Cities” – The Landscape

National Air Quality Conference

1/26/2018

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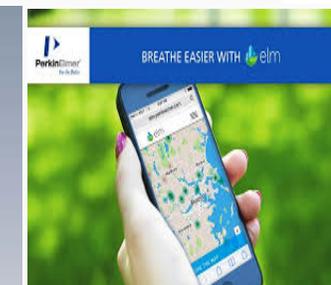
U.S. Environmental Protection Agency

**Disclaimer:** Material presented is for informational purposes only. EPA does not recommend nor endorse any particular sensor product or data management platform.

# Air Pollution Garments

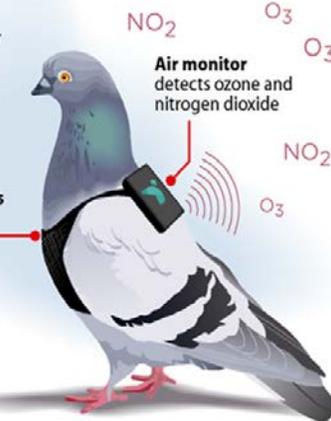


# Proliferation of Sensors & Real-time Data



**21st Century 'Canary in a Coal Mine'**  
 The Pigeon Air Patrol — a joint project by tech companies Plume Labs and DigitasLBI — released pigeons outfitted with air-monitoring packs to record and report real-time air pollution levels in London. This three-day venture was used to spread awareness on London's smog problem.

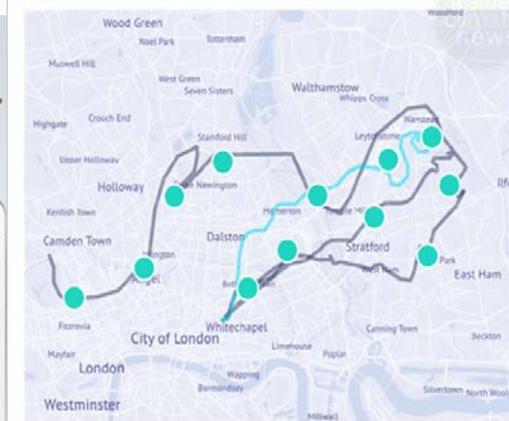
**WHAT IT IS**  
 Racing pigeons wear a small fabric vest outfitted with a feather-light backpack.



**Lightweight fabric harness**

One pigeon wore a GPS device instead of an air monitor.

**HOW IT WORKED**  
 Londoners Tweeted their location to a Pigeon Air team member and received real-time results (via Twitter) of air quality in their area.

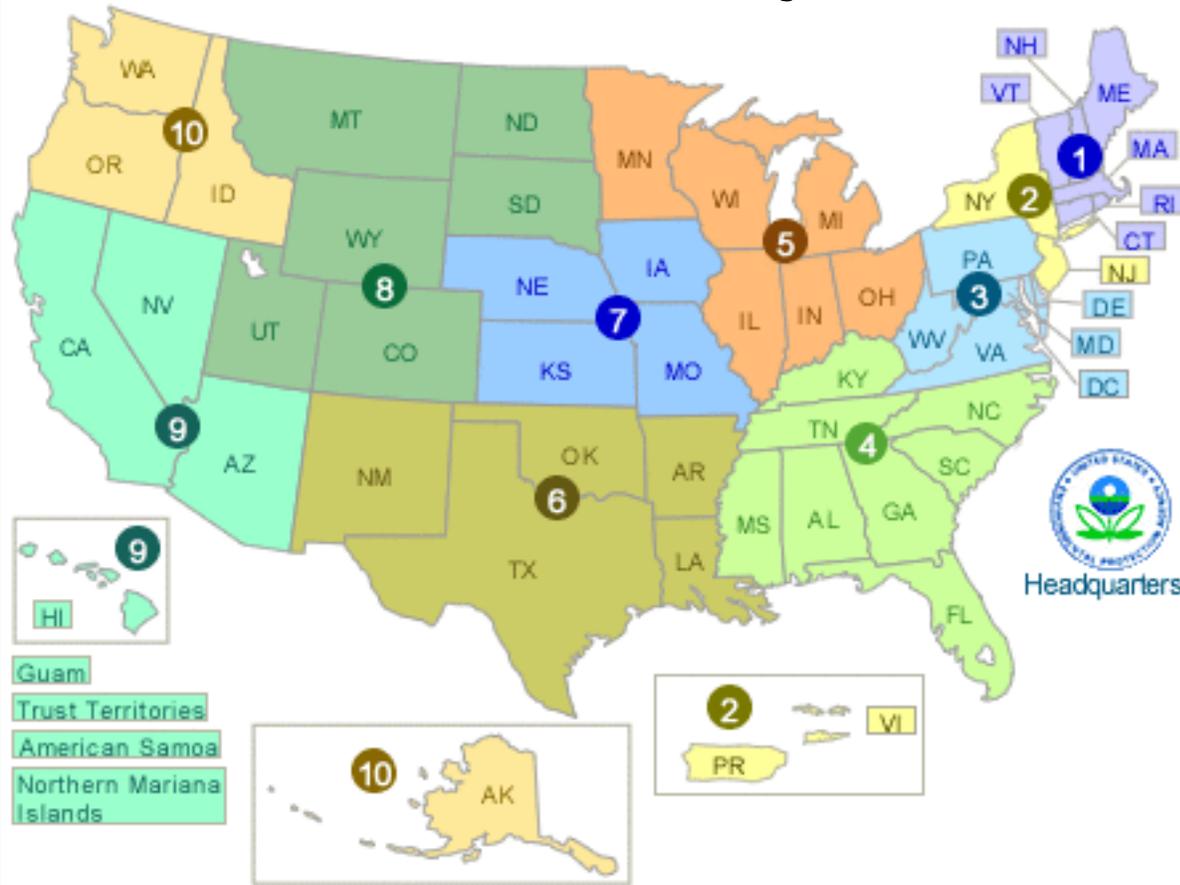


SOURCE: DigitasLBI

PAUL HORN / InsideClimate News



## 25+ Domestic Projects



### Inventory of Sensor Networks

| Region | Number of Projects |
|--------|--------------------|
| 1      | 2                  |
| 2      | 2                  |
| 3      | 5                  |
| 4      | 2                  |
| 5      | 3                  |
| 6      | 2                  |
| 7      | 1                  |
| 8      | 2                  |
| 9      | 7                  |
| 10     | 4                  |

Creating millions of data points from thousands of new monitors...

# Domestic Sensor Networks



## Project Goals (select examples):

- “Smart City” Development
  - Use sensor, traffic and other REAL-TIME data to improve transportation options, livability (noise), public health, economic development, & civic engagement
- Community Engagement
- Near-Source Emission Monitoring
  - Volcanos, wood smoke, facilities
- Personal Exposure Characterization
  - Deploy stationary and/or mobile sensors & monitor health

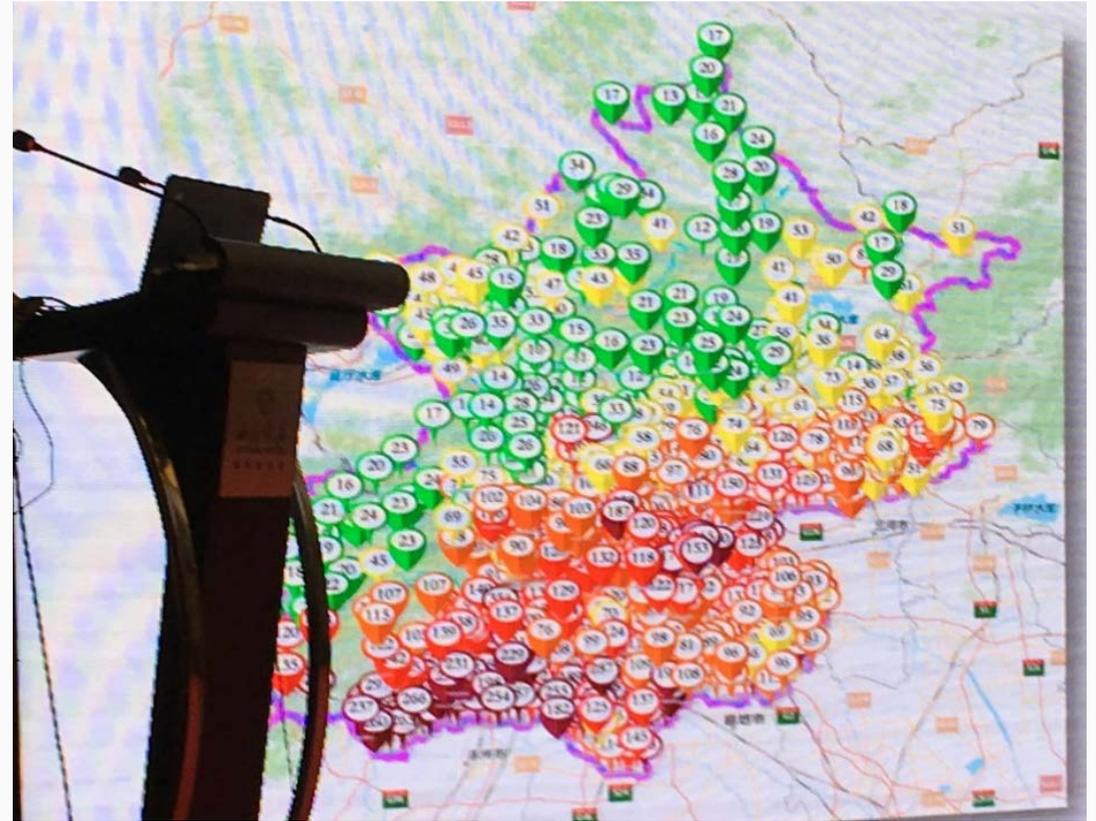


# International Sensor Networks



## Project Goals (selected examples):

- Supplement network monitoring
- Fill in monitoring gaps
- Incorporation of sensors as part of traditional air monitoring network



# Air Sensor "Categories"



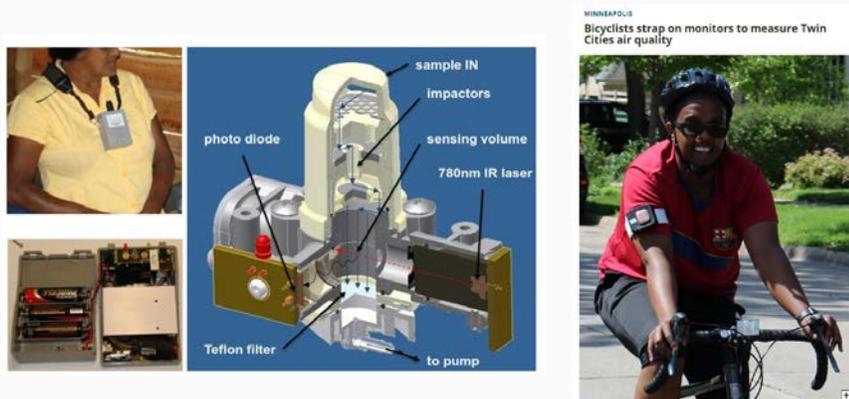
**Consumer-oriented turnkey devices:**



**Researcher- or developer-oriented, OEM sensors:**



**Portable devices for research, advocacy, and screening:**



**Large-scale air monitoring networks**



# Collection of Air Data



- United States is experiencing a **major shift** in the traditional role of government agencies as the *main resource* for collecting, storing, sharing, & communicating air data
  - Growing diversity of air monitoring...
    - Participants: Citizens, communities, researchers, academics, nonprofits, businesses
    - Data sets: Sensor, satellite remote-sensing, traditional monitoring networks
  - Information Technology (IT) companies & air quality data
    - Providing data storage & access, promoting use of cloud and advanced analytics (e.g. machine learning), developing consumer products (e.g. smartphone applications)



***Creating a need to make sense of it all***



## Key Focus Areas:

- ✓ Standardize Performance Characterization
  - ✓ Exploring the development of an independent third-party voluntary certification program
- ✓ Data Interpretation
- ✓ Data Standards

# Sensor Performance – Current State



Collocation of sensors with reference grade equipment in **ambient, stationary environments**

# Sensor Performance – Current State



- Initial testing of individual sensors shows promise
- However, long-term (i.e., more than 12 month) performance generally poorly characterized,
- Some sensors show progressive drift with time

# Sensor Performance – Current State



Research involving collocation of sensors with reference grade equipment near sources is needed – esp for localized pollutants

# Performance Target Workshop



- Purpose - Seeking individual views on non-regulatory sensor performance targets:
  - Pollutants
    - PM<sub>2.5</sub> & Ozone
  - Stakeholders
    - National and international participants from academia, government, manufacturers, and sensor technology end users
- Date and Location – Week of June 25, 2018 in RTP, NC
- Output: Summary of individual perspectives in a journal or report in late 2018
- Findings may inform 3<sup>rd</sup> party conformity assessment organizations interested in developing consensus-based standards for air sensor certification requirements



- Governments recognize...
  - Tremendous opportunity to learn from localized datasets
  - More real-time air quality data is increasingly available
    - But, context is needed – in general, the science on air pollution and health doesn't tell us what a few minutes of exposure to an elevated level of pollution means for an individual
    - There is a need to ensure air quality information is communicated with a scientifically-grounded approach & understand how people react to high-resolution data
    - Creation of unique air quality communication platforms, visualizations, interpretations, use of the AQI or AQI colors in different ways, and alerts have the potential to confuse the public



# Sensor Messaging



## Sensor Scale Project

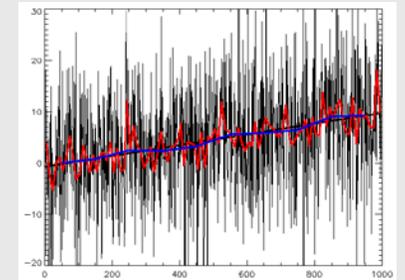


## Considerations

### Health Evidence



### Monitoring Data



### Sources



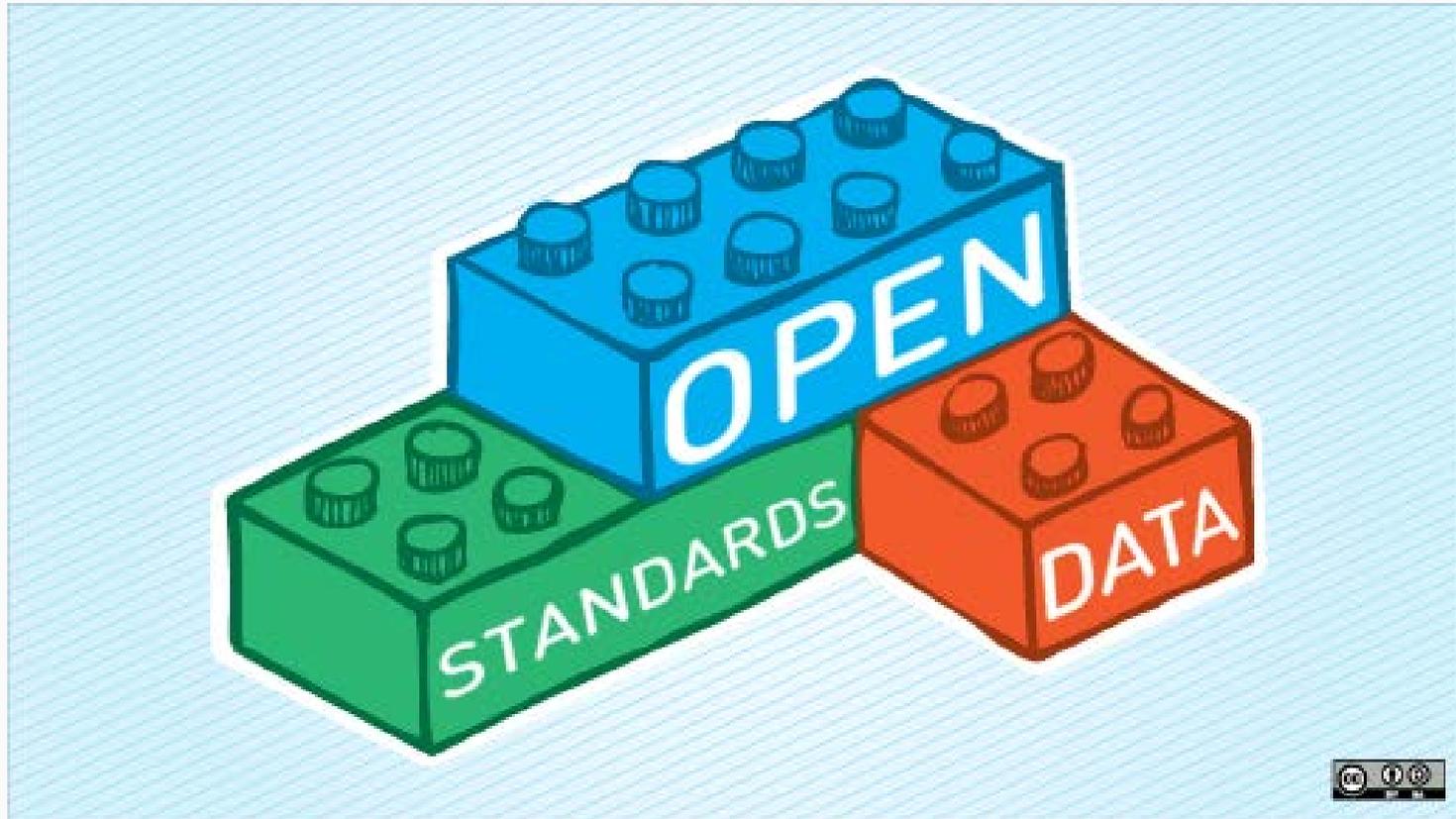
### Population of Interest



<https://www.epa.gov/air-sensor-toolbox>

PM<sub>2.5</sub> and Ozone  
Benzene, NO<sub>2</sub>, SO<sub>2</sub> (in 2018)

# Data Standards – Current State





- CA AB 617

- “The bill would require the state board to select, based on the monitoring plan, the highest priority locations in the state for the deployment of community air monitoring systems. The bill would require an air district containing a selected location, by July 1, 2019, to deploy a system in the selection location.”
- [https://leginfo.legislature.ca.gov/faces/billNavClient.xhtml?bill\\_id=201720180AB617](https://leginfo.legislature.ca.gov/faces/billNavClient.xhtml?bill_id=201720180AB617)

- H.R. 3959

- Crowd Sourcing of Environmental Data Act of 2017
- “To amend the Clean Air Act to give States the option of monitoring covered criteria air pollutants in designated areas by greatly increasing the number of air quality sensors in exchange for greater regulatory flexibility in the methods of monitoring, and for other purposes”
- <https://www.congress.gov/bill/115th-congress/house-bill/3959/text/?format=xml>

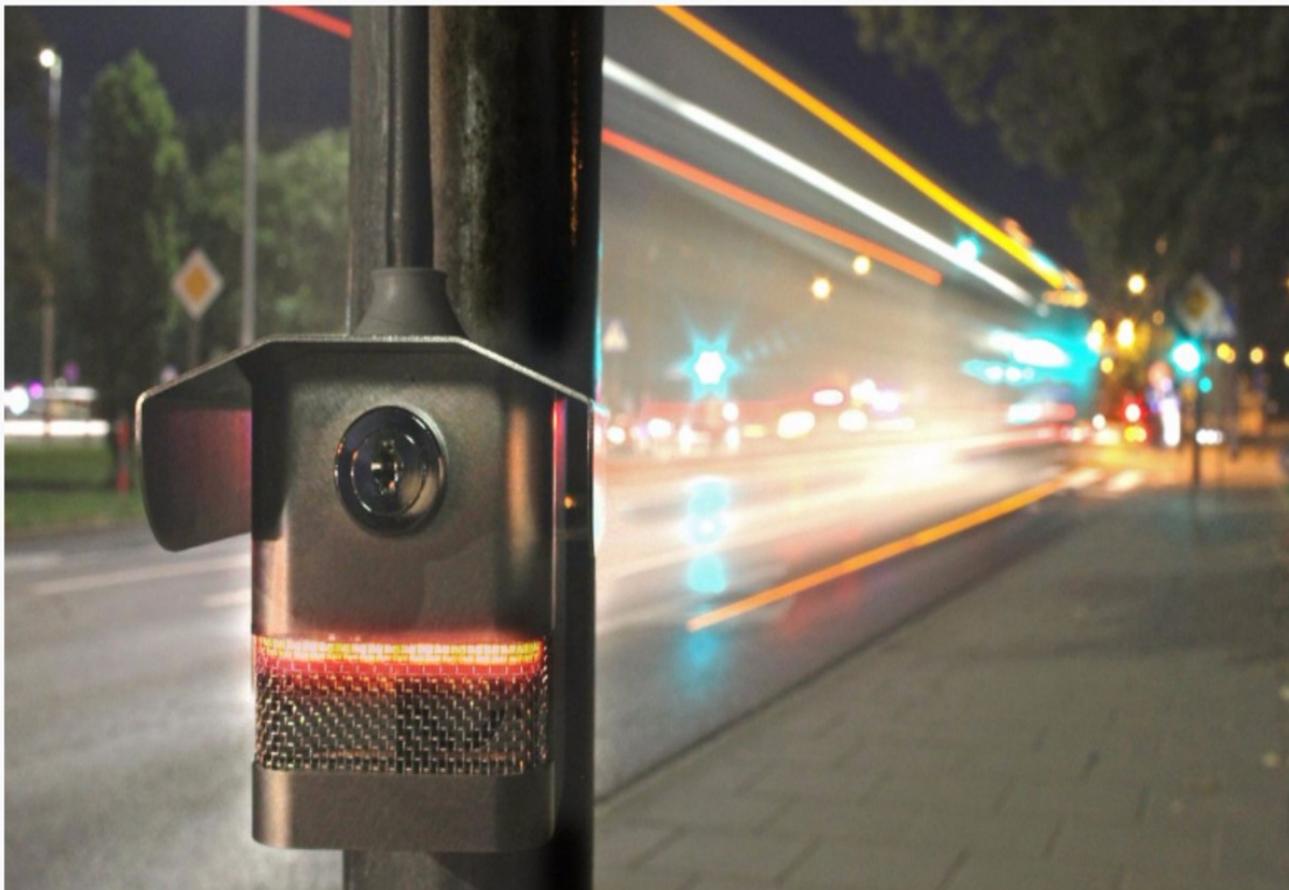


# Air Sensors International Conference



**Dates: September 12-14<sup>th</sup>, 2018**

**Location: Oakland Convention Center**



## Array of Topics Including...

- ✓ Sensors and Smart Cities
- ✓ Data Management Platforms
- ✓ Development of Technology
- ✓ Data Analytics and Communication

**Much more...**

<https://sehall4.wixsite.com/asic/home-landing>

# “Change” Loves Company



“If you compare Eko to Uber, it looks like we’re moving at a snail’s pace...But if you look at health care as a whole, we’re actually making quite a splash.”

<https://www.nytimes.com/2017/08/09/business/heart-and-asthma-monitors-theres-an-app-for-that.html?emc=eta1>



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