

# Participatory Sensing – An Emerging Application of Mobile Broadband

William G. Griswold  
Computer Science & Engineering  
UC San Diego

# EPA finds toxin in air outside 15 schools

By Blake Morrison and Brad Heath  
USA TODAY

Outside 15 schools in eight states, government regulators have found elevated levels of a substance that — in a more potent form — was also used as a chemical weapon during World War I.

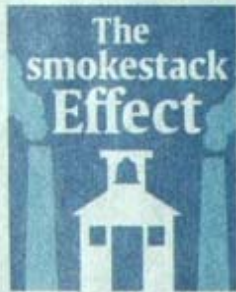
Those findings, based on samples collected for the Environmental Protection Agency (EPA), mark the first time the agency has expressed concern about the chemicals it detected as part of an ongoing effort to check for toxic chemicals in the air outside 63 schools nationwide.

The monitoring is part of a \$2.25 million program that began in response to a USA TODAY investigation that identified hundreds of schools where chemicals from nearby

industries appear to saturate the air. The preliminary results are meant to help determine only whether students face any immediate dangers from toxic chemicals. The EPA will use additional tests to evaluate long-term health risks.

The chemical that once was weaponized, acrolein, can exacerbate asthma and irritate the eyes and throat. It is a byproduct of burning gasoline, wood and cigarettes, and its presence at so many sites was not explained. EPA spokesman Brendan Gillan said the initial readings show "more must be done to reduce the amount of acrolein the American people, especially children, are exposed to."

At the 15 schools — in Alabama, California, Kentucky, Michigan, Mississippi, New York, Ohio and South Carolina — regulators found average



**Toxic air and America's schools**

## Schools with acrolein



Source: Environmental Protection Agency

By Ron Coddington, USA TODAY

acrolein levels at least 100 times higher than what the government considers safe for long-term exposure.

The highest level was recorded in August at Spain Elementary School in Detroit. On Wednesday, the 830 students at Spain were paying homage to the late Michael Jackson when Principal Ronald Alexander heard about the monitoring results. "We've had a very marvelous day today, but this is a con-

cern," he said of the acrolein levels.

Alexander said he sometimes sends asthmatic students across the street to the Children's Hospital of Michigan. Despite 13 years as principal, Alexander said "we didn't really know anything about (the air quality) . . . until they started this monitoring." The findings trouble him, he said, and he plans to call "a parent meeting to talk about what to do."

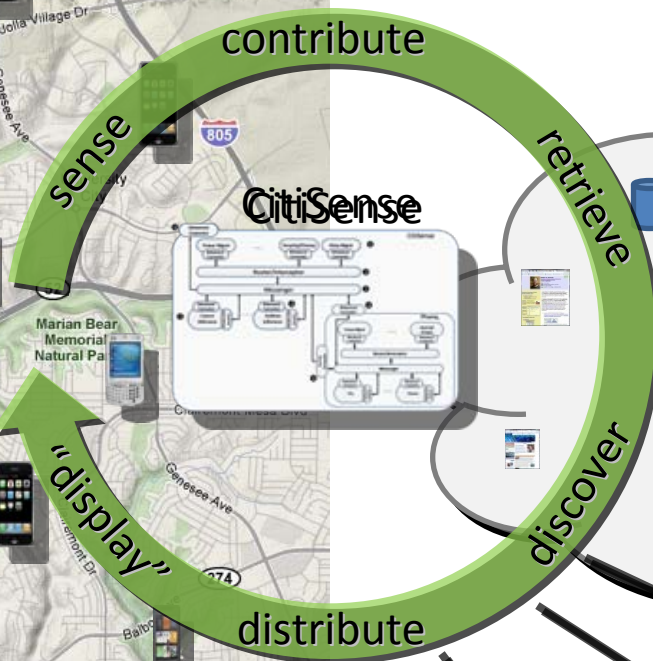
# Fact Sheet: Air Pollution



- 158 million live in counties violating air standards
  - cancer in Chula Vista, CA increased 140/million residents
  - Primarily diesel trucks & autos
    - particulates, benzene, sulfur dioxide, formaldehyde, etc.
- 30% of schools near highways
  - asthma rates 50% higher there
  - 350,000 – 1,300,000 respiratory events in children annually



# CitiSense – Invisible becomes visible



4oz  
30 compounds



## CitiSense Team

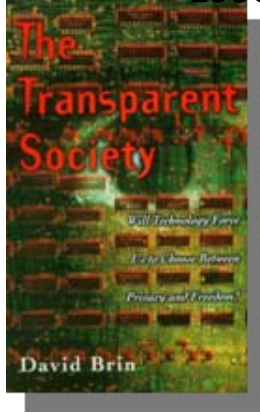
- Ingolf Krueger
- Tajana Simunic Rosing
- Sanjoy Dasgupta
- Hovav Shacham
- Kevin Patrick (Prev. Medicine)

# An idea long in coming...

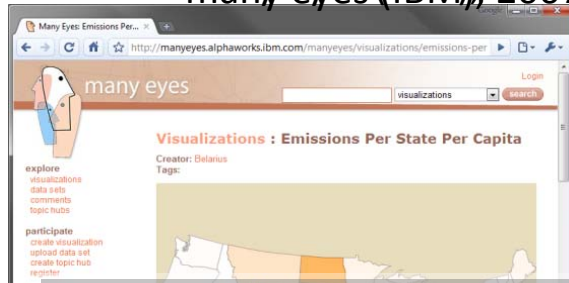
Spanhake et al. (UCSD), 2007



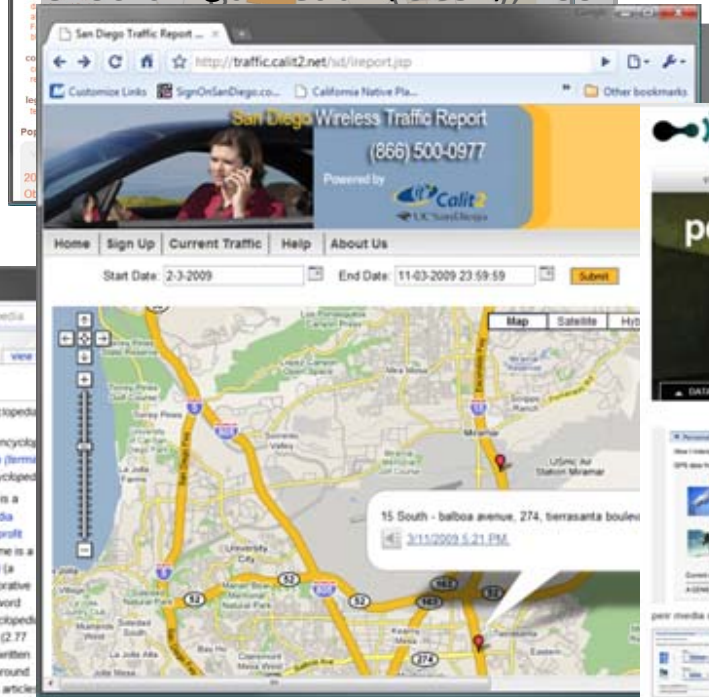
1998



many eyes (IBM), 2007



Chockalingam et al. (UCSD), 2007



Estrin et al. (UCLA), 2009



2001



# ... and a long way to go (a sampling)

- *Openness*
  - Citizens, policy makers, & researchers should be able to easily add sensors, displays, & applications
- *Security and privacy*
  - Data under multiple authorities, sensors not securable
- *Mobile power*
  - Resources inherently scarce at the fringes
- *Inference with commodity sensors*
  - Low cost for ubiquity, heterogeneous due to innovation
- *Social implications*
  - How will people use it, how will it affect policy, etc.?

# Mobile Broadband Challenge - Capacity

- Demands of a sensing phone not high *per se*
  - Limited by power considerations
  - Streaming ~64 bytes per second (bps) on uplink (32 compounds, 12 samples/minute, smart encoding)
  - Benzene today, video tomorrow
- Issue is net uplink capacity of a cell sector
  - Uplink 2-20x slower than downlink, depending on tech.
  - What if “everybody” does participatory sensing?
    - 1xEV-DO Rev-A sector has max. uplink of 1.8Mbps
    - NYC: ~20,000 cell users per registered sector → 100bps
  - Shared with callers and other data users
  - Traffic prioritization needed?