

# Dependable opportunistic communication in a multi-tier sensor network architecture

Atul Prakash, Beng Heng, and Billy Lau  
Computer Science and Engineering  
University of Michigan

Vineet Kamat  
Civil Engineering  
University of Michigan

Contact: [aparakash@eecs.umich.edu](mailto:aparakash@eecs.umich.edu)

# Our past and on-going projects

- **Distributed systems:**
  - Collaboratories: Helped design perhaps the first large-scale scientific collaboratory: UARC project (NSF-sponsored).
- **Pervasive computing:**
  - Privacy policies in location-aware systems. High-performance policy evaluation where results depend on dynamic context (CCS'05)
- **Architectures for monitoring civil infrastructures (e.g., bridges, etc.): New project**
- **Whereabouts project:** <http://whereabouts.eecs.umich.edu> (location-aware computing, assisting blind people, indoor navigation, etc.)
- **Security:**
  - Automatic policy configuration in group communication systems (Oakland S&P, 2002, IEEE TISSEC 2006).
  - Detecting and preventing information leaks. (Oakland S&P, 2009 -- upcoming paper).

# Motivation

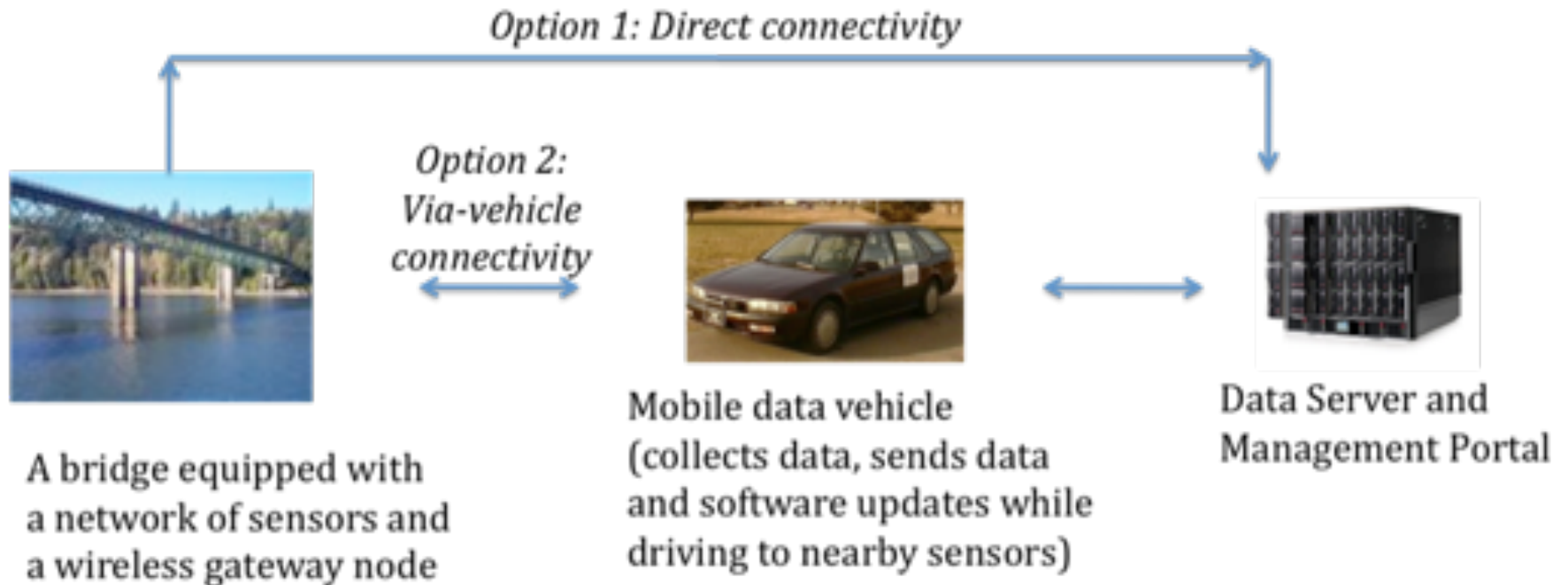
- New project: sensor networks for monitoring physical infrastructure systems.
- Data collection problem:
  - Limited or no network connectivity
  - Power/cost constraints
  - Provide robust communication against sensor failures and security attacks



Similar problems of data collection in other domains  
from sensors in remote areas

Data communication architecture?

# Approach - Multi-tier architecture



# Drive-by data collection

- High sensor densities: raw data: 100 MB to 10 GB of data/day
- Tiers:
  - Sensor ad hoc network <-> aggregator network
  - Aggregator network <-> vehicle
  - vehicle <-> back-end infrastructure

# Requirements

- Opportunistic communication and data collection
- Cooperative data transfer
- End-to-end dependability

# Challenges

- Buffered data at aggregators
- When to delete?
- Potentially large volumes of data
- Compression and prioritization
- Vehicle moving at highway speeds

# Data buffering

- May not be safe to delete data upon transfer to the vehicle
- aggregators <-> back-end infrastructure: acknowledgement desirable
  - potentially long latencies (weeks)
- security: authentication desirable



# Data transfer to Moving Vehicle

- Vehicle moving at highway speeds over large span
- How does it collect data from the aggregators?
- We envision the need for cooperative data transfer algorithms --- multiple aggregators must cooperate to transfer data to a moving vehicle

# Security

- Can we involve citizens in data collection (using smartphones, etc.)?
- Security and reliability? Incentives? Data deletion policy?
- Detecting malicious sensors
- Privacy concerns in some cases

# Summary

- Goal: design a robust and easy-to-deploy architecture for remote sensor networks
- We envision a:
  - multi-tier architecture, consisting of sensor network, network of aggregators, mobile data collection nodes, and back-end infrastructure
- Welcome opportunities for collaboration and finding synergies