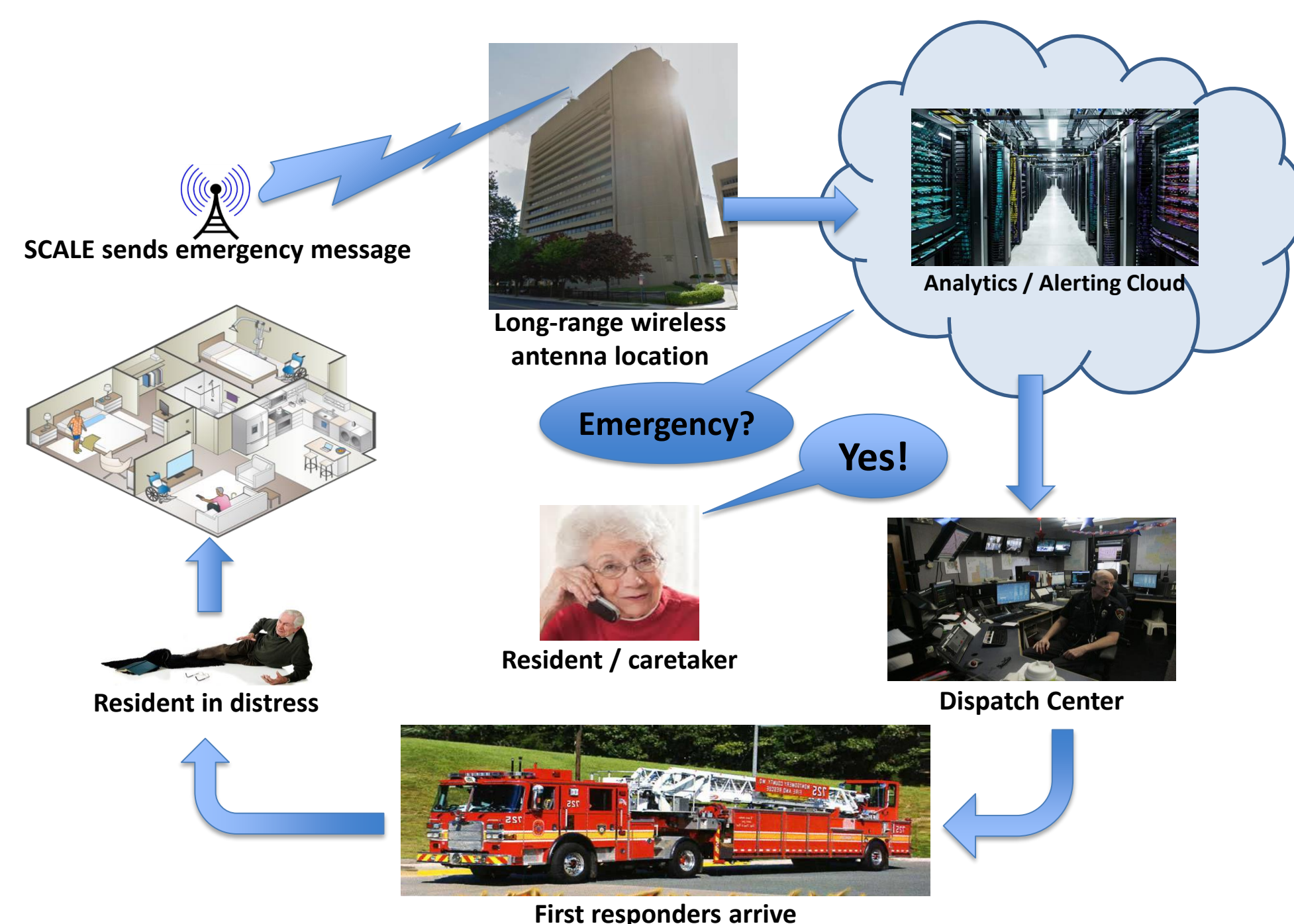




Goals and Overview

- Extend a connected safe home to everyone at a low incremental cost
- Automatically detect emergency events, alert residents, confirm emergency via phone or app, and initiate contacting first responders
- Jump-start a live testbed for identifying and researching Internet of Things (IoT) challenges
- Connect disparate systems via an open multi-protocol data exchange
- Bring together key industry, academic, and government organizations to brainstorm, share ideas, and collaborate on prototype systems
- Expand community awareness and involvement in safety and IoT



SCALE Applications

Home Safety – In Rockville, MD

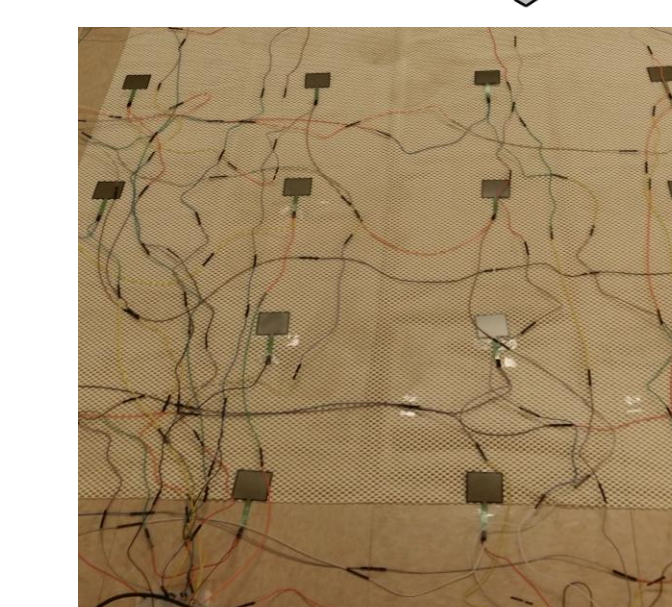
SCALE has been deployed in Victory Court Senior Apartments in Montgomery County, MD. Multiple types of sensors (temperature, light, motion, seismic, and explosive gas) are installed on these boxes to help monitor home safety. How do we make these cheap sensors work together for better sense making? How to make the entire system more resilient?



Hacked 9-volt smoke sensor sends alerts over Sigfox UNB (Arduino-powered)

Fall Detection – In Irvine, CA

Combined in-situ pressure sensors and wearable sensor tags for indoors fall detection. How to leverage the knowledge of the heterogeneous participated IoT objects and the real-time environment conditions to optimize the personal sensing effectiveness in terms of energy consumption and reliability?



The customized prototype sensor mat for fall detection

Air Quality – In Dhaka, Bangladesh

EnviroSCALE is an extension of SCALE for air quality monitoring.

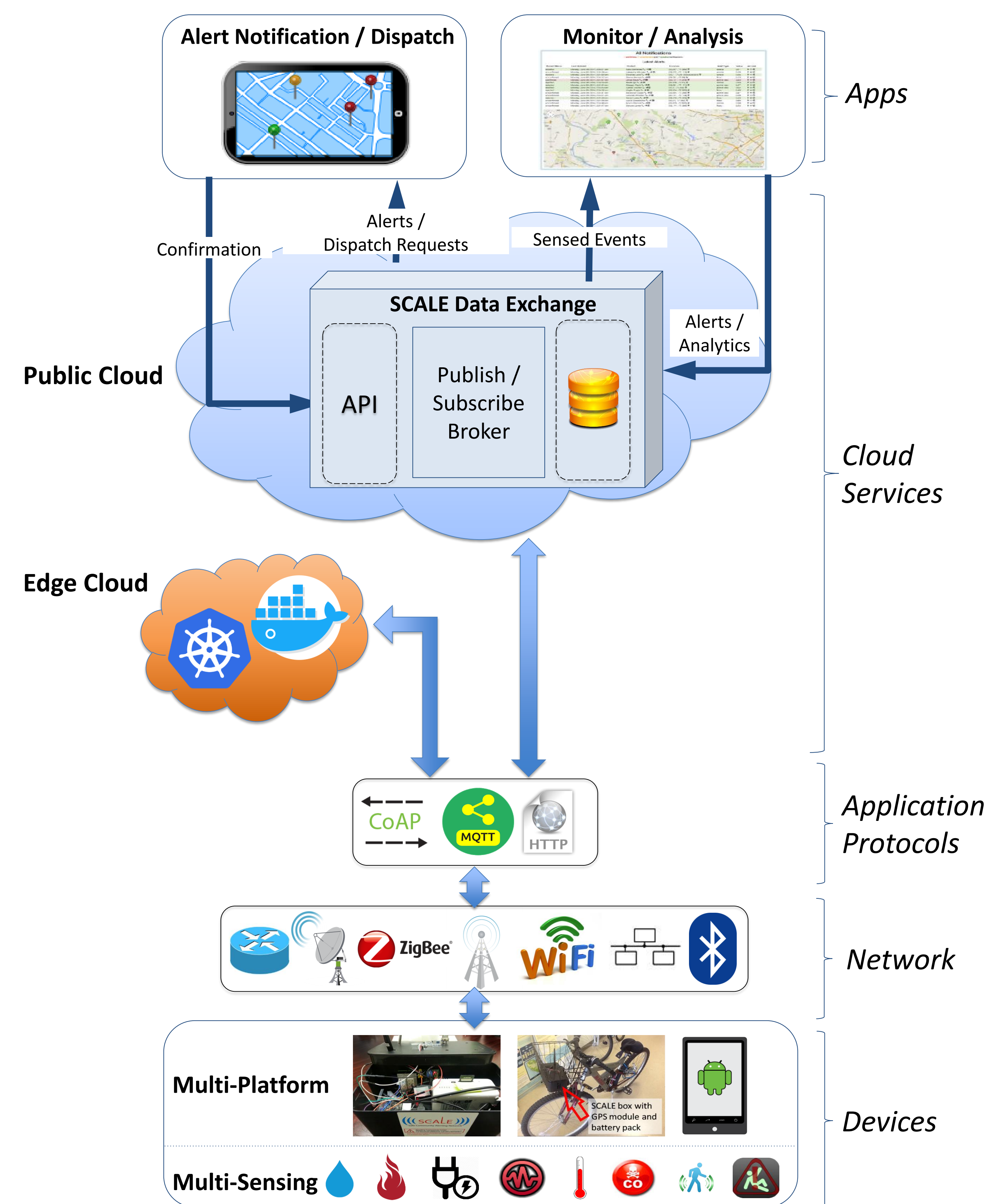
- Cheap commodity gas sensors
- Support of multiple networks (3G and Wi-Fi)
- Battery for outdoors deployments

 How to conduct data compression and schedule communication to fit in the limited 3G data plan? How to improve resilience over network failures?



EnviroSCALE box deployed in Bangladesh with 3G modem and multiple types of gas sensors to monitor air quality

System Architecture: Managing Heterogeneity



Resilient Multi-Network Data Exchange

Network edge services leveraging software-defined networking (SDN) improve system resilience

- System is completely transparent to the IoT devices and requires no client-side modifications.
- Container-managed services run in the public cloud or at the network edge for improved resilience, performance, and scalability.

Fault Avoidance

- **Geo-diverse multi-path routing** increases chances of delivering data during network failures, especially geo-correlated ones (e.g. disasters). Currently implemented as a peer-to-peer overlay, we are incorporating the multi-path heuristics into our SDN-enabled framework.

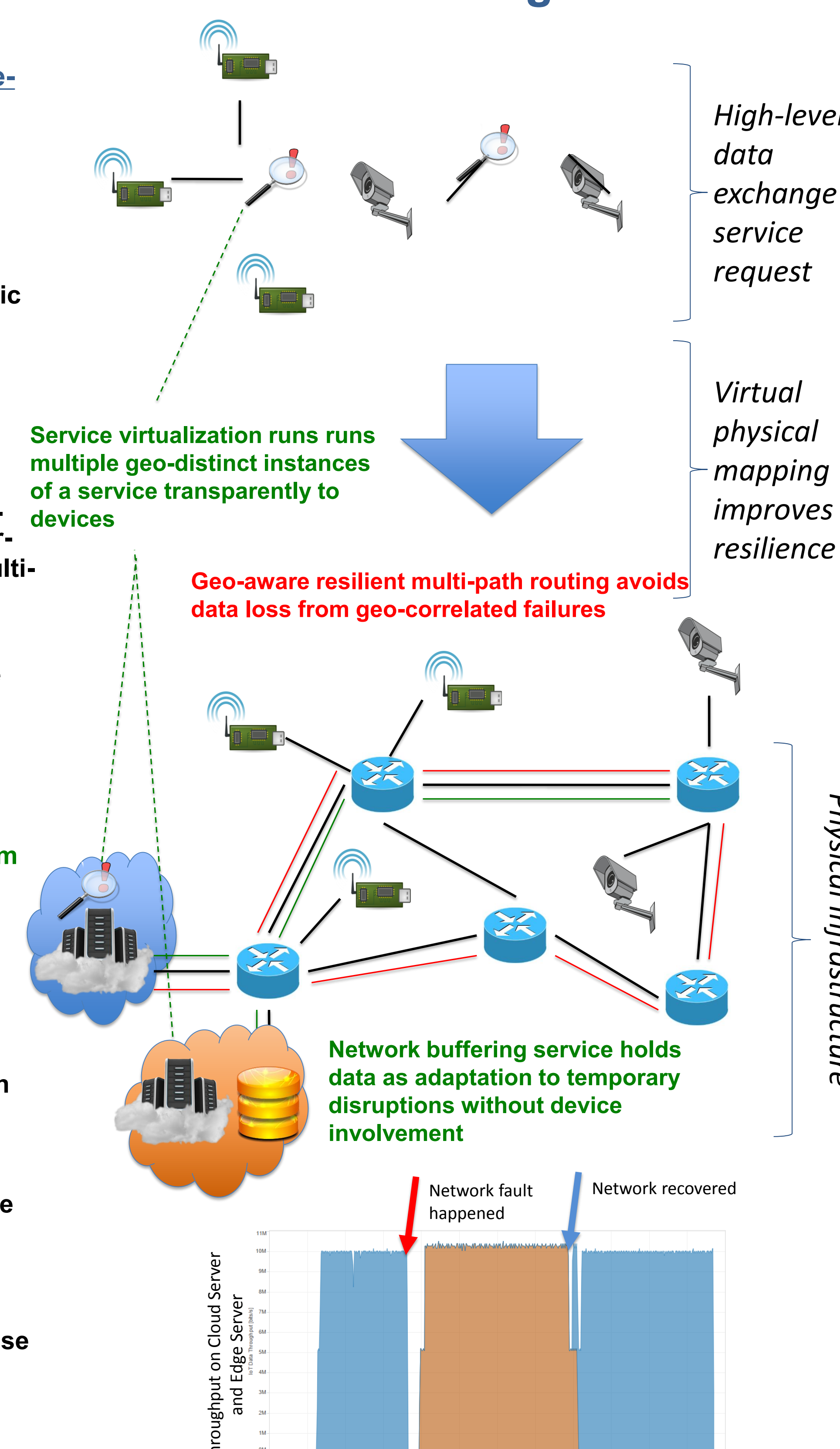
- **Redundant services abstraction** enables the network to handle delivering data to backup services and failing over to them when the primary is unavailable.

Fault Detection

- An edge service uses a heartbeat mechanism to monitor the status of connections to the cloud service. It reports problems due to congestion, failed links, or an outage of the primary cloud service itself.
- OpenFlow-enabled switches can provide network performance metrics to SDN controllers as well as help identify failures in local network.

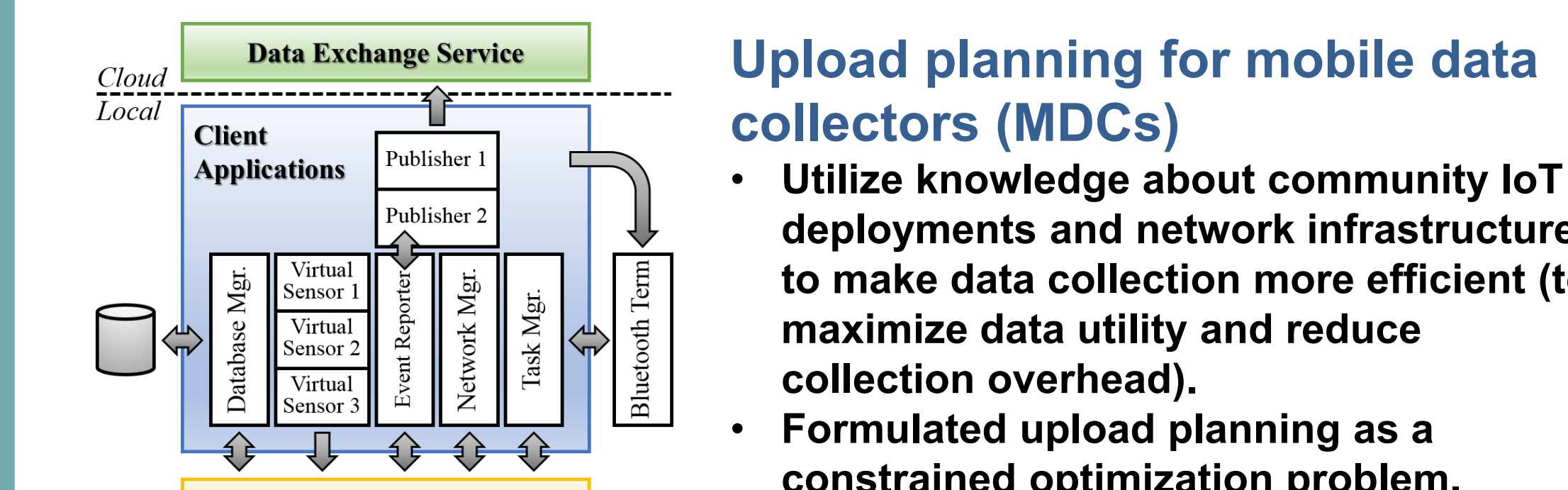
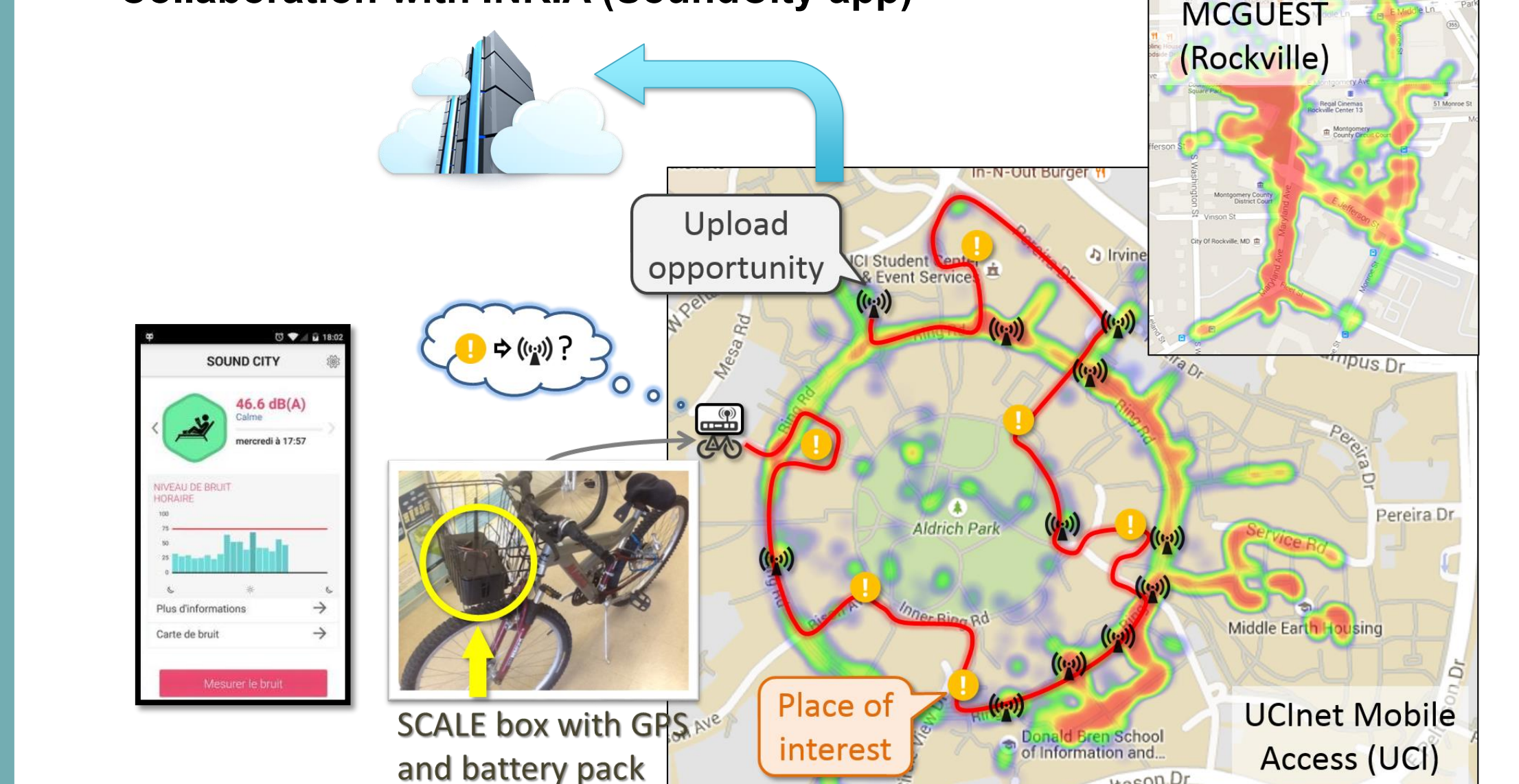
Fault Recovery

- SDN controller adapts network flows to route around perceived failures or even redirects data to a temporary network buffer to avoid data loss until fault is recovered.
- Application services are deployed in response to faults so as to maintain some degree of (degraded) operation (e.g. localized earthquake detection).



SCALECycle: Mobility Enhancement

- SCALECycle platform
- A SCALE multi-sensor box on a bike with GPS locating, battery, and various sensors (Wi-Fi quality, air pollution, etc.)
 - Conducted measurements in two real testbeds: UCI campus and Victory Court Senior Apartments in Montgomery County, MD. Collected Wi-Fi RSSI/quality and air quality.
 - Collaboration with INRIA (SoundCity app)



Proposed a two-phase approach using heuristic algorithms for static planning and Lyapunov control for dynamic adaptation. Simulation results show 30-60% improvement in data utility and up-to 30% reduction in collection delays.

