

SCALE: Safe Community Awareness and Alerting Network

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"Democratizing safety by bringing the Internet of Things (IoT) to everyone"

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

Alert Notification / Dispatch

Confirmation

Public Cloud

Edge Cloud

Expand community awareness and involvement in safety and IoT



Dispatch Requests

System Architecture: Managing Heterogeneity

SCALE Data Exchange

Publish /

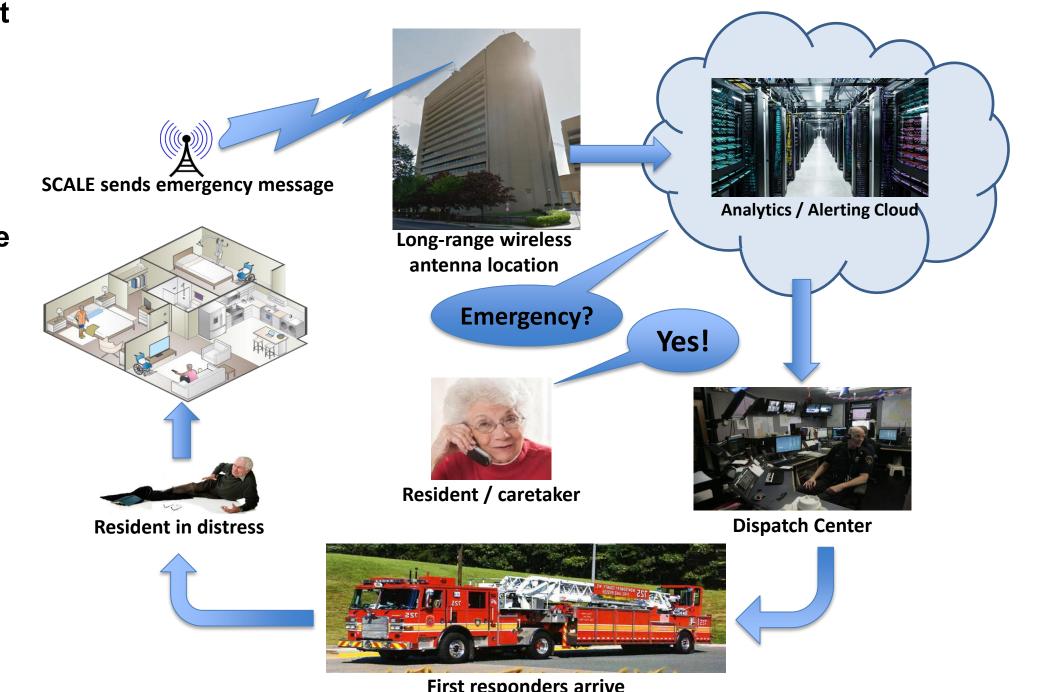
Subscribe

Broker

Monitor / Analysis

Analytics

Sensed Events



SCALE Applications

Fall Detection – In Irvine, CA

sensor tags for indoors fall detection.

How to leverage the knowledge of the

consumption and reliability?

Combined in-situ pressure sensors and wearable

time environment conditions to optimize the

heterogeneous participated IoT objects and the real-

personal sensing effectiveness in terms of energy

High-level

exchange

service

request

data

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?



Sigfox UNB (Arduino-powered)

Resilient Multi-Network Data Exchange



— Air Quality – In Dhaka, Bangladesh **EnviroSCLAE** 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

Apps

Cloud

Services

Application

Protocols

Network

Devices

Network edge services leveraging softwaredefined 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 peerto-peer overlay, we are incorporating the multipath 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.

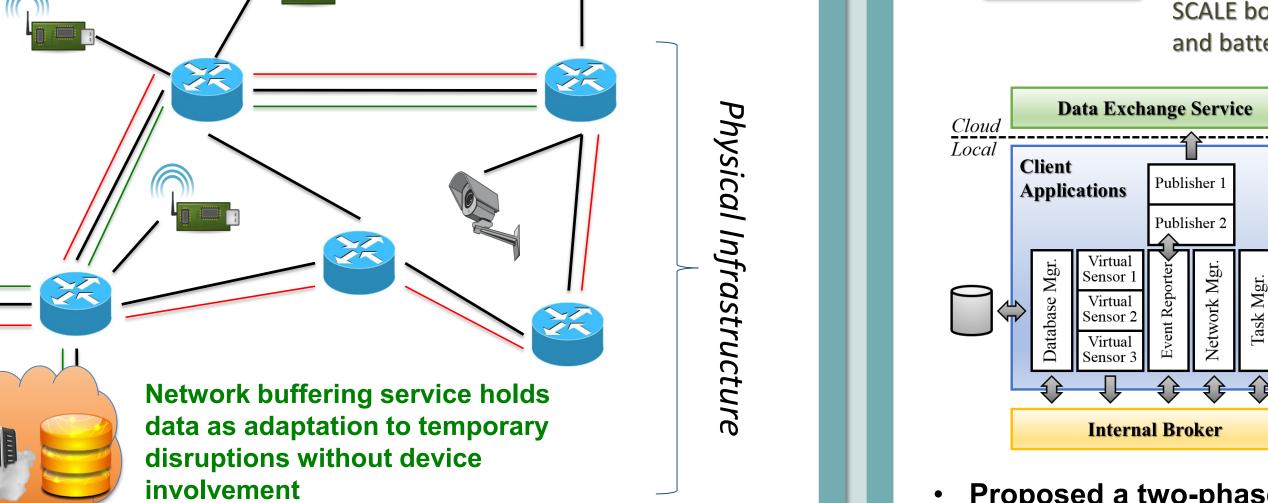
OpenFlow-enabled switches can provide network performance metrics to SDN controllers as well as help identify failures in local network.

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).

Service virtualization runs runs multiple geo-distinct instances of a service transparently to

Virtual physical mapping improves resilience Geo-aware resilient multi-path routing avoids data loss from geo-correlated failures



Network recovered

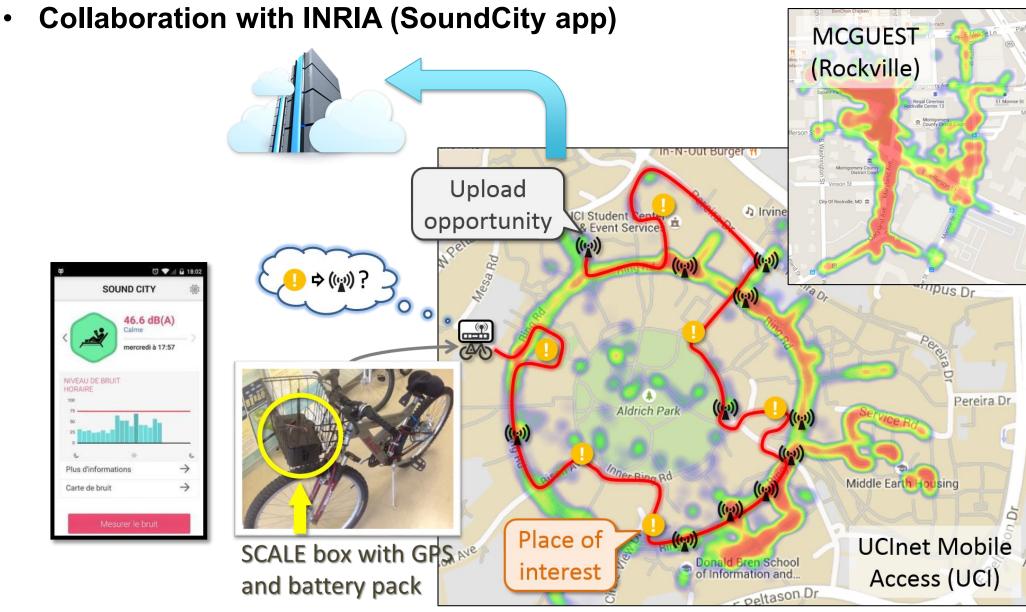
- Proposed a two-phase approach using heuristic algorithms for static planning and Lyapunov control for dynamic adaptation.
- Simulation results show 30-60% improvement in data utility and up-to 30% reduction in collection delays.

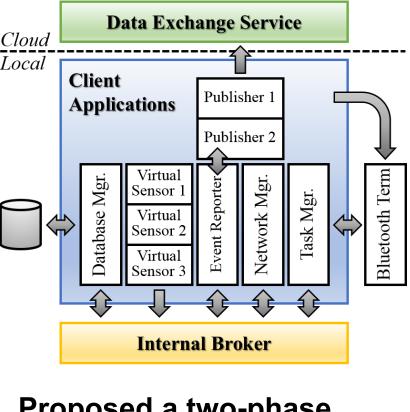
SCALECycle: Mobility Enhancement

SCALECycle platform

The customized prototype sensor

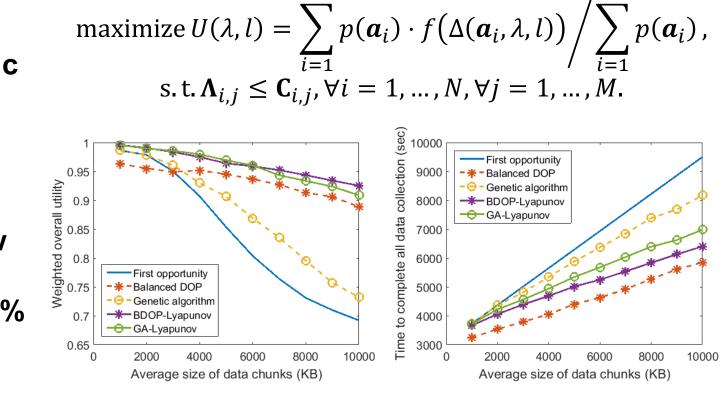
- A SCALE multi-sensor box on a bike with GPS locating, battery, and various sensors (Wi-Fi quality, air pollution, etc.)
- Conducted measurements in two real testbeds: UCI campus and Victory Court Senior Apartments in Montgomery County, MD. Collected Wi-Fi RSSI/quality and air quality.





Upload planning for mobile data collectors (MDCs) Utilize knowledge about community IoT

- deployments and network infrastructure, to make data collection more efficient (to maximize data utility and reduce collection overhead).
- Formulated upload planning as a constrained optimization problem.







Multi-Platform



Multi-Sensing

Multi-Sensing















































Network fault

happened







