SCALE: Safe Community Awareness and Alerting Network

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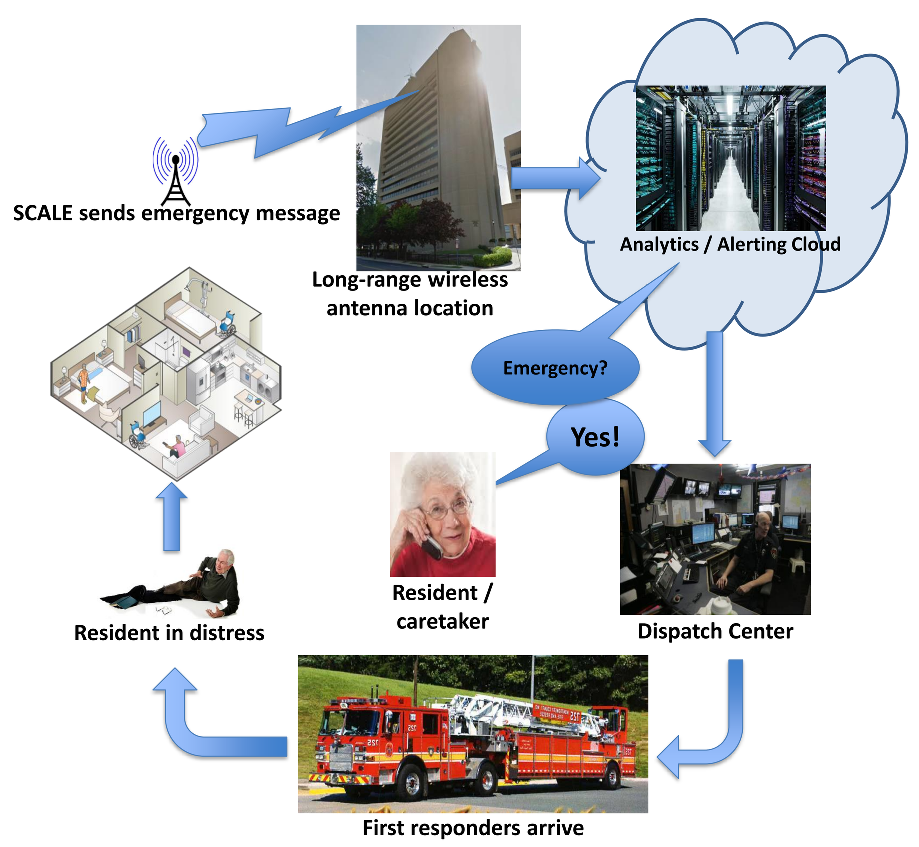
"Democratizing safety by bringing the Internet of Things (IoT) to everyone"

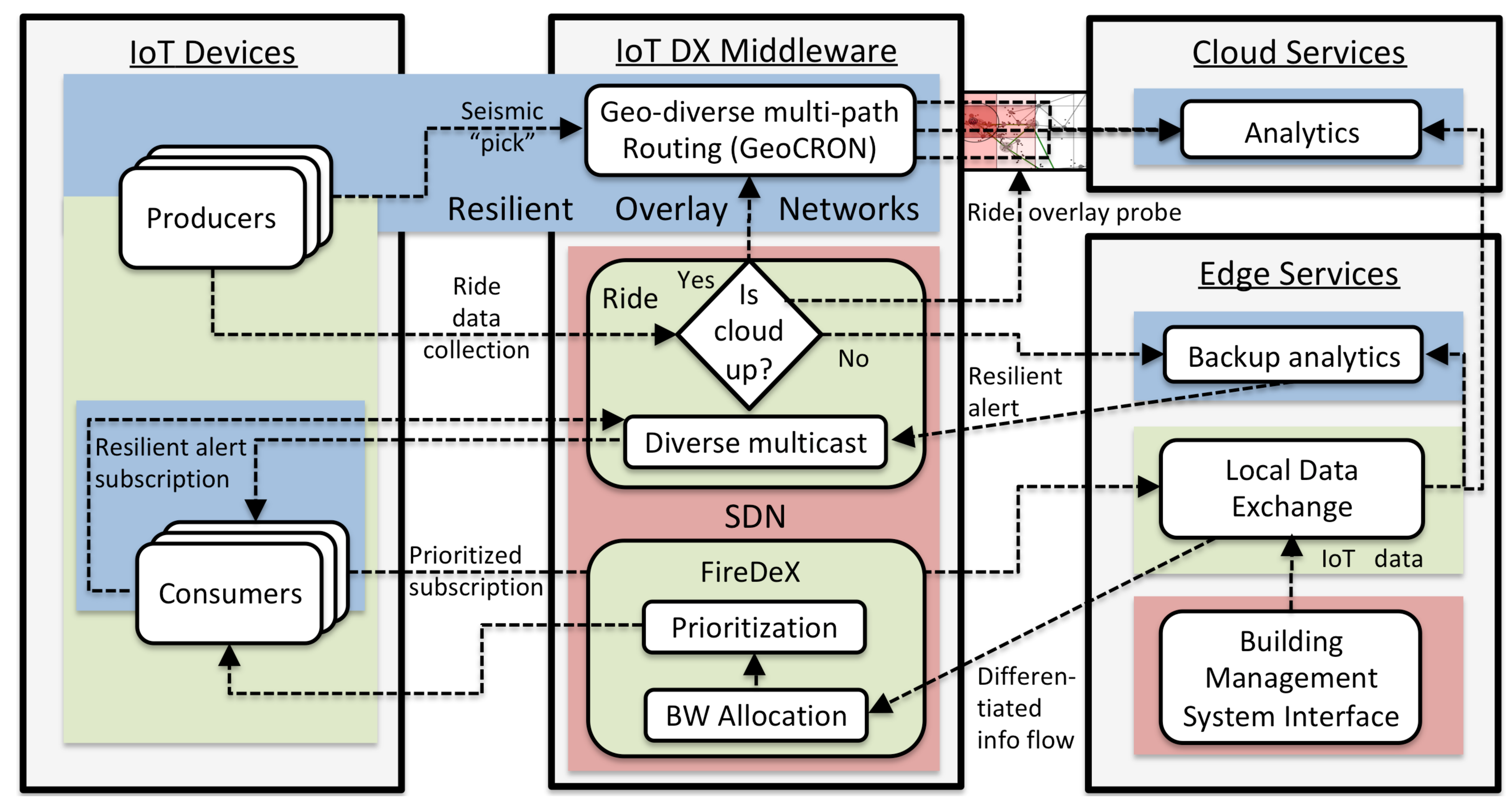
SCALE Safe Community Alerting Network

Goals and Overview

- Resilient and interoperable IoT to everyone at low incremental cost
- Smart-home/community scale platform automatically detects emergency events, alerts residents, confirms emergency via phone or app, and initiates contacting first responders
- A live testbed for identifying and exploring resilience in IoT deployments
- Multi-sector (industry, academic, and government) collaboration
- Community awareness and involvement in safety and IoT



Resilient IoT Data Exchange



GeoCRON

- *Failure avoidance* through geo-diverse multi-path routing.
- GeoCRON establishes a resilient overlay network via IoT devices for resilient cloud-centric data collection.
- Targeted for continued operation of cloud-based analytics during wide-area infrastructure failures such as those caused by a massive earthquake.

Ride

- Resilient IoT Data Exchange middleware (Ride) leverages SDN.
- Ride-C manages data collection by monitoring cloud overlay paths (*failure detection).*
- Ride-C fails over to backup edge services when the cloud is unavailable (*failure recovery).*
- Ride-D disseminates alerts using a resilient multicast mechanism. It pre-constructs multiple maximally-disjoint multicast trees and intelligently selects the best at alert-time based on network state awareness embedded in the data exchange process by Ride-C.

FireDeX

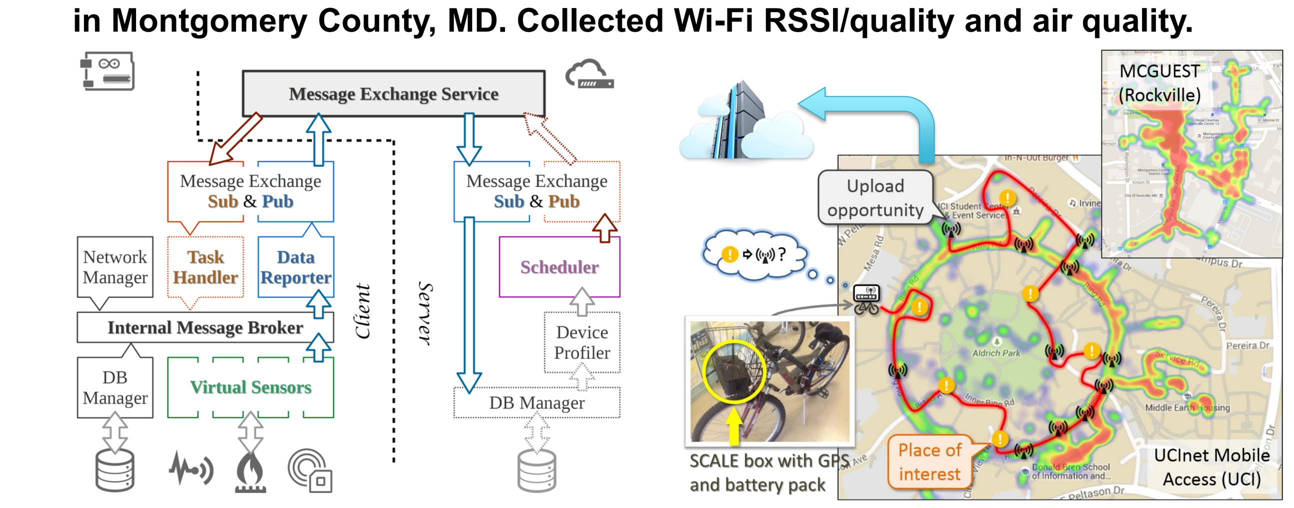
- *Prioritized resource allocation for managing heterogeneous IoT data flows in extreme settings (e.g. fire).*
- A queuing theoretic model for capturing and managing flow of data/information.
- Algorithms to determine correct prioritization and bandwidth allocation for events according to application requirements and network resource constraints.
- SDN based approach for policy enforcement - avoids modifications to IoT deployment or data exchange broker.

Resilient Data Collection Exploiting Mobility

Combines in-situ IoT deployments with mobile sensing and data collection to improve resilience in regions with non-uniform network availability and quality.

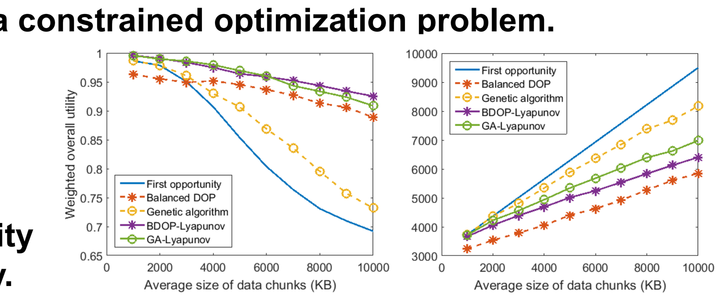
SCALECycle platform

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



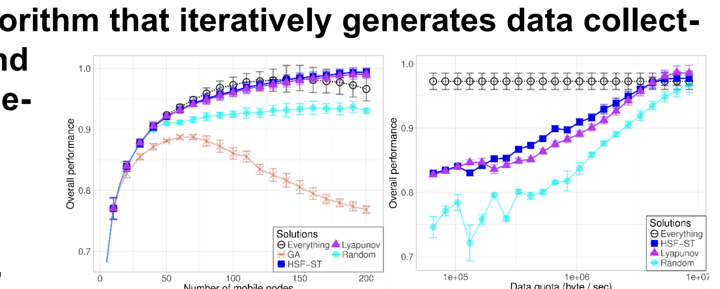
Upload planning for mobile data collectors

- Utilize knowledge about community IoT deployments and network infrastructure to make data collection and upload more efficient (i.e. maximize data utility and reduce collection overhead).
- Formulated upload planning as a constrained optimization problem.
- Proposed a two-phase approach using heuristic algorithms for static planning and Lyapunov control for dynamic adaptation.
- 30-60% improvement in data utility and up to 30% reduction in delay.

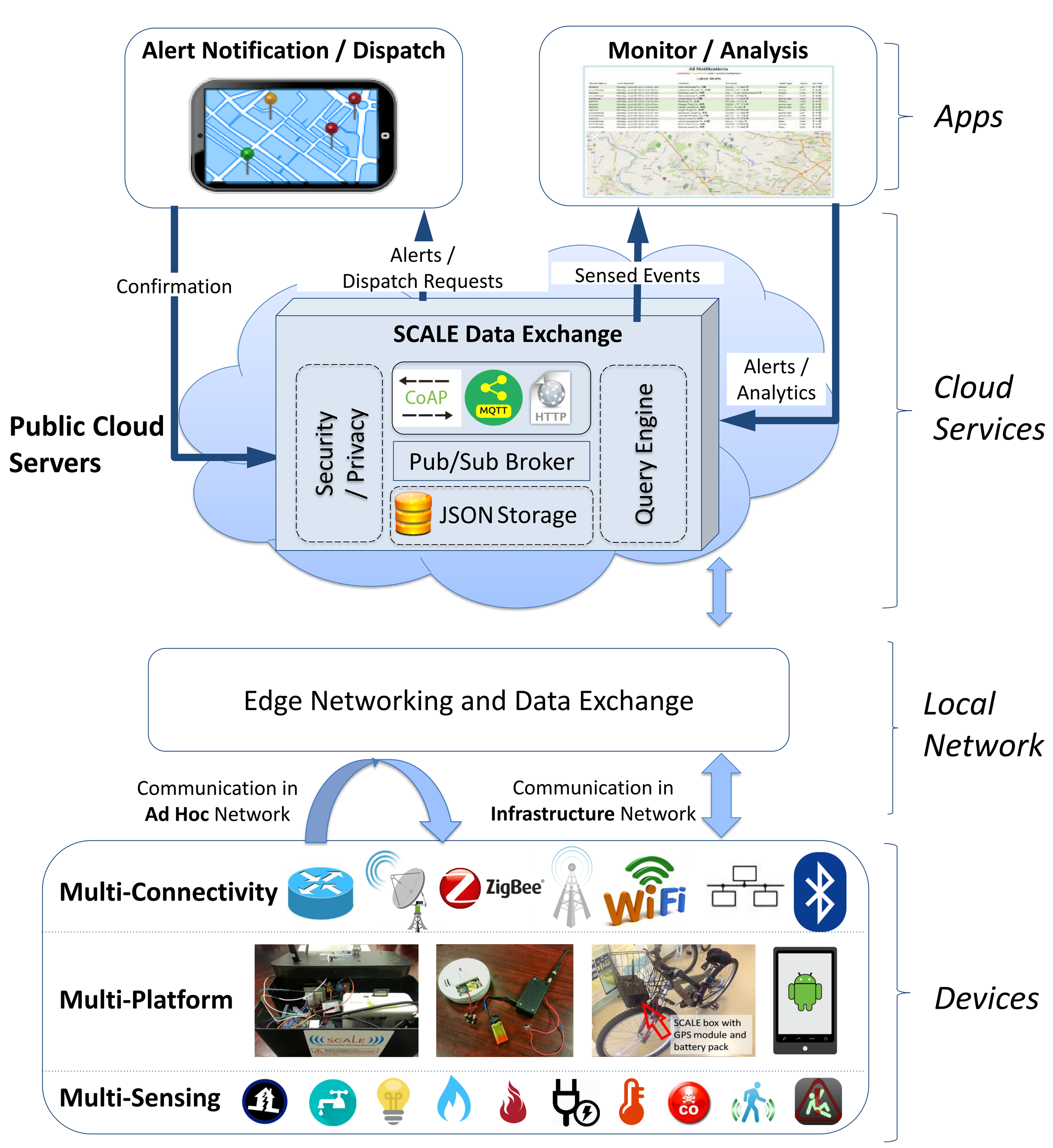


Spatiotemporal scheduling for crowd augmented urban sensing

- Optimally activate/deactivate sensors and devices in realtime to save resources (e.g. bandwidth, computation) for crowd sensing apps.
- Formulated spatiotemporal scheduling as a multi-objective optimization.
- Designed an online planning algorithm that iteratively generates data collection plans using current states and historical data to handle the trade-off between coverage and cost.
- Simulation experiments are established on traces from real deployments and open datasets.
- Achieves the same level of sensing coverage and accuracy with less traffic and active devices. Working on improving our formulation and algorithms.

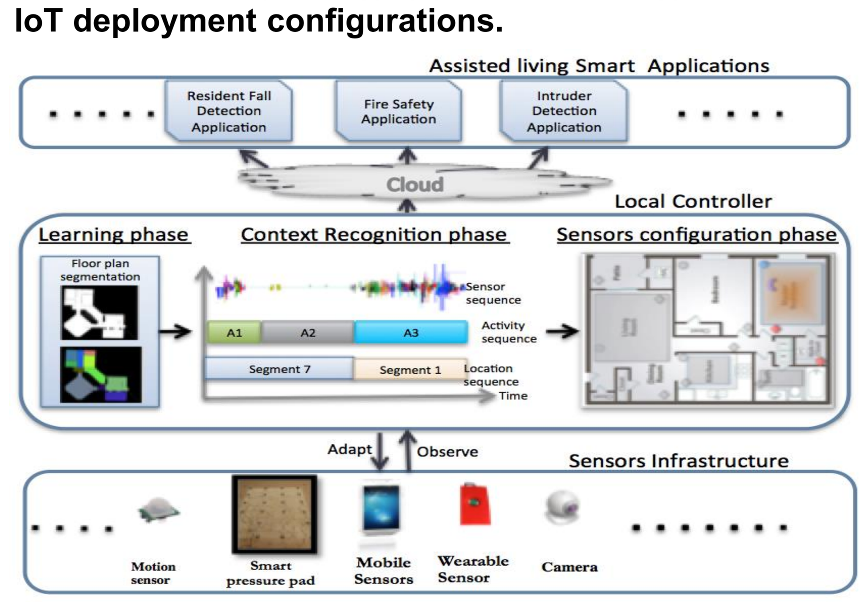


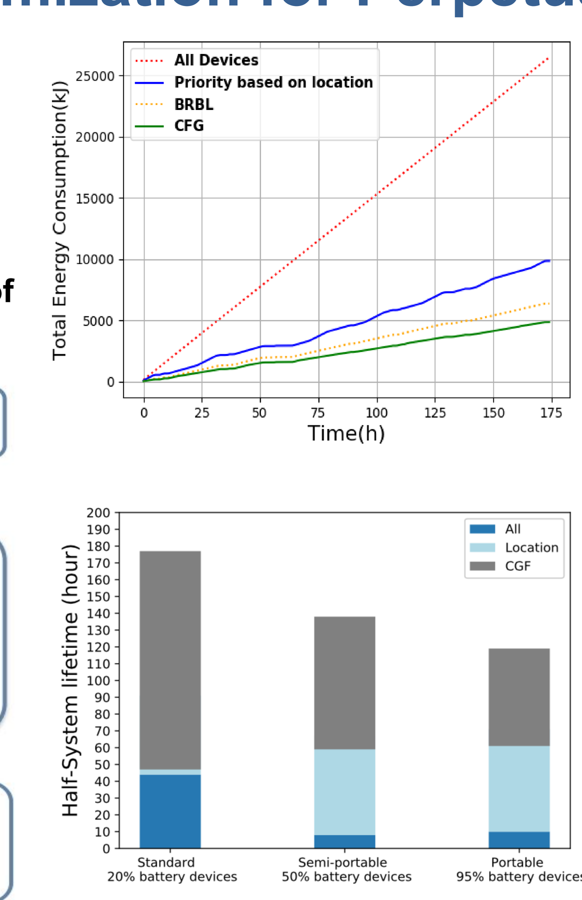
System Architecture: Managing Heterogeneity



Context-Aware Energy Optimization for Perpetual IoT Systems

SAFER – a SCALE-based platform for personal event sensing (e.g. fall detection in senior populations) Semantic activation and scheduling to address tradeoffs in energy efficiency and reliable sensing leveraging (a) Heterogeneity of IoT devices, (b) Context of activities extracted from IoT data (e.g. activities of daily living), (c) Diverse energy profiles of IoT deployment configurations.



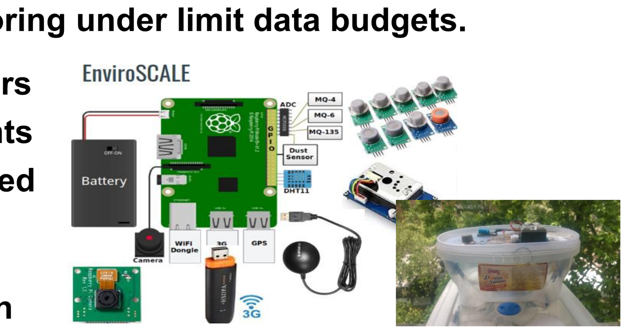


- Experimental studies with real world trace datasets indicated that our proposed algorithms were able to achieve more than 80% reductions in energy consumption, doubling the system-lifetime.
- We examine the effect of different ratios of battery-operated to wall-powered devices in our three settings (standard, semi-portable, and portable). When the percentage of battery devices grows, the time extension in proportion to original system lifetime slightly decrease.

EnviroSCALE

EnviroSCALE is built for air quality monitoring under limit data budgets.

- Cheap commodity MQ-family gas sensors
- Battery powered for outdoor deployments
- Operate over a 3G connection with limited data plan

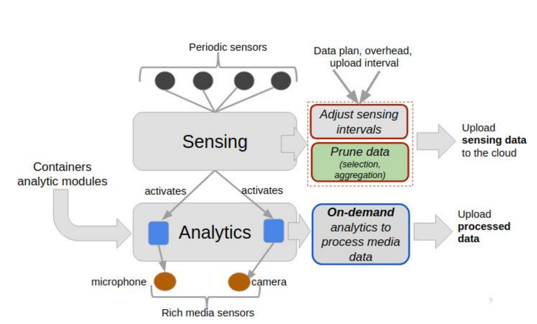


EnviroSCALE box deployed in Dhaka, Bangladesh with 3G modem and multiple types of gas sensors to monitor air quality

The key question is to conduct data compression and schedule communication to fit in limited 3G data plan.

EnviroSCALE uses two adaptation techniques

- Infrastructure level adaptation adjusts sampling intervals of sensors according to the data plan and encodes sensor readings in binary payload instead of using verbose JSON
- Information level adaptation leverages container-driven approach to run rich analytics on media data (e.g., camera data) locally on the device to reduce uploading raw data



EnviroSCALE Middleware

SIGFOX, intel, at&t, Victory Housing, BRIVOLABS, Montgomery County Maryland, thingstitute, TATRC, twilio, IoT DC, Captiva, Extreme networks, WORLD SENSING, senseware, WeatherBug, Massachusetts General Hospital, IBM, UCIRVINE University of California, MIT, IoT Dev Labs, RESPOND, biobright, Del Rey Analytics, Anomaly Systems