SCALE: Safe Community Awareness and Alerting Network

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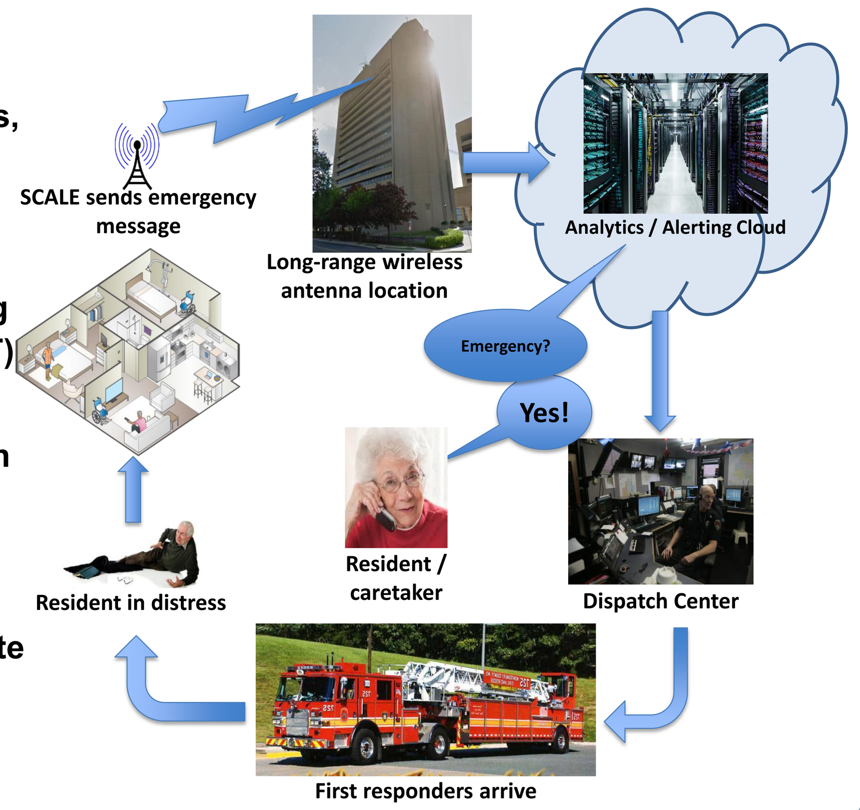
"Democratizing safety by bringing the Internet of Things (IoT) to everyone"

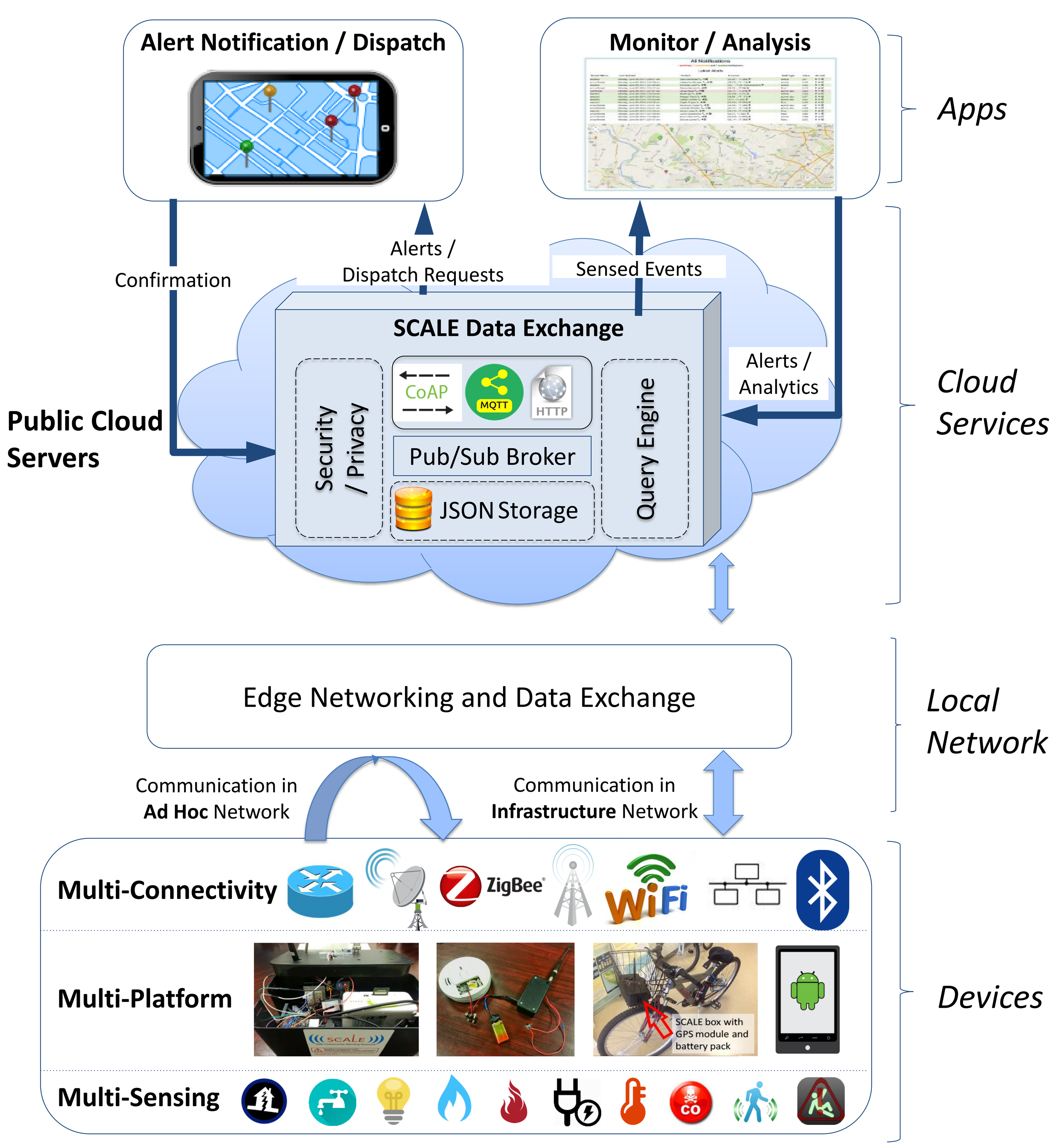
SCALE Safe Community Alerting Network

Goals and Overview

- 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



System Architecture: Managing Heterogeneity



RIDE: Resilient IoT Data Exchange

Failure Avoidance

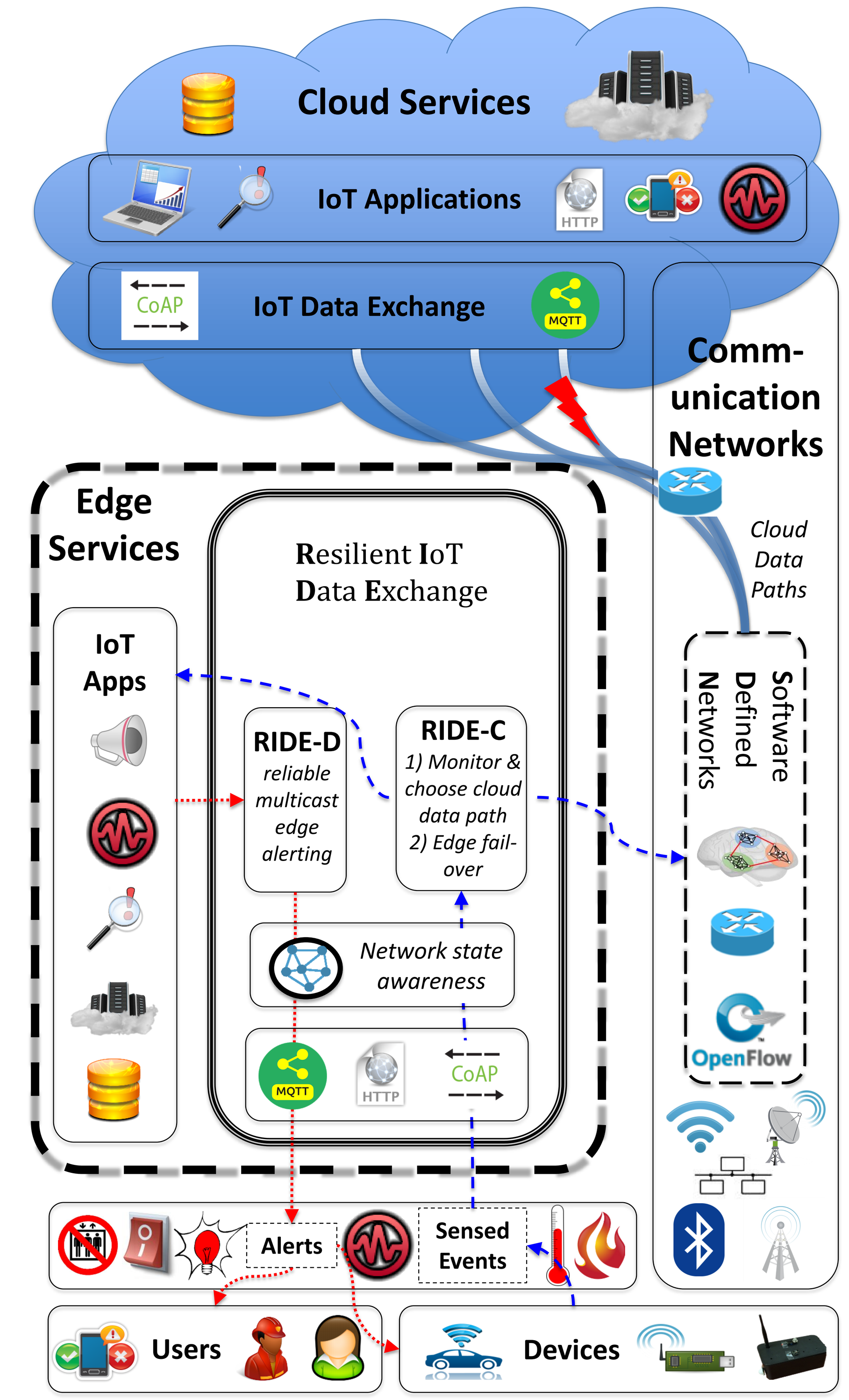
- Multi-path routing increases chances of delivering data during wide-spread network failures:
  - GeoCRON: Geographically-correlated resilient overlay networking solution leverages IoT peer-to-peer capabilities to deliver data to the cloud cloud analytics service despite geo-correlated failures due to e.g. disasters.
  - RIDE-D disseminates alerts using an SDN-based resilient multicast alerting solution. It pre-constructs multiple maximally-disjoint multicast trees and intelligently selects the best at event-time based on network state awareness.

Failure Detection

- RIDE-C ensures resilient IoT data collection. It monitors the status of *Cloud Data Paths (*connections to the public cloud service) using an adaptive resource-conserving network probe mechanism. It generates network state awareness by detecting failures (i.e. congestion, failed links, or an outage of the primary cloud service itself) within an application-specified time.

Failure Recovery

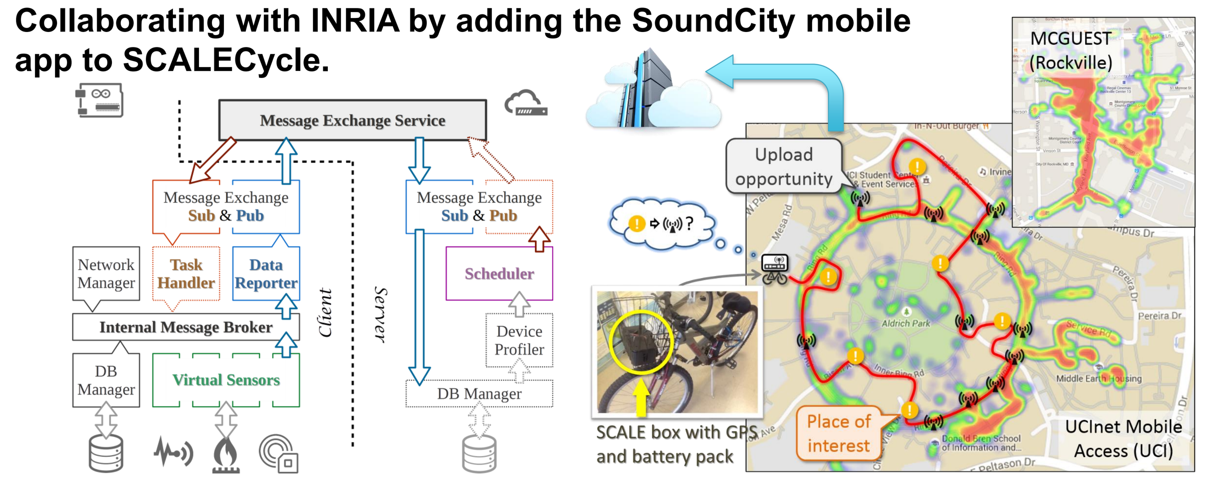
- RIDE-C adapts IoT data flows at the network level (via the SDN controller) in response to perceived failures. It redirects data to an edge backup service or network buffer to maintain service continuity or avoid data loss until fault recovers.
- RIDE-D leverages network state awareness embedded in IoT data flows (i.e. data collection and alert responses) to ensure reliable alert delivery at the edge despite failures.



Resilient Data Collection Exploiting Mobility

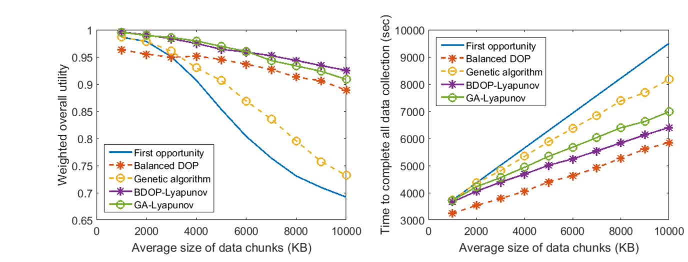
SCALECycle platform

- A SCALE multi-sensor box on a bike with GPS receiver, 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.
- Collaborating with INRIA by adding the SoundCity mobile app to SCALECycle.



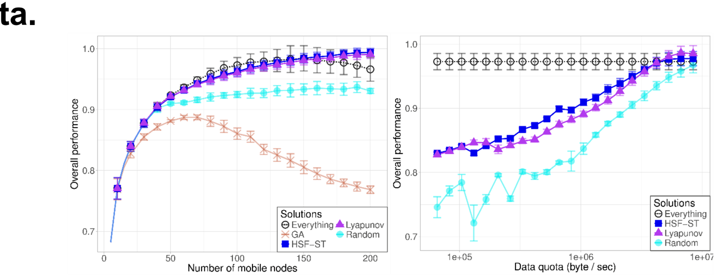
Upload planning for mobile data collectors

- 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.
- Simulation results show 30-60% improvement in data utility and up to 30% reduction in delay.



Spatiotemporal scheduling for crowd augmented sensing

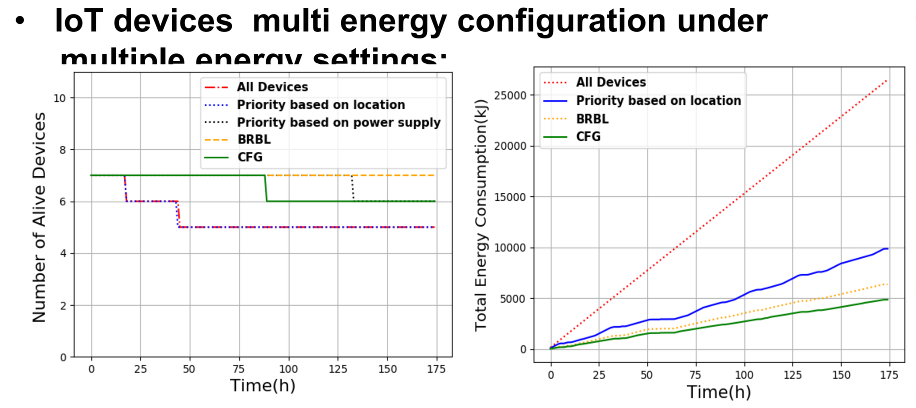
- Optimally activate/deactivate sensors and devices in realtime to save resources (e.g. bandwidth, computation) for crowd sensing apps.
- Formulated spatiotemporal scheduling as a multi-objective optimization.
- Designed an online planning algorithm that iteratively make plans using current states and historical data.
- Handle the tradeoff between coverage and cost and achieve the same level of sensing coverage and accuracy with less traffic and active devices.

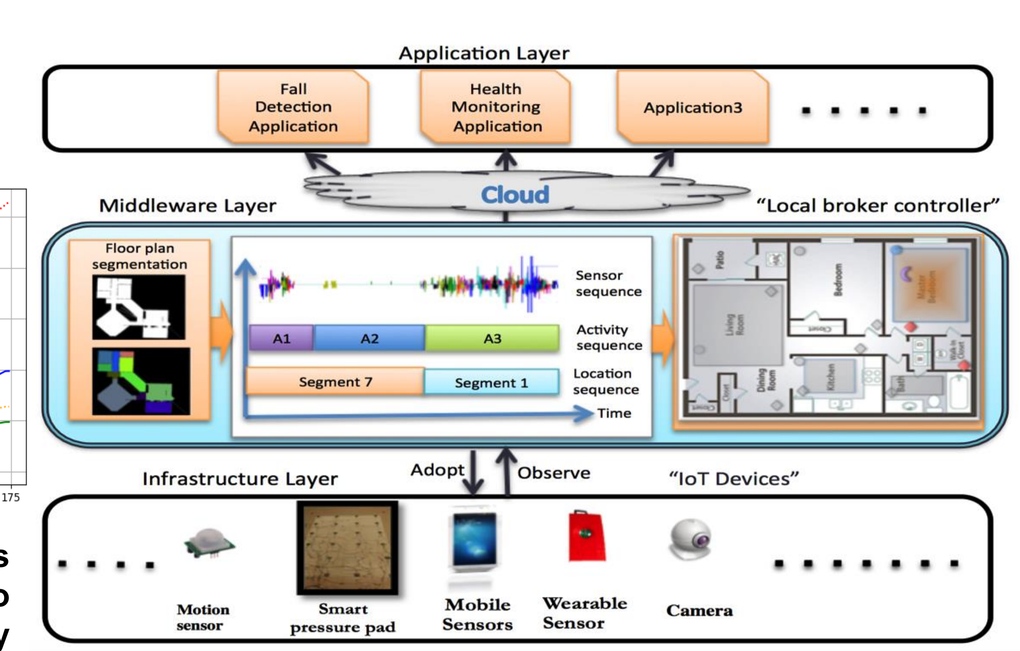


SAFER: Perpetual IoT for Assisted Living

In SAFER we introduced a the cross- layer personal sensing optimization in terms of energy efficiency and reliability by leveraging:

- Heterogeneity of IoT devices,
- Real time semantic knowledge of applications (Activities of daily living).
- IoT devices multi energy configuration under multiple energy settings:





- 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.

EnviroSCALE

•EnviroSCALE is an extension of SCALE for air quality monitoring.

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

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

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

- EnviroSCACLE uses two techniques to reduce data volume
  - Adjust sampling intervals of sensors according to the data plan budget
  - Encode sensor readings in binary payload instead of using verbose JSON
- Budget-aware sensing requires to find sensing intervals, T_i for sensor i, so as to $\sum_{i=1}^{k} \frac{S_i}{T_i} = \frac{M}{D} - \frac{\alpha}{T}$ which has solutions: $T_i = \frac{1}{\beta}\frac{S_i}{w_i}$ for some per sensor weight ω_i
- The platform also leverages container-driven approach to run rich analytics on media data (e.g., camera data) locally on the device to reduce uploading raw data

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