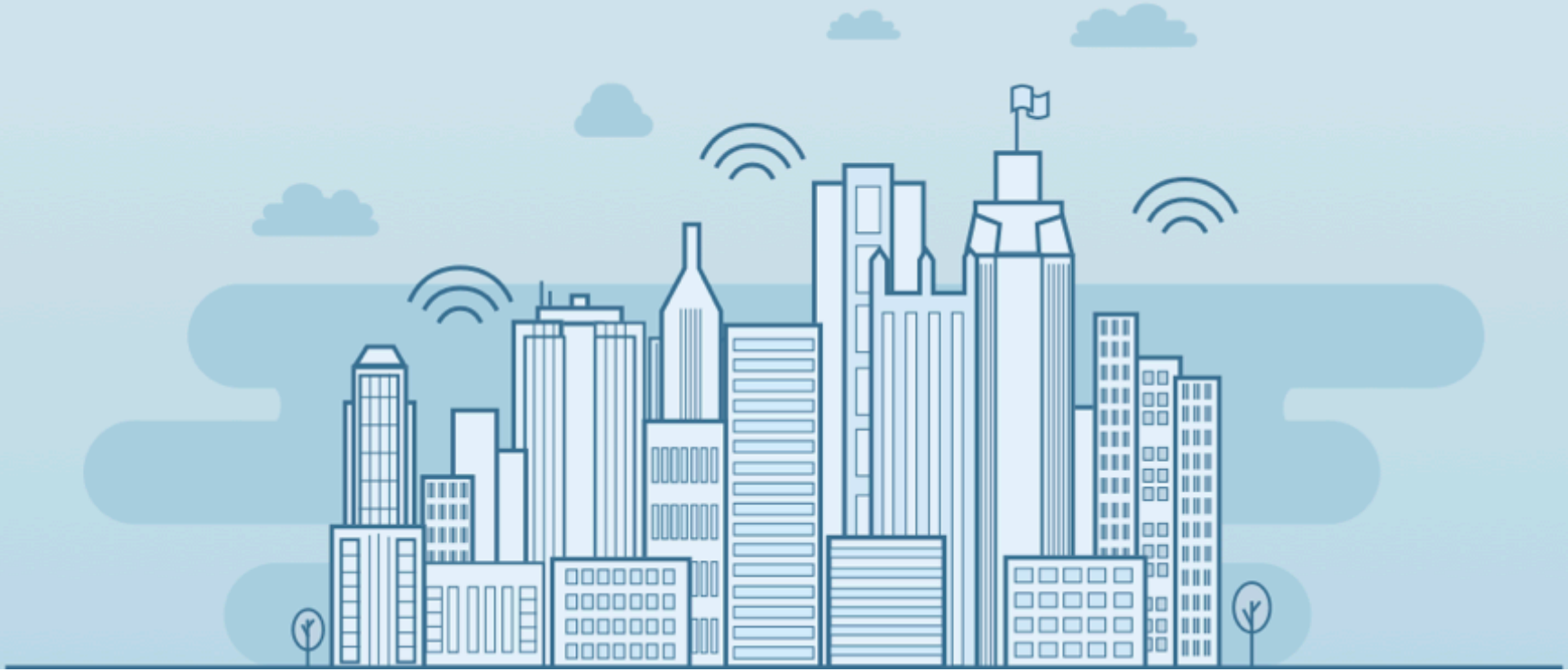
OpenChirp

Carnegie Mellon University

Community-Driven Low-Power Wide Area Networking

http://www.openchirp.io



Low-Power Wide Area Networking (LP-WAN)

- IoT is ready to leave the building…
- Wide area low data-rate and low-power IoT City Networks
- Transmitters can send a few bytes per second over kilometers
- Sub 1GHz support deeper building penetration

Existing Technologies

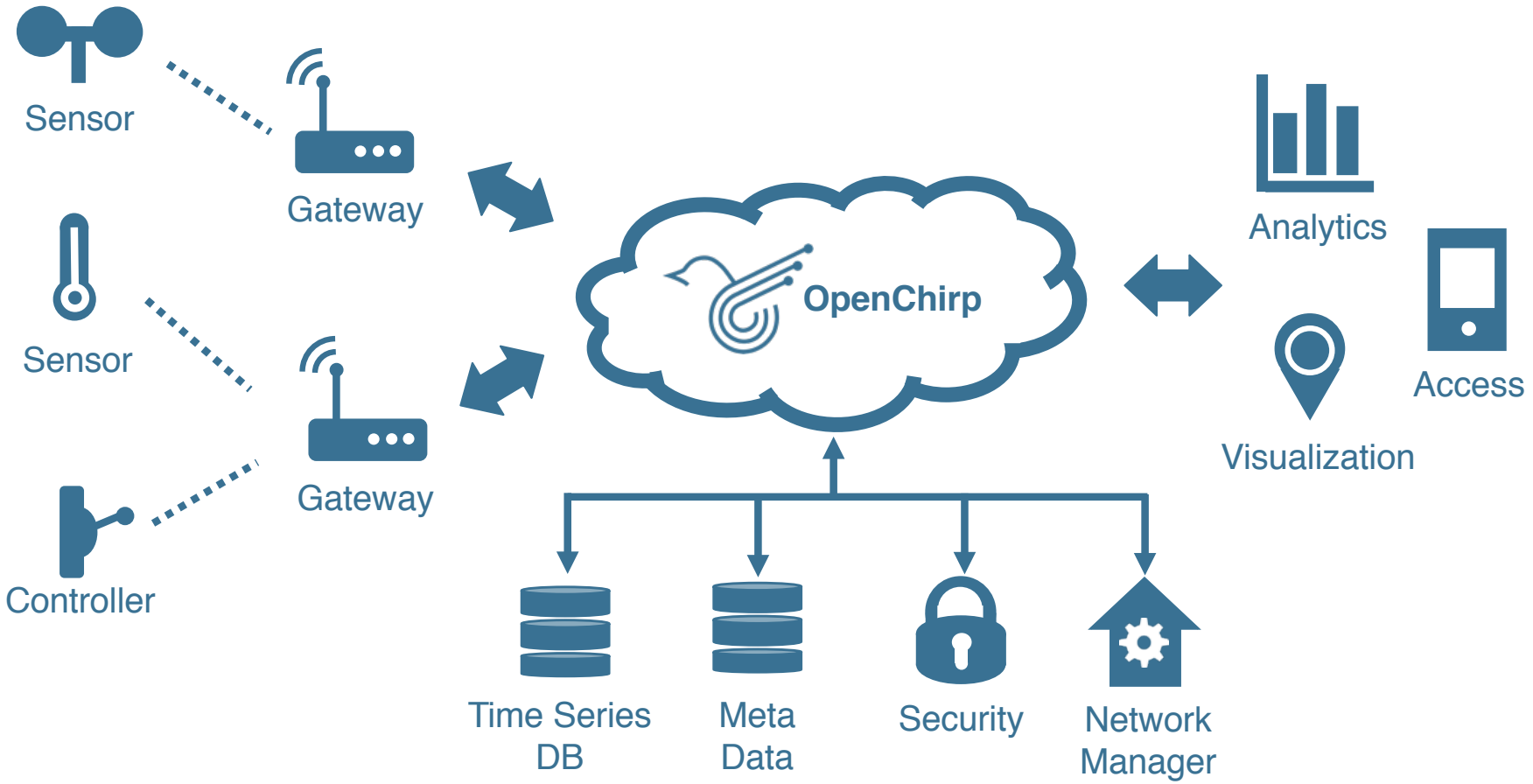
- NarrowBand IoT (3G cellular IoT channel)
- SIGFOX
- LoRaWAN (open standard)

Challenges

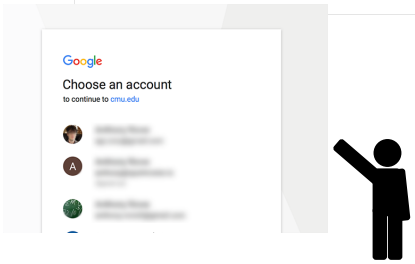
- User / Service / Device Management
- Network Management
- Data Representation and Sharing
- Plugging in Analytics
- Security & Privacy

What is OpenChirp?

- Management Platform for LP-WAN Networks
- Web Portal for sharing and managing data sources
- Provides Data context, storage, visualization
- Developer API and tools

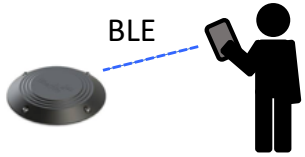


OpenChirp Concept

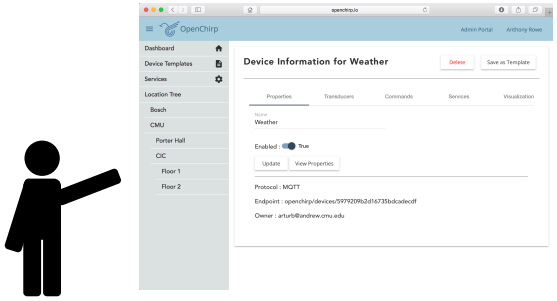


Step 1: Login using Google ID

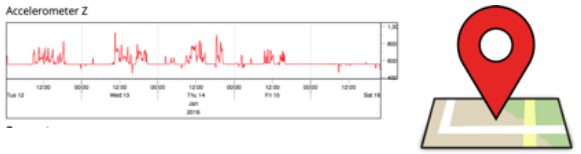
Step 2: Grab a LoRa Device



Step 3: Configure Devices



Step 4: Register on Web Portal



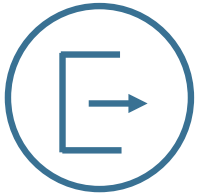
Step 5: Manage Devices

Sounds easy, but there is a lot that needs to be done under the hood…

OpenChirp Features

ProtoBuf serialization
from end-device to cloud

MQTT for scalable real-time publish subscribe

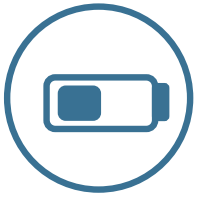


Bring your own gateway
to crowd-source coverage

REST interface for configuration and management

Open-Source Technologies

- Scalable PubSub Architecture (MQTT)
- Time Series Datastore (InfluxDB)
- Data Visualization and Analytics (Grafana)
- REST Interface (node.js)
- Authentication (OAuth2 integrated with Google)
- Meta Data storage and search (MongoDB)

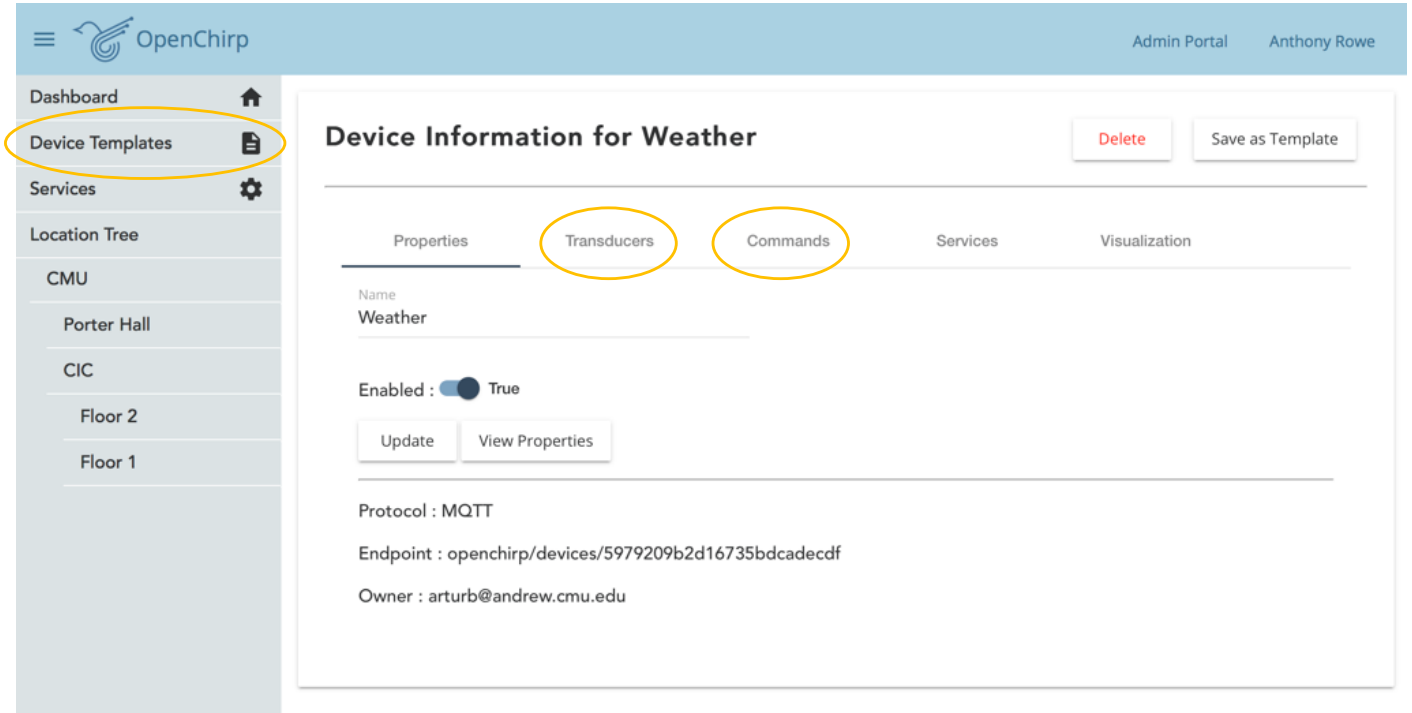


Energy-Efficient
Reference Firmware

Intelligent Network Management

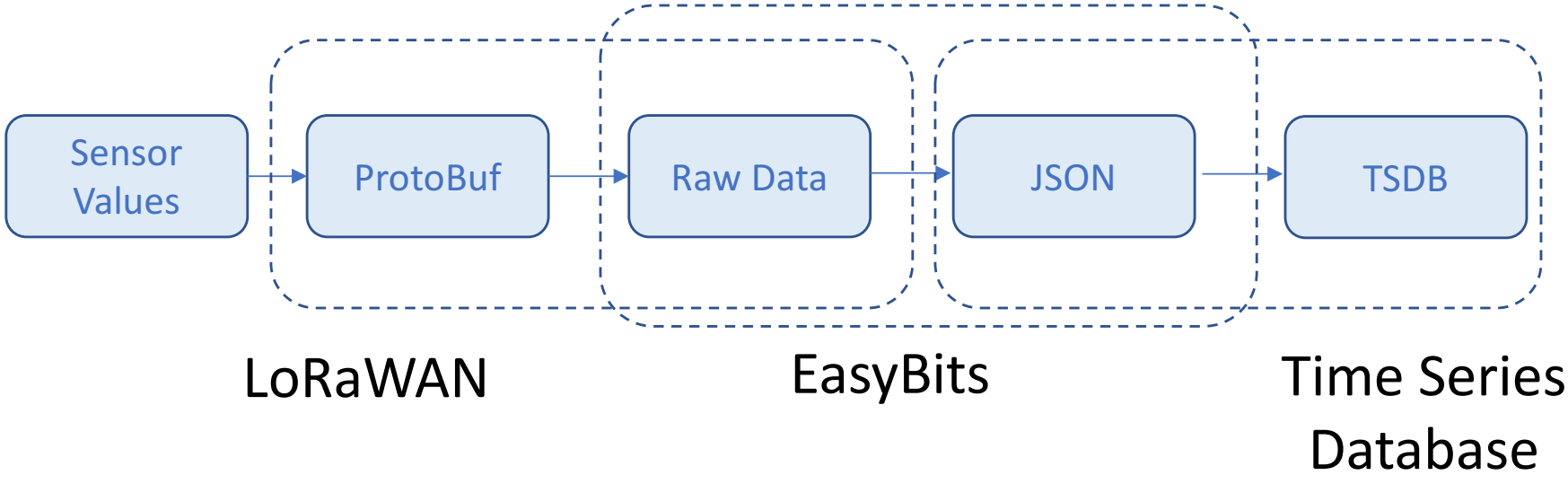
Devices

- **Transducers**
  - Sensor / Actuator Name, Unit, Value, Timestamp
- **Commands**
  - Shortcut for writing a value to a transducer
  - Captures typical ”actuate” requests
  - Shareable links
- **Device Templates**
  - Package of common transducers / commands with services



Services

- Plug-ins for processing data
  - “Stackable” setup a processing pipeline



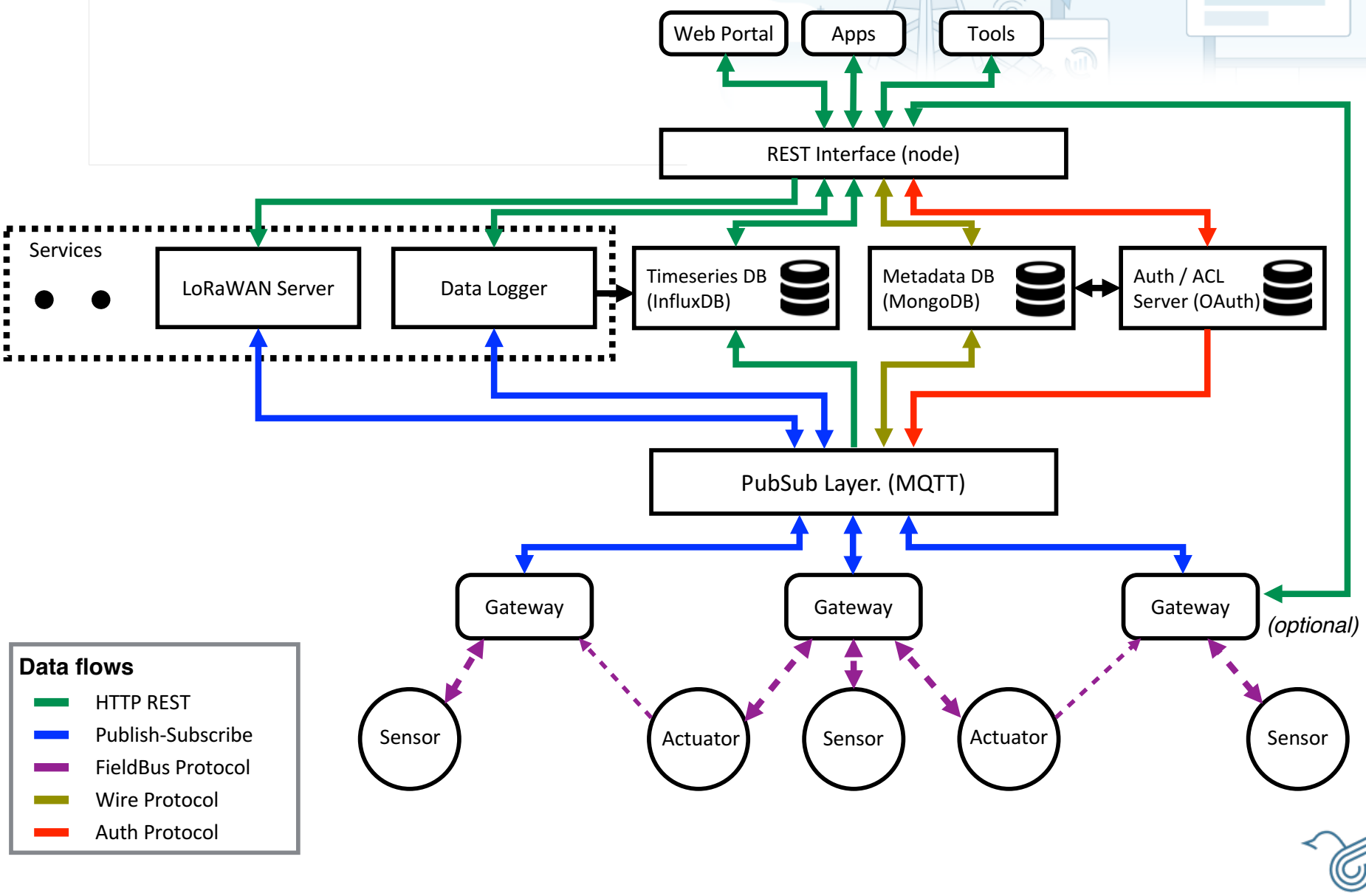
Example Services

- **Time series data store**
  - Store data in a TSDB like influx
- **LoRaWAN device**
  - Link a device with a LoRaWAN end-point
- **LoRaWAN gateway**
  - Link a gateway with a LoRaWAN server
- **EasyBits**
  - Link a binary stream to Transducers
- **Trigger**
  - Push a URL on a data event

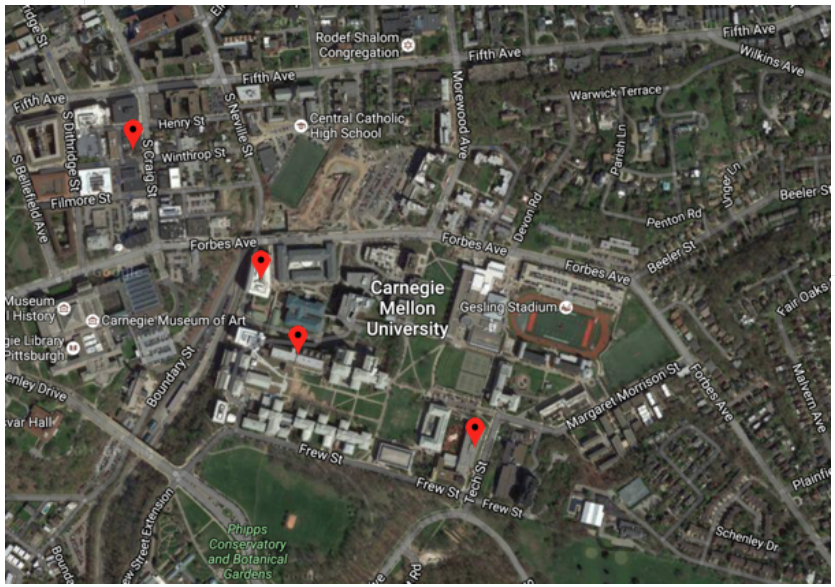
Security

- **Authentication**
  - Login with google ID for Authentication (OAuth2)
- **“Thing” Credentials**
  - Tokens for users, devices and services
  - Limited domains
- **Access Control**
  - Users / Groups
  - Public Links

OpenChirp Architecture



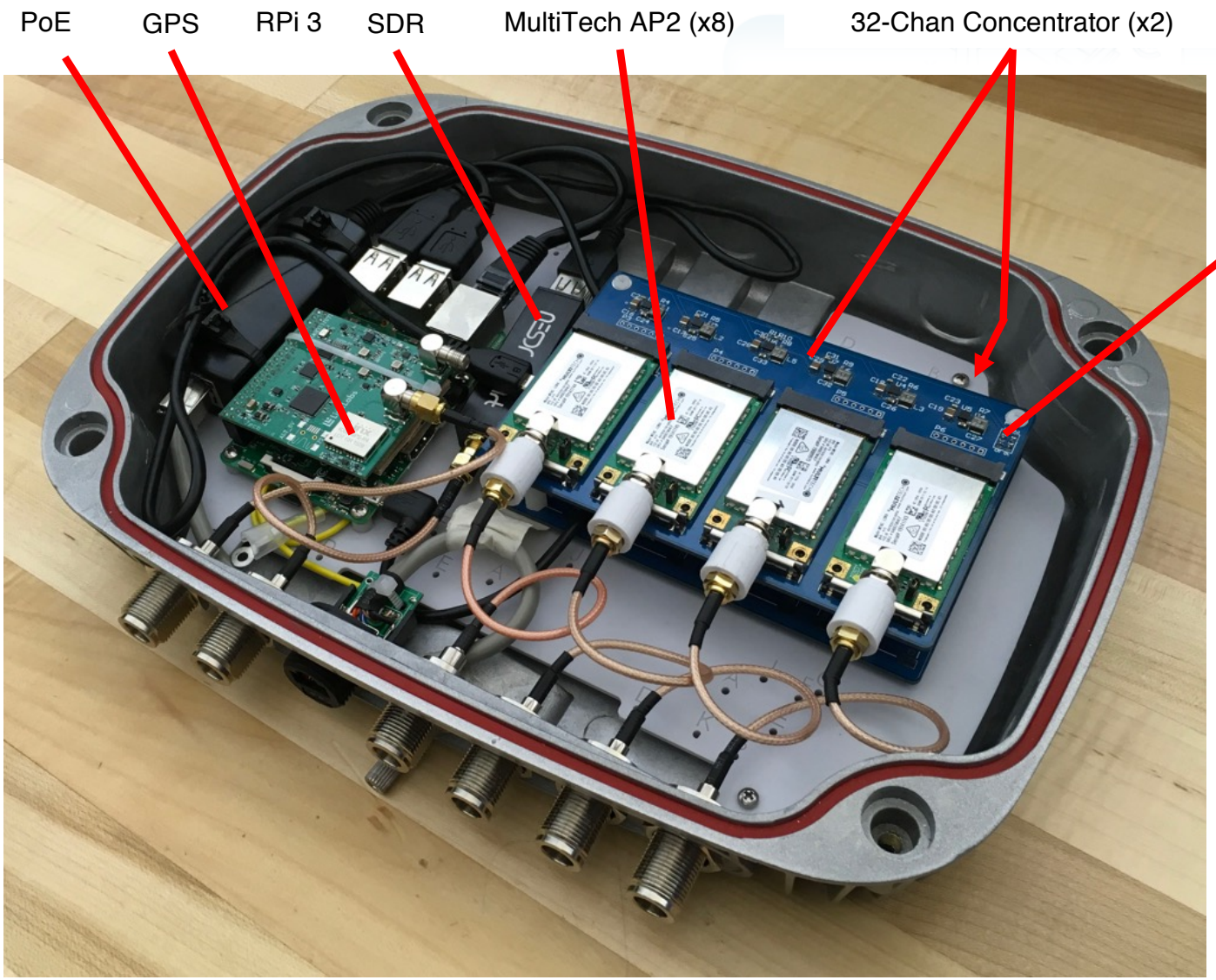
Pilot Deployments



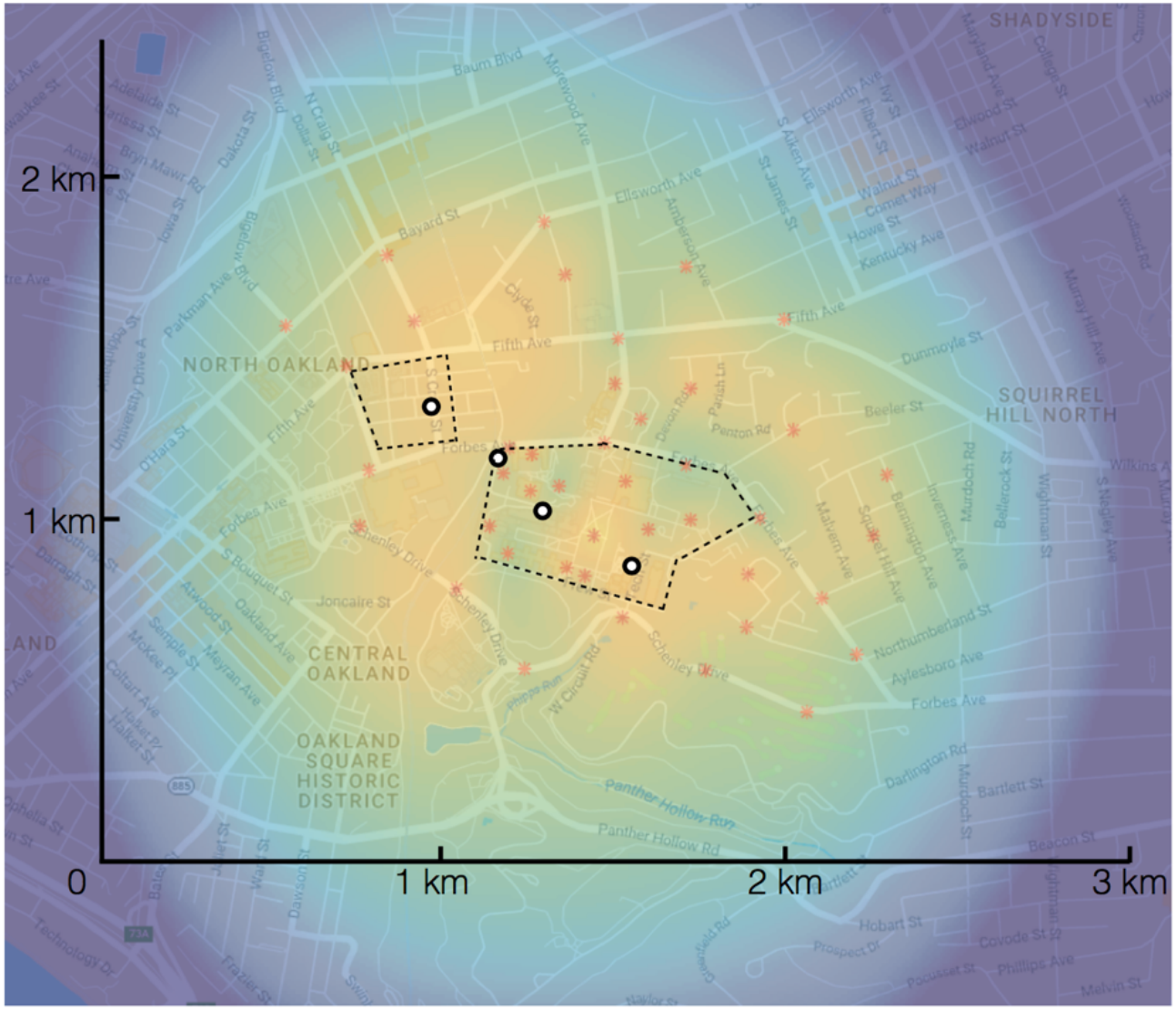
1-λ separated 5.5dBi 902MHz ~ 928MHz

Rooftop Gateway

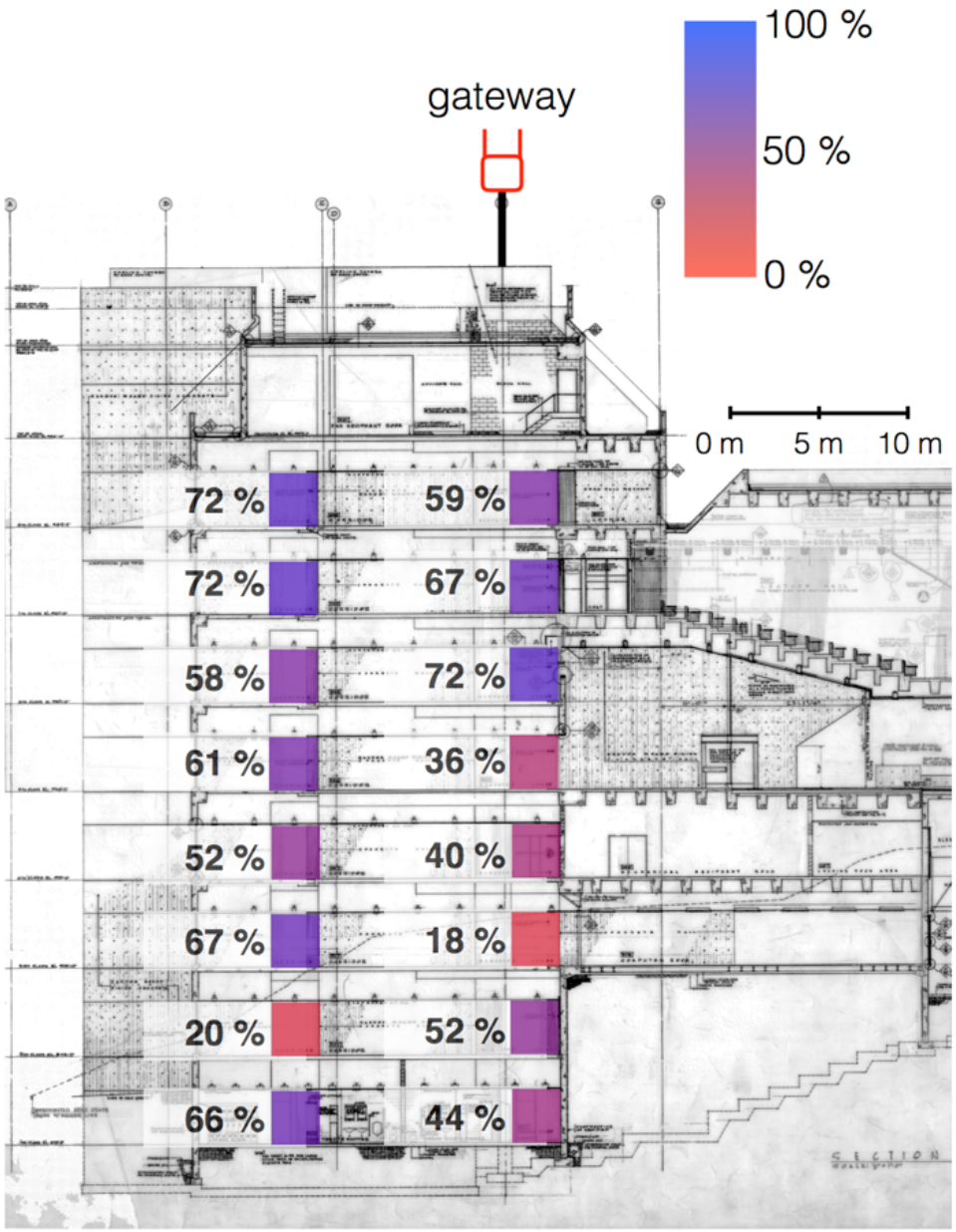
CMU LoRa Gateway



Campus Coverage



Building Penetration



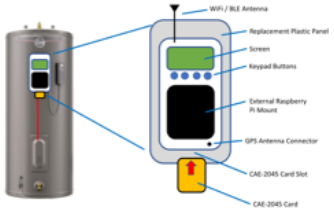
9 Floor poured concrete building

LoRa Devices on Campus

- LoRaBug
  - Open environmental sensor
  - Monitors environment in remote indoor areas

- Laser Ranger
  - Time-of-flight laser ranger
  - Monitors structural deflection over time

- Occupancy Sensing
  - Measure people traffic across spaces

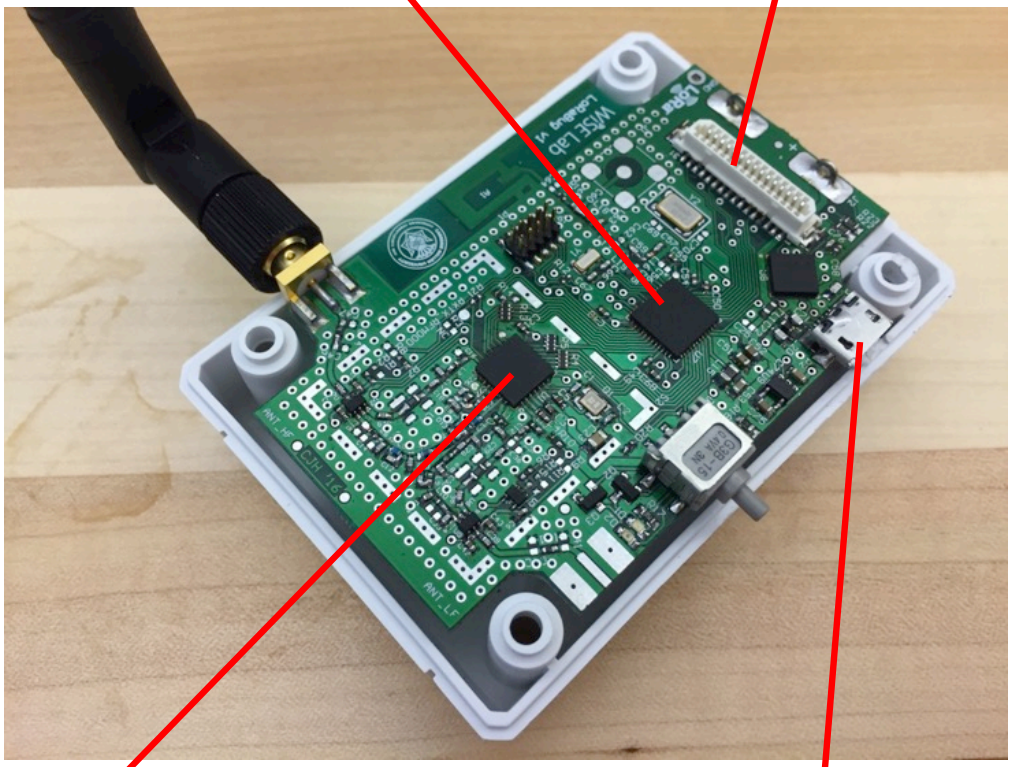


- Water Heater Controller
  - Demand-Response peak shifting

LoRaBug – Sensing Platform

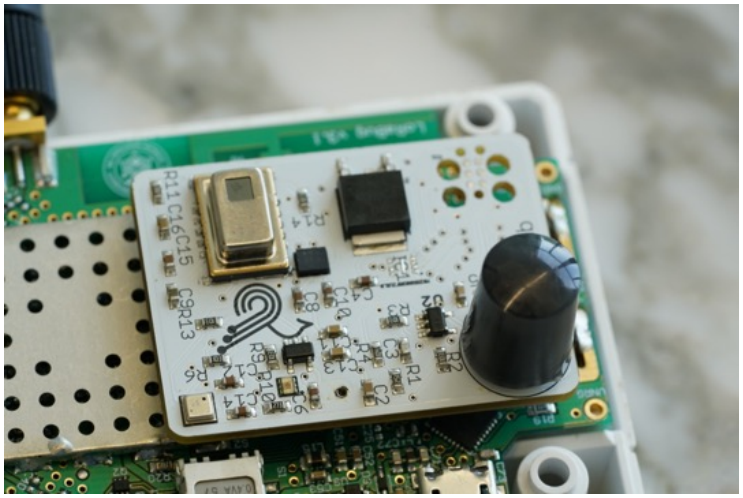
TI CC2650 ARM M3
BLE + 802.15.4

General Purpose
Sensor Header



SX1276
LoRa Radio

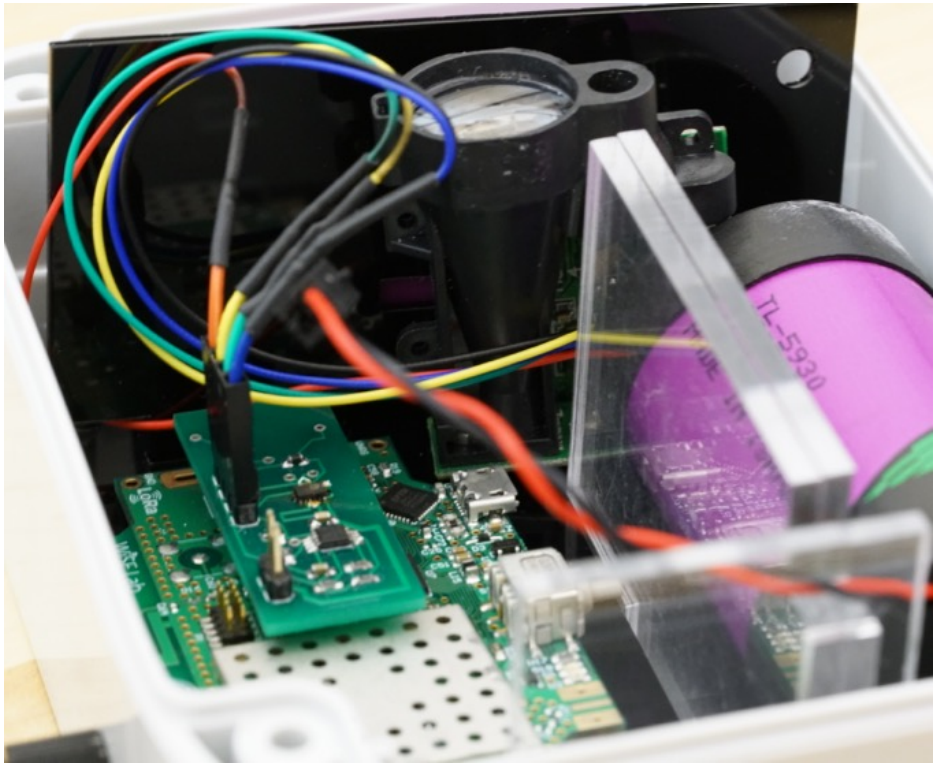
USB



Sensor Board: Light, Temperature, Accelerometer, Magnetometer, Rate Gyro, Humidity, LEL, Water Contact, Pressure, Audio, PIR motion, 8x8 FLIR imager

5 years @ 15 min

Laser Monitoring

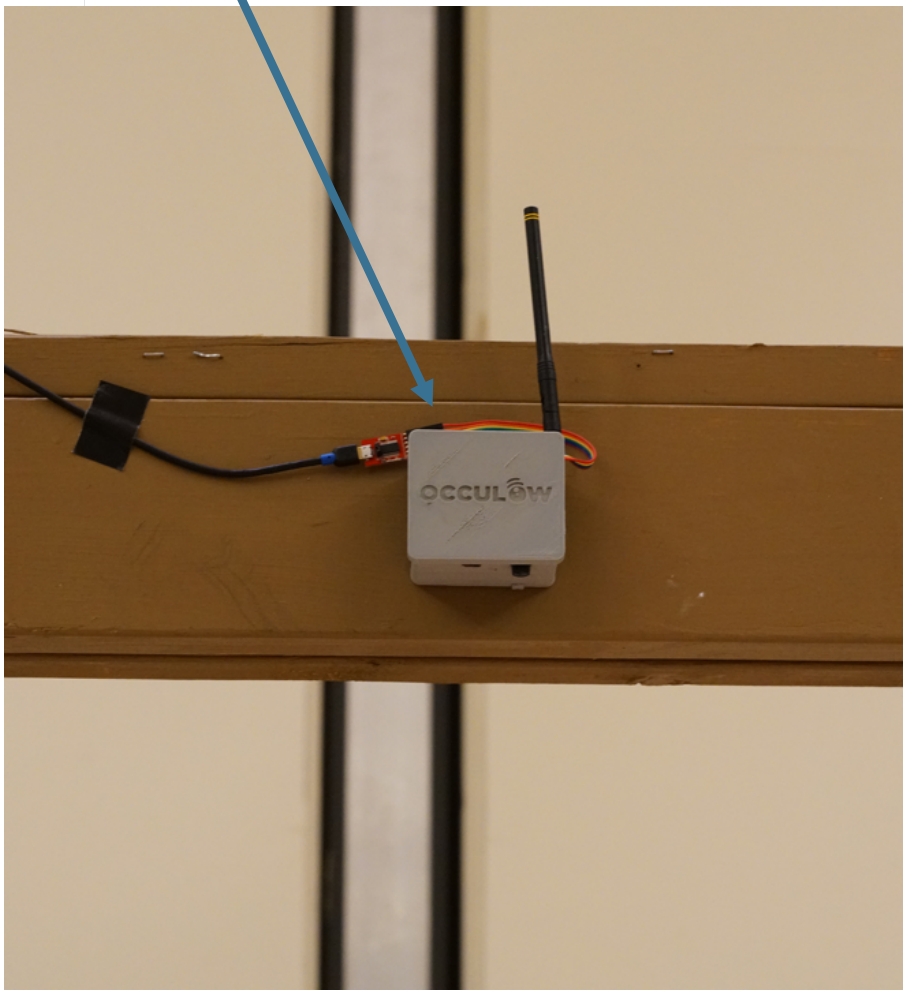


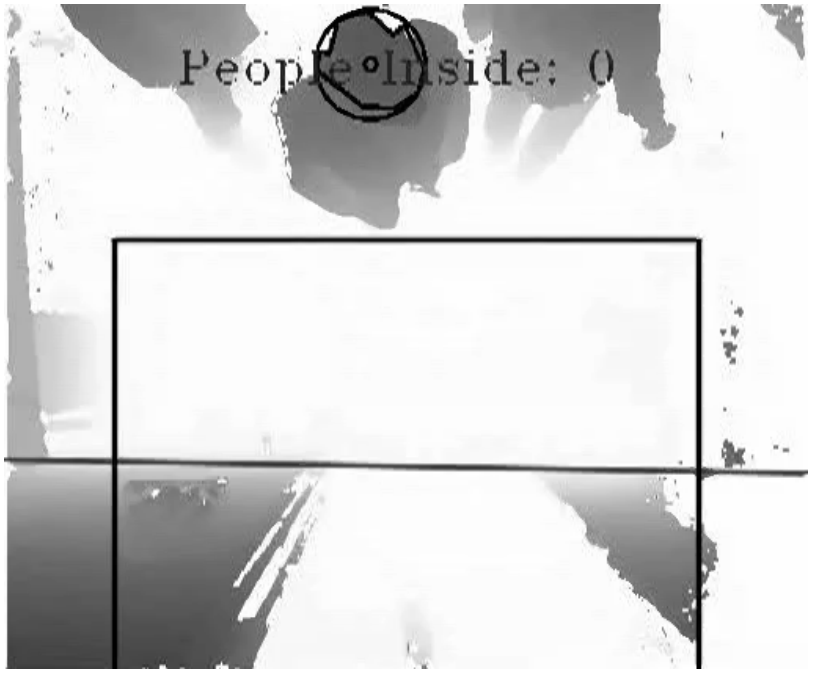
Range: 150m
Resolution: 1mm
Accuracy: 2mm
Lifetime: 5 years @ 15min

Bridge Monitoring Example

Campus Occupancy Sensing

Door Frame Sensor

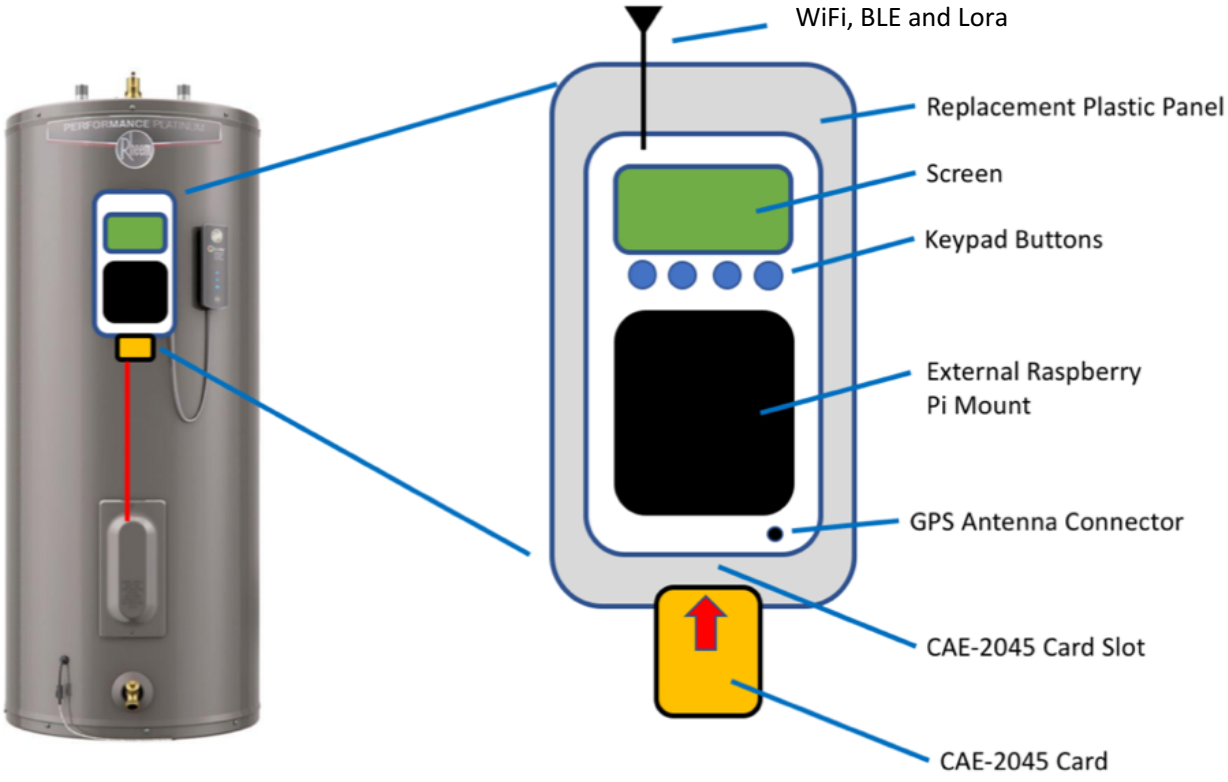


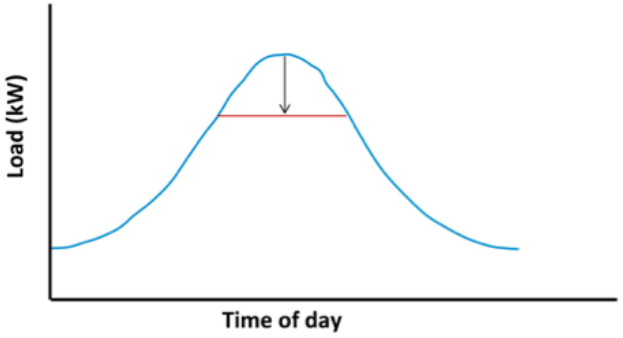


BOSCH

U.S. DEPARTMENT OF ENERGY

GridBallast – Water Heaters





Electric Water Heater Controller

- Learns Grid load profile (Voltage Frequency / ADR)
- Learns User Patterns
- Platform for Demand Response Algorithms

arpa·e
CHANGING WHAT'S POSSIBLE

Research Thrusts

- Network Management
  - Automatic configuration with Bring Your Own Gateway model
  - Mix of Towers (Macro-cell) and Home APs (Micro-cell)
  - Decoupling Data / Control Plan to create “OpenFlow” of LP-WAN
  - Security
- Whitespace Offloading
  - Integrate our framework with FCC database for WS registration
  - Dual-mode MAC layer
- Localization
  - Collaborative localization with APs and Peers
  - Improved performance based on RF-modeling and geometry constraints
- Application Drivers
  - Campus sensing
  - Energy-efficient client support

Thanks, Questions?

http://www.openchirp.io

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