OpenChirp: A Low-Power Wide-Area Networking Architecture

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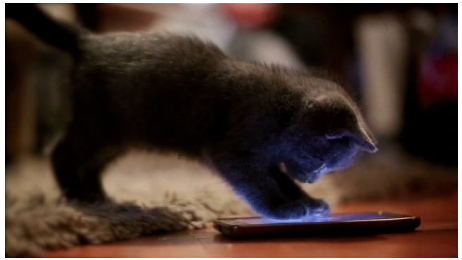
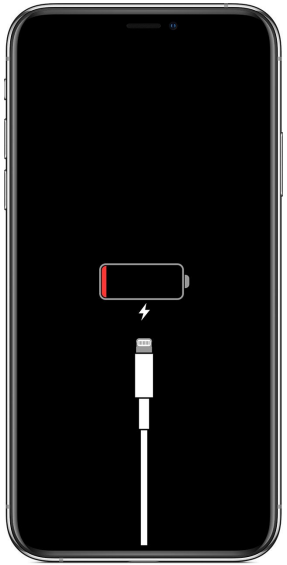
Goal

Main factors of IoT’s Network

- High bandwidth?
- Energy efficiency?
- Cover Range?





Your phone can be recharged anywhere and anytime

IoT App requirements:

(1)Transmit small packets

(2)For years or even a decade

(3)A single battery charge

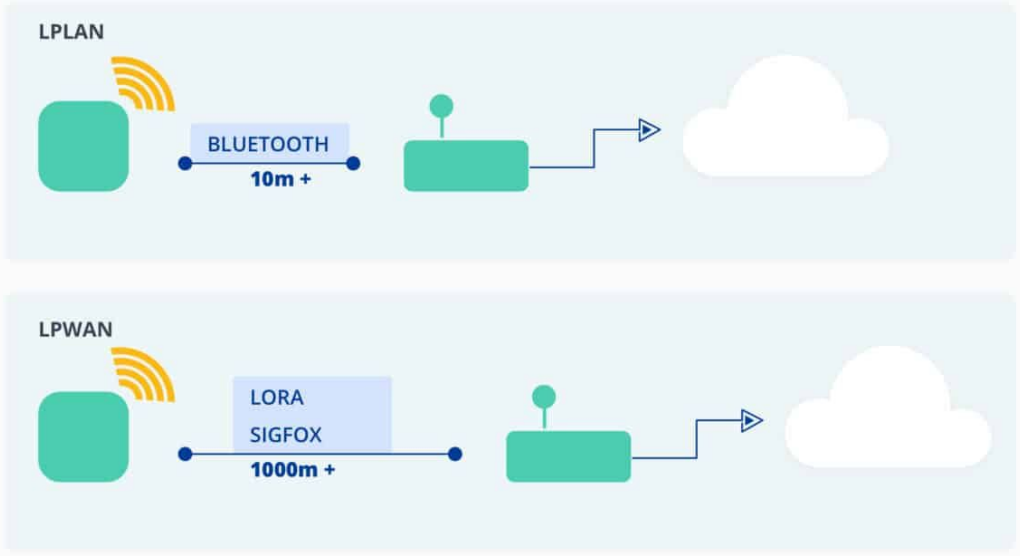
LPWAN

What is LPWAN?

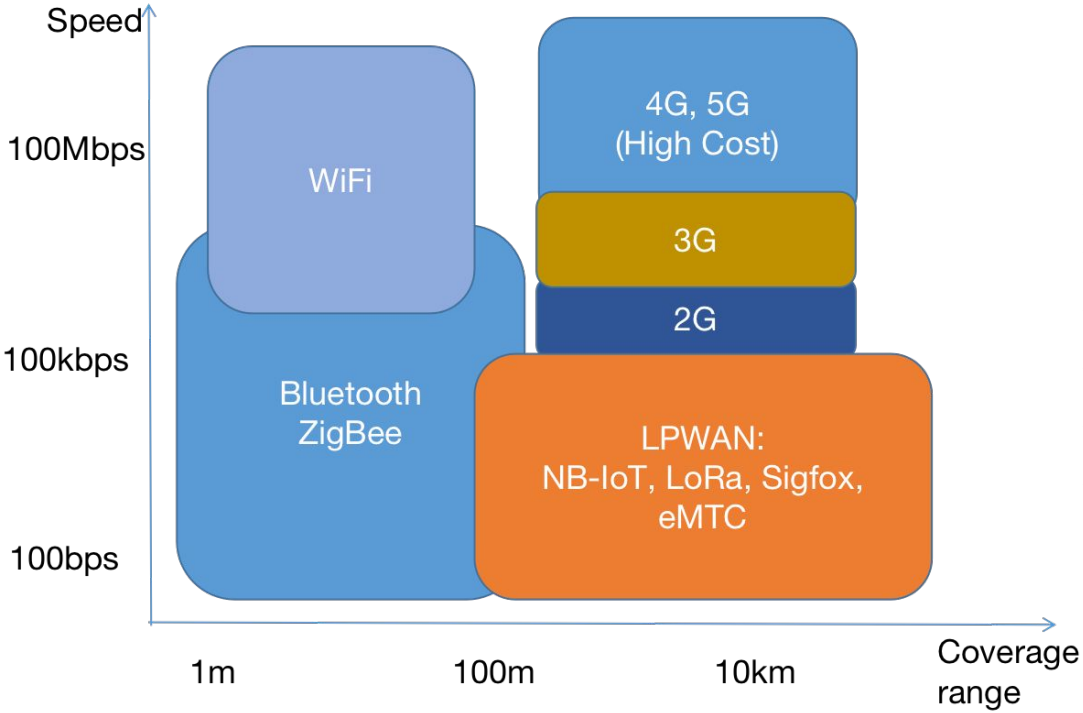
LPWAN

(1) A type of wireless telecommunication wide area network

(2) Designed to allow long-range communications at a low bit rate among things

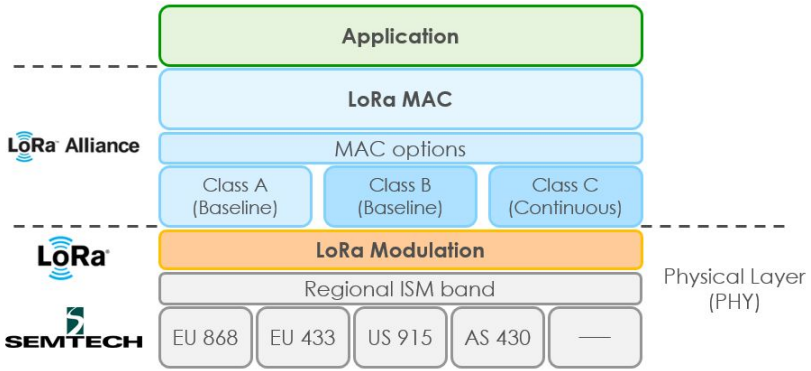


LPWAN in IoT



- Small packets
- Low power
- Wide-area
- Lower cost
- Greater power efficiency
- Low data rate

LoRa and LoRaWan



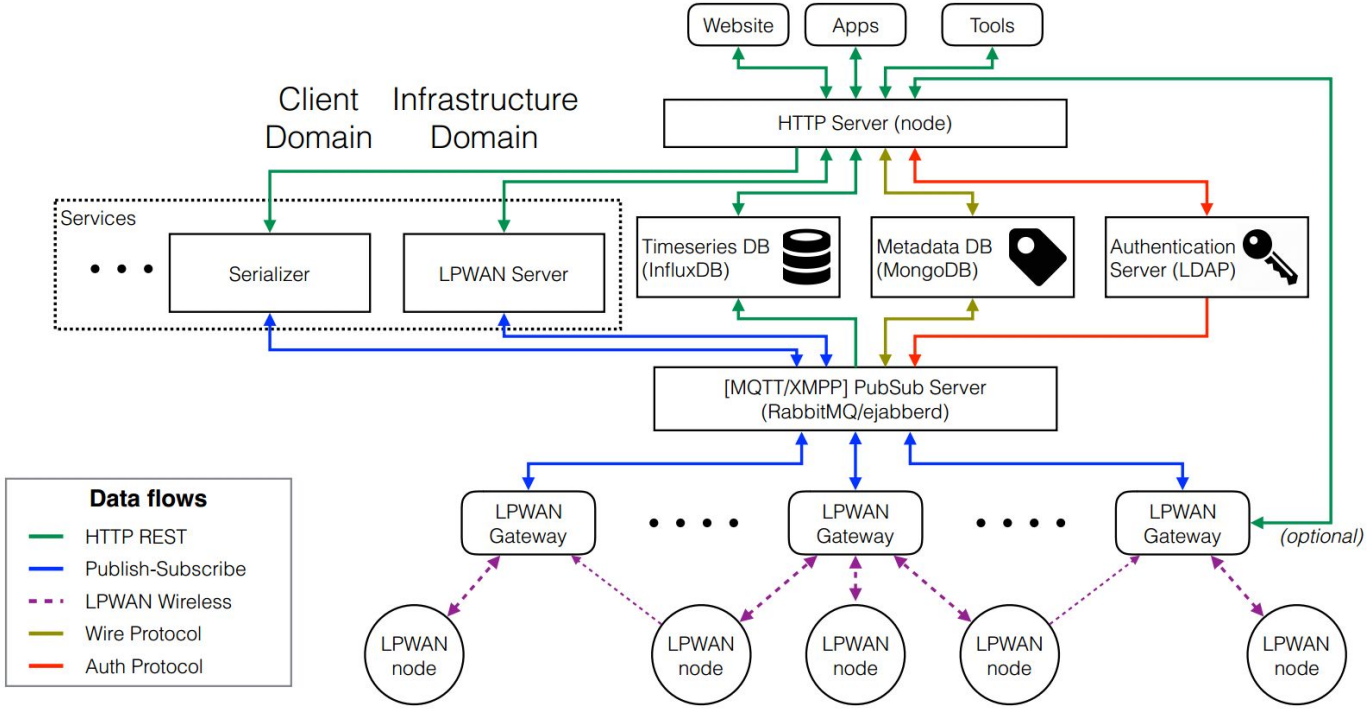
- LoRa radios define the first and second layers (Physical and Data Link) of LPWAN.
- Layers three and four (Network and Transport) are analogous to the LoRa Wide-Area Network (LoRaWAN) protocol.
- LoRaWan defines the communication protocol of LPWAN.

Paper Contribution

- Architecture of OpenChirp network using LPWAN technology

- LoRaBug: an open-source low-cost low-power hardware reference

System architecture for the OpenChirp network



A. API

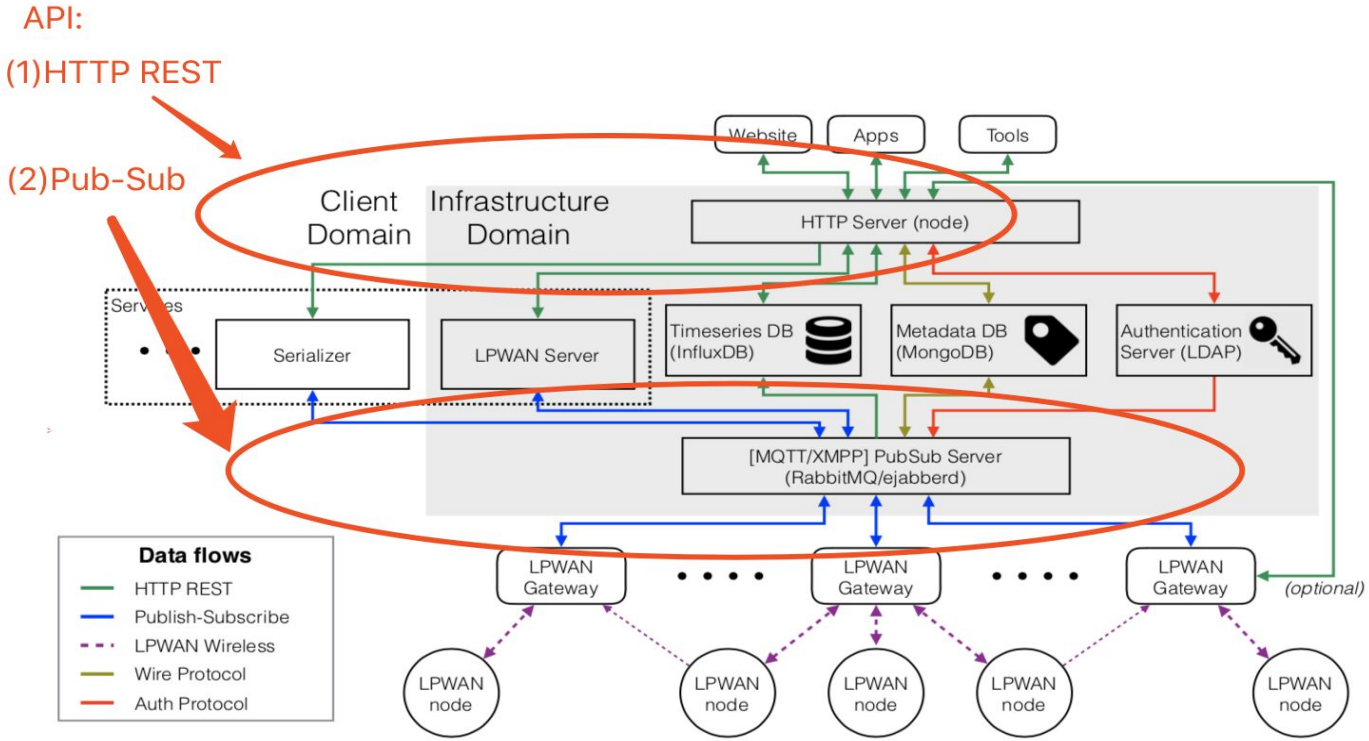


Fig. 1. System architecture for the OpenChirp network

B. Publish-Subscribe Dataflow

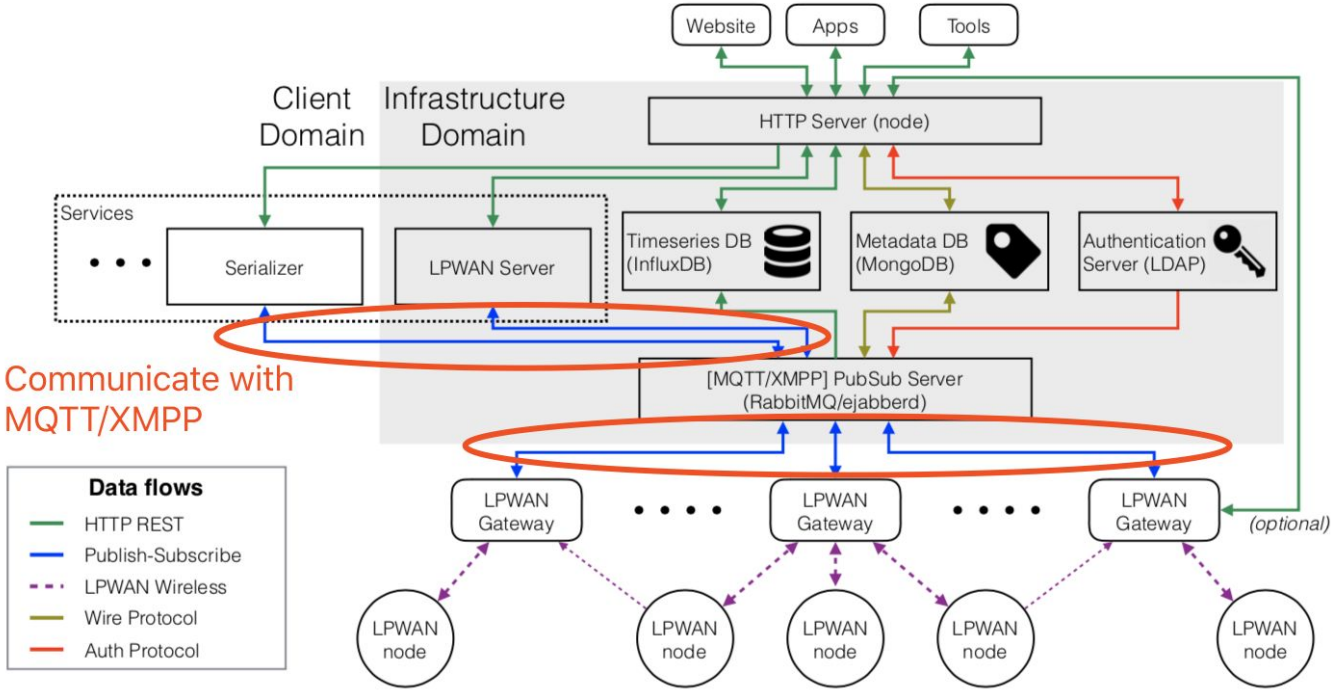


Fig. 1. System architecture for the OpenChirp network

C. Services of HTTP Server

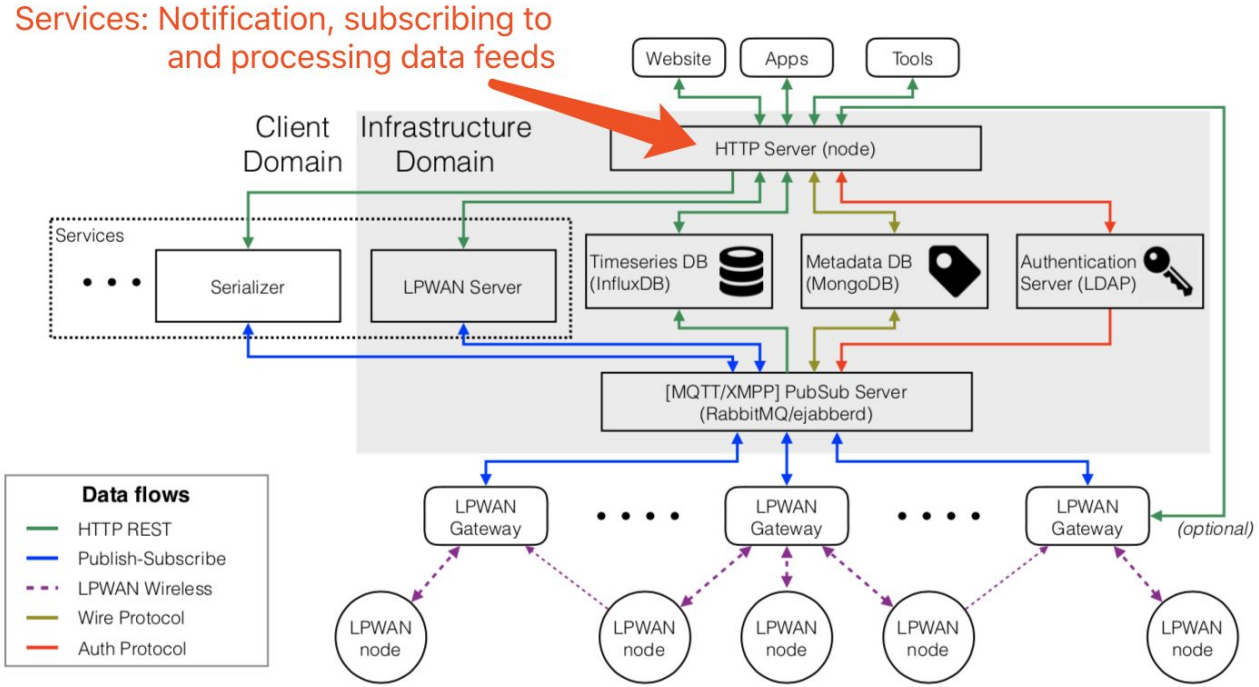


Fig. 1. System architecture for the OpenChirp network

D. Database

(1)Store data history
(2)Applications and services can access through REST API

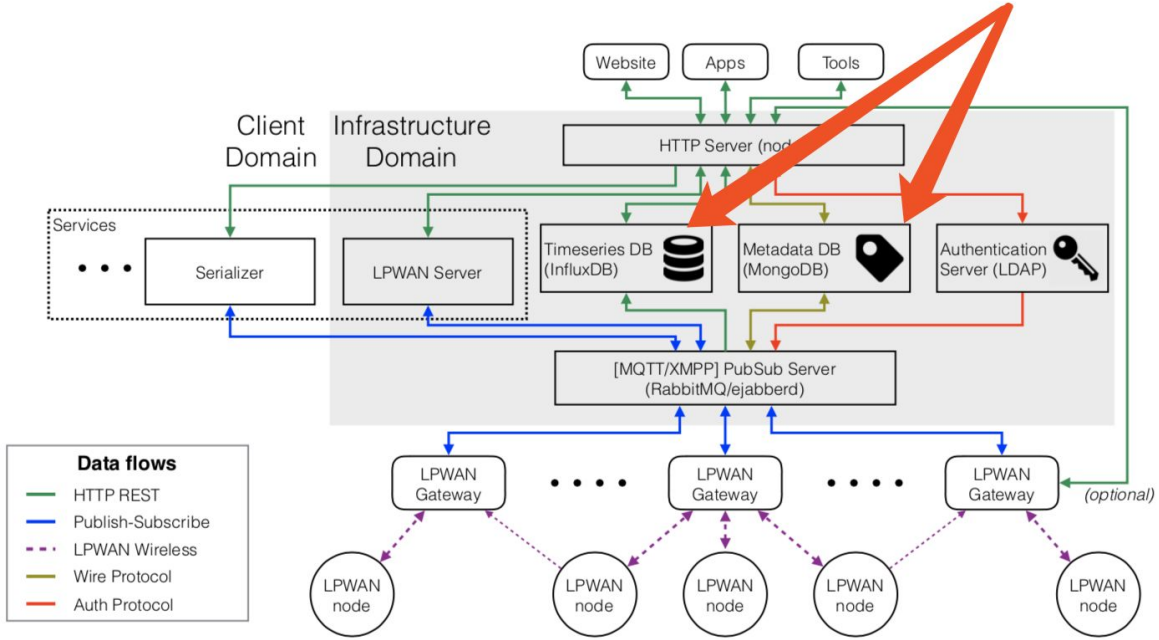


Fig. 1. System architecture for the OpenChirp network

E. LPWAN Gateways

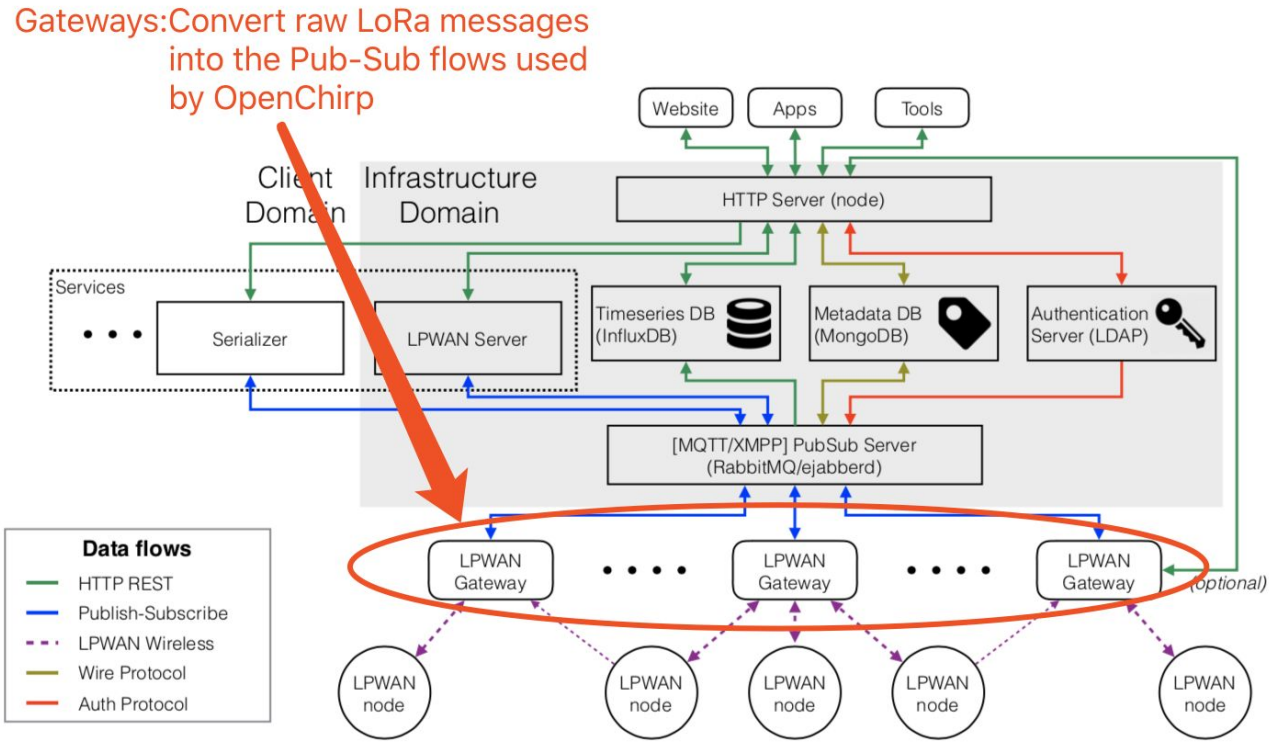


Fig. 1. System architecture for the OpenChirp network

F. Network Coverage and Signal Penetration

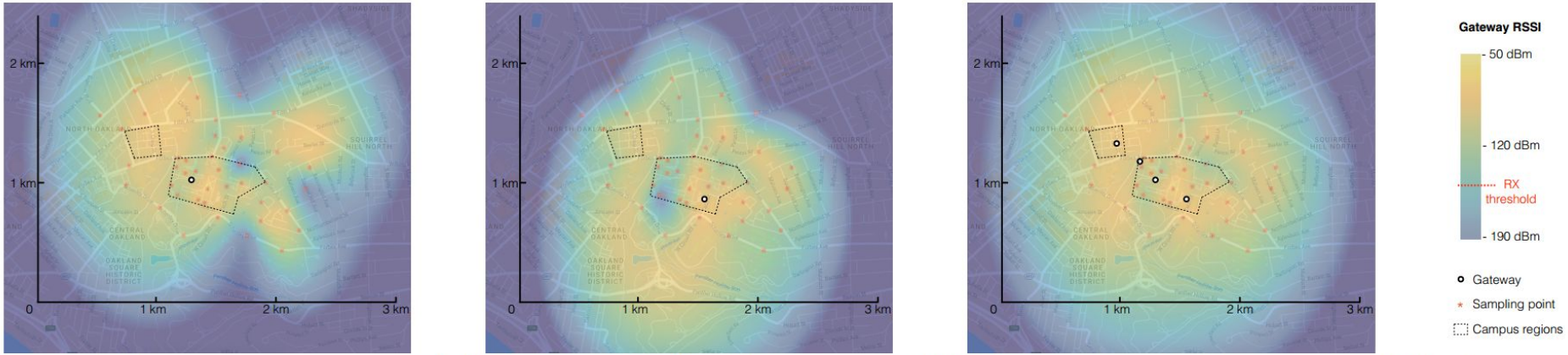
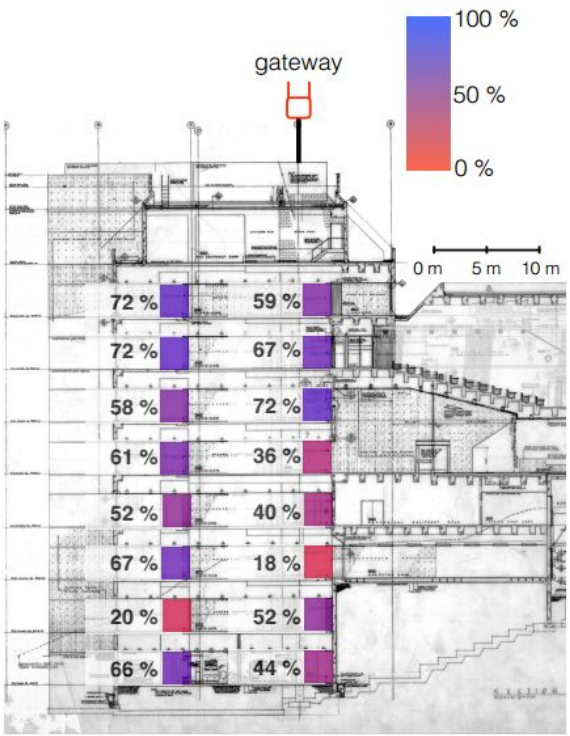


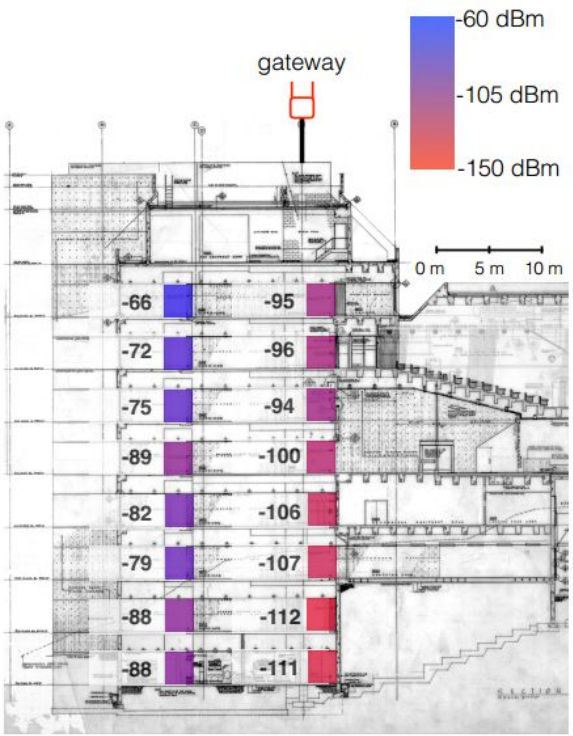
Fig. 4. Network coverage in and around CMU campus. (left) Wean Hall gateway, (middle) GSIA gateway and (right) combination of all gateways.

F. Network Coverage and Signal Penetration

Bi-directional packet success rate



Gateway RSSI for successful packets



Paper Contribution

- Architecture of OpenChirp network using LPWAN technology

- LoRaBug: an open-source low-cost low-power hardware reference

Motivation

- Ease-of-use in terms of registration
- Expandability
- A well profiled reference firmware stack that can maintain low-power consumption

LoRaBUG

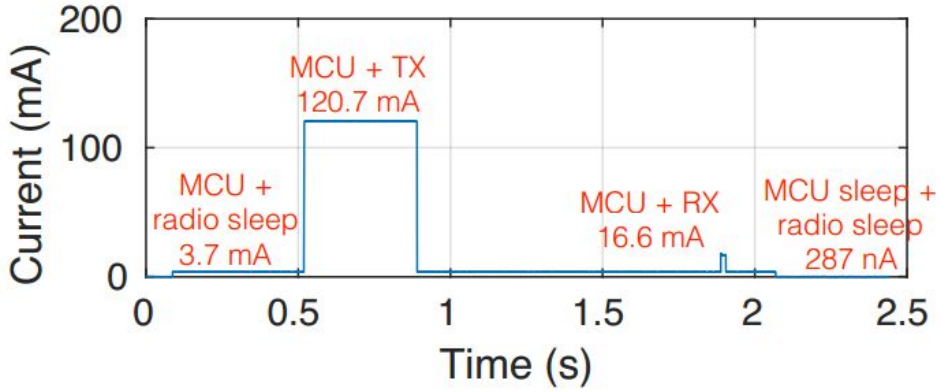
(1) Firmware with a minimal multitasking:

TI-RTOS

(2) Energy consumption:

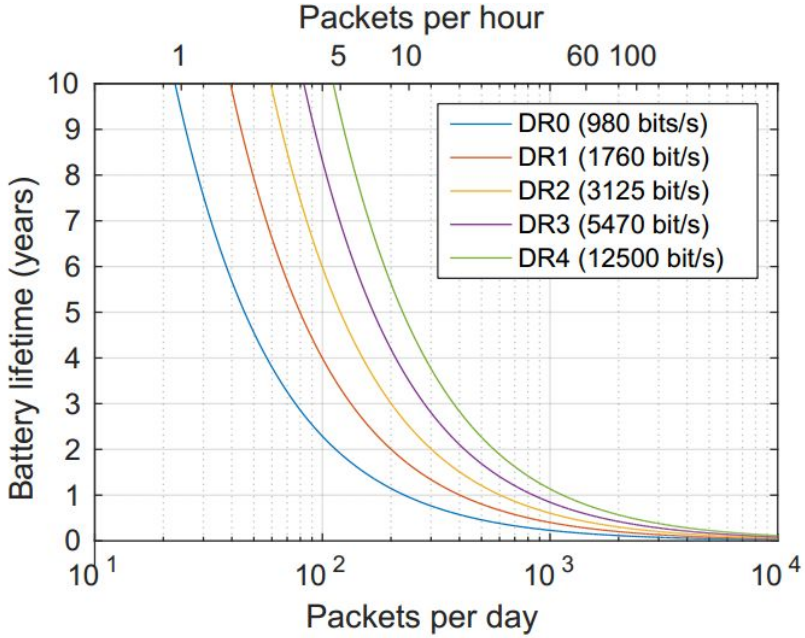
Multiple sleep and function states

Energy Consuption



(a) LoRaBug current consumption over time for transmitting a packet and then checking for an ACK from the gateway.

Energy Consuption



(b) Lifetime of a LoRaBug powered by two AA batteries at various operating points based on a measured energy profile.

Challenges

- Localization
  - LoRaWAN hardware and software implementations limit timestamp resolution to 1 μsec.
  - Localization accuracy > 300m
- Scalability
  - MAC-in-the-cloud concept: high latency, overload, reliability, etc.
- Security and Privacy
  - LPWANs is vulnerable to attack

Challenges

- Spectrum efficiency
  - Develop protocols for current gateway chipsets that can use all 72 channels
  - Develop better listen-before-talk MAC protocols

Conclusion

OpenChirp:

- Energy efficiency
- Large cover range
- High scalability

Critique

✔️ Low Energy

✔️ Low cost

❌ Security and privacy issues