An Energy-Efficient Long-Range Water Monitoring System: Challenges and Use Cases

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Paper Outline

Introduction

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- Smart city

- Water monitoring benefits:

  - Governments

  - Citizens

- Identified gaps:

  - Power consumption

  - Communication

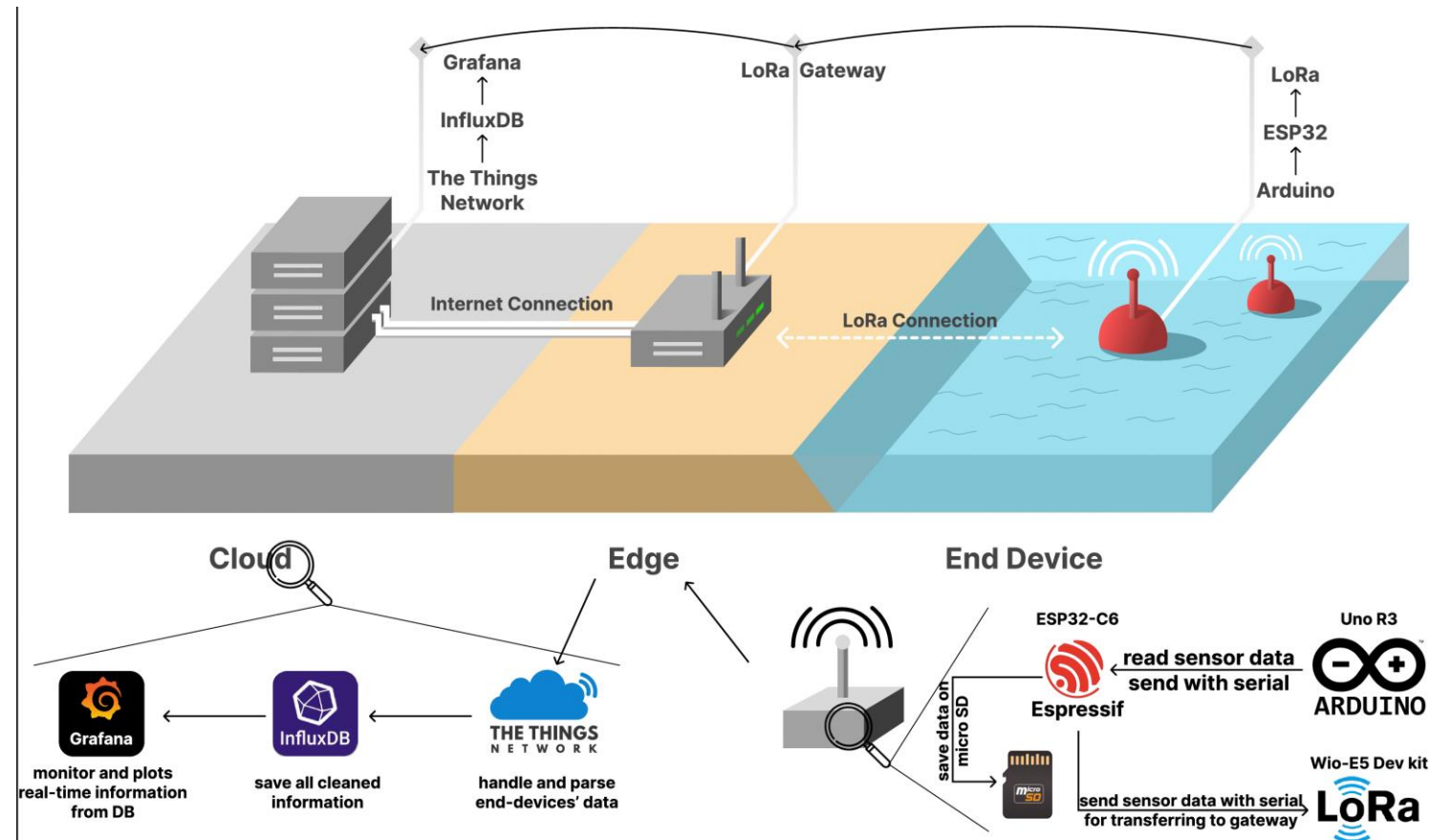 - Real-world challenges

  - Scalable framework

Proposed Method

Proposed Method

Framework parts:

- End device

  - Arduino

  - ESP32C6

  - LoRa

- Edge

  - LoRa gateway

- Cloud

  - The Thing Network

  - InfluxDB

  - Grafana

(a) End device prototype

(b) Gateway

(c) Deployed prototype on the water

Long-Range IoT Water Monitoring Prototype and Deployment

Experiments

Experiments

Power Consumption Analysis

Four end device configurations:

- Raspberry Pi
  - 5 hours of operation

- A: ESP32C6
  - 867% improvement over Raspberry Pi

- B: ESP32C6 + Deep-sleep
  - 43% improvement over config A

- C: ESP32C6 + Deep-sleep + Relay
  - 43% improvement over config B
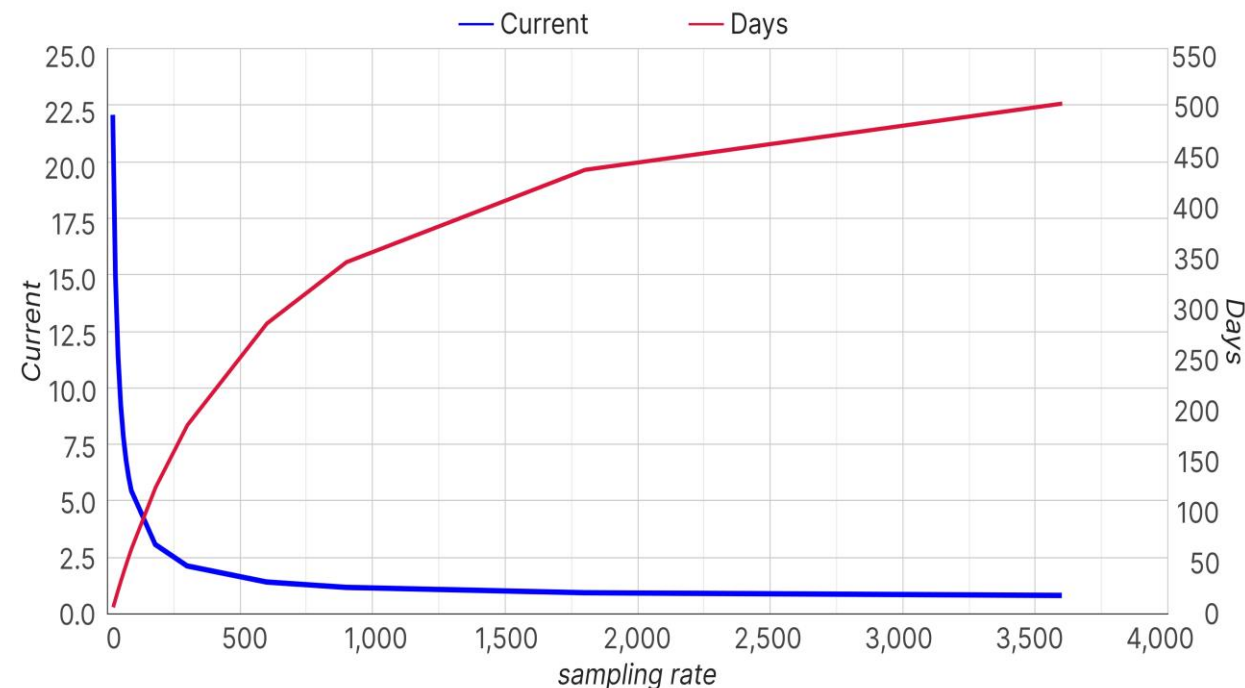
Power Consumption Analysis
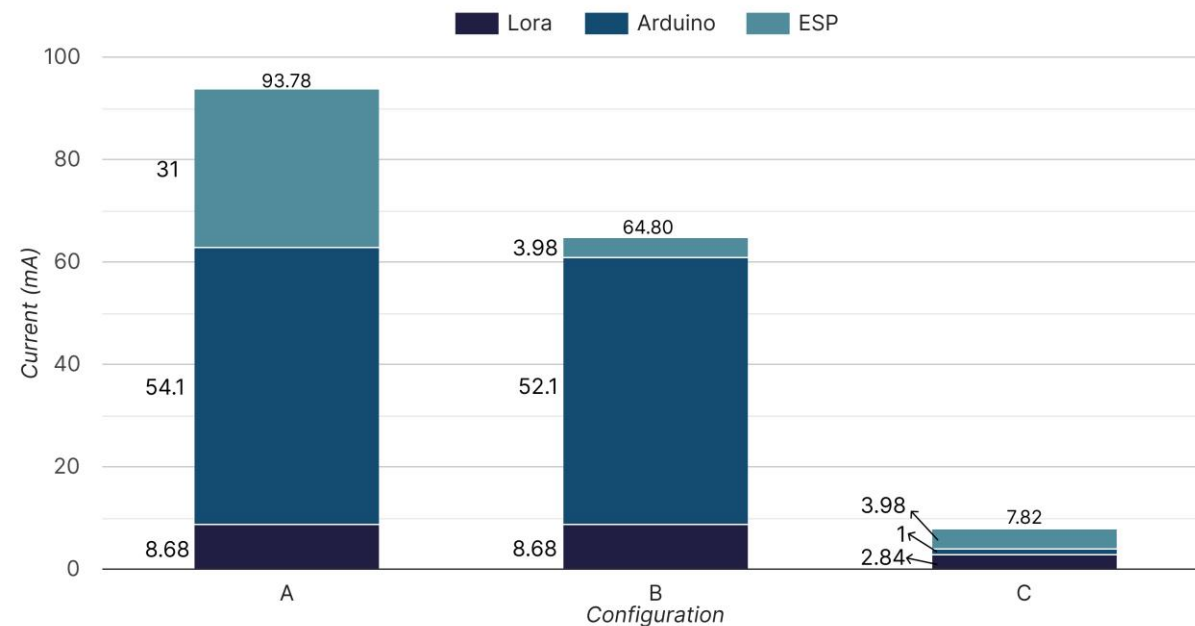
Operation hours calculation:

$$Time(h) = \frac{Battery\ Capacity(Ah) * Battery\ Voltage\ (V)}{Circuit\ Current\ (A) * Circuit\ Voltage\ (V)}$$

With a standard 10,000mA battery:

- Current draw regarding the sampling rate (Blue Line)

- Operation hours regarding the sampling rate (Red Line)

Maximum sampling rate to operate about one year is 15m

Experiments

Grand Lake

Real-world challenges:

- End device safety

- Citizen training

- Floating structure

- Wind and tidal forces

Use Cases

Use cases

- Flood Monitoring

  - Water level sensor

- Green-Blue Algae

  - Turbidity sensors

- Water Pollution Management

  - Heavy metals sensor

  - pH sensor

Conclusion

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- We designed and implemented a remote water monitoring framework.

  - Long distances

  - Long term monitoring

- We tested our prototype in the Grand Lake.

  - Discussed real-world deployment challenges

- We provided a comprehensive analysis of power consumption.

  - Tested several architectures

- We discussed some possible applications of our system.

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