

# PERFORMANCE ANALYSIS OF HETEROGENEOUS NETWORKS FOR ROBOTIC NAVIGATION



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## Introduction

During disaster recovery, we must take the assistance of robots to navigate hostile terrains. Robots can autonomously make application-oriented decisions and send data to human personnel for decision-making [2]. Communication in a disaster-struck environment can be challenging with the destruction of communication infrastructure or lack thereof.

## Background Information

LoRa is a wireless technology that uses Chirp Spread Spectrum (CSS) technology for long-range communication over low bandwidth. LoRaWAN is a wide area network implementation on top of LoRa. Previous works showed [1] the viability of sending images via MQTT, a network protocol for message queuing for limited bandwidth over WiFi.

## Statement of the Research Problem

In the absence of WiFi network, LoRaWAN is a potential candidate to transmit data. However, the data transmission can be impacted due to low bandwidth. We analyze the performance of LoRa to observe the delay. We compare the same with WiFi.

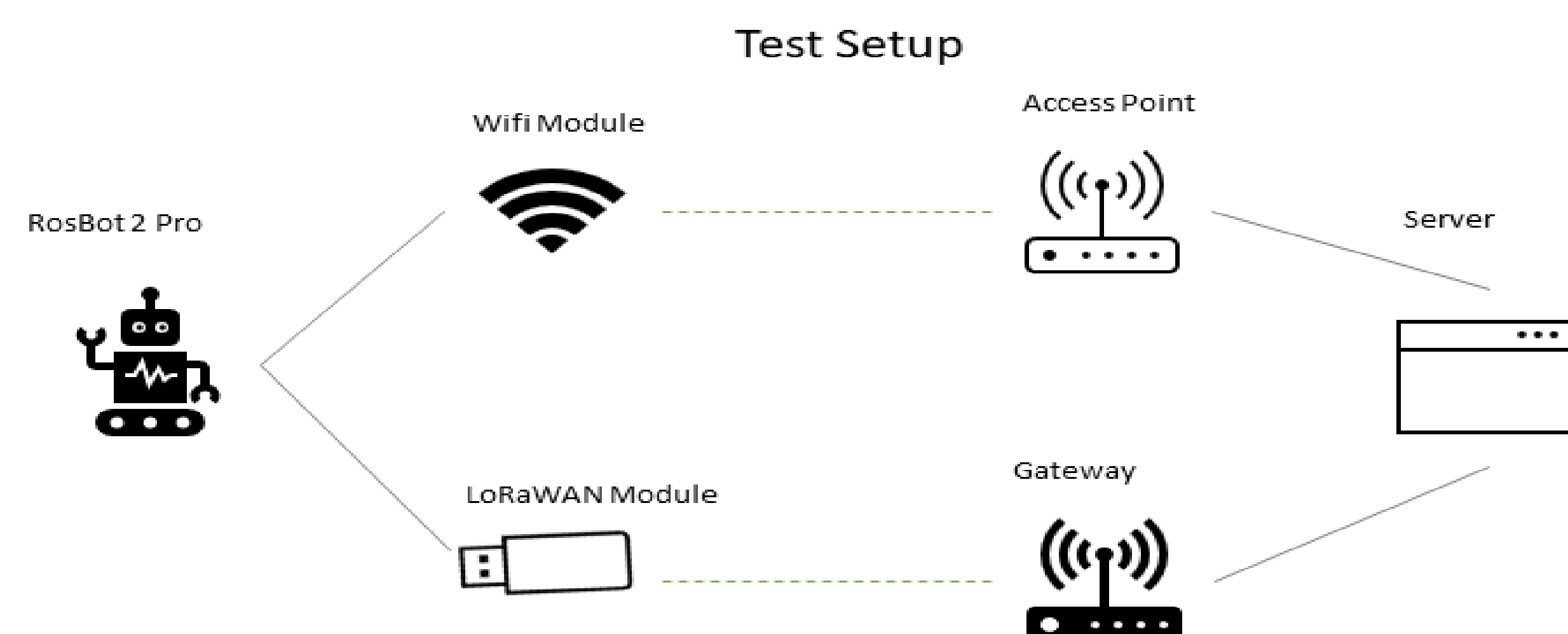


Fig1: Architecture Diagram of TestBed. We use a ROSbot 2 PRO equipped with WiFi module and LoRaWAN module to transmit data

## Data

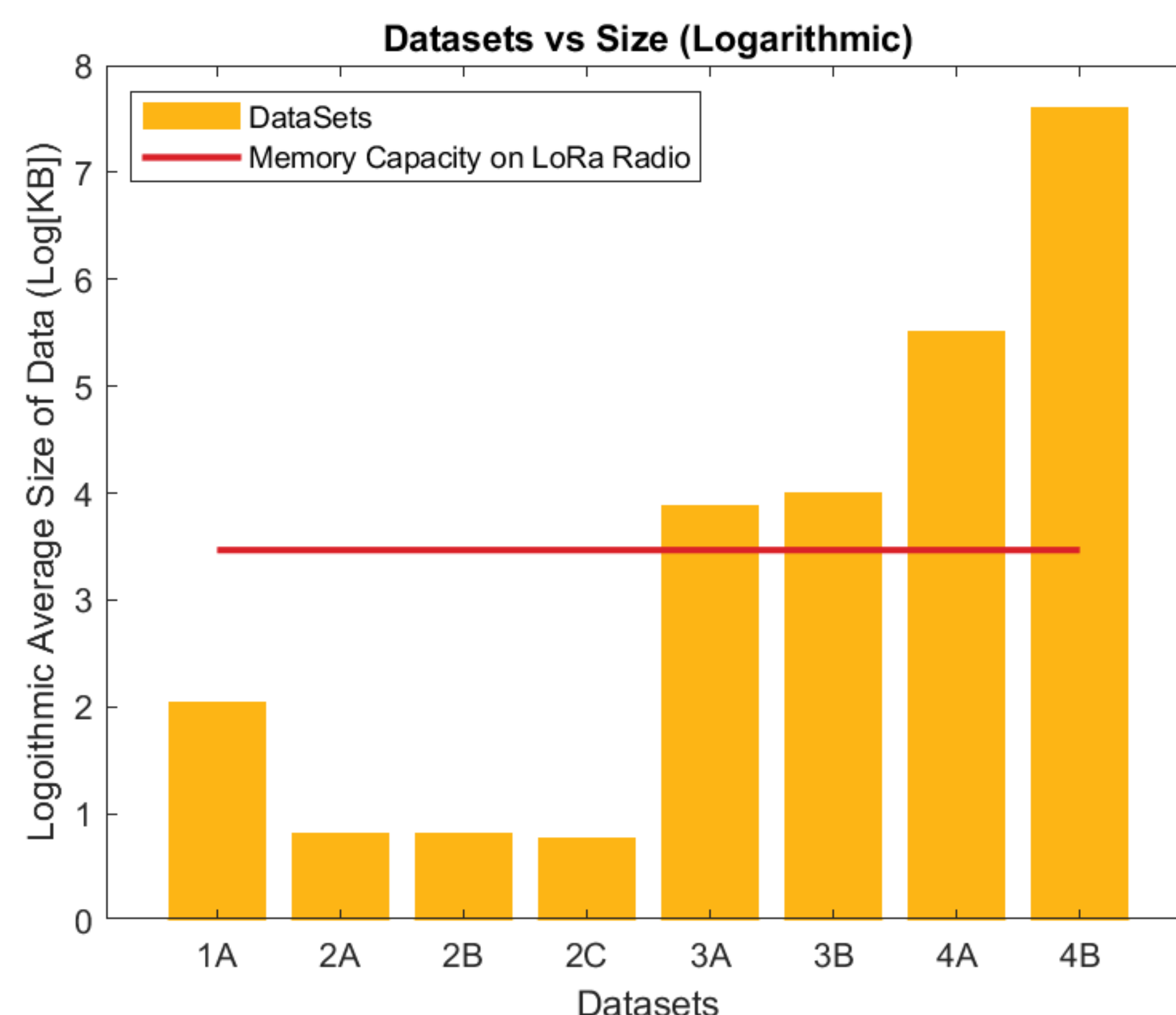


Fig2: Demonstrating different sizes of datasets

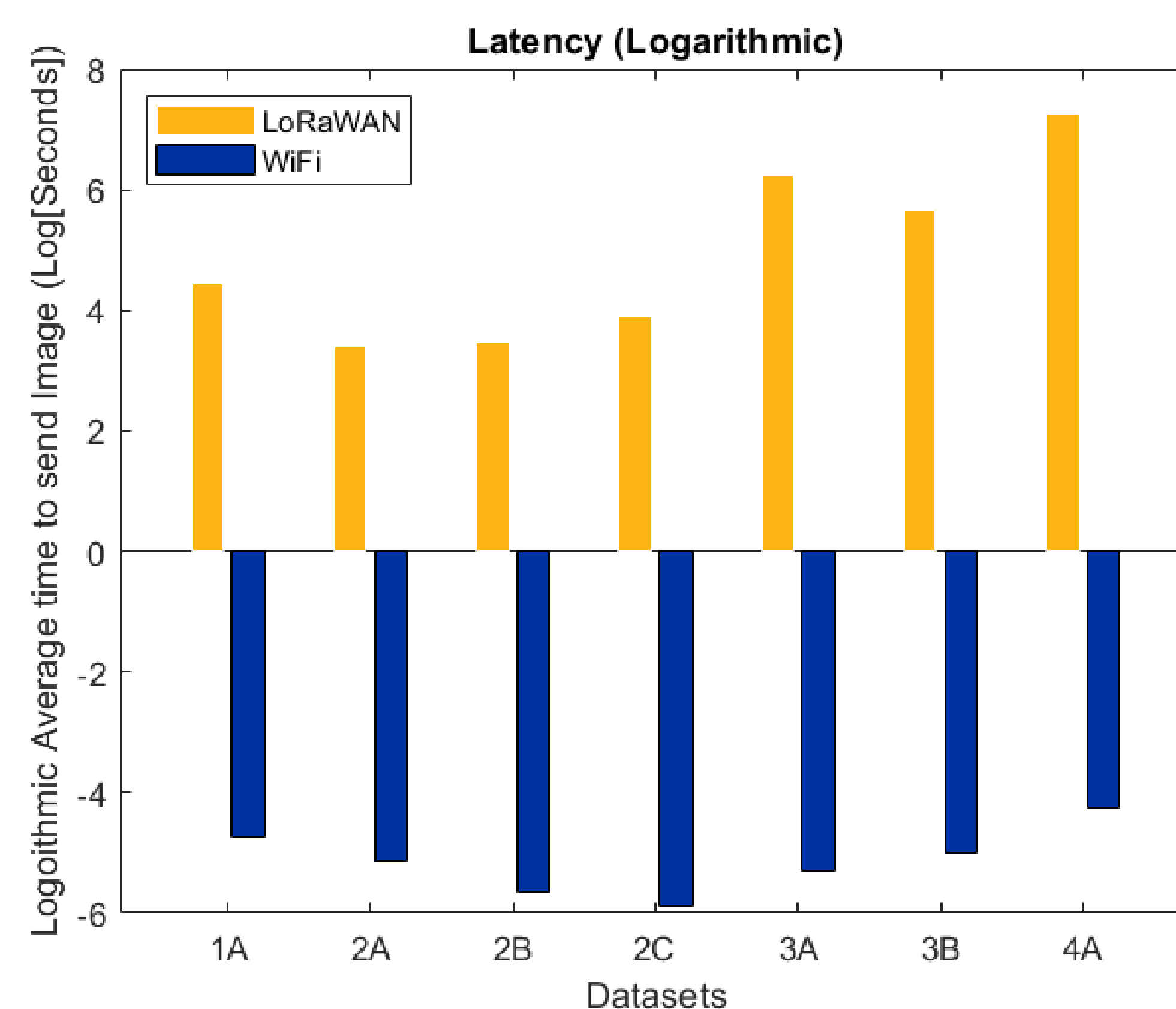


Fig3: Performance Delay to send datasets across WiFi Vs LoRaWAN

## Methods/Formulas

We developed and deployed a LoRa/LoRaWAN radio that connects via a Serial USB port to a computing device. We benchmarked the transfer of eight datasets of varying sized images. We observe the delay in sending data across varying Sizes (Logarithmic), via both LoRaWAN and Wifi (via MQTT).

## Discussion

This project demonstrates that it is possible to send images using LoRaWAN, however it is at a significant latency cost compared to WiFi (via MQTT). Nevertheless, LoRa can operate at a much larger range than WiFi. If the image could be compressed it will improve performance and could make the latency competitive. The amount of memory on LoRaWAN radio causes instability preventing transmission when images exceed the buffer size. We are only able to send a handful of the 3A/B and 4A images and none of the 4B images via LoRaWAN.

## References/Citations

- [1] M. Saeid Anwar, E. Dey, M. K. Devnath, et al., "Heteroedge: Addressing asymmetry in heterogeneous collaborative autonomous systems," arXiv e-prints, arXiv2305, 2023.
- [2] J. Bravo-Arrabal, M. Toscano-Moreno, J. Fernandez Lozano, A. Mandow, J. A. Gomez-Ruiz, and A. Garcia Cerezo, "The internet of cooperative agents architecture (x-ioca) for robots, hybrid sensor networks, and centers in complex environments: A search and rescue case study," Sensors, vol. 21, no. 23, p. 7843, 2021.

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