L-Università ta' Malta
Faculty of Information & Communication Technology

B.Sc. (Hons.) Computer Engineering

Miniature Implementation of an IoT-based Smart City

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INTRODUCTION

Smart cities are digitally-enabled urban environments that leverage technology to improve resource efficiency, quality of life, and economic competitiveness sustainably. This involves employing intelligent solutions for various aspects like infrastructure, energy, housing, mobility, services, and security.

These solutions rely on integrated sensor technologies, connectivity, data analytics, and independent value-added processes. Through digital transformation, cities achieve intelligent, autonomous, and networked systems, supporting ecological and social advancements.

Distributed ledger technologies facilitate secure transactions and identities within cities, while artificial intelligence and machine learning enable pattern recognition and autonomous system management.

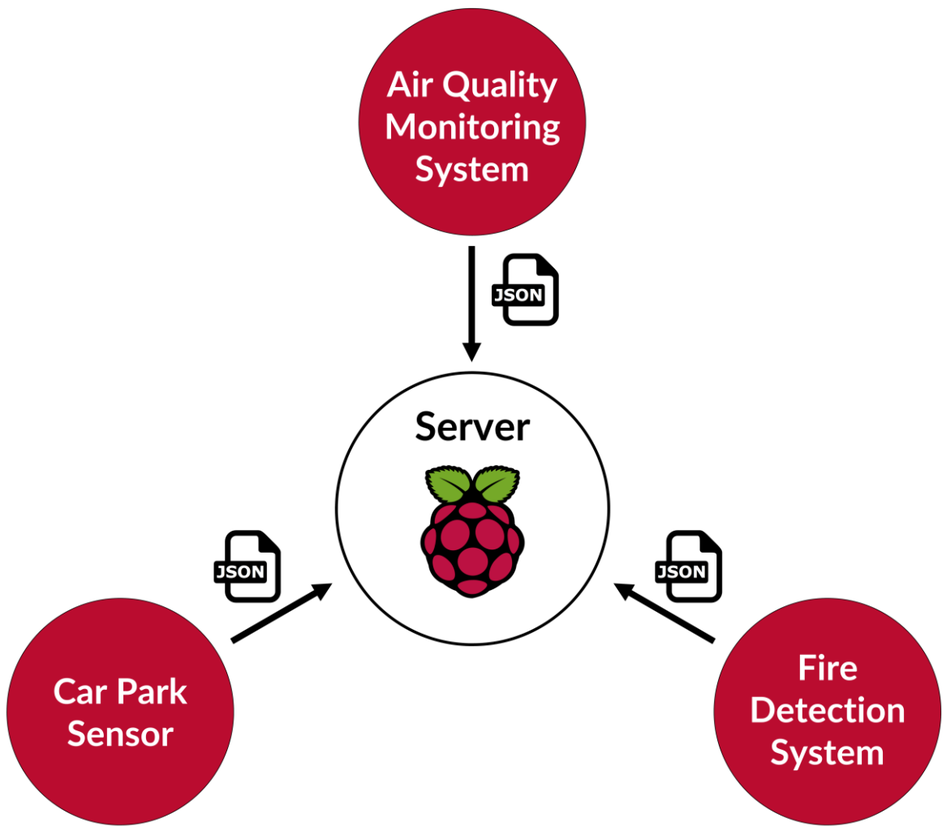
The focus of this project, the Internet of Things (IoT) serves as the interface between the physical world and the digital representation of the city. [1]

AIM

The main goal of this project was to develop a Smart City model with a focus on data collection. This will be done using a small number of physical nodes. Other project objectives include minimizing power consumption, selecting the optimal Application Layer Protocol and LPWAN technology, and devising a data collection pipeline using existing software platforms for proper data storage and visualization.

SYSTEM ARCHITECTURE

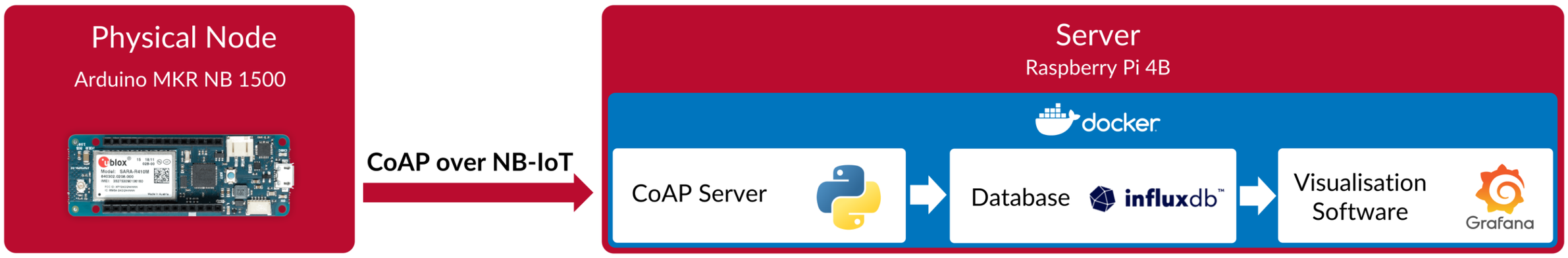
The system architecture consists of a centralized server that employs a star topology to receive data from the physical nodes. The car park sensor detects vehicle presence, while the air quality monitoring system collects data on air quality. The fire detection system aims to gather data for fire presence correlation. All data is sent to the server in the form of JSON documents, enabling efficient transmission and storage.



METHODOLOGY

The implementation involves three physical nodes: an air quality monitoring system, a car park sensor and a fire detection system. All physical nodes collect data by making use of specialised sensors. Following data collection, the data is stored and visualized on a server setup to handle such data accordingly.

The approach consists of a centralized server that uses a star topology to receive data from different physical nodes. Using NB-IoT and CoAP, each physical node sends data to the server, which handles it accordingly. A data collection pipeline was created utilizing a Raspberry Pi 4B as a server to provide efficient data gathering, storage, and visualization from data gathered by the physical nodes. A CoAP server, InfluxDB, and Grafana are all operating in separate Docker containers as part of the pipeline.



RESULTS

The implementation successfully demonstrated the communication between the physical nodes and the server that was set up. Each of the physical nodes, including the air quality monitoring system, the car park sensor and the fire detection system, effectively sent data to the server.

Furthermore, the server's functions efficiently handled the received data. The server, designed with a star topology, received data from the different physical nodes and managed it appropriately. This ensured that the collected data was processed and stored correctly.

The successful data transmission and proper handling of data by the server highlight the effectiveness and reliability of the implemented system. These results validate the functionality and efficiency of the communication and data management components in the Smart City model.

CONCLUSIONS AND FUTURE WORK

The implementation was successful, demonstrating effective data transmission and handling by the server. Future work includes exploring scalability options and considering custom-designed hardware for improved system efficiency.

REFERENCES

1. O. Gassmann, J. Böhm, and M. Palmié, *Smart Cities: Introducing Digital Innovation to Cities*, First edition. Bingley, UK: Emerald Publishing, 2019, ISBN: 1-78769-614-6.