
## Faculty of Electrical and Electronic Engineering Technology

# DEVELOPMENT OF IOT BASED REAL-TIME ASSET TRACKING SYSTEM



**SITI NADIAH BINTI HAMZAH**

**Bachelor of Electronics Engineering Technology (Telecommunications) with Honours**

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# DEVELOPMENT OF IOT BASED REAL-TIME ASSET TRACKING SYSTEM

**SITI NADIAH BINTI HAMZAH**

**A project report submitted**
**in partial fulfillment of the requirements for the degree of**
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**DEDICATION**

*To my beloved mother, Rusmah Binti Bandi,*

*and father, Hamzah Bin Ayub,*

*and*

*To dearest friend, Safiy Hannani Binti Satar, WAHFIIENS and*

*My Housemate.*

## ABSTRACT

Physical asset management is important for any company or organization, which presents a systematic approach to managing assets from concept to disposal. A systematic approach to managing these assets is important as it is time-consuming and may take more than a day. In addition, lending-related issues may include loss, damage, or theft. Therefore, a tool to track these assets can help to reduce the time to manage them while improving the efficiency and production of work. In this paper, an IoT-based asset tracking system has been proposed to track the location of the assets for asset management purposes. The system integrates the development of hardware and software which can track the assets inside and outside the building. With the proposed asset tracking system, the status of the assets based on their location will be updated from time to time, hence increasing the efficiency of the management. An ESP-WROOM-32 will be used as a microcontroller to control the overall proposed system. Radio Frequency Identification (RFID) module and the Global Positioning System (GPS) will be used in the system to track the location of the assets indoors and outdoors, respectively. In this proposed system, the location of the assets will be updated and stored in the cloud through the BLYNK smart app continuously for monitoring purposes. It is expected that the proposed system has high reliability to track and detect the location of the assets indoors and outdoors.

## *ABSTRAK*

Pengurusan asset adalah penting bagi mana-mana syarikat atau organisasi, yang membentangkan pendekatan sistematik untuk menguruskan aset dari konsep ke pelupusan. Pendekatan sistematik untuk menguruskan aset-aset ini adalah penting kerana ia memakan masa dan mungkin mengambil masa lebih daripada sehari. Di samping itu, isu berkaitan pinjaman mungkin termasuk kerugian, kerosakan, atau kecurian. Oleh itu, alat untuk mengesan aset ini dapat membantu mengurangkan masa untuk menguruskannya sambil meningkatkan kecekapan dan pengeluaran kerja. Dalam kertas ini, sistem penjejakan aset berasaskan IoT telah dicadangkan untuk mengesan lokasi aset untuk tujuan pengurusan aset. Sistem ini mengintegrasikan pembangunan perkakasan dan perisian yang dapat mengesan aset di dalam dan di luar bangunan. Dengan sistem pengesanan aset yang dicadangkan, status aset berdasarkan lokasi mereka akan dikemas kini dari semasa ke semasa, seterusnya meningkatkan kecekapan pengurusan aset. ESP-WROOM-32 akan digunakan sebagai mikropengawal untuk mengawal keseluruhan sistem yang dicadangkan. Modul Pengenalan Frekuensi Radio (RFID) dan Sistem Kedudukan Global (GPS) akan digunakan dalam sistem untuk mengesan lokasi aset di dalam dan luar, masing-masing. Dalam sistem yang dicadangkan ini, lokasi aset akan dikemas kini dan disimpan di awan melalui aplikasi pintar BLYNK berlanjutan untuk tujuan pemantauan. Diharapkan sistem yang dicadangkan mempunyai kebolehpercayaan yang tinggi untuk mengesan dan mengesan lokasi aset di dalam dan luar.

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## LIST OF ABBREVIATIONS

| | | |
|---|---|---|
| $IoT$ | - | Internet of Thing |

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# CHAPTER 1

# INTRODUCTION

## 1.1 Background

Internet of Things (IoT) is a network that consists of interconnected devices equipped with sensors, software, and network connectivity. IoT allows data to be collected and shared across several systems. IoT technology captures crucial information on equipment performance, energy usage, defect detection, and predictive maintenance with the help of sensors that are equipped [1]. In addition, an IoT network is made up of devices that can communicate with their surroundings, a gateway that can collect data and establish a connection to the cloud, and a cloud platform that can store, analyse, and evaluate the information collected [2].



Real-time asset tracking is a system that is often used for asset management or physical asset. It is used to track the physical location of assets by scanning the barcode labels that are attached to the assets using the Global Positioning System (GPS) or Radio Frequency Identification (RFID). The information related to the location of the assets can help the organization to locate the assets so that proper maintenance can be scheduled [3]. According to [4], inventory management is vital, but asset monitoring is just as essential. Therefore, asset tracking identifies and replaces the organizations' lost or missing physical assets.

Several researchers focus on developing the asset tracking system. However, most of the systems are using Wi-Fi, Bluetooth Low Energy (BLE), RFID, and Ultra-Wide Band

(UWB), which may not be the best method to detect the assets in the indoor environment. This is due to their poor accuracy besides having a significant complexity, unreliability, especially for indoor positioning [5].

Therefore, in this work, an IoT-based asset tracking system has been proposed to track the location of the assets in both indoor and outdoor environment. This system aims to allow any organization to continuously record the location of their assets automatically with the help of cloud services for monitoring purposes.

## 1.2 Problem Statement

Human capital moving assets such as cranes and vehicle fleets and non-moving assets such as industrial equipment, raw materials, and completed goods are important assets for a specific organization. The electrical, mechanical, and hydraulic assets require regular maintenance to ensure their functionality within a controlled framework. It considers the asset's entire lifecycle, from acquisition to disposal. Keeping a close and regular check on the location and status of the assets can reduce operating expenses, increases productivity, and extends the asset's life.



Therefore, the company's asset monitoring methods should be robust as asset management is a critical part of business workspace operations. In addition, to manage the essential assets properly, the organization must always know the location of their assets, which may be vital in preventing their loss or collecting data from them for future use [6]. Hence, this work proposes an IoT-based real-time asset tracking system to track the location of assets in an indoor and outdoor environment, using GPS and RFID modules, respectively. An ESP-WROOM-32 microcontroller will be used in the system to run the overall system. The input regarding the real-time location of the assets obtained from the RFID and the GPS module will be processed by the microcontroller and updated in the cloud servers for

monitoring and tracking purposes. BLYNK applications will be used for the data transmission between the proposed asset tracking devices and the users.

## 1.3 Project Objective

This project aims to develop an IoT-based real-time asset tracking system to locate the location of assets for any organization. Specifically, the objectives are as follows:

a) To develop an IoT-based Real-Time Asset Tracking System using ESP-WROOM-32 microcontroller.

b) To evaluate the performance of the developed IoT-based Real-Time Asset Tracking system in terms of its reliability considering the indoor environment.

c) To evaluate the performance of the developed IoT-based Real-Time Asset Tracking system in terms of its reliability considering the outdoor environment.

## 1.4 Scope of Project

The scopes of the project are defined as follows:

a) An ESP32 microcontroller will be used to develop the proposed system due to its small size that fits our application.

b) RFID sensors will be used in the proposed system to determine the location of the assets in the indoor environment. The asset will be equipped with an RFID reader to read the location of the asset based on the RFID card installed at certain places in the building.

c) GPS module will be used in the proposed system to determine the location of the assets in the outdoor environment.

d) The location of the asset will be updated to the cloud server every seconds at intervals.

e) BLYNK applications will be used in the proposed system for data storing and monitoring.

## 1.5 Project significance

The proposed system will be valuable for any organization or company that wishes to increase its efficiency in managing its assets. Besides, with this asset tracking system, the location of their assets can be monitored and tracked anytime as the system will keep updating the assets' real-time location. This asset tracking can also help the organization schedule any maintenance required for their asset.

# CHAPTER 2

# LITERATURE REVIEW

Internet of Things (IoT) technologies aim to join various analog and digital electronic devices, either homogeneous or heterogeneous in nature, but within their overlapping transmission range, so that they may effectively transfer information. IoT is a rising industry that will continue to expand significantly in the next few years. Several insights have enhanced and expanded IoT utilization, particularly in ecosystems [2]. This chapter examines prior articles and research on IoT-based asset tracking.

## 2.1 Introduction

The demand for location services in outdoor and indoor areas has increased significantly during the last decade. Tracking the precise location of assets outside and inside a building has awakened the attention of businesses and researchers. Previously, location monitoring was either too difficult or too expensive for the intended market [7]. However, due to recent advancements in monitoring technology, both the target market and academics have developed a keen interest in outdoor and interior environments.

For the organization to function correctly, it must have assets supporting its operational operations. Additionally, organization are required to do asset maintenance, including being aware of the location and condition of the assets they hold. Real-time asset tracking is where it is required. The asset maintenance process can be done manually by assigning staff to conduct a direct inspection. Then, damaged or required repair assets are recorded and written in the book. These notes can later use for manual report generation.

Unfortunately, this manual recording has many drawbacks. Such as vulnerability to loss, poor data grouping, and others. Especially if the company has assets in large quantities, the manual method will take much time and be ineffective [4]. Therefore, the use of an asset-tracking system will be beneficial. There are several common ways to cover the asset search process. Here are discussed in the below subsections the most commonly used methods of asset tracking.

## 2.2 Low-Power Wide-Area Network

Low Power Wide Area (LPWA) technology developed as a phrase in 2013 not as a new technical standard but as a category of wireless technologies well suited to the demands of machine-to-machine (M2M) and Internet of Things (IoT) devices. Most IoT devices, particularly those in the smart city and industrial sectors, do not need the same bandwidth and speed as consumer cellular devices. However, they need the durability of standard LTE mobile networks.

In 2015, the GSMA wireless industry association established a series of LPWA Network (LPWAN) standards to assist network operators in meeting IoT applications' specific cost, coverage, and power consumption requirements. These standards helped LPWA technology become the preferred choice for IoT applications. These specifications included LTE-M and NB-IoT. Simultaneously, the LoRa Alliance was founded to bolster another growing LPWAN technology by offering a second wireless connection alternative for IoT applications requiring low bandwidth and low latency.

Therefore, A recent ABI Research revealed that 82% of asset monitoring OEMs have adopted or are producing solutions using cellular LPWAN [8]. The tags may function with less infrastructure (NB-IoT tags connect directly to the cellular network, rather than needing a gateway). These technologies are not suited for continuous connection and real-

time monitoring since they are intended for periodic check-ins and cannot sustain tower handoffs.

### 2.2.1 Using the LoRa Technology in Asset Tracking

The authors in [9] examine LoRa technology to communicate truck and asset location data in ports. Geolocation and tracking capabilities provide a novel chance to enhance the port business process. Without using wireless communication, coverage is always visible as an issue. Due to its excellent receiver sensitivity for LPWAN, particularly LoRa, is a viable solution to this problem. It attempts to improve yard operations and coordinate port traffic via localization and tracking techniques. Trucks are equipped with a transportable LoRa-box, including a LoRa transmitter and GNSS receiver, as shown in Figure 2.1 Permanently installed on every container shift equipment is a LoRa-box that captures the asset's position in particular zones. Each LoRa-box broadcasts its associated support's current location to the central gateway.



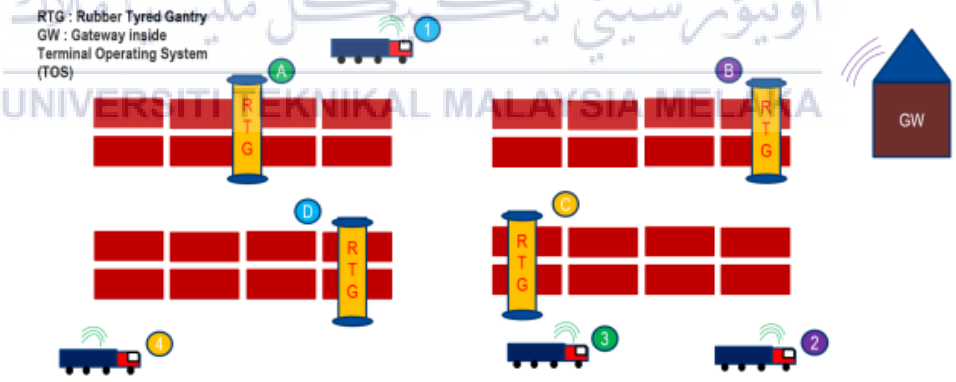


Figure 2.1 Port application : truck and asset localization [9]

In [10], the researcher focuses on the tracking system requiring each bicycle asset to be allocated a BLE beacon device with a UUID, which can then communicate this information to a base station at any permitted bike-sharing drop-off/pick-up location, as