I hereby declare that I have read through this report entitled "**MICROCONTROLLER AND ZIGBEE BASED PUBLIC TRANSPORTATION (BUS) AWARENESS SYSTEM**" and found that it has comply the partial fulfillment for awarding the degree of Bachelor of Electrical Engineering (Control, Instrumentation, And Automation).

Signature: ....

Supervisor''s Name: Assoc. Prof. Mohd Ariff B. Mat Hanafiah

Date   : 1st June 2015

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MICROCONTROLLER AND ZIGBEE BASED PUBLIC TRANSPORTATION (BUS) AWARENESS SYSTEM

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A report submitted in partial fulfillment of the requirements for the degree of Electrical Engineering (Control, Instrumentation And Automation)

Faculty of Electrical Engineering

UNIVERSITI TEKNIKAL MALAYSIA MELAKA

JUNE 2015

I declared that this thesis entitled "**MICROCONTROLLER AND ZIGBEE BASED PUBLIC TRANSPORTATION (BUS) AWARENESS SYSTEM**" is the result of my own research except as cited in the reference. The report has not been accepted for any degree and is not concurrently submitted candidature of any other degree.

Signature: ....

Name: ALI KHALED ALI AL-FARAWI

Date   : 1ˢᵗ June 20

To my beloved father and mother who always there for me

Khaled Ali Al-farawi *and* ***Amani Abdulqadir Al-mihsini***

To my supervisor and lecturer, for their guidance and encouragement

Prof Mohd Ariff Bin Mat Hanafiah

To my friends, for their unconditional support

Dedicated in thankful appreciation for your supporting, encouragement and best wishes

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ABSTRACT

The problems that people face every day at the bus stop can be sometimes very troublesome as it makes people miss their buses or get confused to take which bus. Thus in this paper a system is designed using ZigBee wireless communication to link the buses that arrives at the bus stop with the bus stop. The objective of this product is that it will prevent people from missing their buses and it will avoid people to lose their buses between many other buses. The product will be prototype of two buses and one bus stop, when the bus stop button is pressed the installed LCD on the bus stop will show a message that the bus is ordered and the led and the buzzer on the bus will energized to notify the bus driver that there is passengers on that bus stop. When the bus arrived at the bus stop the message of the arrival of the specific bus will be visualized on the LCD and the installed buzzer on the bus station will energized to notify the passengers, at the same time the buzzer and the led on the bus will turn off. When the bus leave the bus stop, the LCD will show that the bus is leaving and the buzzer on the bus stop will turn off. The methods used in this paper to achieve the objective are to use the ZigBee because it is more reliable and has the least power consumption. The logic signal from the button is then raised to a proper voltage being able to be sent over the wireless communications link. The product will be consisting of two ZIGBEE representing the specific buses and one ZIGBEE at the bus stop. The Arduino is used as a controller.

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CHAPTER 1

INTRODUCTION

1.1 Project Background:

ZigBee is a wireless networking standard that is aimed at remote control and sensor applications which is proper for operation in harsh radio environments and in isolated locations where there is a little or no ability to access the wired link.

ZigBee technology builds on IEEE standard 802.15.4 which defines the physical and MAC layers. Moreover, ZigBee defines the application and security layer specifications enabling mutual operation between products from different manufacturers. In this way ZigBee is a part of the 802.15.4 specification.[1]

With the applications for remote wireless sensing and control growing faster than ever, it is estimated that the market size could reach hundreds of millions of dollars as early as 2007. This makes ZigBee technology a very attractive alternative for many modern applications that are required to be automated or wirelessly controlled.

The distances that can be accomplished transmitting starting with one station then onto the next reach out up to around 70 meters. All that much more prominent distances may be come to by handing-off information starting with one hub then onto the next in a system, though [2].

The control and monitoring of the sensor and the controllers of 802.15.4 family of ZigBee doesn't need high data throughput, thus the application can consume little power. The possibility of remote, battery controlled sensors, low power utilization is a key necessity. Sensors, lighting controls, security and numerous more applications are all contender for the new innovation [1].

The devices and the control unit would all need a typical standard to empower clear correspondence. ZigBee is such a standard for inserted application programming and has been approved in late 2004 under IEEE 802.15.4 Wireless Networking Standards [1].

ZigBee is a set up situated of determinations for remote individual region organizing (WPAN), i.e., computerized radio associations in the middle of PCs and related gadgets. This sort of system takes out utilization of physical information transports like USB and Ethernet links. The gadgets could incorporate phones, hand-held advanced collaborators, sensors and controls situated inside of a couple meters of one another [2].

- **Architecture:**

Despite the fact that WPAN infers a scope of just a couple meters, 30 feet on account of ZigBee, the system will have a few layers, so outlined as to empower intrapersonal correspondence inside of the system, association with a system of more elevated amount and at last an uplink to the Web.

The ZigBee Standard has evolved standardized sets of solutions, called „layers'. These layers provide the features that make ZigBee very attractive. Being of low cost, being able to by easily implemented, reliable data transfer, short-range operations. Moreover, having very low power consumption and adequate security features adds to the benefits of ZigBee. In the following paragraphs the layers of the ZigBee is explained.

- **The first layer is the Network and Application Support layer**

This layer can deal with immense quantities of hubs. This level in the ZigBee structural engineering incorporates the ZigBee Device Object (ZDO), client characterized application profile(s) and the application Support (APS) sub-layer. The APS sub-layer's obligations incorporate support of tables that empower coordinating between two devices and correspondence among them. The viewpoint that recognizes different devices that works in the working space of any device.

The second layer is the physical (PHY) layer. The IEEE802.15.4 PHY physical layer accommodates high levels of integration by using direct sequence to permit simplicity in the analog circuitry and enable cheaper implementations. Figure 1 shows the MAC layer.
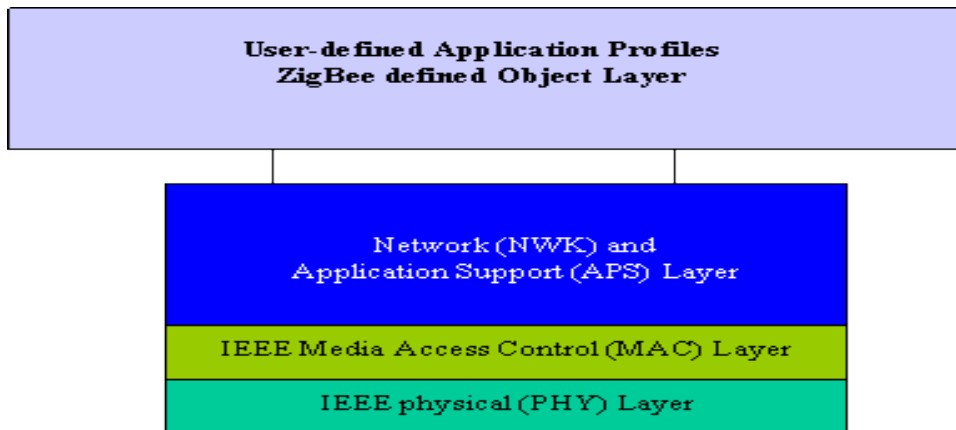
Figure 1.1 "Layers Standards"

The third layer is the MAC (Media Access Control) layer which is determined to work in one of the three licenses free groups at 2.4 GHz, 915 MHz for North America and 868 MHz for Europe. Thusly the standard has the capacity work the world over, in spite of the fact that the precise details for each of the groups are marginally diverse. At 2.4 GHz there are an aggregate of sixteen distinct channels accessible, and the greatest information rate is 250 kbps. For 915 MHz there are ten channels and the standard backings a most extreme information rate of 40 kbps, while at 868 MHz there is stand out channel and this can bolster information exchange at up to 20 kbps [1]

- **Data Transfer:**

The data is transferred in packets that have a maximum size of 128 bytes, allowing for a maximum payload of 104 bytes. Although this may appear low when compared to other systems, the applications in which 802.15.4 and ZigBee are likely to be implemented should not require very extreme data rates[2].

The standard backings 64 bit IEEE addresses and in addition 16 bit short addresses. The 64 bit addresses remarkably recognize each gadget in the same way that gadgets have an interesting IP address. When a system is situated up, the short addresses can be utilized and this empowers more than 65000 hubs to be supported [1].

It also has an optional super frame structure with a method to synchronize the time and give high priority to some massages that need to be processed faster. To achieve this, a guaranteed time slot mechanism has been incorporated into the specification. This enables these high priority messages to be sent across the network as swiftly as possible [2].

As it is discussed in the MSC layer, each band has a different frequency to use and thus, the modulation techniques also change based on the type of band in used. Direct succession spread range (DSSS) is utilized as a part of all cases. Be that as it may, the 868 and 915 MHz groups the genuine type of balance is parallel stage movement keying. For the 2.4 GHz band, counterbalance quadrature stage movement keying (O-QPSK) is utilized.

In perspective of the way that frameworks may work in vigorously congested situations, and in territories where levels of superfluous obstruction is high, the 802.15.4 specification has fused a mixed bag of components to guarantee exceedingly dependable operation. These incorporate a quality evaluation, beneficiary vitality location and clear channel appraisal. CSMA (Carrier Sense Multiple Access) systems are executed to focus when to transmit, and along these lines pointless conflicts are kept away from.

Many years ago, when Bluetooth technology was presented, it was believed that Bluetooth would make WIFI repetitive. Yet, the two coincide well today, so do numerous different Wireless standards like Wireless HART and ISA100.11a. At that point why might we require another WPAN standard like Zigbee? The answer is, the application center of Zigbee Alliance - ease and low power for vitality productive and savvy wise gadgets. In addition, Zigbee and Bluetooth have diverse application center. Notwithstanding of every one of their similitudes, and regardless of the way that both are in view of the IEEE 802.15 measures, the two are diverse in innovation and additionally scope. Bluetooth is made with cellular telephones as its focal point of universe empowering media move at rates in abundance of 1 Mbps while Zigbee is based with accentuation on low information rate control framework sensors highlighting slower information of only 250 kbps.

1.2 Problem Statement:

Nowadays, many people miss their buses at the bus stop due to many interruptions occurred between them and their environment. Moreover, many people get into trouble when trying to catch their buses when there are many buses waiting at the bus stop as well as for the bus drivers may waste their time by going through every bus stop without knowing if there are passengers waiting. Moreover, disabled people also encounter some problems due to their disability.

However this problem can be solved by building microcontroller and ZIGBEE Based Public Transportation Bus Awareness System. In this system, there will be a connection created between the bus and the bus stop so as to ensure the people at the bus stop will be aware of the presence of the buses. In addition, the system will notify the driver about the availability of the passengers at the bus stop, so the driver will avoid going through bus stops free of passengers. Not only that, the system will provide a LCD screen and buzzer to help the normal people and the disabled people to notice the presence of the bus.

1.3 Objectives:

- To make a data communication between the bus and the bus stop.
- To design a system that will aware the people of the presence of the bus.
- To distinguish between the buses and their destinations accordingly.
- To handle the communication that is between the bus and the passengers automatically and effortlessly.

1.4 Scope

The scope of this project is to use ZigBee Radio Frequency data transfer as a means of communication. Also, Arduino microcontroller is been used in this project as the controller of the system. Moreover, there will be an electronic notice board at the bus stop to alert the people of the presence of the bus. This project will be done by using a LCD screen to notify the people. Thus, in this project only the presence of the bus at the bus stop will be notified to the people at the bus stop and the making of bus schedule that needs further components like GPS will not be covered.

1.5 Report Outline

There are five chapters in this thesis which are introduction, literature review, methodology, result and discussion and finally conclusion and recommendation. Each chapter will discuss its own aspects related to the project.

Chapter one is the introduction for the project. Problem statement, object and scope of the project along with the summary of works have been discussed in this chapter. Then, chapter two discusses more on the theory and literature. Besides that, this chapter also discusses the type of Arduino used for the project, the sensor chosen, and the software involve in programming the Xbee and Arduino.

Chapter three focuses on the methodology and approaches on the project. This includes the programming of the software and hardware development of the project. Results and discussion are presented in chapter four. Lastly, chapter five is the conclusion for the whole project. Some future suggestions such as a functional addition and hardware improvement of the project are also mentioned.

CHAPTER 2

LITERATURE REVIEW

2.1 Introduction:

This chapter goes through the past related works that have been done on the protocol communication between the bus and passengers for the sake of implements and design a solution for enhancing the public transportation administration services based on wireless connection such as ZigBee, Gprs, Bluetooth, Gsm and Wi-Fi. Besides that this section discusses in details on the components and instruments used for this project.

Wireless Communication	Wired Communication
No need for physical communication	Need physical communication medium which is cable
No problem in extending the detection range of the signal	Need to change cables length if need to change connection distance
Reduce cost from buying cables	Need extra cost for cables purchasing
Not affected by environment condition	Get affected by environment condition
Less affected by noise produce from surrounding machinery	Easily affected by noise produce from surrounding machinery
Changeable data transfer rate	Data transfer rate is according to the material of the wires
Possible for mobile applications	Not suitable for mobile application

Table 2.1 "Comparison of Wireless and Wired communication"

2.2 Overview of ZigBee:

ZigBee is a new wireless technology. Moreover, it is technological standard created for control and sensor networks based on the IEE 802.15.4 standard, ZigBee created from ZigBee alliance. Plus, ZigBee alliance includes many leading companies

such as Philips, Motorola, Intel, HP they are all members of the alliance. Zigbee is a specification for (WPANs) operating at 868 MHz, 915 MHz and 2.4 GHz. A WPAN means (wireless personal area network) and it‟s a network for interrelationship or interconnecting an individual's devices. Using XBee devices in WPAN can communicate at speeds of up to 250 Kbps while physically separated by distances up to 100 meters in typical circumstances and greater distances in an ideal environment. XBee is based on the 802.15.4 specification and the Institute of Electrical and Electronics Engineering Standards Association (IEEE-SA) approved it [3].

ZigBee supplies for high information throughput in applications where the obligation cycle is low. This makes ZigBee perfect for home, business and modern mechanization where control gadgets and sensors are ordinarily utilized. Such gadgets work at low power levels, and this in conjunction with their low obligation cycle (ordinarily 0.1% or less), interprets into long battery life. Application appropriate to ZigBee incorporate warming, ventilation and ventilating (HVAC), lighting frameworks, fire detecting and the discovery, interruption identification and warning of strange events. ZigBee is good with most topologies including shared, star system and cross section systems.

2.2.1 ZigBee Alliance

The ZigBee Alliance is an assembly of organizations cooperating to characterize an open universal standard for making low-power wireless networks. The target of ZigBee Alliance is to make a detail characterizing how to manufacture diverse systems topologies with information security lineaments and interoperable application profiles. The enforcement incorporates organizations from a wide spectrum of classes, from chip manufactures to system integration companies.

The primary particular was confirmed in 2004 and the original of ZigBee products had come to the business in 2005. A major test for the partnership is to make the interoperability to work among different products. To take care of this issue, the ZigBee Alliance has characterized diverse profiles, depending on what kind of classification the product fits in with.

2.2.2 History of ZigBee

- ZigBee-style systems started to be conceived around 1998, when numerous installers understood the both Wi-Fi and Bluetooth would be unsatisfactory for some applications. Specifically, many architects saw a requirement for self-sorting out specially appointed advanced radio systems.

- The IEEE 802.15.4 standard was completed and finished in May 2003.

- In the mid-year of 2003, Philips Semiconductors, a noteworthy cross section system supporter, stopped the speculation. Philips Lighting has, then again, proceeded with Philips cooperation and Philips remains a promoter part on ZigBee Alliance Board of Directors.

- The ZigBee Alliance reported in October 2004 that the participation had dramatically multiplied in the former year and had developed to more the 100 part organizations in 22 countries. By April 2005 enrollment had developed to more than 159 organizations and by December 2005 participation had passed 200 organizations.

- The ZigBee specifications were confirmed on 14 December 2004.

- The ZigBee Alliance declares public availability of Specification 1.0 on 13 June 2005, known as ZigBee 2004 specification.

- The ZigBee Alliance reports the finishing and prompt part accessibility of the upgraded adaptation of the ZigBee Standard in September 2006, known as ZigBee 2006 Specification.

- Amid the last quarter of 2007, ZigBee PRO the upgraded ZigBee particular was concluded.

2.2.3 XBee vs. Other Wireless Standards

Table 2.1outlines some of the key characteristic of ZigBee and how it stacks up against other common wireless standards.

WIRELESS CONNECTIVITY TECHNIQUES			
	Bluetooth	ZigBee	Wi-Fi 802.11
Data rate	1 Mbit/s	20, 40, and 250 kbits/s	11 and 54 Mbits/s
Range	10 m	10 to 100 m	Up to 100 m
Networking topology	Ad-hoc, small networks	Ad-hoc,peertopeer, star, or mesh	Point to hub
Frequency	2.4 GHz	868 MHz (Europe), 900 to 928 MHz (North America), 2.4GHz(worldwide)	2.4 and 5 GHz
Power consumption	Low	Very low	High
Typical applications	Inter-devicewirelesscon-nectivity, e.g., phones, PDAs,laptops,headsets, cameras, printers, serial cable replacements	Industrial control and monitoring, sensor networks, buildingautomation, toys, games	Wireless local-area network (WLAN) connectivity, broadbandInternet, security cameras

Table 2.2: "ZigBee vs. Other wireless standards"

ZigBee looks rather like Bluetooth however straightforward, has a lower information rate and invests the vast majority of its energy resting. This characteristic implies that a hub on a ZigBee system ought to have the capacity to keep running for six months to three years on only two AA batteries.

The operational range of ZigBee is 10-100 compared to 10m for Bluetooth (without a power amplifier). ZigBee sits Bluetooth in terms of data rate, the data rate of ZigBee is 250 kbps at 2.4 GHz, 40 kbps at 915 MHz and 20 kbps at 868 MHz whereas that of Bluetooth is 1 Mbps.

	WiFi/Android	Bluetooth 2.0+	XBEE 802.15.4
Range	Typical 46m from Hotspot indoors	class 1: up to 100 m (30 typical). class 2: up to 30 m (10 typical)	30 m typical
Expense	$100 xbee wifi kit, assuming network is in-place	$25-100, not dependent on external network	$40-80 typical
Ease of Integration	Relatively simple plug-and-play	Requires adapting/hacking existing product	Simple plug and play
Data Rate	72 Mbps typical for 802.11n*	1 Mbps possible, less typical	250 kbit/s, 100 typical
Operating Frequency	2.4-5 GHz	2.4–2483.5 MHz	902-928 MHz (radio)
Power Consumption	up to 300mW dependent on data rate	up to 50 mW dependent on data rate	peak 150mW
Interface	drop-in board + browser or phone app	drop-in board + bluetooth controller (eg PS3 controller)	drop-in board + analog or digital controller, phone possible
Support	Extensive home networking support, limited RC applications.	Limited RC application due to low range. Limited third party support.	Large amount of support for RC application, from manufacturer and third party users.
Summary	Dependent on in-place router/wifi network. Susceptible to drop-out. Handshaking errors common. Fast transfer speeds, but excessive for hexacopter application. *Based on network configuration/hardware	More than adequate transmission speed, yet low transmission range. RC application not common, resulting in poor product support and few integration options.	Adequate transfer speed for RC application, acceptable transmission range. Low cost and easy integration with copious support.

Table2.3 "Comparison of 3 Wireless communication channels"

Bluetooth's protocol is more complex since it is geared towards handling voice, images and file transfers in ad-hoc networks. Bluetooth devices can support scatter nets of multiple smaller non-synchronized networks (piconets) and it only allows up to 7 slave nodes in a basic master-slave piconet set-up.

When ZigBee node is powered down, it can wake up and get a packet in around 15 mile second whereas a Bluetooth device would around 3 second to wake up and respond.

2.2.4 XBee Vs XBee Pro

The XBee and XBee-Pro RF Modules were built to meet IEEE 802.15.4 models and backing the extraordinary needs of ease, low-control remote sensor systems. The modules oblige negligible power and give dependable conveyance of information between gadgets. The modules operate within the ISM 2.4 GHz frequency band and are pin-for-pin perfect with one another.

Figure 2.1 "Xbee vs Xbee Pro"