

Case study of Wireless Technologies in Industrial Applications

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Abstract- In this current generation, technology is at its best. Many improved technologies are more facile than they have been before. WI-FI, which stands for wireless-fidelity, is a wireless way to handle networking. This functionality allows computers, smartphones, or other contrivances to connect to the Internet or communicate with one another wirelessly within a particular area. This paper explicates information about different communication modules such as Bluetooth, RF, and Zig bee in industrial applications. In this paper, an overall comparison of these three modules are made, which are predicated upon their industrial applications and characteristics such as standards, bandwidth, battery life, data rate, maximum transmission range, etc.

I. INTRODUCTION

Wireless is a term that describes telecommunications where the electromagnetic waves carry the signals over part or all of the communication path. In the early twentieth century, there were wireless transmitters that went on air using Morse code through radiotelegraphy. It was called "radio" because modulation was made possible. Modulation is used to transmit voices and music via this wireless medium radio. Wireless technology is the biggest contribution to mankind thus far, and it is rapidly evolving. Already a large number of people rely on the technology directly or indirectly.

Wireless technology is used for transferring data over long distances efficiently. When wireless technology was created, many new applications were available to designers. Since wireless technology is an electromagnetic transmission medium, it does not require cables and is emitted through the air by wave frequencies that can be used by satellites and infrared rays. This is a promising technology that allows people to do things easier over long distances. It is especially useful when cables cannot physically fit and it is fast and easy to install. It has great advantages in industrial applications, like greater mobility and

the possibility to move devices and connect to smart phones and tablets freely without constraining cables. Depending upon the range, Wi-Fi can be classified in different ways and each wireless technology is developed to serve specific usage segments that are based on a variety of variables, like bandwidth, distance, and power needs.

II. WIRELESS TECHNOLOGIES

Before wireless was invented and implemented, many industries used wired technologies for communication, which has many disadvantages. Also, it was impossible for communication to be established over the longer distances and also was not reliable. Due to this, wireless technology was introduced. There are many benefits and advantages to wireless when compared with wired technologies.

Different types of wireless technologies

There are many different types of wireless devices that have been introduced for use with wireless communication, so users can communicate even from remote areas. For example, a satellite is used for communicating over the world using wireless communications. In closed environments like colleges, banks, offices, industries, etc., the communication or the transfer of the data is done with the help of wireless sensor networks such as RF modems, Bluetooth, wi-fi, and Zig bee.

When we use wireless sensor networks over cabled networks, there are many advantages like:

1. It is reliable;
2. It is authenticated;
3. Cables are not used; and
4. It costs less than wired methods.

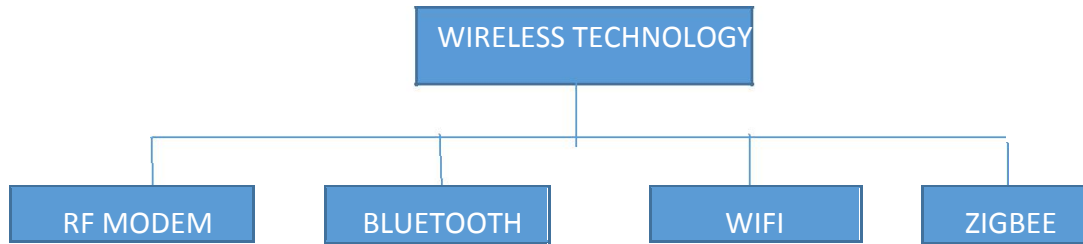


FIGURE 1:Types of Wireless Technologies

III. RF MODULE

The RF module is used to operate the radio frequency and usually the frequency range varies between 30 KHz AND 300 GHz. The RF module is much better than the IR infrared in transmission because the signals through RF can travel through

larger distances, which useful for long-range applications. Also, IR doesn't travel through obstructions, but RF signals can travel even when there is no obstruction between transmitter and receiver.

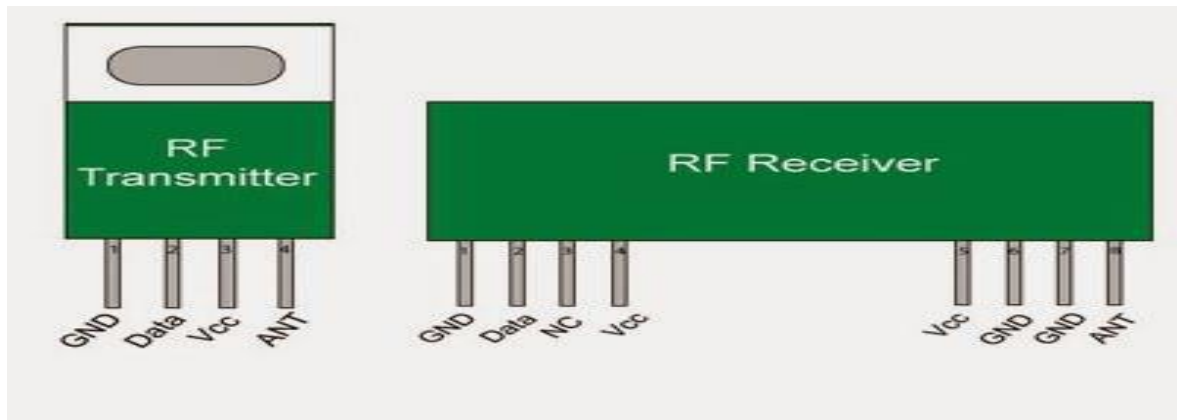


Figure 1 RF MODULE

Advantages of RF

RF is used for radio and television transmissions and also for cellular mobile phone service.

It is also useful in many medical applications, including MRIs, which are used for taking images of the human body and in diathermy instruments for surgery.

It is used for object detection by radar technology.

It is used for satellite communication and microwave line of sight communication systems.

Disadvantages of RF

If the radiation is uncontrolled, then it will have serious impacts, which affects children, older patients with pacemakers, birds, and small insects. Additionally, lightning usually affects RF cellular towers and is prevalent in farmland areas near the RF towers. RF waves can be easily hacked by the intruder and all confidential data can be decoded.

RF MODULE IS INFLUENCED BY THE FOLLOWING FACTORS

Sensitivity of the receiver:

This describes the minimum level that a signal can demodulate before conveying it to the receiver. The amplified signal, which is sent by the transmitter, needs to be softened.

Transmission power

This is the amount of frequency power that comes out of antenna of RF modules.

Line of sight

It is the transmission antenna that can be seen by the receiving antenna in a straight line, which improves communication. Frequently, there will be obstacles such as walls and floors that will absorb the radio wave signal, and the effective operational distance will, in most practical instances, be less than specified.

BLUETOOTH

Bluetooth was initially developed in 1994 by a Swedish mobile phone maker, Ericsson, to let laptop/computers make calls over a mobile phone. Since then, many different companies

have planned to make Bluetooth the low power short-range wireless standard for a wide range of devices. Bluetooth is a short-range technology used for Wireless Personal Area Networks (WPAN) and supports ad-hoc networks. The main aim of Bluetooth is to provide universal short-range wireless capability. With a 2.4 GHz band, two Bluetooth devices can share up to 720 Kbps within 10m of each other. It is also used to support a wide range of applications that are open-ended,

including data, audio, graphics, video, etc. Authentication is also possible with this technology by sending the acknowledgement from the receiver to the transmitter before making a connection between devices. There is a limitation, however, where only eight devices can communicate on a single network. Bluetooth was designed to be as secure as a wire with up to 128-bit public/private key authentication.

Bluetooth network topology

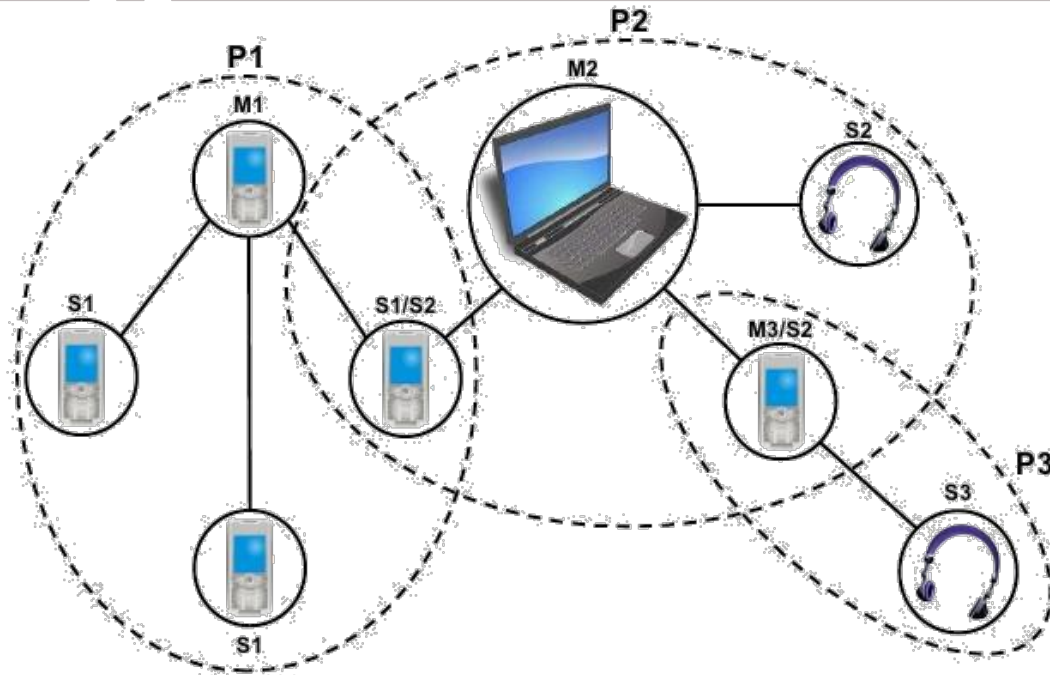


Figure 2 Bluetooth connection

Advantages of Bluetooth:

Bluetooth is easy to connect for sharing data files with other devices.

It uses low power signals, which is an advantage of consuming less battery than other devices.

It has the ability to connect 7 Bluetooth devices at a range of 30 feet, forming a piconet.

Disadvantages of Bluetooth:

The data rate of Bluetooth is 1MBPS, which is slower when compared with infrared.

It is easy to intercept and is vulnerable to attacks because of the high range and radio frequency.

No inbuilt line of sight for security, so it can be more easily hacked than infrared.

WI-FI

WIFI is a short for wireless fidelity, which is a way for wireless devices to communicate. It is also a WI-FI alliance name for wireless standard or a protocol that is used for wireless communication. WIFI devices are certified interoperable, which can run on the medium range networking standard 802.11, which runs at speeds roughly comparable to those of wired networks. It also runs on "free" portions of the radio spectrum, meaning that, unlike cell telephone communications, no license is required to broadcast using 802.11.



Figure 3 Wireless Network

To allow high speed data transfer over short distances, the wireless technology uses waves. There is a problem called multipath interference, which is due to reflection of signals from walls, signals from walls and other obstacles. WIFI provides internet access for many modern devices like laptops, mobiles, tablets, and computers with authentication and increases the devices on a single WIFI connection. The signal strength will be reduced and the connection may get lost, however. Millions of users use WIFI to connect to the internet and private networks without wires.

Advantages of WIFI

1. No wires are needed for establishing an internet connection.
2. Users can access the internet anywhere, anytime and can freely move anywhere within the range of WIFI and can use internet in the surrounding area.
3. Multiple devices can be used to access internet at a time.
4. Cheaper than the wired connections.

Disadvantages of WIFI

1. Wireless connections speed can be sometimes slow when compared to wired connections.

2. When the weather conditions are bad, it slows down the internet speed due to the lack of proper WIFI signals i.e., frequency.
3. Setting up a wireless connection is not cheap, especially in a large facility because companies need many routers and access points to set up the internet connection.
4. Security is one of the major issues in WIFI because when wireless routers and access points grant a direct connection to a company, they can also do the same for an outsider with the right tools.

It can generate radiation, which is very harmful to human health.

IV. ZIGBEE

Zigbee is the wireless technology developed to address the needs of low-cost, low-power wireless Machine to Machine (M2M) networks and operates on the IEEE 802.15.4 physical radio specification. The frequency bands on which zigbee operates are 868MHz, 915MHz, and 2.4GHz and the maximum data rate is 250k bits per second. One of the major advantages of using zigbee is that these devices are capable of operating for several years before their batteries need to be replaced.

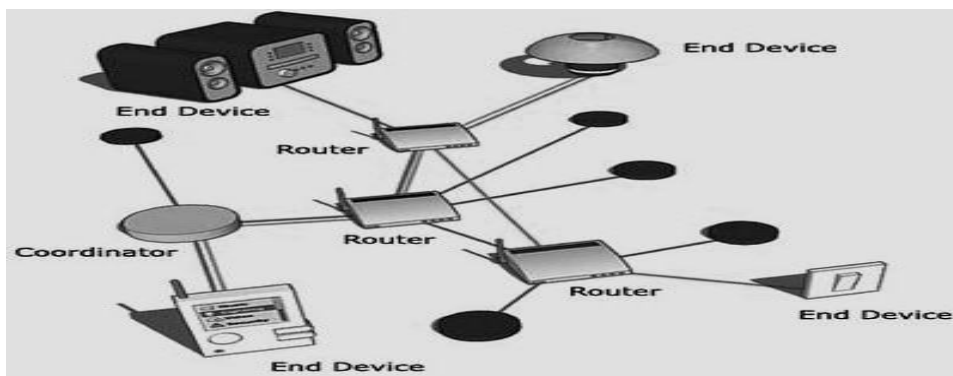


Figure 4 Zigbee Network

TABLE 1:COMPARISON OF KEY FEATURES OF COMPLEMENTARY PROTOCOLS

FEATURES	IEEE 802.11B	BLUETOOTH	ZIGBEE
Power profile	hours	days	years
Complexity	Very complex	complex	simple
Range	100m	10m	70m-300m
Data Rate	11Mbps	1Mbps	250Kbps

TABLE 2:BLUETOOTH VS WIFI

FEATURES	BLUETOOTH	WIFI
Bandwidth	800Kbps	11Mbps
Hardware Requirements	Requires Bluetooth adapter on all devices that connect to each other.	Requires wireless adaptors on all devices of the network ,a wireless router or Access points
Cost	Low	High
Power Consumption	Low	High
Secuirty	Less secure	More secure
Range	10m	100m
Primary devices	Includes usb mouse, mobile phones, keyboards etc	Includes computers, desktops and servers.

TABLE 3:ZIGBEE VS BLUETOOTH

FEATURES	ZIGBEE	BLUETOOTH
Networking Topology	Ad-hoc,star or mesh.	Small networks ,Ad hoc
Frequency	2.4GHz	2.4GHz
Nodes per network	255/65k+	7
Key attributes	Low power, cost and reliable	Cost ,convenience
Application focus	Monitoring and control	Cable replacement

V. CONCLUSION

Zigbee is better for industrial automation applications, as it provides a self-healing network, is easy to install, and has a low-cost deployment. The battery life of zigbee is also much better than Wi-Fi, and needs to be strongly considered if endpoints will run on batteries. There are different zigbee products developed that will function and survive in industrial settings, like high RF noise floors, temperatures, etc.

- [2] Different Types of wireless technologies-<https://www.efxkits.us/different-types-of-wireless-communication-technologies>.
- [3] RF-MODULE-<http://www.engineersgarage.com/electronic-components/rf-module-transmitter-receiver>
- [4] Factors affecting the RF -<http://info.avalanwireless.com/blog/factors-influencing-rf-module-communication>.
- [5] Jacob Hatcher- "Hacking For Beginners and Basic Security: How To Hack".
- [6] Harold Davis-"WIFI-Absolute Beginner's Guide to Wi-Fi Wireless Networking".
- [7] Shahin Farahani-"Zigbee-ZigBee Wireless Networks and Transceivers".

REFERENCES

[1] Wireless communications-
http://www.engineersgarage.com/articles/wireless_communication.

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