

Case Study on Comparison of Wireless Technologies in Industrial Applications

V.Abinayaa*, Anagha Jayan**

PG Scholar, Department of Applied Electronics, Sri Krishna College of Technology, Coimbatore, India

Abstract- This paper conveys more information about communication modules like RF, Bluetooth and Zigbee in industrial applications. In this paper, an overall comparison of these modules on the basis of their industrial applications and characteristics such as standard, bandwidth, battery life, data rate, and maximum transmission range etc.

I. Introduction

Wireless technologies have been available for decades, and in the last several years wireless technologies have been making their way to the factory floor. This technology has been allowed for transferring data efficiently over long distances. When this wireless technology is utilized, a new world of applications is available to designers. Sensors and actuators can be added to many industrial, commercial, and entertainment automation applications.

The main advantages for using a wireless solution in industrial applications are greater mobility and possibility to move devices and connect to smart phones and tablets freely without constraining cables, eliminate expensive and maintenance heavy transmission media such as flexible cables, swivels, bypassing long distances and areas where cables cannot physically fit, fast and easy installation and commissioning, high flexibility if there is a need to modify an installation, increased personnel safety by not having to be physically close to a device during configuration and maintenance, flexible human interface devices (HID), easy integration of devices into the network.

Industrial plants consist of multiple devices interconnected in different ways. These varied types of devices consist of Simple data collection units (I/Os) without built-in intelligence, intelligent devices such as sensors with built-in intelligence, single-loop controllers or programmable controllers, supervisory systems used as human machine interface (HMI), data logging and supervisory control. All these types of devices are interconnected using different communication protocols that in some cases can be replaced by wireless technologies to accomplish the above listed advantages.

II. Wireless Technologies

In the past years, we were used the wired technologies for the communication. These technologies have the greatest drawbacks of using cable and it is impossible to use for long distance and not a reliable one also. To overcome these drawbacks, we have been moved to the wireless one. By using the wireless communication technologies, we make our communication as reliable one and cable free one.

Wireless technologies are applied in various wide applications throughout the world. For communicating over the world, wireless communications communicates via satellite. In the closed environments or limited range applications like school, colleges, offices, factories, and industries, we communicate or transfer the data with the help of wireless sensor networks such as RF modem, Bluetooth, Wi-Fi and Zigbee etc. The primary advantages of wireless sensor networks are,

- Reliable one
- Authenticated one
- No use of cables
- Lesser cost than wired one

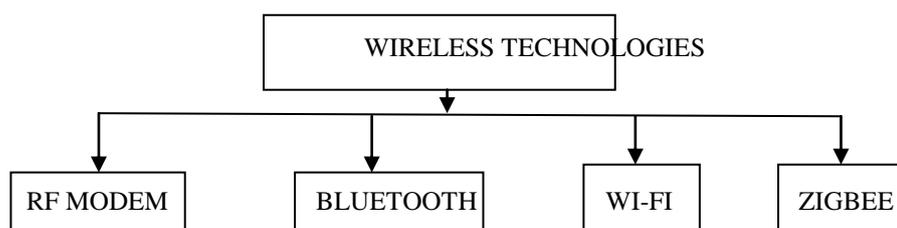


FIGURE 1: Types of Wireless Technologies

III. RF module

An RF module (radio frequency module) is a small electronic circuit used to transmit and receive radio signals on one of a number of carrier frequencies. RF modules are widely used in electronic and designing radio circuitry.

RF modules are most often applied in medium and low volume products depending on consumer applications such as wireless alarm systems, industrial remote controls, smart sensor applications, and wireless home automation systems. Commercially available RF module frequencies are 433.92 MHz, 315 MHz, 868 MHz and 915MHz. These frequencies are used because of national and international regulations governing the use of radio for communication.

IV. Main factors affecting RF module performance

The performance of an RF module will depend on a number of factors such as an increase in the transmitter power and larger communication distance. However, this will also result in a higher electrical power drain on the transmitter device, which will cause shorter operating life for battery powered devices. Likewise, using a higher transmit power will make the system more prone to interference with other RF devices and also by increasing the receiver sensitivity will also increase the effective communication range, but will also potentially cause malfunction due to interference with other RF devices. The performance of the overall system may be improved by using matched antennas at each end of the communication link, such as those described earlier.

The system is normally measured in an open-air line of sight configuration without any interference, but frequently there will be obstacles such as walls, floors, iron construction to absorb the radio wave signals, then the effective operational distance will in most practical instances is less than specified.

V. Bluetooth

For industrial applications, a wireless technology has to work well in a noisy environment. Bluetooth operates based on the features of Adaptive Frequency Hopping (AFH) and Forward Error Correction (FEC). It provides a universal short range wireless capability. It operates in the 2.4 GHz frequency band and the devices within 10m of each other can share the data up to 720Kbps of capacity. This technology is also an authenticated one by sending the acknowledgement from the receiver to the transmitter before making the connection between devices. But its limitation is up to eight devices can communicate in a single network and it asks the confirmation about receiving the each data at every time and also it limits the packet size



FIGURE 2: Bluetooth Network

VI. Wi-Fi

Wi-Fi stands for Wireless Fidelity, which refers to wireless technology that allows devices to communicate over a wireless signal. This network is based on the IEEE standard 802.11; including 802.11a, 802.11b, 802.11g and 802.11n, by using the centralized router devices can share the Wi-Fi signal. Wi-Fi networking technology that uses waves to allow high speed data transfer over short distances. In indoor environment, this technology causing problem called multipath interference due to reflection of signals from the walls, furniture and other obstacles. Wi-Fi allows local area networks (LANs) to operate without cable and wiring. It is popular for the home and business networks. Generally, it can be used to provide the wireless broadband internet access for many modern devices such as laptops, smart phones, tablet and computers with authentication. By increasing the number of devices in a single Wi-Fi connection, the strength of the signal provides to each device becomes weak.



FIGURE 3: Wi-Fi network

VII. Zigbee

The communication layer of Zigbee is at level 3 and upper layer in the OSI model. Zigbee provides a network topology to let a network of devices communicate between them and to set extra communication features such as authentication, encryption, and the association and in the upper layer application services. A reactive Adhoc protocol has been implemented to perform the data routing and forwarding process to any node in the network. The main application of Zigbee is clustering. Zigbee has a lot to offer in industrial applications such as low cost deployment and redeployment, mesh networking to cover entire industrial plants and factories, an open standard with multiple vendors, battery operation.

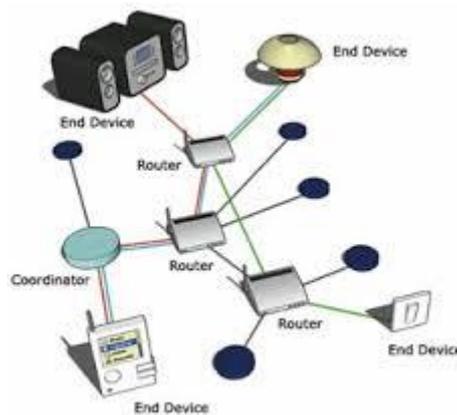


FIGURE 4: Zigbee network

TABLE I: Comparison of Xbee vs Zigbee

PROPERTIES	XBEE	ZIGBEE
STACK LAYER	Layer at level two in OSI model	Communication layer at level three and uppers in the OSI model
PURPOSE	To let communication between two devices	To create a network topology to let a network of devices communicate among them and to set extra communication features such as authentication, encryption, association and in the upper layer application service.
FREQUENCY	3 main bands of frequency	ISM band

	2.40-2.48 GHz 2.40GHz,Xbee802.15.4OEM	2.40-2.48 GHz
BIT RATES	115 kbps	250 kbps

TABLE II: COMPARISON OF KEY FEATURES OF COMPLEMENTARY PROTOCOLS

FEATURES	IEEE 802.11B	BLUETOOTH	ZIGBEE
Power Profile	Hours	days	Years
Complexity	Very complex	complex	Simple
Nodes/Master	32	7	6400
Latency	Enumeration upto 3 seconds	Enumeration upto seconds	Enumeration 30ms
Range	100 m	10m	70m-300m
Extendability	Roaming possible	no	Yes
Data Rate	11mbps	1Mbps	250 kbps

TABLE III: ZIGBEE VS BLUETOOTH

ZIGBEE		BLUETOOTH
Smaller packets over large networks		Large packets over small network
Mostly static networks with many, infrequently used devices		Ad-hoc networks, file transfer
Home automation, toys, remote controls, etc		Screen graphics, pictures, handsets etc
Rechargeable		Non-rechargeable
Devices/network	6500	6500
Link rate	250 Kbps	1 Mbps
Range	100+ meters	10 meters
Air interface	FHSS	DSSS

VIII. CONCLUSION

ZigBee has a great deal to offer in industrial automation applications such as low cost deployment and redeployment, mesh networking to cover entire industrial plants and factories, an open standard with multiple vendors, battery operation. The different Zigbee products are designed as per to function and survive in industrial settings like high RF noise floor, temperature extremes, rough handling.

IX. REFERENCES

1. BA Akyol, H Kirkham, SL Clements, MD Hadley “A SURVEY OF WIRELESS COMMUNICATIONS FOR THE ELECTRIC POWER SYSTEM” Prepared for the U.S. Department of Energy under Contract DE-AC05-76RL01830, January 2010.
2. Zigbee case study, www.science.smith.edu/~jcardell/Courses/.../Zigbee%20ACaseStudy.pdf
3. Demystifying 802.15.4 and zigbee, ftp1.digi.com/support/documentation/demystifyingzigbeeand802154.pdf
4. <http://www.britannica.com/EBchecked/topic/1473553/Wi-Fi>
5. <http://www.techterms.com>
6. William Stallings, “Wireless Communications and Networks” book 2nd edition, published by pearson edition, sgar91.files.wordpress.com