A Relative Study of Heterogeneous Wireless Protocols

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Abstract

Wireless technologies such as Bluetooth, ZigBee, WirelessHART and Wibree are protocol standards which are being adopted rapidly. These protocols are for short range low power wireless communications. Commonly described application of Bluetooth is that of a "cordless computer", ZigBee is oriented to control networks, Wibree is designed for low power consumption and WirelessHart is designed to enable secure industrial wireless network communication. These wireless technologies also use adequate security features for many applications.

This paper provides a brief overview of these protocols and evaluating their main features. By providing this analysis, it is believed that this paper would benefit system designers in selecting an appropriate protocol.

Keywords: Bluetooth, Wireless protocols, Wibree, Zigbee, WirelessHart.

I.   INTRODUCTION

Wireless Network Technologies have been flourishing in recent years. They have been used widely and adopted in every part of our everyday life. The emergence of these technologies will enable opportunities for industrial communication and decreased raw material costs, reduced energy consumption and also reduces the cost of maintenance and other restrictions that are applied on wired communication. There are number of protocol standards used by the system designers and other working groups. So they must understand the differences between the technology standards. In all communications the protocols are the main attributes or we can say that they are

the main characteristics, so it is necessary to choose them intelligently and with high efficiency.As this technology is growing very fast, there is a need to adopt low power, low cost and long distance by the wireless protocols. The goal of this paper is to examine the four protocols: Bluetooth, ZigBee, Wibree, WirelessHART and design a comparative analysis of these protocols on the basis of their transmission rate, network topology, power, cost, etc. We have looked at the different properties of these technologies and how they affect the communication.

In this paper, Section I describes the brief introduction about the wireless standard protocols we attempt to make a preliminary comparison of them. Section II brief describes the features and overview about all the wireless protocols. In Section III a comparative study of these protocols is summarized in table form and at last paper is concluded.

II.   Wireless Protocols

This section provides brief overview of the Bluetooth, ZigBee, WirelessHART and Wibree which corresponds to the IEEE 802.15.1, IEEE 802.15.4 standards. A protocol is a set of rules for data communication. Its main aim is to provide representation to data, signaling, authenticates data and detects errors in the information which is going to send or sent over a communication channel [1].

The information present in this Section is present in the literature and hence it only provides the comparison between various protocols.

A.   *Bluetooth over IEEE 802.15.1*

Bluetooth concept was experienced in 1994 by telecom vendor Ericsson. It is managed by the Bluetooth special Interest Group (SIG) since 1996. It is a standard for exchanging data over short range and replacing cables in computer peripherals like keyboards, mouse, headphones, speakers and printers etc. Bluetooth has a unique technology that uses master- slave relationship between nodes. The network formed by Bluetooth is based on piconet and scatternet topologies [2]. Each node in the network can communicate maximum to 8 nodes and the network forms a piconet. In each piconet one node serves as master and other one and more serve as slaves. The master node's clock and frequency hopping sequence is used to synchronize all slaves present in the network. Slave communication with their master is point-to-point or point-to-multipoint. A slave in one piconet can be master in another piconet. So the nodes can adopt point- to- point and point- to- multipoint communication, several piconets can be formed and collecting these piconets together can form a large network with many levels which is called scatternet. A device in one scartternet serves as master in only one piconet but can serve as slave in many piconets [3].

B.   *ZigBee over IEEE 802.15.4*

ZigBee is low rate, low power standard for supporting devices that operates in a range of 10m. It is developed by ZigBee Alliance firstly for monitoring and controlling

products. ZigBee is a mesh network topology which is used by wide applications because of multihop and self organized network with long battery life due to low power consumption feature [4,5]. ZigBee is aimed at remote control and sensor applications that are suitable for strong radio environments and also for isolated locations. Due to the feature of low power consumption it can run for years. It is being used for everything in the consumer market from linking low power household devices like smoke alarms to control housing control unit, to centralized light controls.

ZigBee network contains mainly three types of nodes. ZigBee Coordinator (ZC), ZigBee Router (ZR), ZigBee End Device (ZED).

- *ZigBee Coordinator, ZC:* It is the most capable node and it is the root of the network and might connected to the other network. ZC is the node/ device which start the network and there is only one ZC in each ZigBee network.
- *ZigBee Router, ZR:* It acts as a intermediate router for passing data from one device to other device and run an application function.
- *ZigBee End Device, ZED:* This is least expensive in all nodes with least power consumption because it fell asleep(even for days) when not participating in communication. It cannot take data from other devices and hence can take only with ZC and ZR the parent nodes [6].

C.   *WirelessHART over IEEE 802.15.4*

WirelessHART was released by HART (Highway Addressable Remote Transducer) communication foundation in 2007. This is a very specialized standard which uses factory and process control. This technology basically provides built-in security to the wireless sensor networks. WirelessHART uses AES-128 encryption due to which the messages are encrypted and that only can decrypt by the destination nodes. It is a fully featured mesh and self organizing network which contains field devices/sensor nodes, adapter, security manager, handheld, gateway and network manager who is responsible for configuring and managing the network. The field device is used to collect necessary information and transmit it back to the plant network for monitoring and controlling process. Field devices contain the routing capabilities. Adapters are used to convert the wired network protocols into wireless field bus protocols to connect the HART devices to the WirelessHART network. The gateway acts as an interface between the plant automation network and WirelessHART network. Network manager acts as an administrator and controlled the whole network. It controls scheduling, distribution of resources and identifies the best paths. The data which flows between network manager and field devices has to pass through gateway. So it is necessary to provide a security environment. Security manager manages this security environment. The handheld are used for installation, configuration and maintenance of the field devices. WirelessHART mainly aims at sensors and actuators and rotating equipments like kiln dryers, and environmental health and safety applications. In WirelessHART, communication is mainly based on Time Division Multiple Access (TDMA) that means timeslots are scheduled first and then transmission occurs in a synchronized manner and makes use of a channel-hopping

scheme. It also uses centralized system to generate and schedule support to the traffic between the sensor nodes and the manager.

WirelessHART network is configured to avoid specific channels that are highly utilized by other networks and therefore provides interference. Before transmitting data WirelessHART tries to listen the frequency of neighboring node to avoid conflicts. If any conflict is found then it back off and attempt the communication in another timeslot on a different frequency. [7][8]

D.   *Wibree over IEEE 802.15.4*
Wibree is an open standard based on Bluetooth. We can say that Wibree is a low power Bluetooth. It has same bit rate (1Mb/s) as Bluetooth. Except the power consumption Wibree have same properties as Bluetooth. Power consumption of Wibree is ten times less than the Bluetooth. Wibree technology can work in two ways in standalone and dual mode device. In standalone mode Wibree can communicate with other standalone and due mode devices. In dual mode it can communicate with other standalone and dual mode devices as well as Bluetooth chips. Wibree allow devices to send small amount of data very fast even in disconnected state. So it gives a new feature to the market in which one can transmit small amount of data. It is also reduces cost by reducing size and specification parameters [7,9].

III.   **RELATIVE STUDY**
  A.   *Data Rate:*-Bluetooth and Wibree provide same data rate which is high as compared to ZigbBee and WirelessHART.
  B.   *Radio Channels*: -They all have spread spectrum techniques in the 2.4 GHz band, which is unlicensed in most countries and known as industrial, scientific, and medical (ISM) band. Bluetoth uses frequency hopping spread spectrum (FHSS) with 79 channels and 1 MHz bandwidth, while ZigBee and WirelessHART uses direct sequence spread spectrum (DSSS) with 16 channels and 2MHz bandwidth.
  C.   *Network Size*: -In a Bluetooth network the maximum number of devices which can take part in the environment is 8(7 slaves plus one master), over 65000 for a ZigBee.
  D.   *Security:* -All the four protocols have the encryption and authentication mechanisms.

Table-I summarizes the main differences among the four protocols. All these protocols based on IEEE standard Acronyms: GFSK (Gaussian frequency SK), BPSK/QPSK (Binary/ Quardrature phase SK), O-QPSK (offset-QPSK), FHSS/DSSS (Frequency hopping/ direct sequence spread spectrum), AFH (Adaptive Frequency Hopping) [3,10].

Table.1 Comparison of the Bluetooth, ZigBee, WirelessHART and Wibree Protocols.

	Bluetooth	**ZigBee**	**WirelessHART**	**Wibree**
IEEE Specification	IEEE 802.15.1	IEEE 802.15.4	IEEE 802.15.4	IEEE 802.15.4
Band	2.4GHz	2.4GHz, 868MHz, 915 MHz	2.4GHZ	2.4GHz
Antenna/HW	Shared	Independent	Shared	Shared
Power	100mW	30mW	10-40mW	~10mW
Range	10-30 m	10-75 m	10 m	10-30 m
Modulation type	GFSK	BPSK (+ASK), O-QPSK	GFSK	GFSK, TDMA
Spreading	FHSS	DSSS	DSSS	AFH
Data Rate	1-3 Mbps	25-250 Kbps	1 Mbps	250 Kbps
Component Cost	$3	$2	869$	Bluetooth + 20€
Target Battery Life	Days – months	6 months- 2 years	>10 years	1-2 years
Network Topologies	Ad hoc, point to point, star	Mesh, ad hoc, star	Smart Mesh, ad hoc	Ad hoc, point to point, star
Security	128-bit encryption	128-bit encryption	128-bit encryption	128-bit encryption
Time to wake and transmit	3s	15ms	10ms	6ms
Maximum Number of Cell nodes	8	>65000	500	Not Defined (Depend on Implementation)

IV.   CONCLUSION

This paper has presented a brief overview of the four short range wireless standards, Bluetooth, ZigBee, WirelessHART, and Wibree. A quantitative evaluation has been done in terms of transmission time, data rate, power consumption, radio channels, network size and security. This paper does not provide any conclusion related to the superiority of any protocol.

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