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Bluetooth Technology Working, Applications, Protocol and Latest Versions

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Abstract: Bluetooth is a wireless medium of communication which is mainly used in Wireless Personal Area Networks (WPAN). Its usability expands from headset cable replacement to as far as supporting ad-hoc networks. The main purpose of this technology is to connect multiple devices amongst each other in a wireless means of communication. This technology reduces the efforts of human being to a great extent. There is a specific range already assigned to the different versions of this technology. The devices can connect or communicate to each other within this specified range only. Media files such as images, videos and different data files can be easily shared and accessed from multiple devices using this technology. Bluetooth helps in forming small networks known as piconets and scatter nets which help in the main transmission of files within this technology. Bluetooth is mainly used in latest earphones, headphones, cars, speakers and is available in almost every mobile device.

Keywords: Bluetooth, piconet, application, version, piconet, scatternet, master, slave.

I. INTRODUCTION

Bluetooth is a wireless technology which is primarily used for exchanging or transferring data between two communicating devices [1]. The main transfer of data is done by the means of fixed or mainly stipulated and short wavelength UHF radio waves in the areas of industrial, scientific and medical radio bands specifically ranging between 2.400 to 2.485 GHz. Ericsson brand originally called or named their very latest wireless technology 'Bluetooth' after the king of Denmark, Harald Bluetooth. During his rule, Denmark and Norway were much united, so Ericsson was inspired to use the analogy that he "made possible or rather allowed much greater and effective communication between people" when naming their wireless communication protocol.

Bluetooth is administered by the Bluetooth Special Interest Group, which has more than 15,000 member associations in the areas of telecommunication, computing, and networking. Bluetooth used to be standardized as *IEEE 802.15.1*, but the standard is no longer exists. To be known as a Bluetooth device, it must meet to the standards defined by the SIG board. Bluetooth is a connective mechanism which provides high-speed, low power microwave wireless technology, designed to connect phones, laptops, speakers to other portable devices

together. Bluetooth makes the life of the user easier by simple and effective connectivity between multiple devices.

II. LOGO

The Bluetooth logo is bind rune combing the Younger Furthrak (ᚼ) and Bjarkan (ᛒ), Harald's initials [2]. Bluetooth logo was almost copied or replicated from the original symbol of the brand which was designed during 1970 by the Beau knit Textiles, a sub organization of Beau knit Corporation.

Fig 1: Bluetooth Symbol

III. WORKING

Bluetooth works on the mechanism of a master slave structure. The master can communicate to the slaves in the way it wants and can also communicate to one or multiple slaves at a time. It main follows a packet-based control mechanism. Packet transfer is done on the interval of some stipulated time interval which is tracked by the master's clock [3]. Packets are transferred on the interval of averaging time which is around 312.5 µs. In the case of single slot packets the master transmits in even intervals or time slots and receives in odd intervals or slots. Meanwhile the slave receives in even intervals and transmits in odd intervals. Packets are generally of 1,3 or up to 5 slots but in all cases the link is initiated by the master and the transmission will begin in even intervals only. The working of Bluetooth is the transfer of packets between the master and slave within a piconet which can also be considered as a small network among which all the devices are interconnected among them.
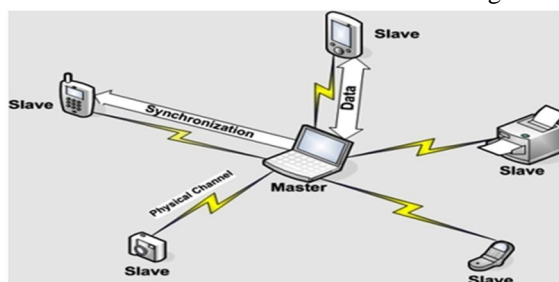

Fig 2: Bluetooth Piconet

IV. COMMUNICATION AND CONNECTION

A connecting Bluetooth device or the master in the network can communicate or connect with a maximum of seven devices in a piconet (an ad-hoc computer network implementing Bluetooth technology), though not every device reaches this limit. The devices can switch their jobs by mutual agreement and the slave can become the master of the network (for example, a mobile initiating a connection to a speaker will obviously begin as master, as mobile is the initiator of the connection; but it may or may not prefer to be the slave). The Bluetooth technology also provides for the connection of two or more piconets to form a larger network also known as scatternet, in which some devices simultaneously as per the need play the master role in one piconet and can plays the role of the slave in another. At any point of time, the packets or data can be transferred between the master and one other device. The master has the right to choose which slave device is to be addressed. Typically, it switches rapidly from one device to another through a technique known as round robin wherein the schedule of the processes is determined. Since it is the master which chooses which slave to address, whereas a slave is (in theory) supposed to receive the data in each receive slot, being a master is comparatively easy than being a slave. Being a master of multiple slaves is possible but being a slave of more than one master is difficult. The specification is vague when it comes to the behavior in scatternets.

V. PICONET AND SCATTERNET

Bluetooth is actually a WPAN (Wireless Personal Area Network) open standard that facilitates an ad-hoc way of connecting devices in a short range. The Bluetooth containing devices can locate each other, but user action is essential in order to establish connections with other devices and from various different networks. Up to eight devices can be connected in a Bluetooth network called, PICONET. One of those eight devices act as a master and remaining of them act as slaves. So, a maximum of 7 slaves can be approved or supported inside a piconet. Whenever two or multiple devices detect each other and communicate through Bluetooth, a small network which is known as piconet is formed. A scatter-net is developed or formed when two or multiple piconets connect together. These multiple piconets are mainly connected through bridges acting as nodes. In addition to seven slaves acting upon a piconet, there can be up to 255 parked nodes in the same network that can only respond to a beacon signal when delivered from the master. The slaves are dumb devices that performs the task that the master orders them to do. All the communication or data transmission is between the master and slave and not among the slaves. In the figure below there are two separate piconets which combinedly forms a larger network known as scatternet. Devices which are present in adjacent piconets provide a bridge like nodes to support inner-piconet connections, allowing assemblies of multiple linked piconets to form a physically extensible and effective communication infrastructure known as Scatternet. Piconet generally covers a small area of network whereas scatternet covers or provides a larger range of network connectivity. Piconet provides less efficient use of available Bluetooth channel bandwidth whereas scatternet provides efficient use of Bluetooth channel bandwidth.
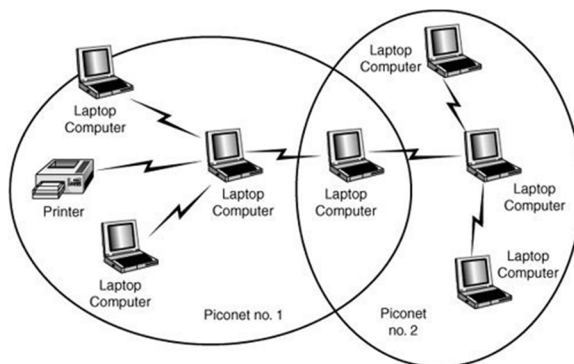
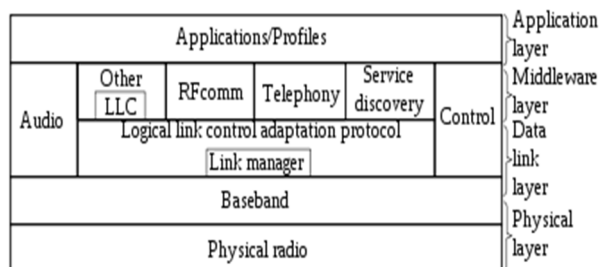. Fig 3: Bluetooth Scatternet

VI. BLUETOOTH PROTOCOL STACK

Fig 4: Bluetooth protocol stack

The header mainly consists of 4 different layers namely:

1) Application Layer
2) Middleware Layer
3) Data Link Layer
4) Physical Layer

The Bluetooth Protocol Stack is the main architecture which consists of core protocols, various cable replacement protocols, different types of telephonic control protocols, Extensible communicating protocols and adopted protocols. Mandatory protocols for all Bluetooth stacks are mainly LMP, L2CAP and SDP. In addition, devices that communicate with the help of Bluetooth almost universally can use these protocols the protocols such as HCI and RFCOMM.

The Application layer enables the user or any individual to interact with the application installed for the usage of the Bluetooth technology.

VII. APPLICATIONS

A. Bluetooth is used to transfer various files, images and MP3 or MP4 between cell phones, tablets, laptops.
B. It is used for low bandwidth applications where higher USB bandwidth is often not required and cable-free connection is desired.
C. It is frequently used in data logging equipment to transmit data to a computer via Bluetooth technology.
D. Wireless control and communication between a mobile cellphone and a Bluetooth compatible car stereo system.
E. For controls where infrared sensors or technology is often used.
F. Real-time location systems (RTLS) are mainly used to track and identify the location of various live objects in real-time activities using "tags" attached to, or inserted in the objects tracked, and "Readers" that receive and simultaneously process the wireless signal networks from these tags to determine their accurate locations.
G. Bluetooth is often used in the case of wireless communications for which a common example is WAN (Wireless Area Network).
H. The technology of Bluetooth is also used in case of wireless mouse, keyboards, headphones and all the latest wireless gadgets in the market.

VIII. LATEST BLUETOOTH TECHNOLOGY

Bluetooth 5.0 is the latest and most effective version of the Bluetooth wireless communication standards. A latest version of the Bluetooth standard expects many improvements and effectivity, but only when used with compatible devices or peripherals [4]. There is no immediate benefit from upgrading to a device with Bluetooth 5.0 if all your Bluetooth accessories are already designed for an older version of Bluetooth. However, Bluetooth is backwards effectively compatible, so that the user can continue using the existing Bluetooth 4.2 and the older device with a Bluetooth 5.0 standard phone. Bluetooth 5.0 enables a cool new and modern feature that allows the user to play audio on multiple connected devices at the same time. The new Bluetooth technology allows to stream two different audio sources to two different audio devices at the same time, so two or multiple people could be listening to two different genres of music, but streaming from the same device. The benefits of Bluetooth 5 mainly are threefold: range, speed, and high bandwidth. The wireless range of Bluetooth 5.0 exceeds out to 120 meters, compared to 30 meters which was quite low for the older version of Bluetooth v4.2. This extension in range and in addition the ability to transmit audio to two devices, means that people could transfer audio to multiple areas in a room which creates a stereo effect in one confined space, or share audio sounds between two different sets of headphones. The extended range also helps in better communication between the devices. Bluetooth 5.0 also adds improvement is with Beacon technology, in which businesses and marketing areas, such as retail can transmit messages to nearby potential customers quite effectively with huge dealing offers or advertisements. Beacon technology also facilitates navigating indoors areas such as in an airport or stations and makes it comfortable and easier for warehouses to track inventory.

IX. BLUETOOTH 5.0 VS BLUETOOTH 4.2

Bluetooth 5.0 beats the older version of Bluetooth 4.2 in almost every aspect. Due to increase range, power, reliability and performance Bluetooth 5.0 is preferred more over Bluetooth 4.2. The use of Bluetooth beacons has flourished and is more popular now due to the increased range of the latest Bluetooth 5.0 technology [5]. All the latest IoT devices have this Bluetooth technology installed ass it provides effective performance and accurate results.

Parameter	Bluetooth 5.0	Bluetooth 4.2
Speed	2 Mbps	1 Mbps
Power Requirement	Low	High
Battery Health	High	Low
Data throughput	1.6 Mbps overhead	1 Mbps overhead
Range	Increased range extending to 40 meters in indoor range	Only 10 meters in indoor
Security	High	Low
Message Capacity	Round off to 255 bytes	Round off to 31 bytes
Support for IoT devices	Yes	No
Reliability	High	Low
Digital Life	High	Low
Robustness	High	Low
Bluetooth Beacon	More in use due to increased range	Less in use due to short range

. Table 1: Bluetooth 5.0 vs Bluetooth 4.2

X. CONCLUSION

Bluetooth is very a powerful wireless technology using air interface to make pairing and connection possible between multiple devices. It allows us to exchange and transfer files, videos, texts, images, etc. over a network with different range according to the various Bluetooth technologies. Bluetooth can be very effectively used as portable or fixed kind of device. Also, the upgraded and high-end security techniques have built trustworthiness for the private and sensitive data transfer. This technology is also very easily affordable.

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