

An Overview of Bluetooth Technology

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Abstract: Bluetooth is a short-range wireless communication system that incorporates radio waves to communicate between fixed or mobile devices without the need for cable wire while improving overall security levels. Bluetooth technology is becoming an important part of this world today in which it offers wireless communication among systems and other low-cost and low-power networks in a short distance making it convenient for users. Bluetooth is a new short range RF wireless technology configured to communicate wirelessly among different devices. Bluetooth technology is growing in popularity, and is being accepted in today's world. There are groups doing Bluetooth technology research, but very few of their research analyzes provide a balanced perspective of technology, which describes its implications for businesses, pros and cons. In this paper analysis different perspectives of the Bluetooth technology were taken into consideration. Bluetooth does not need the 'line of sight' for communication as opposed to the infrareds. Therefore it is a lot more flexible. It was initially called the wireless option for traditional RS-232 cable transmission.

Keywords: Bluetooth, Bluetooth Architecture, Frequency-Hopping Spread Spectrum (FHSS), Wireless Network.

INTRODUCTION

Everyone has experienced the issue that arises when peripheral-computer connections or connections are made between electronic devices. Thus the telecommunications companies required to develop an open, low-cost interface to make communication between devices easier without using wires. Bluetooth is a very short-range wireless technology designed to enable communication between devices such as computers, audio systems and other electronic equipment without the use of cords and connectors[1]. To make the above-mentioned systems, computers and/or related equipment more user-friendly, there is a strong need for a better way for all electronic devices to communicate with each other. The technology requirements define portable computers, cellular telephones, personal digital assistants (PDAs), and a number of other devices that can be linked via low-power, short-range wireless links. Bluetooth technology uses the Frequency-hopping spread-spectrum (FHSS) for communication. Worldwide, the frequency used is 2.4 GHz. The name 'Bluetooth' was named in honor of King Harald I Bluetooth who ruled over the unified Denmark and Norway through the 10th century uniting of the

Danish tribes into a single kingdom[2]. Likewise, Bluetooth's primary objective as a standard is to unify all data transmission technology between portable devices and static electronic devices without any cable media being required.

Bluetooth is the technology that enables the gadgets to communicate with each other, coordinate data and access the internet without use of cords or wires. A Bluetooth radio and base band controller can be mounted on a device that connects to an integrated system board, a Universal Serial Bus (USB) port, or a PC Card to add the Bluetooth interface to a computer or other host device[3]. Figure 1 shows the components of Bluetooth.

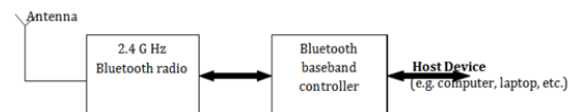


Fig.1: The components of Bluetooth

TECHNOLOGY OVERVIEW OF BLUETOOTH

The hardware specification was clarified in this section. The Bluetooth technology is categorized into two characteristics: first the core and second the specifications of the profile. The core specification describes how the technology works; the profile specification explains how to create interoperating devices using the core technologies. The Bluetooth air interface operates on an antenna capacity of 0 dBm (1 mW) and is globally expanded to 20 dBm (100 mW)[4]. This design complies with ISM band rules of up to 20 dBm in most European countries, America and Japan. In 79 hops displaced by 1 MHz, starting from 2.402 GHz and stopping at 2.480 GHz, the frequency hopping method is used to spread energy across the ISM spectra. The Bluetooth Special Interest Group works to synchronize this 79-channel radio. These 79 channel radio operates globally and has initiated changes in Japan, Spain and other nations. The electronic communication decides whether they have data to exchange, or whether one needs to control the other, if Bluetooth-capable devices come within each other's reach. The users don't need to press a button or send an order; the electronic conversation takes place automatically. Once the conversation has commenced, the devices form a network. The basic unit of communication is the frame consisting of a transmit packet followed by a receive packet shown in Fig 2. Each packet consists of 625 micro sec, multiple slots. The frame Bluetooth hops at 1600 hops / s. Multi-slot frames will allow greater data rates as the turnaround time among packets is eliminated and the header overhead reduction. For example, single-slot frames could have a peak data rate of 172 kbps, while a five-slot, one multi-slot frame supports a five-slot limit of 721 kbps with a one-slot back channel of 57.6-kbps[5]. Figure 2 shows the Bluetooth Frame.

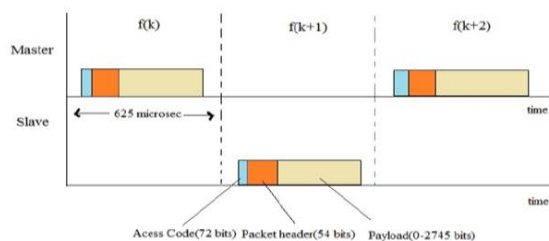


Fig.2: The Figure Depicts the Bluetooth Frame

NETWORK ARCHITECTURE

Bluetooth devices are usually peer-to-peer communications in which each Bluetooth handset is considered equal. They use a term Pico-net in the Bluetooth network architecture which means two or more devices connecting into a small ad hoc network. One of the communication devices serves as the Master in Pico-net and the other devices serve as slaves, this is to be taken into consideration when attaching a Pico-net. In a Pico-net, the communication machines are coordinated with the hopping sequence and the master's clock. The Pico-nets may start with two communication devices, such as a laptop and cell phone, and may include up to eight devices at most. Users can link to other Bluetooth devices within their Bluetooth range automatically. Bluetooth also allows the automatic synchronization of data between the communicating devices. Only master device can be in one Pico-net. This is because the Bluetooth technology supports both point-to-point connections and point-to-multipoint connections[6]. Two or more Pico-nets connected together form a scatter net, and one unit in each Pico-net acts as a bridge in a scatter net between the two or more Pico-nets. As soon as the device joins a Pico-net, the radio or device is assigned a 3-bit Active Member Address and thus allows other device on the Pico-net to address it and start communication. Once Pico-net has eight radios active, the master must then take a radio and "park" it on the Pico-net. This device launches its AMA for 8-bit Passive Member Address (PMA), but remains coordinated with the Pico-net. Any other communicating devices that wish to join the network can be assigned the AMA released. The combination of AMA and PMA allows for an active presence on a Pico-net of over 256 devices but only the eight devices with the AMAs can actively transfer data. Wireless Bluetooth devices can connect to a wired network via a bridge-type access device. The connection system (also known as an access point) contains a Bluetooth transceiver and baseband controller, the circuitry for transferring information from the Bluetooth format to Ethernet format, and interface circuitry for connecting the bridge device to the wired network through cable. In the range of an access unit, mobile users via wireless connections can roam and use the wired network services[7]. Figure 3 shows the Structure of pico-net and scatter-net.

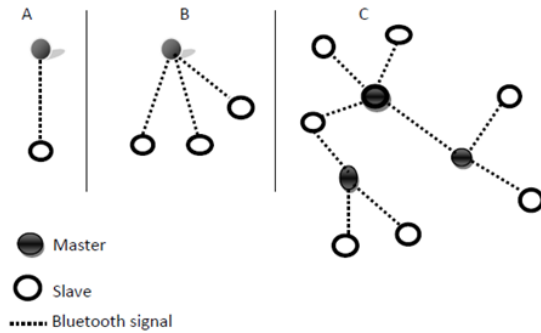


Fig.3: The Structure of Pico-Net and Scatter-Net

ERROR CORRECTIONS AND RETRANSMISSION

The error correction schemes used by Bluetooth technology are forward error correction (FEC) and an automatic repeat request (ARQ) schemes for corrupted or missing data. The Forward error correction reduces the number of retransmitted data packets. The packets are versatile and allow FEC to be used. In case the errors are infrequent, the FEC can be eliminated to reduce overhead. There is a header in every packet that contains the link information. FEC protects the packet headers so they can survive the bit errors. The Bluetooth ARQ scheme uses a 1-bit positive acknowledgement (ACK) or negative acknowledgement (NAK), indicating whether the data which arrives at the receiving station matches the data transmitted. If both the header error check and the cyclic redundancy check (CRC) do not have an error, then the transmitting station gets an ACK. Voice channels use a modulation encoding scheme called the continuous variable slope delta (CVSD) that is immune to errors except in noisy environments. Voice communications are purely real time, i.e. packets which have been lost or damaged are never retransmitted[8]. Figure 4 shows the Bluetooth protocol stack.

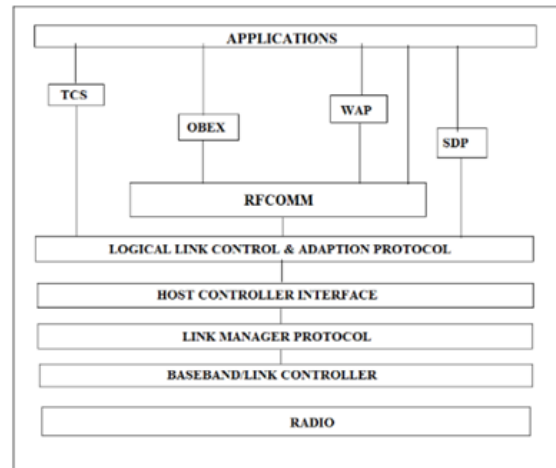


Fig.4: Bluetooth Protocol Stack

BLUETOOTH SECURITY METHODS

Several protection methods exist for protecting the Bluetooth. Such securities are broken down into security at the service level and protection at the device level. These both protect the devices against unauthorized access / data transmission. Bluetooth stable methods discussed in brief below[9]:

Authorization: Bluetooth authorization is manner in which access control of information is represented in general. For example, data in a computer typically allowed to access information about other devices is generally formalized as access control rules in a device system. Throughout operation, system uses the access control regulations to choose whether to approve or reject access requests from the authenticated device user. Resources include personal data and individual files generated by applications or computers. In a simple term, it only makes the devices given.

Authentication: Authentication is the decision process on the other user's identity. This uses the key for this authentication that is already linked to the devices so there is no need to generate new key for each new connection with the same device.

Key management: They have different types of key management in the data encryption and are connected

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key, Pin, encrypted key. Permanent or temporary are sometimes in the connection key. A permanent key can be stored in a non-volatile memory, a can be used in the present situation and will be removed, but in the present situation the temporary key is limited by lifespan. Using a fixed number it is picked in the pin key. Encrypted key will be obtained from the current link key by activating encryption. These Bluetooth securities are subdivided into three modes[10]:

Mode 1:

A Bluetooth device does not invoke protection. This mode is non-secure. Essentially, the security protocols for authenticating and encrypting to allow any Bluetooth device to connect to it.

Mode 2:

A Bluetooth device fails to initiate security procedures before establishing a connection. This mode allows distinct and flexible applications policies, particularly to run applications with various security requirements in the same. This is a security mode which is enforced at service level. This mode introduces the concept of a security manager to control access to the services. The centralized security manager is responsible for maintaining access control policies and for interfacing with other users of protocols and tools. It mode supports the authentication, confidentiality, and authorization.

Mode 3:

A Bluetooth device starts security procedures before the establishment of the link is complete. This is a security mode enforced at the link level, and it is fixed. Since this mode of security is fixed, it is not aware of any security layer of application. This mode supports the authentication and encryption. Authentication and encryption are performed using a shared secret link key derived throughout the pairing process.

CONCLUSIONS

Bluetooth technology is a really efficient solution which can allow communication between devices within the range without the use of wires. Bluetooth is used to blur the boundaries between home, workplace and outer

world. Bluetooth guarantees a seamless connectivity that allows for a range of interactive and extremely transparent personalized services to be explored. Nevertheless, there are some problems that need to be resolved. One potential issue Bluetooth faces is that hardware is being created faster than software for it. Bluetooth transmits information at around 725 kbps. Bluetooth's advantages seem far outweighing the disadvantages and it is becoming a reality. Most Bluetooth pilot devices have already rolled into the market backed by major retailers, which is a very healthy sign of the technology being embraced. Most analysts think Bluetooth technology will ultimately sky rocket. It's estimated that Bluetooth will support 75 percent of all mobile devices.

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