An Overview of Bluetooth–Wireless Technology

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Abstract:- **Bluetooth is a short – range technology that uses WPAN with gross data less than 1Mbits/s. It uses UHF radio waves In the ISM band from 2.4 to 2.485 GHz. Managed by Bluetooth Special Interest Group (SIG).**
Invented by telecom vendor Ericsson in 1994, has spread its blue rays all over the world. This paper highlights the Bluetooth technology .

Key terms: ISM,MAC, piconet,SIG,L2CAP,LMP,SDP

INTRODUCTION:

The history of Bluetooth starts in the 10th century, when Harald Gormsen , King of Denmark ,nicknamed "Blue tooth" because of a disease that was giving him this coloration, erected a rune stone in memory of his parents. This stone had 3 sides with elaborate carvings. One side of the picture shows Christ .He not only united Norway and Denmark but also brought Christianity in to Scandinavia.
Thousands of years later, in 1994, the Swedish IT Company Ericsson initiated studies based on multi – communication
link. This project was renamed and Bluetooth was born.
The Bluetooth logo combines the representation of the Nordic runes
Hagalaz (transcribed by 'H') and Berkana (transcribed by 'B') in the same symbol.

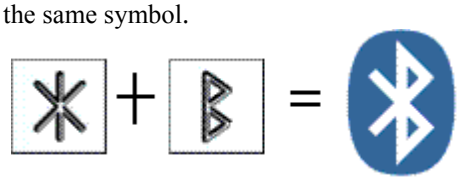

Figure 1

How it works?
Bluetooth is a globally free spectrum that operates on 2.45 GHz ISM ***industrial, scientific and medical (ISM)*** band with 1MHz carrier spacing. The range differs in different countries.

COUNTRY	FREQUENCY RANGE	RF CHANNELS	
EUROPE & USA	2400 – 2483.5 MHz	f = 2402 + k MHz	k = 0,… …,78
JAPAN	2471 – 2497 MHz	f = 2473 + k MHz	k= 0,… …,22
SPAIN	2445 – 2475 MHz	f = 2449 + k MHz	k= 0,… …,22
FRANCE	2446.5 – 2483.5 MHz	f = 2454 + k MHz	k= 0,… …,22

Figure 2

Thus, the system can be used all over the world owing to the radio transmitters that covers 2.400 & 2.500 MHz.

NETWORKING:

It uses the Master / slave Network topology.

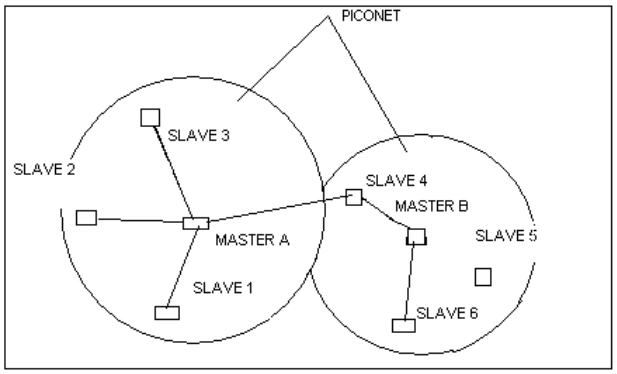

Figure 3

The initiator is the Master & the other device is the Slave. A master can support up to 7 slaves per piconet.
Connection over a Bluetooth can be :

1) Point – to – connections;
2) Point – to – multipoint;
3) Scatternet;

Point – to – connections:
2 devices locates each other, gets connected and transfers the data. The data could be any thing like Photos, Videos, text files , resource sharing and many more.

Point – to – multipoint:
When 2 devices are in point – to – connection , a third device comes in to the range. Data transfer to this will be possible only after this 3rd is discovered and added to the existing piconet. A master supports up to 7 slaves. Data transfer between the slaves is possible only thru' the master based upon the time defined by it on the piconet.

Scatternet:
It permits devices to be active in numerous piconets. A slave in one piconet can be master in another piconet, but device being master in 2 piconets is impossible.
The BT devices are assigned with a unique 48 – bit MAC address by the BT SIG.
The address is split in to 3 parts namely , LAP, UAP, and NAP

LAP is Lower Address Part (0:23)that generates frequency hop pattern and header sync word.
UAP is Upper Address Part (24:31) that initialize the HEC CRC engines.
NAP is a Network Access Point that provides the service of routing network packets between PAN Users by using Bluetooth Network Encapsulation Protocol (BNEP) and the layer-3 routing mechanism. A NAP can also act as a bridge between Bluetooth networks and other network technologies by using the layer-2 bridging mechanism.

ARCHITECTURE:

The BT technology is classified in 2 categories of specifications namely the core and the profile specifications.
The core specification deals with the working of the technology , whereas the profile specification concentrates on how to build interoperating devices using the core technology.
The core protocols of Bluetooth comprise the following elements:

- **Radio:** Specification of air interface, i.e., frequencies , modulation , and transmit power.
- Baseband : Description of basic connections establishment, packet formats, timing, and basic QoS parameters.
- **Link Manager Protocol (LMP):** Link set – up and management between devices including security functions and parameter negotiation.
- **Logical link control and adaptation protocol (L2CAP)**: Adaptation of higher layers to the baseband (connectionless and connection oriented services).
- **Service discovery Protocol (SDP):** Device discovery in close proximity plus querying of service characteristics.

This paper discusses the core technology, taking into account the lower layers of the BT architecture.

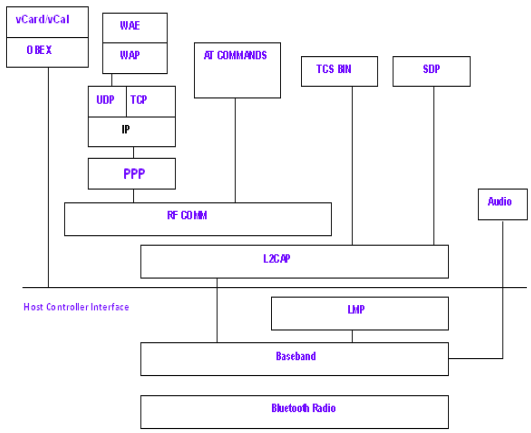

Figure 4

THE RADIO FREQUENCY LAYER:

BT uses the license – free specification band at 2.4 GHz permitting worldwide operation with some adaptation to national restrictions. It uses frequency – hopping / time – division duplex scheme for transmission. Fast hopping rate is of 1,600 hops / sec. The time between 2 hop is called a slot , which is an interval of 625 µs. BT uses 79 hop carriers equally spaced with 1MHz.
BT transceivers uses Gaussian FSK modulation. They are available in 3 classes:

CLASS	MAXIMUM POWER	RANGE
CLASS 1	100 mW (20dBm)	~ 100 meters
CLASS 2	2.5mW (4dBm)	~ 10 meters
CLASS 3	1mW (0dBm)	~ 1 meters

Figure 5

- **Power class 1:** Maximum power is 100 mW and minimum is 1 mW (typ. 100 m range without obstacles). Power control is mandatory.
- **Power class 2 :** Maximum power is 2.5 mW , nominal power is 1 mW and minimum power is 0.25 (typ. 10 m range without obstacles). Power control is optional.
- **Power class 3:** Maximum power is 1 mW

THE BLUETOOTH BASEBAND:

The baseband layer's function is complex , since it performs frequency hopping for mitigation for medium access . The below figure depicts the frequency selection during data transmission. Each device participating in a certain piconet hops at the same time to the same carrier frequency. The master sends data at f(k) while the slave answers at f(k+1).
Within each slot the master or one of the slaves may transmit data in an alternate way. BT has single slot and multi slot packets. 3 slot and 5slot falls in to the category of multi – slot.

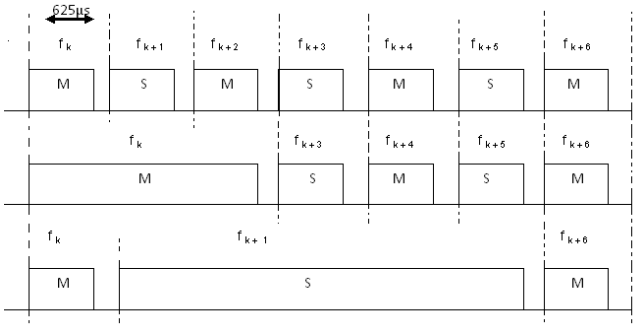

Figure 6

Single-slot packets can achieve a maximum data rate of 172Kbps, while a 5 slot , one multi slot frame will support a 721kbps rate.

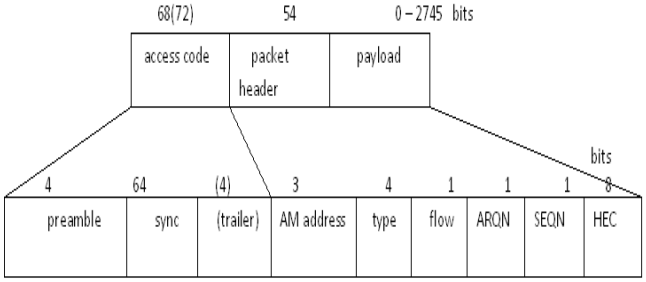

Figure 7

Figure 7 shows the components of a BT. The packet consist of 3 fields namely :

- *Access code ,*
- *packet header and*
- *payload.*

ACCESS CODE :

It consists of a **4**bit Preamble , **a Synchronization field ,and a trailer**. The 64bit synchronization field is derived from the lower 24 bit of an address **(lower address part LAP)**. If the access code is used for channel access – transmission between a master and slave or vice versa, the LAP is derived from the master's globally unique 48 – bit address. To discover other devices in transmission range BT uses a special reserved LAP.

PACKET HEADER :

It contains the typical layer 2 features: **address, packet type, flow & error control, and checksum**. The 3 bit **active member (AM)** address represents the active address of a slave. It is temporarily assigned to slave in a piconet When a master sends data to the slave, the address is interpreted as receiver address. When a slave sends data to a master, it is considered as the sender address. Everything works well as long as one master communicates with the slave. Seven addresses may be used as follows:

The zero – value is reserved for broadcast from the master to all the slave.

The 4 - bit **type** field determines the type of packet.

Packet may carry synchronous , asynchronous or control data.

A simple flow control mechanism for asynchronous for traffic uses the 1 – bit flow field.

- If packet received with flow = 0, asynchronous data transmission stops.
- If flow = 1, transmission resumes.
- To acknowledge the packets (if required) BT sends this in slot following the data

A single bit alternating protocol **SEQN (sequence number)** and **ARQN (acknowledgement number)** can be used.

An 8 – bit **header error check (HEC)** is used to protect the packet header. It is also protected by 1/3 rate **forward error correction (FEC)** code.

PAYLOAD **:**

Up to 343 bytes payload can be transferred.

Its structure greatly depends on the type of link used.

Security:

A radio interface is by nature easy to access. BT devices are used to transmit private data. A user never likes eavesdrop of data transfer by another person. Thus, let us about the various security features offered by BT:

BT is an open source and may face some security problems. It offers mode level, device level and service level security. Under modes of security it offers us with 3 modes:

- **Mode1** - non – secure;
- **Mode2** – service level enforced security;
- **Mode3** – link level enforced security.

These modes of each and every product is decided by the manufacturer.

Under Device level security we have 2 levels o f security:

1. trusted device,
2. un trusted device.

Under services we have 3 levels: the services may require –

1. Authorization and Authentication or
2. Authentication only or
3. Open to all devices.

It is up to the user to choose the right security feature to keep their data secured, since it is vulnerable to attacks. **Listed below are some of the security recommendations and precautions for the usage of BT:**

- Enable BT functionality only when needed.
- Make devices visible or discoverable if and only if required.
- Maintain physical control of devices at all times.
- Independently monitor devices and links for unauthorized BT activity.
- Never choose commercial BT headsets.
- Keep anti–virus software up to date , use device firewalls.
- Abide with all applicable directives, policies, regulations and guidance.

CONCLUSION:

BT, a wireless technology plays a vital role in the fields of Computer Science and Telecommunications. It had replaced the wired connection between electronic devices like cellular phones, computers, laptops, PDAs and many other devices. The highlight of this technology is that, the creation of networks. With BT technology it is possible to form different LAN with relatively great speed of transmission. Another advantage of this technology is , easy manipulation and configuration of networks and sub-networks within the same space.

As we know that "every coin has two sides" , this technology has its drawbacks also due to its limited scope.

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