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Intervention of Bluetooth with WLAN and WiMAX

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Abstract

Bluetooth technology unplugs the digital peripherals and comes as cable replacement technology. IEEE 802.11 and Bluetooth are two operating in the unlicensed 2.4 GHz frequency. WiMAX is operating both licensed and unlicensed frequencies (2-11GHz). The devices equipped with IEEE 802.11 and Bluetooth are mobiles, laptops, watches and many more and in future with WiMAX. Result is the number of co-located devices may cause interference issues in the 2.4 GHz radio frequency spectrum. Bluetooth supports both voice (SCO) and data (ACL) packets. In ACL, there is retransmission of packet if it is lost while transmitting but in SCO there is no retransmission of packet. So, retransmission is big issue in Bluetooth. In this thesis, these interference issues are investigated and implement a new Bluetooth voice packet named synchronous connection-oriented with Repeated Transmission (SCORT) with WLAN interference and WiMAX interference to study the improvement in performance by using MATLAB Simulink. SCORT technique also helps in reducing co-existing interference by using HV3 type of packet in voice signal. By this technique BER does not effect at all and very minimal delay comes due to retransmission.

Index terms— CVSD, GFSK, ARQ, HEC, BER, CRC, SCO, ACL, SCORT.

1 Introduction

ireless technology allows us to connect with people around the world and delivers lifechanging services to global communities that heal, educate, empower, and delight. Wireless communication enables anywhere, anytime, mobilizing the rapid transfer of information and services over immense distances, unbound by geographic barriers. Wireless technology has been at the forefront of a technological revolution that has materially improved the lives of many people. A wireless device continues to expand and the development of mobile technology continues to improve the society beyond what we can currently imagine. We switch to wireless from wired communication because cost of wired link will be much higher compared to the Antenna cost of wireless link. With the help of wireless technology like Bluetooth, WI-Fi, WiMAX, device can communicate directly with the mobile phones without having wires plugged in. In short these are Cable-replacement technologies. Bluetooth has less data rate and WiMAX has maximum data rate and high bandwidth is used. Bluetooth is an application that allows mobile devices to transmit data over short distances and creating PANs (Personal Area Networks) with high levels of security. Bluetooth technology has Author ? ? : M.Tech Ece, Lovely Professional University Phagwara, India. E-mails : pnkjgarg5@gmail.com, ruby.vrma5@gmail.com enabled people to free their hands. For example, Bluetooth headsets with cell phones make enable that people can talk without having to hold the phone up to their ear. Bluetooth is widely available to most people because of the relatively low cost of the technology and ease in implementation. Bluetooth technology is also important because of its mobility.

2 a) Bluetooth

Bluetooth technology is a short-range communications technology that is simple, secure. It is replacing the cables connecting devices, while maintaining high levels of security. The key features of Bluetooth technology are

robustness, low power, and low cost. When two Bluetooth enabled devices connect to each other, this is called pairing. It is operation on unlicensed industrial, scientific and medical (ISM)band at 2.4 to 2.48GHz, using a spread spectrum, frequency hopping, full-duplex signal at up to 1600 hops/sec [1]. The signal hops among 79 frequencies at 1MHz. The Bluetooth Specification defines a short (10 meter) or optionally a medium range(100 meter) radio link capable of voice or data transmission to a maximum capacity of720 kbps per channel (with a gross throughput of 1Mbit/sec) **??** Bluetooth Specification a) Synchronous Connection Oriented (Sco) Link [3,4] SCO is used for voice transmission of Bluetooth. The SCO link is a symmetric point to point voice link for sending and receiving voice packets at regular intervals of time. Bluetooth can support a maximum of up to three voice calls at the same time. It is generally only used for audio connections. Due to the isochronous (time dependant) nature of audio-data, and the unpleasant sound of delays in conversations, this method is generally to be preferred in duplex (two-way) audio communication. A Bluetooth audio connection transfers data at 64 kb/s and supports audio frequencies of up to 4 kHz; this is sufficient for speech, but not for music or other signals requiring higher frequencies. The SCO is circuit-switched connection between the master and the slave. The packets are used a CRC and are never retransmitted [5]. It uses different types of packet which are given below-HV1 packet: HV stands for high-quality voice. The HV1 packet carries 10 information bytes, which are protected with a rate 1/3 FEC. This packet has to be sent every two time slots and can support 1.25ms of speech at a 64Kb/s rate.

HV2 packet: This packet carries 20 information bytes, which are protected with a rate 2/3 FEC. This packet has to be sent every four time slots.

HV3 packet: This packet carries 30 information bytes, which are not protected. This packet has to be sent every six time slots.

DV packet: The DV packet is a combined datavoice packet. The payload is divided into a voice field of 80 bits and a data field of up to 150 bits. b) Asynchronous Connection Less (Acl) Link [3,4] Bluetooth data transmission is called ACL. If an error occurs, those packets must be transmitted again. In the case of ACL transmission, the system will wait for acknowledgement from the receiver. It will send the packets repeatedly till an acknowledgement is received. The receiver will check the packet and verify the cyclic redundancy code (CRC) to make sure that the packet is received correctly. The ACL link provides a packetswitched connection between the master and all active slaves in the piconet. The specifications define 7 kinds of ACL packets, three DM (data-medium rate) packets, three DH (data-high rate) packets and one AUX Pocket [6].

DM: These packets are coded with a rate 2/3 FEC. They contain a 16-bit CRC code and are retransmitted if no acknowledgement is received. Three DM packets have been defined, DM1, DM3 and DM5, which cover 1, 3 and 5 time-slots respectively.

DH: These packets are similar to the DM packets, except that the information in the payload is not FEC encoded. Similar to the DM packets, three DH packets (DH1, DH3 and DH5) have also been defined.

AUX: This packet is like a DH1 packet, but has no CRC code and is not retransmitted.

3 c) Scort

Synchronous connection oriented with retransmission (SCORT) is proposed technique used in retransmission of voice signal in Bluetooth. In SCO connection there is no retransmission process if data is failed. SCO is used to send the voice signal to other terminals. In SCORT we can send three packets at a time, if one packet fails due to bad hop then second packet will transmit in SCO interval. In SCORT technique, it is synchronized the transmitter and receiver through ARQN. The 1-bit acknowledgment indications ARQN is used to inform the source of a successful transfer of payload data with CRC, and can be positive acknowledge ACK or negative acknowledge NAK. If the returned, otherwise a NAK (ARQN=0) is returned. This provides an improvement for frame-error rate (FER) in an interference scenario. It does not affect the BER of the payload [7].

4 III.

5 Bluetooth Simulation

This section deals with Bluetooth's transmitter, receiver and channel interference which is created by WLAN and WiMAX at 2.4 GHz of frequency bandwidth because Bluetooth works at 2.4 GHz band. It is unlicensed band of frequency so, that's why lots of interference is there. Transmitter has CVSD encoder, upsampler, GFSK modulator, Frequency hopping, FEC, and HEC with CRC generator. Channel consists of AWGN noise with WLAN and WIMAX interference Receiver consists of GFSK demodulator, frequency hopping, access code checker, header information detector, switch, FEC, CVSD decoder and downsampler.

6 a) Transmitter

Bluetooth has one transmitter which is called master transmitter which may master of a piconet or scatter net. It consists of CVSD encoder which encodes the voice signal [8]. CVSD is linear delta modulation with the addition of an adaptive step-size. By adjusting or adapting the step-size to the changes in slope of the input signal, the encoder is able to represent lowfrequency signals with greater accuracy without sacrificing as much performance due to slope overload at higher frequencies. Each input sample is compared to the reference sample. If the input

sample is larger, the encoder emits a 1 bit and adds the step size to the reference sample. If the input sample is smaller, the encoder emits a 0 bit and subtracts the step size from the reference sample. The GFSK modulation used in the Bluetooth system is a type of binary partial response continuous phase modulation. It is a slight generalization of the GMSK modulation [9] used in the GSM cellular system. In Bluetooth every data bit is transmitted over two symbol intervals, causing inter symbol interference but reducing the required bandwidth. The 366 data bits are transmitted at 1 Mbps. Frequency hopping devices have an inherent level of robustness due to the fact that they do not continually transmit at the same frequency. Bluetooth technology's adaptive frequency hopping (AFH) capability was designed to reduce interference between wireless technologies sharing the 2.4 GHz spectrum. AFH works within the spectrum to take advantage of the available frequency [10]. This adaptive hopping among 79 frequencies at 1 MHz intervals gives a high degree of interference immunity and also allows for more efficient transmission within the spectrum. ii. Wi-Fi Interference Wi-Fi and Bluetooth both occupy a section of the 2.4 GHz ISM band. Bluetooth uses Frequency Hopping Spread Spectrum (FHSS) and is allowed to hop between 79 different 1 MHz-wide channels in this band. Wi-Fi uses Direct Sequence Spread Spectrum (DSSS) instead of FHSS. Its carrier does not hop or change frequency and remains cantered on one channel that is 22 MHz-wide. While there is room for 11 overlapping channels in this 83 MHz-wide band, there is only room for three non-overlapping channels. Thus there can be no more than three different Wi-Fi networks operating in close proximity to one another. When a Bluetooth radio and a Wi-Fi radio are operating in the same area, the single 22 MHz-wide Wi-Fi channel occupies the same frequency space as 22 of the 79 Bluetooth channels which are 1 MHz wide. When a Bluetooth transmission occurs on a frequency that lies within the frequency space occupied by a simultaneous Wi-Fi transmission, some level of interference can occur, depending on the strength of each signal [11].

iii. Wimax Interference Wireless network technology hasan impact in communications: 802.16, better known as Wi-MAX. This technology supports speeds as high as 70Mbps and a range of up to 48 kilometres. WiMAX can be used for Wireless networking like the popular Wi-Fi. WiMAX allows higher data rates over longer distances, efficient use of bandwidth, and avoids interference almost to a minimum. WiMAX can be termed partially a successor to the Wi-Fi protocol. WiMAX operates in a mixture oflicensed and unlicensed bands. The unlicensed bands are typically the 2.4 GHz and 5.8 GHz bands. Licensed spectrum provides operators control over the usage of the band, allowing them to build a high-quality network. The unlicensed band, on the other hand, allows independents to provide backhaul services for hotspots. When frequency bands of 22 MHz of WiMAX is present with channel of Bluetooth then it also causes interference. Being a packet-based system, WiMAX transmission can be characterized as bursts of activity at a Poisson rate [12].

7 c) Receiver

Master slave who receives RF signal and demodulate through GFSK demodulator after despreader signal through frequency hopping. After demodulating signal exact 366 bits are coming out in which 72 bits are access code, 54 bits of header information and 240 bits of payload are de-frame. An access code checker checks whether the bits are correct or not. For checking these bits, total 57 bits are checked of access code starting from 5 to 62. For header information, checks whether information is coming is equal as transmitted signal and after that derepeat the header information then only 18 bits are left in which 8 bits of CRC and 10 bits of header information is extracted. After that a switch is connected which selects whether payload will pass or not. Then un-buffer is used and CVSD decoder is used which decodes the signal and down-sampler is used to down-sample the signals. Through SCORT, retransmission as well coexistence interference is reduced because it does not effect on BER.

IV.

8 Result and Conclusion

Bluetooth model is working on Matlab Simulink where voice signal is send through SCO link and for data signal is send through ACL link.

These are following graph of spectrum of signal which shows the power spectrum density of signal of Bluetooth. Figure **??** shows that spectrum of signal before modulation. It contains access code, header information and payload data. The graph contains a frame of data with frequency in x axis is auto and in y axis maximum magnitude is -52.6 db.

Figure **??** shows spectrum of signal after modulation. When data is going to modulate and adding of frequency hopping spread spectrum then data spreads a little due to frequency hopping. Figure **??** shows the spectrum in which AWGN noise is added. Figure **??** shows that signal after demodulator block. This spectrum shows that signal after demodulation and frequency hopping block. In this graph noisy signal is demodulated and extraction of frequency hopping is done. Only 366 bits are coming out per frame after demodulation block and figure 8 shows the BER of signal from the value of SNR 0 to 20. For unlicensed frequency bandwidth of 2.4GHz, Bluetooth works on it and WLAN and also Wi-MAX cause interference. After demodulation exactly 366 bits are coming out which consists of 72 bits of access code, 54 bits of header information and 240 bits of payload. After de-framing the header, access code and payload, header and access code is checked whether the data received is correct or not. If data which is received at receiver side does not contain ARQ then it enables a technique SCORT. With the help of SCORT technique receiver automatically tells the transmitter With the help of SCORT

techniques, interference issues will reduce but it also causes the power issue and very little delay of receiving a data. If power is used in Bluetooth is more, then interference issues and noise will less. So, in future if power management scheme is implemented with SCORT technique it will benefit in future. For delay in received signals, time computation algorithm is also added.

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Figure 1: W © 2013

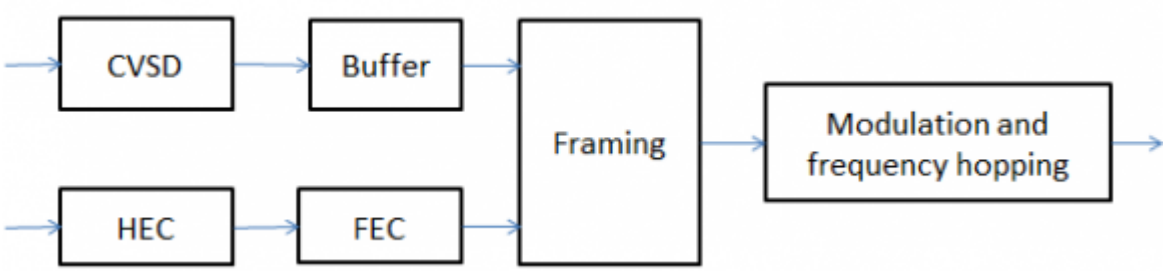
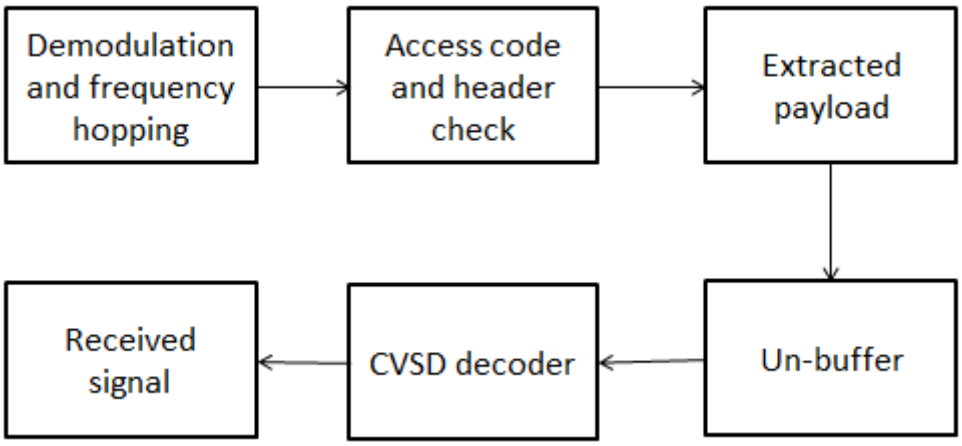
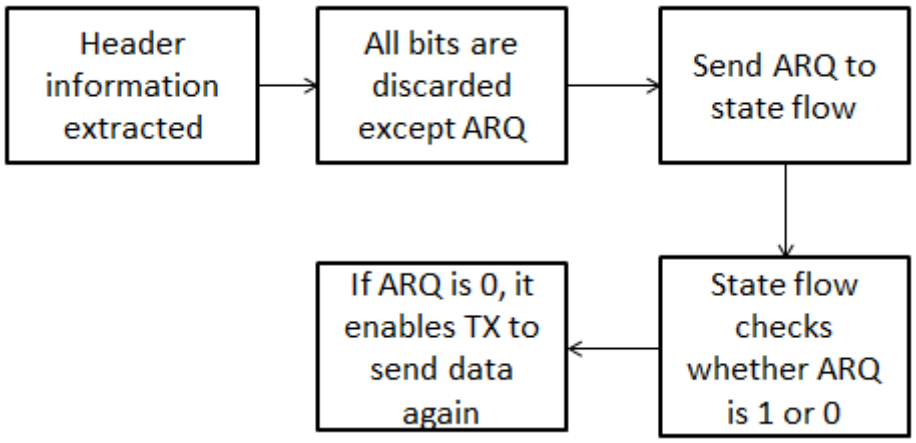


Figure 2: E



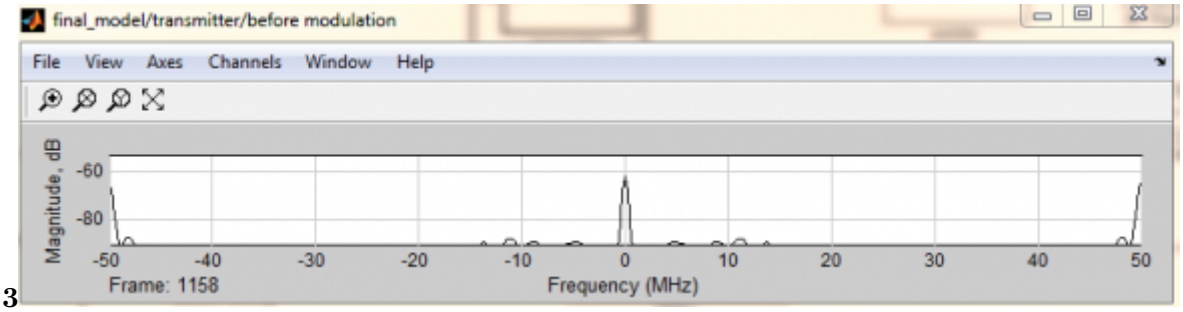
1

Figure 3: Figure 1 :



2

Figure 4: Figure 2 :



3

Figure 5: Figure 3 :

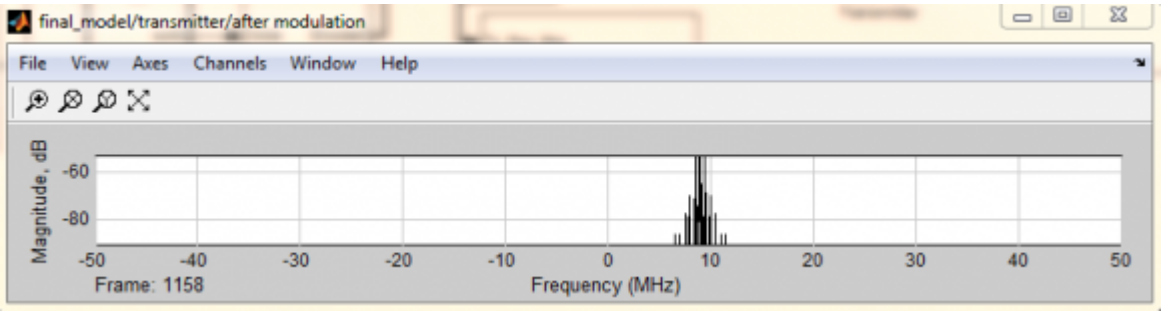


Figure 6: Figure 4 :Figure 5 :

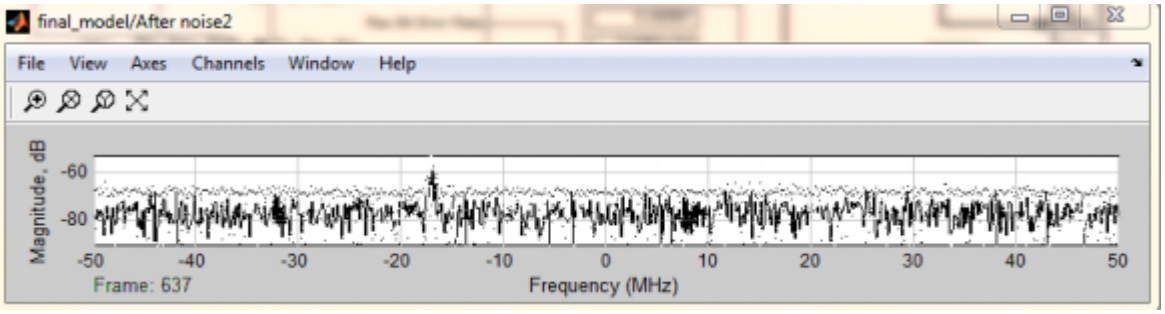


Figure 7: Figure 6 :Figure 7 :

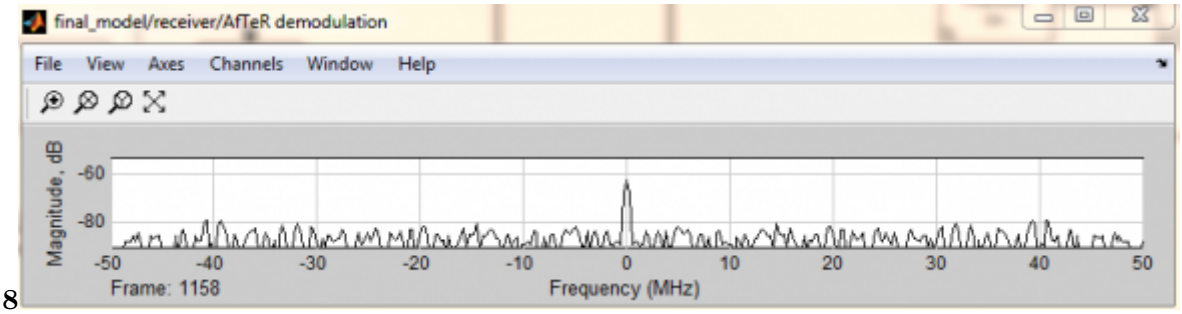


Figure 8: Figure 8 :

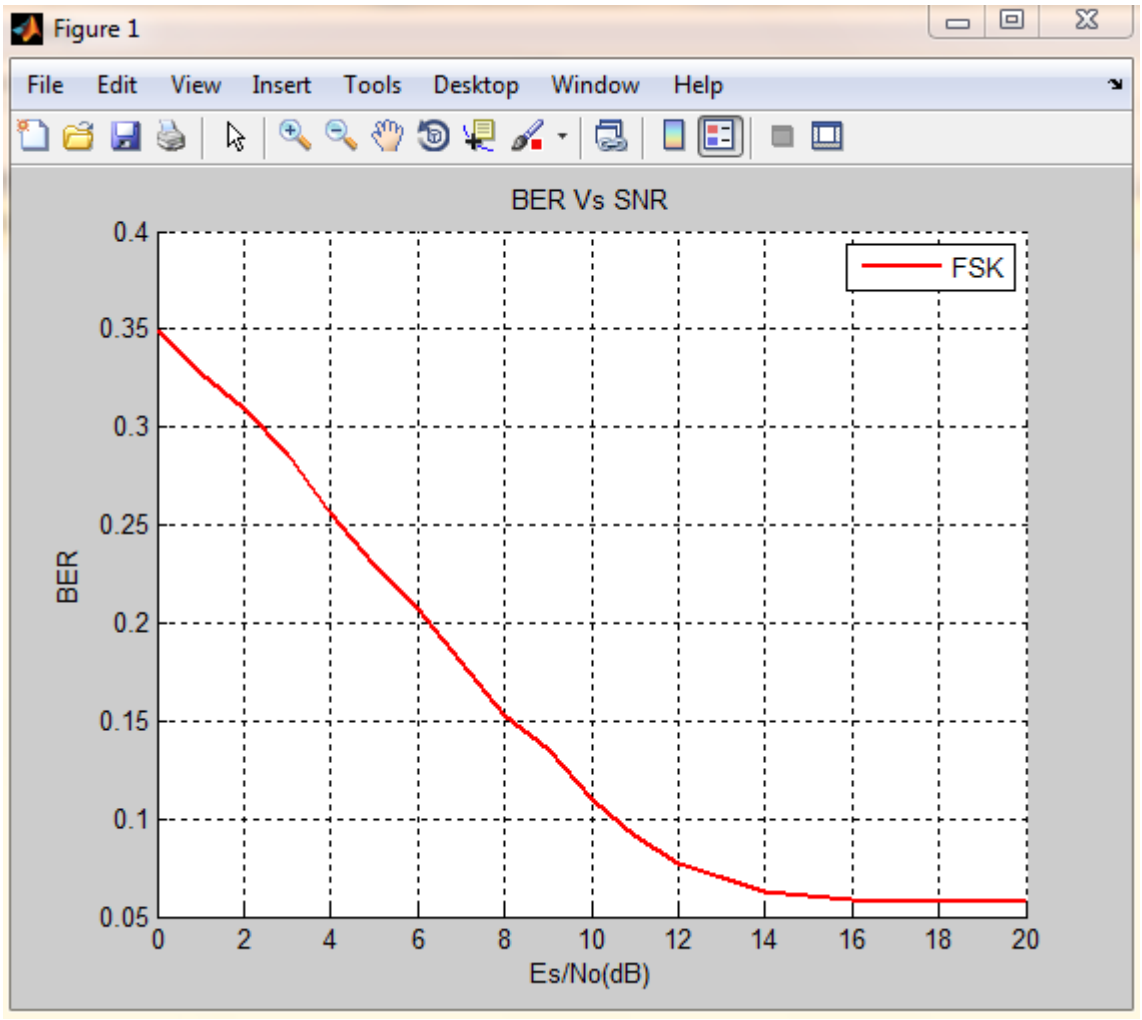


Figure 9: E

Table1 : Bluetooth Versions

Version	Data rate
Version 1.2	1Mbps
Version 2.1+EDR	3Mbps
Version 3.0+HS	24Mbps
Version 4.0 EDR+HS+LE	24Mbps

II.

Figure 10:

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