# Multimedia Issues Over Bluetooth (Video Streaming)

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# Abstract

In this new era wireless ad hoc networks have become a growing area of research. The arrival of Bluetooth wireless technology makes it possible to transmit real-time video/audio in mobile and permeate environments. Multimedia content has become more accessible to mobile phone devices increasing the demand for multimedia services. Streaming video to or from mobile phones over mobile phone operator networks is one option. However, current Bluetooth network is not much suitable for traditional media encoding and real-time transmission due to limited bandwidth, high degree of error rates, and the time-varying nature of the radio link. Therefore video streaming over Bluetooth poses many challenges. In our research we analyzed the performance of Bluetooth video streaming in piconet architecture. Using NS2 simulation tool with the UCBT patch for Bluetooth, the optimal data size and distance along for a piconet with 7 slaves was detected for the intermediate protocol L2CAP. Then performance was analyzed based on Wi-Fi interference and compression techniques.

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## 1) **Introduction**

Bluetooth is a wireless technology standard for exchanging data over short distances (using short-wavelength radio transmissions in the ISM band from 2400–2480 MHz) from fixed and mobile devices, creating personal area networks (PANs) with high levels of security. Created by telecom vendor Ericsson in 1994, it was originally conceived as a wireless alternative to RS-232 data cables. It can connect several devices, overcoming problems of synchronization.

Bluetooth is managed by the Bluetooth Special Interest Group, which has more than 19,000 member companies in the areas of telecommunication, computing, networking, and consumer electronics, Bluetooth was standardized as IEEE 802.15.1, but the standard is no longer maintained. The SIG oversees the development of the specification, manages the qualification program, and protects the trademarks.

*HaraldBlåtand* was King of Denmark from approximately A.D. 940 to 985. During his reign King Harald is reported to have united Denmark and Norway and to have brought Christianity to Scandinavia. Apparently "Blåtand" translates, at least loosely, to "Blue Tooth." The origins of this name are uncertain, although it was relatively common during this time for kings to have a distinguishing name. (Some histories say that the name is attributed to Harald's dark complexion; some accounts even indicate that King Harald was known for teeth of a bluish hue resulting from his fondness for blueberries, although this is probably folklore.) For a technology with its origins in Scandinavia, it seemed appropriate to the SIG founders to name the organization that was intended to unify multinational companies after a Scandinavian king who united countries. Thus was born the Bluetooth name, which initially was an unofficial code name for the project but today has become the trademark name (see footnote 1 on page 3) of the technology and the SIG.

## 2)Applications of Bluetooth

Fig 1:- Bluetooth mobile phone headset

- Wireless control of and communication between a mobile phone and a hands free headset. This was one of the earliest applications to become popular.
- Wireless control of and communication between a mobile phone and a Bluetooth compatible car stereo system.
- Wireless Bluetooth headset and Intercom.
- Wireless networking between PCs in a confined space and where little bandwidth is required.
- Wireless communication with PC input and output devices, the most common being the mouse, keyboard and printer.
- Transfer of files, contact details, calendar appointments, and reminders between devices with OBEX.
- Replacement of previous wired RS-232 serial communications in test equipment, GPS receivers, medical equipment, bar code scanners, and traffic control devices.

- For controls where infrared was often used.
- For low bandwidth applications where higher USB bandwidth is not required and cable-free connection desired.
- Sending small advertisements from Bluetooth-enabled advertising hoardings to other, discoverable, Bluetooth devices.
- Wireless bridge between two Industrial Ethernet (e.g., PROFINET) networks.
- Three seventh and eighth generation game consoles, Nintendo's Wii. and Sony's PlayStation 3, PSP Go and PS Vita, use Bluetooth for their respective wireless controllers.
- Dial-up internet access on personal computers or PDAs using a data-capable mobile phone as a wireless modem.
- Short range transmission of health sensor data from medical devices to mobile phone, set-top box or dedicated telehealth devices.
- Allowing a DECTphone to ring and answer calls on behalf of a nearby mobile phone.
- Real-time location systems (RTLS), are used to track and identify the location of objects in real-time using “Nodes” or “tags” attached to, or embedded in the objects tracked, and “Readers” that receive and process the wireless signals from these tags to determine their locations.
- Personal security application on mobile phones for prevention of theft or loss of items. The protected item has a Bluetooth marker (e.g. a tag) that is in constant communication with the phone. If the connection is broken (the marker is out of range of the phone) then an alarm is raised. This can also be used as a man overboard alarm. A product using this technology has been available since 2009.

- Calgary, Alberta, Canada's Roads Traffic division uses data collected from travelers' Bluetooth devices to predict travel times and road congestion for motorists.

## 3)Bluetooth Operation

### 3.1 How it works

Bluetooth technology is a short-range wireless communications technology to replace the cables connecting electronic devices, allowing a person to have a phone conversation via a headset, use a wireless mouse and synchronize information from a mobile phone to a PC, all using the same core system.

The Bluetooth RF transceiver (or physical layer) operates in the unlicensed ISM band centered at 2.4 gigahertz (the same range of frequencies used by microwaves and Wi-Fi). The core system employs a frequency-hopping transceiver to combat interference and fading.

Bluetooth devices are managed using an RF topology known as a "star topology." A group of devices synchronized in this fashion forms a piconet, which may contain one master and up to seven active slaves, with additional slaves that are not actively participating in the network. (A given device may also be part of one or more piconets, either as a master or as a slave.) In a piconet, the physical radio channel is shared by a group of devices that are synchronized to a common clock and frequency-hopping pattern, with the master device providing the synchronization references.

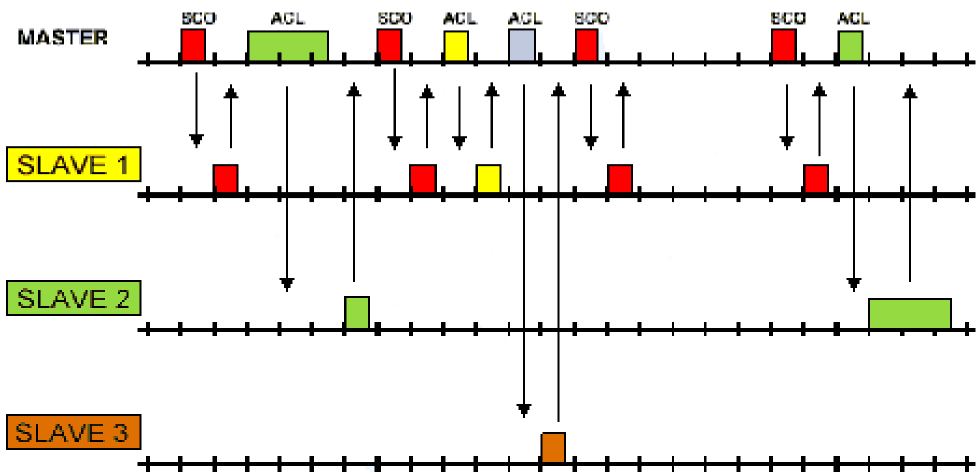


Fig 2:- Master and slave operation

Let's say the master device is your mobile phone. All of the other devices in your piconet are known as slaves. This could include your headset, GPS receiver, MP3 player, car stereo, and so on.

Devices in a piconet use a specific frequency-hopping pattern, which is algorithmically determined by the master device. The basic hopping pattern is a pseudorandom ordering of the 79 frequencies in the ISM band. The hopping pattern may be adapted to exclude a portion of the frequencies that are used by interfering devices. The adaptive hopping technique improves Bluetooth technology's coexistence with static (no hopping) ISM systems, such as Wi-Fi networks, when these are located in the vicinity of a piconet.

The physical channel (or the wireless link) is subdivided into time units known as slots. Data is transmitted between Bluetooth-enabled devices in packets that are positioned in these slots. Frequency hopping takes place between the transmission or reception of packets, so the packets that make up one transmission may be sent over different frequencies within the ISM band.

The physical channel is also used as a transport for one or more logical links that support synchronous and asynchronous traffic as well as broadcast traffic. Each type of link has a specific use. For instance, synchronous traffic is used to carry hands-free audio data, while asynchronous traffic may carry other forms of data that can withstand more variability in the timing for delivery, such as printing a file or synchronizing your calendar between your phone and computer.

### 3.2 How Bluetooth detects other devices

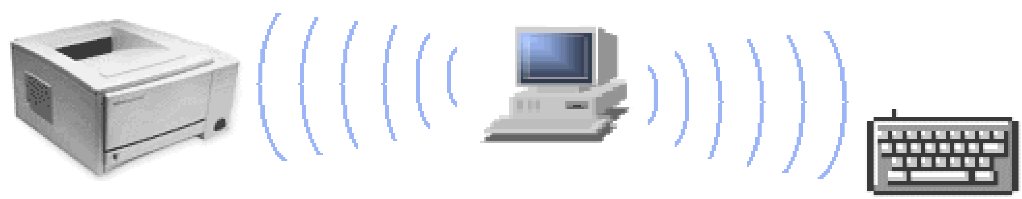

Fig 3:-Nearby device detection

### Creating a Piconet

A piconet can be created in one of 4 ways:

1. A page (used by Master to connect to Slave)
2. A page scan (a unit listens for its´ device access code)
3. A Master – Slave switch is made

4. An ”Unpark” of a unit is made (provided there are no active slaves).

In order to establish new connections the procedures inquiry and paging are used. The inquiry procedure enables a unit to discover which units are in range, and what their device addresses and clocks are. With the paging proce-dure, an actual connection can be established. Only the Bluetooth device address is required to set up a connection. Knowledge about the clock will accelerate the setup procedure. A unit that establishes a connection will carry out a page procedure and will automatically become the master of the connection.

For the paging process, several paging schemes can be applied. There is one mandatory paging scheme which has to be supported by each Bluetooth device. This mandatory scheme is used when units meet for the first time, and in case the paging process directly follows the inquiry process. Two units, once connected using a mandatory paging/scanning scheme, may agree on an optional paging/scanning scheme.

Fig 4:- Mobile and Bluetooth device

### The Connection Establishment

After the paging procedure, the master must poll the slave by sending POLL or NULL packets, to which the slave responds. LMP procedures that do not require any interactions between the LM and the host at the paged unit's side can then be carried out. When the paging device wishes to create a connection involving layers above LM, it sends LMP_host_connection_req. When the other side receives this message, the host is informed about the incoming connection. The remote device can accept or reject the connection request by sending LMP_accepted or LMP_not_accepted.

When a device does not require any further link set-up procedures, it will send LMP_setup_complete. The device will still respond to requests from the other device. When the other device is also ready with link set-up, it will send LMP_setup_complete. After this, the first packet on a logical channel different from LMP can then be transmitted.

## 4) Video Streaming over Bluetooth

### 4.1Intermediate Protocols

**HCI**:

HCI stands for Host Controller Interface. The HCI provides a uniform interface method of accessing the Bluetooth hardware capabilities.

**Use**:

1. Provides a brief overview of the lower layers of the Bluetooth software stack and of the Bluetooth hardware.

2. Provides an overview of the lower HCI Device Driver Interface on the host device.
3. Describes the flow control used between the Host and the Host Controller.
4. Describes each of the HCI commands in details, identifies parameters for each of the commands, and lists events associated with each command.

**L2CAP**:

The Logical Link Control and Adaptation Protocol (L2CAP) takes data from the higher layers of the Bluetooth stack and from applications and sends it over the lower layers of the stack. L2CAP passes packets either to the Host Controller Interface (HCI), or in a host-less system, L2CAP passes packets directly to the Link Manager.

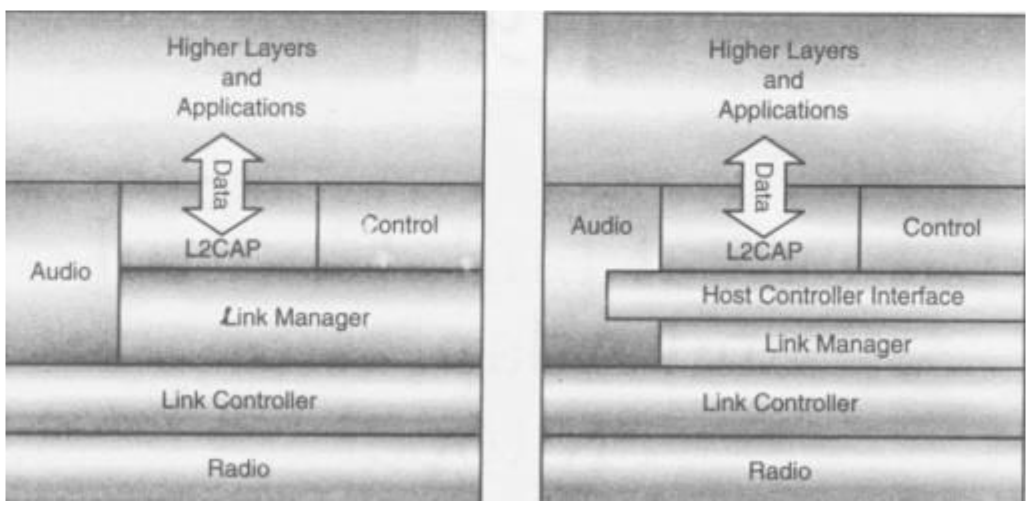


Fig 5 :- Bluetooth protocol architecture

**USE**:

1. Multiplexing between different higher layer protocols, allowing them to share lower layer links.
2. Segmentation and reassembly to allow transfer of larger packets than lower layers support.
3. Group management, providing one-way transmission to a group of other Bluetooth devices.
4. Quality of service management for higher layer protocols.

**BNEP**:

BNEP stands for Bluetooth Network Encapsulation Protocol.

**USE**:

1. Used for transporting both control and data packet over Bluetooth to provide networking capabilities for Bluetooth devices.
2. Provides capabilities that are similar to capabilities provided by Ethernet (EthernetII/ DIX Framing / IEEE 802.3).

**RFCOMM**:

RFCOMM stands for Radio frequency communication**.** The Bluetooth protocol RFCOMM is a simple set of transport protocols, made on top of the L2CAP protocol, providing emulated RS-232serial ports (up to sixty simultaneous connections to a Bluetooth device at a time). The protocol is based on the ETSI standard TS 07.10.

RFCOMM is sometimes called *serial port emulation*. The Bluetooth *serial port profile* is based on this protocol.

Basically two device types exist that RFCOMM must accommodate. Type 1 devices are communication end points such as computers and printers. Type 2 devices are those that are part of the communication segment; e.g. modems. Though RFCOMM does not make a distinction between these two device types in the protocol, accommodating both types of devices impacts the RFCOMM protocol.

**USE**:

1. RFCOMM is used to transport the user data, modem control signals and configuration commands.
2. The RFCOMM protocol provides emulation of serial ports over the L2CAP protocol.
3. The RFCOMM protocol supports up to 60 simultaneous connections between two BT devices.
4. RFCOMM Is only concerned with the connection between the devices in the direct connect case, or between the device and a modem in the network case.

## 5)Current research works on video streaming over Bluetooth

There have been surveys on video streaming over Bluetooth based on QoS mechanisms ,protocols and various video compression techniques.A number of simulation has been done based on various intermediate protocols in a point-to-point environment. A few field studies based on various protocols have been done.

Thus we have chosen to research on video streaming over Bluetooth inapiconet environment.

**Issues**

- QoS Control
- Intermediate Protocols
- Video compression
- Limited bandwidth
- High degree of error rate
- Time varying nature of radio link
- Interference with other devices
- Limited computational capacity

**Solution**

- Providing improved error resilience
- Improved coding efficiency
- Flexibility in assigning computational resources.
- Providing Intelligent QoScontrol.

## 5.1 Video Streaming over different protocols

Taking various factors into account L2CAP and IP appear to be feasible intermediate layers for streaming over Bluetooth.

**Table 1. Comparison of streaming via different protocols**

| | HCI | L2CAP | IP |
|---|---|---|---|
| Logical OSI Layer | Link | Link | Network |
| Implementation Complexity | High | Medium | Low |
| Modified Part | Hardware | Software | Software |
| Segmentation and Reassembly Support | No | Yes | Yes |
| Point-to-Multipoint Support | No | Yes | Yes |
| BT Profile | N.A. | AVDTP | LAP or BNEP |
| Encapsulation Overhead [1] | RTP | L2CAP+ AVDTP+ RTP | L2CAP+ LAP /BNEP+IP+UDP+ RTP |

## 6)QoS Control

The goal of QoS control is to avoid congestion and maximize video quality in the presence of packet loss.

### 6.1 Error Control

There are many potential reasons including out-of-range devices, interface with other devices or external sources that make Bluetooth links have a high degree of error rates. Recent work on this area study the adoption of error control mechanisms including link layer and upper layer FEC,retransmission,error-resilient encoding and error concealment to facilitate error control for streaming over Bluetooth links.

**1) Link Layer FEC and ARQ**

According to Wang (2008), Bluetooth ACL link provides three built-in baseband error correction technique mainly 1/3 rate FEC, 2/3 rate FEC, andARQ.The 1/3 rate FEC scheme is adopted in the header of L2CAP packets; this scheme simply repeats the same bit thrice. The other two error correction techniques are applied to the payload. The principle of FEC is to add redundant information to original message so that it can be reconstructed in the presence of packet loss. The FEC methods are designed to reduce the chances of getting corrupted information and in turn reduce the number of retransmissions. It is widely known that FEC is suited for real-time communications. But varying channel conditions limit its effective use, since a worst-case design may lead to a large amount of overhead, which makes it generally used in relatively error-free environments.

Automatic Repeat Request (ARQ) is a kind of basic delay-constrained retransmission mechanism that is usually dismissed as a method to recover lost packets in real-time video since a retransmitted packet may miss its play-out time.ARQ incurs less overhead than FEC,but is correspondingly less effective, lacking any inability to correct errors. The ARQ scheme requires that header error and CRC are correct, when they are, ACK is sent. If the transmitter does not receive an ACK it resends the data after a predefined time.

Bluetooth built-in error control mechanisms are designed for general data transmission. The methods discussed in following sections adapt them for real-time streaming over Bluetooth links.

**2) Upper Layer FEC**

Wang's (2008) study found the following:

The link layer FEC is intended to limit the number of retransmissions needed in the presence of packet loss. However, this feature does not help much for significant burst. In addition the baseband FEC services are not selectable for each logical channel separately.

In the specification of AVDTP, it is proposed that an upper-layer FEC scheme that protects video packets directly in the transport layer. The benefit of the upper-layer recovery is to provide the means for applications to differentiate the protection according to the video packet types or contents. For instance, an application can decide to protect either video packets or audio packets depending on their respective error-resilience capability or limit the protection to some vulnerable parts of the stream.

AVDTP improves the Bluetooth link layer FEC scheme by separating the transmission of media packets and recovery packets into different logical channels (i.e. media channel and signaling channel).The AVDTP recovery service is based on the RTP payload format for generic FEC, which provides a specification of the packet format to be adopted for generation and encapsulation of the FEC recovery packets. It also mandates the procedures to be used for media packet reconstruction at the receiving side.

In order to provide the means to differentiate the protection according to the packets types or contents, AVDTP recovery modules use two channels for independently transmitting media packets and recovery packets. This recovery service operates independently of the other AVDTP services in a dedicated transport session. A brief recovery process is described as follows:

At the sender side the service is active on application demand through a specific interface. Recovery packets are generated from the set of media packets to be protected. Then the generated recovery packets  are automatically filled onto the associated recovery channel without intervention of media transmission. At the receiver side the service is directly triggered each time a missing media packet is detected in a protected transport session. The recovery service attempts to restore the missing packet using one or several subsequent recovery packets, which have the missing media packet in scope.(p. 4)

We believe that the separation of media and signaling channels provides a potential support for the differentiation of protection based on the media type and content, which could be further extended to exploit the semantic of packets to perform "priority-related FEC".

**3)Upper layer Retransmission (effect of link layer ARQ on the delay jitters of ACL)**

According  to Wang (2008)The delay of ACL link is attributed to two major reasons. One is the baseband contention caused by the multiple slaves competing time slot to communicate with a master. The other reason is bandwidth usage due to ARQ retransmission. The performance study suggests that native ARQ is a performance bottleneck in video transferring QoS control in this field. Cross-layer optimization approach to improve packet retransmission. The key idea is inspired by the famous “selective retransmission”. The novelty of this approach is to make link layer(L2CAP and HCI) aware of the application layer header information. The basic principle behind the scheme is the following. “If a given bandwidth reserved for a video flow allows each frame to be retransmitted a certain number of times on the average, and then the quality of video can be increased by increasing the number of times retransmitted and decreasing the number of times the dependent P/B frames are retransmitted”.

Having knowledge of the semantic priority of different types of MPEG frames, the selective retransmission scheme trades off the increase in reliable reception of I frames with a decrease of P/B frames. The previoussimulation results showed an improvement in video quality using this selective retransmission scheme compared to standard link-layer ARQ scheme of Bluetooth.

## Error Concealment

Error concealment is performed on the receiver side to conceal the lost data and make the video less displeasing to human. There are two basic approaches for error concealment spatial and temporal interpolation. In spatial interpolation missing pixel values are reconstructed using neighboring spatial information. Intemporal interpolation, the lost data is reconstructed from data in the previous frames.

### 1) Error -resilient Encoding

Error-resilient encoding enhancesthe robustness of compressed video to packet loss. The standardized error-resilient encoding scheme includes re-synchronization marking, data portioning, and data recovery.

M. Fahim Tariq et al proposed an error resilient implementation of the matching pursuits algorithm for H.263 video encoding over Bluetooth. The experiment shows that this strategy is superior in term of PSNR to build-in ARQ error correction scheme in the presence of baseband channel error.

**Possible Solution to control error**

- The simplest solution for protecting the video information is to use powerful error-correction coding, in order to improve the robustness against transmission errors.
- The idea is to use a video encoder and transport control software that can dynamically respond to the current conditions of the wireless connection between the Bluetooth devices.
- The goal is to gain the desired protocol responsiveness that deals with the frequent unexpected changes in grades of service.
- Cross layer approach ( interaction of application and data link layer) for adaptation and protect mechanisms.

## 6.2Congestion Control

Loss and delay have a negative effect on video presentation quality and they are often caused by the congestion in network. Thus, congestion control mechanisms are important in reducing packet loss and delay. This would dynamically adapt to the conditions of a connection between devices, using feedback to make necessary changes to transmission rate.

## Rate Control

Rate control is a technique used to determine the sending rate of video streaming traffic on the estimated available bandwidth. Existing rate control schemes can be classified into source-based and receiver-based control. Under the source-based rate control, the sender is responsible for adapting the video transmission rate. On the contrary, under receiver-based rate control, the receiver regulate rate of media streams by adding/dropping channels while the sender does not participate.

Wang (2008) discussed the recent which was conducted to provide adaptive sender based rate control for streaming over Bluetooth piconets and scatternets.In the streaming experiment over Bluetooth piconets, adaptation mechanism is based on an end-to-end periodic feedback that contains the number of packets received during the feedback interval. This feedback is used by streaming server to compute the RTP loss rates. Then media transmission rate is regulated using a min/max loss threshold. Below the minimum packet loss rate (5%) the server attempts to additively increase its rate. When loss rate is above the maximum loss threshold (15%) the server reduces the sending rate, choosing an appropriate rate among 48, 64, 80,128 and 256Kbps . The same experiment on Bluetooth and 802.11 shows that adaptive video streaming is better with Bluetooth than 802.11, in part because the polling schedule of Bluetooth seems to offer a more stable service.

This adaptive rate control scheme is further extended to Bluetooth scatternet environments, which is actually the interconnection of piconets.It is suggested that in Bluetooth scatternets,gateways effectively limit the capacity at a fraction of link layer data rate, while closed loop end-to-end adaptation can be effective in controlling congestion and improving user perceived QoS.This is attributed to the very controlled master centric polling MAC layer(i.e. ,L2CAP) in combination with the time invariant inter-piconet scheduling mechanism that Bluetooth employs.

## Rate Reservation

Resource reservation has been an extensively studied area for supporting timing critical applications such as VoIP and continuous media applications. In Bluetooth environment, when more media streams compete for the limited bandwidth at the same time, resource reservation, especially rate reservation could be very effective.

HCI is responsible for transmitting data between L2CAP and baseband; therefore rate reservation over Bluetooth can be implemented using HCI interfaces. Applications can request a specific transmission rate by an additional resource manager that controls the access to the network. The master can assign data rates to different streaming sessions by changing the poll interval of the connection with slaves. Because of the mobility and the dynamic behavior of Bluetooth devices, the resource manager continuously monitors the actual state of the network (reservations, traffic load, bit error rate etc).In case of too poor link quality, the resource manager could inform the application layer about the changes. The application layer could then adjust the video codec settings or decrease the data rate of other streaming sessions with lower priority.

## Focus on better QoS Control

Traditional QoS control over Internet is mainly implemented in application-layer or transport-layer, and multiple protocol layers often operate without knowledge of each other. On the other hand, Bluetooth mainly provides physical and link layer support. Efficient media streaming over Bluetooth requires higher layers operation be replaced with low layers processes as the fast response and low overhead of link layer make it an ideal place for QoScontrol.Therefore, the link layer of Bluetooth(i.e,L2CAP/HCI) need to be aware of higher layer information to make adaptation.

Among the various control schemes, Upper_LayerFEC, Upper-Layer retransmission and Rate Reservation require the interaction of link layer and application layer, thus they can be categorized into cross-layer approaches.

The idea of the cross-layer interaction has been proposed in the context of wireless networks. We believe that such techniques are very useful for QoS control over Bluetooth links.Currently, each network layer(i.e. physical layer, media access control,network,transport and application layers)provides a separate solution to these challenges by providing its own optimized adaptation and protect mechanisms.

## 7 )Video Compression

The aim of video compression is to remove redundant information from a digitized video sequence. It is critical to choose an appropriate compression method for use in video streaming over Bluetooth, as it provides time-varying wireless link with limited bandwidth up to 732Kbps.

This section briefly describes video compression techniques including MPEG-4 and H.263 that are used by current researches of this area.

## 7.1 MPEG-4

According to Ben Smith (2003)a  large portion of works reviewed in previous sections employ MPEG-4 as video codec for streaming over Bluetooth.

MPEG-4 is a video compression technique and allows much lower compression ratios comparing to other video compression technique.MPEG-4 is ideally suited to low bandwidth applications, exactly matching for video over a wireless Bluetooth network.

MPEG-4 uses motion vectors between frames to encode temporal redundancy and the discrete cosine transform (DCT) to encode spatial redundancy.MPEG-4 provides three modes for encoding an input, these are namely:

1) Intra-frame (I-frame) is encoded independently of any other frame and can be constructed without reference to any other frames.
2) Predicted-frame (P-frame) is predicted(using motion compensation) based on another previously decodedI-frame
3) Bidirectional Interpolated-frame (B-frame) is predicted based on past as well as future frames.

I-frame is used to enable reconstruction of all following B or P frames (until the next I-frame).The MPEG-4 video compression standard incorporates several error resilience tools to enable error detection, containment and concealment.MPEG-4 has a built-in packet technique where several macro blocks (a 16x16 pixel block) are grouped together such that there is no data dependency on the previous packet which helps in localizing the errors.

## 7.2 H.263

H.263 is a video compression algorithm and protocol which is standardized by ITU.It was designed for low bit-rate communication. It is a hybrid of inter-picture prediction to utilize temporal redundancy and transform coding of remaining signal to reduce spatial redundancy.H.263 allows users to scale the bandwidth usage and can achieve full motion video at low speeds. It also allows low-quality stream video at bandwidths as low as 20Kbps.However when compared to MPEG-4 , H.263 does not support features like compression efficiency and channel error robustness.

## 8 )Intelligent Video Bit-rate Control

Ben Smith (2003) suggested that a low level of error detection must be employed so that if the client receiving the compressed video stream detects an error then it can signal this error to the sender and appropriate action can be taken .In this case the bit-rate of the video can be lowered by the encoder, allowing error correction to increase and the lost data to be re-sent. This ensures the overall data-rate remains at a constant level to match the bandwidth of the Bluetooth connection. The existing MPEG-4 video compression technique has to be modified by extending it with ‘Quality of Service’ (QoS) transport control protocol software. The idea is that the transport control softwarewill be responsible for controlling the video compression and dynamically adapt to the network conditions. It should initially decide upon the network parameters by testing the data transmission rate of the Bluetooth link being used. It would then determine the maximum sending rate and hence the video compression bit-rate can be set so that it matches the network bandwidth for maximum efficiency and quality of streamed video. In case of total signal lost between the devices there should be a method for reconnection instead of total connection lost. Once the connection has been established the encoder can send a full I-frame to minimize any errors such as artefacts.When partial data loss occurs, the receiver can minimize the impact of this on the displayed video by using techniques such as image smoothing. This involves ‘guessing’ parts of an image that have been lost by using the surrounding blocks. With 8, 4 or 2 neighboring blocks received (see figure 5 below) the missing block can be recovered using spatial and temporal information from the other blocks. To improve the success of the error concealment scheme, the encoded video can be ‘block-shuffled’ into a random sequence. The idea here is that when the video is being transmitted the blocks are not sent in order so that any losses occurring will contain blocks that are scattered throughout the image. The receiver then has a higher chance of correctly guessing these missing blocks as they will have many surrounding blocks and localized losses are minimized .We can also can introduce a new block shuffling scheme to isolate erroneous blocks caused by packet losses.

# 9 )Our  Project

## 9.1Methodology

We have used ns2.28 and UCBT to create real time environments using L2CAP and RFCOMM protocols. First of all we have found the optimal data size for streaming by sending data packets at 10Kb,20Kband 30Kb.After a plotting a graph of data rate Vs. number of transmission 20Kb was found to be the optimal distance for streaming video over Bluetooth. A graph of time taken Vs. number of transmission was also plotted where 20Kb was roughly found to be the optimal data size for packets.

The optimal distance was then found to be around 4m by plotting a graph of data rate Vs. distance and time Vs.distance. Thirdly graphs of number of transmission Vs. data rate and number of transmission Vs. time taken in presence and absence of WiFi.The presence of Wi-Fi significantly reduced the data rate.

Lastly a comparison between MPEG-4 and H.263 video compression techniques was made. Graphs of PSNR Vs. Data rate were plotted. It was found that the MPEG-4 was the better compression in higher data rates and H.263 was the better compression in lower data rates.

## 9.2) Results and Analysis

### Case 1: Optimization of data size

The video streaming is done over Bluetoothand data is sent in the form of byte array over RFCOMMchannel. The size of data sent was fixed and data rates and timetaken for the transmission is compared with data size of 10Kb, 20Kb and 30Kb sent over the channel.

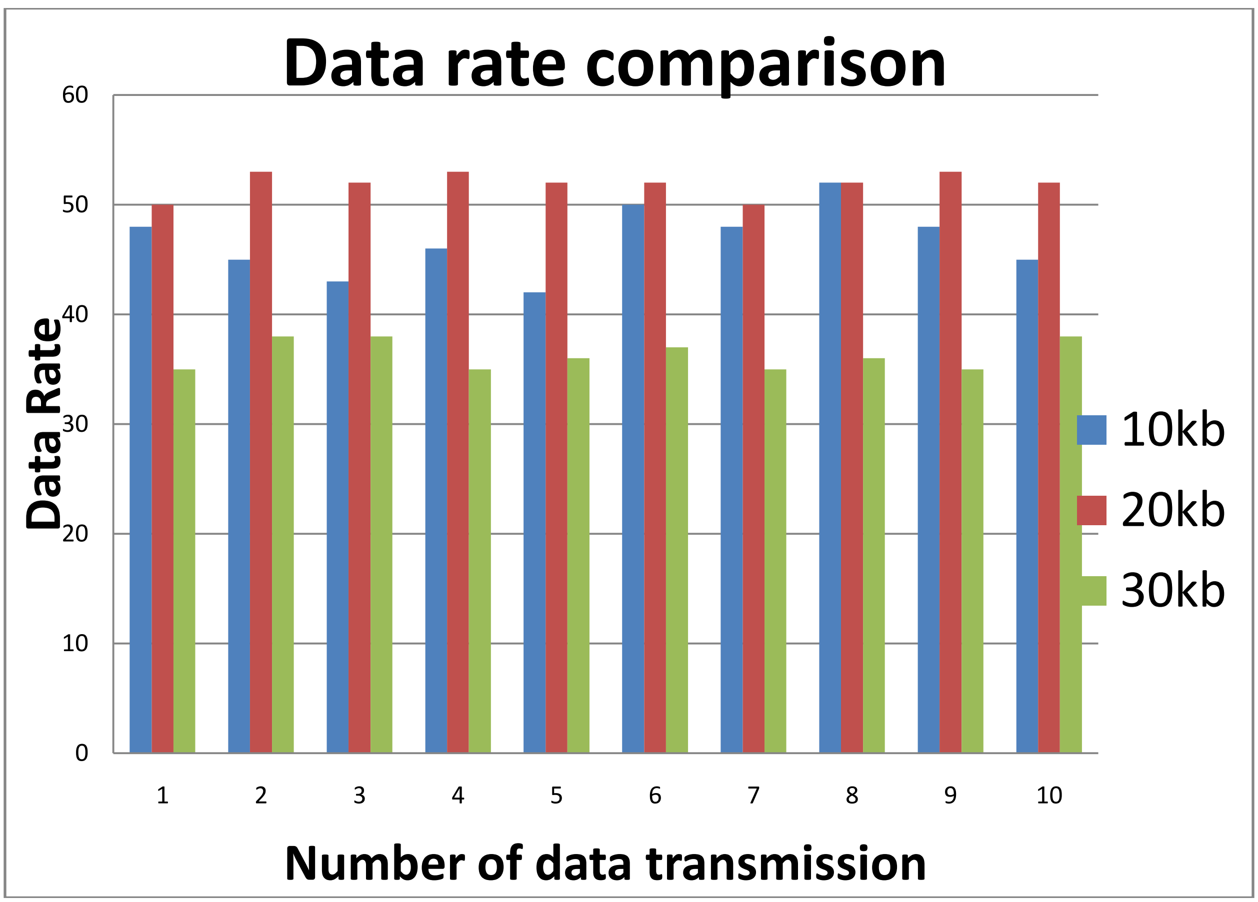


Fig6 : Data rates Vs. Number of transmission

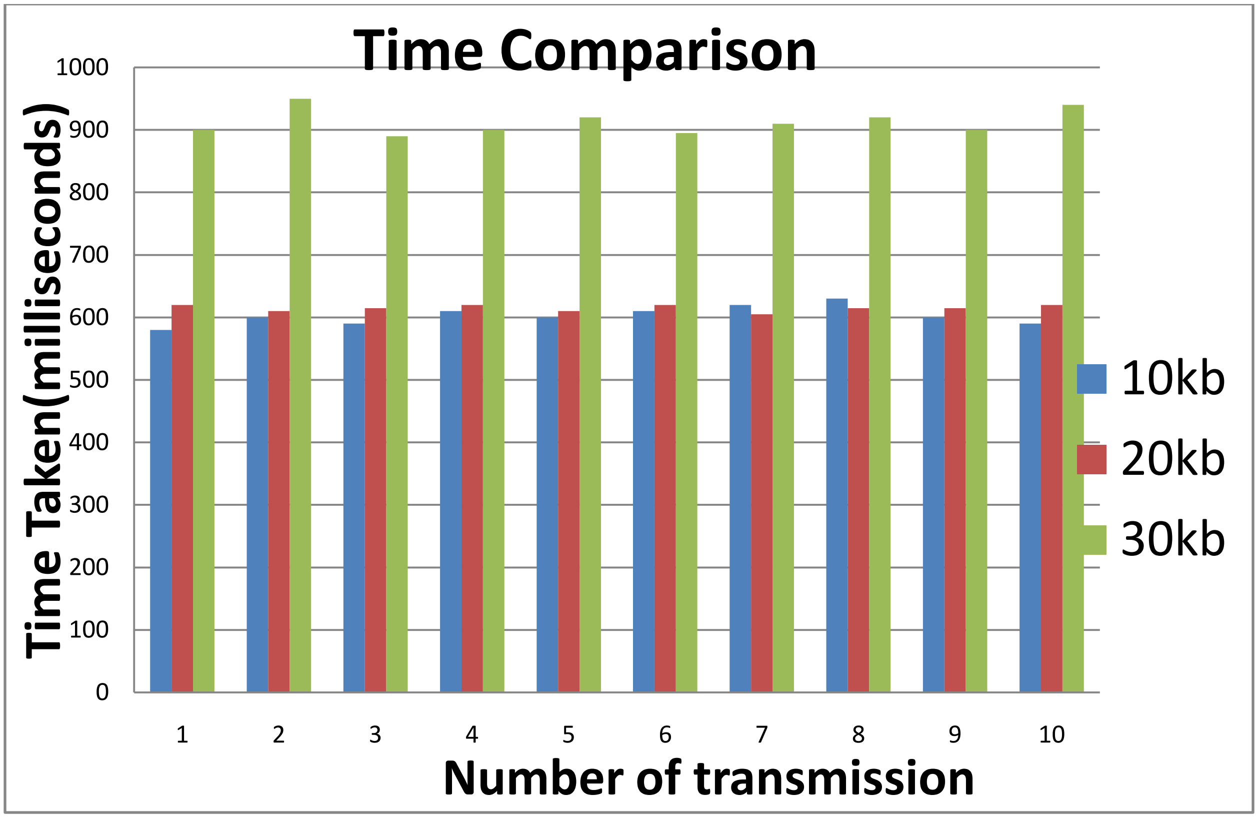


Fig 7: Time taken Vs. Number of transmission

The readings were plotted on a graph shows that if the data size is 20Kb then the data rates are high and consistent and time taken is less, hence let the optimum data size is 20Kb.

## Case 2: Varying Distance

In this case, we selected 20 Kb as a optimum data size for transmission at a distance of 0.5.We checked if the data rates vary due to change in distance by sending 20Kb of data at varying distances in a closedenvironment so as to mitigate the external disturbances and getaccurate results.We notice, that on increasing the 2m distance for each set ofreadings, the data rates gradually decreased with increase indistance and the time taken for the transmission s increased gradually.

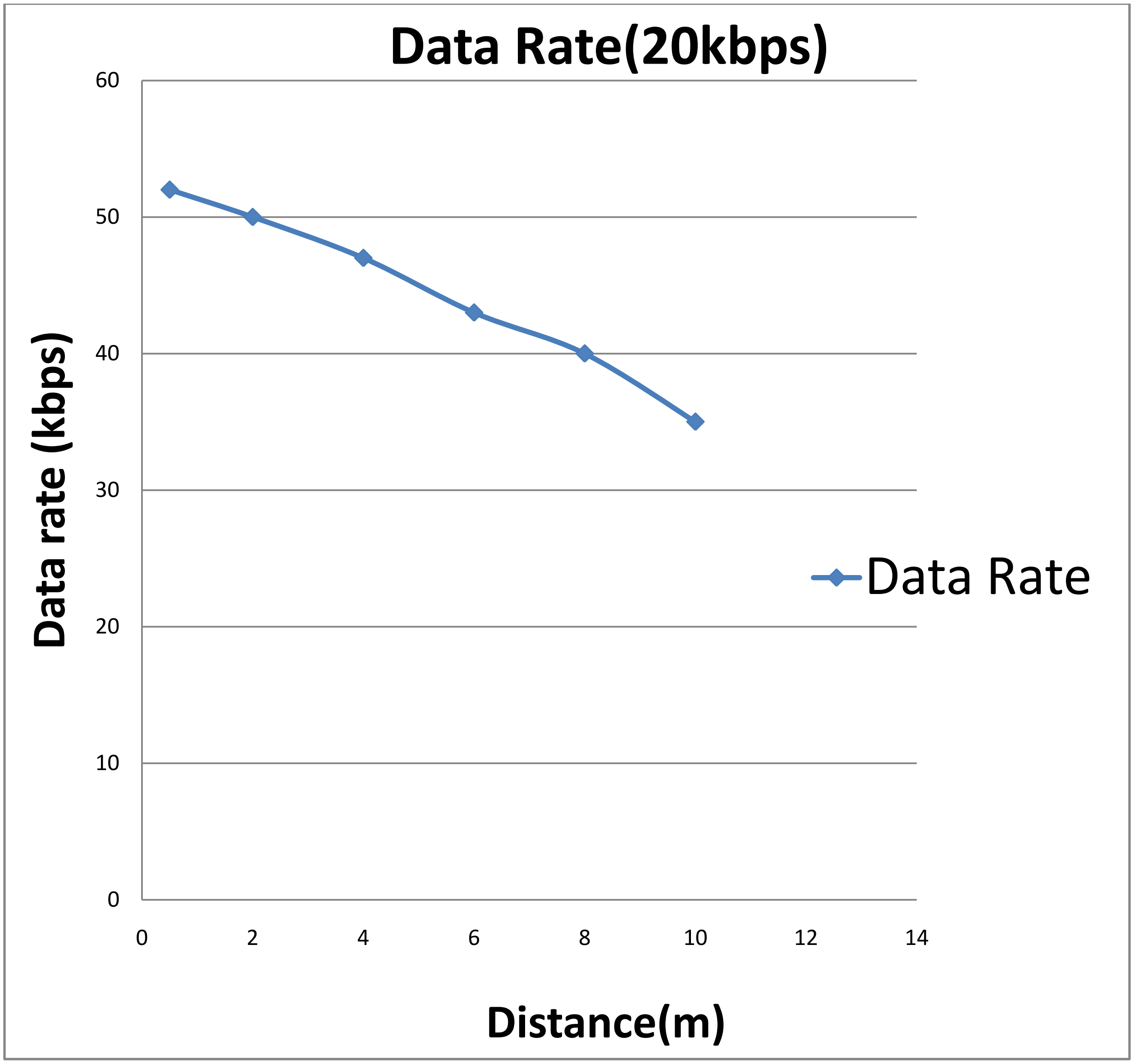


Fig8 : Data rate Vs. Distance

So the optimum distance is within 4m for maximum data rate in 20 Kb segmented streaming over Bluetooth. Below we mention the graph of Data rate and time taken using distance.

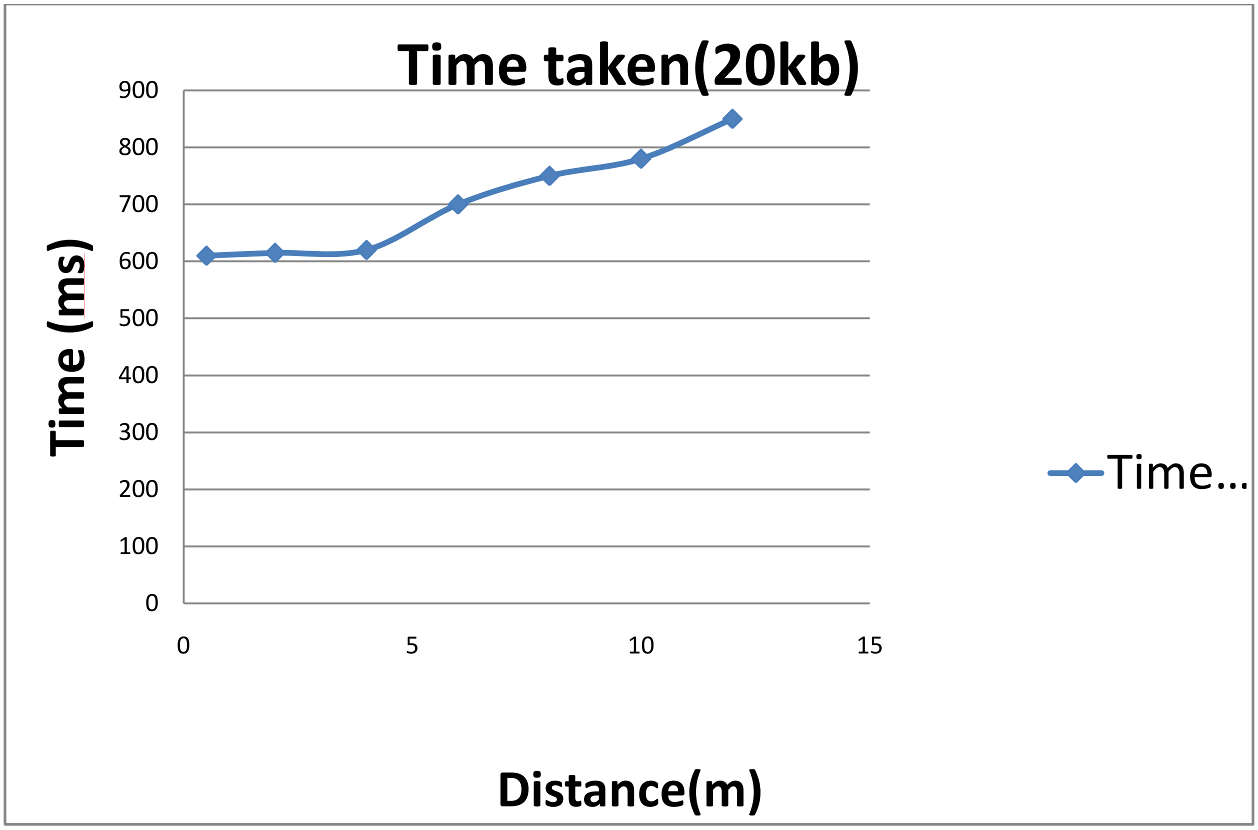


Fig9 : Time vs. Distance

## Case 3: Interference

As we know both Bluetooth and Wi-Fi exist in the same frequency band of 2.4 GHz that is 83 MHz wide. Wi-Fiuses Direct Sequence Spread Spectrum instead of FHSS. When aBluetooth radio and Wi-Fi are operating in the same vicinity thesingle 22 MHz wide Wi-Fi channel occupies the samefrequency space as 22 of the 79 Bluetooth channels which are 1MHz wide. Thedata rates were affected in the presence of Wi-Fi and furtherreduced with decrease in distance between the system andWi-Fi. The secondgraph shows the time taken for transmission which is increased inthe presence of Wi-Fi. Because of the interference there isincrease in network congestion and data is continuously till it isreached, ARQ is

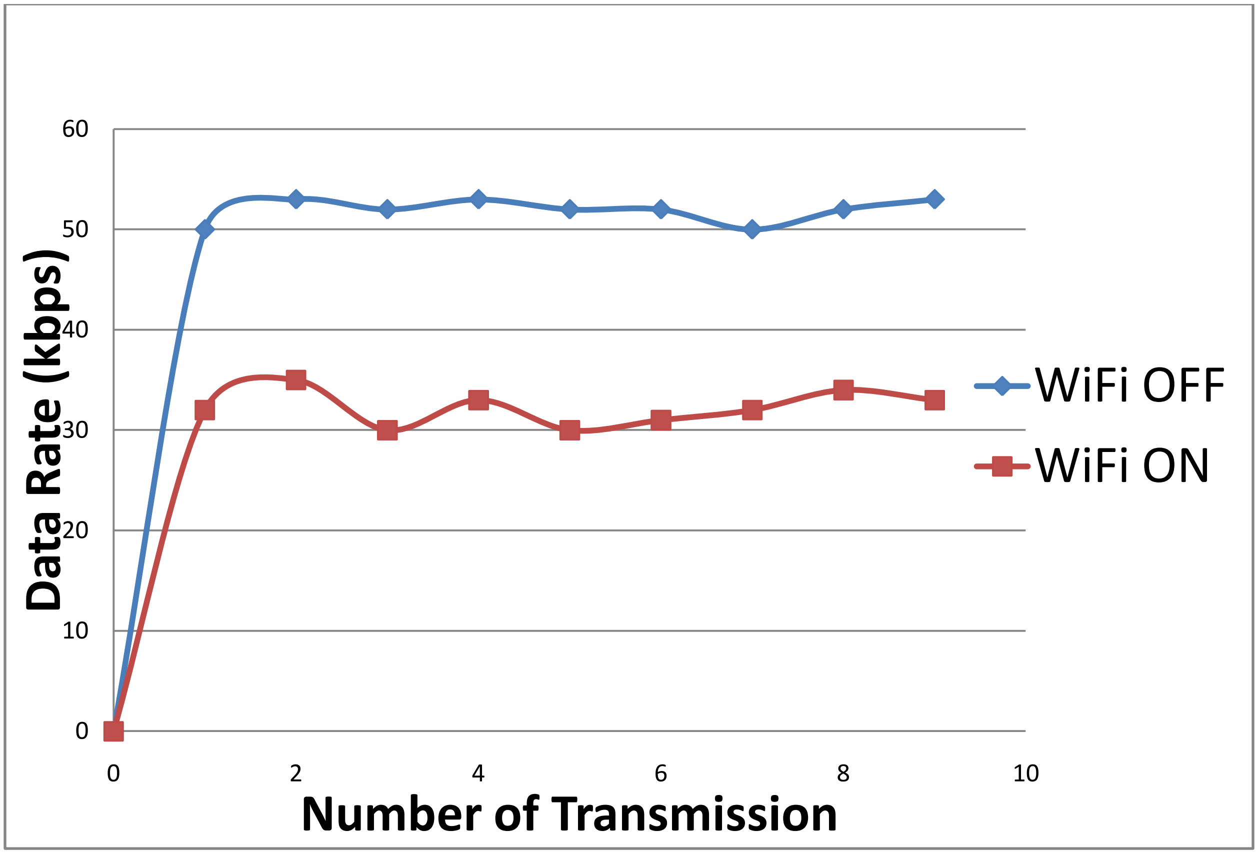


Fig10 : Data rates in presence of Wi-Fi interference

used for effective transmission, but as thecollisions are increased, hence data rate decreases and timeincreases for transmission in the vicinity of WiFi.

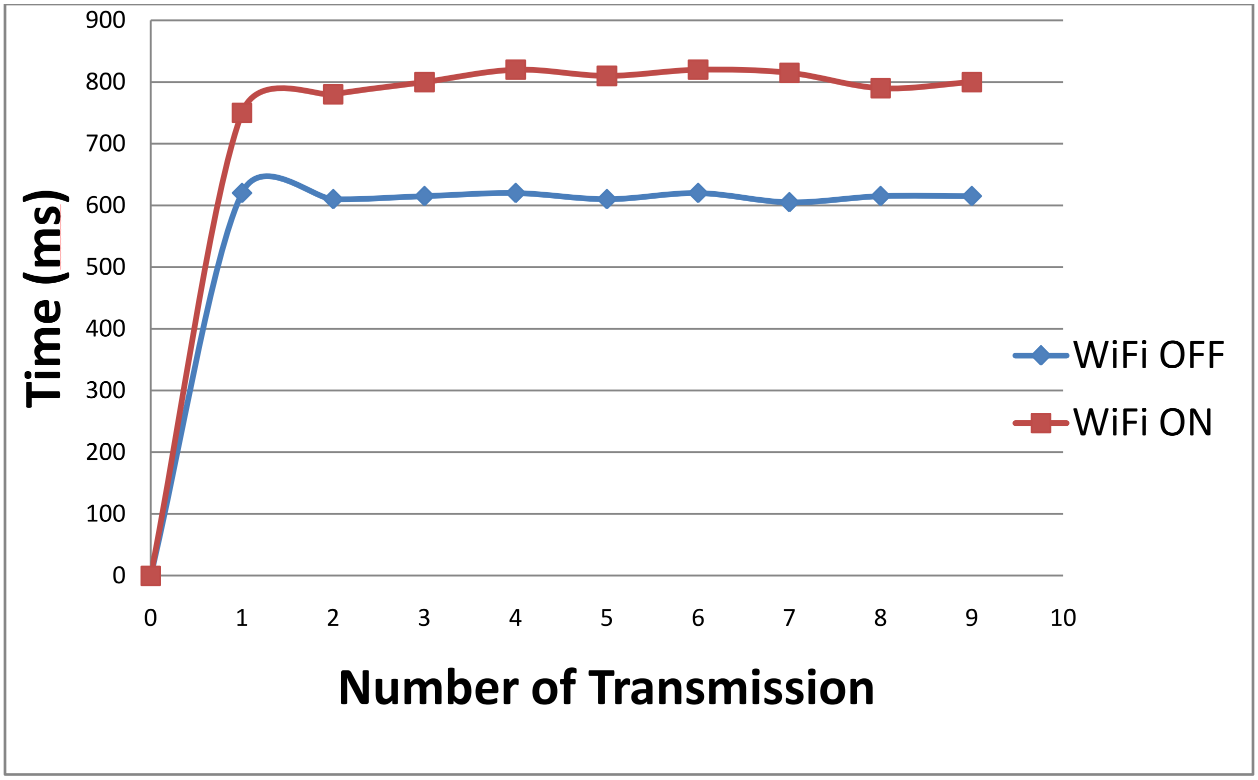


Fig11 : Time Taken in presence of Wi-Fi interference

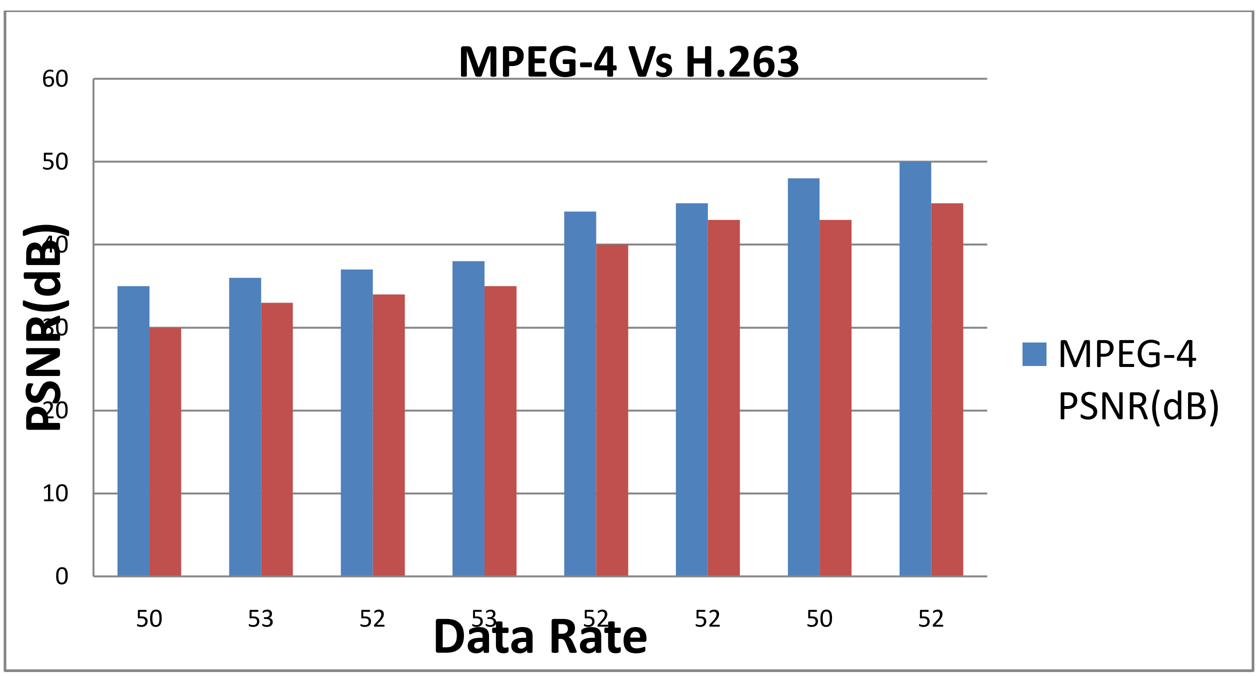


Fig12 : - MPEG-4 Vs. H.263

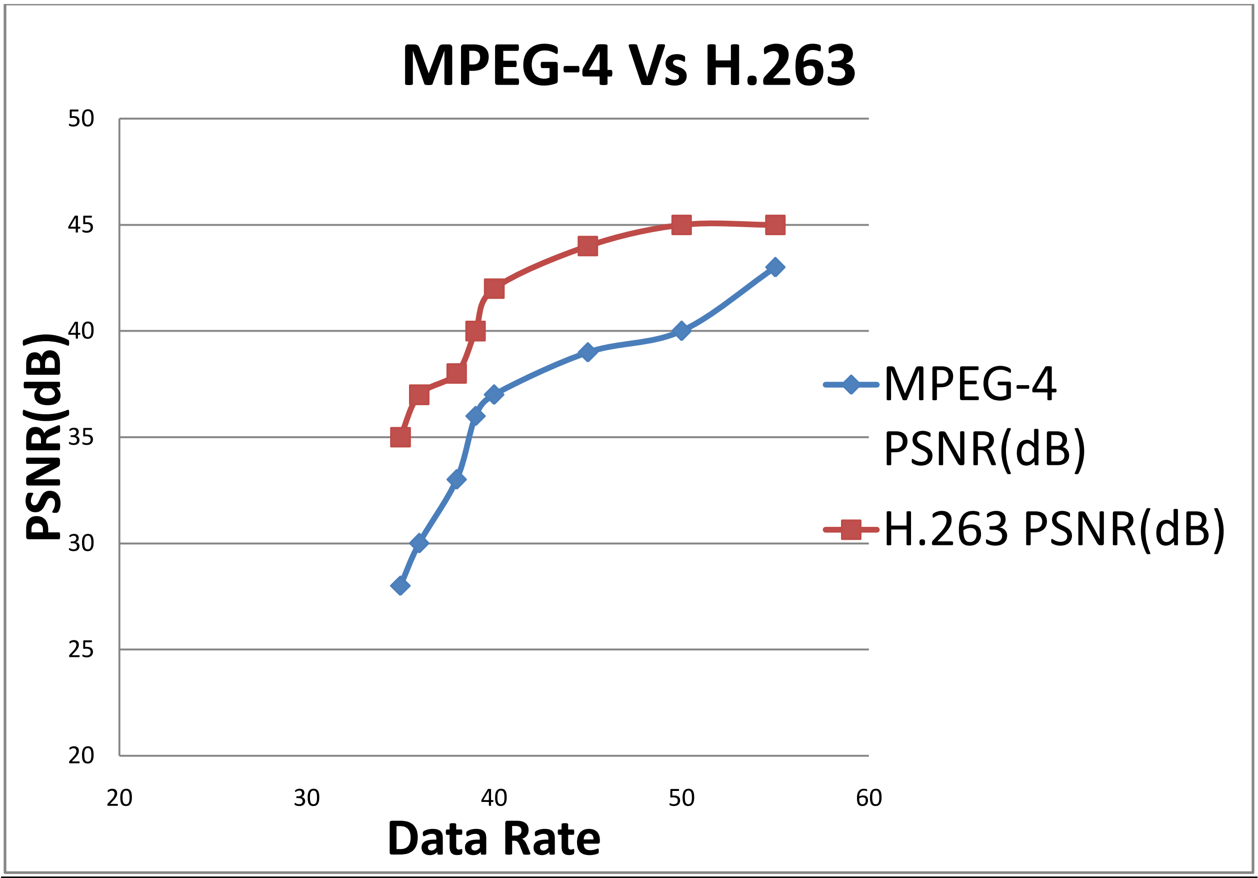


Fig 13 : - MPEG-4 Vs. H.263

## Case 4: Comparison between MPEG Vs. H.263 video compressiontechniques.

In this case we have compared the video compression techniques such as MPEG-4 and H.263.We have plotted graphs of PSNR (dB) Vs. Data Rate. It is found that MPEG-4 is the better video compression technique when the data rate is high because the PSNR of MPEG-4 is high. On the other hand when it comes to low data rate H.263 is the better video compression technique .

## 10) Conclusion

Bluetooth is an exciting technology for mobile devices and serves the purpose of streaming video in an ad hoc network. However, there are not many researchers conducted in this area. So there is always a scope for research in this area.
Our study confirms that video streaming over Bluetooth is releasable although further improvements are required.L2CAP and RFCOMM protocols were found to be the suitable protocol to stream video over Bluetooth. The packet size used when transferring data which was found to be 20Kb was extremely important for increasing data throughput. Improved error resilience, improved coding efficiency, flexibility in computational resources and providing intelligent QoS control can be further research areas at the software level.

## 11) Future work

There is a wide scope of future development in this area. Further research can be done based on improved video compression techniques like H.264/MPEG-4 AVC or its successor HEVC.Bluetooth newer versions like v4 and v4.1 could be used for further research which could improve video streaming due to the significant improvement in the hardware and software features. There is also a scope for research in a scatternet environment.

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