Development of Piconet Pervasive System through Bluetooth Network as Learning Media in Higher Education

Andi Hasad[1], Abdul Hafid Paronda[1] and Dindin Abidin[2]
[1]*Electronic Department, Universitas Islam 45, Jl. Cut Meutia 83, Bekasi, Indonesia*
[2]*Health and Physical Education Department, Universitas Islam 45, Jl. Cut Meutia 83, Bekasi, Indonesia*

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Abstract: The purpose of this study was to develop a Piconet Pervasive system using a client-server connection point to multi-point topology using the Android operating system on the client side and optimize data rate transmission (throughput, delay, jitter and packet loss values) that meet Cisco's standard video streaming QoS, on video streaming via Bluetooth networks. Research methods include Piconet Pervasive Bluetooth network system analysis, system design, audio-video compression, track hints, system testing, system performance measurement, analysis of measurement results, expert performance assessment, system optimization and implementation of learning activities. The results expected through this study are generated systems that produce the best performance and best parameters on data streaming video rates that meet Cisco's standard video streaming QoS for throughput, delay, jitter and packet loss values. This study produces the smallest packet loss value of 3.50% in an environment that does not have Wi-Fi and 4.01% in an environment that has Wi-Fi, at a client-server distance of 5 m, namely by analyzing and optimizing the performance of the Piconet Pervasive system. The results of this study can be implemented as learning media in universities based on Bluetooth technology that is low power, low-cost and easy to use.

1 INTRODUCTION

Research on Bluetooth networks in the field of information and communication technology or the field of electrical engineering as a supporting learning infrastructure has been developed. Wang X. (2004) conducted a study to develop communication between cellular phones and computers, finding that the main thing that became the biggest challenge on Bluetooth networks was the limited bandwidth, which was 732 kbps. In 2008, Catania and Zammit tested streaming video using a Bluetooth network on a computer with a Linux operating system, resulting in the time needed for streaming video transmission, the greater the size of the data packet sent. This study also resulted in the difference in the Bluetooth version on the cellular phone side, having an influence on the number of data packets that could be received by the cellular telephone.

Gupta, Singh and Jain in 2010, developed a system to make it easier for students to understand the working principle of video transmission using Bluetooth networks, by testing various video streaming transmissions using Bluetooth networks on cellular phones to stream video clips and real-time videos from cellular phones to computers and from computers to cellular phones, using the Java platform. As a result, the quality of the video sent decreases with increasing distance and the presence of Wi-Fi interference. In a study conducted by Jung C., Kim K., Seo J., Silva BN, and Han K. in 2017, recommending that for peer-to-peer and client-server communications carried out on 1 channel, the protocol that can be used is RFCOMM, while for many clients, using point to multi-point topology, the protocol used is L2CAP.

Some ways to deal with the weakness of video streaming using Bluetooth networks include video compression, QoS control, and intermediate protocols. Video compression is used to eliminate excess video data information, thereby increasing efficiency in Bluetooth network transmission. QoS which includes congestion control and error control is used to handle packet loss, reduce delay and improve video quality, while intermediate protocols are used to split video data into packets before being sent (Banerjee et al., 2010).

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Margaret T. and Kathrine SA (2012) conducted research to collect data through investigations to their students about their perception of Bluetooth security, resulting in communication via Bluetooth can be safe but still careful in its use. This study suggests that learning about Bluetooth communication technology be included in the college curriculum.

Research conducted by Mahajan, Verma, Erale, Bonde and Arya (2014) resulted in a Bluetooth system that can be integrated into Android, which is the main cellular phone operating system as a mobile communication tool today. This study also developed a chat application using 2-way communication on a Bluetooth network, without other infrastructure. This research is used to develop learning processes based on Bluetooth networks.

Previous research conducted by Hasad A. and Paronda AH. (2016) on a Bluetooth Piconet Pervasive system, it produces the best performance from the system in transmitting data rates via Bluetooth networks. But the research still runs on the symbian platform on the client side. Therefore, in this research Piconet Pervasive system was developed, which runs on the Android open source operating system on the client side; which is a cellular phone operating system that is widely used today. The system produces the best performance on the transmission of real-time video streaming data rates through the Bluetooth Piconet Pervasive network, according to Cisco streaming video standards.

The purpose of this study was to develop a Piconet Pervasive system that uses a client-server connection point to multi-point topology using the Android and Symbian operating systems on the client side (cellular phones), which meet the video streaming QoS standards, both when transmitting video streaming data rates and on the system Piconet Pervasive, in environments that have Wi-Fi interference or that do not have Wi-Fi interference.

The results expected through this research are a system that has the best performance and best parameters for video streaming data rate transmission that meets Cisco standard video streaming QoS for throughput, delay, jitter and packet loss values for video streaming applications on the environment. which does not have Wi-Fi interference or in an environment that has Wi-Fi interference.

The results of this study can also be implemented on Bluetooth technology-based learning that is low power, low-cost and easy to use in the teaching and learning process in universities can improve student skills so that it is in line with the demands of the business world and industry..

2 RESEARCH METHODS

This research was conducted in the laboratory of Electrical Engineering Telecommunications of Universitas Islam 45 in Bekasi and in the laboratory of the Network Computer Centric (NCC) Department of Computer Science, Bogor Agricultural University which runs from January to April 2018.

The material used in this study is a video with a .3gp format with a data rate of 8 kbps. Video encoding resolution is 176x144 pixels. The tools used in the server-side development environment include computers that have Intel Core i5 CPU processor specifications, 8 GB RAM, system type: 64 bit OS, Microsoft Windows 10 Operating System, USB Bluetooth Generic, Intel (R) Core (TM) computers i3-3110 M 2.40 GHz CPU, 4 GB RAM, 32 bit system type, Windows 10 Operating System, Wireshark Software and Darwin Streaming Server. In the client-side development environment cell phones are used which have specifications for Android OS and Symbian OS, Bluetooth v 4.0. Supporting software used include GnuBox, AnalogX, and MP4Box.

The research method includes several stages of research, including Piconet Pervasive Bluetooth network system analysis, system design, audio-video compression, track hint, optimization, system testing, performance measurement, and analysis of measurement results, system optimization, and implementation.

1. Piconet Pervasive Bluetooth System Analysis

The Pervasive Piconet system is a piconet system that connects two different devices so that the existence of these different devices is no longer felt (Arnaldy, 2010). At this stage, identification of the needs of the Bluetooth Piconet Pervasive network system. Needs identification is based on literature studies and literature on hardware and software needed during the research. Literature studies also include multimedia on cellular phones, audio video processing, Bluetooth connections from cellular phones to computers, and from computers to cellular phones.

2. System Design

At this stage, prototype design and construction is carried out for Bluetooth connections from the computer (server) to the cellular telephone (client). The design and configuration carried out on the server side consist of software and hardware. On the server-side, the software used is Darwin Streaming Server and AnalogX, DSS is an open source version of Quicktime Streaming Server (QSS) and can run on Windows, Linux and Mac OS operating systems (Klingsheim, 2004).

Configuration on the client side (cellular telephone) has done by installing the Gnubox software, then configuring the access point. After that proceed with the configuration on Gnubox.

3. Audio Video Compression

The compression process is used to reduce the video data rate. Data must be compressed before sending it via a Bluetooth network (Banerjee, 2010). The compressed data consists of two parts, namely audio and video, including frame size, frame rate, codec, audio rate, sample rate and channels. The video compression format used is 3gp, while audio is amr. The video that has been compressed is then sent via a Bluetooth network with a limited bandwidth of 732 kbps (Wang, 2004).

4. Hint Track

Before the video is sent, the hint track process is first done so that the video can be run/played on the client video player. The hint track process is needed to give information to the video so that it is ready to be sent and can be recognized by the client (Austerberry, 2005). In this study, the hint track process has done by using open source tools called MP4Box. Bandwidth obtained from this process is the limit of videos that can be sent (Arnaldy, 2010).

5. Optimization

This stage has done when the system can work but has not yet produced the expected value based on Cisco's standard video streaming QoS. Optimization on the server has done by tuning up the DSS by installing Active Perl to maximize DSS performance, while on the client side optimization was done by minimizing running background, which consumes memory on cell phones (Hasad A., 2017).

6. System Testing

System testing aims to determine the ability of the Bluetooth network as a video streaming media and to find out the quality of the video received on the client side. Testing has done using the Darwin Streaming Server, and AnalogX proxy on the server and GnuBox side as well as the real player on the client side. The protocol used is RFCOMM with an intermediate protocol in the form of Internet Protocol (IP).

Testing has done on the size of the video data rate and different distances. The video data rate tested is 8 kbps with a resolution of 176 x 144 pixels encoding, while the distance to be tested is 5 meters.

7. Performance Measurement

The parameters used in measuring the performance of this Bluetooth network are throughput, delay, jitter, and packet loss. Measurement of this parameter uses capture network traffic, namely Wireshark.

3 RESULT

The measurement starts with sending a video that is 5 m away from the server, in an environment that does not have Wi-Fi (-100 dBm), and an environment that has Wi-Fi signal strength of -78 dBm and -58 dBm. After each video is measured, then a comparison and analysis of the measurement parameters between the videos are carried out. The results of measuring video streaming at 8 kbps data rate and 5 m client-server distance as shown in Table 1.

Based on Table 1, it can be seen that in an environment that does not have Wi-Fi (-100 dBm), the highest value for throughput parameters is 4.59 packets / second and the lowest value is 4.52 packets / second with an average of 4.56 packages/second. The delay parameter has the highest value of 0.29 milliseconds and the lowest value is 0.25 milliseconds with an average value of 0.27 milliseconds. For the jitter parameter, the highest value is 0.02 milliseconds and the lowest is 0.01 milliseconds with an average value of 0.01 milliseconds. The packet loss parameter has the highest value of 3.52% and the lowest value is 3.50% with an average value of 3.51%.

In the delay parameter, the value obtained is in milliseconds, with the highest value of 0.29 milliseconds, this is in accordance with Cisco's QoS standard which allows a maximum of 5 seconds to stream video streaming. While the jitter parameters in video streaming do not have standard standards because streaming video is not a jitter sensitive based on criteria issued by Cisco (Szigeti and Hattingh, 2004). The Jitter parameter is closely related to the delay parameter, the jitter parameter can be used to determine the stability of the data packet transmission, the closer the value of 0 is the more stable data transmission.

In packet loss parameters, the highest value of packet loss is 3.52%, where the average value is 3.51%. This value is still included in the standard for streaming video based on Cisco QoS, where the standard value that is still allowed is <5%.

In environments that have Wi-Fi (-78 dBm and -58 dBm), the highest value for throughput parameters is 4.45 packets / second and the lowest value is 4.26 packages / second with an average of 4.43 packets / second in the environment with Wi-signal Fi -78 dBm and 4.29 packets / second in an environment with a Wi-Fi signal of -58 dBm. This shows that the stronger the Wi-Fi interference, the lower the throughput value.

Table 1. The measurement results carried out on the client-server distance are 5 m

Parameters	**Wi-fi : -100 dBm**					**Wi-fi : -78 dBm**					**Wi-fi : -58 dBm**				
	M-1	M-2	M-3	M-4	Ave	M-1	M-2	M-3	M-4	Ave	M-1	M-2	M-3	M-4	Ave
Throughput (packet/second)	4.52	4.54	4.58	4.59	4.56	4.44	4.42	4.45	4.39	4.43	4.33	4.29	4.26	4.29	4.29
Delay (millisecond)	0.25	0.26	0.28	0.29	0.27	0.52	0.54	0.56	0.57	0.55	0.60	0.61	0.62	0.63	0.62
Jitter (millisecond)	0.01	0.02	0.01	0.01	0.01	0.02	0.01	0.02	0.02	0.02	0.02	0.04	0.04	0.04	0.04
Packet Loss (%)	3.50	3.52	3.51	3.51	3.51	4.01	4.01	4.01	4.02	4.01	4.20	4.21	4.26	4.27	4.24

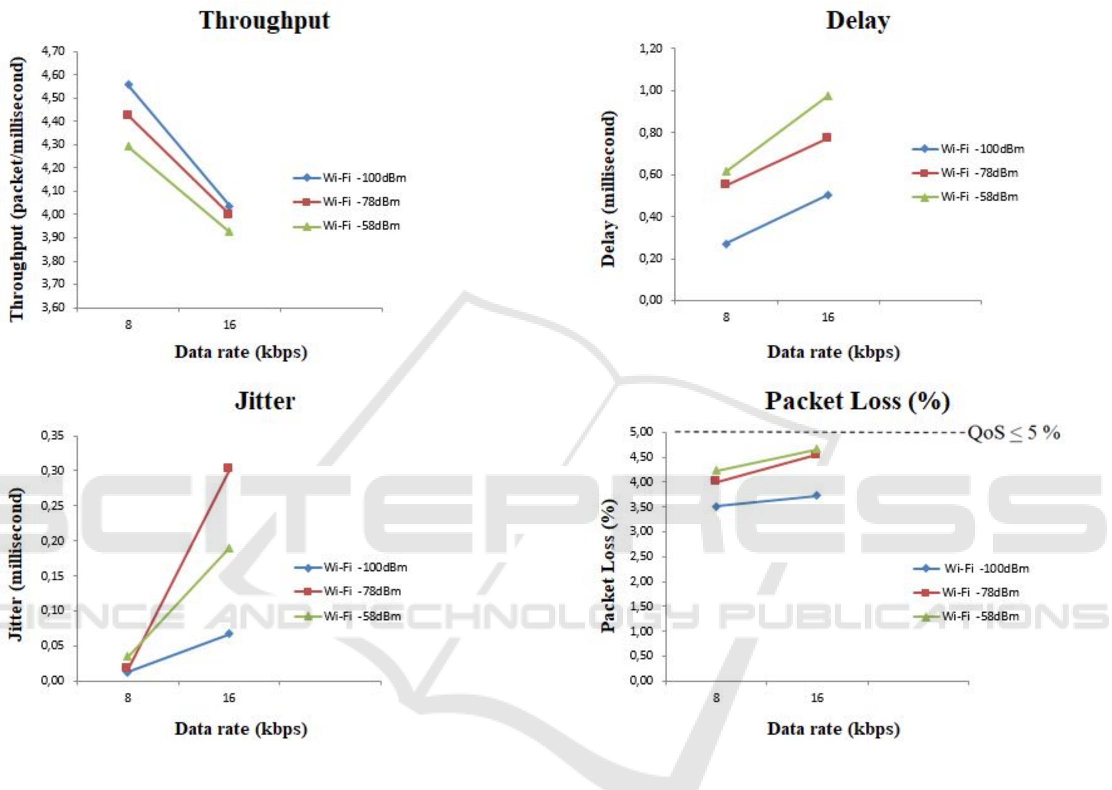

Figure 1. Comparison of measurement results at 8 kbps and 16 kbps data rates

The delay parameter has the highest value of 0.63 milliseconds and the lowest value is 0.52 milliseconds with an average value of 0.55 milliseconds in an environment with a Wi-Fi signal of -78 dBm and 0.62 milliseconds in an environment with a Wi-Fi signal of -58 dBm. These results indicate that the stronger the Wi-Fi interference, the greater the delay. For jitter parameters, the highest value is 0.04 milliseconds and the lowest is 0.01 milliseconds with an average value of 0.02 milliseconds in an environment with a Wi-Fi signal of -78 dBm and 0.04 milliseconds in an environment with a Wi-Fi signal of -58 dBm.

The difference in the numbers obtained by the relatively small difference in value indicates the stability of the network used. It can be seen that there is a decrease in the average value of the jitter in an environment that has a higher Wi-Fi interference that is 0.04 milliseconds on the Wi-Fi signal of -78 dBm to 0.02 milliseconds in the Wi-Fi signal of -58 dBm.

In an environment with Wi-Fi signal of -78 dBm, packet loss parameter values obtained have the highest value of 4.02% and the lowest is 4.01% with an average value of 4.01%, while in environments with Wi-Fi signal -58 dBm, the value packet loss parameters obtained have the highest value of 4.27% and the lowest is 4.20% with an average value of 4.24%. This shows that the stronger the Wi-Fi interference on the network, the greater the value of packet loss.

4 CONCLUSIONS

In this research, the Piconet Pervasive system was successfully developed from earlier research conducted by Hasad A. and Paronda AH. (2017) which analyzed the data rate and the effect of W-Fi interference on video streaming from server to client on the Bluetooth Piconet Pervasive network, by adding the use of Android OS and Symbian OS on the client side.

All data delay and packet loss, which was obtained in this research have met Cisco streaming video standards; with a standard maximum packet loss is 5%.

This research produces the value of the smallest packet loss of 3.50% and the largest packet loss of 3.52% in an environment that does not have Wi-Fi and the smallest packet loss value of 4.01% and the largest packet loss of 4.27% in an environment that has Wi-Fi, the client-server distance 5 m, that is by doing optimization to get the best performance on the Piconet Pervasive system.

The results of this research have implemented as a learning media in universities, based on Bluetooth technology that is low power, low-cost and easy to use. hope you find the information in this template useful in the preparation of your submission.

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