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Analysis of Video CODEC Performance Using Different Softphone Applications

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Abstrak

Sebuah panggilan video terdiri dari beberapa komponen, seperti perangkat IP phone ataupun aplikasi softphone, CODEC, dan server yang digunakan. Pemilihan jenis aplikasi softphone dan CODEC merupakan salah satu hal yang harus diperhatikan dalam komunikasi video karena dapat mempengaruhi kualitas panggilan video. Penelitian ini membahas pengaruh kombinasi aplikasi softphone dengan CODEC terhadap kualitas layanan panggilan video yang diukur berdasarkan parameter QoS, PSNR, dan MOS.

Aplikasi softphone yang diteliti adalah Blink, Zoiper, MicroSIP, PortGo, Linphone, dan X-Lite. CODEC yang diteliti adalah H.264, VP8, H.263+, dan H.263. Setiap aplikasi softphone akan dipasangkan dengan CODEC yang menjadi bawaan atau native dari sofphone tersebut sehingga akan terdapat sembilan buah kombinasi antara aplikasi softphone dan CODEC yang diuji.

Berdasarkan hasil pengujian CODEC H.264 memiliki performa paling bagus pada saat dipasangkan dengan aplikasi softphone Blink. CODEC VP8 memiliki performa paling bagus pada saat dipasangkan dengan aplikasi softphone Zoiper. CODEC H.263+ memiliki performa paling bagus pada saat dipasangkan dengan aplikasi softphone PortGo. CODEC H.263 dan aplikasi softphone X-Lite memiliki hasil pengujian yang paling buruk namun tetap mendapatkan predikat penilaian "bagus" pada saat diuji dengan parameter QoS, PSNR, dan MOS.

Kata kunci— *Softphone, CODEC, QoS, PSNR, MOS*

Abstract

In a video call, there are several components, such as IP phone or softphone, CODEC, and server. The Selection of softphone and CODEC is a consideration in building a video communication network because it will affect the quality of video call. This research compares the quality of video calls based on softphone application and CODEC combination. The quality measured by QoS, PSNR, and MOS parameters.

Softphone applications examined in this research are Blink, Zoiper, MicroSIP, PortGo, Linphone, and X-Lite. CODEC examined in this research are H.264, VP8, H.263+, and H.263. Each softphone application will be combined with a CODEC that is native to the softphone. There are nine combinations of softphone applications and CODEC.

Based on the research results, CODEC H.264 has the best performance when paired with the Blink softphone application. CODEC VP8 has the best performance when paired with the Zoiper softphone application. The H.263+ CODEC has the best performance when paired with the PortGo softphone application. The H.263 CODEC and X-Lite softphone applications have the worst test results but still get "good" grades when tested using QoS, PSNR, and MOS parameters.

Keywords— *Softphone, CODEC, QoS, PSNR, MOS*

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1. INTRODUCTION

Voice over Internet Protocol (VoIP) is a phone which transmits a voice from one place to another using Internet Protocol (IP) [1]. Recently VoIP does not only send voice package but also able to transmit video or moving image so VoIP is developing into a video phone.Video phone permits users to share video and audio information to support applications such as video call and video conference [2].

A video call consists of many components, such as IP phone or softphone, CODEC, server, signaling protocol, and network infrastructure [3]. The component choice can affect the quality of voice and video of a video call. The video call quality is very dependent on Quality of Service parameters, such as delay, jitter, and packet loss because of the call is real-time and the transmission is through internet network [4].

In addition, subjective methods are viewed as the most accurate ways to measure video call quality because they test the experience of users directly to obtain the subjective Mean Opinion Score (MOS) parameter [5]. But they suffer from certain defects, such as time-consuming, human resources consuming, and unrepeatable [6].

Lately, many tools or software have been developed to measure the quality of video calls using MOS parameters to shorten the measurement time. One of the tools which are used in this study is the MSU Video Quality Measurement Tool Free (MSU VQMT). The tools measure picture quality of a video call by comparing the sent and received video when the user making a video call. The result of tools is *a peak signal to noise ratio* (PSNR) parameter that can be converted to MOS parameter [7]

Coding technique or CODEC can be used to enlarge throughput on the cable network and wireless, it also influences other QoS parameters, such as *delay*, *jitter*, and *packet loss*. There are many kinds of video CODEC can be used for video calls, such as VP8, H.263, H.263+, and H.264 [8]. H.264 CODEC is CODEC which has the best quality when using for video calls [9]. However, according to [3], H.264 CODEC can not be used for video call because softphones on the their study did not support H.264 CODEC. The efficiency of the VP8 compression standard outperforms the H.264 compression standard and VP8 can not allow encoding by low bit rates[10]. H.263 is the most compatible CODEC with many softphones and has good quality if compared with another CODEC[9].

CODEC needs a softphone to compress data on a video call. Softphone is software that can be used to make a call by using an internet network. Softphones used in this study are open source or freeware because they are obtainable for free without to pay software license.

The existing studies focus on video CODEC and there is no specific study about the effect of softphone and CODEC combination on the video call quality. The choice of softphone and CODEC combination should be considered as one of the most important aspects of the video communication network. The choice of this combination is important because there are many softphone and CODEC in the world and some softphone supports many types of CODEC while other softphones only support one type of CODEC [3]. Therefore, research needs to be conducted on the effect of the softphone and CODEC combination to the quality of video calls measured by QoS, PSNR, and MOS parameters.

2. METHODS

2.1 System Design

The system design is done by configuring hardware and software. The hardware that should be configured are server, PC, router, switch, ethernet cable, and other peripheral devices. The software configuration is done by installing and setting Linux and Asterisk software on the server-side. On the client-side the configuration is done by installing and setting the softphone applications. This research uses tools to monitor and measure network activity such as Wireshark and MSU Video Quality Measurement Tool Free (MSU VQMT) to measure the quality of a video call. General description of the system design shown in Figure 1.

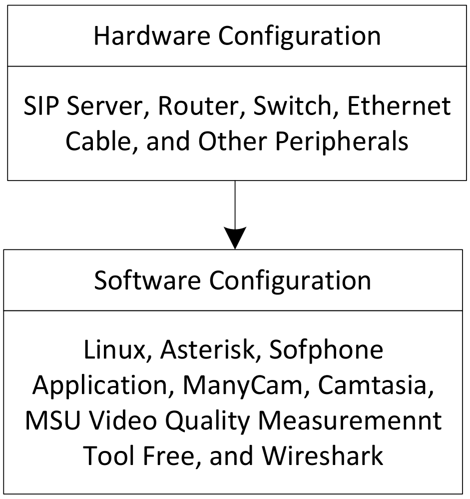


Figure 1 General Description of System Design

Generally, a system consists of input data, process, and outputs as shown in the system block diagram Figure 2. In this research, the input that will be sent on the sender's side is a reference video. Reference video is a pre-recorded video contain many types of movement such as lips movement, hand, body, and head movement, and sudden movement. A reference video will be streamed during a video call by ManyCam. The input will be processed by video phone application by converting analog signals into digital signals. The data of the digital signal will be compressed to make the data compact. The digital signal will be packetized and sent over a computer network. On computer networks, the packet will be processed by a switch, router, and SIP server. On the receiver side, the packet received will be depacketized and converted into an analog signal. The analog signal will be played on the speaker and screen so it can be heard and seen by the receiver.

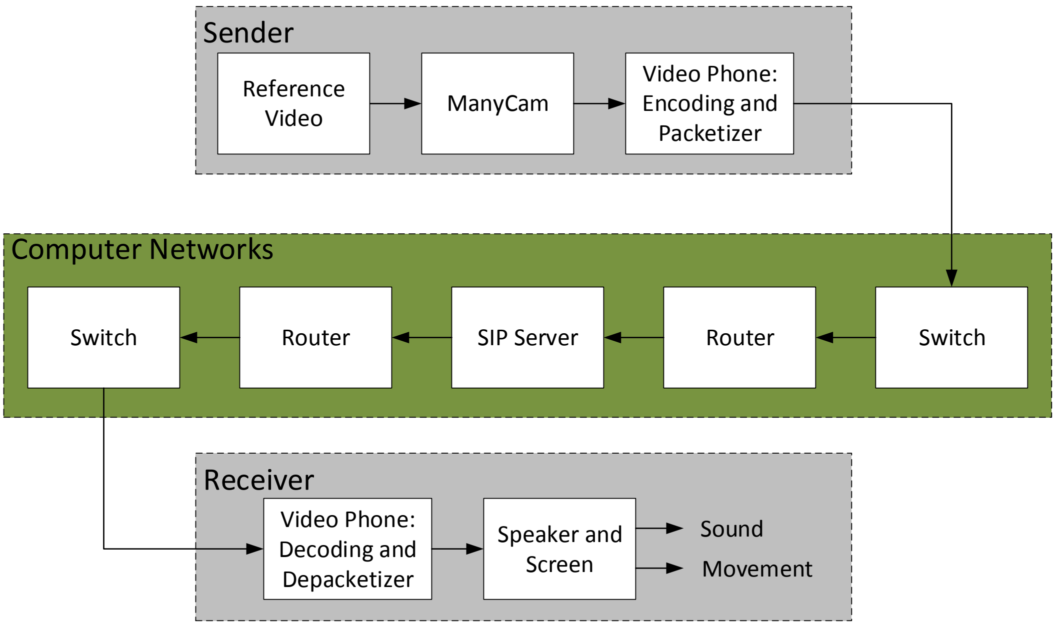


Figure 2 System Block Diagram

2. 2 Network Topology

There are two types of network topologies used in this research, they are local network and intranet network from Direktorat Sistem dan Sumber Daya Informasi (DSSDI) to the Fakultas MIPA UGM. The devices used on both network topologies are SIP server, personal computer (PC), router, and switch. The SIP server used on this network is IP PBX. The IP PBX server is used to connect video phone calls from the user agent client (UAC) to the user agent server (UAS) on the networks. UAC and UAS is a client PC. The devices in the network will be connected to a switch which will send packet data from PC to server and vice versa.

2. 2.1 Local Network Topology

The devices used on the local network topology are two personal computers (PC), one SIP server, and one switch. In this local network topology, all devices are connected by an ethernet cable. Local network topology used in this research is shown in Figure 3.

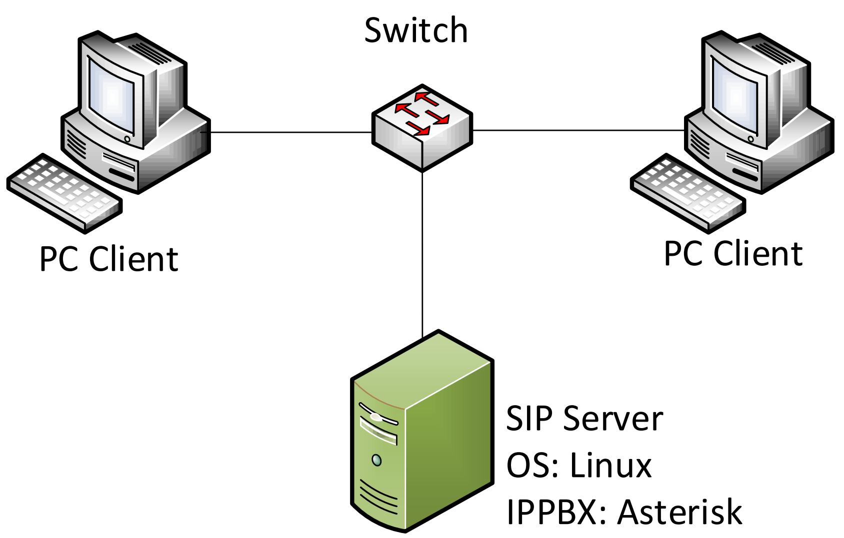


Figure 3 Local Network Topology

2. 2.2 DSSDI-MIPA Intranet Network Topology

UGM intranet network topology, especially intranet network from the Direktorat Sistem dan Sumber Daya Informasi (DSSDI) to Fakultas MIPA UGM. The DSSDI core network is connected through two core switches connected to various faculties and buildings in UGM. That means there will be two main lines (core switches 1 and 2) that can be routed when making video calls from DSSDI to Fakultas MIPA UGM or vice versa. The video phone that will be tested in this study will be implemented on the core switches 1 or 2 in DSSDI and the network in Fakultas MIPA, as shown in Figure 4.

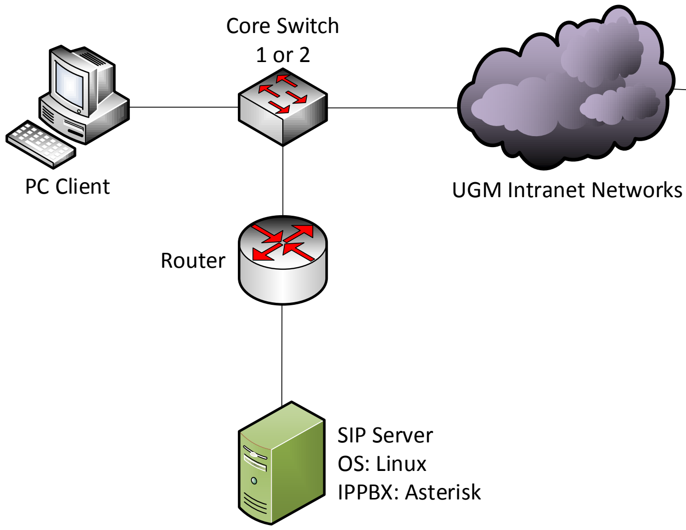


Figure 4 DSSDI- Fakultas MIPA UGM Intranet NetworkTopology

2. 3 CODEC and Softphone Combinations

This research was conducted to see the effect of CODEC and softphone combination on video call service quality. This research uses six softphones, namely Blink, Zoiper, MicroSIP, PortGo, Linphone, and X-Lite and four CODEC, namely: H.264, VP8, H.263+, and H263. The CODEC were chosen because they have good performance when tested in previous studies [3,9]. CODEC and softphone combinations are shown in Figure 5.

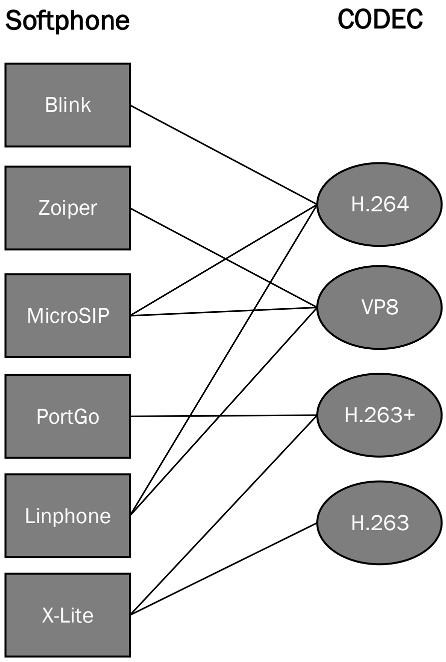


Figure 5 CODEC and Softphone Combinations

As shown in Figure 5, the rectangular symbol represents the softphone applications while the elliptical symbol represents the CODEC. Each softphone will be paired with CODEC which is native or default to the softphone, therefore there will be nine combinations of CODEC and CODEC softphones to be tested.

H.264 CODEC is a native CODEC to Blink, MicroSIP and Linphone softphones so H.264 is tested for all three softphones. VP8 CODEC is a native CODEC on four softphones namely Blink, Zoiper, MicroSIP, and Linphone. H.263+ CODEC is paired with PortGo and X-Lite because H.263+ is the default CODEC of both softphones. H.263 CODEC can only be used by the X-Lite softphone because the other softphone applications in this research do not support H.263 CODEC. Other combinations than the native are not possible because it will be time-consuming to rewrite the softphone source code to add the CODEC to the softphone.

Each CODEC and softphone combination is measured using PSNR, MOS, and QoS parameters such as delay, jitter, throughput, and data compression size. PSNR and MOS are measured using MSU Video Quality Measurement Tool Free (MSU VQMT), while the QoS is measured using Wireshark.

2. 3.1 PSNR Test

All video calls conducted in this research is using a video that has been previously recorded. The previously recorded video is referred to as a reference video. The reference video will be sent from UAC to UAS when a video call is occurring to replace the webcam role on the PC. The reference video contains several movements, such as the first, conversations with few movements or only mouth movements; the second, with many movements such as head and hand movements; and the third is fast and sudden movements. The reference video is recorded using a webcam with MP4 video format, the video size is 123 MB, the resolution is 640x480 pixels, and the frame rate is 30 fps as shown in **Figure 6**.

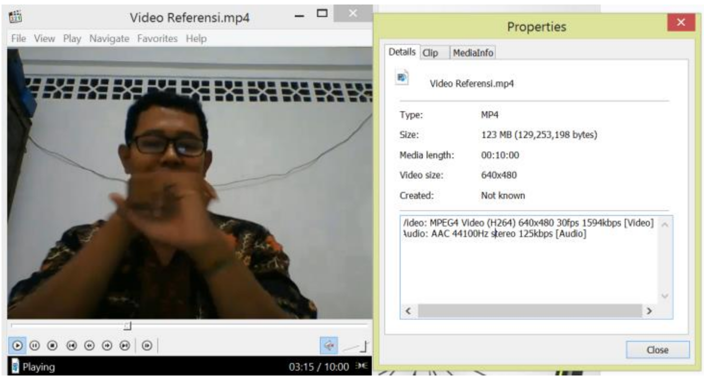
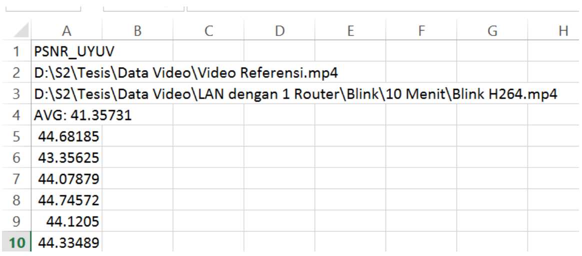


Figure 6 Reference Video

The video received in UAC and reference video is compared by using MSU VQMT tools to measure the PSNR in the U-YUV color component. PSNR is measured in dB units (decibels). The comparison results on the MSU VQMT tool is a .csv file as shown in Figure 7.



	A	B	C	D	E	F	G	H
1	PSNR_UYUV							
2	D:\S2\Tesis\Data Video\Video Referensi.mp4							
3	D:\S2\Tesis\Data Video\LAN dengan 1 Router\Blink\10 Menit\Blink H264.mp4							
4	AVG: 41.35731							
5	44.68185							
6	43.35625							
7	44.07879							
8	44.74572							
9	44.1205							
10	44.33489							

Figure 7 The Comparison Results on the MSU VQMT Tools

The contents of column A in Figure 7 are the PSNR values on the MSU VQMT tools. Each data in the row is the results of each video reference frame and received video frame. Column A has 18,000 rows because the duration of a video call is 10 minutes with the number of frames per second being 30 fps. AVG shows the average PSNR value of the video call tested. PSNR shows how good the quality of video calls from each combination of softphone and CODEC tested in this study. The higher the PSNR value, the better the quality of the video call.

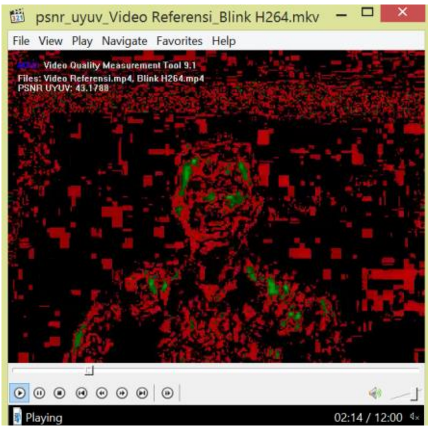


Figure 8 Visualization of Comparison Results

Figure 8 shows the visualization result from comparing the reference video and the video received by UAC. The visualization is a frame to frame comparison video with red and black colors and when there is a movement the green color will appears. In the visualization, there is also information about the PSNR value in each frame.

2. 3.2 PSNR to MOS Conversion

PSNR is an objective video quality testing. PSNR is an approach to measure video quality which is calculated based on the comparison of each frame in the video data. PSNR is set for a video sequence with images that have M x N dimensions and K total of frames as the ratio of the maximum (peak) pixel power to add the Mean Squared Error (MSE) as in equation (1).

$$PSNR = 10\ log_{10} \frac{255^2}{\sum_{k,m,n} \frac{(u(k,m,n) - \hat{u}(k,m,n))^2}{K\ M\ N}} \quad (1)$$

255 is the maximum pixel power, u(k, m, n) is the nth pixel of the mth row in the original image at the time index to k and û(k, m, n) is the generated or compressed pixel. The results from this objective measurement of PSNR can be converted to MOS (subjective measurements), as shown in Table 1.

Table 1 Conversion of PSNR to MOS [7]

PSNR (dB)	MOS	Quality
>37	5	Excellent
31-37	4	Good
25-31	3	Fair
20-25	2	Poor
<25	1	Bad

2. 3.2 QoS Test

QoS parameters are used to measure and analyze the size of a data packet, delay, jitter, and throughput. Video call data in this study will be captured with a Wireshark application and stored in file format with the extension ".pcapng" which will then be analyzed as needed. Data captured by WireShark is all data that comes in or out through the network, therefore a filter is needed to separate video call data. The filter includes the CODEC type, source and destination IP addresses, and also the time when the video call was made. After the data is filtered, each packet captured is counted and analyzed according to QoS parameters such as compression data size, delay, jitter, and throughput.

3. RESULTS AND DISCUSSION

In this chapter, the results of the PSNR and QoS data collection will be presented according to the scenario that has been designed and determined beforehand. The result values show the performance of each CODEC and softphone combination tested in each scenario. The data calculation results will be used to find the best softphone for each CODEC.

Blink softphone has native H.264 and VP8 CODEC but in this study Blink only paired with H.264 because when tested with VP8, Blink can not make a video call. The Zoiper softphone can only use the VP8 CODEC because in the Zoiper's setting can only select the VP8 CODEC. The PortGo softphone also only has an H.263 CODEC as a native, therefore PortGo can not be paired with another CODEC.

3. 1. Data Compression Test

The test result obtained in this scenario is data compression size from each CODEC and softphone combination. The data compression size is captured using the Wireshark tool and it is measured in MegaBytes. The smaller the data compression is the better the capability of each CODEC and softphone combination to compress the data. The data compression size graphics for each CODEC and softphone combination is shown in Figure 9.

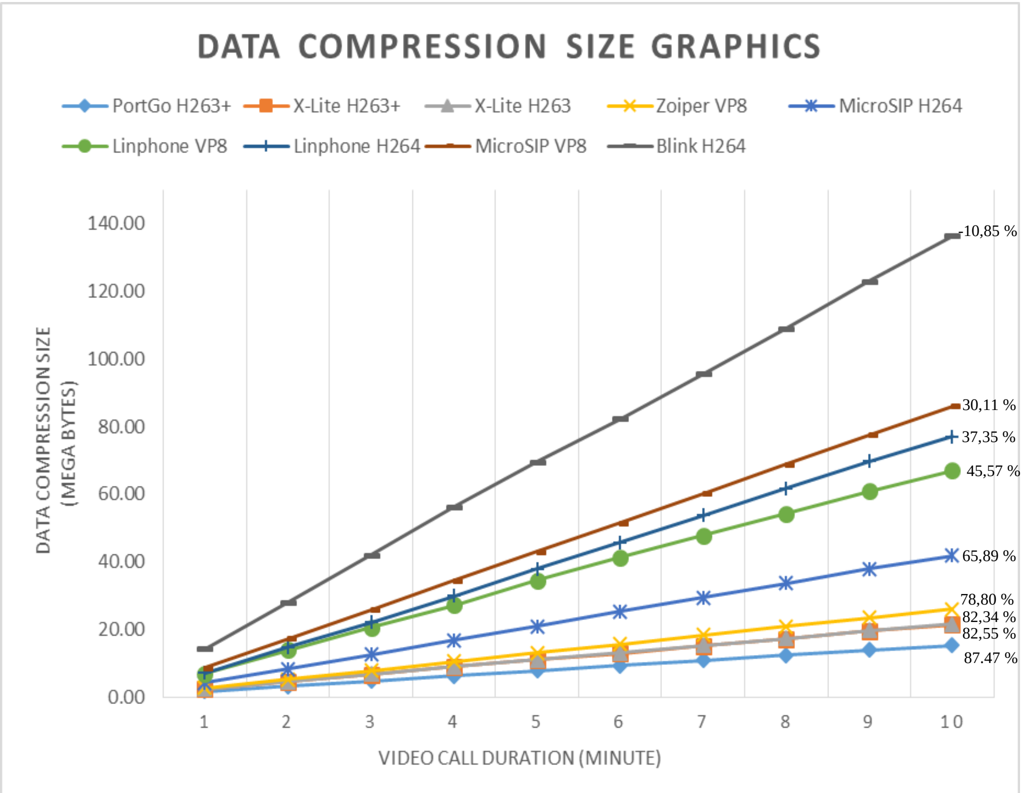


Figure 9 Data Compression Size Graphics

Calculations to get the percentage of data compression used the formula in equation (2):

$$Compression\ Percentage(\%) = \frac{(reference\ data\ size - received\ data\ size)}{reference\ data\ size} x\ 100\% \quad (2)$$

The reference video data size is 123MB. Based on equation 2, PortGo and H.263+ combination has the best compression size with a compression size of 15.41 MB or 87,47 % data compression. H.263+ and H.263 CODEC data compression are great because they can compress more than 80% from the video reference data regardless of the softphone combination. Blink and H.264 combination has the worst compression size with a compression size of 136.34 MB or -10,85% data compression. This might happen because Blink enhance the video quality so the compression size is larger than the reference video.

On H.264 and VP8 the softphones affect the video compression size more than the CODEC. The softphones can affect the compression size because some settings can not be uniformed, such as the default bit rate of each softphone that can affect the amount of data compression.

3. 2. PSNR and MOS Testing

In this research, the main parameters that will be used to see the quality of the video call process between UAS and UAC are the PSNR and MOS values of each CODEC and Softphone combination. The higher the PSNR value is the better the video call quality. The PSNR value will be converted to the MOS value to see the video call quality of each softphone and CODEC combination. The comparison table of the average PSNR and MOS in the local network and DSSDI-MIPA is shown in Table 2.

Table 2 The Average PSNR and MOS Comparison on Local and DSSDI-MIPA Networks

No	Softphone	CODEC	Local Network		DSSDI-MIPA Network	
			PSNR (dB)	MOS	PSNR (dB)	MOS
1	Blink	H.264	42.56	Excellent	41.46	Excellent
2	Zoiper	VP8	41.20	Excellent	40.27	Excellent
3	MicroSIP	VP8	39.55	Excellent	39.58	Excellent
4	PortGo	H.263+	39.37	Excellent	38.65	Excellent
5	Linphone	VP8	38.94	Excellent	37.68	Excellent
6	X-Lite	H.263+	36.06	Good	34.93	Good
7	Linphone	H.264	35.77	Good	34.54	Good
8	MicroSIP	H.264	34.80	Good	34.23	Good
9	X-Lite	H.263	34.56	Good	33.56	Good

The PSNR values on local and DSSDI-MIPA networks does not have a significant difference based on the statistic and because MOS value is the same for local networks and DSSDI-MIPA networks. The largest PSNR difference is 1,26 dB on the VP8 and Linphone combination. H.264 and Blink combination have the highest PSNR value on local and DSSDI-MIPA networks with values of 42,56 dB and 41,46 dB. This combination gets an excellent rating when converted to MOS value. However, when the H.264 CODEC is combined with Linphone and MicroSIP softphones, the PSNR value dropped to below 37 dB and when the value is converted to MOS it gets a good rating. VP8 CODEC, when combined with Zoiper, MicroSIP, and PortGo softphone, gets MOS with excellent ratings. H.263 CODEC and X-Lite softphone have the lowest PSNR value of 34,56 dB on the local network and 33.56 dB on the DSSDI-MIPA network but when it is converted to MOS the rating is still good.

3. 3. Video Call Quality Comparison Based On CODEC

The analysis in this chapter is to determine the performance of the CODEC and softphone applications and to find the best combination. The analysis is done by looking at the QoS parameters such as delay, jitter, and throughput, PSNR and MOS values, and data compression.

3. 3.1 H.264 CODEC

H.264 CODEC can be used by Blink, Linphone, and MicroSIP softphone applications. The comparison of the QoS, PSNR, and data compression sizes of each softphone application that uses the H.264 CODEC is shown in Table 3.

Table 3 Comparison of Softphone Applications That Use H.264 CODEC

H.264 CODEC										
No	Softphone	Delay (ms)		Jitter (ms)		Throughput (KiloBytes/s)		PSNR (dB)		Compression (Mb)
		Local	DSSDI-MIPA	Local	DSSDI-MIPA	Local	DSSDI-MIPA	Local	DSSDI-MIPA	
1	Blink	4.41	4.68	0.14	0.35	244.60	223.00	42.56	41.46	136.34
2	Linphone	6.76	5.70	0.44	0.54	123.80	126.00	35.77	33.56	77.06
3	MicroSIP	8.36	8.23	19.91	17.69	67.70	69.00	34.80	34.54	41.96

The QoS parameters such as delay, jitter, throughput, and PSNR value do not have significant differences when tested on both local networks and DSSDI-MIPA networks based on the statistics. When the PSNR value is converted to MOS, Blink gets an excellent rating while Linphone and MicroSIP get a good rating on both local and DSSDI-MIPA networks. Blink is the best softphone for H.264 CODEC because it has the best delay, jitter, throughput, and PSNR value. However, the data compression size of Blink is the worst when compared to Linphone and MicroSIP.

3. 3.2 VP8 CODEC

VP8 CODEC can be used by Zoiper, MicroSIP, and Linphone softphone applications. The comparison of the QoS, PSNR, and data compression sizes of each softphone application that uses the VP8 CODEC is shown in Table 4.

Table 4 Comparison of Softphone Applications That Uses VP8 CODEC

VP8 CODEC										
No	Softphone	Delay (ms)		Jitter (ms)		Throughput (KiloBytes/s)		PSNR (dB)		Compression (Mb)
		Local	DSSDI-MIPA	Local	DSSDI-MIPA	Local	DSSDI-MIPA	Local	DSSDI-MIPA	
1	Zoiper	23.91	24.30	3.47	2.31	43.40	42.90	41.20	40.26	26.08
2	MicroSIP	8.63	8.66	4.31	4.37	143.30	142.50	39.55	39.58	85.96
3	Linphone	7.40	5.18	0.54	0.78	112.80	134.10	35.77	37.68	66.94

The QoS parameters such as delay, jitter, throughput, and PSNR value do not have significant differences when tested on both local networks and DSSDI-MIPA networks based on the statistics. When the PSNR value is converted to MOS, Zoiper and MicroSIP get an excellent rating on both local networks and DSSDI-MIPA networks. Linphone gets an excellent rating on DSSDI-MIPA networks but on local networks, Linphone only gets a good rating. Zoiper is the best softphone for VP8 CODEC because it has the best PSNR value and data compression size. VP8 and Zoiper combination can compress the video data to the smallest but still has the best video quality compared to MicroSIP and Linphone.

3. 3.3 H.263+ CODEC

H.263+ CODEC can be used by PortGo and X-Lite softphone applications. The comparison of the QoS, PSNR, and data compression sizes of each softphone application that uses the H.263+ CODEC is shown in Table 5.

Table 5 Comparison of Softphone Applications That Uses H.263+ CODEC

H.263+ CODEC										
No	Softphone	Delay (ms)		Jitter (ms)		Throughput (KiloBytes/s)		PSNR (dB)		Compression (Mb)
		Local	DSSDI-MIPA	Local	DSSDI-MIPA	Local	DSSDI-MIPA	Local	DSSDI-MIPA	
1	PortGo	37.34	38.08	1.19	0.80	26.10	25.30	39.37	38.65	15.41
2	X-Lite	26.11	25.96	4.93	3.40	36.60	36.80	36.06	34.93	21.47

The QoS parameters such as delay, jitter, throughput, and PSNR do not have significant differences when tested on both local networks and DSSDI-MIPA networks based on the statistics. When the PSNR value is converted to MOS, PortGo gets an excellent rating on both local networks and DSSDI-MIPA networks while X-Lite gets a good rating on both local networks and DSSDI-MIPA networks. PortGo is the best softphone for H.263+ CODEC because it has the best jitter, PSNR, and data compression size.

3. 3.2 H.263 CODEC

H.263 CODEC can only be used by X-Lite softphone applications. The value of the QoS, PSNR, and data compression sizes of the softphone application that uses the H.263 CODEC is shown in Table 6.

Table 6 The Test Result of Softphone That Use H.263 CODEC

H.263 CODEC										
No	Softphone	Delay (ms)		Jitter (ms)		Throughput (KiloBytes/s)		PSNR (dB)		Compression (Mb)
		Local	DSSDI-MIPA	Local	DSSDI-MIPA	Local	DSSDI-MIPA	Local	DSSDI-MIPA	
1	X-Lite	27.60	27.84	5.28	3.57	36.90	36.40	34.57	34.23	21.72

The QoS parameters such as delay, jitter, throughput, and PSNR value do not have significant differences when tested on both local networks and DSSDI-MIPA networks based on the statistics. H.263 and X-Lite combination has good rating when the PSNR is converted to MOS.

4. CONCLUSIONS

Conclusion of this research is the quality of video in video calls is affected by the choice of CODEC and softphone application. Compression size of a video combination and CODEC is dependent on the throughput, the bigger the throughput the bigger the compression size.

H.264 CODEC has the best performance when combined with Blink softphone because it has the best delay, jitter, throughput, PSNR, and MOS value, but it is the worst data compression size. VP8 CODEC has the best performance when combined with Zoiper softphone, because it has the best PSNR, MOS, and data compression size. However, VP8 CODEC does not compatible with Blink softphone because the combination cannot make a video call. H.263+ CODEC has the best performance when combined with PortGo softphone because it has the best jitter, PSNR, MOS, and data compression size. H.263 CODEC and X-Lite softphone have the worst test result compared to other CODEC but it still gets a “good” rank when the value of PSNR is converted to MOS value.

This research still has some weaknesses and limitations. The suggestion that can be given from this study is conducting further research by adding network loads to see the tolerance level of each CODEC and softphone combination to unstable networks..

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