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A Guideline to Video Codecs Delay

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Abstract

Due to the explosive growth of the internet and increasing demand for multimedia information on the web, streaming video over the Internet has received tremendous attention from academia and industry. Continuous media has a lot of issues and challenges. The most important among of them are delay. Delay is an expression of how much time it takes for a packet of data to get from one point to another. Some of delay source are fixed while the other is not. This paper describes the delay sources and magnitude of the most common video codecs and thus provides a guideline for the choice of the most suitable codec for a given application.

Keywords: Continuous media, Processing delay, Encoder, Decoder

1. Introduction

Telecommunication worldwide has experienced a significant revolution over recent years. The rapid convergence of data, voice, and continuous media (CM), such as streaming video and videoconferencing (video) using IP-based network is delivering advanced services at lower cost across the spectrum including residential users, business customers of varying size, and service providers [1-3]. However, continuous media has a lot of issues and challenges. The most important among of them is delay which effect on the quality of services (QoS) [1]. In term of delay, CM suffers from delay introduced by many sources such as digital conversion (coder), compression, packetization, transmission, decompression, digital conversion vice versa (decoder), encryption, and decryption [3 - 4].

2. Packet flow for continues media

As mentioned in the previous section, the most of the delay source in real time application is: handling delay (coder delay, decoder delay, and other Digital Signal Processing (DSP) such as encryption and decryption processes, serialization delay, queuing delay, propagation delay, and network delay [4-5]. Figure1 shows the delay sources.

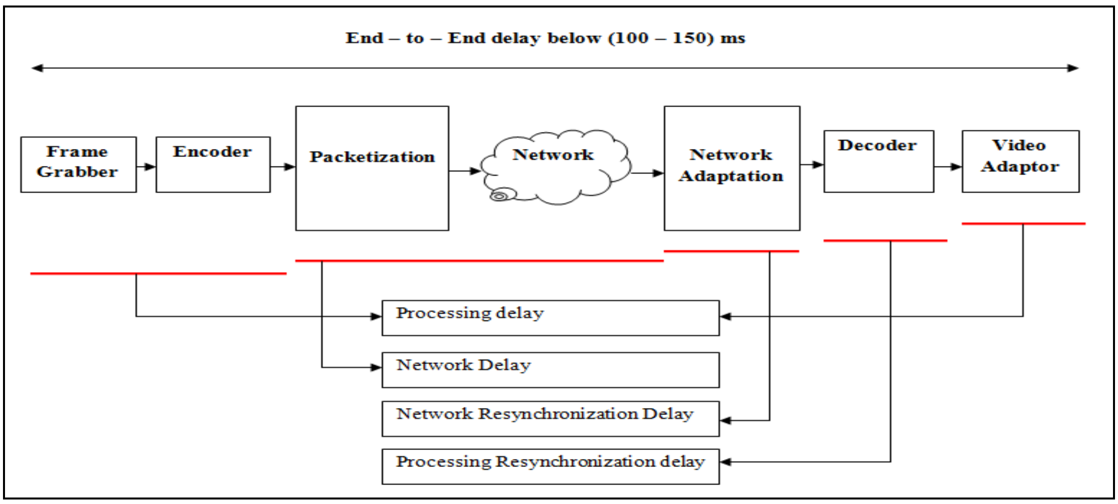

Figure 1. Delay Source of the Video Packet

One of the keys problems is keeping end-to-end delay blow human perception. Therefore, The International Telecommunications Union (ITU) has recommended the end-to-end delay of the video should be blow 100 ms [4] as shown in equation 1:

$$\text{End-to-end Delay} = PD + ND + NRD + PRD <= 100 \text{ ms} \quad (1)$$

2.1 Processing delay

Processing delay consider one of the most delay sources of real time application such as video conferencing [1]. Processing delay consist of coder delay, decoder delay, and other digital signal processing.

2.1.1 Coder delay

A video codec is a device or software that enables compression or decompression of digital video [6]. In details, video coders operate on collections of video samples known as frames. Each block of input video samples is processed into a compressed frame. The coded video frame is not generated until all video samples in the input block have been collected by the encoder (encoder buffer). Thus, there is a delay of one frame before processing can begin. In addition many coders also look into the succeeding frame to improve compression efficiency [7-8]. When the video frames are generated, packetization delay problem rises up. Packetization is the time taken to fill a packet of encoded or compressed video frames. It can be also called accumulation delay, as the video samples accumulate in a buffer (encoder buffer) before they are released. Since each voice sample experiences look-ahead and packetization delays, then these processes are overlapping [9].

The video stream requires high capacity and since network resources are limited, the video pictures should be compressed, in this paper, we have assumed a set of codecs, since they are the most popular techniques, and we have calculated the delay time for each one of them in term of minimum codecs delay in IP environments in two phases: phase one, single frame per packet, and phase two, multi frames per packet where size of the packet around 25 ms.

2.1.1.1 Single frame per packet

The time required to process an input frame is assumed to be the same as the frame length since efficient use of processor resources will be accomplished when an encoder and decoder pair fully uses the available processing power [4]. Thus, the delay through an encoder is normally assumed in the equation 2.

$$\text{Delay} = 2 * \text{Frame Size} + \text{Time to look at the succeeding frame} \quad (2)$$

2.1.1.2 Multi frames per packet

If multiple video frames are grouped together into a single IP packet, the delay through an encoder is assumed in the equation 3 [4].

$$\text{Delay} = \# \text{ frames} * \text{Frame Size} + \text{Time to look at the succeeding frame} \quad (3)$$

Based on above, we have calculated the delay introduced by each video codec's. As shown in the Table 1.

Table 1. Overall delays of various Video codecs operating at their typical bit-rates

Video codec		Application	Resolution	Bit-rate (kb/s)	Frame size (s)	Frame size (ms)	Mean One-way delay introduced by video codec (ms)		
							One frame / Packet	Multi frame of 25 ms / Packet	
							Delay	No. of frames / Packet	Delay
1.	H.264	Live Messenger	G 640x480	600	24	0.024	0.048	1042	25.024
2.	H.264	G-talk	G 512x300	1000	30	0.03	0.06	834	25.03
3.	H.264	Skype	640x480	400	30	0.03	0.06	834	25.03
4.	VP7	Skype	640x480	560	20	0.02	0.04	1250	25.02
5.	MPEG-4	X-lite	240x180	100	10	0.01	0.02	2500	25.01
6.	MPEG-4	Yahoo	320x240	768	30	0.03	0.06	834	25.03
7.	WMA	Yahoo	320x240	384	30	0.03	0.06	834	25.03
8.	WMA	Tokbox	320x240	1536	30	0.03	0.06	834	25.03
9.	WMA	AIM	176x132	22	5	0.005	0.01	5000	25.005
10.	WMA	AIM	240x180	34	6	0.006	0.012	4167	25.006

To make it clear, the following column charts showing the delay time for each of selected video codecs in Figure 2 and 3 respectively.

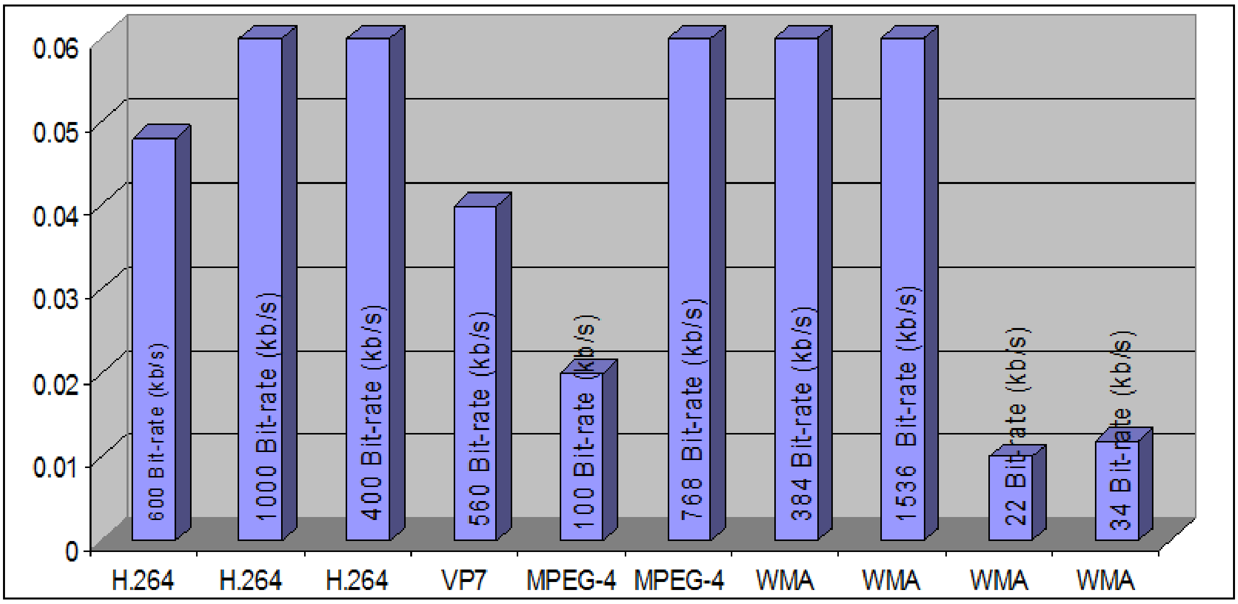

Figure 2. Codec's Delay - One Frame per Packet

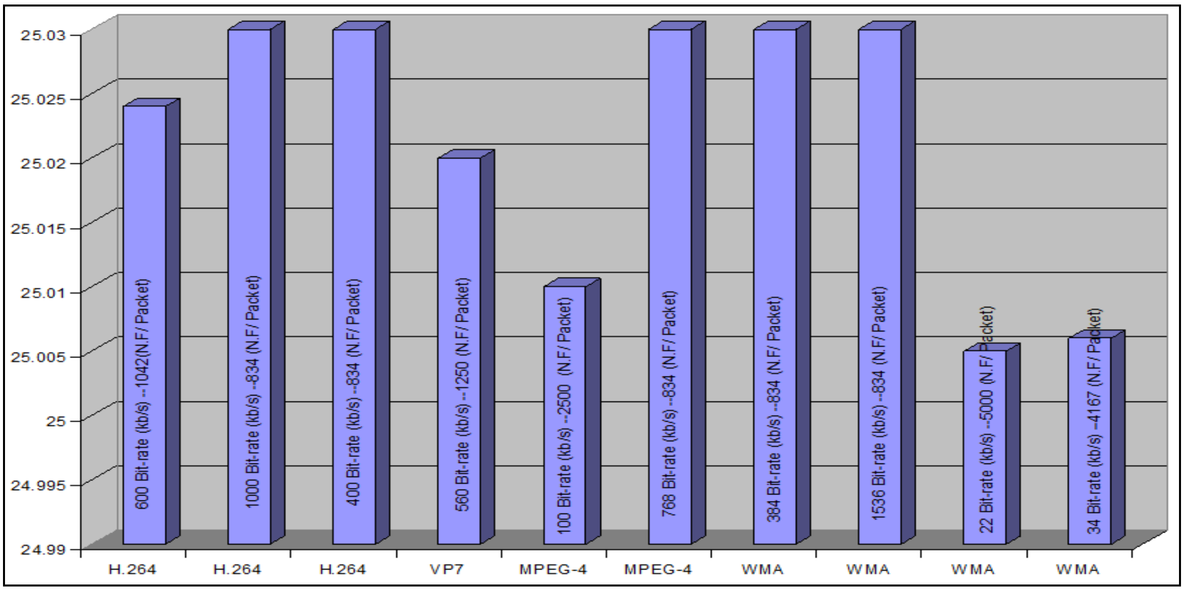

Figure 3. Codec's delay -Multiple Frames per Packet

2.1.2 Decoder delay

At the receiver side, decompression and decoding processes take place [7]. Based in our experimental test, decoder delays can be assumed to be almost half of the encode delays. To make it clear, the following column charts showing the delay time for each of selected video codecs for encoder and decoder processes.

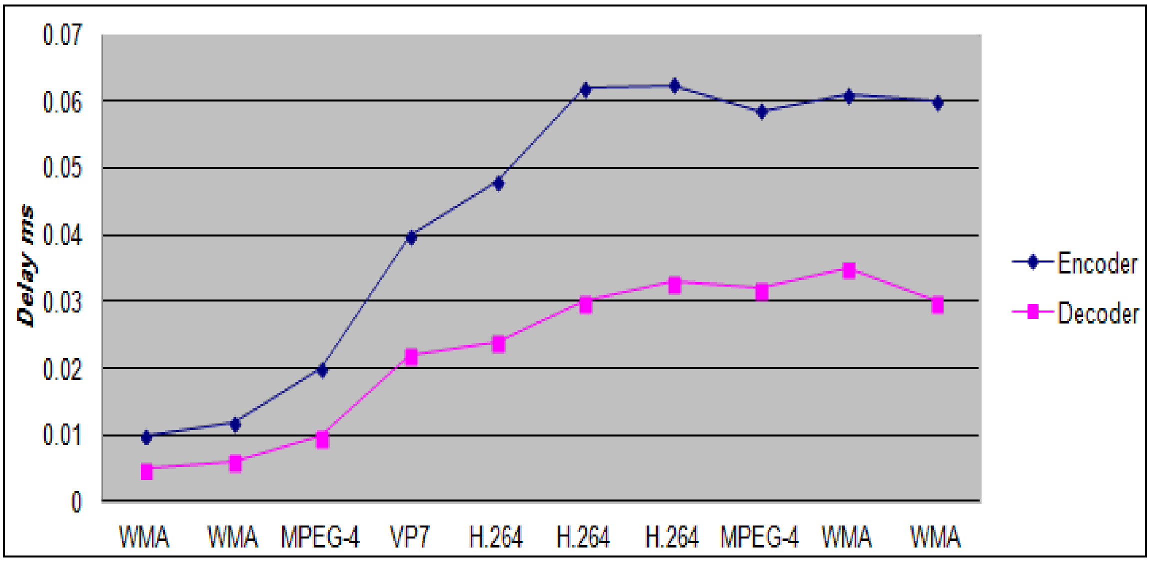

Figure 4: Encoder and Decoder Delay for Variety of Video Codec's

It is clear from figure 4, decoder delay in the most of video codec's can be assumed half of the encode delay.

3. Conclusion

It can be seen that there is a wide variety of video coders available, for a wide variety of applications. This paper described the basic delay sources of compressed video transmission system to provide a guideline for the choice of the most suitable codec. In other words, we have assumed a set of video codec, since they are the most popular techniques, and we have calculated the delay time for each one of them in two phases: phase one, single frame per packet, and phase two, multi frames per packet. And we have found coders where made for high quality, high delay, and high compression ratio as well as decode delays can be assumed to be almost half of the encode delays.

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References

[1] B. Sahoo, "Performance compassion of packets scheduling algorithms for video traffic in LTE cellular network", *International Journal of Mobile Network Communications & Telematics (IJMNCT*), (2013)

[2] Y. Wang, J. Ostermann, Y. Q. Zhang, *Video Processing and Communications, Prentice Hall*, (2002)

[3] R. M. Schreier, " A Latency Analysis on H.264 Video Transmission Systems", *IEEE Int. Conf. on Multimedia and Expo (ICME),* (2008)

[4] ITU-T Recommendation H.263 ,"Video coding for low bit rate communication", (1998)

[5] R. Schreier, A. Rothermel, "Motion adaptive intra refresh for the H.264 video coding standard", *IEEE Tr. on Consumer Electronics, Vol. 52, No. 1, Feb.* (2006)

[6] A. Ortega, "Variable bit-rate video coding", *Compressed Video over Networks*, New York, NY, (2000)

[7] R. M. Schreier, A. M. T. I. Rahman, G. Krishnamurthy, A. Rothermel: Architecture analysis for low-delay video coding", *IEEE Int. Conf. on Multimedia and Expo (ICME),* Toronto, (2006)

[8] ISO/IEC 14496-10. Information technology – Coding of audio-visual objects – Part 10: "Advanced Video Coding", (2003)

[9] Draft Spec SMPTE Standard for Television: VC-9 Compressed Video Bit stream Format and Decoding Process. *SMPTE Technology Committee C24 on Video Compression,* (2003)

[10] G. Schuller, A. Harma: "Low Delay Audio Compression using Predictive Coding", *IEEE International Conference on Acoustics, Speech, and Signal Processing (ICASSP),* (2002)