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The Study of Streaming Traffic behavior*

Sarawut Amarasing[1] and Mayuree Lertwatechakul [2]

[1] Department of Information Technology Engineering, Faculty of Engineering, King Mongkut's Institute of Technology Ladkrabang
[2] Assistant Professor, Department of Information Technology Engineering, Faculty of Engineering, King Mongkut's Institute of Technology Ladkrabang

Email: sarawut.am@gmail.com

ABSTRACT

The use of computer network has no longer been limited to sending and/or receiving files, web browses, or e-mails; it has been designed and developed continuously to serve the users' requirements. Nowadays, teleconference and entertainment online have been widely used; most of those applications are streaming traffics which would play an important role for computer network in the near future. Therefore, the understanding of the streaming traffic's working process is very important. It would be useful for better designing of the computer network system. This research studies the characteristic of streaming traffic such as on demand traffic and real-time live broadcast traffic. The various captured traffics have been analyzed and we could make a conclusion of the difference between on demand traffic and live streaming traffic behavior. And we also find the relationship between the encoding rate and the streaming traffic behavior; as when the source file is encoded with higher encoding rate, the average of the packet size increases and the packet time interval decreases. Moreover, this research also develops the streaming traffic model for both on demand traffic and real-time live broadcast traffic. The developed traffic model could generate traffic similar to the real traffic as shown in the experimental results.

Keywords : streaming traffic, traffic behavior

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INTRODUCTION

With the growing popularity of streaming applications on the Internet as to serve and support unlimited users' requirements such as video, music on the Internet, teleconference etc. Most of these applications are the streaming applications, which are very sensitive traffic with bandwidth and delay constraints.

Many designs and developments of computer network system have given precedence to streaming traffic system – such as bandwidth allocation, quality of services. Therefore, the understanding of streaming traffic behavior is still useful for network system development to efficiently support streaming traffic in the future. Our main objective is to observe the different traffic behaviors of on-demand traffic (stored-media traffic) and real-time live traffic. Moreover, we also study the relative between encoding bit rates and streaming traffic behavior. This research records traffic parameters by measuring output from RealMedia streaming traffic generated by RealServer software. And we consider the recorded data both on packet size distribution and packet time interval distribution.

BASIC BEHAVIORS OF STREAMING TRAFFIC

The behavior of streaming traffic is much different from current other Internet traffic as Web browses, e-mail and FTP. The streaming traffic uses TCP and/or UDP services to communicate by depending on purposes. But in the data transferring section, most of streaming traffic (70 -80%) uses UDP for transferring data and uses TCP to send the control signal such as play, pause, stop etc (A. Mena and J. Heidemann, 2000). Almost of the streaming traffics are highly unidirectional with the bulk of the traffic outbound from server and continuously consume network resources more longer interval than the other Internet applications.

In this study, we focus on 2 main types of streaming traffic: on-demand traffic and real-time live streaming traffic. The most popular on-demand applications are music and video on-demand. The convenience of using on-demand traffic is its ability to select portion to display the data. But for the real-time live traffic such as live broadcast radio and TV on the Internet, the same portion of the display data in that moment will be broadcasted to every user. The main different feature among real-time live application and on-demand application is an ability to select a portion of replay data.

This research studies streaming traffic from RealMedia system. The RealMedia system is the Internet solution for audio and video streaming proposed by RealNetworks (RealNetwork Inc). And the RealServer also support both types of streaming: live broadcasting and on-demand services.

For the display process, users can request published data by using RealPlayer software. Normally, users request the data by HTTP protocol or directly from RealPlayer by using Real-Time Streaming Protocol (RSTP) with start, stop, pause and fast forward control functions. Before sending a media data packet, the RealServer encapsulates data by using a UDP protocol such as the Real-Time Transport Protocol (RTP) or Real Data Transport (RDT) protocol.

In many empirical study of streaming traffic, they mentioned about the characteristic of streaming traffic as Constant-Bit-Rate (CBR) with large time scales analysis. But with small time scales, the streaming traffic pattern exhibits as the on-off pattern (A. Mena and J. Heidemann, 2000).

In the reference of another research, they also described how the streaming traffic could be determined as an on-off pattern. This is because of the encoding behavior after sending a constant number of audio packets, the encoder stops and then starts sending video packets. When this process repeats periodically, the streaming traffic exhibits an on-off pattern (Kuang, Tianbo, Williamson, L. Carey, 2002).

EXPERIMENTAL SCENARIO

This experiment has been tested in the laboratory by using RealServer software to publish video data. RealServer supports both of on-demand and real-time publishing method. To collect the traffic data, we use Ethereal software to sniff the generated data from streaming server and to provide a statistical measure of data.

As to avoid the effects from other network factor, we connected RealServer machine directly to the RealPlayer client. We did the experiment with 2 types of traffic: on-demand traffic and live-traffic to determine what the packet size distribution and packet interval time distribution of each traffic type.

Both of on-demand service and live broadcast service experiments, we used the same set of data sources as to let us compare both types of traffic under equal condition. We used action clips and talk show clips with same 5 minutes display duration for the sample source files. Since 2 types of sample have the different motion in each data frame. Normally, action clip has more motion while there are few motions in a talk show clip. Thus the encoded data from each types of sample clip were different. Moreover, sample clip files were encoded into RealMedia file format with different encoding rate: 56, 128 and 512 Kbps as shown in Table 1 and published by on-demand and real-time live publishing method on the RealServer.

Files Name	File size(MB) - Rate 56Kbps	File size(MB) - Rate 128Kbps	File size(MB) – Rate 512Kbps
Action1	1.28	3.72	16.5
Action2	1.29	3.79	16.7
Talkshow1	1.26	3.67	16.2
Talkshow2	1.26	3.64	16.1

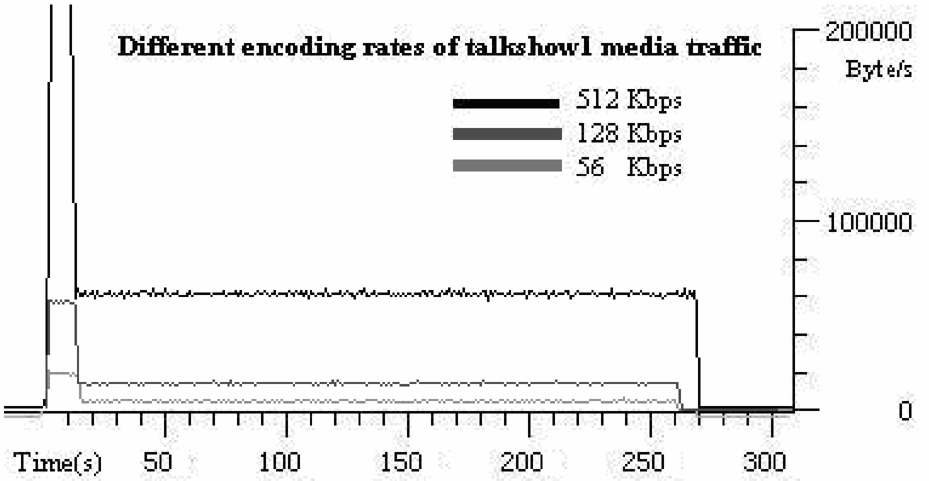
Table 1. *5 minutes sample sources in testing*

RESULTS AND DISCUSSION

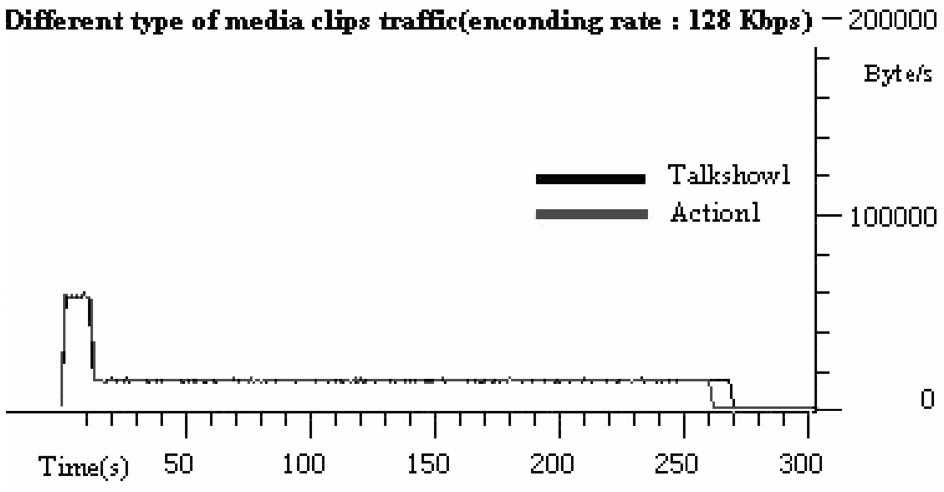
The behavior of on-demand and real-time streaming traffic

We classified the on-demand traffic data according to the sending behavior as shown in Fig 1. We noticed that the large amount of data was sent at the beginning of the transferring process and after that the server continuously sends the streaming data with regularly lower transfer rate until finishes. In the Fig 1, the play duration is 300 seconds but the data actually takes only 270 seconds for transferring. The captured traffics from the request on-demand data to http://news.bbc.co.uk (BBC News) have also shown the similar pattern. After all media data has been sent, RealServer still hold the channel as to exchange controlling packet with its client. The controlling packet is small RSTP packets (approximately 50 bytes) used for checking status of the displaying process until client stops the display or the displaying is finished.

There is the difference between the on-demand service and the live streaming service transmission process. The live streaming services continuously sent media data along the display duration while the client simultaneously displayed the received data as shown in Fig 2.

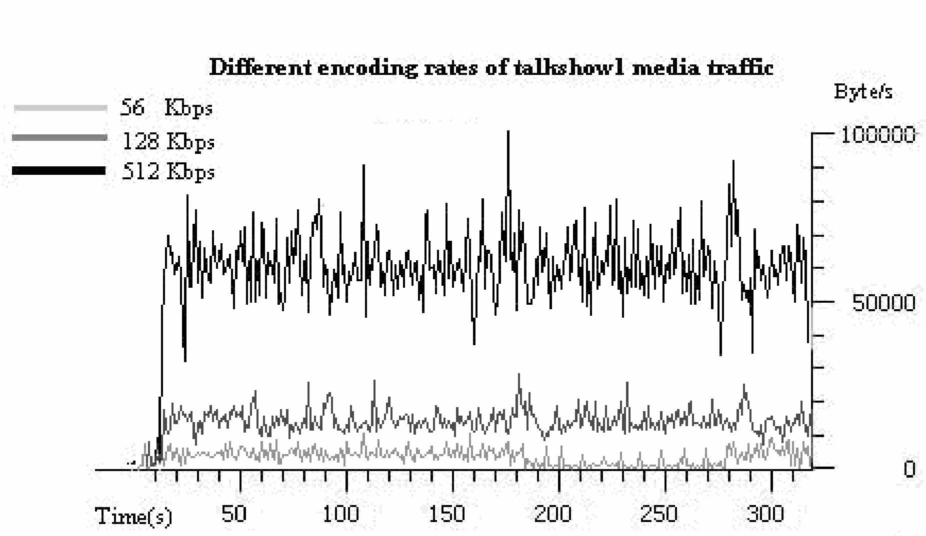


1-a) *Traffic behavior of different encoding rates*

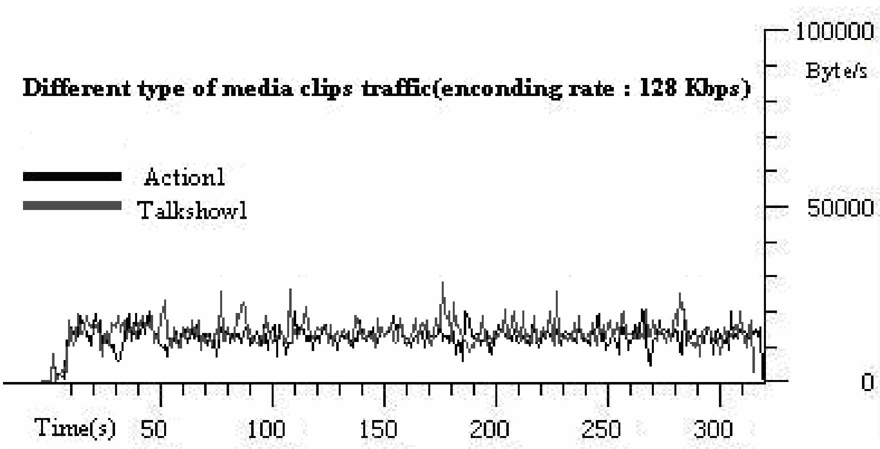


1-b) *Traffic behavior of different media clip types*

Figure 1. *Traffic behavior of on-demand traffic (Byte/s)*



2-a) *Traffic behavior of different encoding rates*



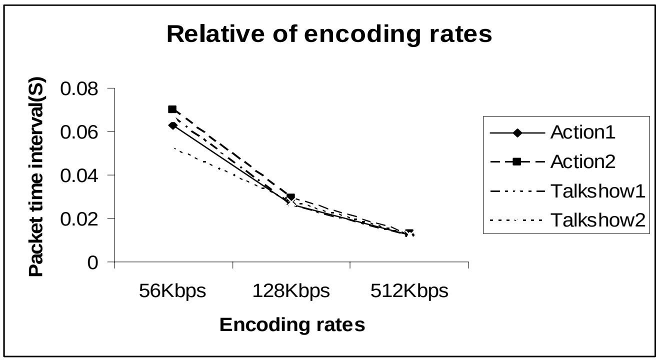
2-b) *Traffic behavior of different media clip types*

Figure 2. *Traffic behavior of real-time live traffic*

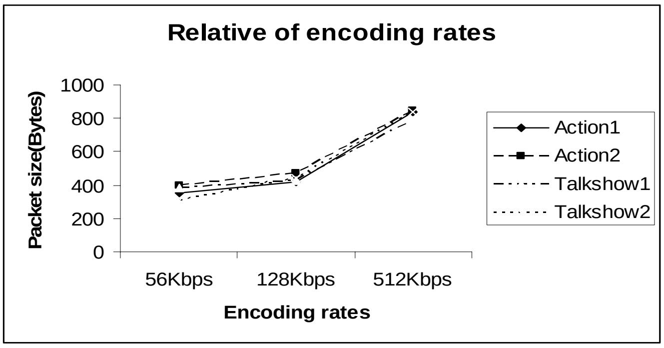
The relationship between encoding rate and traffic behavior

From the Fig. 3, it showed that there is the relationship between encoding rate and traffic behavior of real-time streaming traffic. When the source file is encoded with higher encoding rate, the average of the packet size increases and the packet time interval decreases. This mechanism helped streaming server increase transmission rate when the encoding rate is higher.

We can explain the behavior that when source file is encoded with high encoding rate, the output file is also produced in large size. Therefore, the RealServer manages packet sending process by controlling suitable packet size and packet interval time for each file. But the maximum size of packets in each replaying process is bounded to the specified encoding rate.



3-a) *The relationship between the encoding rates and packet time interval*



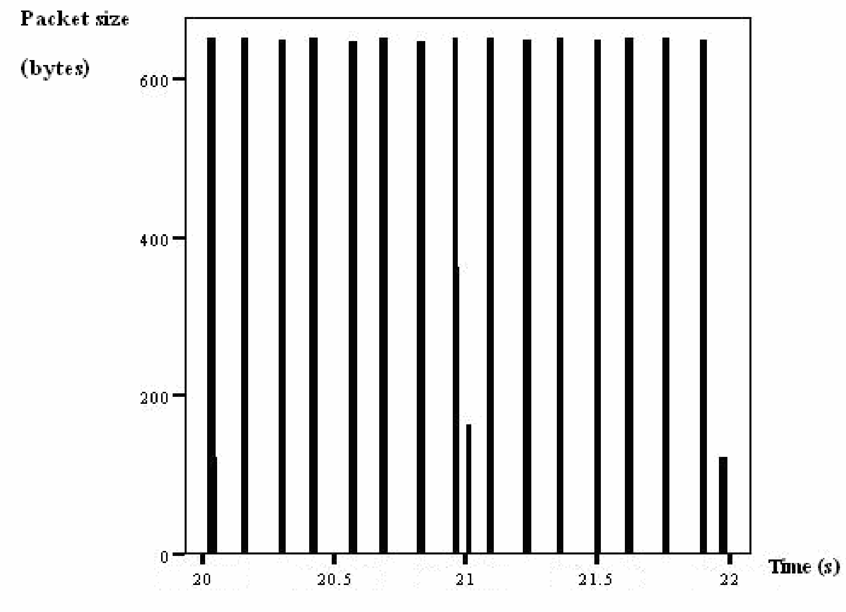
3-b) *The relationship between the encoding rates and average packet sizel*

Figure 3. *The relative of encoding rates and packet size, packet time distribution of real-time streaming traffic*

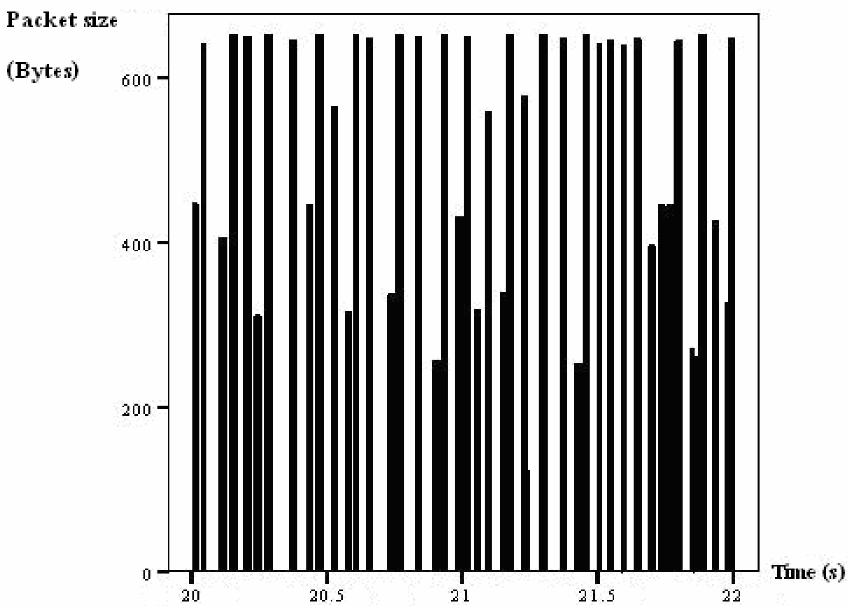
The difference between traffic behavior of the on-demand and real-time live traffic

From the results, we found the difference between on-demand and real-time live traffic behavior. In large time scales result, on-demand traffic sent large amount of data at the beginning of process and regularly followed by sending smaller number of data media packets to client. On-demand streaming traffic did not send data in all along display period. This process then finished by sending a few of controlling data to the end of displaying. This means – the media data transmission process has finished before the displaying process ended. On contrary, live streaming traffic sent the same data rate in all along the display time.

We also used the same captured data to evaluate the distribution for packet size and packet interval time. We have found that the main difference of both methods of publishing is the packet interval time distribution as shown in Fig 4.



4-a) *Packet Transferred behavior of real-time live traffic*



4-b) *Packet Transferred behavior of on-demand traffic*

Figure 4. *Streaming traffic behavior in small time scales*

Therefore, we summarized the difference between the packet time interval distribution of both publishing methods in a small time scales as shown in the Table 2 and 3, and we found that the average packet time interval is similar but the median of packet time interval is quite different. In addition, the packet time interval of the on-demand stream was regular and similar value. Therefore, the packets are sent continuously by similar packet size and interval time. Fig 4 shows that the traffic behavior of live-traffic exhibits as an on-off pattern and interval time is regular with the on period. In additional, the relationship between on-off periods is also affected by encoding rate of files.

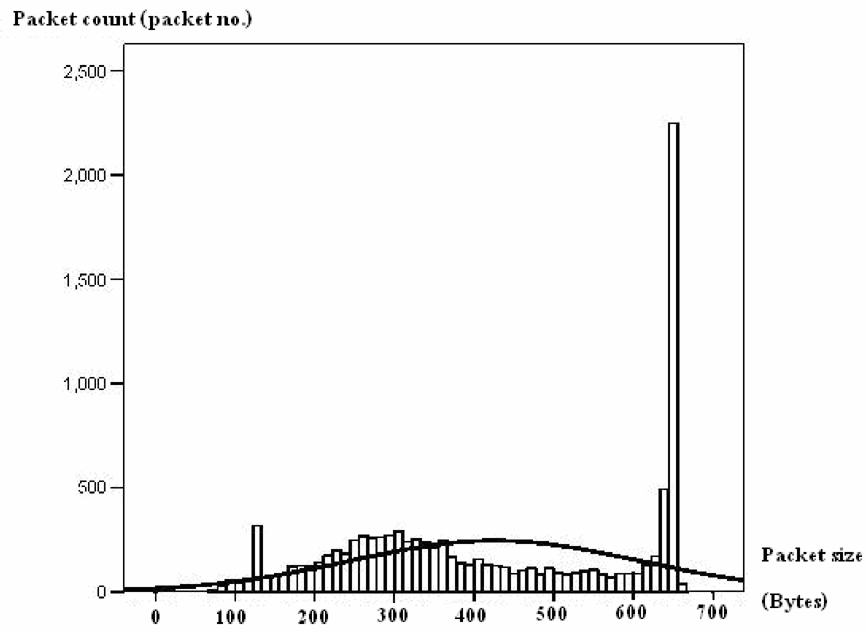
Movie Name	**56Kbps**	**128Kbps**	**512Kbps**
Action1	0.063156	0.026187	0.012644
Action2	0.070224	0.029238	0.012726
Talkshow1	0.066325	0.026007	0.011683
Talkshow2	0.052341	0.027594	0.012346

Table 2. *The relative of encoding rates and average packet time interval of real-time streaming traffic (sec)*

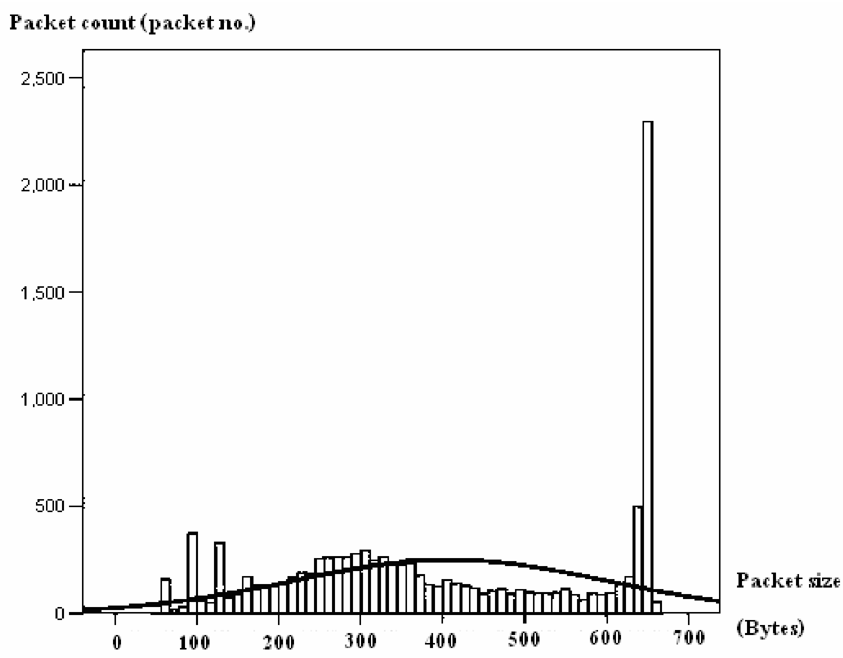
For the difference between the packet size distribution of live and on-demand traffic, the average and distribution of both types is similar. We can conclude that packet size distribution could not be used as a factor of the different traffic behavior between live service and on-demand service publishing method. As shown in Fig 5 the packet distributions of on-demand and real-time streaming traffic are quite similar.

Movie name	**56 Kbps**	**128 Kbps**	**512 Kbps**
Action1-Realtime	0.000155	0.000154	0.000111
Action1- On demand	0.060238	0.029895	0.0096
Talkshow1-Realtime	0.000153	0.000123	0.00004
Talkshow1-On demand	0.067438	0.029403	0.009679

Table 3. *Median of packet time interval (sec)*



5-a) *Packet size distribution of On-demand traffic*



5-b) *Packet size distribution of on Real-time live traffic*

Figure 5. *Packet size distribution of streaming traffic*

Simulate the streaming traffic

In this section, we simulated the streaming traffic by using NS-2 (Network Simulator-2) and compared the result with the real streaming traffic result. From the results and discussion in section IV, we can conclude that the on-demand and real-time streaming traffic behavior. The real-time live traffic model used on-off pattern to generate the traffic. The process of the Real-time function were random packet size and sent each packet in on period until end of on period after then the function stopped sending in a period of off time and resent again in on period as shown in Fig 6. When these processes repeated periodically, the traffic exhibited an on-off pattern as in the Fig 8.

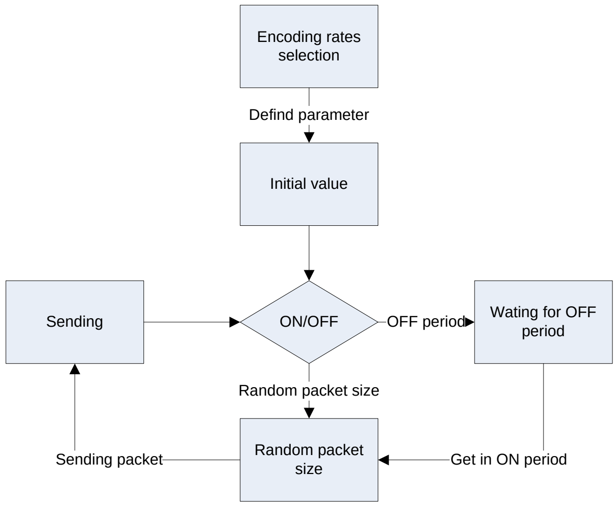


Figure 6. *Process of Real-time live traffic model*

For the on-demand streaming traffic, we used a CBR pattern to generate the traffic. By using 2 modules of generators, one for the beginning period of on-demand traffic, and the other one for the normal period of transmission by using process as show in the Fig 7 . The result of on-demand traffic generators exhibited a CBR pattern along the transmission period as in the figure 9.

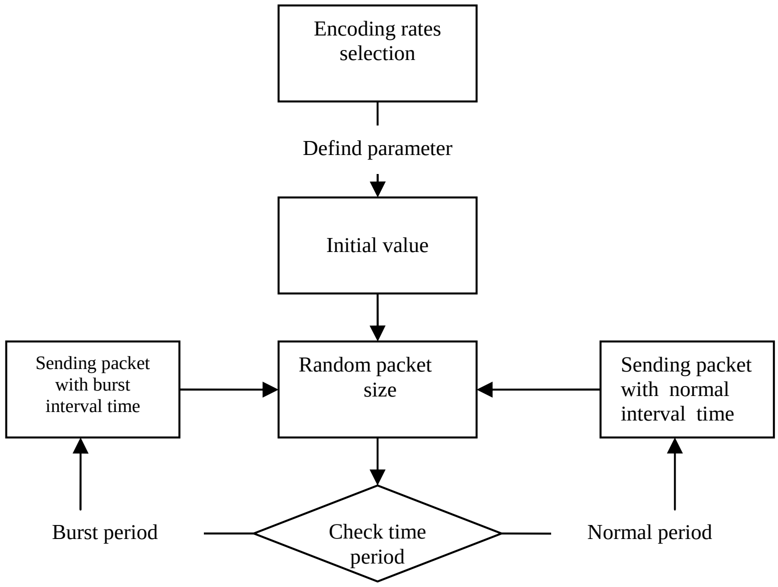


Figure 7. *Process of on-demand traffic model*

When the simulate traffic results are compared with the real streaming traffic results in the large time scales, the results showed that the pattern of generator traffic was similar to real streaming traffic pattern. And if we considered the results in small time scales as shown in Fig 9-10, the streaming traffic generators also exhibited the pattern alike to real streaming traffics.

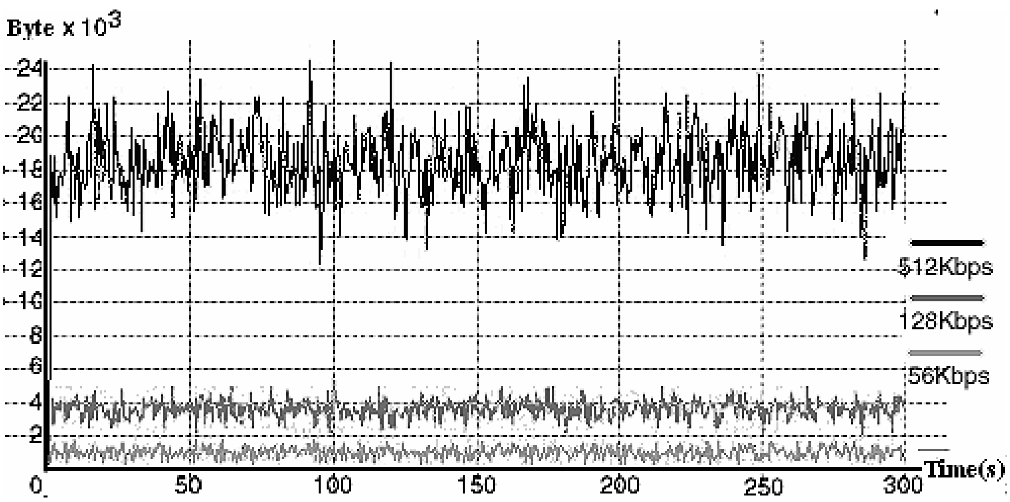


Figure 8. *Simulated traffic of real-time live traffic model*

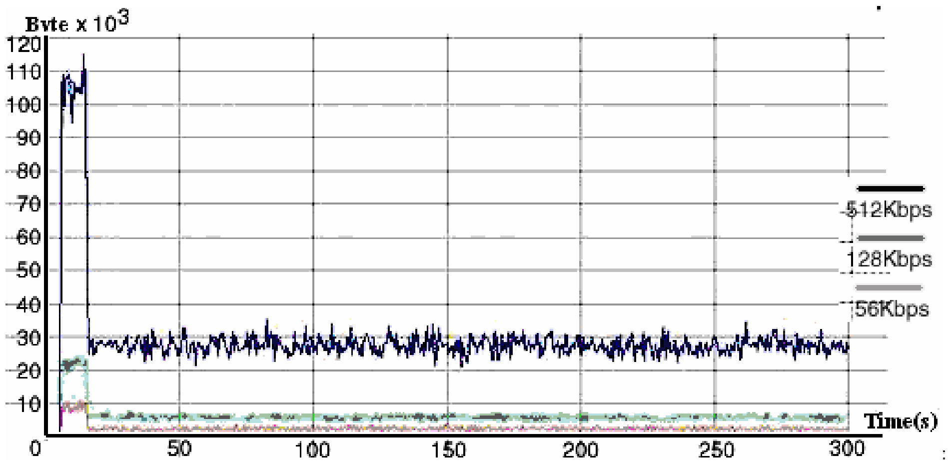


Figure 9. *Simulated traffic of on-demand traffic model*

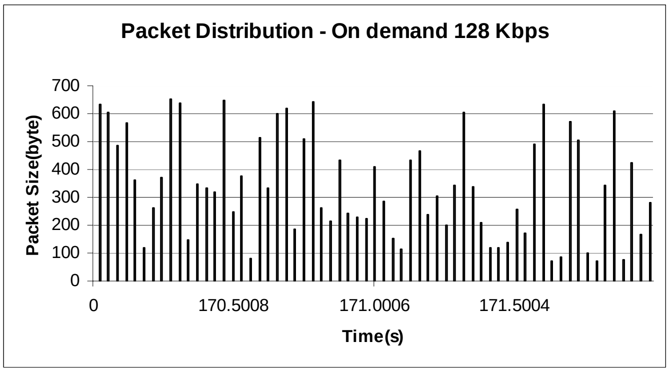


Figure 10. *Traffic behavior of on-demand traffic model in small time scales*

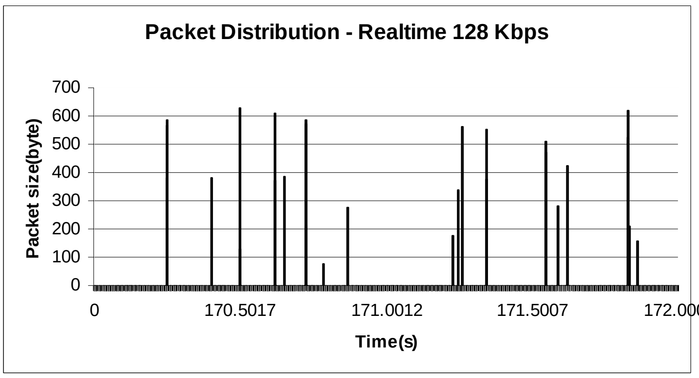


Figure 11. *Traffic behavior of real-time live traffic model in small time scales*

But there was slightly difference from the actual packet size of the real streaming traffic and the packet size of traffic generator. Since, the actual packet size was dependent on the actual data size and content of the data. But in the traffic generator, we used random function to generate the packet size. Thus, this was the factor that made the results get some different value.

CONCLUSION

In this paper, we considered the streaming traffic behaviors to find the difference between the on-demand traffic and real-time live traffic. The real-time live traffic sends media data with almost constant bit rate through the display period. On the contrary, we have found that on-demand traffic sends large amount of data to client buffer at the beginning of the transferring process and sends regular streaming data until finished with lower transfer rate. When we considered within a block of small time scales, we found that the RealMedia system uses time interval to be mechanism for controlling data transfer process. On-demand traffic sends continuous data to client buffer by constant bit rate but real-time live streaming traffic exhibits as on-off pattern. This paper also concerns on the relationship between encoding rate and traffic behavior. And the results showed that changing in the encoding rate has directly effect to packet size distribution, packet interval time distribution and on-off period duration. These results will be helpful in study and for designing the suitable system for streaming traffic.

This research develops the streaming traffic generator models for on-demand and real-time streaming traffic from the analytic results in section IV by using NS-2 and simulate traffic with these traffic model. We also compare the results the traffic generator from the model and real streaming traffic. The pattern of simulate results exhibit the pattern similar to real streaming traffic pattern.

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