

Back-to-Back Networking for Traffic Characteristics on Digital Video Transmission System (DVTS)

Puttinun Patpituck, Suthin Yokbua, Seksan Phosri, and Nopphol Pausawasdi

Abstract—Nowadays, real-time video communication is an increasingly popular application for real-time demonstrations and/or interactive teleconferences offering original quality and assuring smooth movement of the video with clarity of sound over an Intra-Domain and Inter-Domain network. Traffic characteristics analysis are needed to improve the quality service for real-time video communication systems. It is necessary for simulation and study. Recently, VoIP, HTTP, FTP, SMTP and other Internet protocol applications have already been widely studied. However, a characteristic of Digital Video Transmission System (DVTS) is high-quality real-time audio and visual communication which are rarely studied. Therefore, this paper presents characteristics of DVTS over Intra-Domain traffic based on terms of time-delay (msec), packet size distribution (byte), and packet arrival rate (pps). Effects of variable bandwidth are also investigated. In addition, the packet interval time (pps) is represented in the form of Probability Density Function (PDF). The results are very useful for applying to generating and/or simulating DVTS traffic in order to evaluate QoS capability.

Index Terms—Digital Video Transmission System (DVTS), traffic characteristics, teleconferences, telemedicine.

I. INTRODUCTION

Recently, there has been much research about traffic characteristic analysis of HyperText Transfer Protocol (HTTP), TELEcommunication NETWORK (Telnet), File Transfer Protocol (FTP), Simple Mail Transfer Protocol (SMTP), Domain Name System (DNS), Voice over Internet Protocol (VoIP) and other Internet applications in terms of bandwidth usage, packet length (size) distribution (byte) and, volume of packet arriving rate (pps) [1]-[7]. The packet arrival rate is normally measured in a unit of packet per second (pps). The packet length and the packet arriving rate (pps) of VoIP, Telnet, DNS, SMTP, HTTP and FTP on LAN are listed in [1]-[7]. Mean packet lengths are 66.8, 104, 128, 446, 504, 752 bytes for VoIP, Telnet, DNS, SMTP, HTTP, and FTP traffic, respectively. In [1], the internet traffic stream is analyzed in terms of bandwidth usage (byte). There are three types of traffic: Web TCP, Non-Web TCP and UDP. It is found that Web TCP traffic is of the highest volume and UDP traffic is of the lowest volume for both university networks. In [3], Fowler et al. studied traffic characteristics of congestion on LANs with connectionless service. This analysis was presented in terms of packet arrival time by daily in order to understand congestion

management for each application, e.g., FTP, HTTP etc. In [4], there were three traffic models measured as follows: Wired-line LAN, WAN and Intranet. This study focuses on the relationship of IP packets length in bytes and frequency as percentages. The packet length distribution and packet interval time or packet arrival time (pps) of WAN, Wired-line LAN and Intranet traffic are presented. The highest percentage of IP packet length is 46, 144, and 46 bytes on WAN, Wired-line LAN, and Intranet traffic, respectively. In [7], Thompson, et al. reported traffic characteristics that were measured from WAN traffic in terms of traffic volume, flow volume, flow duration and packet size from two locations on an internet Microwave Communications Incorporated (MCI) commercial backbone. Additionally, traffic composition, in terms of IP protocols, TCP and UDP applications, was presented.

Traffic patterns and characteristics are important for network design. Additionally, it is necessary for QoS routing which relates to a constraint of delay-sensitive applications. The constraint of VoIP is that time-delay in a one-way direction of VoIP packet should be less than 150 ms [2], [5]. Telnet's constraint is that teletyping in Telnet should be below 150 ms [1]-[3], [6], [7]. A display of each webpage on browsers (e.g., IE) should be less than 5s [8]. Chen et al. [9], analyzed, compared, and summarized HTTP characteristics and trends in future networks. Currently, the most traffic in backbone and residential access networks is World Wide Web (WWW) traffic. The WWW traffic has been studied extensively in the past, but some of its characteristics have not been covered before. Yang et al. [10], analyzed and characterized the HTTP behavior from an institute Wired-line LAN using a custom program to capture on source or destination port 80. The level of HTTP message in length, and duration distribution of HTTP request and response were analyzed and presented in the form of the Cumulative Distribution Function (CDF). It was found that the size distribution of HTML file in HTTP response has changed only slightly compared with the data measured 10 years ago, when Shimizu et al. [14] conducted 49 teleconferences in 33 medical institutions. Questionnaires were used to evaluate the quality of video and sound system. The reported survey is 70.6%, 22.5%, 2.7%, 1.7%, and 2.5% on very good, good, poor, very poor, and nonresponsive, respectively. In [15], questionnaires reported that 100 teleconferences over the inter-domain are very attractive in terms of good quality. Up to now, the research about DVTS traffic characteristic analysis has rarely been studied. This paper is to analyze DVTS traffic characteristics and two proposed factors; both DVTS characteristic factors and network characteristic factors in terms of statistics are very useful for DVTS traffic simulation, Quality of Service (QoS) testing, and gridline for network design.

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The rest of this paper is organized as follows. In Section II, background is as an introduction. In Section III, experimental setups are explained. Section IV provides the experiment results. Finally, Section V gives conclusions and future work to be presented.

II. BACKGROUND

This section consists of two smaller sections which are as follows: the first relates to Digital Video Transmission System (DVTS), the other is Traffic Characteristic Analysis.

A. Digital Video Transmission System (DVTS)

The Digital Video Transmission System (DVTS) concept is freeware that was developed by the WIDE project. The DV (Digital Video) streams using IEEE1394 interface are sent and received over the Internet protocol with RTP (Real-Time Transportation Protocol). There are 29.97 frames per second (fps) for full digital video stream [11]. It works on both IPv4 and/or IPv6. Basically, the DVTS configurations are (1) personal computer (PC) with operating system, e.g., Windows, MacOS, and/or Unix, (2) IEEE1394 device driver and interface, (3) DV Camcorder, (4) DVTS application, (5) IP network, and (6) Projector or LED Monitor [11] as shown in Fig. 1.

Okamura *et al.* [12], established 20 events for medical video transmission (e.g. endoscopic surgery, microscopic surgery, ERCP procedures, and microscopic pathology) over Internet protocol among four countries in the Asia-Pacific region, which are as high-quality as the original digital video. In [13], tests were conducted 49 international surgical teleconferences with original-quality moving images in 33 medical institutions. Questionnaires were used to evaluate the quality of video and sound systems. The reported survey result are 70.6%, 22.5%, 2.7%, 1.7%, and 2.5% for very good, good, poor, very poor, and nonresponsive, respectively.

Telemedicine is used to provide medical information and services, e.g., live surgical demonstrations using telecommunication technologies [14]. In [15], questionnaires reported that 100 telecommunities over the inter-domain are very attractive in terms of quality.

B. Traffic Characteristic Analysis

Basically, there are two main factors for network simulation: the first is an application factor: packet interval time distribution and packet size distribution; the other is network factors that include delay and loss [1], [3], [4], [7].

Ito *et al.* [4], represented the traffic measured at Bellcore Morristown Research and Engineering facility on October 10 and August 9, 1987 at approximately one million packets. There were three environment traffic models measured: LAN, WAN and Intranet. This focuses on two factors; the first is IP packet length distribution with sizes from 64 to 1,518 bytes in terms of histogram and the other is packet interval time in the form of PDF. The highest percentage of IP packet length are 46, 144, and 46 bytes on WAN, LAN, and Intranet traffic, respectively.

Thompson *et al.* [7], introduce the patterns and characteristics of the Internet traffic that measures actual network from OC-3 trunks at MCI's commercial Internet

backbone over 24 hours and 7 days at about 240,000 flows, in terms of packet size, traffic volume, flow volume, flow duration, traffic composition, and TCP and UTP applications. Fowler *et al.* [3] studied traffic characteristics of congestion on Wired-line LAN with connectionless service. This analysis was presented in terms of packet arrival time by daytime in order to understand congestion management.

Until now, research of DVTS traffic characteristic analysis that focuses on packet size distribution and packet interval time in terms of PDF has rarely been studied. Therefore, there is a need to study DVTS traffic in order to support QoS for simulation, network design, and traffic engineering.

III. EXPERIMENTAL SETUP

In this section, there are two sub-sections as follows: the first is network configuration and network analyzer tools, and the other is experiment configuration.

A. Network Configuration and Network Analyzer Tools

In this sub-section, there is an intra-domain network with non-background traffic environment as shown in Fig. 1. It consists of (1) The DV camcorder connected to a PC sender site (2) IEEE1394 (FireWire) cable (3) Sender's computer (4) Receiver's computer (5) Ethernet switch 10/100/1000 Base-Tx (6) Traffic monitor computer (7) OS, DVTS application, and traffic monitoring tools.

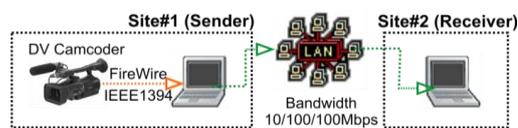


Fig. 1. The DVTS network configuration

For all experiments the equipment used were two HP Elitebook 8540W Mobile Workstations with CPU Intel Core i7-720QM, processor speed: 1.60 Ghz, display: 15.6-inches diagonal 16:9 LED-backlit HD 1,920x1,080 pixels, DDR3 4,096 MB, Hard drive SATAII 500 GB. Their operating systems were Microsoft Windows XP Professional with service pack 3 and DVTS for Windows XP version 0.0.2. The interface ports of the Ethernet switches were connected with two sending computers, receiving computers and another computer for traffic monitoring with speeds of 10/100/1000 Mbps.

Both the sending computer and receiving computer sites have a network protocol analyzer that is known as PRTG (Paessler Router Traffic Grapher) network monitor tool, and Internet Control Message Protocol (ICMP) monitor tools for measuring the nature of DVTS.

The ICMP monitoring tools using hrPing v3.13 continually sent ICMP packet with operational [options] as follows: (1) [-t -l 1024] continue Ping with packet size 1,024 bytes, (2) [-s 100] interval between packets is equal to 100 ms, (3) [-T] Print timestamp, (4) [-F file.txt] saves the log output as a file.txt as shown in Fig. 2.

```
C:\>hrping -t -l 1024 -s 100 -T -F log.txt 192.168.1.2
```

Fig. 2. The operation options for hrPing.exe

The DVTS bandwidth consumption was measured at an

interface of the Ethernet switch using the PRTG Traffic Grapher network monitor tool version 6.1.1.855. The interval between capture the packets is equal to 1ms.

The network protocol analyzer known as Wireshark v.1.6.5 starts capturing the DVTS packets on both sender and receiver sites and saves them in the file type of Packet CAPture (.pcap)

B. Experiment Configuration

This sub-section explains experimental configurations. There are four main experiments. The first experiment is to observe the effect of variable bandwidth on pingRTT. The second experiment is to study the bandwidth consumption of DVTS traffic. Experiment 3 is to compare the packet interval time of DVTS traffic between sender and receiver over speeds of 10, 100, and 1,000 Mbps in the form of PDF. Experiment 4 is to find the packet size distribution in bytes.

IV. EXPERIMENT RESULT

This section consists of four experiment results; pingRTT, bandwidth consumption, packet interval time, and packet size distribution.

A. Result of Experiment 1-- Ping Round Trip Time (RTT)

The goal of this experiment was to investigate the effect of DVTS traffic load using pingRTT and variable bandwidths from 10, 100, and 1,000 Mbps. This experiment presents the PingRTT with and without DVTS traffic. There are two interesting ranges as shown in Fig. s 3, 4, and 5.

- In the first range (1 to 300 packets), there is only ping ICMP packets using hrPing sent continually from receiver to sender every 100 ms with a packet size equal to 1,024 bytes, as shown in Fig. 3.
- In the second range (301 to 600 packets), there are two parts running simultaneously. In the first part, ping ICMP packets using hrPing are sent continually from receiver to sender every 100 ms with packet size equal to 1,024 bytes. In the other part, the sender started sending DVTS. It was measured on 12/09/2011, and 19/09/2011.

Fig. 3 presents the comparison of PingRTT packets without DVTS (1 to 309) and PingRTT packets with DVTS (310 to 600) over data-rate of 10Mbps. It can be seen that when the traffic of DVTS starting at the average of Ping RTT is increased up to 110 times it compares with ICMP only in the first range.

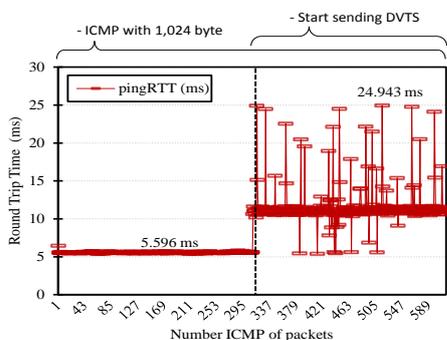


Fig. 3. A comparison of PingRTT with and without DVTS and PingRTT packets with DVTS over a data-rate of 10Mbps

Table I shows the lost, minimum, maximum, average, and standard deviation of pingRTT between “with DVTS” and

“without DVTS” traffic, which is over LAN 10 Mbps. From the result in column 6, it is found that the standard deviation of pingRTT introduces itself at 3,362.50% when compared to non DVTS traffic. In the maximum at column 5, the contrast of values is shown when starting the DVTS traffic. Additionally, the relationship among minimum, maximum, average, and standard deviation of pingRTT are always in the same direction.

TABLE I : STATISTICS FOR ICMP WITH AND WITHOUT DVTS TRAFFIC (10MBPS)

Type	Lost	Min	Avg	Max	Std.
Without DVTS	0	5.40	5.56	6.44	0.08
With DVTS	0	5.38	11.66	24.94	2.77
% - +	0	-0.37	109.71	287.27	3,362.50

Fig. 4 displays the pingRTT packets with and without DVTS over wired-line LAN 100Mbps. It is found that the average of pingRTT increases 37.20 % when compared with ICMP only in the first range.

Table II shows the lost, minimum, maximum, average, and standard deviation of pingRTT between with DVTS and without DVTS traffic, which is over LAN 100 Mbps. From the result in column 6, it is found that the standard deviation of pingRTT introduces itself at 2,042.86% when compared to non-DVTS traffic. The relationships among minimum, maximum, average, and standard deviations of pingRTT are always in the same direction.

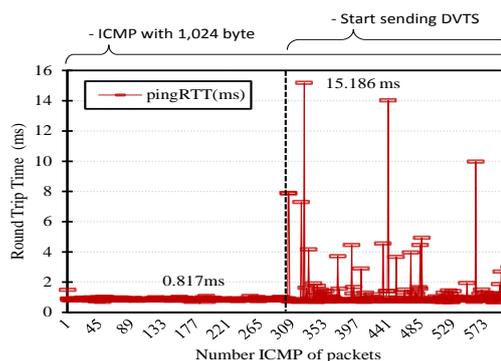


Fig. 4. A comparison of PingRTT with and without DVTS and PingRTT packets with DVTS over a data-rate of 100Mbps

TABLE II: STATISTICS FOR ICMP WITH AND WITHOUT DVTS TRAFFIC (100MBPS)

Type	Lost	Min	Avg	Max	Std.
Without DVTS	0	0.69	0.86	1.49	0.07
With DVTS	0	0.66	1.18	15.18	1.50
% - +	0	-4.35	37.20	918.80	2042.86

Fig. 5 displays the pingRTT packets with and without DVTS over wired-line LAN 1,000Mbps. It is found that the average of pingRTT increases 155.56 times when compared with ICMP only in the first range.

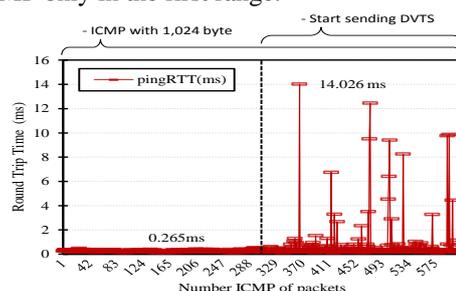


Fig. 5. A comparison of PingRTT with and without DVTS and PingRTT packets with DVTS over a data-rate of 1,000Mbps

Table III shows the lost, minimum, maximum, average, and standard deviation of pingRTT between with DVTS and without DVTS traffic, which is over LAN 100 Mbps. From the result in column 6, it is found that the standard deviation of pingRTT is introduced up to 2,300 times when compared to non DVTS traffic.

TABLE III: STATISTICS FOR ICMP WITH AND WITHOUT DVTS TRAFFIC (100MBPS)

Type	Lost	Min	Avg	Max	Std.
Without DVTS	0	0.13	0.27	0.52	0.07
With DVTS	0	0.11	0.69	14.02	1.68
% - +	0	-15.38	155.56	2596.15	2300.00

B. Result of Experiment 2—Bandwidth Consumption

Normally, generic video conferencing needs a bandwidth of approximately 384 kbps to 12.6 Mbps including overhead network. For this experiment, all of the DVTS packets that transmit from the sender to receiver computer over an interface of Ethernet switch in an intra-domain network were captured and analyzed by the PRTG Traffic Grapher network monitor tool. The interval between packets captured is equal to 1ms. This was done on September 21, 2011 between 01.00 PM. to 02.00 PM. It is found that the average bandwidth with high-quality voice and video stream is about 29 Mbps, maximum bandwidth is approximately 29.69 Mbps, and minimum bandwidth is approximately 27.41 Mbps per channel, as shown in Fig. 6 and 7.

Results in Fig. 6, display the natural patterns of DVTS bandwidth that show there are increase and decrease linearly. More detail can be found in Fig. 7. It is important to note that the bandwidth consumption is seasonality. This is because the patterns are always introduces itself in the same direction.

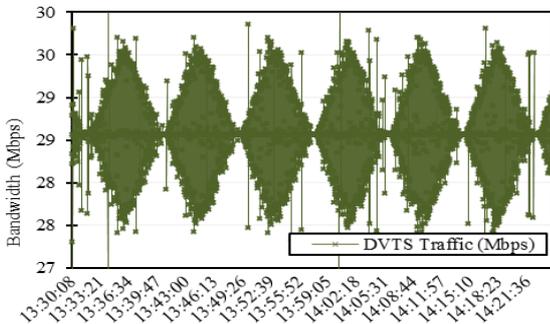


Fig. 6. The nature of DVTS traffic in bandwidth consumption as measured with PRTG Traffic Grapher network monitor tool

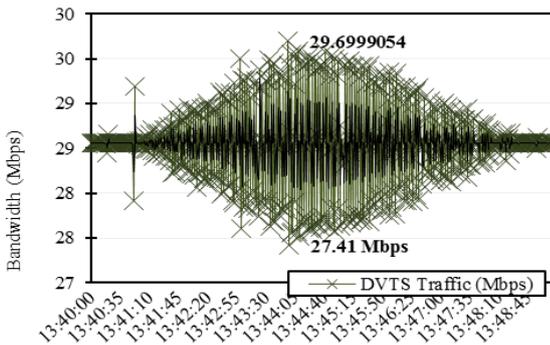


Fig. 7. More details of DVTS traffic in bandwidth consumption

C. Result of Experiment 3—DVTS Characteristics between Sender and reCeiver on Variable Bandwidth from 10, 100, and 1000 MBPS.

This experiment focuses on the packet interval time that is one of the important parameters for packet traffic simulation. This is divided into three sub-experiments. In each sub-experiment, there are two different environments: the first site is the DVTS sending computer, and the other site is DVTS receiving computer that captures all packets with the Wireshark tool which includes six DVTS flows that consist of more than 2,500,000 packets per flow.

The graphs of packet interval time distribution on both sites are shown in the below Fig. 8 for comparison. The red line is from the DVTS-sending computer, The green line is from the DVTS-receiving computer, as shown in Fig. 8 to 10. The result of Fig. 8 show the packet interval time during 0.00 to 1.30 ms of both sites in the form of PDF. It is seen that the DVTS-sending computer there is one major curve and two smaller curves, and on the DVTS-receiving computer with the green line it can be seen that there are two curves. It provides the definition in nature of the patterns of DVTS style on Wired-line LAN over a data-rate of 10 Mbps.

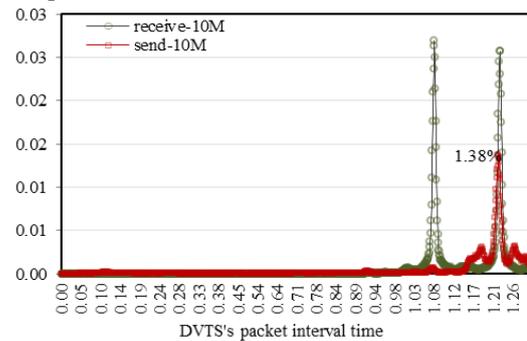


Fig. 8. The comparison between DVTS-sender and DVTS-receiver in packet interval time over Wired-line LAN 10Mbps

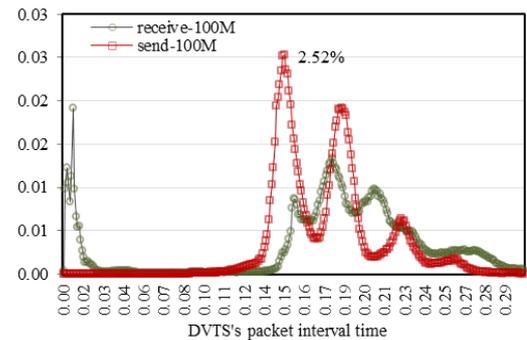


Fig. 9. The comparison between DVTS-sender and DVTS-receiver in packet interval time over Wired-line LAN 100Mbps

Fig. 9 shows the packet interval time between 0.00 and 1.30ms. It can be seen that there are two major curves and one small curve for the DVTS-sender, while there are three small curves for the DVTS-receiver. It can be seen that both graphs the patterns are not similar.

In Fig. 10 it can be seen that both of the graph patterns of the DVTS-sender and the DVTS receiver are different; there is one major curve and two smaller curves for the sender site, while there is only one curve for the receiver site.

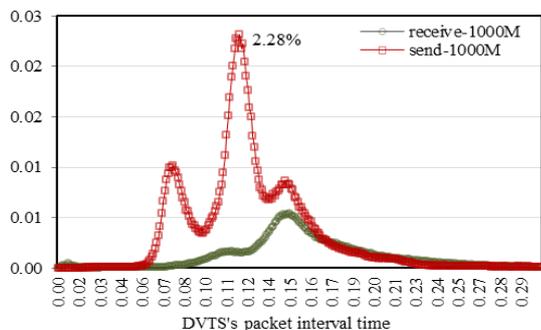


Fig. 10. The comparison between the DVTS-sender and the DVTS-receiver in packet interval time over Wired-line LAN 1000Mbps

From the comparison of the DVTS-sender and the DVTS-receiver, it is found that the PDF graph patterns are quite different. The DVTS-sender gives higher curves than the DVTS-receiver. However, the number of curves is also different, except on a data-rate of 10 Mbps. As per the result shows in Fig. 8 to 10, the definition of the nature of DVTS on data-rates from 10, 100, and 1,000 Mbps is indicated.

D. Result of Experiment 4-- Packet Size Distribution

The packet size distribution of DVTS measurements on a clean network of approximately a million packets, using the Wireshark network analyzer. From table 4, it can be seen that the highest volume of packet size distribution is 1,414 bytes (99.05%). The second highest is 1,254 bytes (0.94%) and the third highest is 92 bytes (0.0017%). The lowest packet size is 257 byte (only 0.0001%).

TABLE IV: STATISTICS FOR IP PACKET SIZE DISTRIBUTIONS

Packet size (byte)	92	257	1,254	1,414
Frequency of length (%)	0.0017	0.0001	0.9433	99.0549

V. CONCLUSION

This paper analyses the traffic characteristics of Digital Video Transmission System (DVTS) in an intra-domain network. The proposed consist of two interesting factors: the first is DVTS factors, which contains packet size distribution, packet interval time, and bandwidth consumption, and which are represented as the DVTS characteristic factors. The other is a relating factor that consists of an average pingRTT and ping standard deviation, which are represented into network characteristic factors. Both factors mentioned above are presented in terms of statistics. From experimental results, it is found that the DVTS characteristics on variable data-rates from 10, 100, and 1,000 Mbps are quite different. The nature of DVTS for full digital video whose average bandwidth is 29 Mbps, maximum bandwidth is 29.69 Mbps, and minimum bandwidth is 27.41Mbps per channel.

Furthermore, the traffic characteristic comparison and analysis of the nature of DVTS between an intra-domain and inter-domain network will be studied.

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