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On the Delay and Quality of DV Transmission Systems using ATM Networks

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Abstract

In these days, transmitting DV data which needs 28 Mbps traffic has been possible, because public ATM networks, like Japan Giga-bit Network(JGN)can be used. DV system is not only good quality of audio and video, but also has small processing delay. DV system is suitable for interactive systems like teleconferencing for the small delay. In this paper, we report the result of measurements of delay time of DV systems on JGN. DVTS over IP and SONY SEU-TL100 over ATM are measured. The delay time of the systems are 90 - 220 msec including NTSC / DV converter. The delay time of the ATM network is 11 msec for Tokyo-Osaka that varied for distance and routes. Jitters are also varied for congestion. The jitters make the quality of DV decrease rapidly when system buffers are small.

1. Introduction

In these days, large area wideband network has become available in Japan, such as Japan Giga-bit Network (JGN) [1] which has begun its services since last year. Because the conventional narrow band Internet was mainly used up to now, the video transmission system used at first was MBONE [2] tools such as vic & vat by that group which used high performance UNIX workstation. Recently, a lot of systems, like Microsoft Net Meeting, CU-See Me, and Picture Tel, etc., to which H.323 [3] conforms have come to be used, because the personal computer has come to be able to process. However, the picture quality has been insufficient yet. Though the picture quality was improved in the one-way video distribution by Real system and Microsoft Media Tool that uses MPEG4, the processing delay cannot be accepted for two-way teleconferences. The other hand, the processing delay did not become a big problem in the bucket relay type Internet, because the transmission delay is so large. Then, using wideband layer 2(ATM) like JGN, it is possible that less delaying and transmitting of high-quality multimedia data.

DV systems have widely used rapidly in recent years. Not only be used with a video camera but also attract attention as a serial bus of peripherals of the computer along the IEEE1394. The video transmission system that used DV is a multimedia system, with low delay and high-quality picture. The development of DVTS [4], which system is DV over IP, is advanced on the WIDE project, and SONY makes SEU-TL100 [5], which system is DV over ATM, to a product.

However, the DV transmission system is still on the way, and the trouble often occurs when real operating. Up to now, we have been examining the trouble because of a synchronous gap of the ATM network [6], and have evaluated the DV transmission system by the objective image quality evaluation system for MPEG2 [7].

In this article, we describe the result of measuring the delay time of the DV transmission system which uses JGN, and examine the relation between that delay time and the quality. When delay time grows, the quality of User Interface is inferior in the interaction of teleconference, and the delay jitters cause the packet loss according to the size of the buffer of the system. And then, we measured the transmission delay of JGN, and clarified that the distance is not necessarily in proportion to the transmission delay.

2. Delay time of DV transmission system

In the transmission of DV, it is possible to divide into the processing delay with the systems used and the transmission delay with the line. The DV transmission systems that examined at this time are DVTS [4] over IP, and SONY ATM-IEEE1394LinkUnit SEU-TL100 [5], which

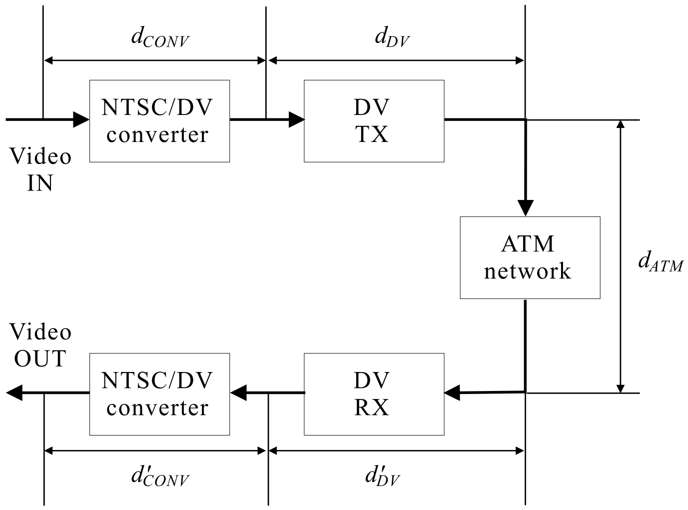

Figure 1. Block diagram.

uses ATM (Hereafter, it is abbreviated as SEU-TL100). Both of system configuration as shown in Fig.1. Though the input with DV data such as DV cameras is becoming popular, there are a few monitors that can display DV directly. Two NTSC/DV converters are used for both the input side, and the output side uses NTSC composite signals. Because it is preferable to measure that the transmission side and the reception side are the symmetry. JGN is used for the ATM network, and IP over ATM is also used. On the other hand, though, the ATM switches and routers, etc. were used, the processing time of these equipments can be neglected because they are less than 1 msec.

2.1. Processing delay

The processing delays; encoding and decoding by DV / NTSC converters; were measured, using alternately presenting a white screen and a black screen every one second which using the frame memory as shown in Fig.2.

First, the following formula came out by the composition of connecting directly only DV / NTSC converter (SONY DVMC-MS1) by using the IEEE1394 cable as shown in Fig.3.

$$d_{conv} + d'_{conv} = 70.0msec \quad (1)$$

Because the descreat cosine transform (DCT) is necessary for encoding and decoding of the DV data, some processing time is needed.

Next, the processing delay by the DV/NTSC converter and the DV transmission system was measured by using the composition as shown in Fig.4. Though it was not filled in on figure, FastEthernetSwitchingHUB was inserted between DV Tx and DV Rx for DVTS, and ATM Switch was

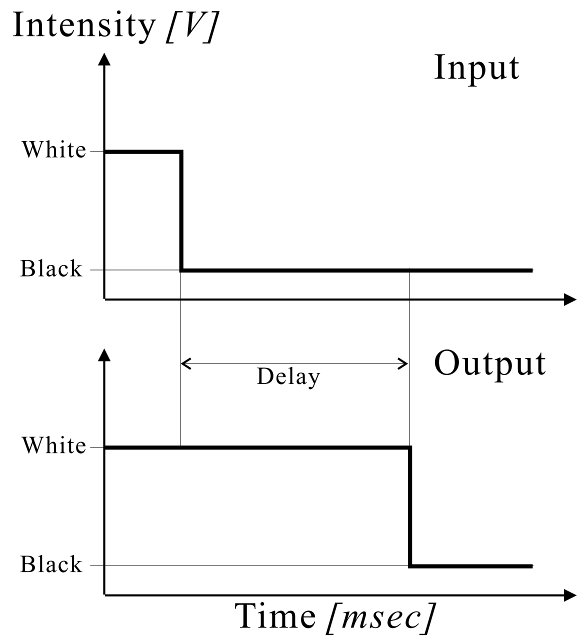

Figure 2. Delay of video signals.

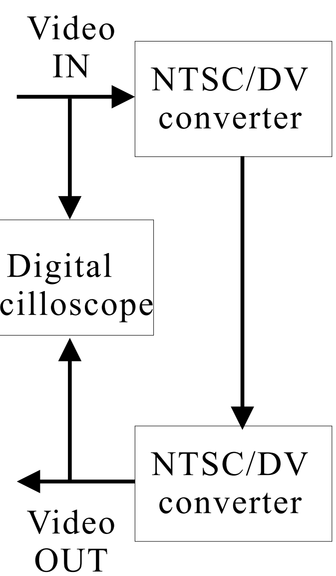

Figure 3. Delay of DV/NTSC converter.

inserted for SEU-TL100. However, because the processing delay by these Switching HUB and ATM Switch was small enough in 1msec or less, we omitted it in the measurement at this time. The result of the measurement became as follows respectively.

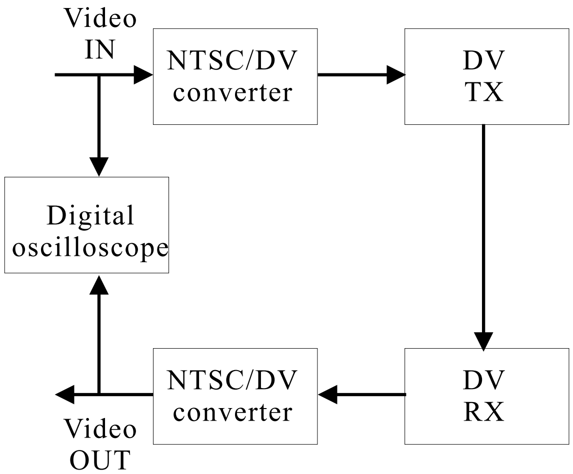

Figure 4. Delay of DV systems.

DVTS+DVMC:

$$d_{conv} + d_{DVTS} + d'_{DVTS} + d'_{conv} = 222.7msec \quad (2)$$

SEU-TL100+DVMC:

$$d_{conv} + d_{TL100} + d'_{TL100} + d'_{conv} = 91.6msec \quad (3)$$

Therefore, delays of DV systems can be shown as follows by subtracting the delay of DV / NTSC converters.
DVTS:

$$d_{DVTS} + d'_{DVTS} = 222.7msec \quad (4)$$

SEU-TL100:

$$d_{TL100} + d'_{TL100} = 91.6msec \quad (5)$$

2.2. Transmission delay and jitter

JGN is an experimental network which uses gigabit class high speed network based ATM. At this time, the transmission delay and jitter in the network of this JGN were measured.

The network topology is shown in Fig.5. An ATM analyzer connects with the JGN access point at Otemachi. Nagoya, Osaka (by way of Tokai and by way of Kanazawa), Okayama, Kitakyushu, and Naha, which were on JGN, were made a return point respectively.

On the other hand, the measurement condition is as shown in Table 1. PVCs used for the measurement were

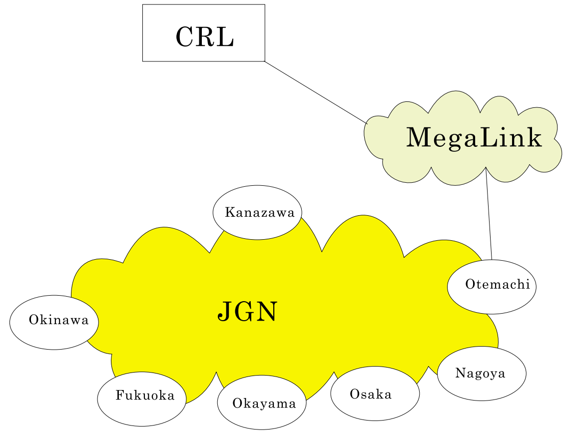

Figure 5. Network topology.

Rate	50 Mbps
Network topology	logical loopback
PVC	UBR 50 Mbps
duration	2 min.
Analyzer	HP 37717C
Background traffic	DV over ATM (38 Mbps) x 2 streams
Access line	NTT Megalink 135 Mbps

Table 1. Mesurement condition.

UBR 50Mbps, and the measurements were done under two conditions, when there was background traffic and when there was not. Amount of 76 Mbps data (two streams of 38Mbps of DV over ATM by SEU-TL100) was used for the background traffic. Therefore, the load of this amount level of the bandwidth of NTT megalink, which is access line of 135Mbps, is put together with 50Mbps of the test traffic.

The measurement result is shown in Table 2. Here, we measured three items of Delay, Jitter (Cell Delay Variance) and Cell loss. ”Approximate distance from Tokyo” is a straight line distance on the map, not a line construction distance.

3. Delay and quality

3.1. User Interface

The convenience of the TV conference between two points (point A and point B) is controlled by the time to require even response arrival from point B to the question in point A. The difference at the response time compared with the case of the face to face is sum of the processing delay and the transmission delay. Therefore, when you hold the TV conference for instance between Tokyo and Osaka, it becomes a calculation which becomes 456.2msec in DVTS, and becomes 194.0msec in SEU-TL100.

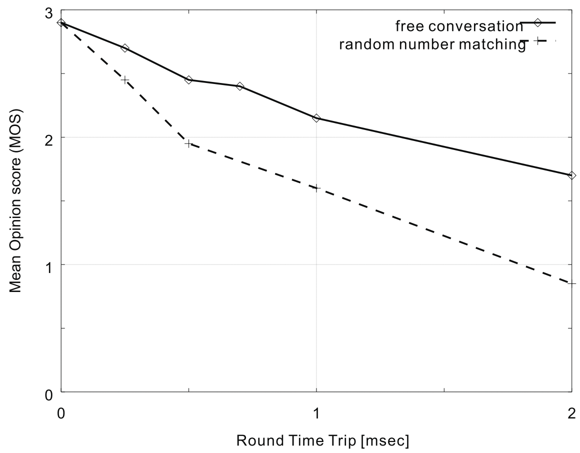

Figure 6. Example of audio delay qulity (from reference [8], Fig.4.4).

According to the example of evaluating the voice delay quality (Fig.6), MOS (mean opinion score) decreases about one grade in the geostationary satellite communication (1 hop for one way about 250msec). It depends the section length and the frequency of the utterance. Though MOS has little deterioration in a conventional telephone (the ground system : the worst delay time of NTT line for one way about 40msec). In addition, it is pointed out that MOS decreases about one grade in a free conversation in the application which has the delay of one way about 500msec such as Internet phone.

According to Figure 6, MOS is deteriorated almost linearly during 0-2 seconds of the return delay time. Therefore, it can be forecast that the quality deterioration by the delay is the twice as large for DVTS as SEU-TL100.

Well, we think about each component which occupies at delay time. The largest one is 152.7 msec of DVTS, which accounts for 67 % of delay time, and it is necessary to speed up. However, speed-up might be easy if DVTS is made to hardware, because it has been achieved in software on general purpose PC. Moreover, if the size of the buffer is assumed to be adaptive changeable to the state of the network, delay time can be reduced, though a present system has the buffer for 1.5 frames. Second largeness to it is 70msec in encoding and decoding of DV / NTSC converter. In DV over ATM combined with SEU-TL100, it corresponds to as much as 72 %, and it is a big problem. I want to expect the maker to improve that. Well, SEU-TL100 excels in the point of delay time, and it is very small delay time, even if the transmission delay is considered (However, the DV/NTSC converter is disregarded). Small buffer size also contributes to the low delay, but when the buffer is small, the gap of the network clock greatly influences, or the influence of jitter described later goes out easily.

Loopback	Distance (km)	No background $delay/CDV$ (μsec)	With background $delay/CDV$ (μsec)
CRL	30	2 / 2	
Otemachi	0	2703 / 0	
Nagoya	350	8051 / 327	9298 / 2785
Osaka	550	10813 / 655	12171 / 2621
Osaka (via Kanazawa)	850	19333 / 655	20728 / 2293
Okayama	700	13434 / 0	14598 / 2621
Kyusyu	1350	18923 / 655	20258 / 2949
Naha	1800	38666 / 0	39876 / 2621
Kanazawa	600	15558 / 655	16868 / 3276

Table 2. Loop back delay in JGN.

3.2. Delay map

When the transmission delay of JGN (Table 2) was drawn on a Japanese map, it became as shown in Fig.7. Fig.7 is a relative reduced scale that the transmission time between Otemachi and Nagoya corresponds to the distance on the geographical map. A Japanese map on the geography is shown in the gray, and the map where the transmission time was converted into a relative distance is moved on the map and displays. As shown in this figure, a big transmission delay is caused in Kanazawa and Naha, however, the transmission delay on the trunk line in the Pacific Ocean belt zone is proportional to a geographic distance. The transmission delay occasionally effects the performance according to the system of the TCP protocol etc. Though the transmission delay of ATM is smaller than the processing delay of the DV system, and the necessity for measuring not only a geographic distance but also the transmission delay directly will occasionally come out.

3.3. Packet loss

The delay swinging might become a packet loss on the way of the data transmission [8]. Because, when the arrival time of the packet varies and the size of the buffer is exceeded, the packet is processed as a loss packet. The tolerance of the delay jitter rises if the buffer is enlarged, but the above-mentioned user interface is deteriorated. It seems that the changeable one of the size of the buffer which has adjusted to the line situation is preferable. The delay jitter changes depending on the crowded condition of the line, and so that is shown in Table 2, when total traffic near the bandwidth exists, big ”Jitter” is caused even if the cell loss is not caused. Because the buffer is small, the influence of the delay jitter of SEU-TL100 is large.

Moreover, it is very eyesore that block noises on the

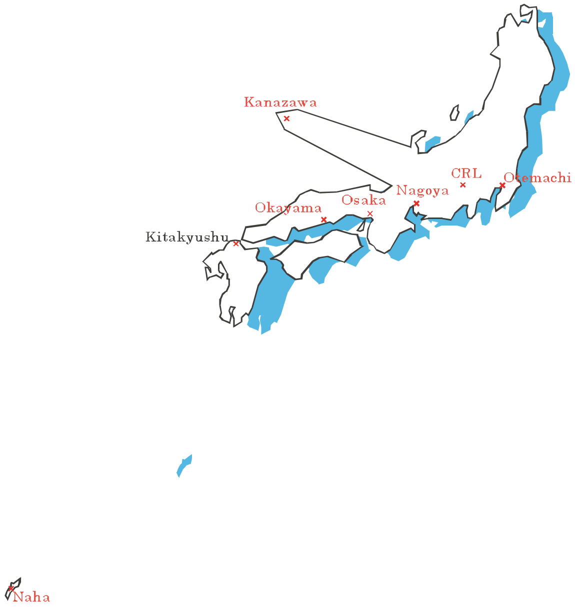

Figure 7. Delay map.

screen are substituted in a gray block in SEU-TL100 when the loss packet is generated. On the other hand, in DVTS, because the loss block is replaced in the block of a former frame, sight deterioration is small [7]. Thus, it is effective that the technology which makes amends for not only size of buffer but also loss packet, and it is effective if it was used together with the error correcting code etc.

4. Conclusion

The delay of the DV transmission system which used JGN was measured, and its quality was examined in this article. As a result, in DVTS which has been achieved with software, a near processing delay of 200msec is possessed as well as other Internet applications, and when the transmission delay was matched to the processing delay, the same degree of the delay as the geostationary satellite communication was measured. On the other hand, in SEU-TL100 which has been achieved with hardware, the processing delay is small. And it is weak to the delay jitter of the processing delay because the size of the buffer is small, and in addition, it has been understood that the quality might be greatly deteriorated because measures against the packet loss are hardly done. Moreover, it is necessary to note because the transmission delay might be not proportional to a geographic distance, and the delay jitter grows if traffic near the bandwidth flows.

In the future, it is scheduled to develop the system which in real time measures the delays and jitters that changes by the crowded condition of the line. We also have a plan to develop a small processing delay audio transmission system.

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