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A Support System for Research Activity Using the Internet

Shigeichi HIRASAWA *
hirasawa@hirasa.mgmt.waseda.ac.jp

Abstract

A research activity support system for researchers over worldwide universities and industries is developed. In order to reduce the running cost, we construct (1) a network conference system using low-cost devices and the Internet. Besides (1), we introduce (2) a private database system and its information retrieval system which are installed on usual low-cost personal computers (PC's). Based on these subsystems, research activity for researchers such as discussions with one another across different countries can be supported. One of the problems we address in this paper is to clarify the conditions whether we can use this system comfortably or not, depending on the quality of service (QoS) of the Internet.

keywords network conference system, multimedia data base, information retrieval, QoS, Internet

1 Introduction

By recent developments in information technology, many educational activity support systems such as a distance learning system are widely in use. Research activity support systems, however, are not so familiar, although we have used networks to discuss with colleagues even if they live in foreign countries. These computer networks were known to us, for example, as ARPANET in the 70's. The author had the opportunity to study at UCLA in 2002 for half a year, which lead us to develop a support system for research activity. In this paper, we discuss a support system focusing on for research activity which is abbreviated by "NetSemi" [1],[5],[7], [6]. In contrast to that for educational activity, the low running cost and keeping the quality of service of the Internet, especially short delay time, are highly recommended. The support system NetSemi developed is composed of: (1) a network conference system which is abbreviated by "NetCon" and (2) a private database system and its information retrieval system which is also abbreviated by "PDB". (1) NetCon provides an electronic conference between long distance to discuss with colleagues who are interested in the same research areas. Using low-cost devices such as PC cameras, PC headsets, microphones, speakers, video-cameras, projectors, tablets, white-boards and so on, a researcher can present his ideas by pointing remarks on figures, tables, and equations in the screen or the displays together with his voice. Animated figures and movies are also applicable. Discussions between researchers can be quickly and easily attained. While, (2) PDB can store private information such as unpublished papers, books and intermediate data for their own research groups, together with published papers in their own interested areas, and can retrieve the necessary information by the information retrieval engine. Based on (1) and (2), we can easily take place technical meetings, seminars, forums, conferences, symposiums and lectures with a small size (a small number of participants). When the Internet is used, however, the quality of service (QoS) extremely affects the performance of the support system. One of the important purposes of this paper is to make clear the conditions that we can comfortably or satisfactorily use the support system. First, we examined actually to use the system between research groups in both domestic and international, and measured the QoS with respect to the delay time and the packet loss rate. Then we evaluate the degree of satisfaction of the support system by questionnaires of the participants (students). Next, simulating the Internet (communication links) by PC, experiments to easily evaluate the degree of satisfaction are performed between two neighbouring rooms, where parameters, the delay time and packet loss rate, are manually set. Then we clarify the conditions shown by the regions of the delay time and the packet loss rate that we can use the support system with satisfactory , with patience or with intolerable. As a result, the condition for both the delay time within 300 [ms] and the packet loss rate within 5 [%] is shown to be tolerable.

2 Configuration of Support System NetSemi

The support system for research activity, NetSemi, is composed of (1) NetCon and (2) PDB as shown in Fig. 2.1. Researchers in universities and industries who have Internet Access and share common interests can work cooperatively.

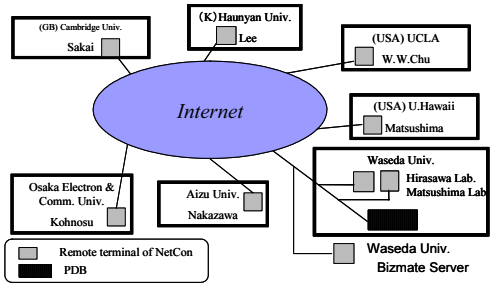


Fig 2.1: The support system for research activity NetSemi

* Department of Industrial and Management Systems Engineering, School of Science and Engineering, WASEDA University. 3-4-1, Ohkubo, Shinjuku, Tokyo 169-8555 Japan. Phone:+81-3-5286-3290. Fax:+81-3-5273-7215.

2.1 Network conference system NetCon

The network conference system, NetCon, is almost the same as a usual electronic conference system except for the communication links. Fig. 2.2 shows a configuration of NetCon. All devices used here are low-cost. Using low-cost devices such as PC cameras, PC headsets, microphones, speakers, video-cameras, projectors, tablets, white-boards and so on, a researcher can present his ideas by pointing remarks on figures, tables, and equations in the screen or the displays together with his voice. Animated figures and movies are also applicable. Discussions between researchers can be quickly and easily attained. The devices used here are shown in Table 2.1.

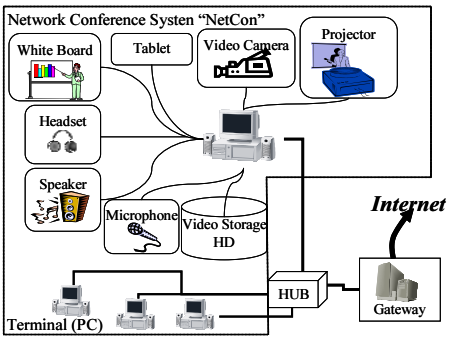


Fig 2.2: The network conference system NetCon

Table 2.1: Devices used for NetCon

Device	Model (Maker)
Projector	ELP-710 (EPSON)
White Board	Mimio (KOKUYO)
Microphone/Speaker	YAMAHA
Video Storage HD	536DX 100GB (Maxtor)
Video Camera	ViewcamVL-MR1 (Sharp)
Tablet	Intuos i-600(Wacom)
Headset	MM-HS02 (SANWA SUPPLY)
CCD Camera	WebCamPlus (Creative)
PC	Dimension 4100*2 (DELL)

In NetCon, terminals are connected each other by the Internet. While the usual electronic conference system adopts the private communication lines with high speed such as 10k-2M[bps], or N-ISDN lines with 1.5 M[bps], hence the quality of service will be kept in high and always guaranteed. NetCon, however, uses the Internet, so there arises an important problem how to keep the QoS of the Internet [NK00]. Otherwise, we cannot expect NetCon to operate satisfactorily. Thus we will evaluate our satisfaction with NetCon by actual and simulated communication links.

2.2 Private database system and its information retrieval system PDB

The private database system and its information retrieval system, PDB, are constructed as shown in Fig. 2.3. We use information retrieval engines and their installed equipments as shown in Table 2.2. Visual Recall (VR) is a keyword-based search engine based on the Boolean model, while Concept Base Search (CBS) is a concept search engine based on the vector space model. The purposes and functions for each engine are different and they complement each other. PDB can store private information such as unpublished papers, books and intermediate data for their own research groups, together with published papers in their own interested areas, and can retrieve the necessary information by the information retrieval engine.

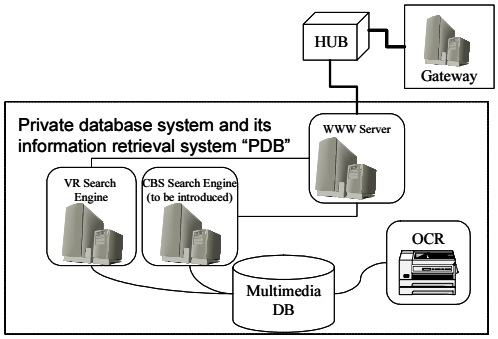


Fig 2.3: Private database system and its information retrieval system PDB

Table 2.2: Software and Hardware used for PDB

Device	Model (Maker)
Direct search engine	Visual Recall(Fuji Xerox)
Concept search engine	Concept base search (Justsystem)
OCR	DocuCenter 400FS (Fuji Xerox)
PC (search server)	Compaq Proliant 1600 (Compaq)
PC (VR database server)	Compaq Proliant 400 (Compaq)
PC (CBS database server)	Dell Dimension 8100 (DELL)
Nonstop Power Supply	Compaq UPS T1500 (Compaq)

3 Quality of Service for Internet

Hereafter, we focus upon NetCon. The most important point for NetCon is to make clear the conditions that the electronic conference is satisfactorily held from the view-point of the QoS for the Internet. Generally speaking, the QoS for communication network can be evaluated by both the delay time and the packet loss rate as shown in Fig. 3.1, which illustrates those for ATM (asynchronous transfer mode) communication. Mixed mode and processor mode for Telematics are classified as shown in Table 3.1. NetCon also uses multimedia sources such as images by power point (ppt), documents by pdf, animations, voice for presentation and video for scenery of the conference room.

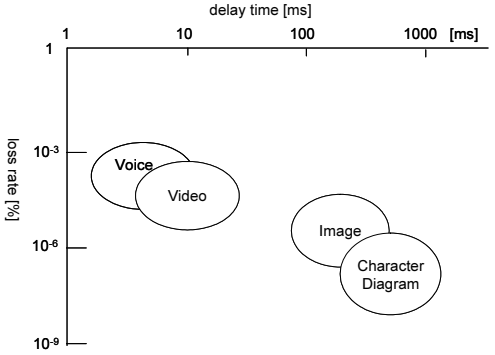


Fig 3.1: QoS for ATM communication network

Table 3.1: Mixed mode and processor mode for Telematics

	Storage type media	Stream type media
contents	Characters Diagrams Images Drawings	Video signals Voice signals
Subjects	Papers (CD-ROM) Hand written documents, Graphs, Figures, Tables, etc.	Discussion Real time communication

The advantages for using the Internet is summarized in Table 3.2, compared with the conventional WAN (wide area network). While, the Internet can be regarded to be located in multimedia communication systems as shown in Table. 3.3.

Table 3.2: The advantages for using Internet

	Wide area network	Internet
	Telephone network, Private line network, Line switching network, Packet switching network, ISDN, Mobile data communication network, etc.	
Data signaling rate	1.2K-622M [bps]	No assurance
Line cost	medium-high	low
Usability	OSI reference model	Unified protocol (TCP/IP) Free software
Extendibility	Telematics communication (G4fax, video fax, audio graphic conference, telewriting, etc.) Multimedia Communication System (TV conference system)	self-propagated network Standardization task for high performance

Table 3.3: Multimedia communications

Network	N-ISDN(64K-1.5M[bps]) Satellite line(10K-1.2G[bps]) Private line(1.2K-156M[bps]) CATV-VOD(30M[bps])	B-ISDN(ATM) (156M[bps]) xDSL(32K-22M[bps]) FTTH(10M-156M[bps])
Standardization	MPEG JPEG H.261(ITU-T) ・・・for TV Conference System	TCP/IP VoIP(IPv6) MPEG-3 MPEG-7
Groupware (ex)	Office MERMAID	NetMeeting PictureTel, net gear CU See Me Centra symposium ProShare BizMate

3.1 Delay Time

The end-to-end delay time is composed of five parts as shown in Fig. 3.3. The total delay time t_o is given by

$$t_o = t_c + t_p + t_n + t_b + t_d, \qquad (1)$$

where t_c, t_p, t_n, t_b and t_d denote Coding delay time, Network delay time, Buffer delay time and Decoding delay time.

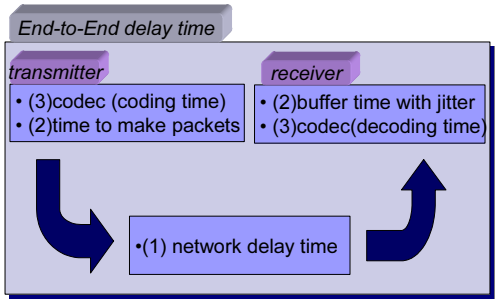


Fig 3.2: Delay time construction

The delay time $t_c + t_d$ is caused by coding and decoding for voice signal and video signal. Due to so called "Lip Sync", the delay time t_c is given by the maximum of the coding delay time for voice and that for video. The values of these delay times are strongly dependent on the CPU power such as the clock, the operating system (OS), the architecture and the hardware for CODEC. These are also dependent on whether back ground jobs are heavily running or not. The delay time $t_p + t_b$ comes from generating packets at the transmitter and storing packets at the receiver. The value of that is also strongly dependent on the CPU and the OS. The delay time t_n is a pure delay time occurred in the network for transmitting the packets, hence it depends on distance and line configuration.

3.2 Packet loss rate

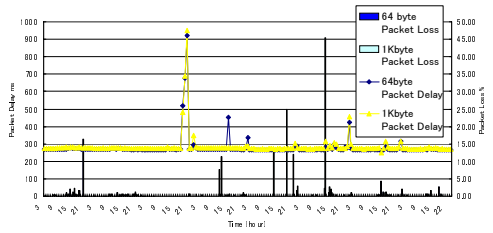
When the network traffic is heavy, the packet loss will occur. Routers in the Internet can store the packets within their capacities of the buffering storages. If the buffer overflows, then the routers eliminate the packets. The packet loss yields noise.

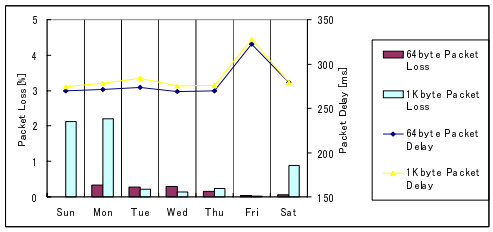
4 Experiments

4.1 Measurements of QoS for real communication links

We evaluate the QoS for real communication links. The delay time t_o and the packet loss rate p_l are measured for links to foreign countries as experiments.
(1) Delay time Network delay time t_n:
The network delay times for links to Cambridge University (CU), England, to University of California, Los Angeles (UCLA), USA, and to University of Hawaii, Manoa (UH), USA from Waseda University (WU), Japan are measured. These can be obtained by a method so called "ping". By sending packets at the transmitter and reflecting them at the receiver, the turn-around time of a packet can be easily measured. Table 4.1 shows typical values of the network delay time for actual links together with those of the packet loss rate. As an example, the network delay time together with the packet loss rate for link to CU from WU with respect to hours in a day and days in a week is shown in Fig. 4.1.
Table 4.1: Typical values of network delay time t_n and packet loss rate p_l

	Packet loss rate [%]		Packet delay [ms]		Through put [KB/s]
Size of packet	64 [Byte]	1K[Byte]	64[Byte]	1K[Byte]	
WU - CU	0.270	0.763	278.089	284.074	248
WU - UCLA	0.000	0.003	144.4	148.5	
WU-UH	0.000	0.000	177. 0	187.3	
within LAN	0.000	0.000	0.945	2.806	30





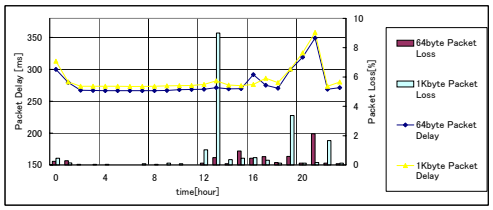
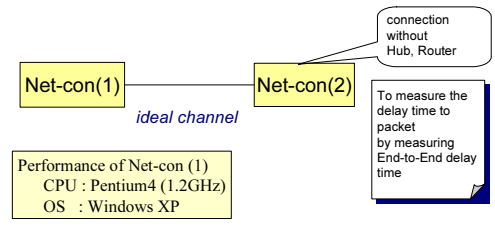


Fig 4.1: QoS for WU-CU

Packet and buffer delay time $t_p + t_b$:
Direct connection between terminals in a room and terminals in the other room realizes an ideal communication link. The conditions for this experiment are shown in Fig. 4.2. Specifications for the PC and the OS are also shown in this figure.

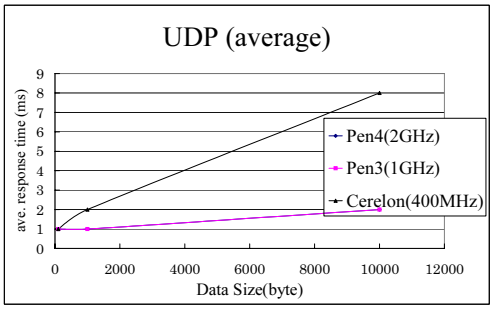


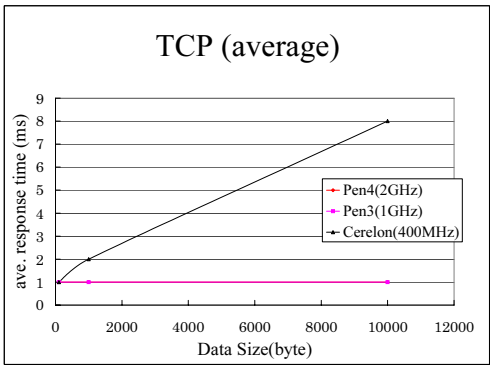
Performance of Net-con (2)

Case	Compared terms			Fixed terms
1	windows 98	windows 2000		Cerelon(400MHz)
2	windows XP	windows 2000		Pentium3(1GHz)
3	Pentium4(2GHz)	Pentium3(1GHz)	Cerelon(400MHz)	windows 2000

Fig 4.2: Experimental Conditions

The results obtained are shown in Fig. 4.3 and 4.4, for the CPU and the OS, respectively.





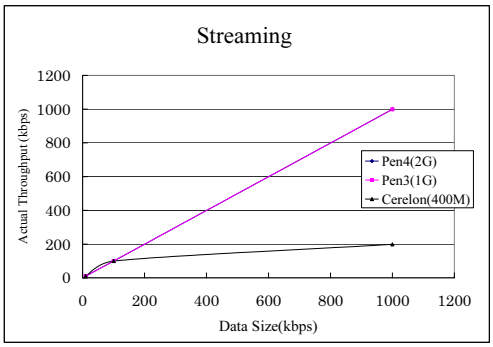
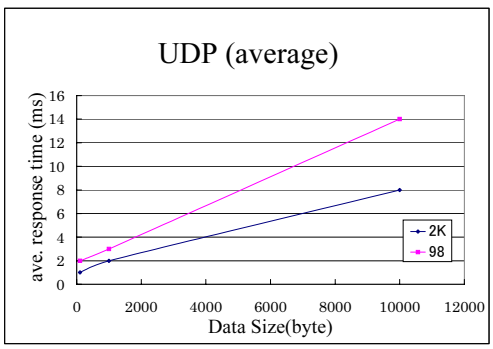


Fig 4.3: Average packet and buffer delay time for different CPU's



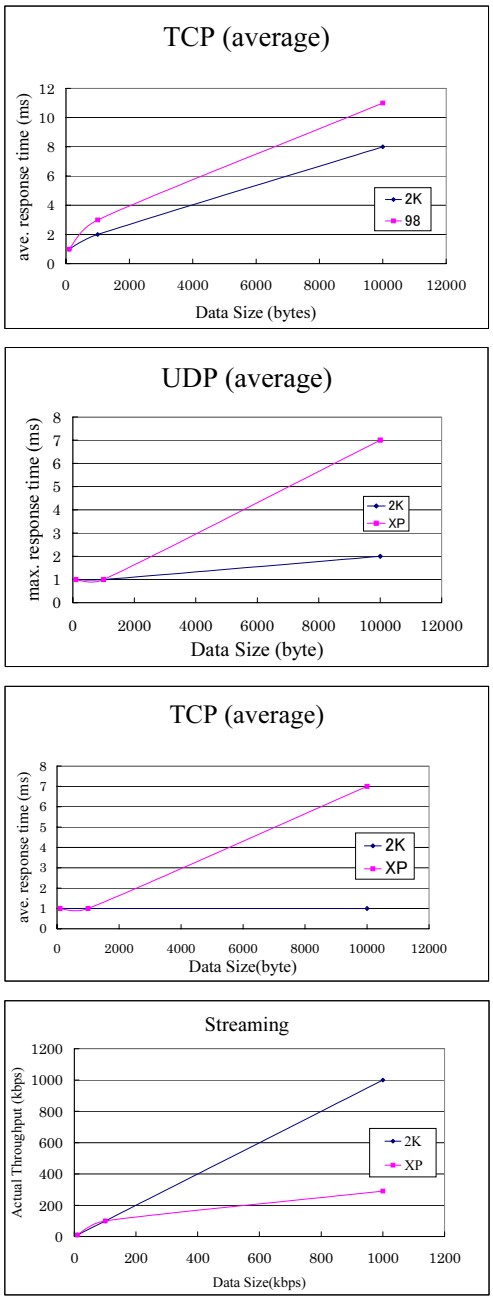


Fig 4.4: Average packet and buffer delay time for different OS's

CODEC delay time $t_c + t_d$:
The codec delay time should be measured by actual PC's with back ground jobs. The recommendation by ITU-T [2], however, is given as shown in Table 4.2.

Table 4.2: Recommendation of CODEC delay time

codec number	bitrate (kbps)	ideal delay (ms)
ITU-T G.711	64	0.125
ITU-T G.723.1	6.3	37.5

(2) Packet loss rate The packet loss rate for the network has been shown in Table 4.1 and Fig. 4.1.

4.2 Evaluations of NetCon by simulated communication link

To evaluate the performance of NetCon, i.e., the degree of satisfaction with using NetCon, the network simulator is inserted between two terminals [9]. Choosing the values of the network delay time t_n and packet loss rate p_l by the network simulator, NetCon is virtually held. The method and conditions of this experiment are shown in Fig. 4.5. The parameters set to the network simulator and the evaluation method are shown in Fig. 4.6.

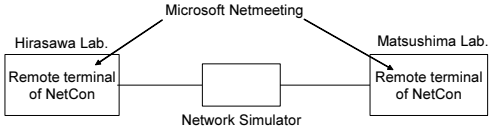


Fig 4.5: Method and conditions of experiment

- parameters of QoS
  - packet delay time 0 , 300, 500, 1000 (ms)
  - packet loss rate 0, 5, 8, 10 (%)
- terms of questionnaire
  - 「with sufficiently — with patient — with intolerable」
    5 ⟷ 1
  - evaluating by voide, video and total
- examinee : 12 people (students in Hirasawa and Matsushima Lab.)
- setting of MS NetMeeting
  - size of video transmission : Large, quality : High

Fig 4.6: Evaluation method

The result obtained by this experiment is summarized in Table 4.3. The other result is shown in Table 4.4.

Table 4.3: Degree of satisfaction for NetCon
Evaluation by video

video		packet delay (ms)			
		0	300	500	1000
packet loss rate(%)	0%	100%	67%	50%	55%
	5%	83%	27%		
	8%	73%			
	10%	54%			

Evaluation by voice

voice		packet delay (ms)			
		0	300	500	1000
packet loss rate (%)	0%	100%	89%	92%	82%
	5%	100%	82%		
	8%	100%			
	10%	54%			

Evaluation by overall

total		packet delay (ms)			
		0	300	500	1000
packet loss rate (%)	0%	100%	100%	92%	55%
	5%	100%	45%		
	8%	92%			
	10%	62%			

Degree of satisfaction [%] shows the ratio of the number of students who feel NetCon can be used satisfactorily to the total number of students (examinees).

Table 4.4: Degree of satisfaction for NetCon

phase	action	degree of satisfaction
explanation	synchronous in pointing and speaking	82%
	synchronous in new page and speaking	80%
discussion	Q & A	91%
	synchronous in new page and speaking	70%

Degree of satisfaction [%] shows the ratio of the number of students who feel NetCon can be used satisfactorily if they adapt to use NetCon by experiences and trainings to the total number of students (examinees).

5 Discussions

5.1 Real communication links

Experimental data for the delay time and the packet loss rate mainly in network show that: (1) There are many bad hours in the QoS to use NetCon dependent on the business hours of each country. These hours should be avoided to hold the electronic conference. (2) The QoS varies with time dependent on paths of the link and jobs processed in routers on the path [8]. (3) The network delay time t_n is not necessarily dependent on its actual distance. It may depend on the constructed path of the link (source to destination). The other experimental data for the delay time in the PC show that: (1) With respect to CPU's, the performance of Cerelon (400MHz) is inferior than that of Pentium III (1GHz) whose performance is almost the same as Pentium IV (2GHz). (2) With respect to the OS's, the performance of Windows 2000 is better than that of Windows 98 or Windows XP. This fact has been known by benchmark test using application programs [3].

5.2 Evaluations by simulated link

Table 4.3 shows that:
(1) There is the region in the delay time and the packet loss rate where the students are satisfied with NetCon. (2) There is a trade-off between the delay time and the packet loss rate in the region. Table 4.4 shows that if the students adapt themselves to use NetCon, then the tolerable region becomes large. The reasons are that: (a) Discussions are made mainly by voice (conversation) not by images. (b) Q&A requires a small delay time. If they carefully start Q&A by their experience, a larger delay time will be tolerable.

6 Concluding Remarks

We have clarified by the experiment of the simulated link that there are the conditions for which NetCon can be satisfactorily used, and by that of the real communication link in the Internet that we can attain these conditions by carefully and properly choosing the hours in a day and the days in a week, even if we want to develop NetCon to all over the world. To do so, we must gather data of the QoS before beginning to hold the electronic conference. It is also shown that choosing CPU and the OS for the terminals are important to keep the QoS. It should be noted that experiences and trainings for users in practical use of NetCon will help to enlarge the regions of the conditions for the QoS. Although detailed experiments and discussions will be necessary to make clear the conditions for the QoS of the communication link (the Internet) whether NetCon can be satisfactorily used, we can roughly conclude the region of these conditions as shown in Fig. 6.

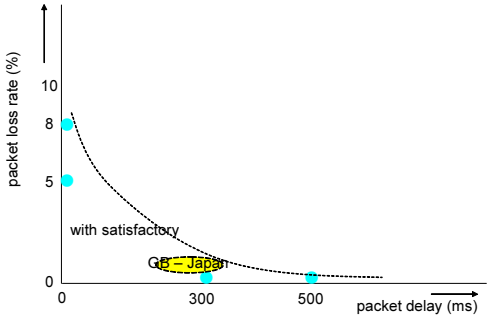


Fig 6: Required conditions for QoS of Internet for NetCon

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