CRL Next Generation Internet Project and APII-testbed Project

Shin-ichi NAKAGAWA, Akihiko MACHIZAWA, Mina AOKI,
Takeshi SAKURADA, Kazunori SUGIURA, Yoshiaki KITAGUCHI, Atsushi ITOU,
Mayumi MIKI, Yuko KOMAKI, Syuko KATO, Takahiro KOMINE,
Kazuyoshi MATSUMOTO, Yutaka KIDAWARA, Masazumi NISHIDA,
Kenji TANAKA, Takeyuki OJIMA, Haruo OKAZAWA, Seiji TSUCHIIKE,
Koichi KAMACHI, Hiroshi NAGATA, and Shunkichi ISOBE

CRL's Next Generation Internet (hereafter CRL-NGI) project has launched in 1999. Its missions are promoting network science, developing novel NGI transfer protocol, integrating several ongoing Internet testbed projects, suggesting a policy model for NGI to be an authentic information infrastructure, and proposing a unique infrastructure model together with coordinating policies based on the survey of current Internet. We have constructed the NGI with very-high-speed and very-wide-area IPv6 by integrating operation of APII testbeds, AI3 testbeds, Japan Gigabit Network and CRL's other networks. As a result, we found out that local loops in Asian countries were yet immature for the development of Asian Internet and obtained some data that indicated the need to introduce a concept of high-speed network's geographical scalability. Based on these results, as for Asian region, it is suggested that knowledge distribution of IPv6 technology and network optimization are crucial in the future.

Keywords
Next Generation Internet (NGI), network policy, Internet measurement, quality of service (QoS)

1 Introduction

The Internet is now recognized as an important key technology that constitutes not only a communication infrastructure but a civil infrastructure. With rapidly increasing use of the Internet, it is estimated that the number of computers connected to the Net has doubled each year and that the number of users would be over 100 million in 1998 and reach a billion in another couple of years. As of 1998, the number of Internet users in Japan was estimated 17 million. When only five years has passed since its commercial use began, the distribution rate of households is said to account for over 10% and this is much faster and wider spread than that of telephones and faxes. In the meantime, the distribution of cellular phone as a personal information terminal is said to be about 50 million as of June 1999, which shows rapid growth of personalized information age. The Internet is what has been widespread and developed with a bottom-up approach, and the Next Generation Internet is what will play the leading role in the future network society. Therefore, the Ministry of Posts and Telecommunications has poured huge sums into those projects such as a five-year plan since 1996 named 'Research and Development for the Next Generation

Internet', 'Japan Gigabit Network designed for Research and Development (hereafter JGN)' in fiscal 1998, and 'Research and Development for the Internet designed for utilization of multiple accesses in schools.'

Fig.1 shows the overview of the Next Generation Internet testbed of CRL-NGI project being established. These network test-bed has following two features. First, to have as a hundredfold data transmission capacity as before, that is, having one-gigabit capacity instead of having 2.4Gbits/sec capacity at the backbone. Secondly, unlike those networks traditionally build by the government such as SINET (Science and Information Network) of former Education Ministry and 'IMnet' by fomer Science and Technology Agency, consisted based on single layer network similar to the Internet, they become multi-layered with the layer 2 technology centering on ATMs and lots of layer 3 networks and layer 2 networks are mixed when operating. Concepts of network operation are shown in Fig.2. As shown in Fig.3, technological development of the Internet is said to enable to achieve rapid progress with highly development efficiency by being allowed to develop in each layer at researcher's own discretion. It was a kind of unique feature that the technology has been developed not only for network researches. Conventional means of communication such as posts, telephone, broadcast and wireless communication have been operated by government initiative. On the contrary, it was another feature that a paradigm shift to the Internet has been implemented by private initiative.

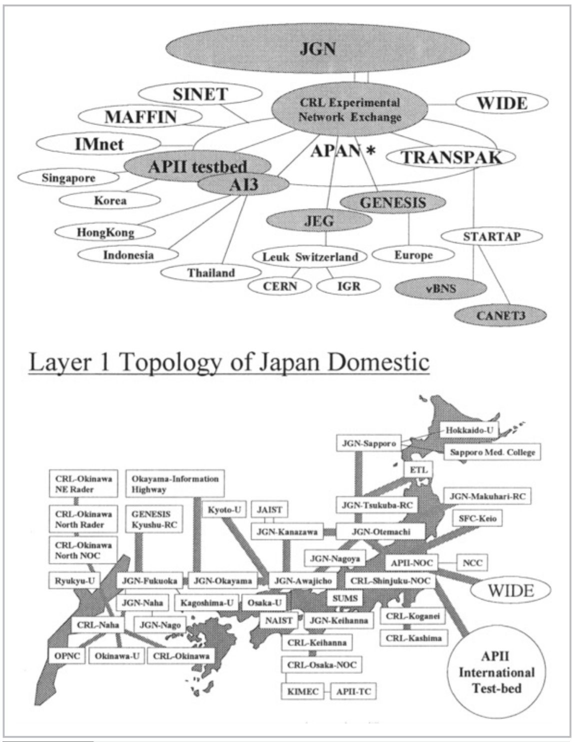


Fig.1 Overview of CRL Next Generation Internet Testbed

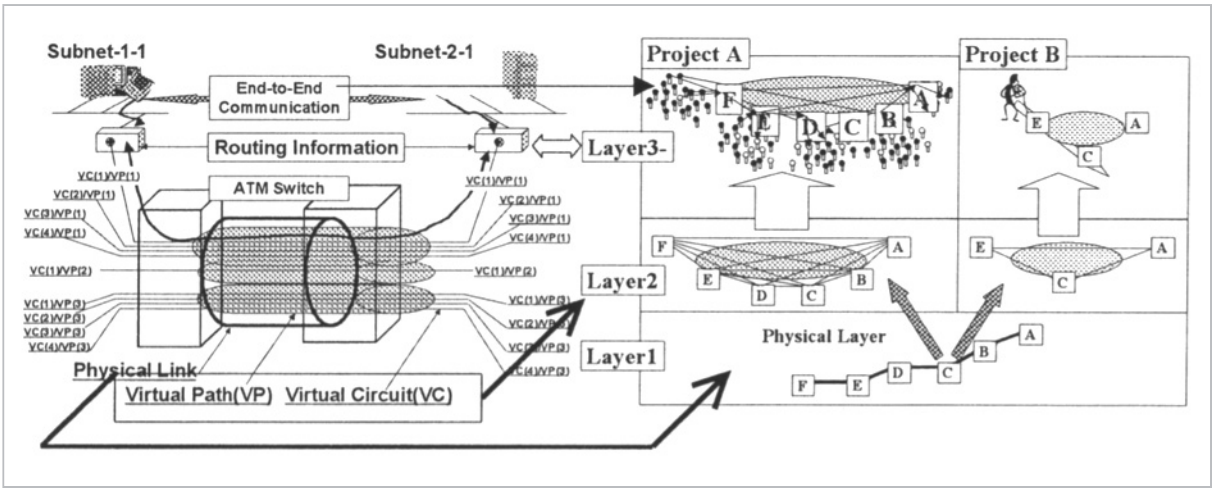


Fig.2 Open Testbed Network Concept for Layer2 based policy

2 Backgrounds: Needs for Estimation of Internet Data Transfer

Precise analysis and examination of the Quality of Service (QoS) of the Internet-based applications is one of the most urgent issues among the researchers. However, the development of a measure to evaluate the efficiency of "Peer-to-Peer Data Transfer" is requires careful analysis and state-of-the-art technology (See Fig. 3). Previous research results have been reported and they proposed methods to evaluate data transfer. These methods are the simulation, data collection on the real Internet test-bed, and the experiment on the emulation of the system similar to the Internet. The most traditional method is the simulation. S. Field and her research group are trying to establish the network simulator for peer-to-peer data transfer, named 'ns.'[S. Field et.al.] It is very useful tool for estimating the efficacy of the peer-to-peer data transport. However, it is required that the all source codes of every entity for simulation. It is becoming more difficult on the Internet to use every source code of implementation of TCP/IP not only commercial based, but also the binary only distributed. Recently, it has also become more difficult to evaluate the peer-to-peer level data transfer on the actual Internet, not only because of concerns regarding privacy issue when monitoring personal data exchange, but also because of the technological difficulties due to the limit on the 'tapping' hardware. It is also pointed out that the Internet-specific manners create the difficulties to analyze its dynamic changes of data transfer over the IP level. It is not possible to measure the real loss of packets on the application level, because the implemented TCP and IP modules always cancel the losses of packets. Several papers have proposed mathematical models to estimate those phenomena, however there is no effective model for deleting the bias effects yet. These phenomena make it extremely complicated to analyze the QoS on the application level, because no quantitative model for evaluating such Internet effect exists to measure the quantitative data of rates of errors in data transfer. Thus, it has been still difficult for dividing the loss of QoS for application problem and the effect of the Internet especially at the evaluation of the data transport. In order to provide the real data based on the LIVE networks as the evidence of these estimations would be very important for the breakthrough. However there was no eligible data for the current Internet test-beds.

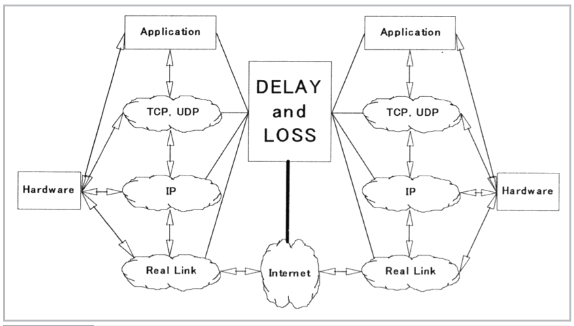


Fig.3 *Difficulties for quantitative evaluation of Qos at peer-to-peer condition*

Every module lying at each protocol layer can produce the delays and losses. The application-to-application level measurement of delays and losses includes the all of those effects. It is difficult for detect the quantitative effect of each modules.

3 Purpose of CRL-NGI project

As a result of practical research and development, for example, finding out every need in the field and reflecting and mounting communication models in each field to the existing Internet technology, rapid development was said to be achieved. These various efforts such as demonstrations with network testbeds have a significant meaning for both researchers and next generation users being an interface between on site user needs and network researches. The current goal of the Internet technology is to build a high-speed inexpensive simple information infrastructure covering a wind range, not going beyond the technological development for means of communication. With inundation of information because of rapid progress of information networks, social phenomena such as 'inhibition of human nature by communication, deviation from social system to the system on the network, emerging new social issues because of the gap between virtual reality and the fact' is said to be realized. Even though the channel has developed ingeniously and the means of communication being unparalleled in history have become possible, that does not usually mean the better quality of human communication because the human being themselves do communicate. Even if an engineer developed a great system and realized virtual reality for the first time ever, it still depends on each user whether he or she learns how to use it and actually uses it. For example, as shown Fig.5, such systems as world wide web (HTTP), mailing list (combination of e-mail and some other programs), Internet multicast (Mbone), and Internet relay chat (IRC) gave users connected to the Internet new means to feature their information to other users in the world whenever they like. But it seems difficult to ask engineers to set rules for operation and to enroot them as a social system. Research on the channels as a mere technological development might generate new technology and new products. However there should be some efforts by not only researchers and engineers who invent and use convenient tools but also users if you want technologies possible to change the essence of communication and create affluent society.

CRL-NGI project was launched since 1999. This project is consisting of following five subprojects. (1) Development of Ultra High Speed Network monitoring system using fiber splitting method and Establish the measurement standard operation procedures for evaluation of internet transporting. (2) Establishing the new mathematical models for network traffic evaluation, (3) Establishing the IP-V6 architecture based routers and fixing the problems of inter network layer and upper protocols. (4) Development of Multi GIGA-bit network test-bed for practical use transporting the commodity traffic. (5) Development of the scalable network middle-ware for transporting the multimedia transport, harmonizing with from the ultra high speed networking devices (i.e. IEEE 1394, ultra high speed wireless

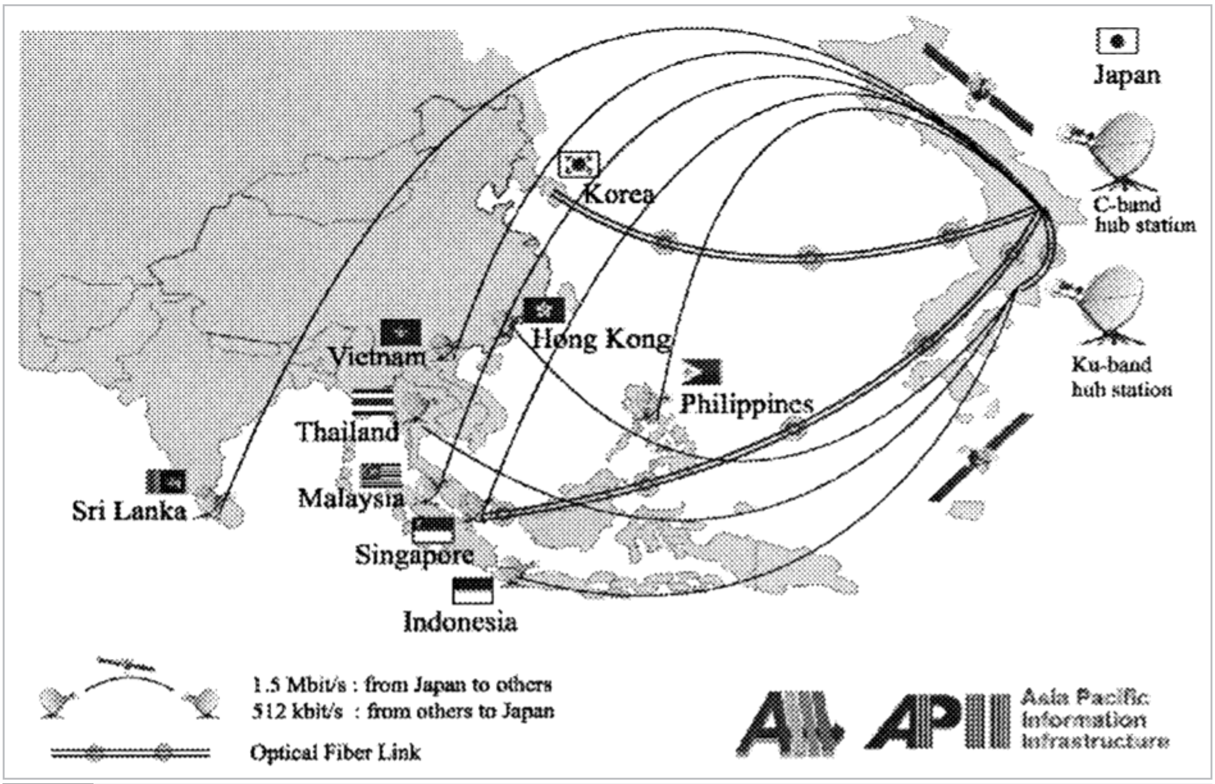


Fig.4 Current APII Testbed Concept

ATM) to the bad physical link with frequent loss and delays (i.e. satellite network links, and other loosely networks.) The overview of current APII test-bed concept is shown in Fig.1 and 4.

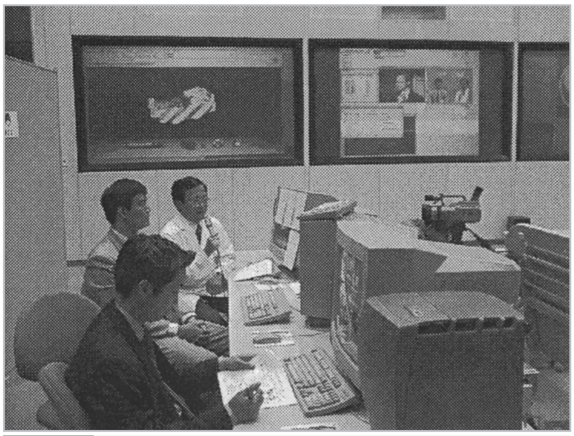


Fig.5 APEC-TELMIN3 Demonstration Japan(CRL) in 1998

3.1 Researching Focus of CRL NGI project

The role of CRL-NGI project is mainly "Integrating the current next generation Internet Testbed" CRL-NGI project is now currently working for the objects as follows. (1) Establishment of QoS measurement method/protocols for peer-to-peer communications on NGI. (2) Development of Dynamic Flow Control on multi-gigabit-network with Widely Integrated Distributed Flow Monitoring System. (3) Standardize the active communication synchronizing control for distributed conferencing on the World Wide Scale with reliable and real-time Internet multicast backbone formed on the chaotic (Optical Fiber, Satellite) physical links. (4) Establishing the inter-operability and inter-connectivity with providing the Ultra-large-scale Testbed around the earth with inter-connecting the several continental and regional scales networks for NGI research activities using the novel global scale experiment (like the G360 at IST'98.)

3.2 Initial Story of APII Test-bed

At the APEC ministerial meeting on telecommunications and information industry, Seoul, in May 1995, Japan proposed six practical including the construction of a research network in the Asia-Pacific region. It was agreed to interconnect the test-beds construct a seamless network in the Asia-Pacific region at the 13th APEC telecommunications working group, Santiago, in March 1996. Korea, Singapore and Japan established relevant working teams at the 14th APEC telecommunications working group, Taipei, in July 1996. In February 1997, the APII Technology Center was established on the campus of the Kansai Advanced Research Center of Communications Research Laboratory, Kobe, Japan. At June, 1998, Special Experiment Team of APII-JP and SINGAREN(Singapore) performed 3rd APEC Ministerial Meeting on Telecom. and Information Industry over the APII testbed. CRL international experiment team is providing the APII testbed in the APEC area (Fig.5.) That testbed is 2Mbps ATM based network, and now the partner countries are Korea and Singapore Republic. Various networking experiments and demonstrations are performed on that testbed Since 1999, the APII Korea-Japan is increased its bandwidth to 8 Mbps. And Since 1999, the AI3 project (Experimental Internet Interconnection Initiatives in Asian area with satellite link, which is connecting more than 8 countries in Asian area) joined the APII-JP project.

4 Objectives

The goal of the APII Test-bed Project is to promote the construction of an efficient information infrastructure which will improve social-economic conditions in the Asia-Pacific region.

The APII Test-bed Project has the following five objectives.

(a) Facilitating the construction and expansion of an interconnected and interoperable information infrastructure in the region;

(b) Encouraging technical cooperation among member economics in the development of the infrastructure;

(c) Promoting free and efficient flow of information;

(d) Furthering the exchange and development of human resources;

(e) Encouraging the creation of policy and regulatory environment favorable to the development of the Asia-Pacific Information Infrastructure.

5 Principles

(a) Encouraging member economics in the construction of domestic telecommunications and information infrastructure based on their own reality;

(b) Promoting a competition driven environment;

(c) Encouraging business/private sector investment and participation;

(d) Creating a flexible policy and regulatory framework;

(e) Intensifying cooperation among member economics;

(f) Reducing the Gap of infrastructure between the advanced and developing economics;

(g) Ensuring open and non-discriminatory access to public telecommnunications networks for all information providers and users in accordance with domestic laws and regulations;

(h) Ensuring universal provision of and access to public telecommunications services;

(i) Promoting diversity of content, including cultural and linguistic diversity;

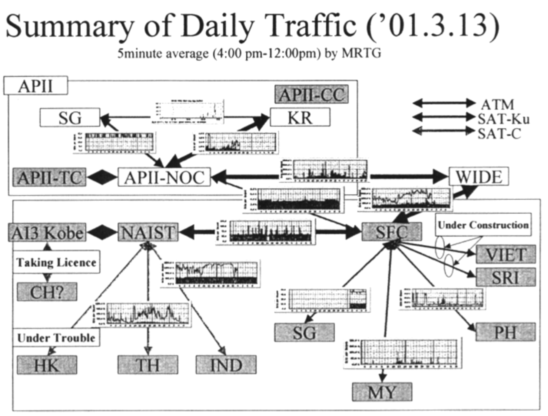
(j) Ensuring the protection of intellectual property rights, privacy and data security.

5.1 APII Proposed Experiments

Currently, the international joint research and experiments on a multimedia information network have been pursued among Korea, Singapore and Japan. Twelve subjects for collaborative experiments using broadband international link were agreed between Republic of Korea, and Japan, in September 1997. Nine subjects for collaborative experiments were also agreed between Singapore and Japan, in February 1998. Experiments regarding next-generation Internet technology such as Resource Reservation Setup Protocol, IP Multicast Backbone on the Internet, IPv6 are also planned. Application experiments concerning tele-medicine, tele-coference, etc. are also planned. Arrangements of experimental links between Japan-Korea and between Japan- Singapore have been made. International joint experiments have been underway. APII experimental network will also play a core role in APAN (Asia-Pacific Advanced Network) project, which is proceeded under the global-scale collaboration.

5.2 Current International APII Testbed Network

In order to promote the APII Testbed Project, the international networks have been configured by international submarine cable systems using optical fibers between Japan and Korea and between Japan and Singapore. The transmission capacity of these international links is 8Mbit/s between Japan and Korea and 2Mbit/s between Japan and Singapore. Between Japan and Korea, we determined to extend the duration of the project until March 31, 2001. Between Japan and Singapore, currently, there is an agreement to keep the submarine cable systems until March 31, 2001. International networks using Ku-band satellite links have been configured among Japan, Hong-Kong, Thailand and Indonesia. Furthermore, C-band satellite links have been added or under planning of construction in 2000 among Japan, Singapore, Malaysia, Philippines, Vietnam and Sri Lanka.The transmission capacity of each satellite link is 1.5Mbit/s from Japan to the other countries and 512kbit/s from the others to Japan. A lot of experiments such as the Next Generation Internet technology have been performed on the links. These satellite-based networks are also called AI3 Testbed Network. Originally it has been initiated in 1996 and kept running for academic and research purposes on a nonprofit and nongovernmental basis in conjunction with many research institutions in Asian countries. Since APII Testbed Project inherited AI3 Testbed Network in April 1999, the APII Testbed Project has been collaborating with AI3 members. The part of satellite networks in the APII Testbed network is connected with each domestic testbed network through each satellite gateway. So we can access many institutes or laboratories in member economies and make progress in the advanced Internet technologies with many researchers in Asian countries by using this APII Testbed network. The summary of the link status and traffic patterns of APII testbed and measured APII testbed traffic are shown in Fig.6.



Measured APII testbed Traffic (Monthly data)
Co-operated with APAN and AI3 project

Link	Ave. In (Kbps)	Ave.Out (Kbps)	Max in (Kbps)	Max out (Kbps)	N of related Facilities	Ave. In Kbps (/facility)	Ave. out Kbps (/facility)
JP-KR	538.0	1384.0	7997.6	7933.0	11	48.9	125.8
JP-SG	211.0	456.0	1563.0	1997.0	30	7.0	15.2
JP-ID	400.2	1160.0	501.0	1468.0	26	15.4	44.6
JP-TH	31.0	46.8	162.4	470.0	1	31.0	1.5
JP-HK	N.m	N.m	N.m	N.m	1	N.m	N.m
JP-SG	3.9	1.4	159.7	26.4	3	1.3	0.5
JP-My	1.1	8.1	12.1	138.9	8	0.1	1.0
JP-PH	14.9	187.4	86.3	947.3	4	3.7	46.9
JP-SRI	N.m	N.m	N.m	N.m	1	N.m	N.m
JP-VIET	N.m	N.m	N.m	N.m	9	N.m	N.m
SFC-NAIST	137.0	94.5	527.4	1158.5		N.m: Not measured.	
AI3-WIDE	494.2	1456.1	1047.0	2465.0			

Fig.6 *Summary of the APII test-bed Traffic analysis*

5.3 CRL-NGI Current Works

Furthermore, we gave some lectures as a tele-education with DVTS system. DVTS enables high-quality video and audio data to be transmitted over Ipv6 Network. In this training course, the trainees in Kobe attended a lecture that was provided by a lecturer in Tokyo (Fig.7). They could listen to the lecture clearly and also look at the presentation slides with no trouble. It was suggested that every trainee scattered in Asia could take a class that was given by lecturers in developed countries. This technology could be a breakthrough for solving the serious issue of digital divide among Asian countries. The IPv6 Connection experiment has started since December 2000 by using APII Technology Center. We connected APII Technology Center and Keihanna CRL with 135Mbps ATM Network. Keihanna CRL connects with JGN. JGN is a nationwide network that stands for Giga-bit network. Using these networks, we are able to develop next generation network technologies. We are making plans to develop new digital content management and distribution technologies. As a first step, we started the high-quality video and audio data transmission experiment with transmitting DV data which needs 28 Mbps traffic over native ATM as an example of broadband application of JGN, 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 on IP and SONY SEU-TL100 on 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 which 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. Further more, we made the JGN-Delay map with comparison between geographical map and JGN-Delay data (Fig.8).

6 Conclusions

CRL-NGI project was launched in 1999.

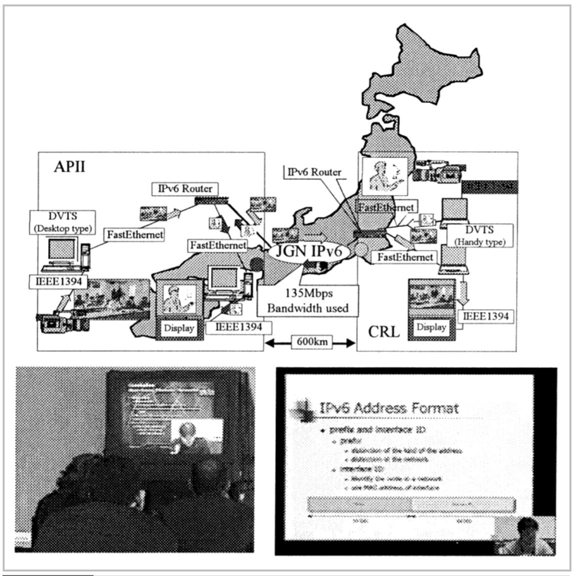


Fig.7 DV based Distance Lecture Experiment over IPv6 network

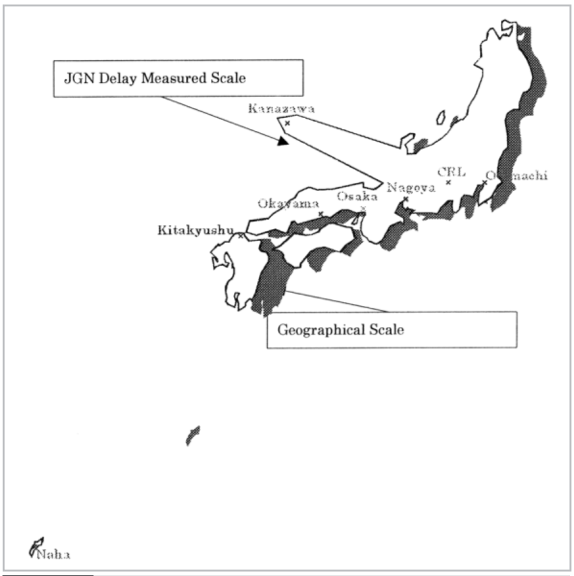


Fig.8 Correlation between the result of Network Measurement on JGN and Geographical Map

Its missions are promoting network science, developing novel NGI transfer protocol, integrating several ongoing Internet testbed projects, suggesting a policy model for NGI to be an authentic information infrastructure, and proposing a unique infrastructure model together with coordinating policies based on the survey of current Internet. They has established the IPv6 by integrating operation of APII testbeds, AI3 testbeds, Japan Gigabit Network, GENESIS and CRL experimental network and other network test-beds. As a result, the local loops in Asian countries are not matured for the development of Asian Internet by the survey of APII test-bed project. JGN based IPv6 survey with experiment suggested that the needs to introduce a concept of high-speed network's geographical scalability. Based on these results, as for Asian region, it is suggested that knowledge distribution of IPv6 technology and network optimization are crucial in the future.

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Shin-ichi NAKAGAWA *,M .D., D.Ms.*

Leader, Next Generation Internet Group, Information and Network Systems Division

Next Generation Internet

Akihiko MACHIZAWA

Senior Researcher, Next Generation Internet Group, Information and Network Systems Division

Next Generation Internet

Mina AOKI

Senior Researcher, Next Generation Internet Group, Information and Network Systems Division

Next Generation Internet

Takeshi SAKURADA

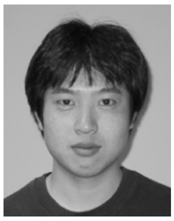
High-Speed Network Group, Information and Network Systems Division

Broadband Networking Research

Kazunori SUGIURA

Researcher, High-Speed Network Group, Information and Network Systems Division

Broadband Networking Research



Yoshiaki KITAGUCHI

Visiting Researcher, Next Generation Internet Group, Information and Network Systems Division

Next Generation Internet

Atsushi ITOU

Visiting Researcher, Next Generation Internet Group, Information and Network Systems Division

Next Generation Internet

Mayumi MIKI

Visiting Researcher, Next Generation Internet Group, Information and Network Systems Division

Next Generation Internet

Yuko KOMAKI

Visiting Researcher, Next Generation Internet Group, Information and Network Systems Division

Next Generation Internet

Syuko KATO

Researcher, Next Generation Internet Group, Information and Network Systems Division

Next Generation Internet

Takahiro KOMINE

Senior Researcher, High-Speed Network Group, Information and Network Systems Division

Broadband Networking Research

Kazuyoshi MATSUMOTO

Senior Researcher, Next Generation Internet Group, Information and Network Systems Division

Next Generation Internet

Yutaka KIDAWARA*, Dr.Eng.*

Senior Researcher, Next Generation Internet Group, Information and Network Systems Division

Next Generation Internet

Masazumi NISHIDA

Senior Researcher, Next Generation Internet Group, Information and Network Systems Division

Next Generation Internet

Kenji TANAKA

Senior Researcher, Next Generation Internet Group, Information and Network Systems Division

Next Generation Internet

***Takeyuki OJIMA**, Dr.Eng.*

Senior Researcher, Next Generation Internet Group, Information and Network Systems Division

Next Generation Internet

Haruo OKAZAWA

*Senior Researcher, Information and Network Systems
Division*

Next Generation Internet

Seiji TSUCHIIKE

Visiting Researcher, Next Generation Internet Group, Information and Network Systems Division

Next Generation Internet

Koichi KAMACHI

Visiting Researcher, Next Generation Internet Group, Information and Network Systems Division

Next Generation Internet

Hiroshi NAGATA

Visiting Researcher, Next Generation Internet Group, Information and Network Systems Division

Next Generation Internet

Shunkichi ISOBE

Leader, Science and Technological Information Group, Research Alliance Office, Strategic Planning Division

Science and Technological Information