第 XXXIV 部

JGNII Operation

第 34 部
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∗Note∗
About 70% of this report has been published at IPv6 Workshop in IEEE/IPSJ SAINT2005. The title of the paper is "JGNII (Japan Gigabit Network II)".

Abstract

JGNII, Japan Gigabit Network II, has been established at the end of March 2004. JGNII is a successor of JGNI, which has been established by Telecommunication Advancement Organization (TAO) in 1999. JGN was designed for the nation-wide R&D network for high speed network infrastructure. JGNII has the same objective as JGN, however uses different layer 2 technologies. JGNI have developed a nation-wide IPv6 testbed, which was the largest scale of multi-vendor IPv6 network. The network transition from JGNI IPv6 to JGN IPv6 has been smoothly achieved with only total of 8 hours transition period. Also, at the end of 2004, the layer 3 topology change has been completed to run IPv6 multicast service using PIM-SM.

JGNII IPv6 network has the following features.

(1) Layer 2 testbed for Layer 3 research activities
(2) Consideration of IP Multicast Research
(3) Global IPv6 connectivity
(4) Policy control to achieve appropriate AUP
(5) Advanced layer 2 technologies; optical, GMPLS and long-distanced-Ethernet
(6) 10 Gbps international link to StarLight

The global collaboration among various research organizations, regarding both research and network operation, is the important agenda, that JGNII will proceed. The 10 Gbps international link has been in operation since August of 2004. This high speed link has been connected to StarLight in Chicago (USA). In January, two real-time HDTV remote presentations have been successfully operated. These demonstrations are first full-scale collaboration with oversea research networks for JGNII operational team. This demonstration was a collaboration among WIDE Project, JGNII, StarLight, University of Washington, NLR, NiCT, PoweredCom, NTT Communications, NTT, APAN, IEEAF, T-LEX, Pacific Northwest Gigapop, Pacific Wave, Pacific Interface, ResearchChannel and University of California San Diego Cal-$(IT)^2$.

第 1 章 Introduction

Traffic measurement of data transmission in the professional networks shows a rapid increase of bandwidth requirement and transparent communications. Especially in these days, the applications that exchange large data volume over the networks with peer-to-peer fashion have been increasing. One of the spectrum is a real-time multimedia communication, such as (ultra) high-resolution digital image and video, or the three dimensional images. The other spectrum is peer-to-peer applications, such as Napstar or SKYPE. In order to accommodate these new applications effectively and smoothly, we have to establish an advanced networking technology. As frequently pointed out, the IPv6 technology can provide the NAT-free IP infrastructure, so as to provide transparent networking environment, and can be the infrastructure to deliver the new applications, such as ubiquitous computing or ubiquitous networking. Therefore, we need an IPv6 based R&D network, which allow to work on the exploration

of new applications on top of ultra broadband network environment. The Japan Gigabit Network, hereafter called "JGNI", which was established by Telecommunications Advancement Organization (TAO), has been operating as a research and development network testbed from 1999 to March 2004. Many researchers have achieved effective R&D activities using JGNI through industry-academia-government collaboration. A lot of prominent achievements has been delivered in the areas of super-high-speed networking technologies and advanced application technologies. These achievements include the development of broadband IP networks throughout Japan and the development of IP version 6 technologies to the Internet.

In April 2004, in response to the announcement of "e-Japan Strategy2" by the Japanese government's IT Strategy Headquarters in July 2003, the National Institute of Information and Communications Technology (NiCT) has started the operation JGNII. JGNII, which is the succession of JGNI, is aiming to accelerate and lead the R&D activities on the advancement of information and communications technology. JGNII is a new advanced network testbed for research and development that builds upon and further development of the technologies developed by JGNI.

Also, NiCT has started the operation of an international broadband testbed between Japan and U.S. from August 2004. This international connection is designed to promote the international joint research activities between domestic and overseas researchers for the next generation Internet technologies.

JGNII will also contribute to human resource development. Regional activities and practical research activities over JGNI infrastructure has stimulated through the use of JGNI network.

This paper describes the outline of JGNII, focusing on the introduction to layer2/3 networking which is called as "JGNII IPv6", using Ethernet technology.

In order to come up with the various technical and operational challenges due to the continuous and rapid growth of the Internet, the research and development on the IP version 6 (IPv6) has been progressed for more than ten years. The IPv6 team of WIDE Project has worked with Telecommunications Advancement Organization (TAO), so as to achieve the successful upgrade of the Japan's nation-wide Gigabit Network (JGN: Japan Gigabit Network) to be compatible with IP version 6 (IPv6). This JGN IPv6 network has 47 access points across nation-wide Japan; including 28 router installation sites and 19 bridge installation sites. With this deployment, an IPv6 network has been developed enabling the execution of various verification and operation experiments, such as early transition of the network from IPv4 to IPv6 and the debagging of commercial products in order to be compatible with IPv6 and to achieve the professional operational quality. To enable the JGN to accommodate various research and development activities related to IPv6 technology, which is a core network protocol for the next generation Internet. Network equipments compatible with IPv6 has been installed and a test operation as a JGN IPv6 network has started on October 1, 2001. The JGN IPv6 network has been established as a native IPv6 network equipped only with IPv6-compatible equipments. And, JGN allows IPv4 traffic via IPv4/IPv6 dual-stack operation, i.e., capable of accommodating both IPv4 and IPv6. In order to contribute to the router vendors, JGN IPv6 network is operated with a multi-vendor environment that includes two US vendors and three Japanese router vendors. JGN IPv6 network contains the Okayama IPv6 Interoperability. In the laboratory, we evaluate each network equipments and application software. The evaluation is functional compliancy of each equipment and interoperability among the network equipments. Also, the JGN IPv6 network has the IPv6 Research and Operation Center in Tokyo (Otemachi), in order to establish the operation and management technologies of the

IPv6-compatible network equipments. Whole of network and research center developed as JGN has been successfully and smoothly transferred to JGNII. During the transition process from JGN to JGNII, the link technology has been changed from ATM to Ethernet/SONET and the layer 3 topology has modified at the end of 2004.

第 2 章 Overview of JGNII network

JGNII is composed of the following 3 functions of network.

- Layer2/3 Testbed Network
- GMPLS 1 Testbed Network
- Optical Testbed Network

2.1 Layer2/3 Testbed Network

JGNII has access points capable of providing layer2/3 services throughout Japan, in 47 prefectures and city governments (total of 63 places) like JGNI. The network's entire core-node link is connected with 10GBase-X. The details such as bandwidth of every link and topology etc., is shown in Figures 2.1 through 2.3. Layer2/3 Testbed Network service provides the following:

- Ethernet connection (Layer2) service
  1. Point-to-Point connection service
     This service connects 2 points by L2 connection based on VLAN.
  2. Multi-point connection service
     This service connects multiple points by L2 connection based on the same VLAN.
- IP connection (Layer3) service
  This service connects JGNII users among each other, or to other research networks and other users, at the IP level (a service with an IPv4/IPv6 dual stack).
- Available interfaces for users
  10/100/1000base-T (for all users)
  1000base-X (for all users)
  10Gbase-X (not for all users)

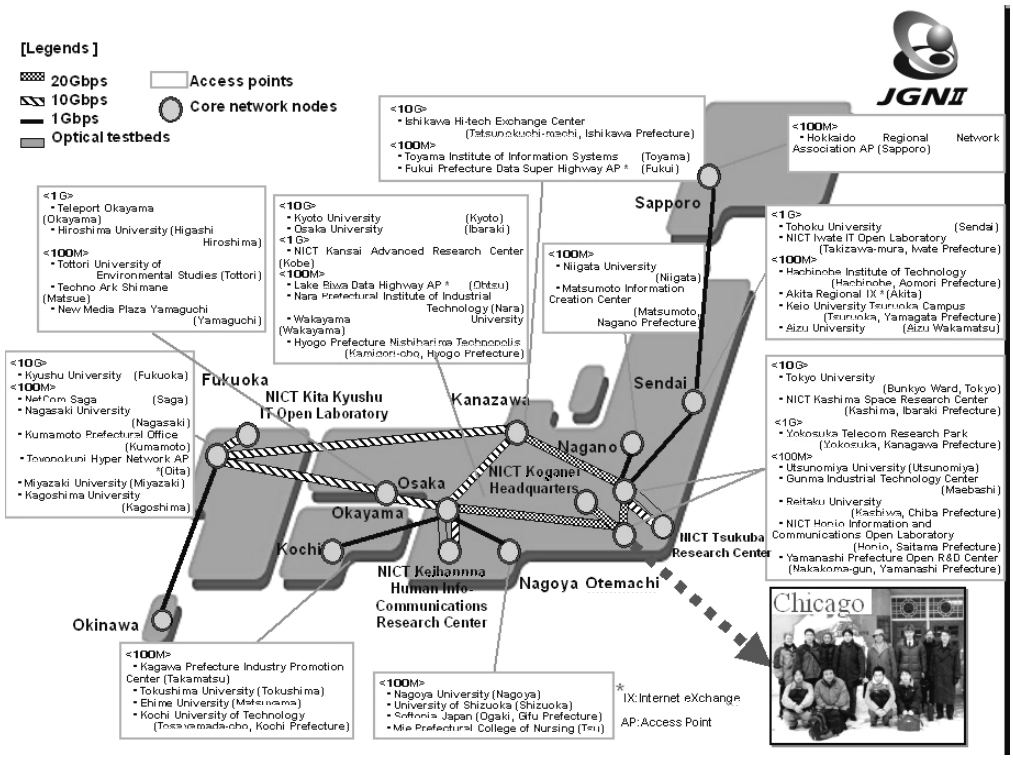


Fig. 2.1. Access Points and Backbone Topology of JGNII

2.2 GMPLS Testbed Network

The GMPLS testbed of JGNII is composed of OXCs 2 and various router models that carries out two different GMPLS Autonomous System (GMPLS-AS), and validates the interoperability by External-Network-Network-Interface (E-NNI) between two different GMPLS-AS.

This GMPLS testbed establishes not only the only-router-connected network but the OXC-router-connected network with high quality interoperability of GMPLS-AS. It is shown in

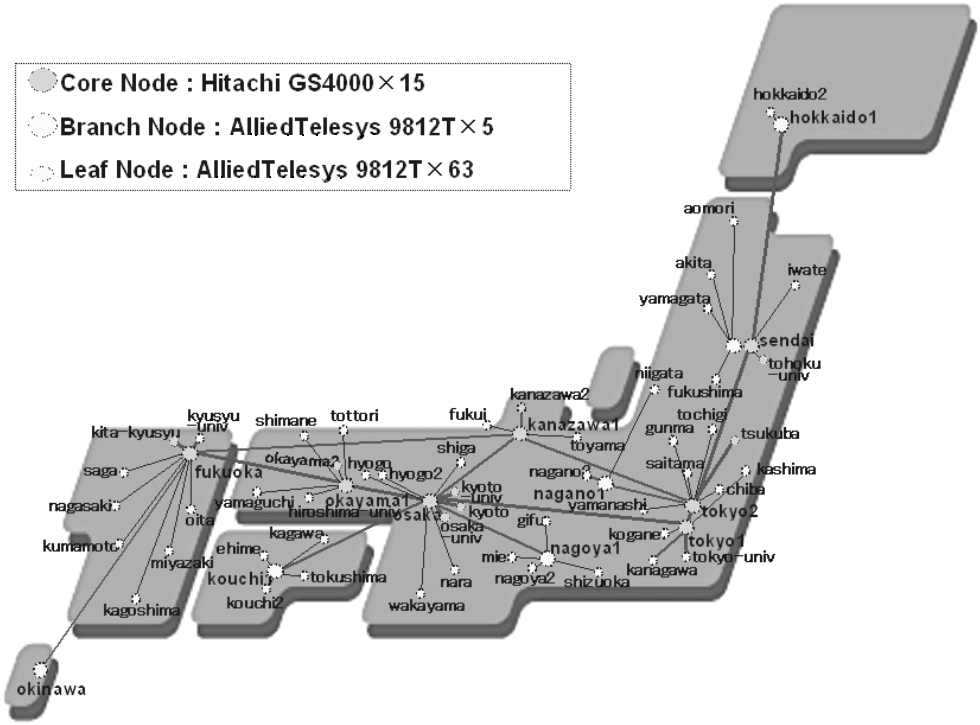


Fig. 2.2. Layer 1 Network Topology of JGNII

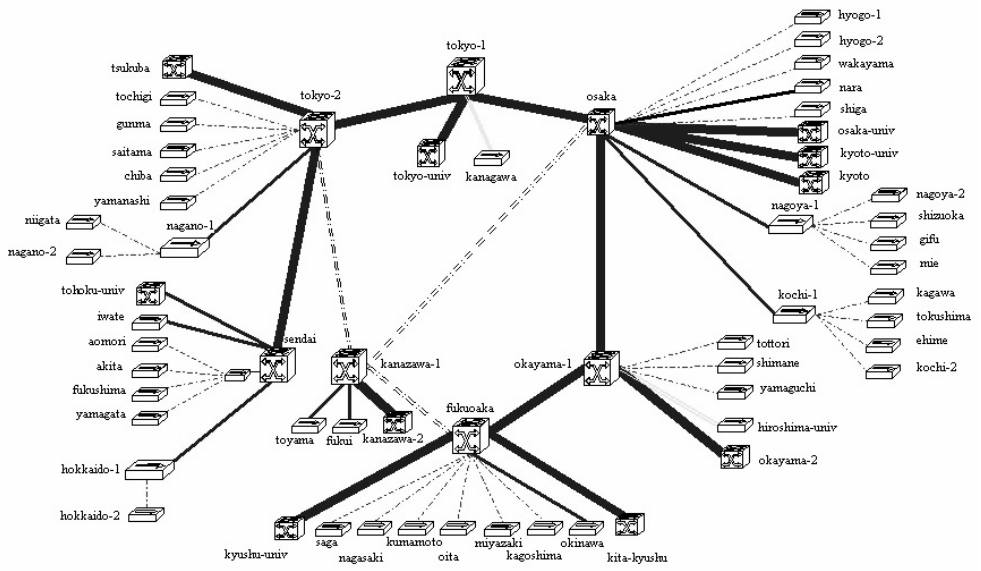


Fig. 2.3. Layer 3 Network Topology of JGNII

Figure 2.4. GMPLS Testbed Network services provides the following: Connectivity at the optical wavelength level, at where OXC is installed. Two types of interfaces are used: 1 Gbps and 10 Gbps.

2.3 Optical Testbed Network

JGNII has two different optical testbed capable of researching various optical properties shown in Figure 2.5 and Figure 2.6.

This testbed enables users to use "wavelength"

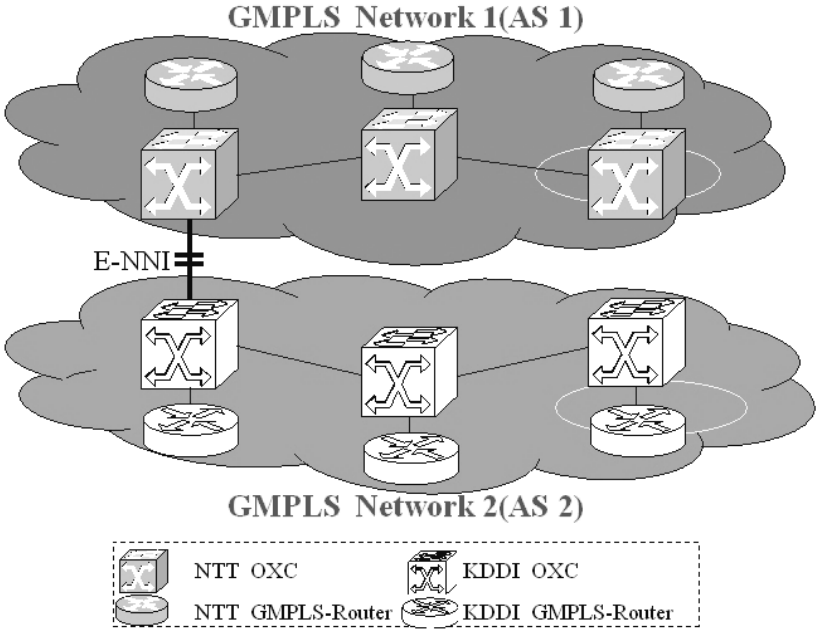


Fig. 2.4. Internetworking of Two GMPLS Networks

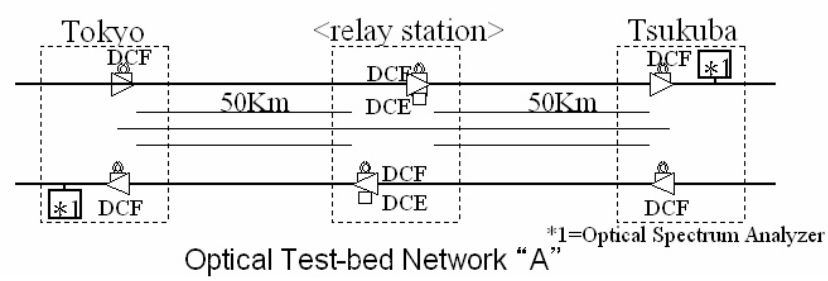


Fig. 2.5. Configuration of Network A

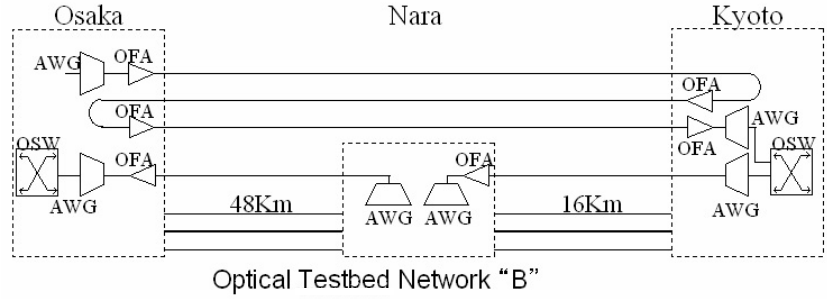


Fig. 2.6. Configuration of Network B

as well as "band" as they please. Also, multiple users can divide the testbed resource and use it simultaneously. Optical Testbed Network service provides the following: Experiments on optical transmission between specific points.

第 3 章　Feature of Layer2/3 network

This section describes the characteristics and transition of JGNII network.

3.1 Design policy of JGNII Layer2 network

JGNII L2 network is constructed based on the following design policy.

- The point-to-point connection service that depends on Ethernet-VLAN (Layer2 based path) can be provided.
- All Layer2-switches have IPv6 MLD-snooping (Multicast Listener Discovery snooping) function, that does not exert influence on the other (non listener) ports.

At first, it was mainly designed to provide L2 based service, though this design policy differ substantially from numerous ISP's and the research and development testbeds of foreign countries (most of them usually offer L3 based services). However, there was a definite reason for the design policy to allow users researching on several issues on IP-layer to offer the path of subordinate position layer (L2). The users say that they are able to use the network freely without considering about AS and domain of the IP address service organization (e.g. NiCT). Next, it is predicted that the demand of multicast contents delivery on the IPv6 network will increase from now on, so the selected devices (Layer2 switches) need to equip the function that can avoid IPv6 MLD-snooping which avoids multicast packet flooding from non-multicast listeners. At present, the interoperability "IPv6 MLD-snooping" function among layer2 switches of various vendors are tackling to commercialization.

3.2 Transition from "JGNIv6" to "JGNIIv6"

The transition of JGNI IPv6 network which that sat on the JGN I's ATM network (hereafter called JGNIv6) to JGNII IPv6 network which sits on the JGNII's Ether network (hereafter called JGNIIv6) was successful in a short period of time.

It was carried out by emulating JGN I's ATM virtual paths (PVC) with JGNII's Ethernet paths (VLAN) and therefore the downtime of the JGNv6 was minimized successfully. The method is as follows (Figure 3.1).

- Make JGNII's Ethernet VLAN-Identification with JGN I's ATM PVC-Identity Operate on both JGNIv6 network and JGNIIv6 network

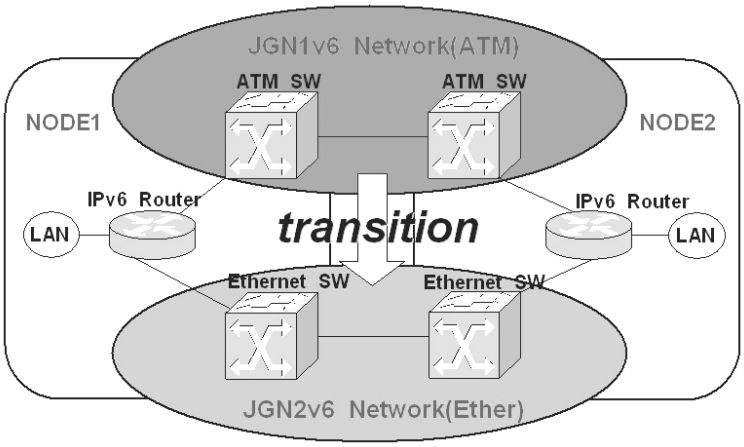


Fig. 3.1. Transition from JGNI to JGNII

throughout the transition period, until the normal operation of JGNIIv6 network is confirmed.

The transition of JGN network was done under the following preconditions, scheduling, technical issue that were strictly set. The challenges of this transition were:

- The difference of technology specification of ATM (JGNI) and Ethernet (JGNII), and the physical topology of JGNI and JGNII, had to be accurately defined, and the optimum design and scheduling of the network transition had to be followed.
- The transition and launch had to be finished within 14 days; all 23 circuits related with JGNIIv6 network, and 63 circuits of JGNII, had to be connected smoothly, and all the circuit examinations had to be completed.
- The migration of network had to be done in the condition without using remote maintenance tools, because all of the network elements (mainly, the circuits) that compose JGNII network were not assembled at the same time.
- Regardless of the construction progress of JGNIIv6 network, all the equipment that compose JGNIv6 network had to be removed before a certain completion term.

On the above condition, this transition was completed perfectly in total of 8 hours (4 hours for two days) without any problem.

To face these challenge, intensive coordination of all the JGNII and JGNIIv6 operators was necessary, in order to succeed in this network transition.

第 4 章　IPv6 Multicast Service using PIM-SM

The layer 3 topology for IPv6 service has not changed, when the JGNII has been launched. This means that the layer 3 topology was the same as the JGNv6 has. The logical network topology is shown in figure 4.1.

In order to have more flexible operation and to start the IPv6 multicast service, we have modified the network topology, as shown in figure 4.2. This topology change has been achieved at the end of

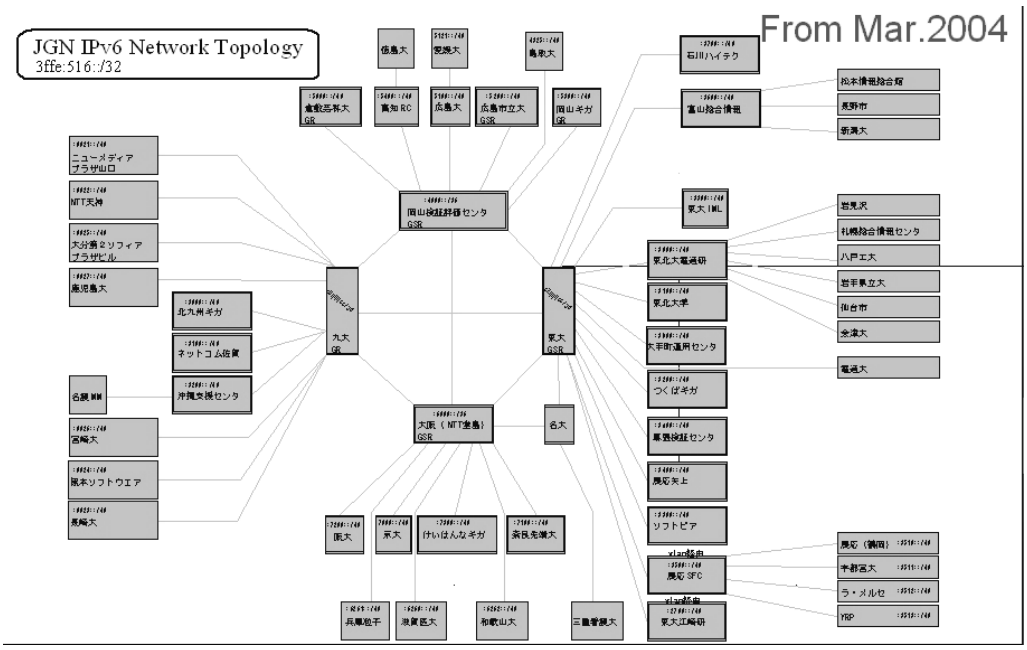


Fig. 4.1. Layer 3 Topology of JGN IPv6 Network (From March 2004)

December 2004.

Based on this new network topology, we have run the PIM-SM on the JGNII network to confirm the correct operation. During January 17–18, 2005, we have run the DV (Digital Video) multicasting all over the JGNII using IPv6. Since the multicast service is using PIM-SM, the multicast source can be anywhere in the JGNII network.

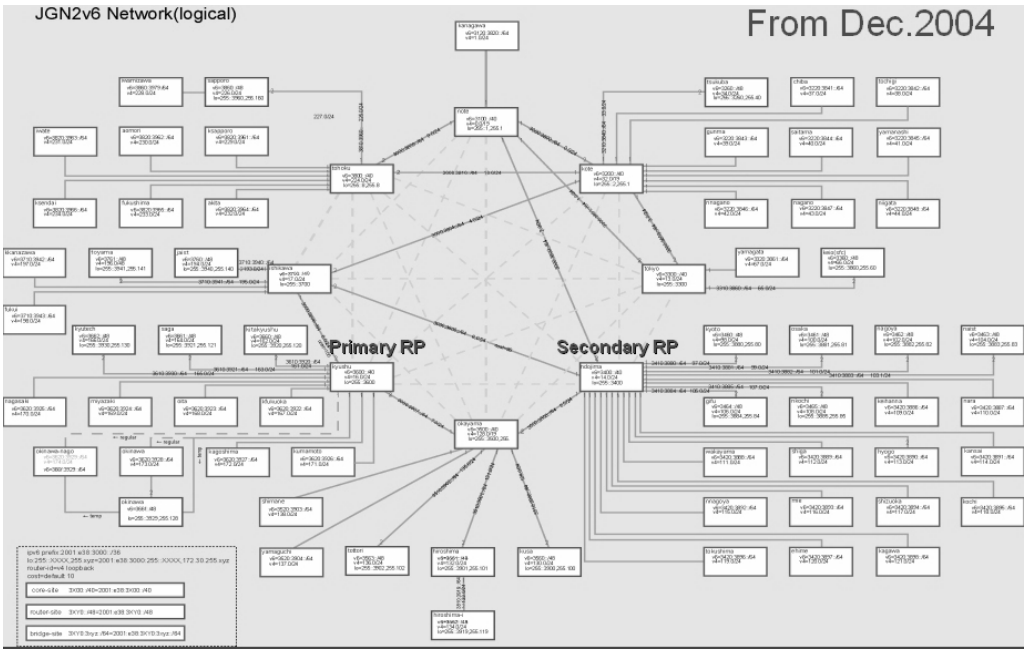


Fig. 4.2. Layer 3 Topology of JGN IPv6 Network (From December 2004)

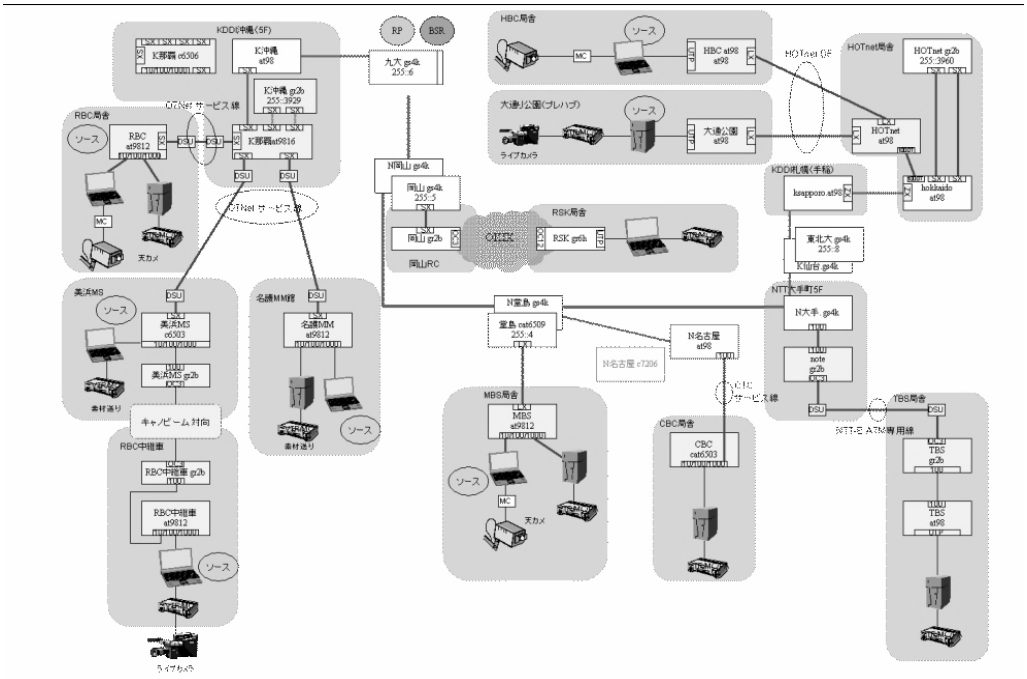


Fig. 4.3. Network Topology for Digital Video Multicasting over JGN II

第 5 章 JGNII International Link

5.1 Overview

The global collaboration among various research organizations, regarding both research and network operation, is the important agenda, that JGNII will proceed. The 10 Gbps international link has been in operation since August of 2004. The operation of this link is collaboration with APAN-Tokyo NOC team and NiCT. This high speed link has been connected to StarLight in Chicago (USA). The landing point in USA is at StarLight NOC in North Western University in Chicago. Figure 5.1 shows the configuration at StarLight, where the JGNII's 10 Gbps link lands.

5.2 HDTV Remote Presentation

In January, two real-time HDTV remote presentations have been successfully operated. These demonstrations are first full-scale collaboration with oversea research networks for JGNII operational team. This demonstration was a collaboration among WIDE Project, JGNII, StarLight, University of Washington, NLR, NiCT, PoweredCom, NTT Communications, NTT, APAN, IEEAF, T-LEX, Pacific Northwest Gigapop, Pacific Wave, Pacific Interface, ResearchChannel and University of California San Diego Cal-(IT)^2. Figure 5.2 shows the whole of network diagram for this particular demonstration event.

On January 17 and 18, 2005, the attendee at the JGNII Symposium 2005 in Osaka, Japan have listened and watched two of keynote presentations on a large HDTV screen above the podium. One is by Professor Jun Murai of Keio University, and the other is by Professor Larry Smarr of University of California San Diego Cal-(IT)^2. Both are remote presentation. Especially, Prof. Smarr was 5,000 miles away in Seattle, Washington from Osaka. Unlike traditional In-person talks the quality with remote presentation, the size and resolution was so great that audience noted they

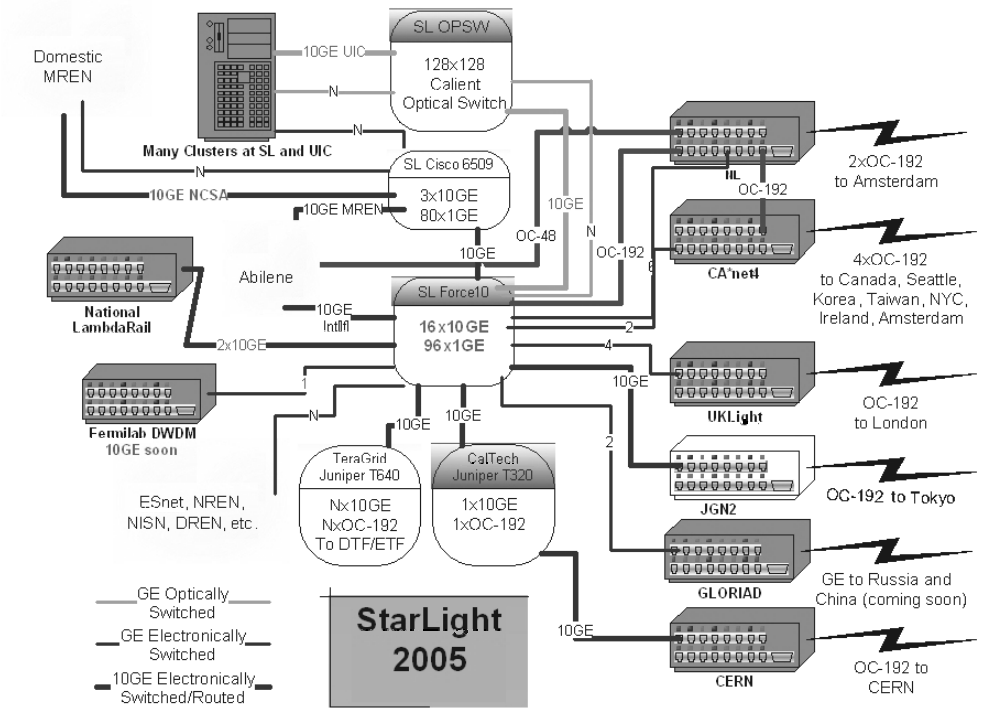


Fig. 5.1. System Configuration at StarLight in Chicago, USA

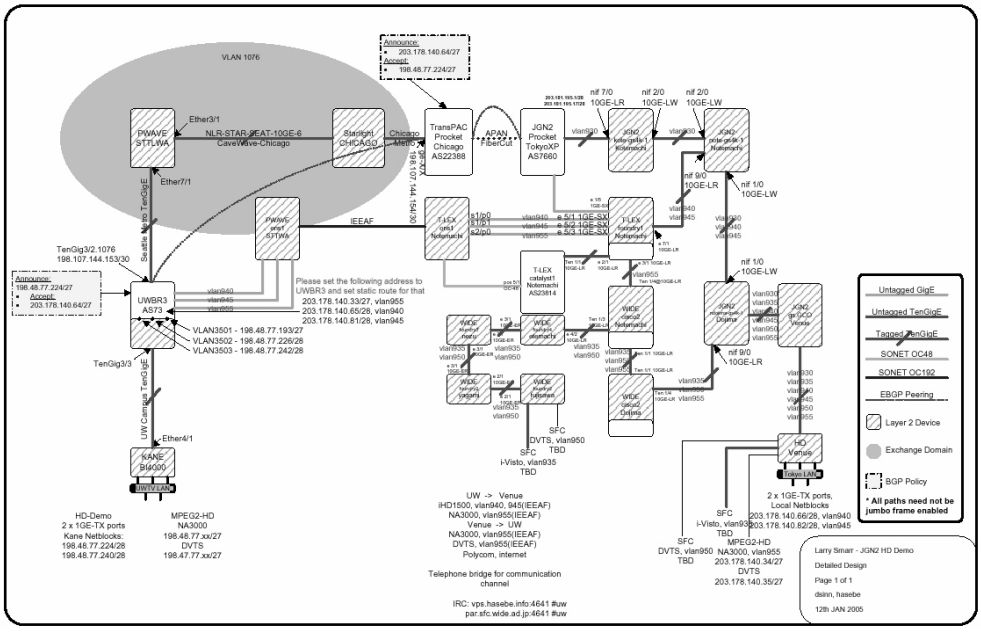


Fig. 5.2. Network Configuration for Uncompressed HDTV Transmission

could see every hair on the speakers head.

Advances in transmitting live, uncompressed high-definition television (HDTV) signals over IP networks are enabling true tele-presence, in which participants feel they are together in the same room. Two of Internet HDTV broadcast systems have been used for this event. One is by the University of Washington for the ResearchChannel, and the other is by NTT and NTT Communications. Servers in Fujisawa and Seattle transmitted uncompressed, real-time, high-definition digital video and digital audio at very high quality and low latency to a client system in Osaka.

Professor Murai's presentation originated on the Keio University Shonan Fujisawa campus in Kanagawa and was transmitted without using any compression at 1.5 Gbps to the Osaka venue, through the JGNII network and the WIDE 10 Gbps network, jointly operated with PoweredCom, NTT Communications and T-LEX.

Professor Smarr's presentation originated on the University of Washington campus in Seattle and was transmitted to the Pacific Northwest GigaPoP (PNWGP), then across a 10 Gigabits per second (Gbps) transpacific link from Seattle to Tokyo, and then via the JGNII to Osaka. The transpacific link was provided by the Internet Educational Equal Access Foundation (IEEAF), and is managed by the PNGWG in Seattle and the WIDE project in Japan.

The following is the list of collaborators regarding this demonstration.

High Speed Links;

- NiCT, National Institute of Information and Communications Technology, `http://www.nict.go.jp/`)
- JGNII (`http://www.JGN2.jp/`)
- PoweredCom (`http://www.poweredcom.co.jp/`)
- NTT Communications (`http://www.ntt.com/`)
- APAN (`http://www.apan.net/`)
- University of Washington (`http://www.washington.edu/`)
- IEEAF (Internet Educational Equal Access Foundation, `http://www.ieeaf.org/`)
- T-LEX (`http://www.t-lex.net/`)
- Pacific Northwest Gigapop (`http://www.pnw-gigapop.net/`)
- Pacific Wave (`http://www.pacificwave.net/`)
- StarLight (`http://www.startap.net/starlight/`)

- NLR (National Lambda Rail, http://www.nlr.net/)

HDTV Equipments

- NTT (http://www.ntt.co.jp/)
- NTT Communications (http://www.ntt.com/)
- Pacific Interface
- ResearchChannel (http://www.researchchannel.org/)
- University of California San Diego Cal-(IT)^2 (http://www.calit2.net/)

Network Equipments

- Cisco Systems (http://www.cisco.com/jp/)
- Bussan Networks (http://www.foundry.co.jp/)

第 6 章 Conclusions

JGNII, Japan Gigabit Network 2, has been established at the end of March 2004. JGNII is a successor of JGNI, which has been established by Telecommunication Advancement Organization (TAO) in 1999. JGNI was designed for the nation-wide R&D network for high speed network infrastructure. JGNII has the same objective as JGN, however uses different layer 2 technologies. The network transition from JGN IPv6 to JGN IPv6 has been smoothly achieved with only total of 8 hours transition period. Also, at the end of 2004, the layer 3 topology change has been completed to run IPv6 multicast service using PIM-SM.

As a result of many promotions of JGNII including the successful transition of JGNv6, utilization rate of JGNII network in September 2004 was several times more than that of JGN. As of September 2004, after 6 months from the launch of JGNII on April 1, 2004, the concrete number of general and/or testbed research is 52, and the number of network event usage is 16. Still, many results associated to rapid application expansion of JGNII network is expected more than ever. Hereafter, the collaborative accomplishment of an integration of the latest research themes such as "IPv6 over GMPLS" is also likely to be expected.

Also, the global collaboration among various research organizations, regarding both research and network operation, is the important agenda, that JGNII will proceed. The 10 Gbps international link has been in operation since August of 2004. This high speed link has been connected to StarLight in Chicago (USA). In January, two real-time HDTV remote presentations have been successfully operated. These demonstrations are first full-scale collaboration with oversea research networks for JGNII operational team. This demonstration was a collaboration among WIDE Project, JGNII, StarLight, University of Washington, NLR, NiCT, PoweredCom, NTT Communications, NTT, APAN, IEEAF, T-LEX, Pacific Northwest Gigapop, Pacific Wave, Pacific Interface, ResearchChannel and University of California San Diego Cal-(IT)^2.

Acknowledgements

We sincerely thank the people who have greatly contributed to this particular project in NiCT. Also, we thank to The Ministry of Internal Affairs and Communications, who gave us the opportunity to be involved in the construction of the JGNII network. The JGNII network is operated by a considerably large number of engineers including network engineers. We would also like to take this opportunity to share our appreciation to the network engineers who takes part in the operation of the JGNII network.

付録 A　Quotes on HDTV Remote Presentation from collaborators.

(1) Dr. Laurin Herr, President, Pacific Interface Inc.

On behalf of Pacific Interface Inc, thank you and congratulations to all for a job well done. Yesterday's JGNII HDTV event was a meaningful achievement on many levels and everyone involved should be very proud of what was accomplished.

First, we demonstrated that, collectively, we were able to pull a high-profile international event together in only one month, over the New Year holidays no less. We were able to smoothly form-up an operational team from multiple organizations in the USA and Japan that worked together effectively. Thousands of emails, two giant conference calls, and key face-to-face meetings helped us overcome time and distance to make a common plan and manage its implementation. Team contributions were enormous. 33 people in Japan, according to Hiroshi's latest list. Many more in America at StarLight and PNWGOP. As Larry said last night, the key to successful optical networks is successful human networks. The greatest resource we had to produce this event was, without a doubt, the human talent with the necessary training, skills and experience. There was steady pressure under tight deadlines, but no friction. This level of sincere cooperation is the fruit, I think, of many successful iGRID events and SuperComputing speed trials and global workshops over the past years.

Second, we demonstrated the GLIF is becoming well-developed enough in Japan, in America, and between the two countries, to start offering multiple possible network paths that can insure a reliable data transfer, no-matter-what. The original plan was quite ambitious, I know, but the engineering teams at StarLight and PNWGPOP and JGNII/WIDE got right on top of it. I'm sure we were well on our way to successfully implementing via StarLight and JGNII when the fiber got cut. Good thing that we were able to build back-up into the original plan. The flexibility of the team and its mastery of the available networking resources were sufficient for us to recover from natural disaster (avalanche/flood) less than a week before the event. Very professionally handled by the "collective" managing the overall network engineering.

(2) Dr. Ron Johnson, University of Washington

It is noteworthy that the (original and very ambitious) plan for this event was to use NLR to get from Seattle/PNWGP/Pacific Wave to StarLight, and then ride the jgn oc192 link to StarLight to Japan. That plan had come together successfully with the usual great help from Linda Winkler et al. at StarLight. However, when a flood cut the cable JGNII uses, the plan was shifted at the last minute to the backup plan to use the IEEAF connection between WIDE in Tokyo and the Pacific NorthWest Gigapop in Seattle.

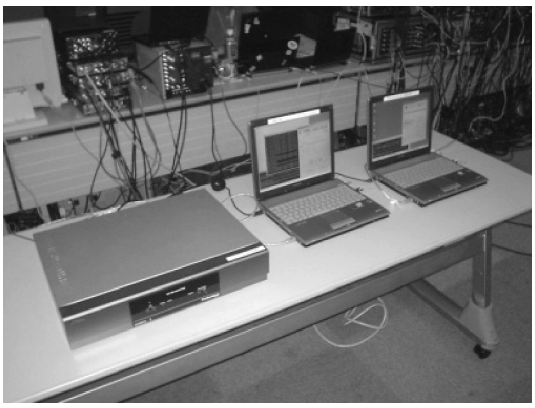
Our colleagues at WIDE and JGN both did a sensational job of working around this major and difficult challenge to establish a PNWGP-WIDE-JGN venue connection; and, their wonderful work and cooperation under very difficult circumstances and time pressures was very very impressive.

(3) Prof. Tomonori Aoyama, The University of Tokyo

The goal of the Symposium was to present the research and development activities taking place using Japan's JGNII, operated by the National Institute of Information and Communications Technology (NiCT). I am very pleased that we used JGNII and IEEAF broadband network technologies during the featured remote presentation by Dr. Smarr to explain the needs and applications for these technologies.

付録 B Pictures at the HDTV Remote Presentations

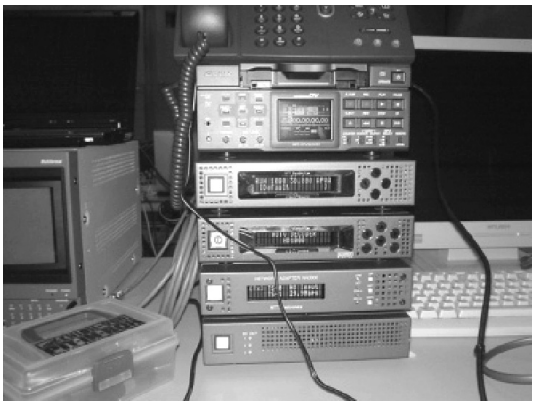


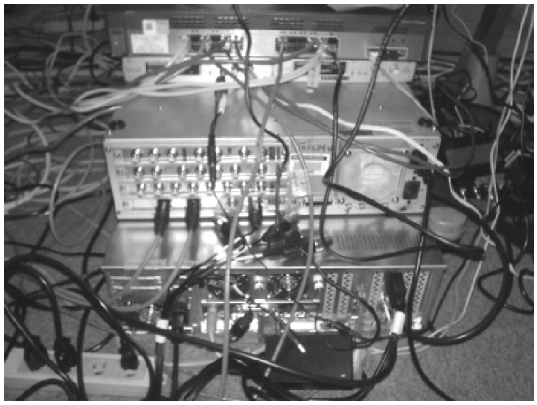



HDTV Equipments by NTT Group

Team NTT Group

Prof. Murai's Presentation





HDTV Equipments by
University of Washington Team

Studio at University of Washington in Seattle (USA)

Prof. Smarr's Presentation

付録 C

PRESS RELEASE 2005 年 1 月 26 日

WIDE プロジェクト
代表　村井　純

グローバル超高速インターネットテストベッドを
用いた高精細リアルタイム伝送映像による
遠隔講演に成功
――HD over IP の本格的導入に向けて――

WIDE プロジェクト（代表：慶應義塾大学　教授　村井純、本件責任者：東京大学　大学院　情報理工学系研究科　助教授　江崎浩）は、2005 年 1 月 17 日(月)–18 日(火)に大阪国際会議場で開催された JGNII Symposium 2005 in Osaka において、日米の研究組織の協力を得て、非圧縮の高精細映像（HDTV; High Definition TV）伝送技術を用いた 2 つのインタラクティブな遠隔講演に成功しました。

本遠隔講演では、高速データ通信回線として、情報通信研究機構（NiCT）開発用超高速テストベッドである JGNII（Japan Gigabit Network：研究開発用ギガビットネットワーク）、PoweredCom/WIDE プロジェクト共同実験用回線、NTT コミュニケーションズ/WIDE プロジェクト共同実験用回線、APAN、ワシントン大学、IEEAF、T-LEX、Pacific Northwest Gigapop、Pacific Wave、StarLight、NLR、シスコシステムズ、物産ネットワークスの協力を、HDTV 映像のリアルタイム伝送に関して日本電信電話(株)、NTT コミュニケーションズ、Pacific Interface 社、ResearchChannel、University of California San Diego Cal-$(IT)^2$の協力を得ました。

1 月 17 日(月)には、慶應義塾大学湘南藤沢キャンパス（神奈川県藤沢市）から同大学　環境情報学部　村井純教授が「JGNII：グローバル R&D への貢献と責任」の題目で、1 月 18 日(火)には、米国ワシントン州シアトルのワシントン大学からカリフォルニア大学サンディエゴ校の Larry Smarr 教授が「Using OptiPuter Innovations to Enable LambdaGrid Applications」の題目で、大阪の会場とリアルタイムに会話を進めながら遠隔講演が行なわれました。

HDTV のリアルタイムでの転送には、約 1.5 Gbps の帯域幅を用いた IP パケットの転送が必要です。今回は天災によるネットワーク切断というアクシデントにも見まわれましたが、本遠隔講演では、日米の研究開発機関が運営する最先端のオプティカルインターネット技術を利用し、さらに、これらを相互接続することによって、参加組織の数や伝送距離など、世界最高水準の遠隔講演を、実質の準備期間が 1 ヶ月未満という条件にて実現することに成功しました。

相互接続にあたっては、ネットワークインフラストラクチャのチューニングには、慶應義塾大学、東京大学をはじめとした多くのコラボレーションによって実現しています。

今後、WIDE プロジェクトでは、超高速インターネットテストベッド環境のグローバルな整備の推進と関係研究組織間での協力関係の強化、さらにネットワーク運用技術の研究開発を推進するとともに、HD 映像リアルタイム転送システムの IPv6 化やマルチキャスト化あるいは 3D 化などの高機能化への取り組みなど、グローバルスケールでの超広帯域インターネット基盤技術の確立を目指し、グローバルなインターネットコミュニティの発展に貢献してまいります。特に、今後の最先端超高速インターネット研究開発基盤のアジア諸国への展開を、T-LEX を欧米からアジアへのゲートウェイ拠点ならびに、国内の研究組織の国外へのゲートウェイ拠点と位置づけ、超高速インターネットテストベッドのグローバル化への貢献と責任を果たすことを目指します。

また、このイベントに対して Pacific Interface 社の Laurin Herr 氏、ワシントン大学の Ron Johnson 氏よりコメントをいただいております。

【原文】

Dr. Laurin Herr, President, Pacific Interface Inc.,

On behalf of Pacific Interface Inc, thank you and congratulations to all for a job well done. Yesterday's JGNII HDTV event was a meaningful achievement on many levels and everyone involved should be very proud of what was accomplished.

First, we demonstrated that, collectively, we were able to pull a high-profile international event together in only one month, over the New Year holidays no less. We were able to smoothly form-up an operational team from multiple

organizations in the USA and Japan that worked together effectively. Thousands of emails, two giant conference calls, and key face-to-face meetings helped us overcome time and distance to make a common plan and manage its implementation. Team contributions were enormous. 33 people in Japan, according to Hiroshi's latest list. Many more in America at StarLight and PNWGOP. As Larry said last night, the key to successful optical networks is successful human networks. The greatest resource we had to produce this event was, without a doubt, the human talent with the necessary training, skills and experience. There was steady pressure under tight deadlines, but no friction. This level of sincere cooperation is the fruit, I think, of many successful iGRID events and SuperComputing speed trials and global workshops over the past years.

Second, we demonstrated the GLIF is becoming well-developed enough in Japan, in America, and between the two countries, to start offering multiple possible network paths that can insure a reliable data transfer, no-matter-what. The original plan was quite ambitious, I know, but the engineering teams at StarLight and PNWGPOP and JGNII/WIDE got right on top of it. I'm sure we were well on our way to successfully implementing via StarLight and JGNII when the fiber got cut. Good thing that we were able to build back-up into the original plan. The flexibility of the team and its mastery of the available networking resources were sufficient for us to recover from natural disaster (avalanche/flood) less than a week before the event. Very professionally handled by the "collective" managing the overall network engineering.

【簡易和訳】

Pacific Interface 社を代表して、今回の成功に感謝しお祝いを申し上げます。JGN II での HDTV のイベントは、多くのレベルで意味のある業績であり、関係する誰もが成し遂げたことを誇りにするべきものです。

第一に、私たちは共同で、年末年始の休日もなく、たったの 1 か月で国際的に注目されるイベントを成し遂げました。アメリカおよび日本の複数の組織から集まった運用チームは、スムーズに形成されとても有能な働きをしました。何千もの電子メール、2 回の大規模な電話会議、そして重要な顔合わせが、時間および距離を克服して共通の計画を作り、かつそのインプリメンテーションをマネージしました。チームの貢献は莫大なものでした。江崎教授の最新のリストによると、日本からは 33 名。アメリカでは StarLight と PNWGOP からさらに多くの人が関係しました。ラリー氏によると、オプティカルネットワークの成功の鍵はよい関係を持った人々のネットワークにある、とのことです。私たちがこのイベントをプロデュースした最大のリソースは、必要なトレーニングを積み、スキルおよび経験を持つ人の才能でした。厳しい時間制限というプレッシャーがありましたがチームに摩擦はありませんでした。これは誠実な協力の賜物で、iGRID のイベントや、SuperComputing のスピード・トライアル、および過去のグローバルなワークショップのたくさんの成功と同じレベルと考えます。

次に、私たちは、GLIF のデモにより、何がおころうと信頼できるデータ通信を保証する複数のネットワーク・パスを提供することが、日本とアメリカ、2 国間で十分に発達していることを実証しました。オリジナルプランがとても野心的なものであったことを私は知っているのですが、StarLight、PNWGPOP、および JGNII/WIDE のエンジニアチームはそれが正しいと感じていました。私は、ファイバーが切断された時に、StarLight と JGNII を経由してうまく行くことを確信していました。私たちは、バックアップをオリジナルに組み込むことができたのです。チームのフレキシビリティおよび利用可能なネットワーク・リソースへ精通していることは、本番前一週間を切ったときに起きた天災（なだれ／洪水）から回復するのに十分でした。「共同的な」総合的ネットワーク・エンジニアリングのマネージによるとても専門的な対応でした。

【原文】

Dr. Ron Johnson, University of Washington

It is noteworthy that the (original and very ambitious) plan for this event was to use NLR to get from Seattle/PNWGP/Pacific Wave to

StarLight, and then ride the jgn oc192 link to StarLight to Japan. That plan had come together successfully with the usual great help from Linda Winkler et al. at StarLight. However, when a flood cut the cable JGNII uses, the plan was shifted at the last minute to the backup plan to use the IEEAF connection between WIDE in Tokyo and the Pacific NorthWest Gigapop in Seattle.

Our colleagues at WIDE and JGN both did a sensational job of working around this major and difficult challenge to establish a PNWGP-WIDE-JGN venue connection; and, their wonderful work and cooperation under very difficult circumstances and time pressures was very very impressive.

【簡易和訳】

このイベントのためのプラン（オリジナルで非常に野心的）が、Seattle/PNWGP/Pacific Wave から StarLight へは NLR を使用し、日本へは JGNII oc192 リンクを使用したことは注目に値します。この経過には、StarLight の Linda Winkler 他のすばらしい協力を得ました。しかしながら、土壇場で洪水のため JGNII が使用するケーブルが切断されたため、プランはシアトルの Pacific NorthWest Gigapop と東京の WIDE との間で IEEAF 接続を使用するバックアップ計画に移行しました。

WIDE と JGN の私たちの同僚はともに、PNWGP-WIDE-JGN 開催地間の接続を確立するため、困難な挑戦と驚くべき仕事をしました。そして、困難な状況と時間的なプレッシャーの中でのすばらしい仕事と協力体制はとても印象的でした。

【協力組織】

〈高速データ通信回線〉

- 情報通信研究機構（NiCT、http://www.nict.go.jp/）
- JGNII（http://www.JGN2.jp/）
- PoweredCom（http://www.poweredcom.co.jp/）
- NTT コミュニケーションズ（http://www.ntt.com/）
- APAN（http://www.apan.net/）
- ワシントン大学（http://www.washington.edu/）
- IEEAF（Internet Educational Equal Access Foundation, http://www.ieeaf.org/）
- T-LEX（http://www.t-lex.net/）
- Pacific Northwest Gigapop（http://www.pnw-gigapop.net/）
- Pacific Wave（http://www.pacificwave.net/）
- StarLight（http://www.startap.net/starlight/）
- NLR（National Lambda Rail、http://www.nlr.net/）

〈HDTV 映像のリアルタイム伝送〉

- 日本電信電話（株）（http://www.ntt.co.jp/）
- NTT コミュニケーションズ（http://www.ntt.com/）
- Pacific Interface 社
- ResearchChannel（http://www.researchchannel.org/）
- University of California San Diego Cal-(IT)^2（http://www.calit2.net/）

〈機材協力〉

- シスコシステムズ（http://www.cisco.co.jp）
- 物産ネットワークス（http://www.foundry.co.jp/）

【本件に関する問い合わせ先】

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付録 D

PRESS RELEASE

Real-Time HDTV Broadcast from USA to Japan Enabled by Advanced Networks

Japan's JGNII Symposium 2005 Features Keynote Speaker Larry Smarr of UCSD Broadcast Live from Seattle over Advanced Optical Networks

January 18, 2005—Dignitaries and researchers attending the JGNII Symposium 2005 in Osaka, Japan today listened and watched as Internet visionary Larry Smarr gave the keynote presentation on a large HDTV screen above the podium. Unlike traditional keynote talks, however, Smarr was 5,000 miles away in Seattle, Washington. And unlike traditional In-person talks the quality, size and resolution was so great that audience noted they could see every hair on the speakers head.

Advances in transmitting live, uncompressed high-definition television (HDTV) signals over optical networks are enabling true tele-presence, in which participants feel they are together in the same room. The Internet HDTV broadcast system used for this event was developed by the University of Washington for the ResearchChannel. A server in Seattle transmitted uncompressed, real-time, high-definition digital video and digital audio at very high quality and low latency to a client system in Osaka. Professor Smarr's presentation originated on the University of Washington campus in Seattle and was transmitted without using any compression at 1.5 Gbps to the Pacific Northwest GigaPoP (PNWGP), then across a 10 Gigabits per second (Gbps) transpacific link from Seattle to Tokyo, and then via the JGNII to Osaka. The transpacific link was provided by the Internet Educational Equal Access Foundation (IEEAF), and is managed by the PNGWG in Seattle and the WIDE project in Japan.

Smarr, director of the California Institute for Telecommunications and Information Technology [Cal-$(IT)^2$] and principal investigator of the National Science Foundation-funded OptIPuter project, talked about the emergence of a new cyberinfrastructure based on dedicated optical paths, in which distributed clusters and instruments are tightly coupled using wavelengths of light, or 'lambdas,' on single optical fibers. The ability to stream video at gigabits per second, like in this HDTV transmission, is enabling new modes of communication and collaboration. "The clear crisp images and sounds that HDTV affords make for better dialogue and interaction with colleagues over distances," said Smarr, who is also a professor at the University of California, San Diego (UCSD) Jacobs School of Engineering. "The goal is to make these sorts of communication technologies persistent, so that far-away colleagues appear to be just beyond the 'Looking Glass'."

In his talk, Smarr noted that Cal-$(IT)^2$ is incorporating advanced video-over-fiber networking technologies into its two new buildings at UCSD and UC Irvine. Facilities are slated to include a digital cinema and HDTV production facility, as well as dedicated meeting and public spaces with large-format displays to support telepresence and collaboration. Said Smarr: "Every type of research will benefit if we can tear down walls and let scientists and engineers talk and work together in real time as if they were in the same room—even if they're thousands of miles away."

Tomonori Aoyama, a professor of Information and Communication Engineering at the University of Tokyo, chair of the JGNII management committee, and chair of the Symposium's keynote session, expressed his sincere gratitude to all who contributed to its success. "The goal of the Symposium was to present the research and development activities taking place using Japan's JGNII,

operated by the National Institute of Information and Communications Technology (NiCT)," said Aoyama. "I am very pleased that we used JGNII and IEEAF broadband network technologies during the featured remote presentation by Dr. Smarr to explain the needs and applications for these technologies."

JGNII, an advanced network testbed for research and development, is both a national and international testbed. It supports high-speed networking technologies and application advancements. Nationally, JGNII is a 20 Gbps backbone network that has access points in all Japanese prefectures. Internationally, JGNII connects Tokyo via a 10 Gbps link to the StarLight facility in Chicago, where it peers with the USA's National LambdaRail, Abilene and other advanced international, national, and regional research and education networks.

"This is a milestone both in the use of technology and the establishment of a new high-water mark in extraordinarily close international collaborations.," explained Ron Johnson, Vice President for Computing & Communications at University of Washington, "We are collectively managing dedicated lightpaths to carry uncompressed HDTV while at the same time supporting scientific research such as the Huygens Titan probe with a lambda based network infrastructure that links Asia, Australia, Europe, and North America. Colleagues at JGNII, WIDE, IEEAF, PNWGP, StarLight, the University of Washington, the ResearchChannel and other like-minded entities worldwide are working together to create 'deterministic' networks using multiple lambdas over optical fibers, to guarantee the bandwidth speeds and latency in order to do things like real-time HDTV transmission and remote steering of scientific instruments. We will continue to pursue this, to make applications like high-quality HDTV transmission both persistent and ubiquitous."

About ResearchChannel

ResearchChannel is a non-profit consortium of leading research universities and labs dedicated to creating a voice for research through both tradition broadcast, satellite and cable TV carriage, as well as via advanced on-demand video and Internet 'channels', while exploring new technologies for communication and collaboration. `http://www.researchchannel.org`

About JGNII

JGNII is a new Japanese ultra-high-speed open testbed network for R&D collaboration between industry, academia, and government, operated by the National Institute of Information and Communications Technology (NiCT) of Japan. JGNII was established in April 2004 with the aim of promoting a broad spectrum of research and development projects, ranging from fundamental core research and development to advanced experimental testing, in areas including the advancement of next generation technologies for networking and diverse network-based applications. JGNII provides nationwide Japanese IP networks, optical wavelength networks, and R&D environments for optical testbeds. JGNII was extended internationally in August 2004 with the addition of a 10 Gbps transpacific link between Japan (Tokyo) and the USA (Chicago). `http://www.jgn.nict.go.jp/e/`

About Cal-(IT)^2

The California Institute for Telecommunications and Information Technology [Cal-(IT)^2] is one of four institutes funded through the California Institutes for Science and Innovation initiative to ensure that the state maintain its leadership in cutting-edge technologies. Cal-(IT)^2 is a collaboration between UC San Diego and UC Irvine. Its mission is to extend the reach of the current information infrastructure throughout the physical world—enabling anywhere/anytime access to the Internet. More than 200 faculty members from the two campuses are collaborating on interdisciplinary projects, with support from more than 130 industry partners. `http://www.calit2.net`

About the University of Washington

Founded in 1861, the University of Washington a top research university with over 41,000 students on campuses in Seattle, Tacoma and Bothell, Washington. http://www.washington.edu

About Pacific Northwest Gigapop

The Pacific Northwest Gigapop (PNWGP) is a not-for-profit corporation serving leading edge organizations and Research and Education networks throughout the Pacific Rim. PNWGP provides robust, highest-speed access to current state of the art Internet; Next Generation Internet services and technology; and the exclusive R&D testbeds where tomorrow's Internet technologies are being developed. PNWGP is built to be the highest caliber Research and Education networking services hub in the world and is the operator of the Pacific Wave distributed west coast international peering and exchange point with integrated pop's in Seattle and Los Angeles. The Pacific NorthWest Gigapop is also the steward for Seattle end of the IEEAF Pacific links. http://www.pnw-gigapop.net

About IEEAF The Internet Educational Equal Access Foundation (IEEAF) is a non-profit organization whose mission is to obtain donations of telecommunications capacity and equipment and make them available for use by the global research and education community. The IEEAF TransPacific Link is the second 10 Gbps transoceanic link provided by IEEAF through a five-year IRU donated by Tyco Telecom; the first, the IEEAF TransAtlantic Link, connects New York and Groningen, The Netherlands, and has been operational since 2002. IEEAF donations currently span 17 time zones. http://www.ieeaf.org/

About WIDE

WIDE, a research consortium working on practical research and development of Internet-related technologies, was launched in 1988. The project has made a significant contribution to development of the Internet by collaborating with many other bodies—including 133 companies and 11 universities to carry out research in a wide range of fields, and by operating M.ROOT-SERVERS.NET, one of the DNS root servers, since 1997. WIDE Project also operates T-LEX (www.t-lex.net/) as an effort of stewardship for the IEEAF TransPacific Link in Tokyo. http://www.wide.ad.jp/

Participating Organizations

National Institute of Information and Communications Technology (NiCT)
NiCT/JGNII, NiCT/APAN
KDDI NTT Group
WIDE Project
University of California San Diego/Calit2
University of Washington
Pacific Northwest Gigapop
Pacific Wave
ResearchChannel
Pacific Interface, Inc.
StarLight
(Argonne National Lab, Northwestern University, University of Illinois at Chicago)
Indiana University
Intel

Circuits

JGNII, WIDE, KDDI, NTT Group IEEAF, NLR (National Lambda Rail)