JGN II (Japan Gigabit Network II)

A research and development system for advanced broadband networks

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Abstract

JGN2, Japan Gigabit Network 2, has been established at the end of March 2004. JGN2 is a successor of JGN1, which has been established by Telecommunication Advancement Organization (TAO) in 1999. JGN1 was desgined for the nation-wide R&D network for high speed network infrastructure.JGN2 has the same objective as JGN, however uses different layer 2 technologies. JGN1 have developped a nation-wide IPv6 testbed, which was the largest scale of multi-vendor IPv6 network. The network transition from JGN1 IPv6 to JGN IPv6 has been smoothly achieved with only total of 8 hour transition period. JGN2 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

1. 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 has been increasing. One of the spectrum is a realtime multimedia communication, such as (ultra) high-resolution digital image and video, or the three dimensional images. The other spectrum is a 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. Therfore, 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[2], hereafter called ”JGN1”, 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 JGN1 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 develoyment of broadband IP networks throughout Japan and the development of IP version

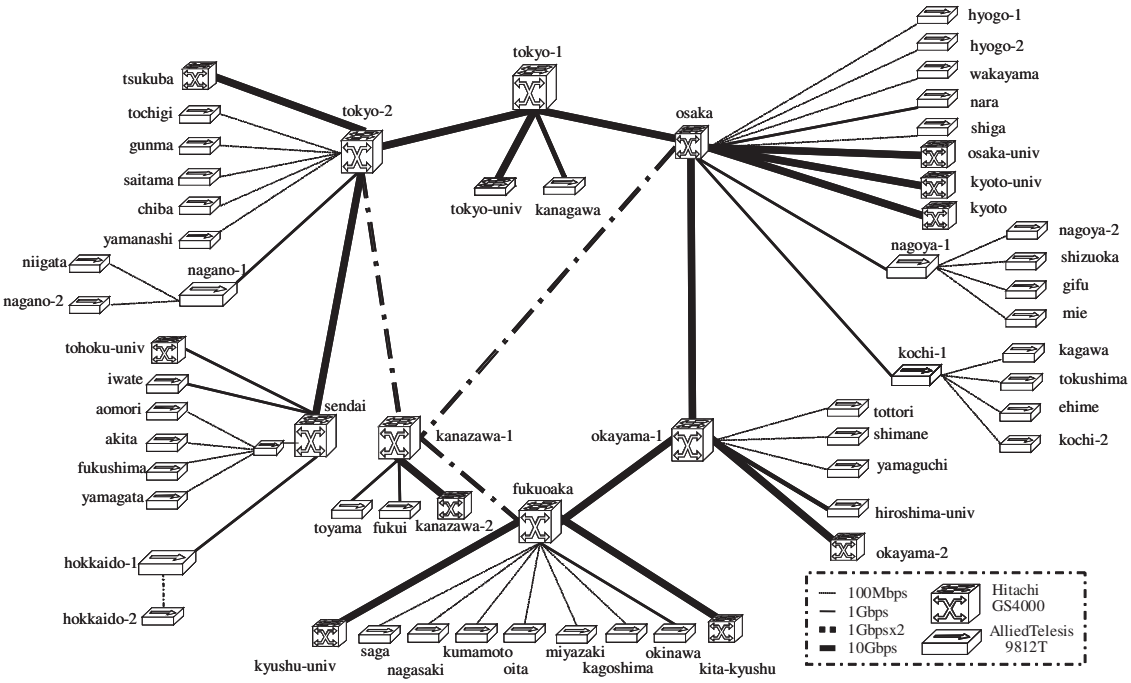

Figure 1. Layer2 network topology

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)[3] has started the operation JGN2. JGN2, which is the succession of JGN1, is aming to accelerate and lead the R&D activities on the advancement of information and communications technology. JGN2 is a new advanced network testbed for research and development that builds upon and further development of the technologies developped by JGN1. 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. JGN2 will also contribute to human resource development. Regional activities and practical research activities over JGN1 infrastructure has stimulated through the use of JGN1 network.

This paper describes the outline of JGN2, focusing on the introduction to layer2/3 networking which is called as ”JGN2 IPv6”, using Ethernet technology.

2. Overview of JGN2 network

JGN2 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

JGN2 has access points capable of providing layer2/3 services throughout Japan, in 47 prefectures and city governments (total of 63 places) like JGN1. 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 Figure 1.

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 JGN2 users among each other,

1 Generalized Multi-Protocol Label Switching

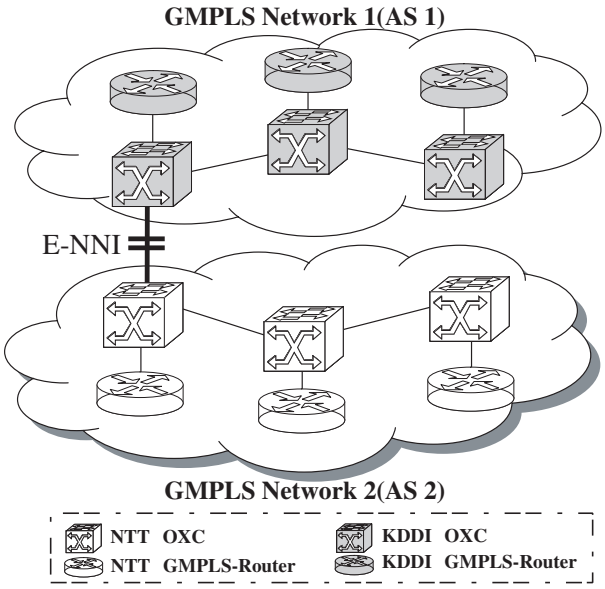

Figure 2. GMPLS Testbed Network

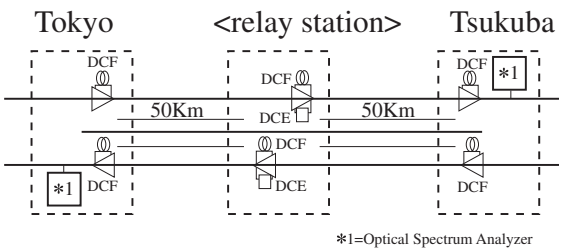

Figure 3. Optical Testbed Network "A"

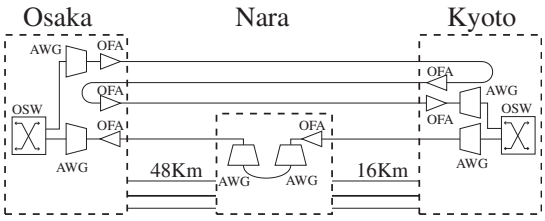

Figure 4. Optical Testbed Network "B"

or to other research networks and other users, at the IP level (a service with an IPv4/IPv6 dual stack).

- Useful interfaces for users
  10/100/1000base-T (for all users)
  1000base-X (for all users)
  10Gbase-X (not for all users)

2.2. GMPLS Testbed Network

The GMPLS testbed of JGN2 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 Figure2.

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

2.3. Optical Testbed Network

JGN2 has two different optical testbed capable of researching various optical properties shown in Figure 3 and Figure 4.

2 Optical Cross Connect

This testbed enables users to use "wavelength" 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.

3. Feature of Layer2/3 network

This chapter describes the characteristics and transition of JGN2 network.

3.1. Design policy of JGN2 Layer2 network

JGN2 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)[1] 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 "JGN1v6" to "JGN2v6"

The transition of JGN1 IPv6 network which that sat on the JGN1's ATM network (hereafter called JGN1v6) to JGN2 IPv6 network which sits on the JGN2's Ether network (hereafter called JGN2v6) was successful in a short period of time.

It was carried out by emulating JGN1's ATM virtual paths (PVC) with JGN2's Ethernet paths (VLAN) and therefore the downtime of the JGNv6 was minimized successfully. The method is as follows (Figure 5).

- Make JGN2's Ethernet VLAN-Identification with JGN1's ATM PVC-Identity Operate on both JGN1v6 network and JGN2v6 network throughout the transition period, until the normal operation of JGN2v6 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 (JGN1) and Ethernet (JGN2), and the physical topology of JGN1 and JGN2, 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 JGN2v6 network, and 63 circuits of JGN2, 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 JGN2 network were not assembled at the same time.
- Regardless of the construction progress of JGN2v6 network, all the equipment that compose JGN1v6 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.

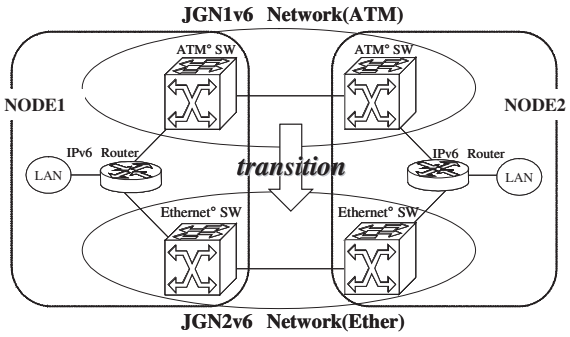

Figure 5. Transition of JGNv6

To face these challenge, intensive coordination of all the JGN2 and JGN2v6 operators was necessary, in order to succeed in this network transition.

4. Conclusions

As a result of many promotions of JGN2 including the successful transition of JGN1v6, utilization rate of JGN2 network in September 2004 was several times more than that of JGN1. As of September 2004, after 6 months from the launch of JGN2 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 JGN2 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.

5. 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 JGN2 network. The JGN2 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 JGN2 network.

References

[1] B. Haberman. Source Address Selection for the Multicast Listener Discovery (MLD) Protocol. RFC 3590, 2003.

[2] N. I. of Information and C. Technology. Japan Gigabit Network.
http://www.jgn.nict.go.jp, 2004.

[3] N. I. of Information and C. Technology. NICT - National Institute of Information and Communications Technology.
http://www.nict.go.jp, 2004.