4-5 About the Interoperability Evaluation of the IPv6 Multicast (Coordinated Verification with Regional Network)

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On the communication and broadcasting uniting age, The IPv6 multicast pays attention to the Internet as a technology that upgrades suitable life for not the mere Web use but the ICT society Especially, it is easily imaginable to be able to use the image material used by the IPv6 multicast as a lifeline in various fields. It is thought that these are promptly achieved by upgrading the Internet, and it contributes to a safe, comfortable life improvement.

Because the interoperability was verified about a technological element to use it at the real operation level, it reports on this IPv6 multicast. In addition, it reports also because the accuracy improvement is advanced in cooperation with the regional network.

Keywords
Multicast, Uniting of communication and broadcasting, Interoperability,
JGNⅡ (Japan Gigabit Network II), Regional network

1 Introduction

We examined interoperability among routers from different vendors at the laboratory level, and discovered a problem in the handling of IPv6 multicast traffic, as well as a problem with interoperability among the multicast protocols. After reporting these results to the relevant vendors, the problem related to multicast traffic handling (i.e., data transfer) in the backbone routers is nearly resolved. Meanwhile, despite our recommendation to implement the “PIM-SM” (Protocol Independent Multicast-Sparse Mode) IPv6 multicast protocol, not all vendors have implemented the recommended functions. This is because foreign vendors still suspect that PIM-SM is useful only in Japan.

We believe, however, that practical-level verification has a significant influence on the market, and that in response to this influence, these skeptical foreign vendors will come to recognize the future importance of developing and promoting the next-generation Internet.

As mentioned above, we view IPv6 multicasting as an integral element of the next-generation Internet. Accordingly, instead of designing a special multicasting network as in the case of IPv4, we have envisioned a mechanism that allows users to perform all tasks through a single port. To prevent multicast traffic from flowing to unnecessary ports, MLD (Multicast Listener Discovery) snooping must be installed on layer-2 switches to which the receiving terminals are directly connected. MLD snooping is equivalent to IGMP (Internet Group Management Protocol) snooping for IPv4. In addition to interoperable routers, layer-2 switches play an important role in the execution of IPv6 multicasting.

A layer-2 switch is an edge device to which terminals are connected. Vendors today are forced to trade off device miniaturization against additional functions such as MLD snooping and IEEE802.1x authentication; such functions are increasingly required in light of demand for enhanced performance in edge switches.

To increase the accuracy of interoperability verification given the above, we decided to perform testing using real networks, selecting the OKayama Internet eXchange (OKIX), which is interconnected both with JGNⅡ and various municipal networks (in Okayama Prefecture).

2 Discussion

2.1 Upgrading from JGN v6 to JGNⅡ v6

To perform testing of a large-scale network on the JGNⅡ testbed, we established a new IPv6 network within JGNⅡ (JGNⅡ v6). This was necessary because the earlier JGN employs ATM (Asynchronous Transfer Mode) in its backbone, which is no longer compatible with current network trends. It is essential to perform testing on the most common type of Ethernet-based network.

The newly built JGNⅡ v6 network has the configuration shown in Fig.1. We designed this network to serve as an R&D testbed and to feature the functions required for a next-generation Internet. To allow various regional networks to connect to JGNⅡ v6, we allowed these networks to refer to the network's routing information at its core and router sites:

(1) JGNⅡ v6 routing tables using OSPFv3 (Open Shortest Path First version 3)

(2) Shared use of PIM-SM RPs (Rendezvous Points)

We then incorporated the following elements into the core of the new network, and identified items to evaluate in terms of the large-scale network:

(1) Use of primary and secondary RPs (in a multi-vendor environment)

(2) Use of MLD snooping to prevent flooding

(3) Multicast availability over the entire JGN Ⅱ v6 (as a standard function)

JGNⅡ v6 must serve both as an R&D testbed for JGNⅡ users and as a research environment for the NICT Okayama JGNⅡ Research Center (RC). To this end, we created a multi-

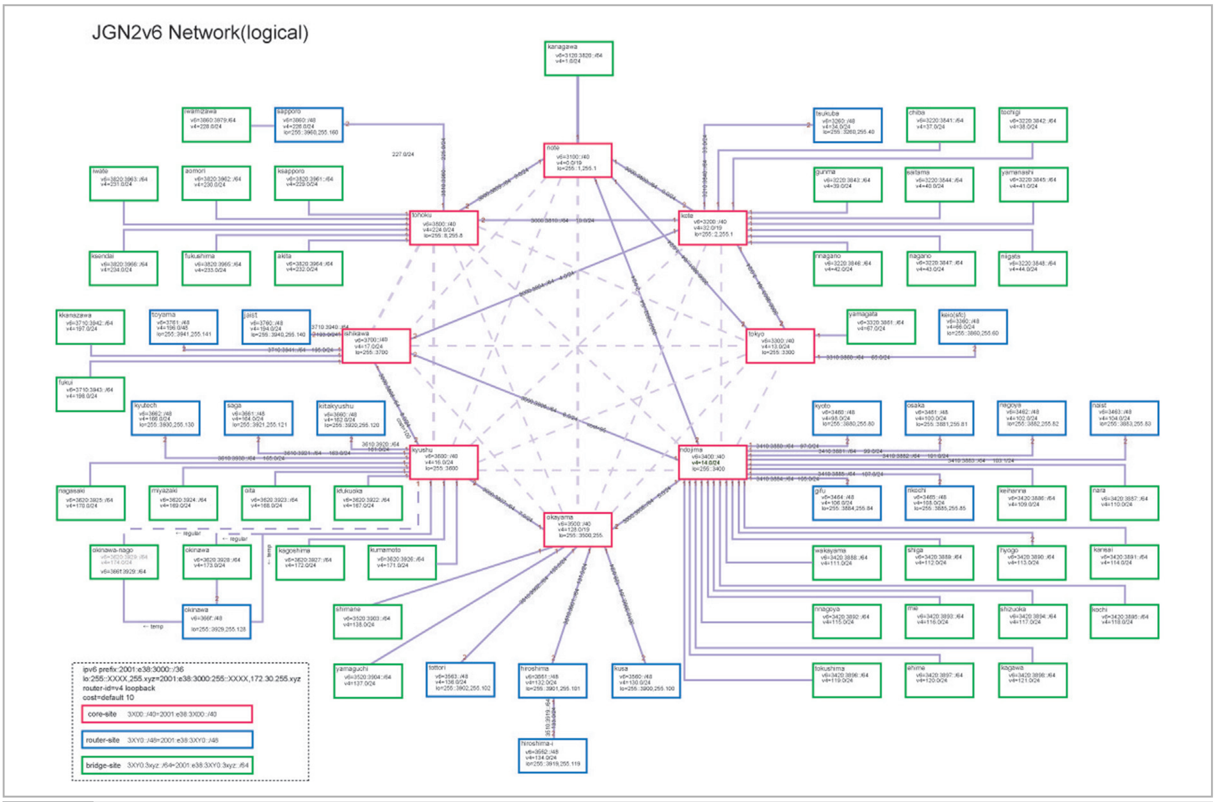

Fig. 1 *Logical configuration of JGNⅡ v6 (overview)*

vendor network environment consisting of the devices shown in Table 1:

Table 1 Router types

Vendor	Product name	Site type
Hitachi	GS4000	Core site
	GR2000-2B	Router site
Cisco Systems	Catalyst6500	Core site
	GSR12406	Core site
Juniper Networks	T320	Core site
PROCKET Networks	PRO8801	Router site

As mentioned above, we are promoting the connection of JGNⅡ v6 with regional networks to improve network usability and to enhance overall network functionality throughout Japan. The development of these regional networks is indispensable in the realization of Okayama RC's vision for future networks. As part of these efforts, it is essential that we provide the results of JGNⅡ v6 verification to all parties concerned.

2.2 Developments in verification of IPv6 multicasting

In February 2004, the TAO Okayama IPv6 System Interoperability and Evaluation Laboratory (the predecessor to Okayama RC) performed the first field trial of IPv6 multicasting. At that time, there were two subjects of initial-phase verification aimed at assessing practicality:

(1) Verification of IPv6 multicasting over a long distance and in a multi-vendor environment
(2) Verification of quality required for use in terrestrial television and verification of user functions

We performed single-stream transmission in only one direction, as this represented our first use of a large-scale network; we were uncertain whether the routers would perform as well as in lab testing. Specifically, we conducted the following four experiments:

(i) Simultaneous receipt of images of the Sapporo Snow Festival at several locations and evaluation of quality
(ii) Use of these images in long-distance terrestrial live telecasts between Sapporo and Okinawa
(iii) Verification of the ability to combine telecasts in a single program, for example, by adding a report on professional baseball spring training, which takes place around the same time as the festival
(iv) Verification of the ability to conduct telecasts entirely through the Internet; use of Internet telephony (VoIP) technology to replace audio loopback lines for reporters and to replace the communications lines indispensable to live remote broadcasting

Figure 2 shows the network configuration. Since some routers used on JGN v6 had interoperability problems with IPv6 PIM-SM, we created a special network consisting of ATM paths. This network was optimized for multicasting but differed from our basic concept of a next-generation network.

After repeated lab testing based on the results obtained in 2004, we set as the goal of the 2005 field trial the simultaneous telecasting of the same content by JNN affiliated multiple broadcasting stations. As the name suggests, multicasting can be used for multiple telecasting of content. However, multicasting is also suitable to store content, in cases where stations share content.

Figure 3 shows the network configuration. In addition to the use of IPv6 multicasting in real terrestrial telecasts as in the February 2004 field trial, we decided to use IPv6 multicasting continuously, collecting content for a month. The aim in this case was to discover potential problems with long-term use.

As shown in Table 2, six JNN affiliated broadcasting stations participated in this field trial. These stations could share content freely. There were two specific subjects of verification, as follows:

(1) Verification of IPv6 multicasting over a long distance and in a multi-vendor environment (as in 2004)
(2) Verification of simultaneous two-way IPv6 multicasting in multiple locations

Specifically, we conducted the following six experiments:

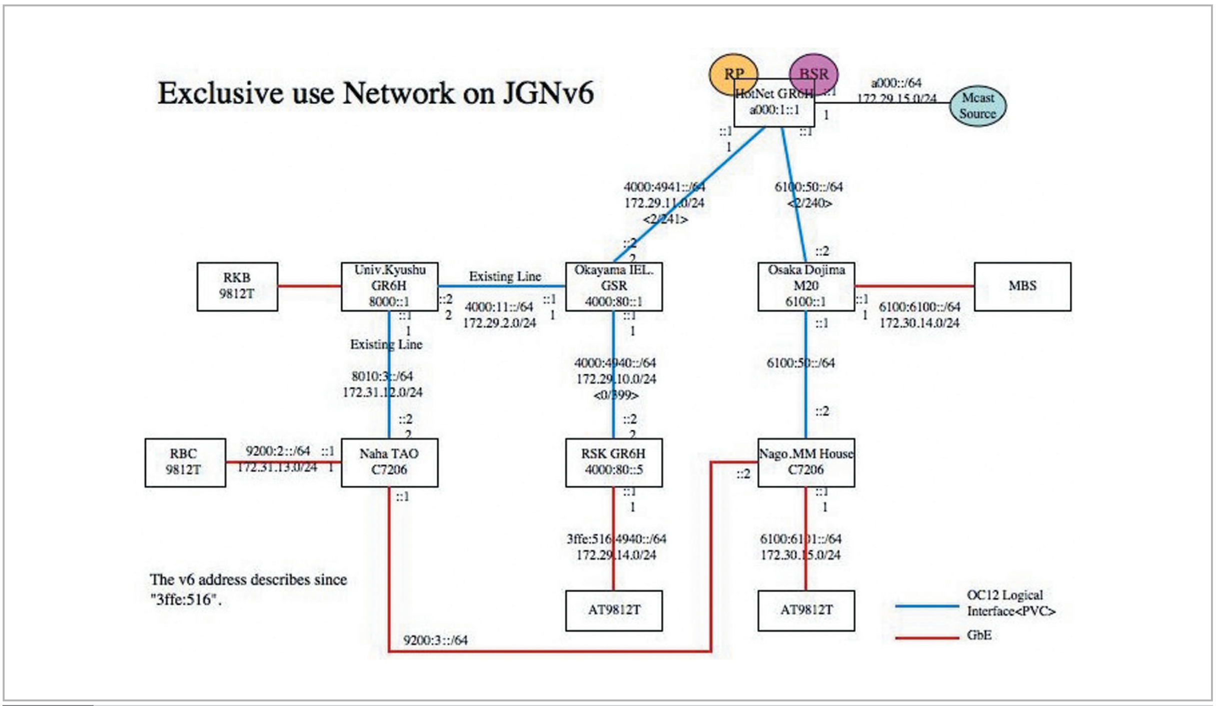

Fig.2 *Configuration used in field trial in February 2004*

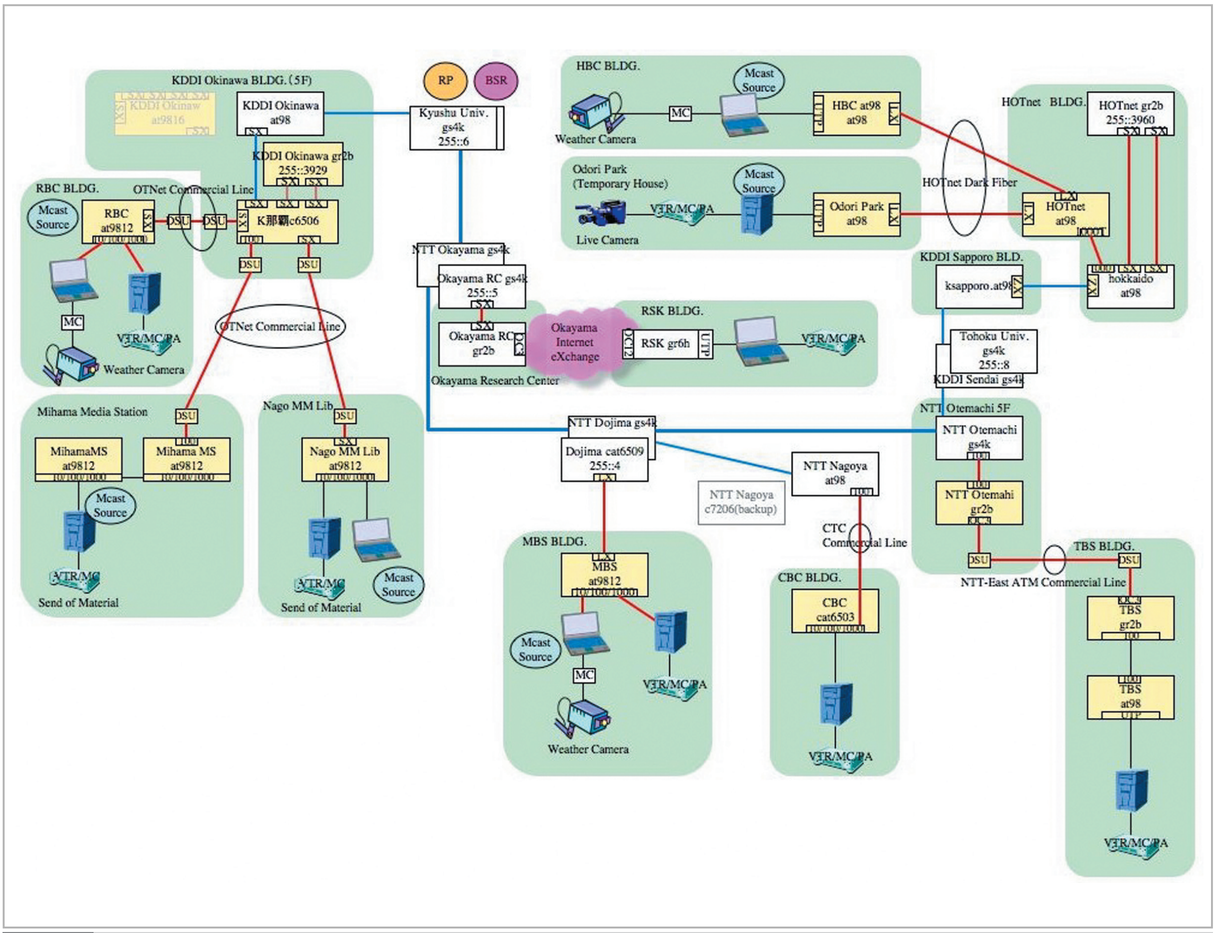

Fig.3 *Configuration used in field trial*

Table 2 *Broadcasting stations that participated in field trial*

HBC 北海道放送	TBS
mbs.jp 毎日放送インターネット	CBCNEWS
RSK	RBC Ryukyu Broadcasting Corp.

(i) Simultaneous receipt of images of the Sapporo Snow Festival at several locations and evaluation of image quality (as in 2004)
(ii) Use of these images in long-distance live terrestrial telecasts between Sapporo and Okinawa (as in 2004)
(iii) Transmission of images of professional baseball spring training simultaneously with festival images
(iv) Simultaneous distribution of content from up to 23 sources
(v) Use of Internet telephony (VoIP) technology to replace audio loopback lines for reporters and to replace the communications lines indispensable to live remote broadcasting (use of VoIP as in 2004)
(vi) Identification of broadcasting requirements (in terms of quality, operability, delays, etc.)

We extended the scope of verification beyond that of the field trial in 2004 to include broadcasting (in addition to basic network testing) as we felt this was important in promoting the adoption of the next-generation Internet in response to market demand.

2.3 Verification Results

We verified the following in terms of the interoperability of IPv6 multicast protocols:
(1) IPv6 multicast group management—MLD (Multicast Listener Discovery)
(2) IPv6 multicast routing—PIM-SM (Protocol Independent Multicast-Sparse Mode)

For MLD, we verified MLD snooping, a layer-2 function. As described above, MLD snooping prevents multicast packets from flowing to unnecessary ports. This function allows users to perform multicasting without the need to change ports.

In this trial, a multicast receiving terminal and a VoIP communications terminal were successfully connected to ports on the same switch for the same VLAN.

Figure 4 presents the concept behind the MLD snooping function.

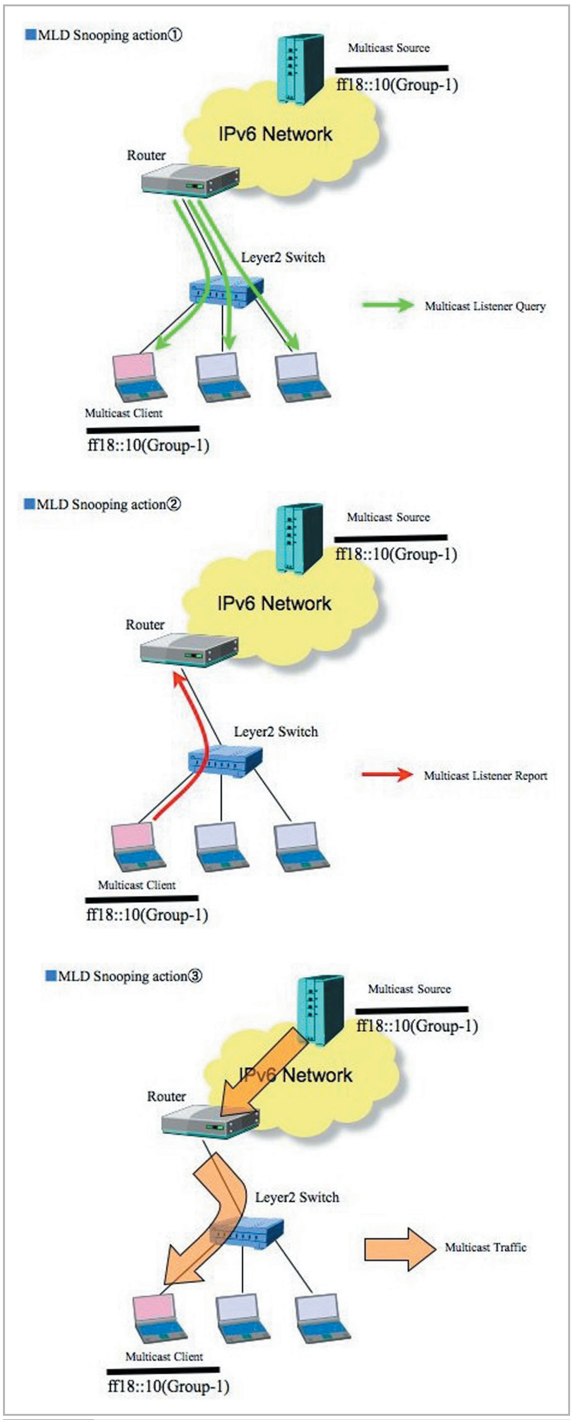

Fig.4 *Conceptual view of MLD snooping*

Through this verification trial, we identified the following problems:

(i) After timeout for a receiving group, a long time is required to reestablish a multicast route (as long as approximately 15 seconds).

(ii) Performing static join settings on upstream routers to avoid (i) causes CPU use to increase, affecting performance.

(iii) With a Windows XP receiving terminal and a different version of MLD Snooping, snooping does not work with Cisco Catalyst6503.

- Allied Telesis AT9812: Version 1
- Cisco Catalyst6503: Version 2
- Windows XP: Version 1
- Router: both Versions 1, 2

(iv) There is a problem related to Cisco6503's designated router (DR); this problem occurs in the following steps:

- There is a multicast route that should not be present.
- Registration of this route begins at an RP.
- "Register Stop" is not issued because traffic does not reach this RP.
- Operation stops in the middle of registration.
- The CPU use reaches 100% due to lack of sufficient hardware processing capability.
- It becomes impossible to send packets.

(v) Layer 2 loop

- A layer 2 loop occurs locally due to incorrect wiring.
- This local loop may expand to the wide area network.

We take the action described in (ii) to avoid (i). When we used (ii) on the same vendor's router in February 2004, the same phenomenon occurred. Since the same phenomenon occurred again on another of the vendor's models, we informed the vendor of these results. We view ours as an appropriate solution because we believe that all groups ought to be present at upstream routers when using multicasting for Internet TV. However, this is not a practical way to control multicast routes in response to downstream receiving conditions.

The phenomenon in (iii) is not consistent with the report by the MLD snooping software vendor that Version 2 is upwardly compatible with Version 1. Therefore, we asked the vendor to analyze the problem.

The problem in (iv) is triggered by a multicast route that should not be present. However, we have not yet determined the precise circumstances in which this phenomenon occurs. As with other problems, we will perform specific laboratory testing to determine the cause.

As indicated in (v), a single local loop could cause a profound impact on the wide area network (Fig.5). STP (Spanning Tree Protocol) is conventionally used as a preventive measure against layer-2 loops. However, we have already determined that STP is not effective in this case. Since STP poses problems in terms of interoperability when using Ethernet to connect regional networks, Okayama RC plans on carrying out specific studies on this protocol.

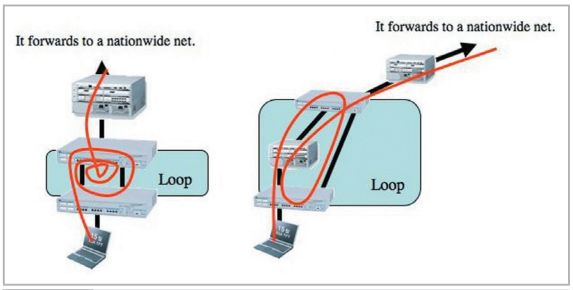

Fig.5 *Impact of local loop*

2.4 Verification in coordination with regional networks

To promote the adoption of IPv6 in actual service, we plan to verify the reliability of the functions required to adapt IPv6 to regional networks, which offer a wide range of possible uses for multicasting. (We will discuss this subject in detail in a separate report.) The main objective of this verification is not to ensure performance but instead to establish a certain level of practicality in an actual environment.

To establish IPv6 multicasting as a technology for image-data distribution in various services, we will create a "video grid" on a regional network (the OKayama Internet eXchange). We will then combine this network with JGNⅡ so that data can be received via JGNⅡ access points throughout the country. We will also publicize the use of IPv6 multicasting and provide technical assistance within the regional network.

Since content will be sent to every part of the country, it is best to select topics with nationwide interest. In this case we have selected the National Sports Festival in Okayama. All sources will use multicasting on their respective regional networks, not on JGNⅡ.

Figure 6 shows a conceptual view of the network used in image-data distribution. In addition to Ethernet connection, ATM is also used on the actual network. Unicast/multicast conversions are thus required in segments where multicasting cannot be performed.

We intend to set up web cameras at individual sites. Transmission will take place through a process that differs from conventional methods of transmission: images will go from the web camera to NTSC output, followed by DV conversion and transmission to the multicast PC. The cameras will be selected to provide high-quality images.

While distributing image data, we will verify a technique to ensure the reliability of RPs (Rendezvous Points) under conditions of heavy load and concentrated functions. We will also make all multicast route entries permanent, as required in actual operation. Since some devices will pose problems in CPU use as described above, we will identify these problems on a device-by-device basis when setting permanent entries.

3 Conclusions/acknowledgements

This R&D project represents a significant means of promoting the adoption of IPv6 networks. However, IPv6 has yet to become widespread, due to a variety of factors. In addition to the specific technical challenges, there is a view in the market that IPv4 provides satisfactory functionality. In other words, those that believe that web-based services have been satisfactorily established on the Internet do not feel a pressing need to replace IPv4 with IPv6.

Given these circumstances, NICT Okayama RC has been promoting the adoption of IPv6 as a basic technology for the next-generation Internet. To achieve this goal, we must be able to verify this technology and to show our results to the market.

At the end of fiscal 2004, IPv6 services became available to consumers. Some ISPs

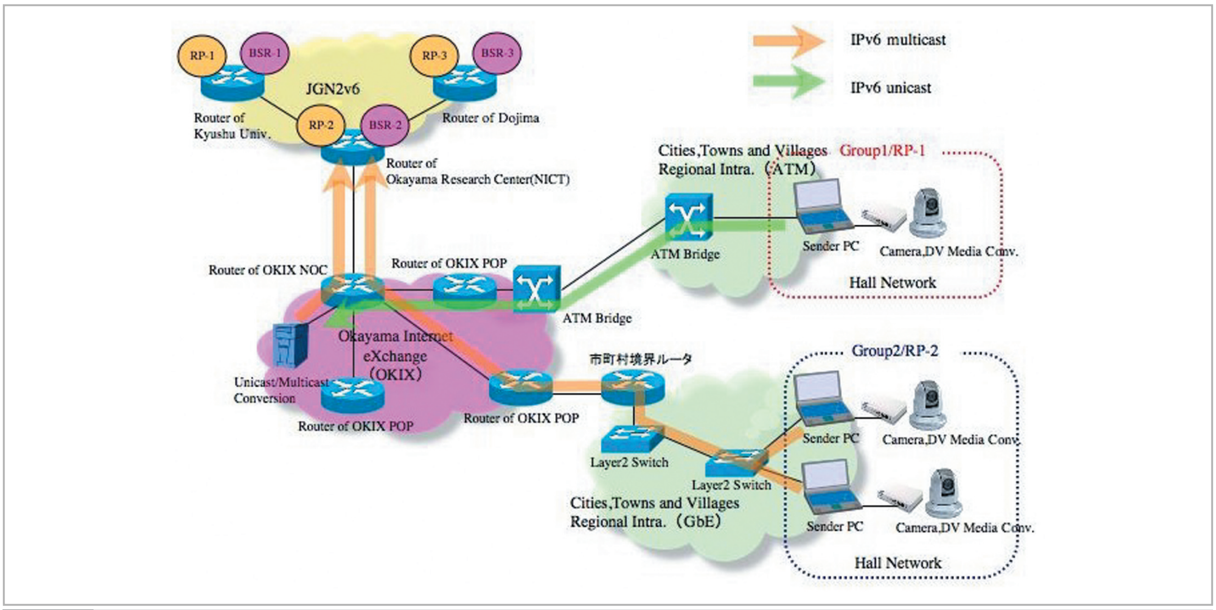

Fig.6 *Network configuration for verification (used in the National Sports Festival in Okayama)*

are now providing IPv6 multicast video distribution services. Moreover, IP transmission will be used in terrestrial digital broadcasting in the near future. This is all good news for those of us who have been working on R&D of IPv6 multicasting.

We believe that our provision of results to vendors has helped enhance the performance of network equipment used in IPv6 multicasting. In the initial stages of this research, we encountered doubt among vendors concerning the potential usefulness of IPv6. However, we have pursued and will continue to pursue R&D in this area in the conviction that the most effective way to promote its widespread adoption is to analyze technology trends in the market and to identify the most appropriate targets of study.

References

1 IETF Home Page, http://www.ietf.org/.

2 Bill Fenner, Mark Handley, Hugh Holbrook, and Isidor Kouvelas, "Protocol Independent Multicast–Sparse Mode PIM-SM): Protocol Specification (Revised)", IETF, draft-ietf-pim-sm-v2-new-07.txt, Mar. 2003.

3 S. Deering and R. Hinden, "Internet Protocol Version 6(IPv6) Specification", IETF, RFC2460, Dec. 1998.

4 WIDE Project Home Page, http://www.wide.ad.jp/.

5 KAME Project Home Page,http://www.kame.net/.

6 Usagi Project Home page, http://www.linux-ipv6.org/.

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