Internet Topics: 4rd Proof-of-Concept Tests for IIJ's Proprietary "SEIL" Routers

With the start of our native IPv6 access service the IPv6 Internet is now a step closer. In a few years the migration from IPv4 to IPv6 will have progressed further, and it is possible that connection to the IPv4 Internet will become more difficult. In response to this, the IPv4 residual deployment (henceforth "4rd") tunneling technology for implementing IPv4 over IPv6 has been proposed, and is currently under discussion at the IETF.

Here we introduce the 4rd implementation researched and developed for use with the "SEIL*1" routers independently developed by IIJ, and proof-of-concept tests using 4rd that were conducted at a WIDE Project*2 research conference.

One of the characteristics of 4rd is that, unlike technology based on CGN/LSN such as DS-lite, NAPT is conducted on customer equipment. The advantages of conducting NAPT on customer equipment are that it enables customers to assess NAPT status themselves with little effort, and also makes redundancy easy because NAPT sessions are not held on ISP equipment. In light of this, we implemented the 4rd protocol on SEIL to prepare for the spread of IPv6.

■ Proof-of-Concept Tests Using SEIL

At the WIDE Project conference held over four days in September 2011, 4rd proof-of-concept tests were conducted on SEIL units with 4rd implemented. IPv6 was the only communication environment available for external access at the conference location, and multiple IPv4-IPv6 transition technologies such as 4rd, DNS64*3, NAT64*4, and SA46T*5 were used to connect to IPv4 sites. The purpose of these tests was to confirm whether communications necessary for everyday use such as Web browsing could be established, investigate which applications functioned, check whether any problems occurred under load, and clarify issues with IPv4-IPv6 transition technologies.

Regarding whether the communications necessary for everyday use could be established, it was confirmed that communications were possible without issue in a 4rd environment. Approximately 150 people participated in the tests at the conference, connecting via VPN to the company network over a 4rd tunnel, and performing actions such as email and Web browsing.

To investigate which applications functioned, participants shared information among themselves about the applications that functioned and those that did not during discussions. Through this investigation we confirmed that applications commonly utilized in a work environment such as L2TP over IPsec VPN, Remote Desktop Connection, and Windows Sharing (Samba) could be used without issue.

Regarding whether there were any problems under load, we confirmed that SEIL functioned normally even with maximum traffic of 100Mbps, a maximum of 1,534 TCP sessions, and a total of 10,365 sessions using NAPT.
Additionally, during the load tests conducted on the night of September 8 (Figure 1), we measured the total number of TCP ports that would be necessary if a single IPv4 address was shared by 150 people. We can surmise that for a medium-sized office there should be no problems as long as allocation of a minimum of approximately 1,000 ports is possible.

As for clarifying the issues with IPv4-IPv6 transition technology, two points regarding 4rd operation that required confirmation were raised.
The first was the phenomenon of sometimes not being able to view content over a content delivery system. We are still looking into the details, but it is possible that IP address-based client authentication is being carried out, so we believe there is a need to consider measures for dealing with this when using 4rd, which shares IPv4 addresses while conducting communications. Existing CGN/LSN may also have similar issues, so we are using these technologies as reference as we examine the problem.
The second point is that support for protocols that do not use port numbers is required for operation. Because the 4rd protocol is dependent on NAPT, individual support is required for protocols that do not use port numbers. In our tests the protocols supported were TCP/UDP, which uses port numbers, and ICMP, for which individual support was provided. However, during actual operation there is a chance that support for a larger number of protocols will be necessary.

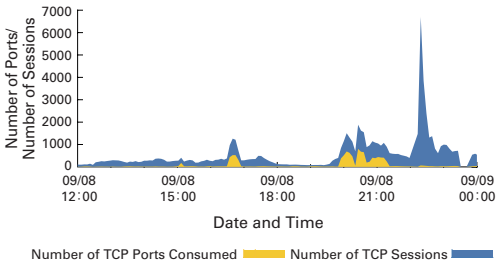

Figure 1: Number of TCP Ports Consumed and TCP Sessions During Load Tests

■ Future IIJ Activities

We believe that 4rd is an important technology for promoting the transition to IPv6. These proof-of-concept tests were a valuable opportunity to shed light on the effectiveness of 4rd as well as points of concern regarding this technology. The tests focused mainly on business usage, and we were not able to fully assess the operation of entertainment applications such as video delivery and online games. IIJ will continue to incorporate the perspectives of a variety of users, and proceed with research and development to bring 4rd technology to a high level of technical readiness.

Author:
Kouki Ooyatsu Research & Development Section, Product Development Department, IIJ SEIL Business Unit

Supervisors/Contributors:
Kiyoshi Ishida IIJ Executive Officer and Division Director, IIJ SEIL Business Unit
Hiroki Suenaga Product Technology Section, Product Development Department, IIJ SEIL Business Unit

*1 Portal site for the "SEIL" high-performance routers developed by IIJ using its expertise as an ISP (http://www.seil.jp/) (in Japanese).
*2 A research organization bringing together industry, government, and academia that started in 1988. The WIDE (Widely Integrated Distributed Environment) Project.
*3 A method for returning a special IPv6 address for NAT64 conversion instead of the original IPv4 address when an IPv4 host name is requested from a DNS. RFC6147.
*4 A method for transferring IPv6 packets with IPv4 address information embedded in them that are directed at a special IPv6 address to the IPv4 Internet after converting them to IPv4 packets (NAT) via an IPv4/IPv6 dual stack gateway host.
*5 A method for embedding an IPv4 address in a special IPv6 address, and automatically constructing an IPv4 over IPv6 tunnel with that address as its destination.