IPv6 Technical Issues—Standardization, Resource Management, and Operation

Tomohiro Fujisaki† *and Shiro Niinobe*

Abstract

With IPv6 (Internet protocol version 6) being widely used not only as a protocol for accessing the Internet but also as a base for many IP-based services, it is becoming an essential element of networking services. This article describes the current situation of IPv6 from the viewpoints of standardization in IETF (Internet Engineering Task Force), IPv6 address allocation status as part of Internet resource management, and operation of the IPv6 network.

1. Introduction

The Internet has been growing along three axes: standardization, resource management, and operation. The IETF (Internet Engineering Task Force) has been standardizing the technology, and regional Internet registries (RIRs) have been managing Internet resources such as IP (Internet protocol) addresses (both IPv4 and IPv6) and autonomous system numbers. Moreover, network operators' groups such as NANOG (The North American Network Operators' Group) and JANOG (Japan Network Operators' Group) have discussed operational issues about the Internet. Although IPv6 has been subject to standardization for some time, after RIRs began to allocate IPv6 address to organizations such as Internet service providers (ISPs), discussions of IPv6 address allocation and assignment policy became active. At the same time, operators' groups also began to discuss operational issues concerning IPv6 networks.

2. Standardization of IPv6 technology

In the IETF, ipng wg (IP Next Generation Working Group) and ngtrans wg (Next Generation Transition Working Group) have standardized IPv6 technology such as IPv6 protocol itself and transition functions for migrating from the current Internet. During the standardization, ipng wg changed its name to ipv6 wg, and ngtrans wg handed over operational topics to v6ops wg (IPv6 Operations Working Group) and disbanded. IPv6-related topics have been discussed in many working groups recently, since the IETF mandated protocol-independent standardization (standardized protocols should work on both IPv4 and IPv6) when Internet-related protocols are discussed. The changes in the IPv6-related working groups in the IETF are shown in **Fig. 1**.

3. Current status of ipv6 wg

The ipv6 wg decided that the wg meeting held in Vancouver in November 2005 was the last face-to-face meeting in the IETF, and they will disband after finishing current working items in order to show the world that IPv6 standardization has finished. One of the main remaining items is to move the IPv6 base specification RFCs (Requests for Comments: protocol specification documents in the IETF) to the final state. The target RFCs are: RFC2460, "Internet Protocol, Version 6 Specification"; RFC2461, "Neighbor Discovery for IP Version 6"; RFC2462, "IPv6 Stateless Address Autoconfiguration"; and RFC2463, "Internet Control Message Protocol (ICMPv6) for the Internet Protocol Version 6 (IPv6) Specification". Currently, these RFCs are in the 'Draft Standard' state, which is the stage before the final 'Standard' state. The standardization process in IETF is shown in **Fig. 2**. Over 4400 RFCs have been issued, but only 66 are in the final 'Standard' state (e.g., IP, TCP

† NTT Information Sharing Platform Laboratories
Musashino-shi, 180-8585 Japan
E-mail: fujisaki.tomohiro@lab.ntt.co.jp

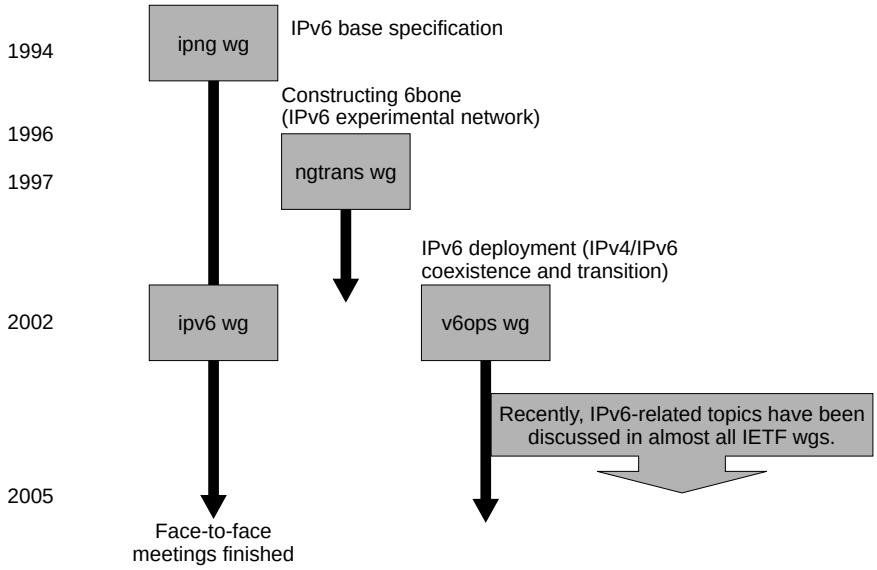


Fig. 1. Changes in IPv6-related working groups in IETF.

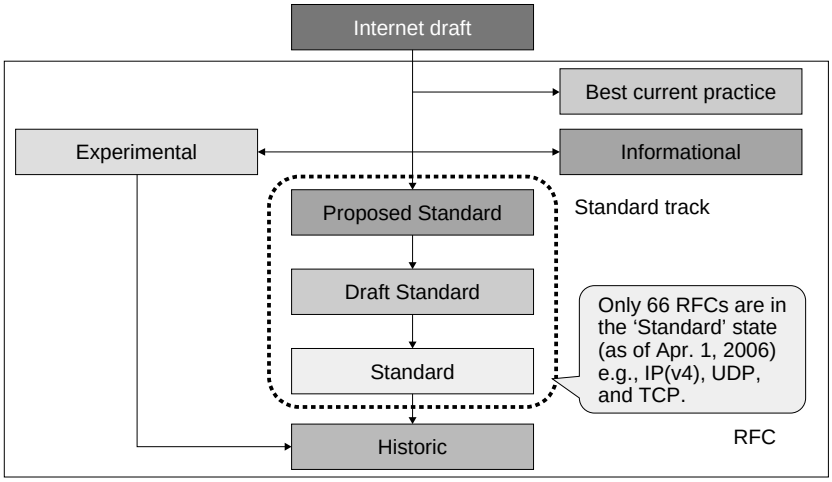


Fig. 2. Standardization process in IETF.

(transmission control protocol), and UDP (user datagram protocol)). Many protocols that are currently used are actually still in the 'Proposed Standard' or 'Draft Standard' state.

4. Trend of the Internet resource management communities

RIRs began to allocate IPv6 addresses in 1999, and today, many organizations have IPv6 address blocks. The changes in the numbers of organizations receiving addresses over time is shown in **Fig. 3**. RIRs allocate IPv6 addresses under almost the same address allocation and assignment policies [1]. The basis of this policy was drafted by Japanese volunteers and went into effect as a world-wide policy in July 2002.

The original IPv6 policy has been modified slightly in each region to reflect the local situation, such as IPv6 deployment status. Address policy modifications of this kind are performed in a bottom-up manner in each RIR. There are five RIRs: ARIN (American Registry for Internet Numbers) in charge of North America, RIPE-NCC (Resource IP Europeans Network Coordination Centre) in Europe, APNIC (Asia Pacific Network Information Centre), LACNIC (Latin American and Caribbean Internet Address Registry), and AfriNIC (Africa Network Information Centre). APNIC, for example, holds open policy

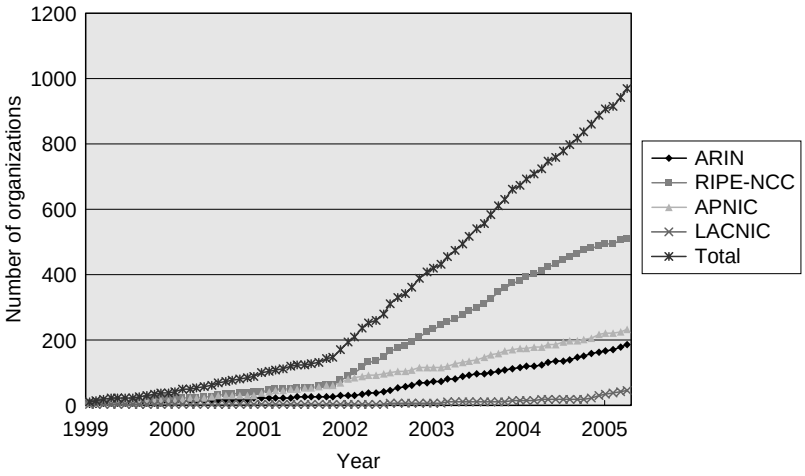


Fig. 3. Changes in numbers of IPv6 address holders.

meetings twice a year, and people who want to modify or create a policy make a proposal at that meeting. Once the proposed policy reaches a consensus in the community, it is implemented by APNIC and goes into effect in the Asia Pacific Region.

The following IPv6 address policy issues have been discussed recently in APNIC.

- Changing IPv6 address allocation and assignment size

  Some people estimate that under the current IPv6 address allocation criteria, IPv6 addresses will be exhausted in 60 years. To increase the lifetime of IPv6, they propose using stricter address allocation criteria.
- IPv6 portable assignment for multihoming

  The person making this proposal said that IPv6 will be used in mission critical systems and that reliability will become more and more necessary. To achieve the same level of reliability as IPv4, IPv6 will require BGP-based multihoming and portable IPv6 addresses should be assigned to end sites (BGP: border gateway protocol).

Policy proposals for Internet resource management in the Asia Pacific region are available online [2].

5. Discussions in operators' communities

Discussions in network operators' communities such as NANOG and JANOG mainly concern practical operational topics, which are based on the IPv4 Internet. However, some IPv6-related topics have begun to be discussed recently. In JANOG in particular, there has been continuous discussion of IPv6 operational issues in recent meetings. This is because IPv6 has become popular in Japan. The discussion topics are:

- Practical operational issues, e.g., how to filter IPv6 packets to protect the IPv6 network.
- IP-infrastructure-related issues, e.g., the DNS (domain name system) will require higher performance when IPv6-enabled machines become common because they will issue more than twice as many DNS queries (i.e., in both IPv4 and IPv6).

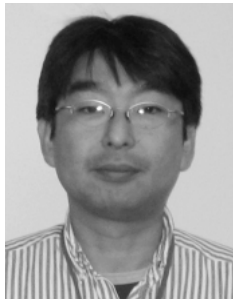
5. Conclusion

NTT Information Sharing Platform Laboratories has tackled Internet-related problems on all three axes by promoting standardization in the IETF, proposing address policies in its RIR, and discussing network operational issues in NANOG and JANOG. We will continue to cope with IPv6-related problems raised by NTT's network and contribute to the deployment of IPv6.

References

[1] http://www.apnic.net/docs/policy/ipv6-address-policy.html
[2] http://www.apnic.net/docs/policy/proposals/index.html

Tomohiro Fujisaki
Senior Research Engineer, Supervisor, Ubiquitous Computing Project, NTT Information Sharing Platform Laboratories.
He received the B.E. and M.E. in information science from Tokyo Institute of Technology, Tokyo, in 1988 and 1990, respectively. In 1990, he joined NTT Software Laboratories, Tokyo. He has been studying IPv6 networking technology since 1997 and his current research subject is operation and management of the IPv6 network. He has been co-chair of the IPv6 technical SIG of APNIC since 2005. He is a member of the Information Processing Society of Japan and the Association for Computing Machinery.



Shiro Niinobe
Research Engineer, Ubiquitous Computing Project, NTT Information Sharing Platform Laboratories.
He joined NTT Electrical Communication Laboratories, Tokyo, in 1985. In 2005, he moved to NTT Information Sharing Platform Laboratories to study IPv6 networking technology. His current research subject is operation and management of the IPv6 network.