인터넷 주소 구조의 문제점에 관한 연구

인민교* · 유태완* · 이승윤*

*한국전자통신연구원 표준연구센터

Review of today's internet architecture problems

Min-kyo In* · Tae-wan You* · Seung-yun Lee*

*ETRI PEC

E-mail : {mkin, twyou, syl}@etri.re.kr

요 약

The explosive growth of the Internet brought serious problems to the Internet routing infrastructure. Especially scaling problems is recognized more seriously. The ever increasing user population, as well as multiple other factors including multi-homing, traffic engineering, and policy routing, have been driving the growth of Default Free Zone (DFZ) routing table size at an alarming rate. While it has been long recognized that the existing routing architecture may have serious scalability problems, effective solutions have yet to be identified, developed, and deployed. Recently, several attempts for finding the concrete problems are made. Especially the report of the routing and addressing workshop which the IAB (Internet Architecture Board) held on 2006 is described the problems of the current internet in detail. This document describes those problems and introduces the related activity to solve the problems.

키워드

Internet, IETF, DFZ

Ⅰ. Introduction

Today, the Internet is an enormous network of millions of computers allowing constant communication throughout the world. However, the Internet is established base on TCP – IP (Transmission Control Protocol – Internet Protocol). The explosive growth of the Internet brought serious problems to the Internet routing infrastructure. Especially scaling problems is recognized more seriously. The ever increasing user population, as well as multiple other factors including multi-homing, traffic engineering, and policy routing, have been driving the growth of Default Free Zone (DFZ) routing table size at an alarming rate [1]. While it has been long recognized that the existing routing architecture may have serious scalability problems, effective solutions have yet to be identified, developed, and deployed. Recently, several attempts for finding the concrete problems are made. Especially the report of the routing and addressing workshop which the IAB (Internet Architecture Board) held on 2006 is described the problems of the current internet in detail.

This paper describes those problems and introduces the related activity to solve the problems.

The rest of this paper is organized as follows. Section II gives the current internet problems first. And then Section III gives some approaches to solve the Internet problems. Finally, section V shows the conclusion.

Ⅱ. Current internet problems

2.1 The scalability of the Routing system

The routing scalability is the most important problem facing the Internet today and must be solved. The routing scalability problem includes the size of the DFZ RIB (Routing Information Base) and FIB(Forwarding Information Base), the implications of the growth of the RIB and FIB on routing convergence times. The following subsections are the main drivingforces behind the rapid growth of the DFZ RIB [1].

2.1.1 Multihoming

Multihoming refers generically to the case in which a site is served by more than one ISP. There are several reasons for the observed increase in multihoming. Multihoming can be accomplished using either PI (Provider Independent) or PA (Provider Assigned) address space [1]. PI prefixes are the address blocks allocated to customer networks directly. The important property of a PI prefix is that its owner has the freedom to switch provides without remembering the network. Furthermore, a network with a PI prefix can connect to multiple ISPs simultaneously. This is known as multihoming, which allows the network, to stay reachable through which ever provides that remain function when some part of the Internet fails [2].

A multihomed site using PI address space has its prefixes present in the forwarding and routing tables of each of its providers. If the addresses are allocated from a 'primary' ISP, then the additional routing table entries only appear during path failures to that primary ISP. A problem with multihoming arises when a customer's PA IP prefixes are advertised by AS (es) other than their 'primary' ISP's. Because of the longest-matching prefix forwarding rule, in this case the customer's traffic will be directed through the non-primary AS (es).

2.1.2 Traffic engineering

Traffic engineering (TE) is the act of arranging for certain Internet traffic to use or avoid certain network paths. TE is performed by both ISPs and customer networks. Network operators usually achieve traffic engineering by "tweaking" the processing of routing protocols to achieve desired results. At the BGP level, if the address range requiring TE is a portion of a larger PA address aggregate, network operators implementing TE are forced to de-aggregate otherwise aggregatable prefixes in order to steer the traffic of the particular address range to specific paths. In today's highly competitive environment, providers require TE to maintain good performance and low cost in their networks [1]. However the current practice of TE deployment results in an increase of the DFZ RIB.

2.1.3 Avoiding renumbering

The numbering can be more cumbersome because IP addresses are often used for other purpose such as access control lists. Therefore customers generally prefer to have PI address space. Doing so gives them additional agility in selecting ISPs and helps them avoid the need to renumber.

2.2 The Overloading of IP address Semantics

IP addresses have been used as both locators and identifiers. As its name suggests, locators identify location in the topology and a network's or host's locator should be topologically constrained by its present position. Identifiers, in principal, should be network-topology independent. That is even though a network or a host may need to change its locator when it is moved to a different set of attachment points in the Internet; its identifier should remain constant. An IP address must be assigned in such a way that it is congruent with the Internet's topology. However, identifiers are typically assigned based upon organizational (not topological) structure and have stability as a desirable property, a "natural incongruence" arises. As a result, it is difficult (if not impossible) to make a single number space serve both purposes efficiently. The locator/identifier overload of the IP address semantics is one of the causes of the routing scalability problem.

III. Some approaches to solve the Internet problems

Over the years there have been many efforts designed to investigate scalable inter-domain routing for the Internet [3]. To benefit from the insights obtained from these past results, followings are major previous and ongoing efforts.

2.1 MULTI6

The MULTI6 working group's exploration of the solution space and the lessons learned. The MULTI6 working group was chartered to explore the solution space for scalable support of IPv6 multihoming. The numerous proposals collected by MULTI6 Working group generally fell into one of two major categories: resolving the above mentioned conflict by using provider-independent address assignments, or by assigning multiple address prefixes to multihomed sites, one for each of its providers, so that all the addresses can be topologically aggregatable. [1]

2.2 SHIM6

The solution to multihoming being developed by the SHIM6 Working Group and its pro's and con's.

The SHIM6 working group took supporting multihoming through the use of multiple addresses. SHIM6 adopted a host-based approach where the host IP stack includes a "shim" that presents a stable "upper layer identifier" (ULID) to the upper layer protocols, but may rewrite the IP packets sent and received so that a currently-working IP address is used in the transmitted packets. When needed, a SHIM6 header is also included in the packet itself, to signal to the remote stack.

With SHIM6, protocols above the IP layer use the ULID to identify endpoints. The current design suggests choosing one of the locators as the ULID. This approach makes the implementation compatible with existing IPv6 upper layer protocol implementations and applications. Many of these applications have inherited the long time practice of using IP addresses as dentifiers.

SHIM6 is able to isolate upper layer protocols from multiple IP layer addresses. This enables a multihomed site to use provider-allocated prefixes, one from each of its multiple providers, to facilitate provider-based prefix aggregation. However this gain comes with several significant costs. First, SHIM6 requires modifications to all host stack implementations to support the shim processing. Second, the shim layer must maintain the mapping between the identifier and the multiple locators returned from IPv6 AAAA name resolution, and must take the responsibility to try multiple locators if failures ever occur during the end-to-end communication. At this time the host has little information to determine the order of locators it should use in reaching a multihomed destination, however there is ongoing effort in addressing this issue.[1]

2.3 GSE

The GSE proposal made by O'Dell in 1997 and its pro's and con's. The GSE proposal changes the IPv6 address structure to bear the semantics of both an identifier and a locator. The first n bytes of the 16-byte IPv6 address are called the Routing Goop, and are used by the routing system exclusively as a locator. The last 8 bytes of the IPv6 address specify an interface on an end-system. The middle (16 - n - 8) bytes are used to identify site local topology. The border routers of a site re-write the source RG of each outgoing packet to make the source address part of the source provider's address aggregation; they also re-write the destination RG of each incoming packet to hide the site's RG from all the internal routers and hosts. Although GSE designates the lower 8-byte of the IPv6 address as identifiers, the extent to which GSE could be made compatible with increasingly-popular cryptographically-generated addresses remains to be determined.

All identifier/locator split proposals require a mapping service that can return a set of locators corresponding to a given identifier. In addition, these proposals must also address the problem of detecting locator failures and redirecting data flows to remaining locators for a multihomed site. The Map-and-Encap proposal did not address these issues. GSE proposed to use DNS for providing the mapping service, but it did not offer an effective means for locator failure recovery. GSE also requires host stack modifications, as the upper layers and applications are only allowed to use the lower 8-bytes, rather than the entire, IPv6 address.

Ⅳ. Conclusion

As mentioned in above, several problems are generated with the explosive increment of an internet. Particularly the scalability is considered as the most urgent problem. The main causes are with multihoming, traffic engineering and renumbering using IP address etc. So far, the various solutions are suggested to solve these problems in several groups in IETF. And the current IP address architecture has some problem to support seamless communication in both mobile and multihomed network environments. This is because the current IP address has multiple semantics such asdevice identifier, location identifier, and -forwarding identifier for routing. When a terminal changes the access network, the terminal's identifier also changes in the multihoming of mobility environment. Therefore, New architecture and method are is required to solve those scalability problems ad multiple semantics problems of IP.

V. Reference

[1] D. Meyer, Ed., "Report from the IAB Workshop on Routing and Addressing", draft-iab-raws-report-01.txt, February 27, 2007

[2] Lixia Zhang, "An overview of multihoming and Open issues in GSE", Sep. 2006.

[3] Doria, A. and E. Davies, "Analysis of IDR requirements and History Group B contribution", draft-irtf-routing-history-00, February 2002.

[4] Hinden, R., "New Scheme for Internet Routing and Addressing (ENCAPS) for IPNG", RFC 1955, June 1996.