EzIP Overview

A Practical Approach to the Internet Address Exhaustion Problem

The Challenge

The depletion of the pool of assignable internet addresses is a problem that has been identified for years, without adequate practical solutions in the near term. IPv4, the current internet protocol, can accommodate only 4 billion addresses. Cisco projects that the Internet of Things (IoT) will create a demand for 50 billion addresses by 2020. IPv6, the successor protocol to IPv4, is meant to address this issue but its deployment and adoption have been sluggish.

The Solution

The EzIP (phonetic for Easy IPv4) is a scheme to significantly increase the Internet public address pool by utilizing a very basic IPv4 standard (RFC791) to transport across the Internet the extension addresses from a long-reserved (240/4) block as part of the IP header payload. Such information can be inserted and extracted by IPv4 compatible inline functional modules (called Semi-Public Router or SPR) at the source and the destination ends of a link, respectively to effect the additional routing.

This solution to the internet address exhaustion problem can be implemented within the IPv4 domain, under the Dual-Stack Internet environment, independently of IPv6.

Effectiveness of Solution

The EzIP can expand the finite IPv4 address pool exponentially. To illustrate, reserving 10 addresses from the IPv4 pool of 4 billion has hardly any effect on the latter. Reusing these 10 addresses to extend each and every remaining address in the pool of 4 billion, however, produces a resource of 40 billion (minus 10 x 10, to be exact) addresses.

By substituting the “10” in the above process with “256M (million)” - the actual potential number, we can produce a fairly large assignable IPv4 pool of 959MB (million-billion), which represents a 240 million-fold expansion from the existing 4 billion addresses.

Differentiation of Approach

Compared to many approaches already being used to mitigate the IPv4 address depletion issue, the EzIP technique is rudimentary and straightforward. Relying only on an original Internet building-block standard, any networking engineer with the skill to manage the TCP/IP stack will be able to easily realize the EzIP.

Implementation

The SPR may be implemented as a functional enhancement to the existing software or firmware of the Internet Edge Router (ER), or as a new stand-alone inline hardware module, between an ER and the Routing / Residential Gateway (RG) that it serves. It could even be an enhancement to an RG for expanding a private network. The SPR approach increases each of the assignable IPv4 public address by 256 million times, without disturbing the established operations of CRs (Core Routers), ERs and RGs. Only finite resources (technical and financial) are required to deploy the SPRs.

Ability to Deploy Solution

As an inline functional module between the ER and the RG, the SPR may be deployed where needed without involving the existing Internet components. This characteristic is very useful, because the EzIP may be deployed regionally or nationally without having to wait for the worldwide Internet to be updated.

Analogy

The SPRs providing additional routing paths are similar to the dial-up modems that enabled the data communication service prior to the establishment of the Internet by sending digitally encoded voice grade signals through the PSTN (Public Switched Telephone Network), stealthily. Now, extended addresses may be conveyed between SPRs for extra routing purpose without the explicit participation of the existing Internet equipment.

Metaphor

The EzIP technique mimics the writing of the office / apartment number of either the sender or the receiver or both on the envelope of a letter, in addition to the street location. While both visible to everyone, the postal service traditionally used only the latter, leaving the former for the mailroom / front door staff to deliver to the specified tenant. Nowadays, many premises can set up personalized mailboxes at the entrance of buildings, allowing the mail carrier to directly deliver letters to an individual's slot. The EzIP mirrors this updated postal practice by making use of the semi-public addresses from the 240/4 block to facilitate the extra stage of routing.

Compatibility

The EzIP utilizes the payload capability of the IP header Options mechanism to convey the extended addresses. The actual application information in the datagram portion of an IP packet is not affected. This is the same as the content of a letter not affected by the address on the envelop. Thus, the EzIP should be compatible with higher layer protocols. However, certain protocols do use the address information in the IP header. A brief review of the "Internet Protocol Suite",
https://en.wikipedia.org/wiki/Internet_protocol_suite

reveals that at the Transport Layer, for example, UDP (User Datagram Protocol) and TCP (Transmission Control Protocol) calculate their checksums based on the IPv4 Source and Destination addresses. Since such addresses are those of the host devices where the respective protocol does the calculation, the EzIP addresses carried as IP header payload probably would not have any effect on the process.

Background Information

Cisco forecast: By Year 2020, IoT needs 50 billion addresses.
https://nishithsblog.files.wordpress.com/2014/04/internet-of-things-market-forecast.jpg

The IPv4 protocol based on the 32 bit format has only 4 billion addresses. Actual utilization is even lower due to inefficient (non-rigid) allocation practices during the early days of the Internet. For example, the 240/4 block consisting of 256 million addresses (one sixteenth of the entire IPv4 pool) has been marked as "RESERVED for Future use", ever since 1981:
www.iana.org/assignments/ipv4-address-space/ipv4-address-space.xhtml

Although IPv6 was selected for serving the future Internet, its deployment is still sluggish after many years:
https://ams-ix.net/technical/statistics/sflow-stats/ether-type
https://stats.labs.apnic.net/ipv6

Utilizing a very original Internet standard, RFC791 – dated back to 1981 when the Internet was still under DARPA (Defense Advanced Research Projects Agency) of the DoD (Department of Defense),
https://tools.ietf.org/html/rfc791

address from the 240/4 block with a 256 million capacity is transported as the payload of the IP header for a remote SPR module to decipher and then to perform the additional routing. This multiplies each public IPv4 address by 256 million times.

Descriptive Documents

A. IETF (Internet Engineering Task force) Draft (2017 June 12)
https://tools.ietf.org/html/draft-chen-ati-adaptive-ipv4-address-space-01

B. ISOC (Internet Society) Open Forum discussion thread (Access requires membership sign-up which is free):

https://connect.internetsociety.org/communities/community-home/digestviewer/viewthread?MessageKey=31b2647c-5940-481c-9cf6-daf679aaee4b&CommunityKey=3a9fa082-a518-475d-9e7f-ecec4ffe56dd&tab=digestviewer&MemberID=ytR8bbneDOo%3d&Timestamp=52YWL6W59va1N0G6cMkcbw%3d%3d#bm0

C. ISOC-NY Chapter Webinar (2017 Mar 07):

https://zoom.us/recording/play/aToGKmLGa3XT44k07i0PGdUiEXnv3lKgwqmB0nyEP1QkMBNfvQT1QImhaAOlz2vQ
with handouts:
- CanWeMakeIPv4GreatAgain.pdf
- CanWeMakeIPv4GreatAgain_References.pdf
- Terminology, Abbreviation, Acronym.pdf