CHAPTER 1

INTRODUCTION

1.1 Motivation

In the Internet, an IP address is used to identify each computer or device which is attached to a link of the network. There are millions of hosts, servers, mobile phones, communication devices, conference services and online electronic devices. Each of them needs an IP address in order to communicate. In addition, new technology, such as Mobile IP, Voice over IP, IP telephony and 3GPP are intending to use IP in their components.

However, the number of IPv4 addresses [1] is limited by their structure. Many are already assigned for nodes while other addresses cannot be assigned. The assignment hierarchy effectively ensures that many of the remaining addresses will never be assigned to actual nodes. As IP addresses have been rapidly used, address depletion will become a problem for the Internet in the near future.

These factors lead to the requirement for a solution to extend life time of IPv4 address usage. Classless Inter Domain Routing (CIDR) [2]-[4] was deployed to arrange number of IPv4 addresses for a group of networks that is a hierarchy of a specific zone. The address arrangement can also to reduce number of records in a routing table. However, this method is not the best way. A size of routing table is still increasing while the number of IPv4 addresses will be exhausted.

The solution to use private IPv4 addresses within local domains was proposed. This is the address reuse solution: IPv4 Network Address Translator (NAT) [5]. It allows the use of private IPv4 addresses within a local domain. NAT is placed the borders of the stub domain. Each NAT box has a table consisting of pairs of local IP addresses and globally unique addresses. The IP addresses inside the stub domains are not globally unique. They are duplicated in other domains that have deployed NAT to reduce the use of global addresses. CIDR and NAT are not permanent solutions to solve the address depletion problem of the IP network.

However, some global addresses are still required by the organizations. The new Internet Protocol, IPv6 [6], was invented to replace the exhausted IPv4. An IPv6 address with 128-bits provides more than 3.40 x 10^{38} addresses to allow a very large number of nodes to be attached to the Internet. The original plan to transition to IPv6 wa gradually to turn on IPv6 in every node that was attached to the Internet or upgraded. This technique is called Dual-Stack [7]. Eventually every node would contain both IPv4 and IPv6. Each node would be able to communicate to other v4 and v6 nodes.

It now seems clear that even if all network modes were able to support IPv6 before the last IPv4 global address is allocated, not all, and perhaps not even most, IPv4 networks will enable parallel operation of IPv6. Once there are no more available IPv4 addresses, new networks joining the Internet will have no choice except to use v6 alone for external communications – private v4 addresses can still be used internally. Some other networks are likely to remain v4 only, even with new ones being v6 only. So the Internet is required to deploy a transition mechanism to allow communication between these worlds which have different IP versions.

Network Address Translation – Protocol Translation (NAT-PT) [8], a translation mechanism, was created to provide communication and applications between v4 and v6 worlds. It translates address, port and protocol between IPv4 and IPv6 which allows transparent communication between the protocols without changing anything at the end nodes. It can provide bidirectional unicast address translation and communication between IPv4 and IPv6.

Since NAT-PT was derived from NAT, they have the same features in some functions. NAT-PT program is available to implement for testing and it is expected to be used in the migration period. These advantages are a motivation to evaluate and enhance NAT-PT's features. There are other translation mechanisms available [9]-[10] we chose to evaluate NAT-PT because of its relationship to NAT which is very widely deployed. We found that NAT-PT has limitations inherited from NAT, as expected, and others caused by the effects of protocol translation. In addition, it provides unicast communication only. It drops multicast packets and does not perform multicast address translation. Thus v4 and v6 nodes cannot participate in a common multicast session.

In the future, multimedia and multicast application such as video, audio, IP telephony, teleconferencing, distance learning are likely be used more. Not only v4 to v4 or v6 to v6 but these applications are also required between v4 and v6 worlds. Multicast sessions are usually accompanied, or processed by the distribution of information to explain the session, including the operating times, media type, encoding method, etc. The information and the group address identifying each session must be distributed in order to allow anyone to join. These procedures are required to provide multicast applications in each v4 and v6 worlds and also between these realms.

This work proposes a solution to improve NAT-PT to provide multicast communication between v4 and v6 worlds. It also presents a way to announce group addresses and advertise available multicast sessions among v4 and v6 worlds.

1.2 Objective

1) To investigate and study IPv4/IPv6 transition mechanisms which are techniques to migrate the Internet from IPv4 to IPv6.
2) To study and evaluate NAT-PT mechanism.
3) To discover and fix, where possible, limitations of NAT-PT.

1.3 Advantages

1) It is useful to discover the available IPv4/IPv6 transition strategies.
2) The multicast address mapping solution can extend the capability of NAT-PT to provide multicast communication between IPv4 and IPv6.
3) Several multicast IPv4 and IPv6 applications can be used between IPv4 and IPv6 realms.
4) The accomplishment and result can be proposed as an alternative solution, used in the real world and published to be a paper.
5) It could be a case study of IPv4/IPv6 transition by using NAT-PT.
6) It may be lead to new idea for developing IPv4/IPv6 transition by using NAT-PT.
7) It is useful to practice and evolve students' skill to solve problems.

1.4 Scope of work

1) To survey and study IPv4/IPv6 transition technique.
2) To install and implement the NAT-PT function into a testbed network.
3) To find out algorithm and mapping solution for multicast address and extend multicast

program and function into the original NAT-PT.

4) To enable NAT-PT to provide multicast communication from v4 to v6, v6 to v4, reverse path and cooperate with Application Level Gateway (ALG) for multicast session in global scope.
5) To verify and validate multicast address translation and multicast communication provided by the NAT-PT multicast router.

1.5 Work plan

1) To survey and study IPv4/IPv6 transition mechanism.
2) To study and evaluate NAT-PT.
3) To design NAT-PT system model.
4) To setup and test DNS-ALG with IPv4 and IPv6 applications.
5) To verify unicast address translation.
6) To extend IPv4 to IPv6 unicast address translation.
7) To design system model for NAT-PT with multicast address translation.
8) To study and implement code of multicast extension.
9) To install the prototype of NAT-PT with multicast address translation.
10) To test multicast application, verify and maintain system.
11) To develop multicast address mapping solution and find other problems.
12) To analyze the result and form conclusion.
13) To write report.

1.6 Outline

This document is organized in 8 chapters as follows:

Chapter 1, Introduction, is the motivation, objective and scope of this work. In addition, it presents the work plan to evaluate and develop NAT-PT in brief.

Chapter 2, Background of Internet Protocol, it present background of IPv4 address usage and problem.

Chapter 3, IPv4/IPv6 transition technique, gives the overview and comparison of IPv4/IPv6 transition mechanisms that are relevant to this work. And it presents the altered technique that is developed.

Chapter 4, Investigation of NAT-PT, introduces the background and principle of NAT-PT. Also it presents the testing and implementation to survey NAT-PT in testbed network.

Chapter 5, Multicast principles and protocols, are about multicast communication principle and the relevant protocols around multicast sessions and applications.

Chapter 6, NAT-PT enhancement to support multicast, proposes the plan, solution, algorithm and procedure to enhance the features of NAT-PT.

Chapter 7, Implementation and testing, presents prototype implementation and method to test multicast address translation and the related issues for operation of NAT-PT with multicast.

Chapter 8, Discussion and conclusion, analyzes, also, describes the limitation and further work required in this area.

Chapters 4, 6 and 7 represent the primary work of this thesis and chapter 8 is the conclusion.