Chapter 1

Introduction

1.1 Anycast Service for the Internet Protocol version 6 (IPv6)

In 1993, Partridge, C. and Milliken, W. (1993) introduced the anycast service for Internet Protocol Version 4 (IPv4). However, this service is not included in the IPv4 standard protocol at that time. Research in anycast becomes popular only after Deering, S. and Hinden, R. (1998) included this service into IPv6 specifications.

By using anycast service, several improvements are possible:

1) Simplified service location at the IP layer
2) Generalization of services such as Domain Name System (DNS) is possible
3) Policy base routing

The anycast service is regarded as one of the major improvements of IPv6 over Internet Protocol Version 4 (IPv4). Although the importance of the anycast service is realized, but there are not many implementations of anycast service in IPv6 due to some unresolved issues of anycast (Jun-ichiro itojun Hagino and Ettikan, K., 2001). However, there are efforts trying to resolve these issues to make the anycast service more viable in the future. Details about the anycasting will be discussed later in Chapter 6.

1.2 Anycast Routing

The function of the anycast routing protocol is to deliver anycast packets to the "nearest" node in an anycast group. The "nearest node" is determined according to the routing protocol's measure of distance. Research on developing anycast routing protocol is still ongoing (Wei Jia et al., 2000b) and no standard anycast routing protocol is available yet at the moment.

There are two approaches in developing an anycast routing protocol, single-path routing and multi-path routing. A typical single-path routing approach is the shortest-path routing. Multi-path routing protocols are basically extensions of existing multicast routing protocols, such as Distance Vector Multicast Routing Protocol (DVMRP), Multicast Open Shortest Path First (MOSPF), Core Based Tree (CBT) and Protocol Independent Multicast (PIM). The issues involved in single-path routing and multi-path routing will be discussed in Chapter 6.

1.3 Motivation

IPv6 anycast is an area of active research. However, current studies in anycast rarely address the performance issues of the anycast routing protocols. Literature review shows that current anycast routing protocols are only capable of giving satisfactory performance under certain network topologies. The problems of using an ineffective load-balancing scheme will affect the anycast routing protocols' performance and reliability. The review also shows that there is a lack of IPv6 network simulator. This thesis intends to study and improve the performance of anycast in IPv6. In addition,

the need to build a simulation environment for IPv6 anycast routing protocol is crucial. This will facilitate the testing and analysis of new anycast routing protocols.

1.4 Thesis Objectives

This thesis undertakes a detailed study of the anycast routing protocol in Internet Protocol Version 6 (IPv6) involves the creation of a simulation environment for the testing and evaluation of anycast routing protocols. Using this simulation environment, an enhanced anycast routing protocol is proposed and evaluated. The objectives of this thesis can be summarized as follows:

- To explore and study IPv6 multicasting and IPv6 anycasting.
- To create a simulation environment for anycast routing in IPv6.
- To propose and evaluate an enhanced anycast routing protocol, named nearest PIM-SM extension.
- To evaluate the performance and reliability of the load-balancing schemes in IPv6 anycast routing.

1.5 Thesis Scope

In conjunction with the objectives of this thesis, the scope of this thesis is defined in order to provide a general guideline to the range and depth of research. The following statements summarize the scope of this thesis in accordance with the stated objectives:

- The study and survey of IPv6 architecture, format and functions and IPv6 addressing architecture. IPv6 protocols implemented in this thesis.

- The study and survey of group membership management protocol for IPv6 and multicast routing protocol such as Multicast Listener Discovery (MLD), multicast distribution trees (source-based tree and shared tree), and several multicast routing protocols including Distance Vector Multicast Routing Protocol (DVMRP), Multicast Open Shortest Path First (MOSPF), Core Based Tree (CBT) and Protocol Independent Multicast Version 2 (PIM)..
- The study and survey of anycast routing protocols using single-path approaches and multi-path approaches.
- The underlying unicast routing protocol, RIPng and IPv6 packet forwarding mechanisms will not be discussed in detail. Other issues such as IPv6 security and anycast security are beyond the scope of this thesis.
- Implementation and evaluation of anycast protocol extended from multicast protocol, PIM-SM. PIM-SM is chosen due to the protocol's stability, availability and efficiency and well acceptance in the existing internetworking environment.
- Implementation and evaluation of the load-balancing schemes implemented.
- The IPv6 anycast simulation environment includes components of the RIPng, anycast routing protocols (RIPng extension, PIM-SM extension and nearest PIM-SM extension) and load-balancing schemes (shortest-path, round robin and fuzzy shortest-path). Other necessary protocols such as ICMPv6 and MLD are implemented as well. Other networking protocols not directly involved in this architecture will not be implemented.

1.6 Thesis Organization

The first part of this thesis, Chapter 2 covers the survey and discussion of the Internet Protocol Version 6 (IPv6), includes the IPv6 architecture, IPv6 format and functions and the IPv6 addressing scheme.

Chapter 2 addresses the problems that lie in the existing Internet Protocol, Internet Protocol Version 4 (IPv4) and the motivation behind the development of a new Internet Protocol, Internet Protocol Version 6 (IPv6). This chapter also discusses about the format and functions of the IPv6, focusing on the structure of the IPv6 packets, IPv6 header and extension headers. IPv6 addressing scheme, the assignments of the new 128-bit IPv6 addresses will also be discussed in this chapter.

The second part of this thesis, comprising Chapters 3, 4, 5 and 6, covers topics that contribute to the building of an anycast routing protocol. Chapter 3 explores the existing multicast trees, that can be modified and being used as an anycast routing protocol.

Chapter 4 gives some fundamental ideas of fuzzy set theory and fuzzy logic control, which will be implemented as one of the load-balancing scheme in this thesis.

Chapter 5 discusses details about anycasting, focuses on the benefits, issues and works on anycasting. Chapter 6 focuses on the idea of Routing Information Protocol next generation (RIPng) extension and Protocol Independent Multicast-Sparse Mode (PIM-SM) extension for anycast, that leads to the preparation of the proposed nearest PIM-SM extension anycast routing protocol.

The third part of this thesis, comprising Chapters 7, 8 and 9, covers the preparation and evaluation of the simulation environment, analysis of results, conclusions and future work.

Chapter 7 gives details of building the simulation environment for anycast routing protocol, including the components that were built for simulations, the topology used and the setting of the parameters. Chapter 8 presented the simulation results, together with the analysis of the results. Chapter 9 summarizes the efforts of this thesis and suggests some future works that can be carried out.