CHAPTER I

INTRODUCTION

1.1 Overview and Motivation

In the past few years we have seen an explosion and increasing variety of wireless and mobile devices offering Internet Protocol connectivity, such as notebook computers, Personal Digital Assistants, and digital cellular phones [1] [2]. However, the application of internet in these mobile devices, such as video conferencing, internet telephony and other real-time applications, introduces some technical obstacles. The most basic technical obstacle is the way the Internet Protocol sends the data packets from the source to the destinations according to Internet Protocol addresses [2].

In the original design, Internet Protocol address is assumed to be static. If a source wants to send packets to a destination, the packets are routed based on the static Internet Protocol address of the destination. When the destination is a mobile device, it means that the device can move from one network to another. If during the movement the mobile is receiving data packets from another device in the internet, this ongoing communication can be terminated since the Internet Protocol address of the mobile device in the previous network is different from the Internet Protocol address of the new network. The mobile device then has to change its Internet Protocol address in the new network to continue the communication. This problem makes the seamless roaming of the mobile device is impossible [2]. One of the solutions to this problem is Mobile Internet Protocol (Mobile IP).

Mobile IP [3] is a proposal from Internet Engineering Task Force (IETF) to support internet in mobile and wireless devices. There are three main entities in Mobile IP: Mobile Node (MN), Foreign Agent (FA), and Home Agent (HA). Mobile IP assigns two Internet Protocol addresses to MN: Home Address which is assigned by the HA in the home network and Care-of Address (CoA) which is assigned by the FA in the foreign network. These addresses make the MN that roams from one network to another can continue the communication without connections being dropped. CoA is updated every time the MN changes its network.

There are three main processes in Mobile IP which are Agent Discovery, Registration, and Tunneling. A MN discovers its FA and HA during Agent Discovery. The HA and FA advertise their presence and services on the network periodically

using Agent Advertisement message. The MN listens to this advertisement to determine if it is connected to its home network or foreign network. When the MN detects that it is in the home network, it acts like fixed node in the home network. However, when it finds that it has moved to new network, the MN obtains new CoA and registers its current location with the FA and HA through registration process. The MN registers to FA and HA by sending Registration Request and receiving Registration Reply message from the HA to report its new CoA through the new FA. In Tunneling, a reciprocal tunnel is set up by the HA to the current location of the MN on the foreign network to route packets to the MN as it roams. The data packets for the MN are always sent to the HA before forwarded to the MN. On the other hand, the MN needs not to send the data packets to the HA, but could send them directly to the destination.

As the basic protocol, Mobile IP still faces a lot of problems, e.g. security, handoff latency, ingress filtering, encapsulation overhead, triangle routing, and signaling load [2]. Paging Extensions for Mobile IP (Paging Mobile IP) [4] is one the proposals that improve the performance of Mobile IP. Paging Mobile IP uses the idea of paging in cellular network, in which registration and paging are used to minimize the signaling overhead and optimize the mobility management performance. As in the case of cellular system, Mobile IP users do not communicate all the time. Most of the time, they are in idle state. Therefore, Paging Mobile IP proposes to only know the approximate location of the idle users. Paging Mobile IP differentiates the state of the MN and uses paging to handle the location management of an idle MN. The wireless system uses paging procedure to search for an idle MN when there is a message for that MN. Here, an idle MN does not need to register its precise location to the system whenever it moves. Paging decreases the signaling overhead related to registration and location system database updates. Paging also reduces the power consumption of the MN since the idle MN does not need to register with the system whenever it roams. However, Paging Mobile IP only concentrates to reduce the number of registrations and still uses the same registration method as Mobile IP, in which the registration may have long handoff latency and high number of lost packets if the distance between the MN and the HA is large [4] [5].

In Mobile IP, the MN registers to the HA every time the MN changes its network. This causes high signaling load and long signaling delay during registration if the distance between MN and HA is large. Mobile IP Regional Registration [6] solves this problem by introducing a new entity called Gateway Foreign Agent (GFA). GFA is a local administrator for some FAs. GFA introduces a hierarchy of the network in the visited network. The address of the GFA is advertised by the FA in the visited domain. When moving from one network to another within the same domain of GFA, the MN does not need to register to the HA. Instead, the MN

performs regional registration with the GFA. Mobile IP Regional Registration can reduce the signaling load to the home network and signaling delay when the MN moves from one network to another in the same visited domain significantly. This also means that Mobile IP Regional Registration has lower number of lost packets and handoff latency than Mobile IP.

Multicasting has been widely used in the internet network. It is used to send data packets from one source to more than one destination. The goal of multicasting is to save the bandwidth resource in the network. The destinations form a group of receivers which is known as the multicast group. The member of the group may locate not in the same geographic area. The node that wants to receive the multicast packets must first join the group which is identified by a multicast address. The sender of multicast packets uses this multicast address to send the packets to the group. To send the data from the source to the destinations, the multicast routers in the internet network use a specific multicast routing protocol.

In this research, we propose to improve the original protocol of Paging Mobile IP. We utilize Paging Mobile IP, combined with Mobile IP Regional Registration and multicasting to achieve good performance. Paging Mobile IP can reduce the number of signaling overhead significantly. Moreover, it also has good power saving mechanism. However, original Paging Mobile IP concentrates only to decrease the number of registrations. It still uses Mobile IPv4 registration, which gives rise to long handoff latency and a lot of lost packets [4] [5].

In this work, we will enhance the performance of Paging Mobile IP so that it can have good performance, not only in term of signaling cost but also in terms of packet loss and handoff latency, when the MN moves from one cell to another. We use regional registration so that the MN does not need to report to the HA every time it moves to new cell. This will reduce the signaling and handoff delay. We employ Protocol Independent Multicast-Sparse Mode to send the packets from the GFA to the FAs in the vicinity of the MN in order to make the MN be able to accept the packets as soon as possible during the registration process.

Hierarchical topology of Mobile IP Regional Registration is adapted in the proposed methods. The GFA has the additional task to conduct the location management of idle mobile users by doing paging process to find the precise location of the idle MN. It also has to multicast data packets to the MN's multicast group. During its movement within the same GFA domain, the MN is assigned a multicast address. The FAs in the proposed methods issue additional messages to support multicasting within the GFA domain. These messages are used by the FAs to construct, to join and to leave the multicast group.

Some works have been done related to our research. Reference [7] adopted paging scheme in Mobile IP Regional Registration. In this work, the GFA buffers the data from the HA and conducts paging process in its domain to search for the MN. When it has known the location of the MN, it forwards any buffered and incoming packets to the MN via the MN's current FA. Reference [5] improved the performance of Paging Mobile IP by using the main idea of Post Registration (low latency handoff) [8]. Post Registration uses link layer to initiate handoff. The registration delay is proposed while the MN is entering the active state to decrease the mobile node waiting time for data packets and data buffering. Post Registration scheme is used during active state. Here, the packets can be delivered to the MN at the new FA even before the formal registration has been completed. Therefore, this method reduces the movement detection time so that the handoff latency and the number of lost packets are decreased.

Micro-Mobile IP in Reference [9] extends Mobile IP Regional Registration to support paging and fast handoff. Micro-Mobile IP has similar structure as Mobile IP Regional Registration. Gateway Mobility Agent (GMA) filters between intra and inter-domain signaling. Subnet Agent (SA) has similar role as Foreign Agent in Mobile IP which covers a specific geographic area. A group of SAs forms a multicast paging area group. Link layer handoff is used here for bi-casting of data packets from GMA to the MN via the SA. Reference [10] proposed a fast and efficient handoff scheme that uses multicast to forward data packets in the local domain to the MN. The local administrator called Domain Foreign Agent multicasts the data packets to the Base Stations (BS) of the MN's multicast group. The current BS forwards the packets, while the neighbor BSs buffer the packets. The buffered packets are directly forwarded to the MN if the MN moves to another BS in the same multicast group.

1.2 Scopes and Goals

This research is based on simulation. We concentrate on the handoff mechanism in Paging Mobile IP to reduce the handoff latency and the number of lost packets. We assume that the system supports security, paging, and multicasting. We only consider the downlink data packets that are sent from the HA to the MN. Signaling messages in both Link Layer and Network Layer are utilized for handoff purposes which are depend on the handoff method in each protocol.

The primary goals of this research are as follows:

1. To study and apply multicasting and regional registration to Paging Mobile IP.
2. To improve the performance of Paging Mobile IP by decreasing the handoff latency and the number of lost packets by using multicasting and regional registration.

3. To implement the proposed methods by means of simulation by using Borland Delphi programming language. Mobile IP, Paging Mobile IP, Paging Mobile IP Regional Registration, and Paging Mobile IP Post Registration are also simulated.
4. To evaluate the performance of the proposed methods in terms of signaling cost, handoff latency, and number of lost packets and compare the proposed methods with Mobile IP, Paging Mobile IP, Paging Mobile IP Regional Registration, and Paging Mobile IP Post Registration. The number of cells in one paging area, the MN's speed, and the number of hop between GFA and HA are varied for this purpose.

1.3 Expected Benefits

This research is expected to yield the follow benefits:

1. An advanced understanding on Mobile IP as the future protocol for internet mobility protocol.
2. The evaluation of the new handoff method of Paging Extensions in Mobile IP based on multicasting and regional registration and its comparison with Mobile IP, Paging Mobile IP, Paging Mobile IP Regional Registration, and Paging Mobile IP Post Registration.
3. The proposed methods to be candidates for various real-time or multimedia services in future wireless network such as internet telephony and video conferencing.

1.4 Thesis Organization

This chapter has discussed about the overview, motivations, scopes, goals, and expected benefits of the research. The rest of the thesis is organized as follows. Chapter 2 gives the literature review about Mobile IP, Paging Mobile IP, Mobile IP Regional Registration, and other related works. Chapter 3 explains the proposed methods in which we apply multicasting and regional registration to Paging Mobile IP to improve its performance in terms of handoff latency and number of lost packet. Chapter 4 describes the simulation model that is used in the research. Chapter 5 presents the performance evaluation of the proposed methods and its comparison with Mobile IP, Paging Mobile IP, Paging Mobile IP Regional Registration, and Paging Mobile IP Post Registration. Finally, Chapter 6 concludes this thesis and gives several explanations and recommendations for future work.