THE IMPLICATION OF THE NEXT-GENERATION WIRELESS NETWORK DESIGN: CELLULAR MOBILE IPv6

Han-Chieh Chao, Yen-Ming Chu and Mu-Tai Lin
Department of Electrical Engineering, National Dong Hwa University
Hualien, Taiwan, Republic of China, 97401
E-mail: {hcc,m8723013, m8823010}@mail.ndhu.edu.tw

ABSTRACT

Recent initiatives to add mobility to the Internet and packet data services for next generation cellular systems are being considered by many mobile service providers. IPv6 is a new version of the Internet Protocol that was standardized by the Internet Engineering Task Force (IETF). It supports mobility and is presently being standardized by the IETF Mobile IP Working Group. At the same time, cellular is an inevitable and developing architecture for the Personal Communication Service system (PCS). *In this paper, Cellular Mobile IPv6 (CMI), a new algorithm that is migrated from Mobile IPv6 is proposed for mobile nodes moving among small wireless cells at high speed. It is important for future mobile communication environments and should eventually integrate its functions with the Internet.* The purpose of this paper is to solve the problems of communication break within smaller cellular coverage during high-speed movement with packet-switched data or the real-time voice messages. *Thus, voice over IP (VoIP) packets were chosen to implement the system. Simulation results show smooth* and non-breaking handoff *during high-speed movement using the proposed algorithm.*

1. Introduction

The current IP protocol version 4 (IPv4) [1] brings this world into the "Net-Era" stage. Following the speedy growth of networks around the world, more and more IPv4 problems have been gradually discovered. In view of this, the Internet Engineering Task Force (IETF) has initiated the Next Generation IP intended to replace the IPv4, and we call it "IPv6"(Internet protocol version 6) [2].

A protocol that cannot support mobility is useless for future networks. IETF formed the IETF Mobile Working Group to draw up mobility support for IPv4 (Mobile IP)[3]. Currently IPv6 is in the development stage.

Not only is the development of network technology fast, but there are numerous breakthroughs in telecommunication technology. From early *Advanced Mobile Phone system (AMPS)* to the present *Global System for Mobile Communication (GSM)* [4] and the third generation mobile communication system, people have gradually moved away from wired limitations. But, there are still many problems must be overcome. For example, the management of resources, larger bandwidth, lower power and the issues of security, etc.

The next generation mobile communication system will be the so-called *Mobile Internet.* All communication and network systems will be integrated into the Internet. Enough bandwidth and a good protocol that can be used in various systems is greatly needed.

This paper is structured as follows. Section 2 presents IPv6 and Mobile IPv6 briefly. Section 3 describes our Cellular Mobile IPv6 proposal. Section 4 compares and evaluates the performance of Mobile IPv6 and our proposal. Section 5 presents the related work and concludes the paper.

2. The IETF IPv6 and Mobile IPv6

In this section, we will become acquainted with IPv6 and Mobility support [5] in the Internet.

2.1 Overview of IPv6

The IPv6 has some improved features compared to IPv4. The IPv6 specification is defined in RFC 1883 [2]. (Obsoleted by RFC 2401) It summarizes the changes from IPv4 to IPv6 such as Expanded Addressing Capabilities, Header Format Simplification, Improved Support for Extensions and Options, Flow Labeling Capability and the support for security.

Original manuscript received June 19, 2000

128-bit Network Address

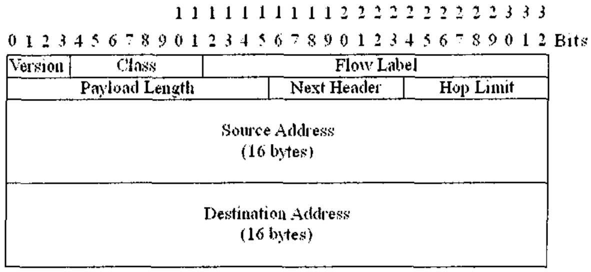

Figure 1: The IPv6 Fixed header [6]

The major difference between IPv6 and IPv4 is the 128 bits network address [6]. This will solve the IP address shortage in IPv4 effectively. Figure 1 shows the main IPv6 header [7].

Autoconfiguration [8]

IPv6 defines both a stateful and stateless address autoconfiguration mechanism.

Stateless autoconfiguration requires no manual configuration of hosts, minimal (if any) configuration of routers, and no additional servers. The stateless mechanism allows a host to generate its own addresses using a combination of locally available information and information advertised by routers.

The basic principle is：

IPv6 address = Prefix_address | MAC_address

In the stateful autoconfiguration model, hosts obtain interface addresses and/or configuration information and parameters from a server. Servers maintain a database that keeps track of which addresses have been assigned to which hosts. The stateful autoconfiguration protocol allows hosts to obtain addresses, other configuration information or both from a server.

Streamlined Header Format [9]

IPv6 simplifies the header from 13 to 8 fields. It will make the router process the IPv6 packets more efficiently.

Better Support for option and extension

Several kinds of *extension headers are defined by the IPv6,* which can provide extra information in the headers of an IPv6 packet [7]. Using the *Next Header*, it can show the following six extensions, including *Hop-by-Hop Options Header, Destination Option Header, Routing Header, Fragment Header, IP Authentication Header, IP Encapsulating Security Payload Header, Upper-Layer Header.*

Flow label

The *Flow Label* field can be used to setup up a pseudo connection for a particular requirement [7][10]. The *Flow Label* field can tag the packets from the sources in order (like a stream). The transmission of these packets requires support from the routers. If a node in the Internet can not support the Flow label function, the field is set to zero on the source and ignored on the receiver.

Security

Security is a very important issue for the Internet. To receive Internet security, IETF developed the *IP Security (IPSec)* protocol, which is optional for IPv4 and a default in IPv6. *Authentication* and *Encryption* are two functions of IPSec. The receiver can be assured with a packet sent by the sender with *IP Authentication Header. IP Encapsulating Security Payload Header* to encrypt the contents of a packet that can only be read by the legal recipient. The IPv6 security architecture is defined in RFC 1825 [11]. (Obsoleted by RFC 2401)

2.2 The IETF Mobile IP

In the Internet, a packet is transmitted from the source to the destination depending on the source address and destination address in the IP header. Without using a Mobile IP, as a station is moving to another sub-net, it must acquire a new IP address along with other necessary information so that it can operate functionally. Using a new IP address will make the station cease to communicate with other stations from its original IP address. In consideration of the importance of the mobility issue, the IETF brings up an idea to solve these issues called Mobile IP.

Mobile IP defines three functional entities where its mobility protocols must be implemented：

Mobile Node

A node which can change its point-of-attachment to the Internet from one *link* to another while maintaining any ongoing communications and using only its (permanent) IP *home address.*

Home Agent

A router with an interface on the mobile node's *home link* which：

a. the mobile node keeps informed of its current location, as represented by its care-of-address, as the mobile node moves from link to link;

b. in some cases, *advertises reachability* to the *network-prefix* of the mobile node's *home address*, thereby attracting IP packets that are destined to the mobile node's *home address*; and
c. intercepts packets destined to the mobile node's *home address* and tunnels them to the mobile node's current location; i.e.: to the *care-of-address*.

Foreign Agent

A *router* on a mobile node's *foreign link* which

a. assists the mobile node in informing its home agent of its current *care-of-address*;
b. in some cases, provides a *care-of-address* and *de-tunnels* packets for the mobile node that have been *tunneled* by its home agent; and
c. serves as a default *router* for packets generated by the mobile node while connected to this *foreign link*.

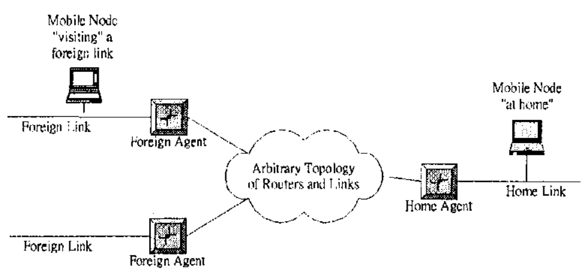

Figure 2: Mobile IP Entities and Relationships

At the beginning, Mobile IP [3] is based on the current IP (IPv4) and is compatible with the IPv4. The basic concept of Mobile IP is using the same IP address wherever the hosts go. This immutable address is called the *home address* in Mobile IP. *Mobile Node (MN)* or is a mobile device that can provide connection while successfully roaming from one sub-net to another sub-net without changing its IP address. *Home Agent (HA)* is a server with a routing function [10]. It manages the registers and stores the related information of the mobile nodes in order to forward the data packets to the mobile nodes when they are roaming away from their home subnet. *Foreign Agent (FA)* is a computer or router in the MN's visited sub-net and it forwards the packets from the HA to the MN. As a mobile node visits a foreign sub-net, the FA will give a temporary *care-of-address* to the mobile node as an exit point when the mobile node is away from its home sub-net. [9][11].

2.3 The IETF Mobile IPv6

In the previous sections, we described how the Mobile IP operates and described the Mobile IP components. The basic concepts of the Mobile IPv6 are similar to Mobile IP. Some new functions of the IPv6 bring the new features and schemes for mobility support. We highlighted the differences between Mobile IPv4 and Mobile IPv6. The items listed below are the new features that influence the Mobile IPv6 design.

Plug and Play

As the MN enters a subnet, it can get an IPv6 address using the IPv6-defined auto-configuration. In Mobile IPv6, the MN will acquire a care-of-address in a foreign network using the same mechanism.

Multiple Care-of-Address and Soft Handoff

A MN will be able to get multiple care-of-addresses in a Mobile IPv6 environment. In a wireless communication system, a transmission packet loss is crucial. The way to overcome this problem is to try to make the MN connect with two or more base station (BS) simultaneously. On the other hand, this scenario can be described as a *smooth handoff* or a *soft handoff* if the MN can be connected to the prior and later subnet domains (receiving the packets from the above two BS) at the same time within the overlap of the cells border.

No Foreign Agent

In a Mobile IP, an MN registers to a foreign node and borrows its' address to build an *IP tunnel* so that the HA can deliver the packets to the MN. In other words, the FA shares its IP address with the MN. But in Mobile IPv6, the MN can get a new IPv6 address, which can be only used by the MN and thus the FA no longer exists. It would be better to say that the role of the FA is replaced by the IPv6 network and the MN itself. [12]

Routing Header and IP Tunnel

There are three methods for overcoming the network-prefix routing insufficiency that makes it unable to deliver data packets to the mobile nodes that are connected