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Seamless Support for Mobile Internet Protocol Based Cellular Environments

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Cellular is the inevitable architecture for the Personal Communication Service system (PCS) in the coming future. Access to the Internet via cellular networks is expected to become an essential portion of future wireless service offerings. Providing seamless support for IP based packet switched services has become an important issue.

The Internet Engineering Task Force's (IETF's) mobile IP protocol offers a standard solution for wide-area mobility at the IP layer. However, Mobile IP does not solve all of the problems involved in providing mobile Internet access to cellular users, especially during handoff period. Thus, IPv6 might be a good candidate to solve this problem.

IPv6 is a new version of the Internet Protocol that was standardized by the IETF. It supports mobility and is presently being standardized by the IETF Mobile IP Working Group. At the same time, cellular is an inevitable architecture for the Personal Communication Service system (PCS).

This paper introduces the current cellular support based on the Mobile Internet Protocol version 6. We will point out the short-falls using Mobile IP and try to emphasize protocols especially for mobile management schemes that can optimize a high speed mobile station moving among small wireless cells. A comparison between those schemes and future work will be presented.

KEY WORDS: Mobile; cellular; seamless; Ipv6; handoff.

1. INTRODUCTION

Although the Internet offers access to information sources world-wide, we do not expect to benefit from this access without being located at some familiar access point -, home, office or school. However, the increasing variety of wireless devices offering IP connectivity, such as digital cellular phones, and PDAs, is beginning to change our perception of Internet access and use [1].

The current IP protocol version 4 (IPv4) brought this world into the net era. Following the speedy growth of the network around the world, IPv4 problems were gradually discovered. In view of this, the Internet Engineering Task Force (IETF) initiated the Next Generation IP, intended to replace IPv4, called "IPv6" (Internet protocol version 6).

A protocol that cannot support mobility is useless in the world of the future. The IETF formed the IETF Mobile Working Group to draw up mobility support for IPv4 (Mobile IP). In 1996 Mobile IP was proposed as an IP enhancement to provide mobility and portability support. Mobile IP requires new network elements and specifies a protocol for the interaction of the new components and the host [2].

The next generation mobile communications system will be the so-called *Mobile Internet*. All communications and network systems will be integrated into the Internet [3]. Enough bandwidth and a good protocol that can be used with various communications systems are essential. At the same time, cellular is the inevitable architecture for wireless mobile communications and should be integrated with the Internet as well.

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Providing seamless mobile station transmissions while the mobile unit is moving at high speed among small wireless cells is an important issue for the future. Recent initiatives to add mobility to the Internet and packet data services for the next generation cellular systems are being considered by many mobile service providers. At the same time, IPv6 is a new version of the Internet Protocol. It supports mobility and is presently being standardized by the IETF Mobile IP Working Group and should be a good candidate to provide solutions [4].

The remainder of this paper is structured as follows. The disadvantages of IPv4 are listed in Section 2. In Section 3, an overview of IETF Mobile IPv6 is introduced. Different kinds of proposals to solve Service Disruption during Handoff are illustrated in Section 4. A summary is presented in Section 5 and Section 6 contains the direction of future work.

2. LIMITATION OF CURRENT INTERNET PROTOCOL (IPv4)

The current Internet Protocol version 4 (IPv4) brought this world into the “Net-Era” stage [5]. Great advances occured in the Internet following the speedy growth of networks. More IPv4 problems were detected as Internet use increased. In this section, we will point out the insufficies in IPv4.

2.1. Address Shortage Issue

In 1977, Dr. Vint Cerf, the Father of the Internet, uttered some very famous “last words,” “32 bits should be enough address space for the Internet.” Unfortunately he was wrong and he admits to it. In fact, the number of addresses provided by IPv4 is about 4 billion (2^{32}) and was enough “in those days.” With the unimaginable advances in the Internet, the number of users and devices have created an “address shortage.” Address exhaustion is one of the most tangible problems facing the Internet today. NAT and CIDR temporarily solved the address exhaustion problem. To further complicate current problems, mobile communications and IA have recently arrived. They create additional Internet use and demand for IP addresses. To affect a permanent cure, a new protocol that can provide enough address numbers is the best solution.

2.2. No Native Mobility Support

In the past, the mobile computing was not a very serious problem because almost all networked devices were stationary [6]. Until the popularization of various personal communication and computing devices, such as the cellular phone, notebook computer, PDA, etc., this issue was not taken seriously. Although the IETF formulated mobility support for IPv4 in RFC 2002 [2], there is a gap in its convenience because it is not native to IPv4.

2.3. Security Issue

E-businesses, e-commerce or any other economic transactions over the Internet have increased dramatically making security issues critical to continued e-commerce growth. In the past, security was not discussed at the Internet layer [7], [8], [9]. The security issues, encryption for payloads, exchange of encryption keys, authentication of entities and access control to resources, etc., are often handled on higher layers, such as transport or application layers. There are a number of security weaknesses, as the Internet is used increasingly for business related activities using IPv4. The IP Security Working Group of IETF proposed and defined a series of encryption and authentication procedures in the IPSEC proposal to be implemented in IPv4. In addition to the disadvantages mentioned above, IPv4 also has QoS guarantee and System Management problems. Figure 1 shows the packet format of both Internet Protocol version 4 and 6. The total number of field has been reduced from 12 to 8 which had reduced the burden of the router CPU. Also, the extension headers in version 6 have been included in the data payload comparing to the options field in version 4. This can further fasten the packets processing speed.

3. ISSUES IN IETF MOBILE IPv6

In the mobile network area, the trend is to move from traditional circuit-switched systems to packet-switched programmable networks that integrate both voice and packet services, eventually evolving toward an all-IP network.

Recently, there has been increased interest in Mobile IPv6 as a potential future mobility standard, combining a cellular system and the Internet as a whole. The benefits of adopting a common mobility solution would include

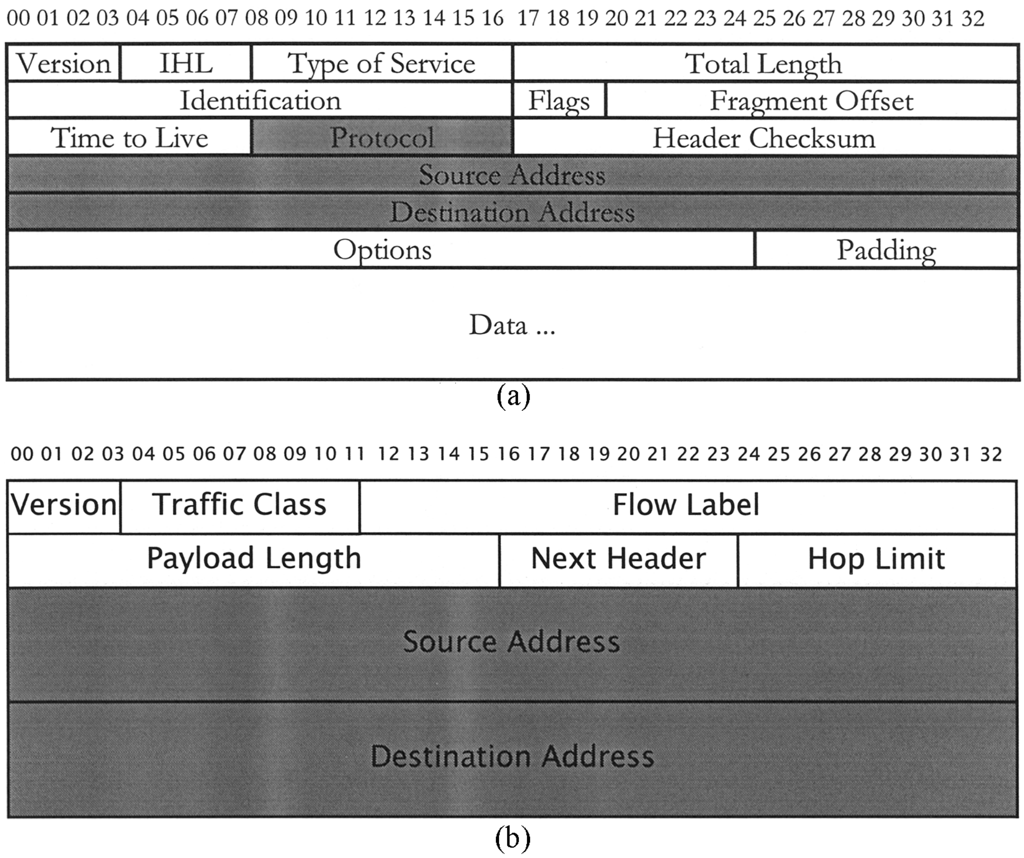

Fig. 1. (a) Internet protocol version 4 packet format. (b) Internet protocol verison 6 packet format.

independence of access network technologies and common solutions for fixed and wireless networks.

After a mobile node has moved from one network to another, packets destined for that node at its previous network address will not be routed to the new location. To receive packets at its new location, the node must obtain a new network address and advertise it to other nodes wishing to correspond with it. How to reduce the number of "in-flight" lost packets is the most important issue in this proposed system.

Though Mobile IPv6 may manage the local mobility of a mobile node successfully, it is not suited for global cellular networks and we will illustrate this in the following sections.

The five possible cellular system architectures are described below:

1) Purebred Cellular Network:

In this network architecture, the cellular network is independent of the other network in the Internet. There is a central office or gateway in the edge between the cellular network and the Internet. Figure 2 shows this network scenario and the scope enclosed by the green dashed line is the cellular network.

2) Hybrid Network Architecture:

This is different from the previous architecture. The distinction is that the cellular network is not independent of the other networks in the Internet. Figure 3 shows this network scenario. Looking at Router B in Fig. 3, one of it's interfaces connects to a common LAN and the other connects to a cellular base station in the cellular network. There is no so-called actual cellular network in this scenario. A base station may be a node, bridge, switch or router in the LAN.

3) Plane Network:

Figure 4 shows the wireless plane cellular network scenario. Every base station connects to a router individually and directly.