Mobility Support for IPv6-Based Next Generation Wireless Networks: A Survey of Related Protocols

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ABSTRACT

This paper presents an overview of IPv6-based mobility management protocols: mobile IPv6 (MIPv6), fast handovers for mobile IPv6 (FMIPv6), hierarchical mobile IPv6 (HMIPv6), and fast handover for hierarchical mobile IPv6 (F-HMIPv6). All these protocols play an important role in the next generation wireless networks, because in such networks, mobile users need to be freely change their access network or domain with on-going real-time multimedia services. The mobility management procedure for each protocol is described in details. Furthermore, handover performance is compared for host-based mobility protocols using analytical modeling. The effect of various wireless network parameters on the performance is studied carefully. Numerical analysis shows that handoff performance in wireless networks is largely dependent on various system parameters such as the user velocity, subnet radius, and session-to-mobility ratio, domain size and binding lifetime; there is a trade-off between performance metrics and such parameters.

Keywords: Mobile IPv6, Mobility Management, Performance, Seamless Handover, Wireless Networks

1. INTRODUCTION

Today, we witness the commercial proliferation of multimode wireless terminals, i.e. smart-phone, iPad, iPod, and the explosion of mobile data. To meet end-users’ needs, multi-technology environments with disparate capabilities are emerging and integrated together. All these changes in wireless communications world have placed extra requirements for mobile operators. Traditional voice, fax, email and paging services need to be replaced by real-time multimedia applications, i.e. audio & video streaming, image transfer. However, the provision of such multimedia services imposes new quality of service (QoS) requirements on the networks. It is well-known that next-generation wireless networks must provide integrated
services with more capabilities to dynamically relocate mobile terminals (Akyildiz et al., 1999). Therefore new challenges have sparked researcher to find new solutions, which can offer undisrupted/seamless multimedia services to roaming users. Given such circumstances, mobility management becomes an important issue to enable telecommunication networks to locate roaming terminals and deliver calls/data to them while these terminals moving into a new access network/domain.

Currently, various wireless technologies and networks exist to satisfy mobile users’ requirements. For example, wireless local area networks make it possible to deliver high data-rate services within small radio coverage area; cellular networks provide voice and data services with a relatively lower data-rate, yet large coverage; satellite networks enable global roaming with worldwide coverage at drastic costs. These networks/systems are designed for meet specific service needs, thus they are significantly different in terms of bandwidth, delay, coverage area, costs and QoS provisioning (Akyildiz et al., 2005). As a result, they tend to complement one another to empower mobile users with “always best connected” (Gustafsson & Jonsson, 2003) to the most appropriate network.

Meanwhile, a variety of heterogeneities exist within next-generation wireless networks (NGWNs), i.e. radio access technology, network architecture, network protocol and service demands. Such inherent heterogeneities require a common infrastructure to interconnect multiple access systems (Akyildiz et al., 2004). Under this circumstance, using all-IP-based infrastructure to support ubiquitous communication appears to be very promising and acceptable by the telecom industry (Saha et al., 2004). First of all, IP-based wireless networks are better suited to support the rapidly growing mobile data and multimedia applications (Chen & Zhang, 2004). This is confirmed by the fact that IPv6 (Deering & Hinden, 1998) is designated as the only IP version supported for IP Multimedia Subsystem (IMS) within the Third Generation Partnership Project (3GPP) (Arkko et al., 2003). Secondly, IP-based wireless networks have already brought global success to Internet services and they will also prove to be a successful platform to foster future mobile services (Chen & Zhang, 2004). Last but not least, IP-based wireless networks are independent of the underlying radio access technologies, making it possible and feasible to maintain seamless connectivity over different radio technologies, while offering global roaming capabilities (Chen & Zhang, 2004). Therefore, NGWNs are designed to take advantage of all-IP-based infrastructure to achieve global roaming amongst a variety of radio access technologies (Akyildiz et al., 2004). The contributions of this paper are two-fold, summarized as follow:

- We present an overview of host-based mobility protocols for next-generation wireless networks: mobile IPv6 (MIPv6) and its enhancements, i.e. fast handovers for MIPv6 (FMIPv6), hierarchical MIPv6 (HMIPv6) and fast handoff for HMIPv6 (F-HMIPv6).
- We evaluate the handoff performance for MIPv6 and its enhancements through analytical modeling, and study carefully the effect of various network parameters on the performance.

The remainder of the paper is organized as follows. Section 2 gives an outline of the challenges of mobility management in NGWNs, and provides a global view of the research background. Section 3 presents the mobility management procedure for each protocol: MIPv6, FMIPv6, HMIPv6 and F-HMIPv6. Section 4 formulates the handoff signaling cost, and binding refresh cost functions using analytical models, and presents detailed numerical results to show the impact of different system parameters, session-to mobility ratio (SMR), number of subnets within a MAP domain, user velocity, subnet radius, domain size, binding lifetime on the performance. Future trends in the design of intelligent mobility management are then described in Section 5, followed by the conclusion mark.
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