

Chapter 7

Protocols and Applications of Cross-Layer in Mobility Management

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ABSTRACT

The design of the mobility management is the key issue in the next-generation mobile networks. It is important to provide seamless service switching for a Mobile Station (MS) or a Mobile Node (MN) with uninterrupted services during an IP-based session between different access networks, where IP convergence has led to the co-existence of several IP-based wireless access technologies and the emergence of next generation technologies. Many recent research results of cross-layer design in mobility aim to minimize the data loss rate and delay time during switching so that users do not experience obvious and unacceptable interruptions during the handoff. The cross-layer design is the important approach for mobility management. This chapter mainly introduces and reviews existing protocols and then discusses the possible interest and useful applications of cross-layer in mobility management.

INTRODUCTION

With the rapid development of wireless technologies, mobile networks have become more popular to provide IP-based media applications. To provide the seamless handoff for a mobile station mov-

ing between different base stations of the mobile networks, a mobility management (Siddiqui, et al., 2006) with low handoff delay is very important for the next-generation mobile networks. Existing handoff results need to perform the layer 2 (link layer) handoff operation to establish new link to the new base station, and then perform the layer 3 handoff operation to maintain network connectiv-

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ity. Existing handoff results thus offer the large handoff latency and the high packet loss rate. It is very useful to have the cross-layer design for the handoff mechanism to significantly improve the handoff latency and packet loss rate to provide a seamless handoff result.

Currently, various wireless technologies have been specified to provide wireless access to the internet, such as WLAN (IEEE 802.11) (Chen, et al., 2009), WiMAX (IEEE 802.16) (WiMAX Forum, 2011), and LTE (Long Term Evolution) (3G, 2011; 3GPP, 2009). The IEEE 802.11 specifications provide a wireless alternative to Ethernet LANs (Local Area Networks). First, the IEEE 802.11 standard has the small coverage area and contention based resource allocation, which results in frequent handoffs, ineffective resource allocation, and intolerable handoff latency. The IEEE 802.16-2004 standard (IEEE, 2004) initially defines physical and Medium Access Control (MAC) layer operations of Broadband Wireless Access (BWA) systems to support the last mile connectivity at high data rate and large transmission range in wireless metropolitan area networks. WiMAX (Worldwide Interoperability for Microwave Access) has been specified in IEEE 802.16 standards for metropolitan networks. The IEEE 802.16-2004 standards are only for the fixed wireless connections; a further amendment, the IEEE 802.16m/j standard (IEEE, 2005), is specified to support mobility for mobile devices. The Third Generation Partnership Project (3GPP) recently has proposed a 3G Long-Term Evolution (LTE) (3G, 2011; 3GPP, 2009) toward the fourth-generation (4G) cellular systems. LTE is based on the Universal Terrestrial Radio Access (UTRA) and High-Speed Down-Link Packet Access (HSDPA) and further strengthen its communications capacity to upload in order to enhance its quality of service. The LTE coexists with 2G/3G systems, WLAN, WiMAX, etc. Therefore, the 4G (Akyildiz, et al., 2004; Raivio, 2001; Raychaudhuri, 2004) heterogeneous networks (Bari, et al., 2009) aim to integrate many up-to-date wireless

technologies, including IEEE 802.11, WiMAX, and LTE technologies, together to provide multimedia services. In 4G heterogeneous networks, a mobile multiple-mode device can move between wireless networks. The design of the cross-layer handover protocols is very important for the mobile networks.

Basically, the handover protocol can be divided into the Layer-2 (L2) handoff operation and the Layer-3 (L3) handoff operation. The L2 handoff operation (IEEE 802.16e, 2005) is that every BS exchanges channel information and Mobile Station's (MS) handoff parameters over the backbone network to speed up L2 handoff. The MSs are advertised by their serving BSs of neighbor BSs' information to support Mobile Station (MS) scanning and handoff procedures. The L2 handoff latency contains probe (channel scanning), authentication, and reassociation delay times (Chen, et al., 2008). With the support for the mobility in L2, a flawless mobility management still requires a feasible handoff operation in L3.

A Layer-3 (L3) handoff operation is required to deal with the problem of the IP mobility. Mobility support in internet protocol version 6 (IPv6) (Johnson, et al., 2004) has been proposed by Internet Engineering Task Force (IETF) Request For Comments (RFC) 3775. In IPv6 protocol, each MS is always identified by the home address. While situated away from the home network, a MS is also associated with a Care-of Address (CoA), which provides information about the MS's current location. The protocol enables IPv6 nodes to cache the binding of a MS's home address with its CoA, and then to send any packets destined for the MS directly to it by the CoA. IPv6 protocol offers a solution to solve the IP mobility, but due to intolerable high data lost rate and long handoff latency. Many research works have been developed to improve IPv6 protocol. An improved protocol, called hierarchical mobile IPv6 had been proposed by Internet Engineering Task Force (IETF) Request For Comments (RFC) 4140 (Soliman, et al., 2005), which extends IPv6

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