Chapter 19
Handover Optimization for 4G Wireless Networks

Dongwook Kim
Korea Advanced Institute of Science and Technology, South Korea

Hanjin Lee
Korea Advanced Institute of Science and Technology, South Korea

Hyunsoo Yoon
Korea Advanced Institute of Science and Technology, South Korea

Namgi Kim
Kyonggi University, South Korea

ABSTRACT

The authors present a velocity-based bicasting handover scheme to optimize link layer handover performance for 4G wireless networks. Before presenting their scheme, as related works, they firstly describe general handover protocols which have been proposed in the previous research, in terms of the layers of network protocol stack. Then, they introduce state-of-the-art trends for handover protocols in three representative standardization groups of IEEE 802.16, 3GPP LTE, and 3GPP2. Finally, they present the proposed bicasting handover scheme. Original bicasting handover scheme enables all potential target base stations for a mobile station (MS) which prepares for handover to keep bicasted data, in advance before the MS actually performs handover. This scheme minimizes the packet transmission delay caused by handover, which achieves the seamless connectivity. However, it leads to an aggressive consumption of backhaul network resources. Moreover, if this scheme gets widely adopted for high data rate services and the demand for these services grows, it is expected that the amount of backhaul network resources consumed by the scheme will significantly increase. Therefore, the authors propose a novel bicasting handover scheme which not only minimizes link layer handover delay but also reduces the consumption of backhaul network resources in 4G wireless networks. For the proposed scheme, they exploit the velocity parameter of MS and a novel concept of bicasting threshold is specified for the proposed mobile speed groups. Simulations prove the efficiency of the proposed scheme over the original one in reducing the amount of consumed backhaul network resources without inducing any service quality degradation.

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INTRODUCTION

Fourth-generation (4G) wireless networks aim at supporting further enhancement of mobile user experience through better wireless communication architecture in terms of quantity and quality. Various real-time services requiring high data rates and low delay constraints have been listed out in (Acx et al., 2003) as the main applications for the 4G wireless networks. For example, real-time gaming services and high-quality video conferences require data rates ranging from 1 to 20 Mbps and delay constraints of less than 20 ms. Geographic real-time data-casting services through real-time video streaming demand data rates ranging from 2 to 5 Mbps with 20 ms delay constraint. As well as the real-time services mentioned above, transport control protocol (TCP)-based services which require very high throughput performance will be also mainly supported in the 4G wireless networks. In wireless networks, handover is the mechanism by which an ongoing connection between a mobile station (MS) and a correspondent base station (BS) is transferred from one point of access to the fixed network to another (Pahlavan, Krishnamurthy, & Hatami, 2000). Hence, handover generally occurs due to the movement of MSs and it causes packet transmission delay. All the real-time and TCP-based services are significantly sensitive to this delay. This is because the packet transmission delay can directly impact on delivering real-time packets or indirectly impact on end-to-end TCP throughput requiring a low and stable round trip time. In (mITF, 2005), it is addressed that, in case of intra-system handover, packet transmission delay fluctuations for real-time streams are desired to be 30 ms or less. And in (Ericsson, 2005), it is noted that, for TCP-based services the interruption time by the handover should be below 50 ms in order to achieve robust TCP throughput performance.

By the way, 4G wireless networks will be envisaged as a heterogeneous network where various wireless access technologies are converged, and universal usage and broadband access to users are supported (Liu, Li, Guo, & Dutkiewicz, 2008; Mohanty & Akyildiz, 2006). In the heterogeneous network such as 4G, the type of handover is classified into two categories: horizontal handover and vertical handover. Horizontal handover occurs between different BSs which use the same radio access technology (RAT). On the other hands, vertical handover occurs when an MS performs handover from a system to another one which employs a different RAT. Thus the vertical handover is also referred to as inter-system handover. Even though there is the evident difference between the horizontal and vertical handovers, fundamental handover procedure in these handovers can be usually described in terms of four phases as follows (Verdone & Zanella, 2002). First, measurement of the link quality (e.g., received power, bit error rate (BER), and etc.) is carried out at MS or BS. Second, based on the link quality and/or other parameters such as network load and available resources, MS or BS decides whether handover is needed or not. Various handover decision algorithms such as received signal strength (RSS)-based (Marichamy, Chakrabarti, & Maskara, 2003; Zhang & Holtzman, 1996) and location-based (Itoh, Watanabe, Shih, & Sato, 2002; Juang, Lin, & Lin, 2005; Ozdural & Liu, 2007; Zaidi & Mark, 2004; Zhu & Kwak, 2007) have been proposed in the previous literature and we will introduce these algorithms in Section II. Third, if the handover is necessary, new wireless resources to support the on-going communication with required quality-of-service (QoS) may be selected in the target BS to which the MS desires to move. Finally, if these resources are selected, the handover is performed by means of break-before-make (BBM) procedure or make-before-break (MBB) procedure. The BBM procedure is referred to as hard handover and the MBB procedure is referred to as soft handover. Both the hard and soft handover methods will be introduced in Section II.

Previous research on the issue of minimizing handover delay has been classified into two cat-