Power Saving Mechanisms of IEEE 802.16e: Sleep Mode vs. Idle Mode*

Beomjoon Kim[1,**], Jaesung Park[2], and Yong-Hoon Choi[3]

[1] Department of Electronic Engineering, Keimyung University, Daegu, 704-701, Korea
bkim@kmu.ac.kr
[2] Department of Internet Information Engineering, The University of Suwon, Gyeonggi-do, 445-743, Korea
jaesungpark@suwon.ac.kr
[3] Department of Information and Control Engineering, Kwangwoon University, Seoul, 139-050, Korea
yhchoi@kw.ac.kr

Abstract. IEEE 802.16e standard specifies two mechanisms, sleep mode and idle mode, for the power-efficient operation of a mobile station (MS). Despite the common purpose, these two mechanisms are different in terms of MS's handover and wakening-up process. Recently, each of them is selected as a required feature in the system profile developed by WiMAX forum, which means that they should be implemented in a single MS for the certification. Therefore, the MS supporting the two mechanisms at the same time will require a method to make a better choice considering the situation that it is placed. As the first step toward designing the method, this paper focuses on evaluating the performance of sleep and idle mode in terms of terminal mobility. Analytic results verified by simulations show that idle mode performs better than sleep mode in supporting mobility.

1 Introduction

In IEEE 802.16 Working Group (WG), Task Group (TG) e has recently completed a project to specify a mobile broadband wireless access (BWA) system based on the baseline standard [1] that mainly concerns fixed terminals. The official standard of IEEE 802.16e-2005 [2] has been published in Feb. 2006.

In the mobile systems based on [2] such as Mobile WiMAX [3] and WiBro (Wireless Broadband) of South Korea, a mobile station (MS) will be powered by battery. Therefore, the power-efficient operation of a MS is one of the important factors that will affect the wide deployment of the Mobile WiMAX and WiBro systems. Reflecting the importance, the standard specifies two mechanisms, sleep

* The present research has been conducted by the Bisa Research Grant of Keimyung University in 2006 and the Research Grant of Kwangwoon University in 2006.

** Correspondence to: Beomjoon Kim, Dept. Electronic Engineering, Keimyung University, 1000 Sindang-Dong, Dalseo-Gu, Daegu, 704-701, Korea. Email: bkim@kmu.ac.kr

G. Min et al. (Eds.): ISPA 2006 Ws, LNCS 4331, pp. 332–340, 2006.

mode and idle mode, in order to achieve the low power consumption in a MS. These two modes lead a MS to very similar operation in that the MS is allowed to power down physical operations related to communicating with a base station (BS) and guaranteed delivery of downlink traffic by periodic messaging. However, they have a few substantial differences in MS's performing handover or returning to awake mode for normal operation.

Sleep mode is available only for the current serving BS, which means that if a MS in sleep mode moves away from the current BS's coverage and decides to perform handover, it has to quit sleep mode without any active connection. In fact, it is highly probable for the MS to request another sleep mode initiation after the handover because whether or not there is traffic to or from the MS has nothing to do with the handover. As a consequence, the handover process performed without regard to the existence of active connections may degrade the power saving efficiency of sleep mode due to uplink transmissions and downlink receptions during the handover process.

On the other hand, idle mode is originally designed to provide a seamless operation under the concept of 'paging group.' A paging group is comprised of a number of BSs, and each BS in the paging group may be regarded as identical by a MS in idle mode. It means that a MS can maintain idle mode as long as it stays within the paging group. Even in the case that the MS moves outside the paging group, rather a simple process may cover the change in its location, if secure location update [2] is available.

Despite the unnecessary handover process, sleep mode has an advantage of quick returning to awake mode for normal operation, i.e. without any additional procedures. It is because the MS in sleep mode maintains registered state with its current serving BS so that all the information and parameters needed for resuming communication are still valid. However, idle mode compromises the prompt transition to awake mode because de-registration from the network is forced at the initiation of idle mode. Every time a MS terminates idle mode, therefore, the process called 'network re-entry' should be performed before communicating with the BS where the MS is now attached. During the network re-entry, the MS has to obtain, negotiate, adjust, and update a set of parameters related to physical transmission, capability, and security.

As briefly discussed so far, sleep mode and idle mode have their own merit and demerit; sleep mode is more appropriate for the services that require a quick response like push-to-talk while idle mode is more appropriate for MSs moving fast. Accordingly, the WiMAX Forum has decided to include both sleep and idle mode as required features in the system profile for certification; it means that these two modes will be implemented in a single MS. In such a case, the MS will require a method to determine which mode is better to choose considering the requirements for applications running on it, its mobility, and etc. In order to design the method, the performance of sleep mode and idle mode need to be evaluated and compared in all aspects.

It is very recent that the official IEEE 802.16e standard has been published, so that there are only few works dealing with this issue. Although the work