Chapter 22
Adaptive Power-Saving Mechanism for VoIP Over WiMAX Based on Artificial Neural Network

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ABSTRACT

The IEEE 802.16 system offers power-saving class type II as a power-saving algorithm for real-time services such as voice over internet protocol (VoIP) service. However, it doesn't take into account the silent periods of VoIP conversation. This chapter proposes a power conservation algorithm based on artificial neural network (ANN-VPSM) that can be applied to VoIP service over WiMAX systems. Artificial intelligent model using feed forward neural network with a single hidden layer has been developed to predict the mutual silent period that used to determine the sleep period for power saving class mode in IEEE 802.16. From the implication of the findings, ANN-VPSM reduces the power consumption during VoIP calls with respect to the quality of services (QoS). Experimental results depict the significant advantages of ANN-VPSM in terms of power saving and quality-of-service (QoS). It shows the power consumed in the mobile station can be reduced up to 3.7% with respect to VoIP quality.

INTRODUCTION

Recently, Voice over Internet Protocol (VoIP) has increasingly become a common service for wireless networks such as worldwide interoperability for microwave access (WiMAX). As the VoIP technology offers Mobile WiMAX clients the ability to use voice services with lower expenses compared with Public Switched Telephone Network (PSTN). Skype has earned more and more popularity since it is seen as the best VoIP software (Adami, Callegari, Giordano, Pagano, & Pepe, 2012). For VoIP calls, packets are required to be sent constantly. Considering the real-time nature of voice, the radio cannot easily save

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power. As it is difficult to transition to sleep state while sending inter-packets intervals (Zubair, Fisal, Abazeed, Salihu, & Khan, 2015).

A mobile station (MS) usually depends on a portable power source like batteries. These batteries have limited lifetime. Thus, all wireless systems offer power-saving classes (PSCs), such as in IEEE 802.16e (IEEE, 2006), to save the power consumed in MSs through sleep and active mode (Ghosh, Wolter, Andrews, & Chen, 2005).

Regarding IEEE 802.16e, an MS operates alternately between awake and sleep mode. It wakes up to exchange data with a base station (BS) in a listening period. The sleep mode includes sleep and listening periods. In sleep periods, BS buffers incoming packets to the MS, and BS sends it to the MS when MS switches to listen periods. To fit services and applications properties, three PSCs are offered by the IEEE 802.16e for different types of traffic for the purposes of power saving. Thus, MS can associate the sleep parameters for the suitable PSC when connected to a BS. The sleep parameters comprise the starting of sleep time, initial sleep period, final sleep period and the listen period. Clearly, the parameters of each class should be carefully determined to minimize the power consumed in the MS with restriction to the quality-of-service (QoS) requirements of that connection.

This chapter focuses on power saving in short latency periods included in active time which is sufficient for VoIP services. This chapter considers two states of VoIP conversation: mutual silent state and talk-spurt state. In mutual silent periods, there are not any packets transmitted between MS and BS. Therefore, the sleep period in mutual silence can be increased more than in the talk-spurt period to reduce the power consumption. Hence to increase energy-efficient, it is necessary to design a new algorithm that can place its sleep intervals flexibly in mutual silence periods.

In this chapter, a power conservation algorithm is proposed based on artificial neural network (ANN-VPSM). The proposed algorithm can be applied to VoIP service over WiMAX systems. Artificial Intelligent model using feed forward neural network with a single hidden layer has been developed to predict the mutual silent period that used to determine the sleep period for power saving class mode in IEEE 802.16. Artificial Neural Networks (ANNs) is a simulation of the biological nervous system in the human brain. That network can regulate neurons and learn through experience. The development of ANN using computer programs to identify patterns of data sets using training data through supervised learning. ANNs has a flexible learning system and adaptive ability allow them to learn from linear and non-linear function (Haykin, 2007).

An overview of previous attempts in power saving for VoIP services is addressed in the next section. Then the proposed prediction mechanism is presented. The simulation results of the proposed mechanism with discussion are introduced in experiment and results. Finally, the conclusion is discussed.

BACKGROUND AND RELATED WORK

WiMAX (IEEE 802.16e) introduces three types of PSCs suitable to several applications that produce different traffic characteristics (IEEE, 2006). There are various QoS requirements, for various types of connections between MS and BS. Subsequently, various connections are classified into varied PSCs to achieve their requirements of QoS.

1. **The Power Saving Class Type I (PSC-I):** Starts with initial sleep window (S_{min}), then this sleep window is doubled, if MS doesn't receive any message about the existence of data packets during