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Analysis of Bandwidth Efficiency in IEEE 802.11 and 802.16 Interworking Networks

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ABSTRACT

With the advances in wireless technology during the past years, continued and reliable connectivity has been also ensured through broadband access network. A present day wireless network which provides affordable speed to end user requirements is wireless LAN (IEEE 802.11 standard), which is commercially known as wireless fidelity (Wi-Fi). One of its shortcomings is limited coverage area and thus, there is a need for wireless networks which can provide high speed with maximum coverage. WiMAX overcomes this need for broadband access with a high coverage area. But the installation cost of WiMAX is considerably high as compared to WLAN. So, the interworking of these two networks will ensure high speed broadband access at all times, a considerable coverage area, and reduced cost. However, interworking of these two networks allows the accommodation of the maximum number of subscribers. Bandwidth efficiency provides insight information of how the frequency spectrum is effectively utilized.

KEYWORDS

Bandwidth Efficiency, IEEE 802.11, IEEE 802.16, IP Multicast, VoIP

1. INTRODUCTION

Bandwidth efficiency is the information rate which can be transmitted in available bandwidth. Basically, it's a measure of how effectively limited frequency range (spectrum) is utilized. It is also referred to as spectral or spectrum efficiency. Bandwidth efficiency is measured in terms of bits/s/Hz. It is one of the critical terms for every wireless network. The main objective to measure bandwidth efficiency is determining how effectively the allocated spectrum is utilized and for service provider's point-of-view to accommodate maximum number of subscribers within a limited bandwidth. There are two types of wireless networks taken as cases in the paper which are IEEE 802.11 and IEEE 802.16. The 802.11 is better known as Wireless Local Area Network (WLAN) and 802.16 are officially called as WirelessMAN and its commercial name is WiMAX (Worldwide Interoperability for Microwave Access). IEEE 802.11 is a wireless standard for transmission in frequency bands of 2.4 GHz, 3.6 GHz and 5 GHz. In this standard there are several protocols, namely: 802.11a, 802.11b, 802.11g, and 802.11n.

The IEEE 802.11 a protocol operates in 5 GHz band with data rates of up to 54Mpbs. It utilizes modulation technique of OFDM (Orthogonal Frequency Division Multiplexing). IEEE 802.11b

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operates in 2.4GHz band and has data rate of around 11Mbps. It uses Direct Sequence Spread Spectrum (DSSS) as modulation technique. The 802.11g operates in 2.4GHz band and has data rate of 54Mbps with both modulation techniques i.e., OFDM and DSSS. The 802.11n protocol has 2.4 and 5GHz frequency bands and data rates of up to 150Mbps. 802.11n uses OFDM modulation.

IEEE 802.16 standard was developed for broadband access. It provides data rates of around 1Gbit/s for fixed stations with the update in the standard in 2011. With the higher coverage area and data rates, WiMAX is an ideal choice for many applications. There is no fixed global frequency spectrum for WiMAX; the WiMAX Forum has published three licensed spectrums: 2.3, 2.5 and 3.5GHz. With many positive features and higher coverage area, WiMAX becomes an alternative for cable and DSL (Digital Subscriber Line). Its architecture consists of a base station, which serves large number of clients (called as subscriber station). Its communication is in two modes; point-to-multipoint (PMP) and mesh mode.

Voice over IP (VoIP) is a communication protocol which involves delivery of voice and multimedia sessions over Internet Protocol (IP) networks. It uses Internet Protocol (IP) to transmit voice as IP packets over a network. In this the voice is converted to digital signal, then compressed, then converted to IP packets and at the end it is sent over the network. There are different encoding schemes used by VoIP traffic like G.729, G.711, etc. In this paper we have used G.711, G.729A, G.723.1 (5.3K and 6.3K), G.728 (12.8K and 16K), and G.726 (32K and 40K) encoders for VoIP traffic.

IP multicast is a method of transmitting IP datagrams to a group of receivers. It is employed for streaming multimedia applications on Internet and private networks. Basically, it's a method for one-to-many or many-to-many real time communication in a network. Multicasting is not connection oriented. The IP multicast group is identified by class D address (224.0.0.0 to 239.255.255.255). In this a host can join or leave multicast group dynamically. Each IP datagram sent to a multicast group is transmitted to all members of the group. In this paper we have considered IP multicast application of streaming multimedia.

The aim of this paper is to analyze bandwidth efficiency in the interworking of 802.11 and 802.16 networks with the traffic types of VoIP and IP multicast. Bandwidth efficiency of VoIP is analyzed for different encoding schemes. At the end of article, we will be able compare and choose best encoding scheme for VoIP traffic with higher bandwidth efficiency. And for streaming multimedia applications how IP multicast traffic provides support in 802.11 and 802.16 networks with effective bandwidth usage.

2. RELATED WORK

To accomplish the mentioned aims, literature reviews are done and network scenarios are simulated using OPNET Modeler. The aim of literature review is to clear and build the basic concepts regarding bandwidth efficiency in a network. Moreover, to give an insight to the identified problem mathematical modeling of the bandwidth allocation mechanism in IEEE 802.16 and 802.11 is done, to show how bandwidth is allocated in these networks. After performing simulations with fixed nodes, mobile nodes are introduced and their effects on the network bandwidth performance are analyzed.

Li-Ping et al. (2011) have suggested a flexible and simple reservation scheme for bandwidth at Subscriber Station (SS). This scheme is given the name of MSBR (Multi-stage self-correction bandwidth reservation). The purpose of this scheme is that to make effective use of bandwidth without violating the QoS requirements for real-time traffic. MSBR introduces a new concept which is of Decision Period (DP), to reserve bandwidth and to reduce control overheads. This paper considers the uplink traffic for real-time. In this paper there is no assumption regarding model of resource demand prediction of traffic. The aim of this scheme is to reduce the volume of bandwidth provision with cost of MAC signaling to a minimum possible level, which also reduces the blocking probability of connection. The mismatch of packet arrival and service rates is also taken into account for bandwidth