Bandwidth Allocation in WiMAX Networks using Scheduling Algorithm

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Abstract— An important problem for the WiMAX networks is how to provide a guaranteed quality of service for applications. A key aspect of this problem is how base stations should share bandwidth capacity between different classes of traffic. The decision needs to be made for each incoming packet and is known as the packet scheduling problem. A major challenge in packet scheduling is that the behavior of each traffic class may not be known in advance and can vary dynamically. This paper has described how the packet scheduling problem has been modeled as an application for reinforcement learning. We have demonstrated how our reinforcement learning approach could learn scheduling policies that satisfy the quality of service requirements of multiple traffic classes under a variety of conditions. The proposed solution has been designed to have an ability to accommodate integrated traffic in the networks with effective scheduling schemes. A series of simulation experiments have been carried out to evaluate the performance of the proposed scheduling algorithm. Results revealed that the proposed solution performs effectively to the integrated traffic composed of messages with or without time constraints and achieves proportional fairness among different types of traffic.

Key words: WiMax, Schedule, QoS, Bandwidth Allocation Scheduling

I. INTRODUCTION

WiMax (World Wide Interoperability for Microwave Access) is a telecommunication technology designed to provide effective transmission of data using different modes of transmission like mesh and PMP (Point to multipoint). WiMax is a high performance end to end network protocol. Its features are increased data rate, high performance, fair QoS, highly secured communication of data with less packet delay. There are two main types of WiMax services: mobile and fixed. Mobile WiMax enables users to access internet while travelling whereas fixed WiMax stations provide wireless internet access to clients within a fixed radius. So concept of WiMax is introduced to increase the range of network.

II. WIMAX ARCHITECTURE

The basic WiMax IEEE 802.16 architecture consists of Base Station (BS) and Subscriber Station (SS). BS acts as a central entity to transfer all the data from SS in a PMP mode. Transmissions take place through two independent channels: Downlink channel (from BS to SS) and Uplink channel (from SS to BS). Uplink channel is shared by all SSs while Downlink channel is used by BS. The standard IEEE 802.16 supports four different flow classes of QoS and the MAC layer supports a request-grant mechanism for data transmission in uplink direction. This standard does not define a slot allocation criterion and scheduling architecture for any type of service.

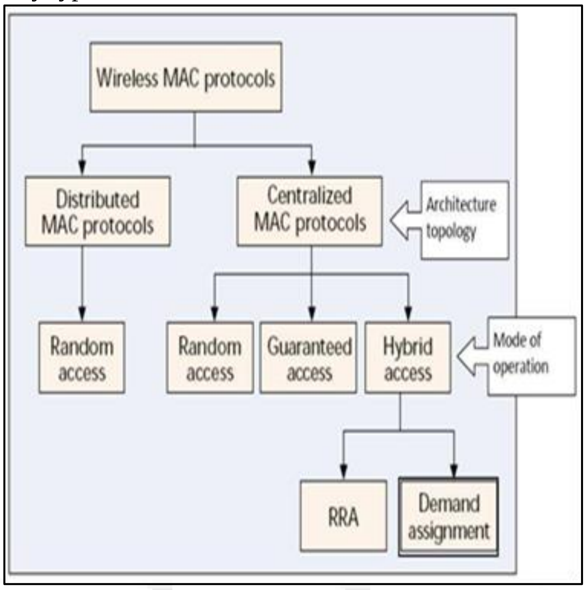

Fig. 1: WiMAX Architecture

A scheduling module is necessary to provide QoS for each class. IEEE 802.16 defines the following four types of service flow with distinct QoS requirements.

These are as follows:

1) Unsolicited Grant Services (UGS) designed to support Constant Bit Rate (CBR) services such as voice applications. Real-Time Polling Services (RTPS): designed to support real-time services that generate variable size data packets, such as MPEG video.
2) Non-Real-Time Polling Services (NRTPS): designed to support non-real-time and delay tolerant services that require variable grant burst type data on a regular basis such as FTP.
3) Extended Real Time Polling Services (ERTPS): designed to support real time applications with variable data rate which require guaranteed data and packet delay.
4) Best Effort (BE): designed to support data streams that do not require any guarantee in QoS.

The network reference model envisions unified network architecture for supporting fixed, nomadic, and mobile deployments. It is based on an IP service model. Below is simplified illustration of an IP - based WiMax network architecture. The overall network is logically divided into three parts- Mobile Stations (MS), Access Service Network (ASN) and Connectivity Service Network (CSN). The network reference model defines a number of functional entities and interfaces between those entities like Base Station (BS), Access Service Network Gateway (ASN-GW), Connectivity Service Network.

A. Scheduling Algorithms

The main focus of this research study is to examine the scheduling schemes in WiMAX network. In order to specify high network performance, an efficient scheduling algorithm is essential as it manages and controls the provision of an efficient level of QoS support. Although many scheduling algorithms have been proposed in the literature for WiMAX network, the design of the algorithms are challenged by having to support different levels of services, fairness and implementation complexity. Many researchers have compared their proposal schemes on different scheduling schemes, but there is no common, simple and standardized packet scheduling to make their comparisons with. In this study, six carefully selected scheduling algorithms in WiMAX wireless network are investigated. These algorithms which are considered the most dominant and popular include Diffserv-Enabled (Diffserv), Round-Robin (RR), Self-Clocked-Fair (SCF), Strict-Priority (SP), Weighted-Fair Queuing (WFQ) and Weighted Round Robin (WRR). Furthermore, these common packet scheduling schemes provides QoS support for real time applications in IEEE 802.16 system.

The mobileWiMAX based on Orthogonal Frequency Division Multiple Access (OFDMA) Physical (PHY) is used to access multiple users simultaneously. It allows sub-channelization in both ULand DL, where sub-channels form the minimum frequency Resource-unit allocated by the BS called slot which is equal to 48 data tones(IEEE 802.16e,Standard2009). The slot allocation depends on the link direction, that is, DL or UL and the sub-channelization mode (Chandrasekaran &Nagarajan, 2014). There two types of sub-carrier permutation for sub-channelization (WiMAX-part M, 2006):

– Diversity permutation
– Contiguous Permutation

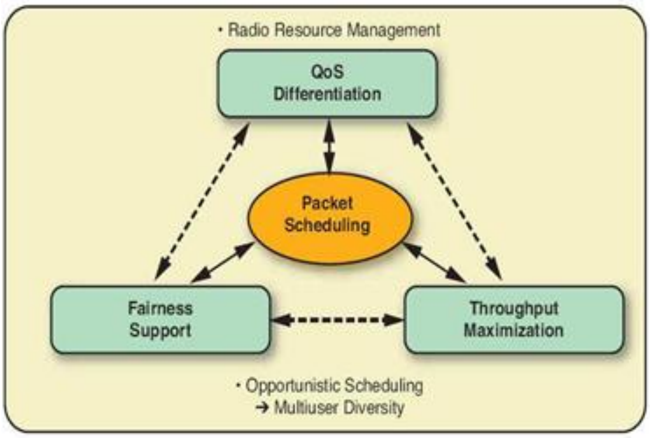

Fig. 2: Resource Management

III. REVIEW OF SCHEDULING ALGORITHMS

This sub-section describes some of the scheduling algorithms used for the maximization of throughput. Scheduling algorithms are mainly responsible for effective use of resource that are available in the network and share them among users in order to ensure the desire quality of service (Nieet al., 2011). However, serving all the users and meet their demand in fair proportion is a real challenge in scheduling. The main-goal of any scheduling algorithm is to maximize the network utilization and achieve fairness among all users (Prasad, 2013). The traditional techniques aim at solving some problems such as providing QoS and distributing the resource among all users fairly. Many of these algorithms were proposed purposely for wired networks. However, they are used in WiMAX networks to satisfy the requirements of scheduling service (Chauhanet al., 2013). Some of the scheduling algorithms are discuss as follows:

1) First InFirst Out (FIFO): This scheduling algorithm is based on a queuing system in which the received packet is served based on the order of arrival. However, it does not take priority or QoS into consideration when packets are queued or dequeued (Dhronaet al., 2008).
2) Round Robin (RR): RR is the plainest scheduling algorithm designed specifically for time distributing systems (Khoeiet al., 2014). It works in a cyclical manner between the existing queues in a time sharing system to avoid starvation on queues with lower priority. It equally designates allocation to all connections one by one. Stations with larger packets experience an uneven advantage with packet- based allocation. However,might not work conserving, the allocation made for connections that may have nothing to transfer; as such RR cannot guarantee QoS for different service classes (Mardini&Alfool, 2011).
3) Earliest deadline first (EDF): The scheduler is developed to serve users of high priority classes in wide area networks. The scheduler allocates bandwidth to all subscriber stations and assigns deadlines to each packet based on maximum delay requirements. The setback of this scheduler is that potentials starvation can occur to subscriber stations with lower class of service since they do not have delay requirements (Nieet al., 2011).
4) Weighted fair queuing (WFQ): This technique is commonly used in uplink traffic in WiMAX networks. WFQ sorts the packets in an increasing order according to its finish time which is computed depending on the size and weight assigned to the packets of the subscriber stations. The main drawback of WFQ is that the start time of the packets is not taken into account (Mardini&Alfool, 2011).
5) Max Rate: Max rate scheduler communicates always to the user having the highest signal to noise ratio, so users that are likely to be scheduled all the time are the users that have the highest fading, while others that experience deep fades are not scheduled at all (Martinez, 2006). Max Rate scheduler yields, higher throughput than anyother possible scheduling policy, however, it totally ignores fairness (Prasad &Kumar, 2013). In wireless environments invariable user‘s channel can be very different, due to different locations from the BS, although both channel fluctuate due to multipath fading (Khamayseh, 2012). So, always selecting the strongest user would be highly unfair.

This sub-section describes some of the optimization techniques for enhancing a system performance. Some of these techniques are:

The algorithm ends when either a maximum number of generations have been produced, that is, a satisfactory fitness level has been reached for the population. The theorem that has stood for a long period as a pivotal result of genetic theory is Schema theorem (McCall, 2005). The theorem made some assumptions by making H to denote a schema, the number of chromosomes belonging to H present in population i of an evolving GA to represent mH(i).

Parameters	Value
Channel bandwidth	10MHz
Frequency band	3.5MHz
DL/UL ratio	35/12
Population size	500
Maximum number of generation	10
Cognitive parameter	1
Constriction factor	1
Number of used subcarriers	720
Number of OFDM symbols	35
Radius of coverage	20km
Number subscriber stations	50
Number of bits per modulation symbol for 7	See Table
layers	3.1
Sampling factor (n)	28/25
Cyclic prefix (G)	1/8
Number of frames	500
FFT size	1024
Duplexing mode	TDD
Link orientation	
Traffic	RTPS
Sub-channelization	PUSC

IV. RESULT

In this paper, we have analyzed the scheduling algorithm bandwidth for Wi-Fi & WiMAX integrated network. For this analysis we have considered two cases. In the first case, a comparison is going on among different scheduling algorithms for specific amount of load in WiFi & WiMAX integrated network From the first analysis we can conclude which will give the best performance for the heterogeneous network. Form Figure 8,10,12 we can conclude that WRR scheduling algorithm gives the best performance for heterogeneous network in terms of maximum throughput, minimum jitter and end to end delay. In second case, for best scheduling algorithm that is WRR, we have analyzed the performance of the network in terms of throughput, end to end delay and average jitter (in Figure 9,11,13) considering four different types of scenarios which are given below. In first case, connections established between users under Wi-Fi coverage with users direct under WiMAX coverage. In second case, connections are established between the users under same Wi-Fi coverage area. In third case connections are established between users under Wi-Fi network to users under another Wi-Fi network. These two Wi-Fi networks are under different WiMAX network. In fourth case connections are established between two mobile Wi-Fi networks under different WiMAX network.

V. CONCLUSIONS

From the above results we can conclude that scheduling algorithm as a model will be able to improve the capacity of a wireless network with efficient utilization of network resources. Through the use of implementation of allacting bandwidth in the priority analysis of simulation we have concluded that WiMax provides best performance for mixed network. We have also verified the performance of the network for various user conditions under Scheduling algorithm. There is a scope to improve performance of the network using the same Wi-Fi access point without accessing the WiMAX base station.

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