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Bandwidth-Aware Stochastic Uplink Scheduling in WIMAX Networks

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Abstract—the bandwidth allocation in the WiMAX networking is the primary process which is utilized for the maximum accommodation of the wireless users. The WiMAX link scheduling plays the significant role in managing the resources efficiently and in serving the internet services to the maximum number of users. In this study, the study of various scheduling strategies in wireless mesh network will be carried out. We will focus mainly on the rtps class as it is the most challenging one. A detailed study of HAS and SADP algorithm will be carried out, analysing its performance for all the service classes. We will then modify the existing algorithm in order to overcome its disadvantages and further improve its performance. The modified algorithm will be implemented in NS2 and simulations will be done. The results obtained from the research will be studied and compared with the previous results and conclusions will be drawn.

Keywords—WiMAX Scheduling, Uplink scheduling, bandwidth allocation, bandwidth adaptation.

I. INTRODUCTION

Wireless means without using wires transmission will takes place using radio wave signals rather than wires. Applications of wireless is very large like, operating TV using remote controller, sharing data files with colleagues outside the premises using enterprise application etc. Characteristics of wireless systems are:

- Mobility: Using wireless systems users can share their data even they are not connected to each other physically. User have the access of their data anywhere around the globe.
- Reachability: sometimes creating a network in rural or remote areas are not possible but by using the wireless systems users are able to connect and share the information.
- Simplicity: the cost of deploying the wireless network is bit higher than wired systems but seeing the broader perspective that can be more affordable than wired networks.

- Maintainability: the cost of maintenance as compared to wired systems is much cheaper than wireless.
- Roaming services: users are able to access the wireless systems while they are roaming.
- New Services: by using the Multimedia Messaging System (MMS) and Short Messaging System (SMS), users are able to transmit the multimedia and text messages through wireless communication systems respectively.

Wireless systems have some flaws too and the three major drawbacks are described below:

- Quality of Service (QoS): QoS being inadequate is one among the first issues of wireless knowledge delivery services. Lost information packets and region interference are some of recurring issues that wireless protocols need to deal with.
- Security Risk: Security has been a serious issue whereas transferring knowledge over a wireless network. Basic network security mechanisms just like the service set identifier (SSID) and Wireless Equivalency Privacy (WEP) is also adequate for residences and little businesses, however they're inadequate for transmission sensitive info.
- Reachable Range: normally, a wireless network offers a variety of about one hundred meters or less. Range may be a function of antenna design and power. At present, the range of wireless is extended to tens of miles to beat scalability problems.

WiMAX networks characteristics are higher bitrates and long range. However, they are inversely proportional i.e. for higher bitrates, WiMAX users must have to be located close to the network and for long ranges, and WiMAX provides lower bitrates. The maximum range of WiMAX is of 50 KM with access of minimum 1Mbps & maximum 75 Mbps bitrates. The spectrum bands used to deploy the WiMAX are 2.3GHz, 2.5GHz, 3.5GHz, and 5.8GHz. WiMAX supports the audio, video and internet data and are able to satisfy the access needs. WiMAX can also provide the broadband connectivity but that could not be fast. Potential applications embrace extending broadband capabilities to bring them nearer to subscribers, filling gaps in cable, DSL and T1 services, wireless fidelity (wife) and cellular backhaul, providing last-mile access, and giving service suppliers another cost-effective possibility for supporting broadband services. WIMAX will support very high bandwidth wherever massive spectrum deployments (i.e. >10 MHz) are desired using existing infrastructure. It keeps prices down while delivering the desired bandwidth to support a full range of high-value transmission services.

The basic IEEE 802.11 architecture consists of one Base Station (BS) and one (or more) Mobile Station (MS). BS acts as a central entity to transfer all the data from MSs in a PMP (Point to Multipoint) mode. Transmissions take place through two independent channels: Uplink Channel (from BS to MS) and Uplink Channel (from MS to BS). Uplink Channel is shared between all MSs While Uplink Channel is used only by BS. The standard defines both Time Division Duplexing (TDD) and Frequency Division Duplexing (FDD) for channel allocation. The IEEE 802.11 is connection oriented. Each packet has to be associated with a connection at MAC level. This provides a way for bandwidth request, association of Quality of Service (QoS) and other traffic parameters and data transfer related actions. The standard supports five different flow classes for QoS and the MAC supports a request-grant mechanism for data transmission in uplink direction. The standard does not define a slot allocation criterion or scheduling architecture for any type of service. It is necessary to provide a scheduling module.

Five types of service flows with distinct QoS requirements:

- Unsolicited Grant Services (UGS): are basically designed to support the Constant Bit Rate (CBR) services like voice applications.
- Real-Time Polling Services (rtPS): are designed to support the real-time services that generate variable size packets periodically which are sensitive to delay like MPEG video
- Extended Real-Time Polling Services (ertPS): are designed to support the real-time applications with variable data-rates, which require guaranteed to delivery data and control delay, e.g. VoIP with silence suppression.
- Non-Real-Time Polling Services (nrtPS): are designed to support the non-real-time and the delay tolerant services which require variable size data grant burst types periodically such as FTP.
- Best Effort (BE): are designed to support the data streams that don't need any guarantee like HTTP.

I. LITERARTURE SURVEY

Chih-Yung chang et. al. [1] has proposed the model for the improvement of the scheduling within the WIMAX environments. This paper proposes an optimum scheduling model known as the scheduling algorithm with dynamic programming approach (SADP), that exploits the opportunities of spatial reuse and maximizes the network output supported the network topology and therefore the uplink bandwidth requests

of each subscriber station. Additionally, a heuristic scheduling algorithm (HSA) is proposed to reduce the computing complexity. The performance results were approximate to the optimum results. The simulation study reveals that the proposed SADP provides the WMN with peak throughput and shortest transmission time, and therefore the proposed HSA possible achieves the optimum results. Prasun Chowdhury, Iti Saha Misra [10] proposes a good and efficient QoS scheduling model for IEEE 802.11 BWA systems that satisfies throughput and delay guarantee to numerous real and non-real time applications. The proposed model QoS scheduling algorithm is compared with an existing QoS scheduling model proposed in literature in recent past. Mahmoud Ahmad Albawaleez, Kamaruzzaman Seman, Kamarudin Saadan [2] proposes a Priority control Scheme (PCS) to supply higher QoS for real time delay sensitive packets in uplink channel. This can be done by classifying the service flow priority of the packets in 2 types that are time delay sensitive and non-time delay sensitive. The performance from the proposed PCS is compared with the WIMAX classification service flow priority. The simulation results by using the OPNET show that the proposed model outperforms the existing model by having less delay. Mahommad Hayajneh, Najah Abu Ali, and Issa Khalil [3] proposes an opportunistic and optimized scheduler that meets connections QoS needs whereas it pledges fairness among admitted connections. This approach involves separating the scheduling model into 2 sub-problems. Within the 1st sub-problem, that addresses interclass time-slots allocation, the proposed scheduler calculates the optimum range of time-slots in each time frame corresponding to the service categories with the target of minimizing the obstruction probability of every category. the second sub-problem, the intra-class slot allocation drawback, time slots for every category are allotted using an integrated cross-layer priority functions (PFs) that give proportional fairness among a category connections. R. Nandhini and N. Devarajan [4] proposed a scheduling model that is capable to reinforce the performance of WIMAX networks. The target of the broadband wireless technologies is to make sure the end to end Quality of Service (QoS) for service classes. WIMAX may be a revolution in wireless networks that may support real time multimedia system services. In order to supply QoS support and efficient usage of system resources an intelligent scheduling algorithm is required. The planning of detailed algorithm may be a major focus for researchers and service providers. In this, a channel aware cross-layer scheduling model for wireless networks has been planned. Sandhya Kulkarni, Shwetha D. Devaraju, J. T. D. Das [5] proposes a scheduling algorithm for SS. The scheduling a part of the IEEE 802.11 (WIMAX) standards is kept as an open issue to supply differentiation among instrument manufacturers and operators. The uplink scheduling is extremely important and more complicated compared to the downlink scheduling, that is the primary reason that this thesis project is based upon the uplink scheduling for the WiMAX networks. Uplink scheduling is split into 2 parts; one is scheduling the resources among several users from a base station (BS) and the another is sharing the resources among its services in an exceedingly single user. Marcio Andrey Teixeira and Paulo Roberto Guardieiro [6] proposed a replacement and efficient scheduling model for uplink traffic in IEEE 802.11e networks. The proposed algorithm uses a novel deadline-based model defined for real-time applications and uses a cross-layer approach. The deadline calculations are designed using the {information the knowledge the data} regarding the MCSs within the physical layer and therefore the information regarding the BW-REQ messages sent by the sss to the bs. Moreover, the algorithm interacts with the polling mechanisms of bs to manage the periodicity of sending unicast polling to the rtPS and nrtPS categories. The behavior of the proposed system was analyzed and compared with the EDF scheduling in an environment where numerous MCSs were used and in an environment where only 1 MCS was used. The simulation results reveal that the proposed system is efficient in both environments, primarily in environments with many burst profiles. This algorithm also interacts with the polling mechanism, adapting the polling interval and guarantying the minimal bandwidth to the real-time and non-real-time applications. P.S.Kumaresh, Ms.M.S.Vinodini, Dr.A.V.RamPrasad [7] proposes a dynamic uplink scheduling system for WIMAX networks. There has been a rapid climb of new services like on-line video games, video conferences and multimedia system services to end users. WIMAX is a rising technology for next generation wireless networks that supports a large variety of users. To attain Quality of Service (QoS) needs, an economical and reliable scheduling system is required. Among a large variety of the proposed systems approaches within the literature, a Variably Weighted round Robin scheduling algorithm (VWRR) has been tried to produce the best performance in an IP backbone network with no attempts on WIMAX networks. They proposes dynamic uplink scheduling algorithm for WIMAX networks supported VWRR to allocate the bandwidth to users to maximise the output and make sure the constraints of delay, jitter, and load.

II. FINDINGS OF LITERATURE REVIEW

The existing system focused on the improvement of performance of scheduling techniques on WiMAX but proposed model focused on dynamic approaches to improve the scheduling to reduce the delay during user handovers. To implement the proposed model a heuristic model has been designed for multiple user scheduling. For packets flows over a shared link, there are number of algorithms are proposed like Fluid Fair Queuing (FFQ), WFQ, SCFQ, WF2Q etc. in wireless networks. To make these algorithms mode scalable to real-time applications, some modifications are made in them because of the location dependent and burst channel errors faced by the wireless networks.

IEEE 802.11 uses the three different scheduling processes for BS & MS where two at the BS and one at the M performed. In BS, packets classifies from uplink channel are put into queues according to theie service flow types. After classification, by going through the set of protocol, queue to be served in next DL-Sub frame is decided. The parameters could be the QoS or channel condition etc. researchers are more likely to focus on the UL and DL schedulers at the Base Station according to the past studies. For WiMAX, choosing an appropriate scheduling model is an open issue for the researchers.

III. METHODOLOGY

The IEEE 802.16 defines the MAC and PHY layers, the QoS classes and the QoS parameters requirement but the scheduling algorithm is left as an open issue to be implemented by vendors and operators. Scheduler is the main component at the MAC layer that impacts significantly on the performance by increasing throughput, decreasing delay and enhancing QoS. Although, it helps to providing service guarantee to heterogeneous classes of traffic where there is variety in QoS requirements. In general, scheduler needs to be simple, efficient, fast, and scalable and have low computational complexity. Actually, the scheduler works as radio resources allocator among the active connections. The allocated resources could be defined as the number of slots and these slots mapped into sub channels and symbols. The slot size depends on the sub channelization modes. In IEEE 802.16, there are three distinct scheduling processes: two at the BS and one at MS. In the BS the classifier classifies packets from upper layer (Uplink Data) and put into different queues for the incorporation of the uplink queues, which are entirely based on service flow types. Then based on some criteria such as (QoS parameters, channel condition) the Uplink scheduler (UL-BS) decides which queue to be served in the next DL-Sub frame and the number of SDUs to be transmitted. Many research proposals have been conducted for WiMAX scheduling and most of these proposals give special attention for UL and DL schedulers at the BS. The choice of scheduling algorithm for WiMAX is an open issue for vendors and many scheduling algorithms are presented in literature. So in this research, study of various scheduling strategies in WiMAX will be carried out. We will focus mainly on the rtps class as it is the most challenging one. A detailed study of mSIR algorithm will be carried out, analyzing its performance for all the service classes. We will then modify the existing algorithm in order to overcome its disadvantages and further improve its performance. The modified algorithm will be implemented in NS2 and simulations will be done. The results obtained from the research will be studied and compared with the previous results and conclusions will be drawn.

IV. CONCLUSION

The bandwidth allocation methods play the most important role in the allocation of the available channels across the WiMAX networks. The bandwidth allocation is usually performed on the basis of dynamic usage tracking and user resource requirement analysis. The bandwidth allocation is very important for the users while performing the uplink scheduling. The uplink is scheduled between the users and the BTS while the users transmit the data towards the base stations. The uplink scheduling in the proposed model will be performed on the basis of adaptive channel allocation by allocating the required number of bandwidth to each user. The unequal band allocation requires the multiple bandwidth parameters tracking across the users sharing the same uplink. The proposed model will be compared on the basis of performance parameters of throughput, delay and uplink overhead.

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