Uplink and Downlink Scheduling in WiMAX Networks

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Abstract:- In past few years WiMAX(Worldwide Interoperability for Microwave Access) technology has become one of the most emerging wireless technology that provide us high speed mobile data and various telecommunication services. It provided different types of services such as data, voice and video and also guarantees the Quality of Service (QoS) at the MAC layer level. Scheduling in WiMAX become one of the most challenging issues which is the main component at the MAC layer since it is responsible for distributing all available resources of the network among different users. So it demand of designing and constructing high efficient scheduling algorithm in order to enhance the network performance by increasing throughput, decreasing delay and enhancing QoS. Many research proposals have been conducted for WiMAX scheduling and most of these proposals give attention for UL (Uplink) and Dl (Downlink) schedulers at the BS (Base Station). In this paper we have proposed a maximum Signal-to-Interference ratio (mSIR) algorithm with modification in order to enhance its performance, focusing on real time polling services (rpts) as well as non real time polling services (nrtps) class. We have implemented the mSIR algorithm and analyze the result by compare them with the previous results.

Keywords:- *IEEE 802.16, WiMAX, MAC, QoS,Uplink Schedulers, Downlink Schedulers, rtps, nrtps, mSIR.*

I. INTRODUCTION

Worldwide Interoperability for Microwave Access (WiMAX) [1] is the latest trend of broadband wireless technologies that is expected to deliver economic data access services to home and corporate users. WiMAX offers an alternative to standardized wired technologies such as Cable Modems, DSL, and T1/E1 links. WiMAX can also provide wide area coverage and QoS capabilities for applications that are ranging from real-time delay sensitive Voice over IP (VoIP) to real-time streaming video and non-real-time downloads. It can also support very high bandwidth where large spectrum deployments (i.e. >10 MHz) are desired using existing infrastructure. It keeps cost down while delivering the required bandwidth to support a full range of high value multimedia services.

II. WIMAX DATA LINKS

A. UPLINK

In context of satellite communications, the communication going from a ground to satellite is known as an uplink (UL or U/L) i.e.the uplink is thecommunication link that used for the transmission of signals from an Earth terminal to a satellite. In context to Global System for Mobile communications (GSM) and cellular networks, it uses the radio uplink is the transmission medium where communication occurs between the mobile stations (cell phone) to a base station (cell site). In context to computer networks, an UL is aupstream connection which connect data communication equipment toward the network core.

B. DOWNLINK

In context of satellite communications, the communication going from a satellite to a ground station is known as downlink (DL or D/L). In context to cellular networks, the radio downlink is the transmission from a cell site or base station to cell phone or mobile station. In context to computer networks, a downstream connection DL is a connection from data communication equipment towards data terminal.

III. SCHEDULING IN WIMAX

Scheduling is an important component of WiMAX network that affect its performance. WiMAX has two modes of operation namely point-to-multipoint and mesh mode.Although IEEE 802.16 standards give us different types of services and applications having various QoS requirements, the problem of scheduling algorithm for both PMP and mesh mode are left unsolved and left as an open research issue.

- *Scheduling in PMP mode*

In Point-to-multipoint (PMP) mode, there is one the BaseStation (BS) and multiple Subscriber Station (SS). In this BS is responsible for scheduling decision for Subscriber Station i.e. communication between different Subscriber Station takes place only through BaseStation. Each frame is assigned a subscriber in a certain time slot with scheduling decision made on a frame by frame basis. A scheduling decision in WiMAX should satisfy the QoS requirements for each requesting service. The basic Architecture of PMP mode is shown in figure below. Scheduler to be defined in this mode is an uplink and downlink scheduler for the BaseStation and only an uplink scheduler for SS.

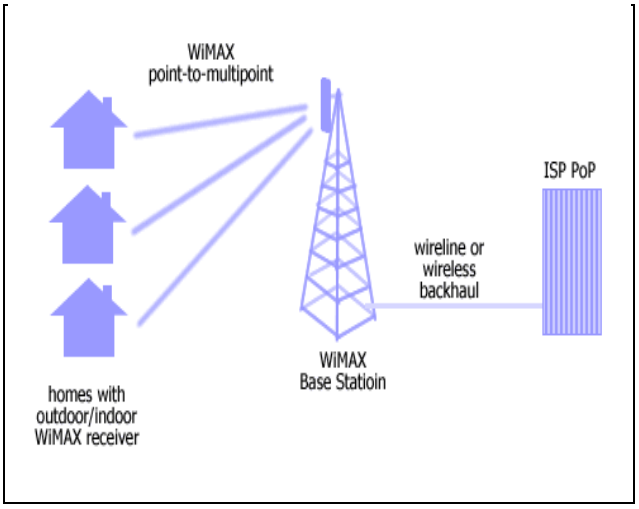

Fig 1:- PMP Architecture

- *Scheduling for mesh mode*

In Mesh mode SS able to communicate among themselves which means every node may be treated as BS and a central node which connected to outside world considered as mesh BS. In WiMAX mesh frame consists of two main sub frames, one dedicated for carrying control information and the other is for carrying data. The control sub frame carries information about the connections establishment, maintenance and scheduling of data transmission between different SS's. Only some nodes in the mesh network can be used to connect the mesh network to the backhaul links in the same fashion as BS do. Scheduling in mesh mode is built over scheduling trees that is rooted at the BS. Basic architecture of mesh mode is shown in figure.

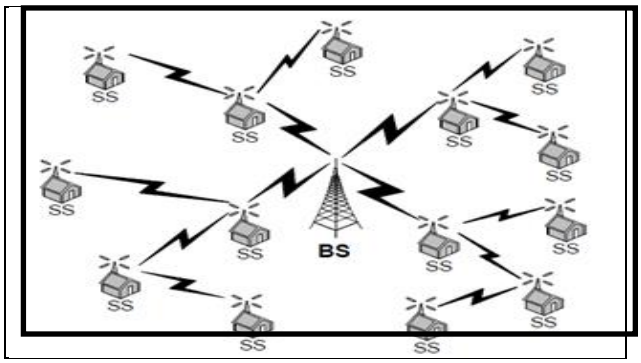

Fig 2:- Mesh Architecture

IV. TYPES OF SERVICE FLOWS WITH DISTINCT QOS REQUIREMENTS

- *Unsolicited Grant Services (UGS):* designed to support constant bit rate (CBR) services like voice applications.
- *Real-Time Polling Services (rtPS):* designed to support real-time services that generate variable size data packets on a period basis, such as MPEG video, but is sensitive to delay.
- *Extended Real-Time Polling Services (ertPS):* support real-time applications with variable data rates, which require guaranteed data and delay, e.g. VoIP with silence suppression.
- *Non Real-Time Polling Services(nrtPS):* designed to support non real-time and delay tolerant services that require variable size data grant burst types on a regular basis such as FTP.
- *Best Effort (BE):* designed to support data streams that do not require any guarantee in QoS such as HTTP.

V. PROPOSED TECHNIQUE AND IMPLEMENTATION

In the proposed work, the first step is to load the topology i.e. WiMAX. The WiMAX networks are designed to provide the high bandwidth connectivity to the users in the long-range connectivity.

Further, the no. of channels is defined and numbers of slots are defined. The maximum numbers of channels that can be considered are 5 and sub channels are 2. The simulation connections are 2 and bandwidth considered is 50. After receiving the request from user the numbers of channels filled are calculated. Finally the bandwidth is sliced using the formula explained below. At last, default time slot is assigned and the sink between node intervals are created.

VI. ALGORITHM

- Load the topology details.
- Start the simulation topology.
- Define the no. of channels (N_C).
- Define the no. of slots per channel (N_{C_S}).
- When received the request from user, check the no. of filled per used channels (N).
  $N = N_C \times N_{C_S}$
- If $N_A < N_C$ (where N_A is no. of assigned channels), register the user with maximum possible bandwidth for each channel.
- If $N_A > N_{C_S}$ && $N_A < N$, check and calculate channel ID,
  $K = N - N_A$
  $K_N = N_C - K$,

  Where K is the no. of available channels and K_N is the channel ID.
- Check the no. of user on K_N i.e. U_N.
- If $U_N >= N_{C_S}$, channel is busy, shift to new channel.
  $K_N = K_N + 1$
- If $U_N < N_{C_S}$, identify the existing user on K_N.
- Slice their bandwidth by following formula
  $BW_C = {BW}/{(U_N + 1)}$
- Assign the channel and bandwidth information with the new node.
- Assign default time slot and create the sink between node intervals.

VII. SIMULATION AND RESULT

The proposed scheme is implemented in NS-2.34 simulator in Linux environment. We have modified ns-2.34 by adding mac802.16-e layer to it for supporting WiMAX.

Input / Output Parameter	Value
Number of channels	5
Number of user nodes	20
Connectivity Mechanisms	WiMAX
Wireless Standard	802.16
Bandwidth	50

Table 1. List of key simulation Parameters

A. Transmission Delay (End-to-End Delay): The transmission delay has been obtained as the parameter from the proposed and existing models. Once the traffic gets stable, the transmission delay remains at the 0.2 seconds for the proposed mode and 0.4 seconds for the existing model.

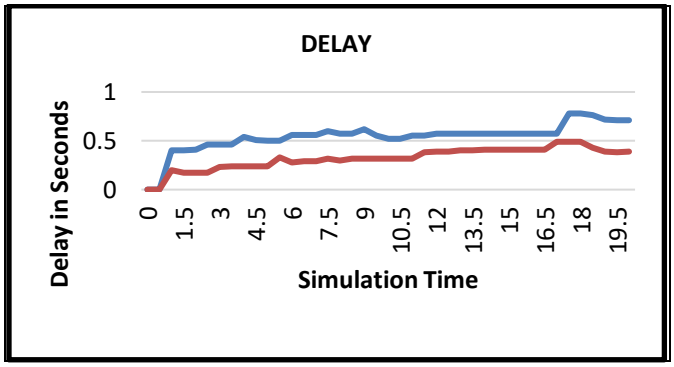

Fig 3:- The transmission delay between the proposed model and existing model

B. Packet Loss (Data Loss): The packet loss is the parameters which indicate the loss of packets during the transmission between the network nodes. The existing model has been found way higher than the proposed model. The proposed model recorded 82% less packet loss as compared to existing model.

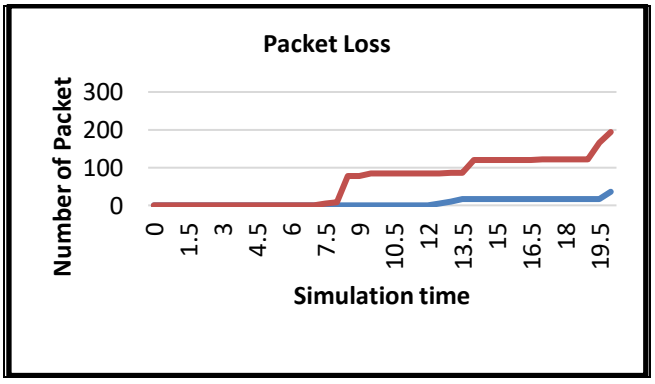

Fig 4:-The packet loss recorded between the proposed model and existing model

C. Throughput: Throughput is the parameters indicate the successfully processed or transferred data between all of the nodes within the network. Throughput is the parameters indicate the successfully processed or transferred data between all of the nodes within the network.

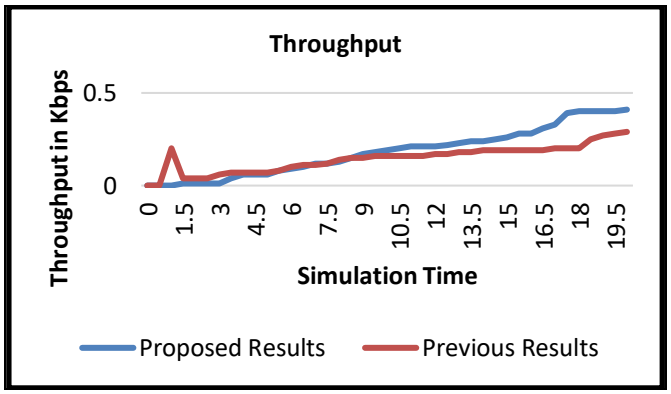

Fig 5:- The throughput recorded between the proposed model and existing model

D. Packet delivery ratio: Packet delivery ratio is the number of packets delivered out of total number of packets sent from sender to receiver. The proposed model has been recorded with the maximum packet delivery ratio at 80 percent and 30 percent for the existing model.

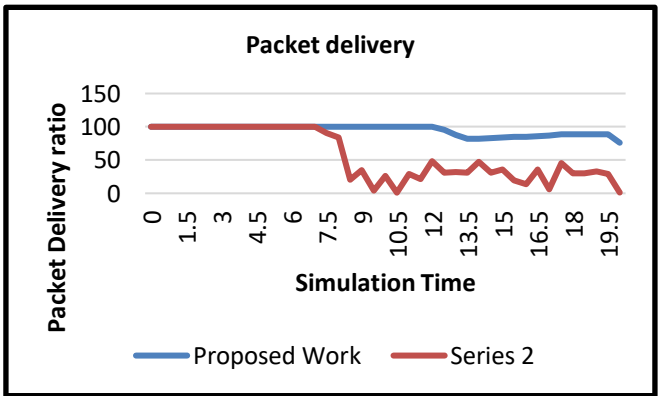

Fig 6:- Packet delivery ratio between the proposed model and existing model

E. Network Load: Network load is the total number of packet that are being sent from the sender side to the receiver side. The total number of packets that exists on the network comes under network load. They may be received, lost, delayed. The network load is the parameter to find the data per time interval on each node for processing.

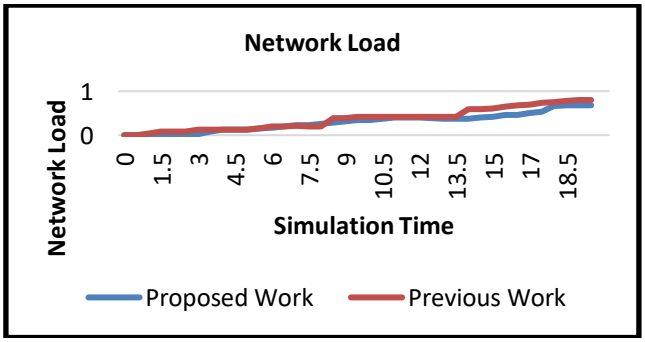

Fig 7:- Load between the proposed model and existing model

VIII. CONCLUSION

The WiMAX networks are the alternatives to the Wi-Fi networks and are popular for the high speed network connectivity in many forms of networks. To validate the proposed algorithm a WiMAX simulation platform based on NS2 has been implemented. In the proposed work, resource scheduling is done, where both bandwidth and time based channel sharing is applied. The aim is to facilitate the higher no. of users on the BTS using the permitted channels. The channel sharing model is procured between multiple nodes in same cluster. Two or more than two users can be facilitated on the same channel. The users are scheduled to share the bandwidth in case of less no. of user per channel, e.g. two users per channel. The user share the time slot when there are more than eligible healthy user on single channel in order to account the complete benefit of available bandwidth with adding the little delay in the communication. The bandwidth slicing is done which is based on queues attached to egress ports. The user (controller) is able to setup and configure queues and then map flows to a specific queue. The queue configuration dictates how a packet will be treated. Finally, the simulation results have verified that our proposed scheduling algorithm is capable to enhance the performance of WiMAX networks by 24% as compared to the previous results.

Currently we proposed a model having 20 users and 5 channels with bandwidth sharing as well as time slot channel sharing showing the effectiveness. In the future work, more no. of users will be considered to share data within the same channel at the same time simultaneously.

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