A SIMULATOR FOR WiMAX NETWORKS

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base station(BS)
subscriber stations (SSs)

The present paper aims at presenting the process of designing the simulation model of 802.16 Networks and Investigation of Bandwidth Request Mechanisms under Point-to-Multipoint Mode.

In response to BWA need, the IEEE 802 committee set up a working group to develop such standard- IEEE 802.16. Later, an industrial association, the Worldwide Interoperability for Microwave Access (WiMAX) Forum, was formed to promote the 802.16 standard.

WiMAX specifies interoperable air interfaces from 2 to 66 GHz with a common medium access control – MAC layer (fig.1).

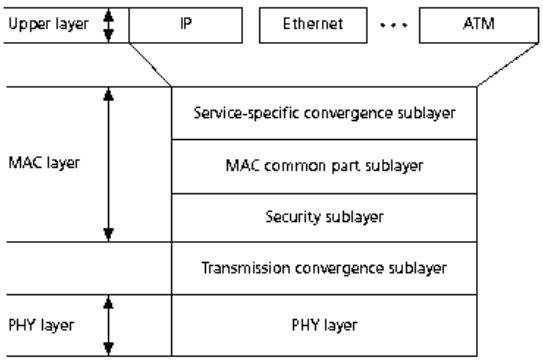

Fig. 1

The 802.16 WiMAX air interface supports two operational modes: a mandatory point to multipoint- PMP mode and an optional mesh mode. In PMP mode, a centralized BS controls all communications among the SSs and the BS, whereas in the mesh mode, SSs can also serve as routers by cooperative access control in a distributed manner.

WIMAX ANDBW-REQ MECHANISMS

Under the PMP architecture, all transmissions between the BS and SSs are coordinated by the BS. The TDMA/TDD frame structure is illustrated in Fig. 2; it consists of a downlink subframe for transmission from the BS to SSs and an uplink subframe for transmissions in the reverse direction. The Tx/Rx transition gap (TTG) and the Rx/Tx transition gap (RTG) are specified between the downlink and uplink subframes, and between the uplink and following downlink subframes in the next frame duration to allow SS terminals to turn around from reception to transmission and vice versa. In the downlink subframe, both the downlink MAP (DL-MAP) and uplink MAP (UL-MAP) messages are transmitted, which comprise the bandwidth allocations for data transmission in both downlink and uplink directions, respectively.

Moreover, the lengths of uplink and downlink subframes are determined dynamically by the BS and are broadcast to the SSs through UL-MAP and DL-MAP messages at the beginning of

each frame. Therefore, each SS knows when and how long to receive data from and transmit data to BS The bandwidth allocated to each direction can be tuned dynamically to match the traffic in the corresponding direction.This means that if an SS needs some amount of bandwidth, it makes a reservation with the BS by sending a request. On accepting the request from an SS, the BS scheduler should determine and grant it a transmission opportunity in time slots by using some scheduling algorithms, which should take into account the requirements from all authorized SSs and the available channel resources.

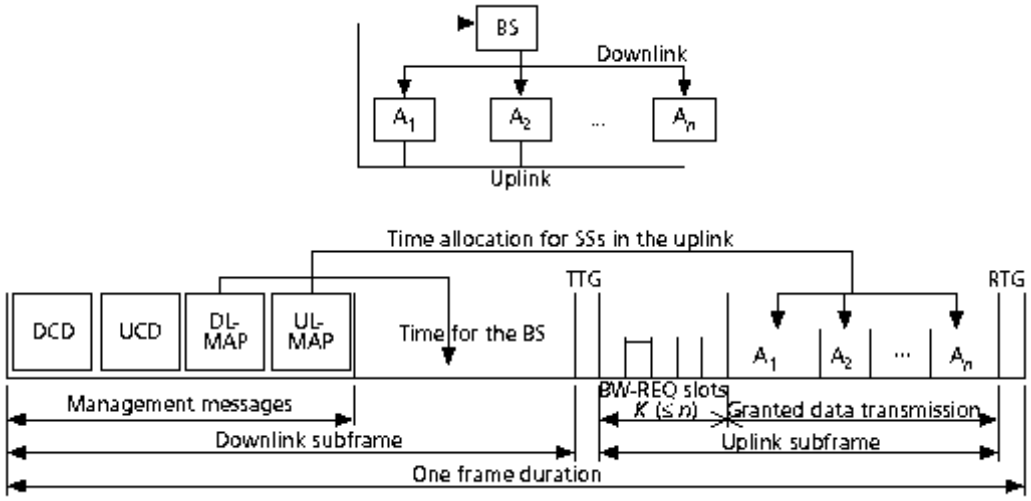

Fig. 2

Two main methods are suggested in the WiMAX standard to offer transmission opportunities for SSs to send their bandwidth request (BW-REQ) messages: centralized polling and contention-based random access. In the first case each SS station is only allowed to send its request when it is polled by the BS.

MODELING POLLING-BASED BW-REQ MECHANISMS

No specific polling algorithms are defined in the standard. The following simple round-robin polling scheme is considered for the analysis: Each of K slots is assigned equally to all of the n stations in the system. In most cases, n is larger than K.

If K>n, the system will be very lightly loaded, and there are more slots than the total number of SSs in the system. All the SSs will be able to send BW-REQs within a frame. The Maximum delay can be easily determined, i.e., one frame duration.

The Q-scheme includes N queues, which is serviced by one server, and a synchronizing process switching between polling and vacation periods. Compared to model described here, the Contention-Free Period (CFP) and Contention Period (CP) correspond to the polling period and vacation period, respectively. The ON-OFF model is assumed to be the source for each of the N queues.

On MAC layer is developing the following processes: The queues filled with a continuous bit stream when the source is in the ON state; The synchronizing process schedules transmission opportunities among all queues during polling periods; A vacation can occur at arbitrary points within a polling cycle, even it can occur multiple times within one polling cycle.

The initial conditions for wireless network are given bellow:

- Number of sources- N;
- Superframe length -Ts;
- Minimum fraction allocated to vacation period- θ;
- Maximum vacation stretch- VSmax ;
- Parameters for CP stretch;
- SS rate;
- Service rate.

The modelling process aims at getting the following results, when preliminaries given at hand simulation conditions are available: Maximum and average time for delay from the access (the time from coming of BW-REQs till their transmitting).

PERFORMANCE ANALYSIS OF BW-REQ MECHANISMS

In this section we investigate the polling BW-REQ mechanism, by using the proposed model above under error-free channel condition. For the WiMAX PHY layer, 256- carrier OFDM and 5 MHz bandwidth are chosen. The frame duration is set to 2.5 ms. In the following plots the arrival rates {1/1000, 1/500, 1/250, 1/167, 1/125} are chosen and axe is denoted by □□

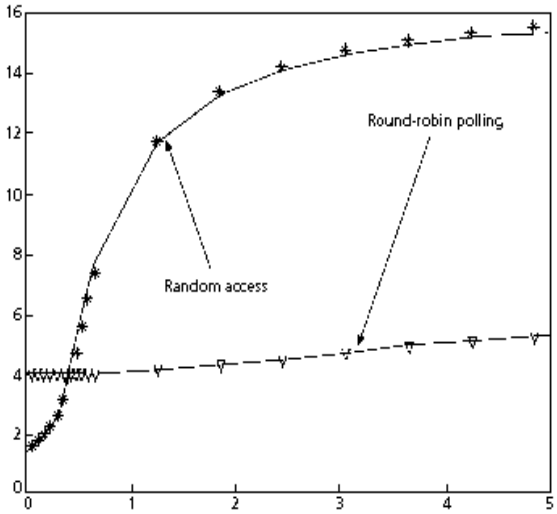

Fig. 3