An Alternative QoS Architecture for the IEEE 802.16 Standard*

Luís Felipe M. de Moraes and Paulo Ditarso Maciel Jr.
High-Speed Networks Laboratory - RAVEL
Systems Engineering and Computer Science Program - COPPE/UFRJ
Tel/Fax: +55 21 2562-7844 - Rio de Janeiro - RJ, Brasil
{moraes,paulo}@ravel.ufrj.br

ABSTRACT

In this paper, we propose an alternative QoS architecture for the IEEE 802.16 Standard, that incorporates a priority based packet scheduling and a new traffic shaping. For this, we present the ideas of a traffic conditioner based on concept of "Fair Marker".

Categories and Subject Descriptors

C.2.1 [**Network Architecture and Design**]: Wireless communication

General Terms

Wireless Communications and Quality-of-Service

Keywords

Wireless Communications, IEEE 802.16 Networks, Quality-of-Service (QoS)

1. INTRODUCTION

The IEEE 802.16 Standard [4] is a technology proposed to offer wireless access to network stations in a metropolitan area environment. These networks are designed to operate at high data rates and to deal with several applications, resulting in different types of traffic profiles and demands. Therefore, the system is required to work with various types of real-time and non-real-time service classes, with different traffic characteristics and quality of service (QoS) guarantees. As part of its specifications, such a system must properly address the combined requirements of wireless communications and multimedia applications.

The IEEE 802.16 Standard specifies the PHY and MAC layers for Broadband Wireless Access (BWA) systems. These systems appeared as a solution for broadband access through wireless network, and can be seen as an alternative to traditional technologies such as DSL and Cable systems. However, the standard does not define a complete architecture to QoS support. For instance, does not describe neither an uplink scheduling traffic mechanism, nor a call admission control, to treat different types and loads of traffic.

This paper propose an alternative traffic shaping for the IEEE 802.16 Standard. More precisely, a structure that incorporates mechanisms to provide packet scheduling and traffic shaping to different traffic flows in the network. The proposed architecture use a scheduling mechanism based on message and/or station priorities described in [2, 3], and a traffic conditioner based on concept of "Fair Marker" [5].

2. MOTIVATION

BWA systems have been developed to transmit data and multimedia services with distinct quality-of-service (QoS) requirements. However, as can be seen in Figure 1 [4], the IEEE 802.16 Standard does not define a complete QoS architecture. It is not defined in the standard: (i) how to schedule different types of traffic in the uplink channel, (ii) a traffic shaping mechanism, and (iii) a call admission control.

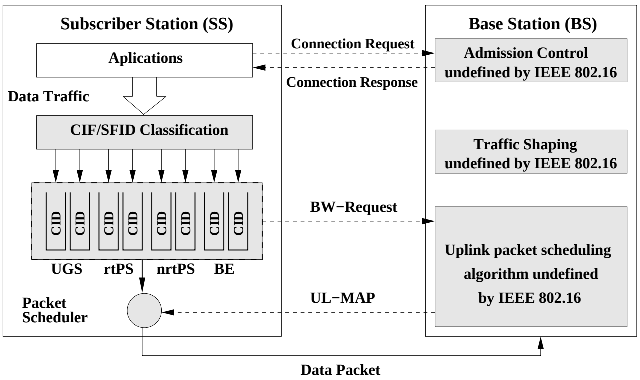

Figure 1: QoS architecture of IEEE 802.16.

In [2, 3], we have proposed a new access scheme that incorporates a scheduling mechanism based on message and/or station priorities, as an alternative MAC protocol to the IEEE 802.16 Standard. Firstly, it was used a fixed priority approach [2] to service differentiation among terminals. Following, an extension was presented in [2], by assigning variable priorities to the network stations sharing access to the communication channel. An analytical model to evaluate the performance of the protocols are also developed, and

*This work was supported by FINEP, through project grant number 1956/04.

CoNext '06 Lisboa, Portugal

results obtained for the messages waiting times from distinct traffic classes at different stations are presented. From the results, we concluded that the proposed protocols are able to differentiate traffic classes and improve channel utilization among the stations in the network. However, a rigid admission control mechanism and a traffic shaping are necessary so that the heavy traffic of a specific class does not overload (and hog) the channel, affecting the response time of the others.

3. PROPOSED ARCHITECTURE

As mentioned in Section 2, the QoS architecture found in the 802.16 Standard lacks components to truly provide QoS requirements to different types of traffic demands. The proposed architecture exposed here, include the priority based access scheme proposed in [2, 3], as a solution for packet scheduling module. Moreover, use a traffic shaping algorithm based on concept of Fair Marker [5] to enforce fairness among distinct flows. It is important to explain that FM was proposed to Internet Diffserv architecture with its most commom protocols (IP, TCP, UDP, etc). Here, we are using the ideas of FM to address traffic shaping of aggregated traffic in the wireless channel of 802.16 networks.

A Fair Marker (FM) was proposed to be used as a component in a Differentiated Services traffic conditioner. It controls token distribution from the token bucket to the flows originating from the same subscriber network, in order to apply fairness among them. Different fair token allocation algorithms may be used by a FM. Figure 2 illustrates the block diagram of FM.

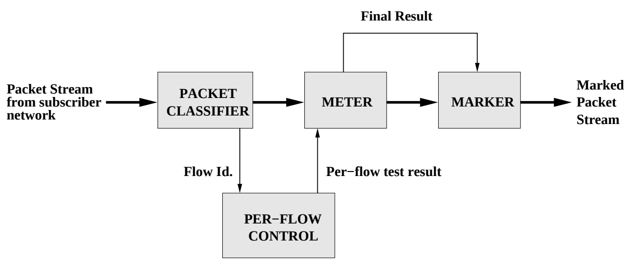

Figure 2: A Fair Marker (FM)

The METER component is configured by assigning values to two traffic parameters: a Profile Rate (PR) and a Burst Length (BL). The PR is measured in bytes per second of MAC frames. The BL is measured in bytes and it must be configured to be greater than 0.

The PER-FLOW CONTROL is configured by installing one or more Flow Identifiers of monitored flows, a packet count variable, and a fair allocation algorithm. The packet count variables are initialized to zero and the fair allocation algorithm may have its own configurable parameters.

At the beginning (time 0), the token bucket is initially full, $T(0) = BL$. The token count T is incremented by one PR times per second up to BL. When a frame with B bytes arrives at time t, the PACKET CLASSIFIER extracts the Flow Identifier from the frame, and feeds the PER-FLOW CONTROL with it and the frame size. The fair allocation algorithm in PER-FLOW CONTROL check if the flow is using disproportionate amount of tokens compared with other flows. The Final Result is calculated by the following rule at the METER:

Algorithm 1 Final Result Algorithm at the METER

```
1: if T(t) − B ≥ 0 and PER-FLOW CONTROL returns
   in-profile then
2:   the frame ins in profile and T is decremented by B
3: else
4:   the packet is out-of-profile
5: end if
```

The FM explores the duality between packet queuing and token bucket utilization. Fairness in token distribution is a function of the fair allocation algorithm used by FM. In order to reach this purpose, it records information regarding the consumption of tokens by the monitored flows.

In our architecture, we are using the fair allocation algorithm proposed in [1], that uses a modified version of *Random Early Detection* (RED) algorithm, called *Flow Random Early Drop* (FRED).

4. FINAL REMARKS AND FUTURE WORKS

For obtaining fairness among aggregated flows, we present an alternative QoS architecture composed by a packet scheduling scheme, and a traffic shaping structure. This structure can be seen as a second step (started in [2, 3]) to a complete QoS architecture for the IEEE 802.16 Standard.

Currently, we are carrying on a performance evaluation of the proposed architecture. More specifically, we are validating the proposed architecture through simulations. Moreover, we are evaluating the behavior of the scheduling scheme with traffic models more suitable to represent multimedia applications.

As future work, we planned to extend the FRED algorithm, in the sense of to get a more “adaptive” fair marker. In a second time, we intend to include in the proposed architecture a call admission control mechanism.

5. REFERENCES

[1] I. Alves, J. de Rezende, and L. de Moraes. Evaluating fairness in aggregated traffic marking. In *Proc. of IEEE GLOBECOM*, 2000.

[2] L. F. M. de Moraes and P. D. Maciel Jr. Analysis and Evaluation of a New MAC Protocol for Broadband Wireless Access. In *IEEE WirelessCom 2005*, Maui, Hawaii - USA, June 2005.

[3] L. F. M. de Moraes and P. D. Maciel Jr. A Variable Priorities MAC Protocol for Broadband Wireless Access with Improved Channel Utilization Among Stations. In *VI IEEE/SBrT ITS2006*, Fortaleza, CE - Brasil, Sept. 2006.

[4] IEEE 802.16-2004. IEEE Standard for local and Metropolitan Area Networks - Part 16: Air Interface for Fixed Broadband Wireless Access Systems, Oct. 2004.

[5] H. Kim. A Fair Marker. *Internet draft, draft-kim-fairmarker-diffserv-00.txt*, April 1999.