Call Admission Control, Packet Level QOS in 4G broad band Wireless Access System with CDMA

[1]M.Annam, [2]Mr.M.Ramasubramanian
[1, 2]Department of Computer Science and Engineering, Vinayaka Missions University
Aarupadai Veedu Institute of Technology, Rajiv Gandhi Salai, (OMR), Paiyanoor-603104
Kancheepuram District, Tamilnadu, India

Abstract:

Consider the problem of scheduling data in the down link of a cellular network over parallel time-varying channels, while providing quality of service (QoS) guarantees to multiple users in the network. I design simple and efficient admission control, resource allocation, and scheduling algorithms for guaranteeing requested QoS. Here propose a novel down link scheduling scheme for QoS provisioning in BWASs.The proposed scheme employs practical economic models through the use of novel utility and opportunity cost functions to simultaneously satisfy the diverse QoS requirements of mobile users and maximize the revenues of network operators. The proposed scheme is general and can support multiple QoS classes with users having different QoS and traffic demands. To demonstrate its generality, I show how the utility function can be used to support three different types of traffic, namely best effort traffic, traffic with maximum data rate requirements, and traffic with minimum packet delay requirements. Extensive performance analysis is carried out to show the effectiveness and strengths of the proposed packet scheduling scheme. High speed Downlink Packet Access System and 802.16 broadband wireless access systems will enhance the multimedia applications that have support of different QoS requirements. The scheduling decision in applicable in code domains as well.

I. INTRODUCTION

EMERGING Broadband Wireless Access Systems (BWASs), such as High-Speed Downlink Packet Access (HSDPA) [1] and 802.16 broadband wireless access system (WiMAX) [2], pose a myriad of new opportunities for leveraging the support of a wide range of multimedia applications with diverse Quality of Service (QoS) requirements. This is due to the high data rates that are supported by these systems, which were previously only available to wireline users. Despite the support for high data rates, satisfying the diverse QoS of users while maximizing the revenues of network operators is still one of the major design issues in these systems. Therefore, QoS provisioning is crucial for the success of BWASs. QoS provisioning in BWASs is a challenging problem due to the diverse QoS requirements of the applications that these systems support and the utilization of downlink-shared channels for data delivery instead of dedicated ones. QoS provisioning in BWASs can be done at three different levels, as shown in Fig. 1. Whereas, class-level QoS provisioning deals with the aggregate demand of admitted users. The functionality of packet-level QoS provisioning is, therefore, equivalent to the functionality of packet scheduling in BWASs. Throughout this paper, packet-level QoS provisioning will be refereed as packet scheduling. Packet scheduling is one of the most important components of BWASs that affects system capacity, revenue, and potential QoS provided to users. This paper focuses on downlink packet scheduling.

II. SYSTEM MODEL

We consider a BWAS consisting of a downlink time-slotted channel, as shown in Fig. 2. Transmission is one in time frames of fixed or variable size duration, where each$ frame consists of a number of time slots. We assume that the base station serves N users. We also assume that there are K classes of traffic, where class i has higher priority than class i þ 1. Let Ni denote the number of class i users and N ¼ PK i¼1 Ni. The base station then would use this information to select the appropriate user(s)

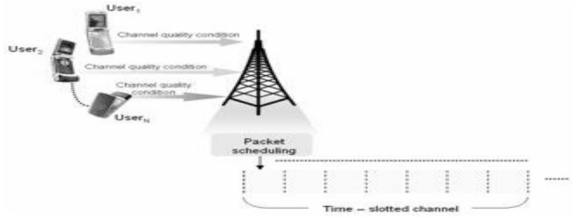


Fig. Packet Scheduling

According to the adopted scheduling scheme. For example, in HSDPA, users are able to measure their current channel quality conditions by measuring the power of the received signal from the base station and then using a set of models described in to determine their current supportable data rate.

III. FAIR CLASS-BASED PACKET SCHEDULING SCHEME

In this section, we present our proposed packet scheduling scheme,1 which we refer to as Fair Class-Based Packet Scheduling (FCBPS). We first begin by outlining the general formulation of the scheduling problem. Then, we state the conditions that the utility function should satisfy and propose a possible utility function that meets the stated conditions. The satisfaction of user j of class i at time t as perceived by the network operator can be expressed by a utility function Uij({Xijz(t)}mij z=1 ={X1ij(t),X2ij(t),….,xijmij(t)} where xij1(t),…,xijmij-1(t) are chosen QoS quantitative measures of the user's satisfactions of the wireless system such as the average throughput, current data rate, average delay, etc., Xijmij(t) is a fairness measure that represents the level of fairness of the scheduling scheme to the traffic generated by user j, z = 1, 2, . . .,mij is an index that refers to any of the QoS measures, and mij is the maximum number of chosen quantitative measures for user j. The main objective of our packet scheduling scheme is to find a subset of users (N*) to transmit their packets to in order to maximize social welfare, which is the summation of user utilities.

$$\begin{aligned}
&\text{Objective:}\ \max_{(i,j)\in\mathbf{N}^*,\mathbf{N}^*\subseteq\mathbf{N}} \sum_{i=1}^{K}\sum_{j=1}^{N_i} U_{ij}\left(\{\mathbf{X}_{ij}^{z}(t)\}_{z=1}^{m_{ij}}\right)\\
&\text{Subject to:}\ \nu_{ij}^{z,\min} \le X_{ij}^{z}(t) \le \nu_{ij}^{z,\max},\ \ \forall j\in \mathrm{N},\ \ \forall z,\ 1\le z\le m_{ij},\\
&\qquad\left(\sum_{(i,j)\in\mathbf{N}^*} R_{ij}(t)\right) \le C,\\
&\qquad OC_{\mathbf{N}^*}(t) \le H,
\end{aligned}$$

where (N*) ⊆ N is the set of users (represented by the tuple(i, j), where i is the class index and j is the user's index within the class) that are selected to transmit to, N is the set of the total number of users in the system, the first constraint is used to ensure lower and upper bounds on QoS provided to users (e.g., minimum and maximum datarate) $\boldsymbol{\nu}_{ij}^{z,\min} \in \{\boldsymbol{\nu}_{ij}^{z,\min}\}_{z=1}^{m_{ij}}$ and $\nu_{ij}^{z,\max} \in \{\boldsymbol{\nu}_{ij}^{z,\max}\}_{z=1}^{m_{ij}}$ are predefined values for the lower and upper bounds corresponding to the zth QoS measure for user j (i.e., Xzij(t)), respectively, Rij(t) is the current supportable data rate of user j at time t, which depends on his channel quality condition, C is the system capacity, OCN* (t) is a cost function representing the cost of serving the selected users at time t (i.e., the users in set N*), and H is a predefined value. We consider the opportunity cost as our cost function. The concept of opportunity cost can be used to manage the trade-off between fairness and revenue. This is because fairness may force the scheduler to serve low-revenue-generating users resulting in revenue loss to the network operator. Therefore, OCN*(t) is used to bound this revenue loss. We define
OCN*(t) as follows. Let

- pij: price per bit for user j of class i.
- $\{\mathbf{Rv}^{g}\}_{g=1}^{N} = \{Rv_{ij}^{1}, Rv_{ij}^{2}, \ldots, Rv_{ij}^{N} \,|\, Rv_{ij}^{g} \ge Rv_{ij}^{g+1}\}$

  , where $Rv_{ij}^{g} = p_{ij}\cdot R_{ij}(t)$ is the revenue that the network operator will earn from user j given that this user is served in the current time frame. That is, the set $\{\mathbf{Rv}^{g}\}_{g=1}^{N}$ contains all users in descending order of the revenue that the network operator will earn from each one of them provided that they are served in the current time frame.

$$\begin{aligned}
\mathrm{Re}\ v_{Max} = \textstyle\sum_{g\in\{\mathbf{Rv}^{g}\}_{g=1}^{N}} Rv^{g},\ \text{given that}&\\
\left(\sum_{(i,\,j)\in\{\mathbf{Rv}^{g}\}_{g=1}^{N}} R_{ij}(t)\right) \le C.&
\end{aligned}$$

Re vMax is the maximum obtainable revenue in the current time frame (i.e., the maximum revenue the network operator can generate in the current time frame). Re vMax is obtained by calculating the revenues of all users that could send in the current time frame (i.e., without exceeding the system capacity) and that if served, they will generate the maximum revenue to the network operator.
Therefore, OCN*(t) is defined as follows:

$$OC_{\mathbf{N}^*}(t) = \mathrm{Re}\ v_{Max} - \sum_{(i,j)\in\mathbf{N}^*} p_{ij}\cdot R_{ij}(t).$$

That is, the opportunity cost is a measure of how much revenue the network operator would forego if the users in set N* are selected for transmission given that there are higher revenue-generating users (i.e., the users that generate Re vMax). The network operator can determine the appropriate level of opportunity cost of fairness by choosing the value of H, and hence, the appropriate level of fairness revenue. only the highest revenue-generating users are scheduled to transmit. On the other hand, if H = Re vMax,then the opportunity cost is ignored. In this case, all users are considered for transmission.

IV. SIMULATION AND TRAFFIC MODELS

We consider a single-cell scenario The base station is located at the center of the cell. The cell radius is 1 km and the base station’s transmission power is 38 dBm. To demonstrate the ability of our scheme to support different QoS with users having different QoS requirements, we assume three different QoS classes with four different types of traffic namely VoIP (class 1), audio streaming (class 2), video streaming (class 2), and FTP (class 3). In addition, to demonstrate the ability of our scheme to prioritize different QoS classes (i.e., interclass prioritization), we assume that class 1 has the highest priority and class 3 has the lowest priority. Moreover, we assume that audio streaming has a higher priority than video streaming in order to demonstrate the ability of our scheme to prioritize traffic with different QoS within the same class (i.e., intraclass prioritization).To achieve such prioritizations, we choose appropriate values for ai, P1 ij, P2 ej, P2 rj, and P2 dj according to their role in the utility function. Furthermore, for demonstration purpose, we assume that pij = 6; 4; 2, and 1 units of money for VoIP, audio streaming, video streaming, and FTP users, respectively. For VoIP traffic, we adopt the model, which assumes Adaptive MultiRate (AMR) codec. In this model, packets are generated using a negative exponentially distributed ON-OFF traffic source to simulate the talk and silence spurts, where the mean duration of both ON and OFF periods is 3 s. the voice quality rating rapidly deteriorates. About 80-150 ms remain for the base station processing and connection reception when the delay induced by the voice encoder/decoder and other components in the system is subtracted. Therefore, we set the maximum delay threshold for VoIP traffic to a value between 80 and 150 ms, specifically 100 ms. Audio streaming is modeled using AMR codec with a minimum rate of 12 Kbps, maximum rate of 64 Kbps, maximum packet delay of 150 ms, and a packet size uniformly distributed between 244 and 488 bits. These values are chosen from within the range of specific QoS requirements defined by WCDMA in order to provide adequate service to mobile users. Video streaming is modeled with a minimum data rate of 64 Kbps, a maximum data rate of 384 Kbps, and a packet size uniformly distributed between 1,200 and 2,400 bit. FTP traffic is simulated by a maximum rate of 128 Kbps and a fixed packet size of 1,200 bits. Call durations of VoIP and video streaming users are modeled by an exponential distribution with a mean value of 30 s. In addition, a feedback delay of three time frames is considered in reporting the instantaneous channel quality conditions of users. Call arrivals are modeled as a Poisson process. The simulation time step is one time frame, which is 2 ms in HSDPA, and the simulation time is 400 s.

V. CHANNEL MODEL

The channel model describes the attenuation of the radio signal on its way from the base station to the user, and therefore, it describes how the channel condition of the user changes with time depending on the user’s environment and speed. In our simulation, we adopt the channel model used, which consists of five parts: distance loss, shadowing, multipath fading, intracell interference, and intercell interference.

VI. SIMULATION RESULTS

To provide QoS guarantees (e.g., minimum data rates or maximum packet delays), the scheduling scheme must be supported by a call admission control in order to block users when there is not enough capacity to support such guarantees. In this paper, we focus on packet scheduling in order to show its performance independently from call admission control. We, therefore, do not consider the case of guaranteed QoS in our experiments. In addition, since existing packet scheduling schemes cannot effectively support different types of traffic with different QoS requirements at the same time, we, therefore, distinguish between two cases. In the first case, all users in the system belong to one traffic type only (i.e., VoIP, audio streaming, video streaming, or FTP). For video streaming and FTP, we compare the performance of our scheme with that of the CIR, PF. In this case, the total arrival rate to the system is equally divided between the three QoS classes.

The following performance metrics are used:

Average packet delay: average amount of time the packet spends in the queue at the base station in addition to the transmission time (delay of discarded packets is not counted). (i.e., intraclass fairness). Let ij be the performance metric for user j, where ij is set to the user’s average packet delay for VoIP and it is set to the user’s average throughput for video streaming and FTP, then the JFI is calculated as follows:

$$JFI = \frac{\left(\sum_{z=1}^{N_{ij}} \psi_{ij}\right)^2}{N_{ij}\sum_{z=1}^{N_{ij}} (\psi_{ij})^2}, \quad \psi_{ij} \geq 0 \quad \forall j,$$

where Nij is the number of users of class i who request the same QoS. Note that if all users that request the same QoS get the same ij, then JFI = 1. Lower JFI values indicate that users have high variances in their achieved QoS, which reveals unfairness in distributing the wireless resources among them according to this scheme.

Fig. The Jain Fairness Index of FCBPS with different revenue loss

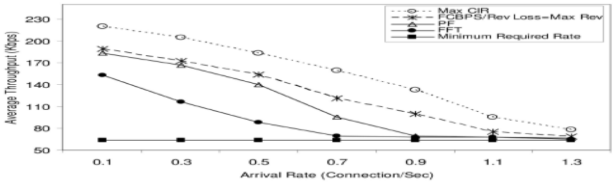
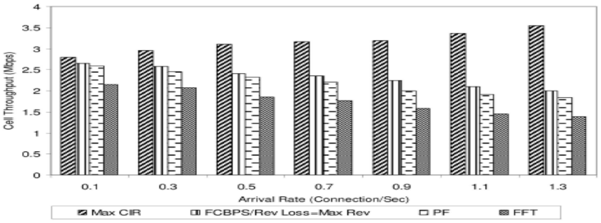


Fig. Percentage of Channel Utilization (Video Streaming)



VII. CONCLUSION

The emergence of High-Speed Downlink Packet Access System (HSDPA) and 802.16 broadband wireless access system (WiMAX) will enhance the support of existing applications and will enable the development of a wide range of heterogeneous "content rich" multimedia applications that have different QoS requirements. However, to accommodate as many users as possible while maintaining the quality of their service, these systems require very robust QoS provisioning techniques. A key component of QoS provisioning is packet scheduling. Packet scheduling will play a very important role in broadband wireless access systems since these systems are characterized by high-speed downlink-shared channels to support the increasing number of mobile data users. In this paper, we propose a novel fair class-based downlink packet scheduling scheme for broadband wireless access systems. The proposed scheduling scheme utilizes utility and opportunity cost functions to simultaneously satisfy the QoS requirements of users and minimize the revenue loss of network operators. Unlike existing schemes, the proposed scheduling scheme is designed to support multiple QoS classes, where users within the same QoS class can have different QoS requirements for call level QoS. The scheme, however, is optimized in time domain only.

REFERENCES

[1] 3GPP TS 25.308, High Speed Downlink Packet Access (HSDPA); Overall Description, Release 5, Mar. 2003.
[2] IEEE 802.16 Working Group, IEEE 802.16-2005e Standard for Local and Metropolitan Area Networks: Air Interface for Fixed Broadband Wireless Access Systems—Amendment for Physical and Medium Access Control Layers for Combined Fixed and Mobile Operation in Licensed Bands, IEEE, Dec. 2005.
[3] H. Jiang, W. Zhuang, X. Shen, and Q. Bi, "Quality-of-Service Provisioning and Efficient Resource Utilization in CDMA Cellular Communications," IEEE J. Selected Areas in Comm., vol. 24, no. 1, pp. 4-15, Jan. 2006.
[4] S. Borst, "Connection-Level Performance of Channel-Aware Scheduling Algorithms in Wireless Data Networks," Proc. IEEE INFOCOM, vol. 1, pp. 321-331, Mar. 2003.
[5] A. Jalali, R. Padovani, and R. Pankaj, "Data Throughput of CDMA-HDR a High Efficiency-High Date Rate Personal Communication Wireless System," Proc. IEEE Vehicular Technology Conf. (VTC '00), pp. 1854-1858, May 2000.
[6] T. Bonald, "A Score-Based Opportunistic Scheduler for Fading Radio Channels," Proc. European Wireless Conf. (EW '02), pp. 2244- 2248, Sept. 2002.
[7] G. Barriac and J. Holtzman, "Introducing Delay Sensitivity into the Proportional Fair Algorithm for CDMA Downlink Scheduling," Proc. IEEE Seventh Int'l Symp. Spread Spectrum Techniques and Applications, vol. 3, pp. 652-656, 2002.
[8] B. Al-Manthari, N. Nasser, and H. Hassanein, "Packet Scheduling in 3.5 G High Speed Downlink Packet Access Networks: Breadth and Depth," IEEE Networks Magazine, vol. 21, no. 1, pp. 41-46, Feb.2007.
[9] B. Al-Manthari, N.A. Ali, N. Nasser, and H. Hassanein, "A Generic Centralized Downlink Scheduler for Next Generation Wireless Cellular Networks," Proc. IEEE Int'l Conf. Comm. (ICC '07), pp. 4566-4572, June 2007.
[10] M. Andrews, K. Kumaran, K. Ramanan, A. Stolyar, R. Vijayakumar, and P. Whiting, "Providing Quality of Service over a Shared Wireless Link," IEEE Comm. Magazine, vol. 39, no. 2, pp. 150-154, Feb. 2001.
[11] M. Andrews, K. Kumaran, K. Ramanan, A. Stolyar, R. Vijayakumar, and P. Whiting, "CDMA Data QoS Scheduling on the Forward Link with Variable Channel Conditions," technical report, Bell Labs, Apr. 2000.
[12] A. Golaup, O. Holland, and A. Aghvami, "A Packet Scheduling Algorithm Supporting Multimedia Traffic over the HSDPA Link Based on Early Delay Notification," Proc. Int'l Conf. Multimedia Services Access Networks (MSAN '05), pp. 78-82, June 2005.