PERFORMANCE ANALYSIS OF WIRELESS DIFFERENTIATED
INTERNET SERVICE IN IMT-2000 SYSTEM

Jee-young Song and Dong-Ho Cho

Department of Electrical Engineering
Korea Advanced Institute of Science and Technology (KAIST)
373-1 Kusong-Dong, Yusong-Gu, Taejon, Korea.
PH: +82-42-869-8067, FAX: +82-42-867-0550
e-mail: jysong@comis.kaist.ac.kr, dhcho@ee.kaist.ac.kr

Abstract - In the case of the current best-effort service, all packets are treated as in the same class. Whatever the incoming packet is, packets are stored in a buffer and served in incoming order. The Differentiated Service (diffserv) schemes were proposed by [1]–[3], but those schemes were just limited for the price differentiation in current Internet service. In this paper, two diffserv schemes such as premium service and assured service are applied to Internet service of IMT-2000 system. Instead of the price paid by service users, the quality of service (QoS) characteristics of each traffic are used for the service level classifier in those schemes. Extended models of these service schemes are described and analyzed in the consideration of wireless voice/data integrated packet networks. Then we can draw conclusions that one of these schemes, assured service, makes the blocking probability and the delay of packets decrease and the other scheme, premium service, guarantees QoS of voice packets at the cost of QoS of delay packets.

I. INTRODUCTION

Nowadays, the directions of developments and researches about communication services are focused on the integration of various services with broadband multimedia services. To support those kinds of services and to extend the concept of quality of service in wireless networks, IMT-2000 systems are suggested and developed. And wireless Internet is forecasted to be one of the most important services of IMT-2000 network. Because of the increase of types of media and the number of subscribers in the field of wireless Internet, the shortage of wireless channel is the one of problems must be solved. Also it is needed that the network providers offer adequate grades of services for various types of traffic with difference QoS levels.

In these past few years there have been major researches for supporting the single class best-effort service for the variety of QoS guarantees. Most related works are just limited to current Internet services and homogeneous data packet networks. Differentiated service (diffserv) are schemes using a single-bit priority field in IP packets have recently been proposed as a low-cost way to augment the single class best effort service model of the current Internet to include some kind of service discrimination. [4] And it is very simply applied to current Internet service since they do not require changes in host, end-users and IP protocol except adding of simple monitoring and scheduling algorithm. Up to now, the priority means "paying more", not different QoS level. Based on these diffserv schemes, instead of users' payment, we adopt characteristics of each traffic as a QoS level classifier. In this paper it means that the packets for voice applications and those for data cases such as WWW, FTP and e-mail services are treated differently. We classify traffic into two classes, the real-time and the non real-time. Those characteristics used for packet classifying and two extended models, premium service and assured service models, are described and analyzed as follows.

In section II, the proposed systems are described and blocking probability of each packet is explained as a performance measure in section III. Numerical results are shown in section IV and finally conclusions are made in section V.

II. SYSTEM DESCRIPTION

In this paper, analytic extended models of two service schemes such as premium service and assured service are described and analyzed in the consideration of the wireless voice/data integrated packet network. In
current best-effort service, all packets are equally treated. Whatever the packet is, incoming packet waits in the queue or is blocked if queue has been filled with packets already. Packets in the queue are served under the FIFO policy. In premium service, a base station has two priority queues. Data packets such as the e-mail or FTP traffic enter into the best-effort queue. On the other hand, voice packets just like voice or video enter into the differentiated service queue. When voice queue is full, voice packets are stored in the best-effort queue or dropped, according to the traffic management policy. In this paper, no special buffer management scheme applied; when the queue is full, packets are discarded. Data packets are served only when the differentiated queue is empty.

At the base station, if congestion occurs or channel capacity decreases, the traffic that is tagged as "out" is dropped preferentially. In assured service, the packets of all the types are aggregated into one queue. Server has two buffer occupancy thresholds for each traffic, voice and data packets, and if buffer is occupied over threshold $K_h$ arriving data packets are dropped. Similarly, if buffer occupancy is over threshold $K_v$, then packets are not accepted any more. (See RED (random early detection) and RIO (random in and out) algorithm in [5])

Following state diagrams (Fig.1 ~ 3) show the acts of the packets in the queue. Two number in the circle means the number of packets in the queue and the first one represents the number of voice packets in the queue, the second one represents the number of data packets.

For proposed services based on Premium and Assured service, Poisson process is used for voice/data traffic model. ([6], [7]) The system has limited number of channels and buffer capacity. All another parameters and environment are succeeded from IMT-2000 service environment.

Figure 1: The state diagram for best-effort service

Figure 2: The state diagram for assured service

Figure 3: The state diagram for premium service

III. PERFORMANCE ANALYSIS

QoS measures can be applied successfully to classify packets sent or received on the network. Blocking probability is the packets’ dropping rate where the queue is filled. Packets’ average delay is the average waiting time in the queue. Generally average delay is increased under the low blocking probability packet arriving and decreased under the high blocking rate.
Those situations can be fully explained with blocking probability and Little’s Law [8], so in this paper numerical results about average delay are omitted. Referring to state diagrams in previous section, blocking probabilities are calculated as follows. In the best-effort service scheme, the number of packets in the queue is over the buffer capacity $K$, then arriving packets are dropped and probabilities of states representing those situations are summed as blocking probability. Blocking probabilities of another schemes are computed in similar manner as following equations.

1. $$Pb = \sum_{i+j=K} P_{i,j}$$
2. $$Pbv = \sum_{j=Kv}^{Kd} \sum_{i=0}^{Kd} P_{i,j}, \quad Pbd = \sum_{i=Kd}^{Kv} \sum_{j=0}^{Kv} P_{i,j}$$
3. $$Pbv = \sum_{j=Kv}^{Kd} \sum_{i=0}^{Kd} P_{i,j}, \quad Pbd = \sum_{i=Kd}^{Kv} \sum_{j=0}^{Kv} P_{i,j}$$

IV. NUMERICAL RESULT

Some numerical results have been generated as shown in Figure 4-8. It can be seen that the blocking rate of the voice packets given higher priority decreases in proposed two schemes. (Fig. 5, 7) In premium service scheme, blocking rate of voice packets is improved at the cost of blocking rate of data packets. But interestingly, in assured service scheme blocking rate of data packets even decreases.

In the premium service scheme, average delay of packet is increased about 15.38% in the case of data packets, and decreased about 3.73% in the case of voice packets compared to the current best-effort service scheme. In the assured service scheme, average delays of data and voice packets are decreased as 79.74% and 9.25% compared to best-effort service respectively.

V. CONCLUSION

In this paper, we analyzed current Internet service scheme and two extended differentiated service schemes in wireless environment. Two schemes are first proposed for supporting different pricing class but in this paper those basic idea to differentiated input flows are extended to classify packets as their characteristics and to sure the QoSs. By analytic results it can be seen that two extended schemes guarantee QoS of packets. In the assured service scheme, blocking probability and average delay of both voice and data packets are decreased. And in the other scheme, premium service, QoS of voice packets are improved at the cost of blocking probability of data packets. Blocking probability of data packets in premium service decreases since many data packets are blocked then the number of data packets staying in the queue are decreased.
Figure 6: Blocking probability of voice packets in premium service

Figure 7: Blocking probability of data packets in assured service

Figure 8: Blocking probability of data packets in premium service

REFERENCES

(7) TIA TR 45.5, the cdma2000 ITU-R RTT Candidate Submission, May 1998.
(8) Kleinrock, L., Queueing Systems, Vol 1., 1976