A Dynamic Priority-based QoS Control Scheme for Wireless Mobile Networks

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Abstract

In this paper, a dynamic priority-based QoS (DPQoS) provision scheme is proposed for the required QoS from one end of the network to the other in wireless mobile networks. The DPQoS model is used to meet diversity multimedia traffic requirements. This model is come up with a framework for the wireless network of which consists of a core-IP network and also a number of wireless access networks. For the true end-to-end QoS, it is required that the core network is able to support the required QoS for the wireless users. This paper shows a solution to optimize the performance for different traffic classes according to the traffic characteristics. The performance of the proposed scheme is evaluated at delay aspects such as delay and throughput.

I. INTRODUCTION

Wireless networks are now in a phase of rapid evolution from both a quantitative and qualitative point of view. While their traffic volumes increase continuously it becomes more challenging to provide different levels of Quality of Services (QoS) for applications with specific service requirements. As the Internet evolves toward a global multi-service network of the future, a key consideration is the support for services with guaranteed QoS. On the other hand, QoS means that the service user receives a predefined, but not necessarily a constant amount of resources from the network, guaranteeing that the user's traffic is delivered to the destination within the set parameters and performance bounds. Another concept, that of Class of Service (CoS) is closely related to QoS. With CoS one user's traffic is treated better than another's, however no absolute guarantees are given, The QoS provision means an extensive re-engineering to the Internet, which includes service model creation, advanced scheduling techniques, admission control, client traffic shaping and so on. The QoS provision is necessary especially when the wireless and mobile network providers have to commit a certain level of service to their users including bandwidth and delay [1][2].

Many solutions have been proposed for handling these QoS problems by both extending the BE service model and also providing guarantees for selected emerging multimedia applications. Integrated Service (IS) and Differentiated Service (DS) are good examples of technologies that are currently standardized and available in commercial products [3]. Here, we propose a DPQoS provision scheme with the use of both the DS-based model for the core network and the upcoming 802.11e standard in the wireless access network [4].

II. QoS SERVICE MODEL

The primary goal of QoS is to provide the prioritized service including dedicated bandwidth, controlled jitter and latency, required by some real-time and interactive traffic, and improved loss characteristics. Also it is important to make sure that providing priority for one or more flows does not make the other flows fail. Fundamentally, QoS enables us to provide better service to certain flows. This is done by either raising the priority of a flow or limiting the priority of another flow. The IS model needs to maintain state information and hence may be unsuccessful to scale in the large public domain. The DS model was introduced to alleviate this problem. Instead of maintaining state information, DS applies different PHBs to packets, which is specified by a DSCP (DS Code Point) in the ToS (Type of Service) field of the IP header. It achieves scalability by aggregating traffic classification state for the IP-layer packets in DS network. The PHB refers to the externally observable forwarding behavior applied at a DS-compliant node to a DS behavior aggregate. According to different kinds of applications, two types of PHB behaviors are defined in DS model, such as AF (Assured Forward) PHB behavior and EF (Expedited Forward) PHB [3]. The routers in a DS domain perform different functions. SLAs (Service Level Agreements) are a kind of contract between a customer and a service provider, which typically cover the issues of QoS service specifications that are to be met by the service provider. TCA (Traffic Conditioning Agreement) is a part of the DS SLA. SLS is defined to be a set of parameters and their values, which together define the service offered to a traffic stream by the DS domain. Also as a part of SLA, the TCA is translated into a DS specific conditioning specification Traffic Conditioning Specification (TCS). The TCS is defined as a set of parameters specifying the traffic *profile*.

Traffic Conditioning Framework (TCF) includes two parts: traffic classifier and traffic conditioner. Traffic classifier is used to select packets from the incoming packet stream according to predefined rules. Two kinds of classifiers are defined in the DS model. The classifiers may be located in the ingress nodes or interior nodes in DS domain. The classifier located at the ingress node is generally a MF (Multi-field) classifier. The other is BA (Behavior Aggregate) classifier located at the interior routers. The EF PHB is intended to provide a building block for low delay, low jitter and low loss, assured bandwidth, end-to-end service through the DS domain. To minimize delay and jitter, the packet serving capacity at the routers should be greater than their arrival rates. The AF PHB is applied to those applications that the traffic out of *profile* will be delivered with less probability as compared with the traffic in *profile*. Also four AF classes have been defined in each node with allocating a certain portion of the forwarding resources. The packets for the assured forwarding are marked with a code point by mapping them to one of these classes. The packets within the classes can be assigned to one of three-drop precedence.

III. DPQoS PROVISION SCHEME

3.1 DS core part

The Core Routers (CR) means the DS routers within the core network. The typical DS core network consists of a number of BRs, a RCA, and a number of CRs. A BR has a number of functions under the control of the RCA. It maintains the interface with the Wireless Access Router (WAR), being in charge of receiving packets from the WAR and marking them with an appropriate DS code point. This is not necessarily a direct translation of the UP tag. This is because if incoming traffic is in excess of what is expected; it will be marked as simply as BE traffic. In this way the BR performs admission control for the incoming traffic. The RCA can also instruct the BR to drop packets from certain users, or of a certain flow. The BR also forwards all incoming traffic information to the RCA. It must also provide policing to account for falsification. This can be done by any standard means such as token bucket. The BR may also take part in control layer signaling with other DS routers as well as the RCA. This signaling is to define emergency conditions, congestion as well as provision. The CR performs the PHB function of the DS network. The RCA can dynamically change the configuration of the CR. For example consider a router with an outbound link of 10-Mbps.

3.2 Interworking scheme

The basic thing that needs to be achieved by the internetworking is to actually translate the 802.11e parameters to DS parameters. As can be seen the four classes of traffic, as specified in the table 3.1, map to different TCIDs within the 802.11e framework. Thus, the table is a direct mapping of the DSCP field to the TCID field, and vice versa.

Table 3.1 The mapping table

Traffic Class	Service Data Types	DSCP	TCID
TC1	Voice (VoIP)	(101)xxx for EF	7
TC2	Video Streaming	(100)xxx for AF4x	5
TC3	Signaling Data	(010) xxx for AF2x	3
TC4	Normal Data (e.g. E-mail, Web)	(000)000 for default BE	1

The EF PHBs is used for mapping the TC1 traffic from the necessary shaping and policing functions, which determine whether they are in profile. The non-conforming packets will be dropped after the shaping process; meanwhile the conformed packets will be marked with the appropriate DSCP value. For TC2 and TC3 mapping, when the conforming traffic is received the access network will forward it with a queuing delay smaller than the burst time. Here, the burst time is derived from the TSpec. A single class can then be divided into several sub-classes according to the burst-time and the conforming traffic can be queued into them for the desired QoS. Non-conformed traffic can be treated as BE without affecting the already existing TC4 traffic. The video and signaling traffics can be implemented using AF4x and AF2x PHB in DS region. At the border router, after the shaping process, the incoming traffic is classified into four delay classes according to their burst time. A separate AF*ix* PHB treats each of them. Maintaining an aggregate TSpec corresponding to each class will be used for admission control. For each AF*ix* class, the shaping process is performed to determine if they are in profile or not. All conforming packets are marked with the DSCP value corresponding to the mapping AF class with the lowest Dropping Precedence (DP). Non-conformed packets are marked with the DSCP value corresponding to the mapped AF*ix* class with the highest DP. Thus, the conformed CLS can be carried out according to the flowspec; meanwhile the non-conformed TC2 and TC3 can be treated as TC4 packet in access network with highest DP value. This mapping implementation is shown in Figure 3.1.

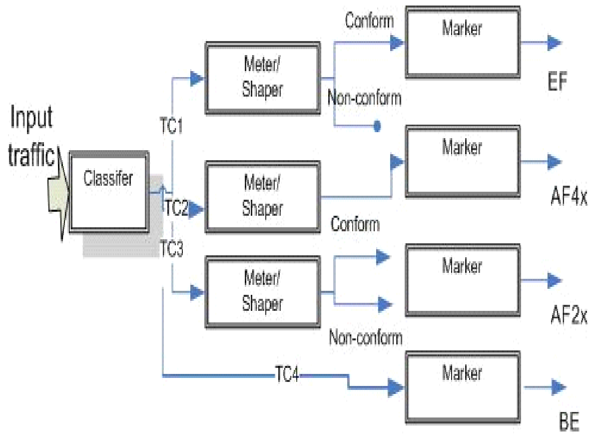

Figure 3.1 QoS mapping implementation framework

3.3 Wireless Access part

The wireless access network consists of two parts, such as the wireless user and the wireless access point. The primary requirement from the wireless user in the proposed architecture is that it be 802.11e compatible. The wireless user should also be capable of sending and receiving RSVP messages, if required. The network will also support legacy 802.11 users, but no QoS will be provided in their case, only BE service. The wireless access point should also be 802.11e enabled. It should be capable of interfacing with the rest of the QoS network.

IV. PERFORMANCE EVALUATION

In order to analyze the performance of the DPQoS model, we consider the efficiency measured by the average delay and throughput. The average delay is the queuing delay that a packet encounters in the router. Though there is also the delay jitter defined as the difference between the packet delays of two consecutive packets we assume that this factor little influence to our performance evaluation. The throughput is measured as the ratio of the number of packets of the outgoing traffic and the incoming traffic. In the network model for simulation, the core routers perform the DS functions. The traffic flows with different QoS requirements are classified into TC1, TC2, TC3, and TC4 after the QoS negotiation. Before entering the core network, the border routers in DS network prepare to perform admission control, traffic conditioning and QoS mapping. The maximum packet lengths of each session and the whole network are set to 260 bytes for TC1, 1024 byte for TC2, 601 bytes for TC3 and TC4.

Some simulation parameters used here are as follows: The number of the maximum connections is 7, while each link has bandwidth of 54Mbps, and the average packet generation intervals are 0.85, 0.9, 1, 1.2, and 2 respectively. Here, the average delay of each traffic class is examined for EF packets. Two scheduling schemes are implemented by using both DPQoS and the fair scheduling (FQ). Then the average delay of the DPQoS scheme with priority queuing is examined by classifying as four classes. Figure 4.1 shows the average access delay of each traffic class, which shows that the

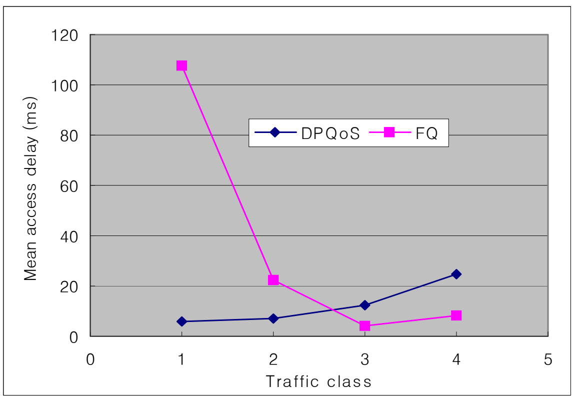

Figure 4.1 Average access delay of each traffic class

delay performance of DPQoS for TC1 and TC2 is much improved compared with FQ. This performance resulted from the dynamic scheduling scheme according to traffic condition of the high priority packets.

V. CONCLUSION

This paper has focused on the QoS provision problems between the core network and wireless access part. The proposed DPQoS scheme is to classify all the traffics into different types and then accordingly treats them differently as performed in DS model. To realize the efficiency of the DPQoS model, the dynamic scheduling scheme can be used to negotiate QoS requirements between mobile users. The simulation results show that the proposed scheme with priority scheduling can perform very well by reducing the delay time. Thus it is possible to meet the QoS requirements of the high priority (TC1) packets. For low priority packets and background packets, the DPQoS scheme can provide high throughput, but the delay performance may be slightly worse than the FQ performance. For further study, we will devote time to the research of more efficient QoS provision schemes to cooperate with next generation wireless mobile networks including the extension of service coverage area.

REFERENCES

[1] G. Bianchi, N. Blefari-Melazzi, M. Femminella, F. Pugini, "Joint support of QoS and mobility in a stateless IP environment", **IEEE Globecom 2001**, San Antonio, 2001.

[2] D. Qin and N. Shhroff, "A Predictive Flow Control Scheme for Efficient Network Utilization and QoS", **IEEE/ACM Trans. On Networking**, Vol. 12, No. 1, Feb. 2004.

[3] Y. Bernet, A. Smith, and D. Grossman, "A conceptual model for DiffServ routers", **Internet Draft**, September 2000.

[4] IEEE 802.11 WG Draft Supplement to International Std, IEEE 802.11e/D2.0, Nov. 2001.