A New Mobile-IPv6 based Buffering Scheme in the All-IP Network

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Abstract: *Realtime applications like VoIP(Voice over IP) in All-IP networks need smooth handoffs in order to minimize or eliminate packet loss as a Mobile Host(MH) transitions between network links. In this paper, we design a new dynamic buffering(DB) mechanism for IPv6 by which an MH can request that the router on its current subnet buffers packets on its behalf while the MH completes registration procedures with the router of a new subnet. Performance results show that our proposed buffering scheme with a dynamic buffer space allocation is quite appropriate for mobile Internet, or the All-IP environment in terms of the datagram loss rate.*

1. Introduction

All-IP architecture[1] is a industry vision of future networks, with different access options, such as broadband, mobile Internet and existing wireless system, seamlessly integrated with an IP packet network layer. IP allows all communication services to be carried over a single network infrastructure, enabling the integration of voice, data and multimedia services. Whereas 2G networks were primarily optimized to support wireless voice, the All-IP mobility system is optimized to support real-time multimedia packet services. The adoption of SIP(Session Initiation Protocol) signaling is a key ingredient in providing this new functionality. The SIP is a common signaling protocol joining the Internet and mobile telephony. It provides integrated multimedia capabilities for IP enabled terminals.

By the way, the Internet has experienced an enormous growth during the last few decades. IETF(Internet Engineering Task force) Mobile-IP working group is proposed Mobile-IP for supporting a unicast routing of MH in the IP network[2-4]. The number of available Internet addresses seemed to be insufficient to meet the future needs of the Internet. Therefore, IETF introduced Mobile-IPv6 as a replacement for current Mobile-IPv4. Mobile-IP is defined by standard interface between PCF(Packet Control function) and PDSN(Packet Data Serving Node) in the 3GPP2(3rd Generation Partnership Project 2)[5-6]. In terms of routing, Mobile-IPv6 is solving potential triangle routing problem[6] in the Mobile-IPv4. Triangle routing is undesirable because HA(Home Agent) seems to be a bottleneck, and more network load and sensitivity to the network partition. We focus a IP datagram routing related to QoS in the wireless environments.

The QoS has become a topical issue with the transition towards the use of Internet Protocol-based transport platforms. One of the most significant advances in 3G mobile communication and the All-IP technology is the support for a richer variety of services and higher level of service personalisation[7]. However, the existing works for QoS guarantee focused on only the wireless work characteristics.

In this paper, we consider an end-to-end QoS problem in terms of datagram loss under the Mobile-IP based network, i.e., the loss of datagrams during transition between networks should be minimal. Therefore, we propose a variable buffering scheme to mitigate datagram loss during the handoff. The MH decides when it needs to transition to a new access router through control information such as signal strength. In order to minimize datagram loss when the MH moves to another network, a buffer in the default router related to the MH has a different mechanism for a voice and a pure text data respectively.

The rest of paper is organized as follows. Section 2 introduces the All-IP network, and we study the Mobile-IPv6 concept. Section 3 describes the traffic type for the MH. In Section 4, we present the simple buffering scheme of access router. Section 5 proposes a new dynamic buffering scheme for the mobile environment. In Section 6 we analyze the performance of DB control strategy. Finally, Section 7 gives some concluding remarks.

2. All-IP Reference Model

The All-IP core network shall be independent of the access network. The core network shall have the ability to support multiple access network technologies. In this paper, we consider the conceptual All-IP network reference model such as Figure 1. The IP Multimedia domain shall be the dominant network technology supporting new and enhanced IP multimedia services. And, the access network for the IP Multimedia domain can support enhanced capabilities in terms of services and QoS. With reference to Figure 1, a several function is shown for the IP-based transport. As, illustrates in Figure1, we show IP-based wireless base station connect radio systems to an IP radio access network.

We consider the Mobile-IP structure to support the diverse IP-network clusters. The Mobile-IP(v4) proposed by IETF[2-4] consists the HA(Home Agent) and FA(Foreign Agent), and MH. In Mobile-IPv4, mobile hosts inform their HA of their CoA(Care-of-Address) through registration messages carried within UDP/IP(User Datagram Protocol/Internet Protocol) datagram. In contrast, the MHs in the Mobile-IPv6[8] use Dastination Options to inform various other hosts of their CoA.

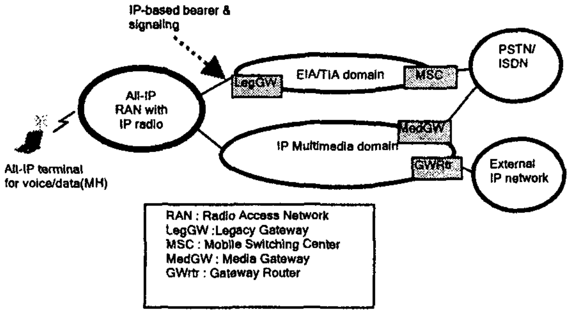

Figure 1. All-IP network reference model

In addition, CNs(Correspondent Node) use the CoA to route datagrams directly to the MH, without requiring the datagram to be routed first to the MH's HA. Thus Mobile-IPv6 has built-in support for route optimization. Figure 2 shows the fast handoff in Mobile-IPv6, where the TempHA is a temporary HA for handoff operation.

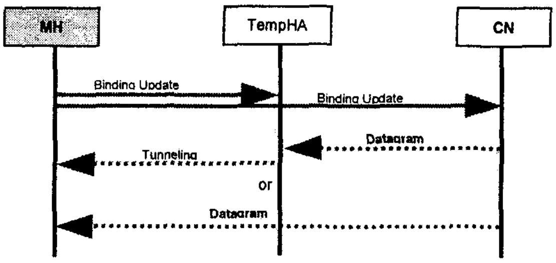

Figure 2. Fast handoff in Mobile-IPv6

Figure 3 shows the basic handoff scenario assumed throughout this paper. In this figure, the O_rt is the MH's default router prior handoff, and N_rt is new router to which the MH attaches after handoff. Incoming datagrams to a MH are buffered at the O_rt while the MF transitions to a new network. Once the MH completes registration and obtains a valid IP address for the network associated with the N_rt, the O_rt forwards the datagrams to the MH at its new address.

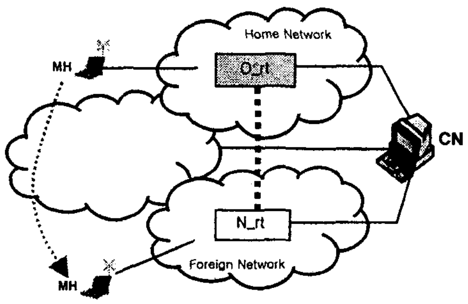

Figure 3. The basic network model for handoff

In this paper, we only consider MH-controlled handoff, i.e., the MH use the control signal to decide whether it needs to change its access router. The impact of buffering according to handoff is analyzed further in the following sections. Buffering scheme for the Mobile-IPv4 is studied by the M. Khalil[8].

Buffer management procedures described in this paper typically performed in association with the delivery of a *Binding Update* from the MH to the targeted mobility agent, i.e., a mobility agent which is to manage that the CoA for the MH. The need for acknowledgments is substantially reduced. If the access router is unable to fulfill the MH's request then it will reply with a NAK. Otherwise, the MH will be assured that its message was delivered to the access router when it receives the *Binding Acknowledgment* from the targeted mobility agent. The general procedures for smooth handoffs require the N_rt to retransmit messages until it is assured that the O_rt has received and acted on them.

3. Input Traffic Classes

This paper is concerned with the datagram loss control of access router. There are only two classes of services; high-priority class as the real-time traffic with strict delay requirement such as a voice, and low-priority class as the traffic type the tolerable delay and strict datagram loss requirements such as a pure data.

Some of the most important classes of existing and emerging end user services are rich call, streaming, browsing, messaging, and M-commerce transactions. In an IP-network, these services use the server-client model. Applications such as streaming and rich call are real-time by nature, involving periodic transmissions of information in the network. Transaction type applications such as M-commerce and Internet browsing produce less regular traffic patterns, but nevertheless pose delay limits for transmission, thanks to their interactive nature. For instance, interactive real-time applications, such as voice or video conferencing, have the most stringent end-to-end delay requirements. For interactive transaction traffic types such as browsing and m-commerce, longer delays are acceptable. Streaming can allow transmission delays up to seconds in length. Instance messaging benefits from short delays, but in e-mail delivery delay is not an important.

4. The Simple Buffering(SB) Scheme of Access Router

Simple Buffering(SB) is based on the general smooth handoff framework[9]. In this paper, we propose an extension to the *IPv6 Router Advertisement message* which allows a router to advertise its ability to support simple buffering. Also, we use three suboptions Buffer Initialize, Buffer Forward and Buffer Acknowledgment.

A router which is enabled to perform buffering advertises its capability to interested MNs using the proposed 'B' bit in its router advertisements. Once a MH receives a router advertisement indicating that simple buffering are available, it may request buffering with the Buffer Initialization suboption. The MH may request a specific buffer size or accept the default size. The router may accept or decline this request based on available resources, or it may allocate a smaller buffer if necessary. The actual size of the buffer allocated is communicated back to the MH through the Buffer Acknowledgment suboption. Buffering state is associated with a target address, the MH's primary care-of address (CoA1). Incoming packets destined for CoA1 are buffered in addition to being forwarded normally. When the MH completes a handoff, it may request that buffered packets be forwarded to its new CoA (CoA2) with the Buffer Forward suboption. In this paper, the MH uses some criteria like *Neighbor Advertisements* to decide whether it needs to change its access router. If presented with multiple options for new routers, it may decide on the new access router based on available resource information passed as destination options of the router advertisement. For mobile node controlled handoffs, the MH must initiate buffer state and explicitly request forwarding of buffered packets.

Figure 4 illustrates an instance of a typical signal flow for simple buffering during a handoff. The scenario assumes that both O_rt and N_rt support buffer management and that the MH will take advantage of the simple buffering services at both nodes.

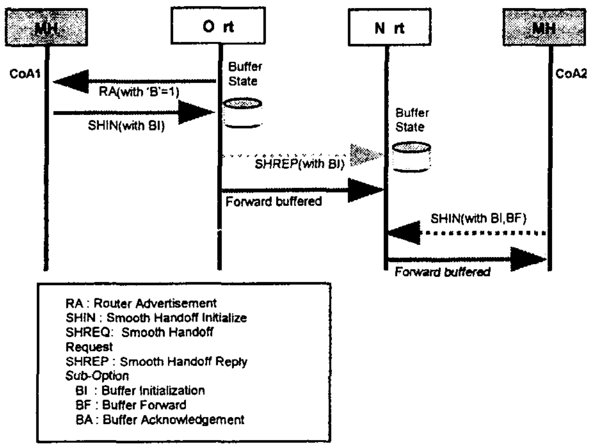

Figure 4. Handoff signal flow

5. The Proposed Dynamic Buffer(DB) Control

To satisfy the requirements of both integrated traffics in the access router. We employ a priority discipline and dynamic buffer(DB) allocation scheme. Therefore, the real-time(i.e., high-priority data) datagrams are given the higher priority to meet the shorter queueing delay in the access router, whereas sufficient buffer capacity is given to the non-real-time(i.e., low-priority data) datagrams to ensure smaller packet loss probability. Therefore, finite-sized buffer of access router is dynamically splitted into two buffer pools based on the incoming traffic volume so that the datagram loss rate of each traffic is adjusted according to the dynamically allocated buffer space.

For analytical modeling, we assign the buffer size of low-priority datagram to be B^L and high-priority datagram B^H, assuming that total buffer size at access router, *i* be B. Let P^H be the probability that the incoming datagram is the high-priority datagram bounding for access router. Then, $1-P^H(=P^L)$ denotes thee probability for low-priority datagram. Hence, $B^H=0$ and $B^L=B$ if $P^H=0$, and $B^H=B$ and $B^L=0$ if $P^L=0$. We can progress the buffer allocation technique Then, we design the following buffer control strategy such as a formula (1) for QoS management in the mobile network.

$$\Pi^H = \{\min P^H \mid \Re^L \le \gamma\}$$
$$B^L = (1-\Pi^H)^\mu \times B,\ B^H = 1 - B^L \qquad (1)$$

In deciding to the buffer control strategy based on handoff, μ and *r* can be used as design parameter and it can be adjusted according to the QoS requirements of high-priority and low-priority datagram. Increasings α allocates more buffering space to high-priority datagrams and less space to low-priority datagrams, and vice versa. Figure 5 depicts our proposed strategy, which dynamically allocates the buffer space depending on the QoS requirements at the access router buffer.

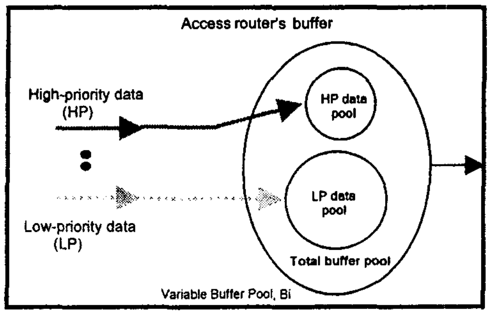

Figure 5. Partition of router buffer pool

6. Performance Results of Buffer Control Strategy

We analyze a major performance factor of datagram loss rate, which are considered to be good measures of QoS requirements in mobile network modeling. In section, we describes the performance results corresponding to two types of service traffices : high-priority datagram and low-priority datatgram. First, for the analysis, we assume the number of MH(i.e., m) as 100 and total buffer size of router as 50. Also, for simply, we use the saturated traffic arrival technique for simplicity.

The main difference between the HA and new access router(N_rt) is that the N_rt is dynamically changed according th the location of the MH, but the HA is unchangeable. The CN acts as server, and initiates a data transmission. Each router has a buffer of small size. The MH shows diverse handoff rate(i.e., HR) ranging from 0 to 1.0. The variable buffer pool size is determined by μ parameter. Figure 6 illustrates the overflow rate versus μ (i.e., mu) when B=50, ρ =0.8, and HR=0.1. With reference to Figure 6, we demonstrate that increasing μ means more buffering room for high-priority(i.e., high_pr) traffic so its loss rate is decreased.

Figure 7 shows the datagram loss rate according to the high_pr traffic when the m=100 and B=50. With a different buffering scheme, we compare the DB with the SB strategy when the high_pr traffic rate is a variable. As shown, loss rate in the DB is much less than loss rate in the SB when the high_pr traffic volume is more than 60%. Also, the result shows that the DB is not affected by the mobility rate.

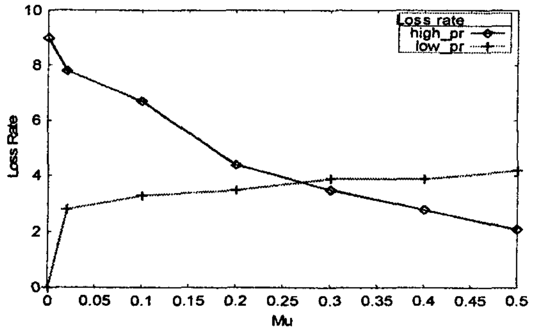

Figure 6. Overflow rate vs. parameter, μ

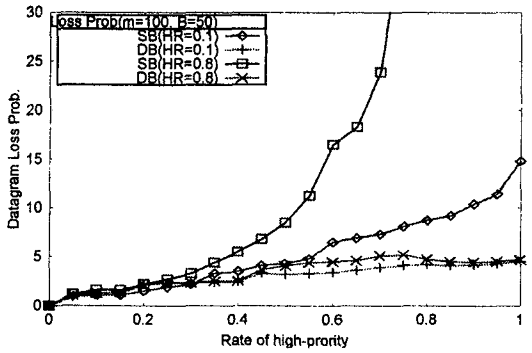

Figure 7. Datagram loss rate versus high_pr traffic

Figure 8 illustrates a datagram loss rate versus buffer size of access router when realtime traffic(i.e., high_pr) rate is 50%. With reference to Figure 8, in case of the SB scheme, it is necessary to add more the buffer space to obtain the same loss rate with the DB.

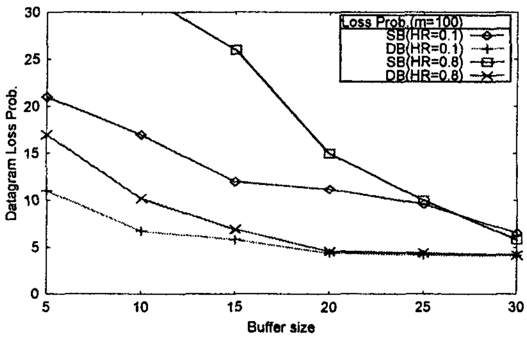

Figure 8. Datagram loss rate versus buffer size

7. Conclusions

We have so far presented and analyzed the performance of the buffering control scheme of access router for better QoS provisioning of wireless multimedia services. The network model considered is the All-IP architecture. The buffering control mechanism we proposed is that different types of traffic are dynamically splitted at the access router, i.e., which dynamically allocates the buffer space in order to reflect the QoS requirements of incoming traffic datagrams. We considered an end-to-end QoS problems in terms of datagram loss under the Mobile-IPv6-based All-IP network, i.e., the loss of datagrams during transition between networks should be minimal. In All-IP environment, we have revealed that proposed DB control scheme in that router is quite effective to handle various types of wireless multimedia traffic through performance analysis.

Acknowledgements

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