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남세현

대구대학교, 정보통신공학부
전화 : 053-850-6627

A new mobile multicast scheme for real-time communication

Sea-Hyeon Nam

Department of Computer and Communication Engineering
Daegu University
E-mail : shnam@daegu.ac.kr

Abstract

A new multicast scheme for mobile nodes is proposed to support real-time communication in a more efficient way. In the proposed multicast scheme, the Explicit multicast (Xcast) is integrated with the Session Initiation Protocol (SIP). The proposed scheme reduces unnecessary network traffic and achieves low latency of packets in the network.

I. Introduction

Providing multicast support for mobile nodes in an IP internetwork is a challenging problem and the solutions rely on the underlying mechanism of mobility support. Currently, there are two basic approaches to support mobility in IP networks. The first one seeks to solve the mobility problem in the network layer by using Mobile IP [1] and related proposals. The other approach is to solve the mobility problem in the application layer by using SIP [2]. All of these schemes rely on the host group model and the traditional multicast routing protocols to support network-layer multicast. Those traditional multicast schemes were designed to handle very large multicast groups. These work well if one is trying to distribute broadcast-like channels all around the world. However, they have scalability problems when there is very large number of small groups. For real-time communications such as IP telephony, multimedia conferencing, collaborative applications, and networked games, there are typically very large numbers of small multicast groups. Xcast [3] is a new scheme for Internet multicast that complements the traditional multicast schemes. Since Xcast eliminates the membership management and routing information exchange in the intermediate routers, it can support very large numbers of small multicast groups. For real-time communications, it is more common to use the Real-Time Transport Protocol (RTP) over UDP, and important issues are fast handoff, low latency, and high bandwidth utilization especially for wireless networks. Therefore, it is desirable to introduce mobility awareness on a higher layer, where we can utilize knowledge about the traffic to make decisions on how to handle mobility in different situations. In this paper, a new multicast scheme for mobile nodes is proposed to support real-time communication in a more efficient way. In the proposed multicast scheme, the Xcast (a very flexible data plane mechanism) is integrated with the SIP (a very flexible control plane protocol) to support super-sparse multicast sessions for mobile nodes.

II. Proposed scheme

In the proposed multicast scheme, the Xcast is integrated with the SIP to support multicast for mobile nodes. Specifically, by using SIP, a full or partial mesh of RTP sessions is established to provide connectivity among multicast members. If a full mesh of sessions is established, then every hosts can send their messages to every other participants. Thus, every hosts can be a multicast sender of the group. This is useful for applications such as multimedia conferences and multi-player games. When a multicast application requires only one sender, a partial mesh that connects one sender to all receivers is established. By using SIP, a host takes the initiative to set up sessions for multicast. When a mobile host (MH) moves during a session, we do not need to reconfigure the multicast delivery tree or rely on the tunneling service between home agent (HA) and foreign agent (FA). With the assistance of SIP servers, sessions for multicast are created and maintained to support pre-call and mid-call mobility. After a full or partial mesh of RTP sessions is established, Xcast is used to deliver identical RTP datagrams sent from a sender to multiple receivers. As long as the current SIP/SDP syntax and semantics are used, one has to rely on the UDP-enhanced version of Xcast with 6 bytes overhead (4 bytes for IP address and 2 bytes for UDP port number) for each destination. When an application decides to use Xcast forwarding, it does not affect its interface to the SIP agent and it can use the same SIP messages as it would for multi-unicasting. Since the application in the sender host keeps track of the participants' unicast addresses, it is a simple matter to replace multi-unicast code of SIP with Xcast code. All that the developer has to do is to replace a loop that sends a unicast to each of the participants by a single "Xcast_send" that sends the data to the participants.

III. Simulation model

The simulations involve a network with a simple tree topology (Fig. 1). With a tree topology, only one shortest path exists between any two nodes, so routing issues do not affect the simulation results. The 64 leaf nodes are considered as networks (or subnets) where stationary and mobile hosts are connected. In the simulation, it is assumed that a multicast sender is a stationary host located at randomly selected network and multicast receivers are all mobile hosts. At the beginning of a simulation, each MH is connected to its home network. After receiving 10 multicast packets in a network, the MH moves to other network with probability 0.1. The foreign networks to visit are chosen equiprobably at random. When a MH moves to a foreign network, it can receive the multicast packets by mid-call mobility mechanism of SIP without the services of HA and FA. In the simulation, the multicast group size was varied from 1 to 20 and the multicast source node appends 6 bytes overhead per each destination to Xcast header. The stream of data is sent using one of two distribution methods: multi-unicasting or xcasting. The data stream is a CBR of 200 byte UDP packets sent every 5 ms. The group of destinations does not change during the course of a simulation run. All links in the network have transfer rates of 2.048 Mbps and queues that can hold 50 packets. The simulation time for a run was selected as the time for a multicast sender to generate 20000 CBR packets for the multicast group.

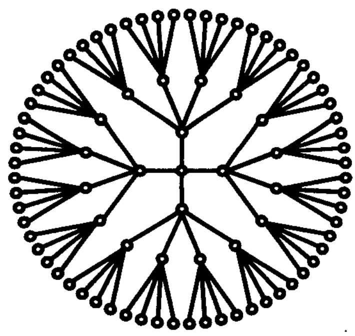

Fig. 1 Network topology used in simulations

IV. Simulation result

Fig. 2 shows the total number of successfully received packets during the simulation. In the simulation scenarios, xcasting is able to deliver all of the packets sent into the network successfully. By contrast, unicasting can not handle the number of packets generated by a data stream sent to more than seven destinations. This sudden degrade of performance occurs because the majority of data stream packets must travel from the stream source to the center of the network in order to reach their destinations. If any link along this path becomes saturated, that link will act as a bottleneck and prevent any additional data stream packets from reaching their destinations.

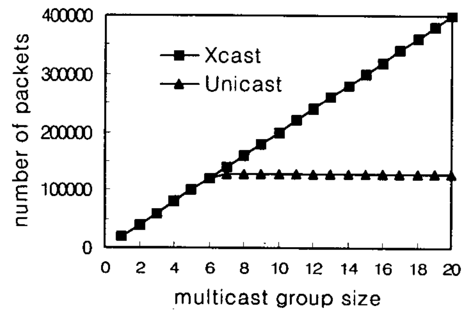

Fig. 2 Number of packets successfully received

Fig. 3 shows the average latency of packets in the network. Again, xcasting exhibits better latency performance than unicasting in situations where unicasting experiences saturated links. For xcasting, the delay increases slightly as the multicast group size increases. This is because a Xcast packet can have multiple destinations, so no redundant data travels over links in the network. However, for unicasting, the delay increases slightly at first, but it shoots up dramatically when a stream is sent to more than seven destinations. This is because the network queues overflow and the packets are discarded after the saturation point.

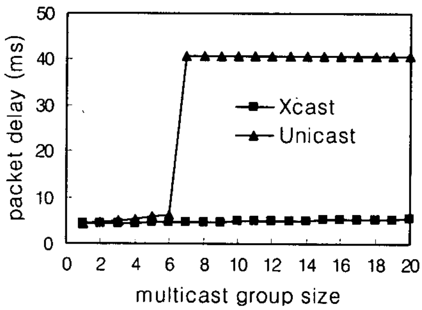

Fig. 3 Packet delay

Fig. 4 shows the number of packet transmissions in the network links. For example, when the multicast group size is six, the multicast source generates 20000 packets during the simulation time and the six mobile hosts totally receive 120000 packets. If unicasting is used to deliver the multicast packets, about 651600 packet transmissions are required in the network links. However, if xcasting is used, about 322400 packet transmissions occur in the network links to deliver the same packets. In Xcast, the number of packet transmissions in the network links increases sublinearly as the multicast group size increases. Also, the graph of unicasting shows similar behavior, but the increasing rate is much higher than the xcasting. In unicasting, the number of packet transmissions in the network links is saturated when a stream is sent to more than seven destinations.

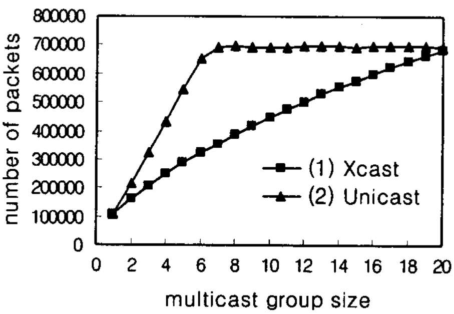

Fig. 4 Number of packet transmissions in network links

V. Conclusion

In this paper, a new multicast scheme for mobile nodes was proposed to support real-time communication in a more efficient way. In the proposed multicast scheme, the Xcast is integrated with the SIP to support multicast for mobile nodes. By using SIP, a full or partial mesh of RTP sessions is established to provide connectivity among multicast members. After establishing connections for multicast, Xcast is used to deliver identical RTP datagrams sent from a sender to multiple receivers. Through the simulation study, it was verified that the proposed scheme can reduce unnecessary network traffic and achieve low latency of packets in the network.

References

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