

Chapter 7

A Multi-Pass Algorithm for Adjusting a Network Topology in Multipoint Communications

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ABSTRACT

Multimedia traffic on the Internet has grown dramatically in the past few years. Web sites, such as YouTube and Hulu, offer entertainment and educational multimedia content that previously was only available through broadcast or cable television and on storage media, such as CD-ROMs and videotapes. Latency is a key issue in the delivery of online content, especially with respect to multicasting. The authors' proposed approach seeks to reduce overall latency for multicast streams.

INTRODUCTION

According to AT&T Labs Research (Erman et al., 2009), HTTP is 68% of downstream Internet traffic and 34% of that traffic is multimedia. Multimedia content using HTTP has a 83% annualized growth rate versus the 26% over all annual growth rate of broadband traffic. More multimedia content becomes available every year. Every minute, ten hours of video is uploaded to YouTube (YouTube

fact sheet). Furthermore, increasing popularity of multiparty video conferencing and computer games places higher load on service providers and affects user experience. This paper presents a new approach to management of multicasting in multipoint collaboration. Latency is a critical issue, especially in a peer-to-peer multicasting (Setton & Girod, 2009), (Sinnreich, 2006). The proposed approach allows minimizing a sum of delays by measuring multicast streams and changing a routing tree accordingly.

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Multiparty conferencing allows exchanging information among a set of participants. Type of communication can be text (chat), voice, video, application sharing, and multiplayer Internet games. Some of these applications require not only minimum delays, but “fair” delays, that allow all users to receive information at the same time. It can be achieved by adjusting a topology of a multicast tree that is used to deliver data. To improve user experience the topology should be selected based on minimization of a sum of delays on all edges of the multicast tree. In peer-to-peer multipoint video conferencing systems hosts forwarding separate data streams to other hosts located down the distribution tree.

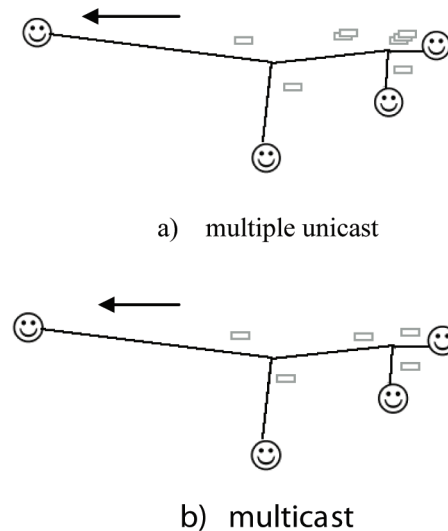
For example, the Multi-Party Conferencing protocol (Luo et al., 2009) is based on the full mesh architecture. All members are equal and connected to communication mesh. The protocol keeps pending list, and moves participant to the member list only after the connection request is accepted. Being equal means no advantages to a presenter, who is the source of the traffic for that particular moment. To avoid loops such protocol needs to use an algorithm similar to the algorithm which generates spanning trees.

CURRENT APPROACHES

Most conferencing tools in use utilize an Application Layer multicast where packets are replicated at the end hosts by sending identical packets over the same link. A Network Layer multicast is more efficient where it starts with a single packet from the source and then routers duplicate the packets only where necessary. In multiple unicasting, packets are generated by the source, thereby creating unnecessary traffic. These two approaches are illustrated by Figure 1.

It is obvious that Network Layer multicasting is more efficient, it reduces traffic by simultaneously delivering a single stream to multiple users. To receive a particular multicast stream, hosts

Figure 1. Multicast vs. multiple unicast messages



must join a multicast “group” by sending an Internet Group Management Protocol (IGMP) message to their *local* multicast router that will use Protocol-Independent Multicast (PIM) to build routing tree. Network infrastructures should be configured to route multicast packets.

Real-time Transport Protocol (RTP) that is commonly used to deliver audio and video over the Internet is an application layer protocol that assigns each media stream a separate unique RTP session ID, with its own RTP Control Protocol (RTCP) packets to report the quality. So it provides multicasting support, but again on application layer. That makes very important the cost of sending message over the “delivery tree.” RTCP is based on the periodic transmission of control packets to all participants in the session, using the same distribution mechanism as the data packets. It is to provide feedback on the quality of the data distribution.

Delay or latency is the amount of time it takes for a packet to reach its destination. There are four major types of delays:

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