Lateral Error Recovery for Application-Level Multicast

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I. Abstract

Application-level Multicast (ALM) has emerged as a promising technique to overcome the current limitations in IP multicast for point-to-multipoint content delivery. Traditionally in ALM research, researchers mostly focus on connectivity among the hosts. In our work, we consider quality of service issue for ALM, in particular the error recovery mechanism.

In ALM, packets may be lost in the network due to congestion, node or link failure, or tree-reconfiguration. Such error has to be recovered via retransmission in a timely manner in order to offer good level of service. Traditionally, recovery is performed "vertically" by requesting the upstream hosts to retransmit the packets. However, vertical recovery is not effective due to high error correlation between the internal hosts and their descendents. Vertical recovery may also cause implosion problem and may not even work for node or link failure.

We therefore propose and investigate lateral error recovery (LER). Hosts in the network are divided into a number of planes, each of which forms an independent ALM tree. Since the correlation of error among the planes is likely to be low, a node recovers its error "laterally" from nearby nodes in other planes rather than vertically along its own plane.

We study how to select plane sources and the particular recovery neighbors upon a packet loss. The basic idea is to find the close hosts in terms of network distance. We employ the technique global networking positioning (GNP) to deal with the problem. Using GNP, each host can obtain its own coordinate. In the GNP space, the distance between two hosts correlates well with their network distance. By constructing a Voronoi diagram, the close neighbors then can be obtained. All the identifying processes of the recovery neighbors are performed before data delivery or during tree-reconfiguration, and hence of low processing overhead.

By simulating an existing ALM scheme Delaunay Triangulation (DT) on Internet-like topologies, we show that our scheme achieve low overheads in terms of relative delay penalty (RDP) and physical link stress. We further show that LER greatly reduces the error rate as compared vertical recovery.