ABSTRACT

This research introduces an efficient and new multicast congestion control algorithm for asymmetric paths with improved Round Trip Time (RTT) calculation. In the current Internet scenario, streaming applications become popular and which use multicast approach. Congestion control in multicast protocol is a difficult task and lot of research is going on in this area. To enhance the bandwidth utilization, instead of symmetric path, an asymmetric path is a viable alternative. But the existing algorithms are not directly applicable for such application. In this thesis, we propose a new protocol in which the receiver explicitly adjusts its reception rate according to the network conditions using TCP throughput equation and Packet-Pair probe. Its effectiveness has been checked by using simulation techniques. The most popular network simulator (ns-2) is used in this analysis.

Congestion is the major problem in the Internet multicast. There is a growing set of non-TCP applications such as Internet audio players, IP telephony, video conferencing and bulk file transfer which are generally called as multicast applications. So far there have been three directions of multicast congestion control proposed, namely sender driven, router based and receiver driven. Out of these receiver driven with multi rate is more suitable for today’s Internet called Multi Rate Multicast Congestion Control (MR-MCC). Internet is having a very large number of computers with different capacities. To achieve the scalability for a very large heterogeneous
group of receivers over the Internet, MR-MCC preferred since each receiver can register with different reception rate (based on its capacity). At present there is a lot of research going on in this area to design new MR-MCC protocols. However, the existing protocols have some drawbacks. Some designs cause over-subscription and high packet losses and others do not use efficient RTT.

Some multicast congestion control protocols are slow to converge and not responsive to changes in network conditions. Some are not TCP friendly. Some designs are too complex or less feasible, some others are not scalable and some do not work well in asymmetric paths. Here asymmetry may manifest itself as a difference in transmit and receive capacity or differences between transmit and receive paths.

Receiver-driven Layered Multicast (RLM) is the first algorithm developed for receiver-driven approach with layered multicast congestion control. However, several fundamental problems of RLM are reported in the literature such as unfairness, TCP unfriendliness, high packet losses due to the join experiment technique and slow convergence. Receiver-driven Layered Congestion control (RLC) has been proposed to improve RLM in terms of TCP friendliness. RLC also introduces the concept of burst test to avoid over-subscription. However, even with the burst test, its join experiment (to adjust the receiver’s reception rate to the network condition) leads to over-subscription and packet losses.
Fair Layer Increase Decrease with Dynamic Layering (FLID-DL) introduces a Dynamic Layering technique. Its rate adaptation mechanism is used to detect congestion and enforce TCP friendliness. However, experiments show that FLID-DL is not TCP-friendly, and by relying on a join experiment, it can oversubscribe and cause high packet losses.

Packet pair Layered Multicast (PLM) has been proposed using Packet Pair approach. PLM relies on Fair Queuing (FQ) at routers to enforce fairness that is not feasible. Experiments show that PLM without FQ can cause starvation of competing TCP connections.

Explicit Rate Adjustment (ERA) is a multi-rate multicast congestion control algorithm in which the receiver explicitly adjusts its reception rate according to the network conditions. ERA supports packet pair approach but does not support asymmetric paths and efficient round trip time.

Round Trip Time (RTT) is important for calculating receiver’s throughput. The existing protocols such as RLM, RLC, PLM and ERA do not support efficient round trip times. So the calculated receiver’s throughput is not accurate and bandwidth can take major part in computing receiver’s throughput which is not always optimal.

There is no accepted Round Trip Time estimation standard in Layered Multicast Protocols (LMP). Full RTT estimation is difficult to estimate in a layered multicast session due to the implosion problem at the sender, which is the result of too many feedbacks from a large number of
receivers. The easiest way to avoid feedback implosion at the sender is not to send feedback. That is the reason why the receiver-based LMP is more popular than the sender-based LMP. The elimination of feedback in the receiver-based LMPs has greatly improved the scalability of layered multicast protocols.

Multicast RTT is essential for calculating receiver’s throughput in receiver driven layered multicast. In unicast, Round Trip Time is estimated using RTT request packet and some multicast protocols estimate RTT as twice one-way latency. In layered multicast protocols Luby et al (2002) has proposed RTT is the difference between the times of issuance of join request and the arrival time of the first packet of the layer. PLM does not use RTT for calculating throughput instead it uses link bandwidth. ERA uses RTT as twice one-way latency. All these concepts are inaccurate for various reasons. (Ashraf and Ioannis 2003; Bin Yu 2001).

Hence, in this research, a new MR-MCC is proposed, which has the following properties: scalability, responsiveness, fairness, efficiency in network utilization and simplicity to implement, asymmetric and better round trip time estimation.

In this research we analyze various receiver driven multicast congestion approaches. Finally we propose a new receiver driven approach named as Cumulative Layered Multicast congestion control for Asymmetric paths (CLMA).
The new design is based on the Packet-Pair probe, TCP throughput equation and improved RTT calculation. It has been simulated using network simulator (ns-2) and demonstrated via simulations.

It is found that the new protocol satisfies to a large extent the basic requirements for an effective Internet multicast protocol such as responsiveness, efficiency in network utilization, scalability, fairness and TCP-friendliness.