Project Proposal:
Adaptive Analysis of High-Speed Router Performance in Packet-Switched Networks

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Motivation

The Internet is a global network of interconnected computer networks that transmit data by packet switching using the standard Internet Protocol(IP). Each message is divided into smaller parts or packets which are routed separately using the address in their headers between nodes over data links shared with other traffic. Once all the packets forming a message arrive at the destination, they are merged together to form the original message.

Traditional IP routing is relatively simple in the sense that it uses next-hop routing where the router only needs to consider the next destination of the packet, and does not need to consider the subsequent path of the packet on the remaining hops toward its actual destination. Whenever a packet arrives at a router, that router consults its lookup table to find another router on the path toward the destination of that packet. So the performance of a router actually depends on how fast it can perform a lookup operation. Over the years, a lot of research have been done to speedup this process.

Instead of increasing the speed of the lookup operation, performance of a router can also be improved by decreasing the total number of lookup operations that are necessary on a given sequence of packets by properly scheduling the packets and dropping some of them if needed. This seemingly simple observation is the guiding principle of this project. We want to establish an appropriate model to address this issue and to perform an adaptive analysis of the performance of high-speed routers based on the 'niceness' of the input packet sequence. We say an input sequence is 'nicer' than another input sequence if the former one has fewer flips than the later one, where we define a 'flip' to be the change of the destination address in two consecutive packets. Hence, each flip corresponds to one lookup operation and consequently a nicer sequence will result in fewer lookup operations. We also want to examine possible ways to increase the niceness of a sequence considering dropping of packets to do so and analyze the effect of applying such techniques.

Previous Works

To the best of our knowledge, no such analysis have been done before in this context. But there are a lot of works that are closely related to this problem. First, there are packet scheduling algorithms that are employed in routers to determine the order of packets belonging to a particular flow to effectively ensure that the QoS service requirements are met. FIFO, Round Robin(RR)[4], Fair Queuing(FQ)[3, 4], Weighted Fair Queuing(WFQ)[3], Generalized Processor Sharing(GPS)[1] and Deficit Round Robin(DRR)[5] are examples of packet scheduling algorithms. On the other hand, there are Differentiated services or DiffServ[2] which is a simple, coarse-grained mechanism for classifying and managing network traffic and providing QoS guarantees on modern IP networks. DiffServ allows classification of packets and marks them to receive a particular per-hop forwarding behavior on nodes along their path. In this project we would like to incorporate all these ideas from different studies to analyze the performance of high-speed routers.

References

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