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Performance Improvement Using Link Management in Wired and Wireless Networks

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Abstract: Knowledge of bottleneck capacity of an Internet path is critical for efficient network design, management, and usage. With emerging high speed Internet links, most traditional estimation techniques used for link capacity estimation are limited in providing fast and accurate capacity estimations. In general for effective and efficient means of communication between the nodes, the packet that has been sent from source node has to reach the destination without any loss. If the packet inflow of the node is greater than the link capacity of the node then the packets are to be queued in the buffer. It leads to the overflow of buffer. The packets that are dropped by the overflow of the buffer will then be stored in the new buffer. The new buffer will then be managed and allows the transfer of those packets to the destination.

By using the link estimation technique named PbProbe, the forward link capacity and the backward link capacity of the path is estimated. Based on these estimations the delay sum and dispersion of the packets is calculated. The packets that are dropped because of the overflow of buffer will then be managed in the new buffer by an active queue management technique named CoDel. This CoDel absorbs all the dropped packets and managed in the new buffer that adapts to changing link capacities and forwards those packets to other end point.

Keywords: *Link capacity, Packet loss, Link Estimation, PbProbe, Buffer Overflow, Codel*

I. INTRODUCTION

Knowledge of end-to-end path capacity is useful for video/audio stream adaptation, network management and overlay design. Capacity estimation in wired and last-hop wireless networks has been extensively investigated [3], but a thorough and systematic study in ad hoc, multihop wireless networks is still lacking. Yet the rate of a wireless link can change dynamically (and rapidly) due to changes in interference, distance or energy optimization policy. Knowledge of bottleneck capacity of an Internet path is critical for efficient network design, management, and usage. With emerging high speed Internet links, most traditional estimation techniques are limited in providing fast and accurate capacity estimations Estimating the bottleneck capacity of an Internet path is a fundamental research problem in computer networking; knowledge of such capacity is critical for efficient network design, management and usage. In the past few years, with the growing popularity of emerging technologies such as overlay, peer-to-peer (P2P), sensor, grid and mobile networks, it is becoming increasingly desirable to have a simple, fast and accurate technique for capacity estimation and monitoring.

To accommodate the diversity in network arrangements, an ideal capacity estimation technique must also be scalable and applicable to a variety of network configurations. Network link quality estimations are essential for the optimal operation of the various network functions like routing and rate adaptation.

PbProbe [2] is to estimate the capacity of the links. PbProbe is based on Cap Probe; however, instead of solely relying on packet pairs, PbProbe employs a “packet bulk” technique and adapts the bulk length in order to overcome the well-known problem with packet pair based approaches, namely the lack of accurate timer resolution. As a result, PbProbe not only preserves the simplicity and speed of Cap Probe, but it also correctly estimates link capacities within a much larger range. Using analysis, we evaluate PbProbe with various bulk lengths and network configurations. We then perform emulation and Internet experiments to verify the accuracy and speed of PbProbe on high speed links.

In network routing, CoDel [5] for controlled delay is an advanced scheduling algorithm for the network scheduler. It is designed to overcome bufferbloat in network links (such as routers) by setting limits on the delay network packets, passing through the buffer being managed by CoDel. CoDel aims at improving on the overall performance of the algorithm by addressing some fundamental misconceptions and by being easier to manage (since, unlike RED, CoDel does not require manual configuration). CoDel is parameter less. One of the weaknesses in the RED algorithm is that it is too difficult to configure (and too difficult to configure correctly, especially in an environment with dynamic link rates). CoDel has no parameters to set at all. CoDel treats good queue and bad queue differently. Good queue has low delays by nature, so the management algorithm can ignore it. Bad queue is susceptible to management intervention in the form of dropping packets. CoDel works off of a parameter that is determined completely locally, so it is independent of round-trip delays, link rates, traffic loads and other factors that simply cannot be controlled or predicted by the local buffer. The local minimum delay can only be determined when a packet leaves the buffer. So no extra delay is needed to run the queue to collect statistics to manage the queue. CoDel adapts to dynamically changing link rates with no negative impact on utilization. CoDel can be implemented relatively simply and therefore can span the spectrum from low-end home routers to high-end routing solutions.

With the increasing deployment of wireless devices (e.g. laptops, PDAs, cellphones, etc.), networking is becoming an increasingly important class of infrastructure less technology for connecting a group of wireless devices. Yet, the end-to-end knowledge of resources such as path capacity is important for network utilization and management. For instance, in a video conference application supported by an "overlay" that spans wired and wireless ad hoc users, the knowledge of path capacity to different destinations helps the sources and proxies adapt the audio/video streaming rates to match user capacities and provide better quality of services.

A simple and accurate end-to-end path capacity estimation technique is needed. The estimation must be fast so that it can reflect the path capacity in a timely even when the actual capacity is varying (for example, because the user is moving from one media to another or the environment interference is changing). The estimation must be independent of cross traffic (as in this case we are interested in evaluating the equivalent of the "bottleneck" capacity in the Internet, as opposed to "available" bandwidth). The estimation technique must be applicable to mixed wired and wireless paths, since several applications (especially the commercial applications) will include extensions as "opportunistic" extensions of the Internet. Finally, the estimation must be non-intrusive so that it will not disturb the ongoing applications traffic in the network.

II. Material And Methodology

In [5], the author has described about an active queue management mechanism regarding the management of buffer to avoid the packet loss in the network. The "CODEL" technique is designed to overcome buffer bloat in network links by setting limits on delayed network packets. In general packets are only dropped if buffer is full. The buffers are fairly small and get filled quickly i.e. buffer has a finite size and it can hold a maximum number of packets called window size. The flow of packets slows down while travelling through a network link between fast and slow network. CoDel adapts to dynamically change in link rates with non-negative impact on utilization of the link. The algorithm is computed at each interval of packets and maintaining a minimum delay below 5ms for the transmission to happen. The algorithmic technique named 'CODEL' is being used in related to my implementation of the project.

In [7], Packet loss in general will occur either due to collision or insufficiently strong signal. Apart from collision packet loss could also be due to weak signal. This can happen frequently as aggressive data rate adaption algorithms like sample rate operate wireless link at highest rate possible. The author has proposed a mechanism for identifying the packet loss i.e. "COLLIE". This determines the reason for packet loss by without requiring any addition transmission from wireless client but by using explicit feedback from the receiver. The mechanism of how the packets being lost will be identified. Based on the received signal strength from the packets received, the error loss will be calculated on cumulative frequency obtained at the receiver end.

In [2], most traditional techniques are limited in providing fast and accurate capacity estimation with emerging high speed links. Instead of solely relying on packet pairs, PbProbe employs a packet bulk technique and adapts the bulk length in order to overcome well known accurate problem of timer resolution. Cap probe is a yet another capacity estimation by round trip estimation technique that works well only on paths that contains symmetric bottle neck link. The PbProbe is used for capacity estimation and monitoring that is scalable and applicable to various network configurations. PbProbe will be estimated based on UDP packets, not only preserves the simplicity and speed of Cap probe it correctly estimates the link capacity within a much larger range. The packet bulk technique will overcome the problems of limited system timer resolution and to avoid additional latency caused by segmentation and reassembly.

In [1], Effective link capacity predicts link capacity by utilizing information such as packet delivery ration and transmission count on data packets derives information from transmitting node. Important functionality in these networks is routing of information from data source to destination. Adhoc on demand distance vector routing protocol is used to manage the routes and routing of data in wireless environments. AODV establishes a route to destination only on demand. AODV avoids counting the infinity problem by using the sequence numbers on route updates. Apart from estimation link capacity, estimated transmission count and expected transmission time for better quality of the link is calculated. Estimated link capacity is based on packet delivery ratio and transmission count of data packet.

In [6], to protect the buffer from overflow by approximately controlling the advertisement window to enhance TCP when becomes congested. The sender will slow down the data sending rate upon the receipt of reduced advertisement window, hence buffer overflow will be alleviated. The authors had addressed wireless loss tolerant congestion control mechanism based non dynamic aided theory. The proposed window will be applied to background traffic such as FTP, than network congestion because of the applications that experience delay and jitter.

III. Analysis On Link Management

So far the nodes in either wired or wireless networks have facing the problem of packet loss during transmission between the source and destination.The problem of estimating the capacity of an Internet path is one of fundamental importance. Due to the multitude of potential applications, a large number of solutions have been proposed and evaluated i.e. Cap Probe, path rate. Till now the link capacity is estimated [2] by using the packet pair and the total round trip time of the packets. Firstly when estimating the capacity of the link from the total round trip time, the time for calculating the total capacity will be too high. When transferring the packets in packet pair the rate of transmission of required data will not be successful all the time. The proposed solutions so far have been successful in partially addressing the problem, but have suffered from being slow, obtrusive or inaccurate.

The nodes experiencing the packet loss has been taken care by calculating the performance of the link that has been used between the nodes. The technique called PbProbe is to estimate high speed links. Instead of solely relying on packet pairs, PbProbe employs a "packet bulk" technique and adapts the bulk length in order to overcome the issues. The packets that are been lost will be stored in the buffer and will be dequeued for forwarding if the congestion at the receiving end will reduced.

The technique in estimating the capacity of the link through the PbProbe gives the accurate results by measuring the capacity both in forward path and backward path. Apart from estimating the capacity of the link, the packets that are lost in transmission will be addressed by an active queue management technique. The signal strength which is dynamic in both the networks is to be calculated. The results demonstrate the efficiency, scalability, and accurate capacity of the link both in wired and wireless network.

IV. DESIGN FOR LINK MANAGEMENT

A. Experimental Setup:

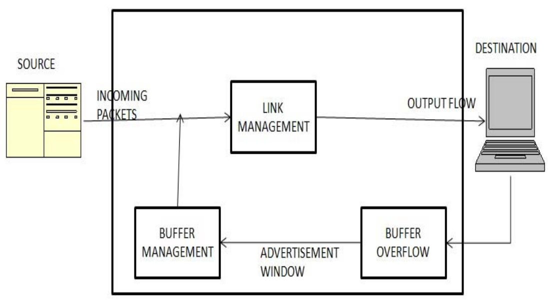


Fig 4.1: structural design architecture

The basic description regarding the architecture fig 4.1 considers of how the packets been transferred from source to destination without having any loss in the packets. Initially the source sends the packets in the form of packet-bulk or packet-pair mechanism. The packet-pair mechanism involves with the transfer of just two packets for one interval of time to the destination. Similar to this the packet-bulk is an advanced mechanism in transmission technique which transfers the packets in the form of bulk length. When transmitting the packets in bulk, the basic advantage is the successful delivery of the message to the destination within a specified time. The path the packets choose to travel to the destination is to be estimated with a technique called probe technique.

The probe technique transfers the packets in bulk i.e. packet bulk transmission. PbProbe is inspired by Cap Probe. However, instead of solely relying on one pair of packets, PbProbe employs the concept of "Packet Bulk" to adapt the number of probing packets in each sample in accordance to the dispersion measurement. More specifically, when the bottleneck link capacity is expected to be low, PbProbe uses one pair of packets as usual (i.e. the bulk length is 1). For paths with high bottleneck capacities, PbProbe increases the bulk length and sends several packets together, which enlarges the dispersion between the first and last packet, to overcome the known timer resolution problem.

Developing effective active queue management has been hampered by misconceptions about the cause and meaning of queues. Network buffers exist to absorb the packet bursts that occur naturally in statistically multiplexed networks. Queues occur in the buffers as a result of short-term mismatches in traffic arrival and departure rates that arise from upstream resource contention, transport conversation startup transients, and/or changes in the number of conversations sharing a link. Unfortunately, other network behavior can cause buffers to fill, with effects that aren't nearly as benign. With the wrong conceptual model for queues, AQMs have limited operational range, require a lot of configuration tweaking, and frequently impair rather than improve performance.

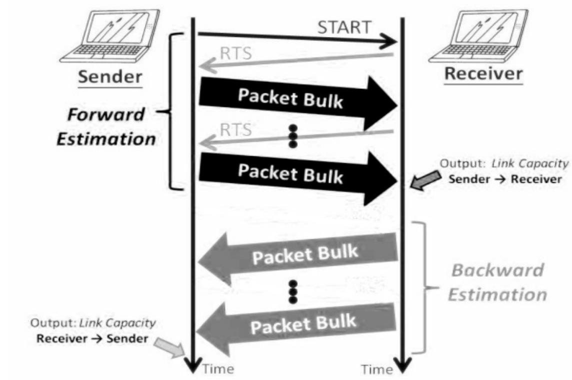


Fig 4.2: Working of PbProbe

B. *Computation of Threshold Technique*

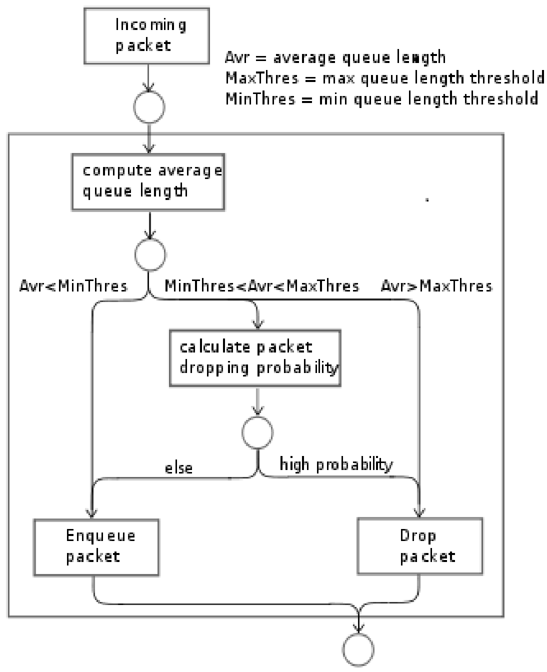


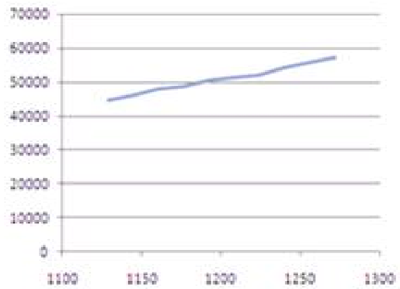
Fig 4.3: Threshold mechanism of packet inflow

The packets that are transmitting will be checking for the bottleneck threshold prescribed explained in fig 4.3 at each interval. If the packets having the average less than the threshold mechanism then the packets will be dequeued for forwarding from the buffer. When the packets had the average greater than the threshold then the packets will be dropped from the queue. If the packets satisfy the threshold condition then the transfer of packets will be done. Similarly if the packets had the average in between both the maximum threshold limit and minimum threshold limit the packets will calculate the packet dropping probability and then transmits the packets to the required destination.

C. ***Performance Analysis***

Packet loss due to buffer overflow:

Packet loss in bytes



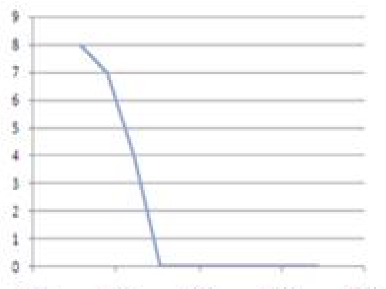
Time in milliseconds

Fig.1: Packet loss due to buffer overflow.

Fig.1 shows the packet loss due to the buffer overflow without the threshold mechanism. It reveals that the packet loss increases when the simulation time increases.

Reducing packet loss in buffer due to buffer overflow

Packet loss in bytes



Time in milliseconds

Fig.2 shows the packet loss due to the buffer overflow with the threshold mechanism. It reveals that the packet loss decreases when the simulation time increases. Explanation of packet loss in link due to link capacity overflows:

Packet loss due to link capacity overflows without the threshold mechanism. It reveals that the packet loss increases rapidly with the decrease in signal strength.

V. Conclusion

This paper presented a threshold mechanism that reduces the packet loss in a buffer and the link of both wired and wireless network. The packet loss in the buffer and link is due to the overflow. Both the buffer overflow and link overflow is determined and controlled with the help of PbProbe and CoDel methodologies. The rate of overflow of packets is reduced as soon as the overflow occurs i.e. threshold is reached and packet loss is reduced.

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