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An Efficient Congestion Control Scheme for Data Using Tokens in Network

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ABSTRACT

Accommodating audio, video, and data traffic simultaneously by Internet requires the packet loss which depends very much on congestion control must be guaranteed. To control network congestion protocols are to be introduced to supplement the mechanism of TCP. Designed as an open-loop controller CSFQ supervises the per-flow bandwidth consumption. But when the P2P flows started to dominate the traffic of the Internet it became helpless. Token-Based Congestion Control (TBCC) is based on a closed-loop congestion control rule, which restricts token resources addicted by an end-user and provides effort service with O(1) complexity. By policing inter-domain traffic it experiences a heavy load for lack of trust. The new protocols introduced - Stable Token-Limited Congestion Control (STLCC) - appends inter-domain congestion control to TBCC and make stable congestion control system. Congestion index was produce by STLCC which pushes the packet loss to the network edge and improves the network performance. The simple version of STLCC introduced is deployable in the Internet without any IP protocols modifications and preserves also the packet datagram.

INTRODUCTION

Modern IP network services require congestion control protocols and algorithms to provide simultaneous digital transmission of voice, video, and data as services that can solve the packet loss parameter can be kept under control. Congestion control is the cornerstone of packet switching networks as it should prevent congestion collapse, give equality to competing flows and optimize transport performance indexes such as throughput, delay and loss. There are papers on high-level models [17][18][19] of the flow of packets through the network. There are also papers on specific network architecture [20][21][22][23][24][25][26] [27].

Congestion control in telecommunication networks struggles with two major problems – (1) The time-varying delay between the control point and the traffic sources and (2) problems related to the possibility that the traffic sources do not follow the feedback signal because some sources are silent as they have nothing to transmit. In the Terminal Dependent Congestion Control model, Congestion control in the Internet originally designed for a cooperative environment is still dependent on the TCP congestion control algorithm at terminals, supplemented with load shedding [1] at congestion links. Routers equipped with Active Queue Management such as RED [2] can improve transport performance, but they cannot prevent congestion collapse and cannot provide fairness to competing flows.

Core-Stateless Fair Queuing (CSFQ) [3] set up an open- loop control system at the network layer to enhance fairness in high speed networks and inserts the label of the flow arrival rate onto the packet header at edge routers and drops the packet at core routers based on the rate label if obstruction happens. CSFQ is the first to achieve fairly accurate fair bandwidth allocation among flows with O(1) complexity at core routers.

The report generated after 2004 result in lot of discussions around the real numbers. Cache Logic report of P2P traffic was 60% of all the Internet traffic in 2004, of which Bit-Torrent [4] was responsible for about 30%In networks with P2P traffic, CSFQ can provide fairness to opposing flows, but unluckily it is not what end-users and operators really want. The total token resource consumed by an end-user is restricted by Token-Based Congestion Control (TBCC) [5]. When TBCC is used, it cannot obtain extra bandwidth resources regardless of number of connections set up by the end-user.

The expansion of CSFQ across the domain border is tried by the Self-Verifying CSFQ [6]– A flow is randomly selected; the flow's rate is re-estimated; consistency of the re-estimated rate is checked with the label on the flow's packet. Thus the Self-Verifying CSFQ will put a heavy load on the border router and makes the weighted CSFQ null and void. In [7][8]the authors present a congestion control architecture Re-feedback that aims to provide the fixed cost to end-users and bulk inter-domain congestion charging to network operators. Re-feedback demands very high level complexity to identify the malignant end-user and is difficult to provide the fixed congestion charging to the inter-domain interconnection with low complexity.

There are three types of inter-domain interconnection polices – (1) the Internet Exchange Points (2) the private peering and (3) the transit. In the private peering polices, the traffic is exchanged between two domains without mutual charge in the Sender Keep All (SKA) peering arrangements. It is difficult for Re-feedback to support the requirements of SKA as Re-feedback is based on congestion charges to the peer domain.

Now a new and better mechanism for congestion control with application to Packet Loss in networks with P2P traffic is proposed in this paper. The edge and the core routers will write a measure of the quality of service guaranteed by the router by writing a digital number in the Option Field of the datagram of the packet and it is called a token. The path routers read the token and the value interpreted will give a measure of the congestion especially at the edge routers. The edge router at the source's edge point will shape the traffic generated by the source and reduces the congestion on the path based on the token number. In Token-Limited Congestion Control (TLCC) [9], the total output token rate to peer domains is restricted by the inter-domain router. When the output token rate exceeds the threshold, TLCC will decreases the Token-Level of output packets, and then the output token rate will decrease. TLCC uses the iterative algorithm to estimate the congestion level of its output link, and requires a long period of time to reach a stable state. TLCC may cause the traffic to fall into an oscillated process with bad parameter configuration. The window size of TCP flows will always increase when acknowledge packets are received, and the congestion level will increase at the congested link. At congestion times many flows will lose their packets. Then, the link will be idle and the congestion level will decrease. The two steps may be repeated alternately, and then the congestion control system will never reach stability.

The Stable Token-Limited Congestion Control (STLCC) introduced solves the fluctuation problem by integrating the algorithms of TLCC and XCP altogether. In STLCC, there is almost no packet loss at the congested link as the output rate of the sender is controlled according to the algorithm of XCP [10]. The edge router allocates all the access token resource to the incoming flows equally. When congestion happens, the incoming to-

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ken rate increases at the core router, and then the congestion level of the congested link will also increase. STLCC measures the congestion level systematically, allocate network resources according to the access link, and keep the congestion control system stable.

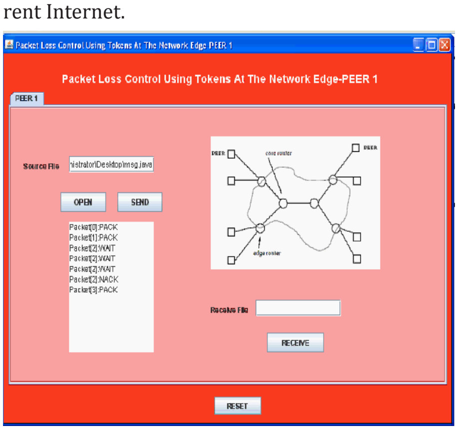
IMPLEMENTATION

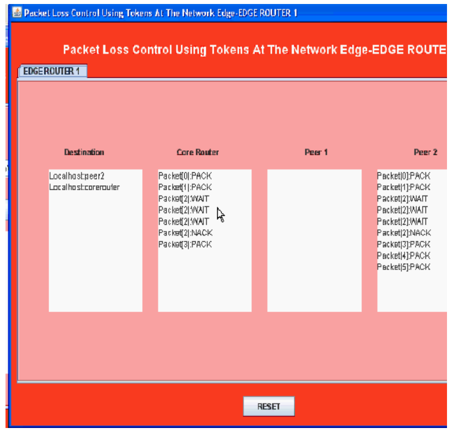
Congestion occurs when the number of packets being transmitted through the network approaches the packet handling capacity of the network. Congestion control aims to keep number of packets below level at which performance falls off dramatically. STLCC is able to shape output and input traffic at the inter-domain link with O(1) complexity. STLCC produces a congestion index, pushes the packet loss to the network edge and improves the network performance. To solve the oscillation problem, the Stable Token-Limited Congestion Control (STLCC) is introduced. It integrates the algorithms of TLCC and XCP [10] altogether. In STLCC, the output rate of the sender is controlled according to the algorithm of XCP, so there is almost no packet lost at the congested link. At the same time, the edge router allocates all the access token resource to the incoming flows equally. When congestion happens, the incoming token rate increases at the core router, and then the congestion level of the congested link will also increase. Thus STLCC can measure the congestion level analytically, allocate network resources according to the access link, and further keep the congestion control system stable.

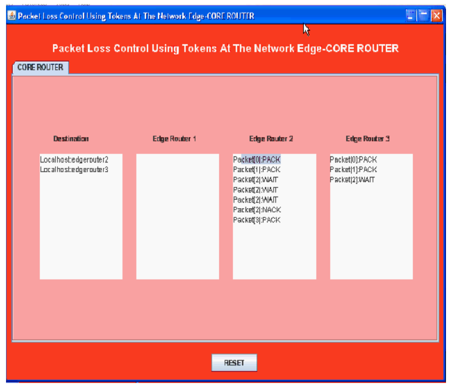
In this paper a new and better mechanism for congestion control with application to Packet Loss in networks with P2P traffic is proposed. In this new method the edge and the core routers will write a measure of the quality of service guaranteed by the router by writing a digital number in the Option Field of the datagram of the packet. This is called a token. The token is read by the path routers and interpreted as its value will give a measure of the congestion especially at the edge routers. Based on the token number the edge router at the source, thus falling the congestion on the path. A core router is a router designed to operate in the Internet Backbone or core. To fulfill this role, a router must be able to support multiple telecommunications interfaces of the highest speed in use in the core Internet and must be able to forward IP packets at full speed on all of them. It must also support the routing protocols being used in the core. A core router is different from an edge router.

Edge routers sit at the edge of a backbone network and connect to core routers. The token is read by the path routers and interpreted as its value will give a measure of the congestion especially at the edge routers. Depend on the token number the edge router at the source, thus dropping the congestion on the path.

In this paper, the architecture of Token-Based Congestion Control (TBCC), which provides fair bandwidth allotment to end-users in the same domain is introduced. Two congestion control algorithms CSFQ and TBCC are evaluated. STLCC is presented and the simulation is designed to demonstrate its validity. The Unified Congestion Control Model is presented which is the abstract model of CSFQ, Re-feedback and STLCC. The simple version of STLCC is proposed, which can be deployed on the current Internet.







CONCLUSION

To inter-connect two TBCC domains, the inter-domain router is added to the TBCC system. To support the SKA arrangement, the inter-domain router should limit its output token rate to the rate of the other domains and police the incoming token rate from peer domains.

To limit the output token rate, three elements *tkprev*, *tkdown* and *tkbackdown* are inserted into the extended header *tkhead.* At the basis edge router, the *tkprev* is set to the same value as the *tklevel* and cannot be altered by routers. The computation of *tkdown* represents the decrements of Token-Level at all the inter-domain routers in the transmission path. When the packet arrives at the destination, the sum of *tkpath and tkdown* is the Congestion-Index of the transmission path. In the reverse packet, the *tkbackdown* is used to return the elements of *tkdown* in the forwarding packet header to the source edge router.

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