Retransmission Reduction Scheme in Concurrent Multipath Transfer

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Abstract. Reaching full path utilization is final goal in Concurrent Multipath Transfer (CMT). To overcome bandwidth limitation several researches related to schemes that integrate available links such as ECMP, SCTP, and MPTCP, was announced. Previous CMT schemes did not offer any real advantage over best-path routing. In this paper, we propose retransmission reduction scheme in CMT and show the proposed scheme is better performance in mobile communication environments

Keywords: CMT, retransmission, mobile, wireless communication.

1 Introduction

In mobile communications, demands on data traffic, that needs high bandwidth such as multimedia streaming, are increasing due to emerging smartphone. New technologies such as LTE (Long Term Evolution), advanced WiMAX can provide wider bandwidth to customers, but, mobile service may be saturated within couple of years. Today, most hosts have more than one interface and the proliferation of smart-phones equipped with both 3G(or LTE) and WiFi will bring a growing number of multi-homed hosts on Internet. A lot of researches has studied to maximize bandwidth utilization in multipath environment.

To overcome bandwidth limitation several researches related to schemes that integrate available links was announced. First result was ECMP (Equal Cost Multi Path) that is a simple concurrent forwarding scheme [1][2]. But, ECMP is not widely used because it has several weak points. Other researches were based on SCTP multi-homing. They identified side effects of reordering introduced by CMT and proposed algorithms to avoid side effects [3][4]. IETF organized MPTCP working group to develop mechanisms that add the capability of simultaneously using multiple paths to a regular TCP session [7]. Their goal is to make deployable and usable without significant changes to existing Internet infrastructure.

In mobile communication environment, a mobile terminal such as a smartphone shows a different behavior from a desktop PC or a notebook. When two processes communicate simultaneously, packet delay is increased significantly because a mobile terminal has limited processing power. Therefore, when a mobile terminal works in CMT mode, RTT might be larger than 1 sec due to packet processing in the system.

In addition, the emergence of high speed mobile network, such as LTE made it difficult for CMT to utilize available bandwidth fully.

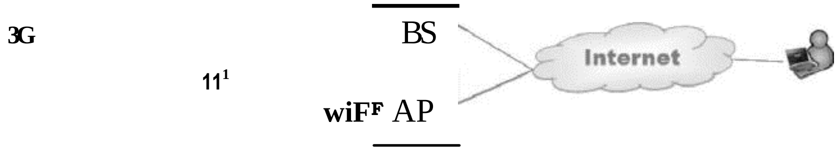

Fig. 1. The Manchester code can trace a collision to an individual bit.

In this paper, we propose retransmission reduction scheme in CMT and show the proposed scheme is better performance in mobile communication environments like figure 1.

2 Related works

Equal-cost multi-path Routing (ECMP) is a routing strategy where next-hop packet forwarding to a single destination can occur over multiple paths. ECMP can be used in conjunction with most routing protocols, since a next-hop selection can be performed in a single router [1]. In many situations, ECMP may not offer any real advantage over best-path routing.

Other researches were based on SCTP multi-homing. They identified three negative side effects of reordering introduced by CMT: unnecessary fast retransmissions at the sender, reduced cwnd growth due to fewer cwnd update at the sender, and more ack traffic due to fewer delayed ack [3][4]. In [5], authors proposed fast retransmission policies to allow better cwnd growth in CMT.

Since 2010, MPTCP working group of the IETF has been developing multipath extension to TCP that enable hosts to use several paths possibly through multiple interfaces, to carry the packets that belong to a single connection. In [5], the implications of MPTCP on receive buffers and coupled congestion control scheme of MPTCP were evaluated. The study showed the MPTCP performance decreases as the delay difference of two path increases in case of small receive buffer size.

3 Retransmission Reduction Scheme

According to the previous studies, there are several factors such as receive buffer size, retransmission scheme, congestion control scheme, etc. to reduce full path utilization in concurrent multipath transfer. In mobile environment, concurrent multipath transfer is quite tough due to higher loss rate, larger delay, lower bandwidth, and wide variation of them compared to wired environment. Most of previous works focused on the viewpoint of network environments. But, we occasionally skipped over something happening in end-devices in case of CMT. In CMT, an end-device uses more than two network interfaces to transmit and receive data. Specially, in case of a mobile terminal such as a smart-phone, influence of packet processing is also important as much as network environment influence because it has limited processing power. In figure 2, WiFi ping delay is usually under 10ms. But, when there is WiFi traffic in the same mobile terminal, average ping delay increased to about 130ms. In 3G case, ping delay increased from 50ms to over 500ms. Therefore, if a mobile terminal transmits data using CMT, difference of packet delay might be larger than 1000ms including packet processing delay and queuing delay in communication channel.

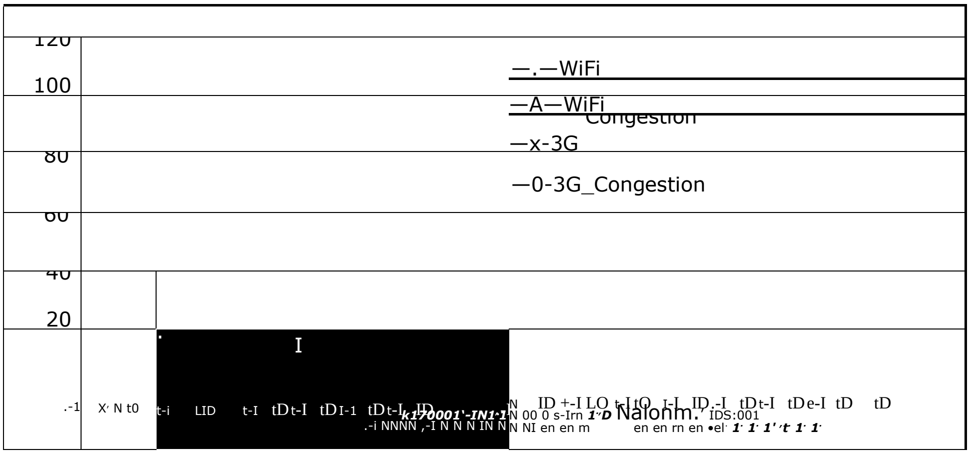

Fig. 2. Change of WiFi and 3G delay distribution (normal and congestion condition).

The retransmission reduction scheme measures RTT through measuring time between data and their acknowledgments and estimates receive buffer utilization at a receiver.as follows

$$ut = (rttpathl - rttpath2) * bw_t \text{ where } rtt_{p}athl > rtt_{path2}$$

If a sender knows receiver's buffer size in advance and RTT difference is longer than predefined time, a sender transmits packets to the path which has larger congestion window till RTT difference reaches under the threshold.

4 Performance Evaluation

To validate retransmission reduction scheme, we measured throughput of four mobile terminals during 10 seconds simultaneously in real environment as shown in Fig. 1. Throughput of our proposed scheme is better than that of previous schemes as shown in Qom! **-a! § § TtrAd LI** But, in half of trial results, CMT at mobile terminal shown lower performance than 3G single transfer. It has several reasons such as packet processing delay, queueing delay and reordering delay. And RTO (retransmission timeout) is shoten due to sending acknowledgeburstly.

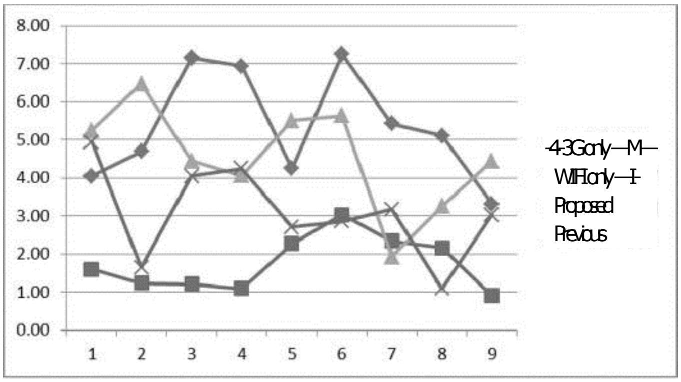

Fig. 3. Throughput performance of four mobile terminals

5 Conclusion

We proposed the retransmission reduction scheme which effectively maximizes multipath utilization in mobile environment. Through measurement results in real environment, we show that proposed scheme generally show better performance compared to previously proposed schemes.

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