MPTCP
Internet Draft
Intended status: Informational
Expires: June 2017

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December 27, 2016

One Way Latency Considerations for MPTCP
draft-song-mptcp-owl-01.txt

Abstract

This document discusses the One Way Latency (OWL) utilization for enhancing multipath TCP (MPTCP) transmission, which is a potential and beneficial technology in MPTCP Working Group (WG). Several representative usages of OWL, such as retransmission policy, crucial data scheduling, are analyzed. Two kind s of OWL measurement approaches are also provided and compared. We believe that more explorations related with OWL will be important for MPTCP.

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1. Introduction

As the basic elements of Internet, both the intermediate devices and the end hosts have equipped more and more physical network interfaces.
For the former, multiple interfaces had been widely used in packet forwarding, traffic engineering, etc. For the latter, the importance of these interfaces had been confirmed and utilized [RFC6419]. Moreover, the capacity of multiple paths created by multiple interfaces is leveraged to aggregate higher bandwidth, achieve lower delay and provide better services. Different with traditional TCP [RFC0793], many transport layer protocols enable the end hosts to concurrently transfer data on top of multiple paths and greatly increase the overall throughput, such as MPTCP [RFC6182][RFC6356].

However, we believe that the performance of current practices of MPTCP could be further improved by fully taking advantage of One Way Latency (OWL) during the transmission. In single path transfer mode, there is less benefits to achieve if one separates the OWL out of Round Trip Time (RTT) because there are no other available paths to choose.

Motivated by previous facts, we suggest discussing the necessary considerations of OWL in MPTCP. The structure of this document is as follows: Firstly, possible usages of OWL in MPTCP are analyzed. Secondly, two kinds of OWL measurements are listed and compared. The consideration related with security and IANA are given at the end.

The potential target readers of this document are application programmer whose products may significantly benefit from MPTCP. This document also provides the necessary information for the developers of MPTCP to implement the new version API into the TCP/IP network stack.

2. Terminology

The key words "MUST", "MUST NOT", "REQUIRED", "SHALL", "SHALL NOT", "SHOULD", "SHOULD NOT", "RECOMMENDED", "MAY", and "OPTIONAL" in this document are to be interpreted as described in RFC 2119 [RFC2119].

The document makes extensive use of the terminology and definitions inherited from Architectural Guidelines for Multipath TCP Development [RFC6182] and TCP Extensions for Multipath Operation with Multiple Addresses [RFC6824].

3. Potential Usages of OWL in MPTCP

There are several potential usages of OWL when MPTCP is enabled by the sender and receiver. Although only five significant aspects are illustrated in this document, more explorations in this direction are still needed.

3.1. Retransmission Policy

When packet is identified by triple duplicated acknowledgements or timeout, the sender needs to select a suitable path for retransmission. Due to the popular mechanisms of sequence control in reliable transport protocols, outstanding packets on multiple paths may reach to the destination disorderly and trigger Receive Buffer Blocking (RBB) problem, which will further affect the transmission performance.

By using the results of OWL measurement, the sender could quickly determine the specific path with minimum forward latency. RBB could be relieved as soon as the receiver obtains the most needed packet(s) and submits them all to the upper layer.

3.2. Crucial Data Scheduling

During the transmission process, there are always some crucial data need to be sent to the destination immediately. For example, the key frame of multimedia, high priority chunk of emergency communication, etc. One can not guarantee the arriving sequence if only RTTs of multiple paths are utilized.

By using the results of OWL measurement, the sender could easily select the fast path, in terms of forward latency, for crucial data transmission. Moreover, the acknowledgements of these crucial data could be sent on the path with minimum reverse latency. Piggyback is also useful when duplex communication mode is adopted.

3.3. Congestion Control Mechanism

Current version of MPTCP includes different kinds of congestion control mechanisms. By reasonably utilizing OWL, the network congestion situation of single direction could be better described. More information needs to be added.

3.4. Bandwidth Estimation

Understanding the bandwidth condition is beneficial for data packet scheduling, load balancing, etc. OWL could be integrated with bandwidth estimation approaches without interrupting the regular packets sending. More information needs to be added.

3.5. Shared Bottleneck Detection

Fairness is critical especially when MPTCP and ordinary TCP coexist at the same network. The sender could treat OWL measurements as the sample process of shared bottleneck detection and accordingly adjust the volume of data packet on multiple paths. More information needs to be added.

4. The Classification of OWL Measurement

Two kinds of OWL measurement approaches are available in current network: absolute value and relative value.

For the absolute value of OWL, the primary condition of measurement is clock synchronization. By using Network Time Protocol (NTP) [RFC5905], end hosts can unify the local time with remote NTP server. The additional information or optional capabilities can be even added via extension fields in standard NTP header [RFC7822]. The calibration accuracy could reach to millisecond level in less

congested situation. Obvious burden is to persuade the end hosts to initial NTP option.

For the relative value of OWL, in some circumstance, it is more than enough to establish applications on top of it. For example, when retransmission is required, the sender just cares about which path minimum forward latency has. When bandwidth is being estimated, the difference of forward latency (i.e. delta latency) among all available paths is needed. By exchanging the local receiving and sending timestamps with corresponding end host, both sides could obtain the relative value of OWL. The matrix operations and algorithm could accelerate the calculation process.

The concerns of the former one are extra protocol requirement and synchronization accuracy. However, it is more convenient for its applications. On the contrary, the latter one only needs to add timestamps into original protocol stack and does not need to worry about the accuracy.

5. Security Considerations

This document does not contain any security considerations. However, future applications of OWL in MPTCP will definitely need to establish relevant mechanisms for security improvement.

6. IANA Considerations

There are presently no IANA considerations with this document.

7. References

7.1. Normative References

[RFC0793] Postel, J., "Transmission Control Protocol", STD 7, RFC793, September 1981.

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7.2. Informative References

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8. Acknowledgments

Many thanks to the reviews of this document for their valuable feedbacks and comments.

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