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**One Way Latency Considerations for Multipath in QUIC**  
**draft-chan-quic-owl-01**

Abstract

This document discusses the use of One Way Latency (OWL) for enhancing multipath transmission in QUIC. Several representative usages of OWL, such as congestion control mechanism, retransmission policy, crucial data scheduling are analyzed. Two kinds of OWL measurement approaches are also provided and compared. More explorations related with OWL will be researched to improve the performance of QUIC.

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## [1.](#) Introduction

Round-trip time (RTT) is commonly used in congestion control and loss recovery mechanism for data transmission. Yet the key issue for data transmission is simply the delay of the data transmission along a path which does not include the return. The latency for uplink and downlink between two peers may be very different. RTT, which cannot accurately reflect the delay of the data transmission along a path, can be easily influenced by the latency in the opposite direction along that path. Therefore, the use of One Way Latency (OWL) [[I-D.song-mptcp-owl](#)] is proposed to describe the exact latency from the time that data is sent to the time data is received.

Using the timestamps information in the ACK Frame of QUIC [[I-D.ietf-quic-transport](#)], the One Way Latency can be calculated in absolute value or in relative value. As multipath will be supported by QUIC, path selection based on One Way Latency can improve the performance of multipath in QUIC in several situations, such as congestion control, packet retransmission, crucial data scheduling, etc.

We suggest discussing the necessary considerations of OWL in QUIC. In the following, possible usages of OWL in QUIC are analyzed, and then two kinds of OWL measurements are listed and compared.



## **2. Conventions and 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 [[RFC2119](#)].

One Way Latency (OWL): the propagation delay between a sender and a receiver from the time a signal is sent to the time the signal is received.

## **3. Potential Usages of OWL in QUIC**

There are a number of potential uses of OWL, especially for multipath in QUIC. Although only 3 significant aspects are illustrated in this document, more explorations are still needed.

### **3.1. Crucial Data Scheduling**

During a transmission process, there are often some crucial data that need to be sent to the destination immediately. Examples of such crucial data are the key frame in multimedia, the high priority chunk of emergency communication, etc. One cannot guarantee the sequence of data arrival along multiple paths if only the RTTs of the multiple paths are used.

The data rate in any given link can be asymmetric. In addition, the delay in a given direction can change according to the amount of packet queue. Therefore delay in a forward direction in a path is not necessarily the same as that in the reverse direction as exemplified in Figure 1.



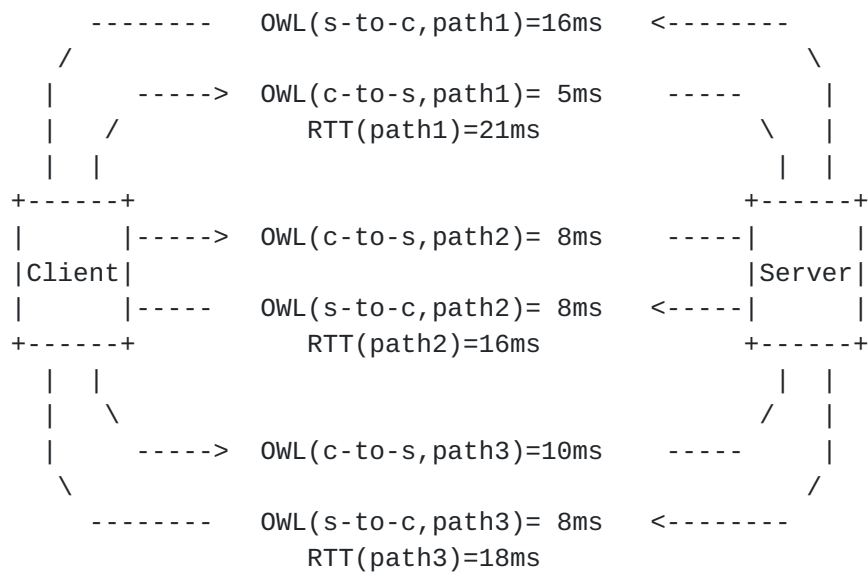


Figure 1. Example with 3 paths between the client and the server with OWL as indicated in the figure. RTT information alone would indicate to the client that the fastest path to the server is path 2, followed by path 3, and then followed by path 1. path 2 is the fastest, whereas OWL indicates to the client that the fastest path to the server is path 1, followed by path 2, and then followed by path 3.

Using the results of OWL measurement, the sender can easily select the faster path, in terms of the latency in the forward direction, for crucial data transmission. Moreover, the acknowledgements of these crucial data can be sent on the path with minimum latency in the reverse direction. Piggyback is then also useful when in duplex communication mode.

### 3.2. Congestion Control

Congestion in a given direction does not necessarily imply congestion also in the reverse direction.



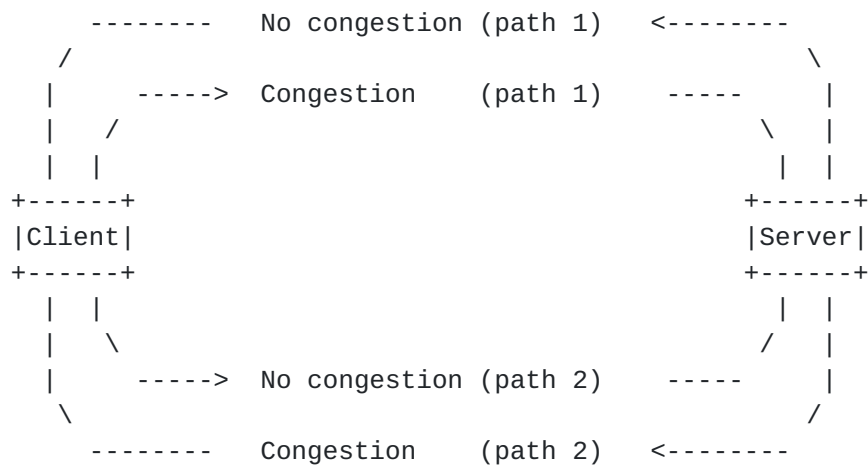


Figure 2. Example of a congestion situation with 2 paths between the client and the server. There is congestion from client to server along path 1 and also from server to client along path 2. RTT information alone will indicate congestion in both paths, whereas OWL information will show the client that path 2 is the more lightly loaded path to get to the server.

Network congestion in a given direction can be better described using OWL rather than using RTT. Especially when the congestion can be a situation in a unidirectional path, the congestion in the path from a client to a server is different from the congestion in the path from the server to the client. The RTT cannot accurately reflect the delay of interest for data transmission along a path. For multipath in QUIC, the client needs to choose a more lightly loaded path to send packets [RFC6356]. It will then be unwise to compare the RTT among different paths, and it should instead compare the OWL among the paths.

### 3.3. Packet Retransmission

Continuous Multipath Transmission (CMT) increases throughput by concurrently transferring new data from a source to a destination host via multiple paths. However, when a packet is lost, Receive Buffer Blocking (RBB) will occur as illustrated in Figure 3.





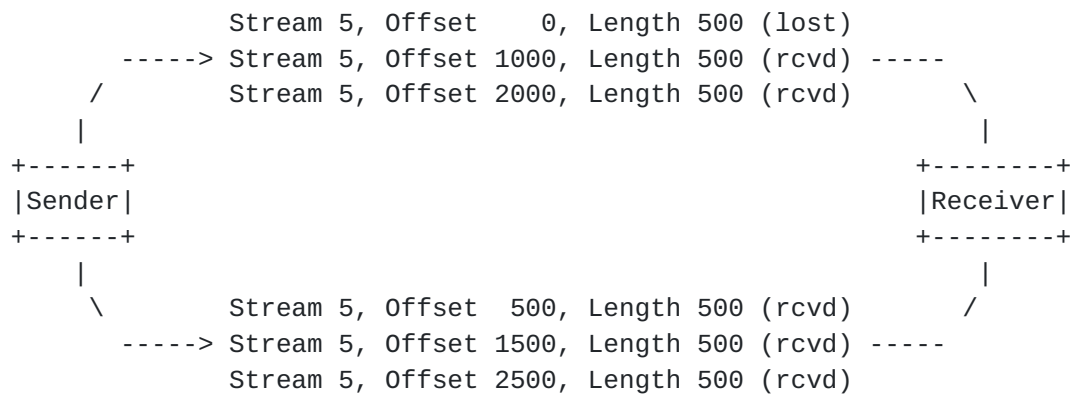


Figure 3. Example of Receive Buffer Blocking: The packet containing octets 0-499 in Stream ID=5 is lost. On the other hand the packets containing Octets 500-999, 1000-1499, 1500-1999, 2000-2499 in Stream ID=5 have all been received. The octets 500-2000 are then all buffered at the receiver, and are blocked by the missing octets 0-499.

Therefore, the sender needs to select a suitable path to retransmit ASAP. Using the results of OWL measurement, the sender can quickly determine the specific path with minimum forward latency. RBB can then be relieved as soon as the receiver obtains the most needed frames in the retransmitted packet(s) and submits them to the upper layer.

#### 4. OWL Measurement

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

To obtain the absolute value of OWL, the primary condition of measurement is clock synchronization. Using Network Time Protocol (NTP) [[RFC5905](#)], end hosts can calibrate the local clock with the remote NTP server. The additional information or optional capabilities can even be added via extension fields in the standard NTP header [[RFC7822](#)]. The calibration accuracy can reach to the millisecond level in less congested situations. The obvious burden here is to persuade the end hosts to initialize the NTP option.

Obtaining the relative value of OWL is more than enough in some circumstances to establish applications on top of it. When retransmission is needed, for example, the sender may only care about which path has the minimum forward latency. When bandwidth is being estimated, the difference of forward latency, i.e. delta latency, among all available paths is needed. By exchanging with correspondent end host the local timestamps of receiving and sending the packets, both sides could obtain the relative value of OWL.



The considerations to obtain the absolute values are the extra protocol requirement and synchronization accuracy. However, using the absolute values is more convenient for its applications. On the contrary, the relative measurement only needs to send timestamps in the acknowledgment and there is no need to worry about the clock synchronization.

## **5. Security Considerations**

TBD

## **6. IANA Considerations**

This document presents no IANA considerations.

## **7. References**

### **7.1. Normative References**

[RFC2119] Bradner, S., "Key words for use in RFCs to Indicate Requirement Levels", [BCP 14](#), [RFC 2119](#), DOI 10.17487/RFC2119, March 1997, <<http://www.rfc-editor.org/info/rfc2119>>.

### **7.2. Informative References**

- [I-D.ietf-quic-transport]  
Iyengar, J. and M. Thomson, "QUIC: A UDP-Based Multiplexed and Secure Transport", [draft-ietf-quic-transport-01](#) (work in progress), January 2017.
- [I-D.song-mptcp-owl]  
Song, F. and H. Zhang, "One Way Latency Considerations for MPTCP", [draft-song-mptcp-owl-01](#) (work in progress), December 2016.
- [RFC5905] Mills, D., Martin, J., Ed., Burbank, J., and W. Kasch, "Network Time Protocol Version 4: Protocol and Algorithms Specification", [RFC 5905](#), DOI 10.17487/RFC5905, June 2010, <<http://www.rfc-editor.org/info/rfc5905>>.
- [RFC6356] Raiciu, C., Handley, M., and D. Wischik, "Coupled Congestion Control for Multipath Transport Protocols", [RFC 6356](#), DOI 10.17487/RFC6356, October 2011, <<http://www.rfc-editor.org/info/rfc6356>>.



[RFC7822] Mizrahi, T. and D. Mayer, "Network Time Protocol Version 4 (NTPv4) Extension Fields", [RFC 7822](#), DOI 10.17487/RFC7822, March 2016, <<http://www.rfc-editor.org/info/rfc7822>>.

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