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Authors:	A. Custura	G. Fairhurst
	<i>University of Aberdeen</i>	<i>University of Aberdeen</i>

Quic Logging for Convergence of Congestion Control from Retained State

Abstract

This document specifies a logging format for a cautious method for Careful Resume when using the IETF quic transport protocol. It defines the logging format for qlog.

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1. Introduction

[[I-D.ietf-tsvwg-careful-resume](#)] defines a Congestion Control (CC) mechanism called Careful Resume, which is expected to reduce the time to complete a transfer when the transfer sends significantly more data than allowed by the Initial congestion Window (IW), and where the BDP of the path is also significantly more than the IW. It introduces an alternative mechanism to

select initial CC parameters that seeks to more rapidly and safely grow the sending rate controlled by the congestion window (CWND). CC algorithms that are rate-based can make similar adjustments to their target sending rate.

When used with the QUIC transport, Careful Resume provides transport services that resemble those that could be implemented in TCP, using methods such as TCP Control Block (TCB) [RFC9040] caching.

2. Language, Notation and Terms

This subsection provides a brief summary of key terms and the requirements language.

2.1. Requirements Language

The key words "MUST", "MUST NOT", "REQUIRED", "SHALL", "SHALL NOT", "SHOULD", "SHOULD NOT", "RECOMMENDED", "NOT RECOMMENDED", "MAY", and "OPTIONAL" in this document are to be interpreted as described in BCP 14 [RFC2119] [RFC8174] when, and only when, they appear in all capitals, as shown here.

2.2. Notation and Terms

The document uses language drawn from a range of IETF RFCs. The following terms are defined:

Careful Resume (CR): The method specified in XXX

CWND: The congestion window, or equivalent CC variable limiting the maximum sending rate;

current_rtt: A sample measurement of the current RTT;

PipeSize: A measure of the validated available capacity based on the acknowledged data;

saved_cwnd: The preserved capacity derived from observation of a previous connection (see [I-D.ietf-tsvwg-careful-resume]);

saved_rtt: The preserved minimum RTT (see [I-D.ietf-tsvwg-careful-resume]).

Unvalidated Packet: A packet sent when the CWND has been increased beyond the size normally permitted by the CC algorithm; if such a packet is acknowledged, it contributes to the PipeSize, but if congestion is detected, it triggers entry to the Safe Retreat Phase.

3. The Phases of CC using Careful Resume

Careful Resume[I-D.ietf-tsvwg-careful-resume] defines a series of phases that a congestion controller moves through as a connection uses the mechanism. The key phases are illustrated in Figure 1.

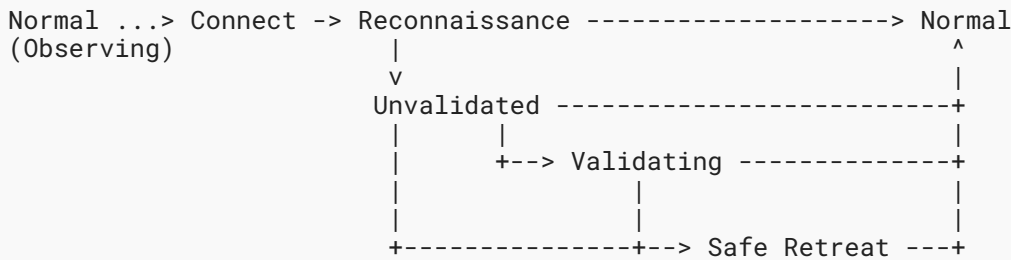


Figure 1: Key transitions between Phases in Careful Resume.

Examples of these transitions between phases are provided in the annexe to [\[I-D.ietf-tsvwg-careful-resume\]](#).

3.1. Observing

There are currently no qlog events associated with this phase.

3.2. Reconnaissance Phase

A sender enters the Reconnaissance Phase after connection setup. In this phase, the CWND is initialised to the IW, and the sender transmits initial data.

Reconnaissance Phase (Path confirmed): When a sender has confirmed the RTT and also has received an acknowledgement for the initial data without reported congestion, it MAY then enter the Unvalidated Phase. The associated qlog event is XXX.

3.3. Unvalidated Phase

The Unvalidated Phase is designed to enable the CWND to more rapidly get up to speed by using paced transmission of a tentatively increased CWND.

Unvalidated Phase (Confirming the path on entry): If the `current_rtt` is not confirmed, the sender MUST enter the Normal Phase (see `trigger_rtt_not_validated` in [Section 4](#)).

Unvalidated Phase (Receiving acknowledgement for an unvalidated packet): The sender enters the Validating Phase when an acknowledgement is received for the first packet number (or higher) that was sent in the Unvalidated Phase or greater than 1 RTT has passed in the Unvalidated Phase (see `first_unvalidated_packet_acknowledged` in [Section 4](#)).

3.4. Validating Phase

The Validating Phase checks whether all packets sent in the Unvalidated Phase were received without inducing congestion. The CWND remains unvalidated and the sender typically remains in this phase for one RTT.

Validating Phase (Congestion indication): If a sender determines that congestion was experienced (e.g., packet loss or ECN-CE marking), Careful Resume enters the Safe Retreat Phase (see trigger `packet_loss` and `ECN_CE` in [Section 4](#)).

Validating Phase (Receiving acknowledgement of the unvalidated packets): The sender enters the Normal Phase when an acknowledgement is received for the last packet number (or higher) that was sent in the Unvalidated Phase (see `last_unvalidated_packet_acknowledged` in [Section 4](#)). This indicates that the packets sent in the Unvalidated Phase were acknowledged without congestion.

3.5. Safe Retreat Phase

This phase is entered when congestion is detected for an unvalidated packet. It drains the path of other unvalidated packets. (This trigger is the same as used by a QUIC sender to transition from Slow-Start to Recovery [[RFC9002](#)].)

Safe Retreat Phase (Acknowledgement of unvalidated packets): The sender enters the Normal Phase when the last packet (or a later packet) sent during the Unvalidated Phase has been acknowledged. On leaving the Safe Retreat Phase, the log is updated to `exit_recovery`, see [Section 4](#).)

4. QLOG support for QUIC

This section provides definitions that enable a Careful Resume implementation to generate qlog events when using QUIC. It introduces an event to report the current phase of a sender, and an associated description.

The event and data structure definitions in this section are expressed in the Concise Data Definition Language (CDDL) [[RFC8610](#)] and its extensions described in [[I-D.ietf-quic-qlog-quic-events](#)]. The current convention is to use long names for variables. For example, "CWND" is expanded as "congestion_window" and "saved_cwnd" is expanded as "saved_congestion_window".

4.1. The `cr_phase` Event

Importance: Extra

When the CC algorithm changes the Careful Resume Phase described in [Section 3](#) of this specification.

Definition:

```

RecoveryCarefulResumePhaseUpdated = {
? old_phase: CarefulResumePhase,
new_phase: CarefulResumePhase,
state_data: CarefulResumeStateParameters,
? restored_data: CarefulResumeRestoredParameters,
? trigger:
    ; for the Unvalidated phase, when no unvalidated packets
    "congestion_window_limited" /
    ; for the Validating phase
    "first_unvalidated_packet_acknowledged" /
; for the Normal phase
; and no remaining unvalidated packets to be acknowledged
    "last_unvalidated_packet_acknowledged" /
    ; for the Normal phase, when CR not allowed
    "rtt_not_validated" /
    ; for the Normal phase,
    ; when sending fewer unvalidated packets than CWND permits
    "rate_limited" /
; for the Safe Retreat phase, when loss detected
    "packet_loss" /
; for the Safe Retreat phase,
; when ECN congestion experienced reported
    "ECN_CE" /
    ; for the Normal phase 1 RTT after a congestion event
    "exit_recovery"
}

CarefulResumePhase =
    "reconnaissance" /
    "unvalidated" /
    "validating" /
    "normal" /
    "safe_retreat"

CarefulResumeStateParameters = {
pipe_size: uint,
first_unvalidated_packet: uint,
last_unvalidated_packet: uint,
? congestion_window: uint,
? ssthresh: uint
}

CarefulResumeRestoredParameters = {
saved_congestion_window: uint,
saved_rtt: float32
}

```

Figure 2

5. Acknowledgments

The authors would like to thank Robin Marx and Lucar Purdue for their fruitful comments in developing this specification.

6. IANA Considerations

No current parameters are required to be registered by IANA.

7. Security Considerations

This document does not exhibit specific security considerations.

8. References

8.1. Normative References

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[RFC9040] Touch, J., Welzl, M., and S. Islam, "TCP Control Block Interdependence", RFC 9040, DOI 10.17487/RFC9040, July 2021, <<https://www.rfc-editor.org/info/rfc9040>>.

Appendix A. Internet Draft Revision details

ID -00 Text extracted from the TSVWG WG draft for CR.

Authors' Addresses

Ana Custura

University of Aberdeen
Department of Engineering
Fraser Noble Building
Aberdeen
AB24 3UE
United Kingdom
Email: ana@erg.abdn.ac.uk

Godred Fairhurst

University of Aberdeen
Department of Engineering
Fraser Noble Building
Aberdeen
AB24 3UE
United Kingdom
Email: gorry@erg.abdn.ac.uk