quic
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QUIC bandwidth awareness Acknowledgements
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Abstract

This document defines a quic ACK frame format for notifying path available bandwidth.

Status of This Memo

This Internet-Draft is submitted in full conformance with the provisions of BCP 78 and BCP 79.

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1. Introduction

In the actual operation of intelligent computing services, high bandwidth demand scenarios are commonly present, while data transmission faces significant challenges in terms of efficiency and stability.

Scenario 1：With the development of AI technology, some large-scale AI projects require computing resources from multiple data centers to participate in training together. For example, data centers in different cities may have different types of data or computing power advantages, and in order to fully utilize these resources, data needs to be transmitted and shared between multiple data centers.

Scenario 2：In order to balance flexible expansion of computing power scale and reduce cost investment, enterprises will distribute storage and computing resources in different geographical locations. For example, placing storage resources in areas with lower costs, while deploying computing resources near user or business needs. In this case, the transmission of data between storage and computing nodes becomes crucial.

These scenarios all have a common feature, which is long data transmission distance and large data volume. Therefore, it is necessary to fully utilize network bandwidth resources and improve data transmission efficiency.

Certain nodes on the forwarding path may experience traffic congestion when the network traffic is high. The actual maximum forwarding traffic of this path will become smaller than expected. Once this situation occurs,The sender needs to adjust the sending strategy based on the available resources of the current path to avoid packet loss due to exceeding the bandwidth.

The perception of available path bandwidth is an important part of reducing network congestion and ensuring network reliability. The sender perceives changes in the network environment and status in

real time, adjusts the speed in a timely manner, and achieves rapid response.The Quic protocol relies on feedback information provided by the ACK mechanism to achieve congestion control and reliable transmission functions. This document is based on an extension of the quic ACK mechanism, which supports carrying the available bandwidth of the path and quickly notifies the sender of this indicator. It is used to directly perform rate control and other operations on the sender, making data transmission more efficient and network resource utilization higher, greatly improving network service quality.

2. Conventions and Definitions

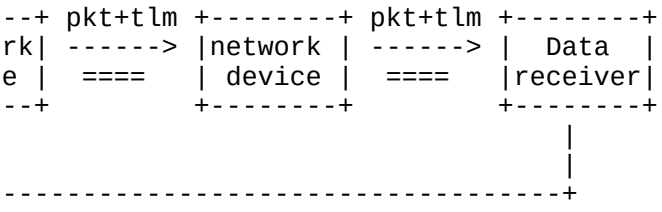
The key words "MUST", "MUST NOT", "REQUIRED", "SHALL", "SHALL NOT", "SHOULD", "SHOULD NOT", "RECOMMENDED", "NOT RECOMMENDED", "MAY", and "OPTIONAL" in this document are to be interpreted as described in BCP 14 [RFC2119] [RFC8174] when, and only when, they appear in all capitals, as shown here.

3. Overview of ACK mechanism

The triggering condition of ACK determines the timing of ACK generation and transmission. The confirmation mechanism of the quic protocol generally involves the receiver immediately replying to an ACK message after receiving a specified number of data packets, or waiting for a specified time delay to reply to an ACK message regardless of whether a data packet has arrived. [RFC9000] specifies a simple delay ACK mechanism, where the receiver can send an ACK every other packet, or send an ACK when the max_ck_delay timer expires.

This document extends the quic ACK mechanism and adds conditions for triggering ACK: when the message received by the receiver carries information about the available bandwidth of the path, an ACK message is generated and sent to the sender, and the ACK message contains the specific value of the available bandwidth of the path, which is used by the sender to adjust the data transmission strategy.The specific value of the available bandwidth of the path in the ACK message is obtained from the available bandwidth information of the path in the message received by the receiver.

4. Perception process of path available bandwidth



The data packet is transmitted between the sender and the receiver, and the network device on the transmission path adds the detected available bandwidth information of the path to the data packet originating from the sender. Specifically, network devices detect network status information based on device configuration information. Device configuration information is used to indicate the collection of network status parameters, or network status information is detected through network status collection instructions in business packets. Network status collection instructions are used to indicate the collection of network status parameters.

The available bandwidth information of the path is detected by the network device and added to the network layer header. After receiving the message, the receiver peels off the network layer header, obtains network status information, and forms the specific value of the available bandwidth of the path, which is added to the transport layer quic ACK message.

When the sender receives an ACK message from the receiver and adjusts the data transmission strategy, based on the specific value of the available bandwidth of the path, the data transmission rate of the data packet is increased or decreased.

5. Path available bandwidth awareness ACK frame

The extended ACK frame format also includes:
1)The type field represents the that contains path available bandwidth
2)The specific value of available bandwidth for the path

```
Network awareness ACK Frame {
Type (i) = 0x20,
Largest Acknowledged (i),
ACK Delay (i),
ACK Range Count (i),
First ACK Range (i),
ACK Range (..) …,
Path available bandwidth (..) ,
}
```

* Type: type=0x20, Indicates that ACK carries path available bandwidth.

* Largest Acknowledged : A variable-length integer representing the largest packet number the peer is acknowledging. This is usually the largest packet number that the peer has received prior to generating the ACK frame, Unlike the packet number in the QUIC long or short header, the value in an ACK frame is not truncated.

* ACK Delay: It represents the time it takes for the receiver to receive a message and for the receiver to send the ACK Frame.

* ACK Range Count:A variable-length integer specifying the number of ACK Range fields in the frame.

* First ACK Range: A variable-length integer indicating the number of contiguous packets preceding the Largest Acknowledged that are being acknowledged. That is, the smallest packet acknowledged in the range is determined by subtracting the First ACK Range value from the Largest Acknowledged field.

* ACK Range:Contains additional ranges of packets that are alternately not acknowledged (Gap) and acknowledged (ACK Range).

* Path available bandwidth : The maximum data transmission rate that a path can provide for subsequent data transmission.

6. Security Considerations

TBD

7. IANA Considerations

The following frame types have requested to be provisionally added to the "QUIC Frame Types" registry under the "QUIC Protocol" heading. +

value	Frame Name	specification
0x20	path available bandwidth	section5

Table1: Addition to QUIC Frame Types Entries

When this document is approved, IANA is requested to change the registration to a permanent allocation of these frame types with the values described above.

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