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Micro-burst Decreasing in Layer3 Network for Low-Latency Traffic
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Abstract

This document introduces a method to decrease the micro-bursts in Layer3 network for low-latency traffic.

Requirements Language

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].

Status of This Memo

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1. Problem Statement

Currently, the DetNet architecture in RFC 8655 [RFC8655] is supposed to work in campus-wide networks and private WANs, and hasn't covered the large-scale ISP network scenario. However, the low-latency requirement exists in both L2 and L3 networks, and in both small and large networks.

As talked in [I-D.qiang-detnet-large-scale-detnet], deploying deterministic services in a large-scale network brings a lot of new challenges. A novel method called LDN is introduced in [I-D.qiang-detnet-large-scale-detnet], which explores the deterministic forwarding over a large-scale network.

According to RFC 8655 [RFC8655], DetNet operates at the IP layer and delivers service over lower-layer technologies such as MPLS and IEEE 802.1 Time-Sensitive Networking (TSN). However, the TSN mechanisms are designed for L2 network originally, and cannot be directly used in the large-scale layer 3 network because of various reasons. For example, some TSN mechanisms need synchronization of the network equipments, which is easier in a small network, but hard in a large network; some mechanisms need a per-flow state in the forwarding plane, which is un-scalable; and some TSN mechanisms need a constant and forecastable traffic characteristics, which is more complicated in a large network where much more flows exist and the traffic characteristics is more dynamic.

The current forwarding mechanism in an IP router is based on statistical multiplexing, and cannot provide the deterministic

service because of various reasons. Even be given a high priority, a deterministic packet can experience a long congestion delay or be lost in a relatively light-loaded network, which is called micro-burst in the network.

Figure 1 show the problem of the current scheduling mechanism of an IP network. Before the scheduling in an IP network, the critical packets are well paced, but after the scheduling, the packets will be gathered even the total traffic rate is unchanged. When an IP outgoing interface receives multiple critical flows from several incoming interfaces, the situation becomes more serious. However, an IP router will try to send them as soon as possible, so occasionally, in some later hops, micro-bursts will emerge.

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                      Before scheduling in an IP network

       _  _  _  _  _  _                _  _  _  _  _
      | || || || || || |              | || || || || |
   ---------------------------------------------------------------------
                      After scheduling in an IP network
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Figure 1: Change of the traffic characteristics in an IP network

This document proposes a method to support the low latency traffic bearing in an IP network by avoiding micro-bursts in the network as much as possible.

2. Mechanism to Decrease Micro-bursts

The mechanism needs the cooperation of the edge node and the forwarding node in an IP network.

2.1. Process of Edge Node

The edge node of the IP network can recognize each critical flows just as in the TSN network, and then give them individually a good shaping. In fact, in TSN mechanisms, no micro-busrt will emerge for critical traffic, and each TSN mechanism is proved to be effective under some conditions.

This document suggests the edge node to shape the critical traffic by using the CBS method in IEEE 802.1Qav, or the shaping methods in IEEE 802.1Qcr. They can generate a paced traffic for each critical flow.

The parameters of the shaper, such as the sending rate, can be configured for each flow by some means.

2.2. Process of Forwarding Node

For the forwarding node, it is uneasy to recognize each critical flow because of the high pressure of forwarding. It is suggested that no per-flow state is maintained in the forwarding node. Hence, the forwarding node needs to aggregate the critical flows and handle them together.

This document suggests that the forwarding node can deploy a specific queue at each outgoing interface. The queue will buffer all critical traffic that need to go out through that interface, and will pace them by using methods mentioned in Section 2.1.

The shaping method in TSN is used here instead of the original forwarding method in an IP router, which can make the critical traffic be forwarded orderly instead of as soon as possible. Therefore, micro-bursts can be decreased in the network.

If all the forwarding nodes can do their jobs properly, i.e., they can well pace the critical traffic, no or rare micro-bursts for the critical traffic will emerge. In this way, the critical traffic will have a relatively low average latency in the IP network.

As no per-flow state is maintained in the forwarding node, the sending rate of the shaper is hard to decide. In this document, the sending rate is suggested to be generated referring to the incoming rate of the queue. The purpose is to maintain a proper buffer depth for the queue.

3. IANA Considerations

TBD.

4. Security Considerations

TBD.

5. Acknowledgements

TBD.

6. References

6.1. Normative References

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6.2. Informative References

[I-D.qiang-detnet-large-scale-detnet]
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[RFC8655] Finn, N., Thubert, P., Varga, B., and J. Farkas, "Deterministic Networking Architecture", RFC 8655, DOI 10.17487/RFC8655, October 2019, <https://www.rfc-editor.org/info/rfc8655>.

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