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IGP-TE Extensions for DetNet Information Distribution
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Abstract

There are requirements in diverse industries to establish multi-hop paths for characterized flows with bounded end-to-end latency and extremely low packet loss rate. Deterministic Networking (DetNet) can provide service satisfying the requirements.

This document describes extensions to IGP-TE, including OSPF-TE and ISIS-TE to distribute information of DetNet, which can be used for DetNet path computation/selection.

This document only covers the mechanisms by which DetNet information is distributed. The mechanisms for measuring, calculating or configuring DetNet capabilities, resources and other relevant parameters are out of the scope.

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](#)].

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[1. Introduction](#)

There are many use cases from diverse industries which have the need in common for deterministic service, for example: audio video production, industrial process control and mobile access networks. The requirements can be summarized as:

Deterministic minimum and maximum end-to-end latency from source to destination

Extremely low packet loss rate

Deterministic Networking (DetNet) can satisfy the requirements by the following techniques:

- o Congestion Protection by reserving data plane resources for DetNet flows in intermediate nodes along the path
- o Explicit Route that do not rapidly change with the network topology
- o Seamless Redundant which can distribute DetNet flow packets over multi paths to ensure delivery of each packet spite of the loss of a path

To make the above techniques work, it's necessary to know the capabilities (e.g., DetNet capable or not, which congestion protection algorithms are supported, etc.), resources (e.g, dedicated bandwidth for DetNet, buffers, etc.), performance (e.g., device/queue/link delay etc.) and other relevant information of each DetNet capable node. Then, a DetNet path computation element (e.g., PCE or ingress of a DetNet flow) can use these information to compute a path that satisfies the requirement of a specific DetNet flow. Specifically, according to the requirements stated in DetNet architecture, the information should include:

- o Whether a node is DetNet capable
- o Congestion protection methods supported by a DetNet capable node;
- o Dedicated bandwidth for DetNet flows;
- o Device and link delay;

Some of information (e.g., Link delay/loss) can be distributed and collected through the Traffic Engineering (TE) metric extensions [[RFC7471](#)], [[RFC7810](#)].

This document defines extensions to OSPF and ISIS to distribute the above DetNet information that can not distributed by the existing protocols.

2. Terminology

All the DetNet related terminologies used in this document conform to the DetNet architecture [[I-D.ietf-detnet-architecture](#)].

3. DetNet Extensions to OSPF TE

This document defines new OSPF TE sub-TLVs for Link TLV to distribute the DetNet required information as stated in [Section 1](#). These sub-TLVs includes:

Type	Length	Value
TBD1	4	Congestion Control Method
TBD2	4	Max DetNet Reservable Bandwidth
TBD3	4	Available DetNet Bandwidth
TBD4	8	Min/Max Queuing Delay

3.1. Congestion Protection Method sub-TLV

This Congestion Protection (CP) Method sub-TLV is used to advertise the DetNet flow congestion protection methods used in transit nodes. It may be required by some DetNet flows that all the transit nodes along the path SHOULD use the same congestion protection method. Some typical congestion protection methods are listed as below:

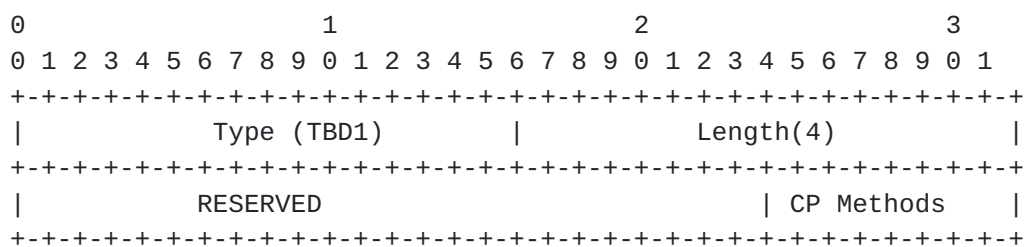
Time Aware Shaping [[IEEE802.1Qbv](#)]

Credit Based Shaper [[IEEE802.1Q-2014](#)]

Cyclic Queuing and Forwarding [[IEEE802.1Qch](#)]

Asynchronous Traffic Shaping [[IEEE802.1Qcr](#)]

The format of this sub-TLV is shown in the following diagram:



The Type field is 2 octets in length, and the value is TBD1.

The Length field is 2 octets in length and its value is 4.

The RESERVED field is reserved for future use. It MUST be set to 0 when sent and MUST be ignored when received.

This Congestion Control Method field presents the congestion protection method used in the transit node.

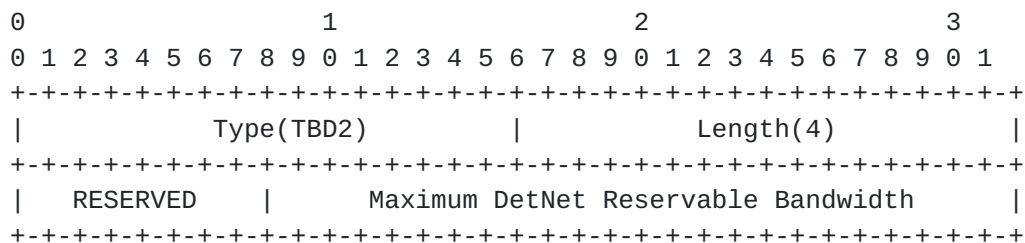
Five congestion protection methods are introduced in this document:

Value	Congestion Control Mechanisms
0	Reserved
1	Time Aware Shaper
2	Credit Based Shaper
3	Time Aware Shaper and Credit Based Shaper
4	Cyclic Queuing and Forwarding
5	Asynchronous Traffic Shaping
6-254	Unassigned
255	Reserved

3.2. Maximum DetNet Reservable Bandwidth sub-TLV

This sub-TLV specifies the maximum amount of bandwidth that is reserved for DetNet on this link. Note that this value SHOULD be smaller than the value of Maximum Reservable Bandwidth sub-TLV [RFC3630]. The value normally depends on the Congestion Protection Method and is user-configurable. In some particular Congestion Protection Method (e.g. Credit Based shaper in AVB), this value will affect the calculation of maximum queuing delay of the DetNet flow. The units are bytes per second.

The format of this sub-TLV is shown in the following diagram:



The Type field is 2 octets in length, and the value is TBD2.

The Length field is 2 octets in length and its value is 4.

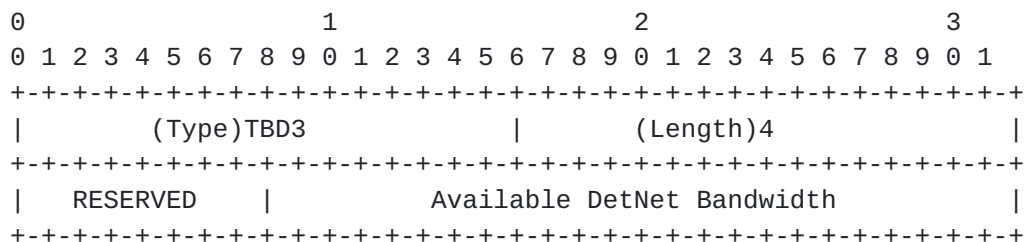
The RESERVED field is reserved for future use. It MUST be set to 0 when sent and MUST be ignored when received.

This Maximum DetNet Reservable Bandwidth presents the maximum bandwidth that may be reserved for DetNet. The units are bytes per second.

3.3. Available DetNet Bandwidth sub-TLV

This sub-TLV specifies the available bandwidth that can be reserved for DetNet flow on this link for now. Considering that there is no generally accepted DetNet traffic classification, this value contains all the available DetNet Bandwidth from different DetNet traffic classes (if there is any), which differs from the Unreserved Bandwidth defined in [\[RFC3630\]](#).

The format of this sub-TLV is shown in the following diagram:



The Type field is 2 octets in length, and the value is TBD3.

The Length field is 2 octets in length and its value is 4.

The RESERVED field is reserved for future use. It MUST be set to 0 when sent and MUST be ignored when received.

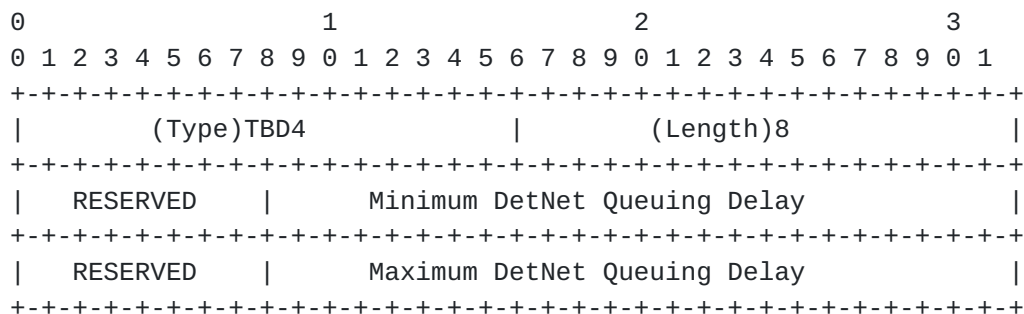
This Available DetNet Bandwidth field presents the available bandwidth for DetNet in this link. The units are bytes per second.

3.4. Min/Max Queuing Delay sub-TLV

[Editor Notes: more consideration and inputs are needed for these queue delays]

This sub-TLV advertises the minimum and maximum queuing delay values of specific DetNet flow in the link. Max/Min Unidirectional Link Delay Sub-TLV [\[RFC7471\]](#) excludes the queuing delay because of its instability. With the techniques used in DetNet, the queuing delay can be limited to a reasonable range, which means that the queuing delay bound is stable enough to be defined as a sub-TLV and advertised over the network.

The format of this sub-TLV is shown in the following diagram:



The Type field is 2 octets in length, and the value is TBD4.

The Length field is 2 octets in length and its value is 4.

The RESERVED field is reserved for future use. It MUST be set to 0 when sent and MUST be ignored when received.

Minimum DetNet Queuing Delay is 24-bit field carrying minimum queuing delay value (in microseconds) encoded as an integer value. Implementations may also add this to the value of Min Delay Unidirectional Link Delay Sub-TLV [[RFC7471](#)] in order to advertise the minimum delay of this link. Min Queuing Delay can be the same with the Max Queuing Delay.

The RESERVED field is reserved for future use. It MUST be set to 0 when sent and MUST be ignored when received.

Maximum DetNet Queuing Delay is 24-bit field carrying the maximum queuing delay value (in microseconds) encoded as an integer value. Implementations may also add this to the value of Max Delay Unidirectional Link Delay Sub-TLV [[RFC7471](#)] to order to advertise the maximum delay of this link.

4. DetNet Extensions to ISIS TE

This document defines new IS-IS TE sub-TLVs that can be announced in the TLVs 22, 23, 141, 222, and 223 in order to distribute DetNet information. The sub-TLV extensions below build on the ones provided in [[RFC5305](#)], [[RFC5316](#)] and [[RFC7310](#)].

4.1. Congestion Protection Method

This Congestion Protection (CP) Method sub-TLV is used to advertise the DetNet flow congestion protection methods used in transit nodes. The reader can know more about this sub-TLV referring to [section 3.1](#).

The RESERVED field is reserved for future use. It MUST be set to 0 when sent and MUST be ignored when received.

The Type field is 1 octet in length, and the value is TBD4.

The Length field is 1 octet in length and it's value is 4.

The RESERVED field is reserved for future use. It MUST be set to 0 when sent and MUST be ignored when received.

Minimum DetNet Queuing Delay is 24-bit field carrying minimum queuing delay value (in microseconds) encoded as an integer value.

Implementations may also add this to the value of Min Unidirectional Link Delay [[RFC7810](#)] in order to advertise the minimum delay of this link. Min Queuing Delay can be the same with the Max Queuing Delay.

The RESERVED field is reserved for future use. It MUST be set to 0 when sent and MUST be ignored when received.

Maximum DetNet Queuing Delay is 24-bit field carrying the maximum queuing delay value (in microseconds) encoded as an integer value.

Implementations may also add this to the value of Max Delay Unidirectional Link Delay Sub-TLV [[RFC7810](#)] to order to advertise the maximum delay of this link.

5. IANA Considerations

5.1. Sub-TLVs for Link TLV

IANA is requested to register the OSPF sub-TLVs defined in this document in the sub-TLVs for Link TLV registry.

Type	Description
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TBD1	Congestion Protection Method
TBD2	Maximum DetNet Reservable Bandwidth
TBD3	Available DetNet Bandwidth
TBD4	Min/Max Queuing Delay

5.2. Sub-TLVs for TLVs 22, 23, 141, 222, and 223

IANA is requested to register the ISIS sub-TLVs defined in this document in the Sub-TLVs for TLVs 22, 23, 141, 222, and 223 registry.

Type	Description
----	-----
TBD5	Congestion Protection Method
TBD6	Maximum DetNet Reservable Bandwidth
TBD7	Available DetNet Bandwidth
TBD8	Min/Max Queuing Delay

6. Security Considerations

This document does not introduce security issues beyond those discussed in [RFC7471] and [RFC7810].

7. Acknowledgements

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