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Q. Xiong
H. Wu
ZTE Corporation
J. Zhao
CAICT
D. Yang
Beijing Jiaotong University
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BGP Flow Specification for DetNet and TSN Flow Mapping
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Abstract

This document proposes extensions to BGP Flow Specification for the flow mapping of Deterministic Networking (DetNet) when interconnected with IEEE 802.1 Time-Sensitive Networking (TSN). The BGP flowspec is used for the filtering of the packets that match the DetNet networks and the mapping between TSN streams and DetNet flows in the control plane.

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1. Introduction

[RFC8655] specifies the architecture of Deterministic Networking (DetNet), which provide a capability for the delivery of data flows with extremely low packet loss rates and bounded end-to-end delivery latency. DetNet-enabled end systems and DetNet nodes can be interconnected by sub-networks, i.e., Layer 2 technologies such as IEEE 802.1 Time-Sensitive Networking (TSN).

As defined in [RFC8655], the DetNet IP and MPLS flows can be carried over TSN sub-networks. DetNet needs to be mapped to the sub-networks technology used to interconnect DetNet nodes. For example, a TSN node may be used to interconnect DetNet-aware nodes, and these DetNet nodes can map DetNet flows to TSN streams. When the Detnet provide the deterministic service for the TSN end system, a DetNet edge node may be used to interconnect the TSN end system, and the DetNet nodes can map the TSN streams to DetNet flows.

As described in [RFC8938], one of the primary requirements of the DetNet Controller Plane is restricting flows to IEEE 802.1 TSN and the requirement could use the centralized network management provisioning mechanisms such as BGP protocol. As defined in [RFC8955], the Flow Specifications for BGP is an n-tuple consisting

of several matching criteria which is comprised of traffic filtering rules and is associated with actions that can be applied to the traffic flows. The DetNet edge nodes can provide the capability to process the traffic including classifying, shaping, rate limiting, filtering, and redirecting packets based on the policies configured by the BGP Flow Specification.

BGP flow specification version 1 (FSv1) has been defined in [RFC8955] and version 2 of the BGP flow specification (FSv2) protocol has been proposed in [I-D.ietf-idr-flowspec-v2]. This document proposes extensions to BGP FSv2 for the interconnection of DetNet and TSN. The BGP flowspec is used for the filtering of the packets that match the DetNet networks and the mapping between TSN streams and DetNet flows in the control plane.

2. Conventions used in this document

2.1. Terminology

The terminology is defined as [RFC8655], [RFC8938], [RFC8955] and [I-D.ietf-idr-flowspec-v2].

2.2. 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.

3. The Requirements for DetNet Control Plane

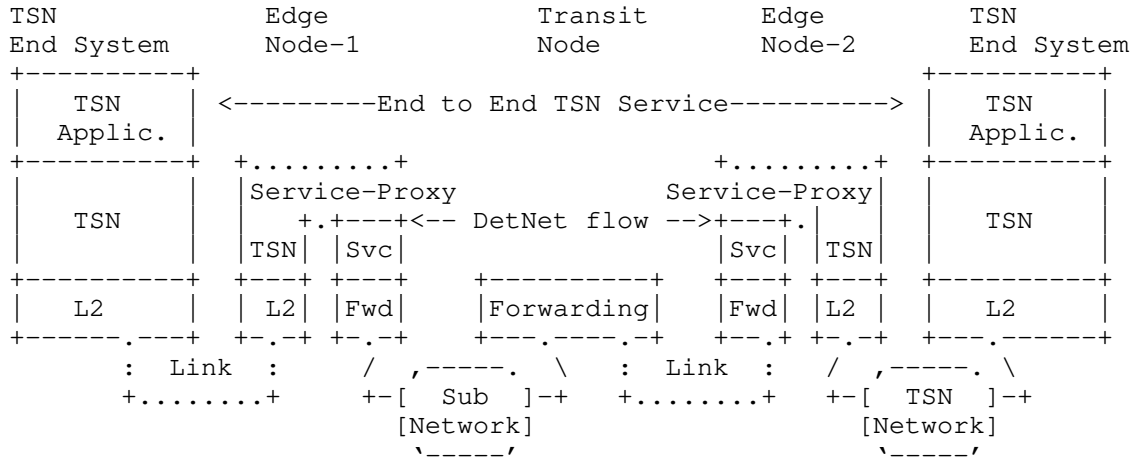
3.1. Functions for DetNet Flow to TSN Stream Mapping

As described in [RFC9024], TSN networks can be interconnected over a DetNet MPLS Network. And as discussed in [RFC9023] and [RFC9037], DetNet IP or MPLS networks can be operating over a TSN sub-network. The mapping between TSN Streams and DetNet flows is required for the service proxy function at DetNet Edge nodes. And the mapping table can be configured and maintained in the control plane. When a DetNet Edge Node receives a packet, it MUST identify and check whether such flow is present in its mapping table and decide to drop (when not match) or to forward the packet (when match) to the associated service.

As Figure 1 shows, it is required to configure the identification information when mapping received TSN Streams to the DetNet flows at Edge Node-1. Mechanisms and Parameters of TSN stream identification

(e.g., Mask-and-Match Stream identification) defined in [IEEE8021CB] and [IEEE8021CBdb] can be used for service proxy function. After the identification of the TSN stream, it need to map the packet to the DetNet flow information such as S-Label, d-CW when in DetNet MPLS data plane and handle the packet as defined in [RFC8964].

When the DetNet Edge Node-2 receives a DetNet flow, it MUST identify the DetNet flow-ID information such as IP 6-tuple in DetNet IP data plane or S-Label and d-CW information in DetNet MPLS data plane. Then the Service proxy function need to map the DetNet flow-ID and flow related parameters to the associated TSN Stream IDs and streams related parameters.



Flow Mapping:

```

| TSN : DetNet | <----- DetNet -----> | DetNet : TSN |

```

Figure 1: Flow Mapping in TSN over DetNet Network

3.2. Aggregation during DetNet Flow to TSN Stream Mapping

As described in [RFC8938], the DetNet data plane allows for the aggregation of DetNet flows, which should also be accomplished in the control plane. IP, MPLS and TSN aggregation has both data plane and controller Plane aspects. Bandwidth reservations, resource assignment, path computation, delay, delay variation and aggregate number should be taken into considerations in the controller plane. Moreover, as defined in [RFC9023] and [RFC9037], 1:1 and N:1 mapping

(aggregating multiple TSN Streams in a single DetNet flow) MUST be supported.

4. BGP Extensions for Flow Specification Encoding

As defined in [RFC8955], the nodes that applied a Flow Specification can filter the received packets according to the matching criteria and can forward the flows based on the associated actions. This document proposes extensions to BGP Flow Specification for the mapping of DetNet flows and TSN streams by using the traffic filtering rules to identify the packet and using the associated action to map the packet to the related service.

4.1. Filtering Rules for TSN Streams

As IEEE Std 802.1Q defined, a Stream ID is a 64-bit field that uniquely identifies a stream and can be generated by the system offering the stream, or possibly a device controlling that system. But it is not carried in the header of the TSN Stream. As defined in [IEEE8021CB] and [IEEE8021CBdb], five specific Stream identification functions are described: Null Stream identification, Source MAC and VLAN Stream identification, Active Destination MAC and VLAN Stream identification, and IP Stream identification, and Mask-and-match Stream identification. It needs to examine the header of the streams such as destination_address, vlan_identifier, IP source address, IP destination address, DSCP, IP next protocol, source port, destination port and mac_service_data_unit.

As defined in [I-D.ietf-idr-flowspec-l2vpn], the Ethernet Layer 2 (L2) related fields have been covered by the L2 traffic filtering rules except the mac_service_data_unit in Mask-and-Match Stream identification. A mac_service_data_unit mask is defined to identify communication flows supported by various higher-layer protocols. L2 Traffic Rules and L2 header TLV in BGP FSV2 of has been defined in [I-D.ietf-idr-flowspec-v2] section 3.4. This document proposes a new L2 SubTLV for TSN Streams in L2 Flow Specification Component shown in Figure 2.

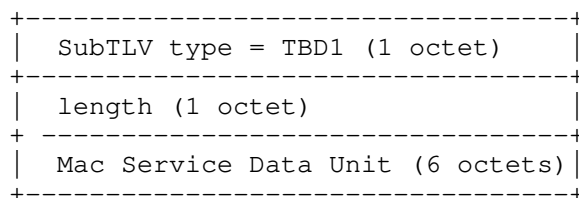


Figure 2: TSN SubTLV

SubTLV type = TBD1: Mac Service Data Unit

Encoding: <type (1 octet), length (1 octet), [op, value]+>

Defines a list of {operation, value} pairs used to match 6-octet Mac Service Data Unit field. Values are encoded as 6-octet quantities. op is encoded as specified in Section 4.2.1.1 of [RFC8955].

4.2. Traffic Action for TSN Streams

The action for an TSN traffic filtering flowspec is to accept the TSN streams that matches that particular rule and map the streams to the DetNet flows. The action for L3 traffic with extended communities types per [RFC8955] and [RFC8956] such as traffic-rate, traffic-marking, traffic-action, and redirect can be used for TSN to DetNet IP flow mapping. The Wide Community has been proposed for FSv2 actions in [I-D.ietf-idr-flowspec-v2] section 3.2.

The DetNet flow is identified by a S-Label and the DetNet Header consists of d-CW and F-Labels. The MPLS label related action for an TSN stream mapping to a DetNet MPLS network can use the Label-action defined in [I-D.ietf-idr-bgp-flowspec-label]. And the action for the information ensuring deterministic latency, this document proposes a new Action SubTLV in BGP FSV2 Wide Community for TSN Streams as following shown.

type	Wide Community	encoding
TBD2	Deterministic Latency Action	bitmask

Table 1

The Deterministic Latency Action SubTLV is shown in Figure 3.

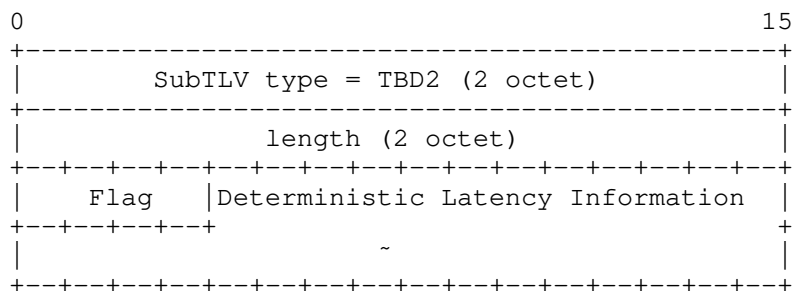


Figure 3: Deterministic Latency Action

Flag: 4 bits, indicates the type of queuing mechanisms:

Deterministic Latency Information: variable length, the information when implementing the DetNet queuing mechanisms to guarantee the deterministic latency. For instance, the cycle ID for cyclic queuing and forwarding or the latency related information for deadline time based queuing in order to enable the applicability of the respective queuing and/or scheduling mechanisms in the large scale network.

4.3. Filtering Rules for DetNet Flows

The L3 traffic filtering rules defined in [RFC8955] and [RFC8956] can be used for DetNet IP flow.

As defined in RFC8964, the MPLS-based DetNet data plane encapsulation consists of d-CW, S-Label and F-Labels. The MPLS label filtering rules have been defined in [I-D.ietf-idr-flowspec-mpls-match]. IP header TLV in BGP FSv2 of has been defined in [I-D.ietf-idr-flowspec-v2] section 3.1.

This document proposes a new IP header SubTLV for DetNet MPLS flows shown in Figure 4.

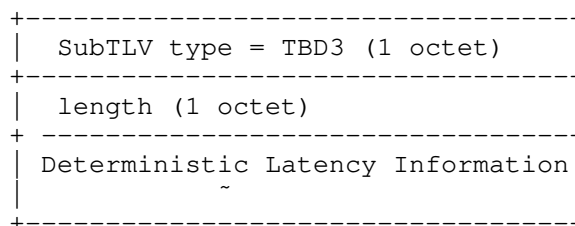


Figure 4: DetNet SubTLV

SubTLV Type TBD3: indicates deterministic latency information.

Encoding: <type (1 octet), length (1 octet), [op, value]+>

Defines a list of {operation, value} pairs used to match Deterministic Latency Information. Values are encoded as variable length. op is encoded as specified in Section 4.2.1.1 of [RFC8955].

4.4. Traffic Action for DetNet Flows

The extended action for an DetNet traffic filtering flowspec is to accept the DetNet flows that matches that particular rule and map the flows to the TSN streams. This document proposes a new Action SubTLV in BGP FSV2 Wide Community for DetNet flows as the following shown.

type	Wide Community	encoding
TBD4	TSN Action	bitmask

Table 2

The TSN Action SubTLV is shown in Figure 3.

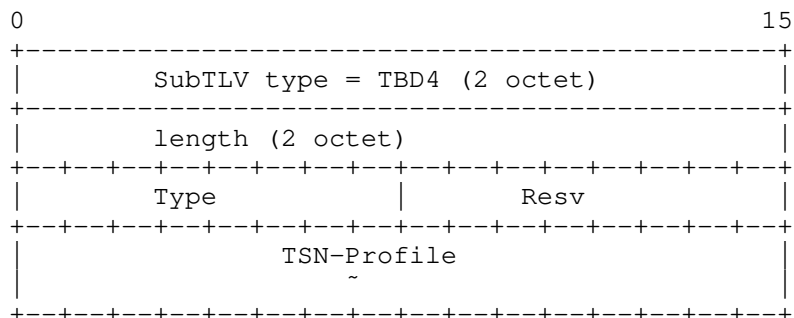


Figure 5: TSN Action

Type: 1-octet, indicates the type of TSN profiles. The value of the types is TBD:

Resv: 1-octet, reserved for future use. MUST be sent as zero and ignored on receipt.

TSN-profile: 4-octet, can be converted to the TSN Stream ID and stream related parameters and requirements as the following shown.

```
stream_handle: identifying the Stream to which the packet belongs in
TSN networks.
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sequence_number: identifying the order in which the packet was transmitted relative to other packets in the same Compound Stream in TSN networks.

traffic_scheduling: identifying the traffic scheduling mechanisms including traffic policy, queuing and forwarding methods in TSN networks.

5. Security Considerations

This document defines new SubTLVs for DetNet and TSN flow mapping, which do not introduce any new security considerations beyond those already listed in [I-D.ietf-idr-flowspec-v2].

6. IANA Considerations

IANA is requested to create new IP SubTLV Types for IP Filters as per [I-D.ietf-idr-flowspec-v2].

Value	Definition	Reference
TBD1	TSN: Mac Service Data Unit	this document
TBD3	DetNet: Deterministic Latency Information	this document

Table 3

IANA is requested to create new Flow Specification v2 Action Types as per [I-D.ietf-idr-flowspec-v2].

Type	Use	Reference
TBD2	DetNet action	this document
TBD5	TSN action	this document

Table 4

7. Acknowledgements

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Authors' Addresses

Quan Xiong
ZTE Corporation
No.6 Huashi Park Rd
Wuhan
Hubei, 430223
China
Email: xiong.quan@zte.com.cn

Haisheng Wu
ZTE Corporation
Nanjing
Jiangsu,
China
Email: wu.haisheng@zte.com.cn

Junfeng Zhao
CAICT
Beijing
China
Email: zhaojunfeng@caict.ac.cn

Dong Yang
Beijing Jiaotong University
Beijing
China
Email: dyang@bjtu.edu.cn