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G. Mirsky
ZTE Corp.
M. Chen
Huawei

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Operations, Administration and Maintenance (OAM) for Deterministic Networks (DetNet)
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Abstract

This document lists functional requirements for Operations, Administration and Maintenance (OAM) toolset in Deterministic Networks (DetNet) and, using these requirements; defines format and use principals of the DetNet service Associated Channel.

Status of This Memo

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This Internet-Draft will expire on November 23, 2019.

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1. Introduction

[I-D.ietf-detnet-architecture] introduces and explains Deterministic Networks (DetNet) architecture and how the Packet Replication and Elimination function (PREF) can be used to ensure low packet drop ratio in DetNet domain.

Operations, Administration and Maintenance (OAM) protocols are used to detect, localize defects in the network, and monitor network performance. Some OAM functions, e.g., failure detection, work in the network proactively, while others, e.g., defect localization, usually performed on-demand. These tasks achieved by a combination of active and hybrid, as defined in [RFC7799], OAM methods.

This document lists the functional requirements toward OAM for DetNet domain. The list can further be used for gap analysis of available OAM tools to identify possible enhancements of existing or whether new OAM tools are required to support proactive and on-demand path monitoring and service validation.

2. Conventions used in this document

2.1. Terminology

The term "DetNet OAM" used in this document interchangeably with longer version "set of OAM protocols, methods and tools for Deterministic Networks".

CW Control Word

DetNet Deterministic Networks

d-ACH DetNet Associated Channel Header

d-CW DetNet Control Word

DNH DetNet Header

GAL Generic Associated Channel Label

G-ACh Generic Associated Channel

OAM: Operations, Administration and Maintenance

PREF Packet Replication and Elimination Function

POF Packet Ordering Function

PW Pseudowire

RDI Remote Defect Indication

Underlay Network or Underlay Layer: The network that provides connectivity between the DetNet nodes. MPLS network providing LSP connectivity between DetNet nodes is an example of the underlay layer.

DetNet Node - a node that is an actor in the DetNet domain. DetNet domain edge node and node that performs PREF within the domain are examples of DetNet node.

2.2. Keywords

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. Requirements

This section lists requirements for OAM in DetNet domain:

1. The listed requirements MUST be supported for any type of underlay network over which a DetNet domain can be realized.

2. It MUST be possible to initiate DetNet OAM session from any DetNet node towards another DetNet node(s) within given domain.

3. It SHOULD be possible to initialize DetNet OAM session from a centralized controller.

4. DetNet OAM MUST support proactive and on-demand OAM monitoring and measurement methods.

5. DetNet OAM packets MUST be in-band, i.e., follow precisely the same path as DetNet data plane traffic both for unidirectional and bi-directional DetNet paths.

6. DetNet OAM MUST support unidirectional OAM methods, continuity check, connectivity verification, and performance measurement.

7. DetNet OAM MUST support bi-directional OAM methods. Such OAM methods MAY combine in-band monitoring or measurement in the forward direction and out-of-bound notification in the reverse direction, i.e., from egress to ingress end point of the OAM test session.

8. DetNet OAM MUST support proactive monitoring of a DetNet node availability in the given DetNet domain.

9. DetNet OAM MUST support Path Maximum Transmission Unit discovery.

10. DetNet OAM MUST support Remote Defect Indication (RDI) notification to the DetNet node performing continuity checking.

11. DetNet OAM MUST support performance measurement methods.

12. DetNet OAM MAY support hybrid performance measurement methods.

13. DetNet OAM MUST support unidirectional performance measurement methods. Calculated performance metrics MUST include but are not limited to throughput, packet loss, delay and delay variation metrics. [RFC6374] provides excellent details on performance measurement and performance metrics.

14. DetNet OAM MUST support defect notification mechanism, like Alarm Indication Signal. Any DetNet node in the given DetNet domain MAY originate a defect notification addressed to any subset of nodes within the domain.

15. DetNet OAM MUST support methods to enable survivability of the DetNet domain. These recovery methods MAY use protection switching and restoration.

16. DetNet OAM MUST support the discovery of Packet Replication, Elimination, and Order preservation sub-functions locations in the domain.

17. DetNet OAM MUST support testing of Packet Replication, Elimination, and Order preservation sub-functions in the domain.

18. DetNet OAM MUST support monitoring any sub-set of paths traversed through the DetNet domain by the DetNet flow.

4. DetNet Data Plane in Support of Active OAM

OAM protocols and mechanisms act within the data plane of the particular networking layer. And thus it is critical that the data plane encapsulation supports OAM mechanisms in such a way to comply with the above-listed requirements. One of such examples that require special consideration is requirement #5:

> DetNet OAM packets MUST be in-band, i.e., follow precisely the same path as DetNet data plane traffic both for unidirectional and bi-directional DetNet paths.

4.1. MPLS Encapsulation

The Det Net data plane encapsulation in transport network with MPLS and IP encapsulations specified in [I-D.ietf-detnet-dp-sol-mpls] and [I-D.ietf-detnet-dp-sol-ip] respectively. For the MPLS underlay network, DetNet flows to be encapsulated analogous to pseudowires (PW) over MPLS packet switched network, as described in [RFC3985], [RFC4385]. Generic PW MPLS Control Word (CW), defined in [RFC4385], for DetNet displayed in Figure 1.

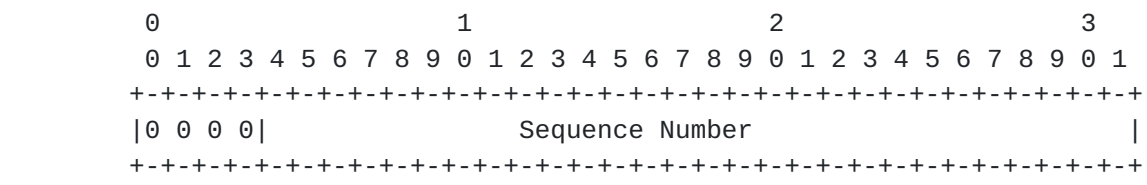

Figure 1: DetNet Control Word Format

PREF in the DetNet domain composed by a combination of nodes that perform replication and elimination sub-functions. The elimination sub-function always uses the S-Label and packet sequencing information, e.g., the value in the Sequence Number field of DetNet CW (d-CW). The replication sub-function uses the S-Label information only. For data packets Figure 2 presents an example of PREF in DetNet domain.

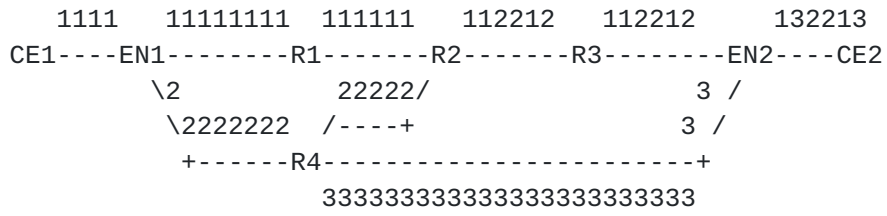

Figure 2: DetNet Data Plane Based on PW

4.1.1. DetNet Active OAM Encapsulation

DetNet OAM, like PW OAM, uses PW Associated Channel Header defined in [RFC4385]. Figure 3 displays the encapsulation of a DetNet active OAM packet.

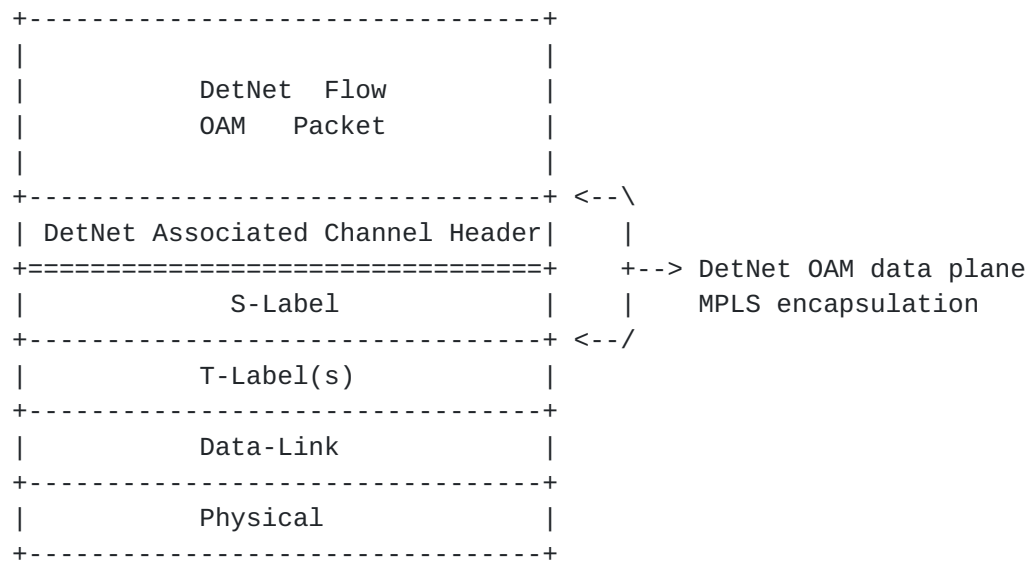

Figure 3: DetNet active OAM Packet Encapsulation

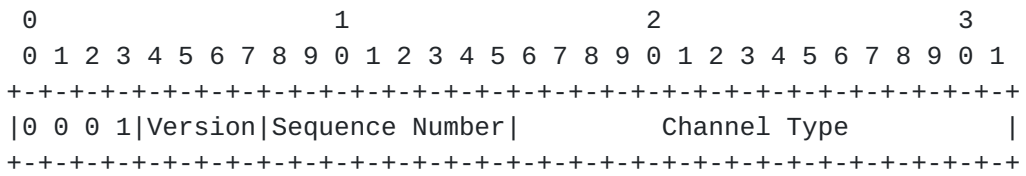

Figure 4: DetNet Associated Channel Header Format

Figure 4 displays the format of the DetNet Associated Channel Header (d-ACH). The meanings of the fields in the d-ACH are:

Bits 0..3 MUST be 0b0001. This value of the first nibble allows the packet to be distinguished from an IP packet [RFC4928] and a DetNet data packet [I-D.ietf-detnet-dp-sol-mpls].

Version: this is the version number of the d-ACH. This specification defines version 0.

Sequence Number: this is unsigned eight bits-long field. The originating DetNet node MUST set the value of the Sequence Number field to a non-zero before packet being transmitted. The originating node MUST monotonically increase the value of the Sequence Number field for the every next active OAM packet.

Channel Type: the value of DetNet Associated Channel Type is one of values defined in the IANA PW Associated Channel Type registry.

The DetNet flow, according to [I-D.ietf-detnet-dp-sol-mpls], is identified by the S-label that MUST be at the bottom of the stack. Active OAM packet MUST have d-ACH immediately following the S-label.A DetNet node originating an OAM packet MUST ensure that the value of the Sequence Number field in d-ACH is monotonically increasing for the given value of the Channel Type field.

The Generic Associated Channel Label (GAL), defined in [RFC5586] and [RFC6423], provides a generalized label-based exception mechanism to indicate that the packet is on a Generic Associated Channel (G-ACh) and that ACH immediately follows the label stack. For the DetNet domain in MPLS transport network, GAL MAY be used. If GAL is used, it MUST precede S-Label on the label stack, and the S-Label MUST be followed by d-ACH.

4.1.2. IP Encapsulation

[Author's Note: This will be defined based on the DetNet Flow ID specification for IP underlay in [I-D.ietf-detnet-dp-sol-ip].]

4.2. DetNet Replication, Elimination, and Ordering Sub-functions Interaction with Active OAM

At the DetNet service layer, special functions MAY be applied to the particular DetNet flow - PREF to potentially lower packet loss, improve the probability of on-time packet delivery and Packet Ordering Function (POF) to ensure in-order packet delivery. As data and the active OAM packets have the same Flow ID, S-label, sub-functions that rely on sequencing information in the DetNet service layer MUST process 28 MSBs of the d-ACH as the source of the sequencing information for the OAM packet.

5. Use of Hybrid OAM in DetNet

Hybrid OAM methods are used in performance monitoring and defined in [RFC7799] as:

> Hybrid Methods are Methods of Measurement that use a combination of Active Methods and Passive Methods.

A hybrid measurement method may produce metrics as close to passive, but it still alters something in a data packet even if that is the value of a designated field in the packet encapsulation. One example of such a hybrid measurement method is the Alternate Marking method described in [RFC8321]. Reserving the field for the Alternate Marking method in the DetNet Header will enhance available to an operator set of DetNet OAM tools.

6. IANA Considerations

TBA

7. Security Considerations

This document lists the OAM requirements for a DetNet domain and does not raise any security concerns or issues in addition to ones common to networking.

8. Acknowledgment

Authors extend their appreciation to Pascal Thubert for his insightful comments and productive discussion that helped to improve the document.

9. References

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Authors' Addresses

Greg Mirsky
ZTE Corp.

Email: gregimirsky@gmail.com

Mach(Guoyi) Chen
Huawei

Email: mach.chen@huawei.com