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Deterministic Networking (DetNet): OAM Functions for The Service Sub-Layer
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Abstract

Operation, Administration, and Maintenance (OAM) tools are essential for a deterministic network. The DetNet architecture [[RFC8655](#)] has defined two sub-layers: (1) DetNet service sub-layer and (2) DetNet forwarding sub-layer. OAM mechanisms exist for the DetNet forwarding sub-layer, nonetheless, OAM for the service sub-layer requires a new mechanism. This draft introduces OAM related procedures for the DetNet service sub-layer functions.

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[1.](#) Introduction

The DetNet Working Group has defined two sub-layers: (1) DetNet service sub-layer, at which a DetNet service (e.g., service protection) is provided and (2) DetNet forwarding sub-layer, which optionally provides resource allocation for DetNet flows over paths provided by the underlying network. In [\[RFC8655\]](#) new DetNet-specific functions have been defined for the DetNet service sub-layer, namely PREOF (a collective name for Packet Replication, Elimination, and Ordering Functions).

Framework of Operations, Administration and Maintenance (OAM) for Deterministic Networking (DetNet) is described in [\[I-D.ietf-detnet-oam-framework\]](#). OAM for the DetNet MPLS data plane is described in [\[I-D.ietf-detnet-mpls-oam\]](#) and OAM for the DetNet IP data plane is described in [\[I-D.ietf-detnet-mpls-oam\]](#).

This draft has been submitted as an individual contribution to OAM discussions, in particular, to kick-off Working Group discussions on introducing OAM functions for the DetNet service sub-layer. It is also up to the Working Group discussions to which draft parts of this contribution may go, if any.

The OAM functions for the DetNet service sub-layer allow, for example, to recognize/discover DetNet relay nodes, to get information about their configuration, and to check their operation or status.

The approach described in this draft introduces a new OAM shim layer to achieve OAM for the DetNet service sub-layer. In the rest of the draft, this approach is referred to as "DetNet PING", which is an in-band OAM approach, i.e., the OAM packets follow precisely the same path as the data packets of the corresponding DetNet flow(s). The OAM packets provide DetNet service sub-layer specific information, like:

- o Identity of a DetNet service sub-layer node.
- o Discover Ingress/Egress flow specific configuration of a DetNet service sub-layer node.
- o Detect the status of the flow specific service sub-layer function.

DetNet PING is applicable both to IP and MPLS DetNet data planes.

2. Terminology

2.1. Terms Used in This Document

This document uses the terminology established in the DetNet architecture [[RFC8655](#)], and the reader is assumed to be familiar with that document and its terminology.

2.2. Abbreviations

The following abbreviations are used in this document:

DetNet	Deterministic Networking.
PEF	Packet Elimination Function.
POF	Packet Ordering Function.
PREOF	Packet Replication, Elimination and Ordering Functions.
PRF	Packet Replication Function.

2.3. 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. Requirements on OAM for DetNet Service Sub-layer

The requirements on OAM for a DetNet relay node are:

1. to provide OAM functions for the DetNet service sub-layer.
2. to discover DetNet relay nodes in a DetNet network.
3. to collect DetNet service sub-layer specific (e.g., configuration/operation/status) information from DetNet relay nodes.
4. to work for both DetNet data planes: (1) MPLS and (2) IP.

4. DetNet PING

4.1. Overview

The "DetNet PING" approach uses two types of OAM packets: (1) DetNet-Echo-Request and (2) DetNet-Echo-Reply. Their encapsulation is identical to that of the corresponding DetNet data flow, so they follow precisely the same path as the packets of the corresponding DetNet data flow. They target DetNet service sub-layer entities, so they may not be recognized as OAM packet by entities not implementing DetNet service sub-layer for a packet flow (e.g., transit nodes). Other entities treat them as packets belonging to the corresponding DetNet data flow.

The following relay node roles can be distinguished:

1. DetNet PING originator node,
2. Intermediate DetNet service sub-layer node,
3. DetNet PING targeted node.

An originator node sends (generates) DetNet-Echo-Request packet(s). DetNet-Echo-Request packet contains an OAM specific "PINGSeqNum", what can be used by the DetNet service sub-layer of relay nodes. Note that "PINGSeqNum" is originator specific.

An intermediate DetNet service sub-layer node executes DetNet flow specific service sub-layer functionality. Packet processing may be done in an OAM specific manner (see details in in [Section 4.2](#)).

A targeted node answers with DetNet-Echo-Reply packet for each DetNet-Echo-Request. DetNet-Echo-Reply packet provides DetNet service sub-layer specific information on (i) identities of DetNet service sub-layer node (e.g., Node-ID, local Flow-ID), (ii) ingress/egress flow related configuration (e.g., in/out member flow specific information (including forwarding sub-layer specifics)), and (iii) status of service sub-layer function (e.g., local PxF-ID, Action-Type=x, operational status, value of key state variable(s), function related counters).

4.2. OAM processing at the DetNet service sub-layer

Detailed OAM packet processing rules of various DetNet relay nodes are described in the next sections.

4.2.1. Relay node with PRF

A DetNet relay node with PRF processes DetNet OAM packets in a stateless manner.

If the relay node with PRF is the target of a DetNet-Echo-Request packet, then the DetNet-Echo-Request packet MUST NOT be further forwarded and an DetNet-Echo-Reply packet MUST be generated. If the relay node with PRF is not the target of a DetNet-Echo-Request packet, then the DetNet-Echo-Request packet MUST be sent over all DetNet flow specific member flow paths (i.e., it is replicated).

A DetNet-Echo-Reply packet MUST contain the following information:

- o Identities related to the DetNet service sub-layer node (e.g., Node-ID, local Flow-ID),
- o Ingress/Egress flow related configuration (e.g., in/out member flow specific information (including forwarding sub-layer specifics)),
- o Status of service sub-layer function (e.g., local PRF-ID, Action-Type=Replication, operational status, value of the flow related key state variable (e.g., "GenSeqNum" in [[IEEE8021CB](#)])).

A DetNet-Echo-Reply packet MAY contain the following information:

- o PRF function related local counters.

4.2.2. Relay node with PEF

A DetNet relay node with PEF processes DetNet OAM packets in a stateful manner.

If the relay node with PEF is the target of DetNet-Echo-Request packet, then the DetNet-Echo-Request packet MUST NOT be further forwarded and an DetNet-Echo-Reply packet MUST be generated. If the relay node with PEF is not the target of DetNet-Echo-Request packet, then elimination MUST be executed on the DetNet-Echo-Request packet(s) using the OAM specific "PINGSeqNum" in the packet. So only a single DetNet-Echo-Request packet is forwarded and all further replicas (having the same originator's sequence number) MUST be discarded.

Note, that PEF MAY use a simplified elimination algorithm for DetNet-Echo-Request packets (e.g., "MatchRecoveryAlgorithm" in [[IEEE8021CB](#)]) as OAM is a slow protocol.

A DetNet-Echo-Reply packet MUST contain the following information:

- o Identities related to the DetNet service sub-layer node (e.g., Node-ID, local Flow-ID),
- o Ingress/Egress flow related configuration (e.g., in/out member flow specific information (including forwarding sub-layer specifics)) ,
- o Status of service sub-layer function (e.g., local PEF-ID, Action-Type=Elimination, operational status, value of the flow related key state variable (e.g., "RecovSeqNum" in [[IEEE8021CB](#)])).

A DetNet-Echo-Reply packet MAY contain the following information:

- o PEF function related local counters.

4.2.3. Relay node with POF

A DetNet relay node with POF processes DetNet OAM packets in a stateless manner.

If the relay node with POF is the target of DetNet-Echo-Request packet, then the DetNet-Echo-Request packet MUST NOT be further forwarded and a DetNet-Echo-Reply packet MUST be generated. If the relay node with POF is not the target of DetNet-Echo-Request packet, then the DetNet-Echo-Request packet(s) MUST be forwarded without any POF specific action.

A DetNet-Echo-Reply packet MUST contain the following information:

- o Identities of the DetNet service sub-layer node (e.g., Node-ID, local Flow-ID),
- o Ingress/Egress flow related configuration (e.g., in/out member flow specific information (including forwarding sub-layer specifics)) ,
- o Status of service sub-layer function (e.g., local POF-ID, Action-Type=Ordering, operational status, value of the flow related key state variable (e.g., "POFLastSent" in [[I-D.varga-detnet-pof](#)])).

A DetNet-Echo-Reply packet MAY contain the following information:

- o POF function related local counters.

4.2.4. Relay node without PREOF

A DetNet relay node without PREOF processes DetNet OAM packets in a stateless manner.

If the relay node without PREOF is the target of DetNet-Echo-Request packet, then the DetNet-Echo-Request packet MUST NOT be further forwarded and an DetNet-Echo-Reply packet MUST be generated. If the relay node without PREOF is not the target of DetNet-Echo-Request packet, then the DetNet-Echo-Request packet(s) MUST be forwarded (as any data packets of the related DetNet flow).

DetNet-Echo-Reply packet MUST contain the following information:

- o Identities of the DetNet service sub-layer node (e.g., Node-ID, local Flow-ID),
- o Ingress/Egress flow related configuration (e.g., in/out member flow specific information (including forwarding sub-layer specifics)) .

5. Security Considerations

Tbd.

6. IANA Considerations

Tbd.

7. References

7.1. Normative References

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