

DetNet  
Internet-Draft  
Intended status: Informational  
Expires: January 13, 2022

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July 12, 2021

## **Services Deployment Guideline in DetNet Network draft-dang-detnet-deployment-00**

### Abstract

Deterministic Networking (DetNet) defined in [[RFC8655](#)] provides a capability for the delivery of data flows with extremely low packet loss rates and bounded end-to-end delivery latency. DetNet network administrators worldwide can deploy DetNet services into their networks. This document aims to provide a guideline for DetNet network administrators.

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## [1.](#) Introduction

Deterministic Networking (DetNet) defined in [\[RFC8655\]](#) provides a capability for the delivery of data flows with extremely low packet loss rates and bounded end-to-end delivery latency. The diverse industries in [\[RFC8578\]](#) have in common a need for "deterministic flows". How to introduce deterministic flows to the DetNet network is required.

While the DetNet technologies are becoming mature, the DetNet deployment is about to enter the live network experiment and even to large-scale commercial deployment. The DetNet network is actively managed by a network operations entity (the "administrator", whether a single person or a department of administrators). A network administrator is responsible for the deployment of DetNet services, who can must master the skills of how to introduce deterministic flows into DetNet networks and the related maintenance.

This document is intended as guidance for DetNet network administrators.

## [2.](#) 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](#).



### **3. Terminology & Abbreviations**

DetNet UPE

A DetNet edge node, which connects DetNet flows into DetNet network.

DetNet P

A DetNet relay node or DetNet transit node.

DetNet PE

A DetNet edge node, where DetNet flows leave DetNet network.

DetNet source

An end system is capable of originating a DetNet flow.

DetNet Destination

An end system is capable of terminating a DetNet flow.

### **4. Preparation of DetNet networks**

The premise of this section is that the network has not yet enabled DetNet capability. First of all, a network administrator must enable the DetNet capability of the network on demand.

The DetNet network administrator must plan the scope of DetNet network, DetNet network topology and DetNet network element roles. As usual, the network controller has collected the topology of the entire network. So the DetNet network administrators only need to specify the scope of DetNet networks, DetNet network topology and DetNet network element roles on the controller interface. When the scope of the DetNet network is determined, the DetNet network administrators can naturally get the DetNet network topology. At that time, the DetNet network administrators must figure out whether the DetNet network is in a single domain or in multiple domains.

- o If in a single domain, it contains DetNet Ingress UPE nodes, DetNet P nodes, DetNet PE nodes. In fact, a P node may be connected to multiple different UPE devices or PE nodes or P node.
- o If in multiple domains, it also contains ASBR nodes in addition to Ingress UPE nodes, DetNet P nodes and DetNet PE nodes, for the purpose of cross-domain interconnection.



The example is shown in Figure 1, which contain DetNet Ingress UPE node, DetNet P nodes, DetNet PE node. In fact, a P node may be connected to multiple different UPE devices or PE nodes or P node.

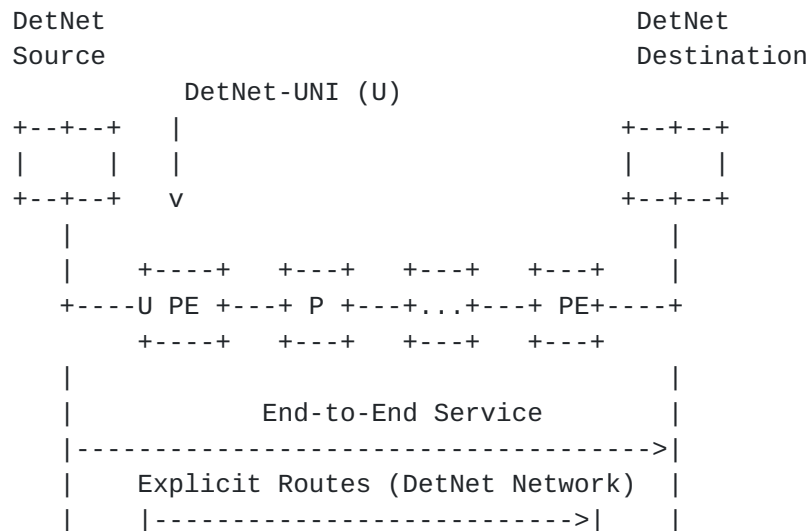


Figure-1: DetNet Network

## 5. How to Introduce Deterministic Flow into DetNet network

For the next work, the DetNet network administrator must specify the following information on the controller.

1. Definition of Deterministic Flow
2. Establishing Explicit Path for Deterministic Flow
  - \* Definition of Deterministic Flow
  - \* Specifying Encapsulation Type of Networking Technology
  - \* Specifying Type of Queuing Mechanism
  - \* Definition of Service Protection
  - \* Network Resource Evaluation and Reservation

The [section 5.1](#) focus on how to use these parameters.

### 5.1. Parameter Specification



#### **5.1.1. Definition of Deterministic Flow**

A DetNet network administrator must figure out

- o how to identify a deterministic flow,
- o the related DetNet SLA requirements,
- o which node the DetNet flow is accessed from and which node the DetNet flow leaves from.

This above information must be given the DetNet network administrator by DetNet service providers who initiate or terminate DetNet flows.

The flow identification in [\[RFC9016\]](#) let the DetNet UPE node identify the flow. Flow identification for MPLS and IP Data Planes are described in [\[RFC8939\]](#) , [\[RFC8964\]](#), and Ethernet information (such as MAC address, VLAN) respectively.

- o IP Data plane: five tuple
- o Ethernet data plane: MAC address or VLAN
- o MPLS or SR data plane: label

The SLA information of DetNet flow in [section 5.9 of \[RFC9016\]](#) are listed as follows.

- o MinBandwidth
- o MaxLatency
- o MaxLoss
- o MaxConsecutiveLossTolerance
- o MaxMisordering

If the deterministic flow has requirement for Jitter, a new parameter named jitter needs to be added.

In the follow-up work, the DetNet network administrator creates explicit route defined in [section 3.2.3 of \[RFC8655\]](#) according to the information which node the DetNet flow is accessed from and which node the DetNet flow leaves from.





### **5.1.2. Establishing Explicit Path**

The DetNet network administrator must pay attention to the encapsulation type of the explicit route, which is added to the DetNet flows when DetNet flow enters the UPE node. The DetNet network administrator may freely choose encapsulation type of the networking technology according to his/her preferences. The way of IP over SR or [[IP-Over-MPLS](#)] or IP over SR) is recommended.

#### **5.1.2.1. Encapsulation Type of Networking Technology**

The DetNet network administrator must pay attention to the encapsulation type of the explicit route, which is added to the DetNet flows when DetNet flow enters the UPE node. The DetNet network administrator may freely choose encapsulation type of the networking technology according to his/her preferences. The way of IP over SR or [[IP-Over-MPLS](#)] or IP over SR) is recommended.

#### **5.1.2.2. Type of Queuing Mechanism**

The DetNet network administrator obtains or sets the queuing type used by the network. If the cyclic queuing mechanism is used in the network, the parameters of the queuing need to be set as follows. This mechanism must allow multiple deterministic flows to share a periodic buffer.

- o CyclicBufferSize: the length of the cyclic buffer
- o CyclicInterval: duration of periodic scheduling
- o BufferNumber: the number of the cyclic buffer
- o MinBurstSize: the minimum burst size that can be tolerated by cyclic queue mechanism, which is specified in octets per second and excludes additional DetNet header (if any). Bandwidth used above the Committed Information rate is called Burst traffic. It is used when the bandwidth available is more than CIR. MinBurstSize is the minimum burst size that has to be guaranteed for the DetNet traffic. The queuing mechanism needs to pay attention to how to shape burst size traffic into buffers.

#### **5.1.2.3. Definition of Service Protection**

The DetNet network administrator can consider how to do with service protection to meet MaxLoss, MaxConsecutiveLossTolerance and MaxMisordering of a deterministic flow. The premise of service protection is that there are multiple available explicit paths for a DetNet flow. These types of packet loss can be greatly reduced by



spreading the data over multiple disjointed forwarding paths. The PREOF embedded in the PE node ensures that packets are not out of order.

#### **5.1.2.4. Network Resource Evaluation and Reservation**

The DetNet network administrator can enable network resource evaluation and reservation of the controller. In fact, the network may support a distributed protocol similar to RSVP defined in [[draft-trossen-detnet-rsvp-tsn](#)], so this function can rely on the distributed protocol.

The DetNet SLA requirements to the DetNet flow generally have deterministic bandwidth, bounded latency and bounded jitter. But in fact these three parameters are interrelated. For example, the insufficient bandwidth reservation might introduce the additional delay or the additional jitter. Therefore, the bandwidth reservation should consider the latency and jitter requirements.

There are three methods here to do with, one is to get it through centralized calculation provided by controller or other centralized systems, the other is to get it through negotiation between DetNet Nodes along the explicit routes, and the third is to rely on the human brain. When the scale of the network becomes larger or the types of services become more, the third method is difficult to handle. Therefore, the first and the second methods are recommended. These centralized and distributed solutions can cooperate with each other, for example, if the centralized system is offline, the distributed system functions will be enabled. Or in order to support rapid network decision-making, the priority is given to using distributed systems for deployment, and the centralized systems are responsible for global optimization.

The algorithm on the network resource reservation is not discussed now in this document.

##### **5.1.2.4.1. DetNet Bandwidth Evaluation and Reservation**

The DetNet network administrator must know the bandwidth resource evaluation and reservation can be divided into service access interface part on the DetNet UPE node and explicit route part.

- o Service access interface part on the DetNet UPE node: The bandwidth of service access interface part on the DetNet UPE is reserved according to the MinBandwidth of the DetNet flow.



- o Explicit route part: This mechanism ensures that the available bandwidth along the explicit path can meet MinBandwidth of DetNet flow.

The P node should take into account that there are multiple explicit routes passing in the same direction. For example, if one interface of P node accesses 3 explicit paths, the reserved bandwidth of the interface is the total required bandwidth of the 3 explicit paths.

It is emphasized that the remaining bandwidth of the interface on the DetNet nodes can also be used for non-DetNet flows.

#### **5.1.2.4.2. DetNet Latency Evaluation**

The DetNet network administrator can let the controller collect the network-wide delay information for calculation and evaluation, and obtain the queuing type.

Given that DetNet nodes have a finite amount of buffer space, the resource allocation necessarily results in a maximum end-to-end latency. The overall latency of the explicit route can be calculated based on the queue scheduling mechanism on the data plane of the DetNet nodes. The queue scheduling mechanisms have various types, such as DiffServ, Qch[IEEE802.1QCH] and so on.

[[DetNet-Bounded-Latency](#)] provides end-to-end delay bound and backlog bound computations for such mechanisms that can be used by the control plane to provide DetNet QoS. If the CQF is used, CyclicBufferSize, CyclicInterval and BufferNumber of queuing mechanism can be included in the calculation factors that affect the E2E delay.

The controller evaluates the path delay based on the resources of the entire network, and judges whether it meets the MaxLatency of the deterministic flow.

#### **5.1.2.4.3. DetNet Jitter Evaluation**

The DetNet network administrator can figure out that there are two aspects to reduce network jitter. The first is through resource reservation in [section 4.4.1](#) to 4.4.2, and the second is through effective queuing control methods. The former is not easy to evaluate jitter, but the latter is very convenient. The DetNet network administrator also can know the queuing type, because not all queuing mechanisms have a jitter control mechanism. The CQF is recommend to effectively solve the uncertainty of jitter. Under this mechanism, the end to end jitter can be controlled within  $2 * \text{CyclicInterval}$ .









## **7. How to Withdraw Deterministic Flow in DetNet network**

TBD

If a DetNet flow deployed needs to be canceled, the network administrator will execute the corresponding undo operation through the controller, and the network will release the corresponding resources.

## **8. Deployment Trial Experience**

TBD

## **9. Security Considerations**

TBD

## **10. Acknowledgements**

TBD

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