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Deterministic Networking (DetNet) Topology YANG Model
draft-ietf-detnet-topology-yang-02

Abstract

This document defines a YANG data model for Deterministic Networking (DetNet) topology discovery and capability configuration.

The YANG module defined in this document conforms to the Network Management Datastore Architecture (NMDA).

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1. Introduction

Deterministic Networking (DetNet) [I-D.ietf-detnet-architecture] is defined to provide high-quality network service with extremely low packet loss rate, bounded low latency and jitter.

DetNet YANG [RFC7950] [RFC6991] models are used for DetNet service configuration, QoS configuration and topology discovery. DetNet service and QoS configuration models are defined in [I-D.ietf-detnet-yang]. This document defines DetNet topology model that can be used for DetNet topology/capability discovery and device configuration. DetNet topology model is an augmentation of the ietf-te-toplogy model [I-D.ietf-teas-yang-te-topo].

2. Terminologies

This document uses the terminologies defined in [I-D.ietf-detnet-architecture].

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. DetNet Topology Model

A DetNet topology is composed of a set of DetNet nodes and DetNet links. DetNet nodes represent the network devices that can transport DetNet services, which are connected by DetNet links. A DetNet Link Terminate Point (LTP) is the connection point between a DetNet node and a DetNet link, which represents the port or interface of a DetNet node. The concept of DetNet node/link/LTP are similar as TE node/link/LTP which are defined in [I-D.ietf-teas-yang-te-topo].

Figure 1 shows a simple DetNet topology: A is a DetNet node, B is DetNet a LTP, and C is a DetNet link.

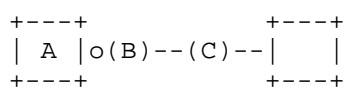


Figure 1. An example of DetNet Topology

DetNet topology model (ietf-detnet-topology) augments ietf-te-topology model [I-D.ietf-teas-yang-te-topo] to cover the following groups of attributes, which are necessary for supporting DetNet congestion protection and service protection:

- * Bandwidth related attributes (e.g., bandwidth reserved for DetNet);
- * Buffer/queue management related attributes (e.g., queue management parameters, etc.);
- * PREOF (Packet Replication, Elimination and Ordering Function) capabilities and parameters (e.g., maximum out-of-order packets, etc.);
- * Delay related attributes (e.g., node processing delay, queuing delay, link delay, etc.);

The above attributes are categorized into three types: node attributes, link attributes and LTP attributes. The detailed descriptions and model definitions are specified in section 3.1, 3.2 and 3.3, respectively.

3.1. DetNet Node Attributes

Section 4.3 of [I-D.finn-detnet-bounded-latency] gives a DetNet time model, which defines that the delay within a node includes five parts: processing delay, regulation delay, queuing delay, output delay and preemption delay. The processing delay, queuing delay and regulation delay are variable in general, but for DetNet, these delays should be bounded, which is the basic assumption of deterministic networking. These bounded delay parameters are necessary to perform DetNet path computation. Among this delay attributes, processing delay and regulation delay are node relevant, and the queuing delay is LTP relevant. In addition, in order to simplify the model and implementation, the processing delay and regulation delay are combined as processing delay, and the preemption delay is included in queuing delay. [Editor notes: more comments and inputs need here].

For the DetNet node attributes, the following variables are introduced:

- * Maximum DetNet packet processing delay
- * Minimum DetNet packet processing delay
- * Maximum DetNet packet processing delay variation

The modeling structure is shown below:

```
augment /nw:networks/nw:network/nw:node/tet:te/tet:te-node-attributes:
  +--rw detnet-node-attributes
    +--rw minimum-packet-processing-delay?      uint32
    +--rw maximum-packet-processing-delay?      uint32
    +--rw maximum-packet-processing-delay-variation?  uint32
```

3.2. DetNet Link Attributes

DetNet link attributes include link delay and link bandwidth for DetNet. This document introduces the following link related attributes:

- * Link delay: link delay is a constant that only depends on the physical connection. It has been defined in ietf-te-topology [I-D.ietf-teas-yang-te-topo], and DetNet can reuse it directly.

- * Maximum DetNet reservable bandwidth: the maximum reservable bandwidth that is allocated to DetNet. For a 10G link, if 50% of the bandwidth is allocated to DetNet, then the maximum DetNet reservable bandwidth is 5G. That means there are 5G bandwidth that can be used by DetNet flows.
- * Reserved DetNet bandwidth: the bandwidth that has been reserved for DetNet flows.
- * Available DetNet bandwidth: the bandwidth that is available for new DetNet flows.

The DetNet link attributes are modeled within a link, and the YANG module structure is shown below:

```
augment /nw:networks/nw:network/nt:link/tet:te/tet:te-link-attributes:
  +--rw detnet-link-attributes
    +--rw maximum-reservable-bandwidth
      |   +--rw te-bandwidth
      |   |   +--rw (technology)?
      |   |   |   +--:(generic)
      |   |   |   +--rw generic?   te-bandwidth
    +--rw reserved-detnet-bandwidth
      |   +--rw te-bandwidth
      |   |   +--rw (technology)?
      |   |   |   +--:(generic)
      |   |   |   +--rw generic?   te-bandwidth
    +--rw available-detnet-bandwidth
      |   +--rw te-bandwidth
      |   |   +--rw (technology)?
      |   |   |   +--:(generic)
      |   |   |   +--rw generic?   te-bandwidth
```

3.3. DetNet Link Terminate Point Attributes

The concept of LTP is introduced in [I-D.ietf-teas-yang-te-topo], and this section introduces attributes for DetNet LTP.

PREOF (Packet Replication/Elimination/Ordering Function) is for DetNet service protection, which includes :

- * In-order delivery function: defined in Section 3.2.2.1 of [I-D.ietf-detnet-architecture]
- * Packet replication function: defined in Section 3.2.2.2 of [I-D.ietf-detnet-architecture]

- * Packet elimination function: defined in Section 3.2.2.3 of [I-D.ietf-detnet-architecture]

The above functions are modeled as a set of capabilities and relevant parameters, which are listed below:

- * in-order-capability: indicates whether a LTP has the in-order delivery capability.
- * maximum-number-of-out-of-order-packets: indicates the maximum number of out-of-order packets that an LTP can support, it depends on the reserved buffer size for packet reordering.
- * replication-capability: indicates whether a LTP has the packet replication capability.
- * elimination-capability: indicates whether a LTP has the packet elimination capability.

In addition, DetNet LTP also includes queuing management algorithms and queuing delay attributes. In the context of DetNet, the delay of queuing is bounded, and the bound depends on what queuing management method is used and how many buffers are allocated. More information can be found in [I-D.finn-detnet-bounded-latency]. Queuing related attributes are listed below:

- * queuing-algorithm-capabilities: it is modeled as a list that includes all queuing algorithms that a LTP supports.
- * detnet-queues: it's modeled as a list that includes all queues of a DetNet LTP. For each queue, it has the following attributes:
- * queue-identifier: an identifier of a queue. It could be an internal identifier that is only used within a node. Or it could be used by a centralized controller to specify in which specific queue a flow/packet is required to enter.
- * queue-buffer-size: the size of a queue with unit of bytes.
- * enabled-queuing-algorithm: indicates what queuing management algorithm is enabled.
- * maximum-queuing-delay: the maximum queuing delay that a packet will undergo when transmitted through the queue.
- * minimum-queuing-delay: the minimum queuing delay that a packet will undergo when transmitted through the queue.

- * maximum-queuing-delay-variation: the maximum queuing delay variation that a packet will undergo when transmitted the queue.

The DetNet LTP attributes are modeled within a LTP, the YANG module structure is shown below:

```
augment /nw:networks/nw:network/nw:node/nt:termination-point/tet:te:
  +--rw detnet-terminate-point-attributes
    +--rw elimination-capability?          boolean
    +--rw replication-capability?          boolean
    +--rw in-ordering-capability
      | +--rw in-ordering-capability?      boolean
      | +--rw maximum-out-of-order-packets? uint32
    +--rw queuing-algorithm-capabilities
      | +--rw credit-based-shaping?        boolean
      | +--rw time-aware-shaping?          boolean
      | +--rw cyclic-queuing-and-forwarding? boolean
      | +--rw asynchronous-traffic-shaping? boolean
    +--rw queues* [queue-identifier]
      +--rw queue-identifier                uint32
      +--rw queue-buffer-size?              uint32
      +--rw enabled-queuing-algorithm
        | +--rw credit-based-shaping?      boolean
        | +--rw time-aware-shaping?        boolean
        | +--rw cyclic-queuing-and-forwarding? boolean
        | +--rw asynchronous-traffic-shaping? boolean
      +--rw minimum-queuing-delay?          uint32
      +--rw maximum-queuing-delay?          uint32
      +--rw maximum-queuing-delay-variation? uint32
```

4. DetNet Topology YANG Structure

```
module: ietf-detnet-topology
augment /nw:networks/nw:network/nw:network-types/tet:te-topology:
  +--rw detnet-topology!
augment /nw:networks/nw:network/nw:node/tet:te/tet:te-node-attributes:
  +--rw detnet-node-attributes
    +--rw minimum-packet-processing-delay?    uint32
    +--rw maximum-packet-processing-delay?    uint32
    +--rw maximum-packet-processing-delay-variation? uint32
augment /nw:networks/nw:network/nt:link/tet:te/tet:te-link-attributes:
  +--rw detnet-link-attributes
    +--rw maximum-reservable-bandwidth
      | +--rw te-bandwidth
      | | +--rw (technology)?
      | | +--:(generic)
      | | +--rw generic?    te-bandwidth
    +--rw reserved-detnet-bandwidth
```

```

|   +--rw te-bandwidth
|   |   +--rw (technology)?
|   |   |   +--:(generic)
|   |   |   +--rw generic?   te-bandwidth
+--rw available-detnet-bandwidth
|   +--rw te-bandwidth
|   |   +--rw (technology)?
|   |   |   +--:(generic)
|   |   |   +--rw generic?   te-bandwidth
augment /nw:networks/nw:network/nw:node/nt:termination-point/tet:te:
+--rw detnet-terminate-point-attributes
|   +--rw elimination-capability?          boolean
|   +--rw replication-capability?          boolean
|   +--rw in-ordering-capability
|   |   +--rw in-ordering-capability?      boolean
|   |   +--rw maximum-out-of-order-packets? uint32
+--rw queuing-algorithm-capabilities
|   +--rw credit-based-shaping?            boolean
|   +--rw time-aware-shaping?              boolean
|   +--rw cyclic-queuing-and-forwarding?    boolean
|   +--rw asynchronous-traffic-shaping?     boolean
+--rw queues* [queue-identifier]
|   +--rw queue-identifier                  uint32
|   +--rw queue-buffer-size?               uint32
|   +--rw enabled-queuing-algorithm
|   |   +--rw credit-based-shaping?        boolean
|   |   +--rw time-aware-shaping?          boolean
|   |   +--rw cyclic-queuing-and-forwarding? boolean
|   |   +--rw asynchronous-traffic-shaping? boolean
+--rw minimum-queuing-delay?               uint32
+--rw maximum-queuing-delay?               uint32
+--rw maximum-queuing-delay-variation?     uint32

```

5. DetNet Topology YANG Model

```

<CODE BEGINS> file "ietf-detnet-topology@20190114.yang"
module ietf-detnet-topology {
  yang-version 1.1;
  namespace "urn:ietf:params:xml:ns:yang:ietf-detnet-topology";
  prefix "detnet-topology";

  import ietf-te-types {
    prefix "te-types";
  }

  import ietf-te-topology {
    prefix "tet";
  }

```



```
import ietf-network {
  prefix "nw";
}

import ietf-network-topology {
  prefix "nt";
}

organization
  "IETF Deterministic Networking(DetNet)Working Group";

contact
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  WG List:    <mailto:detnet@ietf.org>

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description
  "This YANG module augments the 'ietf-te-topology'
  module with DetNet related capabilities and
  parameters.";

revision "2018-09-10" {
  description "Initial revision";
  reference "RFC XXXX: draft-geng-detnet-config-yang-05";
}

grouping detnet-queuing-algorithms {
  description
    "Relationship with IEEE 802.1 TSN YANG models is TBD.";
}
```

```
grouping detnet-node-attributes{
  description
    "DetNet node related attributes.";
  leaf minimum-packet-processing-delay{
    type uint32;
    description
      "Minimum packet processing delay
       in a node. The unit of the delay
       is microsecond(us)";
  }
  leaf maximum-packet-processing-delay{
    type uint32;
    description
      "Maximum packet processing delay
       in a node. The unit of the delay
       is microsecond(us)";
  }
  leaf maximum-packet-processing-delay-variation{
    type uint32;
    description
      "Maximum packet processing delay
       variation in a node. The unit of
       the delay variation is microsecond(us)";
  }
}

grouping detnet-link-attributes{
  description
    "DetNet link related attributes.";

  container maximum-reservable-bandwidth{
    uses te-types:te-bandwidth;
    description
      "This container specifies the maximum bandwidth
       that is reserved for DetNet on this link.";
  }

  container reserved-detnet-bandwidth{
    uses te-types:te-bandwidth;
    description
      "This container specifies the bandwidth that has
       been reserved for DetNet on this link.";
  }

  container available-detnet-bandwidth{
    uses te-types:te-bandwidth;
    description
      "This container specifies the bandwidth that is
       available for new DetNet flows on this link.";
  }
}
```

```
    }  
  }  
  
  grouping detnet-terminate-point-attributes {  
    description  
      "DetNet terminate point related attributes.";  
  
    leaf elimination-capability {  
      type boolean;  
      description  
        "Indicates whether a node is able to do packet  
        elimination.";  
      reference  
        "Section 3.2.2.3 of  
        draft-ietf-detnet-architecture";  
    }  
  
    leaf replication-capability {  
      type boolean;  
      description  
        "Indicates whether a node is able to do packet  
        replication.";  
      reference  
        "Section 3.2.2.2 of  
        draft-ietf-detnet-architecture";  
    }  
  
    container in-ordering-capability {  
      description  
        "Indicates the parameters needed for  
        packet in-ordering.";  
      reference  
        "Section 3.2.2.1 of  
        draft-ietf-detnet-architecture";  
  
      leaf in-ordering-capability {  
        type boolean;  
        description  
          "Indicates whether a node is able to do packet  
          in-ordering.";  
      }  
  
      leaf maximum-out-of-order-packets {  
        type uint32;  
        description  
          "The maximum number of out-of-order packets.";  
      }  
    }  
  
    container queuing-algorithm-capabilities {
```

```
    description
      "All queuing algorithms that a LTP supports.";
    uses detnet-queuing-algorithms;
  }

  list queues {
    key "queue-identifier";
    description
      "A list of DetNet queues.";
    leaf queue-identifier {
      type uint32;
      description
        "The identifier of the queue.";
    }
    leaf queue-buffer-size {
      type uint32;
      description
        "The size of the queue with unit of bytes.";
    }
    container enabled-queuing-algorithm {
      description
        "The queuing algorithms that are enabled on the queue.";
      uses detnet-queuing-algorithms;
    }
    leaf minimum-queuing-delay{
      type uint32;
      description
        "The minimum queuing delay of the queue.
        The unit of the delay is microsecond(us)";
    }
    leaf maximum-queuing-delay{
      type uint32;
      description
        "The maximum queuing delay of the queue.
        The unit of the delay is microsecond(us)";
    }
    leaf maximum-queuing-delay-variation{
      type uint32;
      description
        "The maximum queuing delay variation of the queue.
        The unit of the delay variation is microsecond(us)";
    }
  }
}

augment "/nw:networks/nw:network/nw:network-types/tet:te-topology" {
```

```
description
  "Introduce new network type for TE topology.";
container detnet-topology {
  presence "Indicates DetNet topology.";
  description
    "Its presence identifies the DetNet topology type";
}
}

augment "/nw:networks/nw:network/nw:node/tet:te/"
  + "tet:te-node-attributes" {
  when "../../../nw:network-types/tet:te-topology/"
  + "detnet-topology:detnet-topology" {
  description
    "Augmentation parameters apply only for networks with
    DetNet topology type.";
  }
  description
    "Augmentation parameters apply for DetNet node attributes.";
  container detnet-node-attributes {
  description
    "Attributes for DetNet node.";
  uses detnet-node-attributes;
  }
}

augment "/nw:networks/nw:network/nt:link/tet:te/"
  + "tet:te-link-attributes" {
  when "../../../nw:network-types/tet:te-topology/"
  + "detnet-topology:detnet-topology" {
  description
    "Augmentation parameters apply only for networks with
    DetNet topology type.";
  }
  description
    "Augmentation parameters apply for DetNet link attributes.";
  container detnet-link-attributes {
  description
    "Attributes for DetNet link.";
  uses detnet-link-attributes;
  }
}

augment "/nw:networks/nw:network/nw:node/nt:termination-point/"
  + "tet:te" {
  when "../../../nw:network-types/tet:te-topology/"
  + "detnet-topology:detnet-topology" {
  description
```

```
        "Augmentation parameters apply only for networks with
        DetNet topology type.";
    }
    description
        "Augmentation parameters apply for DetNet
        link termination point.";
    container detnet-terminate-point-attributes {
        description
            "Attributes for DetNet link terminate point.";
        uses detnet-terminate-point-attributes;
    }
}
} //topology module
<CODE ENDS>
```

6. Open Issues

There are some open issues that are still under discussion:

- * The Relationship with 802.1 TSN YANG models is TBD. TSN YANG models include: P802.1Qcw, which defines TSN YANG for Qbv, Qbu, and Qci, and P802.1CBcv, which defines YANG for 802.1CB. The possible problem here is how to avoid possible overlap among yang models defined in IETF and IEEE. A common YANG model may be defined in the future to shared by both TSN and DetNet. More discussion are needed here.
- * How to support DetNet OAM is TBD.

These issues will be resolved in the following versions of the draft.

7. IANA Considerations

This document makes no request of IANA.

Note to RFC Editor: this section may be removed on publication as an RFC.

8. Security Considerations

<TBD>

9. References

9.1. Normative References

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