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On-Path Telemetry YANG Data Model

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Abstract

This document proposes a YANG data model for monitoring On-Path

network performance information to be published in YANG notifications. The Alternate-Marking Method and In-situ

Operations, Administration, and Maintenance (IOAM) are On-Path

hybrid measurement methods considered in this document.

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1. Introduction

Alternate-Marking Method [RFC9341] [RFC9342] (AltMark) is a technique

used to perform packet loss, delay, and jitter measurements on in-

flight packets. In-situ Operations, Administration, and Maintenance

(IOAM) is a method to produce operational and telemetry information

that may be exported using the in-band or out-of-band method. The

data types and data formats for IOAM data records have been defined

in [RFC9197] [RFC9326].

This document defines a YANG data model for monitoring On-Path

telemetry information of Alternate Marking Method and IOAM. It

provides YANG data models with performance monitoring parameters that

can be subscribed for monitoring and telemetry via YANG-Push

specified in [RFC8639] [RFC8640] and [RFC8641].

This document uses the

existing mechanisms of [RFC9341], [RFC9342], [RFC9197], [RFC9326] to

monitor the performance of the network and connectivity services.

1.1. 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.

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1.2. Conventions

The following terms are defined in [RFC7950] and are used in this

specification:

\* augment

\* data model

\* data node

The terminology for describing YANG data models is found in

[RFC7950].

2. Use Case

Some applications may use the subscription model specified in

[RFC8641] to subscribe to the On-Path telemetry network performance

data. For example, Network Telemetry [RFC9232] updates may be subscribed to

YANG-Push on-change notifications [RFC8641] for state changes. YANG-Push periodic notifications [RFC8641]

can be subscribed to obtain real-time performance data.

There is a need for real-time traffic monitoring of the network to

optimize the network performance. The next figure shows an example

of a high-level workflow for dynamic network control based on traffic

monitoring that could use the mechanism described in this document.

+---------------------------------------------------+

| Orchestrator/Controller |

+---------------------------------------------------+

| /|\ | /|\

Monitor | | Monitor | |

Request | | Result Possible | |

| | Optimization | | Optimization

\|/ | \|/ | Result

+---------------------------------------------------+

| Network |

+---------------------------------------------------+

Figure 1: Workflow for dynamic network control based on traffic

monitoring

The Controller sends a Monitor Request and receive Monitor Result.

Because of this Closed-Loop approach, the controller can

take Optimization actions, that can be related to forwarding path

modification or performance measurements variation

([I-D.ydt-ippm-alt-mark-yang]), as also described in [RFC9342] with

regard to the flexible and adaptive performance measurements.

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3. On-Path Telemetry Tree Diagram

Tree diagrams used in this document follow the notation defined in

[RFC8340].

The On-Path Telemetry model is organized as shown in the following

figure. This model complements the AltMark model in

[I-D.ydt-ippm-alt-mark-yang] and the IOAM model in [RFC9617].

module: on-path-telemetry

+--ro on-path-telemetry-data

+--ro timestamp? yang:date-and-time

+--ro interface\* [if-name]

+--ro if-name if:interface-ref

+--ro profile-name string

+--ro filter

| +--ro filter-type? telemetry-filter-type

| +--ro ace-name? -> /acl:acls/acl/aces/ace/name

+--ro protocol-type? telemetry-protocol-type

+--ro node-action telemetry-node-action

+--ro period? uint64

+--ro period-number? uint64

+--ro flow-mon-id? uint32

+--rw method-type? altmark-method-type

+--ro altmark-loss-measurement?

| +--ro in-traffic-pkts? yang:counter64

| +--ro out-traffic-pkts? yang:counter64

| +--ro in-traffic-bytes? uint64

| +--ro out-traffic-bytes? uint64

+--ro altmark-delay-measurement?

| +--ro pkts-timestamps? yang:date-and-time

| +--ro pkt-timestamp? yang:date-and-time

+--ro path-delay?

| +--ro path-delay-mean uint32

| +--ro path-delay-min uint32

| +--ro path-delay-max uint32

| +--ro path-delay-sum uint64

+--ro ioam-incremental-tracing ioam-trace-data

+--ro ioam-preallocated-tracing ioam-trace-data

+--ro ioam-direct-export ioam-trace-data

+--ro ioam-proof-of-transit ioam-pot-data

+--ro ioam-edge-to-edge ioam-e2e-data

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4. On-Path Telemetry Data

The "on-path-telemetry-data" contains detailed information for

the AltMark telemetry data and IOAM telemetry data. The information

includes:

\* timestamp: is the timestamp of the message.

\* interface: indicates the list of interface where the On-Path

Telemetry is applied.

The "interface" contains the detailed information for the each

interface. The information includes:

\* if-name: is the interface name as in ifName [RFC2863] \* profile-name: is the unique identifier for each profile

\* filter: is used to identify the monitored flow

\* protocol-type: is used to indicate the protocol where the On-

path telemetry is applied

\* node-action: indicates the operation applied to the flow.

\* period: indicates the period.

\* period-number: indicates the period number (for AltMark see

[I-D.ietf-ippm-alt-mark-deployment]).

\* flow-mon-id: is used to identify the monitored flow and to

correlate the exported data of the same flow from multiple nodes

and from multiple packets.

\* altmark-loss-measurement: indicates loss counters.

\* altmark-delay-measurement: indicates packet timestamps.

\* ioam-incremental-tracing: indicates IOAM incremental tracing

data.

\* ioam-preallocated-tracing: indicates IOAM pre-allocated tracing

data.

\* ioam-direct-export: indicates direct export data.

\* ioam-proof-of-transit: indicates proof of transit data.

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\* ioam-edge-to-edge: indicates edge-to-edge data.

The "altmark-loss-measurement" contains:

\* in-traffic-pkts: indicates the inbound packets of the period.

\* out-traffic-pkts: indicates the outbound packets of the period.

\* in-traffic-bytes: indicates the inbound bytes of the period.

\* out-traffic-bytes: indicates the outbound bytes of the period.

The "altmark-delay-measurement" contains:

\* pkts-timestamps: indicates the list of packet timestamps for

delay measurement in the period (pkt-timestamp).

The "path-delay" in introduced in

[I-D.ietf-opsawg-ipfix-on-path-telemetry] and contains:

\* path-delay-mean: indicates the mean path delay between the

encapsulation/marking node and the local node.

\* path-delay-min: indicates the lowest path delay between the

encapsulation/marking node and the local node.

\* path-delay-max: indicates the highest path delay between the

encapsulation/marking node and the local node.

\* path-delay-sum: indicates the sum of the path delay between the

encapsulation/marking node and the local node.

5. On-Path Telemetry YANG Data Model

<CODE BEGINS> file "ietf-on-path-telemetry@2024-12-20.yang"

module ietf-on-path-telemetry {

yang-version 1.1;

namespace "urn:ietf:params:xml:ns:yang:ietf-on-path-telemetry";

prefix "on-path-telemetry";

import ietf-access-control-list {

prefix acl;

reference

"RFC 8519: YANG Data Model for Network Access Control

Lists (ACLs)";

}

import ietf-interfaces {

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prefix if;

reference

"RFC 8343: A YANG Data Model for Interface Management";

}

import ietf-yang-types {

prefix yang;

reference

"Section 3 of RFC 6991";

}

organization

"IETF IPPM (IP Performance Metrics) Working Group";

contact

"WG Web: <https://datatracker.ietf.org/wg/ippm>

WG List: <ippm@ietf.org>

Author: giuseppe.fioccola@huawei.com

Author: zhoutianran@huawei.com";

description

"This YANG module specifies a vendor-independent data

model for Alternate Marking Telemetry.

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 (RFC 2119) (RFC 8174) when, and only when,

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(https://trustee.ietf.org/license-info).

This version of this YANG module is part of RFC XXXX

(https://www.rfc-editor.org/info/rfcXXXX); see the RFC itself

for full legal notices.";

revision 2024-12-20 {

description "First revision.";

reference "RFC XXXX: A YANG Data Model for On-path Telemetry";

}

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/\*

\* FEATURES

\*/

feature altmark

{

description

"This feature indicated that the Alternate-Marking Method is

supported.";

reference

"RFC 9341: Alternate-Marking Method;

RFC 9342: Clustered Alternate-Marking Method";

}

feature pathdelay

{

description

"This feature indicated that the Path Delay is

supported.";

reference

"[I-D.ietf-opsawg-ipfix-on-path-telemetry]";

}

feature incremental-trace

{

description

"This feature indicated that the incremental tracing option is

supported.";

reference "RFC 9197: Data Fields for In-situ OAM";

}

feature preallocated-trace

{

description

"This feature indicated that the preallocated tracing option is

supported.";

reference "RFC 9197: Data Fields for In-situ OAM";

}

feature direct-export

{

description

"This feature indicated that the direct export option is

supported.";

reference "RFC 9326: In-situ OAM Direct Exporting";

}

feature proof-of-transit

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{

description

"This feature indicated that the proof of transit option is

supported";

reference "RFC 9197: Data Fields for In-situ OAM";

}

feature edge-to-edge

{

description

"This feature indicated that the edge-to-edge option is

supported.";

reference "RFC 9197: Data Fields for In-situ OAM";

}

/\*

\* IDENTITIES

\*/

identity filter {

description

"Base identity to represent a filter. A filter is used to

specify the flow to which the On-Path Telemetry method is applied.";

}

identity acl-filter {

base filter;

description

"Apply ACL rules to specify the flow.";

}

identity protocol {

description

"Base identity to represent the protocol. It's used to

indicate the protocol for the application of the On-Path Telemetry

method.";

}

identity ipv6 {

base protocol;

description

"The On-Path Telemetry method is applied to IPv6 protocol.";

reference

"RFC 9343: IPv6 Application of the Alternate-Marking Method,

RFC 9486: In-situ OAM IPv6 Options";

}

identity srh {

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base protocol;

description

"The On-Path Telemetry method is applied to SRH.";

reference

"[I-D.fz-spring-srv6-alt-mark]: Application of the

Alternate Marking Method to the Segment Routing Header";

}

identity mpls {

base protocol;

description

"The On-Path Telemetry method is applied to MPLS.";

reference

"[I-D.ietf-mpls-inband-pm-encapsulation]: Application of the

Alternate Marking Method to the MPLS Label Stack";

}

identity nsh {

base protocol;

description

"The described IOAM data is embedded in NSH.";

reference

"RFC 9452: Network Service Header (NSH)

Encapsulation for In-situ OAM (IOAM) Data";

}

identity node-action {

description

"Base identity to represent the node actions. It's used to

indicate what action the node will take.";

}

identity action-marking {

base node-action;

description

"It indicates that the node must mark the AltMark data field,

according to the operations described in RFC 9341 and

RFC 9342";

}

identity action-unmarking {

base node-action;

description

"It indicates that the node must unmark the AltMark data field,

according to the operations described in RFC 9341 and

RFC 9342";

}

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identity action-read {

base node-action;

description

"It indicates the node only reads the AltMark data,

according to the operations described in RFC 9341 and

RFC 9342";

}

identity action-encapsulate {

base node-action;

description

"It indicates the node is to encapsulate the IOAM packet";

}

identity action-decapsulate {

base node-action;

description

"It indicates the node is to decapsulate the IOAM packet";

}

identity action-transit {

base node-action;

description

"It indicates the node is to transit the IOAM packet";

}

identity period {

description

"It indicates the On-Path Telemetry Period.";

}

identity period-number {

description

"It indicates the Period Number.";

}

identity flow-mon-id {

description

"It indicates the FlowMonID.";

}

identity method {

description

"Base identity to represent the AltMark method type.";

}

identity trace-data {

description

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"Base identity to represent trace data.";

}

identity pot-data {

description

"Base identity to represent POT data.";

}

identity e2e-data {

description

"Base identity to represent E2E data.";

}

identity telemetry-param-type {

description

"Base identity for telemetry param types";

}

identity loss-measurement {

base telemetry-param-type;

description

"To specify loss counters according to RFC 9341";

}

identity delay-measurement {

base telemetry-param-type;

description

"To specify timestamps for delay according to RFC 9341";

}

/\*

\* TYPE DEFINITIONS

\*/

typedef telemetry-filter-type {

type identityref {

base filter;

}

description

"It specifies a known type of filter.";

}

typedef telemetry-node-action {

type identityref {

base node-action;

}

description

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"It specifies a node action.";

}

typedef telemetry-protocol-type {

type identityref {

base protocol;

}

description

"It specifies a known type of carrier protocol for the On-path

Telemetry data.";

}

typedef altmark-method-type {

type identityref {

base method;

}

description

"It specifies the AltMark method used.";

}

typedef ioam-trace-data {

type identityref {

base trace-data;

}

description

"It specifies the trace data.";

}

typedef ioam-pot-data {

type identityref {

base pot-data;

}

description

"It specifies the pot data.";

}

typedef ioam-e2e-data {

type identityref {

base e2e-data;

}

description

"It specifies the edge-to-edge data.";

}

/\*

\* GROUP DEFINITIONS

\*/

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grouping timestamp {

description

"Grouping for identifying the time.";

leaf timestamp {

type yang:date-and-time;

description

"Specify the time.";

}

}

grouping telemetry-filter {

description "A grouping for On-path Telemetry filter definition";

leaf filter-type {

type telemetry-filter-type;

description "filter type";

}

leaf ace-name {

when "derived-from-or-self(../filter-type,

'on-path-telemetry:acl-filter')";

type leafref {

path "/acl:acls/acl:acl/acl:aces/acl:ace/acl:name";

}

description "The Access Control Entry name is used to

refer to an ACL specification.";

}

}

grouping telemetry-setup {

description

"A grouping for On-path Telemetry profile.";

leaf node-action {

type telemetry-node-action;

description

"This object indicates the action that the node needs to

take, i.e. marking/read/unmarking/encapsulate/transit/decapsulate.";

}

leaf period {

type uint64;

description

"Specifies the On-path Telemetry period.

It is the marking period for AltMark.";

}

leaf period-number {

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type uint64;

description

"Specifies the On-path Telemetry period number.";

}

leaf flowmonid {

type uint32;

description

"Specifies the 20-bit FlowMonID.";

}

leaf method-type {

type altmark-method-type;

description

"Specifies the AltMark method type.";

}

}

grouping loss-counters {

description

"The set of counters for RFC 9341 loss calculation.";

leaf in-traffic-pkts {

type yang:counter64;

description

"Total inbound packets of the period according to RFC 9341";

}

leaf out-traffic-pkts {

type yang:counter64;

description

"Total outbound packets of the period according to RFC 9341";

}

leaf in-traffic-bytes {

type uint64;

description

"Total inbound bytes of the period according to RFC 9341";

}

leaf out-traffic-bytes {

type uint64;

description

"Total outbound bytes of the period according to RFC 9341";

}

}

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grouping delay-timestamps {

description

"Indicates the set of timestamps for RFC 9341 delay calculation.";

container pkts-timestamps {

description

"The list of timestamps of the period according to RFC 9341";

leaf pkt-timestamp {

type yang:date-and-time;

description

"Specifies the timestamp of the delay packet for delay measurements";

}

}

}

grouping path-delay-metrics {

description

"Indicates the path delay measurements.";

leaf path-delay-mean {

type uint32;

description

"mean path delay as per [I-D.ietf-opsawg-ipfix-on-path-telemetry]";

}

leaf path-delay-min {

type uint32;

description

"min path delay as per [I-D.ietf-opsawg-ipfix-on-path-telemetry]";

}

leaf path-delay-max {

type uint32;

description

"max path delay as per [I-D.ietf-opsawg-ipfix-on-path-telemetry]";

}

leaf path-delay-sum {

type uint64;

description

"sum of the path delay as per [I-D.ietf-opsawg-ipfix-on-path-telemetry]";

}

}

grouping ioam-incremental-tracing-data {

description

"Grouping for incremental tracing data.";

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leaf incremental-tracing-data {

type ioam-trace-data;

description

"Indicates the incremental tracing data.";

}

}

grouping ioam-preallocated-tracing-data {

description

"Grouping for pre-allocated tracing data.";

leaf preallocated-tracing-data {

type ioam-trace-data;

description

"Indicates the preallocated-tracing-data.";

}

}

grouping ioam-direct-export-tracing-data {

description

"Grouping for direct export data.";

leaf direct-export-data {

type ioam-trace-data;

description

"Indicates the direct export data.";

}

}

grouping ioam-edge-to-edge-data {

description

"Grouping for edge-to-edge data.";

leaf e2e-data {

type ioam-e2e-data;

description

"Indicates the edge-to-edge data.";

}

}

grouping ioam-proof-of-transit-data {

description

"Grouping for proof of transit data.";

leaf pot-data {

type ioam-pot-data;

description

"Indicates the proof of transit data.";

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}

}

/\*

\* DATA NODES

\*/

container on-path-telemetry-data {

description "On-Path Telemetry top level container";

uses timestamp;

container interfaces {

description

"Contains the list of available interfaces that support

Alternate-Marking.";

list interface {

key "if-name";

description

"Describes the list of the interfaces activated for AltMark";

leaf if-name {

type if:interface-ref;

description "Reference to the Interface name as in ifName of RFC2863.";

}

leaf profile-name {

type string{

length "1..300";

}

description

"Unique identifier for the On-path Telemetry profile.";

}

container filter {

uses telemetry-filter;

description

"The filter which is used to indicate the flow where

the On-Path Telemetry is applied.";

}

leaf protocol-type {

type telemetry-protocol-type;

description

"This item is used to indicate the carrier protocol where

the On-Path Telemetry is applied.";

}

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uses telemetry-setup;

container altmark-loss-measurement {

if-feature altmark;

description

"Reports the loss measurement data.";

uses loss-counters;

}

container altmark-delay-measurement {

if-feature altmark;

description

"Reports the delay measurement data.";

uses delay-timestamps;

}

container path-delay {

if-feature pathdelay;

description

"Reports the path delay measurements.";

uses path-delay-metrics;

}

container ioam-incremental-tracing {

if-feature incremental-trace;

presence "Enables incremental tracing option.";

description

"Reports the incremental tracing option data.";

uses ioam-incremental-tracing-data;

}

container ioam-preallocated-tracing {

if-feature preallocated-trace;

presence "Enables preallocated tracing option.";

description

"Reports the preallocated tracing option data.";

uses ioam-preallocated-tracing-data;

}

container ioam-direct-export {

if-feature direct-export;

presence "Enables direct-export option.";

description

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"It reports the direct-export option data";

uses ioam-direct-export-tracing-data;

}

container ioam-proof-of-transit {

if-feature proof-of-transit;

presence "Enables Proof of Transit option.";

description

"Reports the PoT option data.";

uses ioam-proof-of-transit-data;

}

container ioam-edge-to-edge {

if-feature edge-to-edge;

presence "Enables edge-to-edge option.";

description

"Reports the edge-to-edge option data.";

uses ioam-edge-to-edge-data;

}

}

}

}

}

<CODE ENDS>

6. Security Considerations

IOAM [RFC9197], Alternate Marking [RFC9341] and Multipoint Alternate

Marking [RFC9342] analyze different security concerns and related

solutions. These aspects are valid and applicable also to this

document. In particular that

Alternate Marking MUST only be applied in a specific limited domain,

as also mentioned in [RFC8799].

The YANG module specified in this document defines a schema for data

that is designed to be accessed via network management protocols such

as NETCONF [RFC6241], RESTCONF [RFC8040] or YANG-PUSH configured subscriptions [RFC8639]. The lowest NETCONF layer

is the secure transport layer, and the mandatory-to-implement secure

transport is Secure Shell (SSH) [RFC6242]. The lowest RESTCONF layer

is HTTPS, and the mandatory-to-implement secure transport is TLS

[RFC8446]. The YANG-Push configured subscription mandatory-to-implement secure transport encryption is TLS [RFC8446]or DTLS [RFC9147].

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The Network Configuration Access Control Model (NACM) [RFC8341]

provides the means to restrict access for particular NETCONF or

RESTCONF users to a preconfigured subset of all available NETCONF or

RESTCONF protocol operations and content.

The top level administrative configurations related to the AltMark

and IOAM functionalities are already reported in

[I-D.ydt-ippm-alt-mark-yang] and [RFC9617]. Unexpected changes to

those items could lead to the AltMark and IOAM function disruption

and/ or misbehavior of the AltMark.

There are several data nodes defined in this YANG module. These

data nodes may be considered sensitive or vulnerable in some network

environments. Write operations (e.g., edit-config) to these data

nodes without proper protection can have a negative effect on network

operations. These are the subtrees and data nodes and their

sensitivity/vulnerability:

\* /on-path-telemetry-data/interface

The entries in the container above include the AltMark and IOAM

profile telemetry data which can be considered sensitive or

vulnerable in some network environments. Write operations (e.g.,

edit-config) to these data nodes without proper protection can have a

negative effect on network operations. It is also important to

control read access (e.g., via get, get-config, or notification) to

the readable data nodes.

7. IANA Considerations

IANA is requested to assign a new URI from the IETF XML Registry

[RFC3688]. The following URI is suggested:

URI: urn:ietf:params:xml:ns:yang:ietf-on-path-telemetry

Registrant Contact: The IESG.

XML: N/A; the requested URI is an XML namespace.

This document also requests a new YANG module name in the YANG Module

Names registry [RFC7950] with the following suggestion:

name: ietf-on-path-telemetry

namespace: urn:ietf:params:xml:ns:yang:ietf-on-path-telemetry

prefix: on-path-telemetry

reference: RFC XXXX

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8. Acknowledgements

TBD

9. Contributors

TBD

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