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Guidelines for Characterizing "OAM"

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Abstract

As the IETF continues to develop different

Operations, Administration, and Maintenance (OAM) protocols and

technologies, various qualifiers and modifiers are prepended to the

OAM abbreviation. While, at first glance, the most used appear to be

well understood, the same qualifier may be interpreted differently in

different contexts. A case in point is the qualifiers "in-band" and

"out-of-band" which have their origins in the radio lexicon, and

which have been extrapolated into other communication networks.

This document considers some common qualifiers and modifiers that are

prepended, within the context of packet networks, to the OAM

abbreviation and lays out guidelines for their use in future IETF

work.

This document updates RFC 6291 by adding to the guidelines for the

use of the term "OAM".

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1. Introduction

It is not uncommon for historical and popular terms to have nuances

in how they are interpreted or understood. This was, for example,

the case with the abbreviation for Operations, Administration, and

Maintenance, "OAM". [RFC6291] provided guidelines for its use as

well as definitions of its constituent parts.

Characterizations or qualifiers for "OAM" within packet networks

encounter similar problems of interpretation, such as with the

adjective phrases "in-band" and "out-of-band". This document

considers some common qualifiers and modifiers that are prepended to

the OAM abbreviation, and lays out guidelines for their use in future

IETF work to achieve unambiguous and consistent characterization.

Additionally, this document recommends avoiding the creation and use

of extended abbreviation for the qualifiers of "OAM". For example,

the first "O" in "OOAM" could mean out-of-band, overlay, or something

else.

This document updates [RFC6291] by adding to the guidelines for the

use of the term "OAM". It does not modify any other part of that RFC.

Note that [RFC7799] defines terms for active and passive performance

assessments through metrics and methods. That RFC does not

substantially discuss OAM, and although the concepts are similar,

this document does not modify the definitions in [RFC7799].

2. In-Band and Out-of-Band OAM

Historically, the terms "in-band" and "out-of-band" were used

extensively in radio communications as well as in telephony signaling

[RFC4733]. In both these cases, there is an actual "Band" (i.e., a

"Channel" or "Frequency") to be within or outside.

While those terms, useful in their simplicity, continued to be

broadly used to mean "within something" and "outside something", a

challenge is presented for IP communications and packet switch

networks (PSNs) which do not have a "band" per se, and, in fact, have

multiple "somethings" that OAM can be carried within or outside. A

frequently encountered case is the use of "in-band" to mean either

in-packet or on-path.

Within the IETF, the terms "in-band" and "out-of-band" cannot be

reliably understood consistently and unambiguously. Context-specific

redefinitions of these terms cannot be generalized and can be

confused by participants from other contexts. Also, even when contextualized, terms such as “in-band signaling” are not explicit enough about their meaning (see, e.g., Section 1.2 of [RFC6826]). More importantly, the

terms are not self-defining to any further extent and cannot be

understood by someone exposed to them for the first time, since there

is no "band" in IP.

The guidance in this document is to avoid the terms "in-band" and

"out-of-band", and instead find finer-granularity descriptive terms.

The definitions presented in this document are for use in all future

IETF documents that refer to OAM, and the terms "in-band OAM" and

"out-of-band OAM" are not to be used in future documents.

Path: OAM in relation to a path.

Path-Congruent OAM:

The OAM information follows the exact same path as the observed

data traffic. This was sometimes referred to as "in-band".

Non-Path-Congruent OAM:

The OAM information does not follow the exact same path as the

observed data traffic. This was sometimes referred to as "out-

of-band".

[RFC6669] gives an example of "Path-Congruent OAM", and further

describes that such OAM packets "share their fate with data

packets."

Packet: OAM in relation to a user data packet.

Shared-Packet OAM:

The OAM information is carried in the packets that also carry

the user data traffic. This was sometimes referred to as "in-band".

Dedicated-Packet OAM:

The OAM information is carried in its own OAM packets, separate

from data traffic. This was sometimes referred to as "out-of-

band".

The MPLS echo request/reply messages [RFC8029] are an example of

"Dedicated-Packet OAM", since they are described as "An MPLS echo

request/reply is a (possibly MPLS-labeled) IPv4 or IPv6 UDP

packet".

In situ OAM [RFC9197] is an example of "Shared-Packet OAM", given that

it: '...records OAM information within the packet while the packet

traverses a particular network domain. The term "in situ" refers

to the fact that the OAM data is added to the data packets rather

than being sent within packets specifically dedicated to OAM.'

Initially, "in situ OAM" [IETF96-In-Band-OAM] was also referred to

as "In-band OAM", but was renamed due to the overloaded meaning of

"in-band OAM". Further, [RFC9232] also intertwines the terms "in-

band" with "in situ", though [I-D.song-opsawg-ifit-framework]

settled on using "in Situ". Other similar uses, including

[P4-INT-2.1] and [I-D.kumar-ippm-ifa], still use variations of

"in-band", "in band", or "inband".

It is noteworthy that Shared-Packet OAM cannot be Non-Path-Congruent

OAM.

Packet Treatment: OAM in relation to the treatment of user data

packets, as for example QoS treatment.

Equal-QoS-Treatment OAM:

The OAM packets receive the same QoS treatment as user data

packets. This was sometimes referred to as "in-band".

Different-QoS-Treatment OAM:

The OAM packets receive different QoS treatment as user data

packets. This was sometimes referred to as "out-of-band".

For a case of either "Non-Path-Congruent OAM" or "Different-QoS-

Treatment OAM", [I-D.ietf-detnet-oam-framework] says "Out-of-band

OAM is an active OAM whose path through the DetNet domain is not

topologically identical to the path of the monitored DetNet flow,

or its test packets receive different QoS and/or PREOF treatment,

or both." [I-D.ietf-raw-architecture] uses similar text.

Combined: OAM in relation to multiple criteria. For example, in

relation to both topological congruence and packet treatment.

[I-D.ietf-detnet-oam-framework] uses Combined OAM when it says

"In-band OAM is an active OAM that is in-band within the monitored

DetNet OAM domain when it traverses the same set of links and

interfaces receiving the same QoS and Packet Replication,

Elimination, and Ordering Functions (PREOF) treatment as the

monitored DetNet flow". [I-D.ietf-raw-architecture] uses similar

text.

2.1. Historical Uses

There are many examples of "in-band OAM" and "out-of-band OAM" in

published RFCs. While interpreting those, it is important to

understand the semantics of what "band" is a proxy for, and to be

more explicit if those documents are updated. This document does not

change the meaning of any terms in any prior RFCs.

For example, [RFC5085] says "as in-band traffic with the PW's data,

or out-of-band", and "in-band (i.e., following the same data-plane

faith as PW data)". Hence, in that specific case, the term "band"

refers to the "Pseudowire data".

3. Active, Passive, Hybrid, and Compound OAM

[RFC7799] provides clear definitions for active and passive

performance assessment such that the construction of metrics and

methods can be described as either "Active" or "Passive". Even

though [RFC7799] does not include the specific terms "Active",

"Passive", or "Hybrid" as modifiers of "OAM", the following terms are

used in many RFCs and are provided here for use in all future IETF

documents that refer to OAM.

Active OAM:

Depends on dedicated, instrumented OAM packets.

Passive OAM:

Depends solely on the observation of one or more existing data

packet streams and does not use dedicated OAM packets.

Hybrid OAM:

Uses instrumentation or modification of data packets themselves.

[RFC9341] and [RFC9197] are examples labeled "Hybrid OAM" under

this definition.

Compound OAM:

Uses a combination of at least two of Active OAM, Passive OAM, and

Hybrid OAM (i.e., a combination of atomic OAM packets, data packet

modification for OAM, and no explicit OAM). Note that [RFC7799]

also uses the term "Hybrid" to refer to metric types in-between

active and passive, for OAM there are no in-betweens per se, only

active, passive, hybrid, or a compound combination.

Compound OAM can be characterized in a more explicit way, for

nuanced use-cases:

\* Active-Passive OAM.

\* Active-Hybrid OAM.

\* Hybrid-Passive OAM.

\* Active-Hybrid-Passive OAM.

Note that Section 3.7 of [RFC7799] describes "passive methods" as "out of band"

which is contrary to the concept of "Passive OAM" as defined here

because there are no OAM packets to be in-band or out-of-band.

Following the guidelines of this document, OAM may be qualified

according to the terms described in Sections 2 and 3 of this

document, and the term "out of band OAM" is not to be used in future

documents.

4. Extended OAM Abbreviations

This document recommends avoiding the creation and use of extended

abbreviations for the qualifiers of "OAM". For example, the first

"O" in "OOAM" could mean out-of-band, overlay, or something else.

[RFC9197] and other dependent documents currently use the

abbreviations "IOAM" for “In situ Operations, Administration, and

Maintenance”. While this document does not obsolete that

abbreviation, it still recommends that the expanded "in situ OAM" is

used instead to avoid potential ambiguity.

5. Processing of OAM Packets by Nodes

There are multiple processing capabilities that nodes processing OAM

packets can utilize. Some of those capabilities are explained in

[RFC9197] for in situ OAM and are further generalized in this

document.

Depending on the Type of OAM processing, nodes are categorized as

follows. Please note that this characterization exists within the

context of a particular OAM protocol instance, and a given node can

support multiple types.

\* Hybrid OAM instruments or modifies data packet themselves.

Consequently:

Encapsulating Node:

Adds OAM information to data packets.

Transit Node:

May process OAM information in data packets.

Transparent Node:

Does not process or even notice OAM information in data

packets.

Decapsulating Node:

Removes OAM information from data packets.

\* Active OAM uses dedicated OAM packets, separate from data packets.

Consequently:

OAM Source Node:

Creates and injects OAM packets into a flow.

OAM Sink Node:

Processes and removes OAM packets from a flow.

A node could be an OAM Source Node and an OAM Sink Node for Active

OAM packets simultaneously.

In some use-cases, such as in situ OAM described in [RFC9322],

Compound OAM is used. In the forward direction, Hybrid OAM is used

with a single Encapsulating Node. Multiple Transit Nodes may process

the OAM information, and this may trigger them to act as OAM Source

Nodes for Active OAM sent back to the Encapsulating Node which serves

as an OAM Sink Node.

6. Security Considerations

Security analysis is improved when terms are used with precision, and their

definitions are unambiguous.

7. IANA Considerations

This document has no IANA actions.

8. Acknowledgements

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