Operations and Management Area Working Group
Internet-Draft
Intended status: Informational
Expires: March 25, 2014

D. King
Lancaster University
M. Boucadair
France Telecom
S. Aldrin
Huawei USA
G. Mirsky
Ericsson
Mishael Wexler
Huawei

September 25, 2014

Use Cases and Requirements for Layer Independent OAM Management in multi-layer environments
draft-king-opsawg-lime-multi-layer-oam-use-case-00

Abstract

As operators deploy and operate multi-layer networks and diverse transport technologies, layer independent Operations, Maintenance & Administration Management (OAM) would be beneficial for monitoring and troubleshooting operations of network and service infrastructure.

This document identifies and discusses the key use-cases and high-level requirements for layer independent Operations, Administration, and Maintenance management to facilitate operations and maintenance in multi-layer and multi-domain networks utilizing a wide variety of heterogeneous networking technologies.

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1. Introduction

This document discusses use-cases for layer independent OAM management that would interface to multi-layer or multi-domain networks to cover various heterogeneous networking technologies.

As operators and providers (e.g., network operators, data center operators, service providers, etc.) continue to deploy and operate multi-layer networks using a wide range of transport technologies, layer independent OAM Management for stitching different layer OAMs is desirable to minimise operational complexity and simplifying O&M (OAM and O&M are used as specified in [RFC6291]).

This document discusses Layer Independent OAM in Multi-Layer Environment (LIME), and is intended to:

- outline use cases for layer independent OAM management and highlight the issues encountered with existing OAM protocols;

- o discuss OAM requirements for when designing and deploying new technologies;

- o outline eixsting technologies to facilitate layer independent OAM management, including MEF work, ITU-T work, IETF related work;

- o discuss how OAM might be configured via a unified management interface:

  * Establishment of OAM Entities(e.g., MEG, ME,MIP,MEP) and Functions(e.g.,CC,CV)

  * Adjustment of OAM Parameters

  * Deleting OAM Entities

- o highlight a generic OAM Management model that may be applied to various OAM technologies:

  * Defining common objects and relationships model for various technologies

  * Defining a common set of methods/calls to use for the various functions

  * Defining a common set of attributes per object

  * Defining a common set of alarms and notifications

  Specific OAM technology models will augment the basic OAM management model defined by the LIME Group.

- o detail OAM fault management(e.g., fault location, path discovery) data model using layer independent OAM Management:

  * Propose means to help during service diagnosis; these means may rely on filtering information so that time recovery can be optimized. A typical example would be efficient root cause analysis that is fed with input from various layers.

  * Propose means that would help to optimize a network as a whole instead of the monolithic approach that is specific to a given layer. For example, investigate means that would help in computing diverse and completely disjoint paths, not only at the overlay but also at the underlay.

- o discuss the security model for layer independent OAM management:

  * Propose means to avoid leaking OAM information to no authorized entities, and to avoid altering OAM information exposed by each

layer.

* Propose means to ensure reliability of OAM information exposed by each layer.

These requirements are not frozen; further discussion is required to target key issues and scope the work to be conducted within IETF accordingly.

The problem statement and architecture is discussed in [LIME-PS].

2. Terminology

2.1. Conventions used in this document

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 RFC2119 [RFC2119].

2.2. Acronyms and Abbreviations

LIME - Layer Independent OAM in Multi-Layer Environment

OAM - Operations, Administration, and Maintenance

O&M - OAM and Management

ABNO -Application Based Network Operation

MEG - Maintenance Entity Group [RFC6371]

MEP - Maintenance Entity Group End Point [RFC6371]

MIP - Maintenance Entity Group Intermediate Point [RFC6371]

CC -Continuity Check [RFC7276]

CV - Connectivity Verification [RFC7276]

CFM -Connectivity Fault Management

EFM - Ethernet In the First Mile

BFD -Bidirectional Forwarding Detect

LBM -Loopback Message

LBR -Loopback Reply

LTM -Linktrace Message

LTR -Linktrace Reply

OSS -Operation Support System

NMS -Network Management System

SFC -Service Function Chain [I-D.ietf-sfc-problem-statement]

SF - Service Function [I-D.ietf-sfc-problem-statement]

TES -Tenant End System [I-D.ietf-nvo3-framework]

NVO3 -Network Virtualization Overlay [I-D.ietf-nvo3-overlay-problem-statement]

WAN -Wide Area Network

VXLAN -Virtual eXtensible Local Area Network [RFC7348]

NVGRE -Network Virtualization using Generic Routing Encapsulation [I-D.sridharan-virtualization-nvgre]

PW -Pseudowire

LSP -Label Switching Path

MPLS -Multi-Protocol Label Switching

3. Layer Independent OAM Management Use Cases

3.1. Multi-layer multi-region OAM Consolidation in the Management Plane

A multi-layer multi-region network will often require data traffic between two customer edges to be transported across two regions, as illustrated in figure 2. In this scenario the same domain and multiple layer OAMs(i.e.,PW OAM,end to end LSP OAM, segment LSP OAM) are used.

For PW OAM is used at the customer level for monitoring the end-to-end connection between the two Provider edges(PEs), while end to end LSP OAM and segment LSP OAM is used at the provider level for monitoring the segment LSP and end to end LSP respectively. A segment is between MEPs and The OAM in each segment is independent of any other segment.

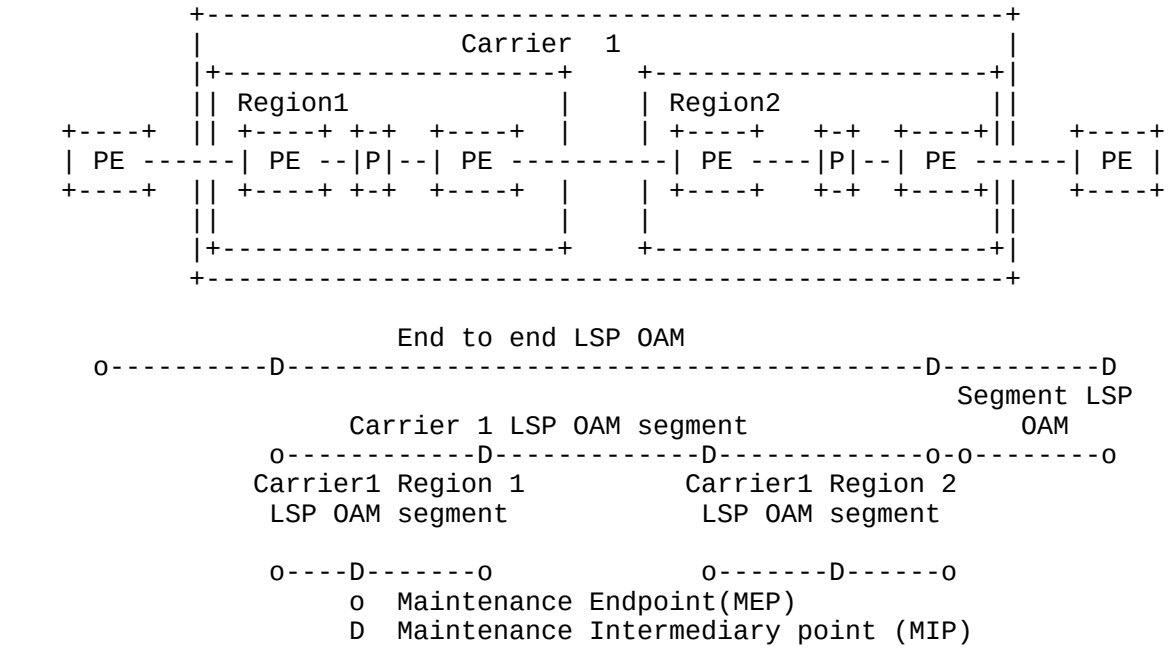

Figure 1: Multi-Region Multi-Layer OAM

With single OSS/NMS in the management plane, customized service diagnose can be provided, e.g.,

- o initiating tests on any layer in the multi-layer network
- o initiating test on any segment of the end to end path
- o initiate test on end to end path
- o check end-to-end connectivity test results across a multi-layer network even when each layer runs a different technology.

3.2. Multiple layer OAMs stitching in different part of the network

Figure 2 illustrates a multi-layer network in which data traffic between two access nodes is transported through access section between access node(AN) and aggregation node(AGG Node) and aggregation section between aggregation node and edge node and even core section from edge node to Internet or WAN. EFM OAM is used at the access section for monitoring the access connection between the access node and aggregation node, CFM OAM and IP OAM is used at the aggregation section for monitoring end to end connection between aggregation node and edge node. BFD is used at the core section for monitoring end to end connection from edge node to Internet or WAN.

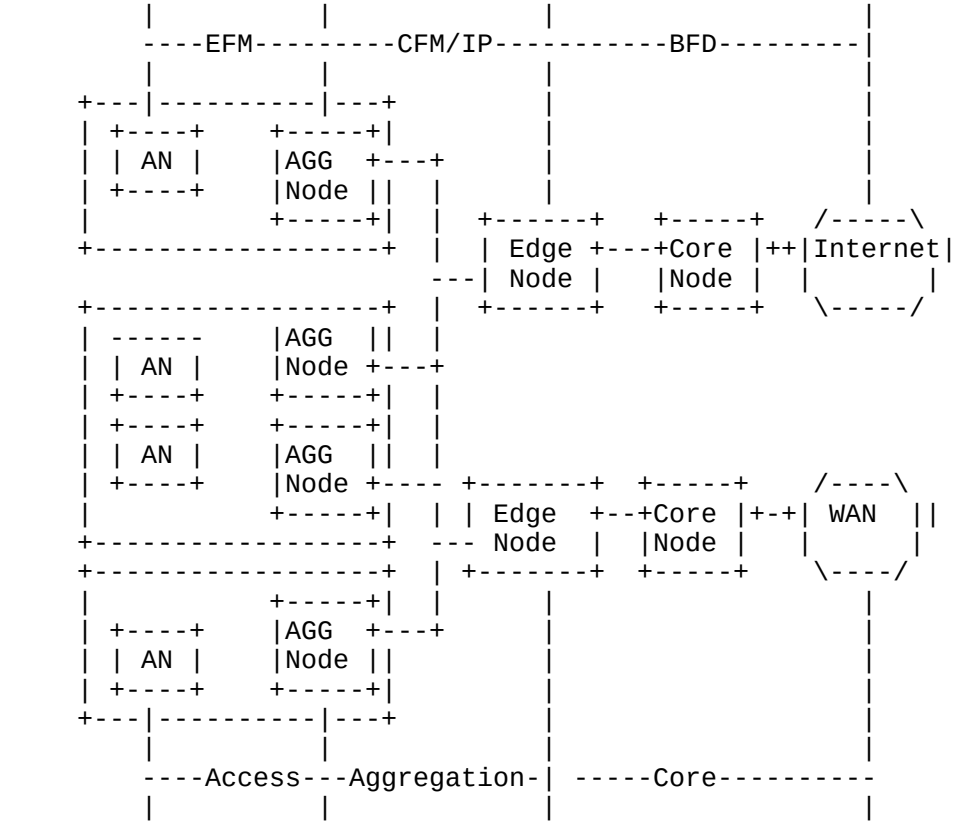

Figure 2

With single OSS/NMS in the management plane, different layer OAM at the different part of the network can be stitching together to provide unified view for network problem reporting by consuming all status reports from the network, aggregating them, correlating them.

In addition, a user who wishes to issue a IP Ping Command or use connectivity verification command in the Ethernet layer can do so in the same manner regardless of the underlying protocol or transport technology. This can be achieved by invoking IP Ping Command or connectivity verification command through uniform interface between management plane and data plane. Consider a scenario where an IP ping to Edge node B from Aggregation node A failed. Between AGG node A and Edge Node B there are IEEE 802.1 [IEEE-802.1Q] bridges a,b and c. Let’s assume a,b and c are using [IEEE-802.1ag] CFM. IP layer Ping can be invoked using uniform interface between single OSS/NMS and AGG node A. Upon detecting IP layer ping failure, the user may wish to "go down" to the Ethernet layer and issue the corresponding fault verification (LBM/LBR) and fault isolation (LTM/LTR) tools, using the same uniform interface used by IP Layer Ping.

3.3. Stitching OAM at layer requiring L4 to L7 service

In Service Function Chain ([I-D.ietf-sfc-problem-statement]), the service packets are steered through a set of Service Function distributed in the network. Overlay technologies and other tunneling techniques can be used to stitch these Service Function Nodes in order to form end to end path (see Figure 3).

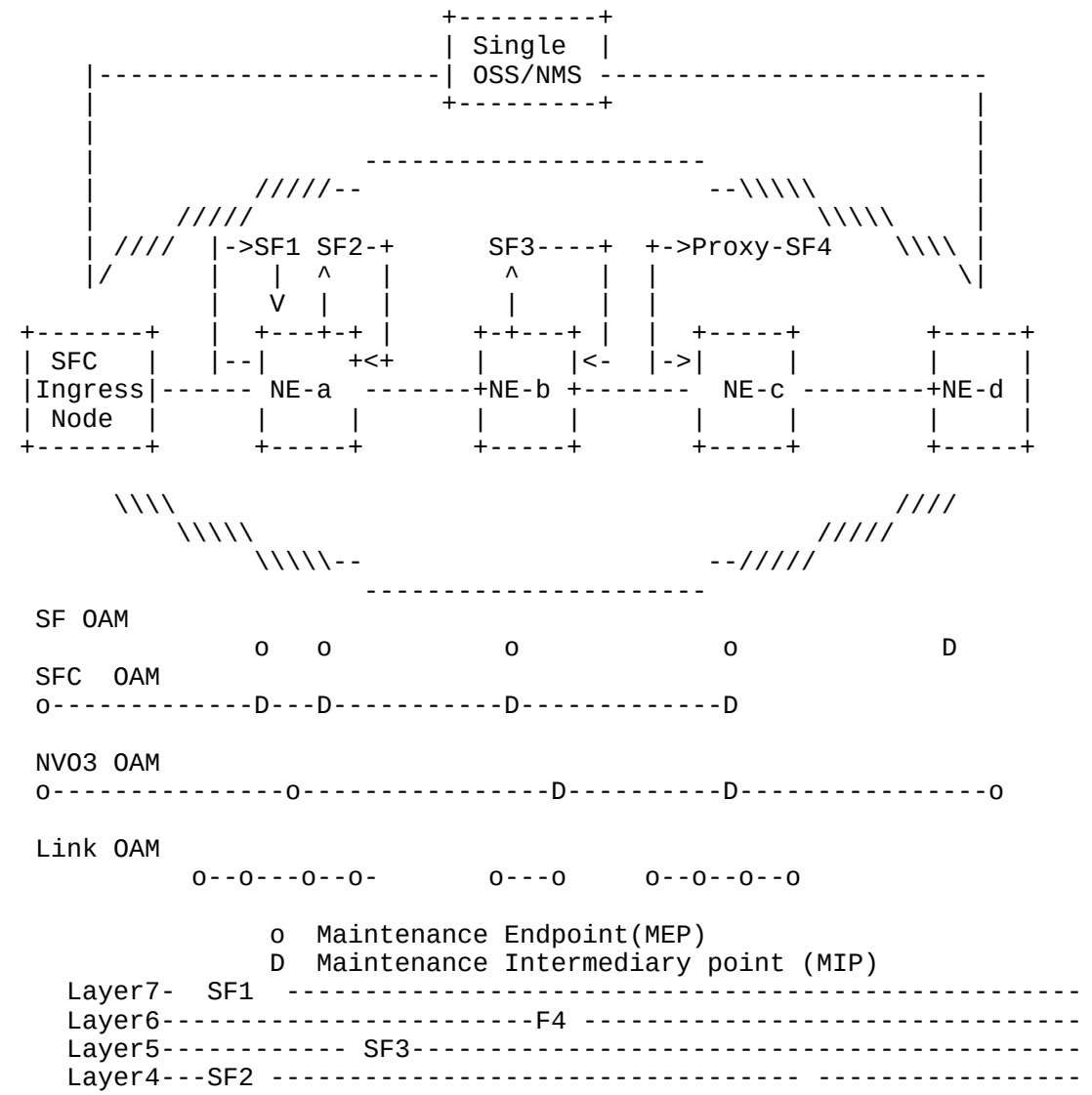

Figure 3: Stitching OAM at layer requiring L4 to L7 service

In figure 3, Link OAM is used between any two adjacent SFs hosted in the same service node in the SFC layer or between a SF and the service node hosting that SF. NVO3 OAM is used between SFC ingress node and NVO3-enabled Network element or any two NVO3-enabled network element in the SFC domain. SFC OAM is used between a set of Service Functions belong to the same service function chain in the SFC domain. SF OAM is used between SF and SF Controller.

When the service packet enters into the network, OAM information needs to be imposed by ingress node of the network into the OAM packet (e.g., packet header extension or TLV extension in the overlay header) and pass through the network in the same path as the service traffic and processed by a set of Service Functions that are hosted in Service Nodes and located in different layers requiring L4-L7 service.

When any Service Nodes or any service segment between two Service Nodes fails to deliver user traffic, there is a need to provide a tool that would enable users to detect such failures (e.g., fault element in the path), and a mechanism to isolate faults.

In case of several SFs co-located in the same Service Node, the packet is processed by all SFs in the Service Node, Once the packet is successfully handled by one SF, the packet is forwarded to the next SF that is in the same Service Node.

When the packet leaves the network, the OAM information needs to be stripped out from the packet.

To provide unified view of OAM information from different layers and different segment of the Service Function Path, these OAM information needs to gathered from various layer using different encapsulation and tunneling techniques and abstracted and provided to the management application via the uniform management interface.

As indicated in [I-D.boucadair-sfc-requirements], the following OAM functions are to be supported:

- Support means to verify the completion of the forwarding actions until the SFC Border Node is reached (see Section 3.4.1 of [RFC5706]).

- Support means to ensure coherent classification rules are installed in and enforced by all the Classifiers of the SFC-enabled domain.

- Support means to correlate classification policies with observed forwarding actions.

- o Support in-band liveliness and functionality checking mechanisms for the instantiated Service Function Chains and the Service Functions that belong to these chains.

Other service diagnosis and troubleshooting requirements are discussed in [I-D.boucadair-sfc-requirements].

3.4. Multi-Operator OAM Stitching

Multi-operator networks can be abstracted, virtualized and shared by several tenants. A tenant has an end-to-end view of its virtual network. Figure 5 illustrates an example of multi-layer multi-operator network in which data traffic between two tenant systems is transported across three operators.

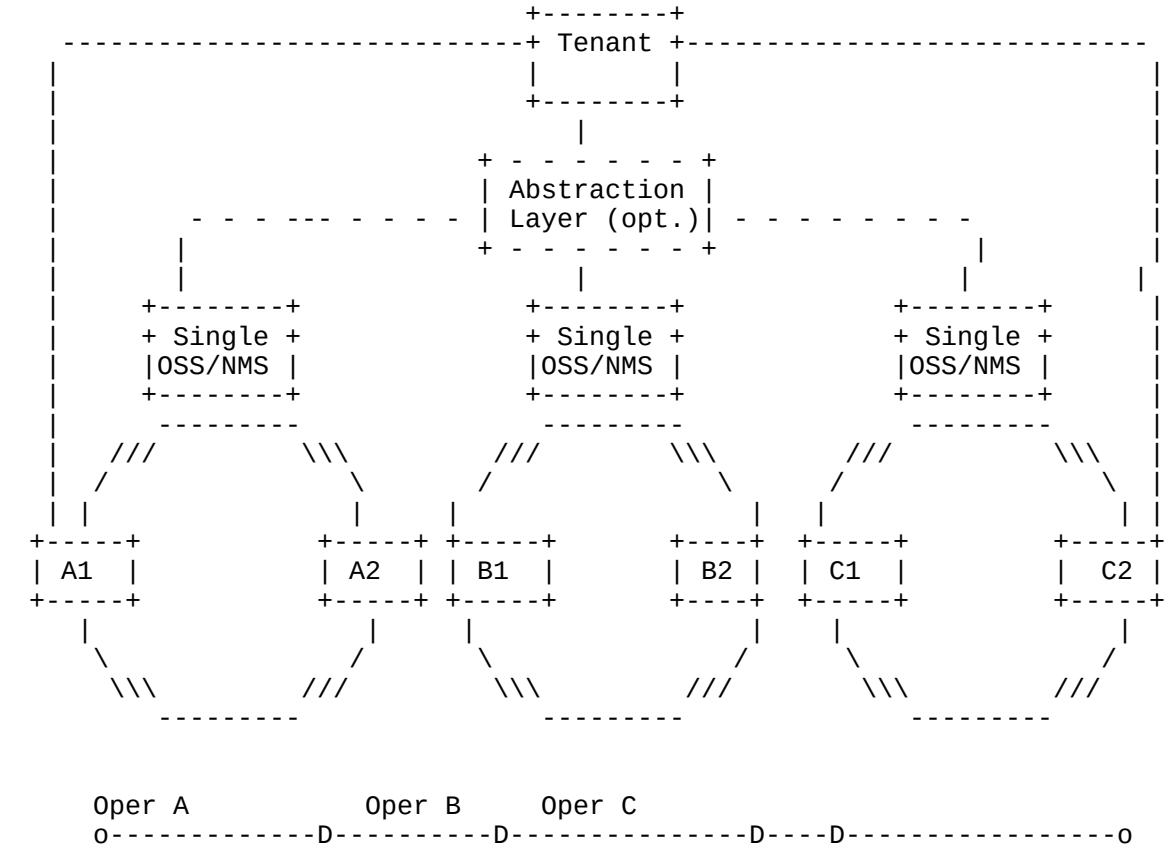

Figure 4: Multi-Operator OAM Stitching

Each operator is using a different management system and is handling only a segment of the whole end-to-end service. Each operator can also use a different technology to transport the clients over its

segment. Within one operator region, multi-layers acn be used, e.g. IP over WDM to transport L3VPN service.

The tenants has to view an end-to-end OAM model via abstraction of each region and/or using abstraction layer between tenants and the OSS/NMSs.

4. Requirements

This section identifies high-level requirements to fulfill layer independent OAM management in Multi-layer Environment to support various use cases discussed in the previous sections.

- The interfaces between the management entity and each Managed device in one administrative domain SHOULD support standards-based abstraction with a common information/data model.

- The management entity should be able to create a single unified view of OAM information that is common to various layers, various segment of the same domain.

- The management entity should provide an unified management interface for multiple OAM technologies that will expose a common set of management interface capabilities for different OAM technologies (e.g. Continuity Check(CC),Connectivity Verification(CV)). The management interface implementation will convert the defined common management capabilities to the OAM technology specific operations.

- The management entity should Model OAM operations management and represent OAM information and mechanisms in the same way using YANG at the management plane to provide consistent configuration, reporting, and presentation for the OAM mechanisms. Specific OAM technology models will augment the basic OAM management model defined by the LIME Group.

- The following capability for layer independent OAM management entity should be supported:

  * Support customized service diagnostic.

  * Support diagnose the availability of a end-to-end path.

  * Support diagnose the availability of a segment Path that is sub-path of end to end path.

  * Support verification on the correct value of Path ID between any two pair of overlay nodes or any two pair of service nodes.

* Support out-band liveliness and functionality checking mechanisms for the overlay node or service node.

5. IANA Considerations

This memo includes no request to IANA.

6. Security Considerations

TBD.

7. References

7.1. Normative References

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Authors' Addresses

Daniel King
Lancaster University
UK

Email: d.king@lancaster.ac.uk

Mohamed Boucadair
France Telecom
Rennes 35000
France

Email: mohamed.boucadair@orange.com

Sam Aldrin
Huawei Technologies USA
2330 Central Expressway
NSanta Clara, CA 95051
USA

Email: aldrin.ietf@gmail.com

Greg Mirsky
Ericsson

Email: gregory.mirsky@ericsson.com

Mishael Wexler
Huawei
Riesstr. 25
Munich 80992
Germany
Email: mishael.wexler@huawei.com

Contributors' Addresses

Qin Wu
Huawei
101 Software Avenue, Yuhua District
Nanjing, Jiangsu 210012
China
Email: bill.wu@huawei.com