LIME Working Group Y. Tochio
Internet-Draft Fujitsu
Intended status: Informational H. van Helvoort
Expires: November 28, 2015 Hai Gaoming BV
L. Xia
Huawei
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Gap Analysis for Layer and Technology Independent OAM Management in the Multi-Layer Environment
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Abstract

This draft analyses the existing management plane OAM related works in different SDOs, against the key objectives of Layer Independent OAM Management (LIME), to find the gap between them. The results can be used as the guidance for further work. This gap analysis is not targeted at L0-L2 transport OAM in ITU-T, either technology specific or generic across those technologies. Rather, it is intended to leverage knowledge from that domain for the benefit of developing generic layer independent OAM management for L3-L7 (and L2.5 MPLS OAM).

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1. Introduction

Operations, Administration, and Maintenance (OAM) mechanisms are critical building blocks in network operations that are used for service assurance, fulfillment, or service diagnosis, troubleshooting, and repair. The current practice is maintenance and troubleshooting are achieved per technology and per layer. The operation process can be very cumbersome. At present, within the L0-L2 technology domains, considerable effort has been expended in ITU-T to establish a coherent approach to OAM, including generic layer independent principles.

Due to this fact, [I-D.edprop-opsawg-multi-layer-oam-ps] discusses a valuable direction in management plane by establishing a coherent approach to OAM information from L2.5-L7 using a centralized management entity and have a unified and consistent OAM view of multi-layer networks. Operators can rely on consolidated OAM management to correlate different layer OAM information (e.g., fault, defects and network failure), and quickly identify the faulty element with its layer information in the network path. Note that current LIME work focuses on layer-independent and technology-independent configuration, reporting and presentation for OAM mechanisms in the context of IP, MPLS, BFD, pseudowires, and Transparent Interconnection of Lots of Links (TRILL) technology developed by IETF. The second important objective of LIME is to achieve a layer and technology independent OAM view of a network and allow management applications present to the user an abstract view of this network and its supporting layers that is strictly topological, free of any technology specific information. This means an abstract and generic OAM management model in the management plane should be utilized (with extensions as appropriate to L2.5-L7), from which OAM specific views can be established, and technology-specific OAM data models can be developed by mapping from the information model view. A generic OAM management model can provide a consistent configuration, reporting, and presentation for the OAM mechanisms. It also can mitigate the problem related to specific OAM technology dependency. [I-D.king-opsawg-lime-multi-layer-oam-use-case] lists the key use case for LIME application.

This draft analyses the existing management plane OAM related work in several SDOs, against the key objectives of LIME, to find the gap between them. The results can be used as the guidance for further work.

2. 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].

2.1. Terminology

DM Data Model

EMS Element Management System

IM Information Model

NMS Network Management System

MP Maintenance Point [802.1Q]

MEG Maintenance Entity Group [G.8013] [RFC6371]

MEP MEG End Point [G.8013] [RFC6371]

MIP MEG Intermediate Point [G.8013] [RFC6371]

ME Maintenance Entity [G.8013] [RFC6371]

MD Maintenance Domain [802.1Q]

MPLS Multiprotocol Label Switching

NE Network Element

NVO3 Network Virtualization Overlays

OAM Operations, Administration, and Maintenance [RFC6291]

LIME Layer Independent OAM Management [I-D.edprop-opsawg-multi-layer-oam-ps]

SFC Service Function Chaining

SFF Service Function Forwarder

SDO Standard Developing Organization

3. Existing OAM Related Works

3.1. Survey of ITU-T Work from L0-L2

3.1.1. Generic L0-L2

[G.800] and [G.805] specify the unified and generic functional architecture of transport networks. [G.806] specifies the generic processing of transport equipment functions, including handling of OAM, defect correlation, and alarm suppression, etc. [G.7710] specifies the generic management requirements for configuration, fault, and performance (i.e. the C, F, P of FCAPS). [G.gim] is on-going work in ITU-T to specify the generic management information model for L0-L2 transport networks.

3.1.2. Technology Specific L0-L2

[G.803], [G.872], [G.8010] and [G.8110.1] specify the functional architecture respectively for SDH, OTN, Ethernet, MPLS-TP transport networks. [G.783], [G.798], [G.8021] and [G.8121]/[G.8121.1]/[G.8121.2] specify respectively the processing of transport equipment functions for SDH, OTN, Ethernet, MPLS-TP, including handling of OAM, defect correlation, and alarm suppression, etc. [G.784], [G.874], [G.8051] and [G.8151] specify respectively the management requirements for configuration, fault, and performance (i.e. the C, F, P of FCAPS). [G.774], [G.874.1], [G.8052] and [G.8152] specify respectively the management information model for SDH, OTN, Ethernet, MPLS-TP transport networks.

3.2. Management Information Models

ITU-T's Recommendation [G.8052] and [G.8152] provide the management protocol-neutral information models for managing network elements in the Ethernet transport network and MPLS-TP transport network as defined in Recommendations [G.8010] and [G.8110.1] respectively. The management information models are derived from the "functional models", which describe the data plane behavior and processing. Management information models manage the "atomic functions" defined in the data plane in transport networks. They contain the object classes for the Ethernet and MPLS-TP NE management. This includes the Termination Point (TP), Maintenance Entity Group (MEG) End Point (MEP), MEG Intermediate Point (MIP), Traffic Conditioning & Shaping (TCS), Loss Measurement (LM), Delay Measurement (DM), and the general Performance Monitoring (PM), Current Data (CD) and History Data (HD). [G.8052] has been published. [G.8152] is still in progress. There is already some degree of consolidation among the /L0 (OTN) [G.874.1], (SDH) [G.774]/, /L1 (OTN) [G.874.1], (SDH) [G.774]/ and /L2 (Ethernet) [G.8052], (MPLS-TP) [G.8152]/ information models specified by these ITU-T recommendations. In fact, they have a common basis for information model and are not technology-specific models any more.

[MEF-7.1] specifies the EMS-NMS interface profile identifying the managed objects (i.e. logical UML objects) needed to support Metro Ethernet services. This specification provides the profile of management entities based on ITU-T [Q.840.1], and also provides a mapping to the TMF's MTNM 3.5 Ethernet model. Specifically this document adds management support for Service OAM. The Ethernet Service OAM object definitions include common OAM objects (e.g., EthMe, EthMeg, EthMep, ,etc), Fault Management Objects (e.g., Continuity Check, Loopback, etc.), Performance Monitoring Objects (e.g., Loss Measurement, Delay Measurement, etc.).

3.3. IEEE CFM MIB

The IEEE8021-CFM-MIB MIB Module and IEEE8021-CFM-V2-MIB MIB module are CFM MIB modules for managing IEEE CFM in [802.1Q]. The former document defines all the MIB objects that used to read, create, modify, and delete OAM related information (i.e., CFM Stack Table, MD Table, MA Table, MEP Table, LinkTrace Reply Table, MEP DB Table, Notifications Table, etc). The latter document defines CFM V2 module for managing IEEE CFM. It contains objects that replace those deprecated in the IEEE8021-CFM-MIB module (i.e., CFM Stack Table, CFM Vlan Table, CFM Default MD Level Table, etc).

3.4. MEF SOAM FM and PM MIB

[MEF-31] defines the MIB modules for MEF Service OAM Fault Management (FM). This document includes two MIBs necessary to support the MEF SOAM FM functionality: the MEF-SOAM-TC-MIB that includes the Textual Conventions (TC) for the SOAM MIB family and the MEF-SOAM-FM-MIB that includes extensions to Connectivity Fault Management (CFM) as developed in IEEE [802.1Q], including MIBs found in [IEEE 802.1Q] and [IEEE 802.1ap], and enhanced by ITU-T [Y.1731] to support the SOAM FM functions as presented in the [MEF-30] specification. It includes the SOAM FM MIB objects such as mefSoamNet, mefSoamMeg, mefSoamMep, mefSoamCc, mefSoamAis, mefSoamLb, etc.

[MEF-36] specifies the Performance Monitoring (PM) MIB necessary to manage SOAM implementations that satisfy the Service OAM requirements and framework specified by [MEF-17], the Service OAM Performance Monitoring requirements as specified by [MEF-35], and the Service OAM management objects as specified by [MEF-7.1] which are applicable to Performance Monitoring functions. Two non-MEF documents serve as the baseline documents for this work: ITU-T [G.8013] and IEEE [802.1Q]. The SOAM PM MIB is divided into a number of different object groupings: the PM MIB MEP Objects, PM MIB Loss Measurement Objects, PM MIB Delay Measurement Objects, and SOAM PM Notifications.

3.5. IETF Technology-specific MIB Series

IETF specifies a series MIB module for various technologies, which includes: [RFC7331] for BFD MIB, [RFC4560] for PING MIB, [MPLS-TP OAM ID MIB] for MPLS-TP MIB, etc.

All these documents are technology-specific and limited to L1, L2, L3. The OAM MIB definition above L3 (i.e., SFC service layer) is still missing in IETF.

3.6. MEF CFM and SOAM YANG Data Model

SOAM CFM YANG module [MEF-38] is an important work that defines the managed objects necessary to support SOAM CFM functionality by using the IETF YANG Module Language [RFC6020]. This YANG module contains the management data definitions for the management of Ethernet Services OAM for Connectivity Fault Management.

[MEF-39] provides the YANG module that supports the Ethernet Service OAM (SOAM) Performance Monitoring functions. This YANG module contains the management data definitions for the management of Ethernet Services OAM for Performance Monitoring and extends the Connectivity Fault Management (CFM) YANG modules.

3.7. YANG Model for OAM Management and Technology-specific extensions

[I-D.tissa-lime-yang-oam-model], [I-D.wang-lime-rpc-yang-oam-management] are two IETF work that creates a YANG unified data models for OAM that is based on IEEE CFM model. [I-D. tissa-lime-yang-oam-model] defines a YANG [RFC6020] data model for Layer independent OAM Management implementations that can be applied to various network technologies. [I-D.wang-lime-rpc-yang-oam-management] describes the abstract notification and rpc command to the YANG Module which is complementary to the one defined in the [I-D.tissa-lime-yang-oam-model]. These efforts are focused on the management plane of OAM and should be complemented by an accompanying data-plane and/or control-plane work. It may require also some extensions to support wider variety of functions and technologies.

[I-D.tissa-nvo3-yang-oam] extends the Generic YANG model defined in [I-D.tissa-lime-yang-oam-model] for OAM with NVO3 technology specifics and presents Yang Module for NVO3 OAM.

[I-D.xia-sfc-yang-oam] extends the Generic YANG model defined [I-D.tissa-lime-yang-oam-model], [I-D.wang-lime-rpc-yang-oam-management] for OAM with SFC technology specifics and presents YANG Module for SFC OAM.

[I-D.wang-bfd-yang-oam]extends the Generic YANG model defined in [I-D.tissa-lime-yang-oam-model], [I-D.wang-lime-rpc-yang-oam-management] for OAM with BFD technology specifics and present YANG Module for BFD OAM.

3.8. Discussion

Until now, all the OAM models and operations in the management plane for L3-L7 are technology dependent and limited to one specific layer. One point which should be noticed is that the information models specified for transport networks (L0/L1/L2, [G.874.1], [G.8052], [G.8152]) by the ITU-T have received some degree of consolidation, and are not technology dependent. [I-D. lam-lime-summary-l0-l2-layer-independent] provides the summary on this point.

4. Security Considerations

TBD.

5. Acknowledgements

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Authors' Addresses

Yuji Tochio
Fujitsu

Email: tochio@jp.fujitsu.com

Huub van Helvoort
Hai Gaoming BV
The Netherlands

Email: huubatwork@gmail.com

Liang (Frank) Xia
Huawei
101 Software Avenue, Yuhua District
Nanjing, Jiangsu 210012
China

Email: Frank.xialiang@huawei.com