Transport Independent OAM Multi-Layer (TIME) Problem Statement & Activity, IETF Toronto
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Presenter: Qin Wu

Author of draft-ww-opsawg-multi-layer-oam

Discussion of TIME

- Transport Independent OAM Multi-Layer (TIME)
  - Generic and integrated OAM with a focus of multi-layer and cross-layer considerations.
- TIME Scope discussed in Problem Statement and Use Case I-D
  - http://tools.ietf.org/html/draft-ww-opsawg-multi-layer-oam-02
  - http://tools.ietf.org/html/draft-king-opsawg-time-multi-layer-oam-use-case-01
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Background

- Typically OAM protocols can not work without provision(e.g., initial bootstrap of OAM).

  - OAM protocol is usually in-band data plane protocols
    - OAM contain a group of network management function for service diagnose, troubleshooting, trigger repair.
  - Provisioning requires management plane protocols
    - Used to configure the network to provide OAM services

- To date, a variety of OAM tools across Standards Development Organizations (SDOs) have been developed for OTN,SDH,Ethernet, MPLS and IP networks.

  - Each technology, used at specific layer, has a specific and best suited set of OAM tools.
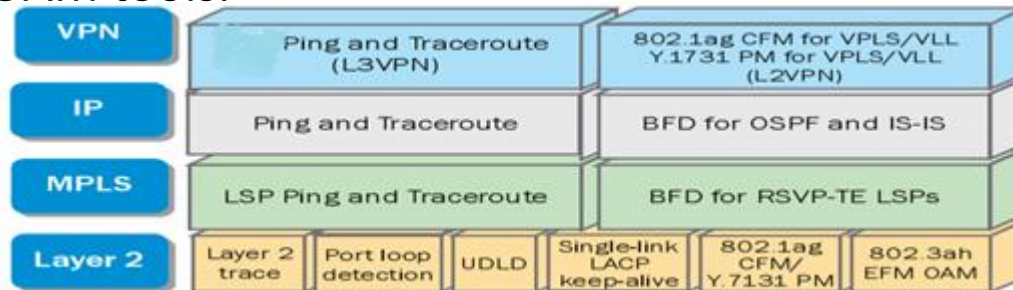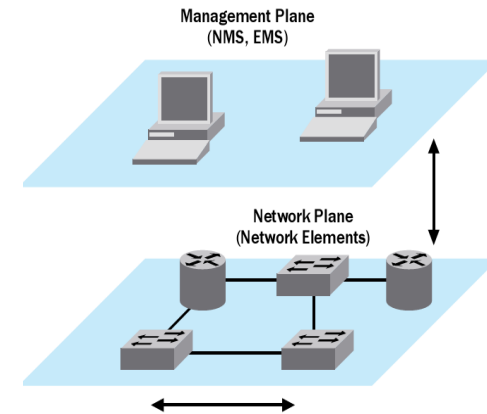

VPN	Ping and Traceroute (L3VPN)		802.1ag CFM for VPLS/VLL Y.1731 PM for VPLS/VLL (L2VPN)		
IP	Ping and Traceroute		BFD for OSPF and IS-IS		
MPLS	LSP Ping and Traceroute		BFD for RSVP-TE LSPs		
Layer 2	Layer 2 trace	Port loop detection	UDLD	Single-link LACP keep-alive	802.1ag CFM/ Y.7131 PM	802.3ah EFM OAM

Figure1

The Problem

- Networks require a set of disparate OAM tools
  - Each domain (technology, layer, administrative region) has its best suited OAM tools.
    - Some have rich functionality (e.g., Y.1731)
    - Others provide specific function in unique protocol (e.g., MPLS OAM, MPLS-TP OAM, Pseudowire OAM)
- Layer 1/2/3 OAM protocols developed and MPLS OAM are successfully deployed, but how these existing OAM being applied to overlay networks(NVO3,SFC,EVPN…) - different encapsulation (VXLAN, NVGRE,GPE,GUE) make it difficult:
  - Different Overlay encapsulation may use different OAM protocol on same functionality.
  - No mechanisms to exchange performance and liveliness information between the underlay and overlay(s) by coordination system
  - The OAM in the underlay may not reflect OAM issue in the overlay
  - Existing layer OAM protocol with some adaptation may be not sufficient

The Problem

- If we split the network is split into Customer, Edge , and Core:

  - Horizontal direction:

    - MEF E-LMI - User to Network Interface (UNI)

    - IEEE Link OAM - Any point-to-point 802.3 link

    - IEEE CFM / ITU-T Y.1731 - End-to-End UNI to UNI

    - MPLS OAM, PW OAM,IETF BFD, RSVP-TE OAM - within MPLS cloud

  - Vertical direction: No overlay OAM configration protocol
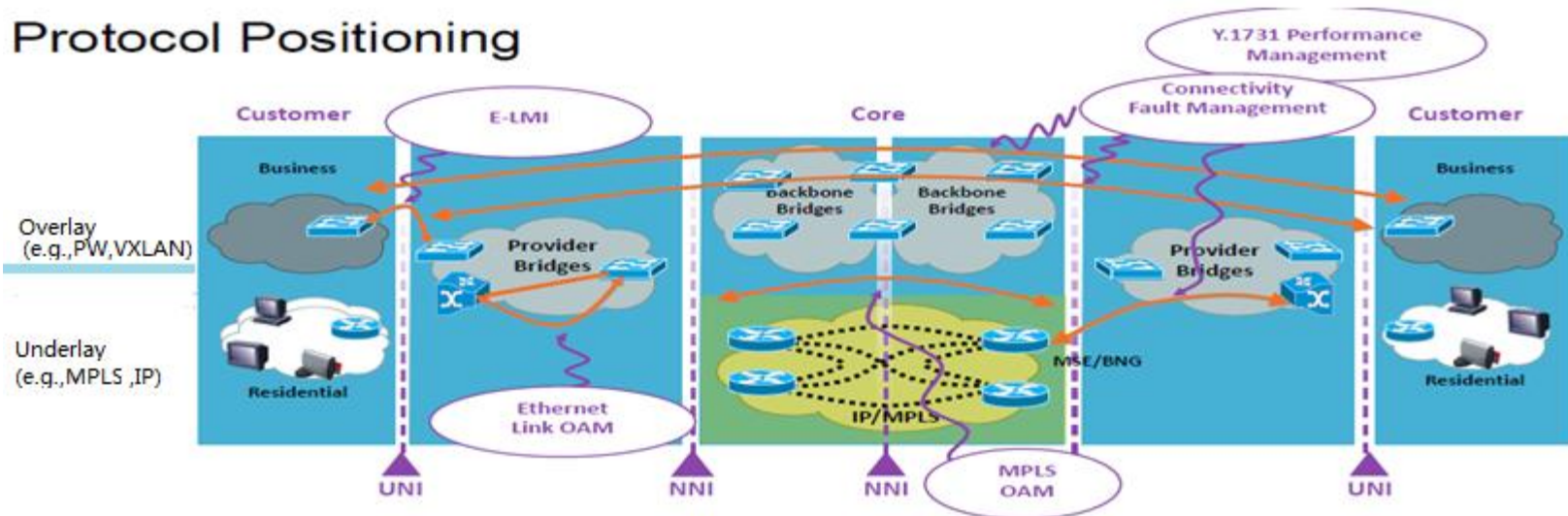
Figure 2

Strong Technology Dependencies

- OAM mechanisms are usually oriented to a single network technology or a single layer.
  - ICMP, LSP Ping provide the same OAM functionality, i.e., Path Discovery but use different network technologies.
  - BFD,LSP Ping provide the same functionality (i.e., Continuity Check) but use different network technologies.

RFC7276 Table 4:
Summary
of the OAM
Functionality
in IETF OAM
Tools

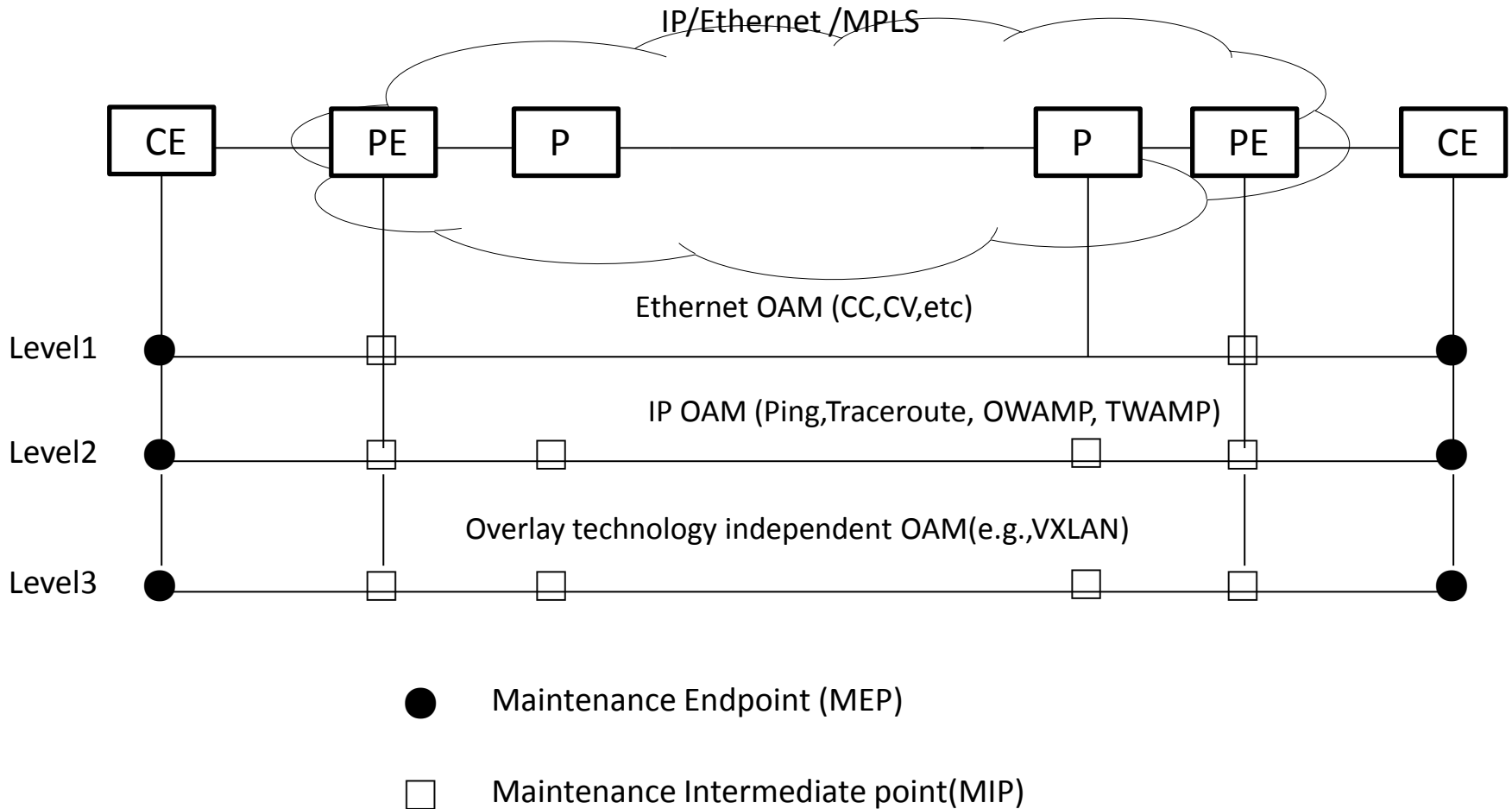| Toolset	Continuity Check	Connectivity Verification	Path Discovery	Perf. Monitoring	Other Functions
IP Ping	Echo				
IP Traceroute			Traceroute		
BFD	BFD Control/Echo	BFD Control			RDI Using BFD Control
MPLS OAM(LSP Ping)		"Ping"mode	"Trace route"mode		
MPLS-TP OAM	cc	Cv/Proactive or on demand	Route Tracing	-LM -DM	-Diagnostic Test -Lock Alarm Reporting -Client Failure Indication -RDI
Pseudowire OAM	BFD	-BFD -ICMP Ping -LSP Ping	LSP Ping		
OWAMP and TWAMP	-Control Protocol			-DM -LM	
TRILL OAM	CC	CV	Path Tracing	-DM -LM	

Weakness of Cross-Layer OAM

- Cross layer OAM is important in NO3 and SFC work
  - Need to Stitching OAM at different layer using different encapsulation
  - Currently no end to end OAM visibility.
- RFC7276 (Overview of OAM) states the following OAM restrictions for multi-layer:
  - OAM message should not cross layers
  - OAM message should not leak outside domain boundaries within a layer

- RFC7276 does not discuss inter-layer OAM operations
  - How would different OAM protocol in the data plane interact through management plane via unified management interface?
  - integration of OAM across multiple technologies is extremely difficult
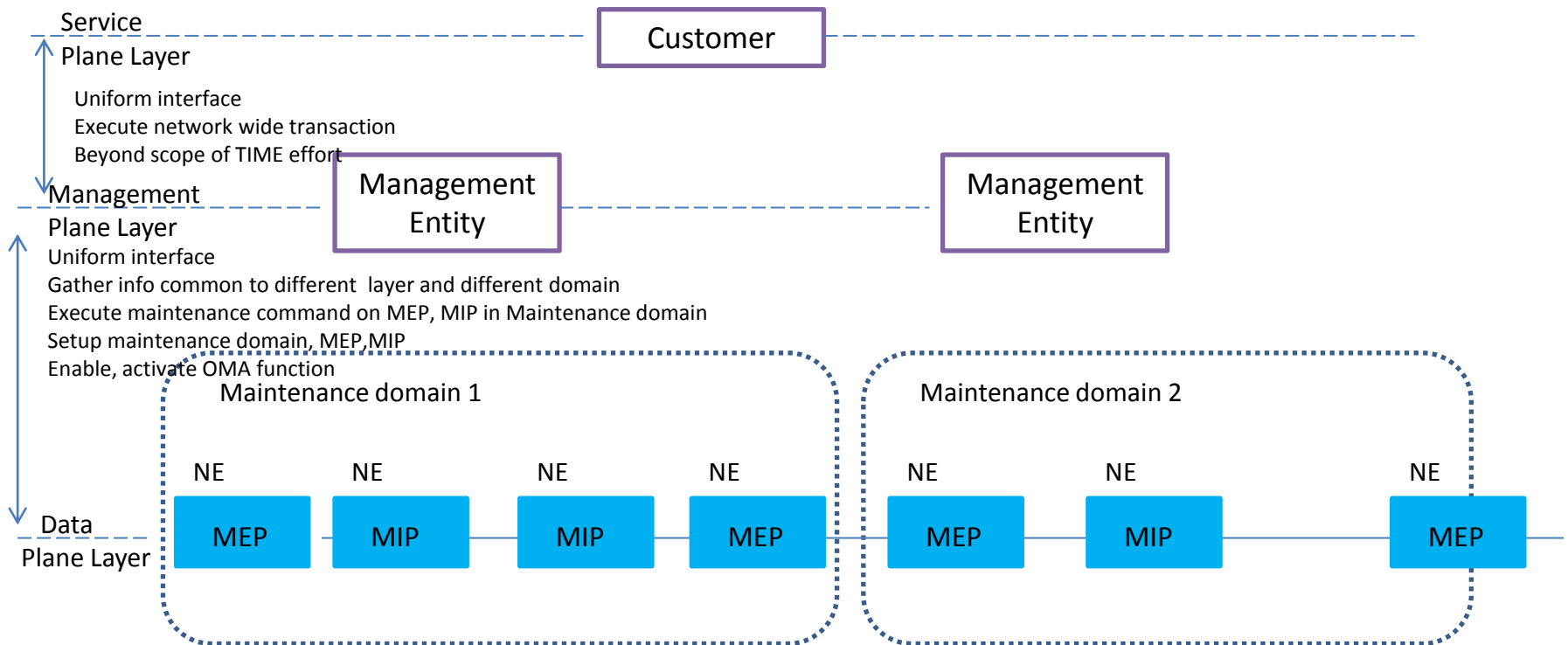 - MPLS-TP has done for link, but nothing done for overlay networks.

Lack of OAM above Layer 3

- Layer 1/2/3 OAM protocols offer rich functionality, standardized (well defined) and heavily used.

- OAM Mechanisms for technologies above Layer 3 have not been defined or developed yet, candidate solutions include:
  - Out of band OAM or control plane OAM(e.g., RSVP-TE)
  - BFD
  - Generic Protocol header
  - Generic TLV extension

- For instance, Service Function Chain, There is no OAM to be defined at the top of layer 3 for service function right now.
  - A Service Function Chaining is composed by a series of service Functions, that can act in different layers but providing an end-to-end chain or path from a source to destination in a given order.
  - How to exchange OAM between service functions in different layers while using various encapsulating protocols?

Simple Case: Multiple Layer OAM

IP/Ethernet /MPLS

CE — PE — P — P — PE — CE

Ethernet OAM (CC,CV,etc)

Level1 ●————————□————————————————————————□————————●

IP OAM (Ping,Traceroute, OWAMP, TWAMP)

Level2 ●————————□————————□————————————————□————————□————————●

Overlay technology independent OAM(e.g.,VXLAN)

Level3 ●————————□————————□————————————————□————————□————————●

● Maintenance Endpoint (MEP)

□ Maintenance Intermediate point(MIP)

Layering OAM architecture in management plane

Service
Plane Layer

Customer

Uniform interface
Execute network wide transaction
Beyond scope of TIME effort

Management
Plane Layer

Management Entity

Management Entity

Uniform interface
Gather info common to different layer and different domain
Execute maintenance command on MEP, MIP in Maintenance domain
Setup maintenance domain, MEP,MIP
Enable, activate OMA function

Maintenance domain 1

Maintenance domain 2

NE   NE   NE   NE

NE   NE   NE

Data
Plane Layer

MEP   MIP   MIP   MEP

MEP   MIP   MEP

NE - Network Element
MEP – Maintenance Endpoint
MIP - Maintenance Intermediary Point
MD -   Maintenance Domain

Issues of Abstraction (1)

- OAM functions are enabled at different layers and various OAM information needs to be gathered from various layers
- How would the management plane consolidate OAM information in different layers, and even different administration region or operators?
  - Management applications must understand (context and function) what information at different part of network using differenet layer OAM protocol stands for.
  - Need to gather and abstract OAM information that are common to different layers through a common interface, regardless of underlying data plane protocol
  - Need to correlate OAM information from different part of network by using management plane entity
  - Need to enable and active OAM function in different domain through unified management interface

Issues of Abstraction (2)

- Covering Heterogeneous Network Technologies or overlay technologies(e.g., VXLAN, NVGRE, MPLS over GRE)
- How one layer OAM in one segment of the network interworking with another layer OAM in another segment of the network in the same domain?
  - E.g.,E-LMI used in UNI interwork with ethernet link OAM used in 802.3 link in the same domain (See figure 2)?
- How one layer OAM interworking another layer OAM in the same segment of the network?
  - Eg.,Ethernet OAM interwork with MPLS OAM in the same segment of the network?
    - i.e., Ethernet OAM and MPLS OAM are both supported by two devices in communication.

Planned TIME Activities

- Problem Statement
  - Set out the problem statement and architecture for the Transport Independent OAM in the multi-layer network
  - and outlines the problems encountered with existing OAM protocol variety and their impact on introduction of new technologies.
- Use Case and Requirements
  - Identify and describe all the use cases that are relevant for TIME
  - requirements that we need to apply in TIME in order to identify the mechanisms, models and protocol to be worked out within TIME
- Framework and Architecture
- Gap Analysis
  - Identify technology dependent and independent component
  - analyze and understand
    - the different motivations and opportunities for optimisation of OAM in different technology networks,
    - and the trade-offs between those optimisations and
    - the overall advantage of a generic OAM mechanism.
- Develop technology independent protocol specification related to the goals in the previous slides

Where to follow TIME Activity

- The TIME mailing list was created in June 10:
  - https://www.ietf.org/mailman/listinfo/time
  - Good discussion and contributions
- A TIME BOF proposal request was sent one week before IESG and IAB
  - BOF Initially declined but IESG encouraged us to continue discussions on TIME problem space
  - Vendors and operators have shown interest in this work
  - IESG and IAB hope to see sufficient preparation and more support in community.
- The TIME BOF proposal is available at:
  - http://trac.tools.ietf.org/bof/trac/wiki/WikiStart#
- The TIME BOF Charter is not available
  - Will use BOF proposal description and some thought in these slides as baseline.
- The TIME problem statement and Use case:
  - http://tools.ietf.org/html/draft-ww-opsawg-multi-layer-oam-01.txt
  - http://tools.ietf.org/html/draft-king-opsawg-time-multi-layer-oam-use-case-00
- Candidate Solutions in management plane:
  - http://tools.ietf.org/id/draft-tissa-netmod-oam-00
  - http://www.ietf.org/id/draft-tissa-trill-yang-oam-00
  - http://tools.ietf.org/html/draft-penno-sfc-yang-01
  - http://www.ietf.org/id/draft-tissa-nvo3-yang-oam-00
- Candidate Solutions / framework/requirements in data plane:
  - http://tools.ietf.org/id/draft-jain-nvo3-overlay-oam-01
  - http://www.ietf.org/id/draft-tissa-nvo3-oam-fm-00
  - http://www.ietf.org/id/draft-kumar-nvo3-overlay-ping-01
  - http://tools.ietf.org/html/draft-aldrin-sfc-oam-framework-00
  - http://tools.ietf.org/html/draft-krishnan-sfc-oam-req-framework-00
  - http://tools.ietf.org/html/draft-jxc-sfc-fm-00
  - http://www.ietf.org/id/draft-salam-l2vpn-evpn-oam-req-frmwk-02.txt

Backup slides

ECMP Issue: Non TIME specific

- Equal Cost Multi Path (ECMP) allows
  - Protection against failures
  - Increased overall end to end BW
- Network Device typically use fields in the MAC or IP header to select the forwarding path among multiple equal cost paths
- ECMP becomes important when Network overlay, service chain technology are introduced
  - E.g., multi-instances of the same service function is invoked for a given chain to provide redundancy.
- Connectivity check and continuity check MUST follow the same path as the data traffic
  - No standard way to exercise end to end continuity and connectivity verifications that covers all of ECMP in IP worlds
  - In IP world, flow identified based on different fields in IP header(5 tuple, source port of UDP header, flow label+ src and dst add), different tunnel type has different key for the load-balancing function(e.g., GRE key in GRE, Session-ID in L2TPv3 over IP)
  - In MPLS world, flow identified based on various fields in IP header and MPLS header (5 tuple or 3 tuple in IP header, one or multiple label assigned to FEC, entropy label)
  - In Ethernet world, flow identified based on different fields In Ethernet header and IP header (src MAC+dst MAC+ VLAN or FGL, src MAC+dst MAC+ src IP+dst IP+ src/dst port, when flow entropy is supported, flow can be identified using data label+src MAC+dst MAC)
  - In SFC or NVO3 case, various tunnel protocol(e.g.,IP in IP, MAC in IP, MPLS over IP) can be supported, selecting key for load balance function can be even complicated.
  - This issue is not specific to TIME, but can we better solved this in TIME?

Constraint and Desired Goal

Assumptions

- Adopt IEEE 802.1ag CFM concept and Stick to terminologies defined in RFC6291 and RFC7276
- Honor strict OAM layering in the data plane/control plane

Requirements

- IP capability is required in the network

Non-Goal

- Working on existing OAM protocol update

Goals

- Overlay Technology Independent Multi-Layer OAM covering various heterogeneous network technologies
- Consolidate in Management plane(e.g.Using Netconf/Yang)
  - All management plane to interact with either technology dependent OAM or technology independent OAM protocol in data plane
  - Abstract OAM information common to different layer
  - Correlate OAM information in different part of network
  - Gather OAM info and provision technology independent OAM function across domain

- Consolidate in Data plane/Control plane
  - Develop technology independent OAM data plane/control plane mechanism not specific a given transport technology(e.g., Generic header, Generic TLV)
  - Allow Exchange OAM information at the layer atop of layer 3
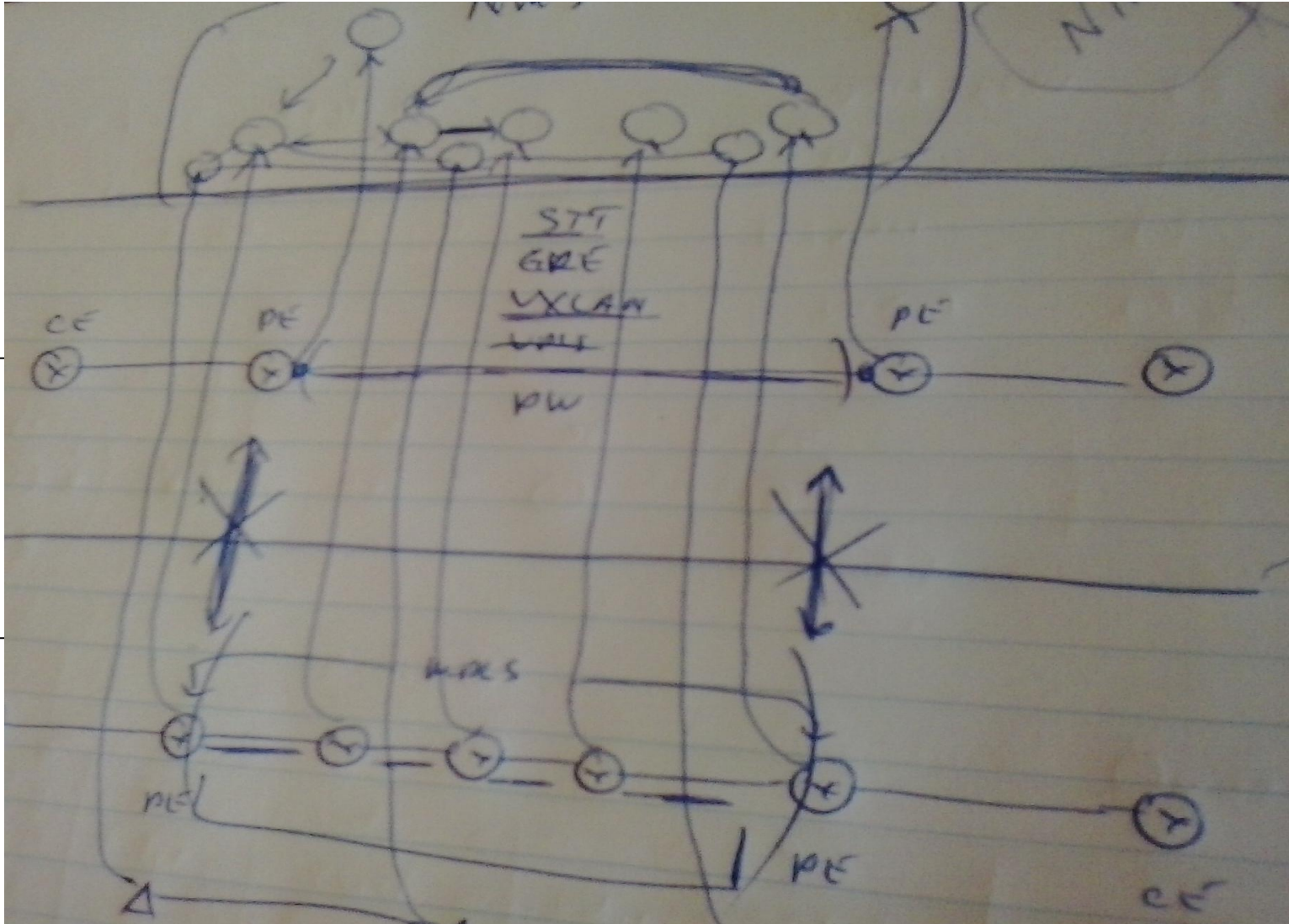
Next Step

- Develop TIME BOF Charter proposal
- BOF preparation for IETF 91 meeting
- Proposal to RTG Area
  - Consolidate data plane OAM in each working group of the routing area and find common place for looking for new requirements and evaluate the existing OAM protocols against them.
  - Or Develop new overlay technology independent OAM protocol.

- Proposal to OPSAWG Area
  - Consolidate management plane OAM and allow management plane to manage various layer OAM in data plane across domains.
  - Abstract OAM information that are common to different layer
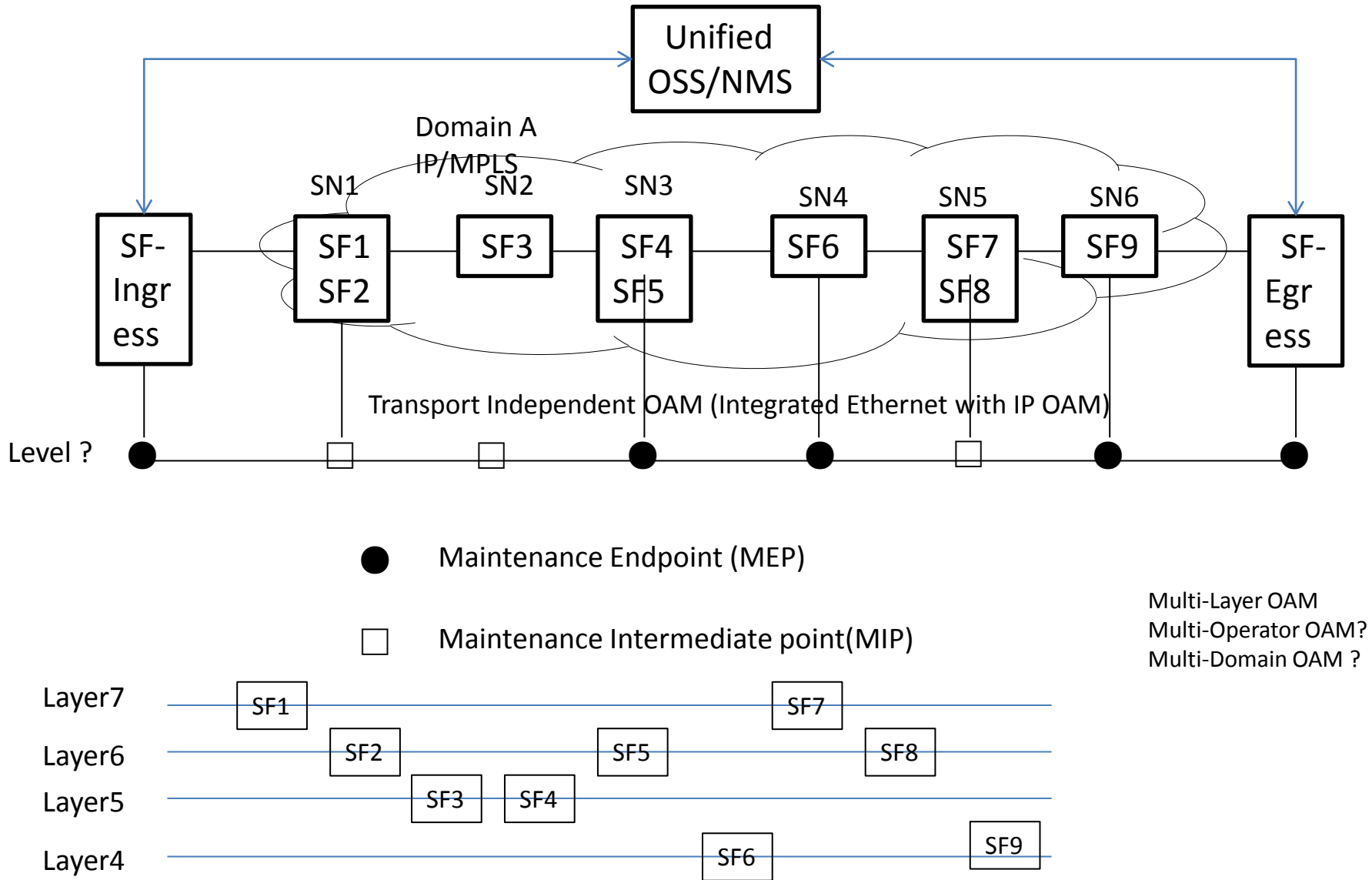 - Correlate OAM information in different part of network

Backup Slides

- Layer OAM in the Management Plane
- Multi-layer and Multi-domain OAM
- Above Layer-3 OAM
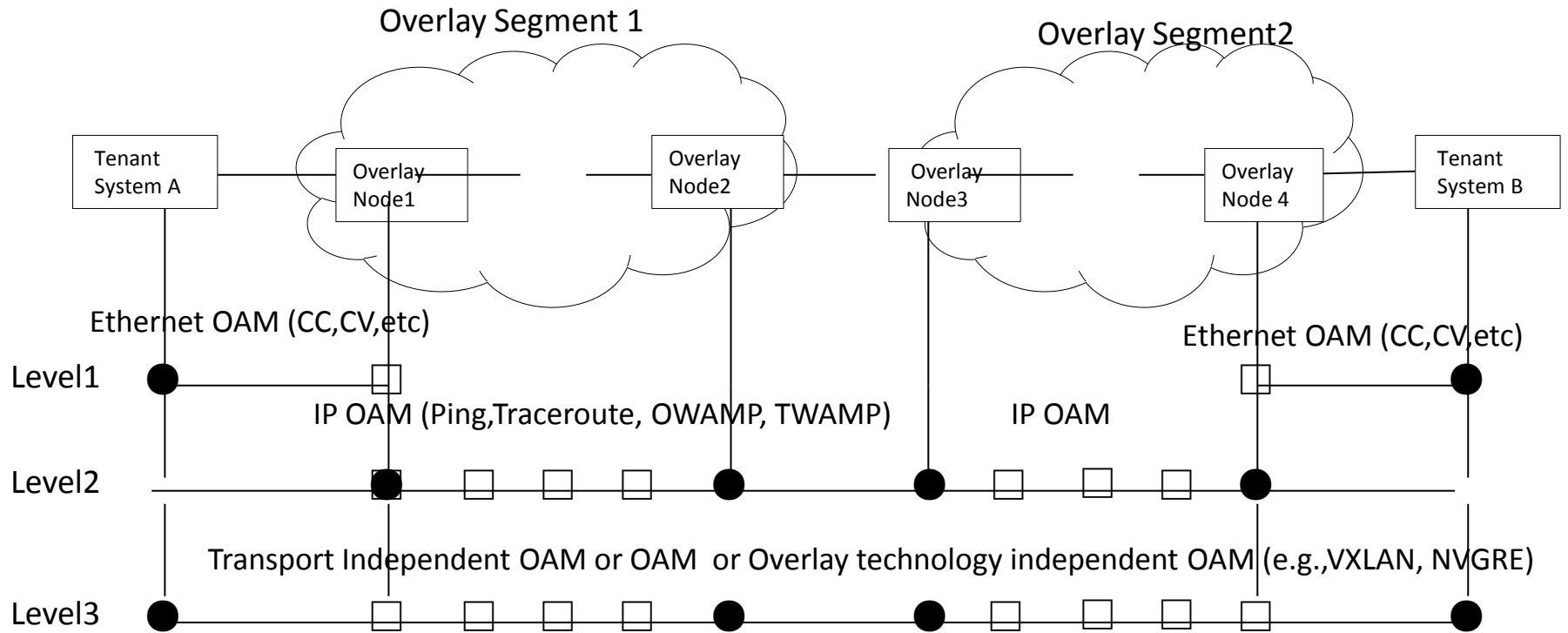- Overlay Network OAM
- Multi-Path issue in SFC OAM

Use Case x: Multiple Overlays case

Use Case2: OAM atop of layer 3

Unified OSS/NMS

Domain A
IP/MPLS

| SN1 | SN2 | SN3 | SN4 | SN5 | SN6 |

SF-Ingress

SF1
SF2

SF3

SF4
SF5

SF6

SF7
SF8

SF9

SF-Egress

Transport Independent OAM (Integrated Ethernet with IP OAM)

Level ?

● Maintenance Endpoint (MEP)

□ Maintenance Intermediate point(MIP)

Multi-Layer OAM
Multi-Operator OAM?
Multi-Domain OAM ?

Layer7 —— SF1 —————————————— SF7 ——

Layer6 —— SF2 ————— SF5 ————— SF8 ——

Layer5 ———— SF3 SF4 —————————

Layer4 ——————————— SF6 ——— SF9 —

Use Case 3:Overlay OAM

Use Case 4:Multi-Path issue in SFC

Ping from A to D

Data packet from A to D with UDP src/dst Port X/Y

Data packet from A to D with UDP src/dst Port Y/Z

Classifier A

SF B or SN B

SF Instance C1

SF Instance C2

SF Instance C3

Service Function D

Service Function E

Service Chain 1

SN : Service Node

- Some link(e.g., link C3-D oversubscribed that cause intermittent packet drops
- Hard to utilize end to end connectivity tools to quickly detect the   failure
- Classifier A may not know how many ECMP from B
- How probe take the same path and/or return path as the normal data
- Different hash algorithm to select ECMP path
- How to describe and return multi-path information for each member link(e.g., link C3-D, link B-C3) corresponding to each SF instance