

Connectivity Fault Management

Layer-2 Performance Monitoring and Troubleshooting

Update

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- Context, Concept and Goals
- Standardisation
- Protocol
- Use Cases, CFM deployment goals
- Scenario: Fault Detection and Isolation
- Scenario: Performance Measurement (Loss, Delay)
- Test results, output examples
- Next steps

- Ethernet services in multiple operator/administrative domain environments introduce complexity to operators task:
Effective isolation of link faults or performance degradation on L2 End-to-End services spanning multiple administrative domains.

- CFM has been standardised in IEEE 802.1ag, key points:
 - Measurement point instances run directly in L2 devices
 - Maintenance Domain Levels, -> Interdomain usability
 - Continuous measurements, on-demand measurements
 - Signalling of failure states between devices
 - Configurable consequent actions can trigger immediate end-to-end service recovery

- Additionally support is provided by ITU-T Y.1731:
 - Frame loss and delay measurements
 - Ethernet Alarm signalling: RDI and AIS

- Ethernet frame with an ethertype of 0x8902
CFM Frame format

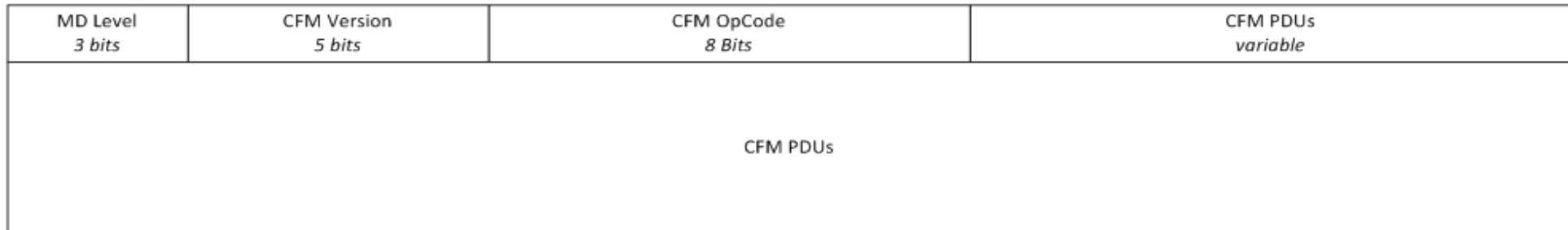
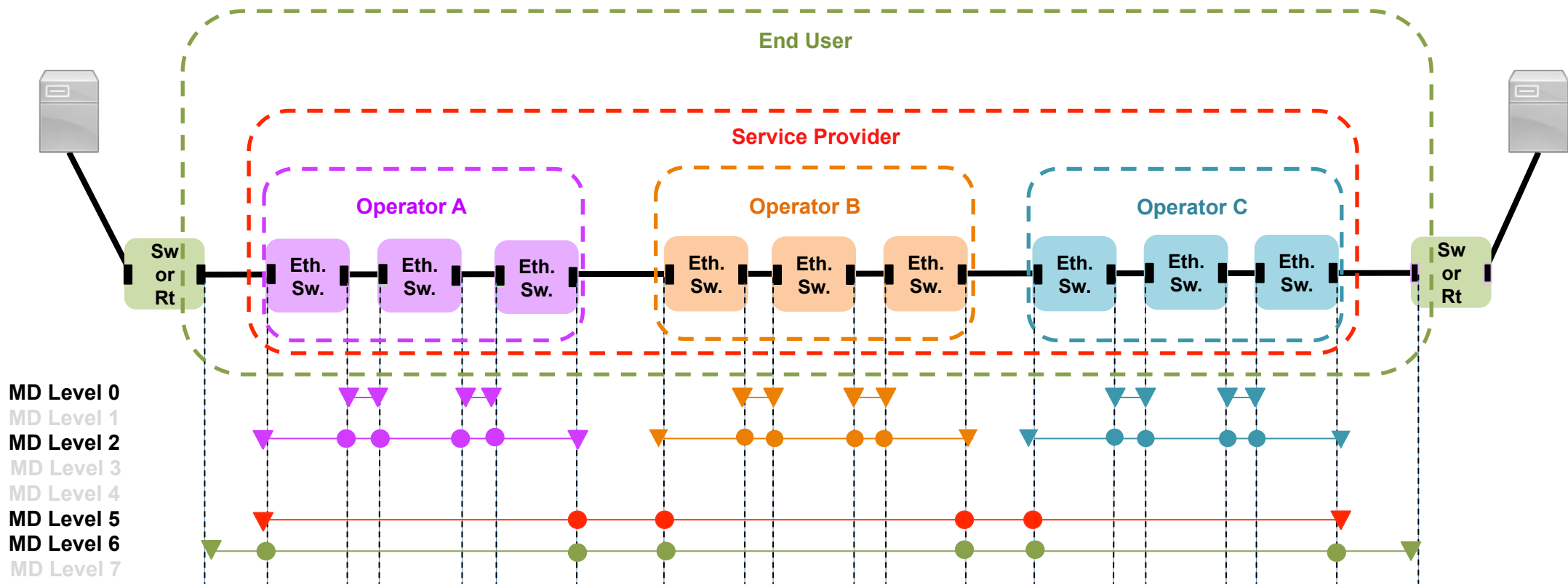


Figure 3. A CFM message frame format

- 5 PDU Types are defined by OpCode Values.
 - Continuity Check Message (CCM)
 - Loopback Message (LBM):
 - Loopback Reply Message (LBR)
 - Linktrace Message (LTM)
 - Linktrace Reply Message (LTR)



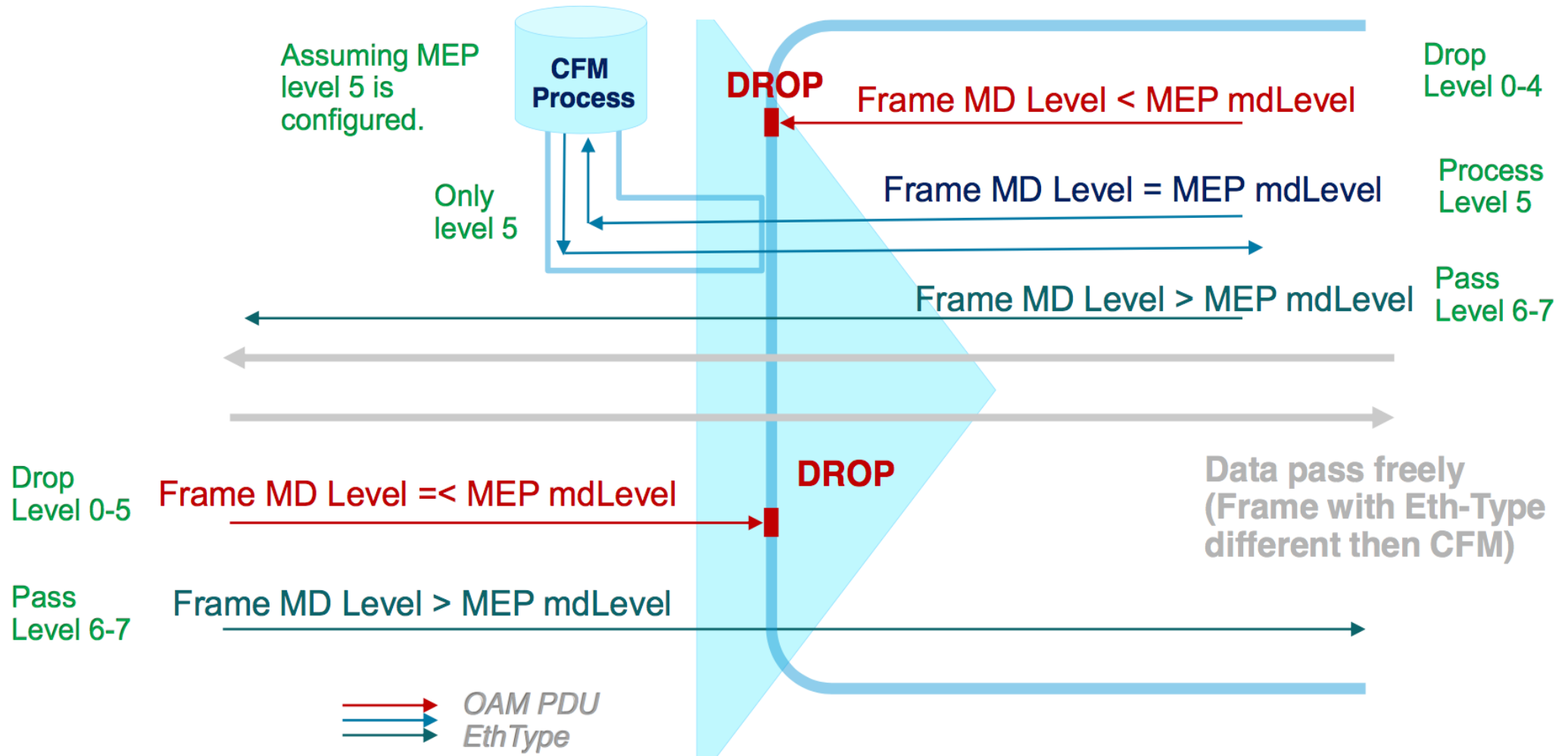
MD: Maintenance Domain
MA: Maintenance Association

▼ **MEP** : Maintenance End Point
 (further distinguished: UP-MEP, DOWN-MEP)
 ● **MIP** : Maintenance Intermediate Point

MEP, MIP behaviour: MEPs generate CFM Message, MEPs and MIPs process CFM Message

- CFM Message with MD-Level > MIP/MIP Level : transparently pass
- CFM Message with MD-Level < MEP/MIP Level : discard
- CFM Message with MD-Level = MIP/MIP Level processes CFM Message (respond, transport or accepts)

How it works / MEP Detailed



➤ Continuity Check Protocol

- Used for Fault Detection, **Notification**, and Recovery
- Per-Maintenance Association **multicast "heart-beat"** messages are transmitted at a configurable periodic interval by MEPs (3.3ms, 10ms, 100ms, 1s, 10s, 1min, 10min, Packet Rate max. 300pps)
Uni-directional (no response required)
- Carries status of port on which MEP is configured
- Catalogued by MIPs at the same MD-Level, terminated by remote MEPs in the same MA

➤ Loopback Protocol

- Used for *Fault Verification* - **Ethernet Ping**
- **Can be used for on-demand frame loss and rtt measurements**
- MEP can transmit a unicast Loopback Message (LBM) to a MEP or MIP in the same MA
- MEP can also transmit a *multicast* LBM (defined by ITU-T Y.1731), where only MEPs in the same MA respond
- Receiving MP responds by transforming the LBM into a unicast Loopback Reply (LBR) sent back to the originating MEP

➤ Linktrace Protocol

- Used for *Path Discovery* and *Fault Isolation* - **Ethernet Traceroute**
- MEP can transmit a multicast message (LTM) in order to discover the MPs and path to a MIP or MEP in the same MA
- Each MIP along the path and at the terminating MP return a unicast LTR to originating MEP

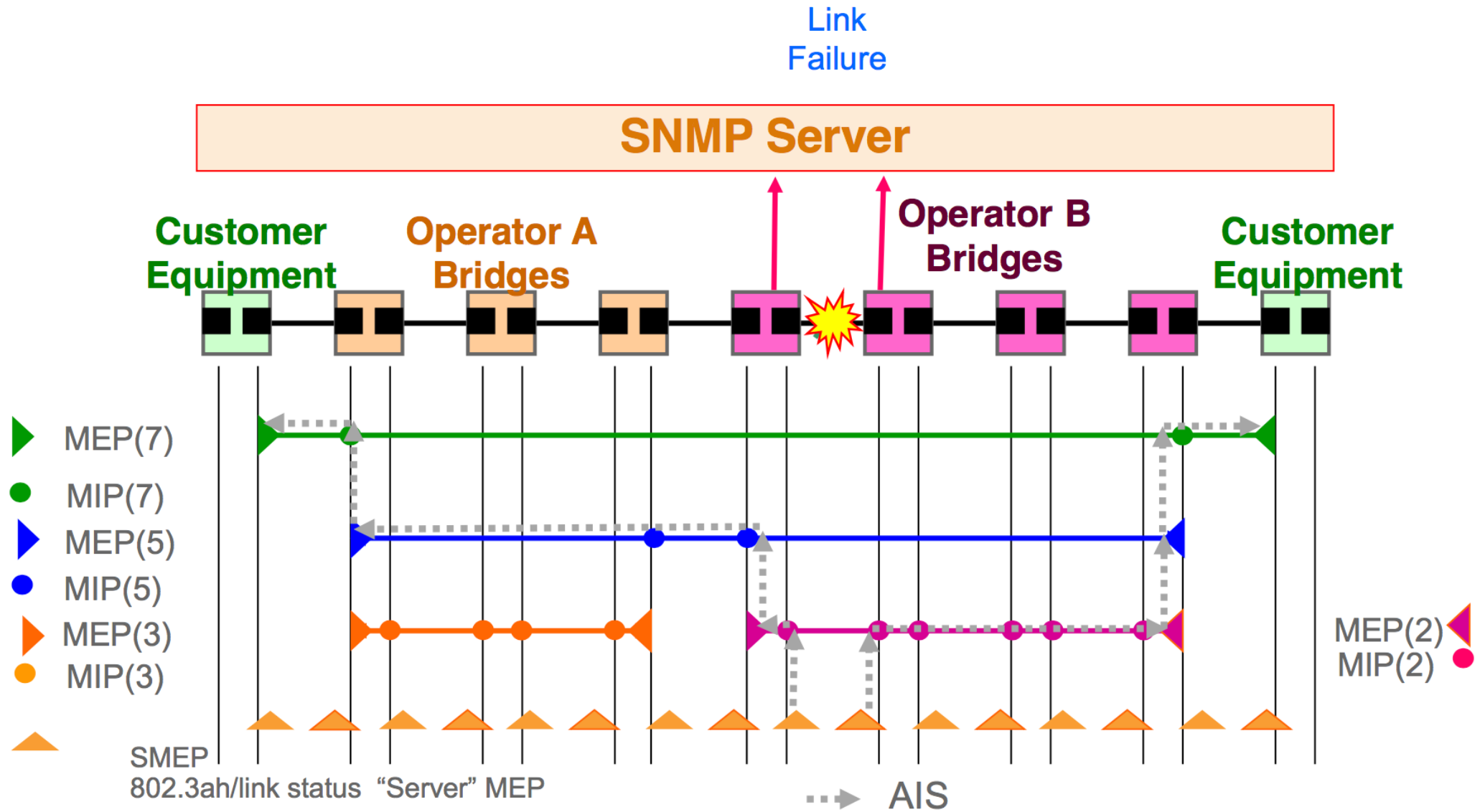
CFM OAMPDUs for IEEE 802.1ag.
Common with Y.1731

CFM OAMPDUs for Y.1731

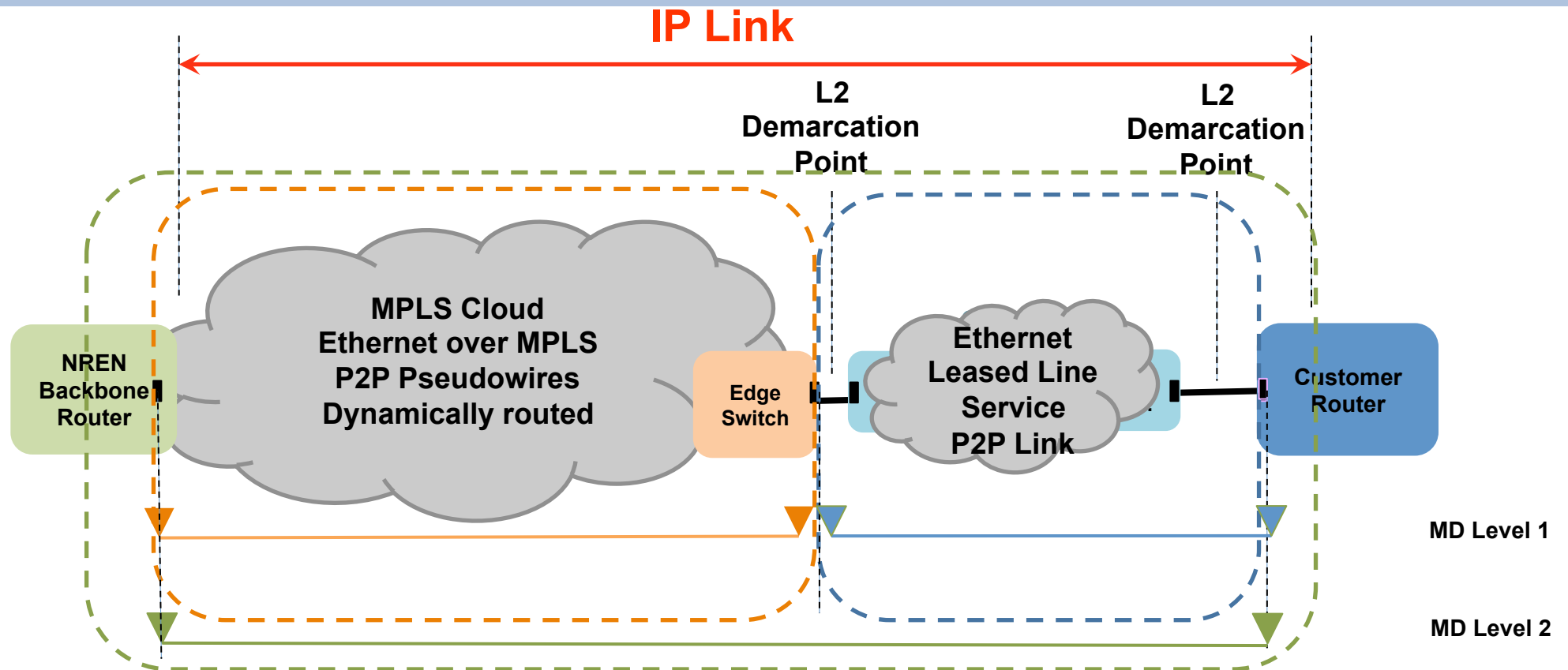
OpCode Value	OAM PDU type	ITU-T Y.1731	IEEE 802.1ag
1	CCM	√	√
2	LBR	√	√
3	LBM	√	√
4	LTR	√	√
5	LTM	√	√
33	AIS	√	--
35	LCK	√	--
37	TST	√	--

- OAM PDU OpCode Assignments

ITU-T Y.1731 - ETH-AIS



Use Case 1: Segmented Customer Ethernet Access



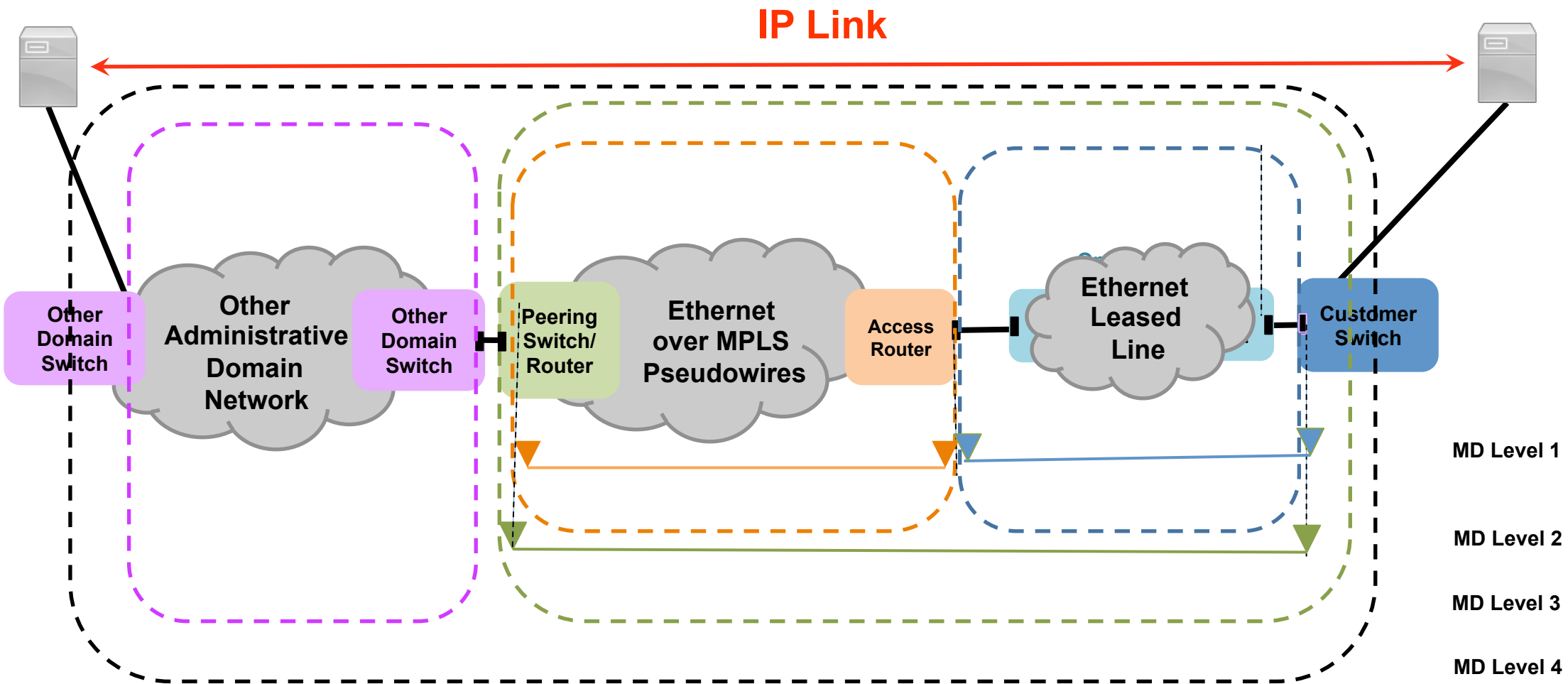
➤ Addressed Issues

- Failure on Ethernet Leased Line Service is not always signalled to NRENs L2 device. Failure isolation on two domains not always effective
- Performance degradation on customer IP access link cannot effectively isolated to one of the domains

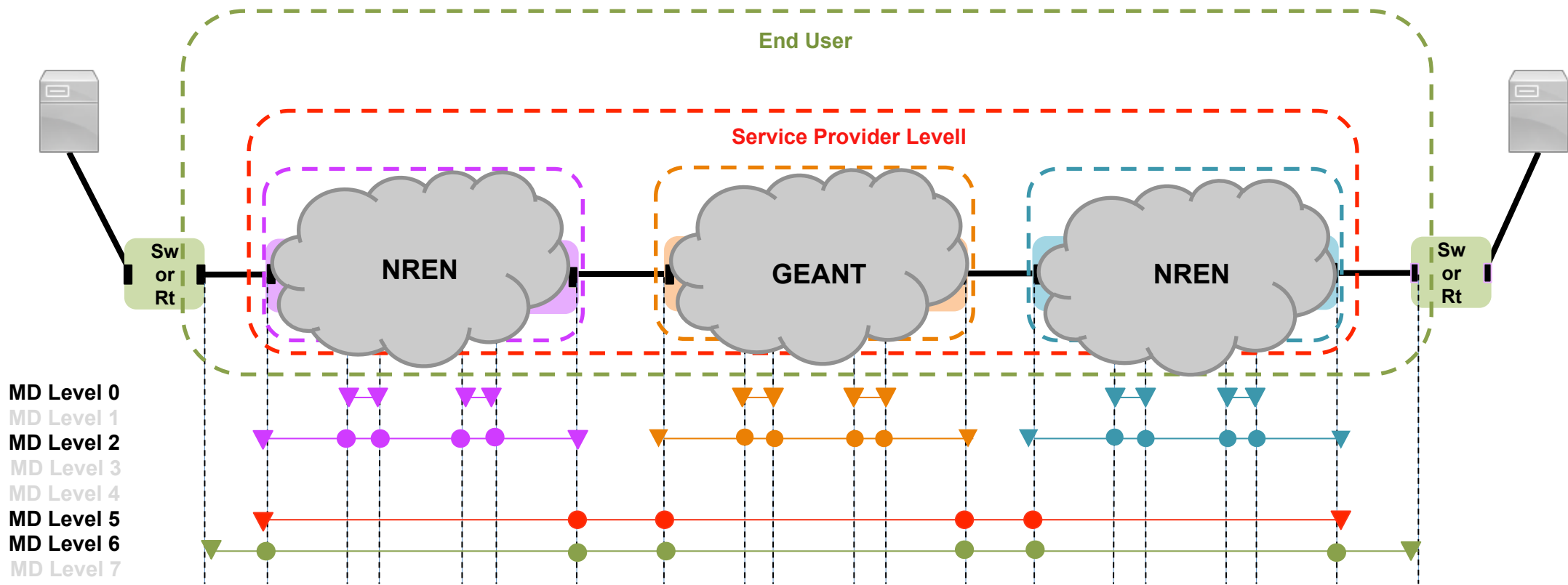
➤ Configuration

- CFM on Leased Line Switch/Router Interfaces : done in testbed, OK
- CFM Interaction with Ethernet Pseudowire Interfaces Headend Interface : todo

Use Case 2 proposed: Extended Layer 2 Connection crossing Domain and Borders

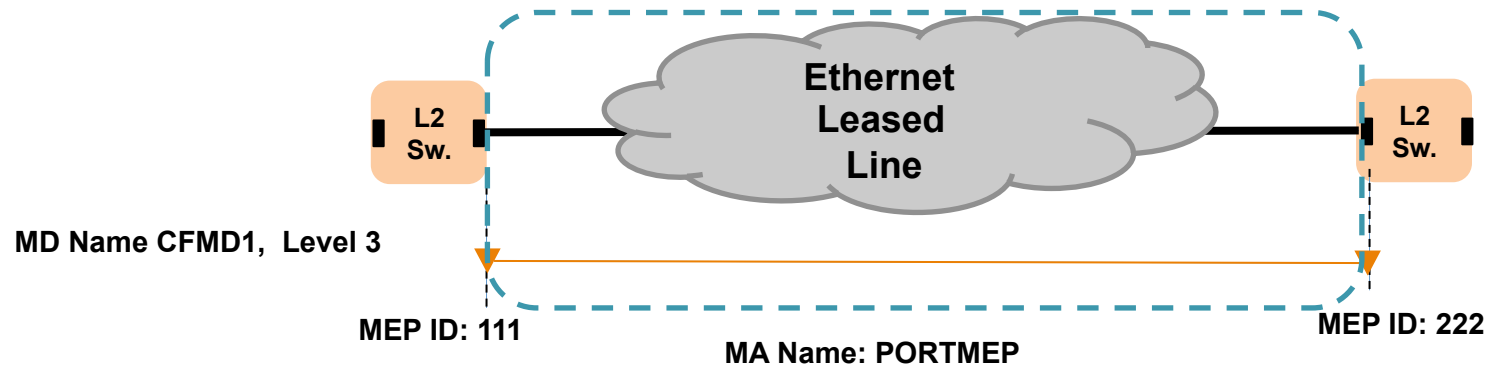


Use case generic: Interdomain L2 Ethernet service between NRENs (with CFM)



Result examples

typical CFM configuration



Switch r-test1

```
-----  
  
ethernet cfm ieee  
ethernet cfm global  
ethernet cfm alarm notification all  
ethernet cfm domain CFMD1 level 3  
service PORTMEP port  
continuity-check interval 3.3ms  
continuity-check loss-threshold 10
```

```
interface GigabitEthernet1/0/5  
ethernet cfm mep domain CFMD1 mpid 111 service PORTMEP
```

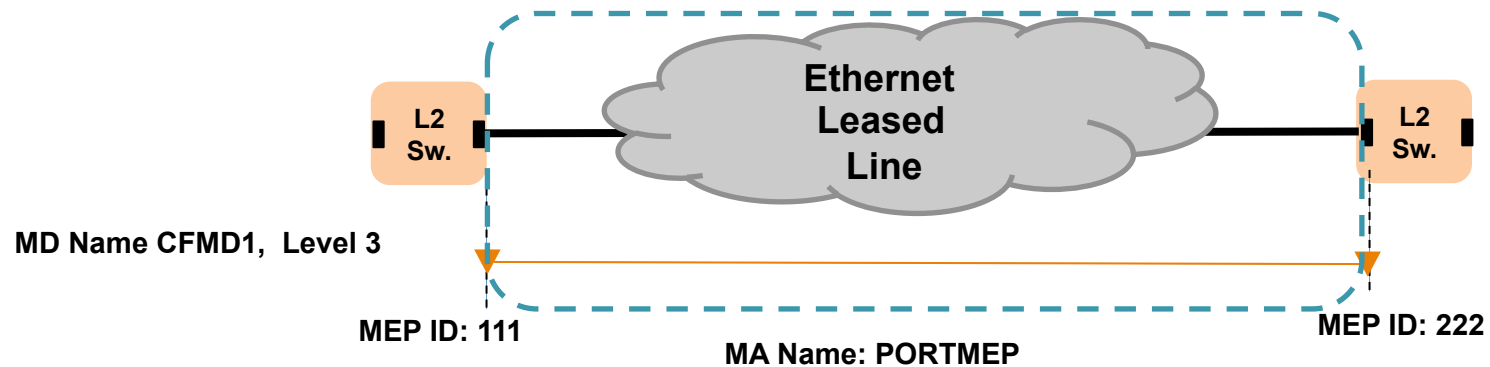
Switch r-test2

```
-----  
  
ethernet cfm ieee  
ethernet cfm global  
ethernet cfm alarm notification all  
ethernet cfm domain CFMD1 level 3  
service PORTMEP port  
continuity-check interval 3.3ms  
continuity-check loss-threshold 10
```

```
interface GigabitEthernet0/0/5  
ethernet cfm mep domain CFMD1 mpid 222 service PORTMEP
```

Result examples

typical CFM configuration



Switch r-test1

```
-----  
  
ethernet cfm ieee  
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ethernet cfm domain CFMD1 level 3  
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```
interface GigabitEthernet1/0/5  
ethernet cfm mep domain CFMD1 mpid 111 service PORTMEP
```

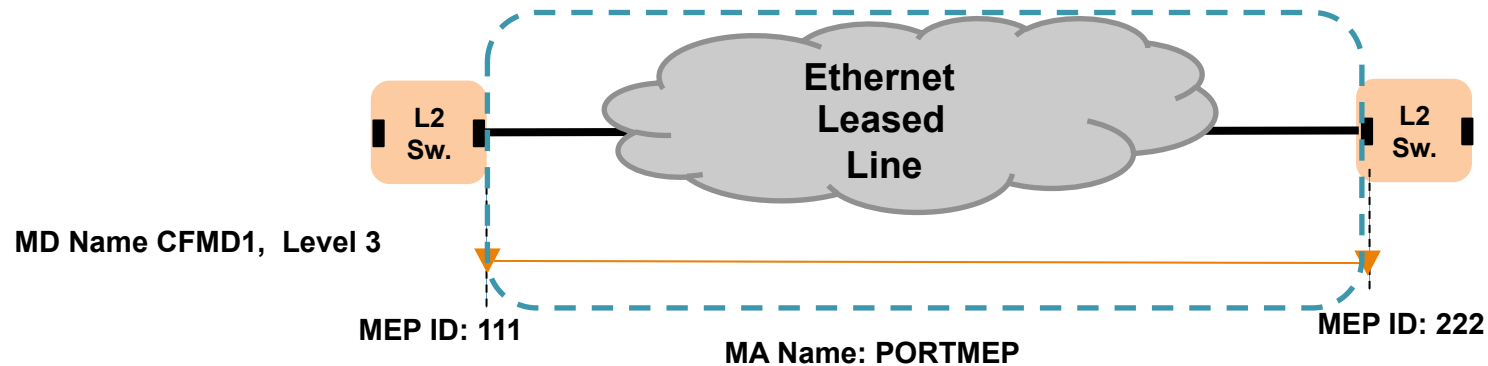
Switch r-test2

```
-----  
  
ethernet cfm ieee  
ethernet cfm global  
ethernet cfm alarm notification all  
ethernet cfm domain CFMD1 level 3  
service PORTMEP port  
continuity-check interval 3.3ms  
continuity-check loss-threshold 10
```

```
interface GigabitEthernet0/0/5  
ethernet cfm mep domain CFMD1 mpid 222 service PORTMEP
```

Result examples

typical CFM state output



```
r-test1#show ethernet cfm maintenance-points local
```

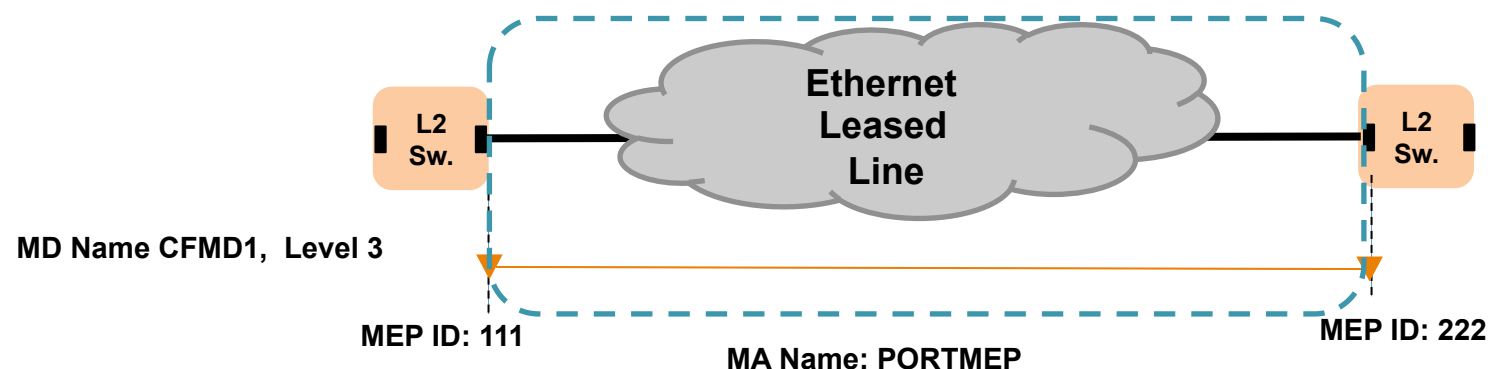
Local MEPs:

MPID	Domain Name	Lvl	MacAddress	Type	CC
Ofld	Domain Id	Dir	Port	Id	
	MA Name		SrvcInst	Source	
	EVC name				
111	CFMD1	3	0081.c4c9.f705	Port	N
Yes	CFMD1	Down	Gi1/0/5	none	
	PORTMEP		N/A	Static	
	N/A				

```
r-test1#show ethernet cfm maintenance-points remote
```

MPID	Domain Name	MacAddress	IfSt	PtSt
Lvl	Domain ID	Ingress		
RDI	MA Name	Type Id	SrvcInst	Age
	EVC Name			
	Local MEP Info			
222	CFMD1	00a2.ee16.fd45	Up	N/A
3	CFMD1	Gi1/0/5		
-	PORTMEP	Port none	N/A	
	N/A		0s	
	MPID: 111 Domain: CFMD1 MA: PORTMEP			

Result examples (MAC ping, MAC traceroute)



```
r-test1#ping ethernet mpid 222 domain CFMD1 service PORTMEP
Type escape sequence to abort.
Sending 5 Ethernet CFM loopback messages to 00a2.ee16.fd45, timeout is 5
seconds:!!!!!
Success rate is 100 percent (5/5), round-trip min/avg/max = 1/1/1 ms
```

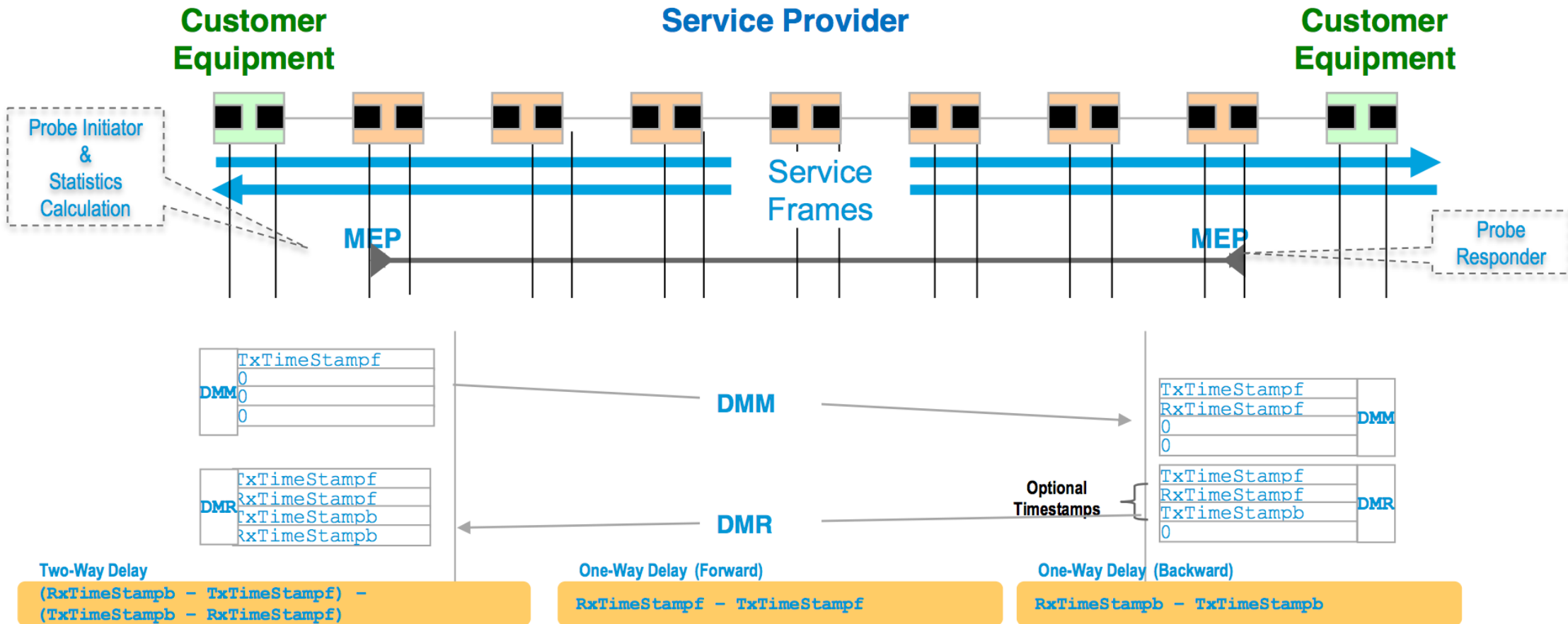
```
r-test2#trace ethernet mpid 222 domain CFMD1 service PORTMEP
Type escape sequence to abort. TTL 64. Linktrace Timeout is 5 seconds
Tracing the route to 00a2.ee16.fd45 on Domain CFMD1, Level 3, service PORTMEP, port
Traceroute sent via Gi1/0/5
```

```
B = Intermediary Bridge
! = Target Destination
* = Per hop Timeout
```

Hops	Host	MAC Forwarded	Ingress Egress	Ingr Action Egr Action	Relay Action Previous Hop
! 1		00a2.ee16.fd45 Not Forwarded	Gi0/0/5	IngOk	RlyHit:MEP 0081.c4c9.f705

ITU-T Y.1731 Overview

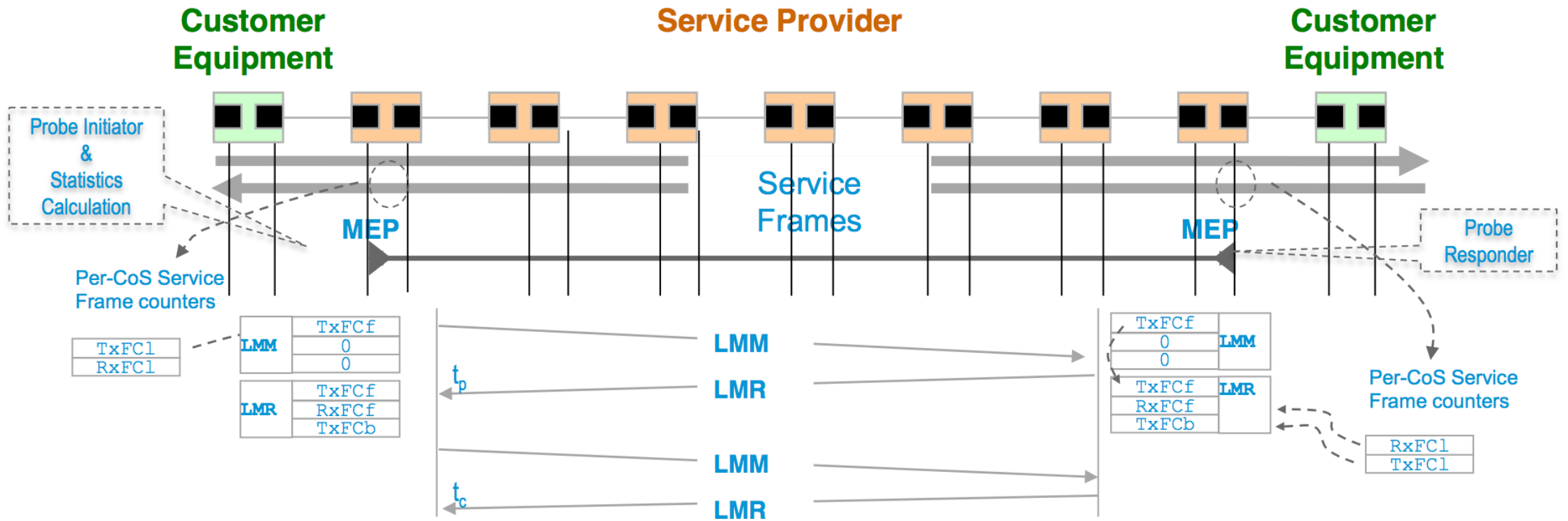
Two-way ETH-DM



DMM – Delay Measurement Message
DMR – Delay Measurement Reply

ITU-T Y.1731 Overview

Single-Ended ETH-LM



Frame Loss (Far-end)

$$(TxFcf[t_c] - TxFcf[t_p]) - (RxFcf[t_c] - RxFcf[t_p])$$

Frame Loss (Near-end)

$$(TxFcb[t_c] - TxFcb[t_p]) - (RxFc1[t_c] - RxFc1[t_p])$$

t_p – Time Previous
 t_c – Time Current

LMM – Loss Measurement Message
 LMR – Loss Measurement Reply

➤ First results

- Modern access switches and routers do support a wide range of CFM features.
- Link states are signalled, consequent actions can be triggered
- Continuous measurements and on-demand measurements are working
- Alarms are working

➤ Next

- CFM setup between EoMPLS terminating virtual Interfaces
- Multi-domain deployment scenarios, - Support from GEANT
- CFM support on end systems: toolset on Linux
- CFM with PM (delay, loss)
- Check and test interfaces with Network Management Stations
 - SNMP MIBs
 - Event logging at devices, event correlation at NMS
 - On demand measurements