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Connectivity Fault Managment

Layer-2 Performance Monitoring and Troubleshooting

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Overview

- Context, Concept and Goals
- Standardisation
- Protocol
- Use Cases, CFM deployments
- First Test results, CFM output examples
- Todos

Connectivity Fault Management
Context and Goals

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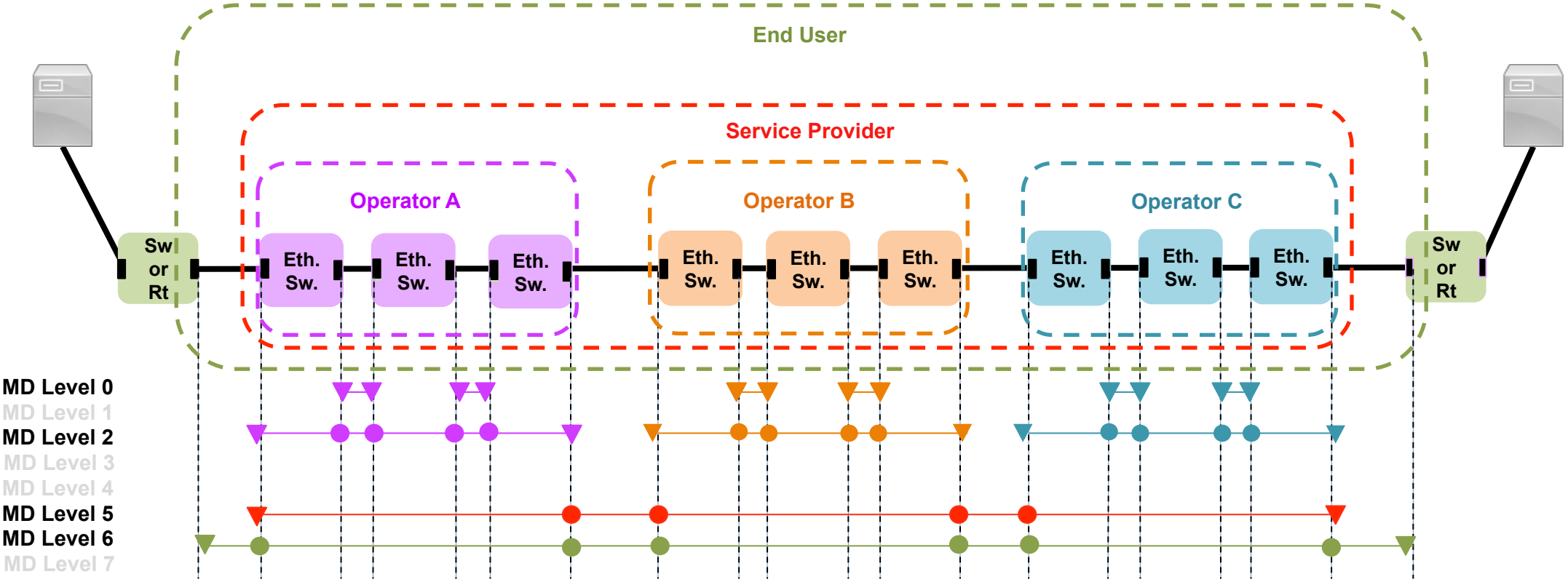
- Ethernet services in multiple operator/administrative domain environments introduce complexity to operators task:
  Effective isolation of link faults or performance degradation on L2 End-to-End services spanning multiple administrative domains.

- CFM has been standardised in IEEE 802.1ag, key points:
  - Measurement point instances run directly in L2 devices
  - Maintenance Domain Levels, -> Interdomain usability
  - Continuous and 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

An Example Deployment Scenario



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)

CFM Protocol (I)

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

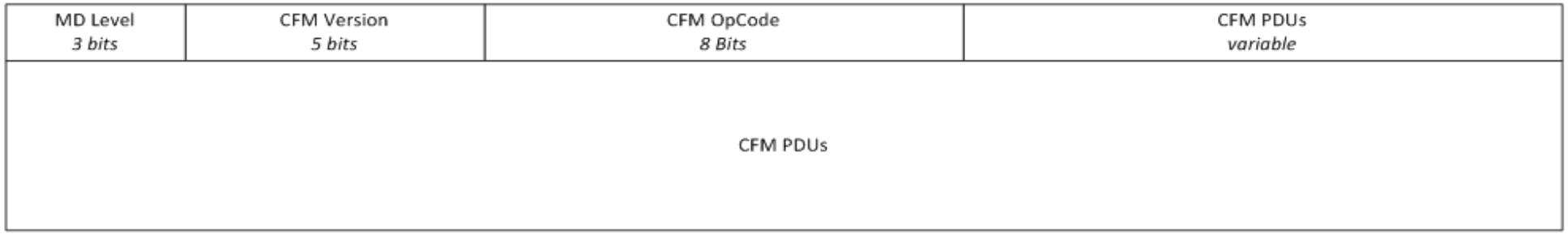


Figure 3. A CFM message frame format

- 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)

CFM Protocol (II)

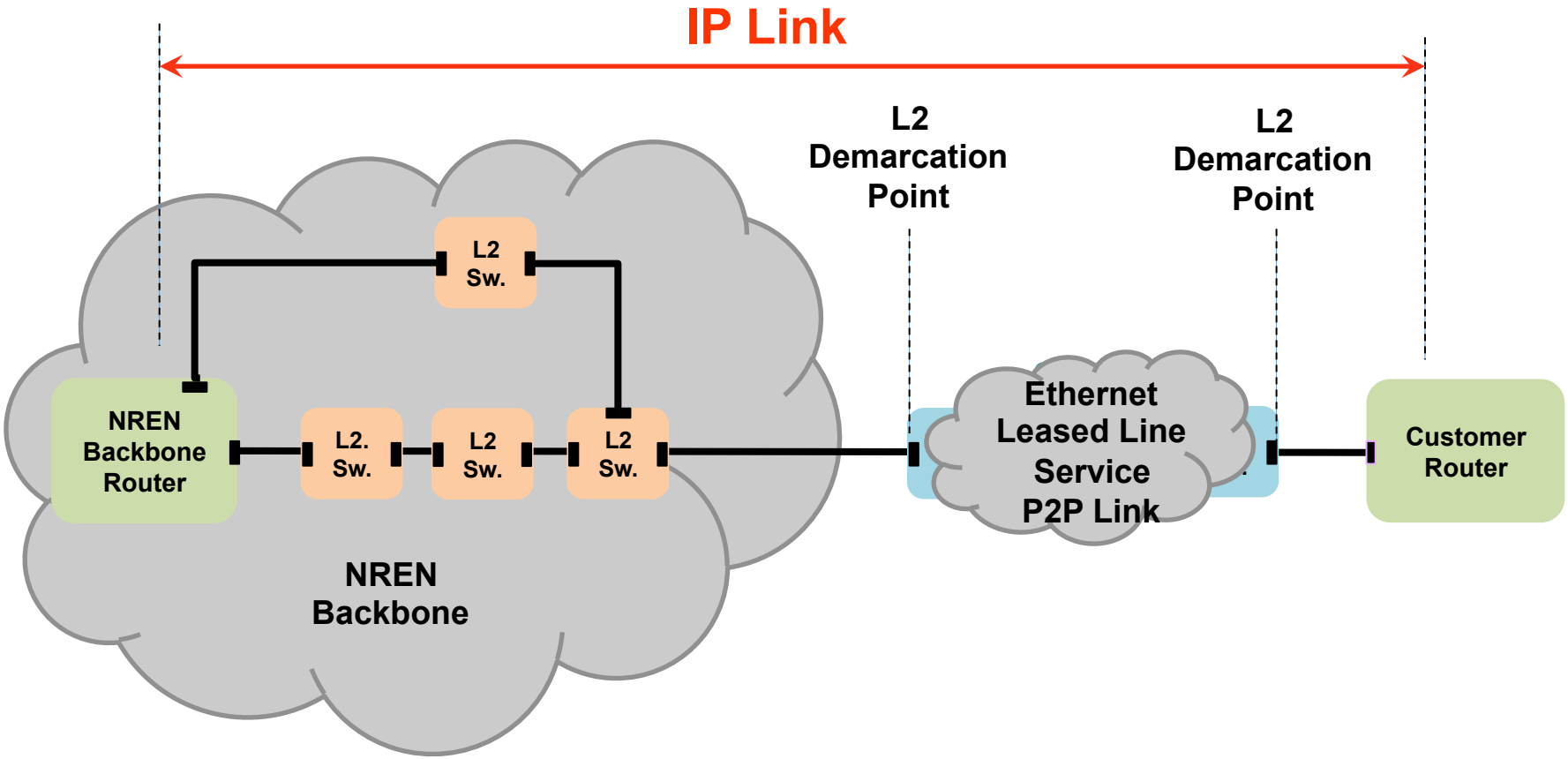
- **Continuity Check Protocol**
  - Used for Fault Detection, Notification, and Recovery
  - Per-Maintenance Association **multicast "heart-beat"** messages are transmitted at a configurable periodic interval by MEPs (3.3ms, 10ms, 100ms, 1s, 10s, 1min, 10min) - Uni-directional (no response required)
  - 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

CFM Protocol (III)

- **Loopback Protocol**
  - Used for Fault Verification - **Ethernet Ping**
  - **Can be used for on-demand frame loss and rtt measurments**
  - MEP can transmit a unicast Loopback Message (LBM) to a MEP or MIP in the same MA
  - MEP can also transmit a *multicas*t 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

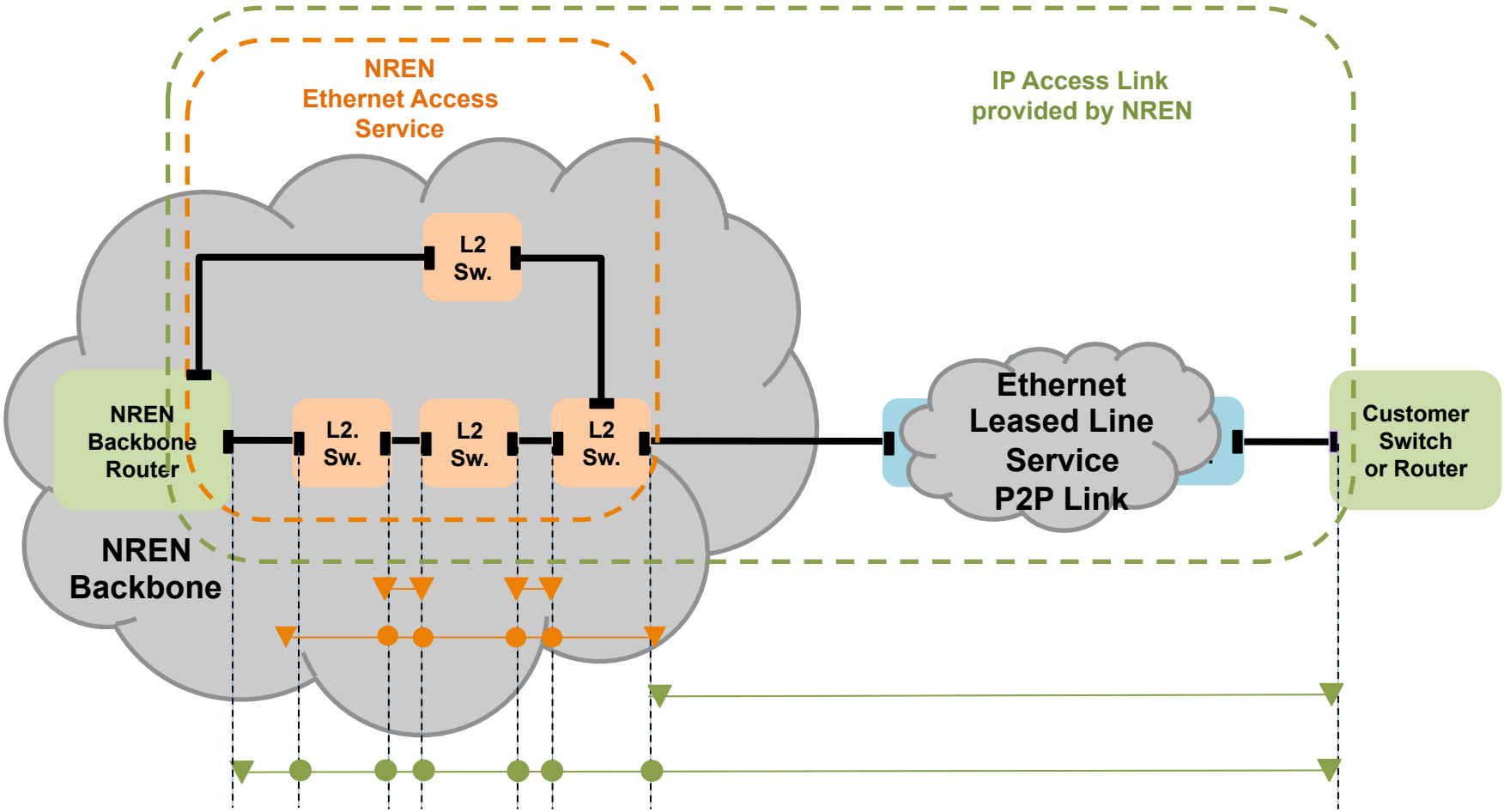
- **Linktrace Protocol**
  - Used for Path Discovery and Fault Isolation - **Ethernet Traceroute**
  - MEP can transmit a multicast message (LTM) in order to discover the MPs and path to a MIP or MEP in the same MA
  - Each MIP along the path and the terminating MP return a unicast LTR to originating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

Use case: Customer backbone access through leased ethernet service



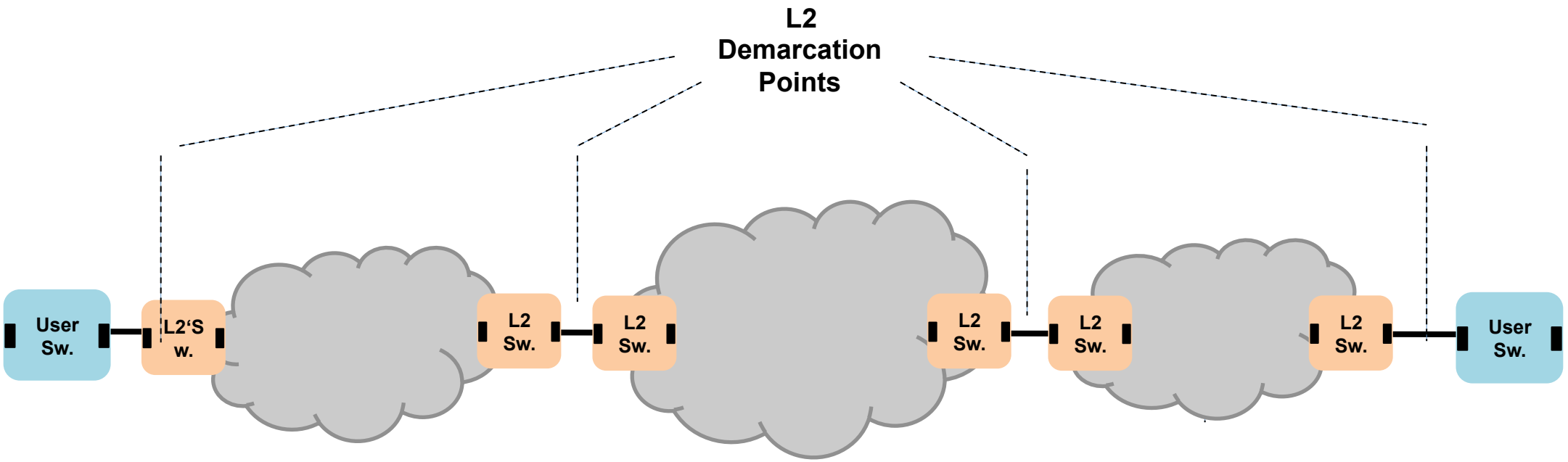
- Problems
  - Failure on Ethernet Leased Line Service is not always signalled to NRENs L2 device. Failure isolation on two domains not always effective
  - Performance degradation on customer IP access link cannot effectively isolated to one of the domains

Use case: Customer backbone access through leased ethernet service (with CFM)



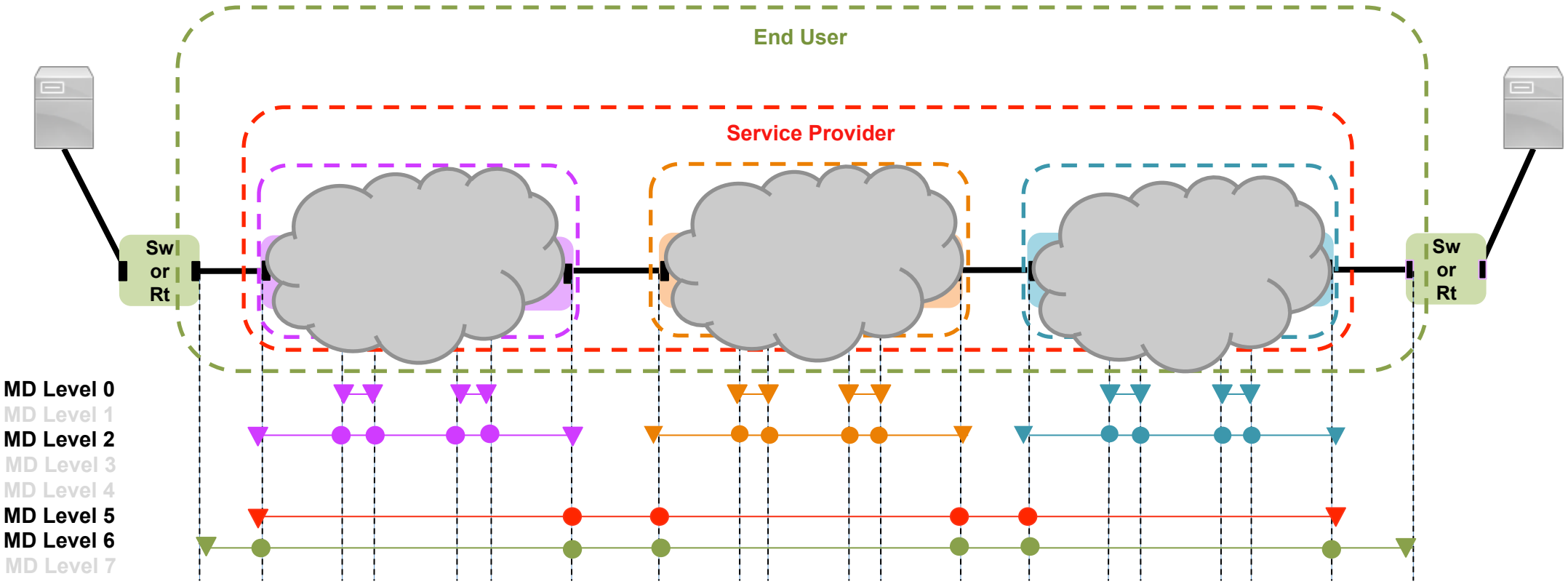
- Deployment of CFM
  - Link interrupts on Ethernet Leasd Line can be detected and signalled into NRENs L2 Switch on ms time range. Consequent actions can be triggered (Link down)
  - Performance degradation can be detected directly on Ethernet Leased line service, frame OWD and frame loss ratio at 0.3%.
  - Fault on Customer IP access link can be isolated rapidly to a Ethernet domain.

Use case example: Interdomain L2 Ethernet service between NRENs

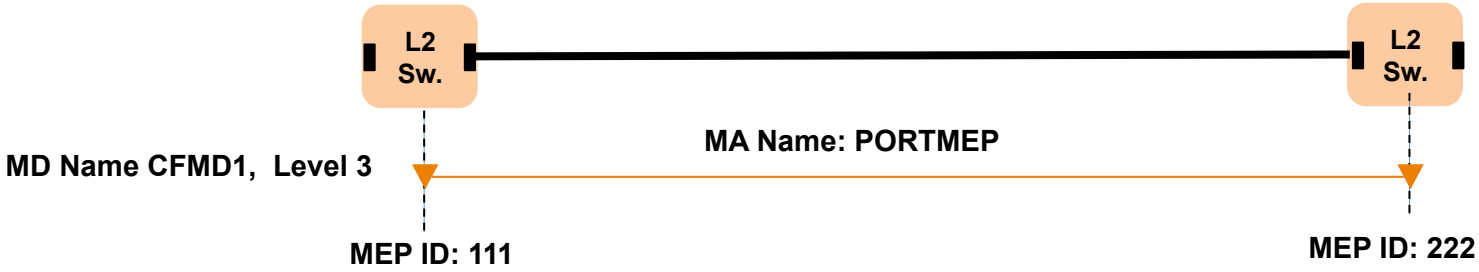


- Challenges
  - Fast fault isolation if performance degradation on End-to-End link
  - Fast signalling of segment interrupts to neighbour domains or user switch

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



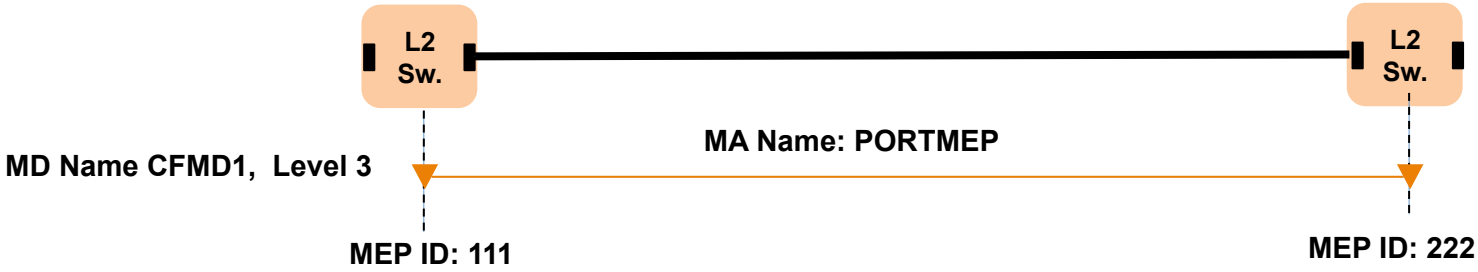
Result examples
typical CFM configuration




```
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
```

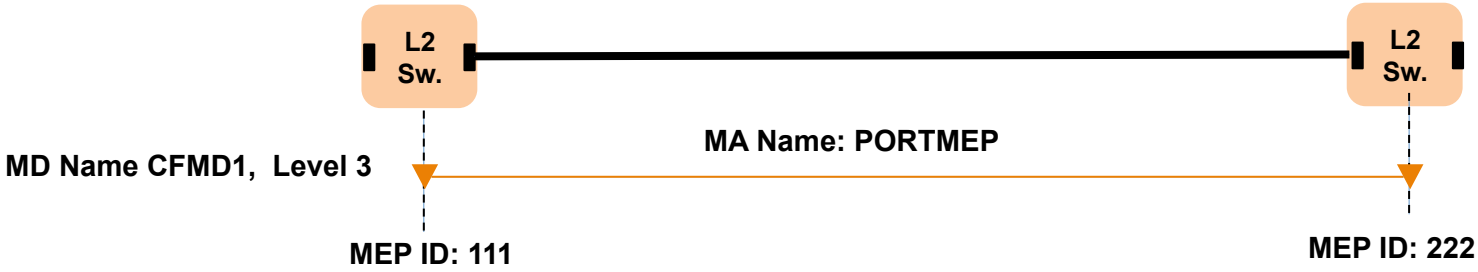
```
Switch r-test2
----------------

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

Preliminary Test results, and todos

- 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
- Todos
  - Check and test interfaces with Network Management Stations
    - SNMP MIBs
    - CLIs output
    - How to read measurement results from MEPs and MIPs into NMS
    - Check alarm features
    - How to start on demand measurements from NMS
  - Think on multi-domain deployment scenarios, L2 problem isolation requires improvements
  - CFM support on end systems: toolset on Linux and other OS