PCEP Procedures and Extension for VLAN-based Traffic Forwarding

[**draft-wang-pce-vlan-based-traffic-forwarding**]

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Motivation

- [RFC8821](#) describes an architecture for providing traffic engineering in a native IP network by using multiple BGP sessions and a PCE-based central control mechanism.

- [RFC9050](#) specifies the procedures and PCEP extensions for PCECC to derive MPLS Label Switched Paths.

- With the large scale deployment of Ethernet interface, it is possible to use the info contained in the Layer2 frame to simplify the E2E packet forwarding procedure.

- Based on the mechanism mentioned in RFC9050 and RFC8821, this document defines PCEP extension for VLAN-based traffic forwarding in native IP network and describes the processes of the data packet forwarding system based on VLAN info.

Intra&inter-domain Scenario
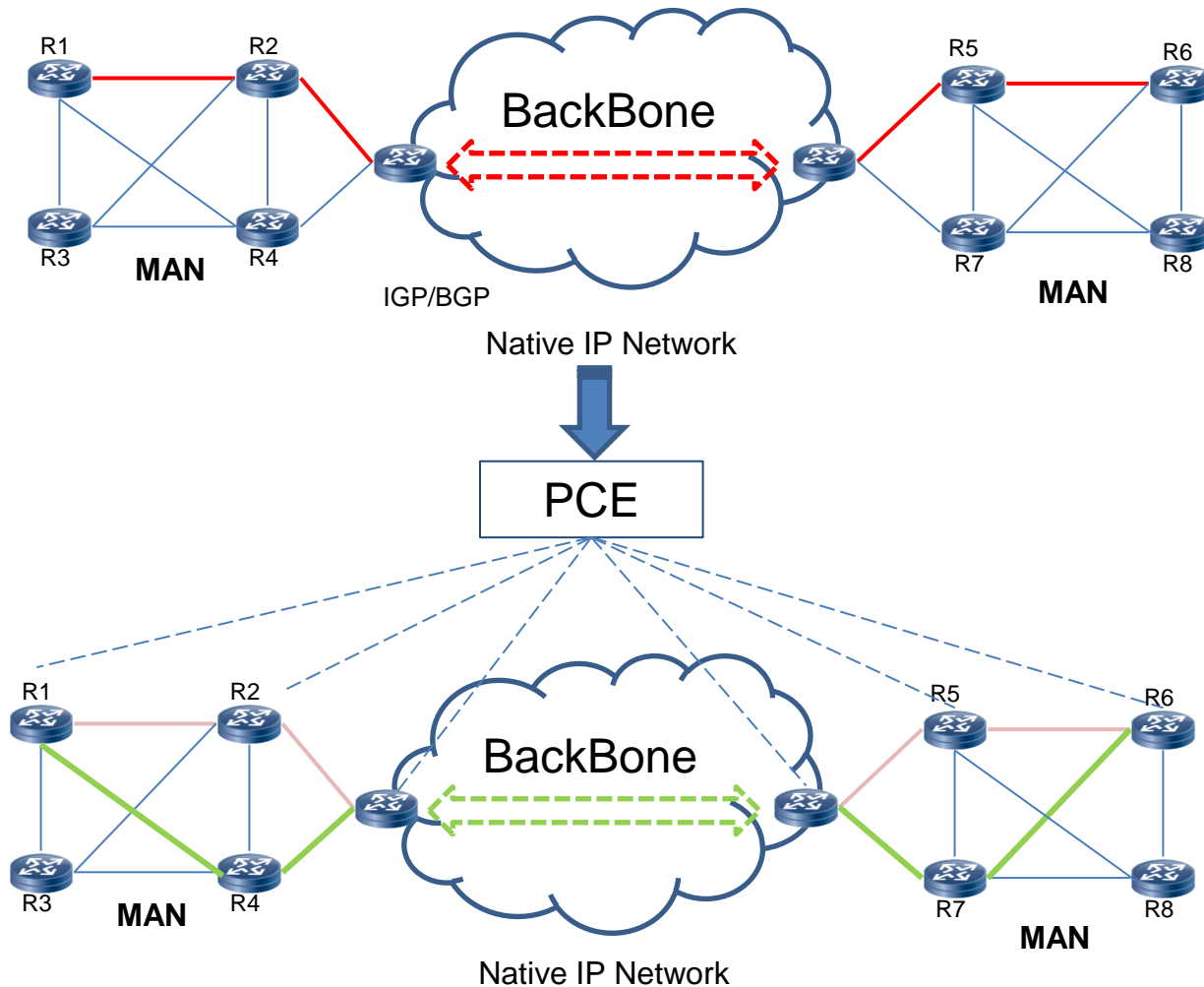
a. Intra-domain or inter-domain traffic guarantee.
b. The controller senses the network status and dynamically adapts to the network status.

Architecture requirements

- Same solution for native IPv4 and IPv6 traffic.

- Support for intra-domain and inter-domain scenarios.

- Achieve E2E traffic assurance, with determined QoS behavior, for traffic requiring a service assurance (prioritized traffic).

- Based on centralized control through a distributed network control plane.

- Ability to adjust the optimal path dynamically upon the changes of network status. No need for reserving resources for physical links in advance.

Procedures for VLAN-based Traffic Forwarding
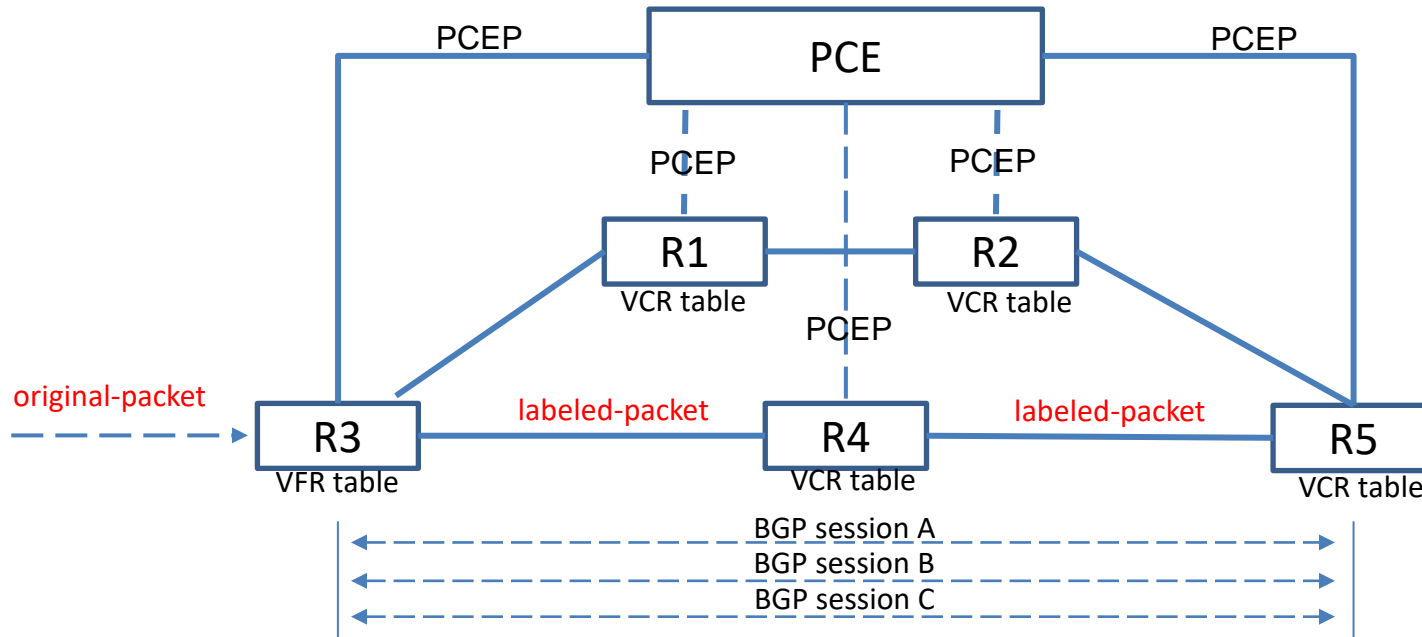
1. The PCE calculates the explict route and sends the route information to the PCCs through PCInitiate messages.
2. The ingress PCC forms a VLAN-Forwarding routing(VFR) table, the transit PCC and the egress PCC forms a VLAN-Crossing routing(VCR) table.
3. The packet to be guaranteed matches the table and then be labeled with corresponding VLAN tag.
4. The labeled packet will be further sent to the PCC's specific subinterface identified by the VLAN tag and then be forwarded.

Data Packet Encapsulation Process
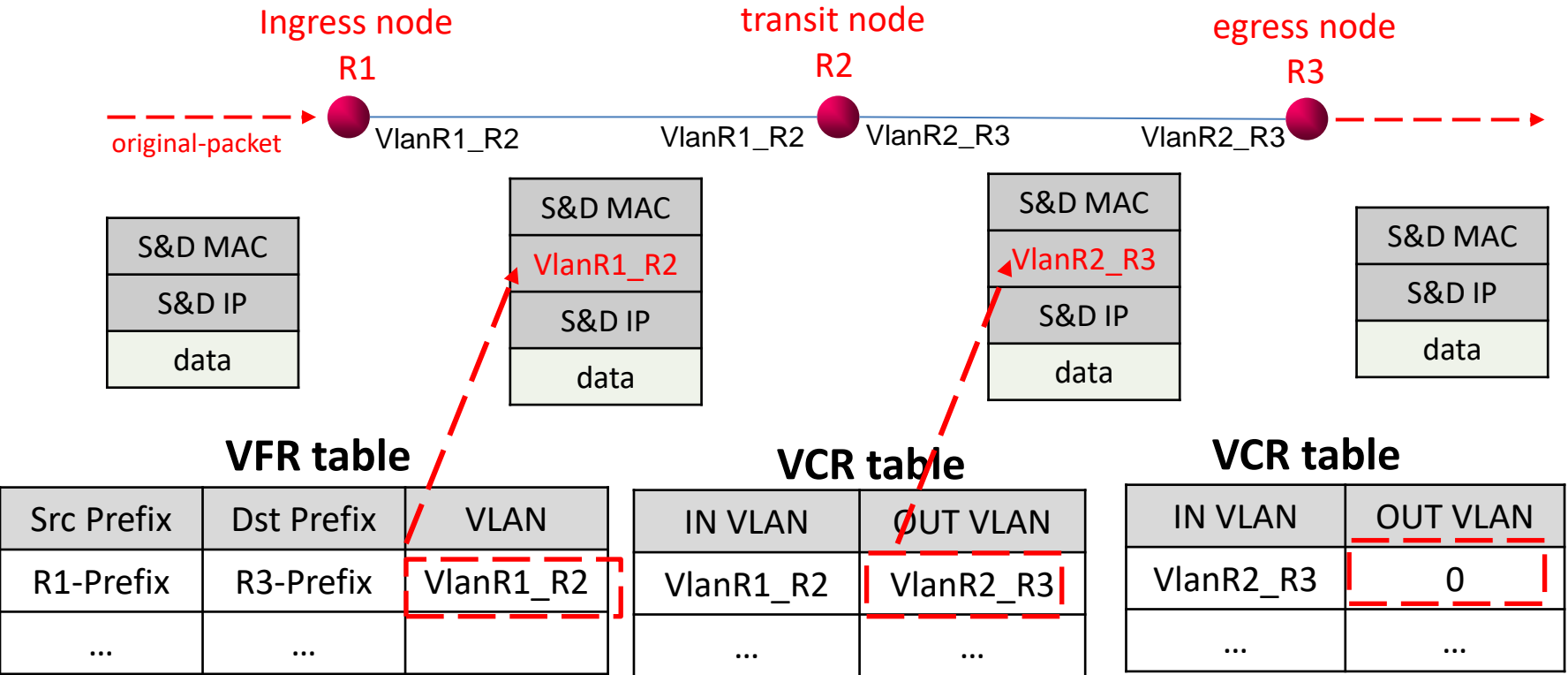
- Use a completely new address space to bypass the already used MPLS label space, which will not conflict with other existing protocols and avoid considering the label overlap of the already used MPLS services in the MPLS-Native IP-Mixed environment.

- Is suitable for ipv4 and ipv6 networks and can leverage the existing PCE technologies as much as possible.

- Avoid SRH Overhead problem.

Updated Contents

```
Table 2: VLAN-Forwarding routing table
+------------------------------------------------------------------+
|        Dst IP Address        |   Interface   |      VLAN      |
+------------------------------------------------------------------+
| Prefixes from R6 Session1 |      INF 1     |   VLAN_R1_R2  |
| Prefixes from R6 SessionX |      INF X     |       X       |
|                              ...                                 |
+------------------------------------------------------------------+
```

VLAN-Forwarding routing (ingress PCC) is used to match the packet to be guaranteed based on the source and destination BGP prefix.

```
Table 4: VLAN-Crossing routing table
+-------------------------------------------------------------------------------+
|  IN-Interface  |    IN-VLAN    |  OUT-Interface  |    OUT-VLAN    |
+-------------------------------------------------------------------------------+
|      INF1      |  VLAN_R1_R2   |      INF2       |   VLAN_R2_R3   |
|      INF3      |       X       |      INF4       |       Y        |
|      INF5      |       Z       |      INF6       |       0        |
|                            ...                                    |
+-------------------------------------------------------------------------------+
```

Through the mapping of the in-VLAN and the out VLAN in the VLAN-Crossing routing table (transit PCC and egress PCC) , the data packet to be guaranteed will be transferred to the specific interface.
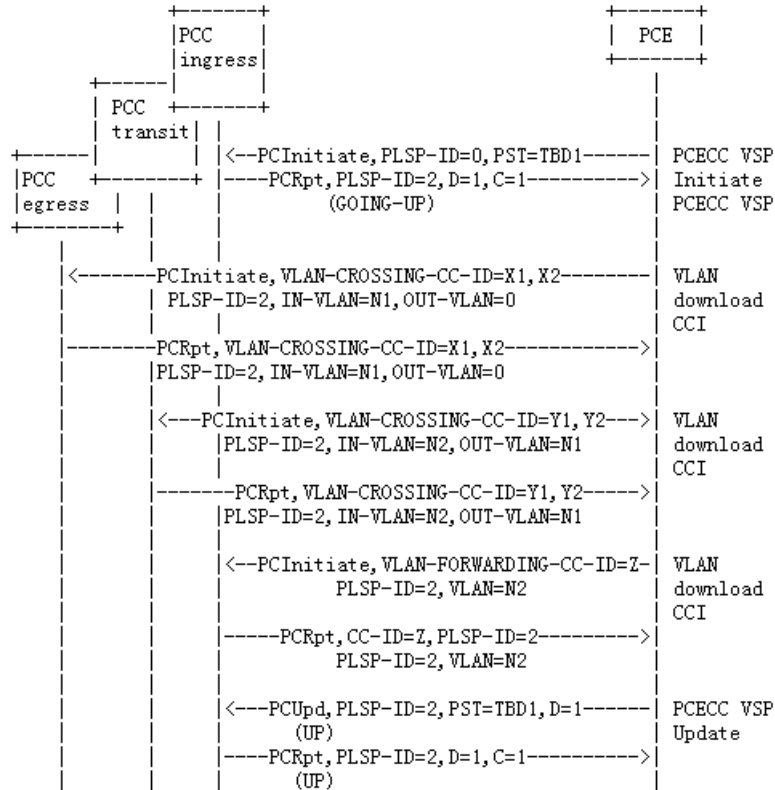
Updated Contents

```
        +-------+                      +-------+
        |PCC    |                      | PCE   |
        |ingress|                      +-------+
    +------|     |                         |
    | PCC  +-------+                        |
    |transit|    |                          |
+------|     |   |<--PCInitiate,PLSP-ID=0,PST=TBD1------|  PCECC VSP
|PCC   +-------+ |  |----PCRpt,PLSP-ID=2,D=1,C=1--------->|  Initiate
|egress |    |   |            (GOING-UP)                 |  PCECC VSP
+-------+ |  |   |                                        |
      |   |  |   |                                        |
      |<------PCInitiate,VLAN-CROSSING-CC-ID=X1,X2--------|  VLAN
      |   | PLSP-ID=2,IN-VLAN=N1,OUT-VLAN=0              |  download
      |   |  |   |                                        |  CCI
      |------PCRpt,VLAN-CROSSING-CC-ID=X1,X2------------>|
      | PLSP-ID=2,IN-VLAN=N1,OUT-VLAN=0                  |
      |   |  |   |                                        |
      |   |<---PCInitiate,VLAN-CROSSING-CC-ID=Y1,Y2--->|  VLAN
      |   | PLSP-ID=2,IN-VLAN=N2,OUT-VLAN=N1            |  download
      |   |  |   |                                        |  CCI
      |-------PCRpt,VLAN-CROSSING-CC-ID=Y1,Y2----->|
      |   | PLSP-ID=2,IN-VLAN=N2,OUT-VLAN=N1            |
      |   |  |   |                                        |
      |   |<--PCInitiate,VLAN-FORWARDING-CC-ID=Z--|  VLAN
      |   |       PLSP-ID=2,VLAN=N2                |  download
      |   |  |   |                                        |  CCI
      |   |-----PCRpt,CC-ID=Z,PLSP-ID=2--------->|
      |   |       PLSP-ID=2,VLAN=N2                |
      |   |  |   |                                        |
      |   |<---PCUpd,PLSP-ID=2,PST=TBD1,D=1------|  PCECC VSP
      |   |      (UP)                            |  Update
      |   |----PCRpt,PLSP-ID=2,D=1,C=1---------->|
      |   |      (UP)                            |
       Figure 1: PCE-Initiated PCECC VSP
```

Adding VLAN Switching Path
 sequence diagram

```
                             +-------+              +-------+
                             |PCC    |              | PCE   |
                             |ingress|              +-------+
                        +------|     |                  |
                        | PCC  +-------+                 |
                        |transit|    |                   |
                   +------|     |   |                    |
                   |PCC   +-------+ |                     |
                   |egress |    |   |                     |
                   +-------+ |  |   |                     |
                     |    |  |   |                         |
                     |<----- PCInitiate,VLAN-CROSSING-CC-ID=NEW-X1,X2----|  New Path
                     |      PLSP-ID=1,IN-VLAN=NEW-N1,OUT-VLAN=0          |  for VSP
                     |    |  |   |                                        |  triggers
                     |--------PCRpt,VLAN-CROSSING-CC-ID=NEW-X1,X2------->|  new CCI
                     |      PLSP-ID=1,IN-VLAN=NEW-N1,OUT-VLAN=0          |
                     |    |  |   |                                        |
                     |    |<----------PCInitiate,PLSP-ID=1------------|
                     |    | VLAN-CROSSING-CC-ID=NEW-Y1,NEW-Y2         |  Label
                     |    |  IN-VLAN=NEW-N2,OUT-VLAN=NEW-N1           |  download
                     |    |  |   |                                        |  CCI
                     |    |-----------PCRpt,PLSP-ID=1------------->|
                     |    | VLAN-CROSSING-CC-ID=NEW-Y1,NEW-Y2         |
                     |    |  IN-VLAN=NEW-N2,OUT-VLAN=NEW-N1           |
                     |    |  |   |                                        |
                     |    |<--------PCInitiate,PLSP-ID=1--------|  Label
                     |    |   VLAN-FORWARDING-CC-ID=NEW-Z         |  download
                     |    |          VLAN=NEW-N2                  |  CCI
                     |    |  |   |                                        |
                     |    |---------PCRpt,PLSP-ID=1----------->|
                     |    |    LAN-FORWARDING-CC-ID=NEW-Z         |
                     |    |          VLAN=NEW-N2                  |
                     |    |  |   |                                        |
                     |    |<---PCUpd,PLSP-ID=1,PST=TBD1,D=1----|  PCECC
                     |    |     (SRP=S)                         |  VSP Update
                     |    |  |   |                                        |
                     |    |---PCRpt,PLSP-ID=1,PST=TBD1,D=1---->|  Trigger
                     |    |     (SRP=S)                         |  Delete
                     |    |  |   |                                        |  former CCI
                     |<------------PCInitiate, PLSP-ID=1--------------|  Label
                     |    |  |VLAN-CROSSING-CC-ID=X1,X2,R=1          |  cleanup
                     |--------------PCRpt,PLSP-ID=1------------------>|  CCI
                     |    |  |VLAN-CROSSING-CC-ID=X1,X2,R=1          |
                     |    |  |   |                                        |
                     |    |<------------PCInitiate,PLSP-ID=1----------|  Label
                     |    |  |VLAN-CROSSING-CC-ID=Y1,Y2,R=1          |  cleanup
                     |--------------PCRpt,PLSP-ID=1------------------>|  CCI
                     |    |  |VLAN-CROSSING-CC-ID=Y1,Y2,R=1          |
                     |    |  |   |                                        |
                     |    |<--------PCInitiate,PLSP-ID=1--------|  Label
                     |    |  |VLAN-FORWARDING-CC-ID=Z,R=1            |  cleanup
                     |    |  |---------PCRpt,PLSP-ID=1----------->|  CCI
                     |    |  |VLAN-FORWARDING-CC-ID=Z,R=1            |
                             Figure 2: PCECC VSP Update
```
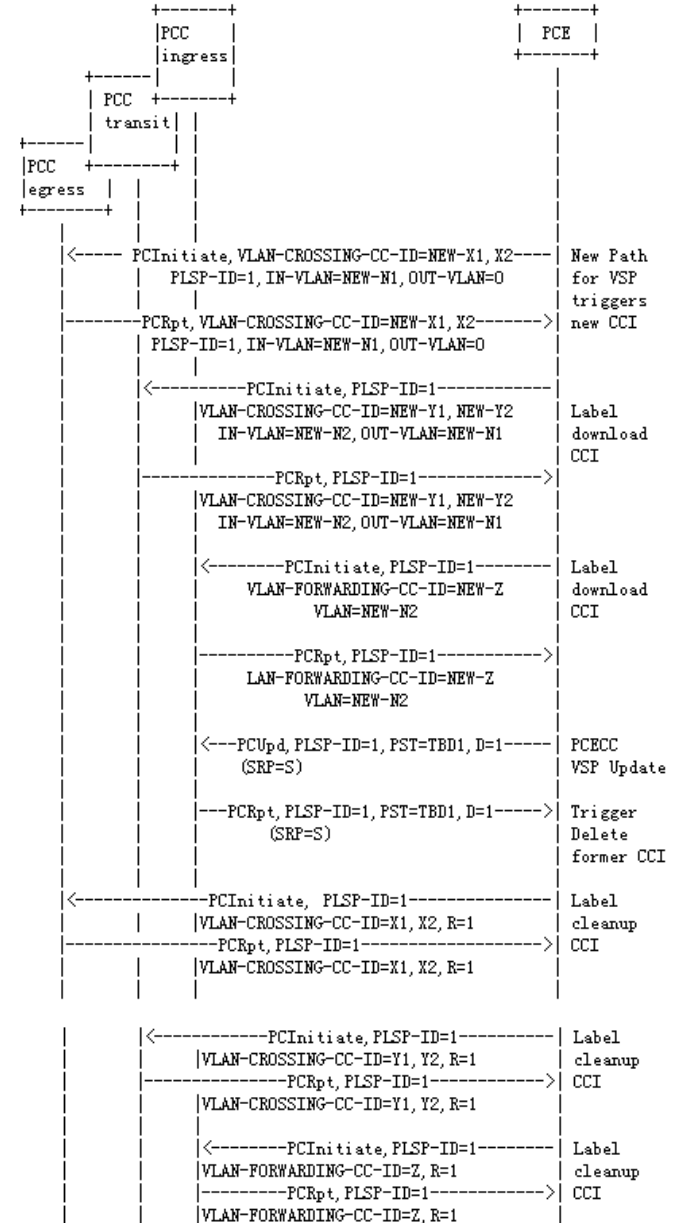
Next Step

- More solutions & comments are welcome.

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