

Use Cases and Framework of Service-Oriented MPLS Path Programming (MPP)

draft-li-spring-mpls-path-programming-00

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Introduction

- SPRING architecture for unicast traffic (Segment Routing) has been proposed to cope with the use cases in traffic engineering, fast re-reroute, service chain, etc. It can leverage existing MPLS dataplane without any modification.
- In fact, the label stack capability in MPLS would have been utilized well to implement flexible path programming to satisfy all kinds of requirements of service bearing.
- This document defines the concept of MPLS path programming, then proposes use cases, architecture and protocol extension requirements in the service layer for the SPRING architecture.

History Review (1)

- Hierarchical LSP: e.g. Option C Inter-AS VPN which adopts LDP over TE as the transport tunnel in the ingress node.

```
+-----+-----+-----+-----+
|VPN Prefix|  BGP  |  LDP  | RSVP-TE |
|  Label  | Label | Label | Label  |
+-----+-----+-----+-----+
```

```
+-----+-----+-----+-----+-----+
|VPN Prefix|  BGP  |  LDP  | RSVP-TE | BYPASS FRR |
|  Label  | Label | Label | Label  | Label      |
+-----+-----+-----+-----+-----+
```

- The MPLS label stack in the MPLS path of the example shows limited programming capability. The limitation has two reasons:
 - The limited label usage. MPLS label is always for reachability.
 - The limited path calculation capability in the distributed environment. SPF is always adopted or complex configuration for traffic engineering.

History Review (2)

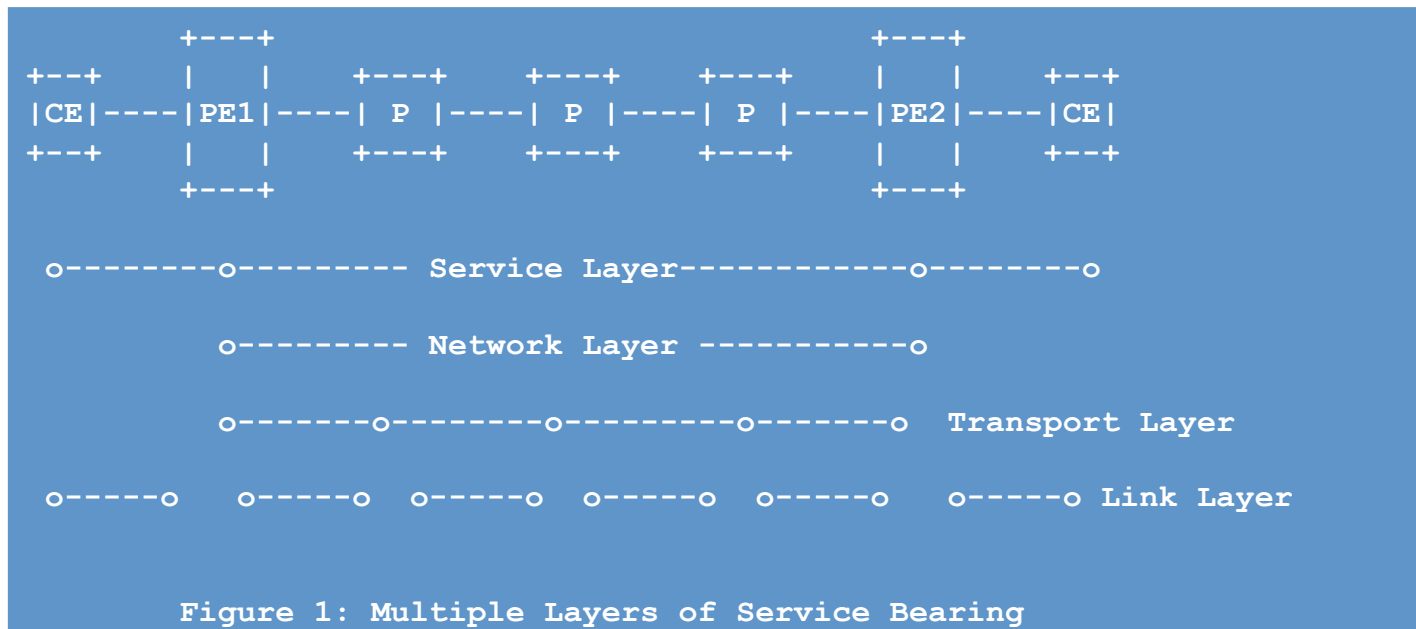
- MPLS Label beyond reachability:
 - Entropy Label
 - Source Label
 - Global label use cases defined in [draft-li-mpls-global-label-usecases].
- Central Control for Enhanced MPLS Path Calculation and label combination.
 - Stateful PCE
 - PCE for Segment Routing

MPLS Path Programming Capability (1)

- MPLS path is composed by label stacks. Since in the label stack the labels in different layers can represent different meaning and the depth of the label stack can be unlimited in theory, it is possible to make up all kinds of MPLS paths based on the combination of labels.
- If we look on the combination of MPLS labels as programming, it can be seen that the MPLS path has high programming capability.
- As the introducing of central control in the network, the flexible MPLS programming capability becomes possible owing to two factors: 1. It becomes easier to allocate label for more purposes than reachability; 2. It is easy to calculate the MPLS path in a global network view.

MPLS Path Programming Capability (2)

- There are multiple layers for MPLS path to bear services which is shown in the following figure:



- Two types of MPLS path programming:
 - Transport-Oriented MPLS path programming: Segment Routing, etc.
 - Service-Oriented MPLS Path programming

Use Cases of Service-Oriented MPLS Path Programming

- Traffic Steering in Service/Network Layer : This method is to directly encapsulate the service flow with the service label stack in the ingress PE before it enters into the transport tunnel.
- Use Cases for Unicast Service
 - Basic Reachability
 - VPN Identification
 - ECMP(Equal Cost Multi-Path)
 - Service OAM
 - Traffic Steering
- Use Cases of Multicast Service
 - Basic Reachability
 - MVPN Identification
 - Source Identification
- Use Cases of MPLS Virtual Network

Use Cases for Unicast Service

- Use cases for unicast service MPLS path programming is shown as follows:

+-----+	+-----+	+-----+	+-----+	+-----+	
Entropy	Steering	VPN Prefix	VPN	Source	---> Transport
Label	Label	Label	Label	Label	Tunnel
+-----+	+-----+	+-----+	+-----+	+-----+	

- ✓ **VPN Prefix Label** : Basic reachability. It is defined in [RFC4364].
- ✓ **VPN Label**: Identification of VPN. It is defined in [I-D.zhang-l3vpn-label-sharing].
- ✓ **Entropy Label**: Identification of ECMP. It is defined in [RFC6790].
- ✓ **Source Label**: Identification of source PE which can be used for OAM. It is defined in [I-D.chen-mpls-source-label].
- ✓ **Steering Label**: [I-D.filsfils-spring-segment-routing-central-epe] illustrates the application of steering label for the Egress Peer Engineering (EPE).

Use Cases of Multicast Service

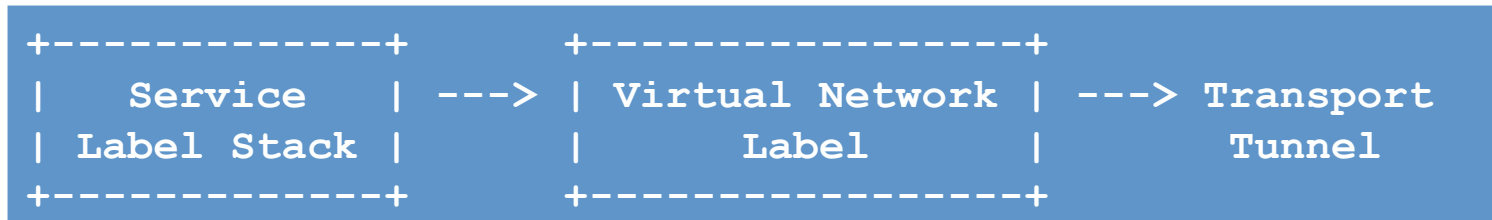
- Use cases for multicast service MPLS path programming is shown as follows (using BUM in EVPN as the example) :

```
+-----+-----+-----+
| Multicast | EVPN   | Source | --->   Transport
| Payload  | Label  | Label  |         Multicast Tunnel
+-----+-----+-----+
```

- ✓ **Basic Reachability**
- ✓ **MVPN Label:** Identification of MVPN which can be used for such use cases as sharing multiple MVPN with one P-tunnel..
- ✓ **Source Label:** Identification of the source Ethernet Segment in EVPN for horizon split or summarization of C-MACs.

Use Cases of MPLS Virtual Network

- The framework of MPLS virtual network has been proposed in [I-D.li-mpls-network-virtualization-framework].
- When the unicast service or the multicast service enters into the transport tunnel, it may take different MPLS virtual network identified by the MPLS label for the purpose of QoS routing, security or virtual operations.
- The MPLS path is as follows:



Use Cases Summary

- Service-oriented MPLS path programming can make full use of flexible combination of MPLS labels to satisfy different requirements for the service flow. Based on the above proposed use cases, MPLS path can be composed adopting part or whole labels for these use cases based on the service requirement.
- More flexible MPLS label combination may be provided:

- Hierarchical process or multiple repeated process:

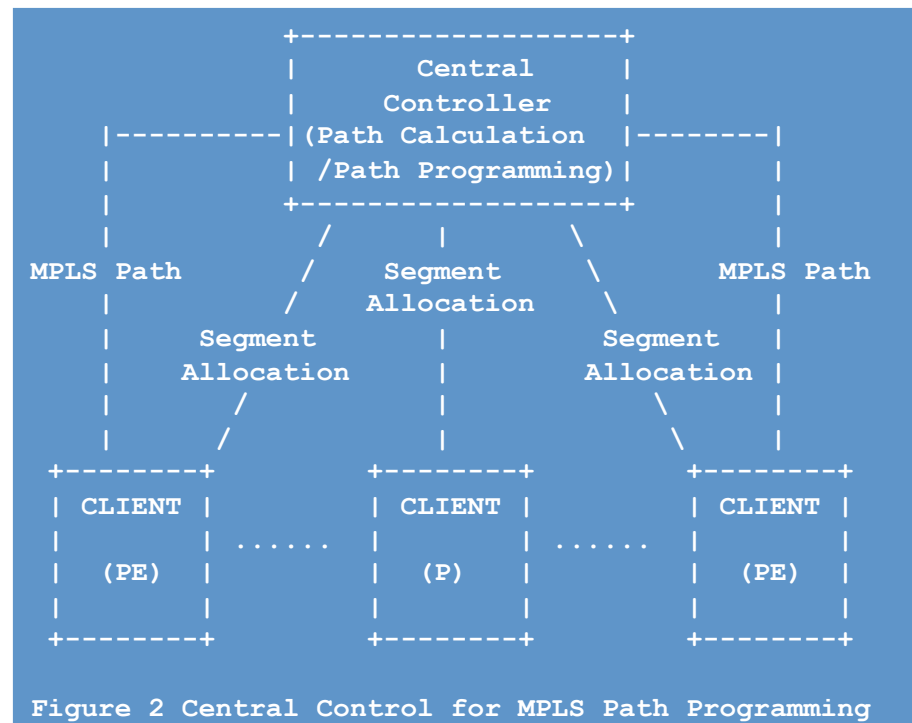
+-----+-----+-----+-----+-----+-----+						
SERVICE	VPN Prefix	SERVICE		VPN	SERVICE	Tunnel
LABEL	Label	LABEL		Label	LABEL	Label
+-----+-----+-----+-----+-----+-----+						

- Special-purpose label indicator:

- Since the label in the service-oriented MPLS programming is for special-purpose process, it may need a special purpose label to indicate the usage of the label followed the special-purpose labels.
- For example, the ELI(Entropy Label Indicator) is introduced for the entropy label. This may introduce more labels for the combination.

Architecture of MPLS Path Programming

- Central control plays an important role in MPLS path programming. It can extend the MPLS path programming capability easily. There are two important functionalities for the central control:
 - Central controlled MPLS label allocation: Label can be allocated centrally for special usage other than reachability. These labels can be used to compose MPLS path. We call it as MPLS Segment.
 - Central controlled MPLS path programming: Central controller can calculate path in a global network view and implement the MPLS path programming based on the collected information of MPLS segments to satisfy different requirements of services.



Central Control for MPLS Path Programming

- For the transport-oriented MPLS path, segment routing is the typical solution:
 - MPLS segment distribution is done by IGP extensions ([I-D.ietf-isis-segment-routing-extensions]) and [I-D.ietf-ospf-segment-routing-extensions]);
 - The programmed MPLS path can be downloaded through PCEP extensions from PCE to PCC([I-D.sivabalan-pce-segment-routing]).
- For the service-oriented MPLS path programming, it not only includes composing the MPLS path in the service and network layer, but also includes determining the mapping of the service path to the transport path. Since the process corresponding to the label in the service label stack is always located at the PE nodes, BGP extensions can be introduced for service-oriented path programming.

Protocol Extensions Requirements for Service-Oriented MPLS Path Programming

- **BGP**

1. REQ 01: BGP extensions SHOULD be introduced to distribute local label mapping for specific process.
2. REQ 02: BGP extensions SHOULD be introduced to distribute global label mapping for specific process.
3. REQ 03: BGP extensions SHOULD be introduced to download label stack for service-oriented MPLS path.
4. REQ 04: BGP extensions SHOULD be introduced to carry the identifier of the transport MPLS path with service MPLS path to implement the mapping.

- **I2RS**

1. REQ 01: I2RS clients SHOULD provide interface to I2RS agent to download policy to implement the mapping of the service path to the transport path.

Next Step

- Seek comments and feedbacks
- Revise the draft