Segment Routing
Co-existence with LDP

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Segment Routing – Co-existence with LDP

- Co-existence with LDP and other MPLS protocols
- Simple migration from LDP to Segment Routing
Segment Routing and LDP Control Plane Co-existence
Co-existence with other MPLS label distribution protocols

• The MPLS architecture permits concurrent usage of multiple label distribution protocols
  – LDP, RSVP-TE, … and SR control plane can co-exist without interaction

• Each node’s Label Manager
  – Reserves a label range (SRGB) for SR control-plane
  – Ensures that all dynamic labels are outside the SRGB block
  – Ensures that a dynamic label is uniquely allocated

• Each LSR must ensure that it can uniquely interpret its incoming labels
  – Adjacency segment: locally unique label allocated by the Label Manager
  – Prefix segment: operator ensures the unique allocation of each label within the allocated SRGB
Segment Routing and LDP Data Plane Co-existence
MPLS-to-MPLS and MPLS-to-IP label switching and label disposition

• For the MPLS2MPLS and MPLS2IP forwarding entries, SR and LDP can co-exist
  – These entries are indexed on a label
  – The local/incoming labels handled by LDP and SR (or other label distribution protocols) are unique
  – The outgoing label is only significant for the downstream neighbor, not for the local node
  – Multiple MPLS2MPLS and MPLS2IP entries can be programmed for the same prefix

>cfr. LSP midpoint cross-connect
### MPLS-to-MPLS and MPLS-to-IP

**Prefix-SID index 5**

<table>
<thead>
<tr>
<th>Node</th>
<th>local/in lbl</th>
<th>out lbl</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>16000</td>
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</tr>
<tr>
<td></td>
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<td></td>
</tr>
<tr>
<td></td>
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</tr>
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<table>
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</thead>
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<table>
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<th>out lbl</th>
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</thead>
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<th>out lbl</th>
</tr>
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<tbody>
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</tr>
<tr>
<td></td>
<td>23999</td>
<td></td>
</tr>
<tr>
<td></td>
<td>24000</td>
<td></td>
</tr>
<tr>
<td></td>
<td>...</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Node</th>
<th>local/in lbl</th>
<th>out lbl</th>
</tr>
</thead>
<tbody>
<tr>
<td>5</td>
<td>1.1.1.5</td>
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</tr>
</tbody>
</table>

All nodes: SR + LDP

Prefix-SID index 5

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MPLS-to-MPLS and MPLS-to-IP
SR Prefix Segment to 1.1.1.5/32

All nodes: SR + LDP

Prefix-SID index 5

1.1.1.5

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MPLS-to-MPLS and MPLS-to-IP
LDP FEC to 1.1.1.5/32

All nodes: SR + LDP

Prefix-SID index 5

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SRGB

Local/in lbl | out lbl
--- | ---
16000 | 16005
... | ...
23999 | 24000
... | ...
24002 | 24001
... | ...
1048575 | ...

SRGB

Local/in lbl | out lbl
--- | ---
16000 | 16005
... | ...
23999 | 24000
... | ...
24001 | 32011
... | ...
1048575 | ...

SRGB

Local/in lbl | out lbl
--- | ---
16000 | 16005
... | ...
23999 | 24000
... | ...
24005 | 16005
... | ...
31999 | ...
32011 | 24003
... | ...
1048575 | ...

SRGB

Local/in lbl | out lbl
--- | ---
16000 | 16005
... | ...
23999 | 24000
... | ...
24001 | 32011
... | ...
1048575 | ...

SR
IP-to-MPLS – label imposition

• Multiple IP2MPLS entries (e.g. LDP and SR) for the same prefix path cannot co-exist
  – These label imposition forwarding entries are indexed on the prefix
  – A forwarding table lookup returns one or more paths to the destination
  – Each path has a single IP2MPLS entry programmed
  – If multiple paths lead to the destination, each path has its own IP2MPLS entry
    > E.g. one path imposing an LDP label, another path imposing an SR label
IP-to-MPLS: which label must be imposed?

<table>
<thead>
<tr>
<th>Node</th>
<th>Prefix-SID index 5</th>
<th>All nodes: SR + LDP</th>
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<tbody>
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</tr>
<tr>
<td>5</td>
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Payload to 1.1.1.5

**segment-routing mpls sr-prefer**

<table>
<thead>
<tr>
<th>Local/in lbl</th>
<th>Out lbl</th>
</tr>
</thead>
<tbody>
<tr>
<td>16005</td>
<td>16005</td>
</tr>
<tr>
<td>23999</td>
<td>24000</td>
</tr>
<tr>
<td>24002</td>
<td>24001</td>
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<tr>
<td>1048575</td>
<td></td>
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</tbody>
</table>

**segment-routing mpls (default)**

<table>
<thead>
<tr>
<th>Local/in lbl</th>
<th>Out lbl</th>
</tr>
</thead>
<tbody>
<tr>
<td>16005</td>
<td></td>
</tr>
<tr>
<td>23999</td>
<td>24000</td>
</tr>
<tr>
<td>24003</td>
<td>24003 pop</td>
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<tr>
<td>1048575</td>
<td></td>
</tr>
</tbody>
</table>

1. Segment-routing mpls sr-prefer
2. Segment-routing mpls (default)
IP-to-MPLS – label imposition

• For IP2MPLS forwarding, LDP XOR SR entry can be inserted into FIB
  – Only one IP2MPLS entry can exists for each prefix path

• Default: LDP label imposition is preferred

```
router isis 1
  address-family ipv4|6 unicast
  segment-routing mpls sr-prefer

router ospf 1
  segment-routing mpls
  segment-routing sr-prefer
```
IGP/SR and LDP programming FIB

- This diagram illustrates the behavior of node1 on slide 8
IGP/SR and LDP programming FIB

- This diagram illustrates the default behavior: prefer LDP label imposition.

<table>
<thead>
<tr>
<th>SRGB</th>
<th>local/in lbl</th>
<th>out lbl</th>
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</thead>
<tbody>
<tr>
<td></td>
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<td></td>
</tr>
<tr>
<td></td>
<td>1048575</td>
<td></td>
</tr>
</tbody>
</table>

Loc_lbl: local label, allocated by local node
Out_lbl: outgoing label

16005: SR label
24002: LDP label

1.1.1.5/32
Loclbl 16005
Outlbl 16005
1.1.1.5/32
Loclbl 24002
Outlbl 24001
IGP/SR and LDP programming FIB

- This diagram illustrates the behavior when preferring SR label imposition

---

**IGP/RIB**

- 1.1.1.5/32
  - LocLbl: 16005
  - OutLbl: 16005

**LDP/LSD**

- 1.1.1.5/32
  - LocLbl: 24002
  - OutLbl: 24001

**FIB**

- 1.1.1.5/32 ➔ 16005
- 16005 ➔ 16005
- 24002 ➔ 24001

**LocLbl**: local label, allocated by local node

**OutLbl**: outgoing label

---

16005: SR label
24002: LDP label
MPLS-to-MPLS forwarding entries

<table>
<thead>
<tr>
<th>Label</th>
<th>Outgoing Label</th>
<th>Prefix</th>
<th>Outgoing Interface</th>
<th>Next Hop</th>
<th>Bytes</th>
</tr>
</thead>
<tbody>
<tr>
<td>24003</td>
<td>24005</td>
<td>100.0.0.3/32</td>
<td>Gi0/0/0/0</td>
<td>99.2.3.3</td>
<td>5670</td>
</tr>
</tbody>
</table>

Both entries are present regardless of the preference setting

All nodes: SR + LDP
IP-to-MPLS forwarding entries with LDP preference

default (LDP is preferred)

All nodes: SR + LDP

Local LDP label

Neighbor’s (remote) LDP label

IP-to-MPLS cef entry has LDP labels programmed
SR and LDP – IP-to-MPLS with SR preference

```
RP/0/0/CPU0:xrvr-3#show route 1.1.1.1/32 detail
Routing entry for 1.1.1.1/32
    Known via "isis 1", distance 115, metric 2, type level-2
    Installed May 21 07:08:45.345 for 00:35:05
    Routing Descriptor Blocks
        99.2.3.2, from 1.1.1.1, via GigabitEthernet0/0/0/0
    Route metric is 2
    Label: 0x3e81 (16001)
    Tunnel ID: None
    Extended communities count: 0
    Path id:1 Path ref count:0
    NHID:0x1(Ref:6)
    Local Label: 0x3e81 (16001)

<...>
```

```
RP/0/0/CPU0:xrvr-3#show cef 1.1.1.1/32
1.1.1.1/32, version 222, internal 0x4000001 0x0 (ptr 0xa1376074) [1], 0x0 (0xa135b560), 0x228 (0xa1411118)
    Updated May 21 07:08:50.475
    local adjacency 99.2.3.2
    Prefix Len 32, traffic index 0, precedence n/a, priority 3
        via 99.2.3.2, GigabitEthernet0/0/0/0, 9 dependencies, weight 0, class 0 [flags 0x0]
        path-idx 0 NHID 0x0 [0xa0e300bc 0x0]
        next hop 99.2.3.2
        tx adjacency
    local label 16001 labels imposed {16001}
```

All nodes: SR + LDP

- Neighbor’s (remote) SR label
- Local SR label
- IP-to-MPLS cef entry has SR labels programmed

sr-prefer configured
Segment Routing and LDP
“Ships in the night”
Deployment Model
“Ships in the Night” Deployment Model

• LDP and SR are kept independent
  – continuous SR connectivity between SR PEs required
  – continuous LDP connectivity between LDP PEs required
  – no SR to LDP or LDP to SR interworking required

• Other deployment models are possible: see “SR/LDP interworking” section
Simplest migration LDP to SR

- **Initial state**: All nodes run LDP, not SR

Assumptions:
- all the nodes can be upgraded to SR
- all the services can be upgraded to SR
Simplest migration LDP to SR

• **Initial state**: All nodes run LDP, not SR
• **Step1**: All nodes are upgraded to SR
  – In no particular order
  – leave default LDP label imposition preference

Assumptions:
- all the nodes can be upgraded to SR
- all the services can be upgraded to SR
Simplest migration LDP to SR

• **Initial state:** All nodes run LDP, not SR

• **Step1:** All nodes are upgraded to SR
  – In no particular order
  – Leave default LDP label imposition preference

• **Step2:** All PEs are configured to prefer SR label imposition
  – In no particular order

**Assumptions:**
• All the nodes can be upgraded to SR
• All the services can be upgraded to SR
Simplest migration LDP to SR

• **Initial state:** All nodes run LDP, not SR

• **Step1:** All nodes are upgraded to SR
  – In no particular order
  – Leave default LDP label imposition preference

• **Step2:** All PEs are configured to prefer SR label imposition
  – In no particular order

• **Step3:** LDP is removed from the nodes in the network
  – In no particular order

• **Final state:** All nodes run SR, not LDP

Assumptions:
- All the nodes can be upgraded to SR
- All the services can be upgraded to SR
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