Segment Routing Mapping Server

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Segment Routing – Mapping Server

- Objective of the Mapping Server
- Configuring the Mapping Server
- Verifying the Mapping Server functionality

Mapping Server

Mapping Server – Functionality

- Advertise Prefix-to-SID mappings in IGP on behalf of other non-SR-capable nodes
  - prefix-to-sid mappings are configured on the Mapping Server
- Enable SR-capable nodes to interwork with (non-SR-capable) LDP nodes, a Mapping Server is required for SR/LDP interworking
  - See the SR/LDP interworking section for more information

Mapping Server – Functionality

- Position of mapping server is comparable to a BGP Route-reflector:
  - Mapping server is a control plane mechanism
  - Mapping server doesn't have to be in the data path
  - Mapping server must be resilient, redundancy should be provided

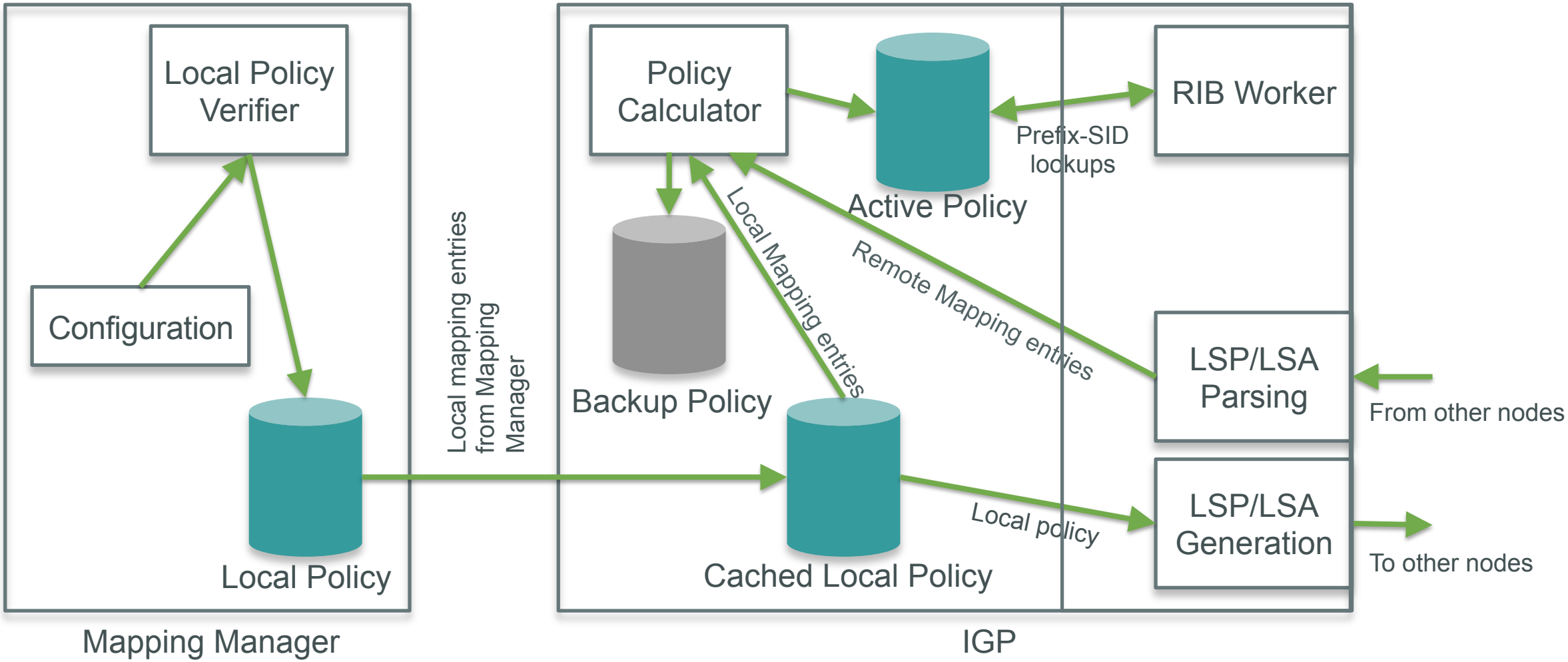
Mapping Client – Functionality

- Mapping Client functionality:
  - Receive and parse prefix-to-sid mappings from Mapping Server(s)
  - Use remotely learnt and locally configured mapping entries to construct a valid and consistent Active SID Mapping policy
    - Mappings that are not selected for the Active policy go to the Backup policy
  - IGP instance uses the Active SID Mapping policy to (re-)calculate the prefix-SID of some or all prefixes

Mapping Client – Functionality

- Common-sense design rule:
  - If a mapping server is used, all nodes should be mapping client to receive the prefix-to-sid mappings that they would not otherwise receive via the link-state advertisement from the non-SR nodes

Mapping Server Architecture



Q: Can I use Mapping Server for centralized SID advertisement? A: No

- A Mapping Server is intended for advertising prefix-to-SID mappings for non-SR-capable nodes
- Prefix-SIDs received from a Mapping Server have an implicit PHP-off behavior: the penultimate hop will not pop the prefix-SID label
  → packets will arrive at the destination with prefix-SID label on top
  - packet with local prefix-SID as top label would require two label lookups at the receiving node to forward packet: top-label lookup, pop top-label, next-label or address lookup → performance impact
  - In IOS XR, no mpls forwarding entry is installed for local prefix-SIDs
    → packets with local prefix-SID as top label are dropped

Q: Can I use Mapping Server for centralized SID advertisement? A: No

- OSPF partially removes this limitation for intra-area prefixes:
  - If the intra-area prefix is local to the nexthop router, then OSPF will pop the label, even if the prefix-SID is received from the mapping server

Mapping Server and multi-area, multi-level networks

- IS-IS: Mapping server advertisements are currently not propagated between levels

  → a mapping server is required per IS-IS area

- OSPF: Mapping server advertisements are propagated between areas

Mapping Server Configuration

Mapping Server Configuration

```
segment-routing
  mapping-server
    prefix-sid-map
      address-family ipv4|ipv6
        <prefix>/<mask> <first-SID-value> range <range>
        [...]
```

- Each line under **`prefix-sid-map`** maps to a prefix-to-sid mapping advertisement

Mapping Server – Routing Protocol CLI

```
router isis 1
  address-family ipv4|ipv6 unicast
    segment-routing prefix-sid-map advertise-local
```

```
router ospf 1
  segment-routing prefix-sid-map advertise-local
```

- **`advertise-local`**
  - IGP advertises locally configured prefix-SID mappings
- **`receive`**: enabled by default for newer releases
  - See client functionality slide
- Mappings are advertised in all levels/areas on L1L2 IS-IS router and OSPF ABR

Configuration Example – Mapping Server

```
segment-routing
  mapping-server
    prefix-sid-map
      address-family ipv4
        ! <prefix>/<len> <1st-SID> range <range>
        10.1.1.1/32 10 range 200
        20.1.1.0/24 400 range 300
!
router isis 1
  address-family ipv4 unicast
    segment-routing prefix-sid-map advertise-local
```

10.1.1.1/32 – prefix-SID idx 10
10.1.1.2/32 – prefix-SID idx 11
...
10.1.1.200/32 – prefix-SID idx 209

20.1.1.0/24 – prefix-SID idx 400
20.1.2.0/24 – prefix-SID idx 401
...
20.2.44.0/24 – prefix-SID idx 699

- Typical Mapping Server configuration
  - **`advertise-local`** command
  - Note: older releases don't have the required client functionality enabled by default
    - > See mapping server client slide

Configuration Example – Mapping Client

- Typical Mapping Client configuration
  - no local SID mapping configured
  - no **`advertise-local`** command
  - **`receive`** functionality enabled by default
- Mapping client functionality can be disabled

```
router isis 1
  address-family ipv4|ipv6 unicast
    segment-routing prefix-sid-map receive    !! default
```

```
router ospf 1
  segment-routing prefix-sid-map receive      !! default
```

Overview Mapping Server Config Options

Configuration option	Advertise local policy	Compute Active Policy
`receive (default)`	no	Ignore local mappings Use remote mappings
`advertise-local` `+ receive disable`	yes	Use local mappings Ignore remote mappings
`receive` `+ advertise-local`	yes	Use local mappings Use remote mappings

- "Compute Active Policy": which mappings are used in the Active Mapping Policy calculation?
  - "Local mappings": locally configured mappings
  - "Remote mappings": mappings received from remote Mapping Servers

Verifying locally configured prefix-to-SID mappings

```
RP/0/0/CPU0:xrvr-3#show segment-routing mapping-server prefix-sid-map ipv4
Prefix               SID Index    Range        Flags
20.1.1.0/24          400          300
10.1.1.1/32          10           200

Number of mapping entries: 2
RP/0/0/CPU0:xrvr-3#show segment-routing mapping-server prefix-sid-map ipv4    il
Prefix
20.1.1.0/24
    SID Index:       400
    Range:           300
    Last Prefix:     20.2.44.0/24
    Last SID Index: 699
    Flags:
10.1.1.1/32
    SID Index:       10
    Range:           200
    Last Prefix:     10.1.1.200/32
    Last SID Index: 209
    Flags:

Number of mapping entries: 2
```

Locally configured mappings

Mapping Server Advertisements

IS-IS Mapping Server Advertisements

- IS-IS advertises prefix-to-SID mappings in the SID/Label Binding TLV
  - The prefix-SID sub-TLV can be a sub-TLV of this TLV
- Each block of prefix-to-SID mappings is encoded in a separate TLV

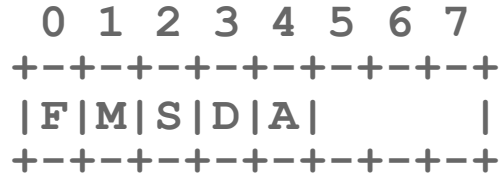
Verifying prefix-to-SID mappings advertisement – IS-IS

```
RP/0/0/CPU0:xrvr-2#show isis database verbose xrvr-3.00-00

IS-IS 1 (Level-2) Link State Database
LSPID                 LSP Seq Num  LSP Checksum  LSP Holdtime  ATT/P/OL
xrvr-3.00-00        * 0x00000195   0x5614        617               0/0/0

<...removed...>

 SID Binding:  10.1.1.1/32 F:0 M:0 S:0 D:0 A:0 Weight:0 Range:200
    SID: Start:10, Algorithm:0, R:0 N:0 P:0 E:0 V:0 L:0
 SID Binding:  20.1.1.0/24 F:0 M:0 S:0 D:0 A:0 Weight:0 Range:300
    SID: Start:400, Algorithm:0, R:0 N:0 P:0 E:0 V:0 L:0
```

Prefix-to-SID mapping TLV
Flag F:0 – IPv4

IS-IS SID/Label Binding TLV flags

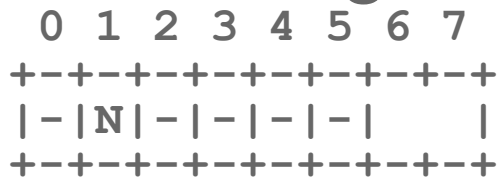
- IS-IS SID/Label Binding TLV has the following flags:



  - F: Address-Family, unset: IPv4, set: IPv6
  - M: Mirror Context, set if the SID/path corresponds to a mirrored context
  - S: Scope, if unset then TLV must not be propagated between leveks
  - D: Down, set if TLV is leaked from Level-2 to Level-1
  - A: Attached, set if prefixes and SIDs are directly connected to their originator

IS-IS Prefix-SID in MS TLV flags

- IS-IS Prefix-SID sub-TLV in the SID/Label Binding TLV may only use the N-flag:



  - N: Node-SID, set if the prefix-SID is a node-SID, i.e. identifies the node

OSPF Mapping Server Advertisements

- OSPF advertises prefix-to-SID mappings in a Extended Prefix (type 7) Opaque LSAs
- In the Extended Prefix Opaque LSA, the prefix-to-sid mappings are encoded in OSPF Extended Prefix Range TLV
  - The prefix-SID sub-TLV can be a sub-TLV of this TLV

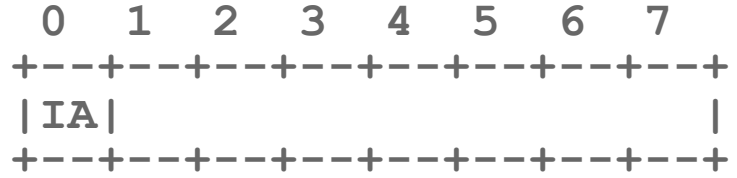
Verifying prefix-to-SID mappings advertisement – OSPF

```
RP/0/0/CPU0:xrvr-3#show ospf database opaque-area self-originate
<...>
  LS age: 910
  Options: (No TOS-capability, DC)
  LS Type: Opaque Area Link
  Link State ID: 7.0.0.5
  Opaque Type: 7
  Opaque ID: 5
  Advertising Router: 1.1.1.3
  LS Seq Number: 80000001
  Checksum: 0x7f0e
  Length: 48

    Extended Prefix Range TLV: Length: 24
      AF        : 0
      Prefix    : 10.1.1.1/32
      Range Size: 200
      Flags     : 0x0

      SID sub-TLV: Length: 8
        Flags     : 0x60
        MTID      : 0
        Algo      : 0
        SID Index : 10
```

Prefix-to-SID mapping

OSPF Extended Prefix Range TLV flags

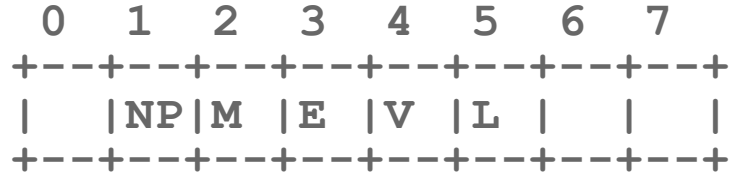
- OSPF Extended Prefix Range TLVs have the following flags:



  - IA: Inter-Area, set if advertisement is of inter-area type, used to prevent redundant flooding between areas

OSPF Prefix-SID sub-TLV flags

- OSPF Prefix-SID sub-TLVs have the following flags:



  - NP: no-PHP, set if the penultimate hop must NOT pop the prefix-SID before forwarding the packet
  - M: Mapping Server, set if the SID is advertised from the Mapping Server functionality
  - E: Explicit-Null, set if penultimate hop must replace prefix-SID with Explicit-Null label
  - V: Value, set if prefix-SID carries a value (not an index) – IOS XR: always unset
  - L: Local, set if prefix-SID has local significance – IOS XR: always unset

Multiple Mapping Servers

Multiple Mapping Servers

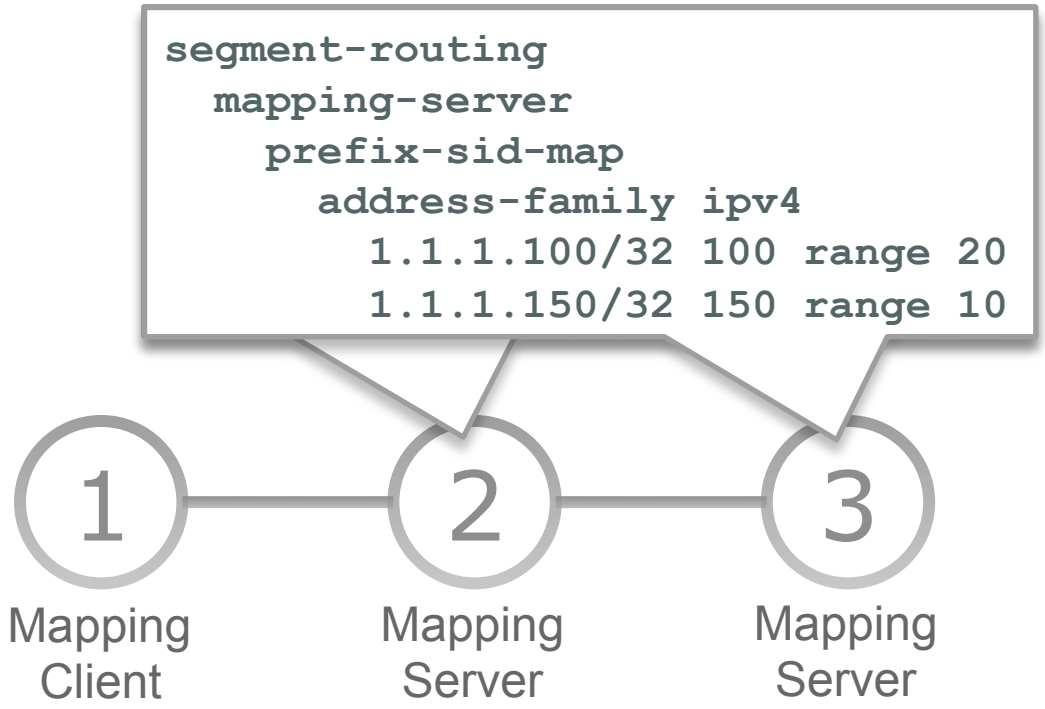
- Two or more mapping servers advertise a set of prefix-SID mappings
- It is expected that these sets are equal for all mapping servers
  - If not, a set of non-overlapping entries is selected as Active Policy
  - Other mapping entries end up in the Backup Policy
- Consistent prefix-SID mapping required throughout the network
  - The Active Policy is guaranteed to be the same on all nodes receiving the mappings

Mapping entry preference

- If a Mapping Client receives two or more overlapping mapping ranges, it selects one of the ranges based on these preference rules:
  1. Largest router-id (OSPF) or system-id (ISIS) is preferred
  2. Smallest area-id (OSPF) or level (ISIS) is preferred
  3. IPv4 range is preferred over IPv6 range
  4. Smallest prefix length is preferred
  5. Smallest IP address is preferred
  6. Smallest SID index is preferred
  7. Smallest range is preferred
  8. First received range is preferred
- This will change in the future, based on the evolution of the draft-ietf-spring-conflict-resolution at the IETF

Multiple Mapping Servers – Example

- Two mapping servers (node2 and node3) advertise a set of prefix-SID mappings
- Mapping client (node1) receives the mappings from both mapping servers
- Mapping client selects a non-overlapping set as Active Policy
  - Based on largest OSPF router-id or ISIS system-id in this example



Verifying active and backup prefix-to-SID mappings – IS-IS

```
RP/0/0/CPU0:xrvr-1#sh isis segment-routing prefix-sid-map active-policy

IS-IS 1 active policy
Prefix                SID Index    Range        Flags
1.1.1.100/32          100          20
1.1.1.150/32          150          10

Number of mapping entries: 2
```

Active mapping policy

```
RP/0/0/CPU0:xrvr-1#sh isis segment-routing prefix-sid-map backup-policy

IS-IS 1 backup policy
Prefix                SID Index    Range        Flags
1.1.1.100/32          100          20
1.1.1.150/32          150          10

Number of mapping entries: 2
```

Backup mapping policy

Verifying active and backup prefix-to-SID mappings – OSPF

```
RP/0/0/CPU0:xrvr-1#sh ospf segment-routing prefix-sid-map active-policy

        SRMS active policy for Process ID 1

Prefix               SID Index    Range        Flags
1.1.1.100/32         100          20
1.1.1.150/32         150          10

Number of mapping entries: 2
```

Active mapping policy

```
RP/0/0/CPU0:xrvr-1#sh ospf segment-routing prefix-sid-map backup-policy

        SRMS backup policy for Process ID 1

Prefix               SID Index    Range        Flags
1.1.1.100/32         100          20
1.1.1.150/32         150          10

Number of mapping entries: 2
```

Backup mapping policy

Prefix-SID Preference

Using which Prefix-SID?

- The prefix-SID received via a “regular” advertisement is preferred
  - IS-IS Prefix-SID sub TLV
  - OSPF Extended Prefix Opaque LSA
- The prefix-SID advertised by a mapping server is used as a last resort
  - If no “regular” prefix-SID is available for a prefix

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