# A First Look at Segment Routing Deployment in a large European IXP


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## ABSTRACT


- **First attempt** to reveal **deployment and usage of Segment Routing (SR) with MPLS** as forwarding plane.
- Longitudinal study from 2018 to 2022.
- Vodafone Germany (ASN 3209).
- **Early results:** SR-MPLS is mainly used in **interworking** with classic MPLS tunnels.


## SEGMENT ROUTING

- Segment Routing (SR) is a loose **source routing** paradigm based on an **ordered list of segments**, i.e., one or more **forwarding instructions.**
- SR can be used for network monitoring, traffic engineering, failure recovery, and much more.
- SR proposes two forwarding plane encapsulations: Extension Headers for IPv6 and **MPLS.**

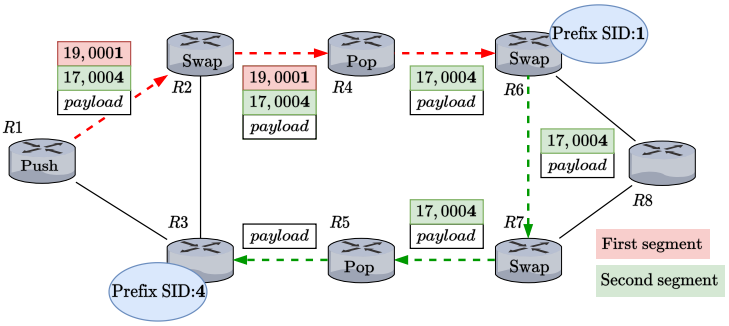


*Fig 1: SR-MPLS operations example (Node Segments)*

*Fig 1*

### SR-MPLS in a nutshell:

- A **Node Segment** represents the **IGP least cost path** between any router and a specified prefix.
- Each segment is identified by a **unique Segment Identifier (SID)**, implemented as an MPLS label.
- **Node Segment labels** are allocated from the SR Global Block **(SRGB)**, a range of labels **used solely for SR.**
- In Fig 1, R1 pushes into the packet a **label stack with two labels**: the outer one representing the node segment to R6, and the inner one representing the node segment to R3.

## IDENTIFYING SEGMENT ROUTING

- The **MPLS** label stack is **quoted in the ICMP time-exceeded message** (only visible for **explicit tunnels**, as opposed to opaque, invisible, and implicit tunnels).
- Recommendation by Cisco is to use **label range 16,000 to 23,999 for SRGB.**
- **Preliminary identification** based on the observation of this range of values in MPLS labels.
- Our results present a **lower bound on SR deployment**: visibility limited to node segments, for explicit tunnels, for Cisco hardware.

## PRELIMINARY RESULTS

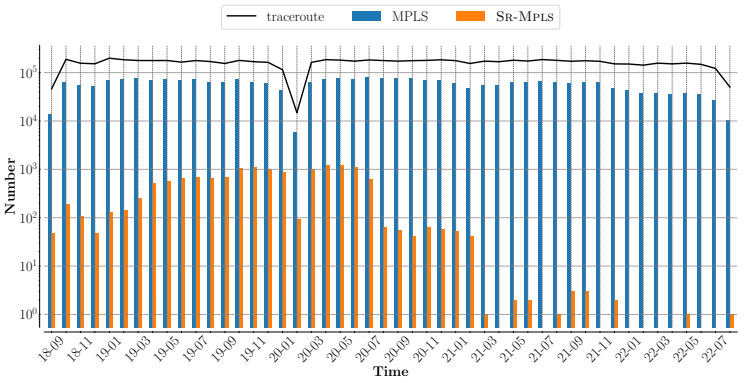


*Fig 2: SR-MPLS deployment in Vodafone*

*Fig 2*

- More MPLS tunnels than SR-MPLS tunnels.
- After mid-2020, drop in the number of SR-MPLS tunnels by 90%.
- Speculation: Vodafone is transitioning to use invisible tunnels.

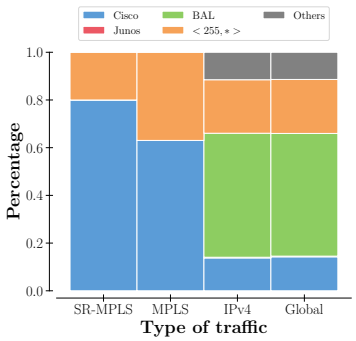


*Fig 3: Hardware distribution*

*Fig 3*

- In 80% of the cases, IP addresses corresponding to SR-MPLS also correspond to Cisco devices.
- Consistent with our assumptions for identifying SR.

*Interworking*

- 90% of the traces only present a single SR hop along the path.
- 93% of the time, that SR hop actually belongs to a longer MPLS tunnel.
- This suggests that SR-MPLS may be used in **interworking with classic MPLS deployment**, with a Mapping Server (incremental deployment).

## FUTURE WORK

- **Extend study** to other ASes.
- Seek **validation** of our inferences from network operators.