Technical Disclosure Commons

Defensive Publications Series

September 07, 2018

TABLE FREE FORWARDING FOR INTERNET PROTOCOL VERSION 6 SEGMENT ROUTING

Arul Murugan Manickam

Julian Soosaimanickam Simon

Vinod Chandran

Follow this and additional works at: https://www.tdcommons.org/dpubs_series

Recommended Citation

TABLE FREE FORWARDING FOR INTERNET PROTOCOL VERSION 6 SEGMENT ROUTING

AUTHORS:
Arul Murugan Manickam
Julian Soosaimanickam Simon
Vinod Chandran

ABSTRACT

Techniques are described herein to forward IPv6 packets without performing table lookup using IPv6 Segment Routing (SRv6). The forwarding pipeline may forward the packet without performing route lookup by parsing the IPv6 Segment Identifier (SID) from the Segment Routing Header (SRH). The next-hop Media Access Control (MAC) address, outgoing interface and outgoing Virtual Local Area Network (VLAN) may be embedded as part of the SID.

DETAILED DESCRIPTION

Recent advances in Software Define Networking (SDN) brings more intelligence to the centralized network controller than network switches/routers. Industry trends toward SDN adoption is continuously increasing. Network switches participating in SDN may have less intelligence because the network controller defines and programs the forwarding rules directly to the switch. With Segment Routing (SR) solutions, the centralized network controller defines a packet forwarding path and programs the network switch to forward/select a path for a given destination. Techniques described herein remove the Internet Protocol version 6 (IPv6) table lookup (especially route and adjacency), which reduces switch packet processing latency, minimizes forwarding dependency on switch intelligence, and provides efficient packet forwarding in IPv6 based Segment Routing (SRv6).

The following are key data required to forward a Layer 3 (L3) packet: destination Media Access Control (MAC) address, outgoing interface, and outgoing Virtual Local Area Network (VLAN) and re-written source MAC address. The source MAC address may be a switch's local MAC address. A forwarding engine may derive the destination MAC address, outgoing interface, and outgoing VLAN from the destination IPv6 address to forward a packet. To obtain the above-mentioned data, the forwarding engine processes

various tables while forwarding a packet. SRv6 forwarding also occurs in a similar way. In the specific case of SRv6 routes, the lookup is performed for the next Segment Identifier (SID). The SRv6 Segment Routing Header (SRH), which carries a list of SIDs that need to be traversed to reach the destination, is described at https://tools.ietf.org/html/draft-ietf-6man-segment-routing-header-07.

The SID (IPv6 address) may be formatted in such a way that the route lookup can be avoided to forward a packet. Figure 1 below illustrates how the format is specified. The locator may be an SRv6 locator ID. The function ID may be an SRv6 Function ID. The VLAN may be the outgoing interface tag value, which is mainly used for L3 sub-interface and VLAN trunk cases. The Out-Interface may be the outgoing interface ID (i.e., Port ID, Local Target Logic (LTL), etc.). The Next-HOP-MAC may be the next hop device MAC address.
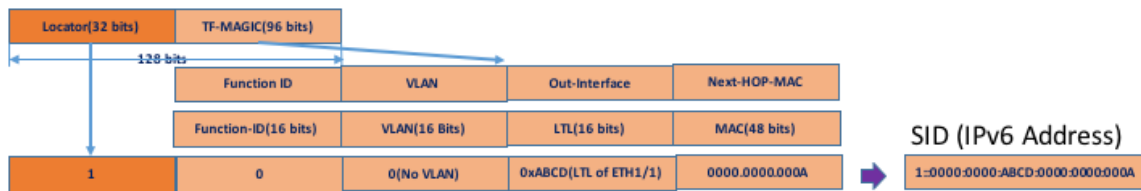

Figure 1

Figure 2 below illustrates an example network. Host H1 is connected to Router R1 and Host H2 is connected with Router R4. In this case the Router R1 adds the SRH with Router R2's and Router R3.A's SID while sending traffic to Host H2. Routers R2 and R3.A are SRv6 aware intermediate routers, which will forward the traffic based on the next SID.
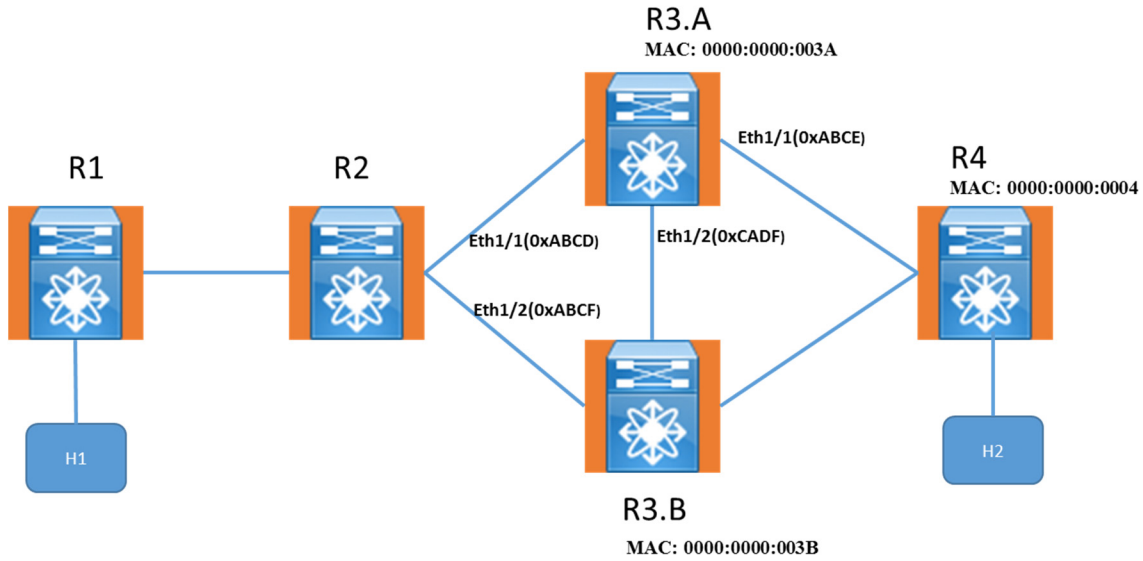
2   5671

Figure 2

Figure 3 below illustrates the construction of the SID for Routers R2 and R3. Router R1 includes {1::0:0:ABCD:0000:0000:003A, 2::0:ABCE:0000:0000:0004} as part of the SRH and forwards the packet toward Router R2. When the packet is received on Router R2, parsing the next SID "1::0:0:ABCD:0000:0000:003A" will provide the next hop destination MAC (0000.0000.0003A), outgoing interface (0xABCD), and outgoing VLAN (0). With these parameters, the packet may be forwarded to the next hop Router R3.A. Router R3.A also performs similar processing to forward the packet to Router R4. This approach avoids the route lookup at Routers R2 and R3.A for efficient forwarding. The SID list may be provided by a network controller to Router R1, so that Routers R2 and R3.A are built with less intelligence (i.e., just parse and forward the packet using the next SID).
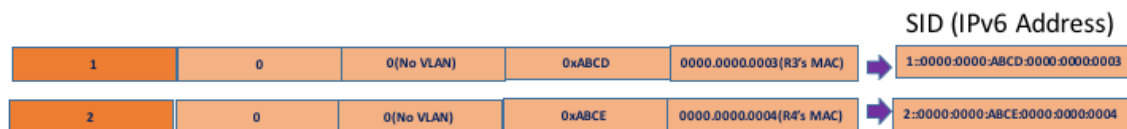

Figure 3

Figure 4 below illustrates the current forwarding behavior. Here, Host H1 sends traffic to Host H2. The Router R1 inserts the SRH {1::2, 1::3a, 1::4, 1::5}, which defines the path to Host H2. Intermediate routers such as Routers R2, R3.a, and R4 forward the

3   5671

packet based on the next segment pointer from the SRH. A route lookup is performed using the next segment and the packet is forwarded by changing the next segment pointer.
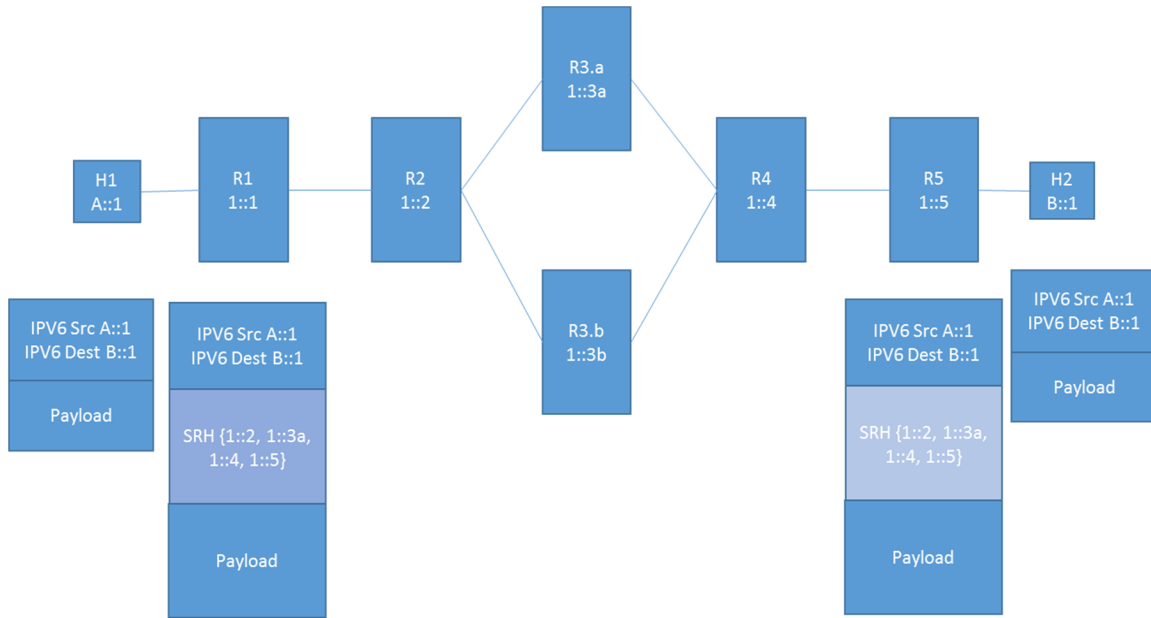

Figure 4

Figures 5 and 6 below illustrate techniques described herein. As shown in Figure 5, Table Free (TF) magic values are embedded in the IPv6 address (i.e., SID). The TF magic value may include information about the function ID, next hop MAC address, outgoing interface and VLAN. To forward a packet, the next-hop MAC address, outgoing interface, and VLAN may be mandatory. These values may be parsed and fetched from the next SID in the SRH.
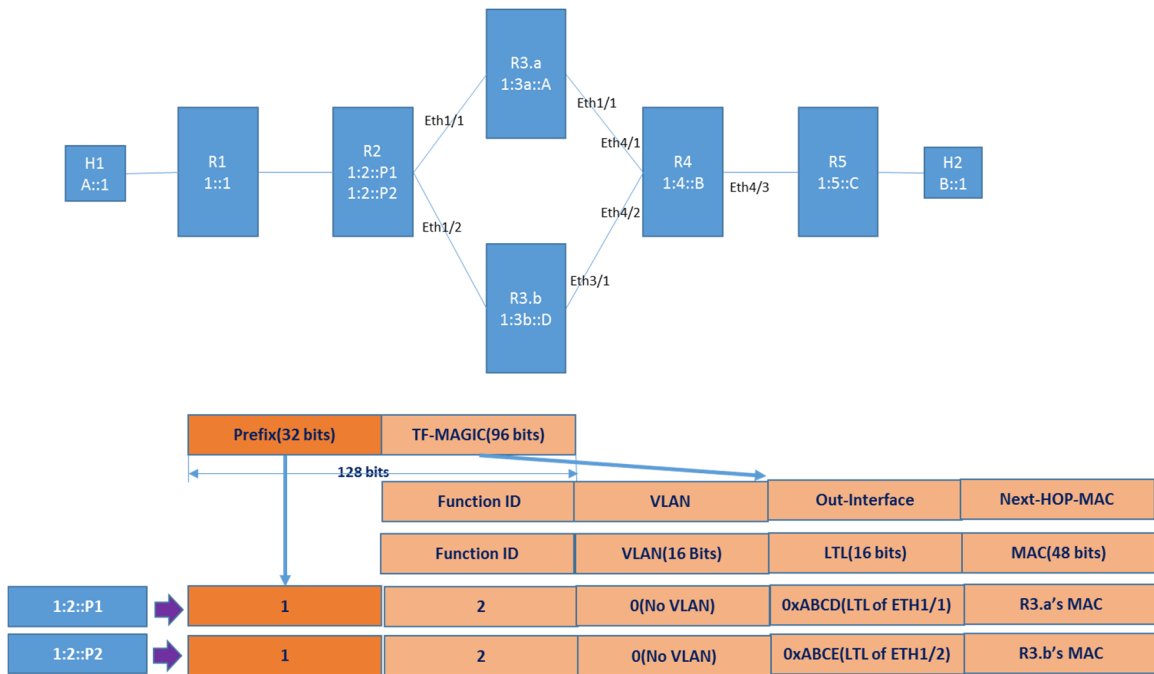
4

5671

Figure 5

As shown in Figure 6, Host H1 sends traffic to Host H2. Router R1 inserts SRH {1:2::P1, 1:3a:A, 1:4::B, 1:5:C}. Router R2 examines 1:2::P1. P1 is identified as the next hop MAC address, VLAN, and Port ID to which the packet should be forwarded. Router R2 fetches the VLAN, Port ID and next-hop MAC address from current SID to forward the packet. Thus using the segment TF magic value, table lookup may be avoided in packet forwarding.
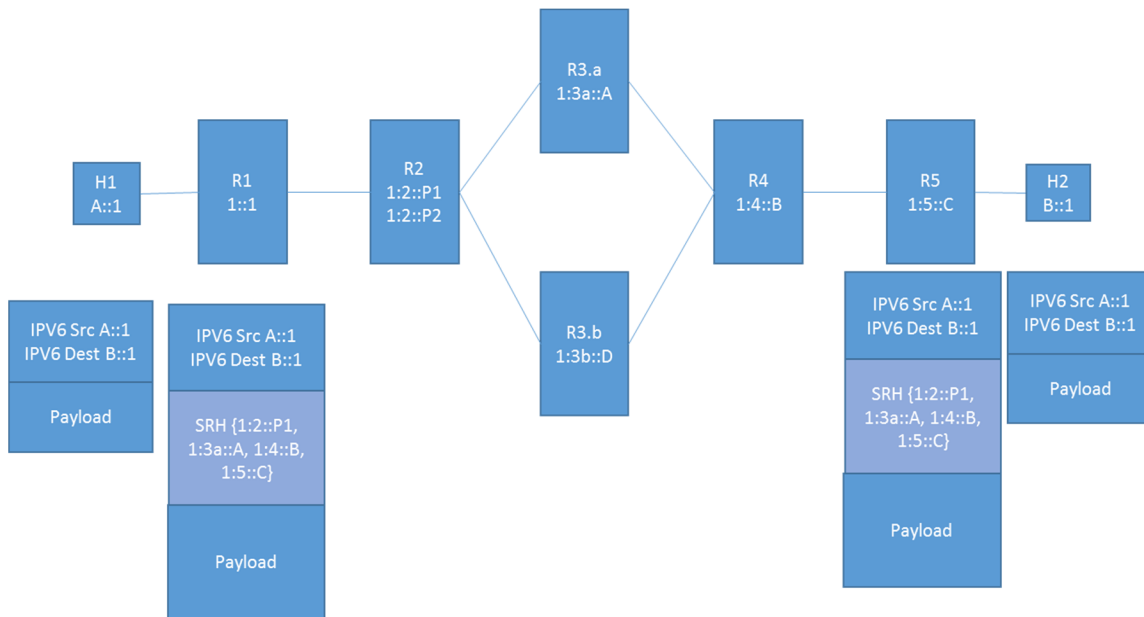

Figure 6

5

5671

Figures 7-10 below illustrate packet forwarding on a Layer 3 interface. As shown in Figure 7, Host H1 generates traffic to Host H2. Router R1 inserts the SRH to use the path including R2, R3.A, R4 and R5 and sends the packet to Router R2.
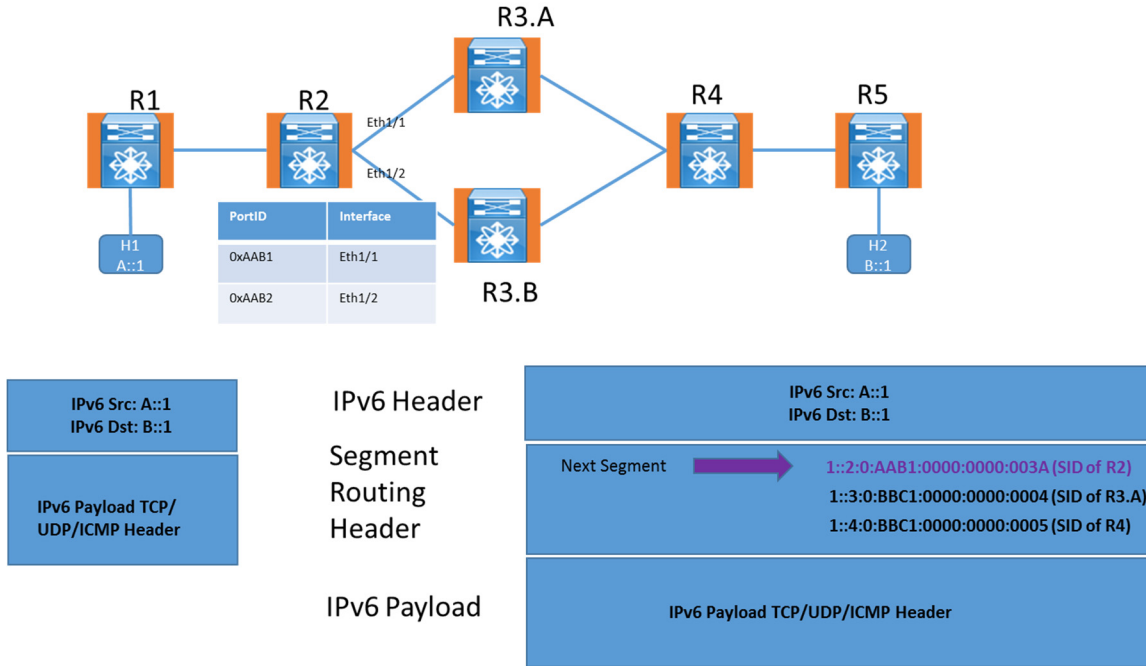

Figure 7

As shown in Figure 8, Router R2 receives the traffic from Router R1. Router R2 parses the next SID to obtain the VLAN, Port ID (outgoing interface) and next hop MAC address. The source MAC address (derived from the local switch) and destination MAC address (i.e., derived from the SID) are rewritten and sent via the outgoing interface (derived from SID). For L3 sub-interfaces/L2 interfaces, VLAN tagging is performed using the VLAN derived from SID.
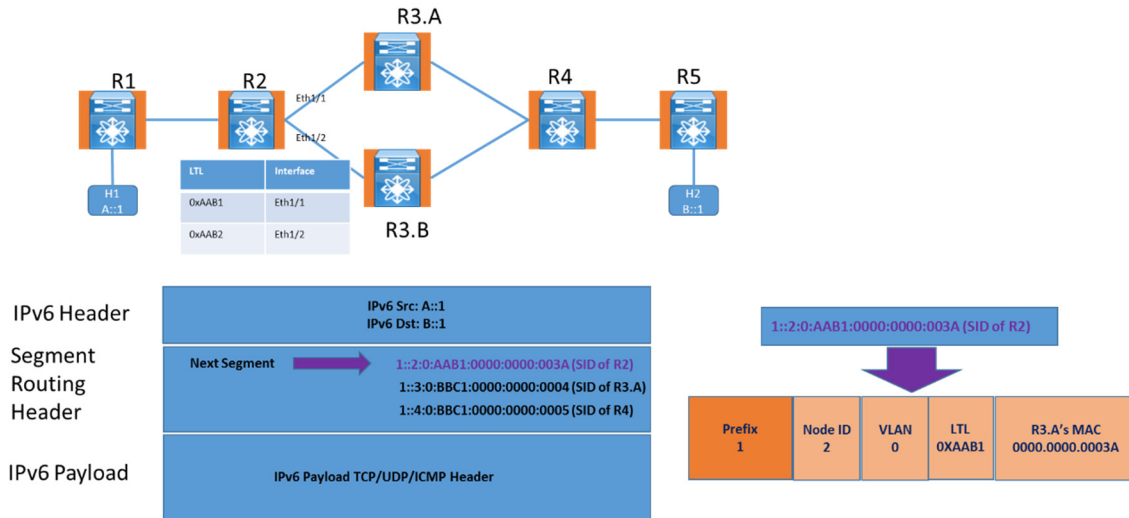
6   5671

Figure 8

As shown in Figure 9, the packet is received by Router R3.A. Router R3.A forwards the packet by parsing the next SID from the path list.
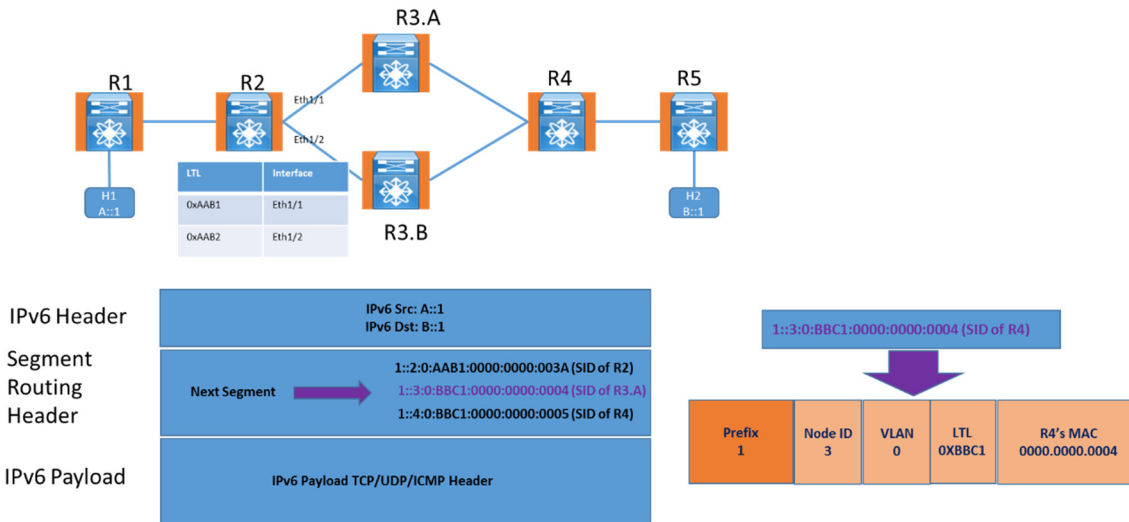

Figure 9

As shown in Figure 10, the packet is received by Router R4. Router R4 forwards the packet by parsing the next SID from the path list. Router R5 forwards the traffic to end Host H2.
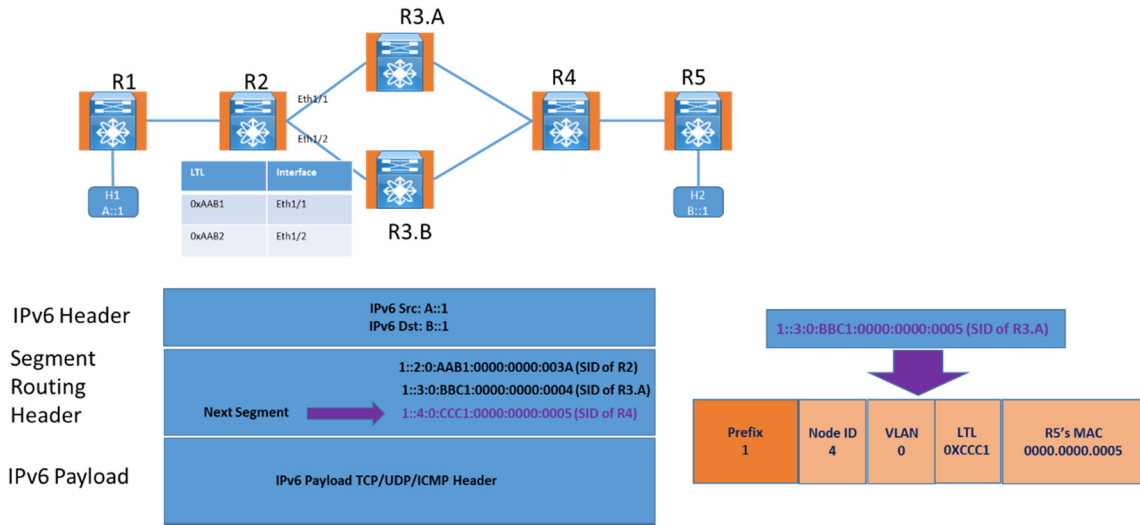
7   5671

Figure 10

In summary, techniques are described herein to perform table free packet forwarding using IPv6 SID. The next-hop MAC address, outgoing interface and outgoing VLAN may be embedded as part of the SID. The forwarding pipeline may forward the packet without performing switch table lookup by parsing the SID from the SRH.

8   5671