TECHNISCHE UNIVERSITÄT BERLIN
Fakultät IV – Elektrotechnik und Informatik
Fachgebiet INET
Prof. Dr. Stefan Schmid

7th Assignment Network Protocols and Architectures, WS 25/26

Question 1: (10 + 10 + 10 + 5 + 10 + 5 + 5 + 5 + 20 + 10 + 5 + 5 = 100 points) *IPv6 Segment Routing*

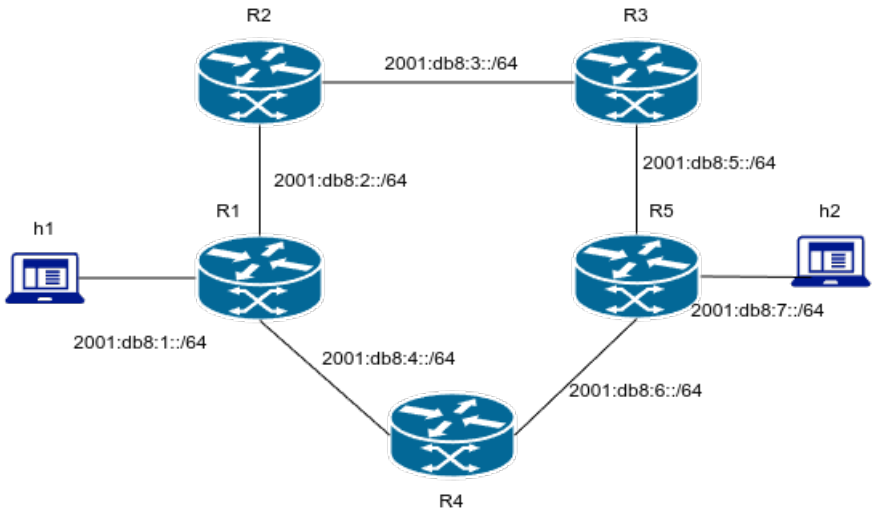

Figure 1: Topology

Objective: In this exercise you will create the network shown in Figure 1 using Linux network namespaces and configure SRv6 routes so that:

- Packets entering the network at R1 destined to 2001:db8:7::/64 are forwarded along R1 → R2 → R3 → R5 then to destination host H2.
- Packets entering at R5 destined to 2001:db8:1::/64 are forwarded along R5 → R4 → R1 then to destination host H1.

Verify the forwarding behaviour by sending ICMPv6 echo requests from H1 to H2 and checking that the request and reply traverse the expected SRv6 paths. You need to submit one bash script, which implements the following tasks. **Add comments to your script to clearly indicate which sections of code correspond to each sub-task.** It is recommended to do this exercise within a VM.

(a) Create a network namespace for each device shown in Figure 1 (H1, R1, R2, R3, R4, R5, H2). See ip-netns.

You may choose your own namespace names if you prefer, but you must include a comment in your script clearly showing the mapping between the figure's device names and the names you used.

(b) Create the network links shown in Figure 1 and assign each link endpoint to the appropriate namespace. See ip-link.

(c) Assign IPv6 addresses to all interfaces according to the subnets shown in Figure 1.

(d) Configure a default IPv6 route for the hosts H1 and H2 to define the next hop toward the network. See ip-address.

(e) Assign a Segment Identifier (SID) to the loopback interface of each router. This works by just adding an IP address to the loopback interface. The SID should follow the scheme:

`fc00:<Router-ID>::1/128`

(f) On each router, define a route for every SID that is reachable from that router. See ip-route.

(g) Enable SRv6 and IPv6 forwarding on each router using sysctl.

(h) Define a routing rule on each router to handle packets whose destination matches the router's SID (End action). See ip-route. (Hint: Look for `encap seg6local`)

(i) Configure SRv6 routes on R1 and R5 to steer traffic along specific paths, so that on R1 packets destined to 2001:db8:7::/64 follow the path R1 → R2 → R3 → R5, and on R5 packets destined to 2001:db8:1::/64 follow the path R5 → R4 → R1. These routes should be implemented using SRv6 encapsulation with the SIDs of the intermediate routers in the Segment Routing Header. See ip-route. (Hint: Look for `encap seg6`)

(j) Test your implementation by sending ICMPv6 echo requests from H1 to H2 using the command `ip netns exec H1 ping6 -c 5 <H2_IPv6_address>`. This will verify that packets are correctly routed through the configured SRv6 paths and that the return path from H2 to H1 is functioning as expected.

(k) Capture traffic on each router interface using `tcpdump` to verify that packets are following the expected SRv6 paths. Run the capture inside each router's network namespace to monitor all relevant interfaces.

(l) Use `tshark` to analyze the packet captures. Verify that the ICMPv6 echo requests traverse only through `R2` and `R3`, and that the echo replies traverse only through `R4`, consistent with the configured SRv6 paths. Your script should print "Ok" if everything worked as expected.

Due Date: Sunday, 07.12.2025, 23:59 pm

- **Upload your solutions as a** `[group-name]-npa-07.sh` via ISIS: https://isis.tu-berlin.de/course/view.php?id=44909
- Submit in groups of 4 and put the names and Student ID numbers (Matrikelnummer) of **all** your group members on your solution!
- Only one student per group needs to upload the solution.