



Final Project

VLAN-based Segment Routing

Deadline: 2022/01/12 (WED) 23:59



Outline

- Review of Labs
- Segment Routing
 - IP Routing
 - Workflow of Segment Routing
 - Node Segment
- Final Project
 - Overview
 - Workflow
 - Requirements



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Review of Labs

- Lab 4 - Unicast DHCP Application
 - Installing flow rules
 - Routing packets with global view of network
 - Configuring controller
 - Lab 5 – Proxy ARP
 - Constructing packets and sending directly to switches
- Note: All of these labs would be used in final project



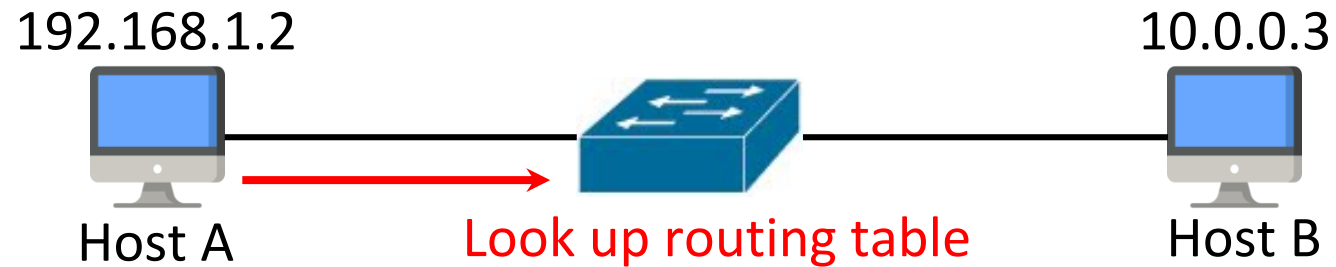
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IP Routing

- Network devices route packets with IP address
 - Maintain routing information on each device
 - Look up IP table when packets arrive
- Determine paths while forwarding packets





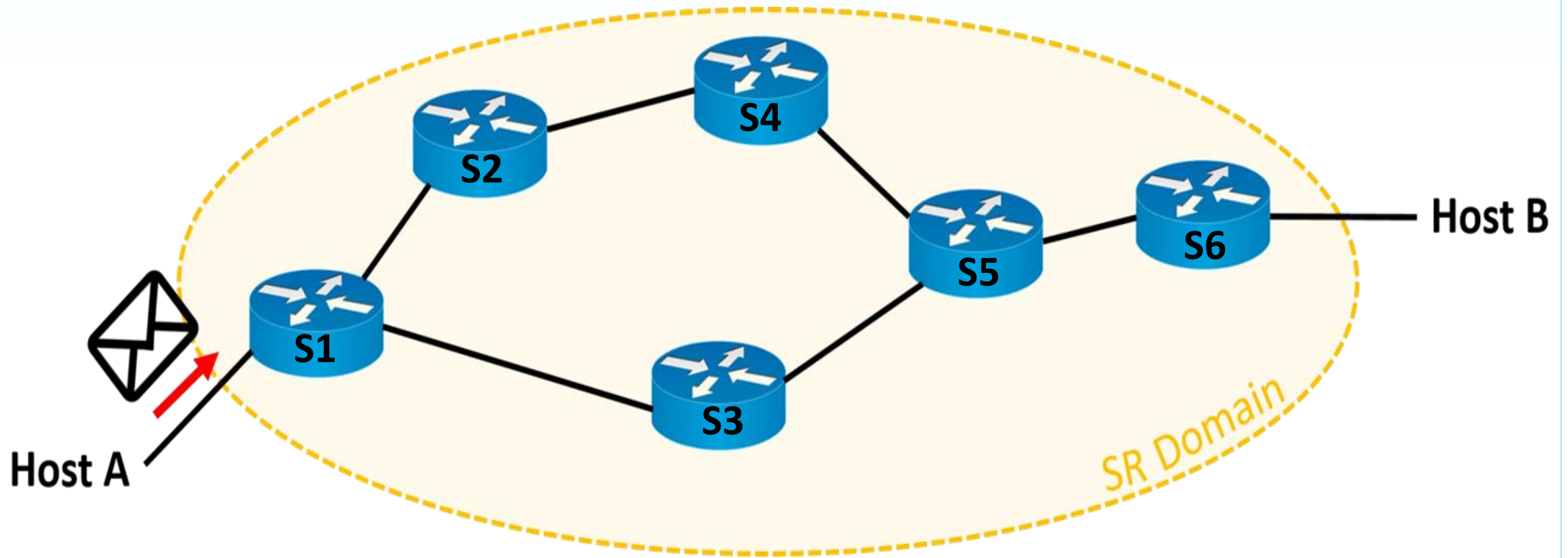
Segment Routing (SR)

- Use **label (segment) switching** instead of IP address
- Sender (or ingress node) of packets specifies **routes** of packets
- Features:
 - **Sender**
 - **Choose a path**
 - **Encode it in the packet header as an ordered list of segments**
 - **The rest of network devices**
 - **Execute the encoded instructions (labels)**
 - i.e., forwarding



Segment Routing – Workflow (1/9)

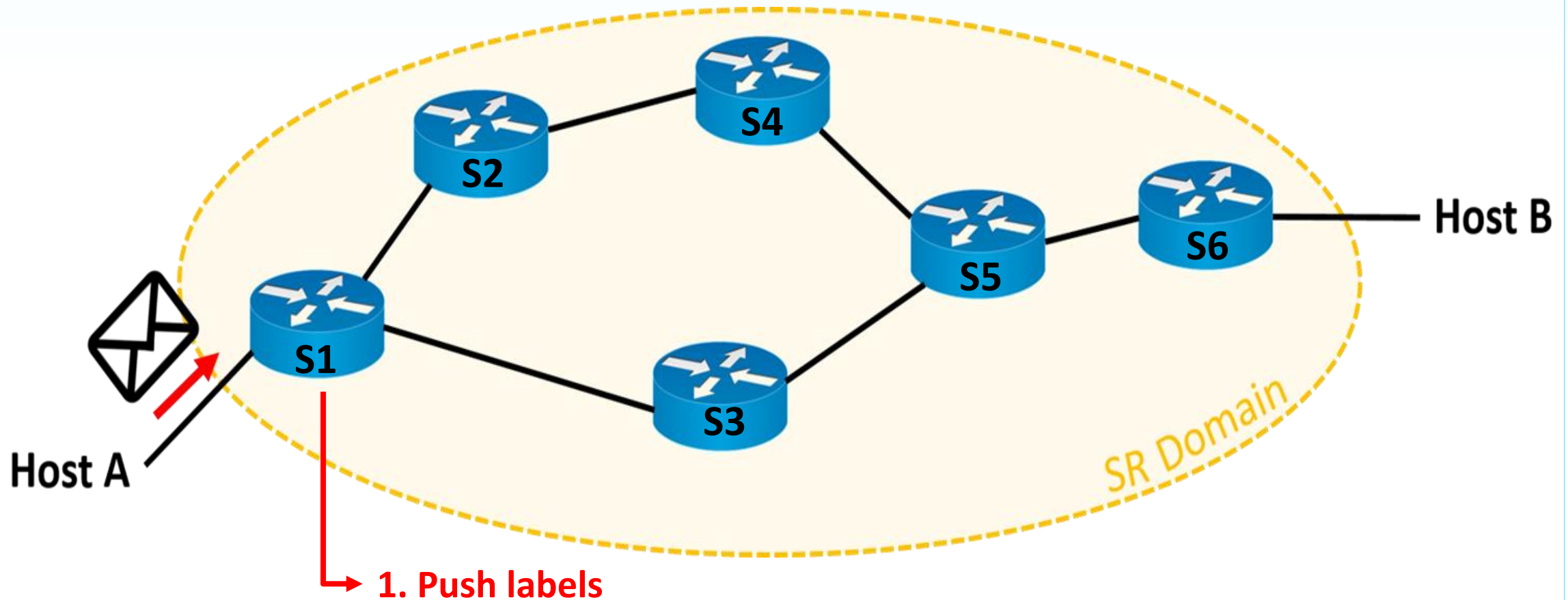
- Host A sends packet to Host B





Segment Routing – Workflow (2/9)

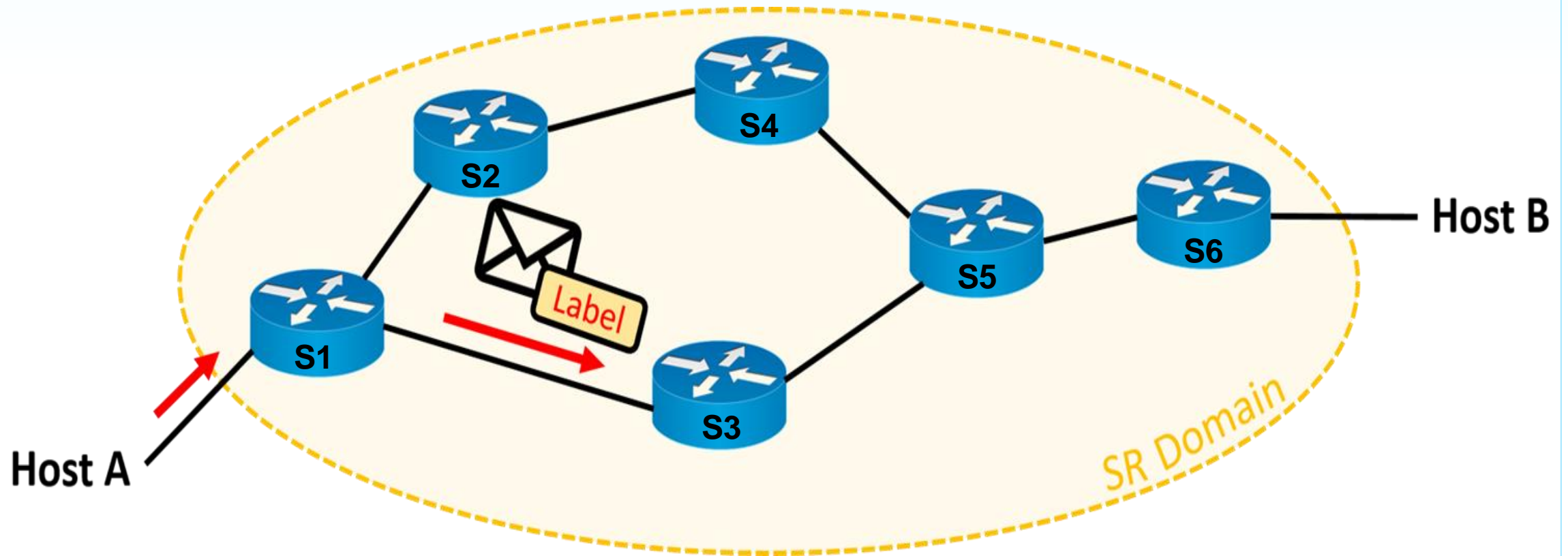
- The edge switch S1 pushes the label of destination device S6





Segment Routing – Workflow (3/9)

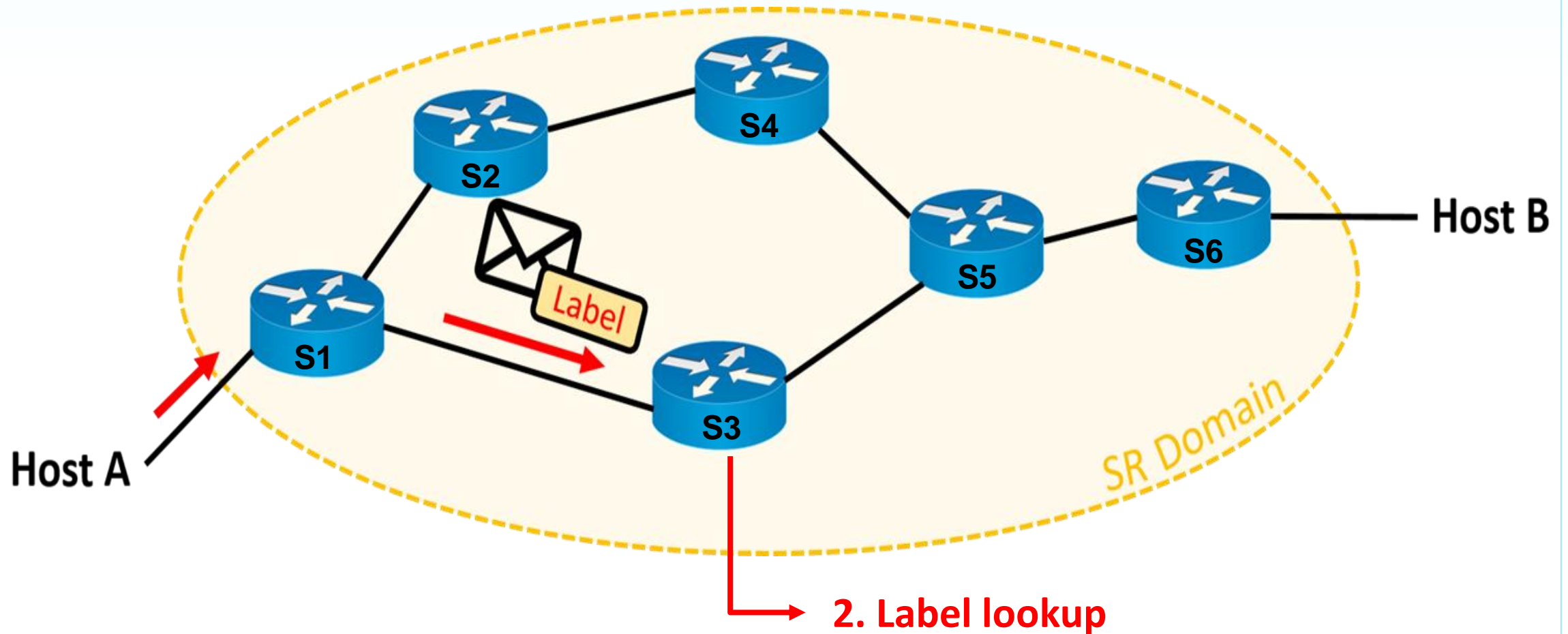
- The edge switch S1 forwards packet with label





Segment Routing – Workflow (4/9)

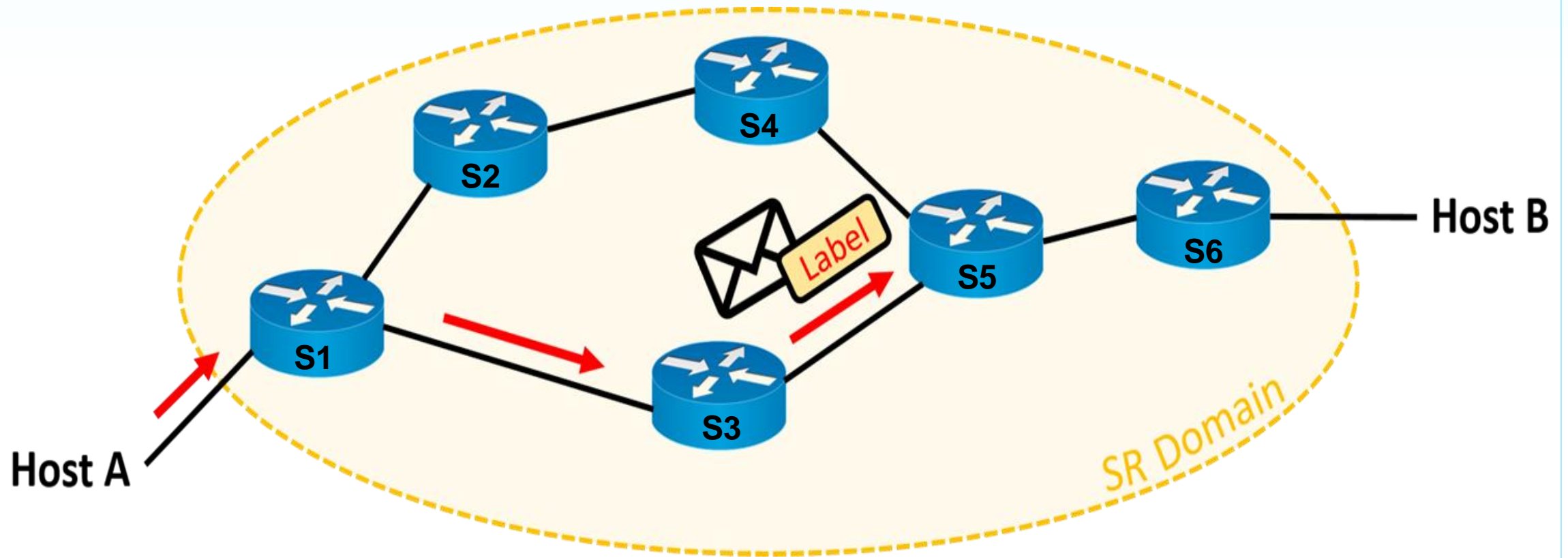
- Switch S3 receives packet with label and lookups flow table





Segment Routing – Workflow (5/9)

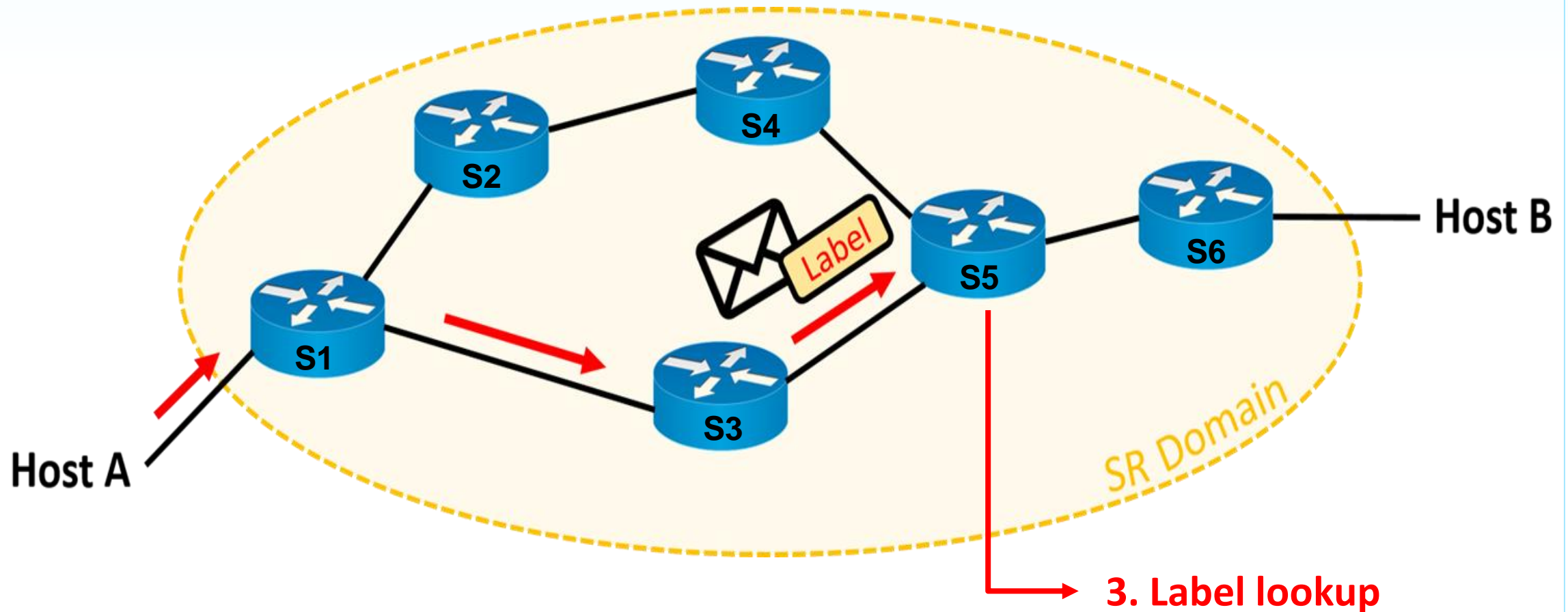
- Switch S3 forwards packet with label





Segment Routing – Workflow (6/9)

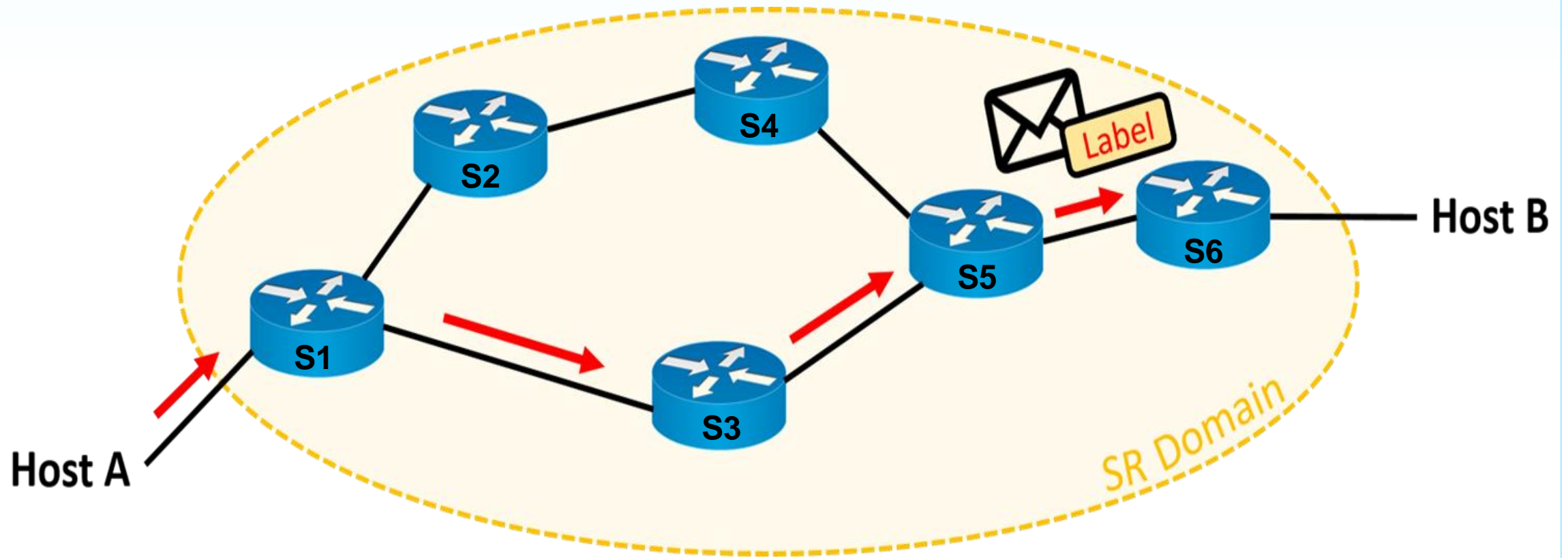
- Switch S5 receives packet with label and lookups flow table





Segment Routing – Workflow (7/9)

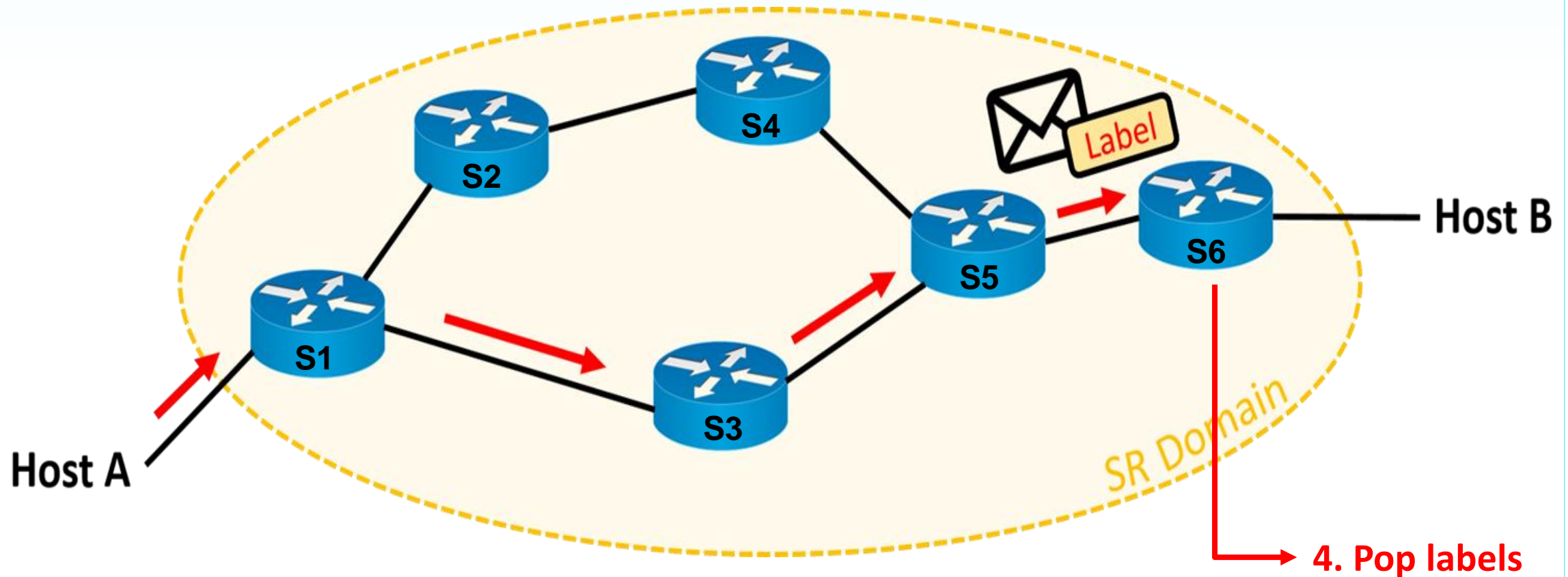
- Switch S5 forwards packet with label





Segment Routing – Workflow (8/9)

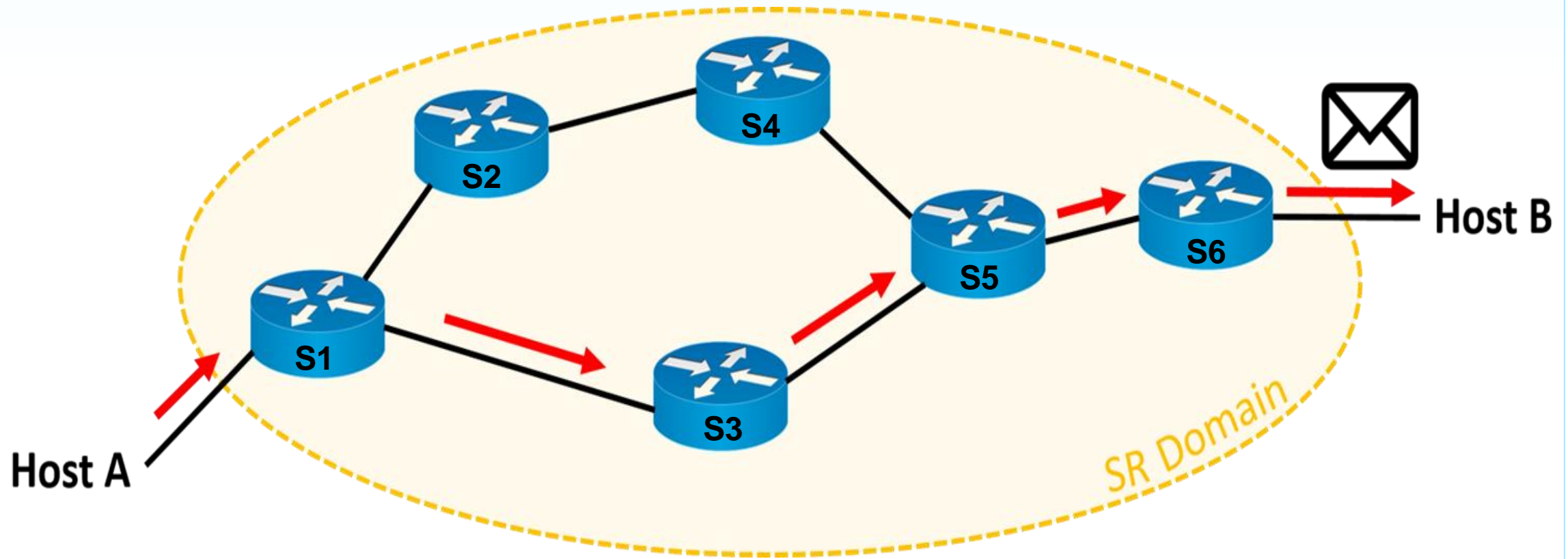
- Switch S6 receives packet with label and pops label





Segment Routing – Workflow (9/9)

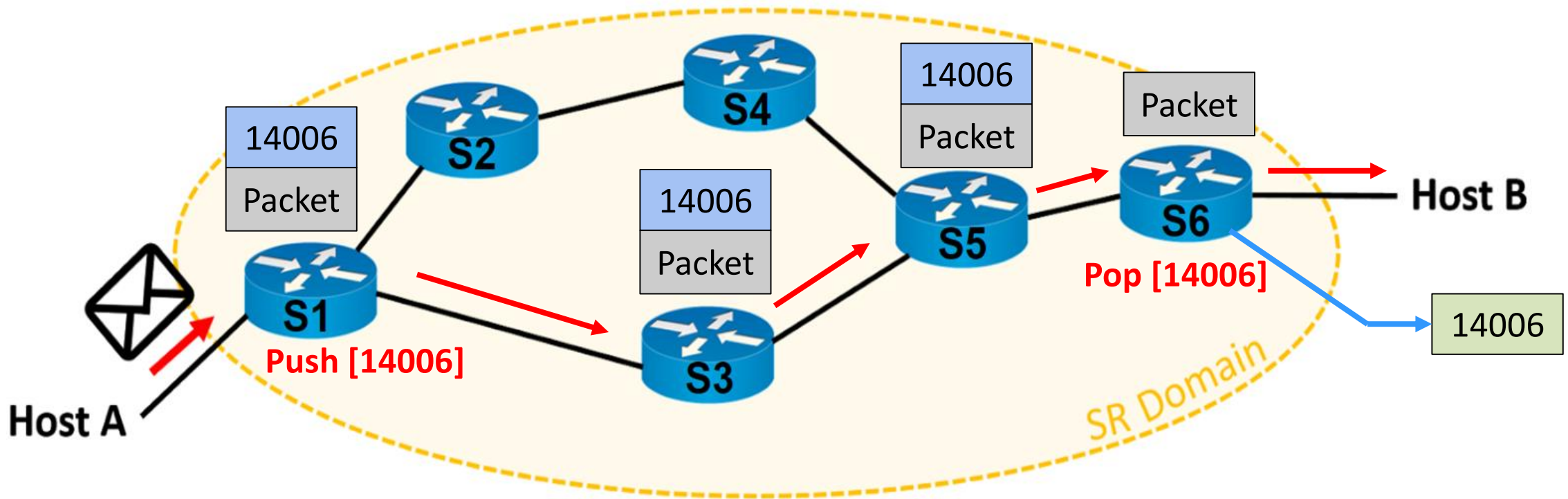
- Switch S6 forwards the original packet to Host B





Node Segment

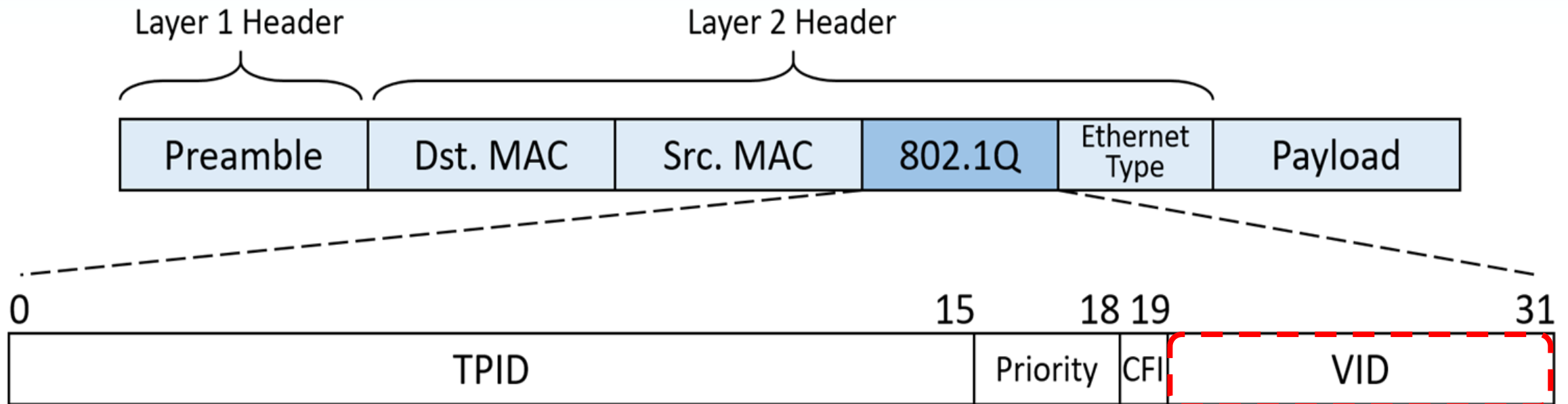
- Node segment ID is globally unique within a SR domain
- Typically multi-hop
 - Shortest-path first (SPF) route to designated node





VLAN

- Segment routing uses labels to route packets
- We will use **VID** field in VLAN (802.1Q) header as label



TPID: Tag protocol identifier (0x8100)
CFI: Canonical Format Indicator
VID: VLAN Identifier



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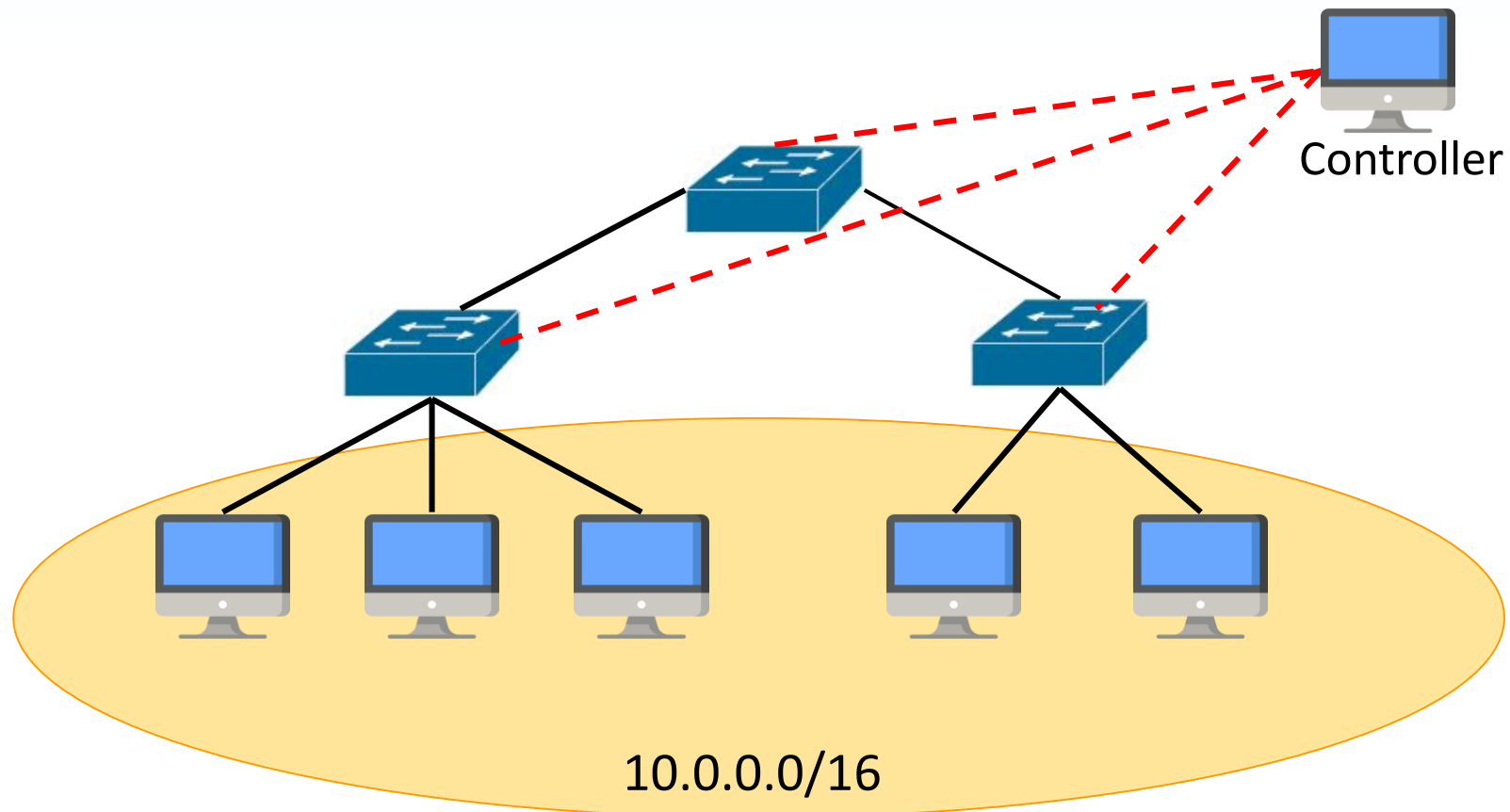
Overview

- You need to implement an VLAN-based segment routing app
 - Configure network
 - DHCP server location,
 - segment ID for each switch, and
 - subnet attached to edge switches
 - Compute path to each edge switches
 - Install flow rules to forward packets



Configure Network – in Mininet

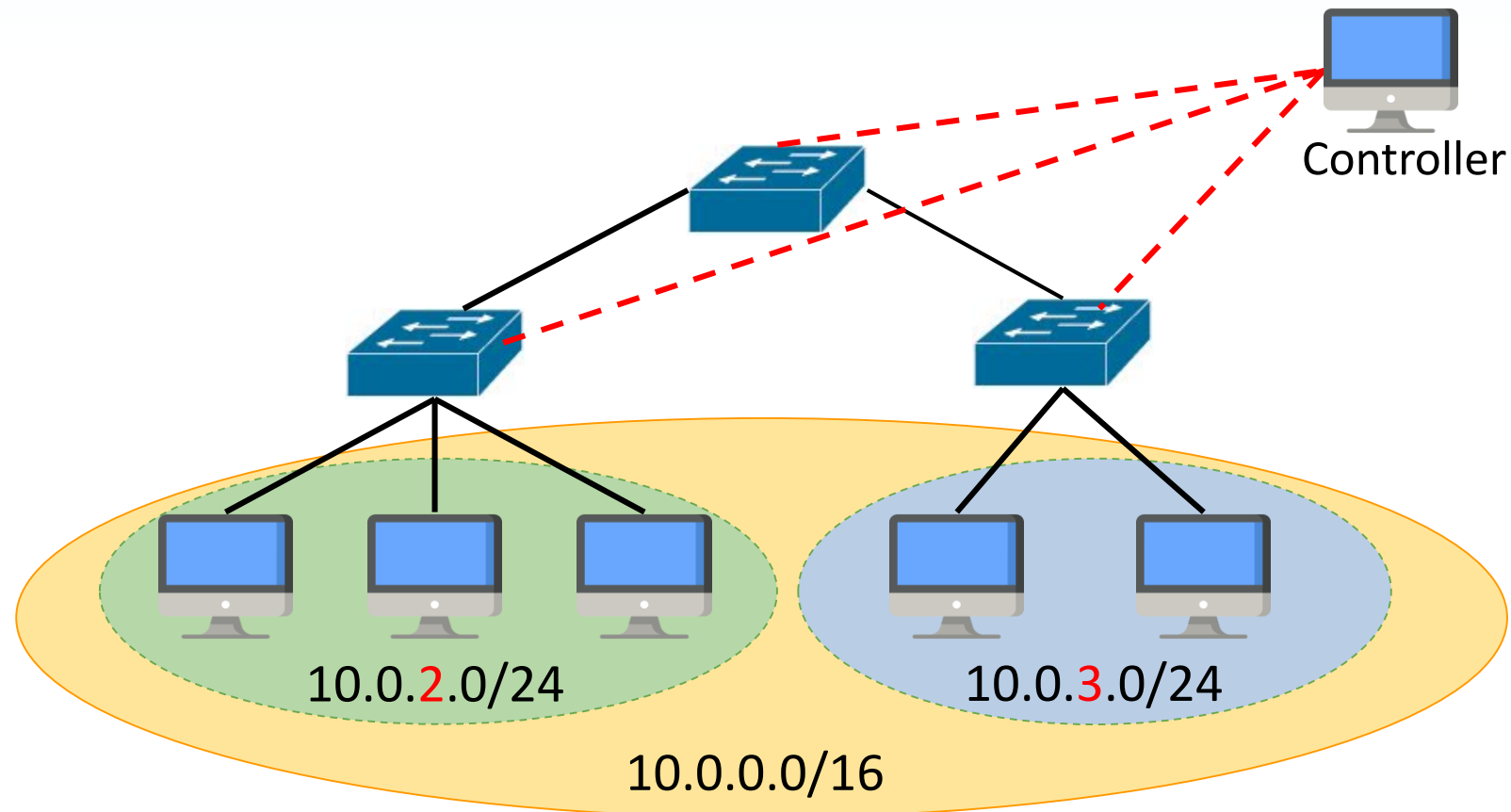
- Mininet topology
 - Hosts are configured under the same subnet





Configure Network – for Controller

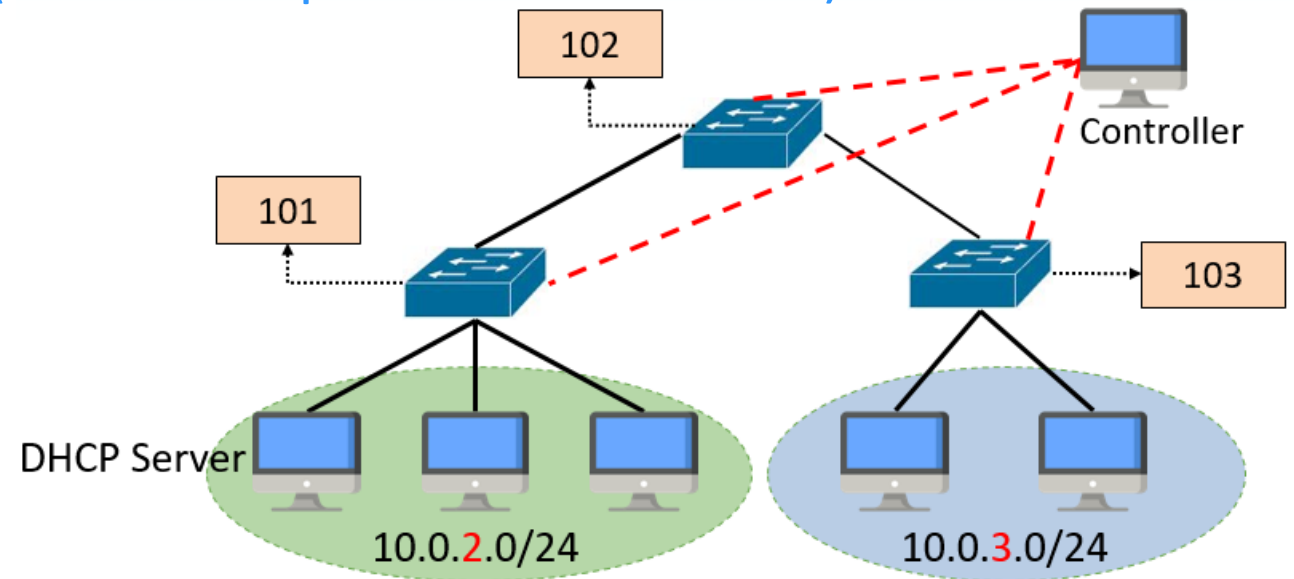
- Controller view
 - Hosts are configured under the **different** subnet





Configure Network – Upload Configuration

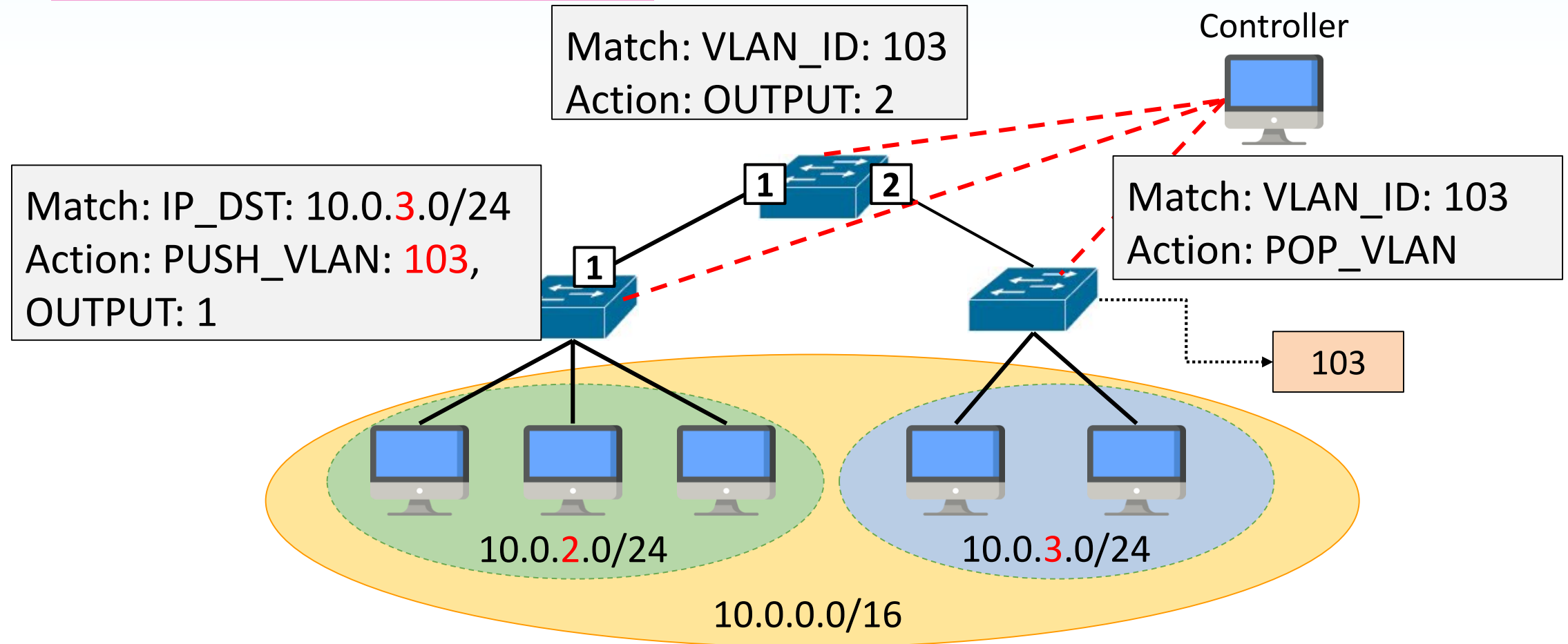
- Upload configuration to controller
 - DHCP server location
 - Segment ID for switch (node segment)
 - IP subnet on edge switch
 - Other configuration as you wish
 - E.g., indication of edge switch (to make implementation easier)





Compute Path and Install Flow Rules

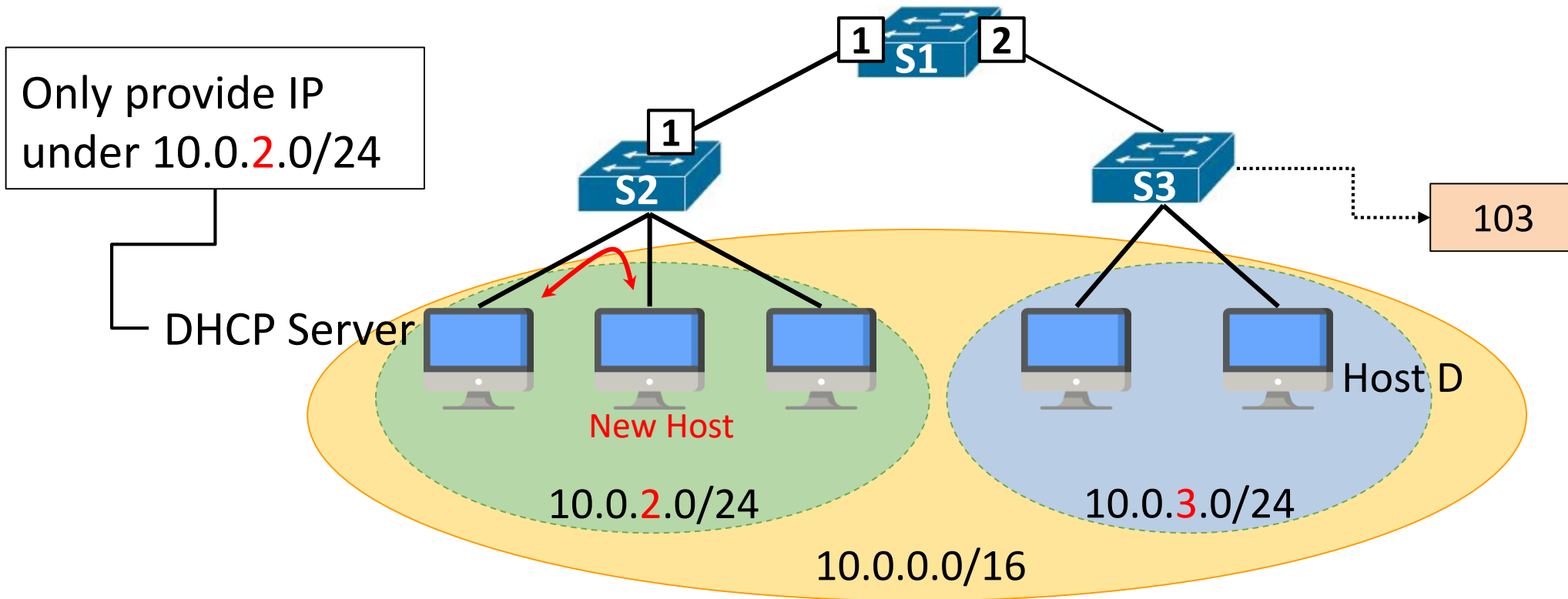
- Compute a path for each pair of edge nodes
- Install flow rules for all paths





Workflow (1/6) – Integration with Unicast DHCP

- New host could request IP address from DHCP server
 - This is what you done in lab 4

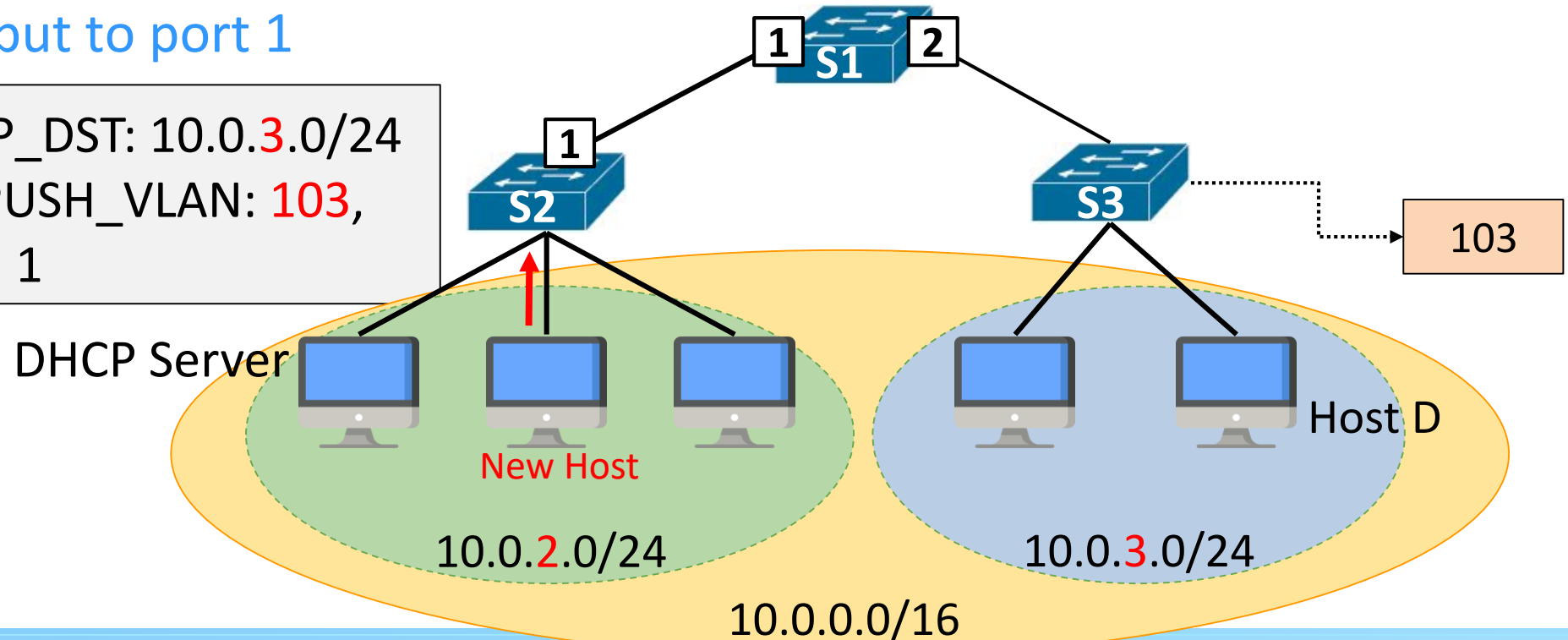




Workflow (2/6) – Host to Host Communication

- Assume new host sends packet to Host D
- Edge Switch S2:
 - Match subnet of destination address
 - Push VLAN tag to packet according to destination edge node
 - Then output to port 1

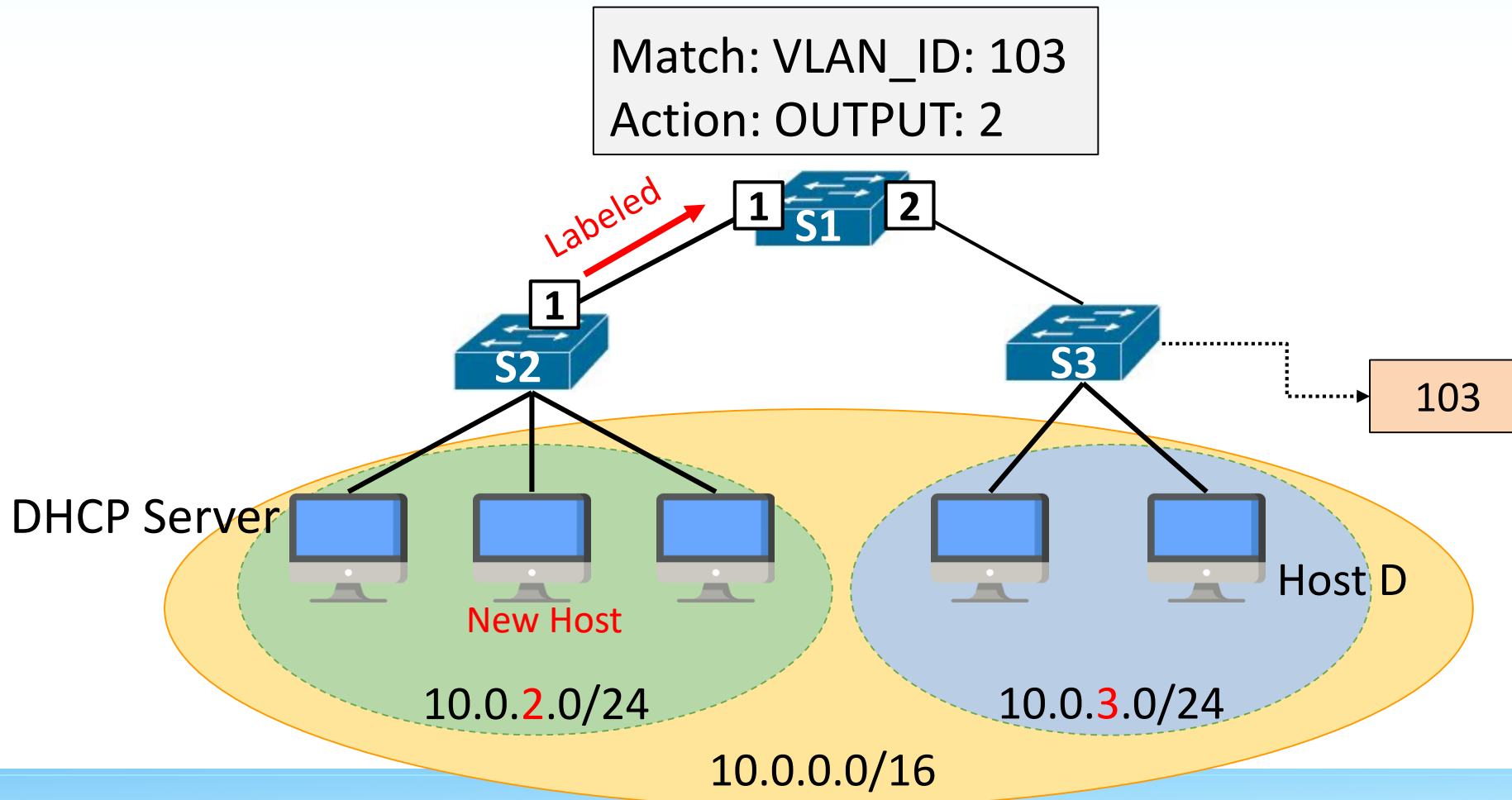
Match: IP_DST: 10.0.3.0/24
Action: PUSH_VLAN: 103,
OUTPUT: 1





Workflow (3/6) – Label Lookup

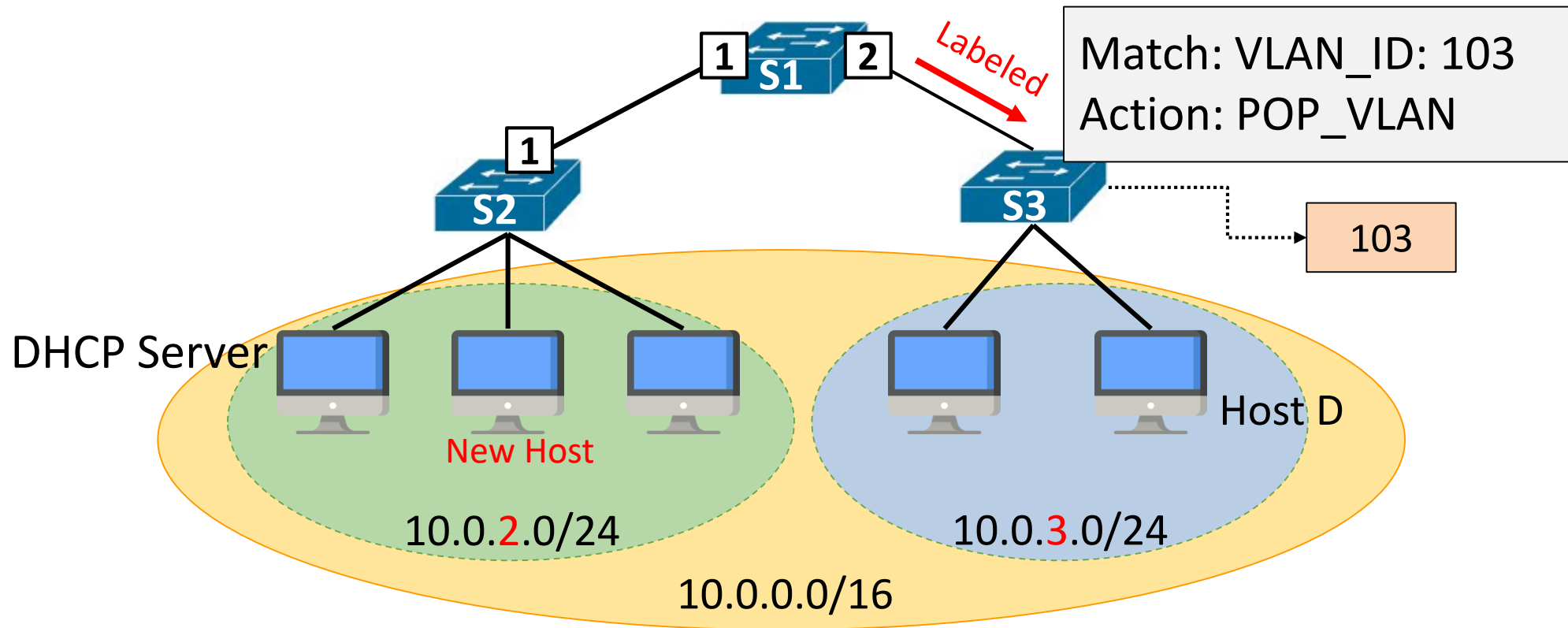
- S1 receives VLAN tagged packet
 - Match VLAN tag and forward tagged packet via port 2





Workflow (4/6) – Label Popping

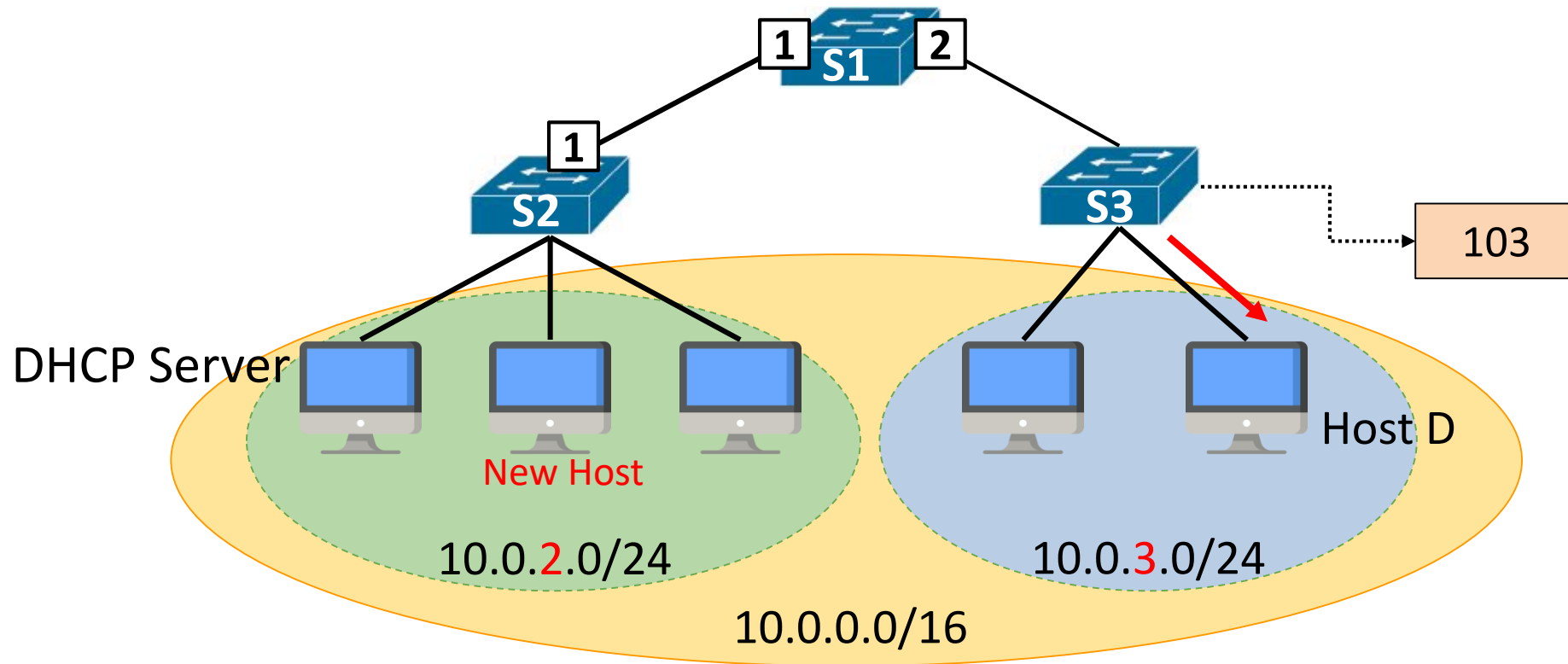
- When destination edge switch S3 receives tagged packet
 - Pop VLAN tag
 - Forward original (untagged) packet to Host D (next slide)





Workflow (5/6) – IP/MAC Forwarding

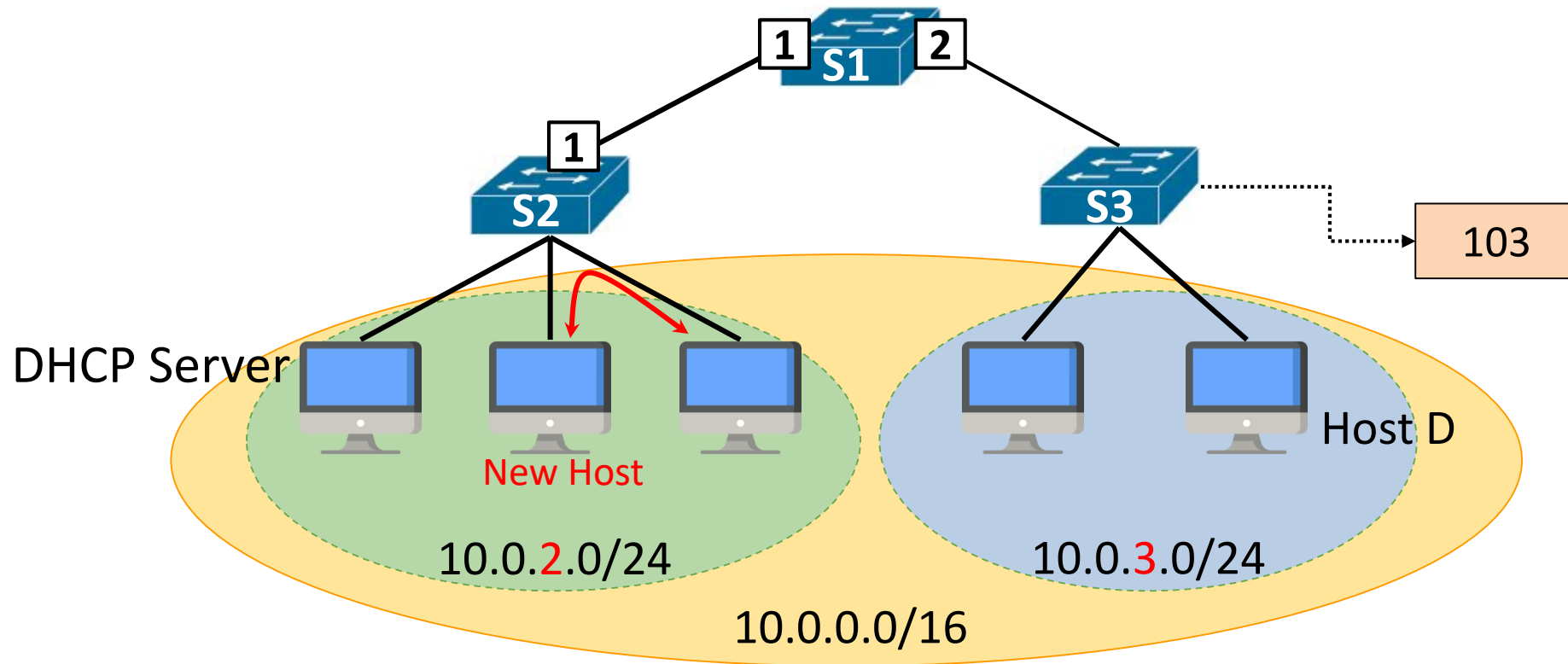
- After label popping, S3 forwards original packet by matching Layer 2 or L3 address





Workflow (6/6) – Intra-device Forwarding

- Intra-device packet could be forwarded by matching Layer 2 or L3 address directly





Requirements

- The following three applications should be activated
 - DHCP Unicast (lab 4)
 - Proxy ARP (lab 5)
 - VLAN-based Segment Routing (this project)
- You **should not activate** any other application except **OpenFlow-related applications** on ONOS
- Install all flow rules when controller receives configuration
- Flow rules for forwarding packets must **match VLAN tag**
 - Except for intra-subnet forwarding



Issues

- Controller may not be able to install correct flow rules when receiving configuration
 - Since controller does not know hosts at the beginning
- First solution
 - Send packets to let controller know host information before uploading configuration
- Second solution
 - Add host information in configuration
- You can figure out other solutions on your own



Naming Requirement

- You should follow the Maven project naming format below, or your project will not be scored
 - <groupId>: **nctu.winlab**
 - <artifactId>: **vlanbasedsr**
 - <version>: <use default> (1.0-SNAPSHOT)
 - <Package>: **nctu.winlab.vlanbasedsr**



Scoring Criteria

- Report: Previous Labs Parts
 - DHCP Unicast and Proxy ARP (5%)
- Report: Final Project Part
 - Activated applications (10%)
 - Only activate DHCP unicast, Proxy ARP, vlanbasedsr, and OpenFlow-related applications
 - Flow rules (25%)
 - Must use VLAN tag to forward packets
 - Connectivity (10%)
 - Hosts under different subnets can send labeled packets to each other
- Demo (50%)
 - TA will produce a different topology to test your app



Submission

- Files:
 - All files in Vlan-based Segment Routing app
 - No need to submit DHCP Unicast and Proxy ARP app
- Submit:
 - Upload a “.zip” file to e3
 - Named: **final_<studentID>.zip**
 - Incorrect naming convention or format will not be scored