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Master Course Computer Networks

Exercise 4
(submission until December 17th, 10:30 CET via SVN)
(submission of corrected version until December 20th, 10:30 CET via SVN)

Note: Each subproblem gives you 0, 1 or 2 points. See the slides from October 29th for more information on the 0.3 bonus.
Note 2: Subproblems marked by * can be solved without preceding results.

MPLS (Multi Protocol Label Switching)

a)* What is the purpose of *Multi Protocol Label Switching*? Name at least two use cases! What was the initial thought behind developing MPLS?

Have a look at Figure 1 for the following subtasks. It shows a network topology with a source host, 5 MPLS routers and a destination host. Additionally, the routers' table entries label, prefix, outgoing interface and remote label are given.

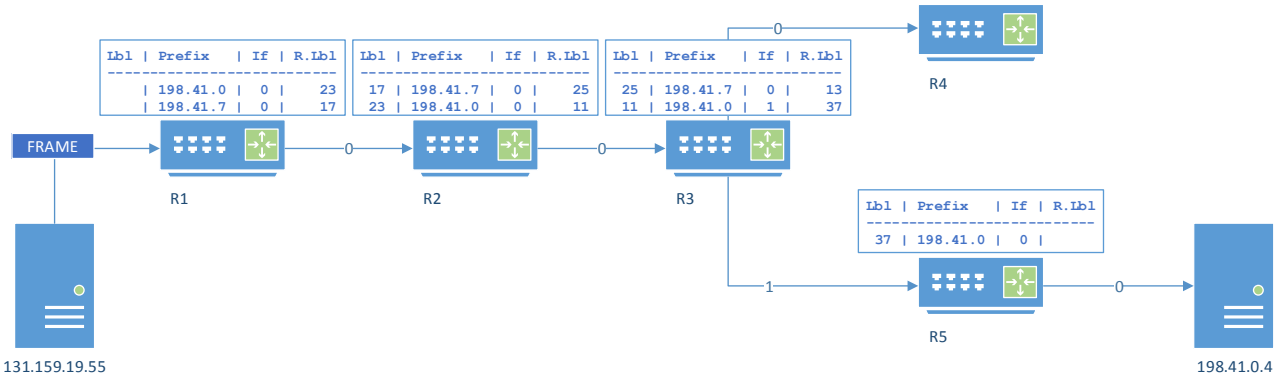

Figure 1: MPLS topology.

Figure 2 shows the "in flight" Ethernet frame observed at *FRAME* in Figure 1, after it left 131.159.19.55 and before reaching R1. The frame starts with the destination MAC address, the MAC FCS is omitted.

b)* How does the frame look like after it was processed and sent out by R1? Write down and explain the bytes that were changed, added and removed!

c)* How does the frame look like after it was processed and sent out by R2? Write down and explain the bytes that were changed, added and removed!

```
0000   00 25 90 ab cd ef 3c 97 0e ca ff ee 08 00 45 00
0010   00 3b 78 e1 00 00 03 11 e1 cd 83 9f 13 37 c6 29
0020   00 04 dd fe 00 35 00 27 5e 79 c5 66 01 20 00 01
0030   00 00 00 00 00 01 02 64 65 00 00 02 00 01 00 00
0040   29 10 00 00 00 00 00 00 00
```

Figure 2: Hex dump, leftmost column indicates the hex offset from the beginning of the frame.

d)* Is the length of 20 bits of an MPLS label enough for destination based addressing? How does the overhead in percentage for the frame shown in Figure 2 with MPLS tunneling compare to IP tunneling?

e)* Will the encapsulated packet reach its destination? Explain why or why not!

f) What will be the response according to RFC 3032?

g) How does the response change when the Label Switched Routers implement RFC 4950?

NAT (Network Address Translation)

When ISPs deploy Large Scale NAT within their network, they face several challenges. One approach for this case is to implement bulk allocation, which means that a whole range of ports is allocated for a customer when creating the first mapping. All further connections from this customer are mapped to a port from this range.

a)* What are the consequences of using bulk allocation when operating a LSN? Name and explain at least two implications of bulk allocation.

b)* Explain why UDP hole-punching has a higher success rate than TCP hole-punching. What is the purpose of using a small TTL value for TCP hole-punching?

For the following subtasks assume the following communication between a client behind NAT and a server with a public IP address:

1. The client sends a UDP packet to the server creating a mapping in the NAT.
2. The server performs a UDP traceroute with the client's public endpoint as destination IP address and port.

c)* Is it possible to determine the position (hop number) of the NAT and the private IP address of the client from the traceroute results? Why or why not? Assume a Full Cone NAT, so inbound connections are not filtered by their source.

d) What does the traceroute reveal if we change its UDP destination port to a different (closed) port?

The slides from October 29th explain the SVN submission process.