SDN Exercise 1

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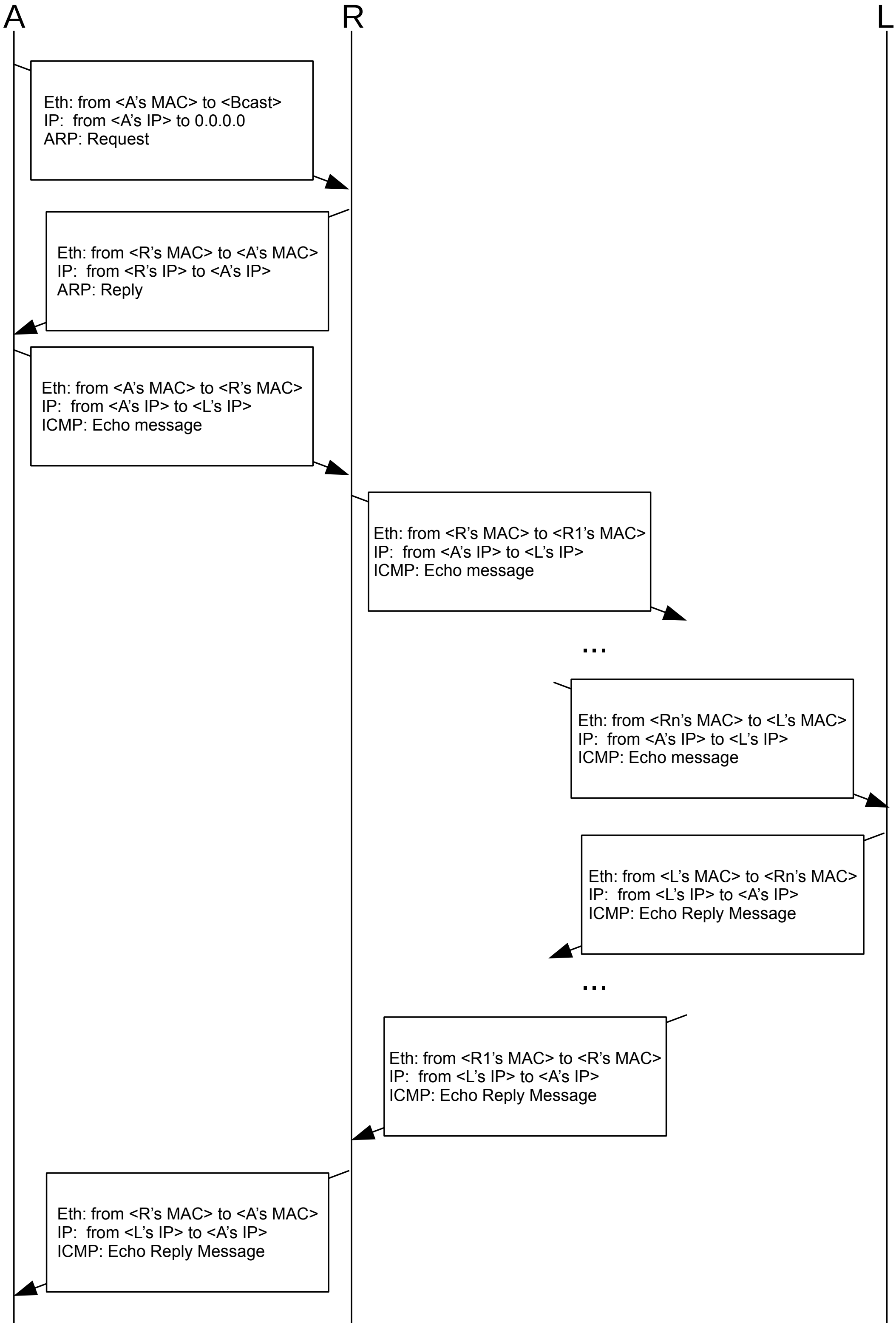
Problem 1.1



Eth: from <A's MAC> to <Bcast>
IP: from <A's IP> to 0.0.0.0
ARP: Request

Eth: from <R's MAC> to <A's MAC>
IP: from <R's IP> to <A's IP>
ARP: Reply

Eth: from <A's MAC> to <R's MAC>
IP: from <A's IP> to <L's IP>
ICMP: Echo message

Eth: from <R's MAC> to <R1's MAC>
IP: from <A's IP> to <L's IP>
ICMP: Echo message

Eth: from <Rn's MAC> to <L's MAC>
IP: from <A's IP> to <L's IP>
ICMP: Echo message

Eth: from <L's MAC> to <Rn's MAC>
IP: from <L's IP> to <A's IP>
ICMP: Echo Reply Message

Eth: from <R1's MAC> to <R's MAC>
IP: from <L's IP> to <A's IP>
ICMP: Echo Reply Message

Eth: from <R's MAC> to <A's MAC>
IP: from <L's IP> to <A's IP>
ICMP: Echo Reply Message

Problem 1.2

a.

IP: IP protocol offers relay of datagrams over the network, enables addressing, routing and traffic control functionality.

TCP: TCP protocol offers a connection oriented reliable transmission service, which is called by the network layer. TCP also provides congestion and flow control as well as error check.

UDP: UDP realizes the familiar functionality like TCP, but only offering connectionless and unreliable service.

b.

Routing is an algorithm, it is a successive exchange of connectivity information between routers. Each router builds its own routing table based on collected information.

Forwarding is a process, it is switch- or router-local process which forwards packets towards the destination using the information given in the local routing table.

c.

Link state:
OSPF (Open Shortest Path First)
IS-IS (Intermediate System to Intermediate System)

Distance vector:
RIP (Routing Information Protocol)
IGRP (Interior Gateway Routing Protocol)

d.

Key Difference:

Link state:
1. receive information from directly connected neighbors;
2. full topology of the network.

Distance vector:
1. receive information from both directly & indirectly connected neighbors;
2. only routing information of neighbors.

Explanation:

Link state routing makes each router compile a list of directly connected neighbors with associated metric, and those lists consist of all the routing information of the network.

In distance vector routing, each router reports a list of (directly or indirectly) reachable destinations and the routing metric to its neighbors periodically, and updates its internal tables according to the received information.

e.

Routing protocol that exchanges routes between autonomous systems is called Exterior Gateway Protocol(EGP). The most widely used EGP is Border Gateway Protocol(BGP).

f.

I.

FEC is Forwarding Equivalence Class in the context of MPLS. It describes a set of packets with similar and / or identical characteristics which may be forwarded the same way. Typically, FEC depends on destination ip address, but other information such as entrance port(of switch or router) can also be a determinant role.

II.
Technical advantages:
1. MPLS is quite suitable for switches, which are uncapable to analysis headers of packets, however
can handle label lookup and update assignments.
2. Since it's determined at the very beginning that which FEC should a packet enter, all information (even the ingress router information) inside a packet can be used for a better decision, when the normal routing strategy decides the assignment only through limited header information. Besides as this assignment job can be more and more complex with the transmission of packets, there's no doubt that network will become less efficient when dealing with more work with less information.
3. When a packet wants to transmit through a specified route path, by normal routing additional information will be added to packets. Instead by MPLS only some modifications of label need to be done without any redundant payload.

III.
MPLS works on both Network layer & Link layer of the IP protocol stack.

Problem 1.3

a.

In SDN three abstractions are taken to reduce difficulties in control programming.
Three abstractions are:

1. Distributed state abstraction
2. Specification abstraction
3. Forwarding abstraction

b.

Only those packets that match this table can pass this switch. So with this entry only those packets, whose TCP destination port number is 22, can be further transmitted. This filtration function acts as a firewall.

c.

One important function of firewall is the **NAT(Network Address Translation)**, it cannot be realized in an OpenFlow switch without network controller.
NAT can remap the IP address space into another by modifying IP packet headers while they are in transit across the firewall. With this technique, the ip address of inside hosts cannot be seen outside of the firewall, so the inside hosts can be protected from some outside attacks.
NAT needs the firewall to set and update a translation table between original addresses and public addresses, this table is based on connection information such as destination address and port number. However, an OpenFlow switch without network controller has only the ability to forward or drop packets according to the flow table, it hasn’t ability to set and modify such a complex address translation table for NAT.