CNT 4007C Computer Networks Fundamentals
Instructor: Prof. A. Helmy

Homework 4: Network Layer

Assigned: Nov. 22nd, 2019. Due Date: Dec 3rd, 2019

(submission instructions similar to hwk3, on canvas then hard copy in class and ofc hrs)

Q1. What are the 2 most important network-layer functions in a datagram network, and what is the difference between them?

Q2. How many columns does a bare-bones forwarding table in a MPLS-capable router have? What is the meaning of the values in each of these columns?
How many columns does a bare-bones forwarding table in a datagram network have? What is the meaning of the values in each of these columns?

Q3. An application generates chunks of 40 bytes of data every 20msec, and each chunk gets encapsulated in a TCP segment and then an IP datagram.
What percentage of each datagram will be overhead, and what percentage will be application data?

Q4. What is the triangle routing problem in mobile IP? Suggest an improvement to it.

Q5. Detail two examples in which tunneling helps in mobile IP and IPv6 deployment.

Q6. How does IPv6 help in supporting mobility, compared to IPv4?

Q7. Why is MPLS sometimes called layer 2.5?

Q8. Can label numbers be reused in MPLS? Why?

Q9. Mention two examples in which IP addresses can be reused, explaining the reasons for their reuse.

Q10. Compare and contrast link-state and distance-vector routing algorithms.

Q11. Compare and contrast the advertisements used by RIP and OSPF.

Q12. Fill in the blank: "RIP advertisements announce the number of hops to various destinations. BGP updates, on the other hand, announce the _____ to the various destinations".

Q13. Complete the following sentence in ***three*** different ways, each time using one of the following words: 'vector', 'domain', 'gateway'

"RIP is a _____ _____ protocol, while BGP is a _____ _____ protocol."

Q14. Suppose you purchase a wireless router and connect it to your cable modem. Also suppose that your ISP dynamically assigns your connected device (that is, your wireless router) one IP address. Also suppose that you have five PCs at home that use 802.11 to wirelessly connect to your wireless router. How are IP addresses assigned to the five PCs? Does the wireless router use NAT? Why or why not?

Q15. Consider the network setup in the figure below. Suppose that the ISP instead assigns the router the address 126.13.89.67 and that the network address of the home network is 192.168/16.

a. Assign addresses to all interfaces in the home network.
b. Suppose each host has two ongoing TCP connections, all to port 80 at host 128.119.40.86. Provide the six corresponding entries in the NAT translation table.

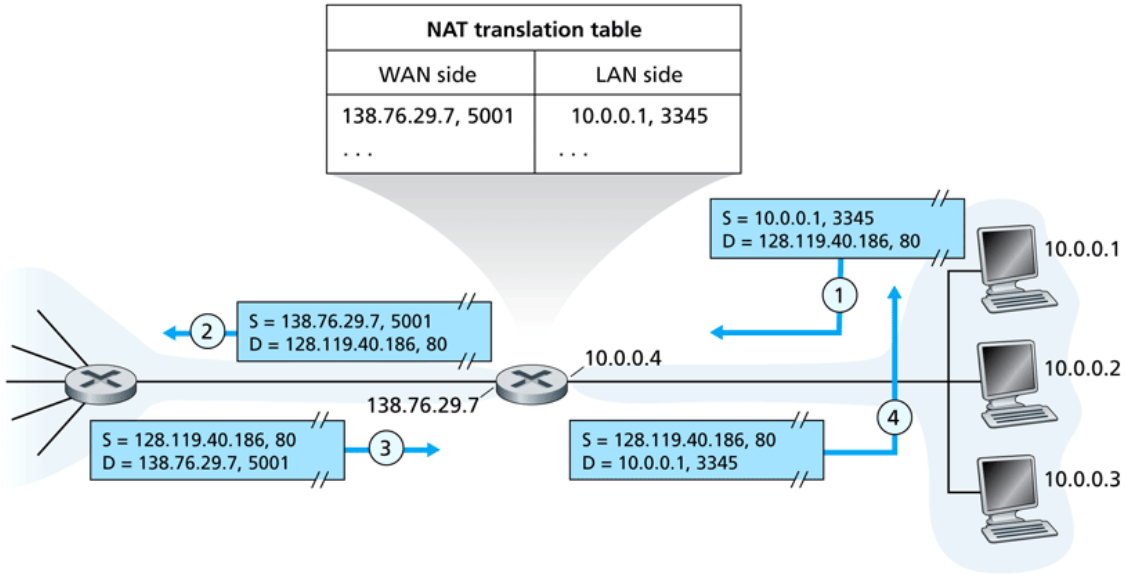


Figure 4.22 ♦ Network address translation

Q16. What is the '*rendezvous problem*' in multicast? How can it be solved? (mention three main approaches/algorithms to the solution along with the protocols that use them)

Q17. How does SDN extend the notion of matching to define firewalls and NAT boxes, while traditional longest-matching is limited?

Q18. Do you see a layer violation in BGP peering? Explain.

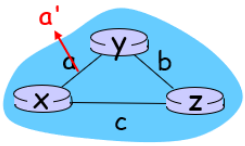
Q19. Provide example of route oscillation in link state routing (e.g., Dijkstra's algorithm).

Q20. Explain the 'count-to-infinity' problem and why it happens in distance-vector routing algorithms (like Bellman-Ford in OSPF), then suggest an improvement. Mention a limitation of your suggestion.

Q21. What is the advantage of using multicast over unicast? Give example and provide a quantitative analysis (i.e., numbers) to solidify your argument (you can use a drawing of the network topology).

Q22. [Extra points] Consider the network topology in the figure below with nodes *x*, *y*, *z*. Assume that distance-vector routing is used with Bellman-Ford algorithm. The link cost between *x* and *y* changes from *a* to *a'* , where *a'* >> *a*, and *a'* > *c*. Focus on nodes *y* and *z*, their routing table updates, and messages exchanged between them.

I. Derive an equation for the number of iterations needed for the routing to converge as a function of the link costs *a*, *a'*, *b* and *c*.



II. Suggest an improvement that would speed up the convergence and prevent looping in the above case. Explain your solution and how it works.

Q23. [Extra points] Mention the two main reasons why broadcast-and-prune multicast does not scale**.**

Q24. [Extra points] Mention two reasons why an optimal *RP* placement is not used (or needed) in PIM-SM**.**