Assignment 3

CS224

Note: *Solve all problems on your own.* Upload your solutions as a single pdf file to Moodle. Approach the instructor for clarifications.

1. AS1 in Figure 1 has the following characteristics.

   - All routers run OSPF as the interior gateway protocol (IGP). Recall that OSPF is a link-state routing protocol.
   - Only the border routers connecting AS1 to neighbouring ASes run BGP.
   - Link weights are static and specified in the diagram.

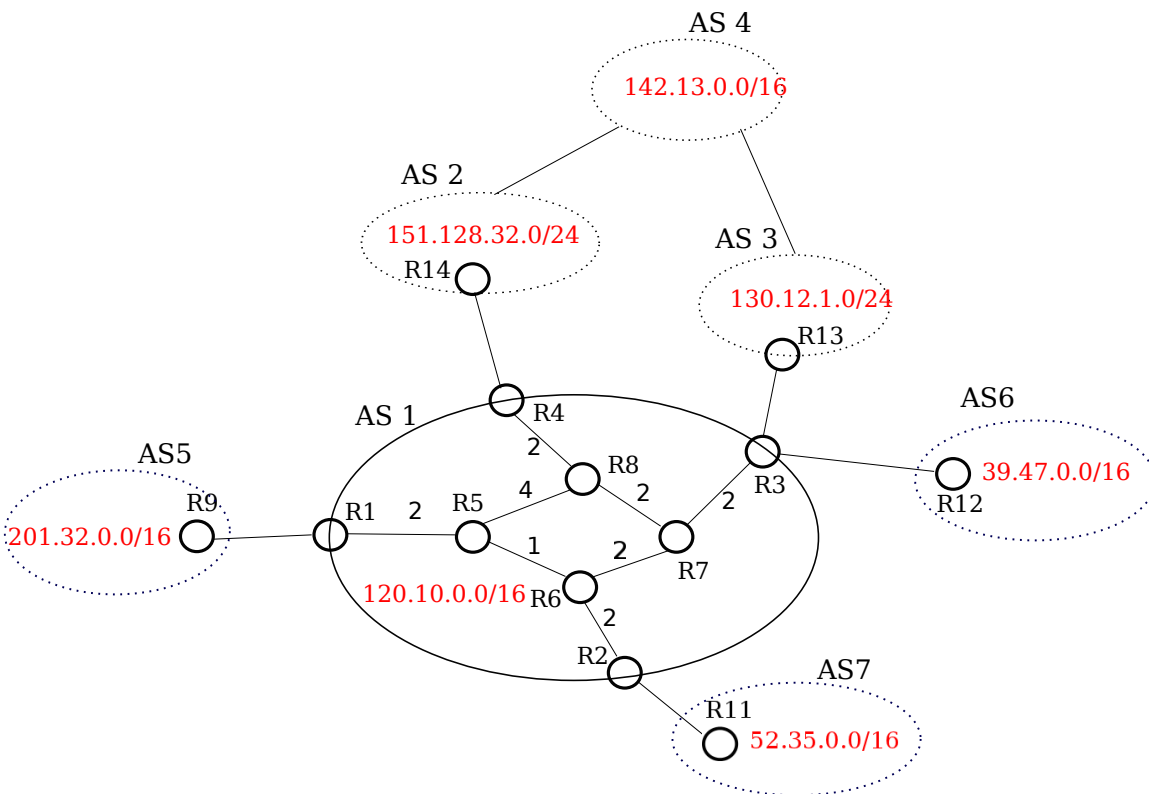   *State any assumptions that you make to solve the problems.*

Figure 1: Routing topology

(a) (8 marks) Using Djikstra's algorithm determine the shortest path from R1 to all other routers within AS1. Give details of the different stages in creation of the routing tree using diagrams. Similarly determine the shortest path from R2 to all other routers, and show your working with diagrams.

(b) Corresponding to each of the ASes is an IP-prefix as shown. R14 of AS2 advertizes the paths [151.128.32.0/24 AS2], [142.13.0.0/16 AS2-AS4] and [130.12.1.0/24 AS2-AS4-AS3] to router R4 of AS1. R13 of AS3 advertizes the

paths [130.12.1.0/24 AS3], [142.13.0.0/16 AS3-AS4] and [151.128.32.0/24 AS3-AS4-AS2] to R3 of AS1.

Suppose the administrator of AS1 has set LOCAL_PREF to the same value for all BGP advertisements and assume that the MED attribute has not been set in any of the advertisements.

   i. (2 marks) Explain which NEXT_HOP router does each BGP router in AS1 use to send packets to destination prefix 151.128.32.0/24. Give the reasons for these choices. Recall that the NEXT_HOP router for a BGP advertisement is the router in the neighbouring AS which sent the corresponding advertisement to a router in AS1. Examples of these are R14, R13 etc.[1]

   ii. (2 marks) Explain which NEXT_HOP router does each BGP router in AS1 use to send packets to destination prefix 130.12.1.0/24. Give reasons for these choices.

   iii. (2 marks) Explain which NEXT_HOP router does each BGP router in AS1 use to send packets to destination prefix 142.13.0.0/16. Give reasons for these choices.

   iv. (2 marks) In case the administrator of AS1 wants all BGP routers to use NEXT_HOP router R14 to send packets to destination prefix 142.13.0.0/16, how can he accomplish this by setting attributes of the BGP advertisement?

(c) Assume that Encapsulation is the solution used by AS1 for BGP-IGP interaction. The BGP routing table at each BGP speaker contains a list of IP prefixes learned using eBGP or iBGP and the corresponding exit routers. Every router in AS1 has an IGP (which is OSPF here) routing table which contains the IP address of all other routers within AS1 and the corresponding next hop on the shortest paths to those routers.

Suppose a packet P1 is forwarded to R1 from AS5 with destination 142.13.5.4. Explain how the routers of AS1 encapsulate and forward this packet toward its destination. Your answer should explain at each router along the path in AS1 the following.

   i. (3 marks) Explain which router encapsulates P1 and which router eventually de-encapsulates it. Call the new packet formed after encapsulation P2. Explain which router the destination IP of P2 corresponds to.

   ii. (3 marks) Which forwarding table(s) the various routers look up in order to find the next hop to forward P2 (you can say if it is IGP, BGP or both, and also state which router should be there in the next hop of the table)

2. (8 marks) Network address translation (NAT) helps solve the problem of IP address space shortage. Look up any text book or the web to learn about NAT. Briefly explain how NAT works (using at most a page to explain with an example). Does NAT help prevent some security attacks? If so, which ones? (use at most a page to describe security attacks mitigated by NAT).

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[1]Technically, the NEXT_HOP attribute is the IP address of the interface from which the BGP advertisement reached AS1. To simplify matters, we are here just using the router name instead of the IP address of its interface.