Written Assignment 2

Total Points: 100
Due Date: 2025/05/25, 21:00
TA email: 林致佑 d09921030@ntu.edu.tw, 羅士朋 r13921099@ntu.edu.tw

Homework Policy

1. Please do not plagiarize. Any suspected plagiarism will be investigated by the TA You will receive zero points if plagiarism is confirmed.
2. It is okay to discuss the homework in general terms with your classmates. However, all the content is expected to be your own work. Please avoid using AI tools to generate any answers.
3. Contact TAs for any questions. Use the subject **[2025ICN] WA2** as the email title.
4. Professor Liao and the TAs preserve the authority to modify the rules and grades.

Submission Policy

1. Submit your assignment in `[student_id]_WA2.pdf` to NTU Cool.
2. Late submission: $\frac{1}{3}$ deduction from your original score for one-day late submission. $\frac{2}{3}$ score deduction from your original score between one day and two days. No credit will be given for the submission beyond two days late.

1. Consider a datagram network using 32-bit host addresses. Suppose a router has four links, numbered 0 through 3, and packets are to be forwarded to the link interfaces as Figure 1.

Destination Address Range	Link Interface
11100000 00000000 00000000 00000000 through 11100000 00111111 11111111 11111111	0
11100000 01000000 00000000 00000000 through 11100000 01000000 11111111 11111111	1
11100000 01000001 00000000 00000000 through 11100001 01111111 11111111 11111111	2
otherwise	3

Figure 1

   a) Provide a forwarding table that has five entries, uses longest prefix matching, and forwards packets to the correct link interfaces. (8%)

   b) Describe how your forwarding table determines the appropriate link interface for datagrams with destination addresses shown in Figure 2. (8%)

11001000 10010001 01010001 01010101
11100001 01000000 11000011 00111100
11100001 10000000 00010001 01110111

Figure 2

2. Consider the topology shown in Figure 3. Denote the three subnets with hosts (starting clockwise at 12:00) as Networks A, B, and C. Denote the subnets without hosts as Networks D, E, and F.

   a) Assign network addresses to each of these six subnets, with the following constraints: All addresses must be allocated from 214.97.254/23; Subnet A should have enough addresses to support 250 interfaces; Subnet B should have enough addresses to support 120 interfaces; and Subnet C should have enough addresses to support 120 interfaces. Of course, subnets D, E and F should each be able to support two interfaces. For each subnet, the assignment should take the form a.b.c.d/x or a.b.c.d/x –e.f.g.h/y. (8%)

   b) Using your answer to part a), provide the forwarding tables (using longest prefix matching) for each of the three routers. (8%)

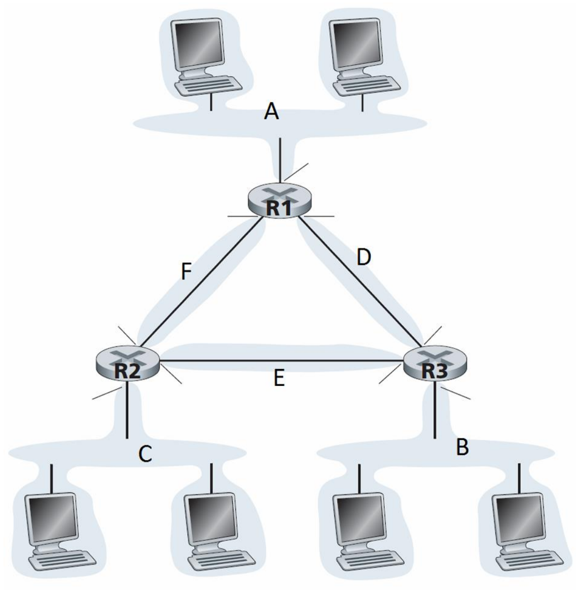

Figure 3

3. Consider sending a 2400-byte datagram into a link that has an MTU of 700 bytes. Suppose the original datagram is stamped with the identification number 422.
   a) How many fragments are generated? (3%)
   b) What are the values in the various fields in the IP datagram(s) generated related to fragmentation? (5%)
4. Suppose you are interested in detecting the number of hosts behind a NAT. You observe that the IP layer stamps an identification number sequentially on each IP packet. The identification number of the first IP packet generated by a host is a random number, and the identification numbers of the subsequent IP packets are sequentially assigned. Assume all IP packets generated by hosts behind the NAT are sent to the outside world.
   a) Based on this observation, and assuming you can sniff all packets sent by the NAT to the outside, can you outline a simple technique that detects the number of unique hosts behind a NAT? Justify your answer. (8%)
   b) If the identification numbers are not sequentially assigned but randomly assigned, would your technique work? Justify your answer. (8%)
5. Consider the SDN OpenFlow network shown in Figure 4 . Suppose that the desired forwarding behavior for datagrams arriving at s2 is as follows:
   - any datagrams arriving on input port 1 from hosts h5 or h6 that are destined to hosts h1 or h2 should be forwarded over output port 2;
   - any datagrams arriving on input port 2 from hosts h1 or h2 that are destined to hosts h5 or h6 should be forwarded over output port 1;
   - any arriving datagrams on input ports 1 or 2 and destined to hosts h3 or h4 should be delivered to the host specified;

- hosts h3 and h4 should be able to send datagrams to each other.

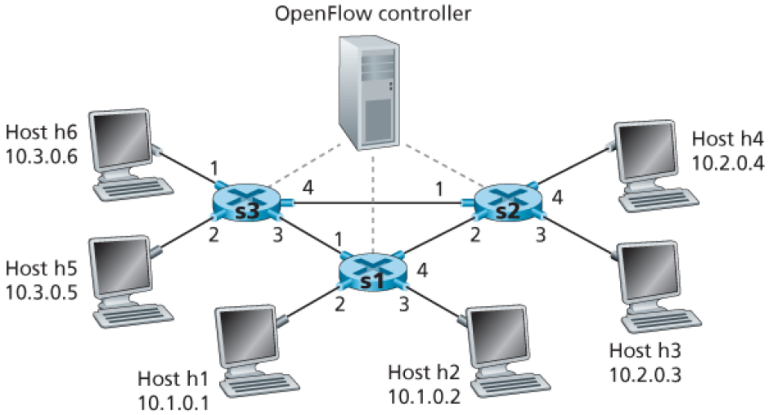

Figure 4

Specify the flow table entries in s2 that implement this forwarding behavior. (10%)

6. Consider the network shown in Figure 5. With the indicated link costs, use Dijkstra' s shortest-path algorithm to compute the shortest path from x to all network nodes. Show how the algorithm works by computing a table similar to Table I. (10%)

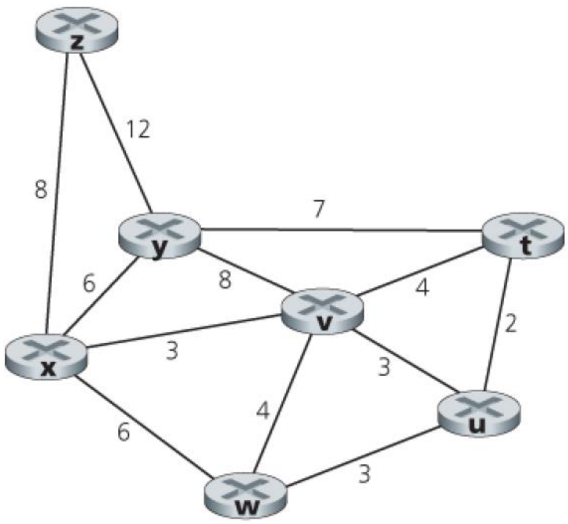

Figure 5

Example:
Consider Figure 6. The source node is u. Compute the least-cost paths from u to all possible destinations. Table I summarizes the computation result using Dijkstra's algorithm.

$D(v)$: Cost of the least-cost path from the source node to destination v as of this iteration of the algorithm.
$p(v)$: Previous node (neighbor of v) along the current least-cost path from the source to v.
N': Subset of nodes; v is in N' if the least-cost path from the source to v is definitively known.

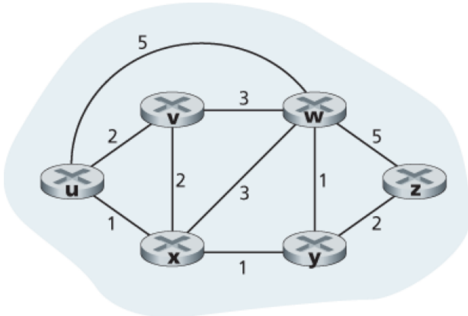

Figure 6

step	N'	D (v), p (v)	D (w), p (w)	D (x), p (x)	D (y), p (y)	D (z), p (z)
0	u	2, u	5, u	1,u	∞	∞
1	ux	2, u	4, x		2, x	∞
2	uxy	2, u	3, y			4, y
3	uxyv		3, y			4, y
4	uxyvw					4, y
5	uxyvwz					

Table I: The summary of the algorithm's computation.

7. Consider the network fragment shown in Figure 7. x has only two attached neighbors, w and y. w has a minimum-cost path to destination u (not shown) of 5, and y has a minimum-cost path to u of 6. The complete paths from w and y to u (and between w and y) are not shown. All link costs in the network have strictly positive integer values.

   a) Give x's distance vector for destinations w, y, and u. (2%)
   b) Give a link-cost change for either c(x, w) or c(x, y) such that x will inform its neighbors of a new minimum-cost path to u as a result of executing the distance-vector algorithm. Justify your answer.(5%)
   c) Give a link-cost change for either c(x, w) or c(x, y) such that x will not inform its neighbors of a new minimum-cost path to u as a result of executing the distance-vector algorithm. Justify your answer. (5%)

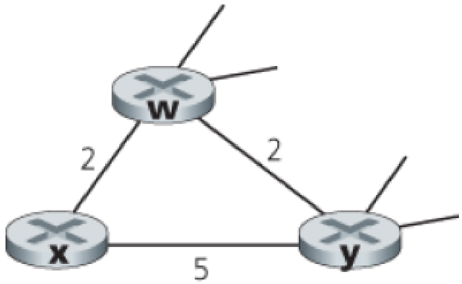

Figure 7

8. Consider the network shown in Figure 8. Suppose AS3 and AS2 are running OSPF for their intra-AS routing protocol. Suppose AS1 and AS4 are running RIP for their intra-AS routing protocol. Suppose eBGP and iBGP are used for the inter-AS routing protocol. Initially suppose there is no physical link between AS2 and AS4.

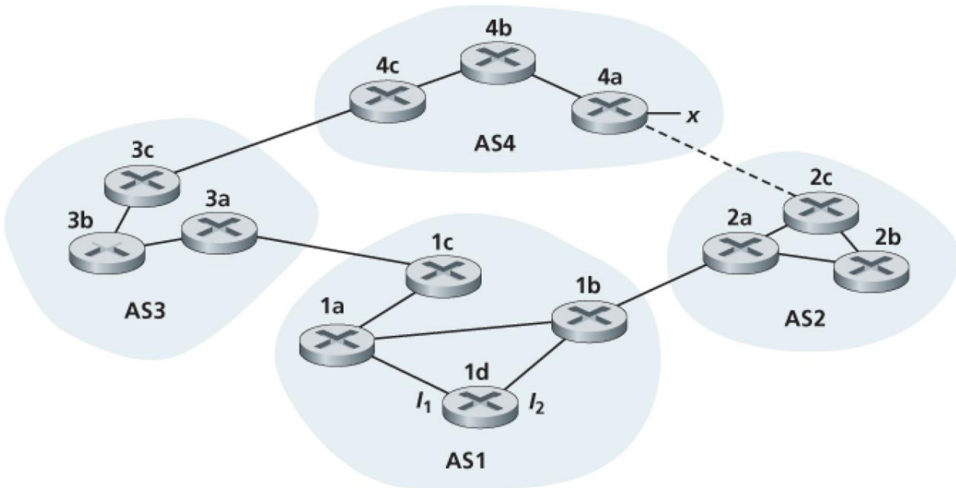

Figure 8

(a) Router 3c learns about prefix x from which routing protocol: OSPF, RIP, eBGP, or iBGP? (3%)

(b) Router 3a learns about x from which routing protocol? (3%)

(c) Router 1c learns about x from which routing protocol? (3%)

(d) Router 1d learns about x from which routing protocol? (3%)