1.Application to the real world

(a) You are the lead network operator of an ISP. At 8am you suddenly get phone calls from a large number of customers experiencing high rates of packet loss.
How would you figure out what is happening?

(b) You are still the lead network operator at an ISP. Business is booming. You are running a large OSPF network and need to provision two more routers to handle capacity. However you want to install them without taking down the rest of your production network. What needs to be done to bring these routers online? How do they end up acquiring information about the topology?

(c) Why don't we use all-software routers? What is the benefit of specialized hardware (interconnects, hardware queues, etc)?

(d) Which would be easier for an ISP operator to deploy, fair queuing or ECN? Why?

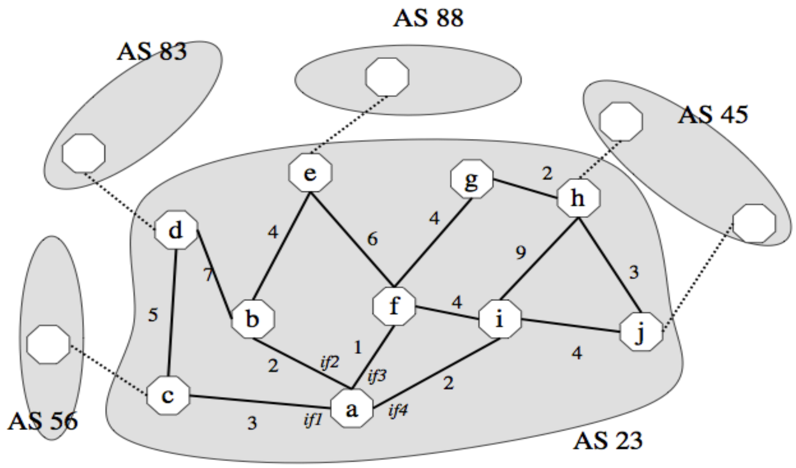
2.CIDR

The following table is a routing table using CIDR.
Address bytes are in hexadecimal. The notation “/12” in C4.50.0.0/12 denotes a netmask with 12 leading 1 bits: FF.F0.0.0.
State to what next hop the following will be delivered:
(a) C4.4B.31.2E
(b) C4.5E.05.09
(c) C4.4D.31.2E
(d) C4.5E.03.87
(e) C4.5E.7F.12
(f) C4.5E.D1.02

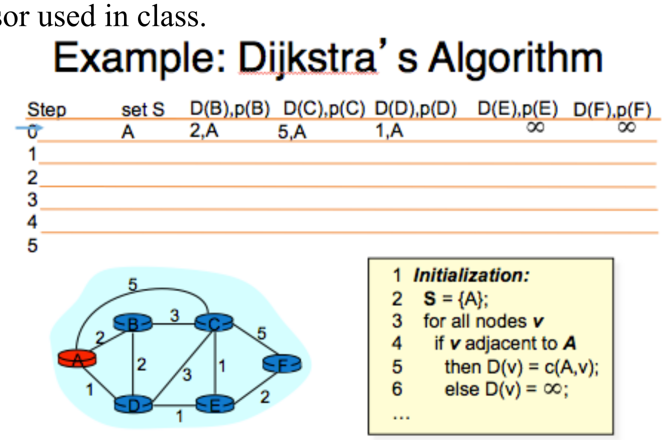
Net/MaskLength	Nexthop
C4.5E.2.0/23	A
C4.5E.4.0/22	B
C4.5E.C0.0/19	C
C4.5E.40.0/18	D
C4.4C.0.0/14	E
C0.0.0.0/2	F
80.0.0.0/1	G

3.LS and BGP

Answer questions referring to the following figure 1.



(a)Referring to the above figure, compute the least-cost paths from router a to all the other routers in AS 23 using Dijkstra's algorithm. Use a table similar to which the professor used in class.



to record your work. Here N′ represents the set of routers for which the least-cost path is known, D(v) represents the current best guess for distance to node v and p(v) is the predecessor of v on the least-cost path towards it.

step	N'	D(b),p(b)	D,p(c)	D,p(d)	D,p(e)	D,p(f)	D,p(g)	D,p(h)	D,p(i)	D,p(j)
0	a	2,a	3,a	∞	∞	1,a	∞	∞	2,a	∞

(b) Suppose that the gateway routers of AS 23 receive the following BGP advertisements from their BGP peers:

Network	AS Path
AS 56	
1.2.3.0/24	56 83 99
1.3.8.0/23	56 75
1.4.5.0/24	56 97
AS 83	
1.7.128.0/17	83 117
1.4.4.0/24	83 62 103
AS 88	
2.3.0.0/16	88 107 56 23
2.7.9.0/24	88 107
AS 45	
7.5.8.0/22	45
7.12.0.0/16	45 75 23
1.2.3.0/24	45 99

Show the routing table in router a that will be formed as a result of these advertisements. Assume that no routes are rejected due to local policy rules. Represent the routing table in this form:

Network	Interface
5.5.5.0/24	if1

4. Broadcast in AS23

In the same figure of **Question 3**

Assume that router a sends a broadcast packet to all other routers in AS23.

(a) If application-level broadcast is used, what is the total cost of sending this message? (Add up all the link costs traversed by each packet; i.e. if 3 packets go over a link, count three times the cost.)

(b) If Reverse-Path Forwarding is used, list how many copies of the packet each router receives. (Hint: there is a fast way to count this.)

(c) What is the total cost of sending the broadcast using RPF?

(d) What is the total cost of sending the broadcast using a least-cost path tree rooted at router a?

5.Switch Fabrics

Banyan and Batcher networks are two types of self-routing fabrics often used to construct large switches from simpler components. A single stage of a n×n Banyan network consists of n/2 switches of dimension 2×2. An n×n Batcher network can be made from two Batcher networks of size n/2×n/2 plus a merge network with n/2 log2n switches.

(a) For n = 64 inputs, how many stages are required to route packets from the inputs to the outputs of a Banyan Network?

(b) How many 2×2 switches are required for the network in part (a)?

(c) Write down a recurrence relation T(n) for the number of switches in a Batcher network of size n×n.

(d) Give the number of switches required for n=32.