Spring 21, EE 357: Computer Networks

Solution to Homework 4

Solution to problem 1

1.

Destination Prefix	Link Interface
11100000 00	0
11100000 01000000	1
1110000	2
11100001 1	3
otherwise	3

2.

Destination Prefix	Link Interface
11100000 00 (224.0/10)	0
11100000 01000000 (224.64/16)	1
1110000 (224/7)	2
11100001 1 (225.128/9)	3
otherwise	3

3.

Destination Prefix	Link Interface
11001000 10010001 01010001 01010101	3 (matching 5^{th} entry)
11100001 01000000 11000011 00111100	2 (matching 3^{rd} entry)
11100001 10000000 00010001 01110111	3 (matching 4^{th} entry)

Solution to problem 2

1. Subnet A: 214.97.255/24 (256 addresses)

   Subnet B: 214.97.254.0/25 - 214.97.254.0/29 (128-8 = 120 addresses)

   Subnet C: 214.97.254.128/25 (128 addresses)

   Subnet D: 214.97.254.0/31 (2 addresses)

   Subnet E: 214.97.254.2/31 (2 addresses)

   Subnet F: 214.97.254.4/30 (4 addresses)

2. To simplify the solution, assume that no datagrams have router interfaces as ultimate destinations. Also, label D, E, F for the upper-right, bottom, and upper-left interior subnets, respectively.

Router 1

Longest Prefix Match	Outgoing Interface
11010110 01100001 11111111	Subnet A
11010110 01100001 11111110 0000000	Subnet D
11010110 01100001 11111110 000001	Subnet F

Router 2

Longest Prefix Match	Outgoing Interface
11010110 01100001 11111111 0000000	Subnet D
11010110 01100001 11111110 0	Subnet B
11010110 01100001 11111110 0000001	Subnet E

Router 3

Longest Prefix Match	Outgoing Interface
11010110 01100001 11111111 000001	Subnet F
11010110 01100001 11111110 0000001	Subnet E
11010110 01100001 11111110 1	Subnet C

Solution to problem 3

		Cost to				
		u	v	x	y	z
From	v	∞	∞	∞	∞	∞
	x	∞	∞	∞	∞	∞
	z	∞	6	2	∞	0

		Cost to				
		u	v	x	y	z
From	v	1	0	3	∞	6
	x	∞	3	0	3	2
	z	7	5	2	5	0

		Cost to				
		u	v	x	y	z
From	v	1	0	3	3	5
	x	4	3	0	3	2
	z	6	5	2	5	0

		Cost to				
		u	v	x	y	z
From	v	1	0	3	3	5
	x	4	3	0	3	2
	z	6	5	2	5	0

Solution to problem 4

LSR and DVR are two main routing algorithms widely used practically. We can't say which one is better, both have its own advantages and disadvantages. The comparison is based on the following 4 facets:

1. message complexity: how many msgs sent between all n nodes?

- LS: with n nodes, E links, totally O(nE) msgs sent
- DV: exchange between neighbors only, totally O(n) msgs sent

2. computation complexity: algorithm for calculating least cost each

- LS: each node calculate using Dijkstra , $O(n^2)$
- DV: each node calculate the least cost to (n-1) nodes using Bellman-Ford equation , O(n)

3. speed of convergence: given a change, how long until the network re-stabilizes?

- LS: 1 iteration. may have oscillations
- n iterations. good news travel fast, but possible count-to-infinity problem for bad news.

4. Robustness: what can happen if a router fails or misbehaves?

- LS: robust. Node route calculations are somewhat separated
- DV: an incorrect node calculation can be diffused through the entire network. A node can advertise incorrect least-cost paths to its neighbors and then pass indirectly to its neighbor's neighbors and then to all destinations.

According the above analysis, LSR variants are suitable for small networks, and DVR variants are suitable for relatively large networks. Both are widely used in Internet. For example: Intra-AS routing protocols:

- RIP: DVR based. The distance metric is # of hops, limits networks to 15 hops ($16 = \infty$ to avoid count-to-infinity)
- OSPF: LSR based. Hierarchical OSPF for large networks.

Inter-AS routing protocols:

- BGP: DVR based. DVR with explicit AS path avoid count-to-infinity

Solution to problem 5

Intra-AS and Inter-AS routing differ in the following 2 facets: policy:

- Inter-AS: admin wants control over how its traffic routed, and who routes through its net. (untrusted)
- Intra-AS: single admin, so no policy decisions needed (trusted)

performance:

- Intra-AS: can focus on performance
- Inter-AS: policy may dominate over performance

Solution to problem 6

Methods to reduce the size of routing table include but not limited to:

- Using network prefix instead of the whole destination IP address.
- Using CIDR technology to converge multiple continuous IP prefix into one.
- Using hierarchical routing to reduce destination prefix.

Solution to problem 7

The reasons for replacing IPv4 with IPv6 include but not limited to:

- To provide more IP addresses, IPv6 have larger IP address space.
- To simplify the IP header and speed up the routing processing.
- To support more features, including QoS, IP security etc.

Solution to problem 8

network	network prefix	network mask	network	network prefix	network mask
LAN0	206.0.64.0	255.255.255.255	LAN7	206.0.66.128	255.255.255.192
LAN1	206.0.64.0	255.255.255.128	LAN8	206.0.66.192	255.255.255.192
LAN2	206.0.64.128	255.255.255.128	LAN9	206.0.67.0	255.255.255.192
LAN3	206.0.65.0	255.255.255.128	LAN10	206.0.67.64	255.255.255.192
LAN4	206.0.65.128	255.255.255.128	LAN11	206.0.67.128	255.255.255.192
LAN5	206.0.66.0	255.255.255.192	LAN12	206.0.67.192	255.255.255.192
LAN6	206.0.66.64	255.255.255.192			

R1		
Prefix	Mask	Interface
206.0.64.0	255.255.255.128	1
206.0.64.128	255.255.255.128	2
206.0.65.0	255.255.255.128	3
206.0.65.128	255.255.255.128	4
R3		
206.0.67.0	255.255.255.192	1
206.0.67.64	255.255.255.192	2

RA		
Prefix	Mask	Interface
206.0.64.0	255.255.255.255	0
206.0.64.0	255.255.254.0	1
206.0.66.0	255.255.255.0	2
206.0.67.0	255.255.255.128	3
206.0.67.128	255.255.255.128	4

The above table isn't the only one solution. Other options could start from 68, 72,76...124 instead of 64 for the third 8-bit in the four 8-bit IPv4 address.