ETH

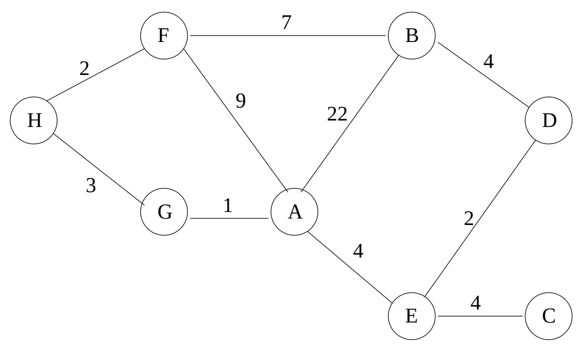
Eidgenössische Technische Hochschule Zürich
Swiss Federal Institute of Technology Zurich
Spring Term 2014

Operating Systems and Networks
Assignment 7

Assigned on: **3rd April 2014**
Due by: **10th April 2014**

Initial remarks

Exercises 1 and 2 both refer to the graph below.



1 Dijkstra's Algorithm

In the lecture you learned how to use Dijkstra's algorithm to compute the shortest path from a node to all the other nodes in a graph.

Think the given graph as a map, where the nodes (Vertices) represent cities, the edges represent the streets between the cities and the numbers labeled on the edges represent the time it takes to travel between the cities.

Every year, Ueli, a farmer from Adelboden (node A) sends all his friends a large quantity of potatoes, as New Year greetings. He usually uses his tractor and trailer to deliver the potatoes from city to city. Unfortunately, this year the tractor broke down and he has to use his car instead. Because of the limited capacity of the car, he needs to go back to the farm to reload after each visit. Can you help him to optimize the process so that he can finish the delivery as fast as possible? Design a plan for Ueli using Dijkstra's algorithm.

Answer:

Step	Visited	Set of blue nodes B(with distance, predecessor)
0	A	G(1,A),E(4,A),F(9,A),B(22,A)
1	A,G(1,A)	H(4,G),E(4,A),F(9,A),B(22,A)
2	AG,H(4,G)	E(4,A),F(6,H),B(22,A)
3	AGH,E(4,A)	D(6,E),F(6,H),C(8,E),B(22,A)
4	AGHE,D(6,E)	F(6,H),C(8,E),B(10,D)
5	AGHED,F(6,H)	C(8,E),B(10,D)
6	AGHEDF,C(8,E)	B(10,D)
7	AGHEDFC,B(10,D)	

Table 1: Steps in finding shortest path starting from vertex A

2 Distance Vector Routing

a) *Instead of Dijkstra's algorithm, you should apply the Distance Vector Routing algorithm on the same graph as given above. Calculate the distance table for node A and write it down on the additional answer sheet.*

Answer: The requested table can be determined from the given values and the cost of A to the neighbouring nodes. For example, the value for the route from A to G through B is the lowest value for the route from B to G (in this case 11) to which we add to the cost from A to B (in this case 22), for the total value of 33.

		Cost to destination via			
	$D^A()$	B	E	F	G
Destination	B	22	**10**	16	12
	C	32	**8**	23	10
	D	26	**6**	20	8
	E	28	**4**	19	6
	F	29	14	9	**6**
	G	33	9	14	**1**
	H	31	12	11	**4**

b) *How long does it take to converge? Report the number of steps/messages needed to converge to a final state to fill in the missing entries for node A.*

Answer: The number of messages can be counted while constructing the tables. This number is specific to a given setup. In general, it is hard to compute the number of steps necessary to fill in a single table. The number of steps for this concrete setup, where only one table is missing, can be counted easier. For every row, the shortest path for all neighbours has to be looked-up. This turns into the number of neighbours times the possible destinations. In this case 4 * 7. Note that this question is a very open one.

3 LPM

a) *If an endhost has the following entries in its ip route table:*
Address/mask Interface
135.46.56.0/22 Interface 2
135.46.60.0/22 Interface 1
192.53.40.0/23 Interface 3
default interface 4
For each of the following IP addresses in the packets, which interface would the endhost send each packet?
(a) 135.46.63.10
(b) 135.46.57.14

(c) 135.46.52.2
(d) 192.53.40.7
(e) 192.53.56.7

Answer: (a) Interface 1
(b) Interface 2
(c) Interface 4
(d) Interface 3
(e) Interface 4

b) *A router has just received the following new IP addresses: 57.6.96.0/21, 57.6.104.0/21, 57.6.112.0/21, and 57.6.120.0/21. If all of them use the same outgoing line, can they be aggregated? If so, to what? If not, why not?*

Answer: They can be aggregated to 57.6.96.0/19.

4 ARP

In this exercise you will use Wireshark to examine the ARP protocol in more detail. You will ping the IP address 8.8.8.8 and analyze the exchanged messages.

a) *MAC addresses are stored in the ARP cache to avoid successive ARP requests. In order to ensure that ARP messages will be exchanged you have to clear the ARP cache. Use the man page of the arp command to find out how to delete ARP cache entries. Verify that the table is empty using arp -nv. What is the approximate lifetime of an ARP cahce entry?*

Answer: ARP cache entries have a typical lifetime of 20 minutes, after which the entry should be refreshed.

b) *Open Wireshark and start capturing incoming and outgoing traffic. Use the ping command to send 3 ICMP echo requests to the IP address 8.8.8.8. Locate the ARP messages exchanged (you can use appropriate display filters) and note the Ethernet and IP source and destination addresses. To which entities do these addresses belong and why?*

Hint: Use the command *ip route show* to check the local routing table. After running ping check the ARP table entries with the *arp* command. Use the results to explain you answer.

Answer:
ICMP echo request

Source MAC	Destination MAC
MAC of your interface used	Gateway MAC

Table 2: Layer 2 addresses

Source IP	Destination IP
your IP	8.8.8.8

Table 3: Layer 3 addresses

ICMP echo reply

Source MAC	**Destination MAC**
Gateway MAC	MAC of your interface used

Table 4: Layer 2 addresses

Source IP	**Destination IP**
8.8.8.8	your IP

Table 5: Layer 3 addresses