18-345
Introduction to Telecommunication Networks
Homework 4 solution

1. An Ad hoc wireless network consists of three laptops: **A**, **B** and **C**. One process on Laptop **B** is uploading a large file (300 MB) to Laptop **A** as fast as possible, with average throughput of 6Mbps.

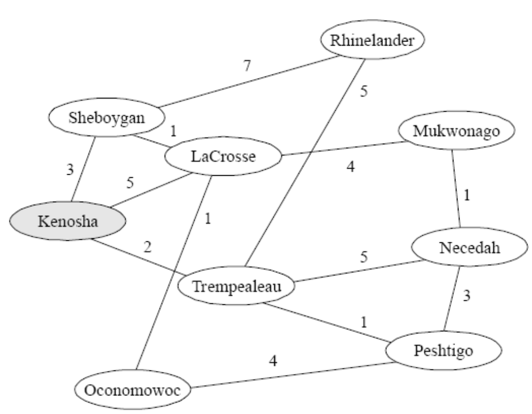
a. After a few seconds, the same process on Laptop **C** starts to upload a large file to Laptop A as well. All of a sudden, the throughput on Laptop **B** drops dramatically (~ 0.5Mbps). Explain what happens.

It is because of the hidden terminal scenario when Laptop C can not hear the transmission from Laptop B to Laptop A. Therefore packets from Laptop B and Laptop C collide at Laptop A.

b. RTS/CTS is then turned on for all the laptops. Assume RTS/CTS adds 20% overhead to the transmission time. What is the average throughput on Laptop **B**?

As the wireless media is shared between connection B ➔ A and C ➔ A, the average rate for Laptop B is 6Mbps/2/(1+20%)= 2.5Mbps.

2. You just moved to Kenosha, Wisconsin, and you would like to find the shortest routes to the following cities: LaCrosse, Mukwonago, Necedah, Oconomowoc, Peshtigo, Rhinelander, Sheboygan, and Trempealeau. The map is show below, with travel times marked on each route between cities.

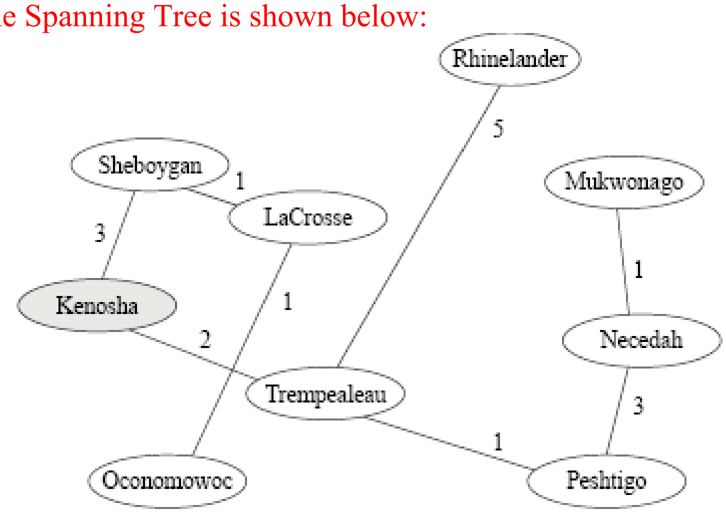


Use Djikstra's algorithm to find the spanning tree rooted at Kenosha. This is equivalent to finding the shortest paths from Kenosha to each of the other towns. At each iteration of the algorithm, please evaluate the nodes in alphabetical order. Also, draw the resulting spanning tree rooted at Kenosha.

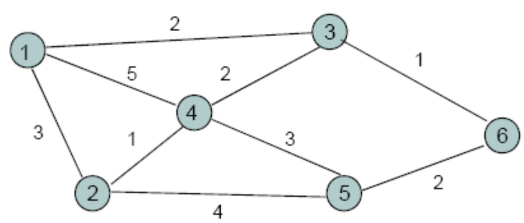
Solution:

	d(L)	d(M)	d(N)	d(O)	d(P)	d(R)	d(S)	d(T)
N{K}	5						3	2
N{K,T}	5		7		3	7	3	2
N{K,P,T}	5		6	7	3	7	3	2
N{K,P,S,T}	4		6	7	3	7	3	2
N{K,L,P,S,T}	4	8	6	5	3	7	3	2
N{K,L,O,P,S,T}	4	8	6	5	3	7	3	2
N{K,L,N,O,P,S,T}	4	7	6	5	3	7	3	2
N{K,L,M,N,O,P,S,T}	4	7	6	5	3	7	3	2
N{K,L,M,N,O,P,R,S,T}	4	7	6	5	3	7	3	2

The Spanning Tree is shown below:



3. Consider the network shown in Figure 7.30 in Leon-Garcia.



a. Use the Bellman-Ford algorithm to find the set of shortest paths from all nodes to destination node 3

Solution:

Iteration	Node 1	Node 2	Node 4	Node 5	Node 6
Initial	(-1,∞)	(-1,∞)	(-1,∞)	(-1,∞)	(-1,∞)
1	(2,∞) (3,2) (4,∞)	(1,∞) (4,∞) (5,∞)	(1,∞) (2,∞) (3,2) (5,∞)	(2,∞) (4,∞) (6,∞)	(3,1) (5,∞)
2	(2,∞) (3,2) (4,7)	(1,5) (4,3) (5,∞)	(1,7) (2,∞) (3,2) (5,∞)	(2,∞) (4,5) (6,3)	(3,1) (5,∞)
3	(2,6) (3,2) (4,7)	(1,5) (4,3) (5,7)	(1,7) (2,4) (3,2) (5,6)	(2,7) (4,5) (6,3)	(3,1) (5,5)

b. Now continue the algorithm after the link between node 3and 4 goes down.

Solution:

Iteration	Node 1	Node 2	Node 4	Node 5	Node 6
Before Break	(3,2)	(4,3)	(3,2)	(6,3)	(3,1)
1	(2,6) (3,2) (4,7)	(1,5) (4,3) (5,7)	(1,7) (2,4) (5,6)	(2,7) (4,5) (6,3)	(3,1) (5,5)
2	(2,6) (3,2) (4,9)	(1,5) (4,5) (5,7)	(1,7) (2,4) (5,6)	(2,7) (4,7) (6,3)	(3,1) (5,5)
3	(2,8) (3,2) (4,9)	(1,5) (4,5) (5,7)	(1,7) (2,6) (5,6)	(2,9) (4,7) (6,3)	(3,1) (5,5)
4	(2,8) (3,2) (4,11)	(1,5) (4,7) (5,7)	(1,7) (2,6) (5,6)	(2,9) (4,9) (6,3)	(3,1) (5,5)

4. (Pb. 8.6 In Leon-Garcia): A host in a organization has an IP address 150.32.64.34 and a subnet mask 255.255.240.0. What is the address of this subnet? What is the range of IP addresses that a host can have on this subnet?

Solution:

IP Address	150.32.64.34	xxxxxxxx.xxxxxxxx.01000000.xxxxxxxx
Subnet mask	255.255.240.0	11111111.11111111.11110000.00000000
Subnet address	255.255.64.0	xxxxxxxx.xxxxxxxx.01000000.00000000
Range of IP	150.32.64.1 to 150.32.79.255	xxxxxxxx.xxxxxxxx.01000000.00000001 to xxxxxxxx.xxxxxxxx.01001111.11111111

5. (Pb. 8.7 in Leon-Garcia): A university has 150 LANs with 100 hosts in each LAN.
   a. Suppose the university has one Class B address. Design an appropriate subnet addressing scheme?

Solution:

A Class B address has 14 bits for the network ID, and 16 bits for the host ID. To design an appropriate subnet addressing scheme, we need to decide the allocation of number of bits for the host ID versus the subnet ID.
Minimum number of bits that the subnet ID requires = ceiling ($\log_2(150)$) = 8
Minimum number of bits that the host ID requires = ceiling($\log_2(100)$) = 7
Allocate 8 bits for the subnet ID, and 7 bits for the host ID. There will be sufficient subnet-id bits to cover the 150 networks and enough host-id bits to cover the 100 hosts for each network. The subnet mask to be used is 255.255.255.128. Note that $(128)_{10} = (10000000)_2$. The layout of the IP address is as shown:

0	1	2 – 15	16	17 – 24	25 – 31
1	**0**	**Network ID**	**0 or 1**	**Subnet ID**	**Host ID**

   b. Design an appropriate CIDR addressing scheme.

Solution:

We waste one bit when using one class B address for 150 LANs with 100 hosts in each LAN. Using CIDR addressing scheme we can now allocate 15 bits for subnetID and host ID, and the first 17 bits will be used as Network ID, which can provide up to 2^17 = 131072 network IDs. The subnet mask remains the same (255.255.255.128). The layout of the IP address is as shown:

0 – 16	17 – 24	25 – 31
Network ID	**Subnet ID**	**Host ID**