1. What are the benefits of IPv6 over IPv4?

   See notes and the following link:
   http://en.wikipedia.org/wiki/IPv6#Comparison_to_IPv4
   http://www.networkcomputing.com/ipv6/six-benefits-of-ipv6/230500009

2. Describe both Link-State & Distance Vector approaches to routing.

   See notes and the following link:
   http://packetlife.net/blog/2008/oct/02/distance-vector-versus-link-state/
   http://www.javvin.com/routing-protocols.html
   http://en.wikipedia.org/wiki/Distance-vector_routing_protocol
   http://en.wikipedia.org/wiki/Link-state_protocol

3. Classify RIP/OSPF/BGP according to the following metrics: LS or DV, Intra-AS or Inter-AS, Centralized or Distributed.

   RIP – DV, Intra-AS, Distributed
   OSPF – LS, Intra-AS, Centralized
   BGP – DV, Inter-AS, Distributed

4. Many network engineering problems are about resource allocation – namely the allocation of a set of finite resources amongst users with certain needs. Suppose there are 3 users competing for a 90 mbps link. Users 1 and 2 want 50 mbps each and User 3 wants 10 mbps. My solution is to give each one 30 mbps. Is this fair?

   Equal Distribution could be considered fair. It depends on your definition of fairness.

   Another definition of fairness is Proportional Fairness – meaning you give each user bandwidth in proportion to what was requested:
   User 1 and User 2 each get 90*50/110 mbps and User 3 gets 90*10/110 mbps.

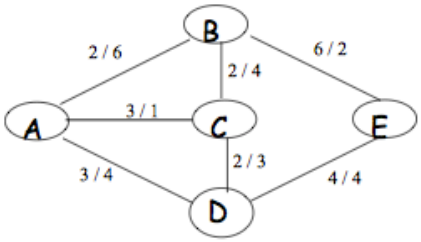
5. We discussed max-min fair in class. What is the max- min fair allocation? What is the TCP fair solution?

   Max-Min Fairness: The aim is to maximize the minimum resource any flow gets. This means that small flows receive what they demand and larger flows share the remaining capacity equally. Bandwidth is allocated equally to all flows until one is satisfied, then bandwidth is equally increased among the remainder and so on until all flows are satisfied or bandwidth is exhausted.

   For the previous problem, the max-min fair allocation is:
   User 3=10 mbps, User 1= User 2 = 40mbps

   TCP Fairness – the allocation algorithm must give the same average resources the same flow using TCP. See http://en.wikipedia.org/wiki/Fairness_measure

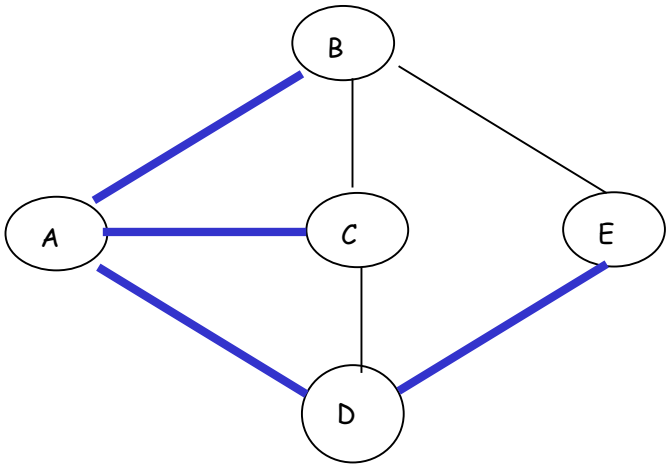
6. Consider the communication graph below. The edge labels are of the form a / b, where a is the cost in dollars of using that link and b is the delay in seconds of using that link. Run Dijkstra's algorithm on this graph and find the optimal route from A to E.



Let's compute least cost optimal routes.

	B	C	D	E
A	2A	3A	3A	∞
AB	--	3A	3A	8B
ABD	--	3A	--	7D
ABDC	--	--	--	7D
ABDCE	--	--	--	--

Shortest path: A-D-E
Shortest path Spanning tree shown in bold in graph



Question: What would happen if you had broken the tie differently?

7. For the communication graph above, state the distance vector table that would be computed by node D using the distance vector algorithm.

Let's compute least cost DVs.

		Via (Neighbors of D)		
		A	C	E
Destin-ation	A	3	5	11
	B	5	4	10
	C	6	2	10
	D	6	4	8
	E	10	8	4

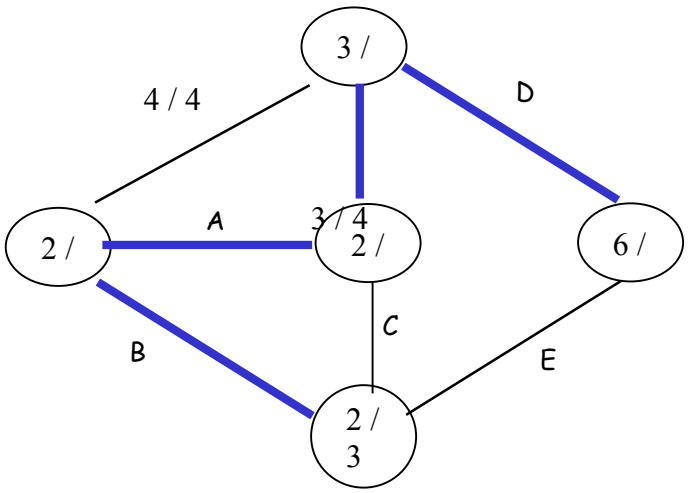
8. Did you notice that the previous two questions (6 &7) were not well defined? Remember that when you see the word "optimal", you should first ask what is the optimality metric? Is it cost? Or is it delay? Compute both the delay optimal route and the cost optimal routes.

   Let's compute minimum delay routes using Dijkstra's Algorithm.

	B	C	D	E
A	6A	1A	4A	∞
AC	5C	--	4A	∞
ACD	5C	--	--	8D
ACDB	--	--	--	7B
ACDBE	--	--	--	--

Shortest path: A-C-B-E

Minimum Delay Spanning tree shown in bold in graph

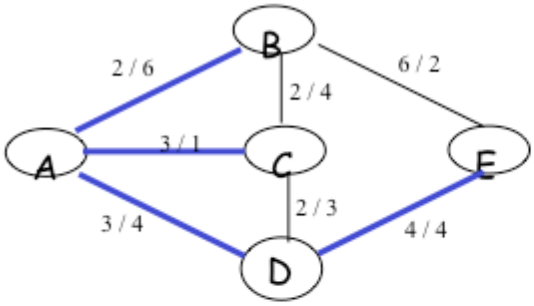


9. In the resource allocation problem, you were asked to compute a "fair" solution. Again, you need to ask first what is the fairness metric? What are some notions of fairness?

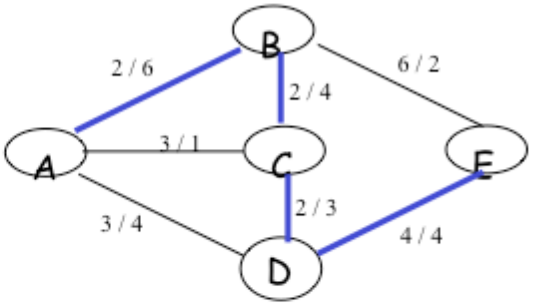
   Equal Distribution Fairness
   Proportional Fairness
   Max-min Fairness
   What other types of fairness can you think of?

10. Compare the Dijkstra Shortest Spanning Tree to the Minimum-cost Broadcast Spanning Tree for the graph in Question 6.

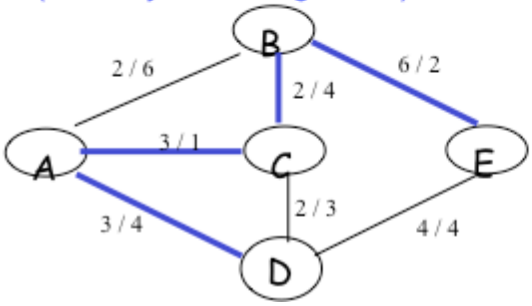
Minimum-cost spanning tree from A
(from Dijkstra's Algorithm)



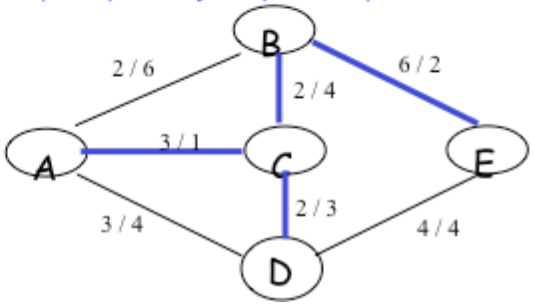
Minimum-cost broadcast spanning tree
(compute by inspection)



Minimum delay spanning tree from A
(from Dijkstra's Algorithm)



Minimum delay broadcast spanning tree
(compute by inspection)



11. Consider a wireless network. Does carrier sensing always work in wireless networks? What MAC does WiFi (802.11) use? Describe it and compare it to the MAC used in Ethernet.

For an overview, see: http://en.wikipedia.org/wiki/Carrier_sense_multiple_access

Ethernet uses CSMA/CD:
http://en.wikipedia.org/wiki/Carrier_sense_multiple_access_with_collision_detection

Wifi (802.11) uses CSMA/CA:
http://en.wikipedia.org/wiki/Carrier_sense_multiple_access_with_collision_avoidance

802.11 also has an additional mechanism called the RTS/CTS mechanism:
http://en.wikipedia.org/wiki/IEEE_802.11_RTS/CTS