1. Routers typically employ many buffers/queues in their design.

   (a) What is the purpose of the buffer at the input ports of the router? When would the user need to use this buffer? Describe a situation when this buffer might fill up to its capacity.

   (b) What is the purpose of the buffer at the output ports of the router? When would the user need to use this buffer? Describe a situation when this buffer might fill up to its capacity.

   (c) Give one reasonable course of action for a router to do when a buffer is completely full.

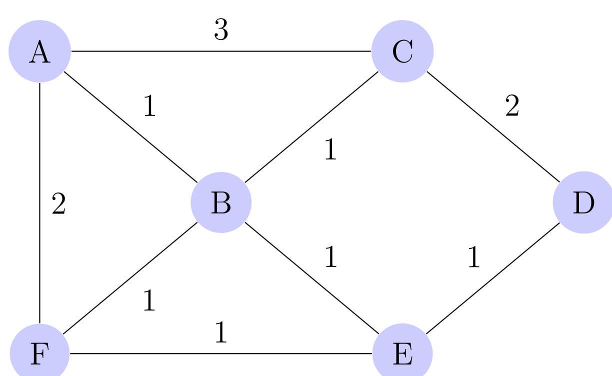
2. Layer 2 switches and Layer 3 routers have similar functionality in that they take a chunk (e.g., frame and packet, respectively) of data coming in on one port and send it out on a different one. Where there is a switch in a network, it is usually possible to replace it with a router and vice-versa. Let's examine some of the reasons influencing a network engineer's choice to use a switch (and make the LAN bigger) versus a router (to connect two separate LANs).

   (a) What are some pros and cons of switches versus routers when considering management and set-up?

   (b) What are some pros and cons of switches versus routers when considering network size?

   (c) What are some pros and cons of switches versus routers when considering how efficiently the packet traverses the network?

3. Consider the following network:



The following table above shows a routing table on node A before any distance vector updates have been received (assume A knows the cost of reaching its immediate neighbours). As you can see, each row of the table stores the distance to a particular node through one of A's neighbours.

to/via	B	C	F
B	1	∞	∞
C	∞	3	∞
D	∞	∞	∞
E	∞	∞	∞
F	∞	∞	2

(a) What does the table look like when A receives the initial distance vector update from node C?

(b) What does the table look like when A receives the initial distance vector update from node B?

(c) What does the table look like in the steady state, after several updates?

4. For this question you will design a custom link-state routing system for a network. You can assume that all links are bi-directional and every node has a unique network identifier of four bytes. You can also assume that the link layer provides a mechanism for a node to exchange arbitrary messages with its immediate neighbours.

   (a) Design the messages that nodes will exchange to obtain information about the state of the link between itself and its immediate neighbours.

   (b) Describe the steps (using the messages you designed above) that nodes should follow in order to collect link state information from their immediate neighbours.

   (c) Design an appropriate link-state message for communicating link-state information across the entire network.

   (d) Describe the steps nodes should employ to share out the link-state messages in designed in the previous part.

   (e) A network using your system has n nodes, l links, the maximum degree of any node is k and there is a path between any two nodes of not more than d hops. Give a bound on the total amount of information which must be transmitted (in bytes) to ensure that every node acquires complete topology information, in terms of n, l, k and d.

5. You are attempting to get two computers (computer A and computer B) on the same Ethernet network connected over IP manually (i.e., no DHCP server on the network). You set computer A's IP to be 172.16.123.10 with subnet mask /25 (sometimes written as 255.255.255.128).

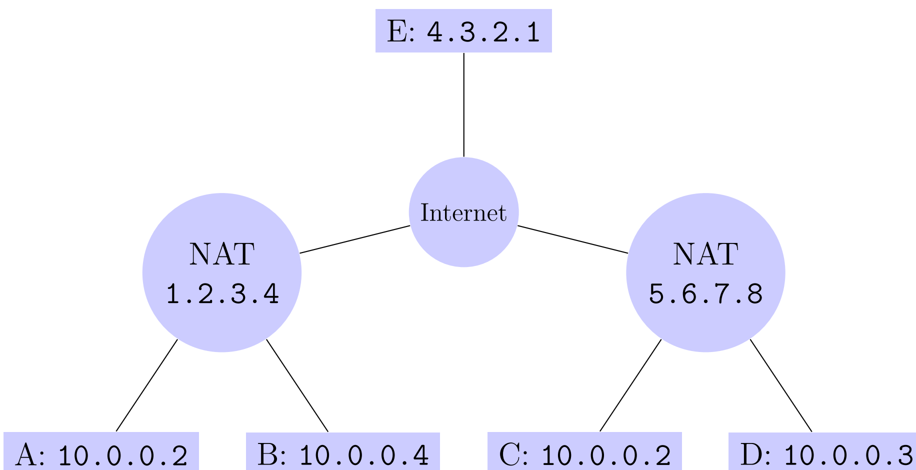
   (a) What is a possible IP address you could assign to computer B that would allow A to communicate with B over the LAN?

   (b) What would happen if on computer B you made a typo and set the subnet mask on computer B to /24?

   (c) What would happen if instead your typo had set the subnet mask to /29?

6. Course handout question 12

7. Consider the following network topology where some residential hosts connect to the Internet via NAT devices:



   (a) Host A has an active SSH connection (Port 22) to Host E. Give a plausible value for the (source address, destination address, source port, destination port) 4-tuple for packets in this connection as they exit Host A's computer. Indicate what elements of the tuple would be assigned at connection time (pick whatever value you want for these *ephermeral* ports).

   (b) What is a plausible value for the (source address, destination address, source port, destination port) 4-tuple for packets for the connection in (a) when they arrive at Host E? Again, indicate what elements would be assigned at connection time.

(c) Suppose Host D wishes to serve web pages (on port 80) to the Internet. What must happen in order for devices on the Internet to access the server on Host D?

(d) Host B attempts to connect Host D (i.e. by sending a packet to D). List out how the (source address, destination address, source port, destination port) 4-tuple evolves as it traverses the network from B to D. Indicate what elements would be assigned at connection time.

(e) Host A and Host C have the same IP address. Is this an issue? Explain why it is or isn't.