1. (a) Sketch the signal on a wire if the bit sequence 11111010 is to be transmitted using Manchester Coding (Slide 12 in Topic 3). Note: It will be easier to make this sketch if you draw a reference clock signal.

   (b) One of the reasons why Manchester-coding is used, despite having a bitrate that is half the baud rate, is because the receiver can synchronize with the sender's clock using the data stream. This allows the sender to send data at high bitrates on a single wire (i.e., no need for a separate clock signal). Suppose the receiver starts listening to the signal at some arbitrary time after the signal has started arriving. Explain how the receiver can identify which edges in the received signal are the ones that correspond to data bits.

   (c) A quad-level code (same slide) has a bitrate that two times the baud rate. What is the bitrate in terms of a baud rate of an 8-level (oct-level?) code? Explain what physical limits exist that prevent an arbitrarily large amount of data to be sent using a very slow clock.

2. (a) Using the CRC-8 polynomial $x^8 + x^2 + x + 1$, compute the 8-bit CRC of the 16-bit message 0xCAFE.

   (b) Show the computation the receiver performs in order to detect that the above message is corrupted when several bits are flipped.

3. A standard Ethernet frame consists of a number of fields.

   (a) Explain why the source address field is important.

   (b) If a user only knows the IP address of a host on the network and not its MAC address, how does the computer know what to put in the destination address field?

   (c) Give a reason why it makes sense for error detection to be implemented in the Ethernet link layer rather than in the network layers above.

4. How does a sender on a shared medium network know a collison has occured?

5. If you recall, in our last supervision we discussed the value of adding encryption at the link layer to safeguard the traffic being flood-forwarded in Ethernet hubs and switches. The security advantages are compelling, but the end-to-end principle says to be careful about introducing too much functionality in intermediate layers. What are some of the problems adding encryption at the link layer might introduce?

6. Define one ‘bit-time’ as the time it takes for a network interface to place a bit onto a link. Two hosts, A and B, are connected by a link over some distance. On this link, it takes 340 bit-times for data to propagate from one host to the other (but the hosts have no way of knowing this). Messages on the link have a size of 576 bits.

   Consider the case where at time 0, A sends a single message. At some later time t, B begins transmitting a message of its own.

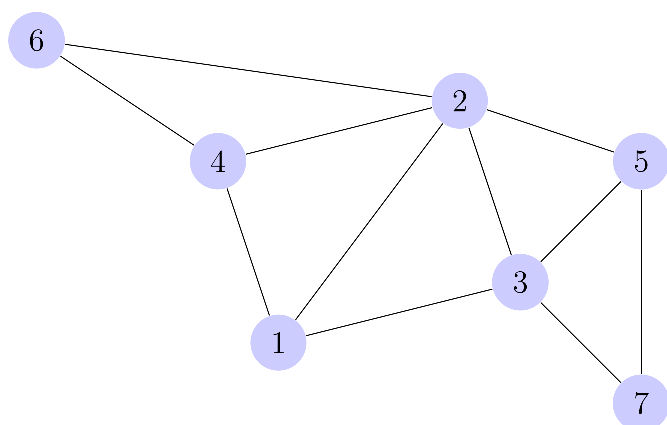
   (a) For what values of t will there be a collision?

   (b) For what values of t will there be a collision that A is not aware of?

   (c) For what values of t will there be a collision that neither A nor B is aware of?

   (d) How do your answers change if A and B are separated by 1000 bit-times?

7. Consider the following topology of devices within a LAN.



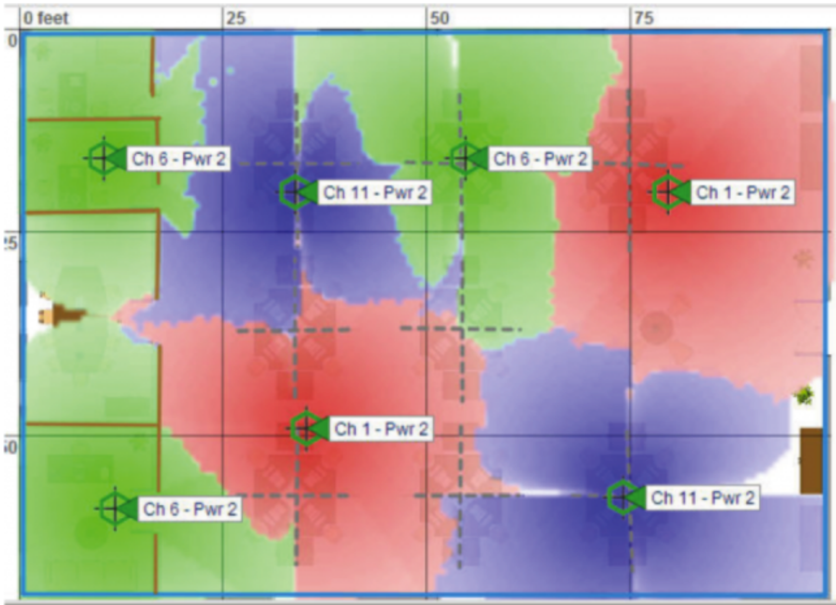
   (a) If the circles represent Ethernet hubs, what problem will arise?

   (b) If the circles represent Ethernet switches that implement the spanning tree protocol (the switch IDs are the numbers within the circles, assume all links have a distance of 1), what is the resulting spanning tree that is formed?

   (c) How does the tree change if switches 1 and 3 are removed?

8. A common recommendation for setting up Wi-Fi access points in a building is to give adjacent APs different channels as in the figure below. Another recommendation, which seems counter-intuitive at first, is to *reduce* the transmission

power of each AP for better performance. Explain why these recommendations make sense within the context of a building.



9. Layer 2 switches and Layer 3 routers have similar functionality in that they take a packet 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.

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

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

   (c) What are the pros and cons of switches versus routers when considering the path a packet takes when traversing the network?

10. You have been asked to design a topology discovery protocol for a network of switching nodes interconnected by links. There are 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. All links are bi-directional. Each node has a unique identifier of four bytes which it knows.

    (a) Design a protocol (including message formats) for nodes to learn about their immediate neighbors.

(b) Design a protocol (including message formats) for distributing this information across the network.

(c) Give a bound on the total amount of information which is transmitted (in bytes) to ensure that every node acquires complete topology information.

11. As you know, every network card is given a globally unique MAC address. Someone proposes that we could do away with having to configure IP addresses on computers if we simply used the MAC address as a device's IP address (adjusting the size of the address field accordingly). Explain why this might be a bad idea (and why IP does not do this).