Homework 1: Link Layer

Due: 11:59 PM, Oct 1, 2019

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1 168. . . Mbps

You are taking 168, and are tasked with achieving at least 168Mbps in a new wireless transmission scheme. The radio you are given is using the 2.4GHz unlicensed spectrum (same as some of the WiFi specs), and channels of 21 MHz of bandwidth (B). You have the following modulation schemes to choose from in the chipset of your radio: BPSK, QPSK, 8PSK, 16-QAM, and 256-QAM. PSK is phase-shift keying, and QAM is Quadrature Amplitude Modulation (when we vary both phase and amplitude). The number of "levels" (M) of these schemes are, respectively, 2, 4, 8, 16, and 256.

1. What is the simplest of these schemes you need to use to achieve 168Mbps (168×10^6 bits/s)?
2. You measured the noise floor to be -90dBm, and the receive power at the receiver to be -70dBm. Show what the S/N ratio is (not in dB), and then compute the highest bitrate you can get on this channel. What is the best among the modulation schemes above that you can use, and what rate does it achieve?
3. If that is not enough to transmit 168Mbps, by what factor do you have to multiply the transmit power of the radio so that you can achieve the desired rate of 168Mbps?

2 Up the stack

You are designing a new networking stack, and have the choice of where to place functionality. Here we are going to compare the effects of adding retransmissions at the link layer to offer reliability. Suppose you have a single link between two nodes, and there is a 10% chance of a frame not making it to the other side. You propose a scheme that does up to 3 retransmissions.

1. On the good side, by doing retransmissions, you increase the chance of a packet making it through. Assume timeouts are perfect, and that the receiver is happy as soon as it gets a copy of the frame. (For example, if a packet makes it, and the ack fails, and there is another retransmission, the first one already counts. In other words, losing an ack doesn't matter

for this calculation.) **With up to 3 retransmissions, what is the probability that a packet is received?** (It may be easier to think of the complement of the probability of a packet not making it. . .)

2. On the not so good side, **what is the expected time it takes for the first successful transmission of a packet?** (Expected time is just the sum of products of the probability of an a scenario by the time in that scenario). Give the times in units of an RTT (e.g., a packet received in the first transmission takes 0.5 RTT).
3. These numbers look pretty good. However, give a reason why you would like to add the retransmissions, an one why you would not.

3 Stubborn Switches

In class we talked about learning switches.

1. What is the difference in correctness and performance, between the following switches: (a) a switch that doesn't learn (has no table to store any mapping); (b) a switch that has memory for just 2 entries in its learning table; (c) a switch that has enough memory for all nodes in a network; and (d) a switch that never forgets an entry. If there are any correctness issues, describe a scenario in which something bad happens for the corresponding switch.
2. We talked in class about an attack to learning switches, where an attacker can make a switch forget a mapping to a victim, and then start broadcasting packets for that node, which the attacker can then get. If a victim sends 10 equally spaced packets/s and the switch has 32 entries in its MAC learning table, how many packets per second does an attacker have to generate so that it can snoop on (almost) all packets sent to the victim? Assume the switch removes entries in LRU (least-recently-used) fashion.

4 Don't shout at the same time!

1. What does it mean to say that all packets on an Ethernet network are in the same broadcast domain?
2. What is the advantage of the randomized exponential backoff scheme for Ethernet, when compared to a scheme in which you just assign defined time slots for each node to transmit?
3. If you use MAC learning switches, which avoids broadcasts, then you don't need to worry about the Spanning Tree algorithm. True or False, and why?

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