ECE438 MP4 analysis

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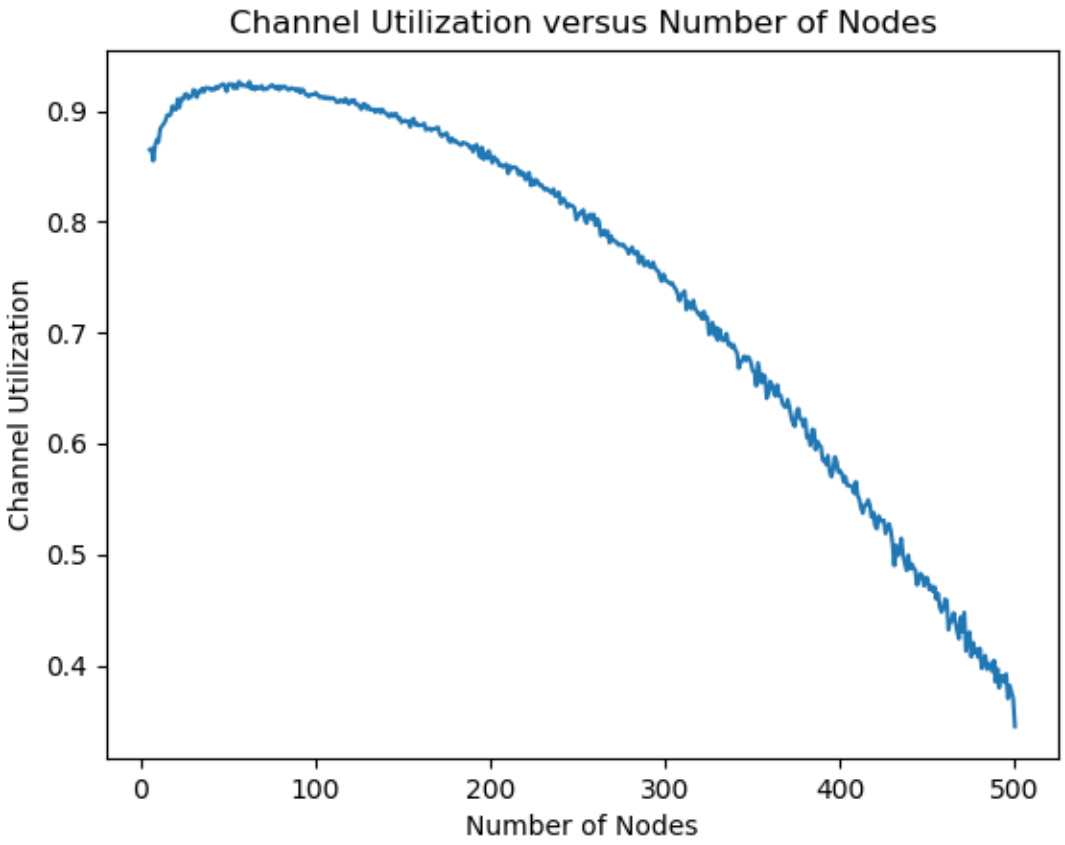
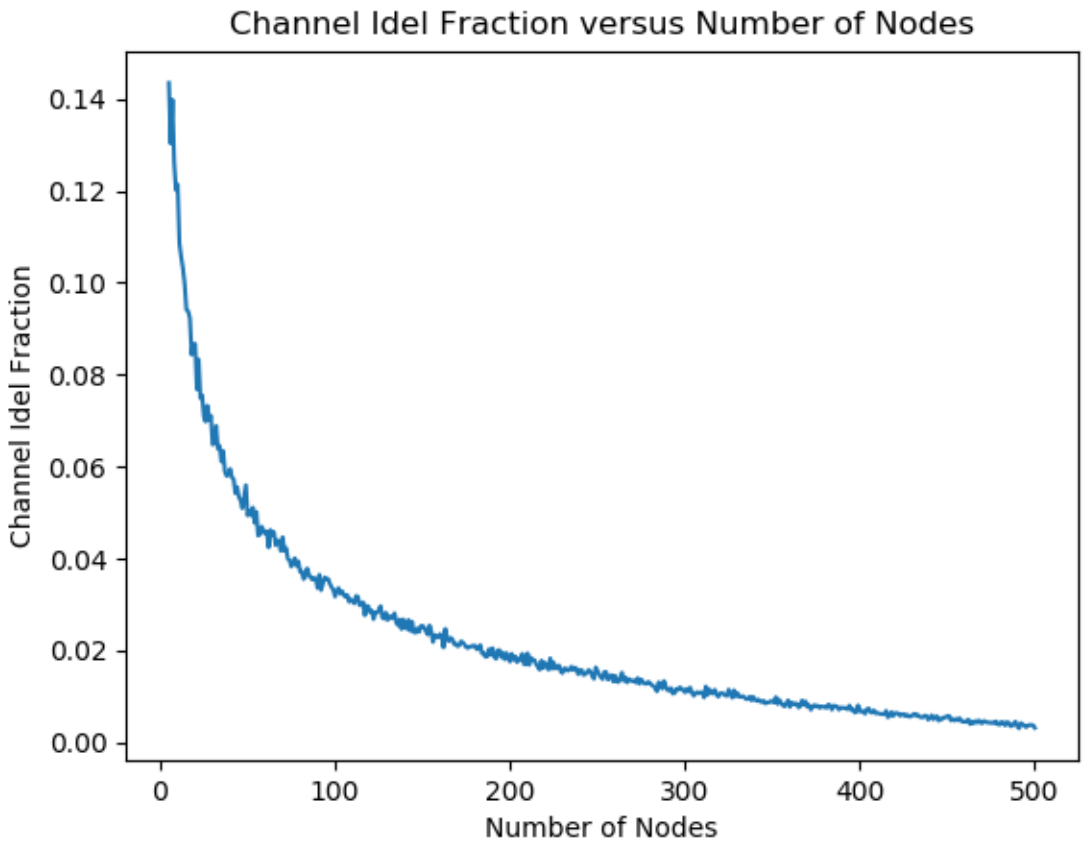
(a)



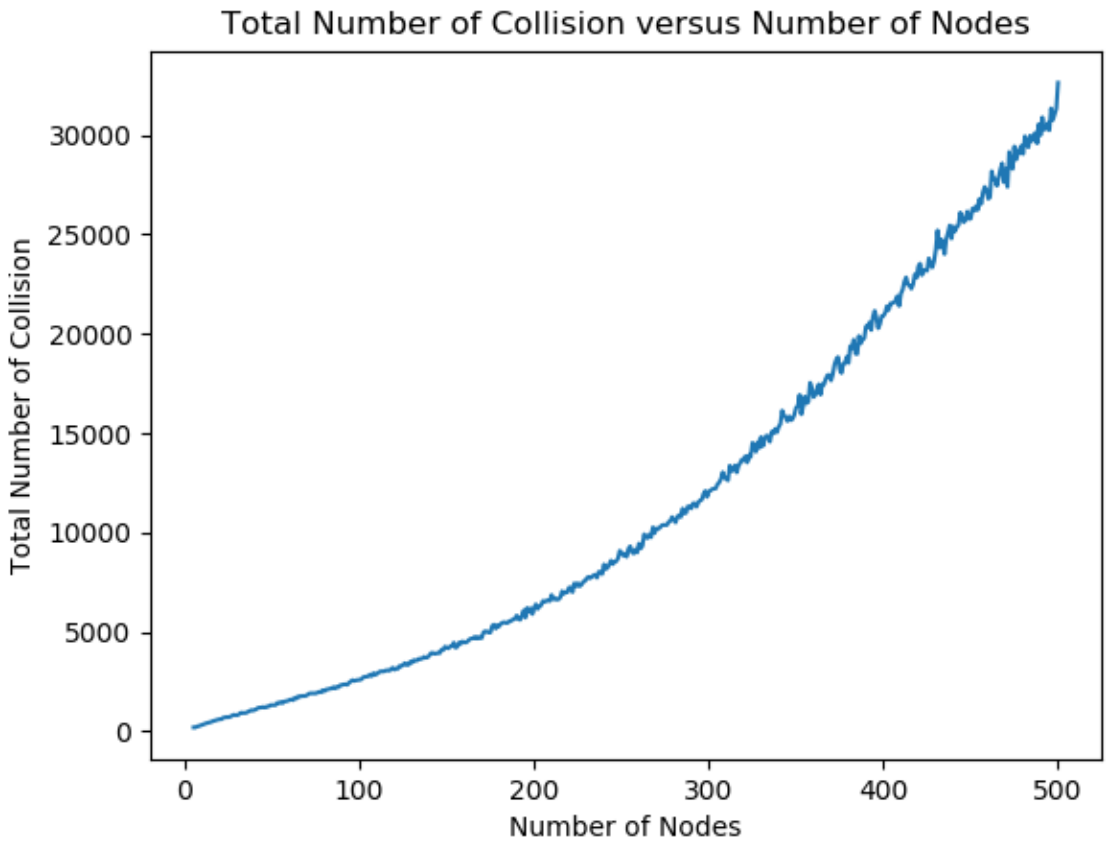
Explanation: Channel utilization first increases then decreases as number of nodes increases. It first increases because as number of nodes increase from 5 to around 80, more nodes randomly count down to zero. Since initially the network is underutilized, the possibility that in each time unit there is exactly one node ready to send a packet increases, which results in increasing correct communication time. However, as number of nodes keeps increasing, the possibility of node collisions also increases. Since the network is congested, in each time unit, it is more likely that more than one node is ready to send a packet. As a result, after number of nodes exceeds around 80, channel utilization decreases because of increasing collision rate.

(b)



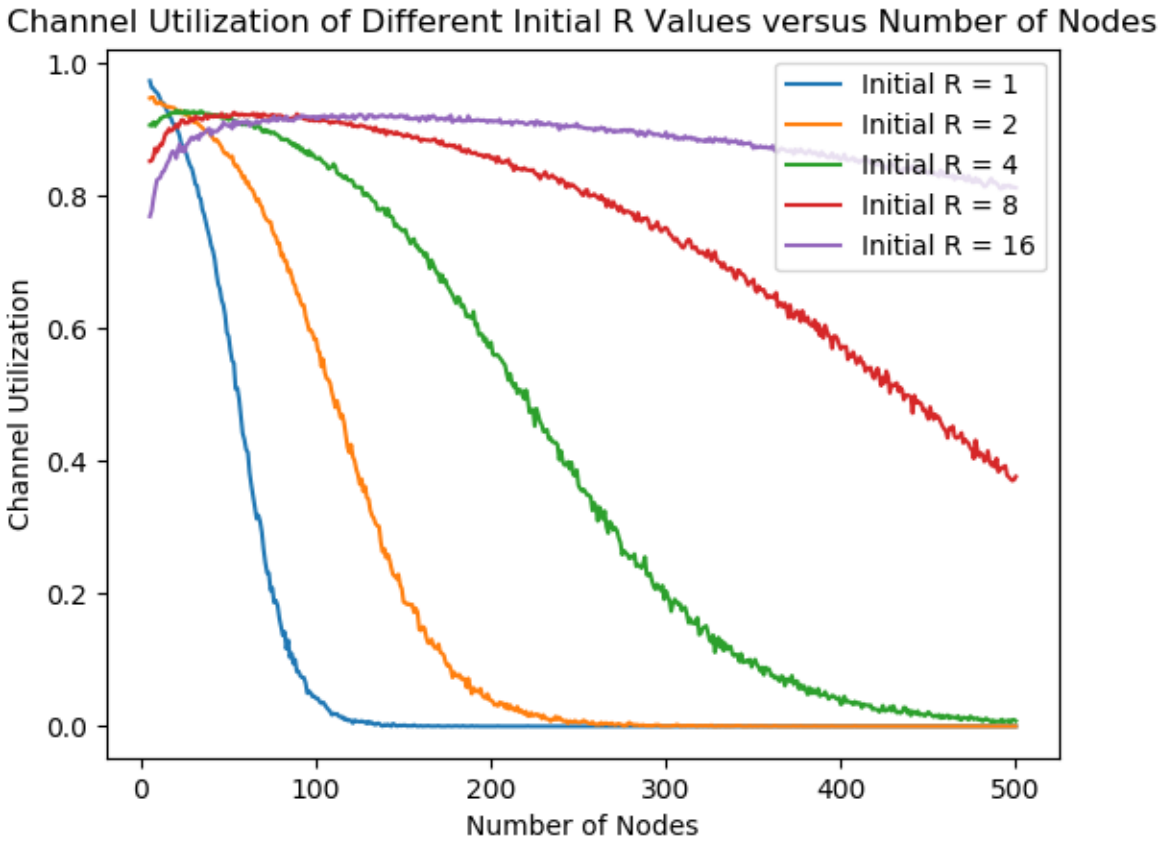
Explanation: Channel idle fraction decreases as number of nodes increases. Channel is idle if in a time unit none of the nodes is ready to send a packet. Channel idle fraction decreases because as number of nodes increases, more nodes randomly countdown to zero. Therefore, the possibility that in each time unit there is one or more nodes ready to send a packet increases. Consequently, channels are less likely to be idle and idle fraction decreases.

(c)



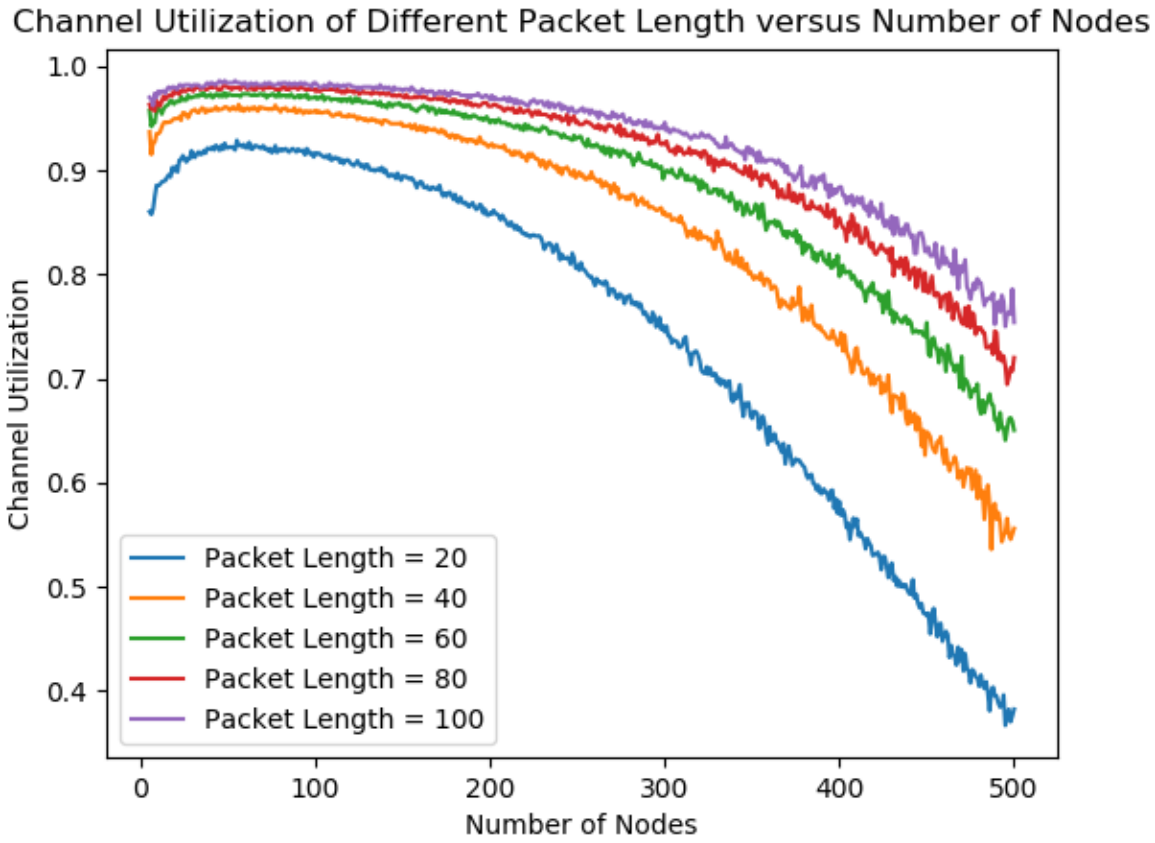
Explanation: Total number of collisions increases as number of nodes increases. It increases because as number of nodes increases, more nodes randomly countdown to zero. Therefore, the possibility that in each time unit more than one node are ready to send a packet increases. As a result, there are more collisions when nodes increase.

(d)



Explanation: If R is initialized as 4, 8 or 16, channel utilization first increases then decreases as number of nodes increases. If R is initialized as 1 or 2, channel utilization strictly decreases as number of nodes increases. The network is underutilized initially, therefore channel utilization first increases as nodes increase. After a certain point, network become congested and the performance decrease caused by node collision out-weights the performance gain from having more nodes sending packets. As a result, channel utilization decreases. For different initial countdown values, the optimum number of nodes differs. For R = 4, the optimum point (the point where channel utilization is the highest) is around 60. For R = 8, it is around 80. For R = 16, it is around 120. This is because as initial R increases, the random count down limit increases, which means nodes are less likely to collide. Therefore, the point where the negative effects of node collision out-weights the positive effects of node increase moves to right as R increases. For R = 1 or 2, the initial countdown value is too small that as soon as number of nodes increase, the negative effects of node collision out-weights the positive effects of node increase. Therefore, channel utilization strictly decreases for R = 1 or 2.

(e)



Explanation: Channel utilization first increases then decreases as number of nodes increases. As packet length increase, channel utilization increases. The network is underutilized initially, therefore channel utilization first increases as nodes increase. After a certain point, network become congested and the performance decrease caused by node collision out-weights the performance gain from having more nodes sending packets. As a result, channel utilization decreases. For same number of nodes, channel utilization increases as packet length increase, because more time are spent on sending packets than counting down and handling node collisions. As shown in the graph, the optimum point (the point where channel utilization is the highest), which is between 60 to 80 nodes, is not relevant to packet length. But channel utilization changes more smoothly for a larger packets length as nodes increase. It increases less and decreases less. This is because while a node is taking a long time to send a large packet, all other nodes have to freeze their count down and wait. Therefore, the positive effects of having more nodes counting down is decreased as most of the time the nodes will wait for the large packet to finish sending. Channels are fully utilized even when number of nodes are small. On the other hand, because the packets are large, node collisions are less likely to happen. More time are spent on sending packets than counting down and handling collision when multiple nodes count down to zero.

(f) see explanations of (d), (e) above.