Mobile Communications
Problem Set 8

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1. Assume an IEEE 802.11n system with a capacity of 600 MBit/s. If you transmit packets of 1400 Byte length and no frame bursting takes place (i.e. each frame has its own PHY and MAC header), which long-term average throughput could you achieve using the distributed coordination function (DCF) without the RTS/CTS scheme? What does this mean with respect to efficiency? Assume a slot time of 9 μs and a backoff value drawn from a uniform distribution between 0 and 31.

   Solution:

   First, we need to calculate the average backoff time $\bar{t}_{backoff}$:

   $$\bar{t}_{backoff} = 9\mu s * \frac{31-0}{2} = 139,5\mu s \tag{1}$$

   The payload transmission time can be computed as $t_{data} = l/C$ with l being the packet length and C being the channel capacity:

   $$t_{data} = \frac{1400 * 8Bit}{600MBit/s} \approx 18,67\mu s \tag{2}$$

   Using the renewal reward theorem as used in the DCF, we can compute the long-term average throughput S in the following way:

   $$S = \frac{l}{t_{SIFS} + t_{DIFS} + t_{preamble} + t_{data} + t_{ack} + \bar{t}_{backoff}} \approx 46MBit/s \tag{3}$$

   Thus, the efficiency $S/C \approx 7.67\%$, which is very low.

2. An IEEE 802.11a network that covers a large hall has to be planned. The goal is to provide a minimum data rate of 24 Mb/s all over the place. What are the constraints that have to be satisfied? How can we assure these? The access points have a transmit power of 63 mW. Transmit antennas with a gain of 2 dB are used. The required received signal power to ensure a data rate of 24 Mb/s is -74 dBm. Assume a path loss coefficient of $\gamma = 2.5$. What is the maximum cell size? How many different channels N are required for $S/I \geq 13$ dB?

   Solution:

   The solution is included in the slides "Problem Set 8.2 sol.pdf".