Mobile Communications
Problem Set 6

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1. You want to deploy a Gigabit local area network in your company using Jumbo frames of size 9000 Byte and link speeds of 1 Gbps. The maximum distance of the computing stations in your network is 500 meters. Assume a wave propagation speed of $2 \cdot 10^8 m/s$ in cable. Which random MAC technique would you use and why?

   Solution:

   In the lecture we reviewed the random multiple access techniques CSMA and ALOHA. Given the scenario above we calculate the vulnerability period t_P, i.e., the time until all stations sense the ongoing transmission as

   $$t_P = \frac{500m}{2 \cdot 10^8 m/s} = 2.5\mu s.$$

   We calculate the collision window t_T for slotted ALOHA as

   $$t_T = \frac{9000 * 8bit}{1 \cdot 10^9 bit/s} = 72\mu s.$$

   Since the vulnerability period is much smaller than the collision window, i.e., $t_T >> t_P$ we choose CSMA.

2. Consider a 802.11 system using the DCF. The throughput for a single station can be calculated using the renewal reward theorem as

   $$S = \frac{l}{t_{\text{DIFS}} + t_{\text{backoff}} + t_{\text{preamble}} + t_{\text{data}} + t_{\text{SIFS}} + t_{\text{ack}}}$$

   with $t_{\text{data}} = l/C$ where l is the packet length in bit and C is the nominal channel capacity. Name 4 different possibilities to increase the throughput of the considered systems including pros and cons.

   Solution:

   In case of IEEE 802.11g with 54 Mbps nominal capacity we have $t_{\text{DIFS}} + t_{\text{backoff}} + t_{\text{preamble}} + t_{\text{SIFS}} + t_{\text{ack}} \approx 240\mu$s and $t_{\text{data}} \approx 220\mu$s. The throughput depends on packet size such that for a packet size of 1500 Byte we find a throughput of 26 Mbps!

   To increase the we have several possibilities such as

   - increasing the packet size l. Note that 802.11 is often used in combination with Ethernet. Thus, from a practical view 1500 Byte is the maximum transfer unit that does not get fragmented when using Ethernet.

- increasing the capacity C. This can be done by increasing the channel bandwidth as in the case of 802.11n with 40 MHz instead of 20 MHz.
- decreasing the mean backoff time through adjusting the parameter of the exponential backoff distribution. In case of a single station this is good idea. However, for more than one station this would lead to an increase of the collisions.
- decrease the preamble time. The preamble is important for synchronization and channel error estimation. A change of the preamble means that older equipment is not supported anymore. A too short preamble may lead to synchronization problems.