Mobile Communication

Exercise Sheet # 2

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Exercise 1: Basics of IEEE 802.11 medium access

1. The DCF allows for automatic medium sharing through the use of CSMA/CA with a random backoff time following a busy medium condition. All directed traffic uses immediate positive acknowledgment (ACK frame) where retransmission is scheduled by the sender if no ACK is received.
   Let's assume that a node has data that it needs to transmit. First it will wait a random backoff time. This is a random number of time slots which is within a contention window. If at any time the node senses that another node is using the channel, it will pause its timer until the other node has finished transmitting. When the backoff time has expired, the node will "sense" the channel to determine if there is another node transmitting. If the channel is clear, it will then wait for a short time and sense the channel again. If the channel is still free, it will transmit a request to send (RTS) to the destination. The destination will respond with a clear to send (CTS) if it is available to receive data (i.e. if it is not receiving data from another node). When the source node receives the CTS, it will transmit its data. After correct reception of the data, the destination will transmit an acknowledgment (ACK) back to the sender. At this point, if the sender has more data to transmit, it will again begin its backoff and repeat the process.
   As we can see from the example above DCF uses collision avoidance (CA) as collision detection (CD) is not possible because of the wireless medium. Carrier sensing is the primary method used to avoid collision. Along with carrier sensing, interframe spacing is primarily used to ensure that the channel is truly free. When a node is sensing the channel, it must be free for the length of the DCF interframe spacing (DIFS) period. The short interframe spacing (SIFS) is used as the wait time between the RTS, CTS, DATA and ACK frames. Since the SIFS is always shorter than the DIFS, this ensures that another node does not incorrectly determine that the channel is idle during the handshake and that priority is given to the transmission in progress.

   -5 wrong!

   RTS/CTS is optional

2. IEEE 802.11b standard:
   slot time = $20\mu s$, DIFS = $50\mu s$
   $DIFS = SIFS + 2 * slotTime \Rightarrow SIFS = 10\mu s$

   Backoff Calculation:
   In order to avoid collisions, DCF also specifies random backoff, which forces a station to defer its access to the channel for an extra period.
   After detecting the channel as being idle for a minimum duration called DCF Inter Frame Space (DIFS), sender performs a random backoff procedure. The duration of this random backoff time is determined as a multiple of a slot time:

   $$BackoffTime = random() * aSlotTime$$

   If the channel remains idle, the backoff time counter is decremented by one for each idle time slot. If the channel becomes busy, backoff counter is frozen until the medium becomes idle

again. Once the backoff counter reaches the 'zero', the device is allowed to acces the medium and transmits. Each device maintains a so-called Contension Window (CW), from which sender chooses a random backoff time before transmission. Backoff Time (BT) in IEEE DCF is calculated as below:

$$BT = Random(0, CW_i) * aSlotTime$$

Here CW is the contension window. After each succesfull transmission, the contention window is reset to CW_{min}, otherwise CW_i is calculated as $CW_i = 2^{k+i-1}$, where i is the number of attempts (including the current one) that have been made to transmit the current packet, and k is a constant defining the minimum contention window CW_{min}. And $aSlotTime$ is the slot time determined by physical layer characteristics.