Mobile Communication
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Assignment Sheet #5

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Exercise 13: (Active Scanning)

The following example of a moving device was shown in the lecture. The device moves out of the transmission range of AP1. Thus it needs to find new access points in reach as quickly as possible (figure 1).

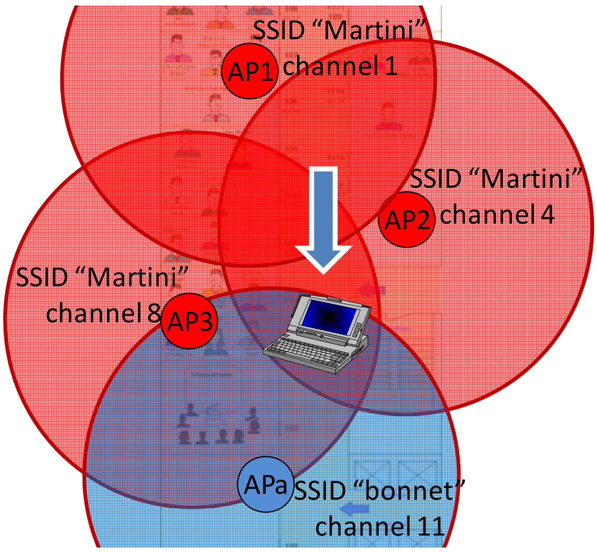

Figure 1: Moving device gets within reach of 3 different access points

The moving device is now within the reach of 3 different access points, which belong to 2 different service sets. This layer 2 handoff process requires 3 steps to be performed by the client: scanning, authentication and association. We assume here that an "active scanning" procedure is used [1].

a) Draw a detailed sequence diagram of the message exchange during the handover procedure. What would be different if AP2 and AP3 share the same channel (IBSS)?

b) The discovery process can take a significant fraction of the time of the handoff procedure. Discuss what influences the speed of the discovery process. Compare the "active scanning" and "passive scanning" procedure.

Exercise 14: (IEEE 802.11 Medium Access Control)

Plot the timeline of the following scenario for an IEEE 802.11 network operating in ad-hoc mode with stations A, B, C, and D, which are all within each others transmission ranges:

- At time t=0, station A generates two unicast frames of length 1000 bytes for station B.
- At time t=2ms, station C generates one unicast frame of length 1200 bytes for station D.
- At time t=6ms, station B generates one unicast frame of length 100 bytes for station A.
- At time t=10ms, station D generates one unicast frame of length 200 bytes for station A.
- The following backoff times are chosen: A: 120µs and 200µs; B: 40µs and 180µs; C: 80µs; D: 100µs.

All frame lengths already include the MAC overhead! All frames are sent at 2MBit/s. Furthermore, assume that the "ack timeout", i.e. the timeout that triggers a retransmission of an unacknowledged fragment, does not take signal propagation delays into account. I.e., a retransmission is triggered exactly when the last bit of the missing acknowledgement should have been received.

To solve this task, some information is necessary in addition to what has been taught in the lecture. In the IEEE 802.11 specification [1], you can find that for the DSSS PHY layer, a slot time is 20µs, a SIFS is 10µs, and a DIFS is two slot times longer than a SIFS. Each IEEE 802.11 packet is preceded by a ("long") PLCP (Physical Layer Convergence Protocol) preamble and header with a total length of 192 bits that are always transmitted at 1 MBit/s (cf. chapter 5, slide 63). IEEE 802.11 acknowledges each correctly received frame with an immediate ACK frame with constant size of 14 bytes (sent after a SIFS).

Exercise 15: (IEEE 802.11b data rate)

IEEE 802.11b devices have a gross data rate of 11 MBit/s. However, the net data rate, i.e. the data rate available to higher layers, is considerably lower.

Your task is to calculate the net data rate in a simple IEEE 802.11b network, where a single station receives unicast data from a server via an access point as fast as possible. Some additional information is needed for this task: The maximum contention window CW (in time slots) is given by a value 2^n-1, and for the DSSS PHY, $31 \leq CW \leq 1023$. Additionally to the "long" PLCP preamble and header, IEEE 802.11b defines a "short" PLCP preamble and header: The 72 bit preamble is sent at 1 MBit/s, and the 48 bit header at 2 MBit/s (cf. chapter 5, slide 64). "Virtual carrier sensing" can be achieved by the RTS/CTS mechanism; an RTS frame has a constant size of 20 bytes, a CTS frame of 14 bytes.

For subtasks a)-g), the communication channel is assumed to be "perfect", i.e. no transmission errors occur.

a) Calculate the net data rate in the optimal case: All data and control frames are sent with 11 MBit/s, the short PLCP preamble and header are used, and the SDUs have maximum size. RTS/CTS and fragmentation are disabled.

b) How does the result of a) change, if the long PLCP preamble and header are used?

c) How does the result of b) change, if the basic rate is changed to 2 MBit/s (i.e., control frames are sent at 2 MBit/s and data frames at 11 MBit/s)?

d) How does the result of c) change, if the SDU size is changed to 1500 bytes?

e) How does the result of d) change, if the SDUs are split into 2 fragments?

f) How does the result of e) change, if the SDUs are split into 3 fragments?

g) How does the result of d) change, if RTS/CTS is enabled?

References:

[1] http://standards.ieee.org/getieee802/download/802.11-2007.pdf