Exercise Sensor Networks - (till may 30, 2005)

Lecture 5: MAC in radio networks

Exercise 5.1: Aloha with preamble sampling

A sender wants to transmit a packet to exactly one receiver via unicast (in contrast to broadcast). On the MAC layer Aloha with preamble sampling is implemented.

a) Why is transmitting a packet in this situation (unnecessarily) energy consuming both for the sender and the receiver?

b) How could the protocol be improved with regard to the problems identified in a) without having to synchronize the nodes? In other words: The solution should be able to work without a synchronized watch.

Exercise 5.2: SMAC

Ye, Heidemann and Estrin describe in their paper „An Energy-Efficient MAC-Protocol for Wireless Sensor Networks“ their SMAC approach. Therefor nodes have to synchronize themselves from time to time. Otherwise their sleep- and listen periods would diverge too much.

Some nodes may adopt more than one schedule, the one of their own cluster and one or more of neighboring clusters. The authors only describe how the schedule is synchronized within one's own cluster.

a) What is special about nodes that store more than one schedule and which know about the existence of more than one cluster, especially with regard to the synchronization?

b) The authors do not address the problem from a). How could it be solved?

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Exercise 5.3: Wise-MAC

A sender wants to transmit a message to a receiver using Wise-MAC. Therefor it emits a preamble prior to the estimated wake-up time of the receiver and then adds the message.

a) In contrast to Aloha with preamble sampling a sender using Wise-MAC knows when the receiver will wake up. What is the preamble good for in Wise-MAC?

b) The type of clocks being used for specific sensor nodes exhibit a maximum inaccuracy of theta time units per time unit (theta can be considered to be a small fraction, e.g., in the degree of magnitude of 10^{-5} seconds). The authors of Wise-MAC claim that after L time units a sender has to extend its preamble up to 4 x theta x L. Explain why. When does a senders have to start sending the preamble if it expects the receiver to wake up at time t_0 and if the receiver was silent for L time units?

c) We consider a channel which is free at about 80% of the time and occupied for the rest. The occupied 20% are further subdivided into 10% preamble time and 90% time for the actual data. How long does a node have to listen who is i) the receiver of a message all the time or who is ii) always uninvolved (not addressed by a sender)? Short wake up times are not considered and we assume that the ID of the receiver is included into the message (actual data transmission phase) at the very beginning.

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Exercise 5.4: Hidden- and exposed station problem

Six stations are grouped around a mountain in a chain topology. Each station is able to hear the next and the previous neighbor in the chain. Station 6 and station 1 can also hear one another. Stations optimize their behavior in order to avoid collisions if possible. We consider only single packets which means that no RTS/CTS is used.

a) Station 2 is sending to station 1 already. Station 3 wants to address station 4. Is 3 allowed to send a packet and will it do so? Where does the collision occur?

b) Station 3 sends to station 2 and 5 would like to send a packet to station 4. Will station 5 start sending and should it?

c) Station 1 and 2 are sending. Which stations belief that they can send and which ones are actually allowed to do so?

d) Station 1 and 4 send. Which stations belief that they can send and which ones are actually allowed to do so?

Exercise 5.5: AMRIS protocol

a) Is it possible that a msmID is used more than once in AMRIS. Why and when does it happen?

b) Is it possible to address a particular node from the root even though msmIDs are not pairwise different? And is it possible for every node to address the root (we don't consider packet loss or node failure)?

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