Exercise Sensor Networks

Lecture 4: Energy efficient MAC

Exercise 4.1: Poisson distribution

An audience consists of 10 listeners. Every listener produces an arrive rate of 0.1 phonemes (basic atoms which build spoken language) per time unit. The speaker (in front of the audience) is able to talk at a rate of 2 phonemes per time unit. Each time the speaker encounters 3 or more phonemes the particular time unit is lost and he has to repeat himself. How high is the data rate that can be achieved in this scenario?

Solution:

Average arrival rate per person = 0.1 / for 10 persons = 10 x 0.1

The speaker can handle 0, 1 and 2 arrivals from the audience. These occur with the following probability:

$$P = \sum_{i=0}^{i=2} \frac{(10 \times 0.1)^i}{i!} e^{-10 \times 0.1} \approx 0{,}92$$

The speaker can talk at 92% of his maximum speed because he is disturbed at 8% of the phonemes.

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Exercise 4.2: Energy efficiency of pure Aloha

A sensor node consumes the following amount of energy:

Basic consumption	: 8 mA
additional consumption for sending	: 20 mA
additional consumption for receiving	: 6 mA

A node must meet a particular energy constraint that requires it not to consume more than 18 mA. How high can the transmission rate per node be chosen in order not to violate the constraint?

Solution:

$(1-e^{-g})x20 + e^{-g}x6 + 8 <= 18$
$20-20e^{-g} + 6e^{-g} + 8 <= 18$
$e^{-g}(6-20) <= -10$
$e^{-g} >= 10/14$
$1/e^{g} >= 10/14$
$14/10 >= e^{g}$
$\ln(14/10) >= g$
$0.336 >= g$

Note on the expression "arrival rate": The term is misleading in so far as it denotes only the average number of frames (or MAC layer packets) per frame time which are "issued onto the channel". It does however not mean, at least not necessarily, that the packets are actually received by another node.

A node can increase its arrival rate (avg. number of packets it sends to the channel on average) up to 0,336 frames per frame time and will consume less than 18mA.

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Exercise 4.3: Genie aided Aloha

Genie-aided Aloha was an estimate for the energy efficiency of the Aloha protocol. Is GAA better than pure Aloha in every case and if not when and why?

Solution:

Genie-aided Aloha is only an estimate for a lower bound of eng. consumption. The savings are achieved by avoiding idle listening as much as possible. In scenarios with much communication the potential to avoid idle listening low.