

## Exercises for the lecture

### *Collaborative transmission in wireless sensor networks*

Term: Summer 2010

Stephan Sigg (sigg@ibr.cs.tu-bs.de)

Exercise: 17.05.2010, 08:00 – 09:30

## 2 Communication in wireless networks

### 2.1 Doppler Shift

- Assume a car heading directly towards a base station at a speed of 50 km/h. What is the amount of the Doppler frequency for a signal at 950 MHz?
- Of what amount is the Doppler frequency if the car is circling around the base station at a speed of 70 km/h and with a radius of 20m?

### 2.2 Cellular networks

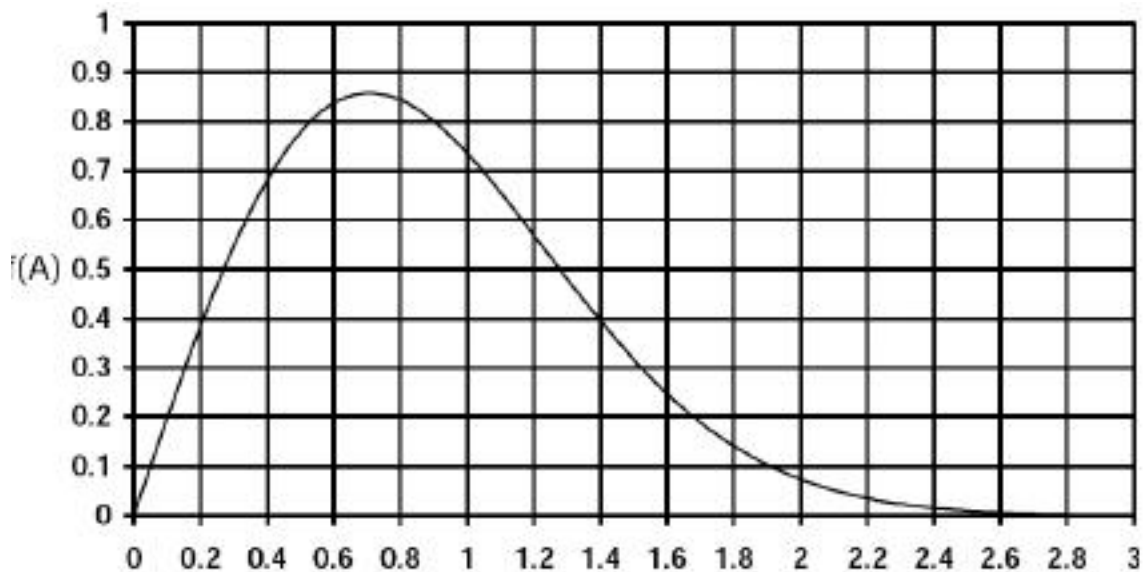
- Which method is used to optimise the use of the available frequencies in a mobile network without disturbing other senders in the neighbourhood ?
- Another method is the use of beam antennas. Why does this lead to an improvement?
- How does the SNR for equal channels ( C/I ) improve if you use beam antennas with an apex-angle of  $60^\circ$  ? Spec.:  $\gamma = 5$ ,  $N=7$ ,  $r = R$  ;  $d = D+0,7R$

### 2.3 Bluetooth basics

- During a bluetooth transmission, frequency hopping is utilised over 79 frequency channels that are separated from each other by 1 MHz. The System changes the transmission frequency 1600 times per second. The transmission times of 0,445ms each are interleaved by 0,220ms idle periods in which the frequency is switched. What is the benefit of this frequency hopping technique?
- Other wireless techniques as for example Wlan also utilise the 2.4GHz band. What impact do you expect on Wlan and Bluetooth transmissions, if the transmission is simultaneously?
- In bluetooth, various profiles are utilised for different connections. What is the use of these profiles?

### 2.4 Fading incursions

Consider a speech call in a GSM 900 network. Assume that the fading incursions due to multipath fading of the incoming signal are described by the probability density function depicted in the figure below. Furthermore, assume that the amplitude of the incoming signal is not allowed to fall below 0.4 since an operation below this amplitude is not possible in the GSM system. In the figure, mark the region that describes the probability that the amplitude of the incoming signal falls below 0.4.



## 2.5 Sample spaces

Consider a parking place with four parking lots A,B,C,D. Three cars (red, green, yellow) are at the parking place at one time and compete for the four parking lots.

- What is the probability space for this scenario?
- What is the probability space, if cars are indistinguishable?
- What is the probability space, if cars and parking lots are indistinguishable?

## 2.6 Expectation

Consider the experiment of throwing a dice with six sides and a coin that is labelled 1 and 2 on both sides.

- When both are thrown together what is the expectation on the sum value of dice and coin?
- Calculate with the Markov inequality the probability that the actual value deviates from the expectation by value 1
- Calculate with the Chernoff inequality the probability that the actual value deviates from the expectation by value 1