Exercise 3

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Pathloss with different wireless technologies

Jennic sensor node:	3dBm transmission power (antenna gain 0dBi)
mobile station:	transmits at 2W in GSM (antenna gain 0dBi)
GSM base station:	transmits at 10W (antenna gain 3dBi)
DAB transmitter:	1 kW EIRP (230 MHz)
DVB-T transmitter:	EIRP of 10kW (800 MHz)
Bluetooth transmitter:	2.5 mW EIRP (2.4GHz)
Wlan transmitter:	100mW EIRP (2.4GHz)

Calculate the signal strength in a distance of

- *10cm*
- *1m*
- *1km*
- *10km*

Assume that the receiver has an antenna gain of 0dBi.

Note: Antenna gain of a DVB-T roof-mounted antenna with 800MHz: 12dB. Indoor antenna: -2 to 0 dB)

Pathloss with different wireless technologies

$$P_E = P_S\left(\frac{\lambda}{4\pi \cdot d}\right)^2 G_S G_E = EIRP \cdot \left(\frac{\lambda}{4\pi \cdot d}\right)^2 G_E$$

$$900MHz \rightarrow \lambda = 0.33m$$

$$800MHz \rightarrow \lambda = 0.375m$$

$$230MHz \rightarrow \lambda = 1.30m$$

$$2.4GHz \rightarrow \lambda = 12.5cm$$

	10 cm	*1m*	*1km*	*10km*
Mobile phone	*0.1379 W*	*0.0014 W*	*0.001* μW	*1.379* $\cdot 10^{-5}\ \mu W$
Base station	*1.379 W*	*0.014 W*	*0.01* μW	*1.379* $\cdot 10^{-4}\ \mu W$
DAB	*1070,21 W*	*10.7021 W*	*10.7021* μW	*0.0107021* μW
DVB-T	*890.518 W*	*8.905 W*	*8.905* μW	*0.089* μW
Bluetooth	*0.024 mW*	*0.24* µW	*2.4* $\cdot 10^{-13}$ W	*0.024* $\cdot 10^{-13}$ W
Wlan	*0.989 mW*	*98.9* µW	*9.89* $\cdot 10^{-12}$ W	*9.89* $\cdot 10^{-14}$ W

CDMA encoding and decoding

Consider four senders A, B, C, and D. Which are assigned the following chip sequences:

A_{chip}= 11110000

B_{chip}= 11000011

C_{chip}= 10011001

D_{chip}= 10010110

The data sequences to transmit are

A_{data}= 00

B_{data}= 11

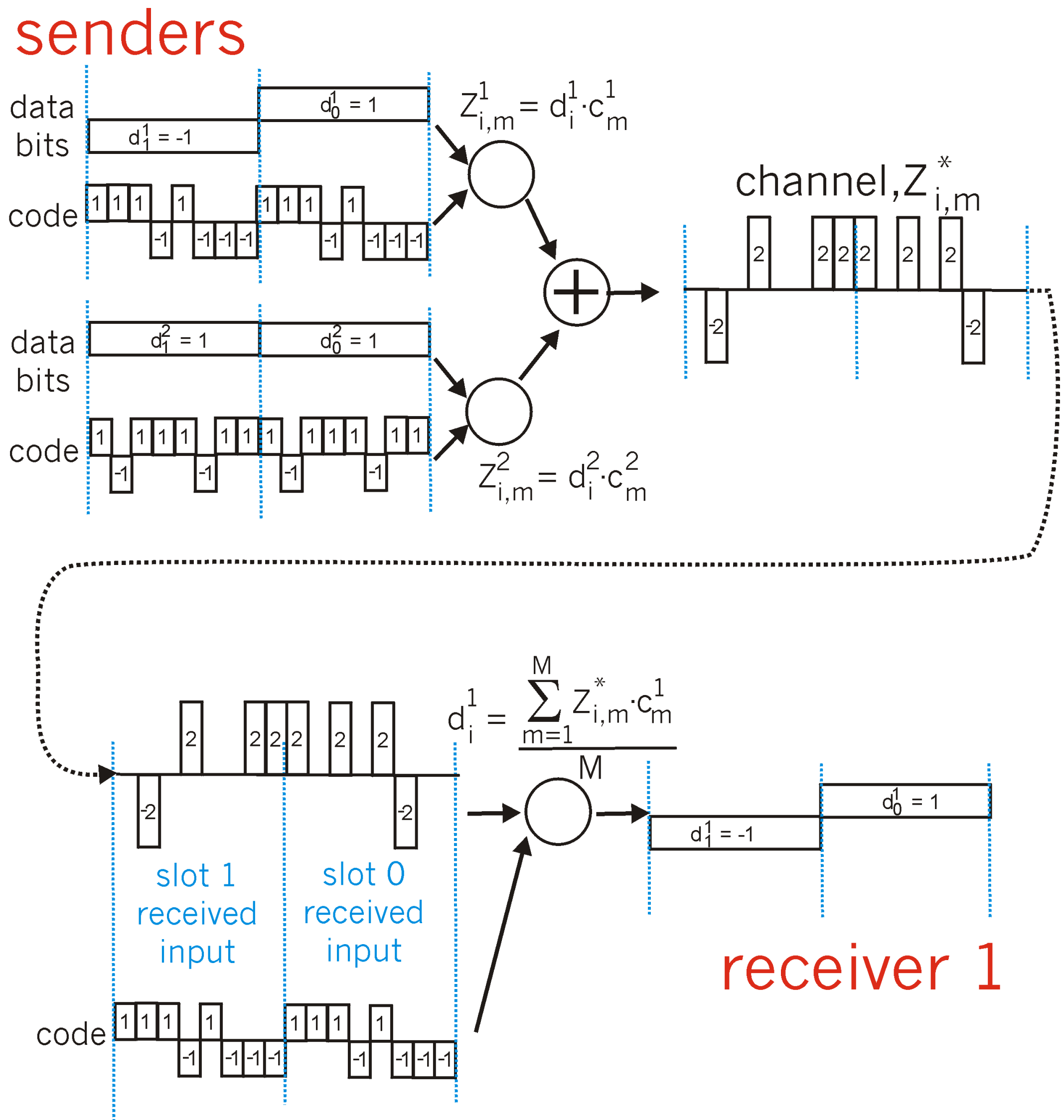
C_{data}= 10

D_{data}= 01

a) Calculate the combined and encoded sequence obtained at a receiver

b) Demonstrate the decoding of the respective sequences at the four receive nodes

CDMA encoding and decoding



Thermal noise

Estimate the thermal noise in an indoor environment (assume a room temperature of 20°C) for a 1Mhz signal.

Thermal noise

Noise

- Thermal noise can also be estimated analytically as

$$P_N = \kappa \cdot T \cdot B$$

- $\kappa = 1.3807 \cdot 10^{-23} \frac{J}{K}$: Boltzmann constant
- T: Temperature in Calvin
- B: Bandwidth of the signal.

CSMA/CA

How does CSMA/CA tackle the problem of collisions (what steps are taken at the sender and receiver respectively)?

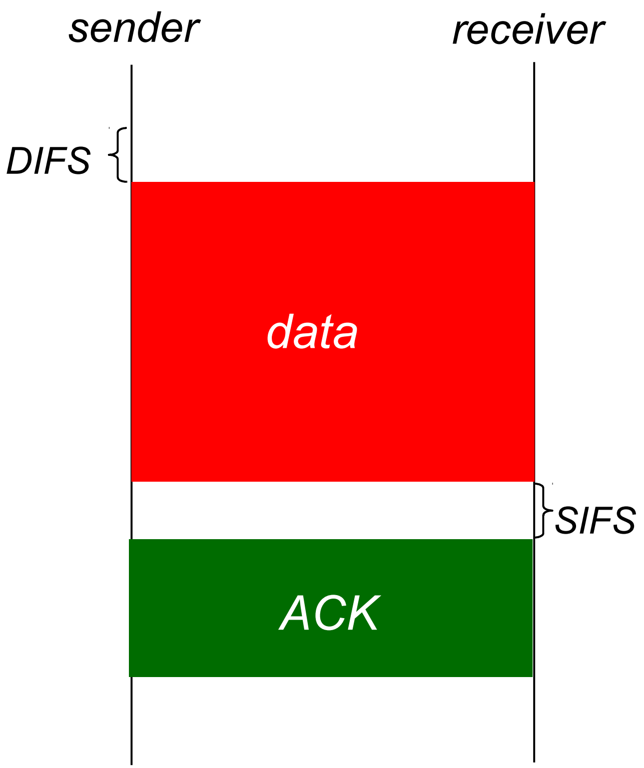
CSMA/CA

Sender:

Sense channel

If idle for a certain amount of time (802.11: DIFS, ~50 µs) transmit entire frame

If busy, start exponential backoff (see last weeks exercise)



Receiver:

If frame received OK, return ACK after waiting a certain amount of time (802.11: SIFS, ~10 µs)

Hidden terminal problem