Wireless Networks, answers, exam part II, 2011/12

1) Book, page 32 – 37.

$$\lambda = \frac{c}{f}$$

Increasing frequency, results in shorter wavelength. Decreasing frequency, results in longer wavelength.

$\lambda = wave\ length\ in\ [meter]$
$c = velocity\ of\ light\ [m/s]$
$f = frequncy\ in\ [Hz]$

2) Book, page 16 – 19.

The three most common modulation techniques (keying methods) are: amplitude modulation, frequency modulation, and phase modulation.

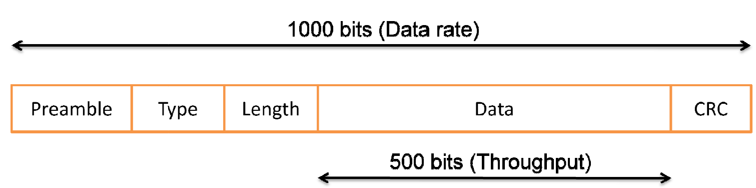
Amplitude modulation alters different amplitudes to be able to distinguish between logic levels as e.g. zeros and ones.
Frequency modulation uses different frequencies, and **phase** modulation uses phase shift when modulating the carrier wave.

3) Book, page 156.

Data rate: The number of bits provided by the wireless link in the physical layer.

Throughput: The number of usable “data” bits sent over the wireless network.

Throughput can never exceed the data rate.



The figure shows an example where the physical wireless link enables 1000 bits/second but where the actual information transferred is 500 bits/second (the data in the packet shown).

4) Book, page 40 – 45.

Diffraction: Signal is caused to change direction, "bending", around obstacles. The edges of the object react as **points of radiation,** and give multiple new signal paths around the object. The signal strength for every new path is lower than the incoming signal.

Reflection: $\boldsymbol{\lambda}$ **< object,** signal is reflected in a new direction; typically the reflection occurs when hitting a smooth large object. If the reflection not is a hundred percent, some of the energy is absorbed by the reflecting object. The two main types of reflections are microwave and sky wave reflection. For frequencies below 1 GHz (with longer wave lengths) it is possible to get sky wave reflection.

Absorption: When the RF signal not is reflected, travels around or passes through an object the signal is absorbed, converted into heat.

5) Lecture 4

RFID can be categorized in two groups, **passive** and active **RFID**.

Passive RFID: The passive transponder (tag) has no own power source, the power is sourced from the passive RFID reader. In most cases this is done by inducing a magnetic field (the near filed is used) into the relatively large tag antenna, this field is converted into electricity and is used to drive the tag electronics. Due to the fast decay of the magnetic field in the near field the tag reading range is rather short, typically from a couple of centimeters up to a few meters. The energy retrieved by the passive tag is not enough for driving advanced processors, sensors or large memories. Applications for passive RFID system are in e.g. logistics, security, theft protection, and authentication.

Active RFID: The active tag has an energy source of its own, in most cases a battery. This energy source enables to use a transmitter-receiver (transceiver) in turn giving long reading range (communication in the far field) and fast data transfer. The energy source can be used to provide the tag with an advanced energy consuming processor enabling high calculation ability. Sensors can be used to log e.g. temperature data into a large memory. Applications for active RFID can be in logistics for logging events during transportation, high security payment functions, and applications needing reading long range.

6)

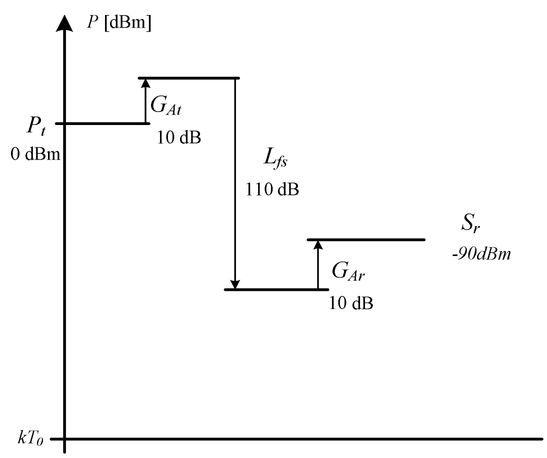
The two base stations acquire different amount of output power to secure the wireless link in between them. This because of the base stations different receiving sensitivities.

The output power for base station 1 (BS1) with the sensitivity of -100 dBm is calculated as follows:

$$P_t = S_r + L_{fr} - G_{Ar} + L_{fs} - G_{At} + L_{ft}$$
$$P_t = -90 + 0 - 10 + 110 - 10 + 0 = 0\ dBm$$

The output power for base station 2 (BS2) with the sensitivity of -90 dBm is calculated as follows:

$$P_t = S_r + L_{fr} - G_{Ar} + L_{fs} - G_{At} + L_{ft}$$
$$P_t = -100 + 0 - 10 + 110 - 10 + 0 = -10\ dBm$$



The figure shows the link budget diagram for BS1. The base station needs 0 dBm to be able to communicate with the base stations (BS2) which have a sensitivity of -90 dBm.