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wiki.unik.no/index.php/Courses/UNIK4700radio

Ongoing thesis
Completed thesis
Open Thesis

Research
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About UniK

ICT research
ICT@UNIK
PhD Research
Projects

History: Courses/UNIK4700radi

Welcome Josef Noll
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Attach:LectureNotes3-H09.pdf Δ

(edit)

UNIK4700 Radio and Mobility

Lecture 2: Basics of communications

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Sign as Author Josef Noll Post Reset

(edit)

Block seminar 5.-6. Nov 2009

Practical info:
- Book flights asap (flying out: 5.Nov, 08:00, returning 6.Nov NOK)
- send copy of tickets to josef@unik.no
- discuss accommodation

Two days programme:
- Presentations and discussion of selected topics
- Measurements of attenuation
- Matlab programming

(edit)

Detailed programme

Thursday 5. Nov - not updated
- Overview, Q&A radio propagation
- Presentations A,B
  - LTE - Andreas
  - WRAN - Hemdan
  - WiMAX - Reidar
  - WiBree - Anders T.
  - WiMedia - Eystein
  - Wireless USB - Simen
  - NFC - Shabnam
  - Wireless HART - Magnus

1200 lunch
- Tasks & Programming tips
- Radio Programming (slide)

Friday 10. Oct
not updated
- 0900 Measurements
- 1100 Comparison Measurements-Theory

1200 lunch
- Presentations C, D
- 1530 end of day 2

(edit)

Topics for programming

Propagation Models
- indoor (statistical, deterministic), outdoor (rural, city), indoor-outdoor propagation
- comparison to satellite link

System parameters
- CDMA-2000, W-CDMA (UMTS), GSM 900, WLAN 802.11b, 802.11a, Bluetooth
- Receiver sensitivity

i/Basics_of_Communication_and_Assignments

dit)

presented	by Josef Noll
Objective	The objective of this lecture is to explain the principles of radio communication
Learning outcomes	What will we learn today ▪ Basics of radio communication ▪ Typical radio transmission ▪ What effects the signal strengths ▪ Basics of radio communication ▪ Typical radio transmission ▪ What effects the signal strengths" cannot be used as a page name in this wiki.
Pensum (read before)	Read before: ▪ http://wiki.unik.no/index.php/Courses/UNIK4700radio ▪ http://wiki.unik.no/index.php/Courses/UNIK4700radio&quot ; cannot be used as a page name in this wiki.
References (further info)	References: A Practical Evaluation of Radio Signal Strength: ▪ http://www.chriskarlof.com/papers/p41-whitehouse.pdf Propagation characteristics of wireless channels: ▪ [[Media:Propagation_characteristics.pdf A Practical Evaluation of Radio Signal Strength: ▪ http://www.chriskarlof.com/papers/p41-whitehouse.pdf Propagation characteristics of wireless channels: ▪ [[Media:Propagation_characteristics.pdf" cannot be used as a page name in this wiki.
Keywords	SNR, Transmit Power, Scattering, Reflection, Diffraction

Slides for lecture

this page was created by Special:FormEdit/Lecture, and can be edited by Special:FormEdit/Lecture/Basics of Communication and Assignments.

1 Homework

Physics

frequency

antenna

(Power Tx)

Interference / noise

Services – voice, video, www

Range

Capacity = f(Bit Error Rate)

Mobility

Service infrastructure

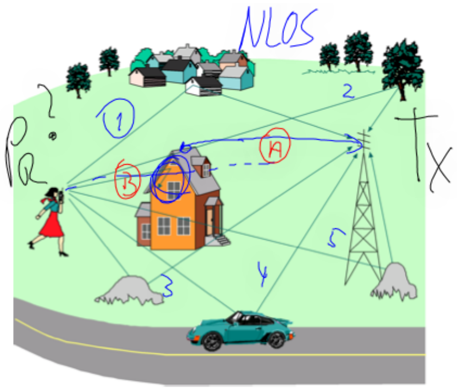
SIM

Home Location Register

HLR

System / Mobile, Wireless, Sensor

Business, Provider



P_R ? Tx P_{Tr}

$P_R = f(\text{direct, LOS, Multipath, diffracted})$ — receive; reflection $1 \ldots 5$; NLOS (B); (A)

- basics of radio communication
- sampling theorem
- typical radio transmission
- what effects the signal strengths

Faktor : 100

$P_{NLOS} \lesssim P_{LOS} - 20\,dB$

$P_{dB} = 10 \log \frac{P[W]}{1W}$

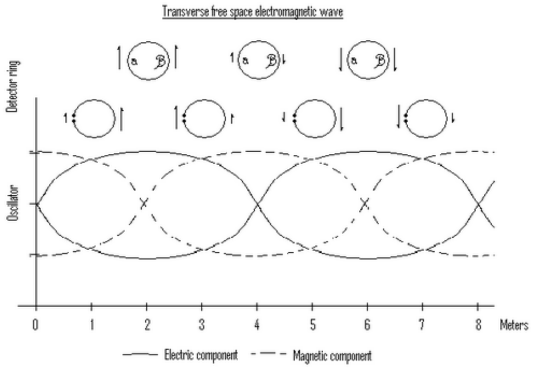
W.f.: max Transmit: $P_{Tx} = 100\,mW$

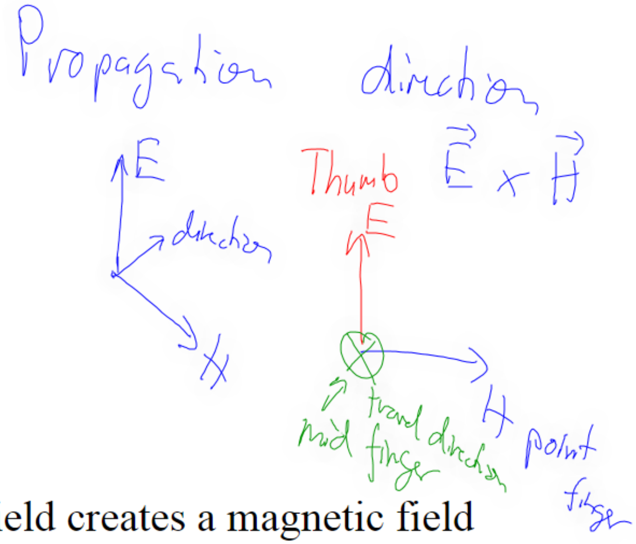
$P_{dBm} = 10 \log \frac{P[mW]}{1\,mW}$

Reference $1\,mW \rightsquigarrow P_{dBm} = 0\,dBm$

$P_{dBm} = 10 \log \frac{100\,mW}{1\,mW} = 20\,dBm$

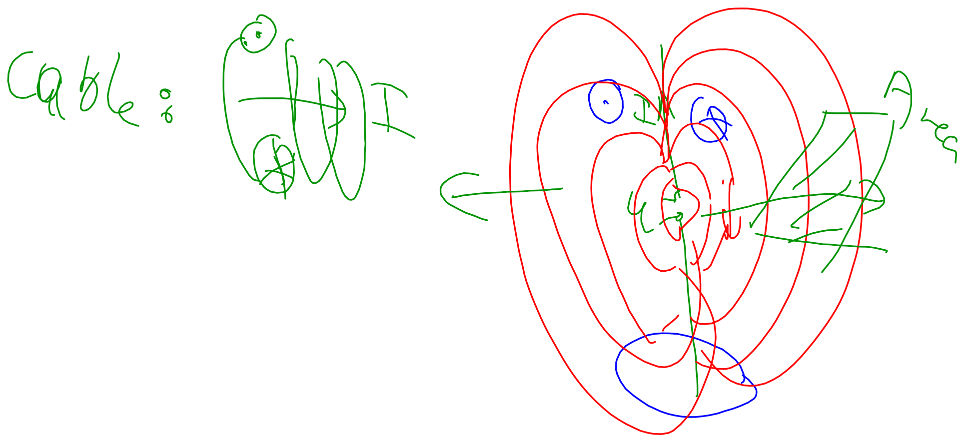
Heinrich Hertz - Radiowave Propagation



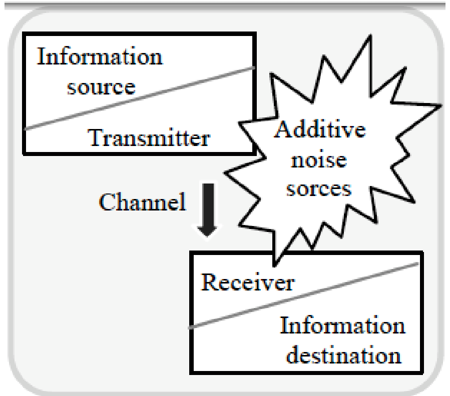


Basics of wave propagation:

- The variation of an electrical field creates a magnetic field
- The variation of a magnetic field creates an electrical field



Electromagnetic Channel



The radio channel is always affected by noise, which restricts the information flow to the receiver

[Source:Neelakanta et. al., Fig1.2]

entry to brain: 32 kbit/s channel

analogue voice 3 kbit/s

GSM voice 16 kbit/s

HQ voice 64 kbit/s

mp3 stereo 128 kbit/s

video > 128 kbit/s

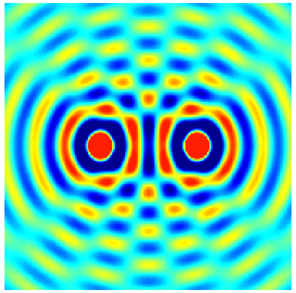
HD video ~ 2.5 Mbit/s

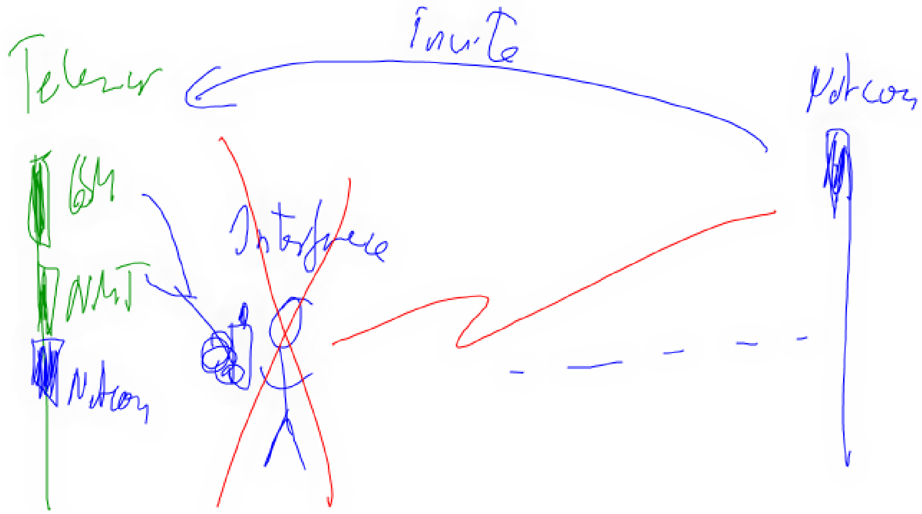
4k video ~ 16Mbit/s (?)

Sources Of Noise

- Electronic parts of transmitter and receiver (components)
- Spurious electromagnetics (lines radiating on the chip)
- Fluctuations in power (switching CMOS circuits)

Radio





- In-band interference
- out-of band interference, e.g. GSM/NMT interference

Maxwell's Equation In A Source Free E

Source free environment and free space:

$$\nabla \cdot \vec{E} = 0 \qquad (1)$$

$$\nabla \times \vec{E} = -\frac{\partial}{\partial t}\vec{B} \qquad (2)$$

$$\nabla \cdot \vec{B} = 0 \qquad (3)$$

$$\nabla \times \vec{B} = \mu_0 \epsilon_0 \frac{\partial}{\partial t}\vec{E} \qquad (4)$$

where div is a scalar function

$$\operatorname{div} \vec{v} = \frac{\partial v_x}{\partial x} + \frac{\partial v_y}{\partial y} + \frac{\partial v_z}{\partial z} = \nabla \cdot \vec{v}$$

and curl is a vector function

$$\operatorname{curl} \vec{v} = \left(\frac{\partial v_z}{\partial y} - \frac{\partial v_y}{\partial z}\right)i + \left(\frac{\partial v_x}{\partial z} - \frac{\partial v_z}{\partial x}\right)j + \left(\frac{\partial v_y}{\partial x} - \frac{\partial v_x}{\partial y}\right)k = \nabla \times \vec{v}$$

Wave Equation

Taking the curl of Maxwell's equation

$$\nabla\times\nabla\times\vec{E} = -\frac{\partial}{\partial t}\nabla\times\vec{B} = -\mu_0\varepsilon_0\frac{\partial^2\vec{E}}{\partial t^2}$$

$$\nabla\times\nabla\times\vec{B} = \mu_0\varepsilon_0\frac{\partial}{\partial t}\nabla\times\vec{E} = -\mu_0\varepsilon_0\frac{\partial^2\vec{B}}{\partial t^2}$$

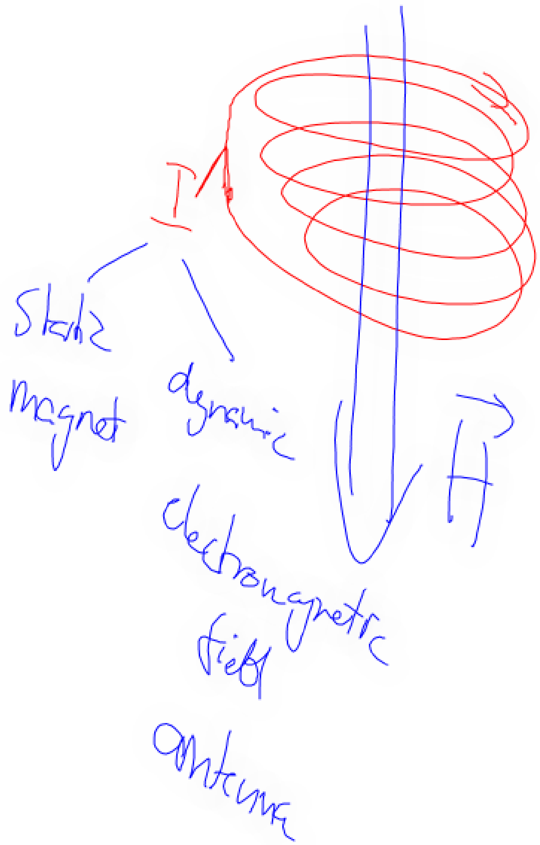
yields the wave equation:

$$\frac{\partial^2\vec{E}}{\partial t^2} - {c_0}^2\cdot\nabla^2\vec{E} = 0$$

propagation constant c_0

$$\frac{\partial^2\vec{B}}{\partial t^2} - {c_0}^2\cdot\nabla^2\vec{B} = 0$$

with $c_0 = \frac{1}{\sqrt{\mu_0\varepsilon_0}} = 2.99792458\times10^8$ m/s ~ 3E8 m/s



[Source: Wikipedia]

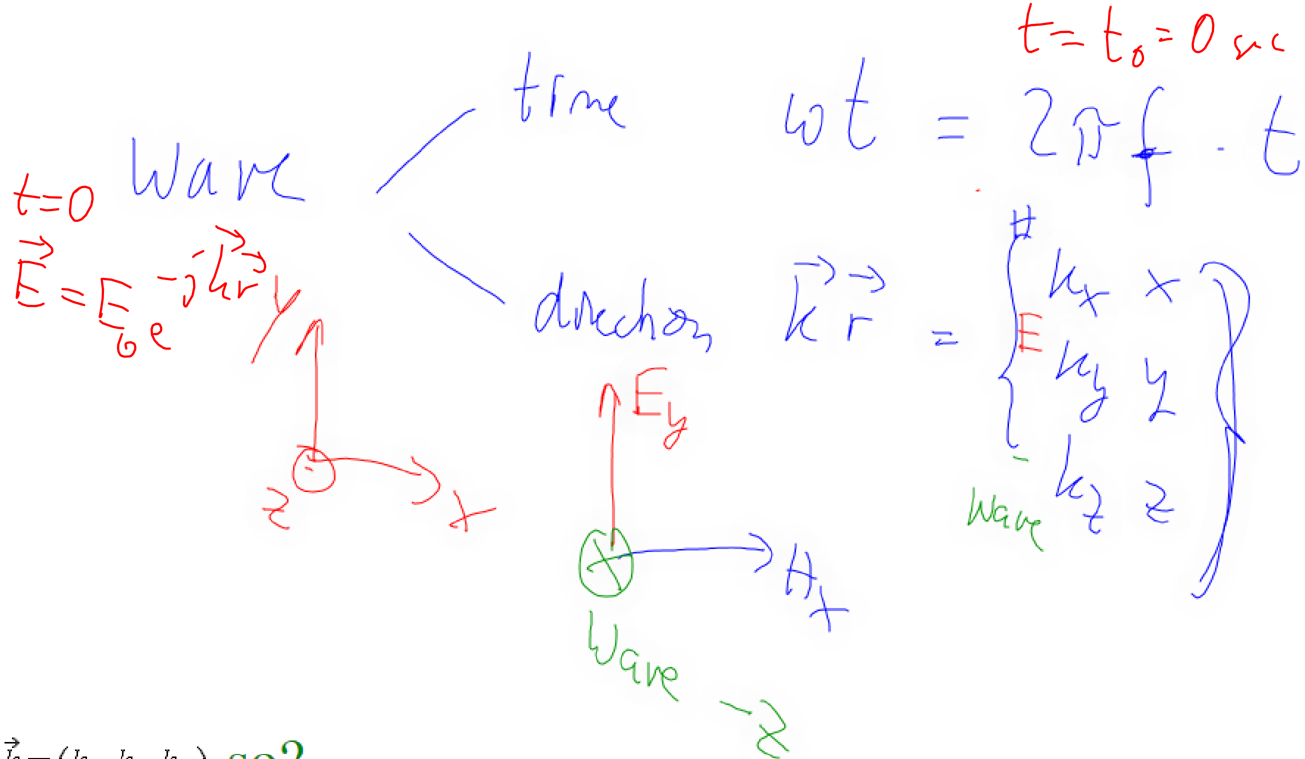
Homogeneous Electromagnetic Wave

single frequency

$\vec{E}(\vec{r}) = E_0 e^{j(\omega t - \vec{k}\cdot\vec{r})}$,

$\vec{B}(\vec{r}) = B_0 e^{j(\omega t - \vec{k}\cdot\vec{r})}$,

[Source: Wikipedia]



where

- $\vec{r} = (x, y, z)$ and $\vec{k} = (k_x, k_y, k_z)$ so?
- j is the imaginary unit
- $\omega = 2\pi f$ is the angular frequency, [rad/s]

Boundary Conditions

- What is happening on electrical walls, magnetic walls?

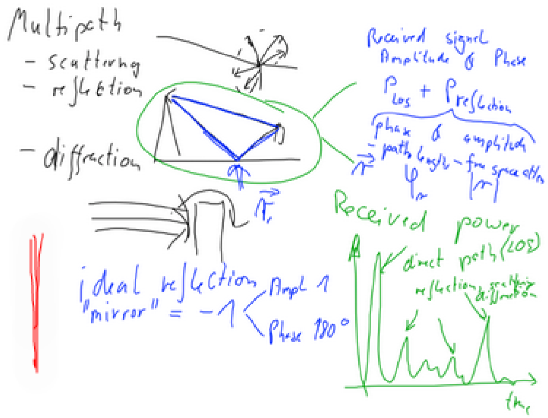
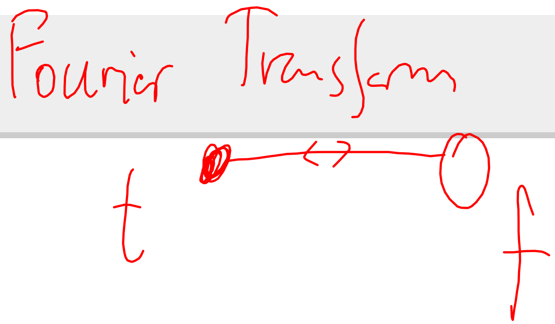
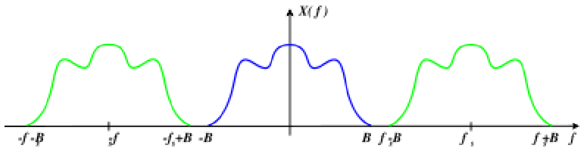


Figure: Reflection of an electromagnetic wave at the ground plane

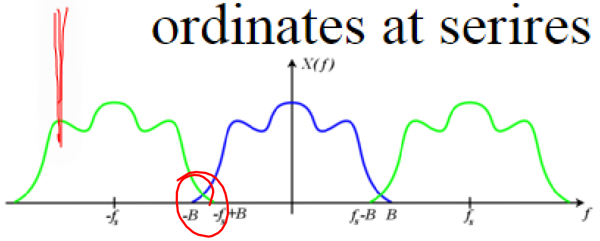
Scattering, reflection and diffraction (explain differences) are the three major components in wave propagation. Ideal reflection environments are characterised through $|r|=1,\ \phi_r=180\deg$

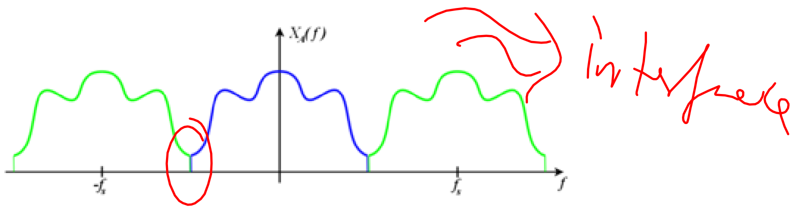
Nyquist Theorem

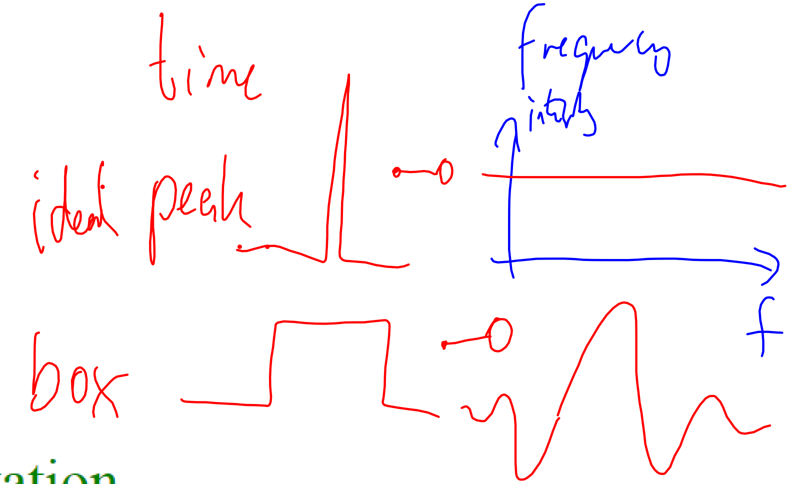




- Shannon: If a function $f(t)$ contains no frequencies higher than W [cycles/s], it is completely determinded by giving its ordinates at serires of points spaced $\frac{1}{2W}$ seconds apart







- band-limitation versus time-limitation
- Fourier transform

Signal/Noise Ratio

SNR

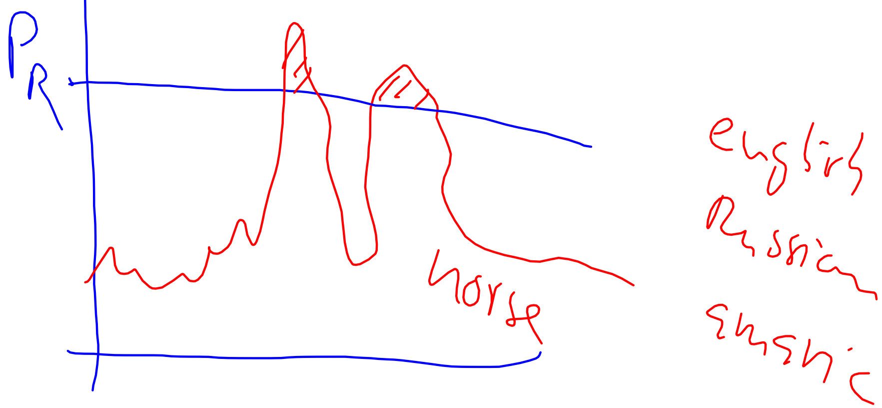
$$\mathrm{SNR} = \frac{P_{signal}}{P_{noise}}$$

$$\mathrm{SNR(dB)} = 10\log_{10}\left(\frac{P_{signal}}{P_{noise}}\right),$$

where P is average power

dB, dBm
see earlier

- why talking about noise?
- dB, dB_m, dB_a
- near-far problem

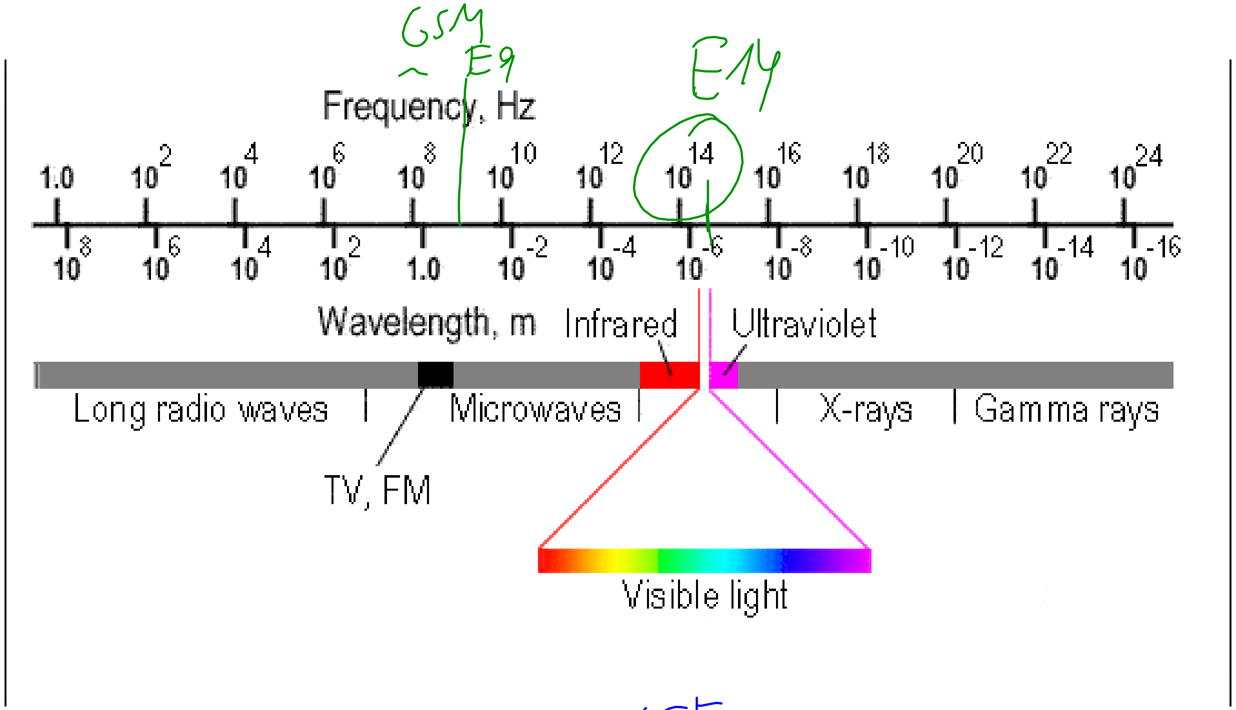


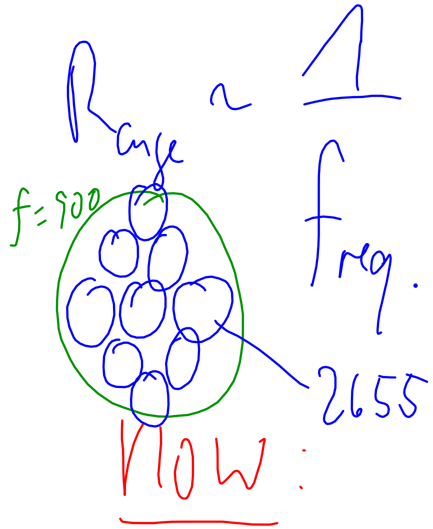
cwi.unik.no/wiki/Mobilstraaling

- En GSM sektor antenna med 14,5 dB gevinst, som dekker en sektor (120 grader). Verdier er estimert basert på Kathrein 730 684 GSM antenne.
- et barn med 1,5 m høyde og varierende avstand fra antenna

- Media:Standordberechnung-Mobilfunk.xlsx, adaptert fra http://http://www.salzburg.gv.at/celltower med norsk betegnelse og beregning av antenna

Mobilstråling inn i kroppen





UMTS 900

LTE 900

GSM 900, 1800 MHz (LTE)

UMTS ~1900 -- 2100 MHz

LTE 2655 MHz

iPhone LTE 1800

Examples of Topics

Ali Zaher:

- Media:Master thesis lu NFC.pdf
- Media:UNIK4700 Security in NFC.pdf
- Media:Specific_absorption_rate_nfc.pdf
- Media:medical_devices_nfc.pdf
- Media:Components of the RFID System.pdf
- Book:RFID Handbook Fundamentals and Applications in Contactle
- Radio Frequency Identification and Near Field Communication Thi
- Parts related to passive devices Type 1 tags and NFC-A Tech: Mec

Dag Ove Eggum:

- File:Achieving Wireless Broadband with WiMax.pdf
- Media:IEEE 802.16 Standards - The working group and document
- Media:Sleep Mode Operation - WiMax.pdf
- Media:The WiMax IEEE 802.16e Physical Layer Model.pdf
- Media:Wimax - Current Performance Benchmarks and Future Pote

Håvard Austad:

- Media:UNIK4700-Antennas.pdf Introduction to patch antennas
- Book: Stallings; Wireless Communications & networks
- Book:Thorvaldsen & Henne; Planning of line-of-sight radio relay s
- Book:Balanis: Antenna Therory: Analysis and Design

Joachim Tingvold:

- Wave Propagation Parameters

Johan Tresvig:

- Book: WirelessHART - Applying wireless technology in real-time ir
- Media:A Comparison of WirelessHART and ZigBee for Industrial Ap
- Media:A Location-determination Application in WirelessHART.pdf
- Media:Comparison of Industrial WSN Standards.pdf
- Media:WirelessHART - Applying wireless technology in real-time ir

Susana Rodriguez de Novoa:

- Media:UNIK4700-Wlan.pdf
- Media:An_Introduction_to_wifi.pdf
- Media:radiomobile.pdf
- Media:WLANSecurity.pdf
- Book: Antennas and Propagation for Wireless Communication Sys
- Book: CCNA Wireless. Oficial Exam Certification Guide

Thomas Aasebø:

Invers MVNO

Basic I2 kret

Ad-hoc video network

Distribution Of Work

- Radiation equation josef
  - power budget, examples
- Radiation and health Rolf
  - absorption examples (see Cost259)
- Range of wireless communications
  - selected papers on comparison of theory and measurements (WLAN) - Thomas
  - selected papers for GSM900, GSM1800 and WDCDMA - Espen
- System capacity
  - selected papers on WLAN (802.11a and 802.11n) - Zahid
  - selected papers on WDCDMA - Sarfraz
- Propagation models
  - indoor, outdoor, indoor-outdoor
- Systemparamters and performance - Øystein
  - CDMA-2000, W-CDMA (UMTS), GSM 900, WLAN 802.11b, 802.11a, Bluetooth