UNIK 4700

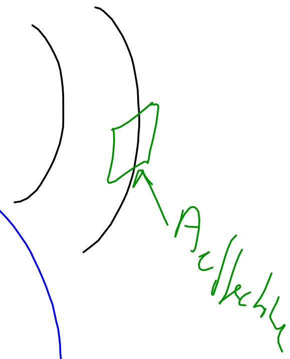
Agenda

- Open issues $\left(\frac{\lambda}{4\pi r}\right)^2$ ← A_{eff} ; $Z_0 = 377\,\Omega = \sqrt{\frac{\mu_0}{\varepsilon_0}}$ ← wave equation
- Compendium → Question: Wiki: / UNIK4700 600 pp Plus
- Raul: freq range & transm. rate
- Yu Ai: propagation model

Propagation equation

sphere

$$P_r = P_t \cdot G_t \cdot G_R \cdot \frac{1}{4\pi R^2} \cdot \frac{\lambda^2}{4\pi}$$



↳ see Compendium

$\neq 1$

$$\left(\frac{\lambda}{4\pi R}\right)^2$$

Free space path loss

Antenna interaction:

$$l \approx \frac{\lambda}{2}$$

15 cm for GSM at ~1 GHz

$$\lambda = \frac{c}{f} = \frac{30}{f\,[GHz]}\ \text{cm}$$

Free space path loss

$$L_p \approx \left(\frac{\lambda}{4\pi R}\right)^2 \rightsquigarrow L_p = 10 \log\left(\frac{\lambda}{4\pi R}\right)^2$$

Power

$$= 20 \log \frac{\lambda}{4\pi R} \quad *2$$

Analogon:

$U = R \cdot I$

resistance $[\Omega]$

$\vec{P} = \vec{E} \times \vec{H}$

$P = E \cdot H = Z \cdot H^2$

$\hookrightarrow E = Z \cdot H$

$E, H \rightsquigarrow 20 \log$

free space impedance $Z_0 = 377\Omega$

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

$$L_p = \text{const.} +/- 20 \log(f[\text{GHz}]) +/- 20 \log(R[\text{km}])$$

course	Master

Edit the page by Special:FormEdit/Course/UNIK4700.

Lecture overview

	Date
LTE and Voice over LTE	17 October 2014
Wifi WiMax and Security in NFC	10 October 2014
- Autumn holidays - no lecture	3 October 2014
Frequency Ranges and Propagation Models for Communications	26 September 2014
Antennas and their communication parameters	19 September 2014
Radio propagation equation	12 September 2014
Basics of Communication	5 September 2014
UNIK4700/9700-Introduction	27 August 2014

To add new lectures, use: Add a lecture

For **assignments to be presented** during the course, please visit typical topics at UNIK4700:Assignme

Lot's of course material is still on our old wiki.unik.no, Courses, UNIK4700

Contents [hide]

ilding_Mobile_and_Wireless_Networks_Compendium

UNIK wiki | WNaS@UNIK | Master/PhD Courses | Master Thesis | Research Areas

Page | Discussion | *Edit* | History | Delete | Move | Protect | Unwatch | Refresh

Building Mobile and Wireless Networks Compendium

Disclaimer: This compendium provides information on aspects of radio wave propagation, antennas, system aspects, and handover schemes for mobile and wireless systems. The compendium is foreseen for the UNIK4700 course on Building Mobile and Wireless Networks, and is kept on the system aspects level. UNIK has several courses on Radio and Network technologies as part of the Wireless Networks and Security (WNaS) research area.

Contents [hide]

UNIK 4700 Building Mobile and Wireless Networks [edit]

Title
Building Mobile and Wireless Networks

Subtitle
Table-of-Content

Author
Josef Noll

Footer
Building Mobile and Wireless Networks Compendium

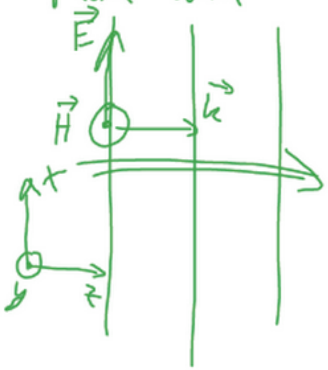
Subfooter
UNIK4700/UNIK9700

Building .... Networks

$t=0 \qquad \vec{H} = H\,\vec{u}_y\, e^{-j k_z z} \qquad k_z = \frac{2\pi}{\lambda}$

Wave number $\vec{k} = (k_x, k_y, k_z)$

Plane wave



$$\vec{E} = E\,\vec{u}_x\, e^{j(\omega t - k_z z)}$$

$$\vec{H} = H\,\vec{u}_y\, e^{j(\omega t - k_z z)}$$

$$\vec{\nabla} \times \vec{E} = -\mu_0 \frac{\partial \vec{H}}{\partial t} \quad *1$$

$$\vec{\nabla} \times \vec{E} = \begin{vmatrix} \vec{u}_x & \vec{u}_y & \vec{u}_z \\ \frac{\partial}{\partial x} & \frac{\partial}{\partial y} & \frac{\partial}{\partial z} \\ E_x & E_y & E_z \end{vmatrix}$$

$$\frac{E_x}{H_y} = Z_0 = 377\,\Omega = \sqrt{\frac{\mu_0}{\varepsilon_0}}$$

No higher resolution available

$$*1 \quad = -\mu_0 \frac{dH}{dt} = -\mu_0 \frac{d H_y u_y e^{-j(\omega t - k_z z)}}{dt}$$

$$\mu_0 c = \frac{1 \cdot \mu_0}{\sqrt{\mu_0 \varepsilon_0}} = \sqrt{\frac{\mu_0}{\varepsilon_0}}$$

Advertisible throughput is obtained by " sending and receiving " pure payload without any overhead

Throughput varies based on a number of different factors.We can roughly approximate Wi - Fi throughput to be about half advertised throughput in the best case : LOS close to transmitter,no interferences and multipath ways.

MAX

↓

P.L.
I.
Number
M.P.

Conclusions

- trans rate $\sim \frac{1}{r^2}$; $\sim \frac{1}{f^2}$
- typical trans. rate ~ 50% advertised
- Reasons
  - path loss
  - interference
  - number of users
  - multipath

Titel

Overview

Introduction

Conclusion

Summary

"My take"

- Wireless Channel
  - path loss
  - fading
  - shadowing
  - multipath
  - etc

e.g. 1-20 dB
impact
f, outdoor, fr.....

- Wireless Channel Models
  - modeling approaches : 3 main directions
  - different scenarios

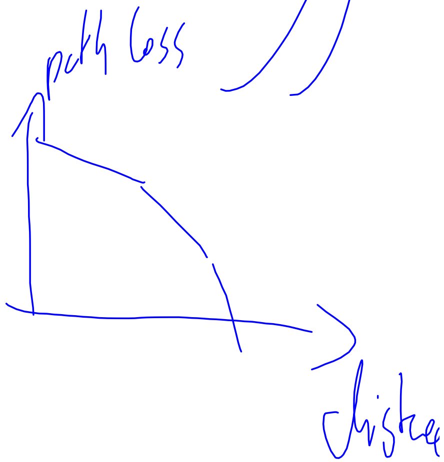
types of models

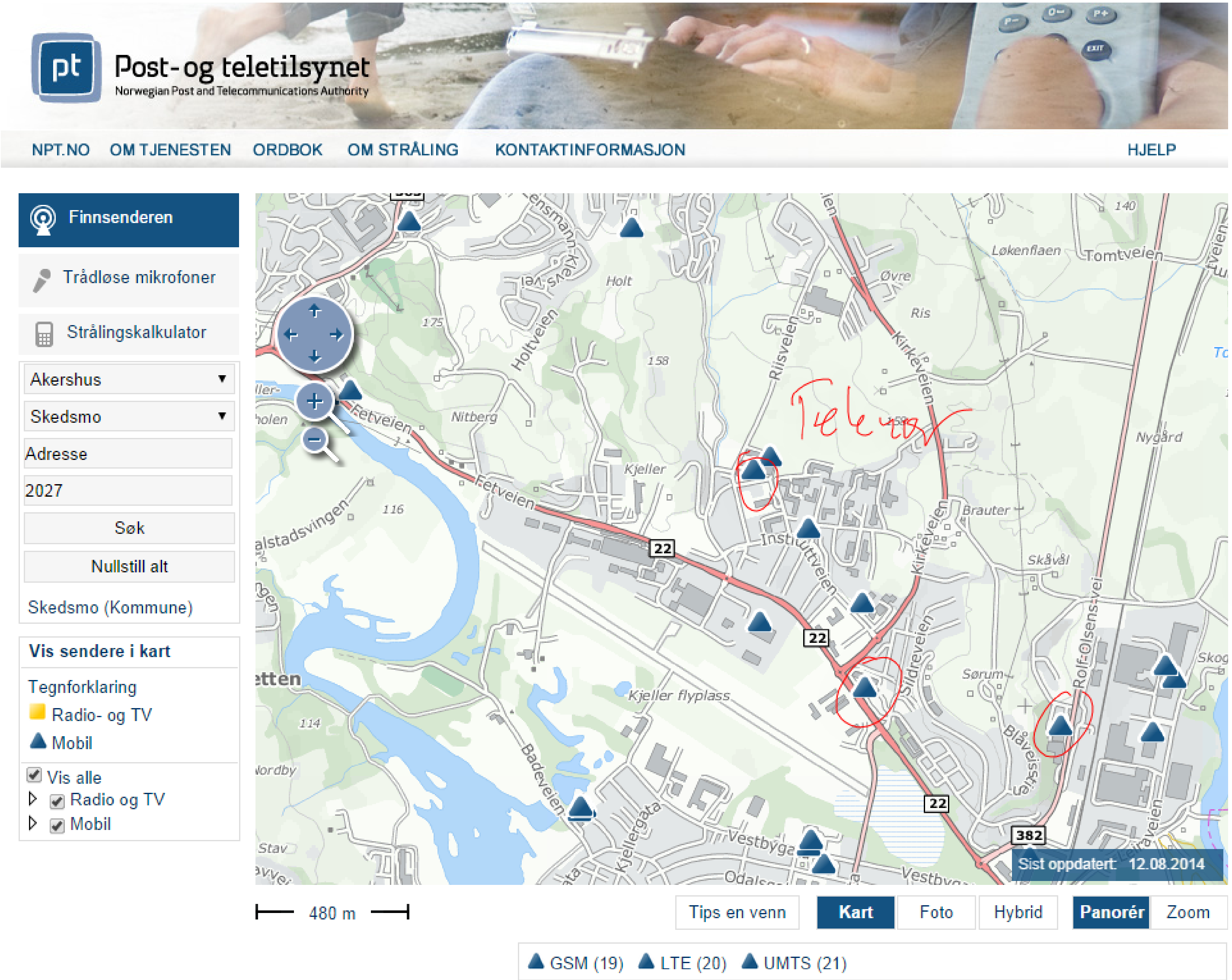
400 – 1000 MHz

1–2 GHz

5 GHz

20, 80 GHz





less Mobility

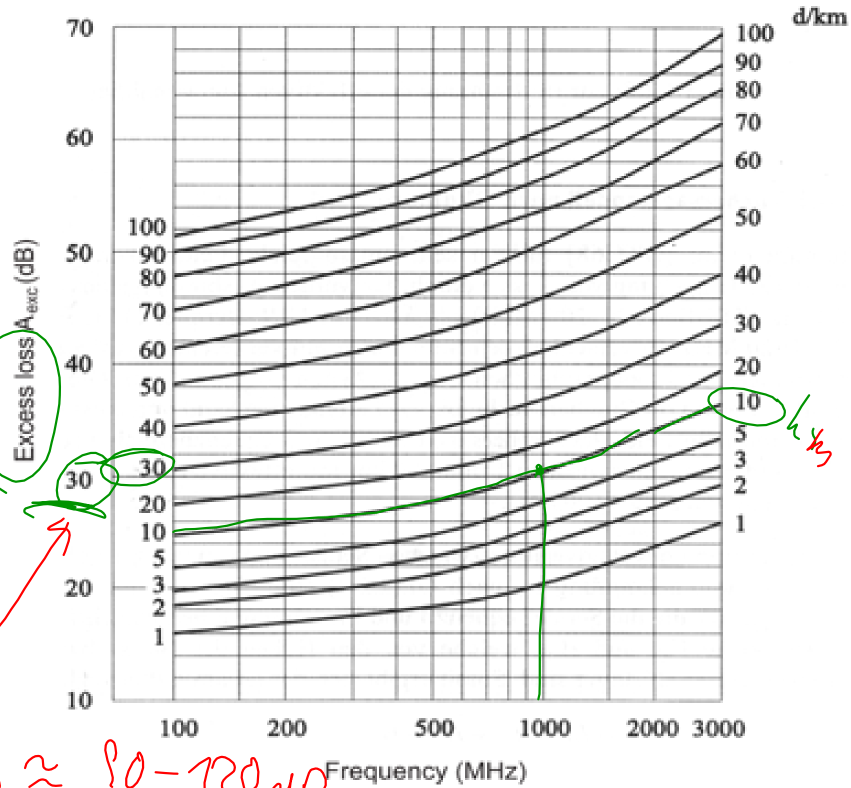
more Building Networks

Path loss according to the Okumura-Hata model

?? "does not fit"

Path loss vs. Frequency

Path loss vs. distance



Andreas

free space path loss

additional path loss

Source: A. Molisch book

total path loss ≈ 80–120 dB

provides a good indication