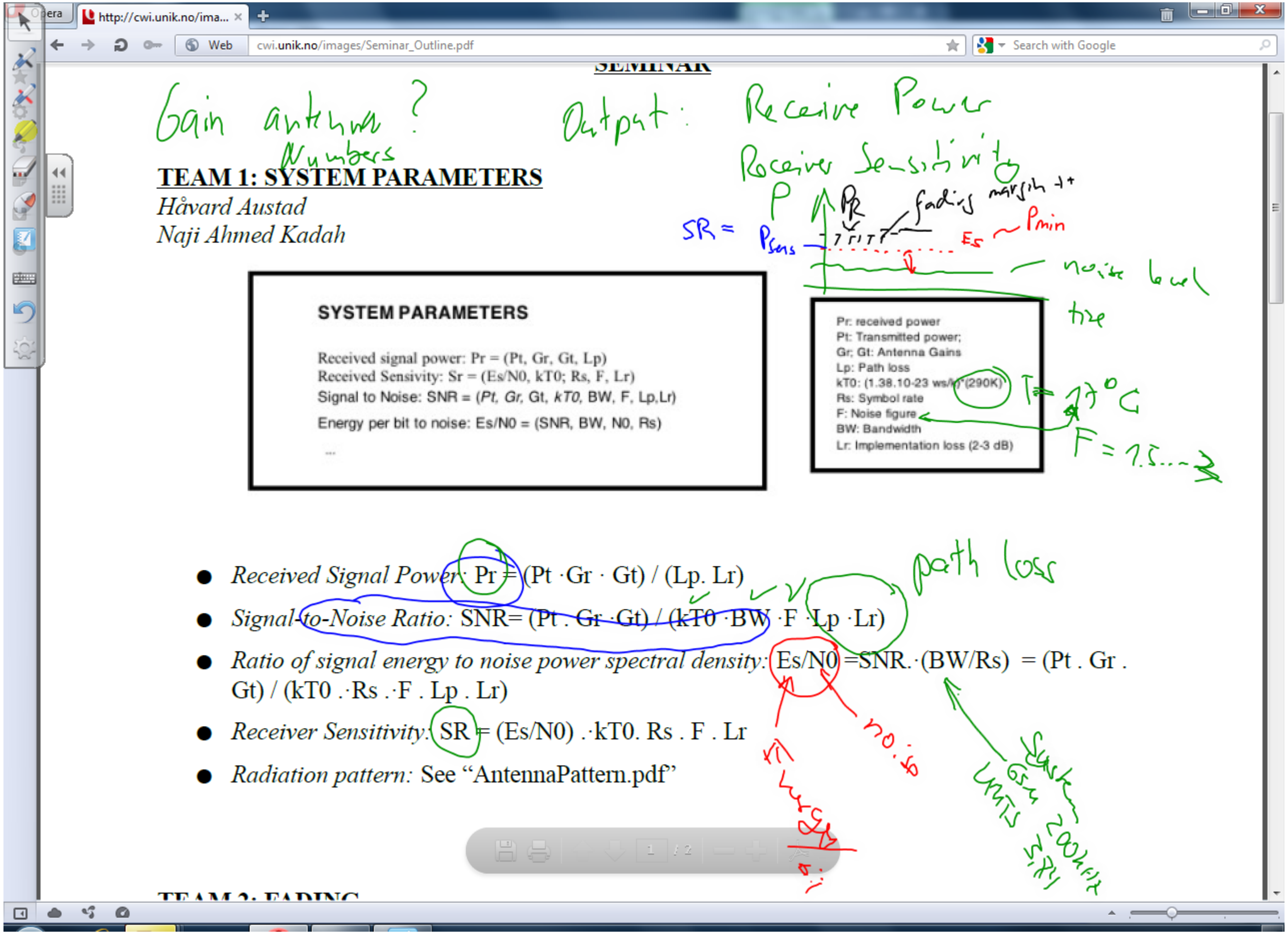


SEMINAR

Gain antenna ?

Numbers

Output: Receive Power

Receiver Sensitivity

TEAM 1: SYSTEM PARAMETERS

Håvard Austad
Naji Ahmed Kadah

SR = P_{sens}

P

Pr

fading margin +

Es ~ P_{min}

noise level

[illegible]

SYSTEM PARAMETERS

Received signal power: Pr = (Pt, Gr, Gt, Lp)
Received Sensivity: Sr = (Es/N0, kT0; Rs, F, Lr)
Signal to Noise: SNR = (*Pt, Gr,* Gt, *kT0,* BW, F, Lp,Lr)
Energy per bit to noise: Es/N0 = (SNR, BW, N0, Rs)
...

Pr: received power
Pt: Transmitted power;
Gr; Gt: Antenna Gains
Lp: Path loss
kT0: (1.38.10-23 ws/K)*(290K)
Rs: Symbol rate
F: Noise figure
BW: Bandwidth
Lr: Implementation loss (2-3 dB)

T = 17°C

F = 1.5...3

path loss

- *Received Signal Power:* Pr = (Pt ·Gr · Gt) / (Lp. Lr)
- *Signal-to-Noise Ratio:* SNR= (Pt . Gr ·Gt) / (kT0 ·BW ·F ·Lp ·Lr)
- *Ratio of signal energy to noise power spectral density:* Es/N0 =SNR.·(BW/Rs) = (Pt . Gr . Gt) / (kT0 .·Rs .·F . Lp . Lr)
- *Receiver Sensitivity:* SR = (Es/N0) .·kT0. Rs . F . Lr
- *Radiation pattern:* See "AntennaPattern.pdf"

Energy

noise

System

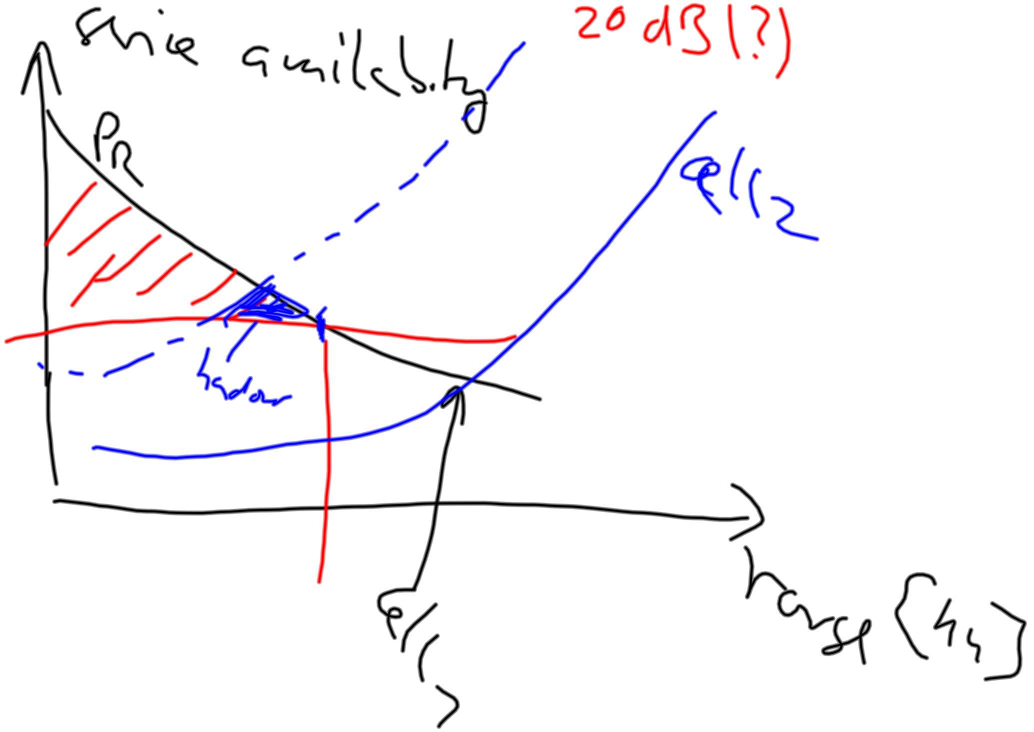
GSM 200kHz

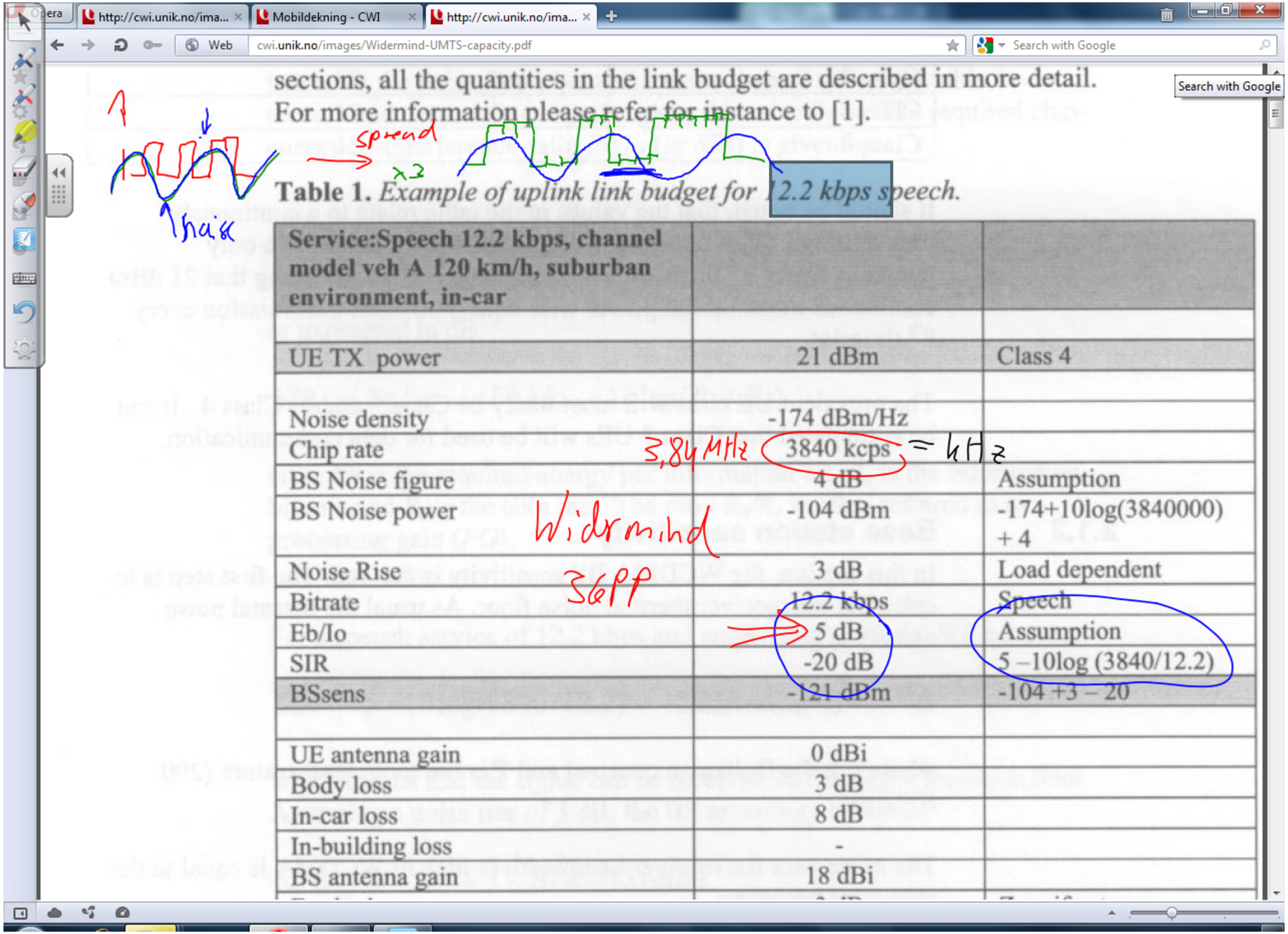
UMTS 5MHz

TEAM 2: FADING

Input $\frac{E_B}{I_0}$ voice 5 dB

data 20 Mbit/s 20 dB (?)

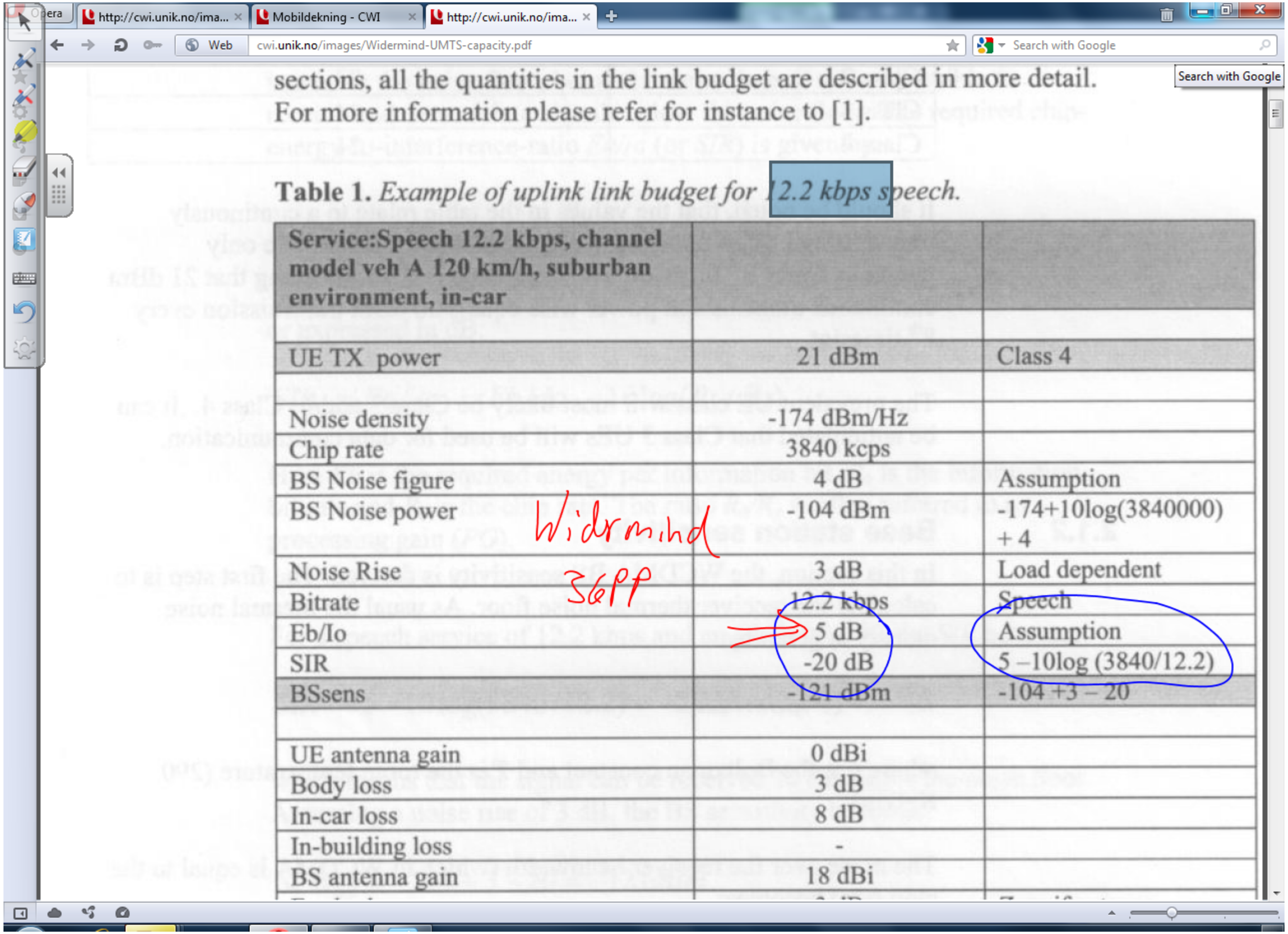




sections, all the quantities in the link budget are described in more detail. For more information please refer for instance to [1].

Table 1. *Example of uplink link budget for 12.2 kbps speech.*

Service:Speech 12.2 kbps, channel model veh A 120 km/h, suburban environment, in-car		
UE TX power	21 dBm	Class 4
Noise density	-174 dBm/Hz	
Chip rate	3840 kcps	
BS Noise figure	4 dB	Assumption
BS Noise power	-104 dBm	-174+10log(3840000) + 4
Noise Rise	3 dB	Load dependent
Bitrate	12.2 kbps	Speech
Eb/Io	5 dB	Assumption
SIR	-20 dB	5 – 10log (3840/12.2)
BSsens	-121 dBm	-104 +3 – 20
UE antenna gain	0 dBi	
Body loss	3 dB	
In-car loss	8 dB	
In-building loss	-	
BS antenna gain	18 dBi	



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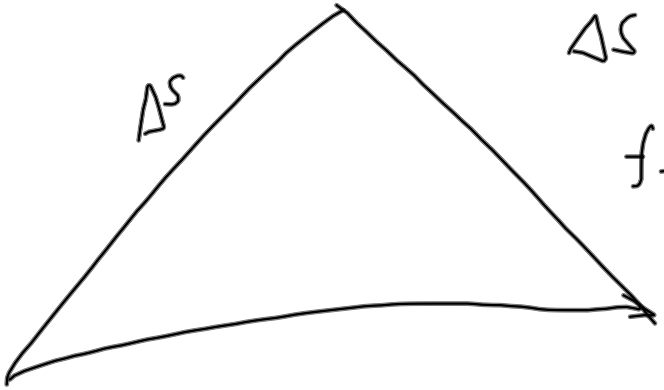
Widrmind

3GPP

fast fading ⟷ slow fading

UMTS



$\Delta s \sim 180°$

$7.5\,\mathrm{cm}$

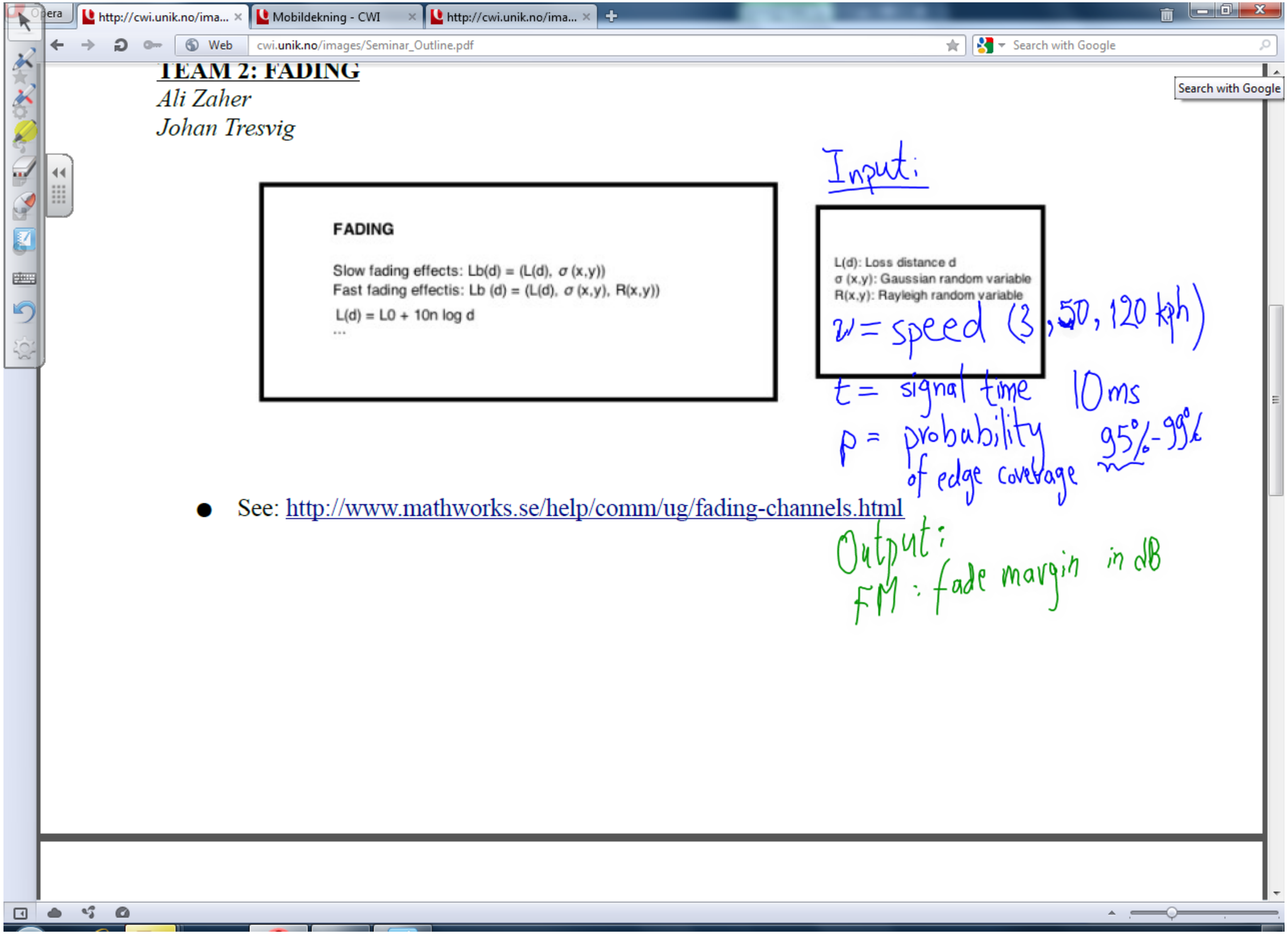
$f = 2.1\,\mathrm{GHz}$

$\lambda = 15\,\mathrm{cm}$

$0 \ldots 15\,\mathrm{cm}$

$f = f_1 = 2.1\,\mathrm{GHz}$

$2.10 \ldots 2.12\,\mathrm{GHz}$



TEAM 2: FADING

Ali Zaher
Johan Tresvig

FADING

Slow fading effects: Lb(d) = (L(d), σ (x,y))
Fast fading effectis: Lb (d) = (L(d), σ (x,y), R(x,y))
L(d) = L0 + 10n log d
...

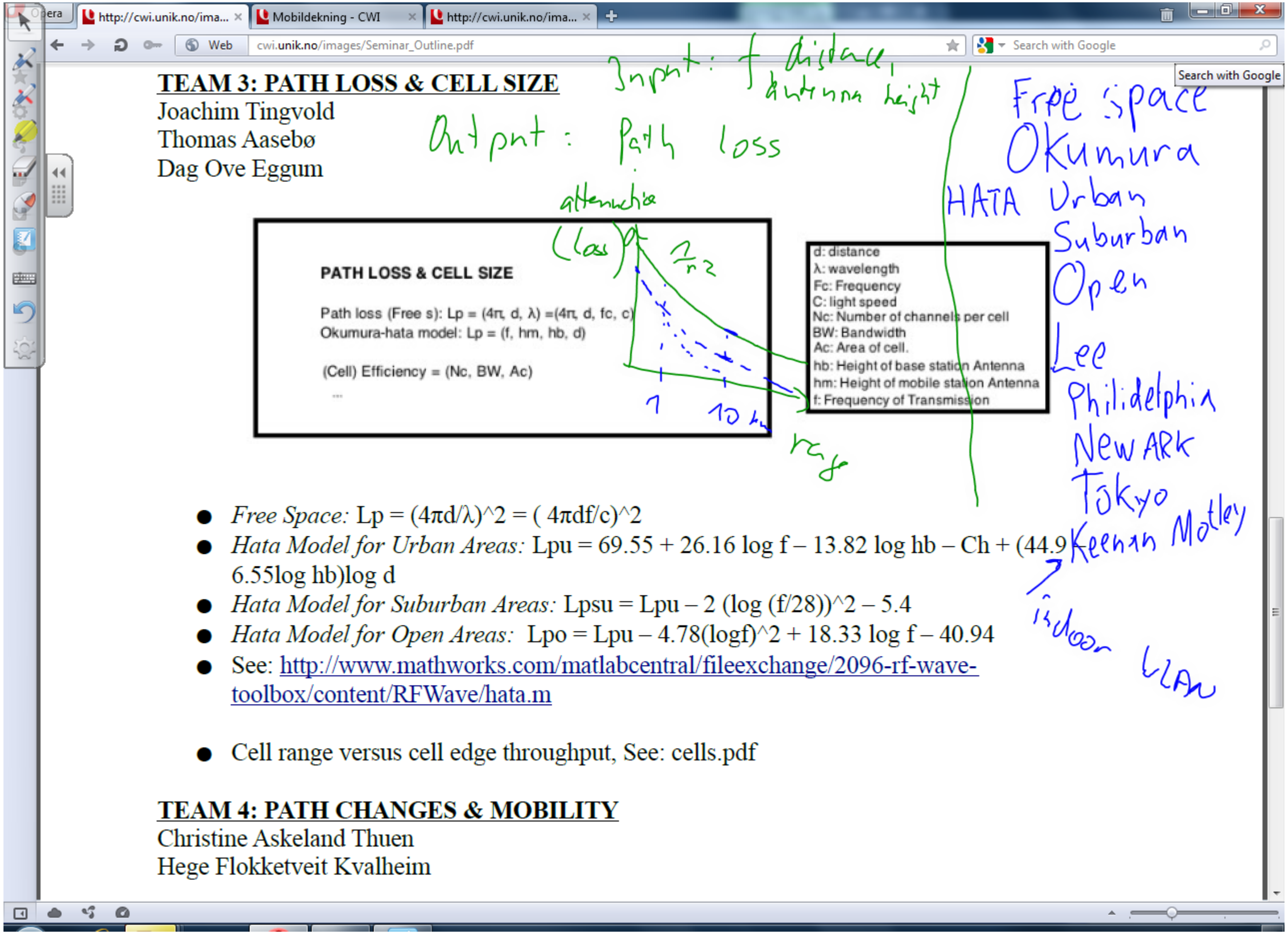
Input:

L(d): Loss distance d
σ (x,y): Gaussian random variable
R(x,y): Rayleigh random variable

v = speed (3, 50, 120 kph)
t = signal time 10ms
p = probability of edge coverage 95%-99%

- See: http://www.mathworks.se/help/comm/ug/fading-channels.html

Output:
FM : fade margin in dB



TEAM 3: PATH LOSS & CELL SIZE

Joachim Tingvold
Thomas Aasebø
Dag Ove Eggum

Input: f, distance, antenna height

Output: Path loss

PATH LOSS & CELL SIZE

Path loss (Free s): Lp = (4π, d, λ) =(4π, d, fc, c)
Okumura-hata model: Lp = (f, hm, hb, d)

(Cell) Efficiency = (Nc, BW, Ac)

...

d: distance
λ: wavelength
Fc: Frequency
C: light speed
Nc: Number of channels per cell
BW: Bandwidth
Ac: Area of cell.
hb: Height of base station Antenna
hm: Height of mobile station Antenna
f: Frequency of Transmission

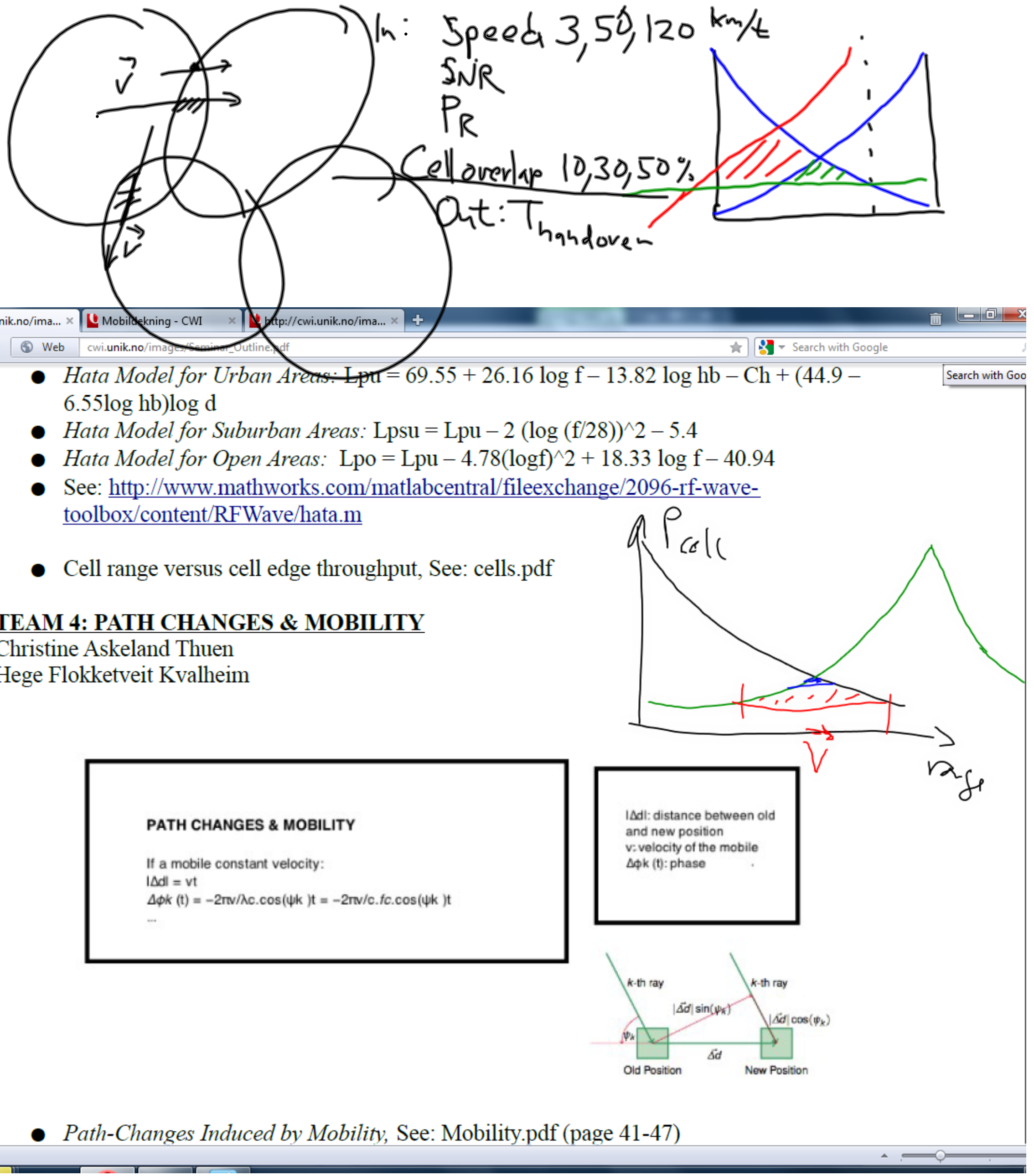
Free space
Okumura
HATA Urban
Suburban
Open
Lee
Philidelphia
New ARK
Tokyo
Keenan Motley
indoor
WLAN

- *Free Space:* $L_p = (4\pi d/\lambda)^2 = (4\pi df/c)^2$
- *Hata Model for Urban Areas:* $L_{pu} = 69.55 + 26.16 \log f - 13.82 \log h_b - C_h + (44.9$ $6.55 \log h_b)\log d$
- *Hata Model for Suburban Areas:* $L_{psu} = L_{pu} - 2 (\log (f/28))^2 - 5.4$
- *Hata Model for Open Areas:* $L_{po} = L_{pu} - 4.78(\log f)^2 + 18.33 \log f - 40.94$
- See: http://www.mathworks.com/matlabcentral/fileexchange/2096-rf-wave-toolbox/content/RFWave/hata.m

- Cell range versus cell edge throughput, See: cells.pdf

TEAM 4: PATH CHANGES & MOBILITY

Christine Askeland Thuen
Hege Flokketveit Kvalheim



- *Hata Model for Urban Areas:* $L_{pu} = 69.55 + 26.16 \log f - 13.82 \log h_b - C_h + (44.9 - 6.55 \log h_b) \log d$
- *Hata Model for Suburban Areas:* $L_{psu} = L_{pu} - 2 (\log (f/28))^2 - 5.4$
- *Hata Model for Open Areas:* $L_{po} = L_{pu} - 4.78(\log f)^2 + 18.33 \log f - 40.94$
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- Cell range versus cell edge throughput, See: cells.pdf

TEAM 4: PATH CHANGES & MOBILITY
Christine Askeland Thuen
Hege Flokketveit Kvalheim

PATH CHANGES & MOBILITY

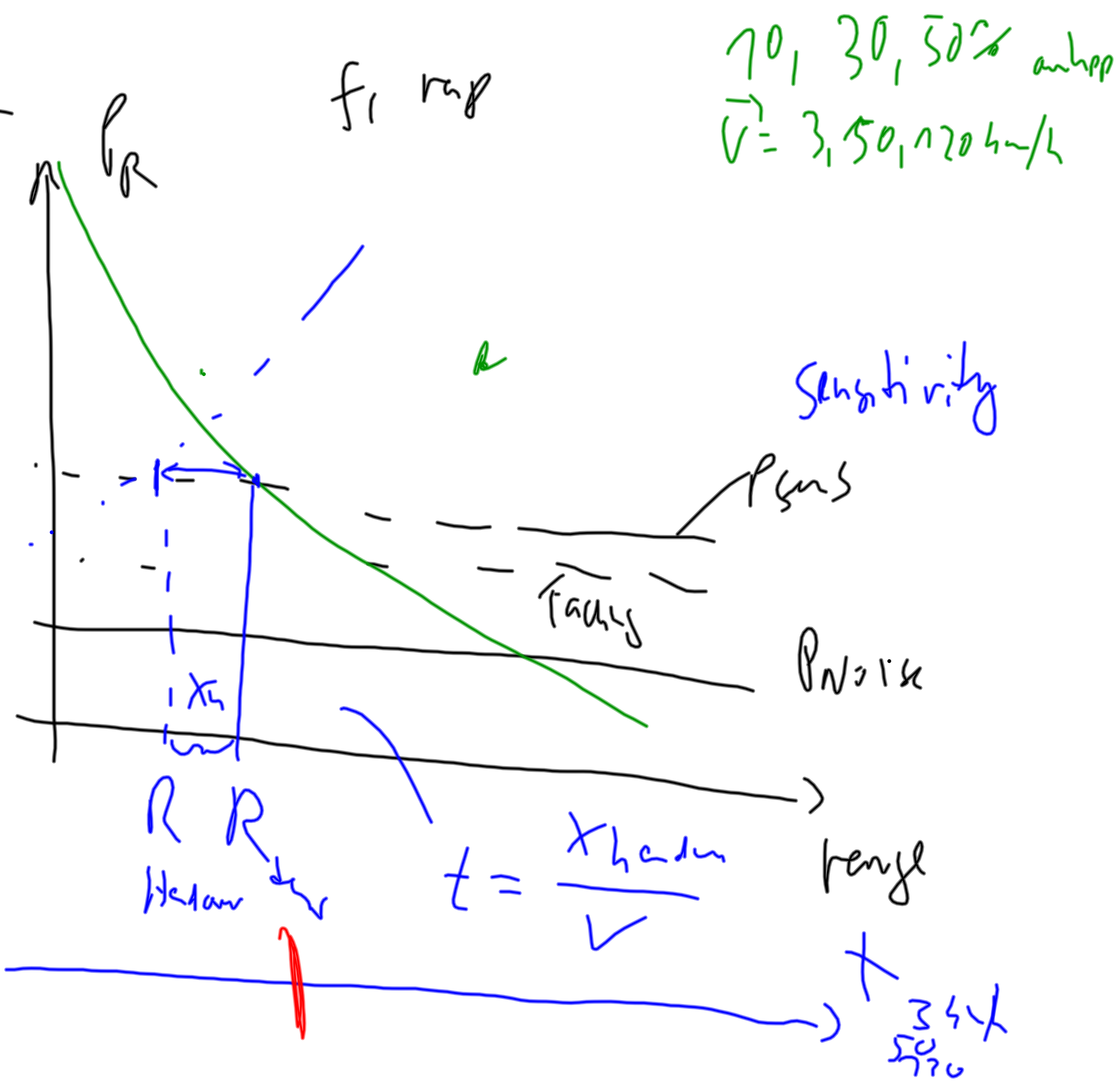
If a mobile constant velocity:
$|\Delta d| = vt$
$\Delta\phi k\,(t) = -2\pi v/\lambda c.\cos(\psi k)t = -2\pi v/c.fc.\cos(\psi k)t$
...

$|\Delta d|$: distance between old and new position
v: velocity of the mobile
$\Delta\phi k$ (t): phase

- *Path-Changes Induced by Mobility,* See: Mobility.pdf (page 41-47)

	f [MHz]	BW [MHz]	P_T download [dBm]	Speed [km/h]	time	G_R, G_T	P_{Sens} = SR dBm
GSM	1800 (900)	0.2	25 W	3, 50, 120	100ms	1.5 .... 3 dB , 14	Loss margin −105 (−115) Check
UMTS	2100	3.84	25W		10ms	1.5 .. 3 14	−115 SR
802.11a	5200	40	100 mW	3, 50	10ms	omni, → directional 2 ... 9 $G_R \approx 3$	−95
802.11b	2400	20	100mW	95% probability	100ms	3, 2 ... 9	−95 dBm

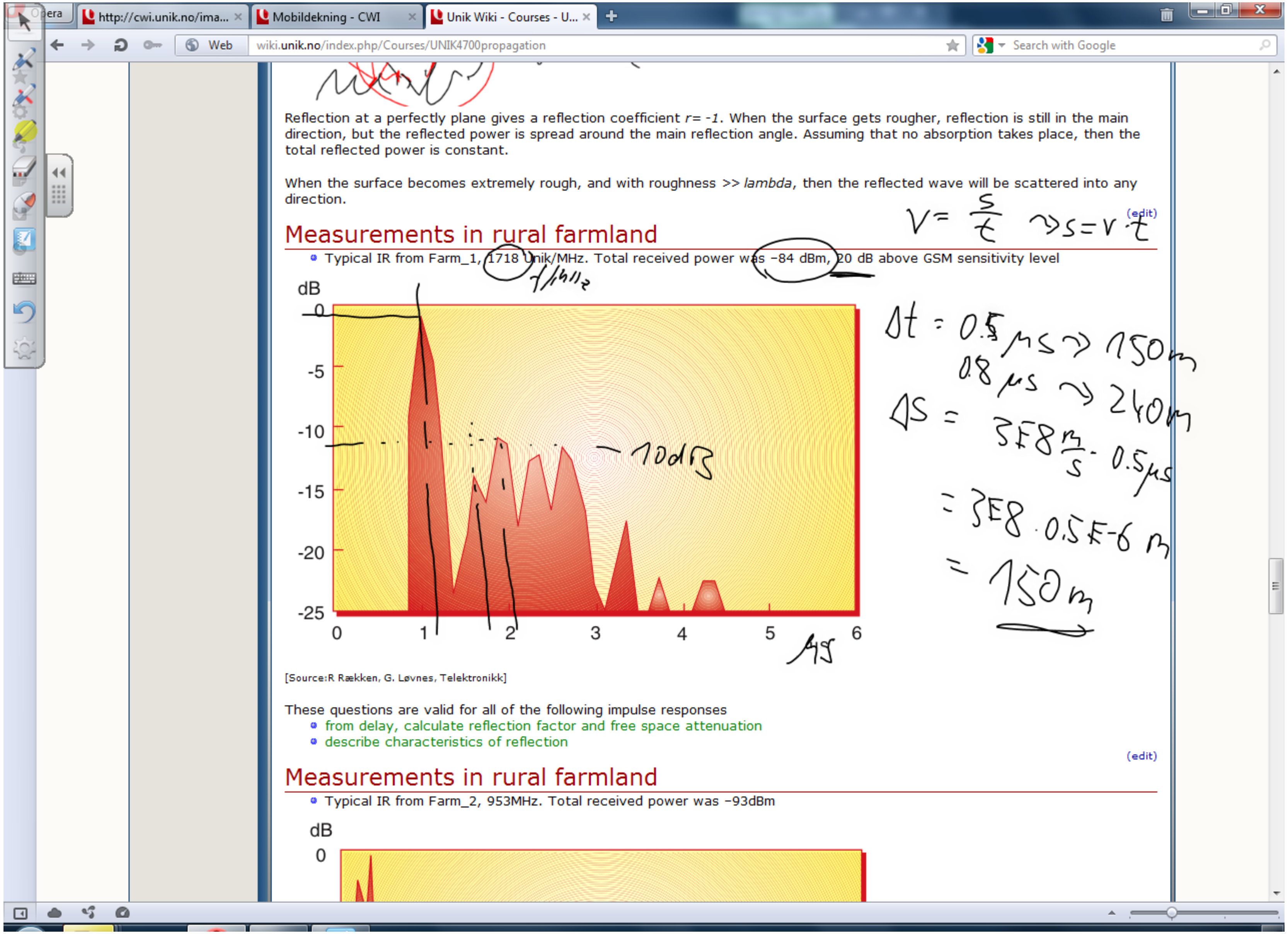
Output



10, 30, 50% anhpp

$\vec{v} = 3, 50, 120$ km/h

$$t = \frac{x_{shadow}}{v}$$



Reflection at a perfectly plane gives a reflection coefficient *r= -1*. When the surface gets rougher, reflection is still in the main direction, but the reflected power is spread around the main reflection angle. Assuming that no absorption takes place, then the total reflected power is constant.

When the surface becomes extremely rough, and with roughness >> *lambda*, then the reflected wave will be scattered into any direction.

$V = \frac{s}{t} \Rightarrow s = v \cdot t$

Measurements in rural farmland

- Typical IR from Farm_1, 1718 Unik/MHz. Total received power was -84 dBm, 20 dB above GSM sensitivity level

f/MHz

-10dB

μs

$\Delta t = 0.5\,\mu s \rightarrow 150\,m$

$0.8\,\mu s \rightarrow 240\,m$

$\Delta s = 3E8\,\frac{m}{s} \cdot 0.5\,\mu s$

$= 3E8 \cdot 0.5E\text{-}6\ m$

$= 150\,m$

[Source:R Rækken, G. Løvnes, Telektronikk]

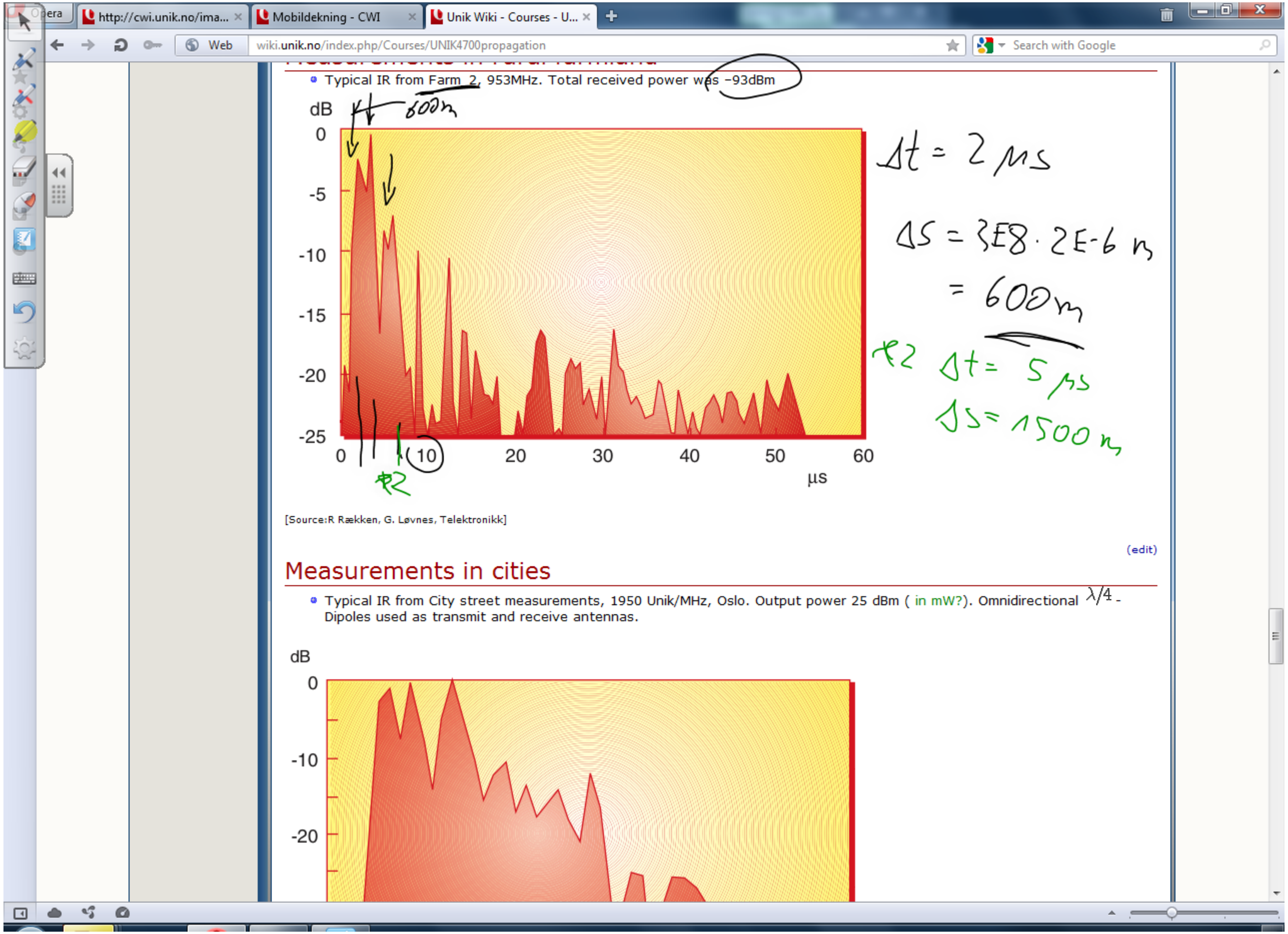
These questions are valid for all of the following impulse responses

- from delay, calculate reflection factor and free space attenuation
- describe characteristics of reflection

(edit)

Measurements in rural farmland

- Typical IR from Farm_2, 953MHz. Total received power was -93dBm



- Typical IR from Farm 2, 953MHz. Total received power was −93dBm

$\Delta t = 2\ \mu s$

$\Delta s = 3E8 \cdot 2E\text{-}6\ m$

$= 600m$

#2 $\Delta t = 5\ \mu s$

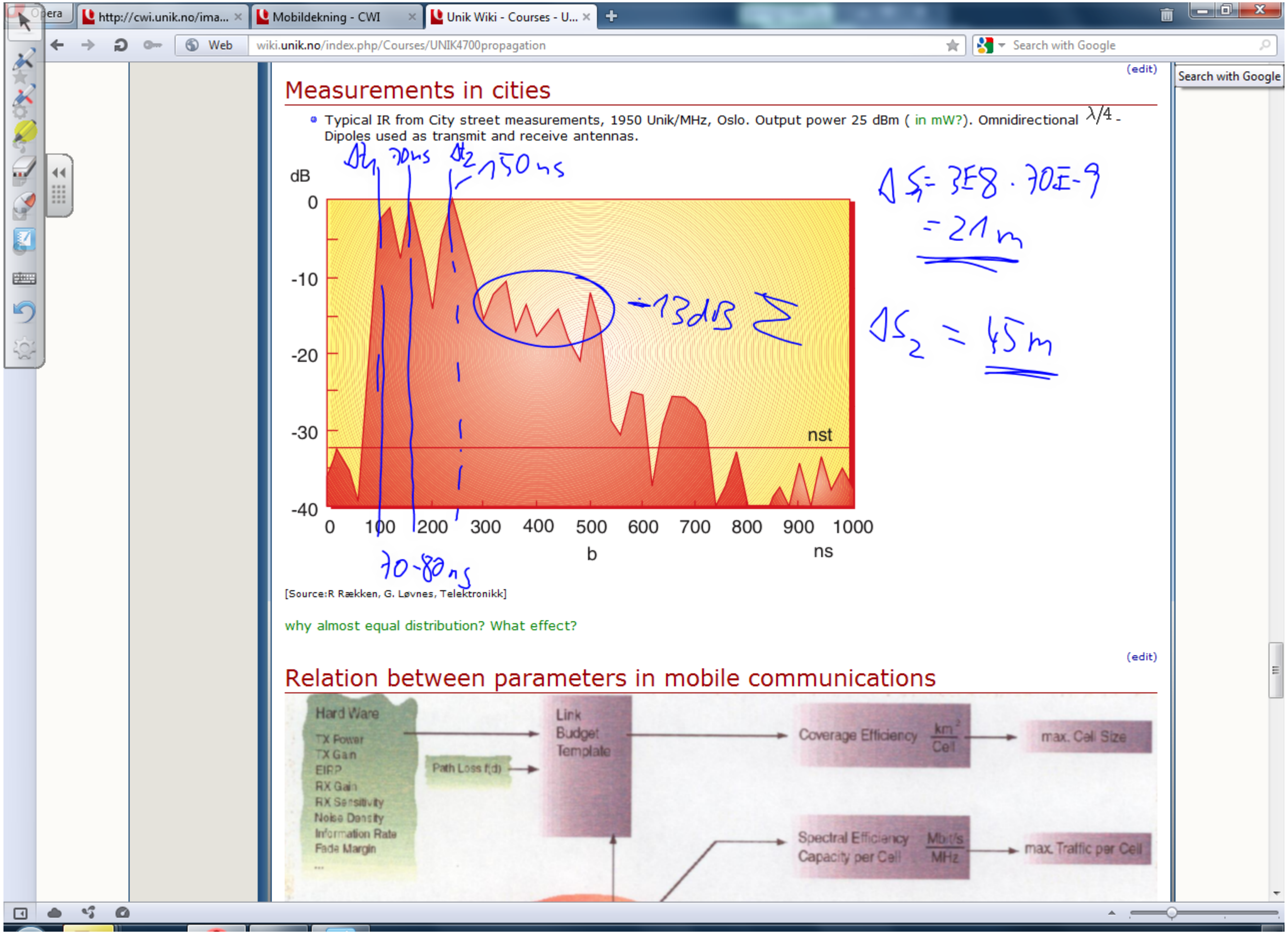
$\Delta s = 1500\ m$

[Source:R Rækken, G. Løvnes, Telektronikk]

(edit)

Measurements in cities

- Typical IR from City street measurements, 1950 Unik/MHz, Oslo. Output power 25 dBm (in mW?). Omnidirectional $\lambda/4$ - Dipoles used as transmit and receive antennas.



Measurements in cities

- Typical IR from City street measurements, 1950 Unik/MHz, Oslo. Output power 25 dBm (in mW?). Omnidirectional $\lambda/4$ - Dipoles used as transmit and receive antennas.

$\Delta S_1 = 3E8 \cdot 70E\text{-}9$

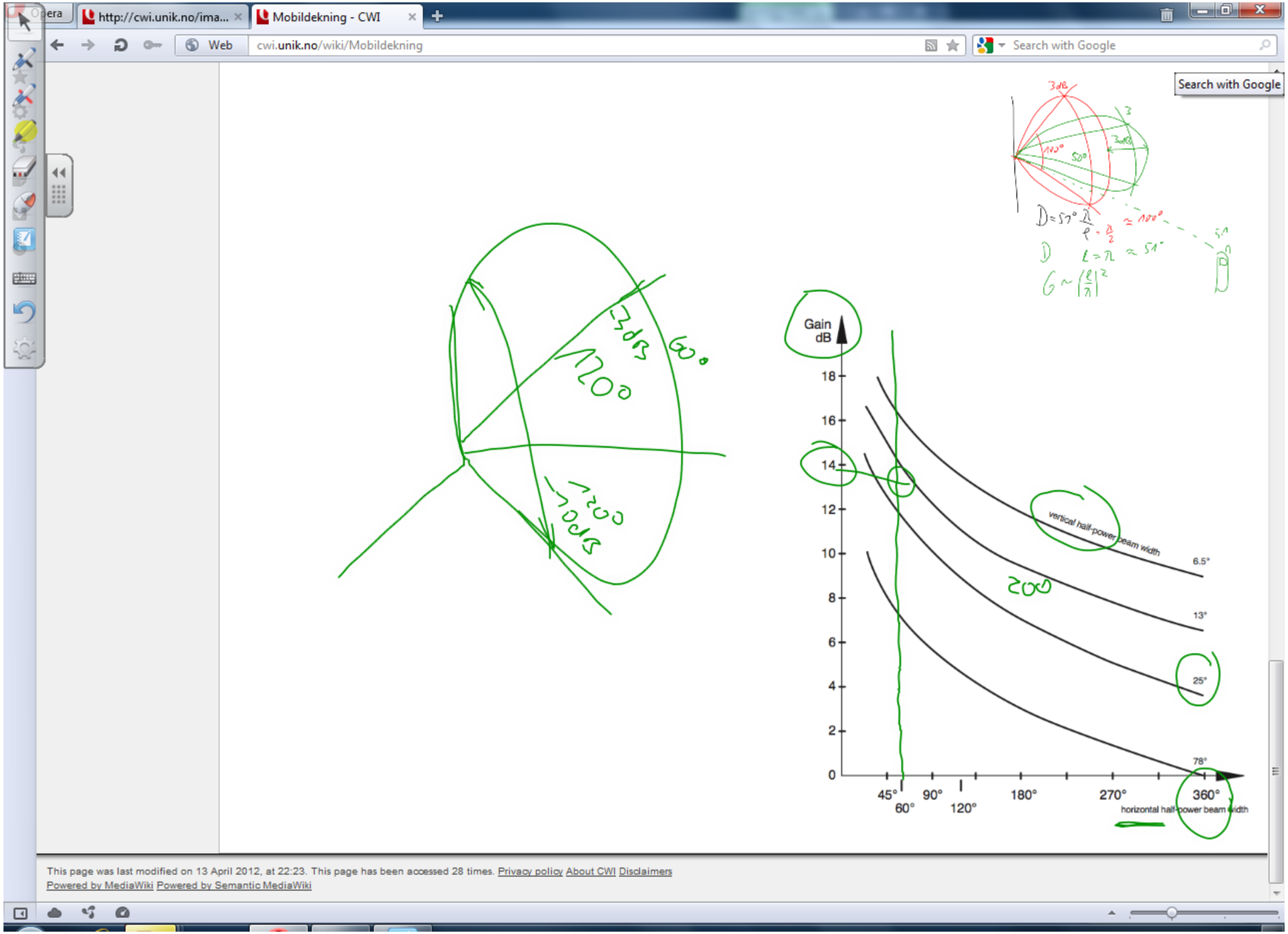
$= 21\,m$

$\Delta S_2 = 45\,m$

[Source:R Rækken, G. Løvnes, Telektronikk]

why almost equal distribution? What effect?

Relation between parameters in mobile communications



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