

- Recall "State of knowledge"
- Lack of appropriate propagation models
└ Convert free space loss $\rightarrow$ dB better $\Rightarrow$ SW model
- Example: Free Internet access for everybody
apply 700... 5 GHz
- "Measurements" indicative (mobile) including 802.11ac

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cwi.unik.no/images/Propagation_discussion.pdf

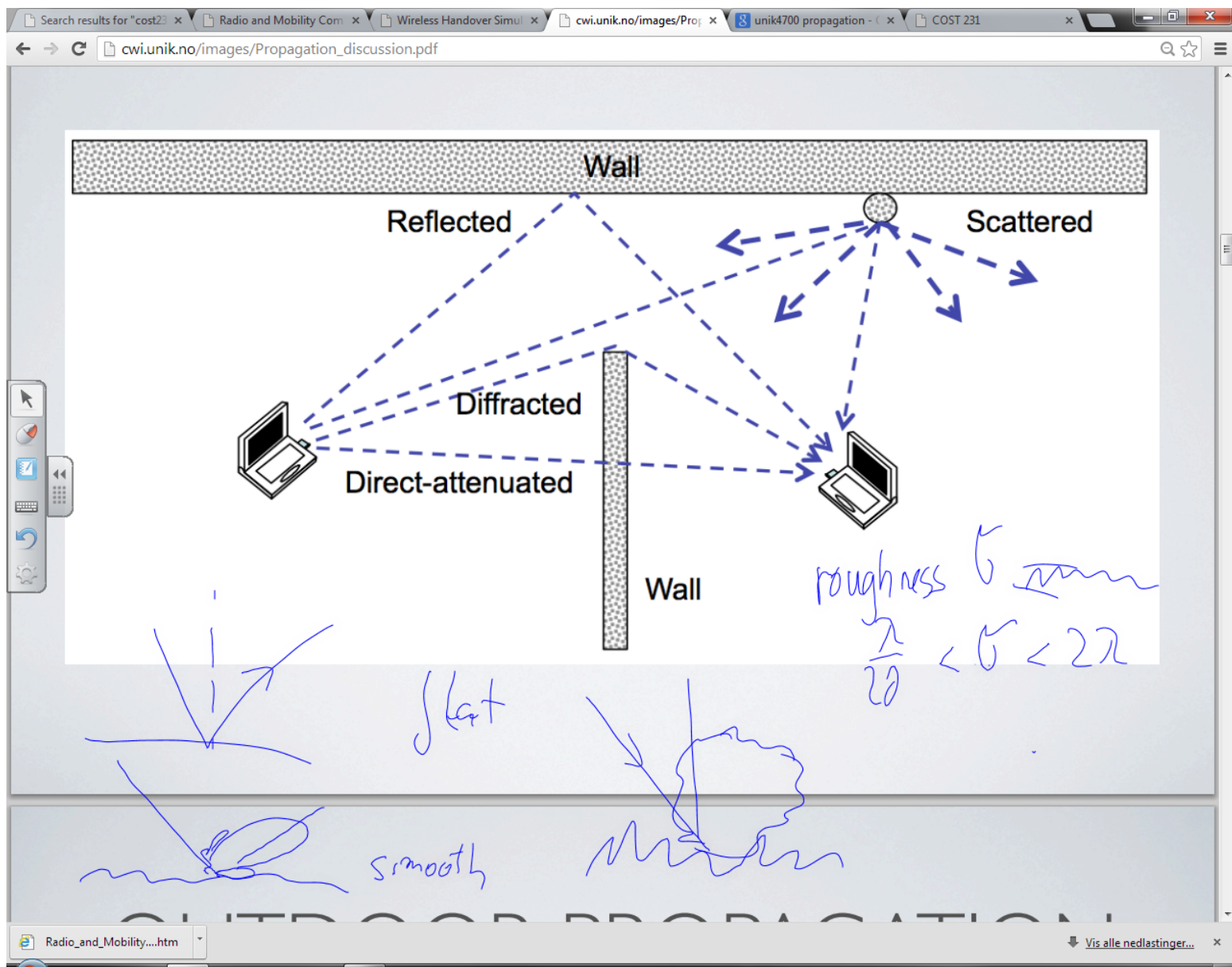
PROPAGATION CONSTANT

- Maxwell's equations
- γ - Propagation constant (m):
$$\gamma = \alpha + j\beta$$
- α - Real part: attenuation constant (Np/m)
- β - Imaginary part: phase constant (rad/m)

Handwritten notes:

- $e^{-j(\vec{k} \cdot \vec{r} - \omega t)}$
- $\vec{k} = \frac{2\pi}{\lambda} \begin{pmatrix} x \\ y \\ z \end{pmatrix}$
- $\lambda = \frac{c}{f} \sqrt{\epsilon_r}$
- $\cos \theta$

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PROPAGATION MODELS

Empirical mathematical formulation

- Used to define wave propagation (path loss)
- A function of frequency, distance, and other conditions *add-on*
- Usually one single model for propagation for all similar links under similar circumstances
- Many different models: various propagation mechanisms, different environments (indoor, outdoor, land, sea, space, etc), different applications, different frequencies, etc.

$L = 70 \log\left(\frac{\lambda^2}{4\pi R}\right)$

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

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NON-LOS

- If the first Fresnel zone is obstructed
- Obstacles not entering the first zone, can be ignored
- And/or if signal reaches the receiver due to reflection, refraction, diffraction, etc
- Obstructions can be located to either sides of the path, or above/below.

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FADING

```
graph TD; FadingChannel[Fading channel] --> LargeScaleFading[Large-scale fading]; FadingChannel --> SmallScaleFading[Small-scale fading]; LargeScaleFading --> PathLoss[Path loss]; LargeScaleFading --> Shadowing[Shadowing]; SmallScaleFading --> MultiPathFading[Multi-path fading]; SmallScaleFading --> TimeVariance[Time variance]; MultiPathFading --> FrequencySelectiveFading[Frequency-selective fading]; MultiPathFading --> FlatFading[Flat fading]; TimeVariance --> FastFading[Fast fading]; TimeVariance --> SlowFading[Slow fading];
```

ground reflection rural

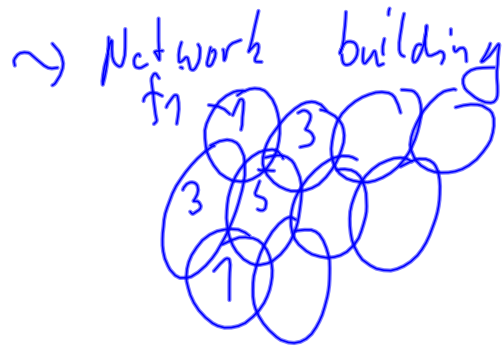
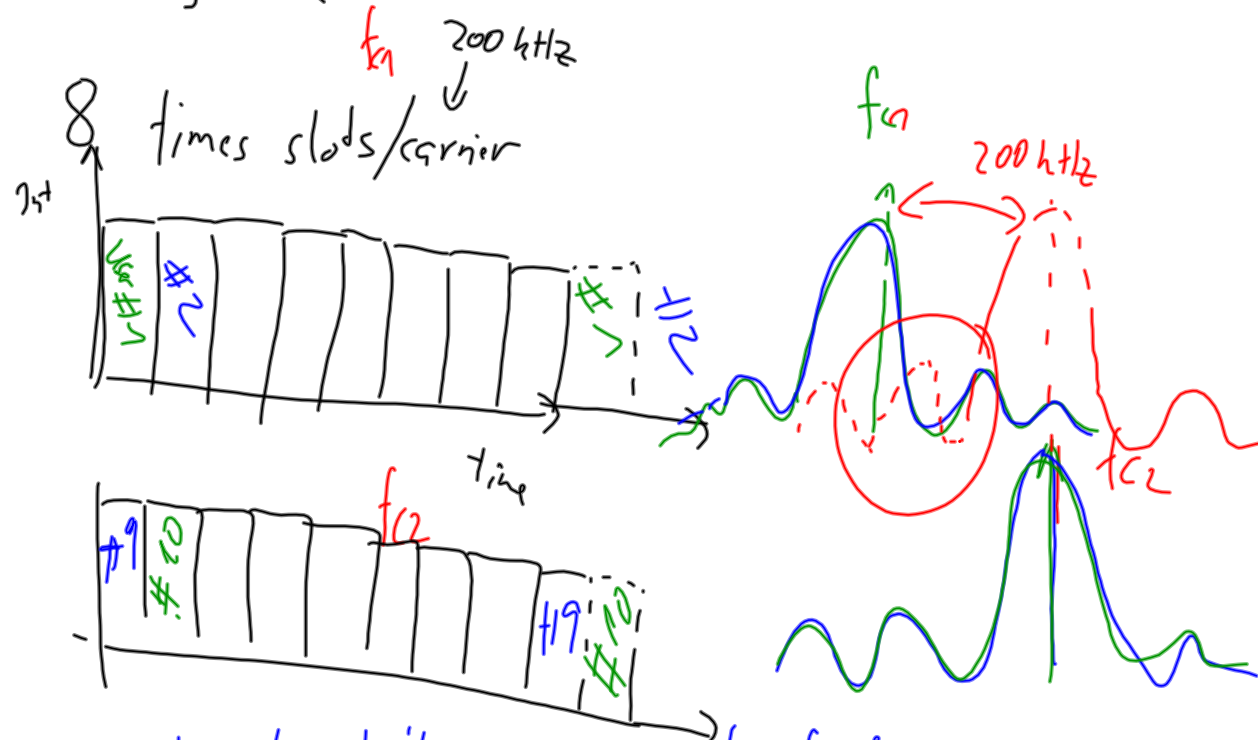
City

atmosphere

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Interference in GSM

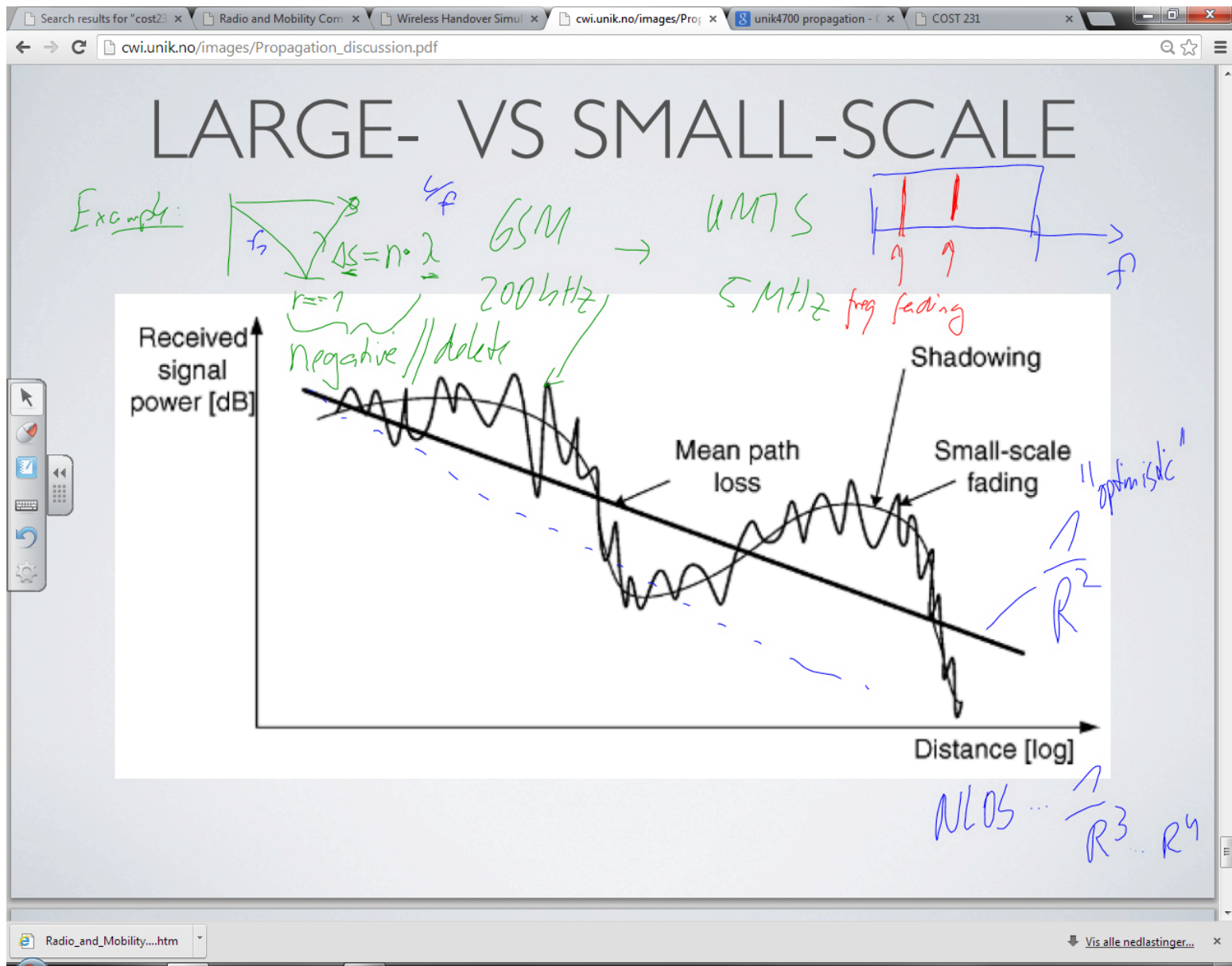


f_1, f_3, f_5

Macro cells = coverage

Micro cells = capacity (smaller lower)

f_2, f_4, f_6



Goal: Better propagation model

- analyse last 231 models
- present
- program
- compare

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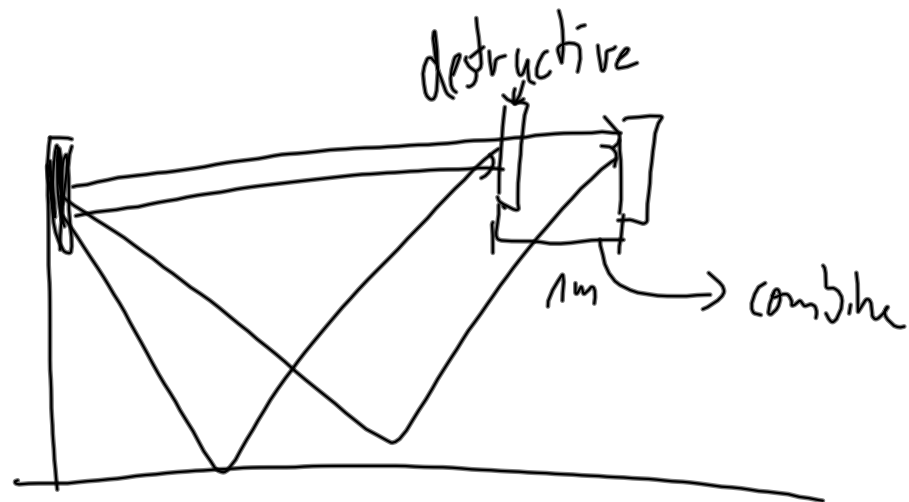
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Intro
Main?

Side remark: Diversity $\leftarrow$ space



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↓ WLAN

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- Norsk

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Objective Get a programming tool for simulating the handover times between wireless and mobile networks. Establish scenarios for wireless to mobile, mobile to mobile and wireless to wireless; simulate the scenarios and discuss the results

Keywords Handover, Simulation, GSM, UMTS, Wifi, 802.11

Wireless Handover Simulations Handover Scenarios System parameters Propagation models [Antennas](#) [edit](#)

Fading Simulation results Software & Background

One of the ongoing discussions in radio systems is the required time for handover between access points. This wiki page explains the background for the software package: **Radio network planning and handover: Programming framework for radio propagation and handover evaluation**. It provides an overview over the phenomena, gives a set of typical input parameters for wireless/mobile simulations and presents typical results for mobile and wireless handover.

The main goal by creating the software simulation tools addressed

- Understand the typical cell/coverage sizes in mobile and wireless systems.
- Understand on how cell size and cell dimensions affect handover.

Simulations

- [Click here to read more about our scenarios...](#)
- [Click here to see the simulation results](#)

Participants [edit](#)

The initial work was performed as part of the UNIK4700 course on Radio and Mobility in autumn 2012. UNIK4700H12Participants contributed to the first solution, and invite everyone to contribute to the simulation tool.

References [edit](#)

References were provided in each section.

- ↑ Louay M.A. Jalloul, and Sam P. Alex, "Coverage Analysis for IEEE 802.16e/WiMAX Systems", IEEE Trans. on Wireless Comm., 7(11), Nov 2008, pp 4627-4635
- ↑ Filipe D. Cardoso, and Luis M. Correia, "Fading Depth Evaluation in Mobile Communications - from GSM to Future Mobile Broadband Systems", PIMRC'2002, available at DOI 10.1.1.11.4072
- ↑ COST 231, Digital mobile radio towards future generation systems, Final Report, COST Telecom Secretariat, European Commission, Brussels, Belgium, 1999, http://info.grow.inov.pt/cost231/final_report.htm

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Fm space loss $\rightarrow$ dB log req. [1]

$$L = 20 \log \left(\frac{\lambda}{4\pi R} \right) \quad \lambda = \frac{c}{f}$$

use 6Hz

$$L^* = 20 \log \left(\frac{4\pi}{c} \right) + 20 \log f + 20 \log R$$

~~3E8 m/s~~

6Hz
f [MHz]
~~E9 E6~~

R [km]
~~E3~~

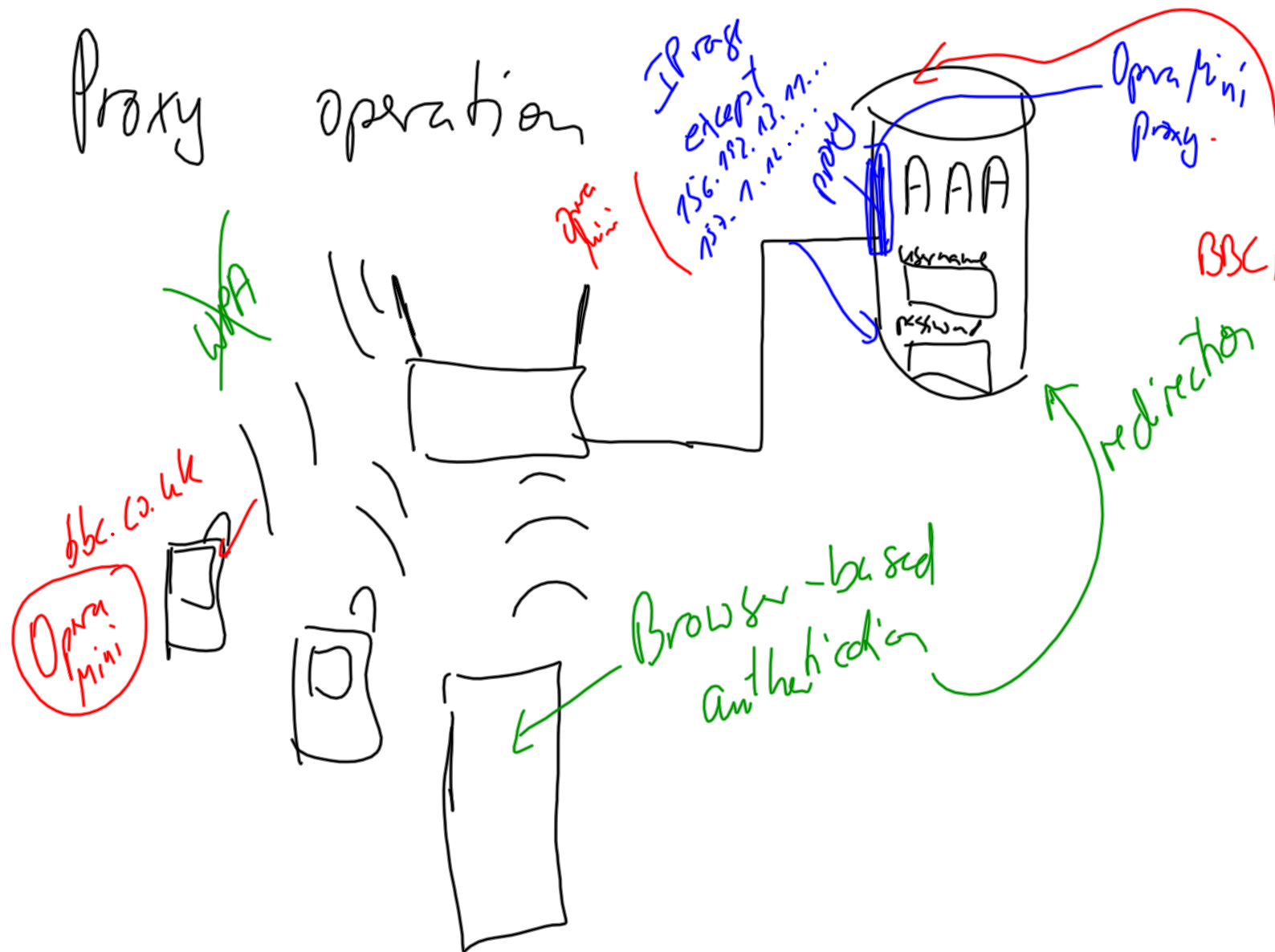
+ 20 log f [MHz] + 20 log R [km]

Table

	$f[\text{GHz}]$	R [km]
6sm	1	0.1 1 10 100
4mIS/w.f.	2	0.01 0.1 1 10
20217g	5	0.01 0.1 1

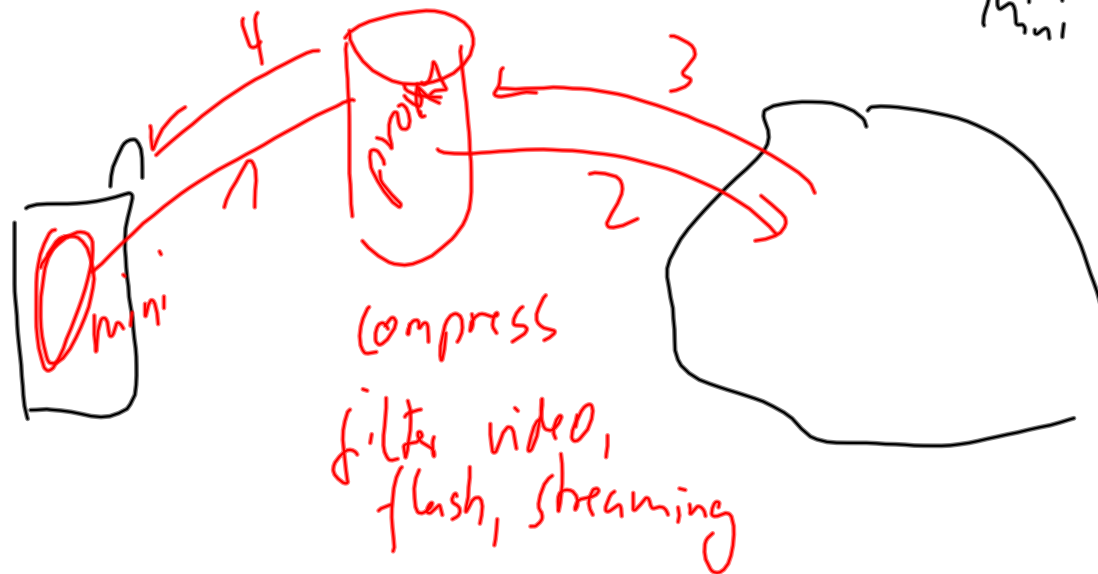
L^*

231 indoor
231 outdoor



By installing app (Opera Mini)

- associate a IP range for Opera Mini Proxy



- Proxy for 20-30 kbit/s
- Authentication

background free
10-30 kbit/s

background hungry
payed

PL, DR, DF, NO

always
online

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bandwidth limited, access to the Internet through user involvement we have demonstrated that our access solution is much cheaper than conventional approaches. Together with our partners are actively seeking for solutions which will provide even cheaper Internet access

Efficiency
We believe that the basic need is to get access, and that users are willing to pay more for broadband services. Our focus is on the basic need of providing the access to information for education, health and innovation.

Business models
Our approach of *user involvement* results in the a network infrastructure where *the user owns the network*, and we provide the backbone access. Our resellers have demonstrate innovative solutions for providing access.

We believe that access to the Internet will contribute to

Education
Education means access to public knowledge through libraries such as [Wikipedia](#) , to background information, to basic and higher education. Nextelco has established partnership with the Center for Wireless Innovation Norway ([CWIN.no](#)) for higher education in wireless networks, and seeks cooperation with partners providing help in education on all levels. CWI Norway has a close collaboration with Nordic Universities in Denmark (Aalborg University), Finland (Lappeenranta University) and Sweden (Karlstad University), and through the partners reaches a worldwide network of educational institutes.

Health
Health information is available in the Internet to at large account. By providing doctors and patients access to the Internet we will contribute to less mortality.

Innovation
Innovation is best fostered when people with different background discuss. Our approach of *user involvement* brings people together, and creates links between emerging economies and the Scandinavian countries.

News [edit]

- August 2013: Nextelco successfully demonstrated the voucher-based hot-spot operation in Kinshasa
- August 2013: [Internet.org](#) has the vision of bringing Internet to the two thirds of people in the world who don't have access
- May 2013: Google supports Internet in emerging economies: "[Google to Fund, Develop Wireless Networks in Emerging Markets](#)"

Links [edit]

- Nextelco home page: <http://nextelco.net>
- Nextelco Foundation: <https://www.facebook.com/nextelco.foundation>
- Crowdfunding - <http://foend.no/Project/a7cce9d8-f130-4c6e-a79d-a6627347a242>

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