

- Recall "state of knowledge"

- Lack of appropriate propagation models  $\rightarrow$  better SW model  
└ Convert free space loss  $\rightarrow$  dB

- Example: Free Internet access for everybody

- "Measurements" indicative including 802.11ac (mobile)

Search results for "cost2" x Radio and Mobility Com x Wireless Handover Simul x cwi.unik.no/images/Prop x unik4700 propagation - x COST 231

cwi.unik.no/images/Propagation\_discussion.pdf

# PROPAGATION CONSTANT

- Maxwell's equations
- $\gamma$  - Propagation constant (m):  

$$\gamma = \alpha + j\beta$$
- $\alpha$  - Real part: attenuation constant (Np/m)
- $\beta$  - Imaginary part: phase constant (rad/m)

Radio\_and\_Mobility...htm

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The diagram illustrates radio wave propagation in a room with two walls. A transmitter (circle) and two receivers (laptops) are shown. The paths are labeled as follows:

- Direct-attenuated:** A dashed line from the transmitter to the receiver on the right, passing through a vertical wall.
- Diffracted:** A dashed line from the transmitter to the receiver on the right, passing over the top of the vertical wall.
- Reflected:** A dashed line from the transmitter to the receiver on the right, reflecting off the top horizontal wall.
- Scattered:** Multiple dashed lines radiating from the transmitter towards the receiver on the right.

Handwritten notes and diagrams:

- Below the diagram, there are two diagrams illustrating surface roughness:
  - Left: A smooth surface with a single reflection point. Labeled "smooth".
  - Right: A rough surface with multiple reflection points. Labeled "rough".
- Text: "Start" and "roughness  $\sigma$ ".
- Equation:  $\frac{\lambda}{20} < \sigma < 2\lambda$

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# PROPAGATION MODELS

Empirical mathematical formulation

- Used to define wave propagation (path loss)
- A function of frequency, distance, and other conditions
- 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.

$L = \eta_0 \log\left(\frac{\lambda^2}{4\pi R}\right)$

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

*add-on*

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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

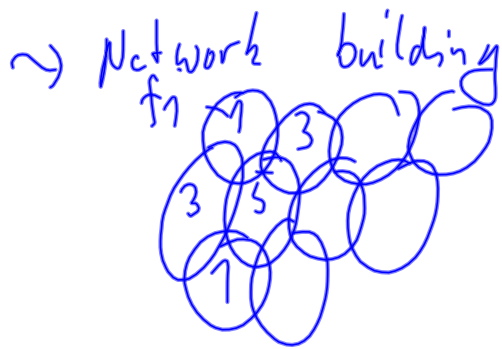
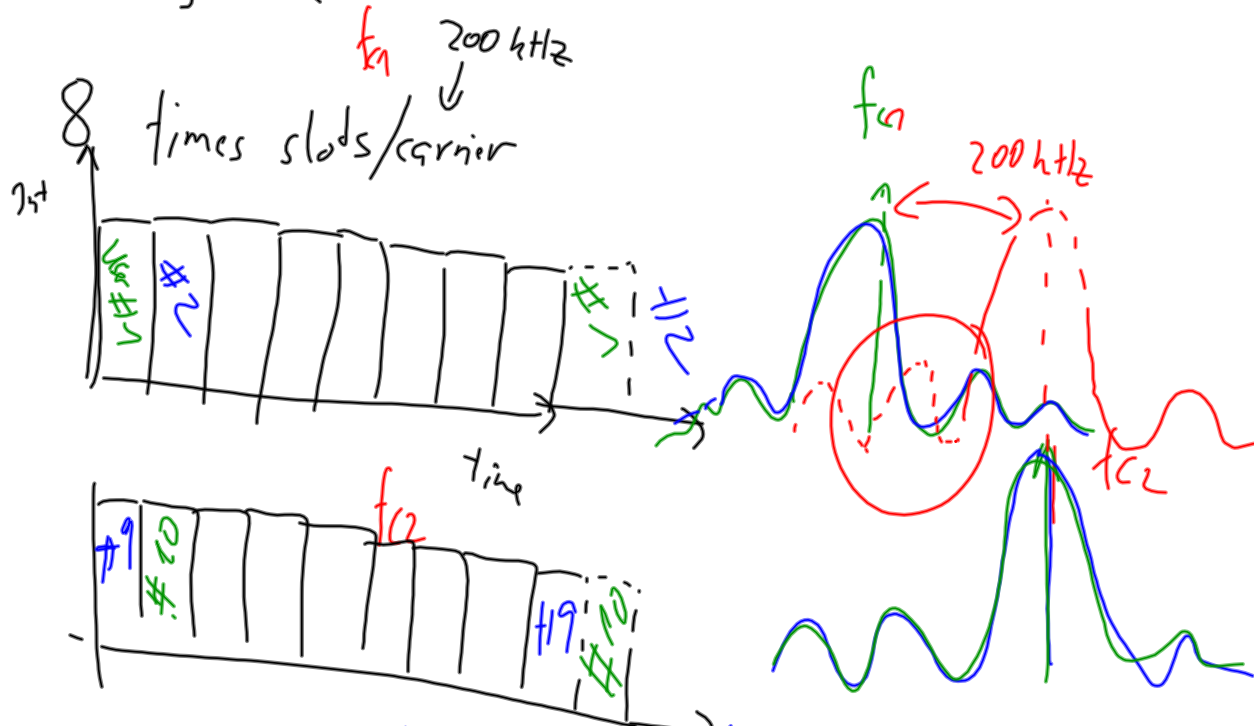
City

atmosphere

Radio\_and\_Mobility...htm

Vis alle nedlastinger...

# Interference in GSM



$f_{c1}, f_{c3}, f_{c5}$   
 Macro cells = coverage  
 $f_{c2}, f_{c4}, f_{c6}$   
 Micro cells = capacity (smaller lower)

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# LARGE- VS SMALL-SCALE

Example:  $f_c$   $\Delta f = n \cdot \lambda$   $r = -1$   $\frac{1}{R^2}$   $\frac{1}{R^3} \dots \frac{1}{R^4}$

GSM  $\rightarrow$  UMTS  $\frac{1}{R^2}$   $\frac{1}{R^3} \dots \frac{1}{R^4}$

200 kHz  $\rightarrow$  5 MHz  $\rightarrow$  freq fading

Received signal power [dB]

Distance [log]

Mean path loss

Shadowing

Small-scale fading

negative // delete

optimistic

NLOS ...  $\frac{1}{R^3} \dots \frac{1}{R^4}$



Goal: Better propagation model

- analyse last 231 models
- present
- programm
- compare

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## Table of Contents

<b>Editors' Preface</b>	v
<b>Table of Contents</b>	ix
<b>List of Figures</b>	xv
<b>List of Tables</b>	xxv
<b>List of Acronyms</b>	xxix
<b>Introduction</b>	<b>1</b>
<b>1 COST 231 in the European Telecommunication Environment</b>	<b>5</b>
1.1 The Evolutionary Vision of Mobile Communications in Europe	5
1.2 System Migration Prerequisites	10
1.2.1 Frequency Allocations and Spectrum Efficiency	10
1.2.2 Enabling Technologies and Advanced Service Provision	14
1.2.3 Terrestrial/Satellite Mobile Networks Integration	16
1.2.4 Standardisation	17
1.3 Medium/Long-Term Action Perspectives	18
1.3.1 Objectives and Participation	18
1.3.2 Liaisons with European Research and Specification Bodies	19

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6 / 30 133% Find

2.3.2 Objectives of the COST 231 Propagation Measurements	51
2.3.3 <u>Narrowband and Wideband Measurements</u>	52
2.3.4 Analysis of Propagation Measurements	53
2.3.5 Indoor Measurements	53
2.3.6 Outdoor Measurements	57
2.3.7 Fading and Path Loss Characteristics	57
2.3.8 <u>Results for Frequency Selectivity in Different Environments</u>	58
2.3.9 Determination of Directions-of-Arrival	60
<b>2.4 Propagation Modelling for the Simulation of the Radio Channel</b>	<b>61</b>
2.4.1 Radio Channel Simulation	61
2.4.2 Long Term Area Simulations	62
2.4.3 Narrowband System Simulations	63
2.4.4 Wideband System Simulations	63
2.4.5 UMTS Simulators	66
2.4.6 Hardware Channel Simulators	68

*Handwritten notes:*  
"Main Characteristics"  
"Keywords"

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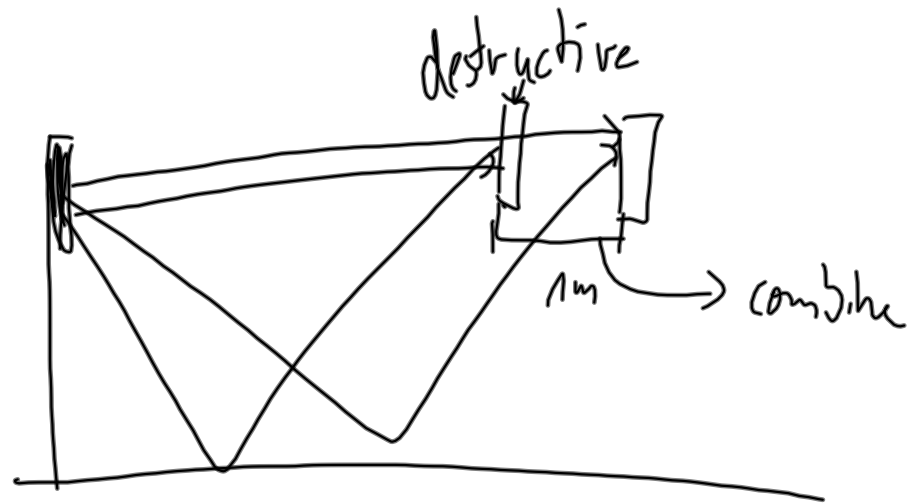
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6 / 30 133% Find

2.3.2 Objectives of the COST 231 Propagation Measurements	51
2.3.3 Narrowband and Wideband Measurements	52
2.3.4 Analysis of Propagation Measurements	53
2.3.5 Indoor Measurements	53
2.3.6 Outdoor Measurements	57
2.3.7 Fading and Path Loss Characteristics	57
2.3.8 Results for Frequency Selectivity in Different Environments	58
2.3.9 Determination of Directions-of-Arrival	60
<b>2.4 Propagation Modelling for the Simulation of the Radio Channel</b>	<b>61</b>
2.4.1 Radio Channel Simulation	61
2.4.2 Long Term Area Simulations	62
2.4.3 Narrowband System Simulations	63
2.4.4 Wideband System Simulations	63
2.4.5 UMTS Simulators	66
2.4.6 Hardware Channel Simulators	68
<b>2.5 References</b>	<b>71</b>
<b>3 Antennas and Antenna Diversity</b>	<b>79</b>
<b>3.1 Antenna Design</b>	<b>80</b>
3.1.1 Extremely Wideband Antennas	80
3.1.2 Millimetre-Wave Antennas	82
3.1.3 Internal Antennas for Handsets	85
<b>3.2 Base Station Antenna Relations</b>	<b>86</b>
3.2.1 Angular Relations between BS-Antennas and Radio Environment	86
3.2.2 Environmental Influence on Perceived Antenna Pattern	88
3.2.3 Adaptive Base Station Antenna Arrays	91
<b>3.3 Antennas for Portables</b>	<b>92</b>
3.3.1 Antenna Performance	92

*Intro*  
*Main?*

Side remark: Diversity  $\leftarrow$  Space



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7 / 30 133% Find

<b>4 Propagation Prediction Models</b>	<b>115</b>
<b>4.1 General Considerations</b>	<b>115</b>
<b>4.2 Geographical Information for Propagation Modelling &amp; Simulation</b>	<b>117</b>
4.2.1 Canonical Scattering Problems	117
4.2.2 Acquisition of Geographical Data	120
4.2.3 Accuracy of Data	121
4.2.4 Model Evaluation	121
4.2.5 Manipulation of Geographical Data	122
4.2.6 Exchange of Measurement and Geographic Information	123
<b>4.3 Propagation Mechanisms</b>	<b>124</b>
4.3.1 General	124
4.3.2 Propagation Mechanisms in Ray Theory	127
4.3.3 Other Propagation Mechanisms	131
4.3.4 Main Propagation Mechanisms	132
<b>4.4 Propagation Models for Macro-Cells</b>	<b>134</b>
4.4.1 Semideterministic and Empirical Models for Urban Areas	134
4.4.2 Influence of Vegetation	140
4.4.3 Modelling of Large-Scale Terrain Variations	140
4.4.4 Estimation of Time Dispersion	145
4.4.5 General Models	147
<b>4.5 Propagation Models for Small- and Micro-Cells</b>	<b>149</b>
4.5.1 General	149
4.5.2 Two-Dimensional Models for Below Roof-Top Propagation	150
4.5.3 Two-Dimensional Models for Over Roof-Top Propagation	153
4.5.4 Three-Dimensional Models for Arbitrary Base-Station Heights	155
4.5.5 Overview about the Prediction Models	158
4.5.6 Comparison with Path Loss Measurements at 947 MHz	158
<b>4.6 Building Penetration</b>	<b>167</b>
4.6.1 Introduction and Definitions	167
4.6.2 Building Penetration Loss at Line of Sight Conditions	169
4.6.3 Penetration Loss at Non Line of Sight Conditions	171
4.6.4 General Building Penetration Model	174
<b>4.7 Indoor Propagation Models</b>	<b>175</b>
4.7.1 General	175
4.7.2 Empirical Narrow-Band Models	176
4.7.3 Empirical Wide-Band Models	179

*Main*

*for info*

*WLAN*

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File Edit View Document Comments Forms Tools Advanced Window Help

Create Combine Collaborate Secure Sign Forms Multimedia Comment

10 / 30 133% Find

7.3.5	Chip Rates, Spreading Factors, Symbol Rates and Bit Rates	395
7.3.6	Compatibility with GSM	399
<b>7.4</b>	<b>Joint Detection CDMA</b>	<b>400</b>
7.4.1	Design Rationale	400
7.4.2	System Description	402
<b>7.5</b>	<b>References</b>	<b>410</b>
<b>8</b>	<b>Broadband Systems</b>	<b>415</b>
<b>8.1</b>	<b>Introduction</b>	<b>415</b>
8.1.1	Infra-Red Safety	416
8.1.2	Millimetre Wave Safety and Technology	417
<b>8.2</b>	<b>Material Characterisation</b>	<b>418</b>
8.2.1	Measurement Methods	418
8.2.2	Measurement Results and Parameter Estimation	420
8.2.3	Isolation and Transmission of Building Materials	423
<b>8.3</b>	<b>Indoor Radio Channel</b>	<b>425</b>
8.3.1	Narrowband Measurements	425
8.3.2	Wideband Measurements	429
8.3.3	Statistical Modelling	432
8.3.4	Deterministic Modelling	435
<b>8.4</b>	<b>Outdoor Radio Channel</b>	<b>438</b>
8.4.1	Path Loss Modelling	439
8.4.2	Wideband Characterisation	442
<b>8.5</b>	<b>Transmission Performance Evaluation</b>	<b>446</b>
8.5.1	Early Performance Predictions	446
8.5.2	Spread Spectrum	447
8.5.3	Multicarrier Modulation	449
8.5.4	Antenna Diversity	449
8.5.5	Adaptive Equalisation	451
8.5.6	HIPERLAN	452
8.5.7	Channel Coding	454
<b>8.6</b>	<b>Network Performance Evaluation</b>	<b>455</b>
8.6.1	Centralised Control Based on Pooling	455
8.6.2	Centralised Control Based on Random Access	458
8.6.3	Distributed Networks	459
<b>8.7</b>	<b>Summary</b>	<b>463</b>

(cost) 237

preface

chap. 2.3

53-58

chap 2.4

~~67-68~~ system

4.5

147 ff

4.6/4.7

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8.4

348

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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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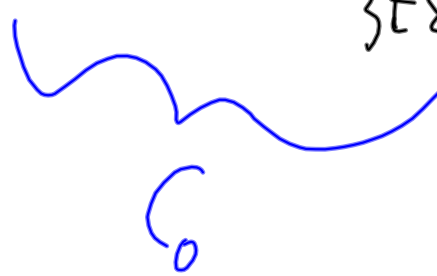
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Fru space loss  $\rightarrow$  dB Log req. [1]

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

use GHz

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

~~3E8 m/s~~  


f [MHz] <sup>GHz</sup>  
 E9 E6 ~~5~~  
 R [km]  
 E3 ~~M~~

$$+ 20 \log f \left[ \begin{matrix} \text{GHz} \\ \text{MHz} \end{matrix} \right] + 20 \log R [\text{km}]$$

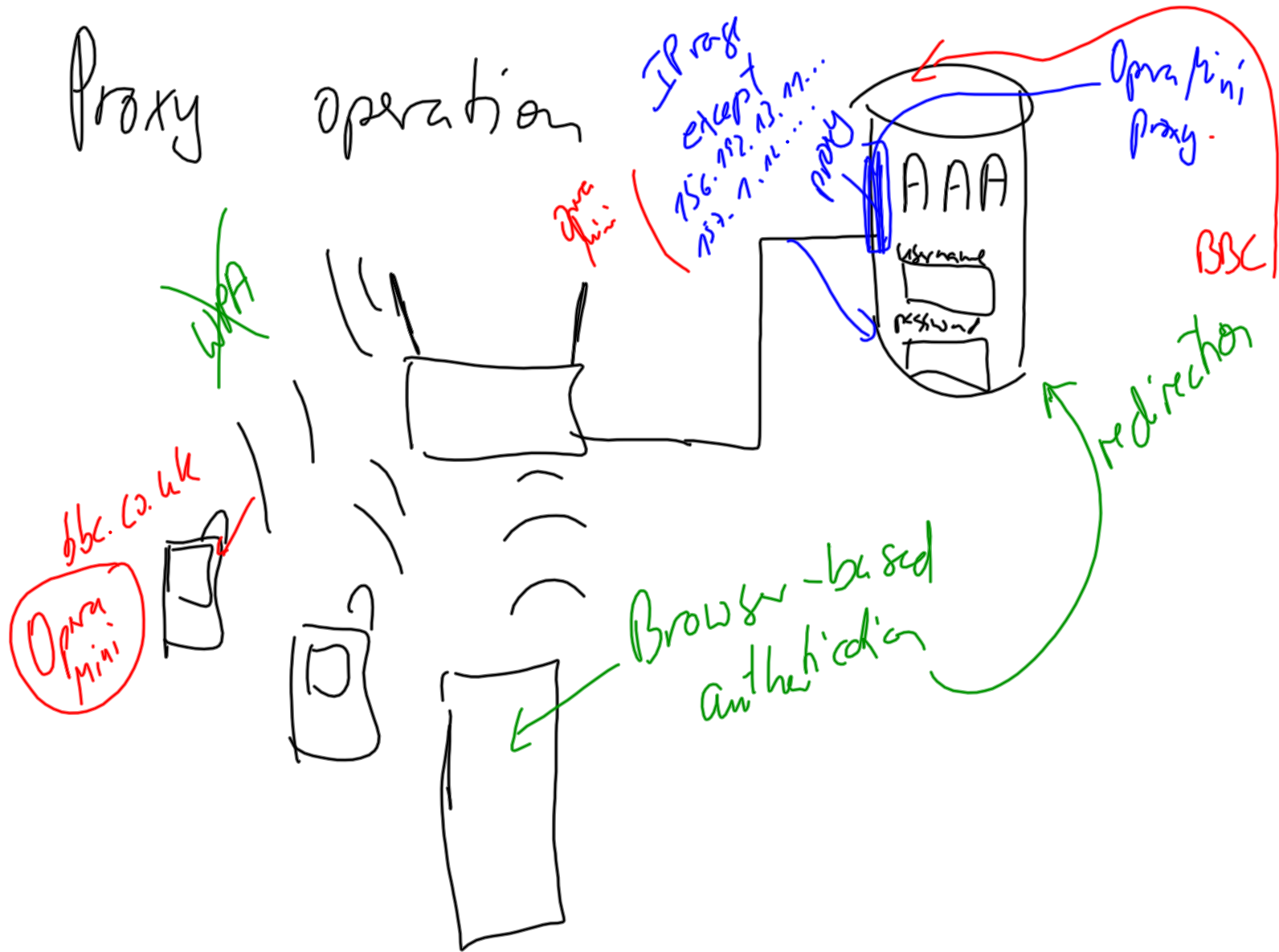
# Table

	$f$ [GHz]	$R$ [km]
6sm	1	0.1
		1
		10
		100
UMTS/w.f.	2	0.01
		0.1
		1
		10
202-17g	5	0.01
		0.1
		1

$L^*$

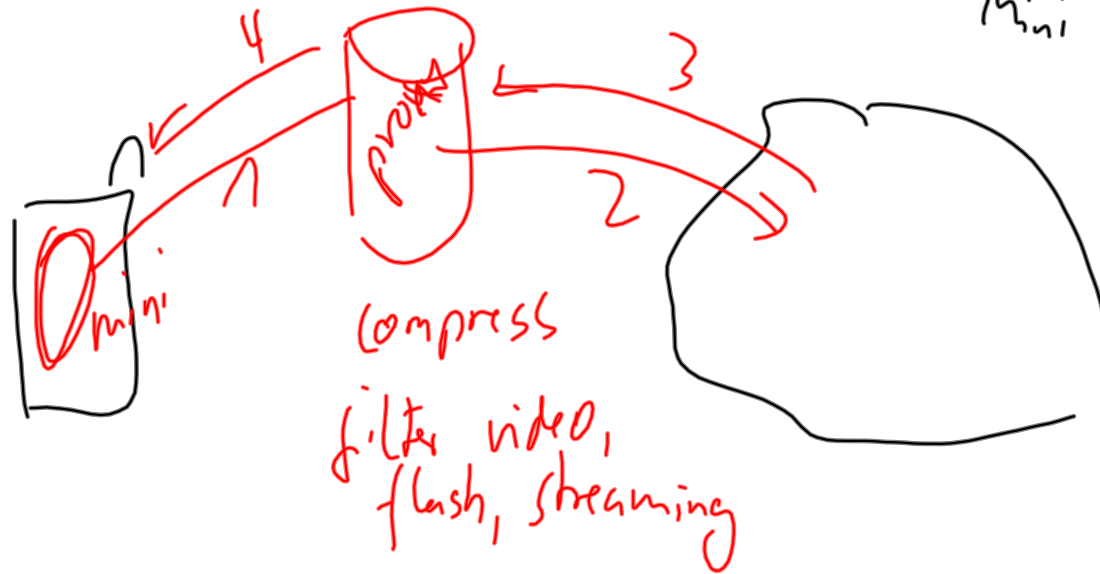
231 indoor  
231 outdoor

# Proxy operation



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 busy  
 payed

PL, DR, DF, NO

always  
 online

Cwi.unik.no/wiki/Nextelco

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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