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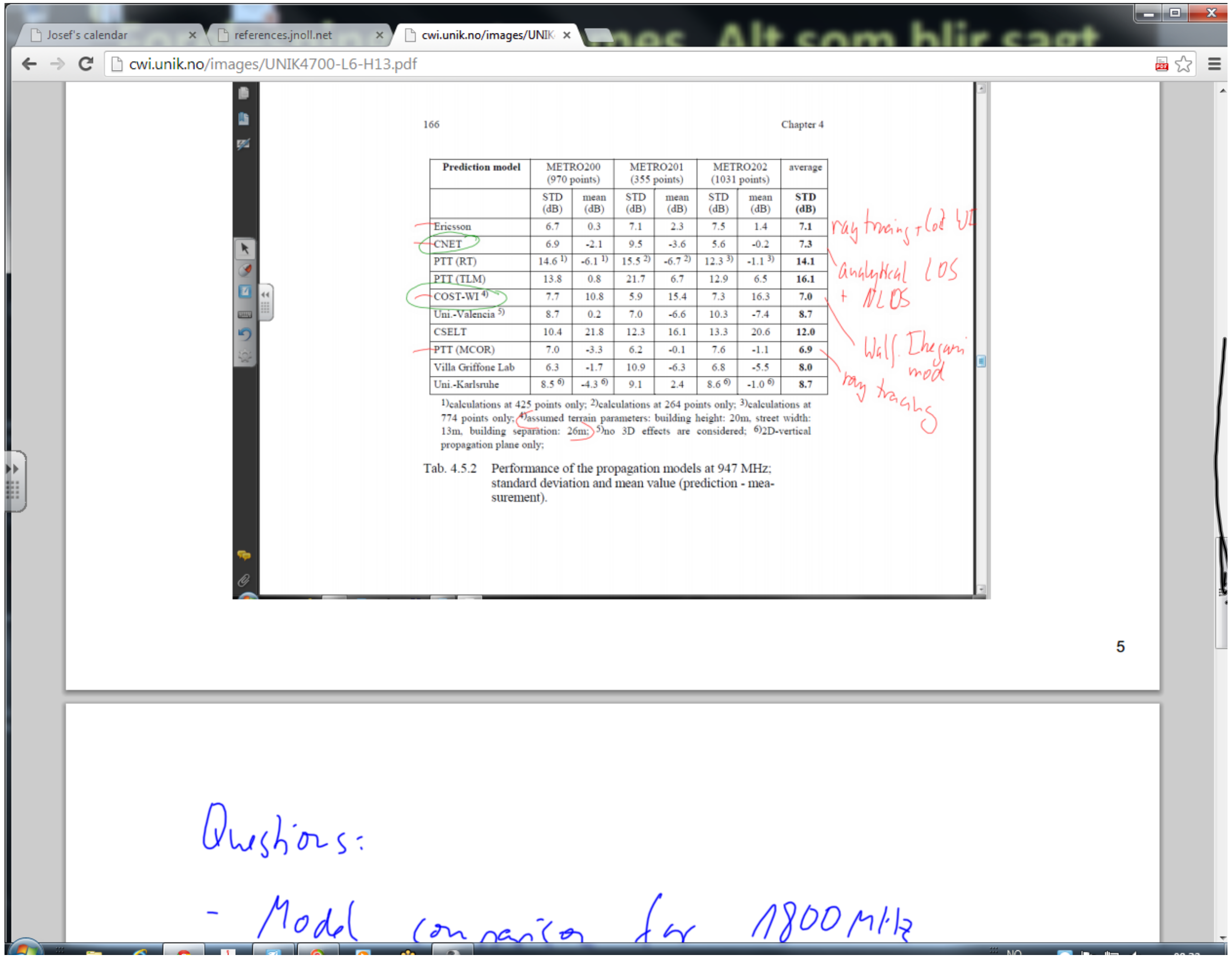
Presentations given by Josef Noll

1. "Målbar Sikkerhet for tingenes internet Δ", ISF medlemsmøte , 20. Nov 2013, Oslo
2. "Providing Internet Access to Emerging Economies - The Business of Free AccessΔ", Keynote at the The Third International Conference on Mobile Services, Resources, and Users. MOBILITY 2013, 27.-22. November 2013, Lisboa, Portugal
3. "Mobility 2020 - Change of ParadigmΔ", Panel contribution at the Third International Conference on Mobile Services, Resources, and Users. MOBILITY 2013, 27.-22. November 2013, Lisboa, Portugal
4. Mario Hoffmann, Josef Noll, "The Life Management Initiative - Towards User-centric and Personalized Service ProvisioningΔ", Keynote at The Sixth International Conference on Advances in Human oriented and Personalized Mechanisms, Technologies, and Services, CENTRIC 2013, 27.10.-1.11.2013, Venice, Italy
5. Josef Noll, Zahid Iqbal, Martin Folkestad, "Attribute based access to industrial life-cycle data, the semantic dimensionΔ", Workshop ISO 15926 and Semantic Technologies 2013, 5.-6. September 2013, Sogndal, Norway
6. "Measurable Security for the Internet of ThingsΔ", Semantic Days 2013, 29-30. May 2013, Stavanger, Norway
7. "Measurable Security for the Internet of ThingsΔ", 7. Strategic Workshop, 21.-23.May 2013, Marbella, Spain
8. "Measurable Security - a discussion of potential approaches"Δ, FFI Seminar on Advances in ICT, 24.-25.Apr2013, Jeløya,
9. "Measurable Security in Mobile Networks"Δ, Invited Talk at the IDC Enterprise Mobility Series, 28.Nov 2012, Budapest, Hungary
10. "Security, Privacy and Dependability in Mobile Networks"Δ, Keynote at the The Second International Conference on Mobile Services, Resources, and Users. MOBILITY 2012, 21.-25. October 2012, Venice, Italy
11. Internet of Things - Finding its Way to IndustryΔ, IFEA Wireless Summit, Oslo, 17.-18. April 2012
12. Secure Interoperability - The Challenge for the Internet of ThingsΔ, FFI ICT Seminar, Jeløya, Apr 2012
13. Internet of Things - a Scandinavian PerspectiveΔ, 4th CMI conference *Internet of Things - our environments becomes intelligent*, 24.-25. Nov 2011, Copenhagen
14. Security challenges in the Internet of ThingsΔ, ITEA/Artemis Co-Summit, Panel on *Trends in ICT Security*, 24.-26. October 2011, Helsinki
15. Integrating context- and content-aware mobile services into the cloudΔ, CWI/CTIF seminar on *Mobile Cloud Computing and wireless applications*, 24.-25. October 2011, Aalborg University in Copenhagen
16. Security, Privacy and Dependability in the Internet of Things (IoT)Δ, WWRF#27,

CNET: 9 LOS + 9 NLOS rays

test area: Munich (vector data of houses)



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Prediction model	METRO200 (970 points)		METRO201 (355 points)		METRO202 (1031 points)		average
	STD (dB)	mean (dB)	STD (dB)	mean (dB)	STD (dB)	mean (dB)	**STD (dB)**
Ericsson	6.7	0.3	7.1	2.3	7.5	1.4	**7.1**
CNET	6.9	-2.1	9.5	-3.6	5.6	-0.2	**7.3**
PTT (RT)	14.6 [1)]	-6.1 [1)]	15.5 [2)]	-6.7 [2)]	12.3 [3)]	-1.1 [3)]	**14.1**
PTT (TLM)	13.8	0.8	21.7	6.7	12.9	6.5	**16.1**
COST-WI [4)]	7.7	10.8	5.9	15.4	7.3	16.3	**7.0**
Uni.-Valencia [5)]	8.7	0.2	7.0	-6.6	10.3	-7.4	**8.7**
CSELT	10.4	21.8	12.3	16.1	13.3	20.6	**12.0**
PTT (MCOR)	7.0	-3.3	6.2	-0.1	7.6	-1.1	**6.9**
Villa Griffone Lab	6.3	-1.7	10.9	-6.3	6.8	-5.5	**8.0**
Uni.-Karlsruhe	8.5 [6)]	-4.3 [6)]	9.1	2.4	8.6 [6)]	-1.0 [6)]	**8.7**

[1)]calculations at 425 points only; [2)]calculations at 264 points only; [3)]calculations at 774 points only; [4)]assumed terrain parameters: building height: 20m, street width: 13m, building separation: 26m; [5)]no 3D effects are considered; [6)]2D-vertical propagation plane only;

Tab. 4.5.2 Performance of the propagation models at 947 MHz; standard deviation and mean value (prediction - measurement).

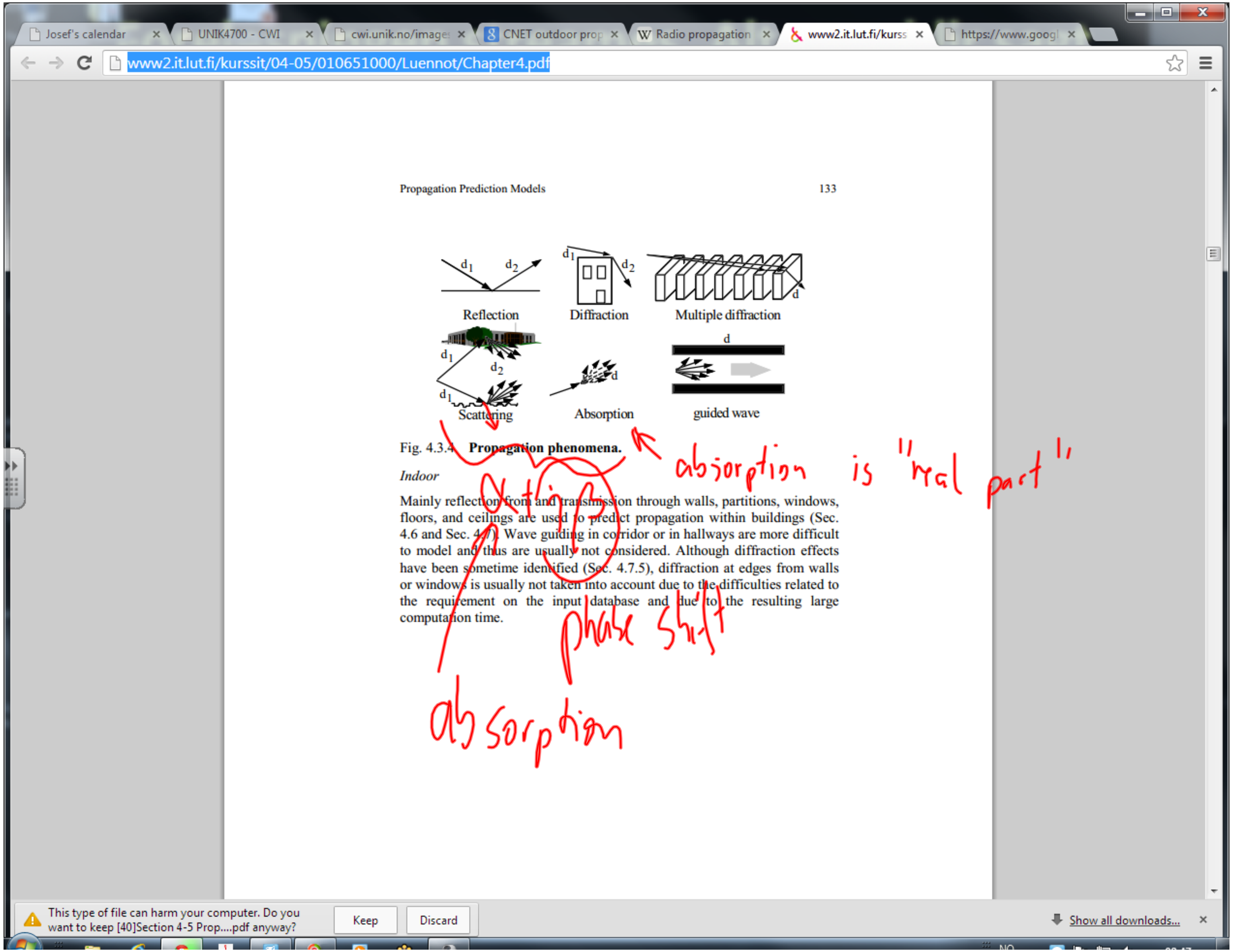
Comparison of radio prop. models

free space $\sim \frac{1}{R^2}$

?

Walfish-Ikimura

CNET

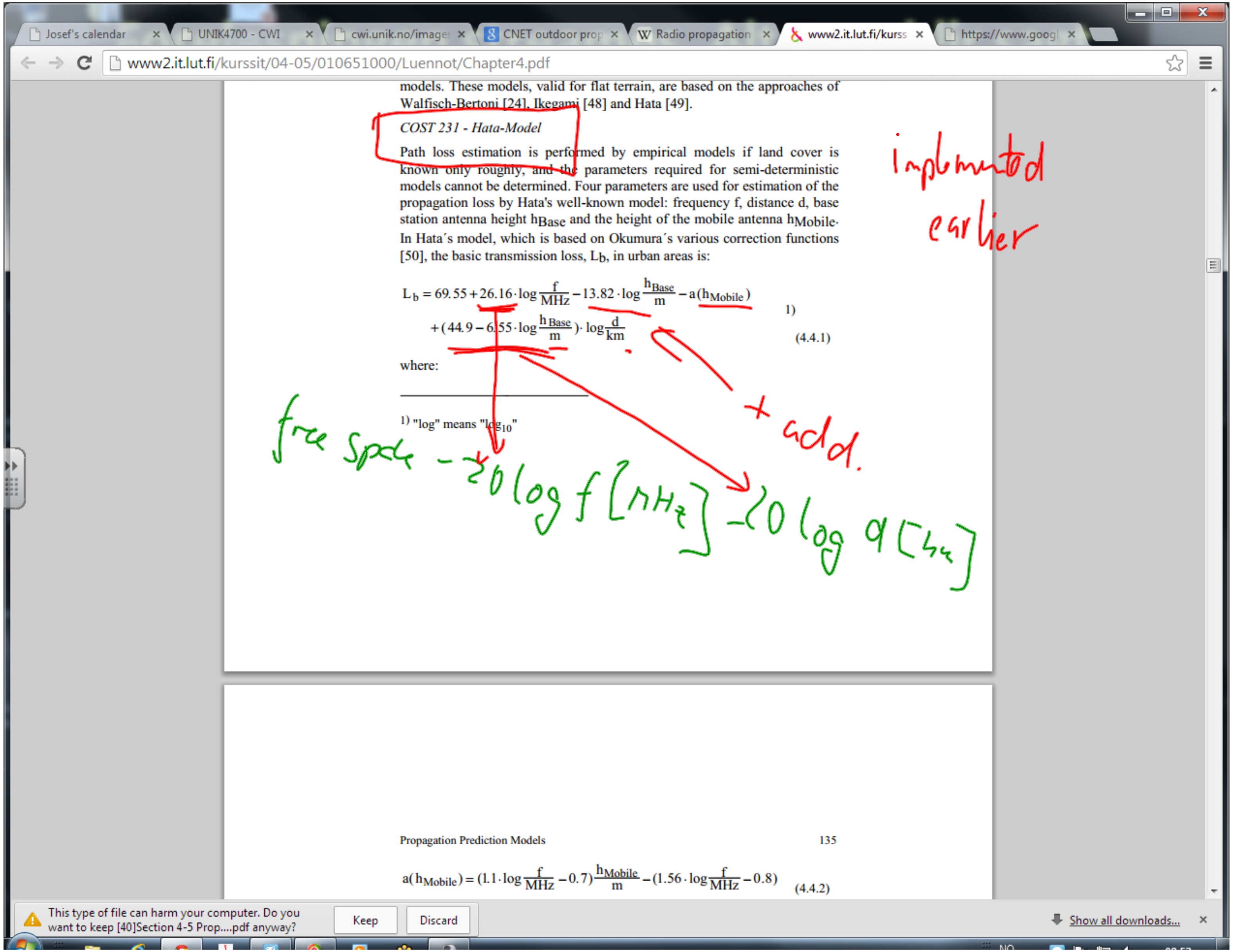


Propagation Prediction Models 133

Fig. 4.3.4 **Propagation phenomena.**

Indoor

Mainly reflection from and transmission through walls, partitions, windows, floors, and ceilings are used to predict propagation within buildings (Sec. 4.6 and Sec. 4.7). Wave guiding in corridor or in hallways are more difficult to model and thus are usually not considered. Although diffraction effects have been sometime identified (Sec. 4.7.5), diffraction at edges from walls or windows is usually not taken into account due to the difficulties related to the requirement on the input database and due to the resulting large computation time.



models. These models, valid for flat terrain, are based on the approaches of Walfisch-Bertoni [24], Ikegami [48] and Hata [49].

COST 231 - Hata-Model

Path loss estimation is performed by empirical models if land cover is known only roughly, and the parameters required for semi-deterministic models cannot be determined. Four parameters are used for estimation of the propagation loss by Hata's well-known model: frequency f, distance d, base station antenna height h_{Base} and the height of the mobile antenna h_{Mobile}. In Hata´s model, which is based on Okumura´s various correction functions [50], the basic transmission loss, L_b, in urban areas is:

$$L_b = 69.55 + 26.16 \cdot \log \frac{f}{MHz} - 13.82 \cdot \log \frac{h_{Base}}{m} - a(h_{Mobile}) + (44.9 - 6.55 \cdot \log \frac{h_{Base}}{m}) \cdot \log \frac{d}{km} \quad ^{1)} \quad (4.4.1)$$

where:

1) "log" means "$\log_{10}$"

Propagation Prediction Models 135

$$a(h_{Mobile}) = (1.1 \cdot \log \frac{f}{MHz} - 0.7) \frac{h_{Mobile}}{m} - (1.56 \cdot \log \frac{f}{MHz} - 0.8) \quad (4.4.2)$$

$$a(h_{Mobile}) = (1.1 \cdot \log\frac{f}{MHz} - 0.7)\frac{h_{Mobile}}{m} - (1.56 \cdot \log\frac{f}{MHz} - 0.8) \qquad (4.4.2)$$

The model is restricted to:

f:	150 ... 1000 MHz
h_{Base}:	30 ...200 m
h_{Mobile}:	1 ...10 m
d:	1 ...20 km

COST 231 has extended Hata´s model to the frequency band $1500 \leq f(MHz) \leq 2000$ by analysing Okumura´s propagation curves in the upper frequency band. This combination is called "COST-Hata-Model" [51]:

$$L_b = 46.3 + 33.9\log\frac{f}{MHz} - 13.82\log\frac{h_{Base}}{m} - a(h_{Mobile})$$

$$+(44.9 - 6.55\log\frac{h_{Base}}{m})\log\frac{d}{km} + C_m \qquad (4.4.3)$$

where $a(h_{Mobile})$ is defined in equation (4.4.2) and

$$C_m = \begin{cases} 0\text{ dB} & \text{for medium sized city and suburban centres with medium tree density} \\ 3\text{ dB} & \text{for metropolitan centres} \end{cases} \qquad (4.4.4)$$

The COST-Hata-Model is restricted to the following range of parameters:

f:	1500 ... 2000 MHz
h_{Base}:	30 ... 200 m
h_{Mobile}:	1 ... 10 m
d:	1 ... 20 km

The application of the COST-Hata-Model is restricted to large and small macro-cells, i. e. base station antenna heights above roof-top levels adjacent to the base station. Hata´s formula and its modification must not be used for micro-cells.

COST 231 - Walfisch-Ikegami-Model

Furthermore COST 231 proposed a combination of the Walfisch [24] and Ikegami [48] models. This formulation is based on different contributions from members of the "COST 231 Subgroup on Propagation Models" [51]. It

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is called the COST-Walfisch-Ikegami-Model (COST-WI). The model allows for improved path-loss estimation by consideration of more data to describe the character of the urban environment, namely

- heights of buildings h_{Roof},
- widths of roads w,
- building separation b and
- road orientation with respect to the direct radio path φ.

The parameters are defined in Figs. 4.4.1 and 4.4.2. However this model is still statistical and not deterministic because only characteristic values can be inserted and no topographical data base of the buildings is considered.

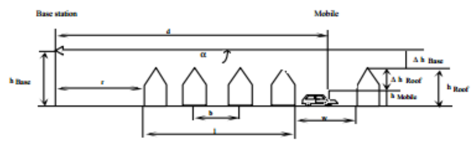

Fig 4.4.1 Typical propagation situation in urban areas and definition of the parameters used in the COST-WI model and other Walfisch-type models [24], [45], [52].

The model distinguishes between line-of-sight (LOS) and non-line-of-sight (NLOS) situations. In the LOS case -between base and mobile antennas within a street canyon - a simple propagation loss formula different from free space loss is applied. The loss is based on measurements performed in the city of Stockholm:

$$L_b(\text{dB}) = 42.6 + 26\log(d/\text{km}) + 20\log(f/\text{MHz}) \quad \text{for } d \geq 20 \text{ m} \qquad (4.4.5)$$

where the first constant is determined in such a way that L_b is equal to free-space loss for $d = 20$ m. In the NLOS-case the basic transmission loss is composed of the terms free space loss L_0, multiple screen diffraction loss L_{msd}, and roof-top-to-street diffraction and scatter loss L_{rts}.

$$L_b = \begin{cases} L_0 + L_{rts} + L_{msd} & \text{for } L_{rts} + L_{msd} > 0 \\ L_0 & \text{for } L_{rts} + L_{msd} \leq 0 \end{cases} \qquad (4.4.6)$$

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b = 20 ... 50 m

w = b / 2

φ = 90°

The COST-WI model is restricted to:

f :	800 ... 2000 MHz
h_{Base} :	4 ... 50 m
h_{Mobile} :	1 ... 3 m
d :	0.02 ... 5 km

The model has also been accepted by the ITU-R and is included into Report 567-4. The estimation of path loss agrees rather well with measurements for base station antenna heights above roof-top level. The mean error is in the range of ±3 dB and the standard deviation 4-8 dB [53], [54]. However the prediction error becomes large for $h_{Base} \approx h_{Roof}$ compared to situations where $h_{Base} >> h_{Roof}$. Furthermore the performance of the model is poor for $h_{Base} << h_{Roof}$. The parameters b, w and φ are not considered in a physically meaningful way for micro-cells. Therefore the prediction error for micro-cells may be quite large. The model does not consider multipath propagation and the reliability of pathloss estimation decreases also if terrain is not flat or the land cover is inhomogeneous.

Comparison with other models

Saunders and Bonar [52], [39] as well as Bertoni and Xia [24], [56], [45], [57] published different closed-form solutions for L_{msd} which are applicable for all values of base station antenna heights. Several papers compare the different approaches with measurements [53], [39], [54], [58], [59], [60].

The results, however, differ markedly depending on the situation, where the models are applied. This effect can be explained by the different validity limits of the different approaches. The Walfisch-Bertoni-Model supposes a high base station antenna ($h_{Base} > h_{Roof}$). The COST-Walfisch-Ikegami-Model is valid for base station antenna heights below 50 m and gives reasonable agreement with measured values for $l > d_s$ (see Fig. 4.4.1), where d_s is called the "settled-field"- distance [53], [61]:

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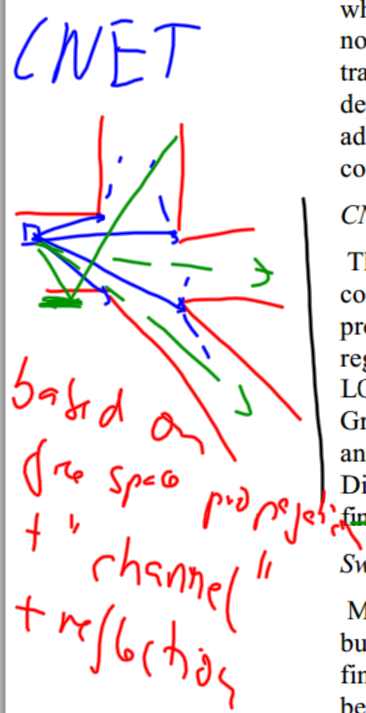
which is defined by a recursive expression as a function of the
nodal points and corresponding street orientation angles of the path between transmitter and receiver. The dual-slope behaviour [94] of the distance dependence of the path loss is also included in the proposed model. In addition, the distance dependence of the COST-WI model is applied to consider over-roof-top propagation in case of NLOS.



CNET micro-cell model

This model is based on an analytical, semi-deterministic approach for the consideration of reflected and diffracted waves [100]. Only below roof-top propagation around buildings and street crossings with four corners are regarded. The angle of crossing streets can be arbitrary. Nine reflections in a LOS case and nine reflections in a following NLOS case are included. Ground reflections and street corner diffraction between the line-of-sight and the non-line-of-sight street are regarded as well. The Uniform Theory of Diffraction is used for the street corner diffraction calculation, wherein the finite conductivity of the walls is introduced through heuristic coefficients.

Swiss Telecom PTT micro-cell ray tracing model

Micro-cell environments are described by a two-dimensional layout of buildings which are given to the software program in terms of vectors defining the building walls. Arbitrary two-dimensional building geometry can be handled. Additionally, the permittivity and conductivity of each building wall can be considered if available. In operational use the electrical characteristics are usually taken to be the same for all buildings in a given area. Specular reflection and diffraction are the propagation phenomena taken into account [101]. Ground reflection, scattering and over-roof-top propagation which are expected to dominate in areas far from the transmitter are neglected so far. The software computes all reflected and diffracted rays up to some predetermined order. This is performed according to an efficient implementation of the image theory which takes advantage of the assumed

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CNET refrece

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To Do: a) control algorithms

(A) test cases
- (h ~ 100 m)
- manual control points

2/3 cases (C) b) sensitivity analysis

Applicability
(1) Free space
- "up into the sky"
- "focussed link"

(B)

(2) Hata ant. height > building height

(3) Cost 237-WI: Walfish-Ikegami

"typical Bergen"

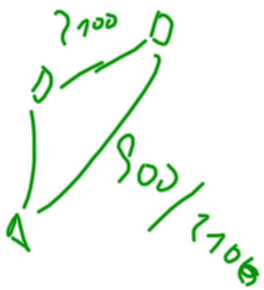
(D) Cost 231 WI is implemented

- realistic assumptions for environment & distance between building
- finnsenderen.no + gulesider.no/kart

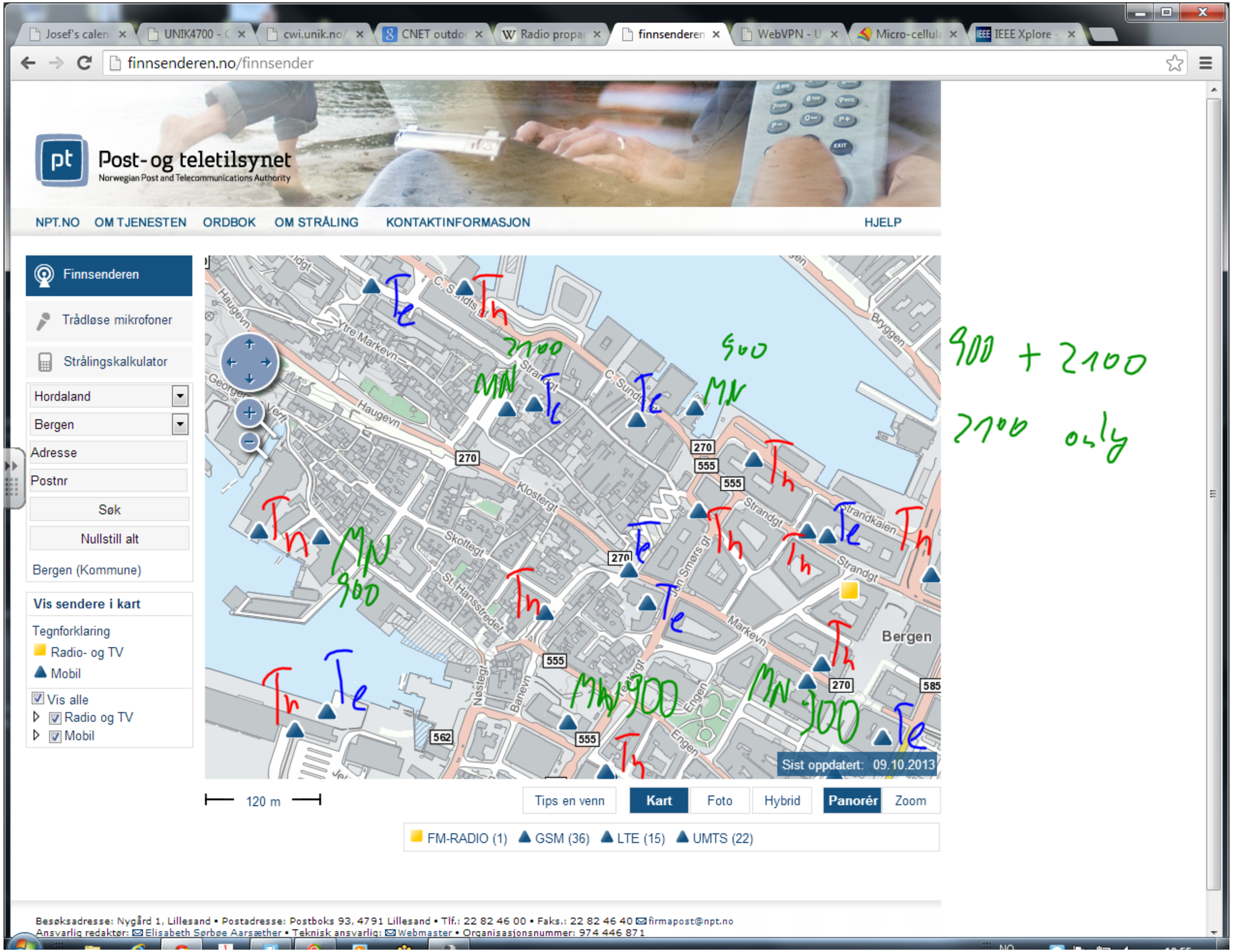
One operator   google maps

(D)

- 900 link
- 2100 link

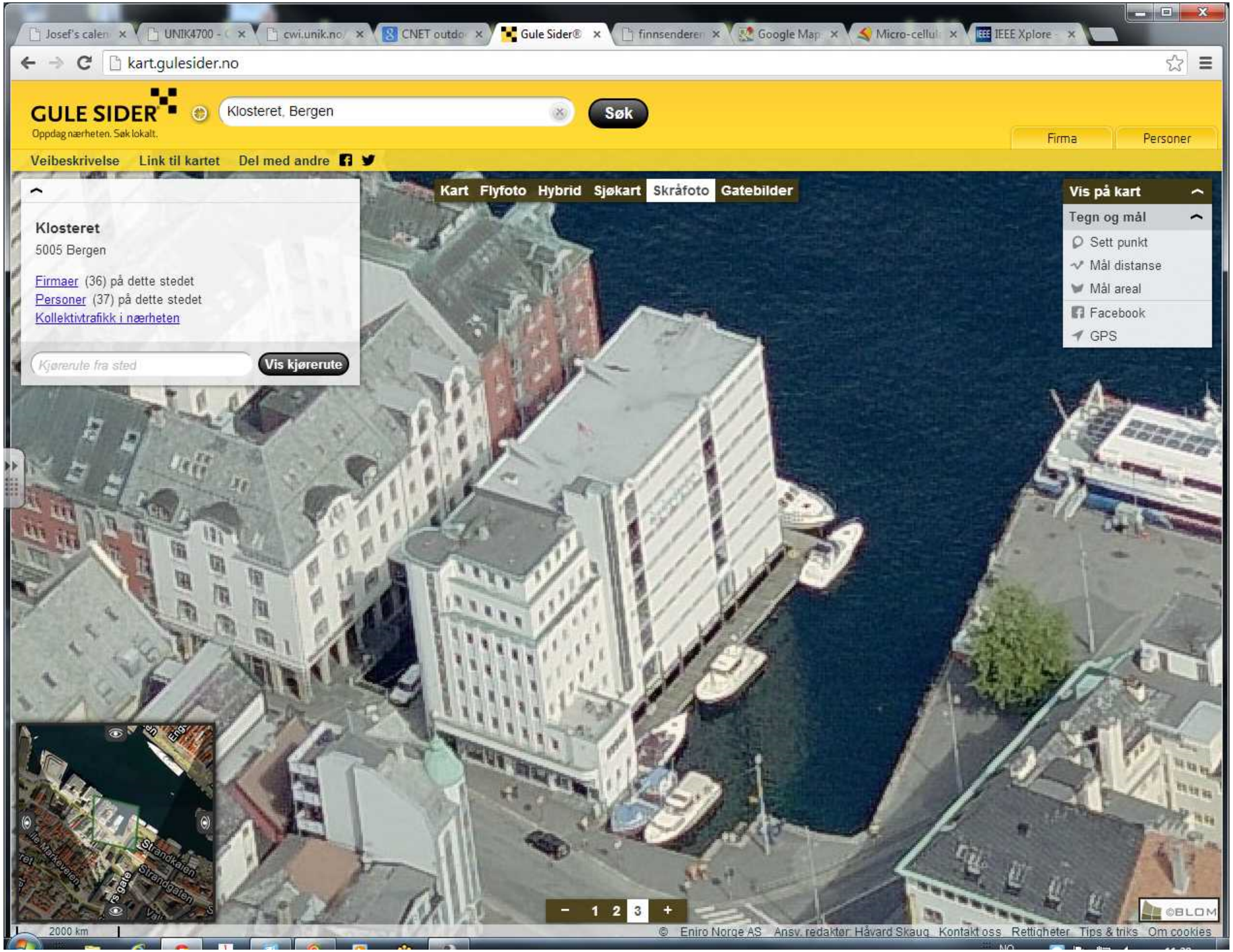


Comparison: handover numbers (E)



900 + 2100

2100 only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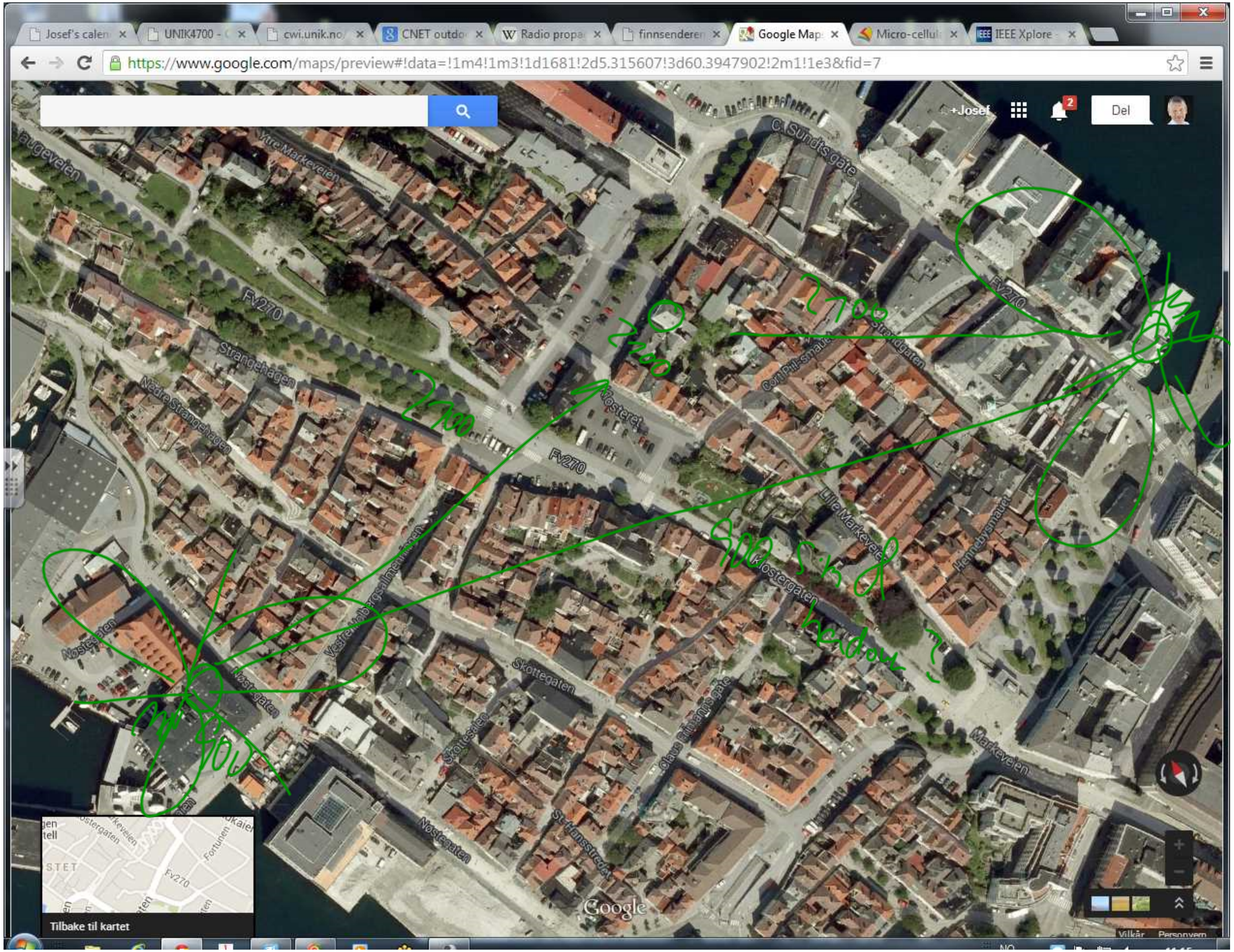

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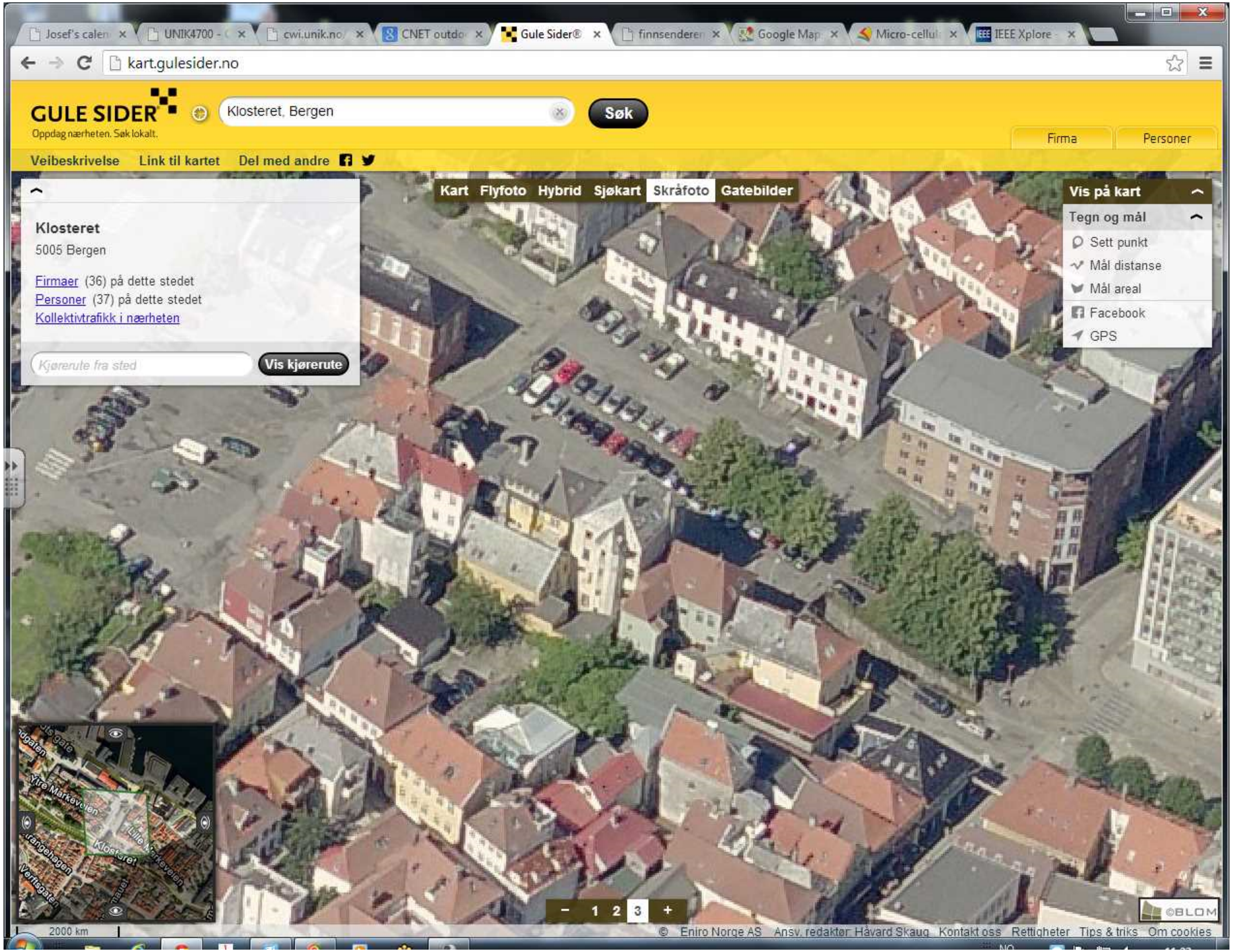
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