



Automated Intelligence: models and learning

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(address will change!)

Intelligent Systems
specialisation area

The specialisation area of Intelligent Systems studies issues related to the design and analysis of computational methods for adaptive and intelligent systems. The area covers several fields in computer science such as artificial intelligence, computational intelligence, artificial life and search methods. Future information technology will include more and more adaptive components both in hardware and software and therefore many of the methods studied are core components for future systems.

The curriculum of the Intelligent Systems area contains a wide variety of special courses, which typically require as prerequisites good programming and problem solving skills and a solid analytical background. Studies of automating intelligent behaviour are by necessity drawing ideas from many sciences, and thus the studies in many cases are multidisciplinary in nature. In addition to the methodological courses in the Three Concepts series, other suitable courses can be selected either from more applied topics (robotics, string matching, data mining) or from the general introductions such as artificial intelligence and machine learning. A research seminar in Intelligent Systems is intended for postgraduate level studies and multidisciplinary studies in cognitive science, neurocomputing (in cooperation with Helsinki University of Technology) and theoretical philosophy are strongly encouraged.

The research in the Intelligent Systems area is focused on issues related to deep foundational issues in modelling and learning, and their applications to various fields from engineering to social sciences and medicine. Most of the research is associated with the Complex Systems Computation Group (CoSCo), which studies theoretical and applied topics in probabilistic and information-theoretical modelling and stochastic search methods. Current ongoing projects have applications e.g. in user profiling and personalisation, adaptive learning environments, autonomous satellite diagnosis systems and telecommunications. The contact person in Intelligent Systems is Professor Henry Tirri

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[Laudatur module](#)
[People](#)

http://cosco.hiit.fi/

**Complex Systems Computation Group
CoSCo**

20-25.10.2002 Jorma Rissanen gives an invited talk "Kolmogorov's structure function for probability models" at IEEE Information Theory Workshop, Bangalore, India.
→ [IEEE Information Theory Workshop](#)


21-22.10.2002 Wray Buntine presents the paper "Building and maintaining Web taxonomies" at XML Finland seminar, Helsinki, Finland.
→ [XML 2002](#)

2.9.2002 Professor Henry Tirri is an external reviewer for Qusay Mahmoud's PhD works at Middlesex University, London, England.
→ [Middlesex University](#)

19-23.8.2002 Wray Buntine presents the paper "Variational Extensions to EM and Multinomial PCA" at the 13th European Conference on Machine Learning, Helsinki, Finland.
→ [ECML-2002](#)

29.6.2002 Teemu Roos receives the Huygens scholarship for a 5 month visit to the CWI institute in Amsterdam, the Netherlands, in the Fall 2002.
→ [CWI](#)

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[B-Course](#)



MDL on the Web - Microsoft Internet Explorer

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Address http://www.mdl-research.org/

mdl-research.org

Minimum Description Length on the Web

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Welcome to the MDL Web Site

What is MDL?

The purpose of statistical modeling is to discover regularities in observed data. The success in finding such regularities can be measured by the length with which the data can be described. This is the rationale behind the **Minimum Description Length (MDL) Principle** introduced by **Jorma Rissanen** (Rissanen, 1978).

" The MDL Principle is a relatively recent method for inductive inference. The fundamental idea behind the MDL Principle is that any regularity in a given set of data can be used to *compress* the data, i.e. to describe it using fewer symbols than needed to describe the data literally. " (Grünwald, 1998)

What is mdl-research.org?

Minimum Description Length on the Web is intended as a source of information for everyone who wants to know more about MDL. The site contains links and references to suggested reading, tutorials, lecture notes, etc. on MDL as well as links to people who are working on MDL and related topics.

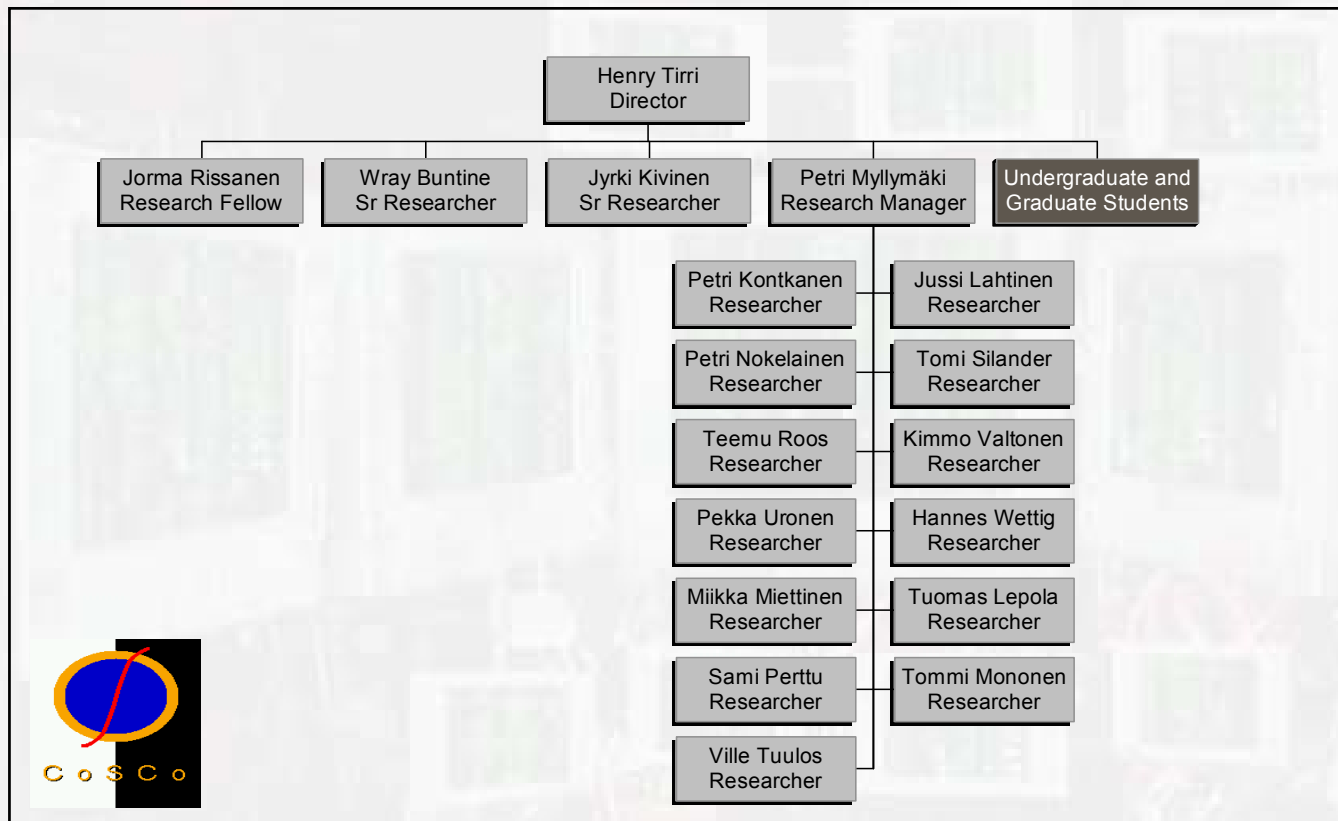
The [Reading](#) section contains references to selected articles, books, and lecture material, and links to journals and conferences that publish MDL related material.

The [Demonstrations](#) section will illustrate MDL through on-line demonstrations. The section is under construction but you can already find a demonstration on Markov chain order selection.

The [People](#) section has links to researchers who are working on MDL and related fields. You can find loads of related material in their homepages.

Done Internet

Complex Systems Computation Group



- Peter Cheeseman
NASA
- Phil Dawid
Univ. College London
- Dawid Dowe
Monash University
- Peter Grünwald
CWI
- Thomas Richardson
Univ. of Washington
- Linus Torvalds
Transmeta
- Pekka Ruohotie
University of Tampere
- Kimmo Kaski
Helsinki University of Technology
- Hannele Niemi
University of Helsinki
- Jaakko Kurhila
University of Helsinki



Intelligence?

- Computer science is considering ways to **make things automated**
- Artificial Intelligence, Adaptive and Intelligent Systems, Computational Intelligence ... all try to figure out **how could intelligence be automated?**
- Intelligent **behavior** can be characterized by **learning/adaptation**
- In order to learn one needs to **remember** and **generalize** (world is never repeating itself!)
- In order to generalize one needs **models**

Research in general

- Artificial Intelligence (AI) (knowledge reresentation, reasoning logic, expert systems, Machine learning...)
- Computational Intelligence/Soft Computing (neural networks, fuzzy systems, evolutionary computing)
- Adaptive and Intelligent Systems (AI)
- Artificial Life, Complex Systems Research

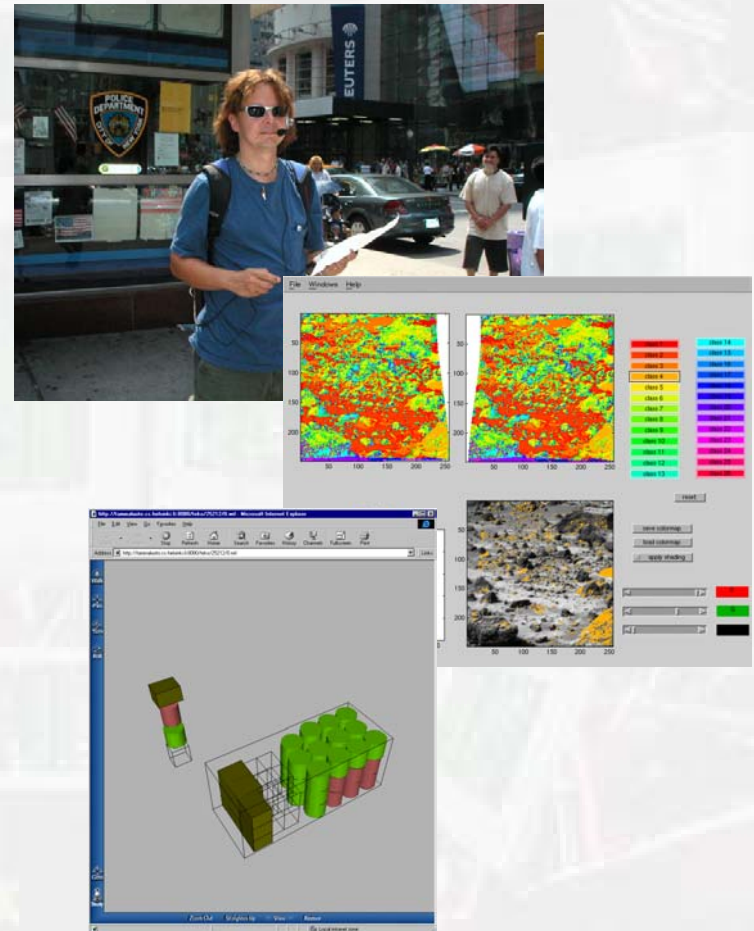
The terms in the field are really confusing 😊

Research areas

- Probabilistic and information-theoretic modeling in sciences and business
 - Bayesian and Causal Networks
 - Information-theoretic modeling approaches
 - Very Large Scale Data Analysis
 - Competitive online statistics
- Stochastic optimization in complex domains
 - simulated annealing
- Tools and theory for E-learning

Student: So what is it like to do research in AI?

- Great fun!
- Some **hacking**
- some **math**
- Some **gaming**
- Some **technology "freaking"**
- Some **science fiction**

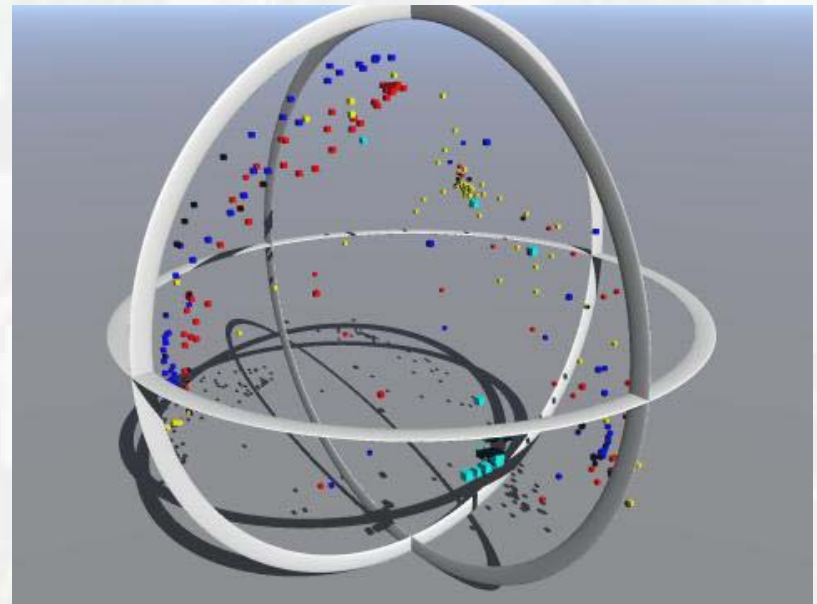


Current areas of interest

- Building (predictive) models from very large data sets (DeepC)
- Finding the position of a mobile device (LocIt)
- Personalization (PAI, LockUp)
- Intelligent Search
- Collaborative tools for e-learning (EDUCO, OurWeb)

DeepC

Very Large Scale Data Modeling



Quick Summary

- Designed for dependency analysis with graphical models
- ASP architecture (works with most browsers)
- inference of Bayesian networks (and elementary causal networks)
- "tutorial style" user interface
- no user modifiable parameters
- interactive tool for inference
- extendible platform (v 2.0 classification)

B-course Data Analysis Server (<http://b-course.cs.helsinki.fi>)

Final report of Housing [Bcourse] - Microsoft Internet Explorer

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Address <http://b-course.cs.helsinki.fi/cgi-bin/showreport.py?sid=8F76AC8DF292E0A4735A798A021F62C7&n=Final> Go Links

Final report of Housing

The search is now over. Here you can find a picture of the final model, both in full-size viewing (PNG) and printable (Post-Script) formats. You can study the strengths of the arcs and also take a look at the two causal graphs that speculate about the possible causalities underlying the observable statistical dependencies. Finally, you can study the models interactively.

```
graph TD; CharlesRiver((Charles River)) --> non-retail%((non-retail%)); CharlesRiver --> access((access)); CharlesRiver --> H_oxidis((H_oxidis)); CharlesRiver --> rooms:dwelling((rooms:dwelling)); tax rate((tax rate)) --> non-retail%; tax rate --> black index((black index)); non-retail% --> pupils:teachers((pupils:teachers)); non-retail% --> distance((distance)); non-retail% --> H_oxidis; non-retail% --> pre40's%((pre40's%)); access --> distance; access --> crimes:capitu((crimes:capitu)); pupils:teachers --> H_oxidis; distance --> H_oxidis; distance --> pre40's%; crimes:capitu --> pre40's%; H_oxidis --> rooms:dwelling; H_oxidis --> pre40's%; rooms:dwelling --> low status((low status)); pre40's% --> low status; pre40's% --> residential%((residential%)); low status --> home value((home value)); residential% --> home value;
```

Dependency model

- » [Strength of dependencies \(arcs\)](#)

Causal models

- » [Naive causal model](#)
- » [Not-so-naive causal model](#)

Playgrounds

- » [Java playground](#) (Recommended!)
- » [Vanilla playground](#)

Pictures

- » [Natural size picture \(png-format\)](#)
- » [Picture for printing \(ps-format\)](#)

Hugin Lite export

- » [HUGIN Lite file](#)

Information about the search

During the search, 80408 candidate models were evaluated. Doing the extra 69685 evaluations since last report paid off, since the new model is over million times more probable than the last time best

Internet

So what "science" was needed?

- Theory, heavy theory
- Empirical work with data sets ...
- Multidisciplinary cooperation
- Brilliant hacking (B-course had predecessors: D-Side, BAYDA)



"On the shoulders of Giants"



Andrey Nikolaevich Kolmogorov



Rev. Thomas Bayes

Bayes vs. MDL

Under regularity conditions $-\log P_{NML}(x^n | M) =$

$$-\log P(x^n | \hat{\theta}_i(x^n)) + \frac{k}{2} \log \frac{n}{2\pi} + \log \int \sqrt{\det I(\theta)} d\theta + o(1)$$

Under regularity conditions $-\log P_{Bayes}(x^n | M) \approx$

$$-\log P(x^n | \hat{\theta}_i(x^n)) + \frac{k}{2} \log \frac{n}{2\pi} - \log w(\hat{\theta}) + \log \int \sqrt{\det I(\theta)} d\theta + o(1)$$

If we take Jeffrey's prior

$$w(\theta) = \frac{\sqrt{\det I(\theta)}}{\int \sqrt{\det I(\theta)} d\theta} \dots \text{☺}$$

Locit

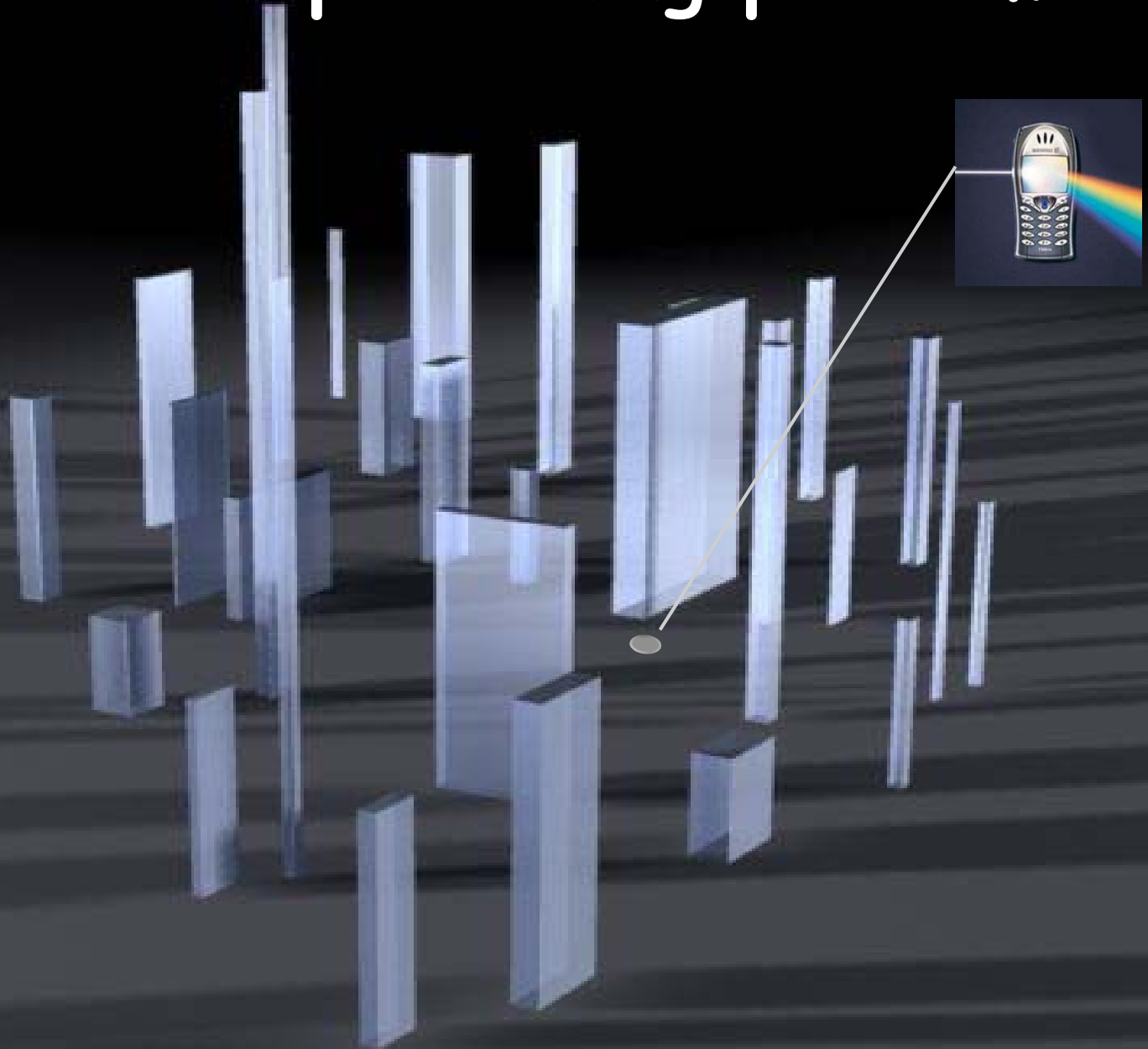
A busy city street scene, likely Times Square in New York City, with many pedestrians and tall buildings with billboards. The word "Locit" is overlaid in large, 3D, metallic letters. The background shows a dense crowd of people, some looking at their phones, and various signs and advertisements on the buildings.

Mobile Device Positioning

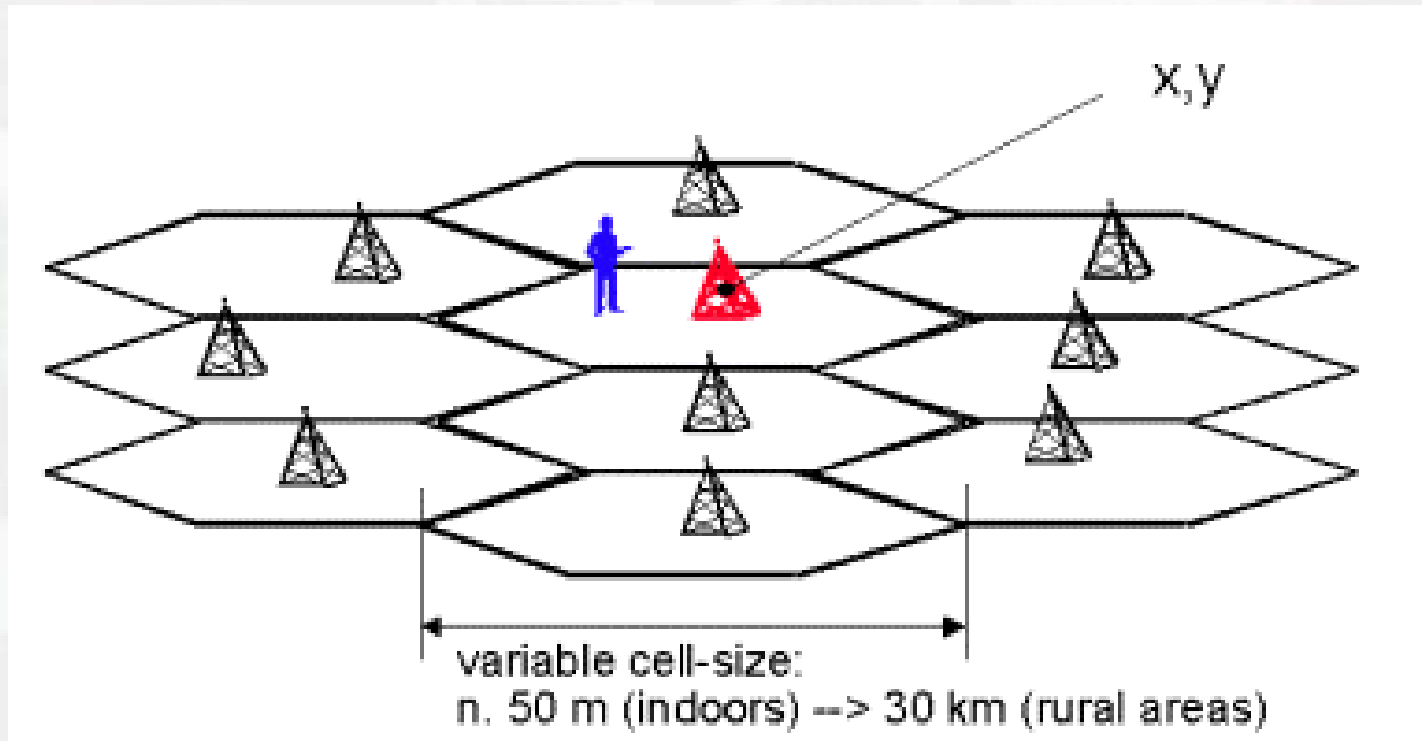
Mobile Positioning: Manhattan Trial



Location positioning problem



Cell ID

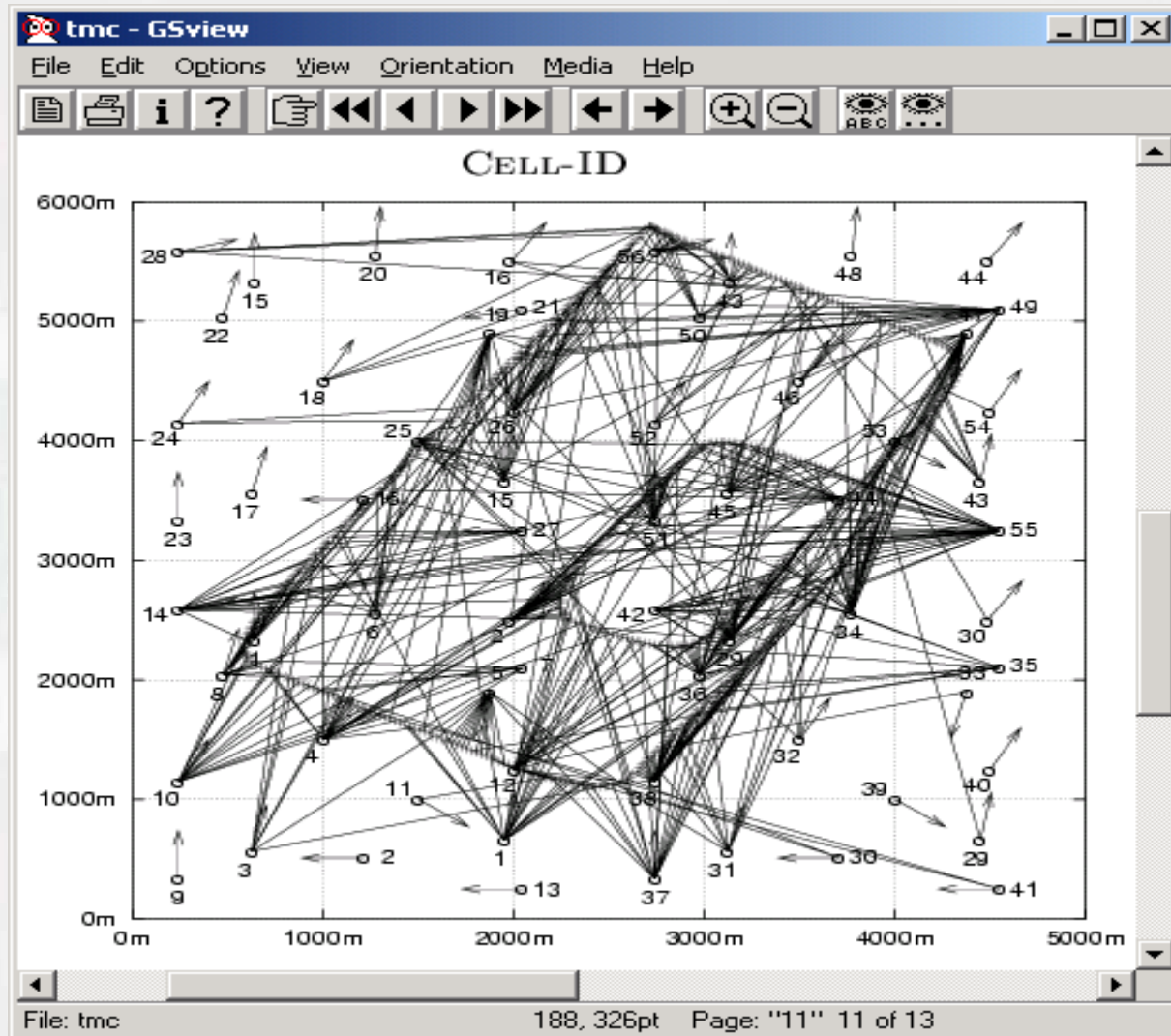


Urban positioning

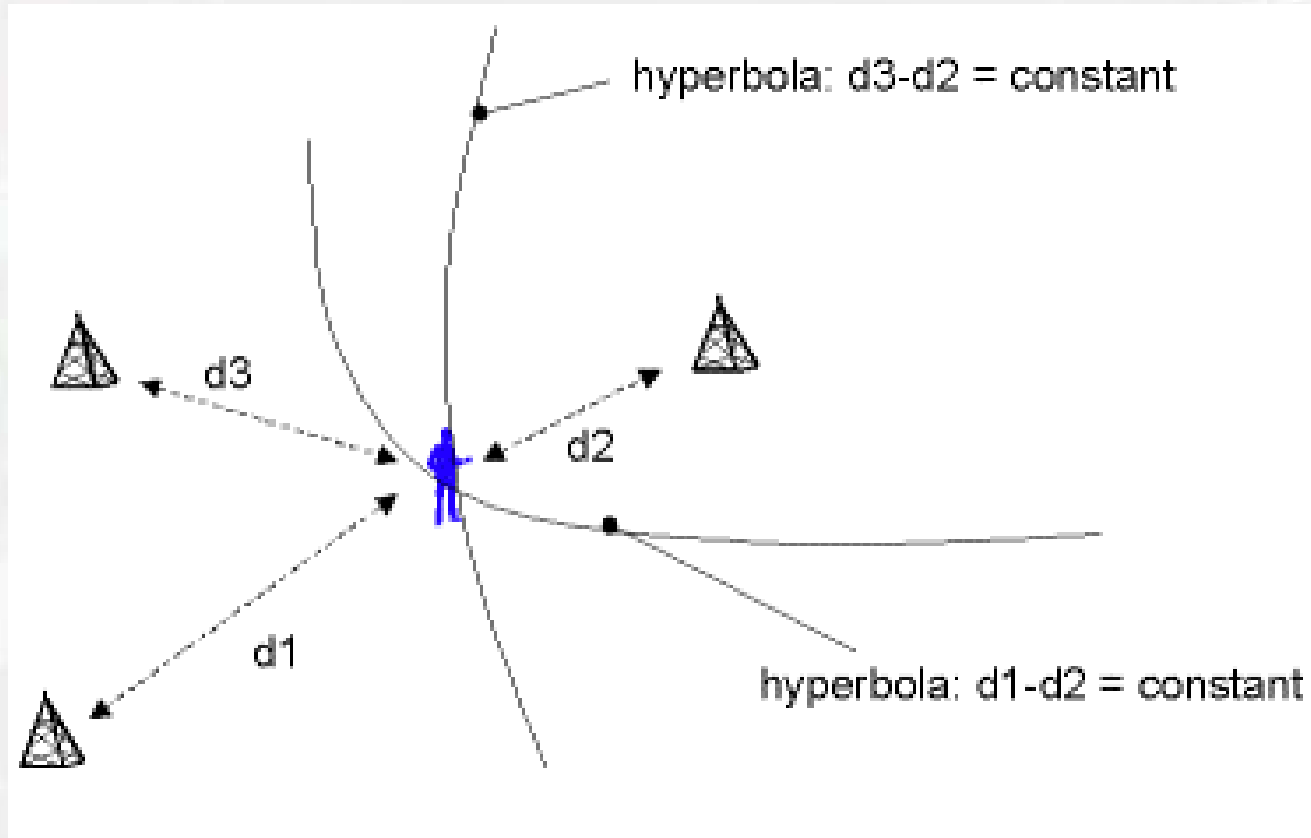


- errors > 500m common
+ simple

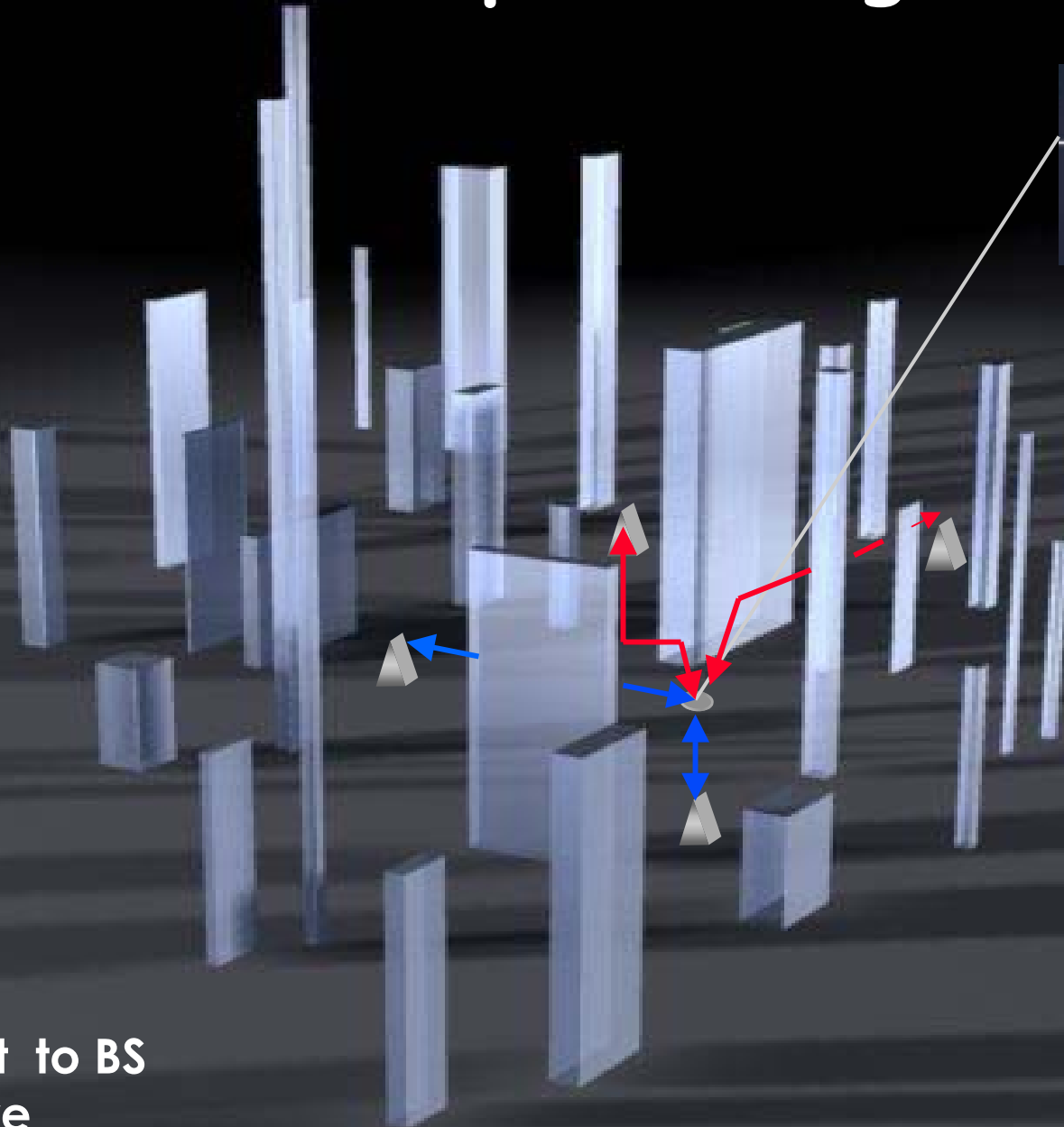
Cell ID errors



Enhanced Observed Time Difference (E-OTD)

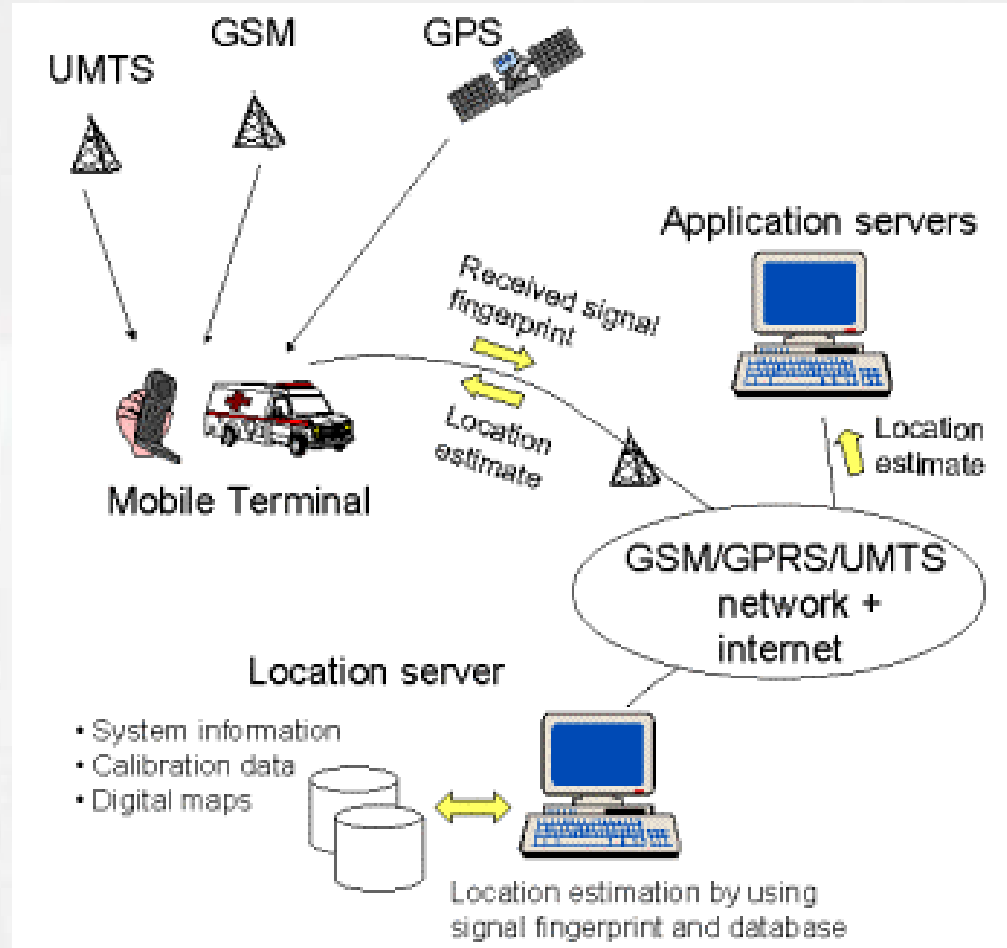


Urban positioning

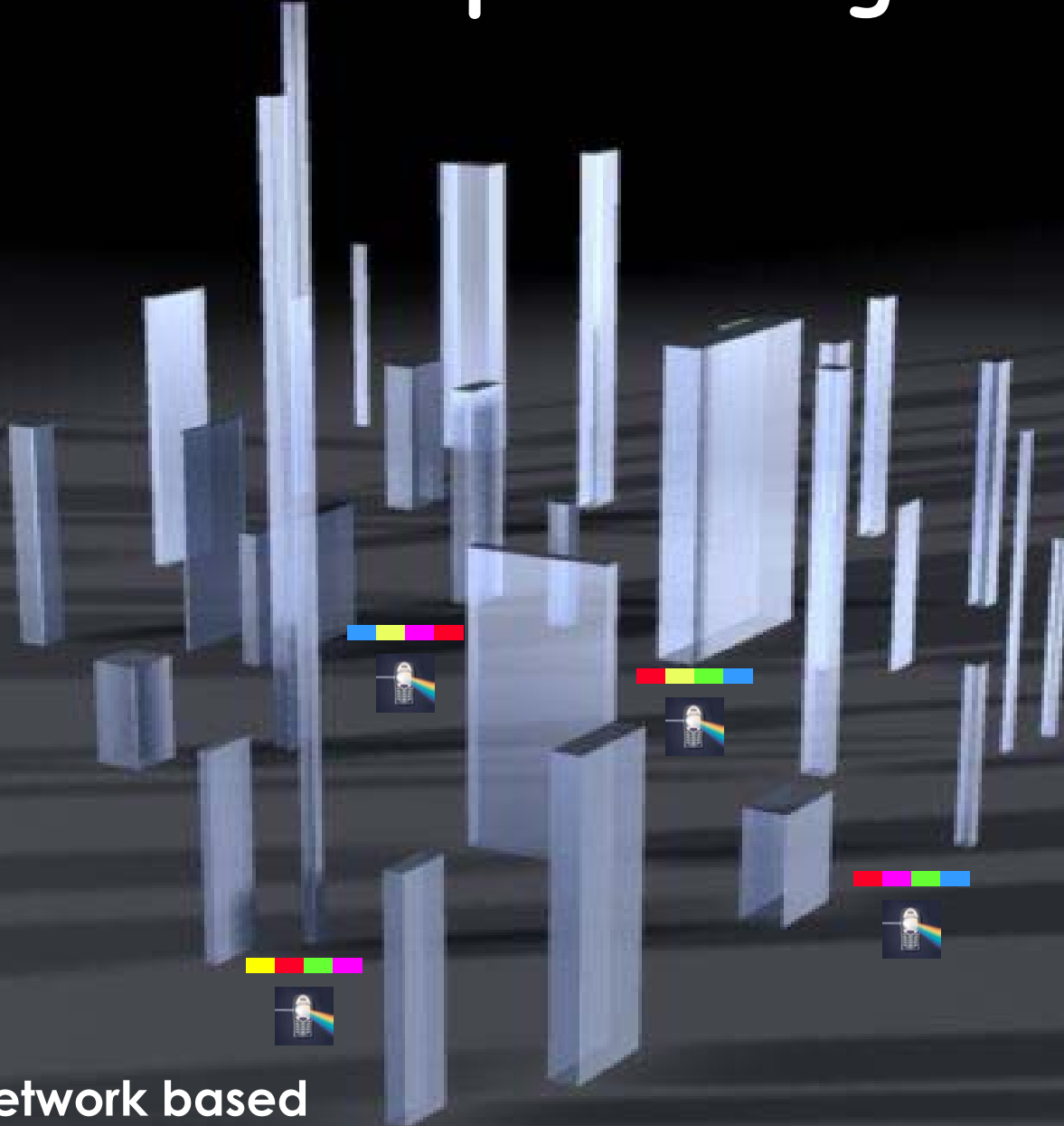


- multi-paths
- no line of sight to BS
- extra hardware

Modeling approach



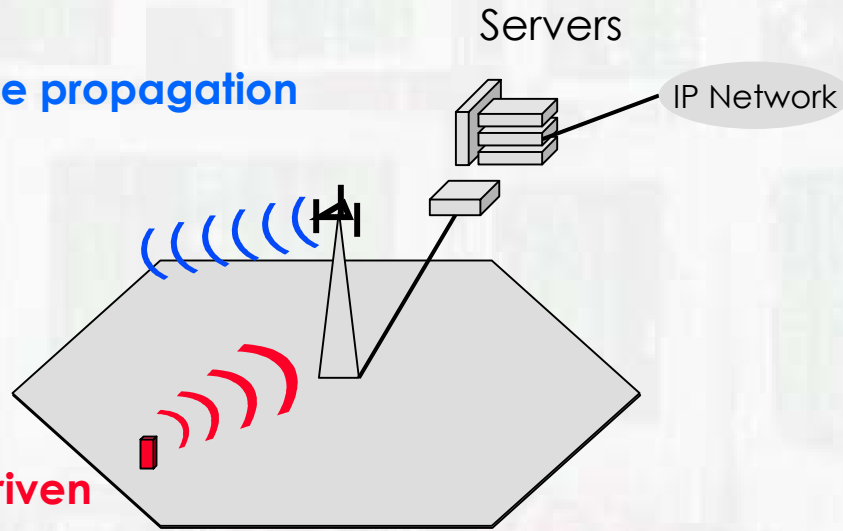
Urban positioning



- +accurate
- +handset or network based
- modeling required

Modeling alternatives

"Downlink modeling: the propagation models (GM level 1)"



"Uplink modeling: data driven models (GM level 2)"

Modeling architectures

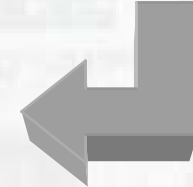
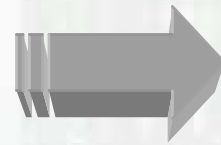
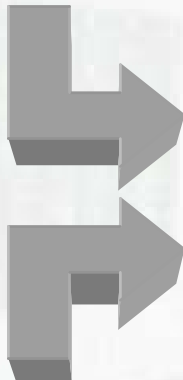
- three modeling architectures varying in
 - data gathering,
 - network information requirements,
 - accuracy
- GeoMode Network (GM-N)
- GeoMode Data (GM-D)
- GeoMode Hybrid (GM-H)

GM Network (GM-N)

Network information



Phone fingerprint

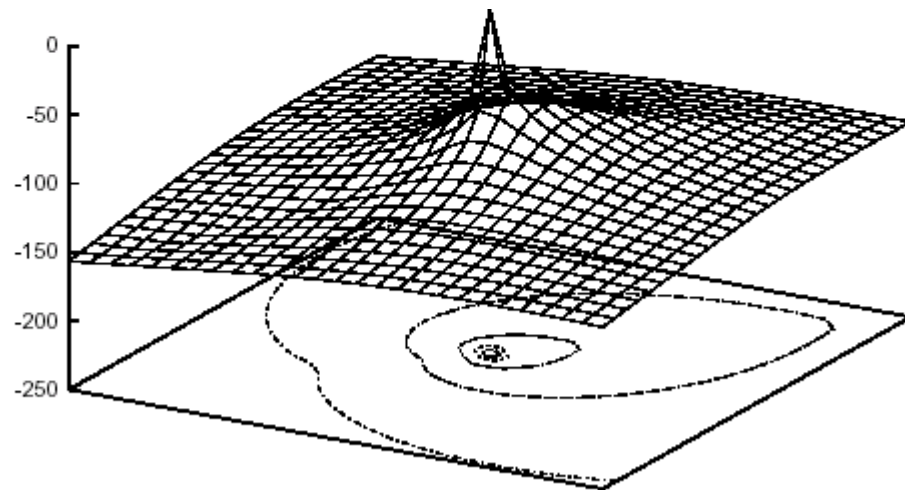
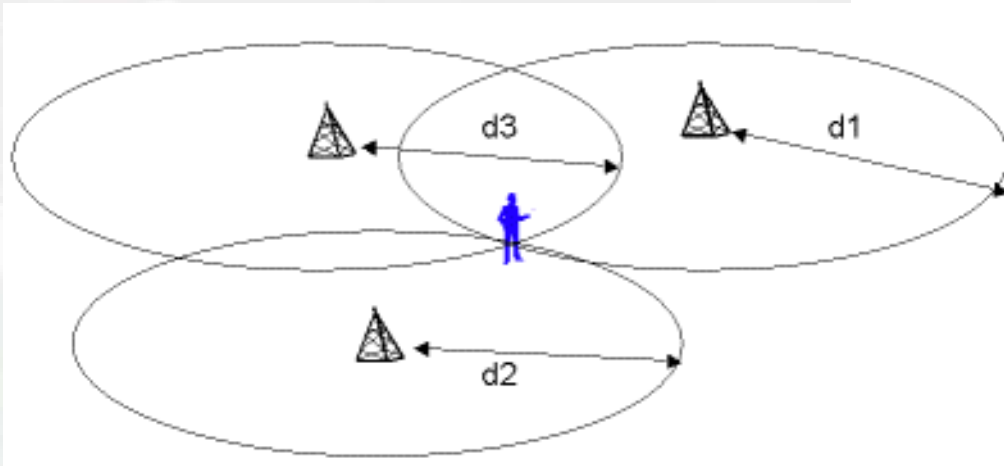


Coordinates

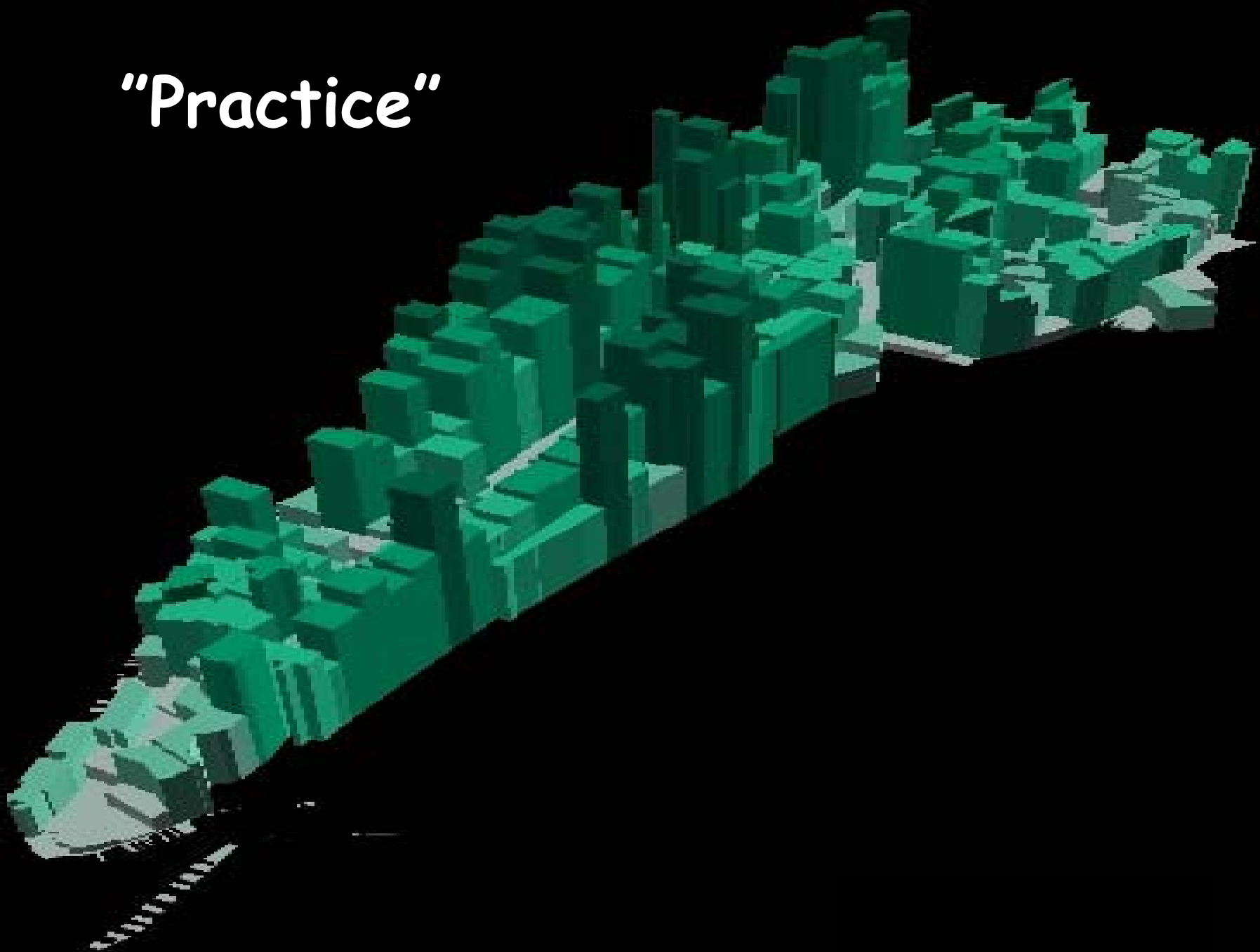


Parameter tuning measurements

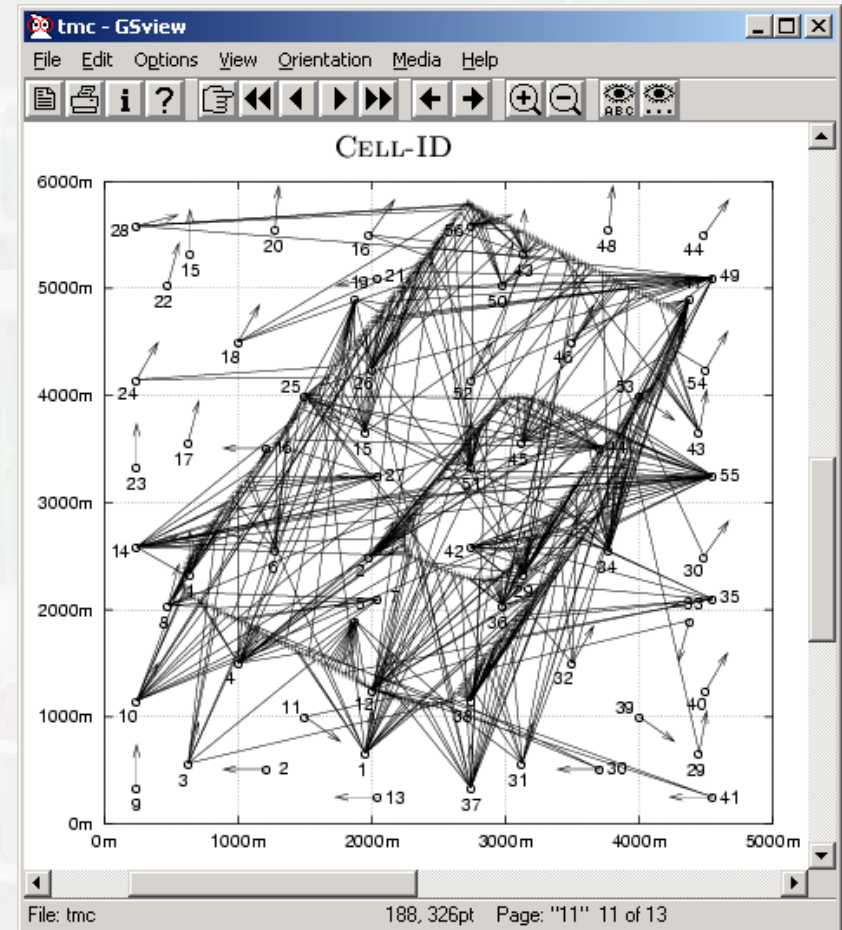
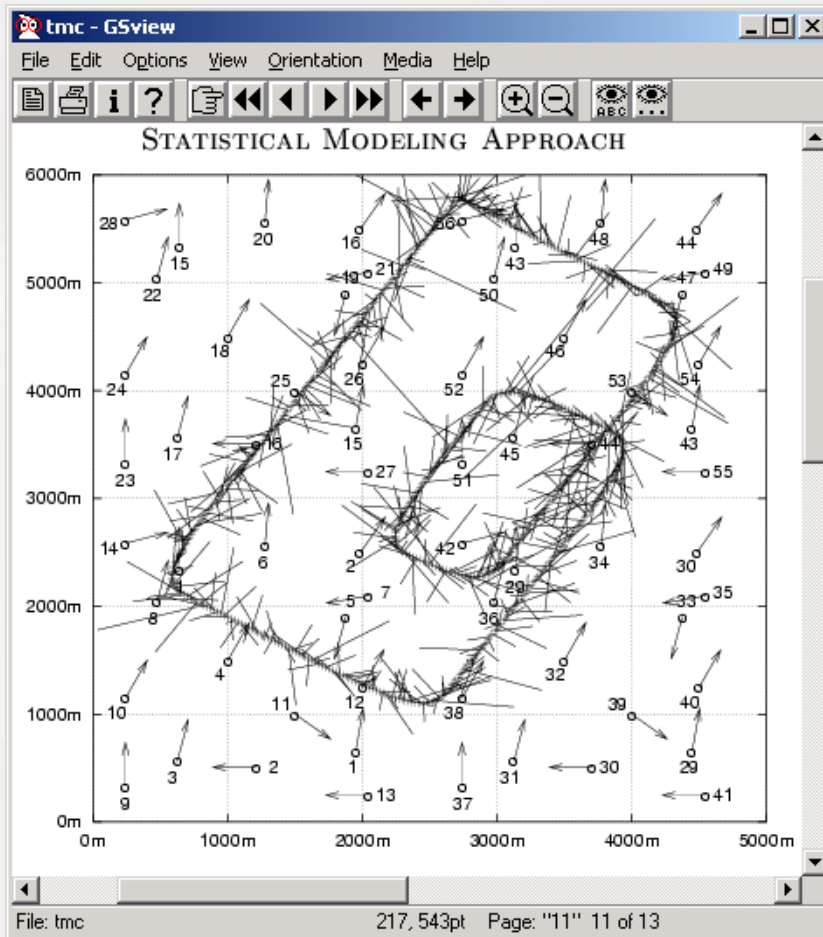
"Theory"



"Practice"



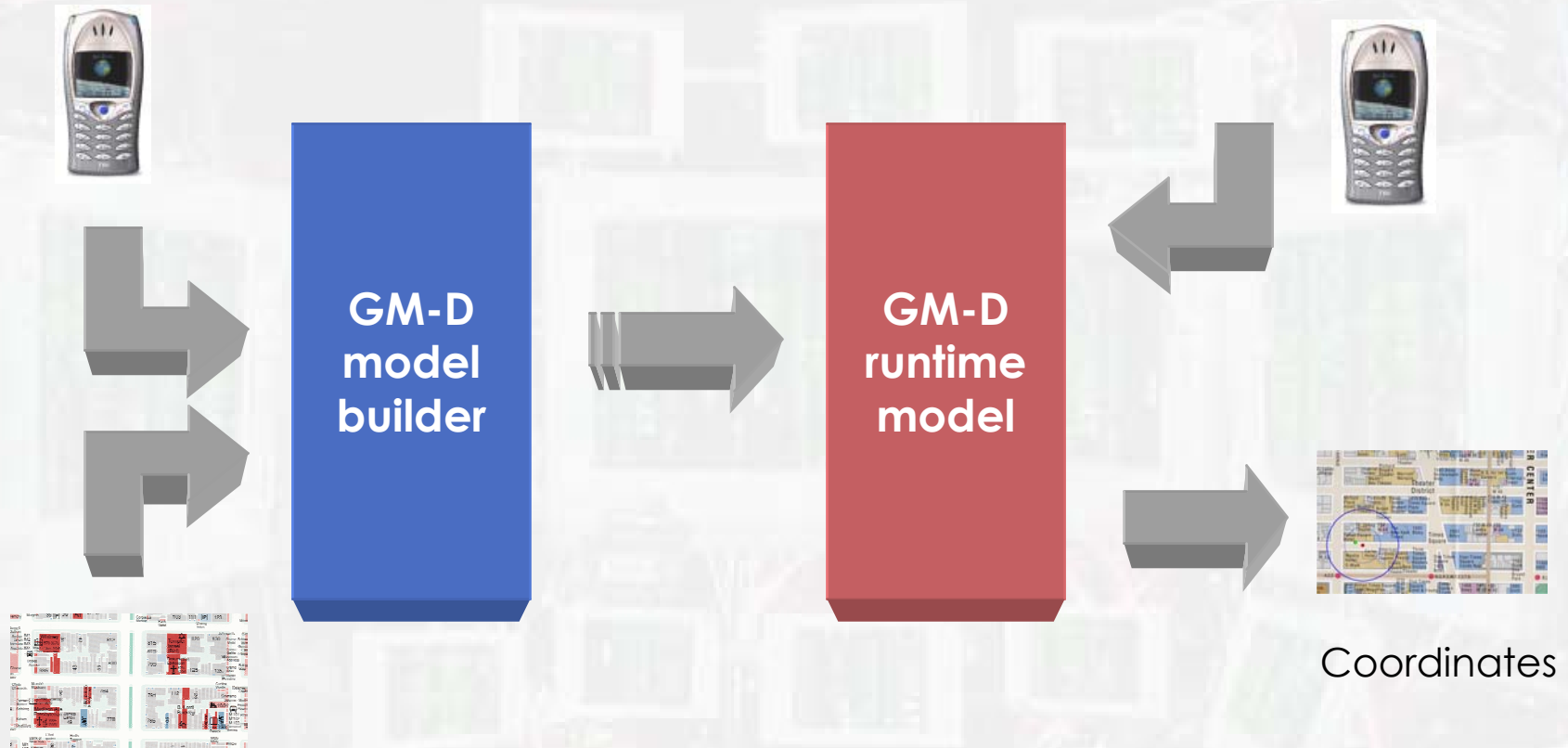
GM-N vs. Cell ID errors visualization



GM Data (GM-D)

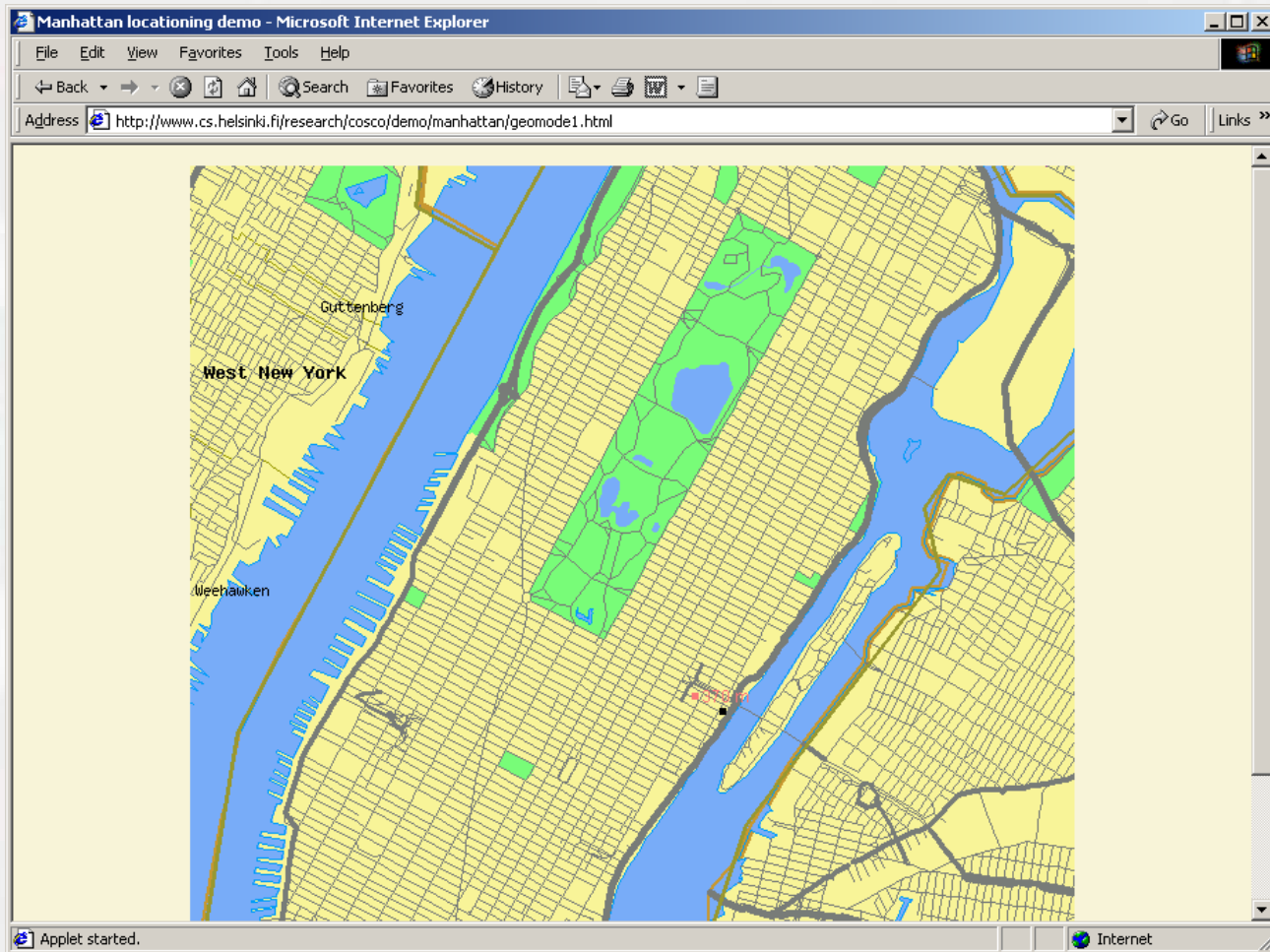
Fingerprint data gathering

Phone fingerprint

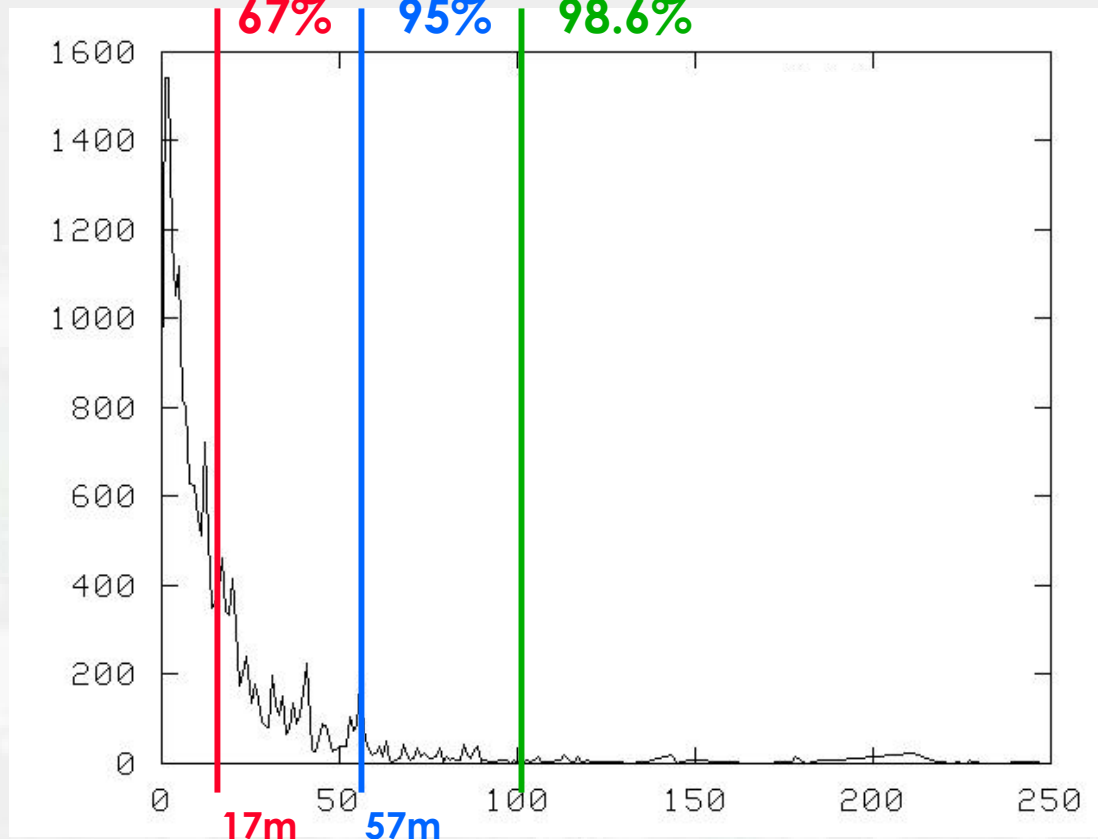


Calibration testing

NYC Trial 2001

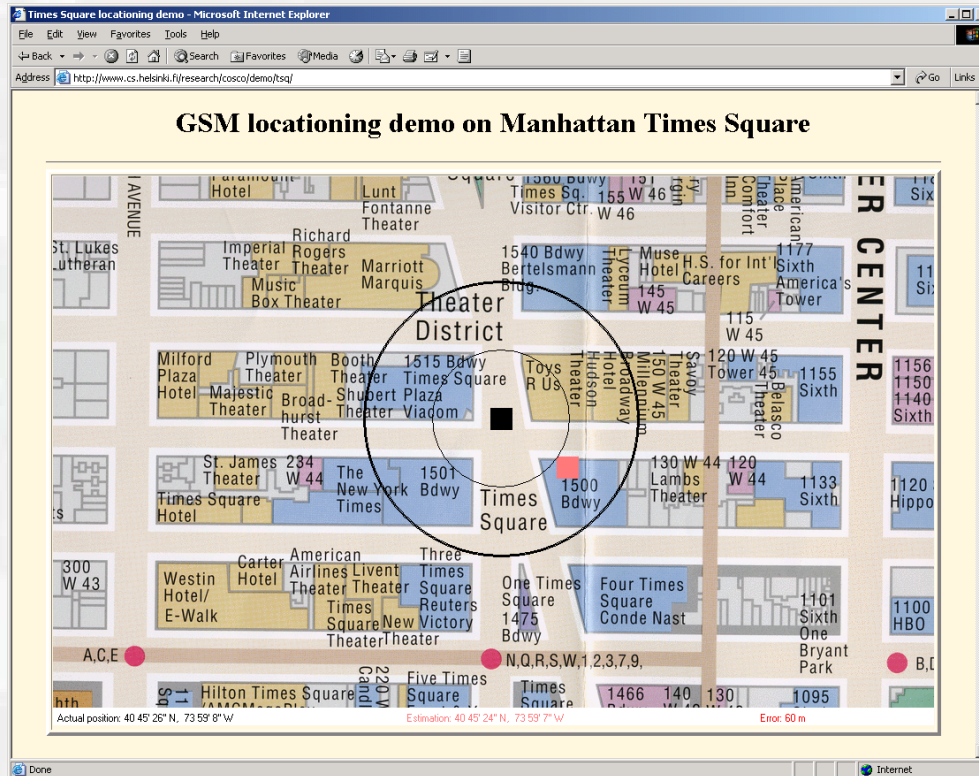


Accuracy NYC Trial 2001

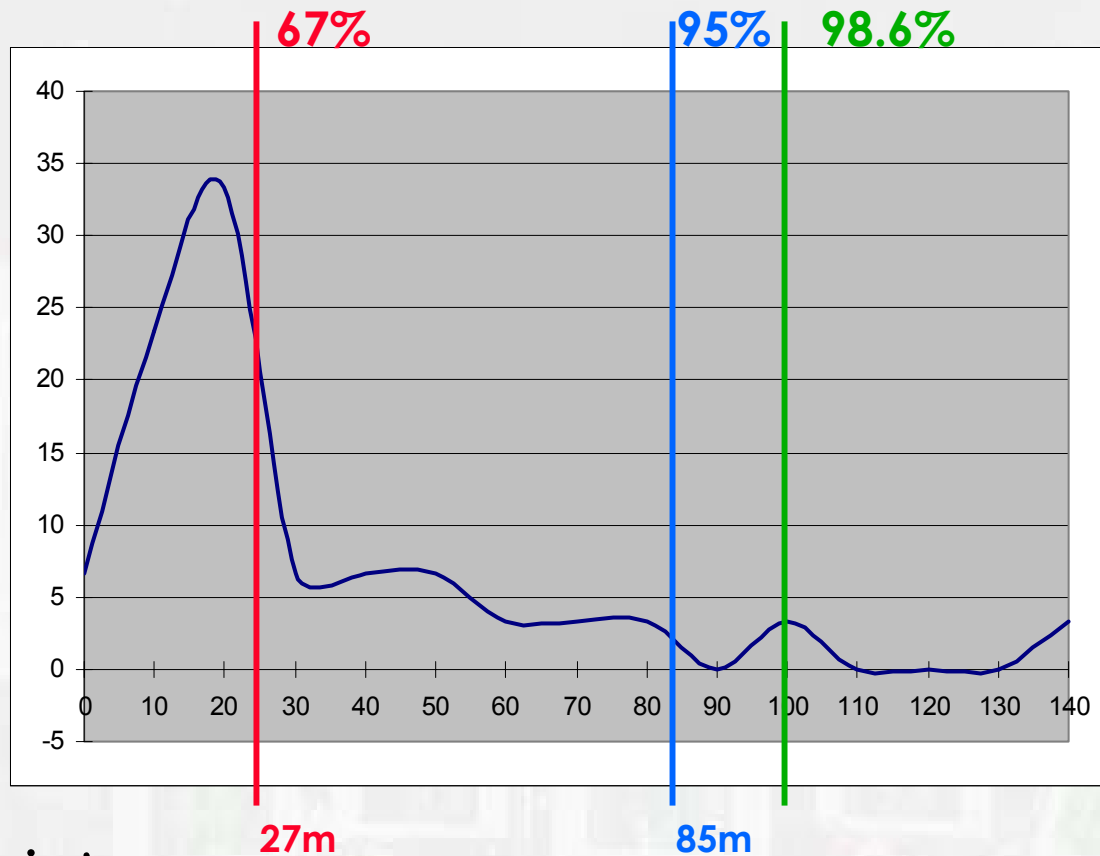


- 20166 points
- tracking; testing done in a car;

Trials: Manhattan 2002



Accuracy NYC Trial 2002



- 30 points
- static; testing done by walking;

Generalization: WLAN


EKAHAU - Positioning Engine Demonstration - Microsoft Internet Explorer

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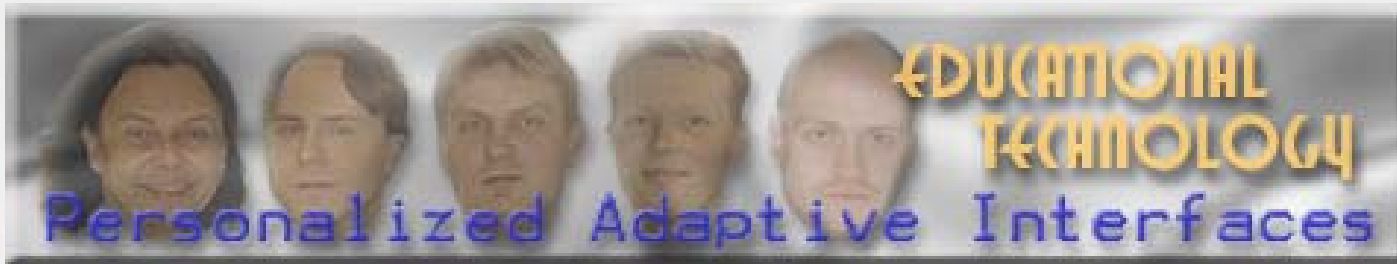
Ekahau Positioning Engine Demonstration



The diagram is a detailed floor plan of a building, likely a restaurant or office space, with various rooms, tables, and chairs. A grid of small black squares is overlaid on the plan, representing the estimated user location. A larger, solid black square is placed on the grid, representing the actual user location. A blue square is also present, representing the estimated user location and its location error. A small blue square with the text '0.7 m' is positioned next to the blue square, indicating the distance between the actual and estimated locations.

- Actual user location
- Estimated user location and location error

Done Internet



Intelligent Tools for E-learning

EDUFORM

EDUFORM - Microsoft Internet Explorer

EDUFORM
by
CoS Co

Learning Experiences and Motivation

Disagree 1 2 3 4 5 Agree

5. During an exam I wonder how I am performing in comparison to other students.

6. When taking part in a practical examination I am concerned about failing and what will happen as a result.

7. When answering essay questions I am also concerned about the other questions on the test that I cannot answer.

42% left

0% 100%

Internet

EDUCO

EDUCO - Microsoft Internet Explorer

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Address <http://cosco.hiit.fi/edutech/educu/demo/> Go Links

Welcome to EDUCO!

Australian Journal of Educational Technology
2000, 16(3), 258-282.

AJET 16

Case studies: Integrating the use of web based learning systems into student learning

Simon Housego and Mark Freeman
[University of Technology, Sydney](#)

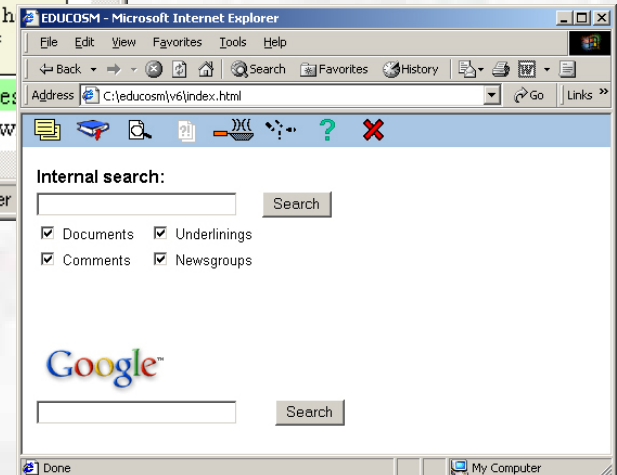
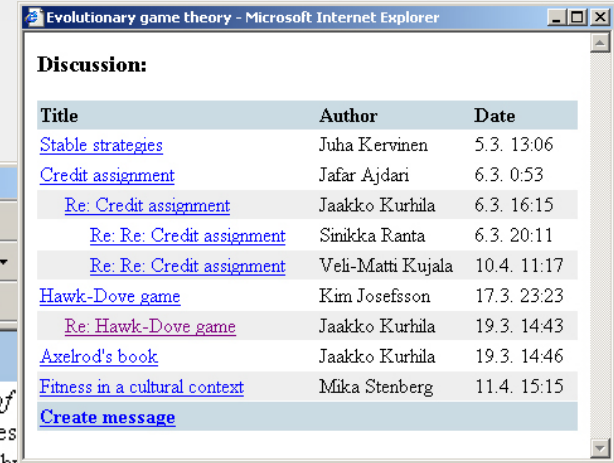
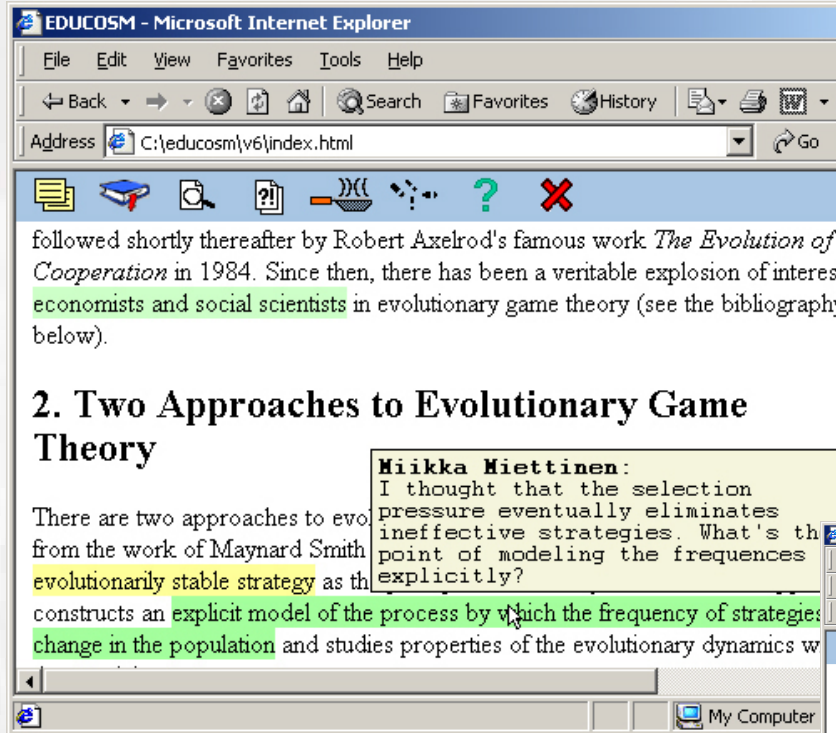
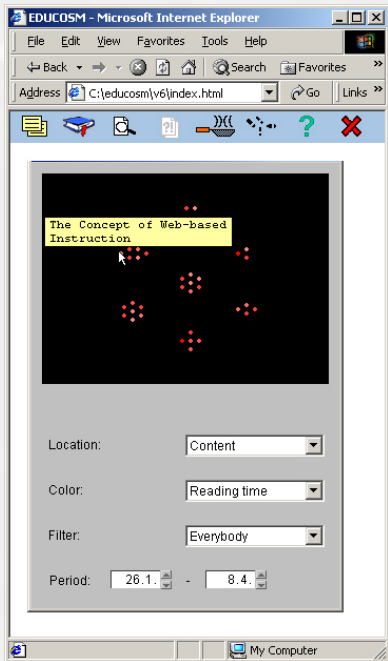
Competitive pressures on universities to adopt flexible learning are intense. Many academics and managers are responding by incorporating web based learning (WBL) tools into the teaching environment. WBL tools have proliferated in recent years, and some can be used to manage entire courses. The simplicity of WBL systems, like WebCT, TopClass and Blackboard, makes their use in teaching an option for many academics, even those operating without institutional support or encouragement.

Academics are seeking meaningful uses of these WBL systems for teaching and learning. The objective of this paper is to describe some meaningful uses with five fictional case studies based on our experiences in innovation and academic development. Our motivation is that academics and academic managers will identify one or more opportunities from the case studies to apply in their own context. Others including Hara and Kling (1999) have identified the need for this research. The case studies show ways in which teaching, learning and administration can be supported, adapted and extended with web based learning systems. Well understood teaching strategies can be improved with simple and easily implemented uses of WBL systems that can benefit on and off campus students. If underpinned by student centred teaching practices, these tools can make significant contributions to the effectiveness of teaching without also imposing an unsustainable demand for resources.

EDUCO

Internet

OurWeb

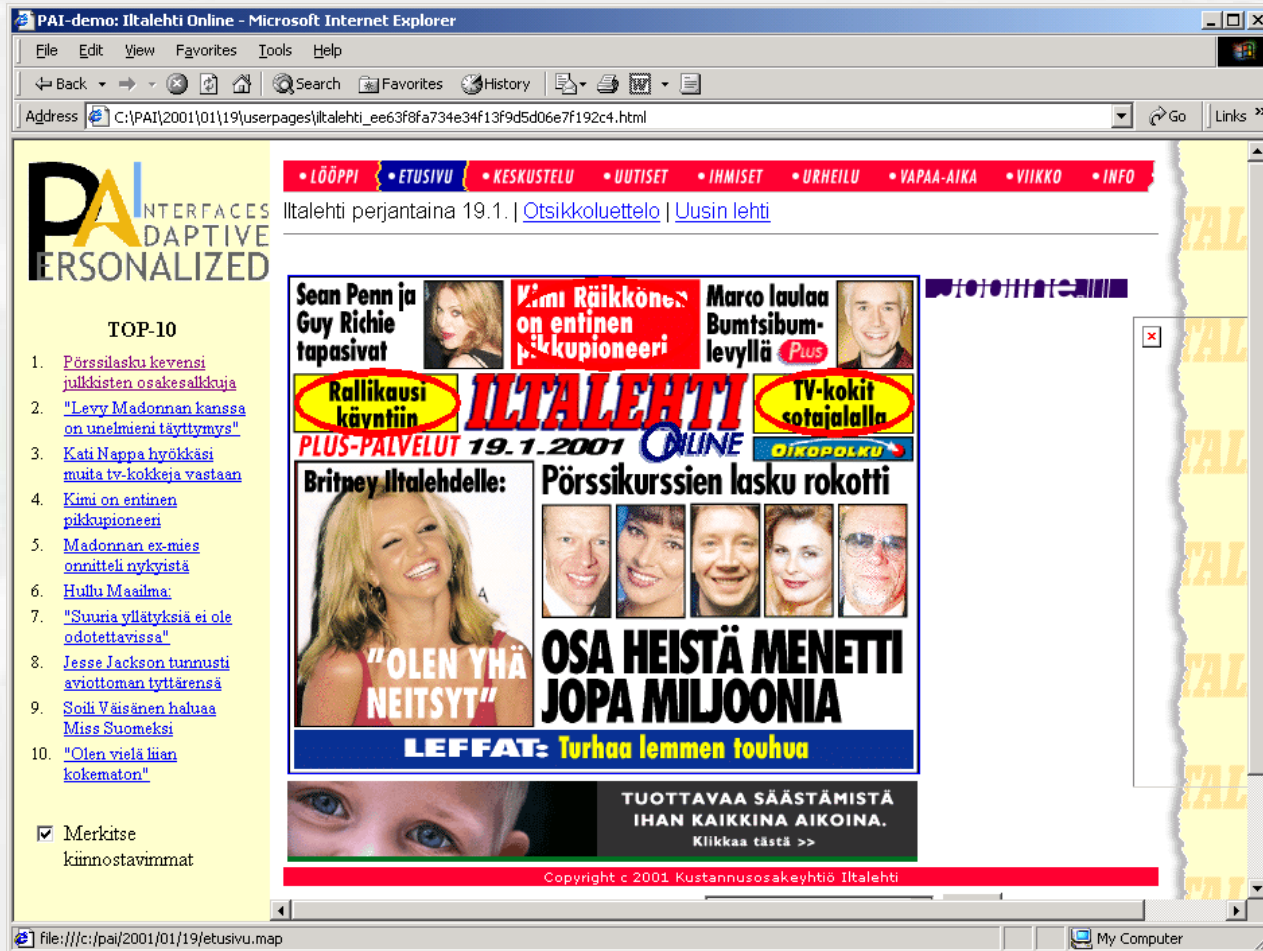


Personal WEB

Personalization and Intelligent Search



Personalized, adaptive interface



Search-In-a-Box concept

ERICSSON

Query

The Nokia Activ Server is an open software platform that enables secure mobile connectivity to a company's existing information systems, Intranet and Extranet services. Corporations can transform their static services into real-time mobile business by offering customers a new channel to make transactions with them. Furthermore, by providing the mobile workforce with an interactive mobile channel to corporate data companies can increase their

Document style: technical

Content: mobile enterprise

Query results

- EVO the wireless link to the corporate network.**
... Exchange Server Business Application Server LAN File Server Web/Intranet Access Network GSM, GPRS, D-AMPS, CDPD, PSTN, Mobitex and UMTS EVO Server Mobile
www.ericsson.com/enterprise/library/brochures_datasheets/EVO/EVO_1023371.pdf
- The path to the Mobile Enterprise**
... This, combined with the Mobile Extension, gives users access to both voice services and Intranet in ... feature-rich services are ported to an open server, ...
www.ericsson.com/products/white_papers_pdf/whitepaper_mobile_enterprise_rc.pdf
- Ericsson news archive**
Ericsson Enterprise WAP gateway allows secure mobile access to ... done by the access server, by the gateway and by the application server ... Financial services (eg mobile banking) ? Travel and transport services Mobile Intranet ...
www.ericsson.com/US-CA/enterprise/news_archive/20010416-001.htm

more ...

Personal context

- Product brochures — Software — Enterprise
 - [Peer to peer services](#)
 - [Linux software — Tutorials](#)
 - [... ignore](#)

Query categories

- Computer software
 - Intranet and WAP
 - Telecommunications
- Business services
 - Productivity

Announcing The Wireless Developer Forum - Sponsored by Ericsson... Tuesday, October 15, 2002 - Presented by the Wireless Developers Network and Ericsson. An information packed educational Forum held in conjunction with WirelessIT... Agenda is now online.

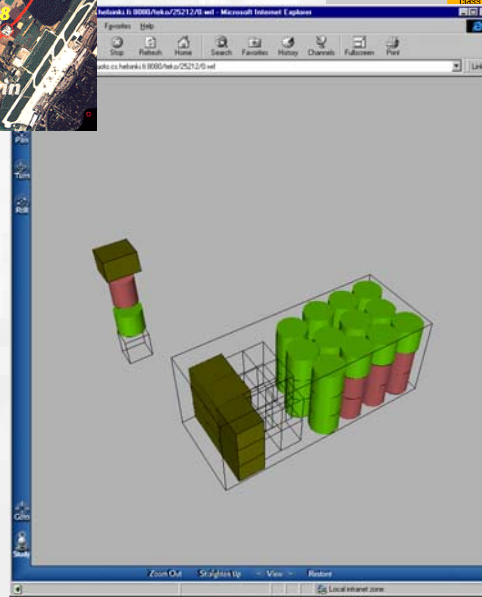
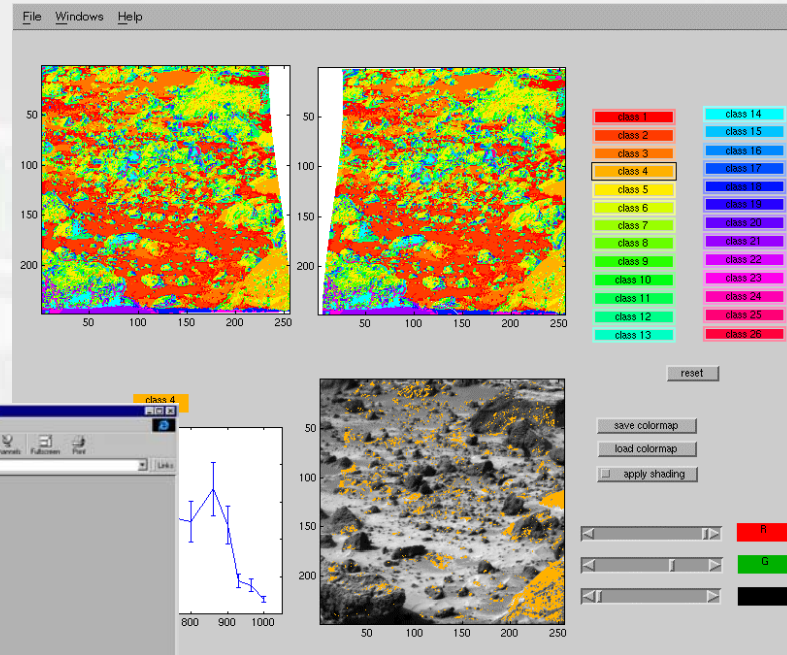
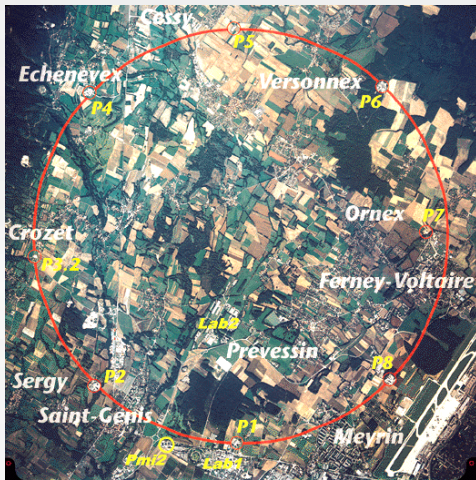
Wireless Developer Forum

Successful developers share their Experiences.

October 15, 2002 - Las Vegas, Nevada

search-in-a-box

and other things



Termejä

- computational intelligence = laskennallinen älykkyys
- artificial intelligence = tekoäly, artificial life = keinoelämä
- probabilistic modeling = probabilistinen mallintaminen
- positioning = paikannus