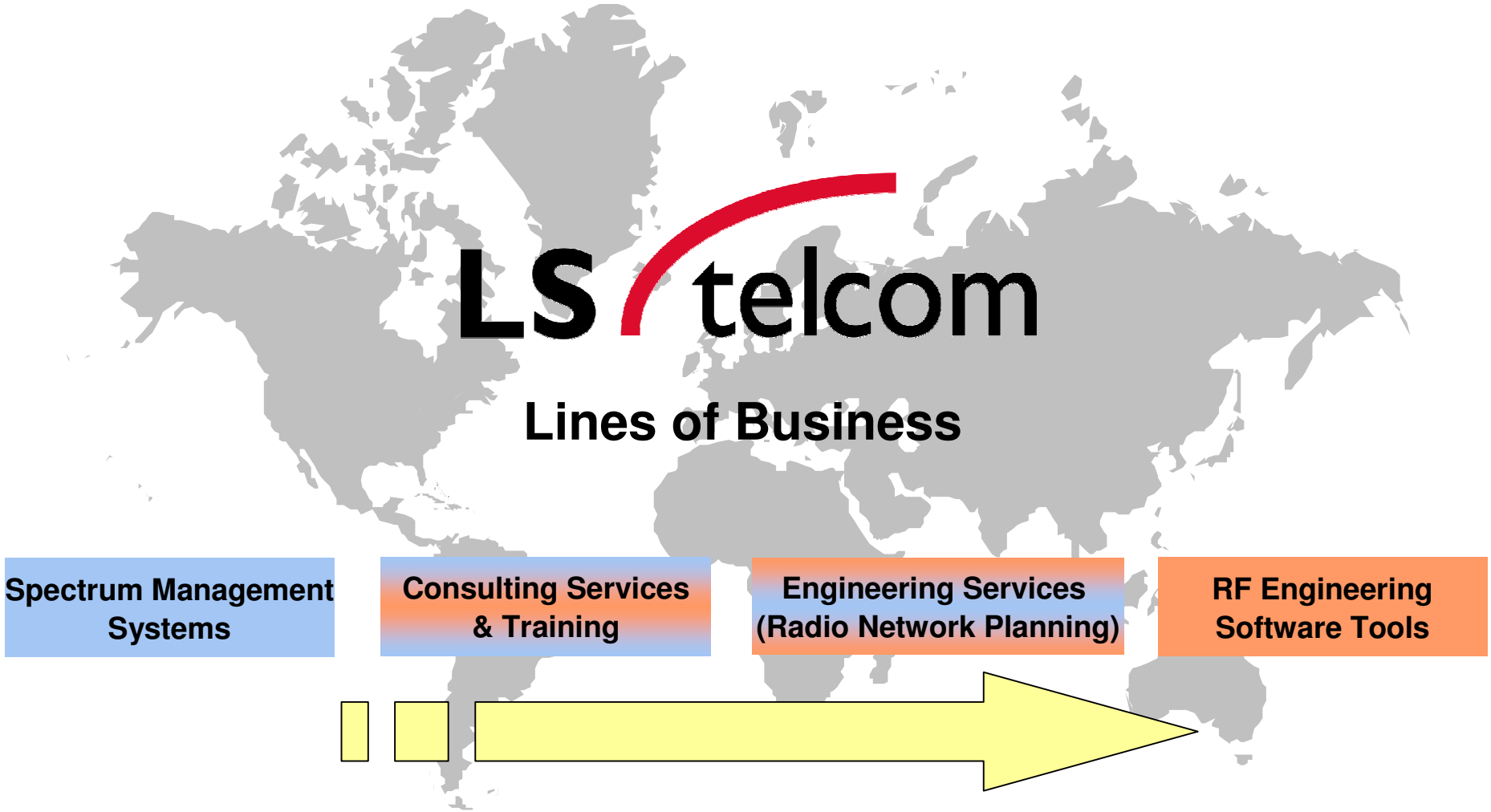
Radio Network Planning Tools
Basics, Practical Examples & Demonstration on NGN Network Planning
Part I

Roland Götz
LS telcom AG

Regional Seminar on evolving network infrastructures to NGN and related Planning Strategies and Tools, for the CEE, CIS and Baltic States

Belgrade, Serbia and Montenegro, 20-24 June 2005

Lines of Business



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Lines of Business – Consulting Services & Training

Trainings and Seminars

This comprises a wide variety of trainings in the whole field of telecommunications, including:

- Basic- and Expert-seminars for our Software Solutions
- Expert trainings for Radio Network Planning (mobile, microwave, WLL…)
- Seminars for Broadcast Planning (RRC04/06, TV, FM, ...DAB, DVB, DRM…)
- Spectrum Management Workshops
- Expert Trainings on Spectrum Monitoring

LS TrainingCenter, Germany

AIBD - Asia-Pacific Institute for Broadcasting Development, Malaysia

ITU Centers of Excellence

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Lines of Business – Consulting Services & Training

- Our Consulting Team includes Spectrum Managers and RF Specialists, who have managed Spectrum of various countries and assisted regulators worldwide.
- Several hundred person years of experience and capability in:
  - Feasibility Studies / Expert Surveys
  - Vendor Selection
  - Process / Workflow Development
  - Technical Concepts
  - Radio Policy
  - Frequency Planning
  - Spectrum Operations
  - Automated Tools
  - Radio Monitoring
  - Preparation of Tender Documents

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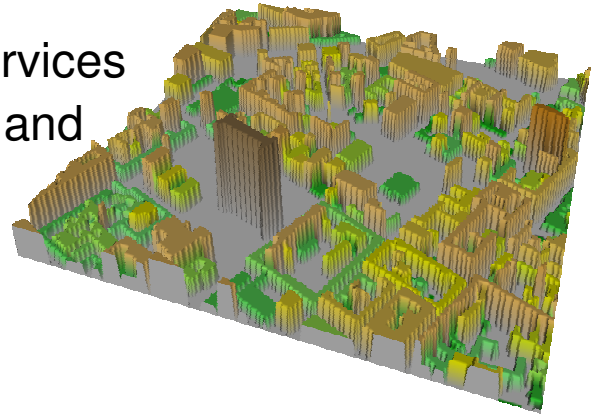
Lines of Business –
Engineering Services (Radio Network Planning)

Radio Network Planning and Engineering Services



This comprises all sorts of engineering and planning services relevant to network operators, regulatory organisations and system suppliers, including:

- coverage analysis and studies
- frequency planning & coordination services
- network design (cellular and transmission)
- network implementation
- network optimisation: coverage, interferences, capacity
- geo data: consulting, generation, conversion and acquisition
- project management

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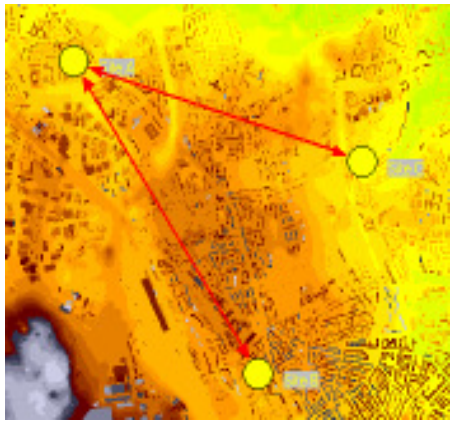
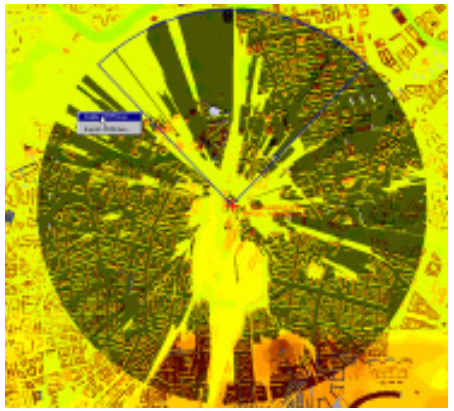
Lines of Business –
RF Engineering Software Tools

Software for Radio Network Planning and Engineering

- By use of LS telcom‘s comprehensive software solutions, clients can perform all essential planning, optimisation and management tasks, which there are:
  - Network calculations, dimensioning and analysis
  - Coverage, frequency and traffic planning as well as market opportunity simulations
  - Site planning for base stations; database for existing radio sites
  - Management of sites and network elements
  - Acquisition and maintenance of geo-data
  - Terrain and field-strength profiles





Software for Fast and Cost-Efficient Rollout and Operation of Wireless Networks

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Lines of Business – RF Engineering Software Tools

Radio Network Planning Tools

Mobile Networks

Solutions for fast and cost-efficient rollout, operation and optimization of mobile communication networks

- Covers the whole range of mobile network planning aspects
- Multi Technology Support (TETRA, TETRAPOL, 2G, GSM, CDMA,2,5G, 3G, WCDMA)

Microwave Networks

Design tool for microwave links, WLL, PMP, WiMAX

- Interactive link engineering
- Interference analysis
- Channel assignment
- Availability calculation
- Flexible report generation
- Implemented ITU-R recommendations

Broadcast Networks

Design tool for the planning and coordination of analog (FM,TV) and digital (DAB, DVB, DRM) networks

- Frequency selections according to ITU recommendations and plans
- LF/MF and HF frequency coverage

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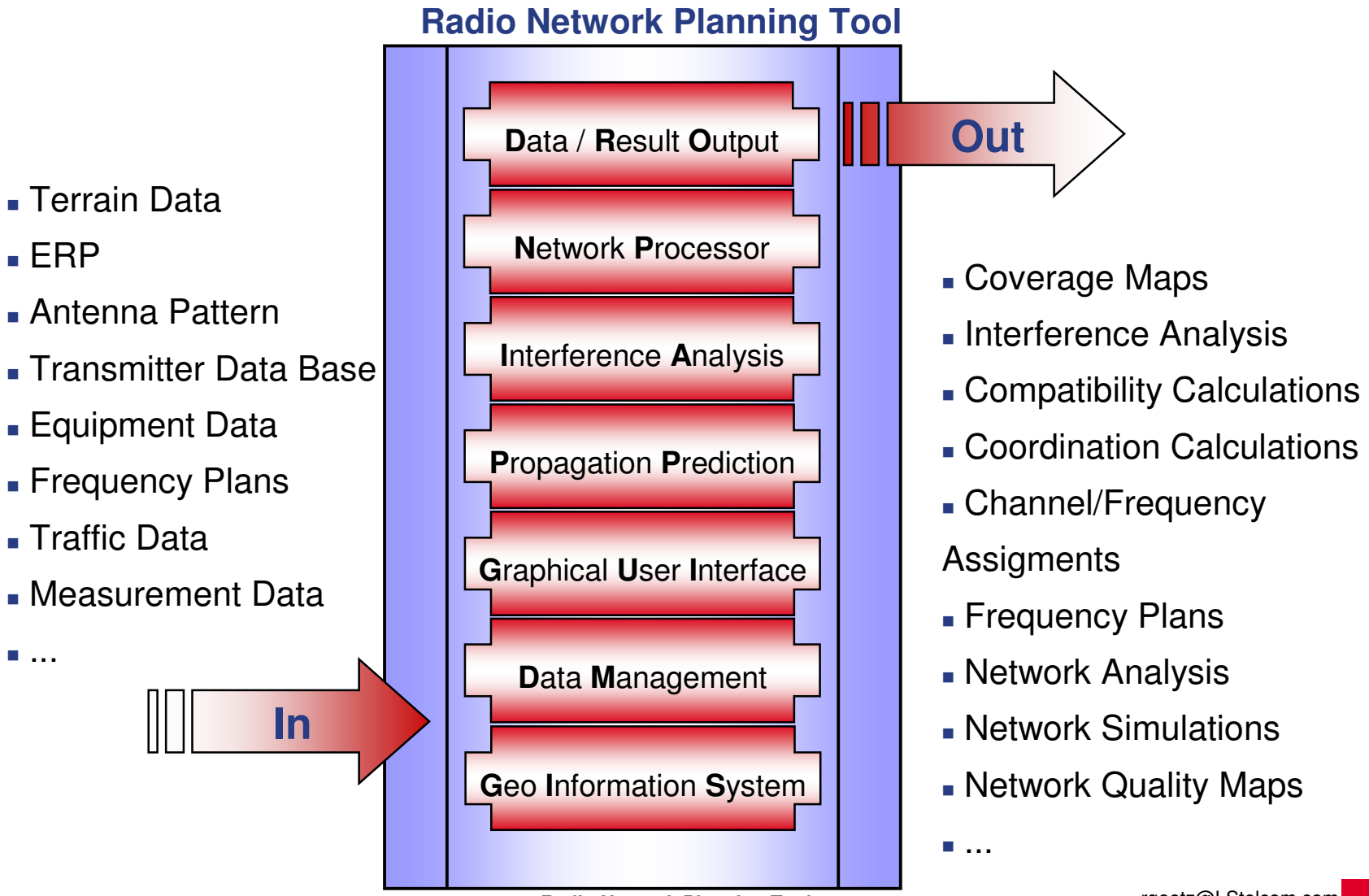
Radio Network Planning Tools
Basics, Practical Examples & Demonstration on NGN Network Planning

Radio Network Planning Tools - Basics



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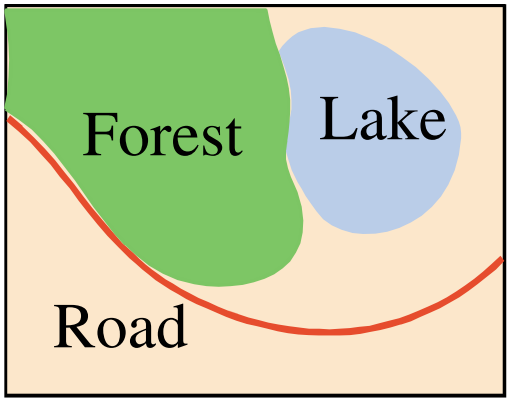
Radio Network Planning Tools - Basics

Two basic Data Formats

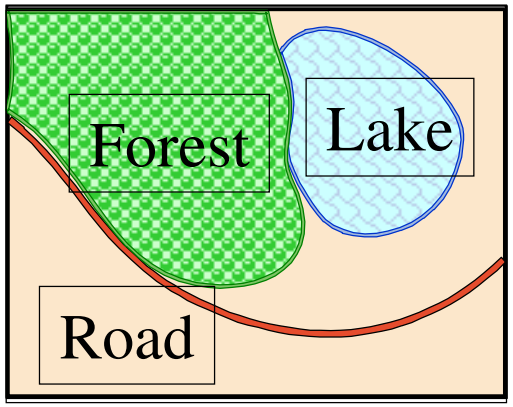
Vector Format

Geographical features described as:

- Points
- Lines
- Polylines



e.g.:
Names, Contours, Borders, Roads



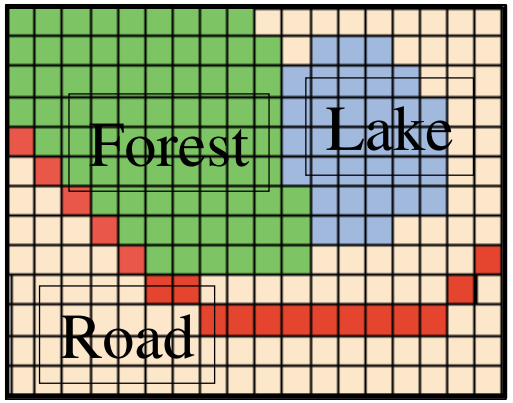
Raster Format

Geographical region divided in equally spaced areas (pixel)

One valued information for each pixel

e.g.:

Elevation, Clutter type



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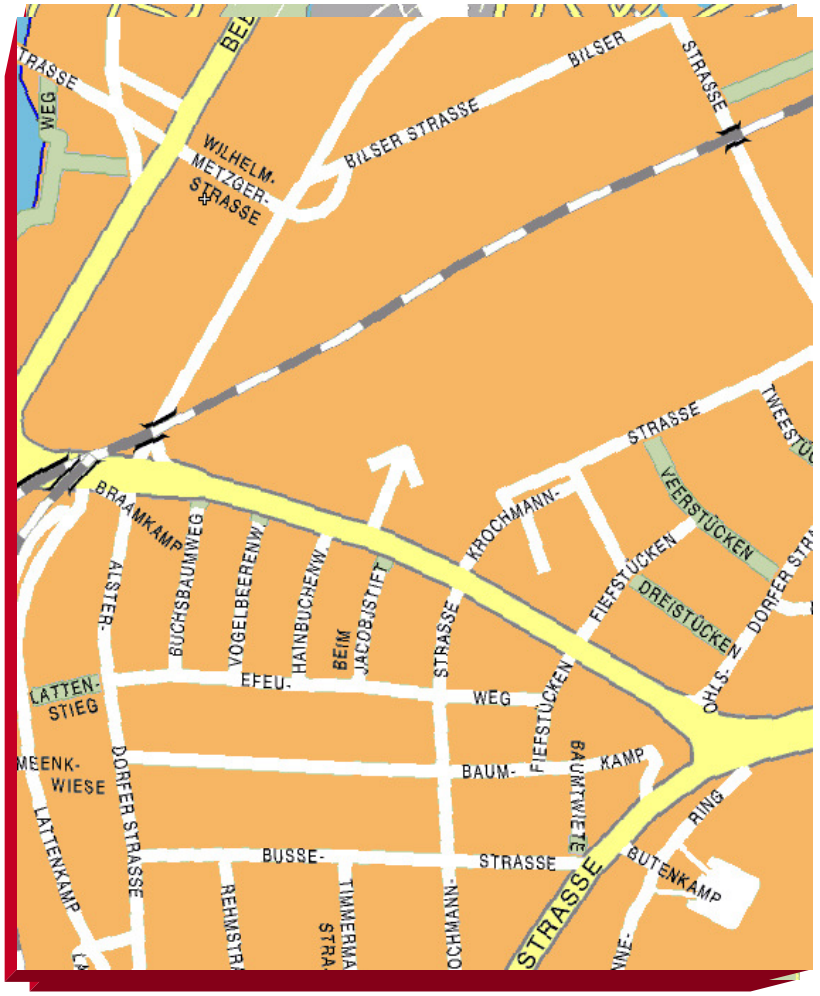
Radio Network Planning Tools - Basics

Overview Maps, Road Maps

... used for Display, Visualisation and Overlay Functionalities

- Sources
  - National Ordnance Survey
  - Local Map Suppliers
  - International Flight Maps
- Scales
  - 1:7,500
  - 1:10,000
  - 1:50,000
  - 1:200,000
  - 1:500,000
  - ≥ 1: 1,000,000



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Radio Network Planning Tools - Basics

Satellite based products:

- Orthorectified Images
- Digital Elevation Models (DEM)
- Clutter
- Updated roadmaps

- Sources:
  - LandSat7™
  - Spot5™
  - IRS 1C/1D™
  - Ikonos™
  - Quickbird™
- Resolutions:
  - 0.2 m
  - 1 m
  - 10 m
  - 35 m
  - 100 m

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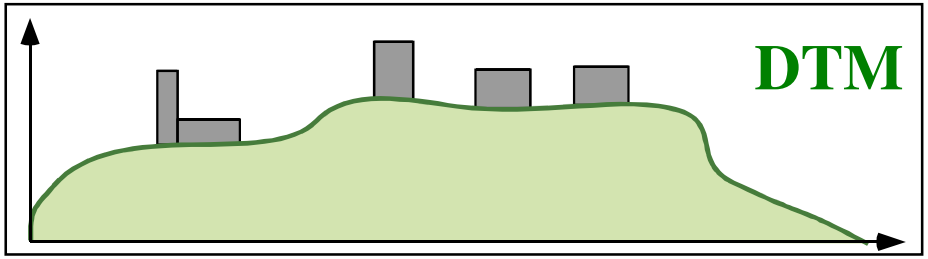
Radio Network Planning Tools - Basics

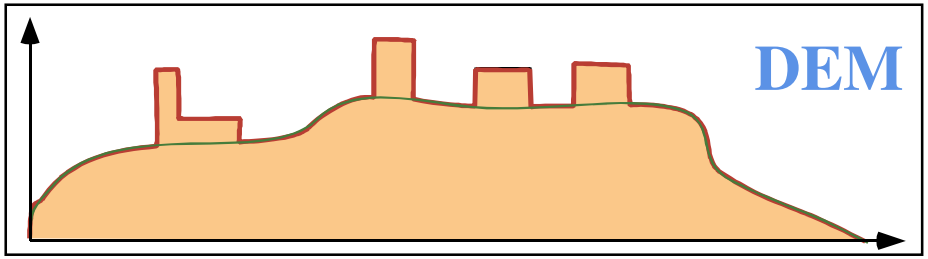
Topographical Data ⇔ Elevation Data

... for Calculations and Analysis

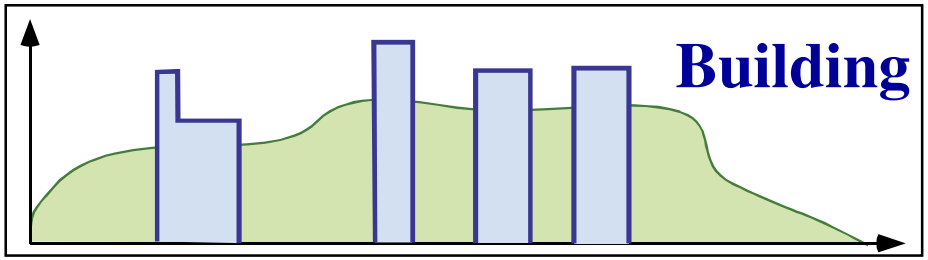
- **DTM – Digital Terrain Model**
  - Elevation of earth surface



- **DEM – Digital Elevation Model**
  - Elevation of earth surface + building height



- **Building**
  - Elevation of earth surface + building height
  - Only at building areas



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Geo Information System

Radio Network Planning Tools - Basics

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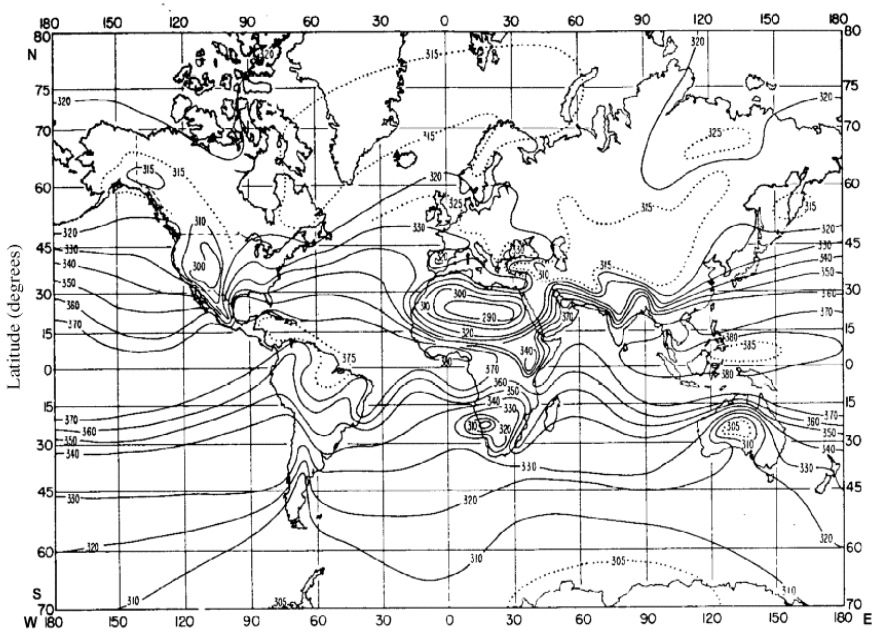
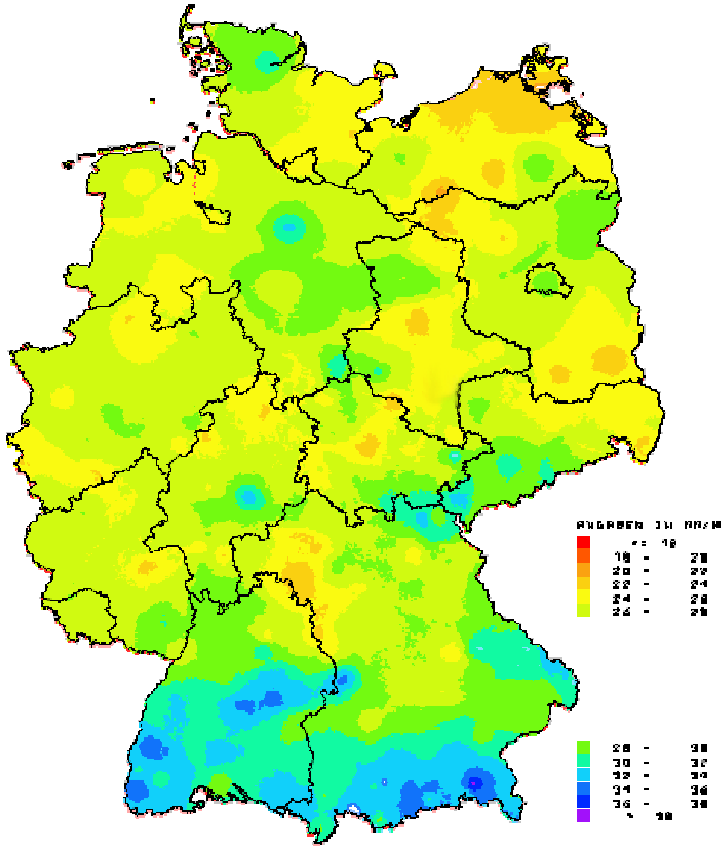
... for special Calculations and Analysis

- Radio Climatic Zones
- Rain Rates
- Sea Level Surface Refractivity N0
- Electrical ground Conductivity
- Population Density

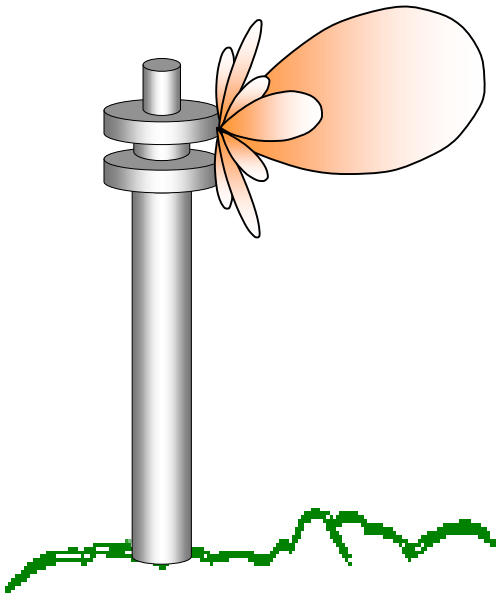


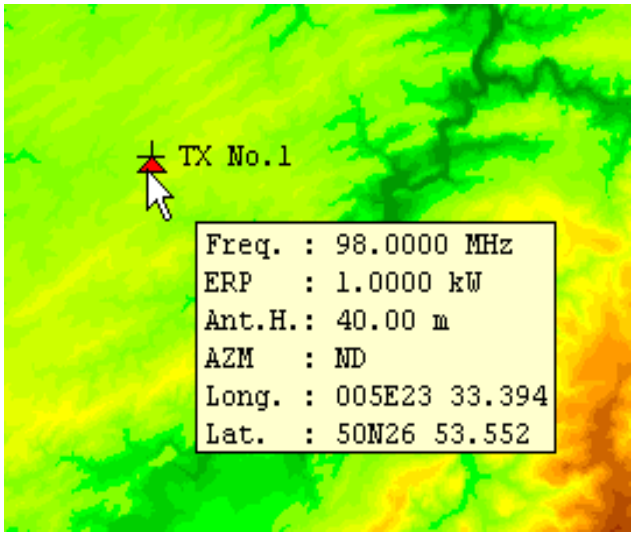


Radio Network Planning Tools - Basics

What is the Minimum Set of Data you need to perform a Basic Coverage Prediction?

- Coordinates of the Transmitter
- Radiated Power
- Frequency
- Antenna Pattern





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Radio Network Planning Tools - Basics

What other kind of Data have to be managed and Why?

- **Data describing the Transmitter/Receiver**
  - antenna
  - all technical parameters (power range, frequency range, sensitivity...)
- **Data describing the Network**
  - sites
  - cells, sectors, links
  - neighbouring relations
  - frequency plans, frequency rasters
- **Data describing Interfering Networks**
  - same service other operators
  - other services
  - in other countries
- **Data for Tool Administration**
  - user / role
  - password
  - system layout
- **Result Data Base**
  - coverage maps
  - interference relations
  - network analysis results
- **Libaries**
  - antennas
  - transmitters
  - receivers
  - frequency rasters/plans

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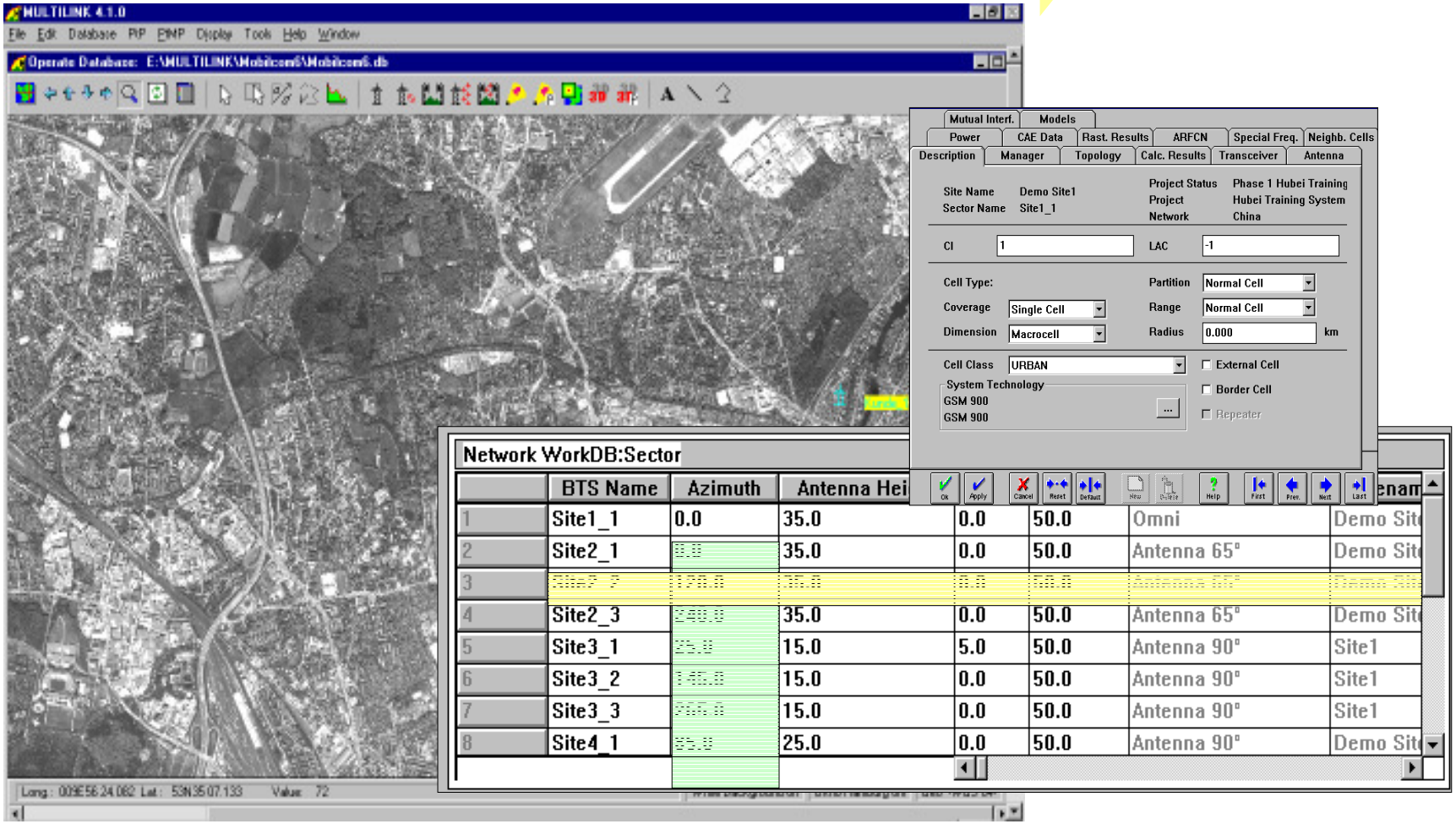
Graphical User Interface

Radio Network Planning Tools - Basics

Working window, spreadsheet, editors

...see Live Tool Demo



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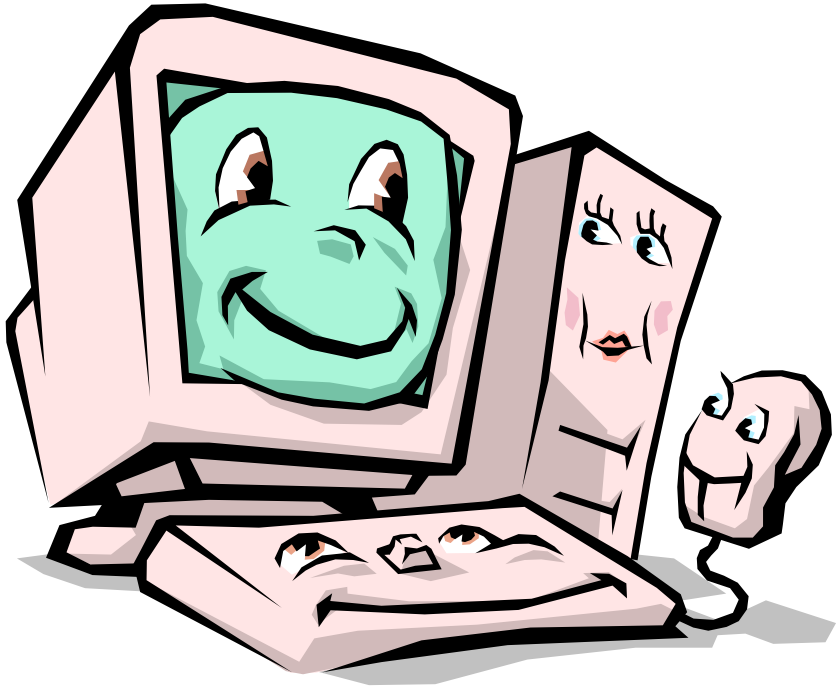
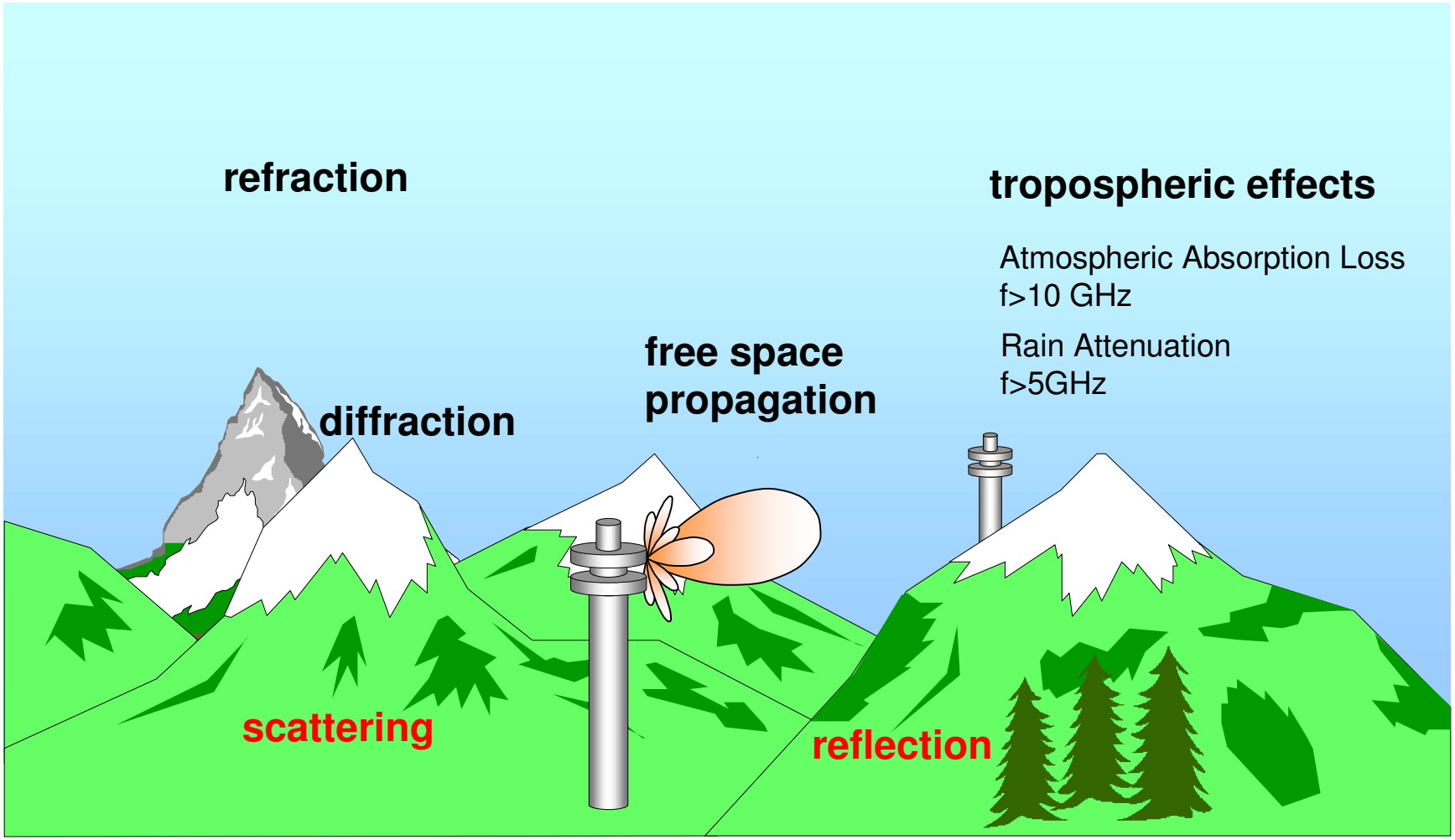
Live
Planning Tool Demonstration



Radio Network Planning Tools - Basics



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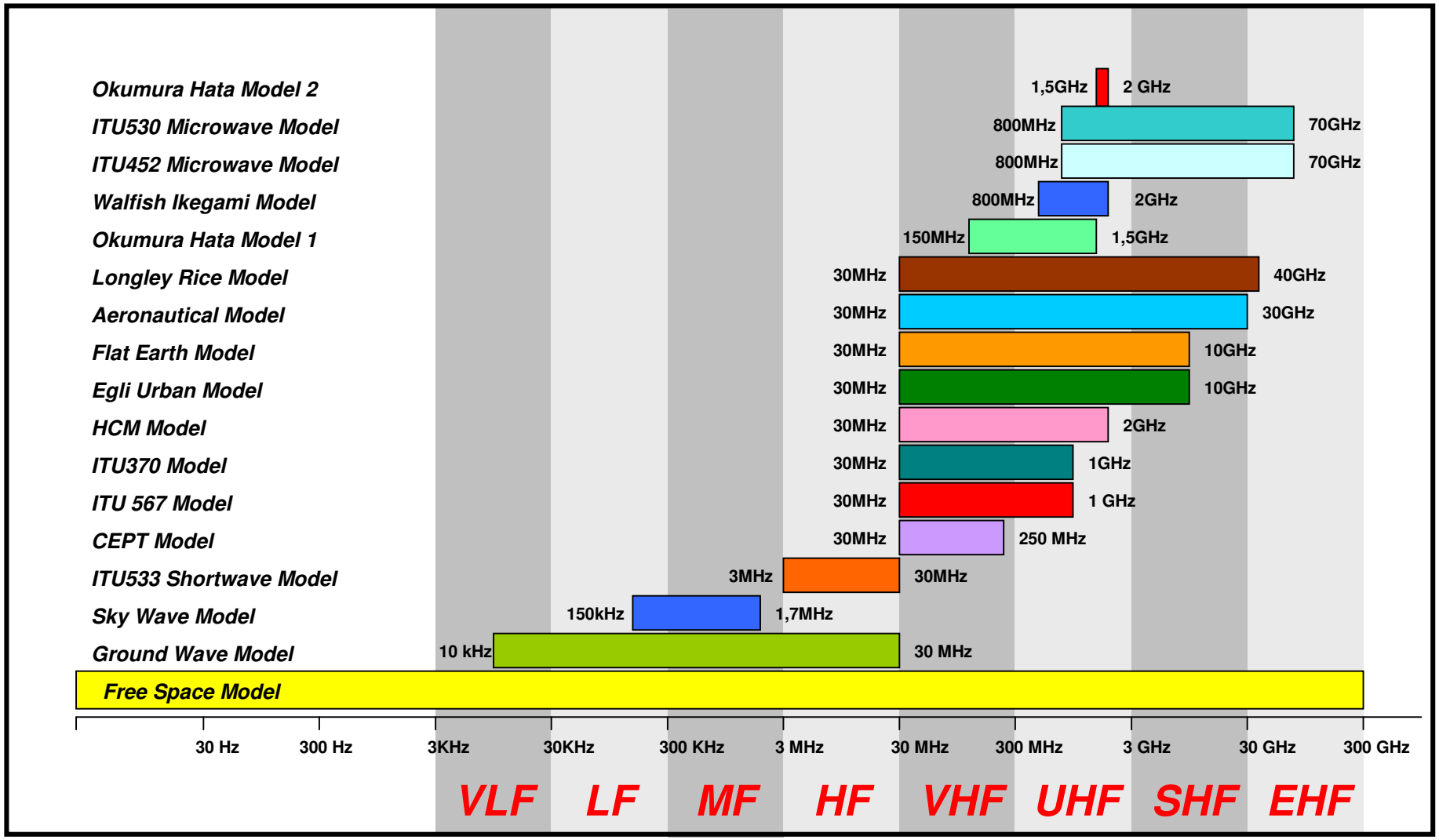
Radio Network Planning Tools - Basics



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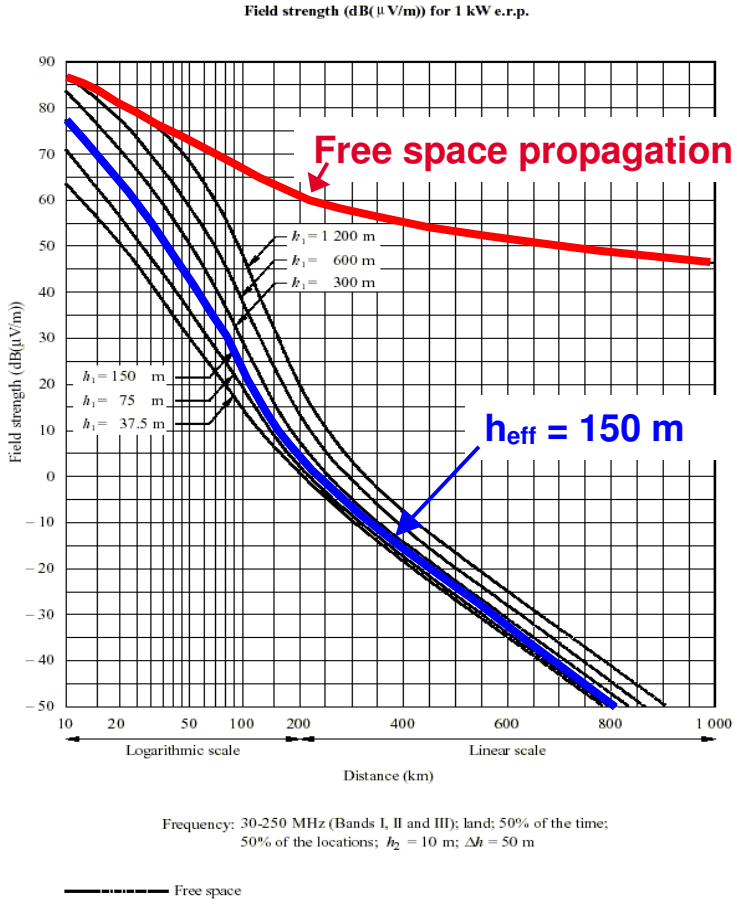
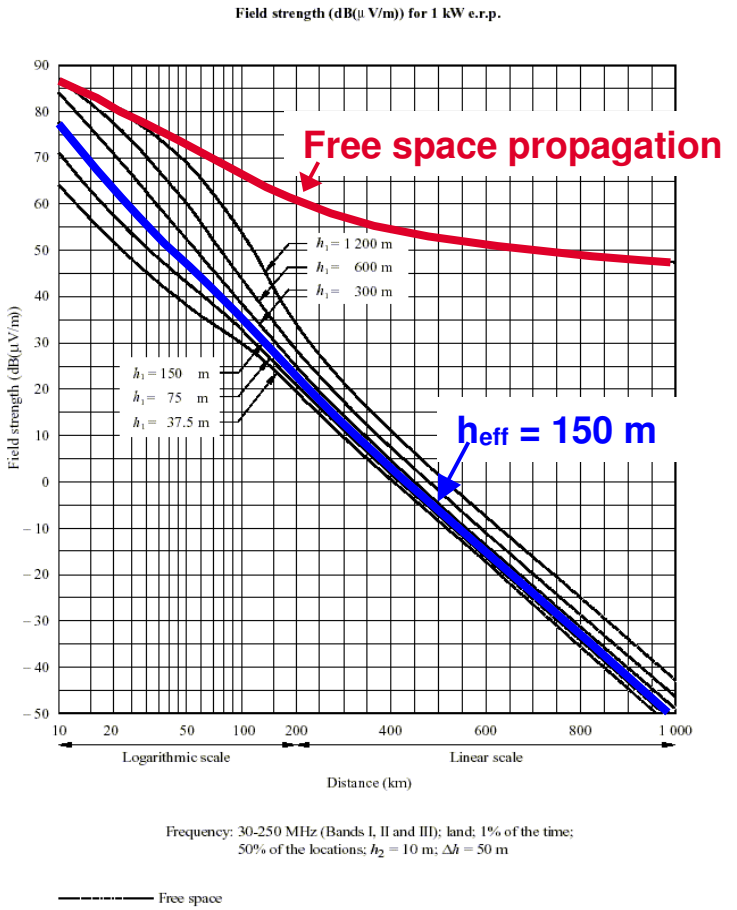
Radio Network Planning Tools - Basics

ITU-R 370 – Propagation Curves



propagation curve 50% time
(steady or continuous)



propagation curve 1% time
(tropospheric)

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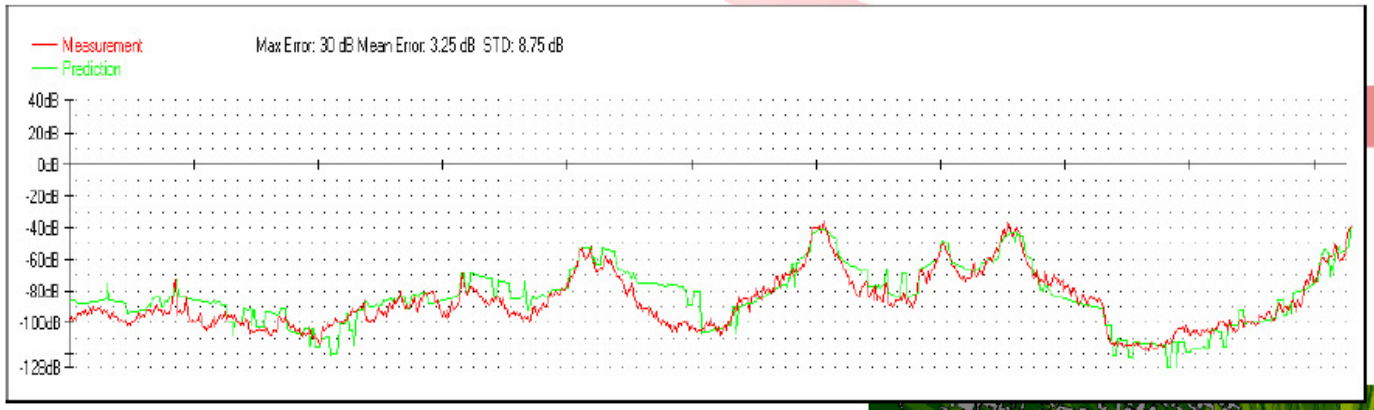
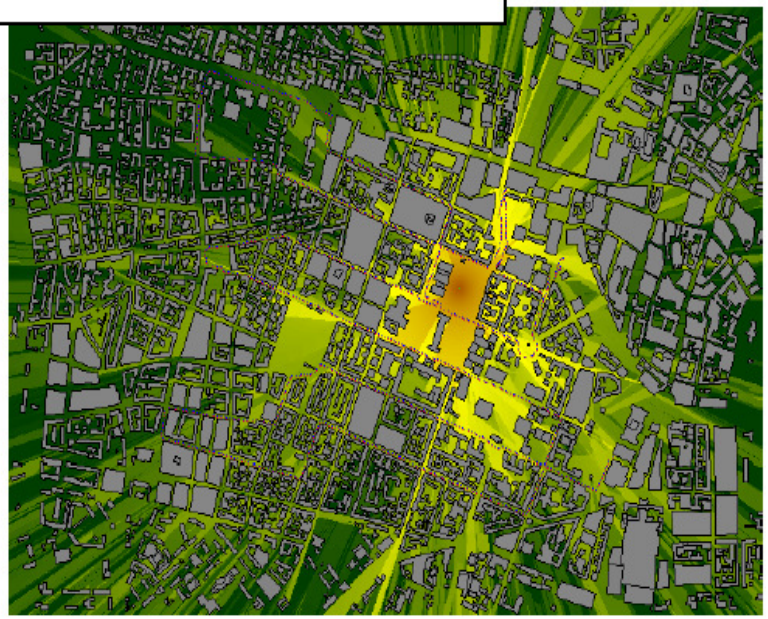
Radio Network Planning Tools - Basics

Ray-Optical Micro Cell Model



HIGH ACCURACY

Comparison of drive test and predictions done for the city area of Munich



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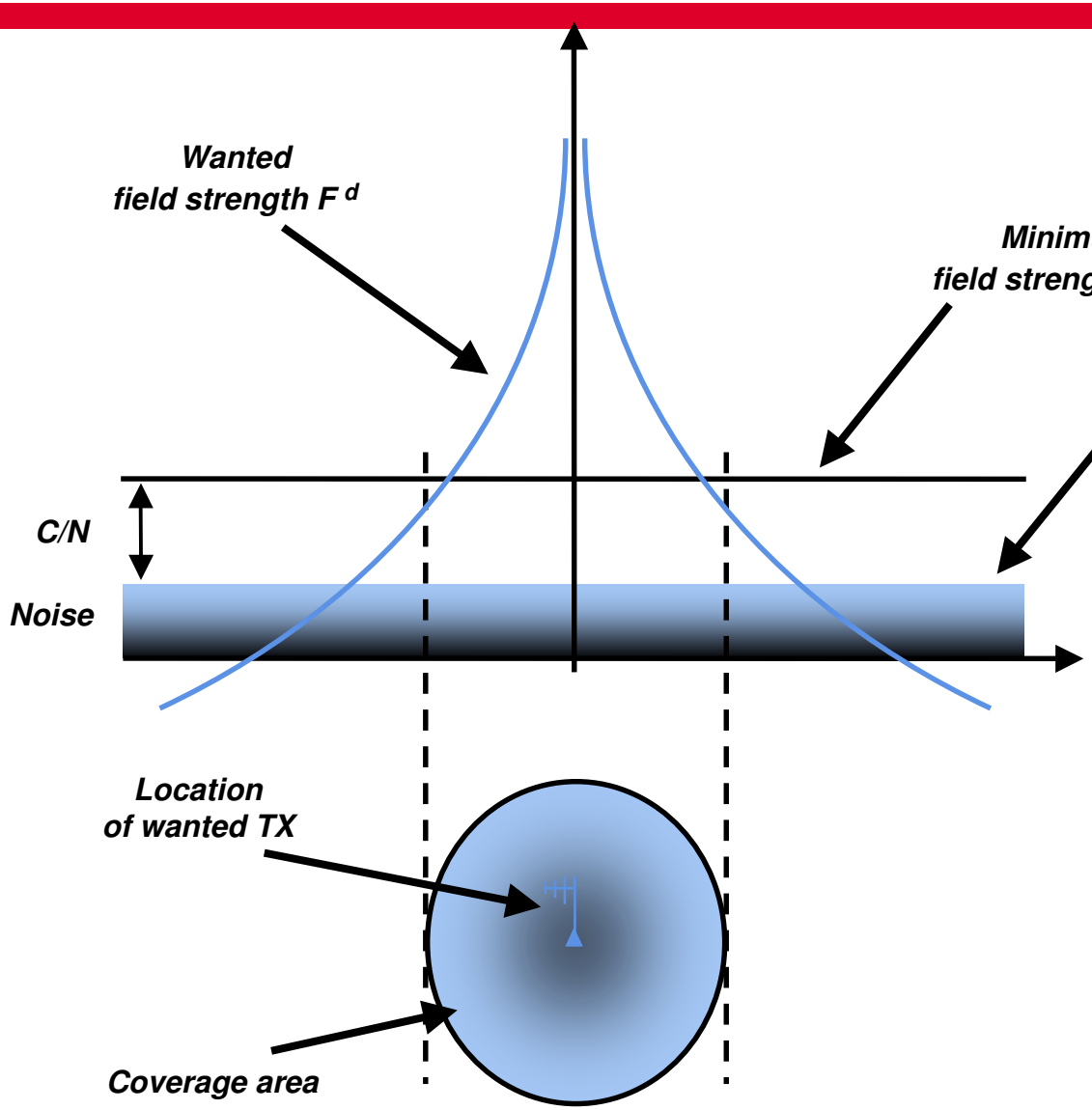
Interference by Noise



Minimum field strength (C/N):
It is a minimum field strength level which is necessary to fulfil the signal quality for coverage.

1. Criteria for coverage

Wanted Field Str. > Minimum Field Str.

$$F^d > \underbrace{F^N + C/N}_{F^{min}}$$

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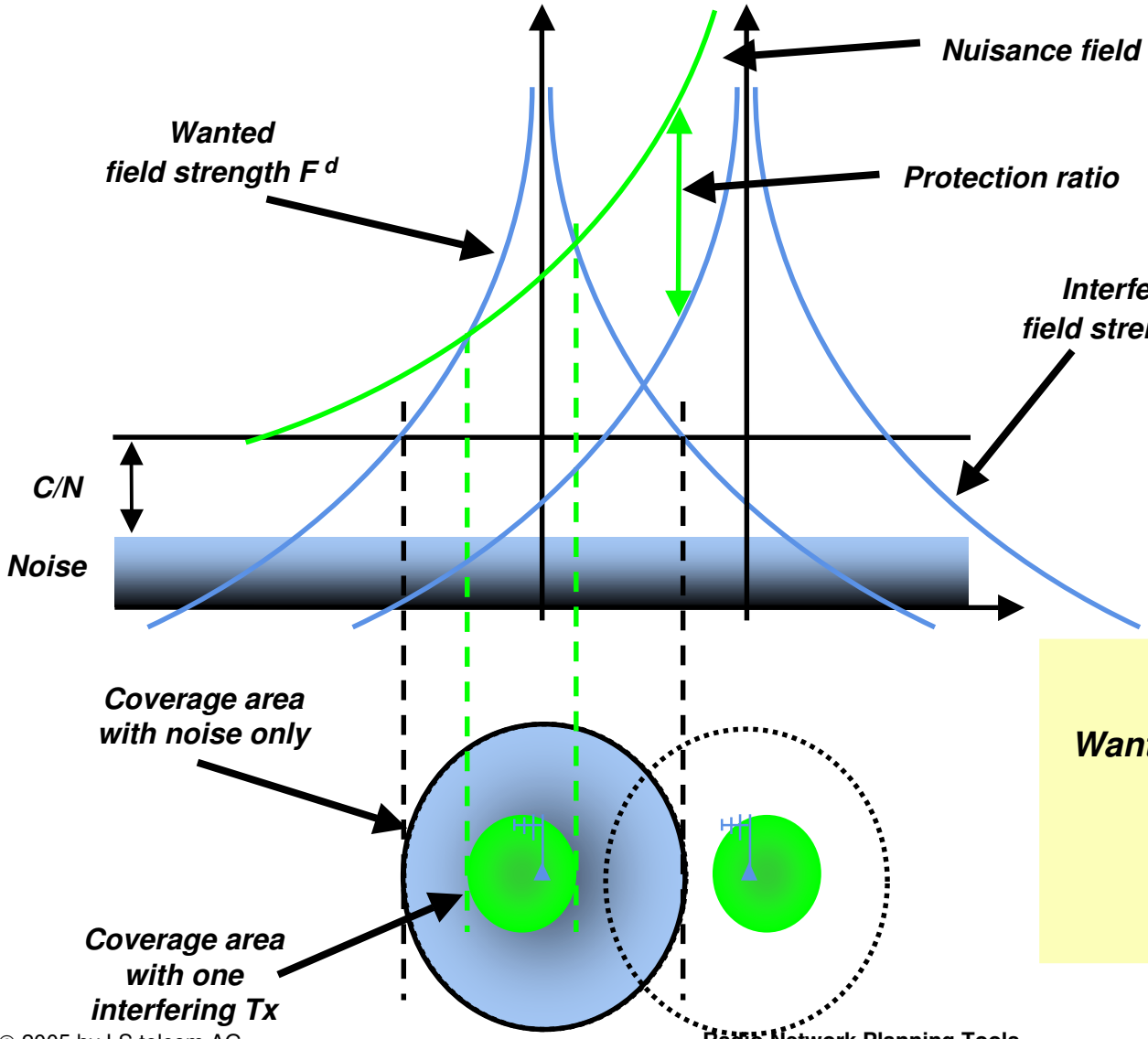
Interference by one Transmitter



Nuisance field:
Interference field strength at the reference point plus the protection ratio (C/I) required for the considered service.

2. Criteria for coverage

Wanted Field Str. > Nuisance Field Str.

$$F^d > \underbrace{F^i + A}_{F^n}$$

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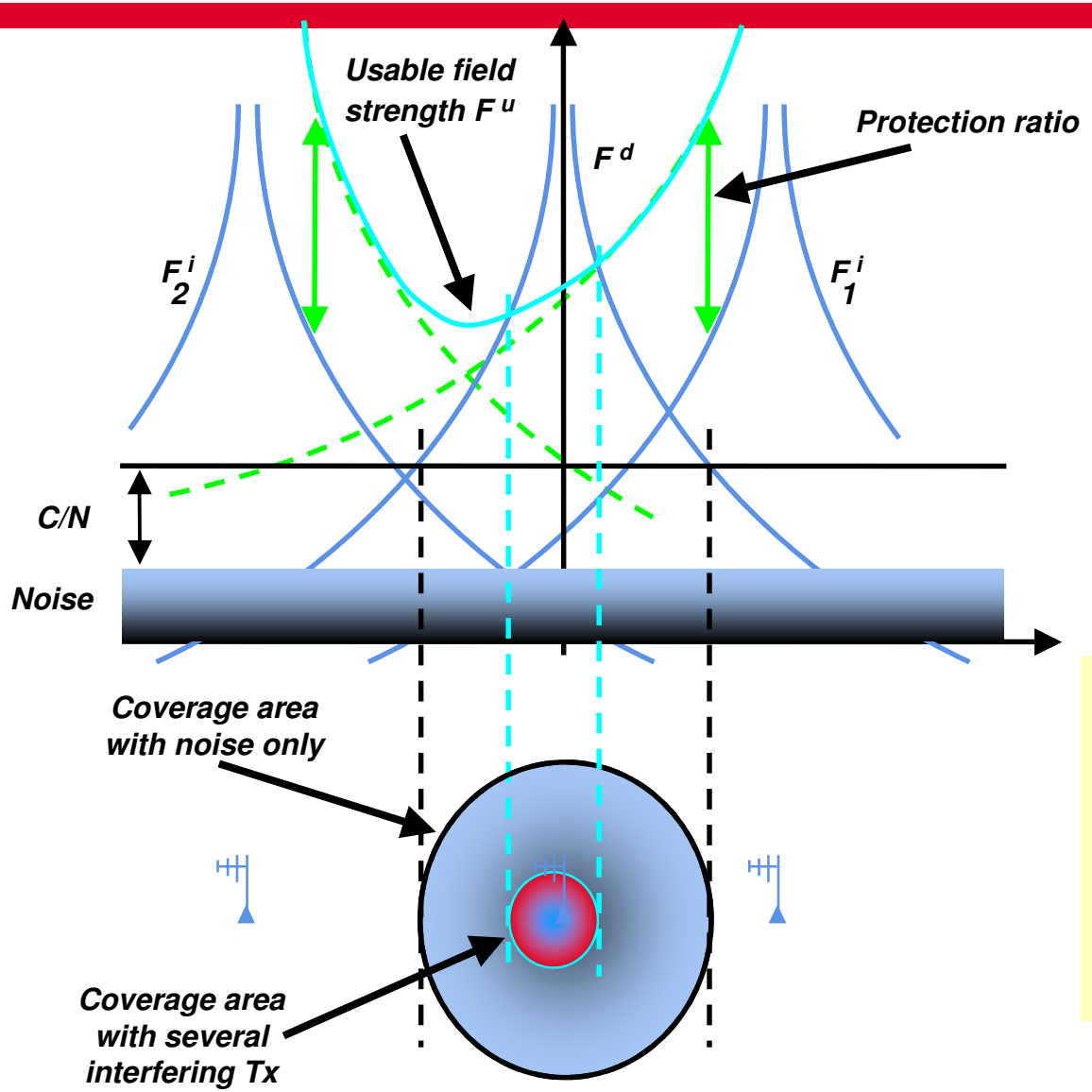
Interference by several Transmitter



Usable field:
Summation of the nusiance fields of the interfering tansmitters according to a certain summations algorithm (maximum, simplified multiplication, ...)
It is the fieldstrength value which is *usable* by a possible new site just to fulfill the condition of coverage (C/I>0) by the existing interferer situation.

3. Criteria for coverage

Wanted Field Str. > Usable Field Str.

$$F^d > \underbrace{\sum_{j=1}^{M} F_j^n}_{F^u}$$

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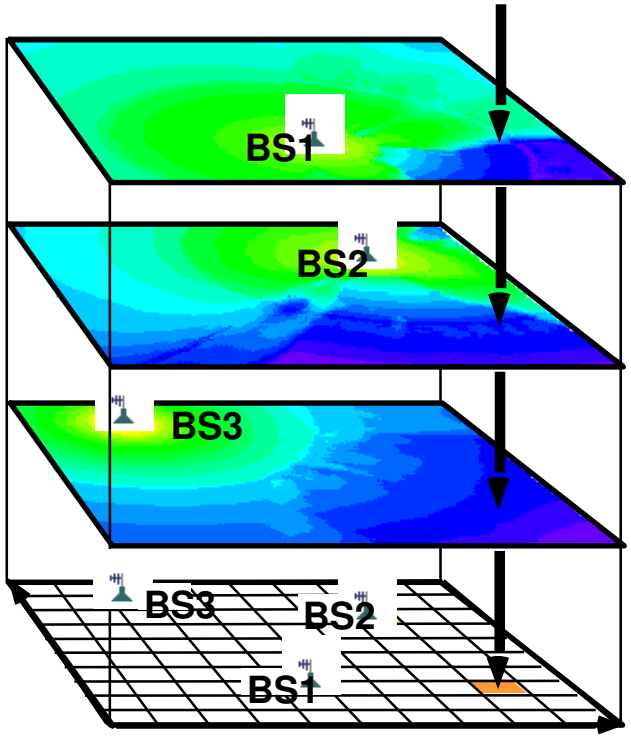
Radio Network Planning Tools - Basics

The Network Processor

- produces network-wide results out of the single-cell-based results
- allows to analyse the radio network
- allows to simulate changes of the network parameter
- allows to simulate changes of the network design
- allows to optimise the radio network
- allows to plan the future roll-out phases
- produces statistics on the selected results



each Service needs an own service-specific Network Processor

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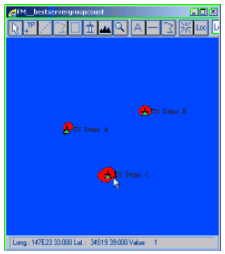
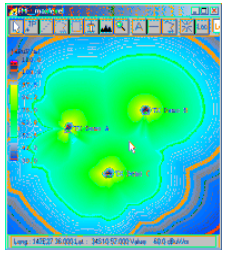
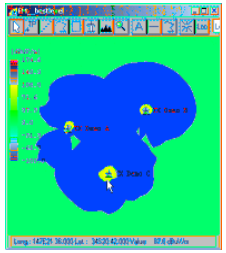
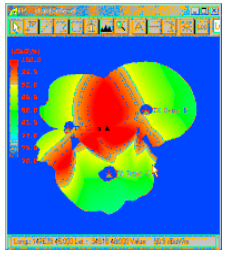
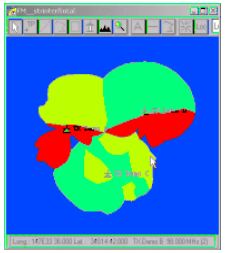
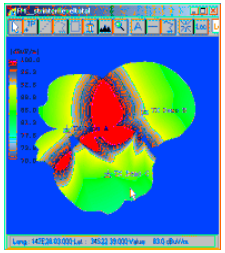
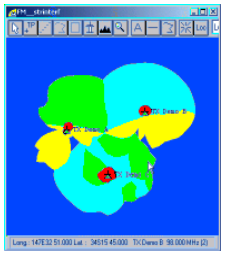
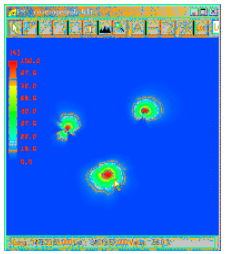
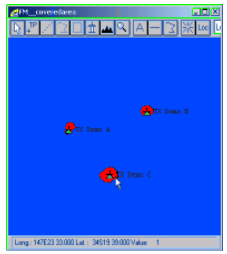
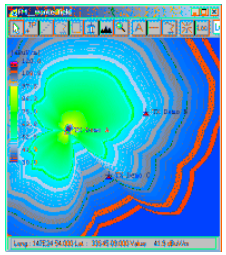
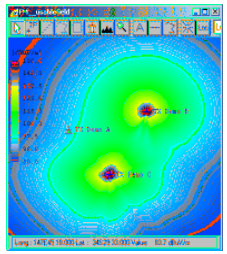
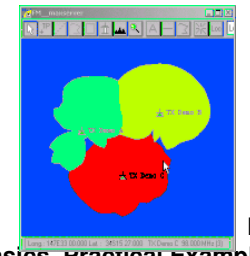
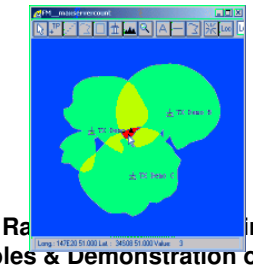
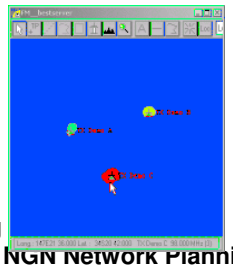
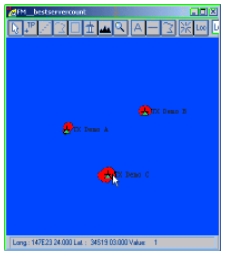
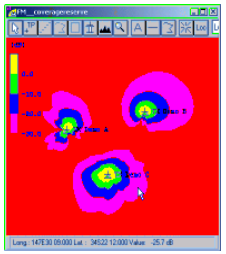
Radio Network Planning Tools - Basics

many other service-specific results can be processed by a powerful Network Processor, like:

- Number of Max Sever
- Number Best Server
- Strongest Interferer
- Level of Strongest Interferer
- Coverage Probability
- Coverage Reserve
- Power Difference
- Assignment Probability
- Handover Zone
- Requeired Channels
- Coding Sheme Area (GPRS)
- SFN Level Gain
- ...

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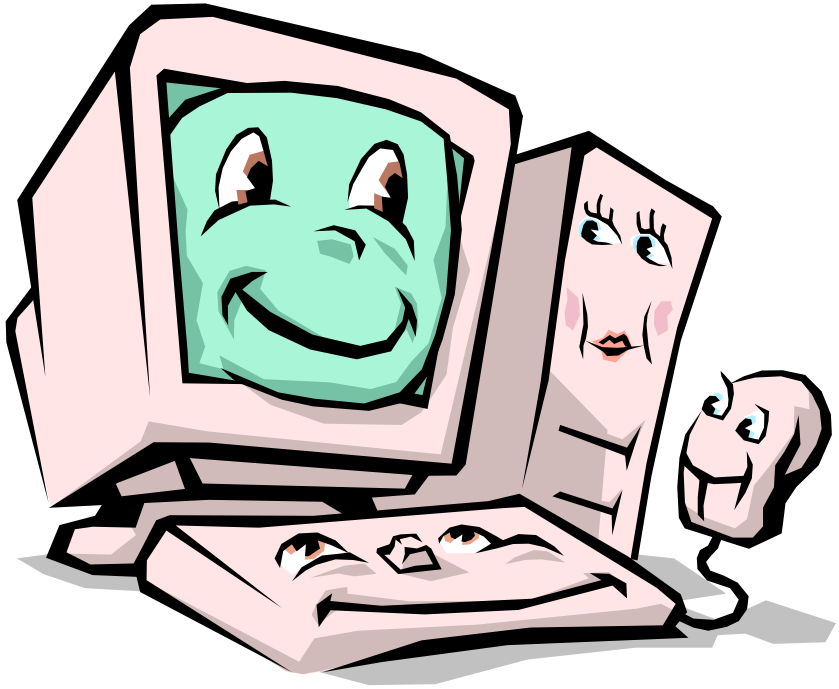
Live
Planning Tool Demonstration



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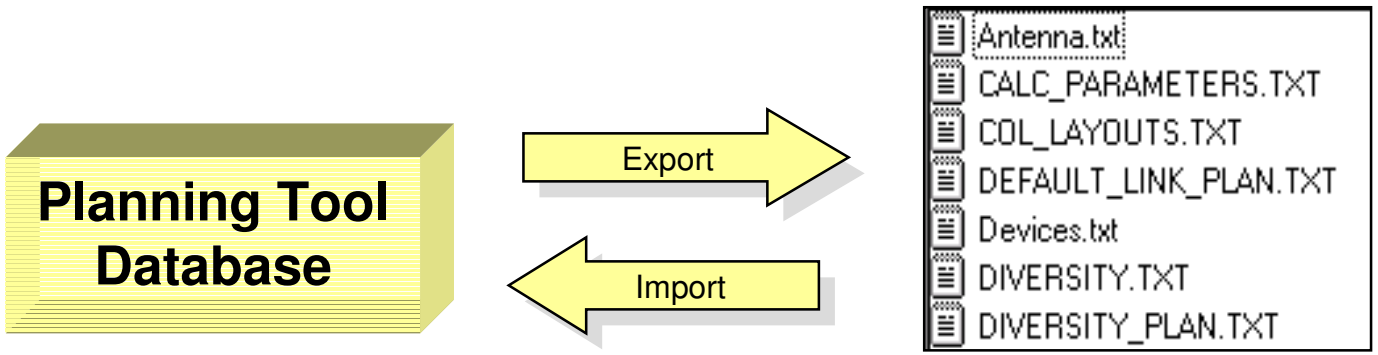
Radio Network Planning Tools - Basics

Import and Export of

Databases and Tables (Sites, Antennas,…)
Result Files
Measurement Data

in several formats (.txt, .xls, ASCII, .jpg, …)



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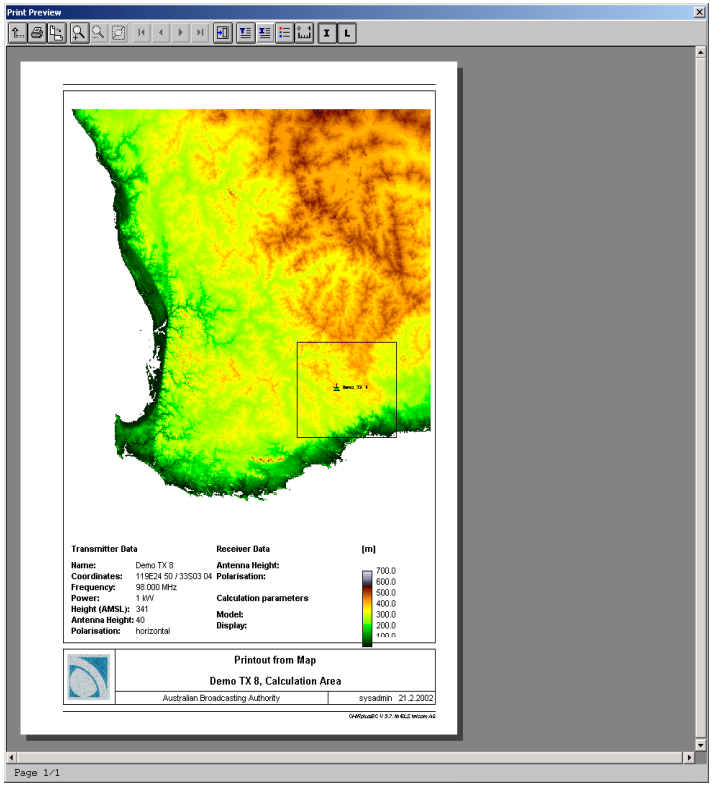
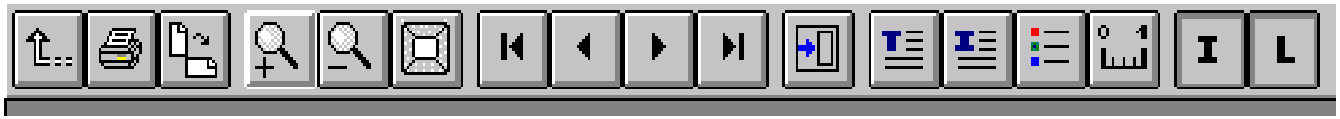
Radio Network Planning Tools - Basics

Printing of Maps and Result Plots



Print Process Preview

- Application specific frame
- Legend
- Print in specific map scale
- Specify margins and borders
- Multiple printing
- Support various paper sizes
- Add site specific information



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Thank you for your attention !

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