Spectrocan

LS telcom

Session 5.8

Supporting Network Planning Tools II

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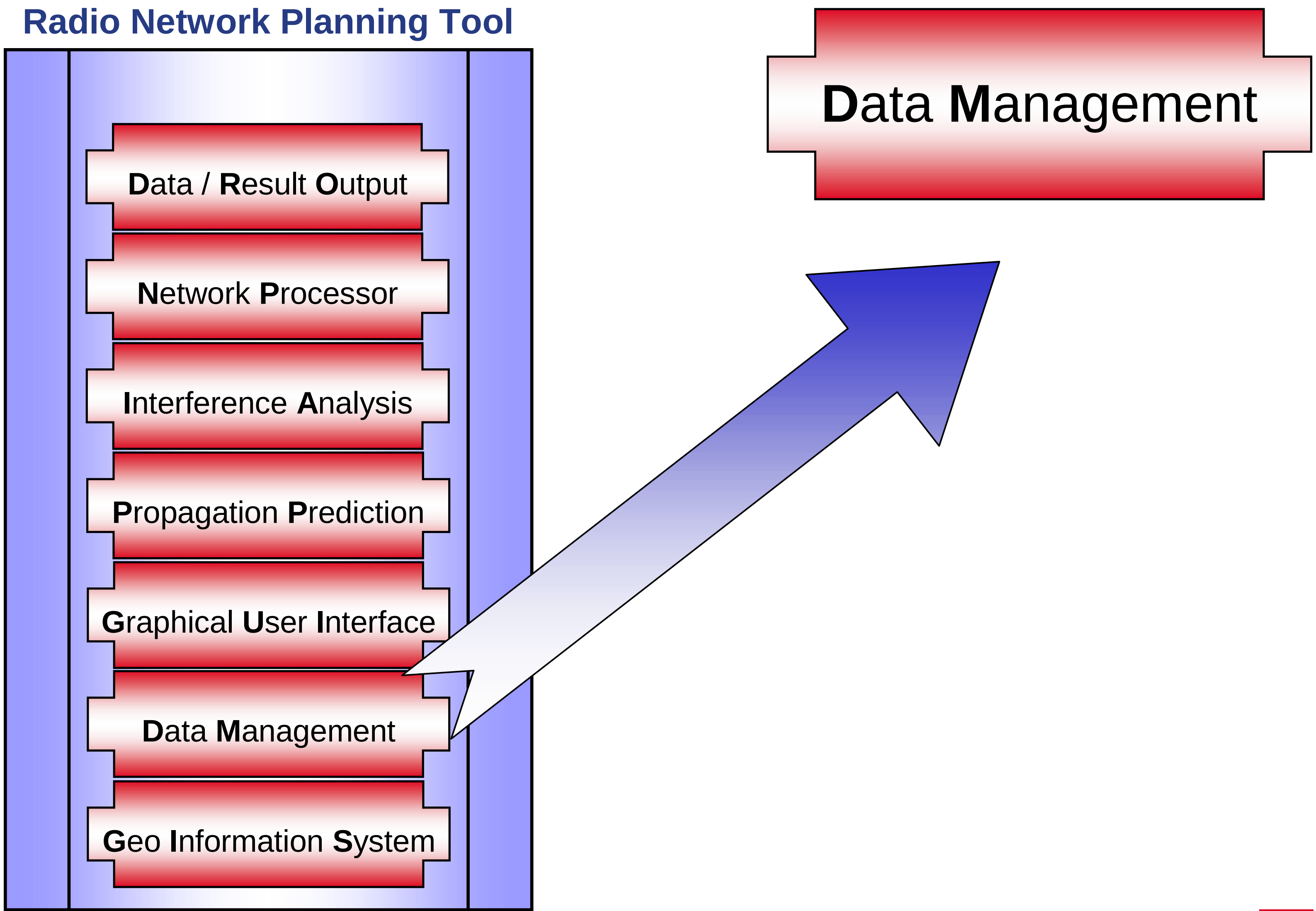
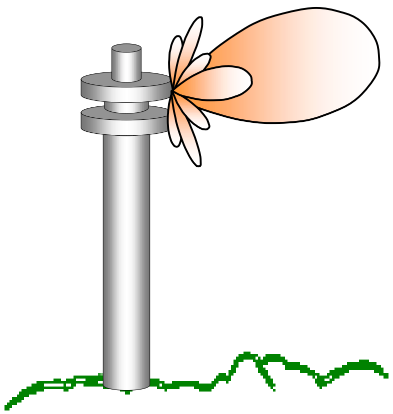
LS telcom AG / Spectrocan

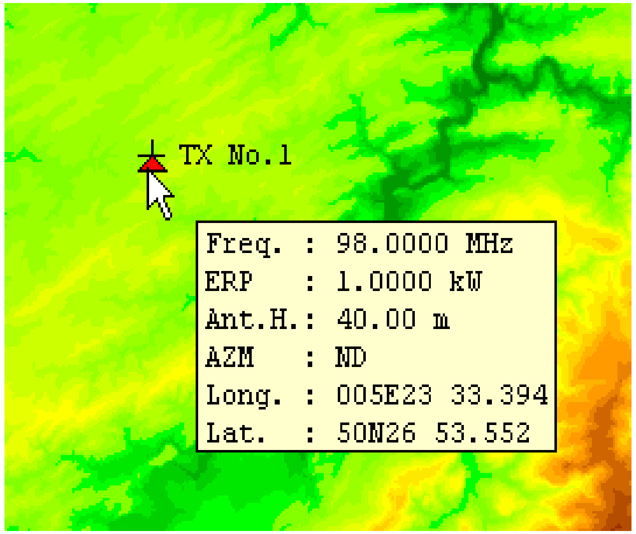

Radio Network Planning Tool
Data / Result Output
Network Processor
Interference Analysis
Propagation Prediction
Graphical User Interface
Data Management
Geo Information System
Data Management

Data Management

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

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





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

- **Data describing the Transmitter**
  - 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

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Data Management

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

- **for Tool Administration**
  - User / Role
  - Password
  - System Layout
- **Result Data Base**
  - Coverage Maps
  - Interference Relations
  - Network Analysis

  which have been performed in the past

- **Libaries**
  - Antenna Equipment
  - Transmitter Equipment
  - Receiver Equipment
  - ...

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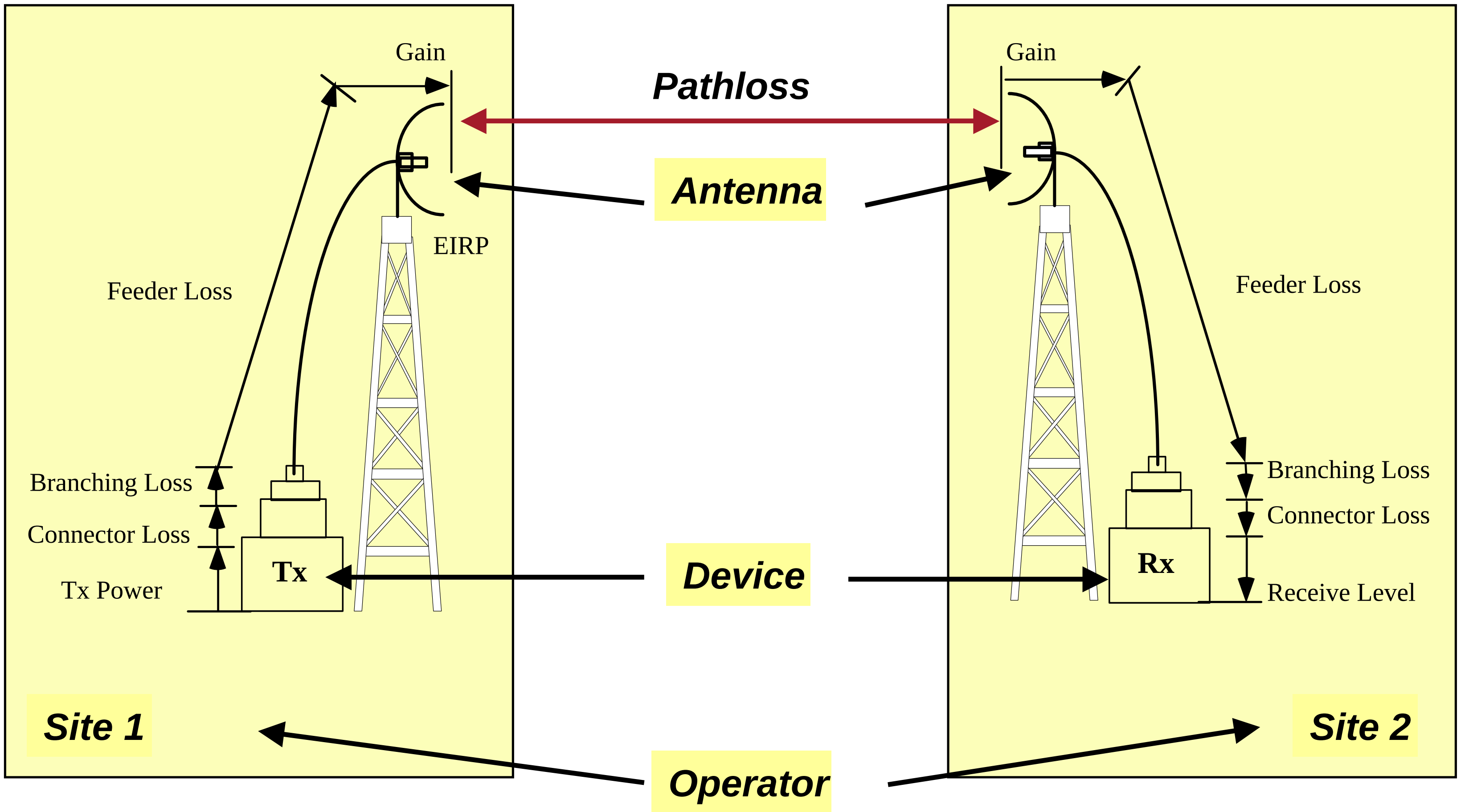
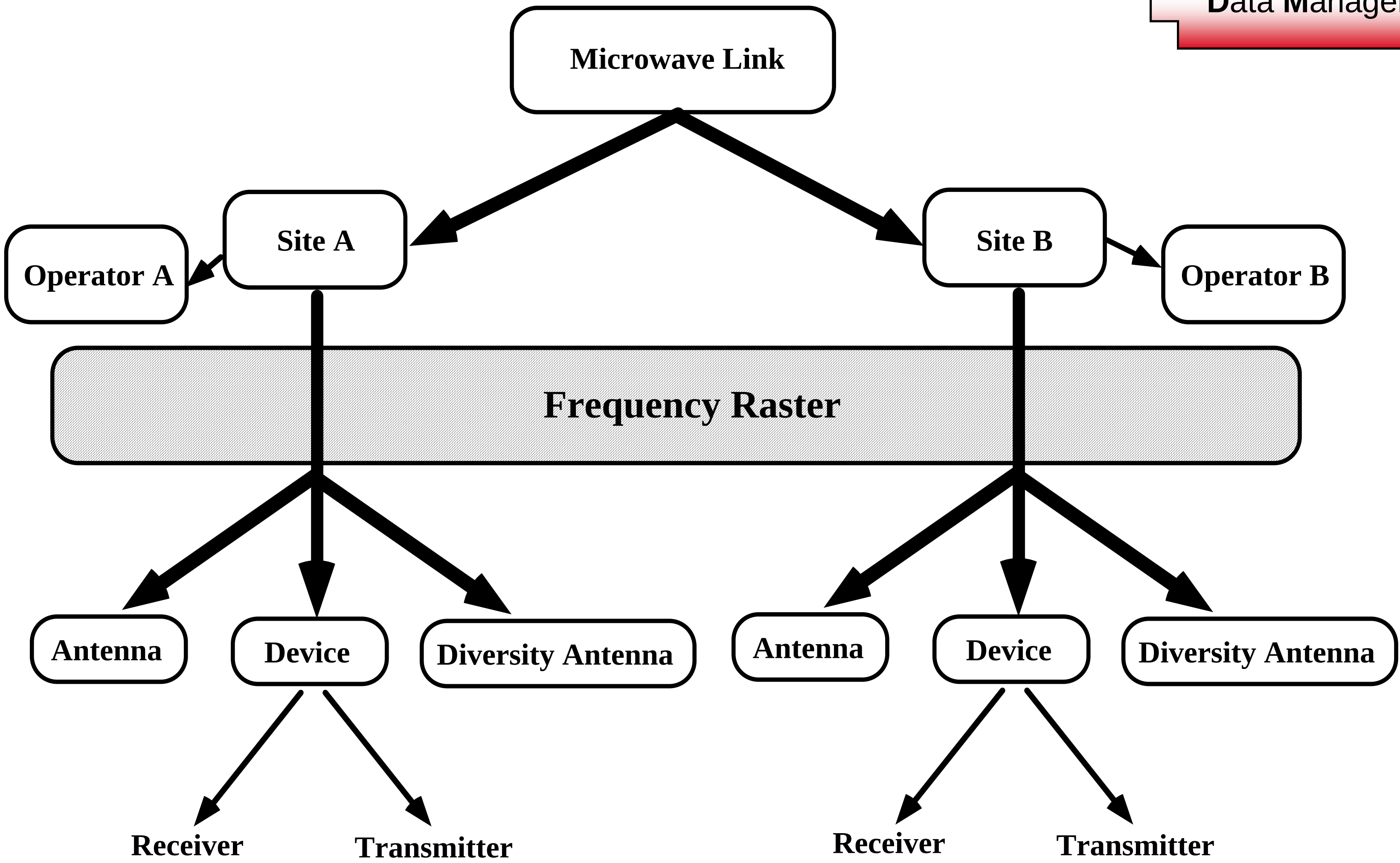
Example: Microwave Link



Example: Microwave Link

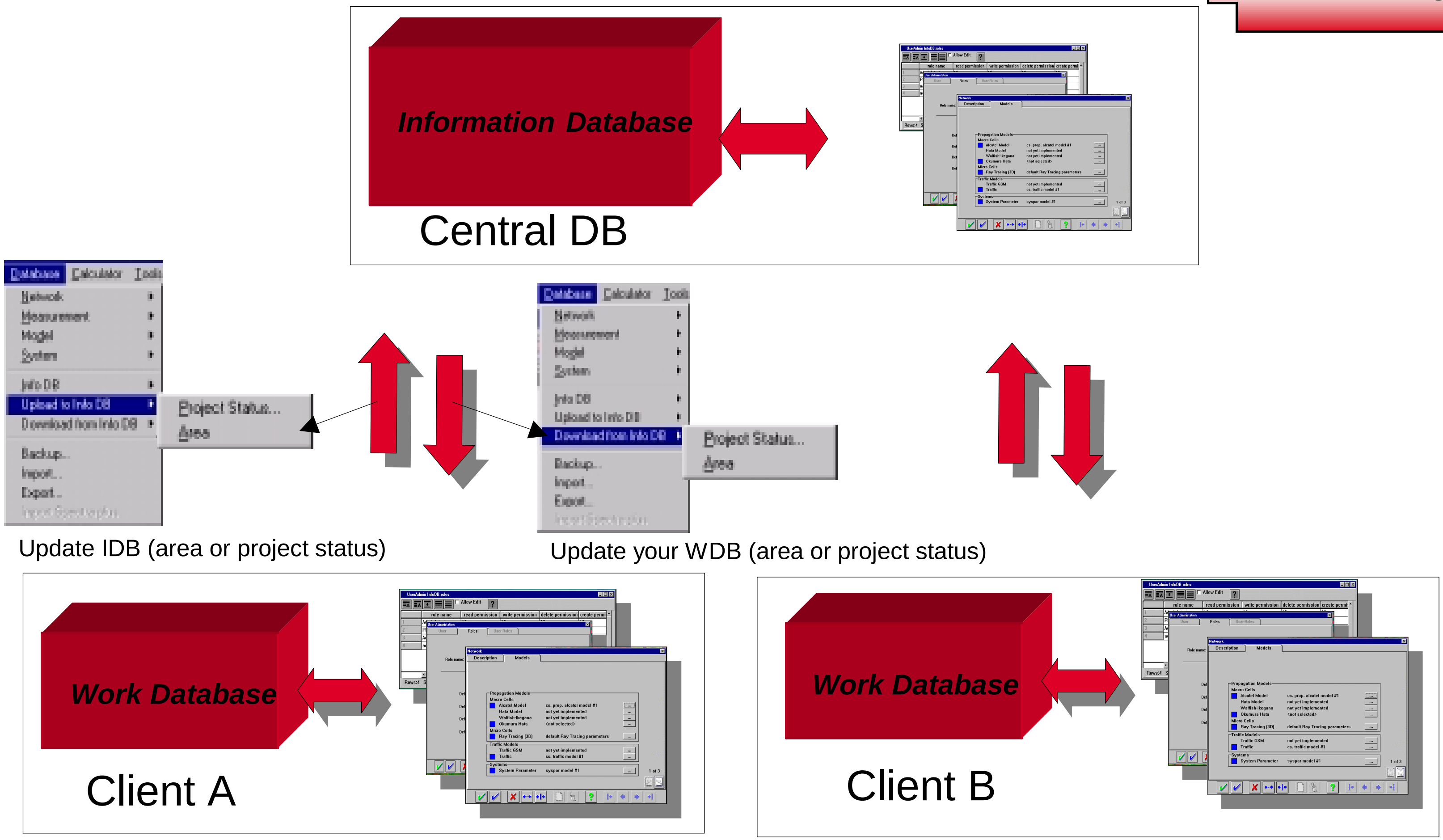
Data Management



Database Concepts

Data Management

Information Database



Working Database

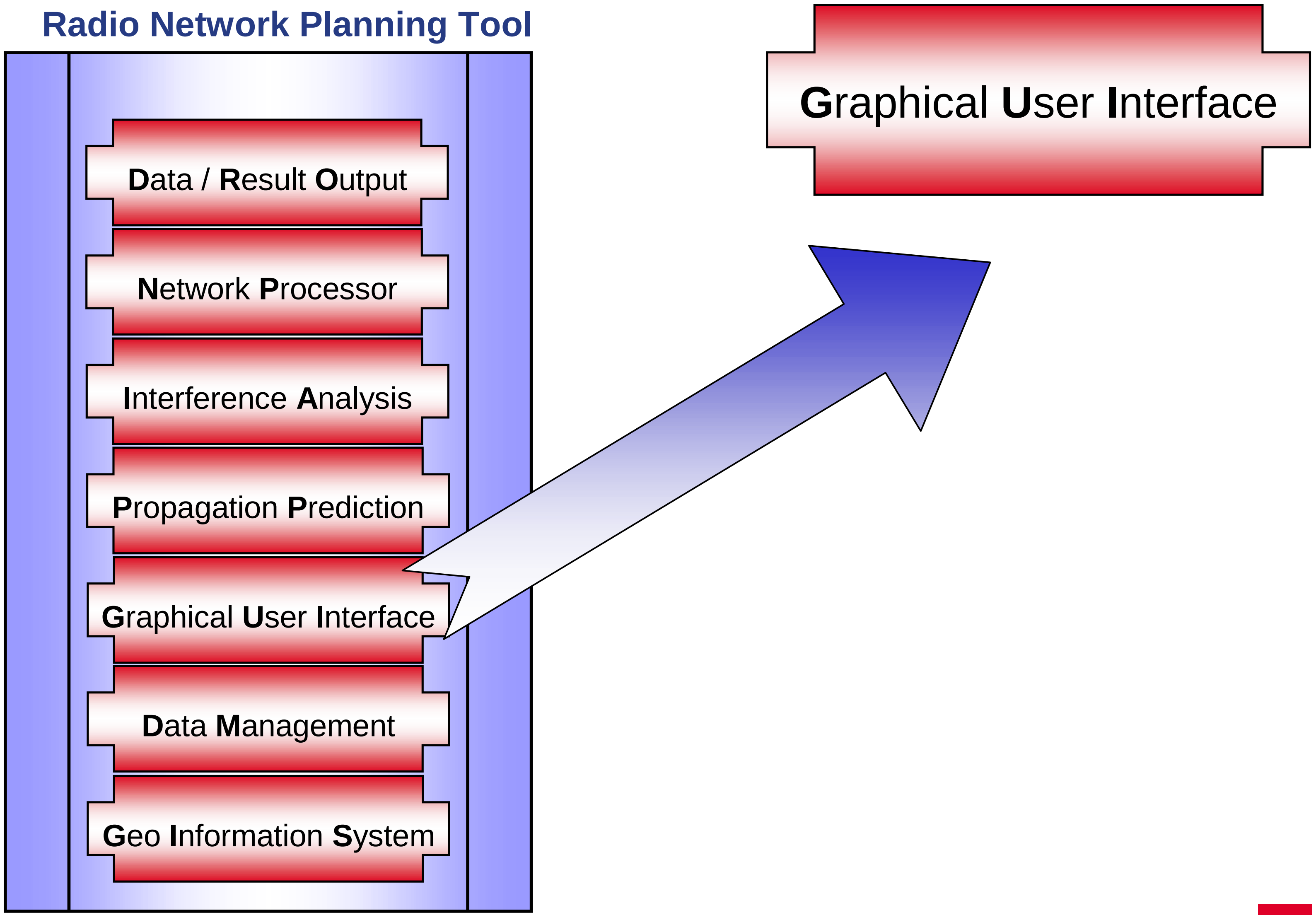
Data Management

Detailed Data Information

- are necessary to perform comprehensive network analysis / optimisations

An comprehensive Data Management

- allows keeping all network data in one central data base
- makes daily work easier (Libraries)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Graphical User Interface

Spreadsheets offer a view on database tables.

All records of the related database table (e.g all sectors) can be edited:

Network WorkDB:Sector

	BTS Name	Azimuth	Antenna Height	Downtil	EIRP dBm	Antenna Name	Sitenam
1	Site1_1	0.0	35.0	0.0	50.0	Omni	Demo Sit
2	Site2_1	0.0	35.0	0.0	50.0	Antenna 65°	Demo Sit
3	Site2_2	120.0	35.0	0.0	50.0	Antenna 65°	Demo Sit
4	Site2_3	240.0	35.0	0.0	50.0	Antenna 65°	Demo Sit
5	Site3_1	25.0	15.0	5.0	50.0	Antenna 90°	Site1
6	Site3_2	145.0	15.0	0.0	50.0	Antenna 90°	Site1
7	Site3_3	265.0	15.0	0.0	50.0	Antenna 90°	Site1
8	Site4_1	85.0	25.0	0.0	50.0	Antenna 90°	Demo Sit

Each row contains information for one object e.g Antenna type, antenna height, azimuth etc. for a specific sector

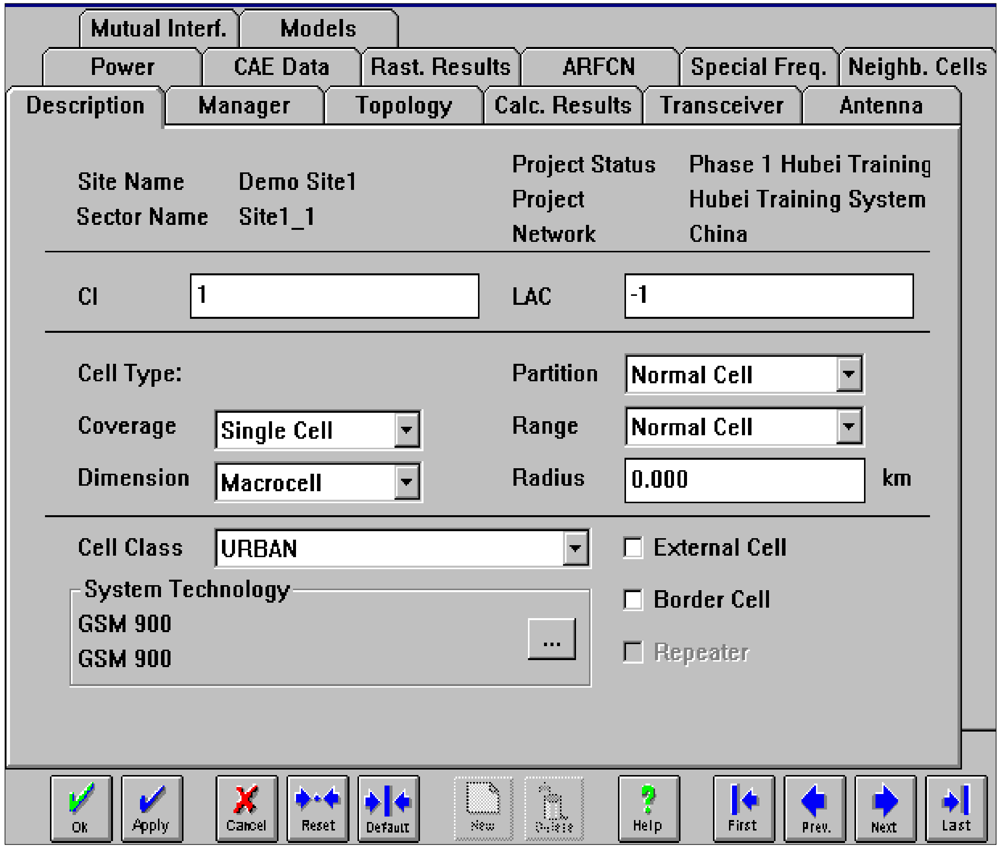
Each column stands for one specific database field e.g Antenna Height

The following options are available to work with spreadsheets

- Edit functions
- Query Functions
- Functions to change the layout of the spreadsheet
- Functions for graphical display of the spreadsheet data
- Import / Export Functions

Graphical User Interface

Editor views allow to edit all data related to a specific object



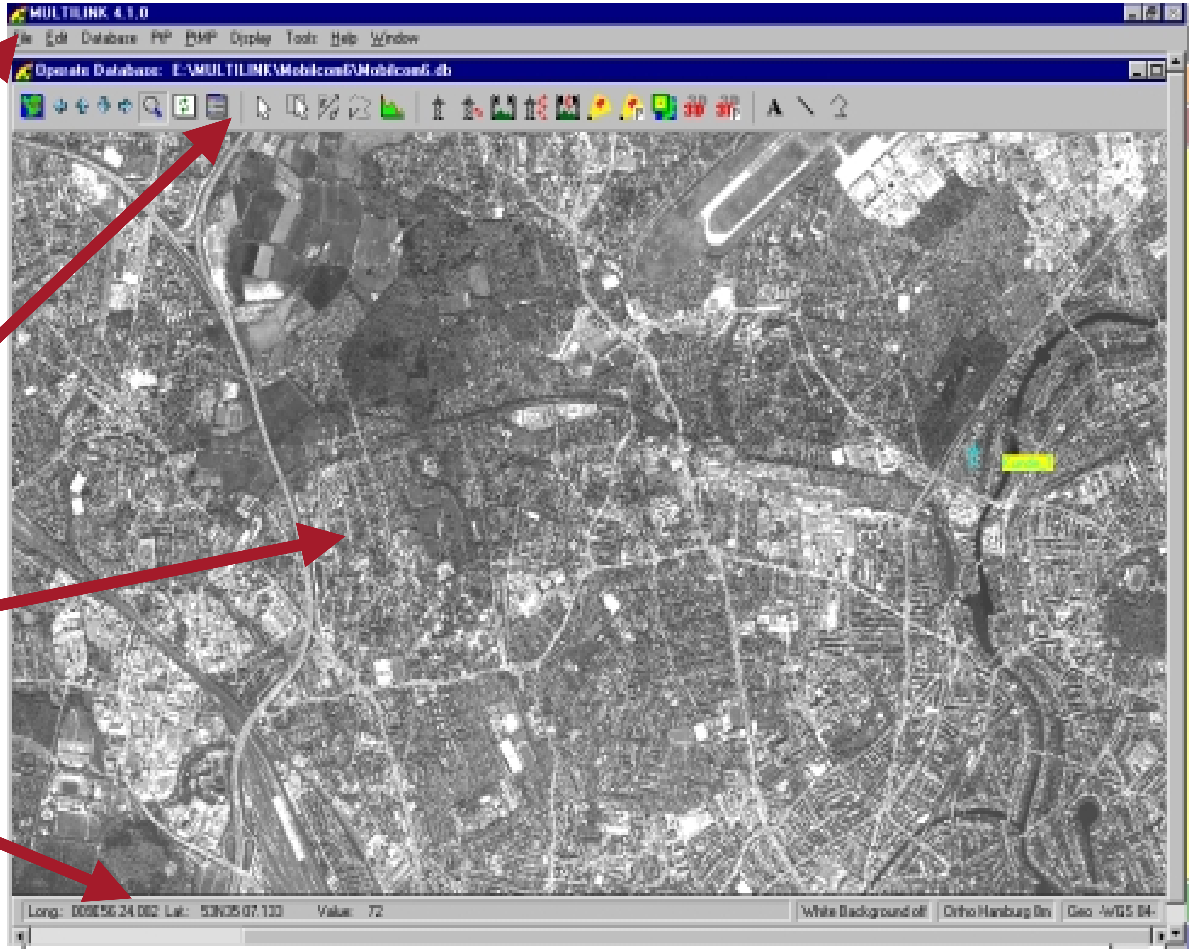
Graphical User Interface

Menu

Toolbar

Working map

Value display
(status bar)

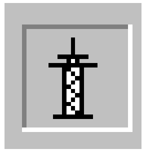


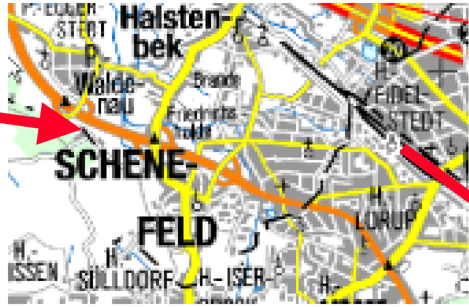
Task: Creating new Sites

Graphical User Interface

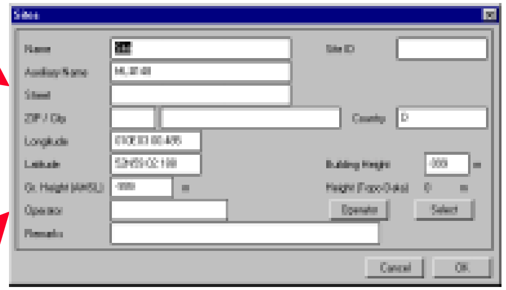
1. Graphically on a map:

- *Activate the site tool*
- *Click on a pixel on the map*

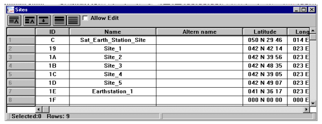


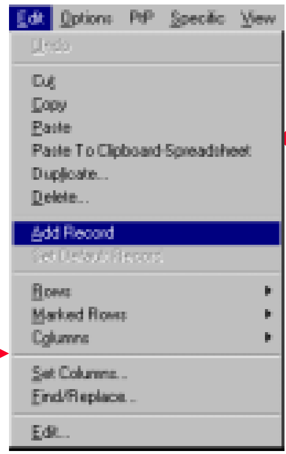


Co-ordinates from selected position on map



2. In the site table:





Enter co-ordinates manually

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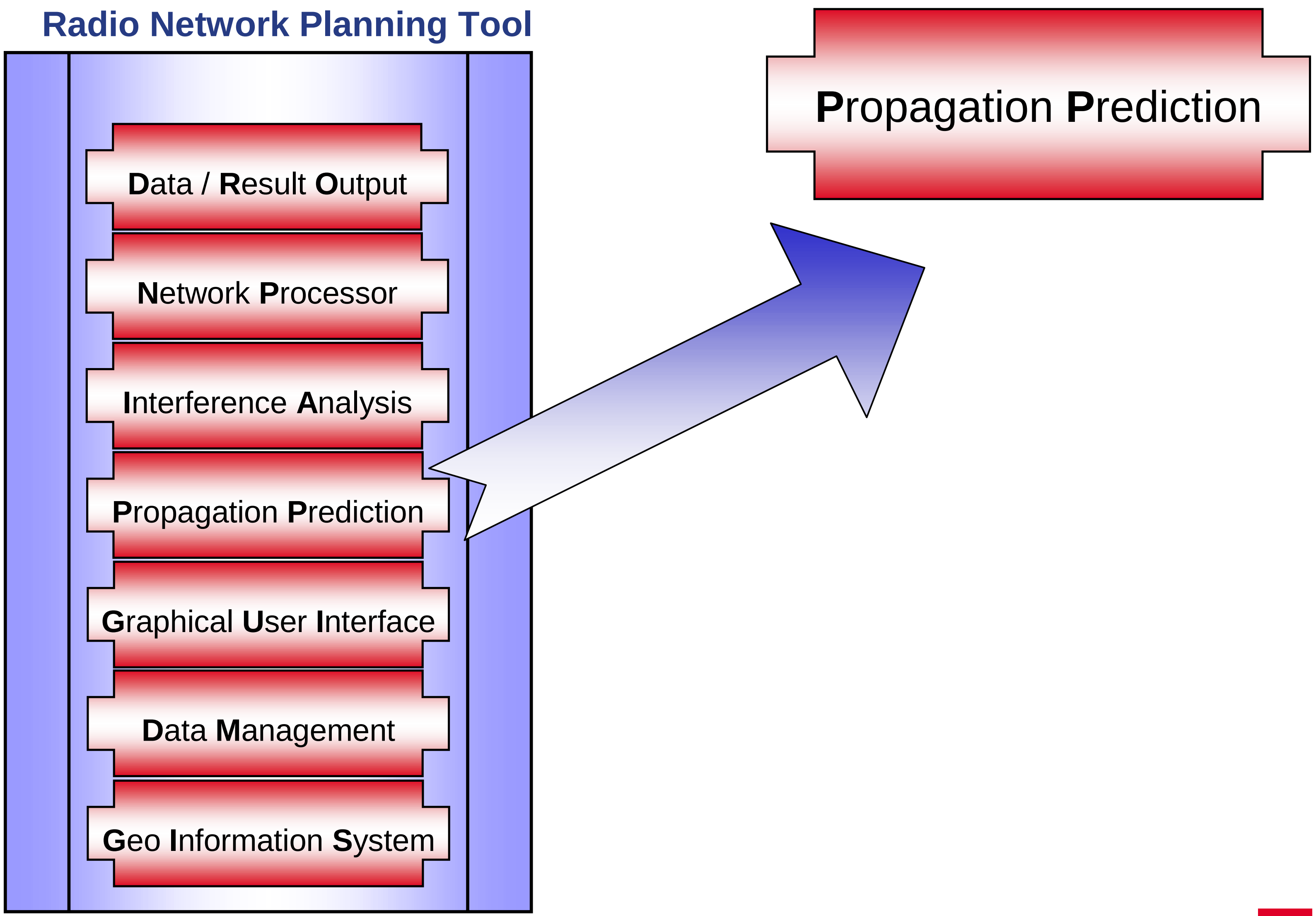
Live
Planning Tool Demonstration

„MULTIlink“
Design Tool for Engineering Microwave Links and PMP / WLL / LMDS Planning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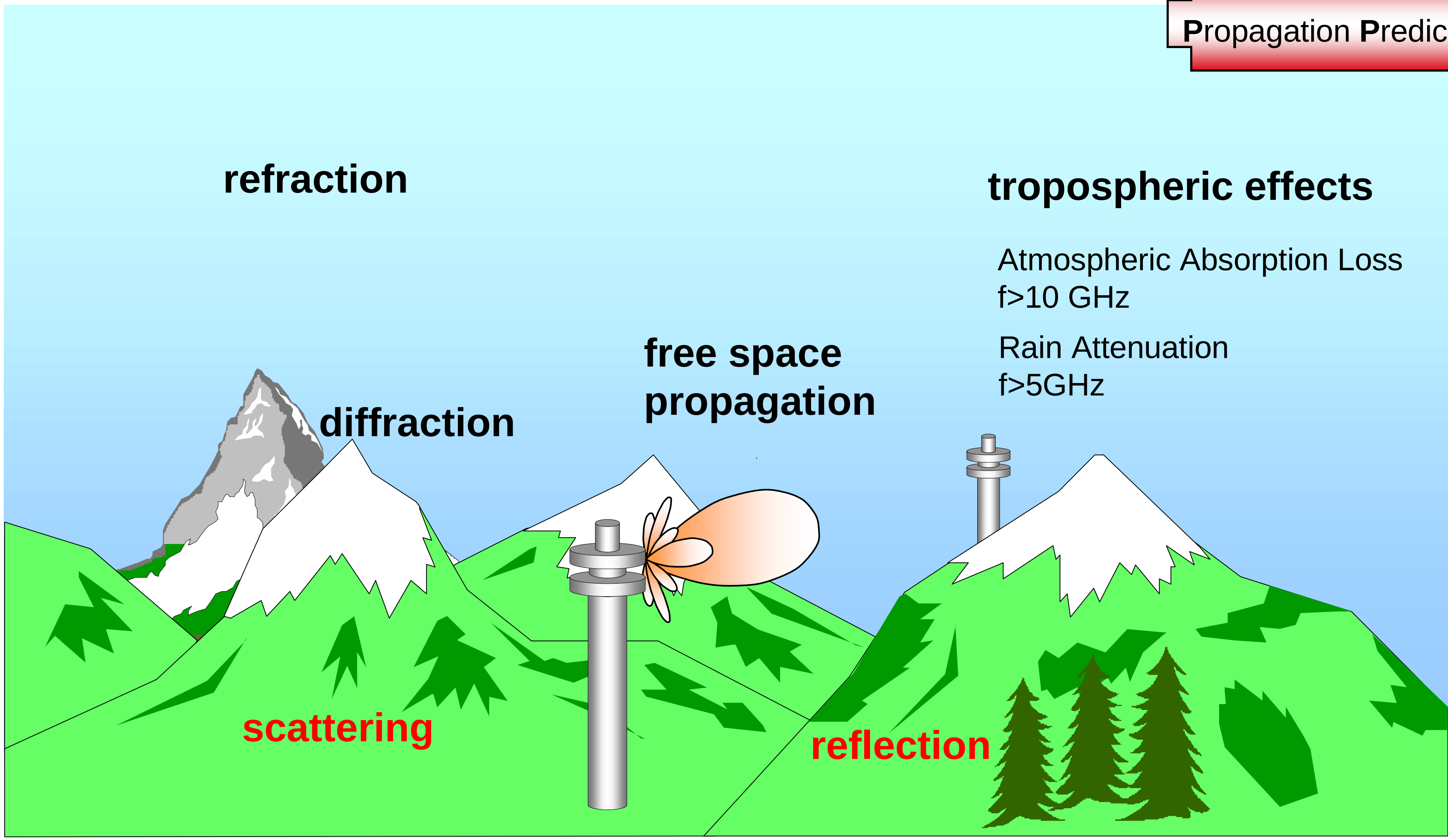
Wave Propagation Effects



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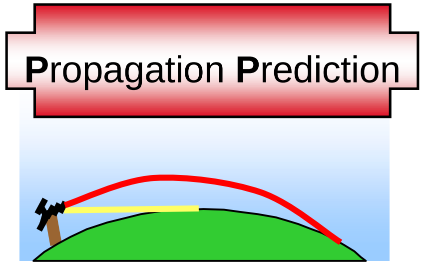
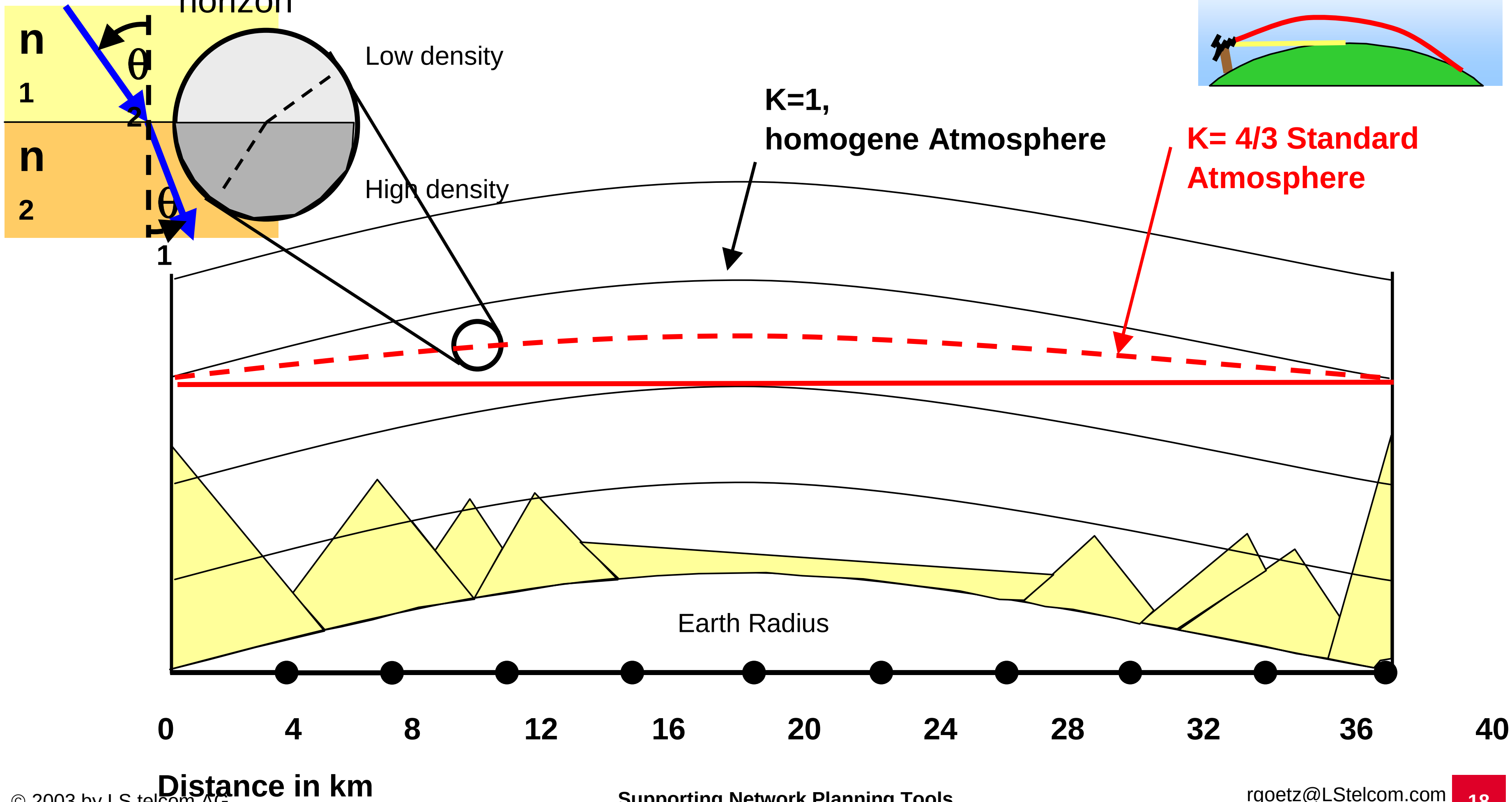
Refraction

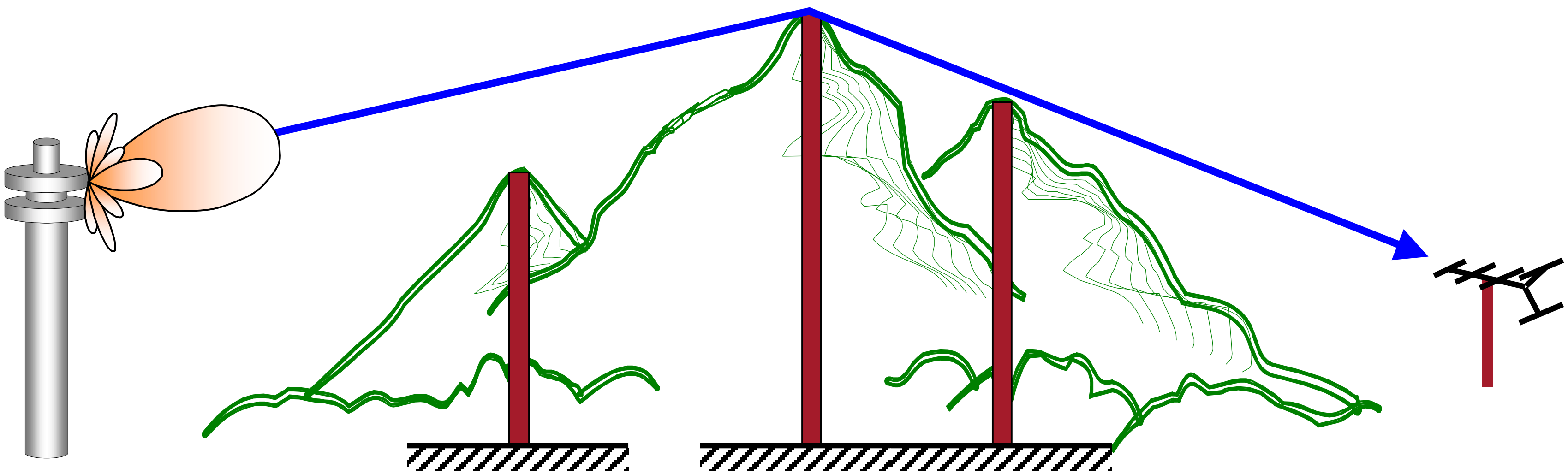


The refraction of the VHF/UHF signal in the troposphere causes an enhancement of the radio horizon compared to the geometric horizon



Diffraction:

- a signal could be received even if there is no line of sight
- diffraction means also an attenuation of the wave.
- higher frequency -> higher diffraction attenuation.



- replace obstacles by Knife-edges

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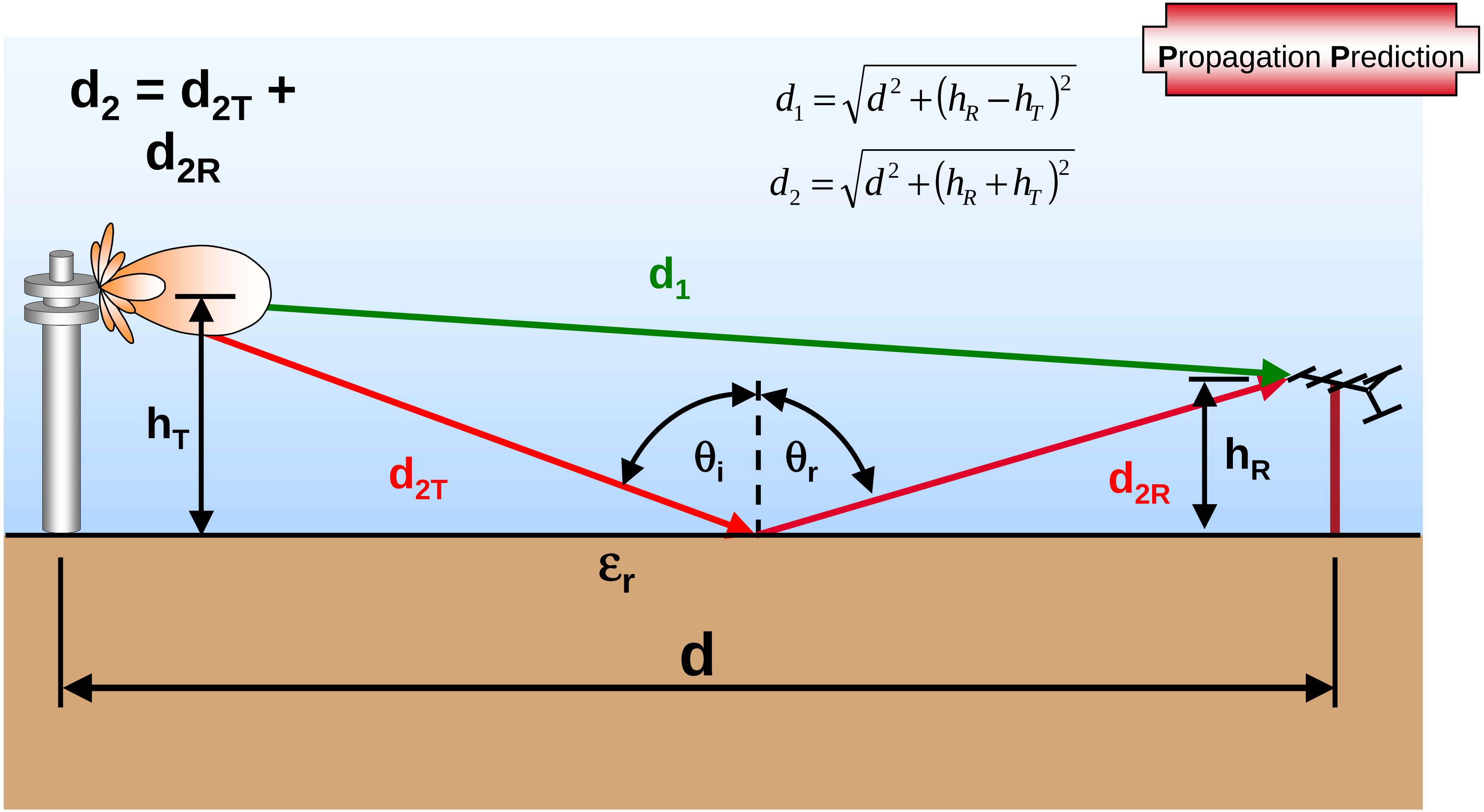
Reflection



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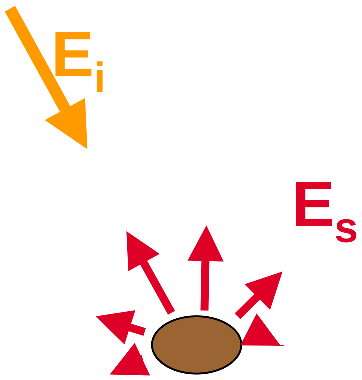
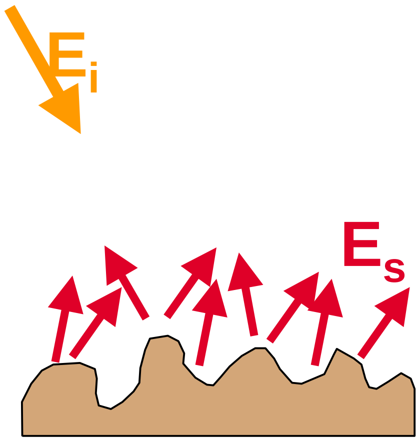
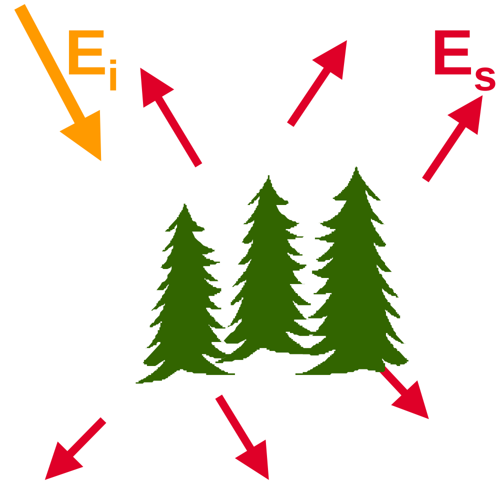
Scattering

from point	from rough surface	from volume
		

analytical model for sphere
numerical techniques

modified reflection
coefficient

radiative transfer theory
statistical models

Propagation Prediction

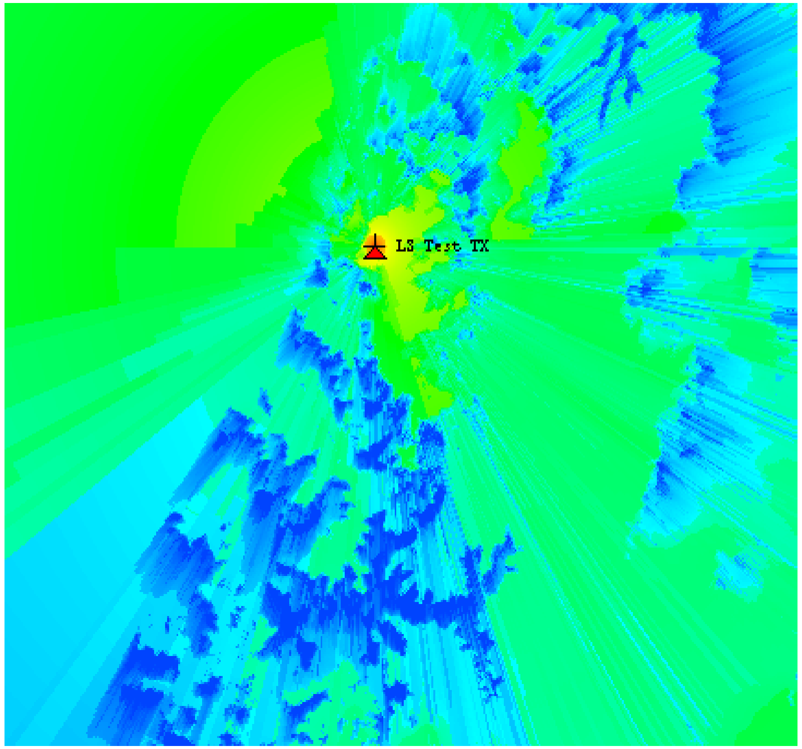
Modern Radio Network Planning Tools offer a wide range of Propagation Models

Information models
- Sight Check
- Sight Check (Fresnel)

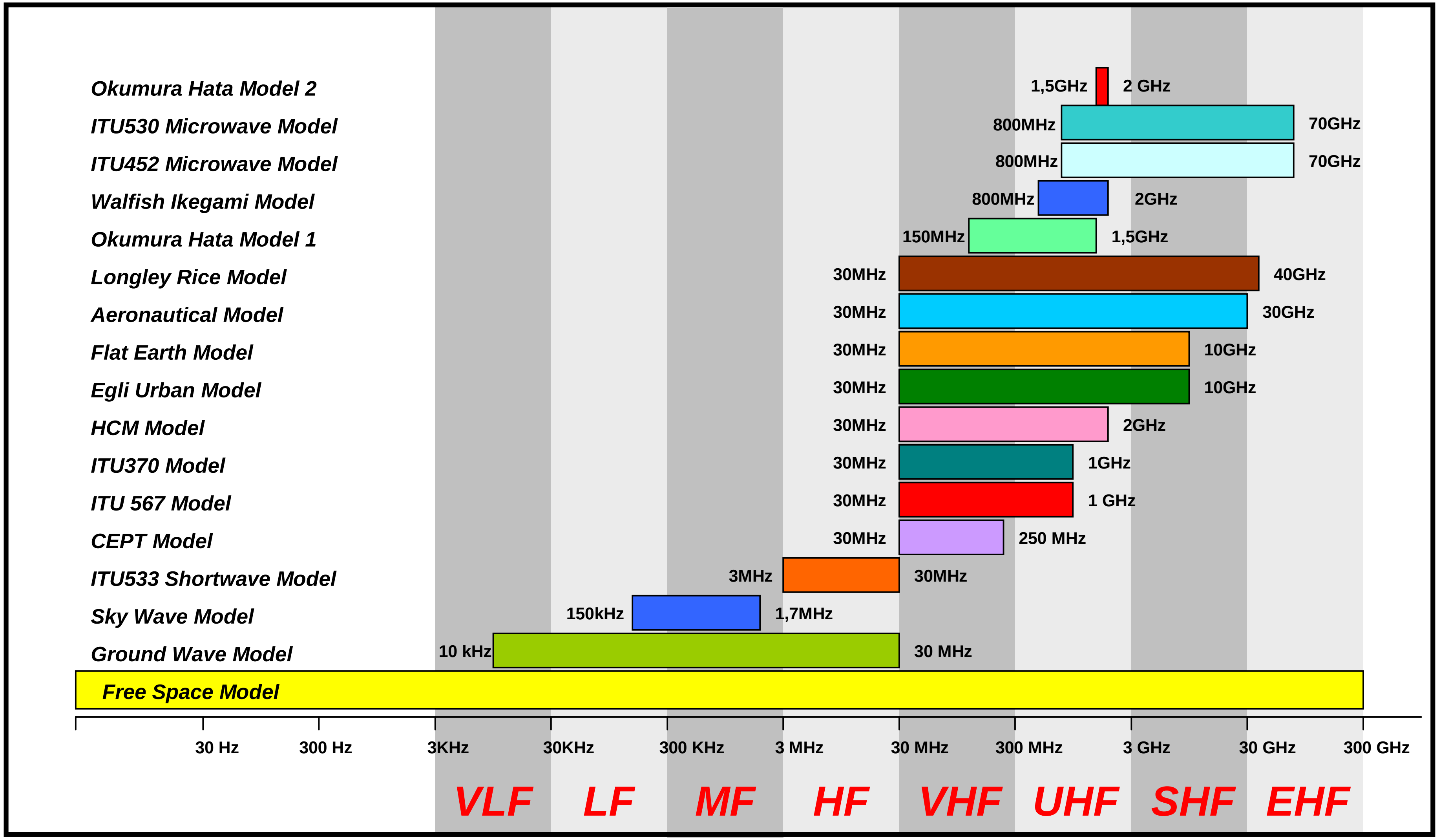
Physical models
- Free space
- Epstein-Peterson

Empirical models
- Okumura-Hata

Mixed models
- Longley-Rice
- ITU-R P.370
- ITU-R P.1546
- GEG
- L&S VHF/UHF



Models and Frequency Ranges



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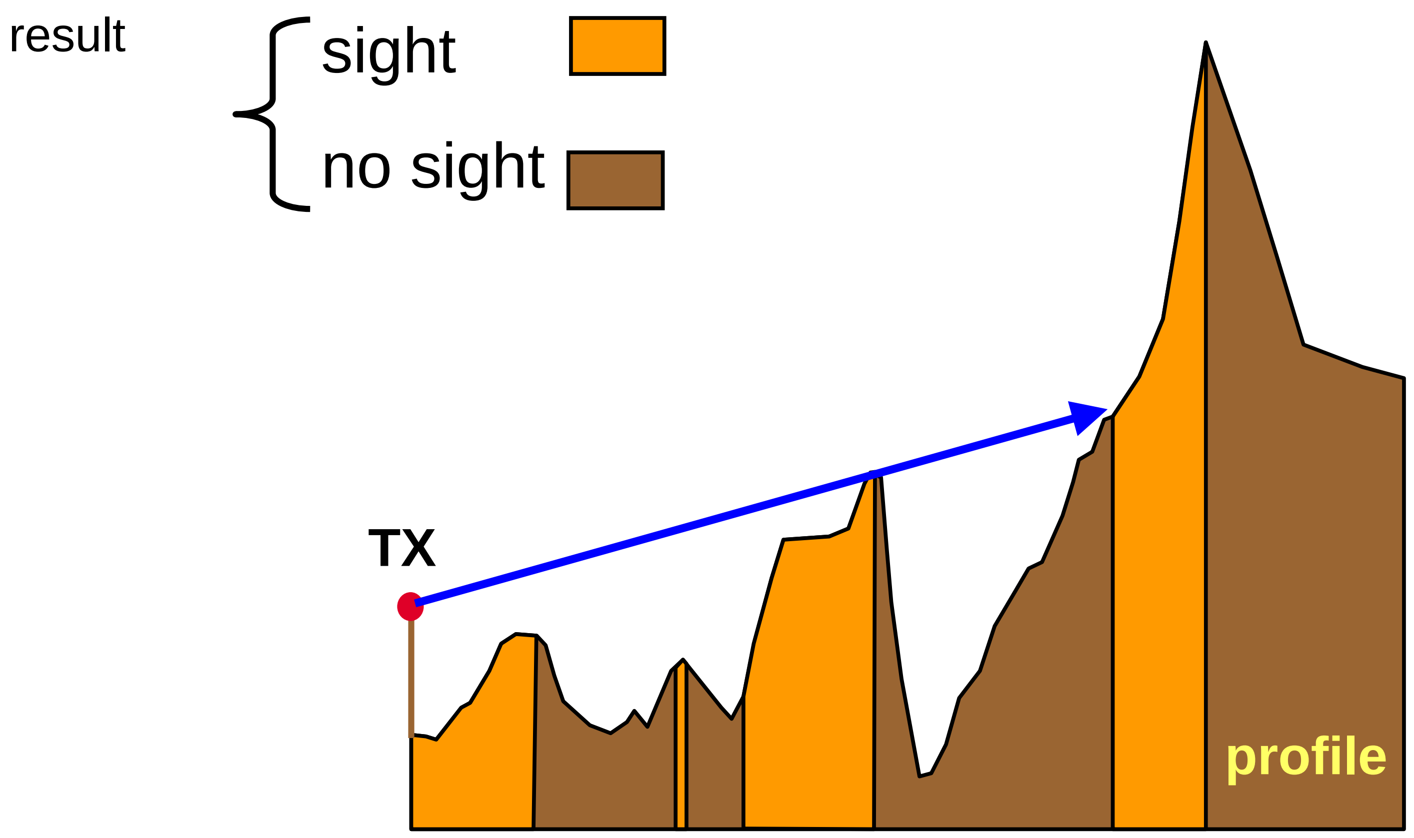
Propagation Prediction

performs line of sight (LOS) check

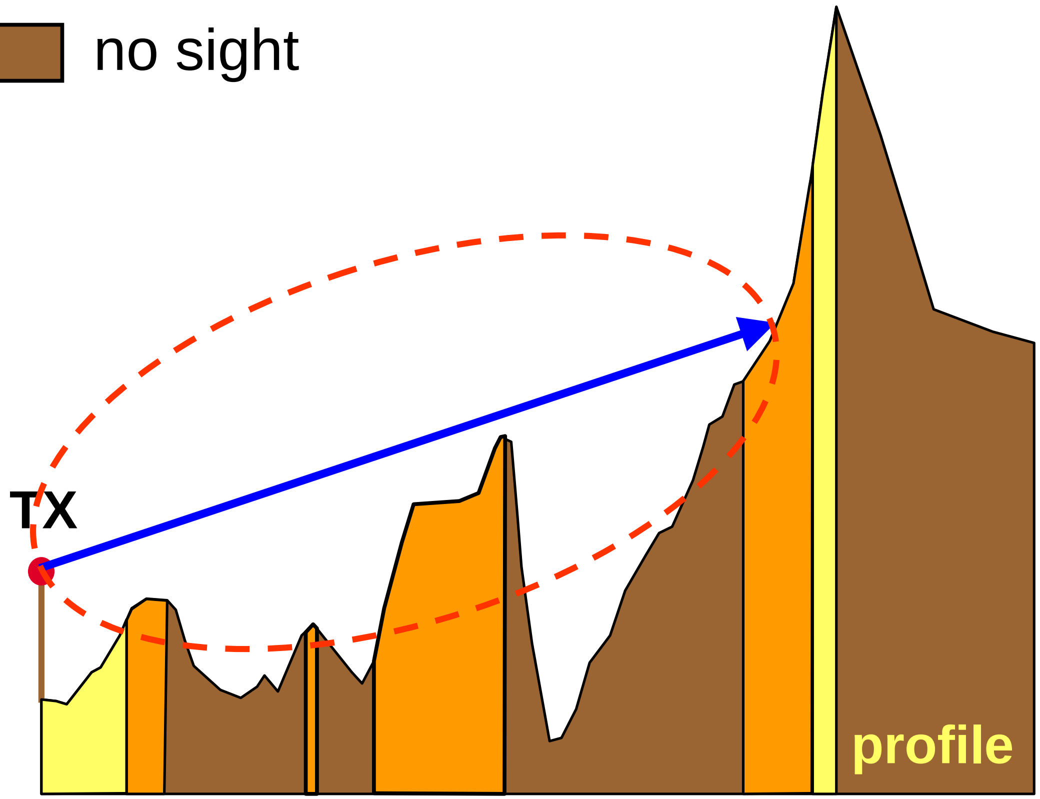


Sight Check (Fresnel)

Propagation **P**rediction

performs extended line of sight (LOS) check

result
- sight, no obstacles within 1st Fresnel zone
- sight, but obstacle within 1st Fresnel zone
- no sight



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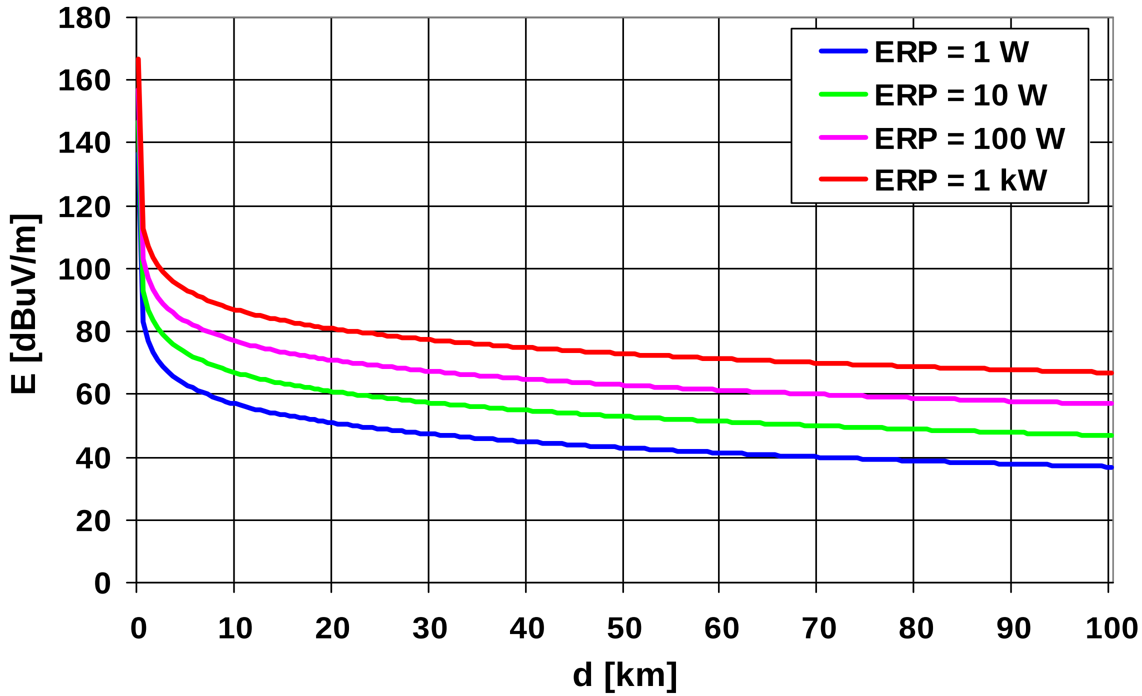
Free Space



propagation over a flat earth

- Determines the field strength value purely on the basis of the loss due to the distance d from the transmitter
- Selected calculation mode affects the k-factor for the calculation (see sight check)
- Additionally the consideration of morphological classes is possible if available; the clutter heights of the urban and rural morphologic classes are added to the topological heights

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Propagation Model ITU-R 370

- latest version 1995
- coordination model ⇒ tends to overestimate fieldstrength
- basis:

  measured data from North America, Europe, North Sea (cold) and Mediterranean Sea (warm)

  condensed to a set of curves: fieldstrength E over a homogenous terrain as a function of distance d (10 km ... 1 000 km) for ...

  - frequency ranges VHF (30 ... 250 MHz) and UHF (450 ... 1 000 MHz)
  - power of 1kW ERP
  - effective transmitter antenna height 37.5 m ... 1 200 m (3 km $\leq$ d $\leq$ 15 km)
  - terrain roughness Δh = 50 m (10 km $\leq$ d $\leq$ 50 km)
  - receiver location over land, cold sea or warm sea
  - receiver antenna height h_R = 10 m
  - 50 % location probability
  - 1%, 5%, 10% and 50% time probability

Used for highest compatibility with international planning procedures

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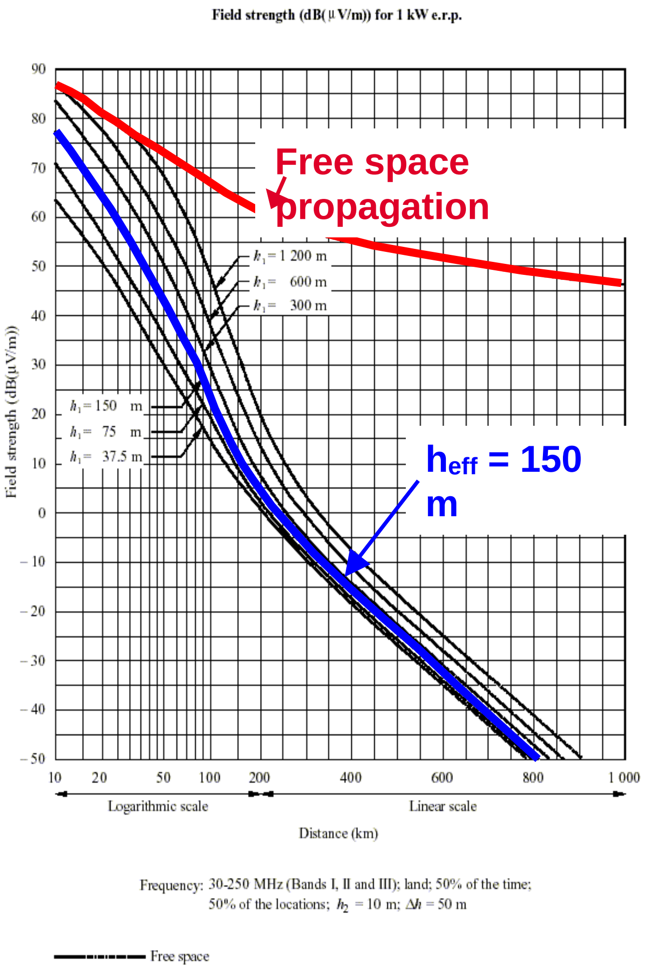
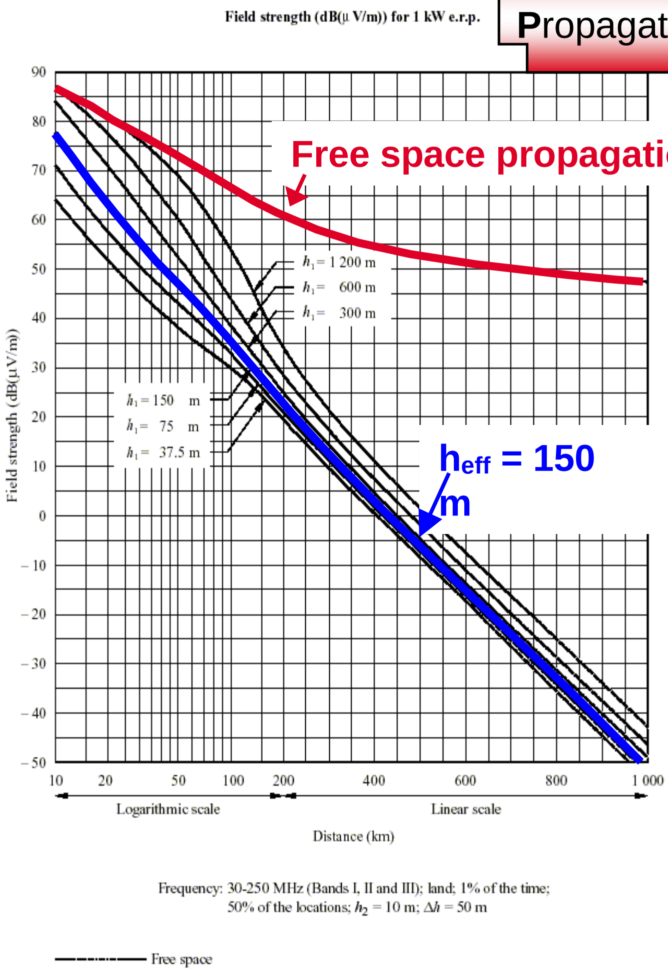
ITU-R 370 – Propagation Curves



propagation curve 50% time

(steady or continuous)



propagation curve 1% time

(tropospheric)

Major changes between ITU-R 370 and ITU-R 1546

- Interpolation and extension in frequency (between 3 curves from 30 MHz ... 3 000 MHz)
- Extension to distances below 10 km from transmitter (1 km)
- Terrain roughness is no longer a parameter
- More complex calculation near the transmitter
- calculation procedure for negative h_{eff}, curves extended to 10 m
- Interpolation for time variability (between curves)
- Location's standard deviation as a function of frequency
- More complex land sea path calculation

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- empirical model for propagation along flat and homogenous urban terrain
- based on measurements for vertical polarization by Okumura and ...
- interpolated formulas by Hata

Extensions to Okumura-Hata

- calculation of effective transmitter antenna height
  $h_T \rightarrow h_{T,eff}$ (different options)
- additional diffraction term for paths without sight
- consideration of morphological heights in diffraction term
- subdivision of the 4 morphological classes of Okumura-Hata into 16 classes
  (morphological gain with respect to urban areas)
- correction for non flat earth (terrain slope)

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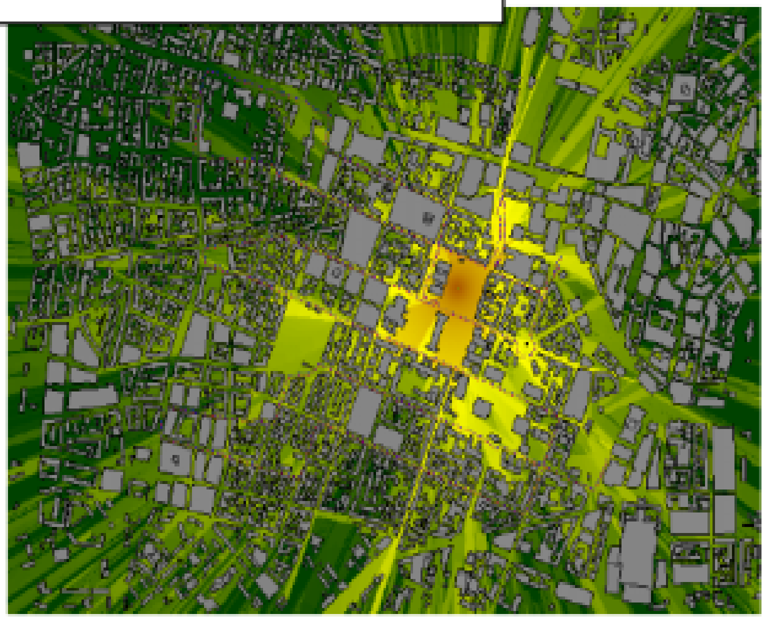
Micro Cell Model

Propagation **P**rediction

HIGH ACCURACY

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

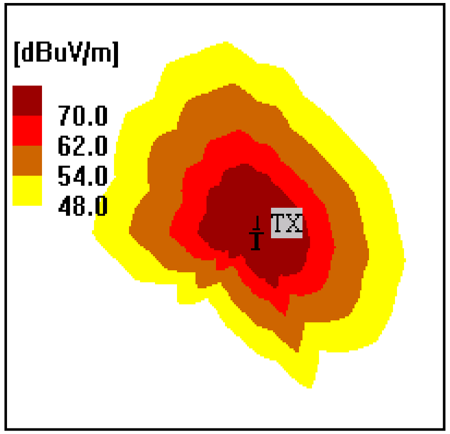


Propagation Prediction

Non-Terrain Based

- Use of "effective antenna height"
- Monotonous decline of field strength with increasing distance to transmitter

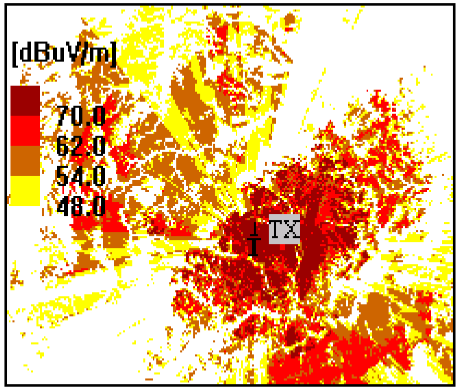
Example: ITU-R P. 370



DTM Based

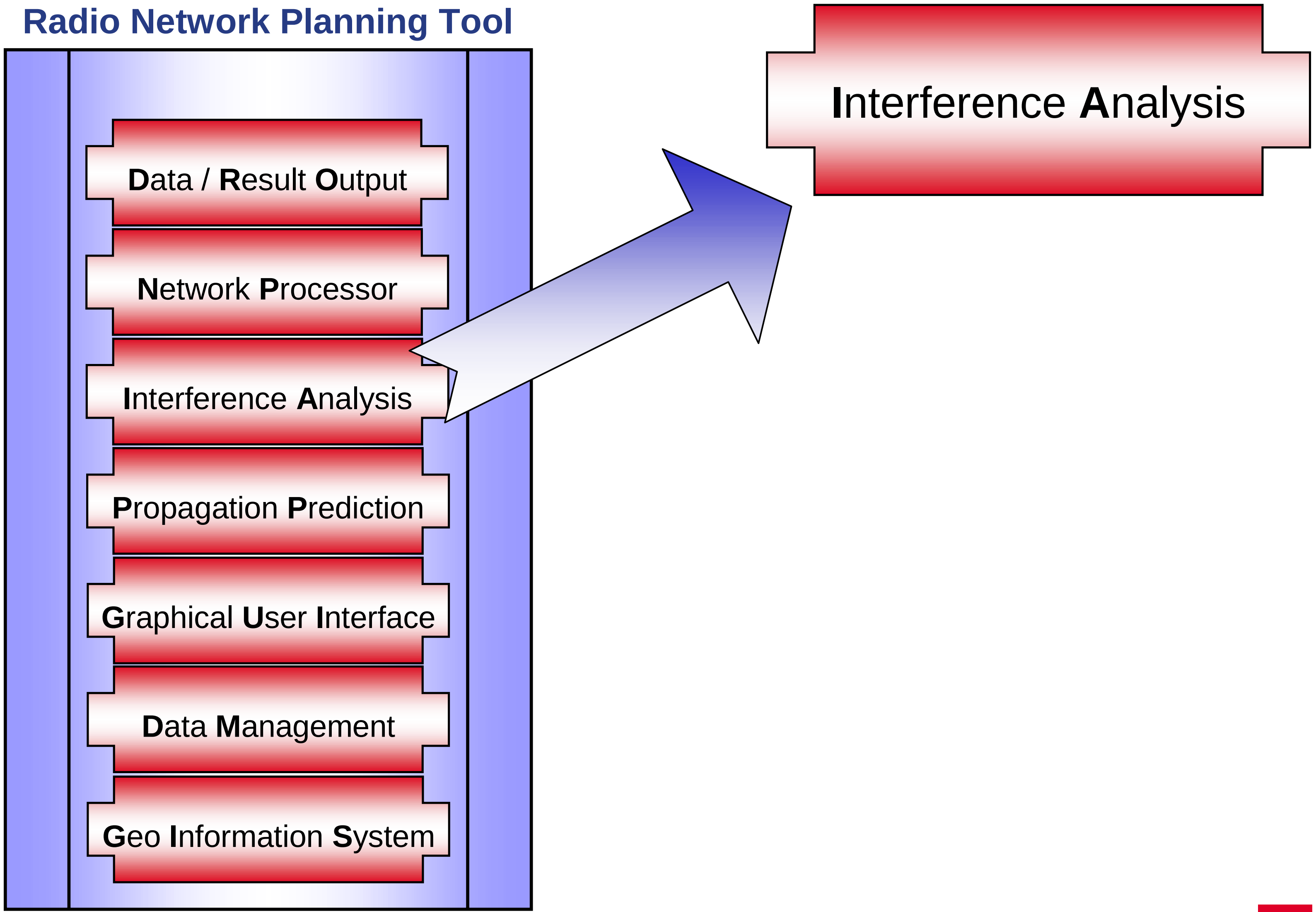
- Diffraction, shading, reflection
- Terrain elevation and land use (morphology)
- 2D and 3D models

Examples: "Epstein-Peterson", "Longley&Rice", "Okumura-Hata"



Live
Planning Tool Demonstration

„CHIRplus_BC“
Planning and Coordination of Broadcast Services
(FM, TV, DAB, DVB)



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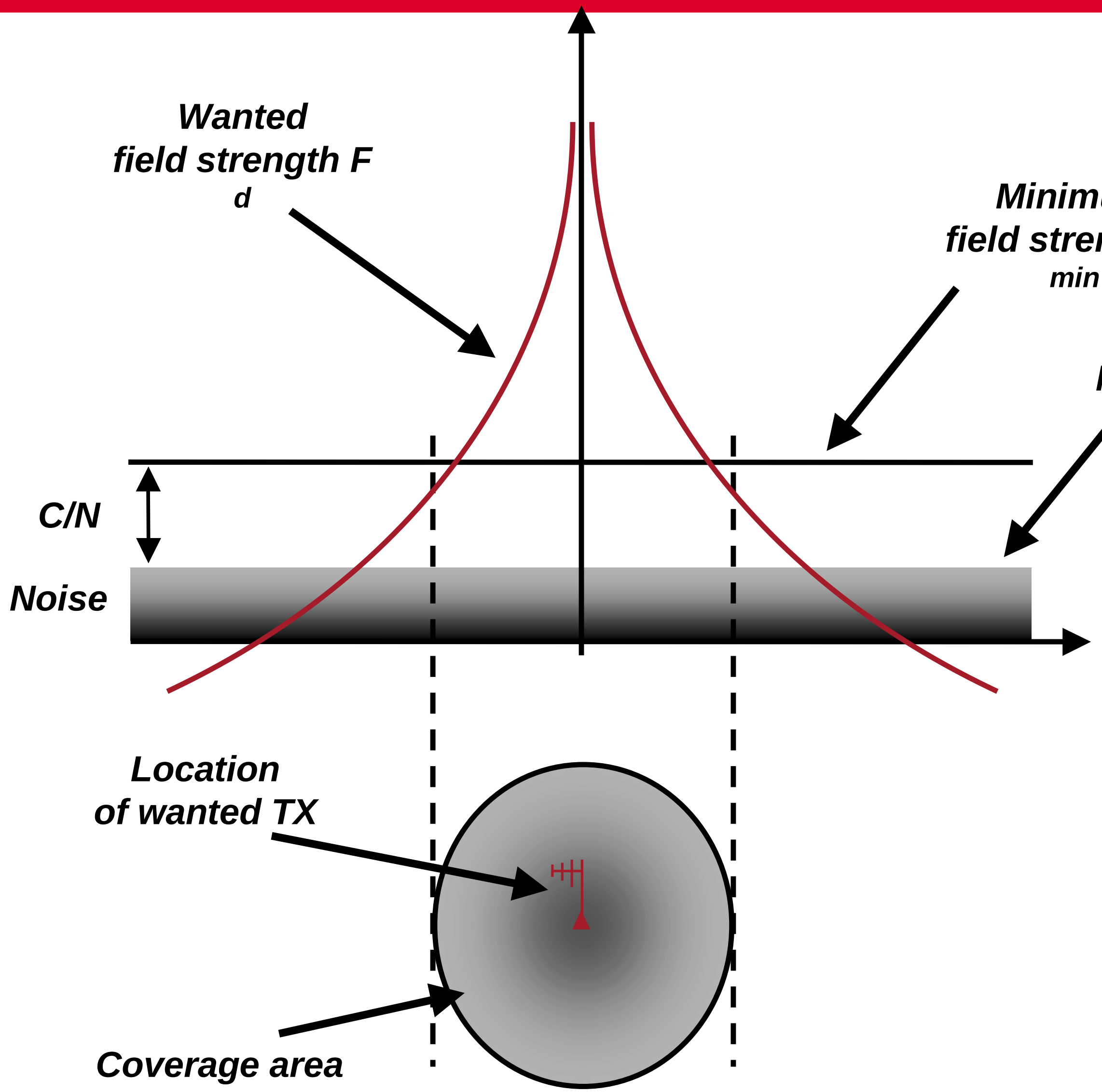
Interference by Noise



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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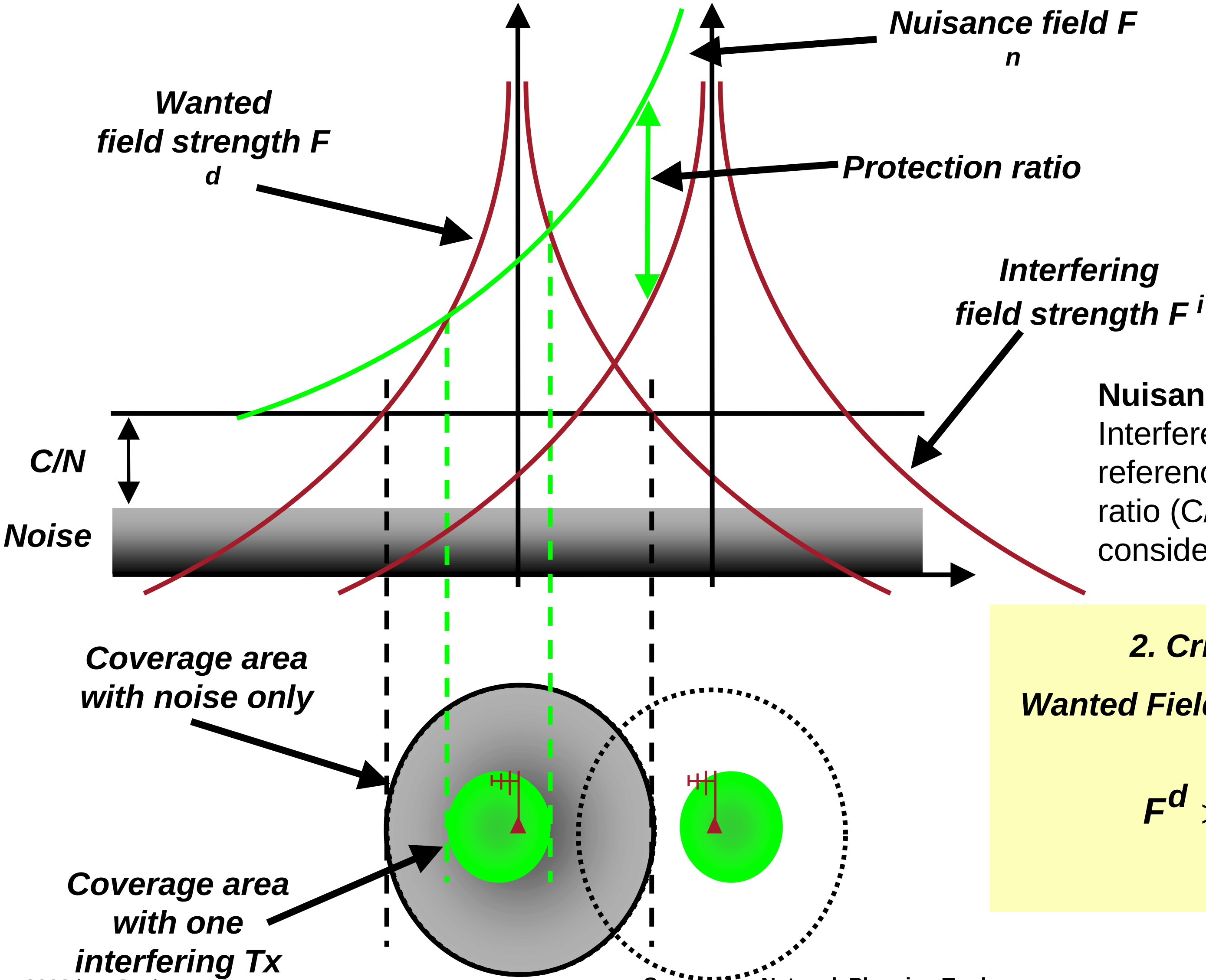
Interference by one Transmitter

Interference Analysis



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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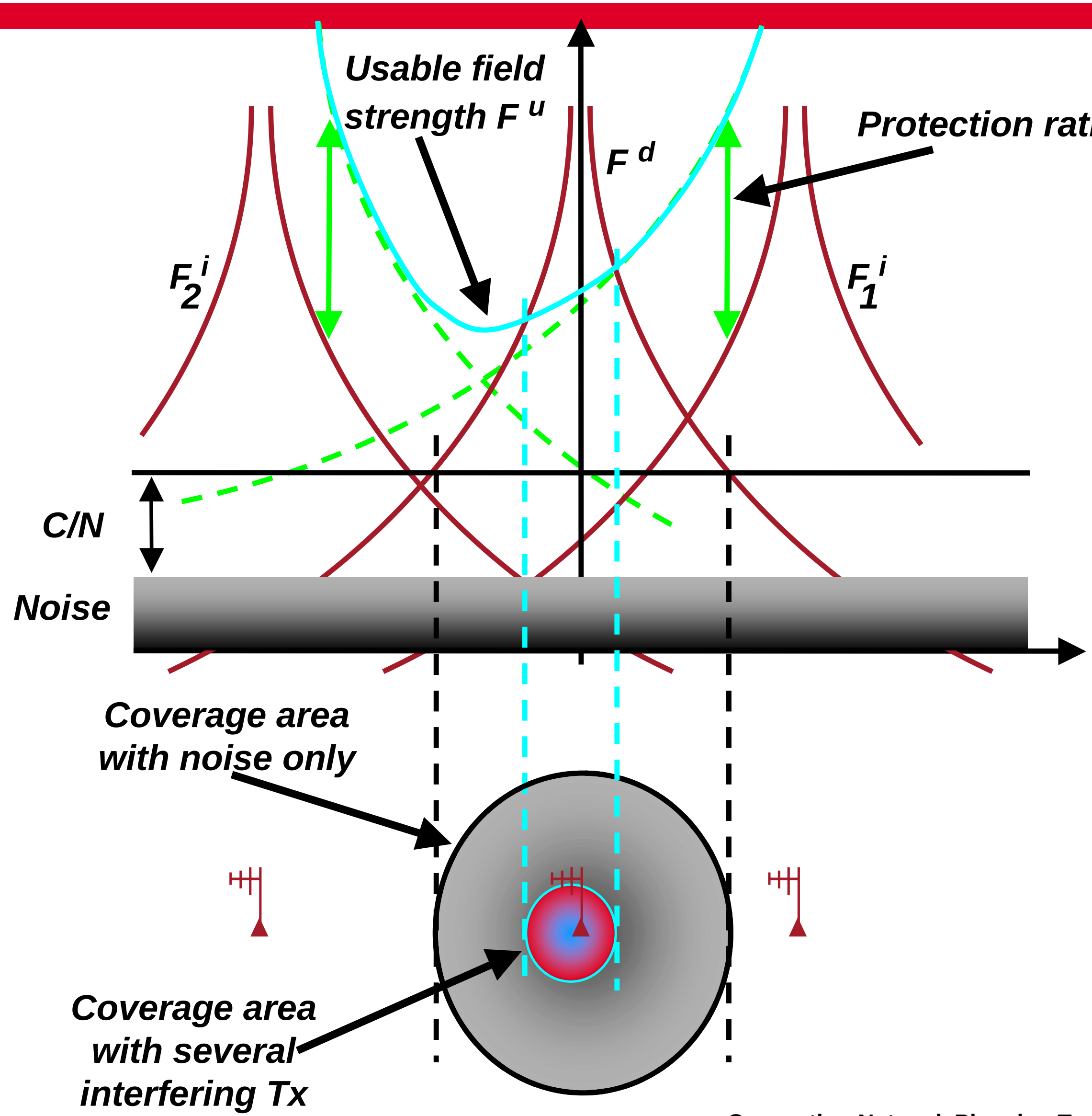
Interference by several Transmitter

Interference Analysis



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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Procedures of Summation for Interference Calculation

In modern Planning Tools, the cumulation of the single interfering fields can be done in several different ways.

The various procedures differ in the way how simplifications are used to minimize the calculation effort.

In the following a short overview is given for the procedures which are most often used in interference calculations.

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Summation Procedures

Non-statistical methods:

- Maximum procedure
- Power-sum method

Statistical methods:

- Integration method
- Log-normal method
- Multiplication method
- Simplified multiplication method
- Simplified Log-normal method
- Trilinear Log-normal method

Most use is made of the power-sum method and the simplified multiplication method

Reference CCIR Report 945-2: Methods for the Assessment of Multiple Interference

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Interference Analysis

Frequency Scan

- This function is used to find out gaps in the frequency spectrum where new TV or FM transmitters could be planned. At a desired transmitter site (transmitter coordinate) a wanted transmitter calculation based on a frequency range given by the user is done and the usable field strength calculated for each frequency point.

F_TX De087.5_002.txt

38.67 Useable Fieldst - Analysis Method: Simplified Multiplication

No	Frequency	Channel	UFS	A/sqkm	Max.Interferer		
1	87.50000	-2	38.7	0.00	SW Slopes/E Riverina	88.30	AUS
2	87.60000	2	40.7	0.00	SW Slopes/E Riverina	88.30	AUS
3	87.70000	+2	42.7	0.00	SW Slopes/E Riverina	88.30	AUS
4	87.80000	-3	43.7	0.00	SW Slopes/E Riverina	88.30	AUS
5	87.90000	3	45.5	0.00	SW Slopes/E Riverina	88.30	AUS
6	88.00000	+3	60.4	0.00	SW Slopes/E Riverina	88.30	AUS
7	88.10000	-4	73.6	0.00	SW Slopes/E Riverina	88.30	AUS
8	88.20000	4	87.7	0.00	SW Slopes/E Riverina	88.30	AUS
9	88.30000	+4	99.7	0.00	SW Slopes/E Riverina	88.30	AUS
10	88.40000	-5	87.7	0.00	SW Slopes/E Riverina	88.30	AUS
11	88.50000	5	70.0	0.00	SW Slopes/E Riverina	88.30	AUS
12	88.60000	+5	65.0	0.00	SW Slopes/E Riverina	88.30	AUS
13	88.70000	-6	74.4	0.00	Walwa/Jingellic	88.70	AUS
14	88.80000	6	66.8	0.00	SW Slopes/E Riverina	89.10	AUS
15	88.90000	+6	75.3	0.00	SW Slopes/E Riverina	89.10	AUS
16	89.00000	-7	87.7	0.00	SW Slopes/E Riverina	89.10	AUS
17	89.10000	7	99.7	0.00	SW Slopes/E Riverina	89.10	AUS
18	89.20000	+7	87.7	0.00	SW Slopes/E Riverina	89.10	AUS
19	89.30000	-8	70.3	0.00	SW Slopes/E Riverina	89.10	AUS
20	89.40000	8	61.8	0.00	SW Slopes/E Riverina	89.10	AUS
21	89.50000	+8	68.9	0.00	Orange	89.50	AUS
22	89.60000	-9	64.5	0.00	SW Slopes/E Riverina	89.90	AUS
23	89.70000	9	74.9	0.00	SW Slopes/E Riverina	89.90	AUS
24	89.80000	+9	87.7	0.00	SW Slopes/E Riverina	89.90	AUS
25	89.90000	-10	99.7	0.00	SW Slopes/E Riverina	89.90	AUS
26	90.00000	10	87.7	0.00	SW Slopes/E Riverina	89.90	AUS
27	90.10000	+10	70.2	0.00	SW Slopes/E Riverina	89.90	AUS
28	90.20000	-11	63.0	0.00	SW Slopes/E Riverina	89.90	AUS
29	90.30000	11	71.1	0.00	Bendigo	90.30	AUS
30	90.40000	+11	66.1	0.00	SW Slopes/E Riverina	90.70	AUS
31	90.50000	-12	76.3	0.00	SW Slopes/E Riverina	90.70	AUS