Spectrocan

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Session 5.7

Supporting Network Planning Tools II

by

Roland Götz

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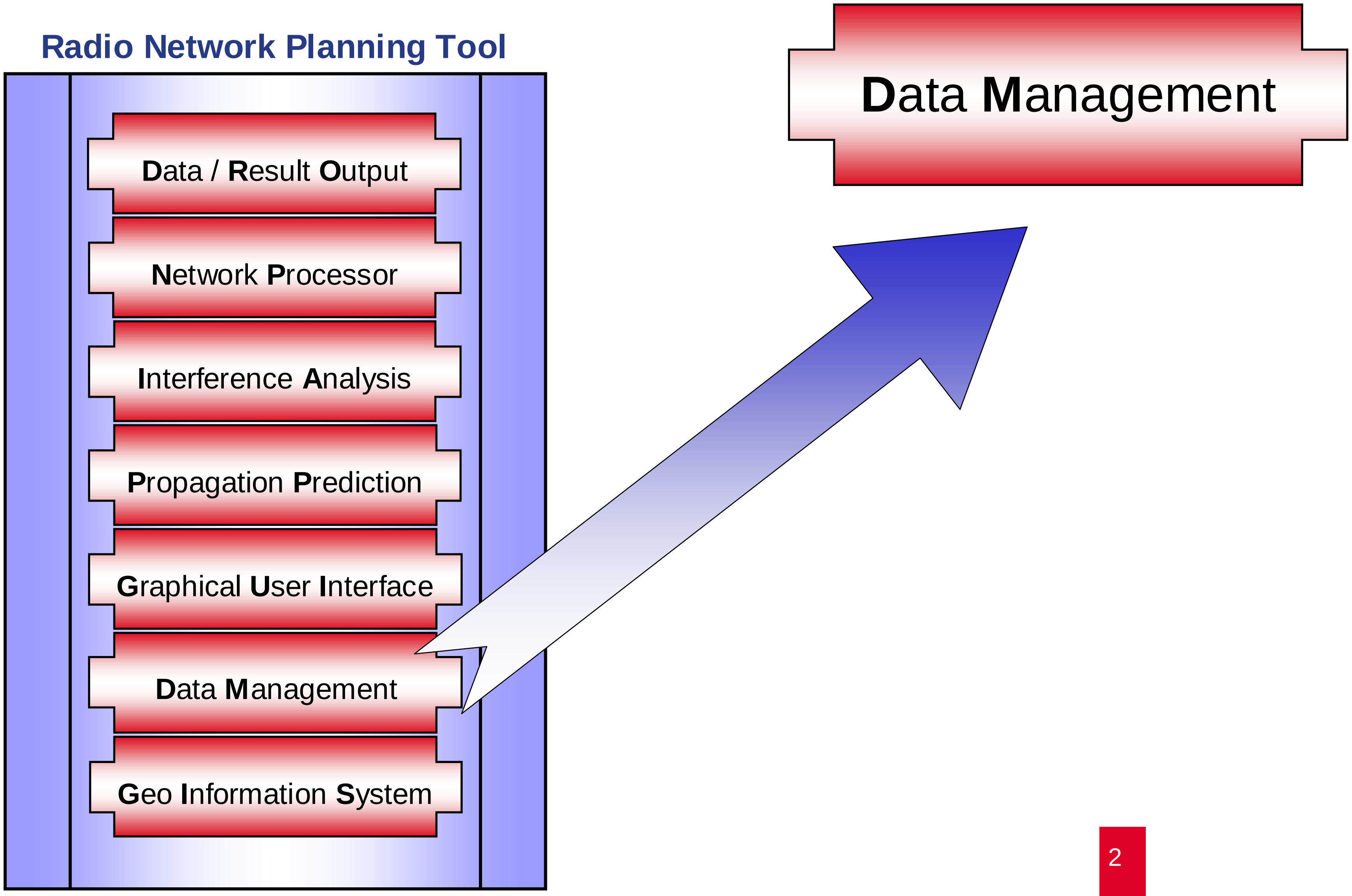

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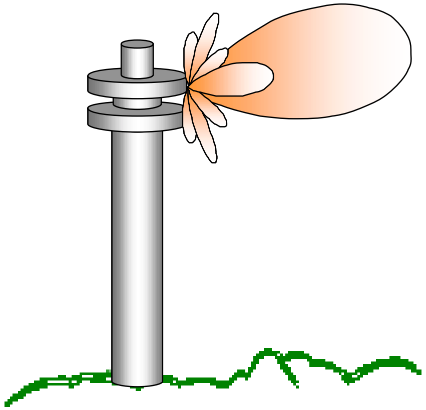
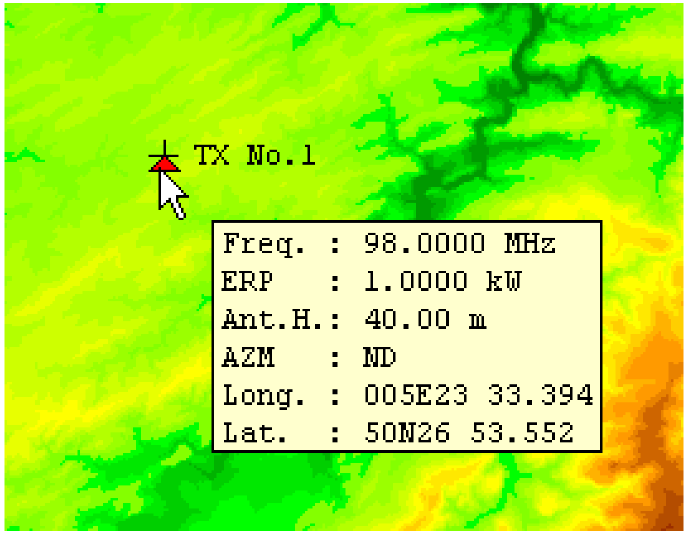
What is the Minimum Set of Data you need to perform a Basic Coverage Prediction?

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





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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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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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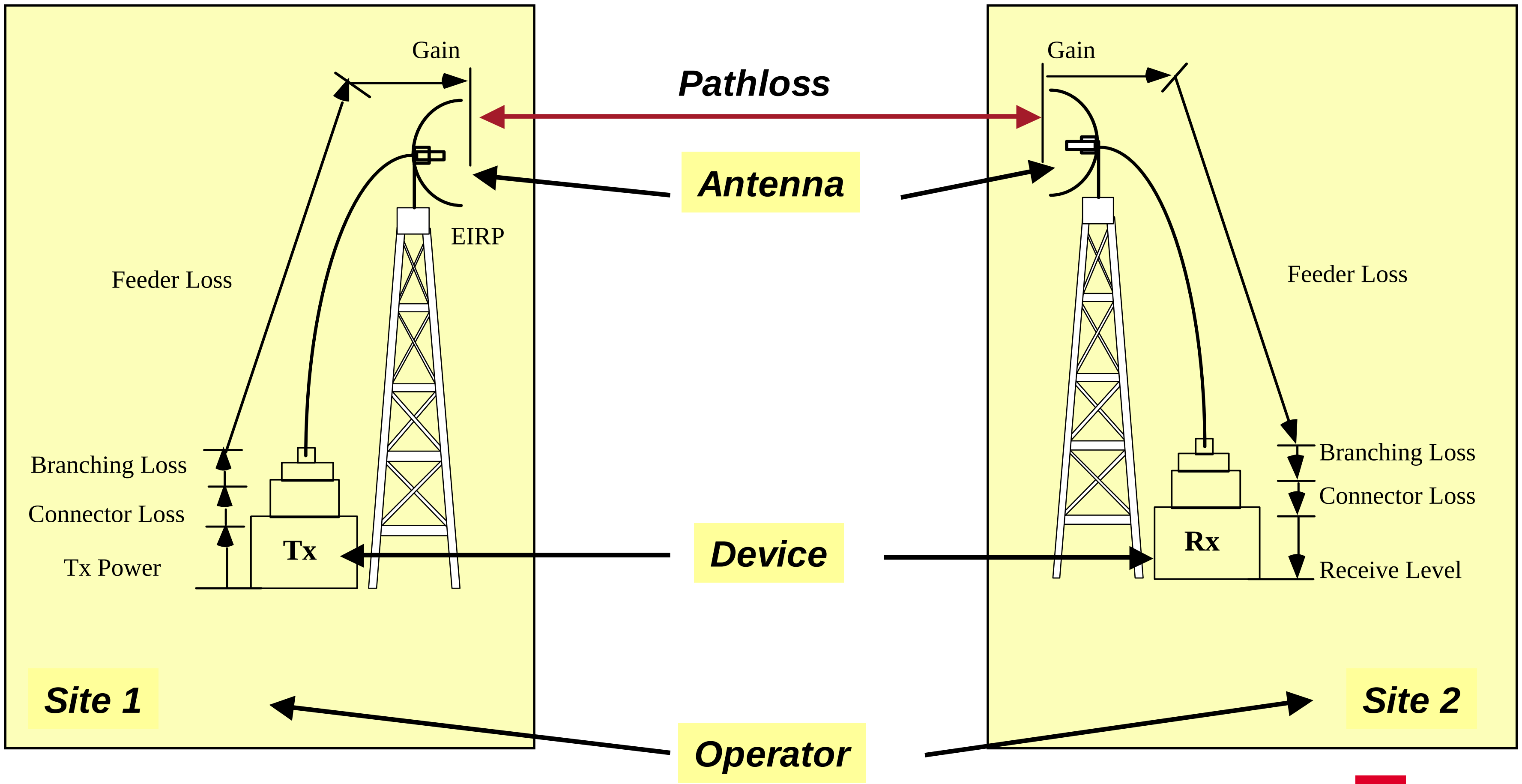
Example: Microwave Link



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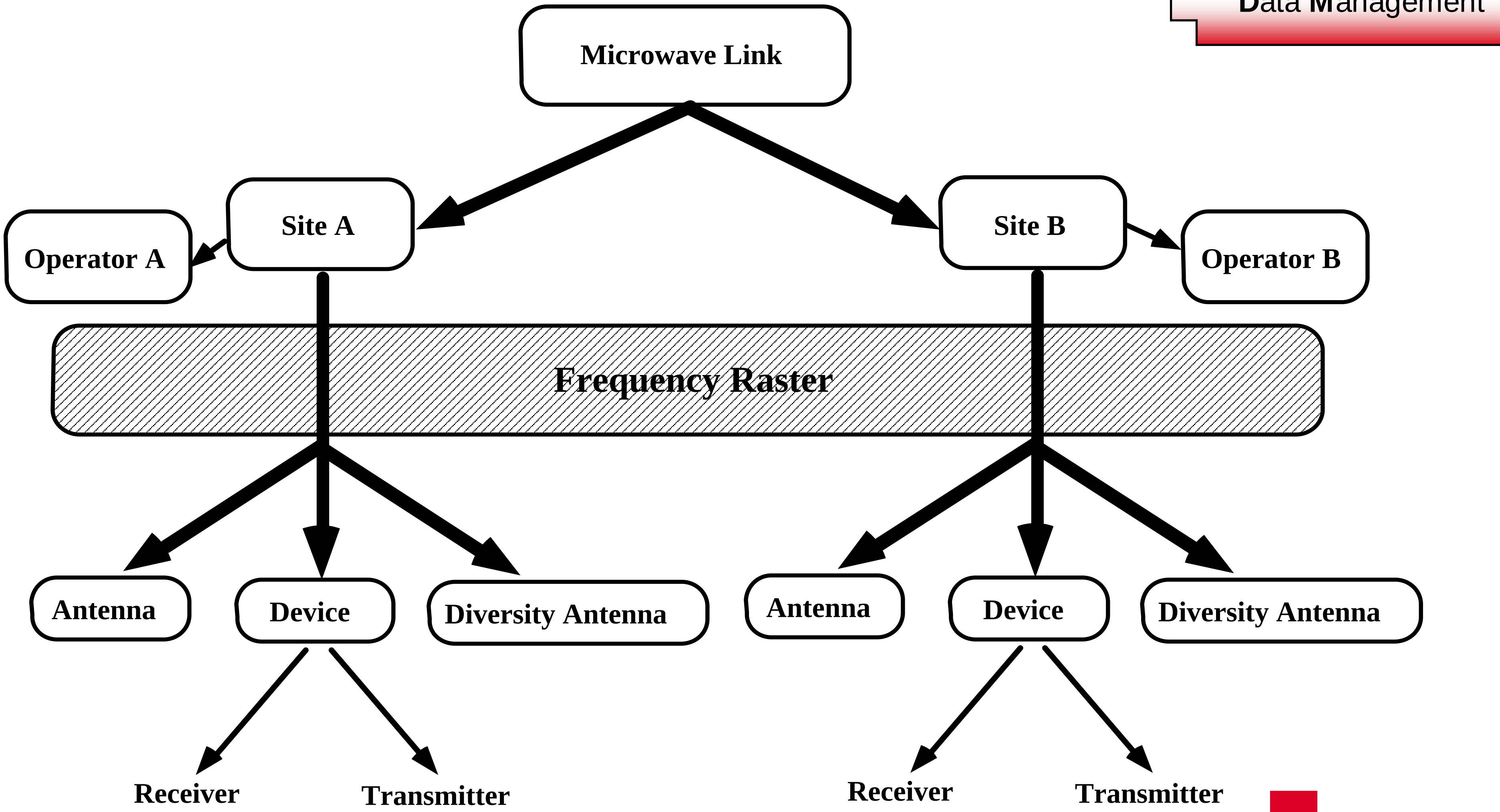
Example: Microwave Link



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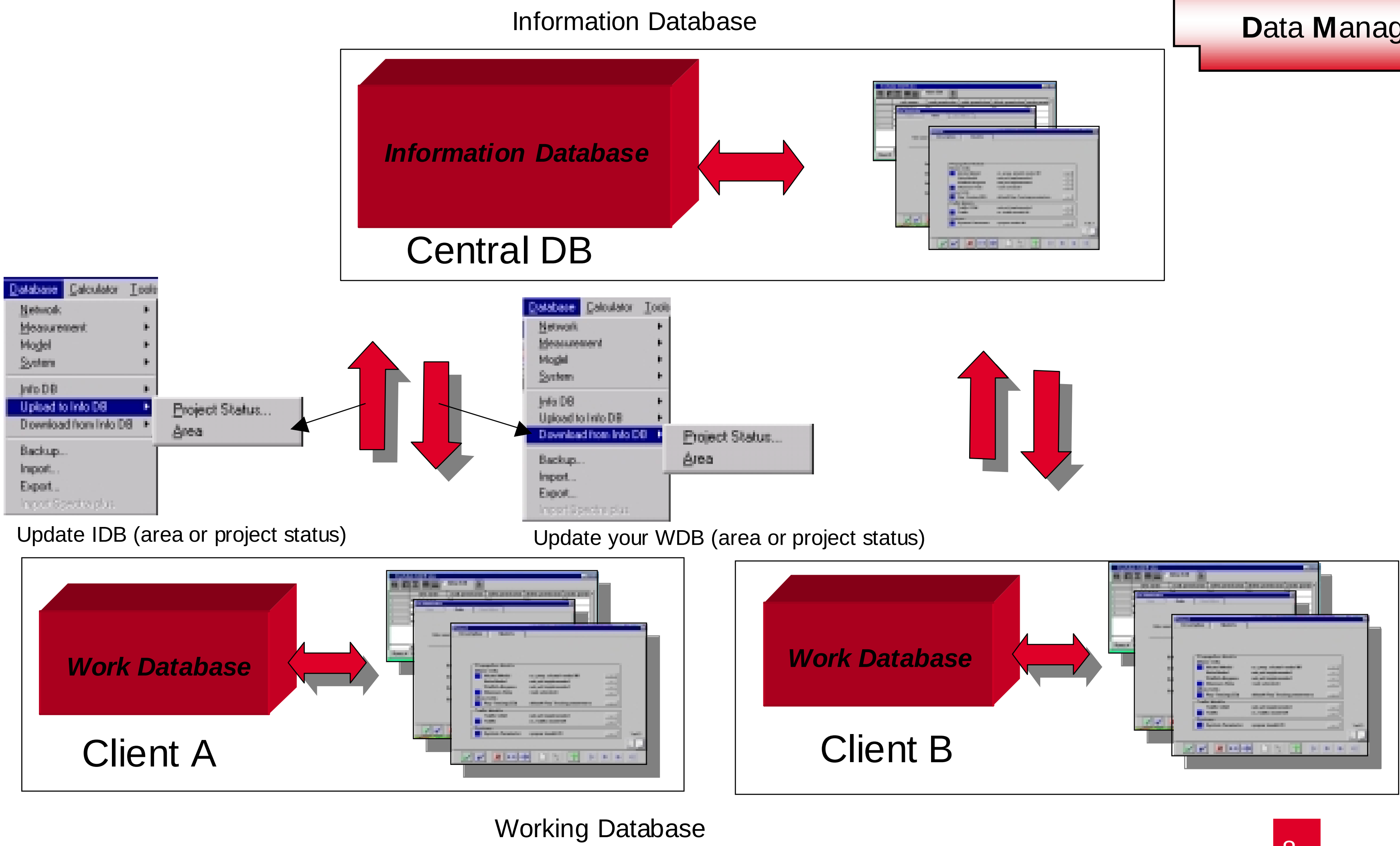
Database Concepts



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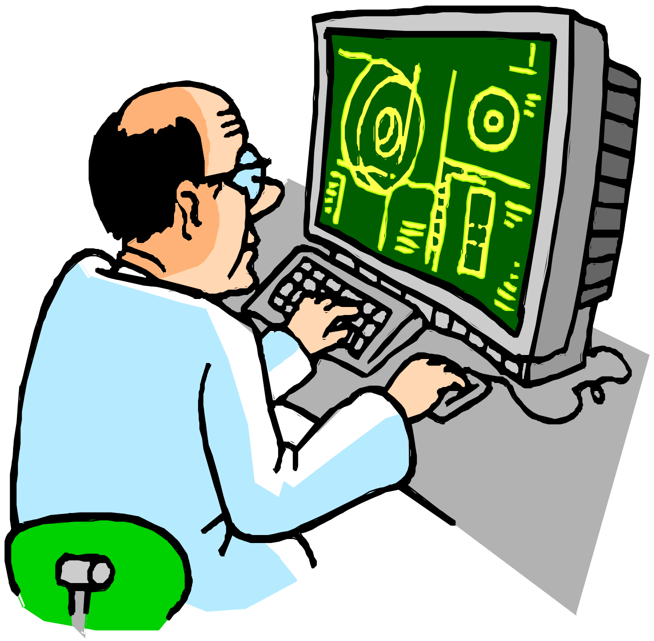

Live
Planning Tool Demonstration

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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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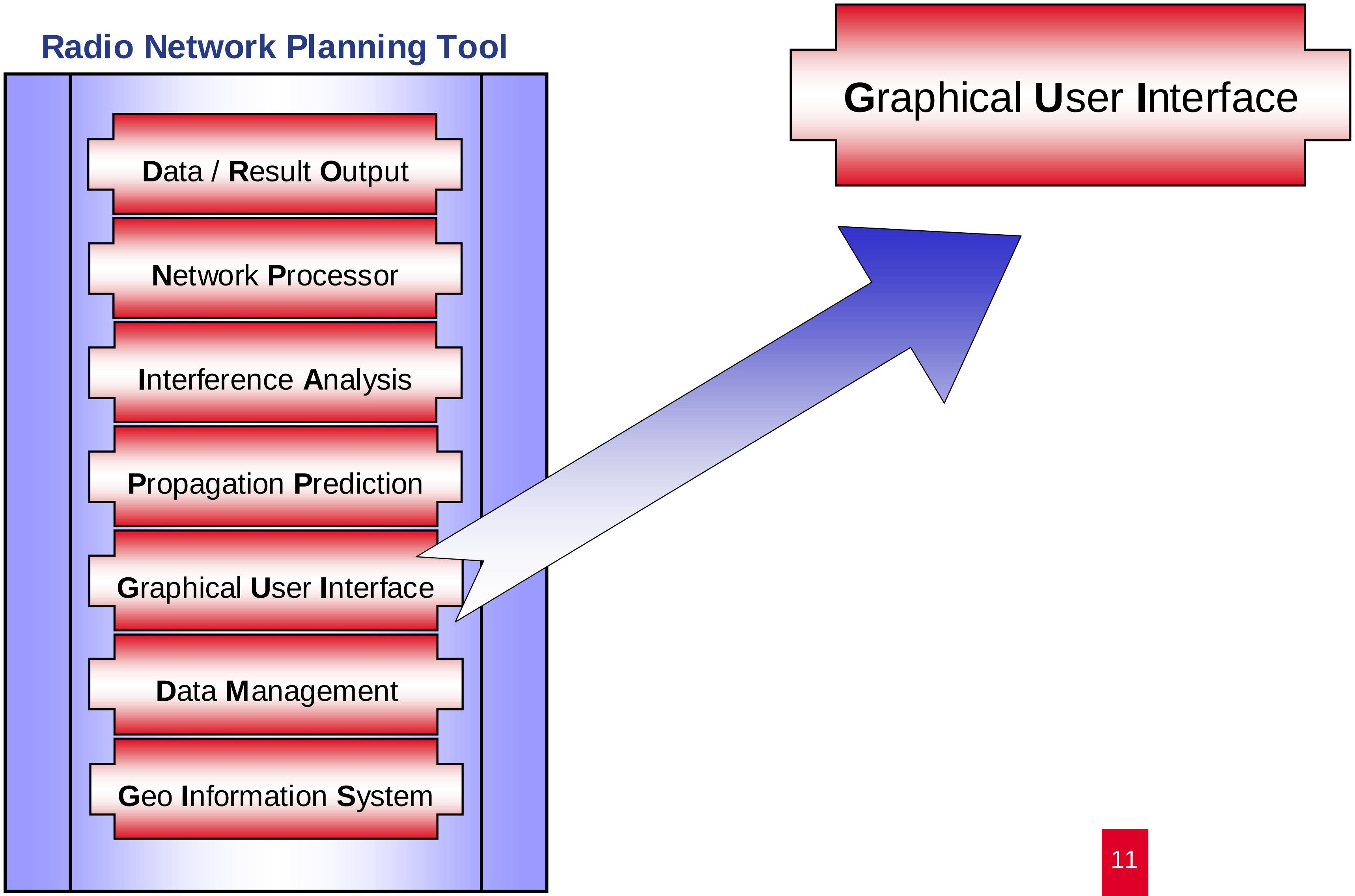
Modern Radio Network Planning Tools



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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

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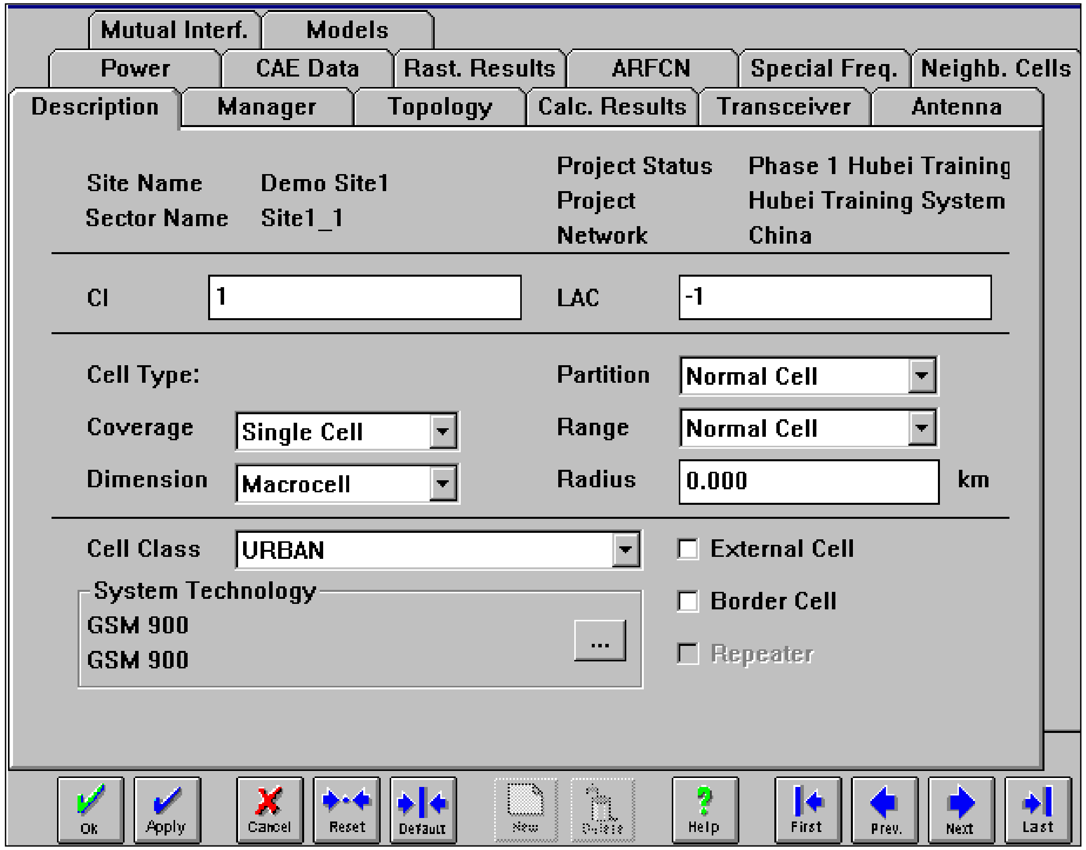
Graphical User Interface

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



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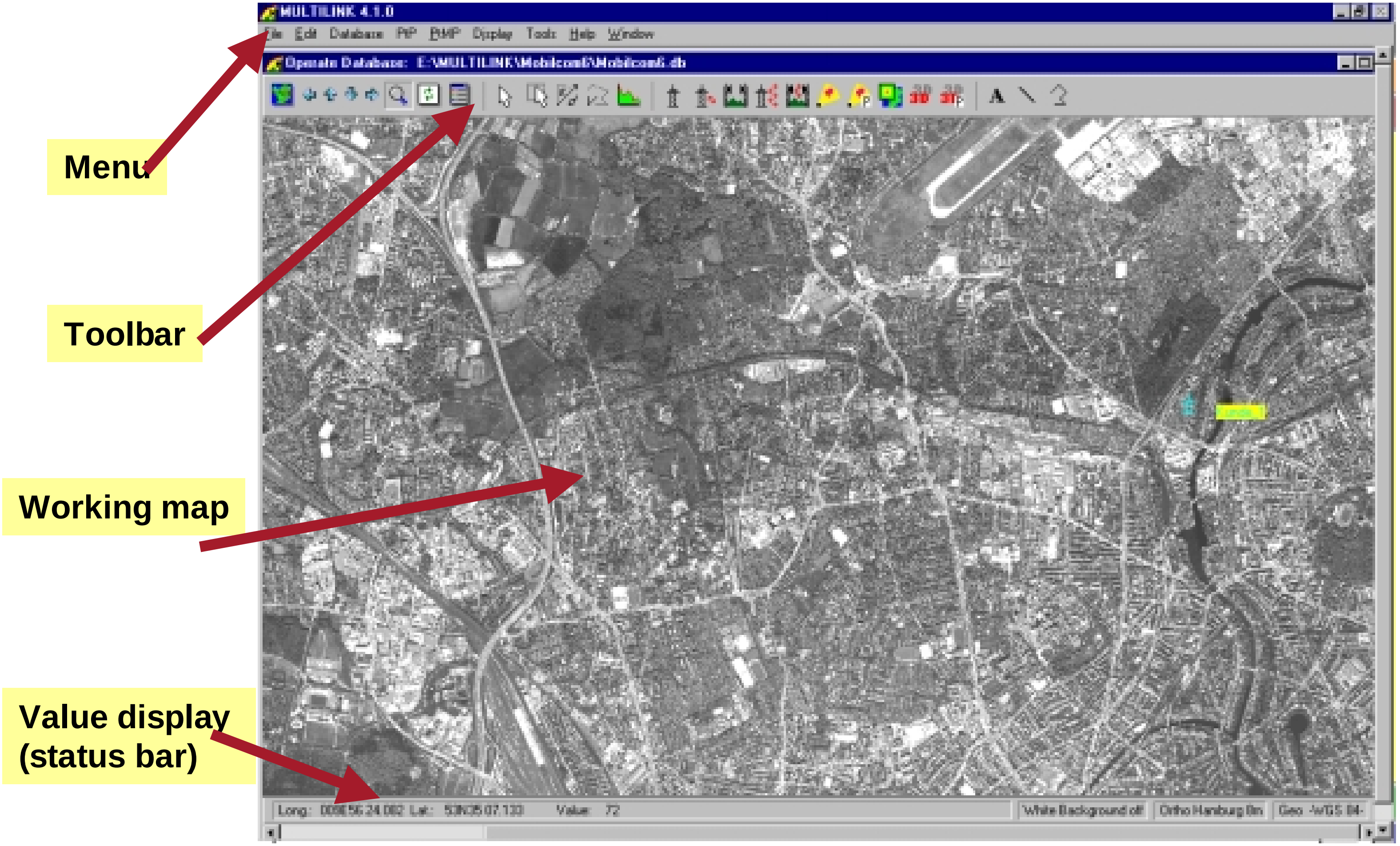
Working Window

Graphical User Interface



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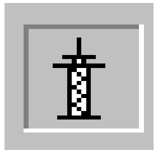
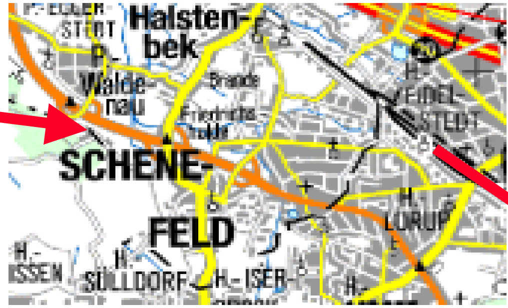
Task: Creating new Sites

Graphical User Interface

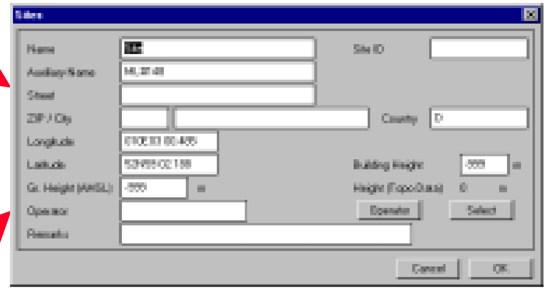
1. Graphically on a map:

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

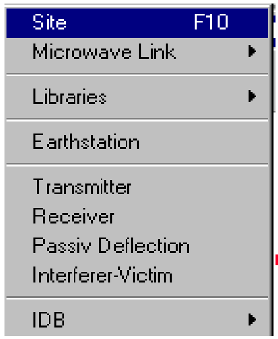


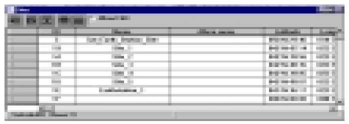


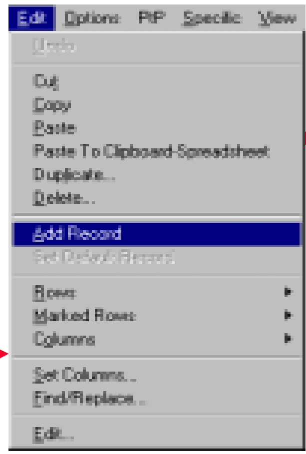
Co-ordinates from selected position on map



2. In the site table:







Enter co-ordinates manually

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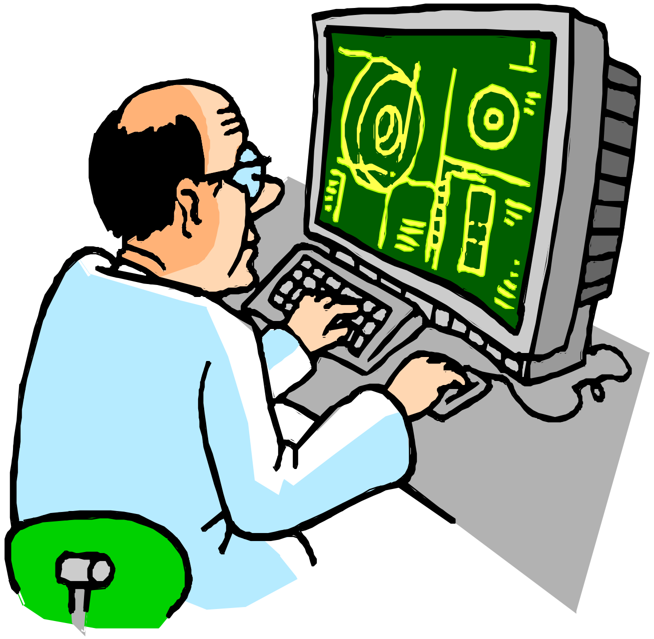

Live
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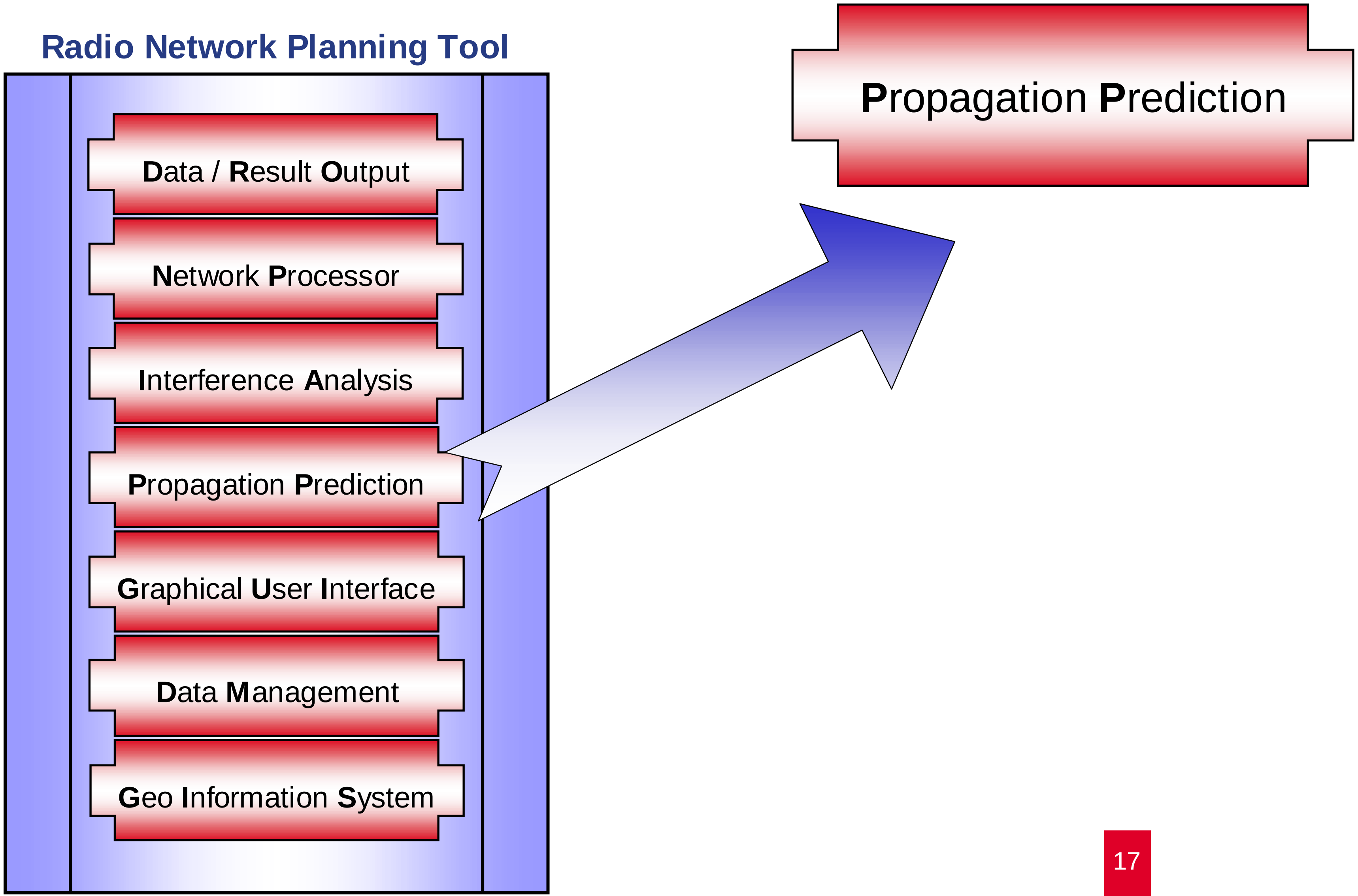
Modern Radio Network Planning Tools



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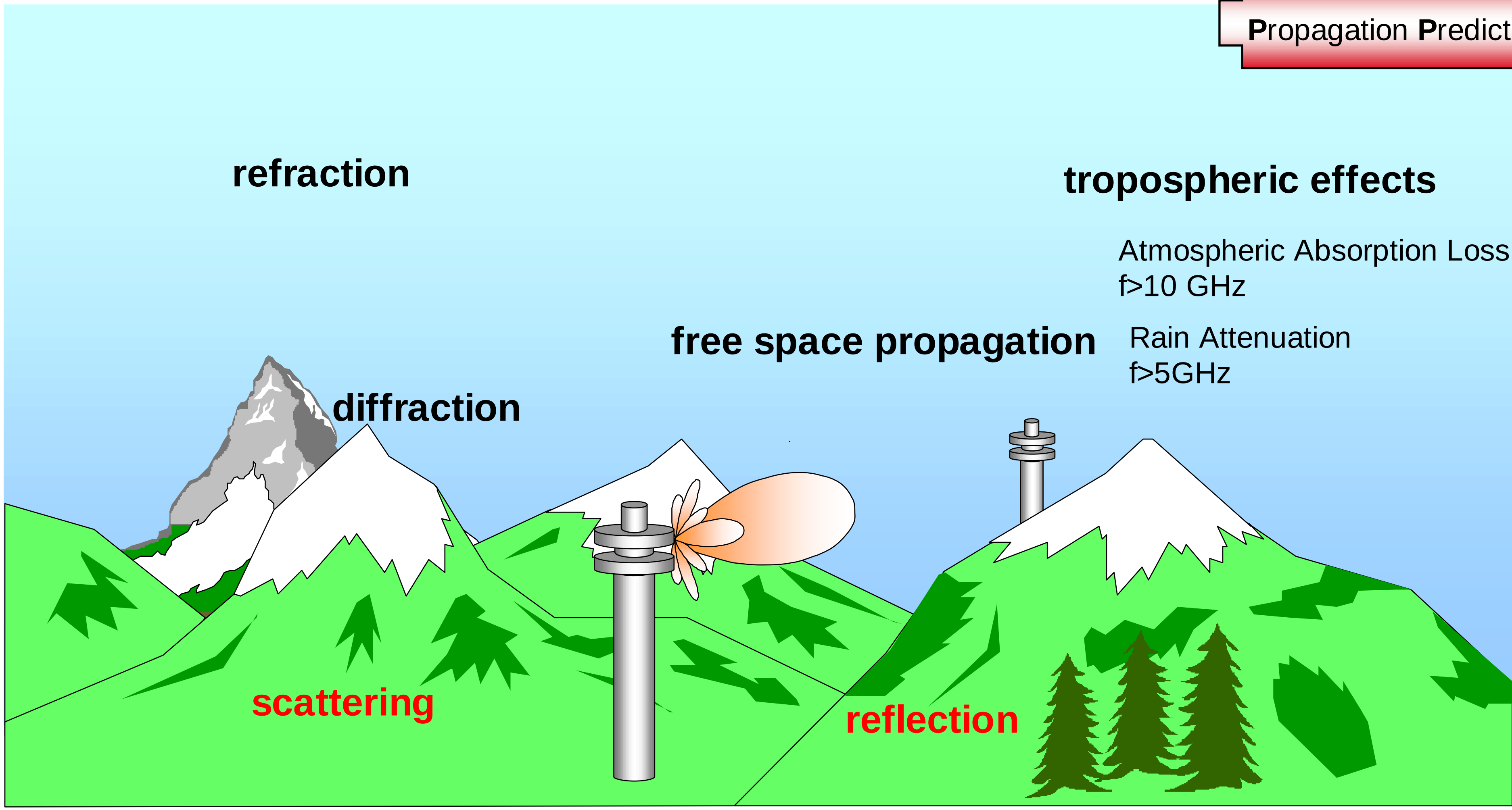
Wave Propagation Effects



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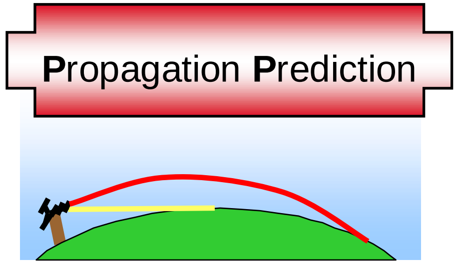
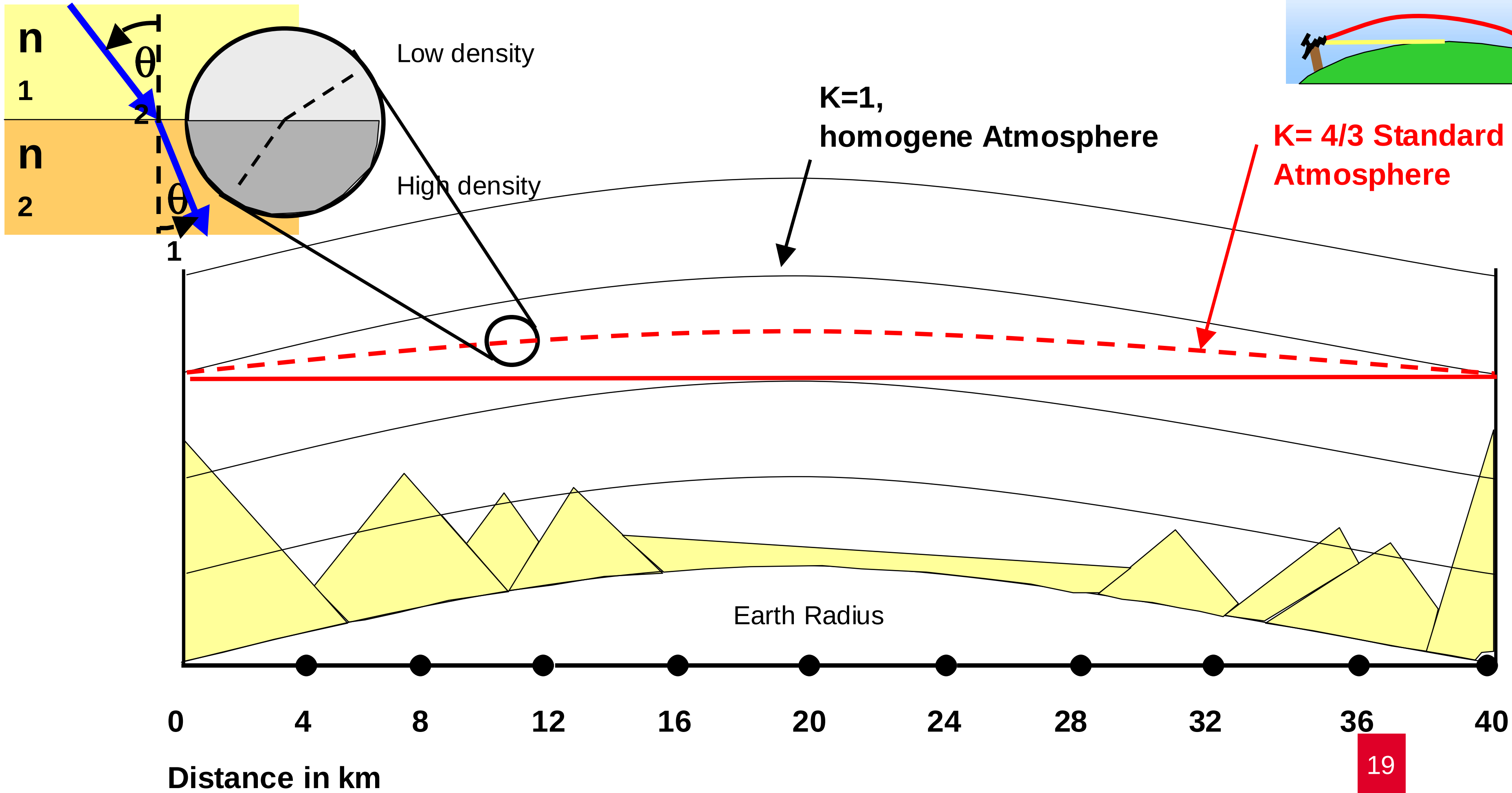
Refraction



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



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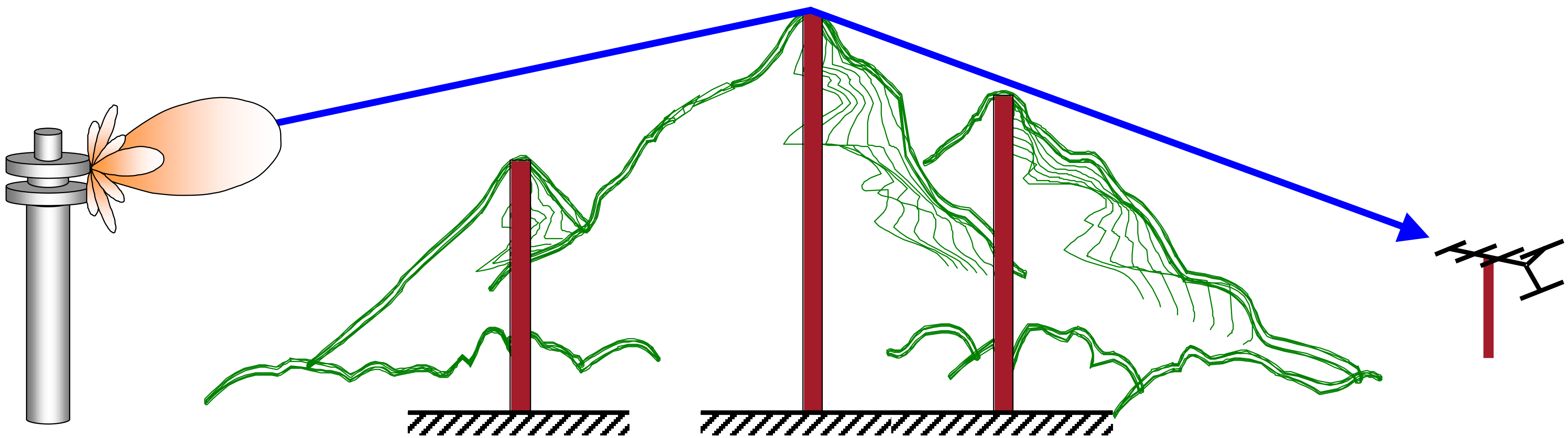
Diffraction:

- 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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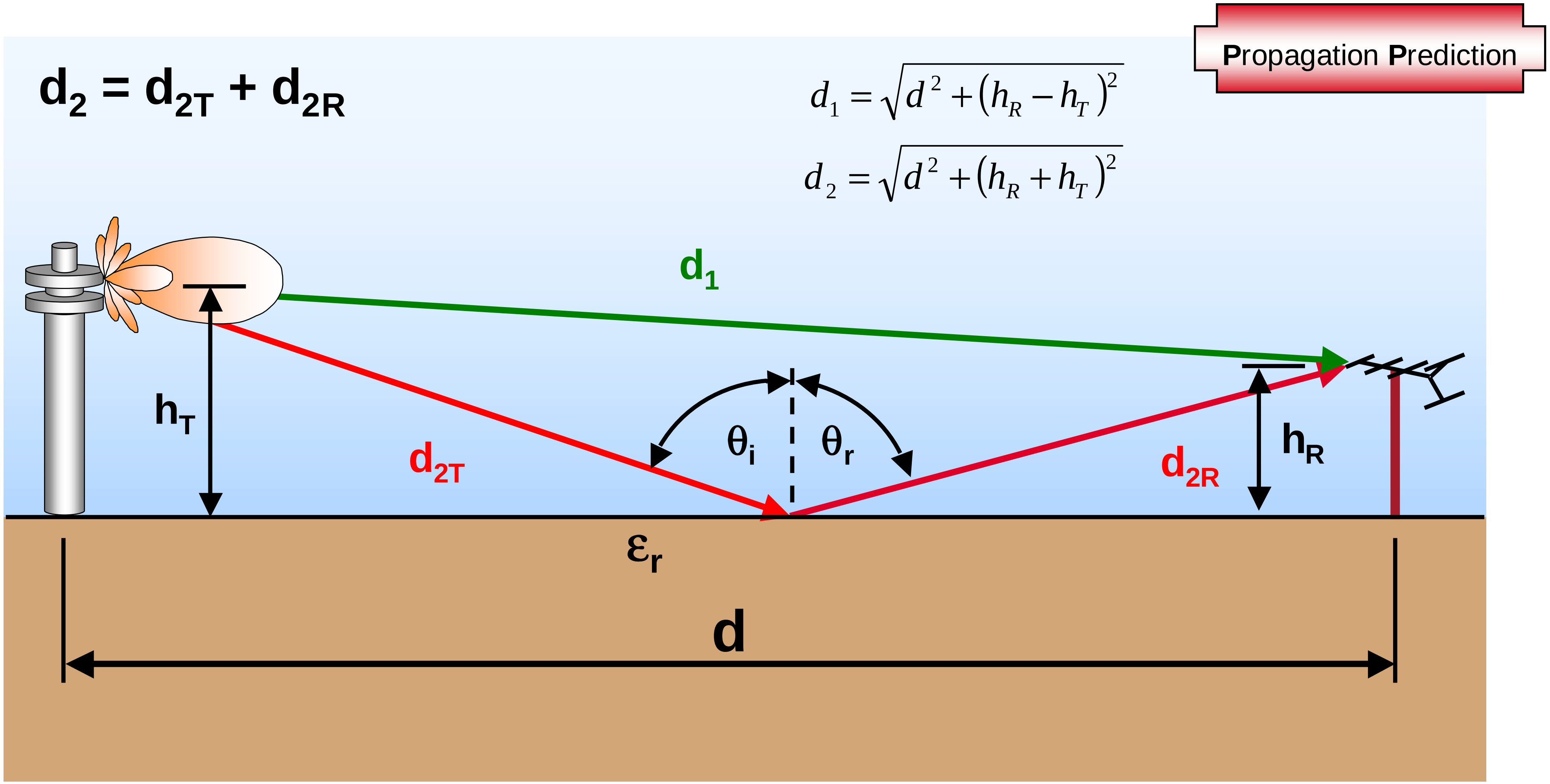
Reflection



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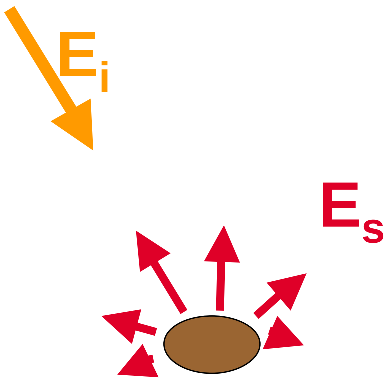
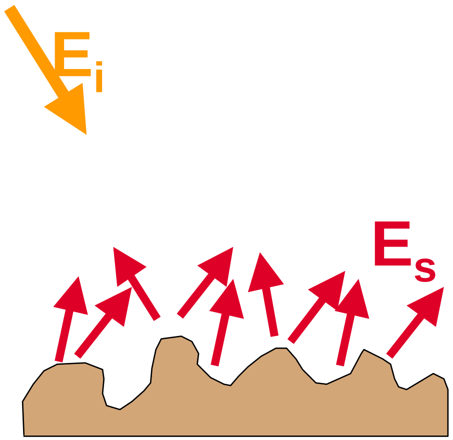
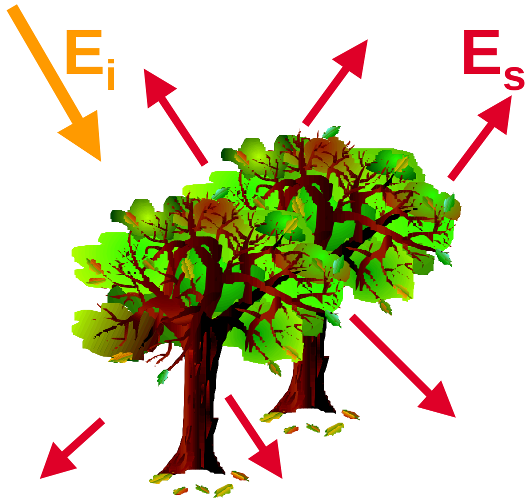
Scattering

from point	from rough surface	from volume
		
analytical model for sphere numerical techniques	modified reflection coefficient	radiative transfer theory statistical models

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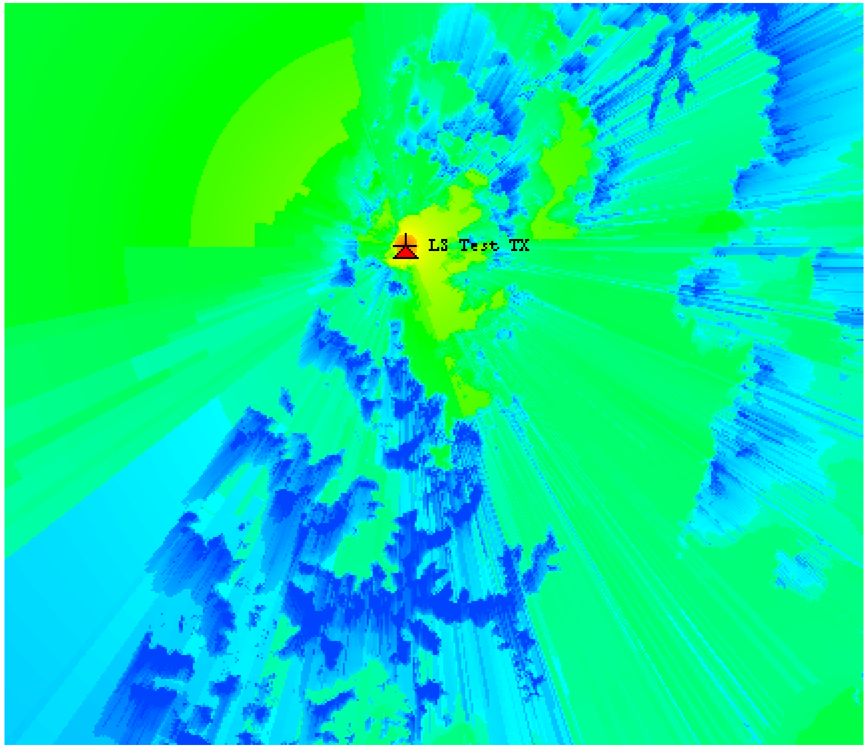
Modern Radio Network Planning Tools offer a wide range of Propagation Models

Propagation Prediction



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

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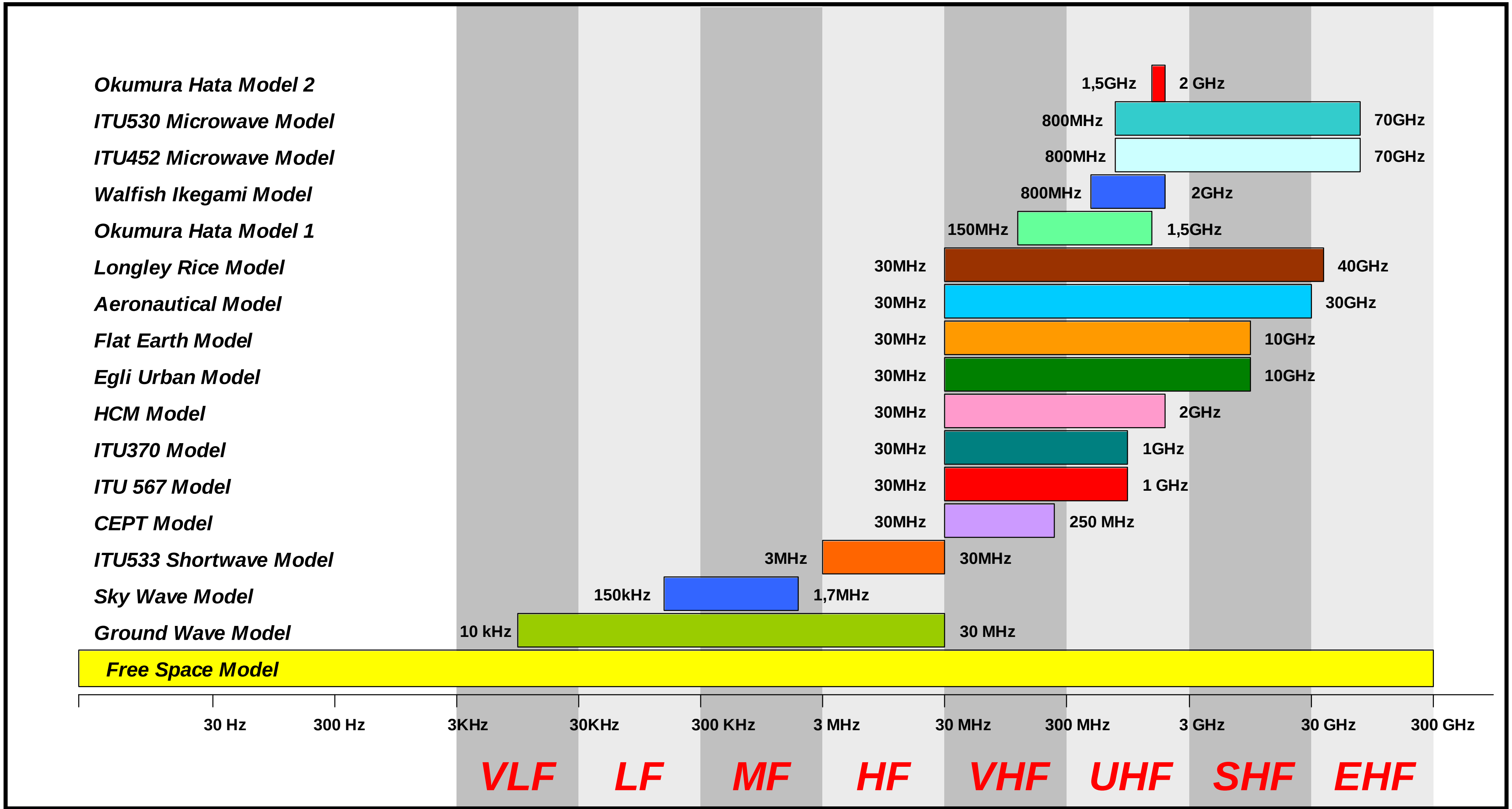
Models and Frequency Ranges



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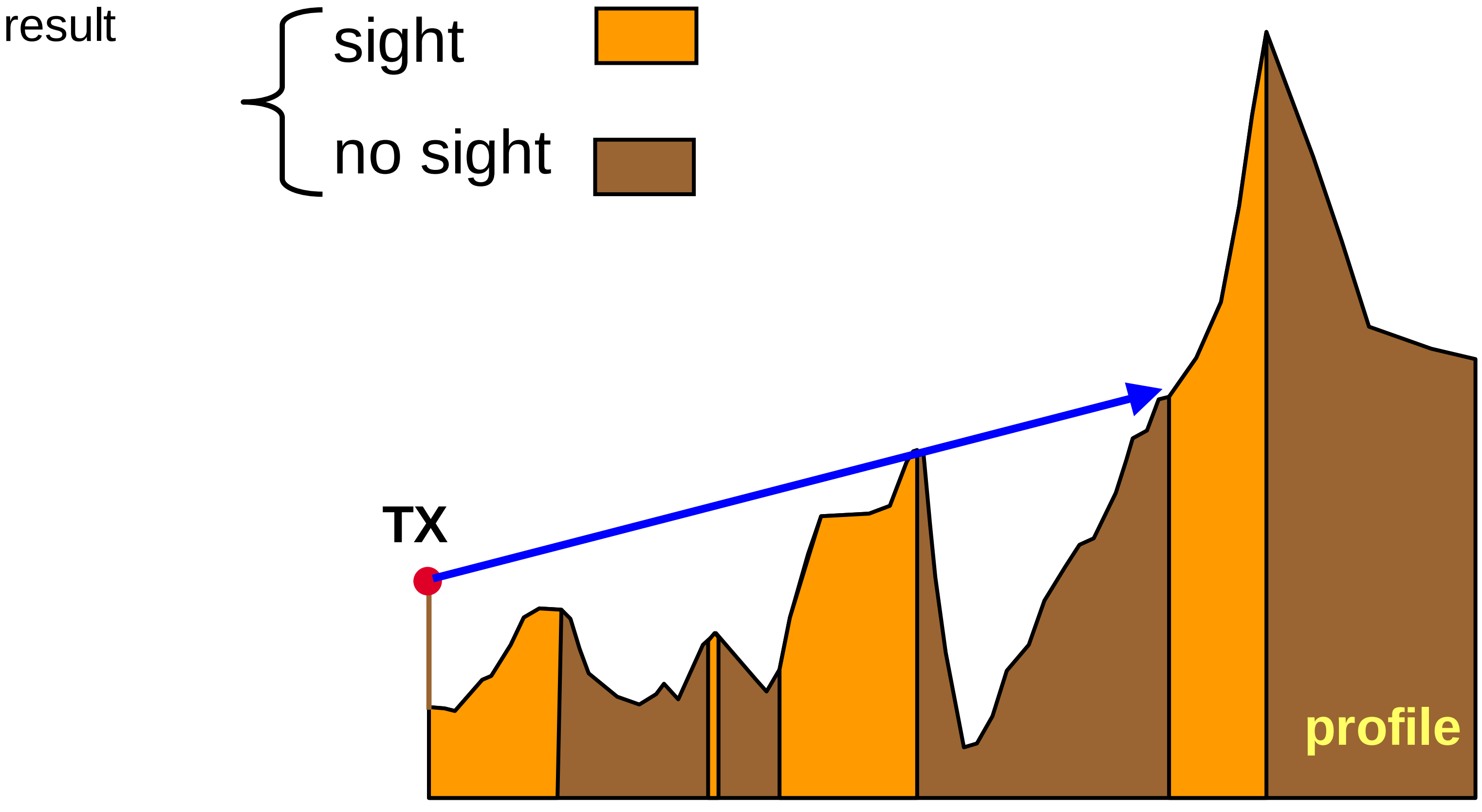
Sight Check

performs line of sight (LOS) check



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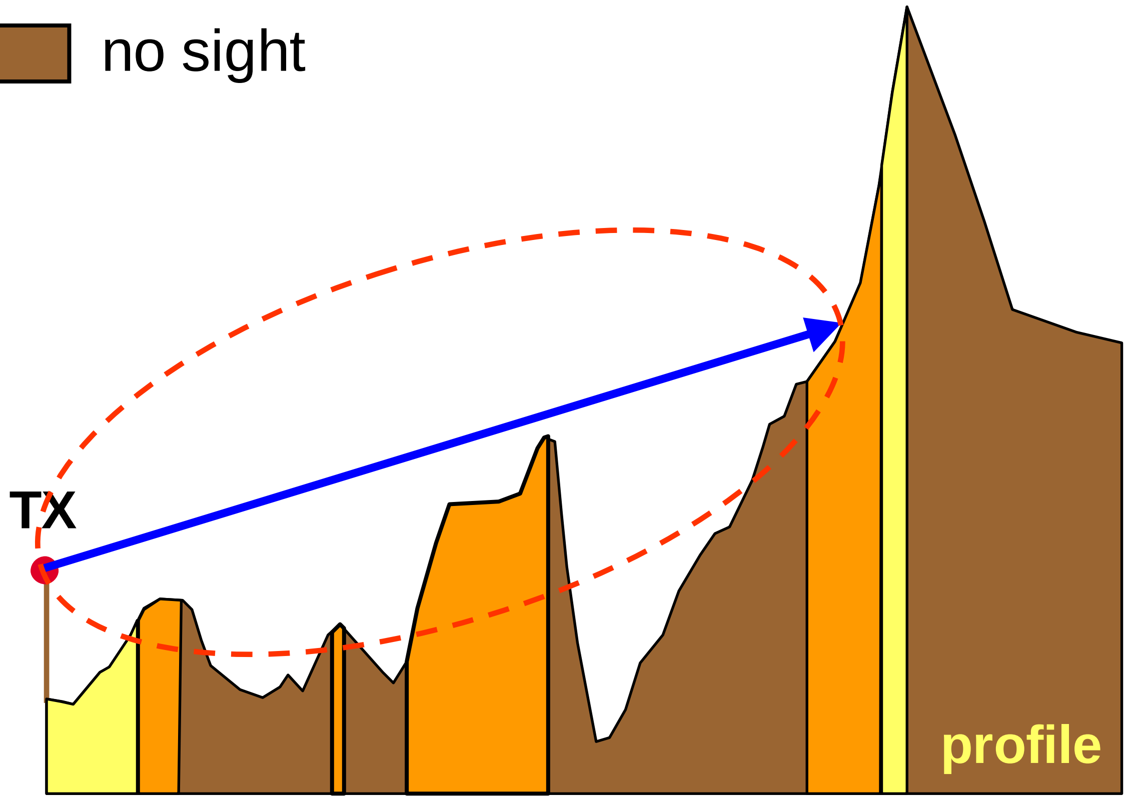
Sight Check (Fresnel)

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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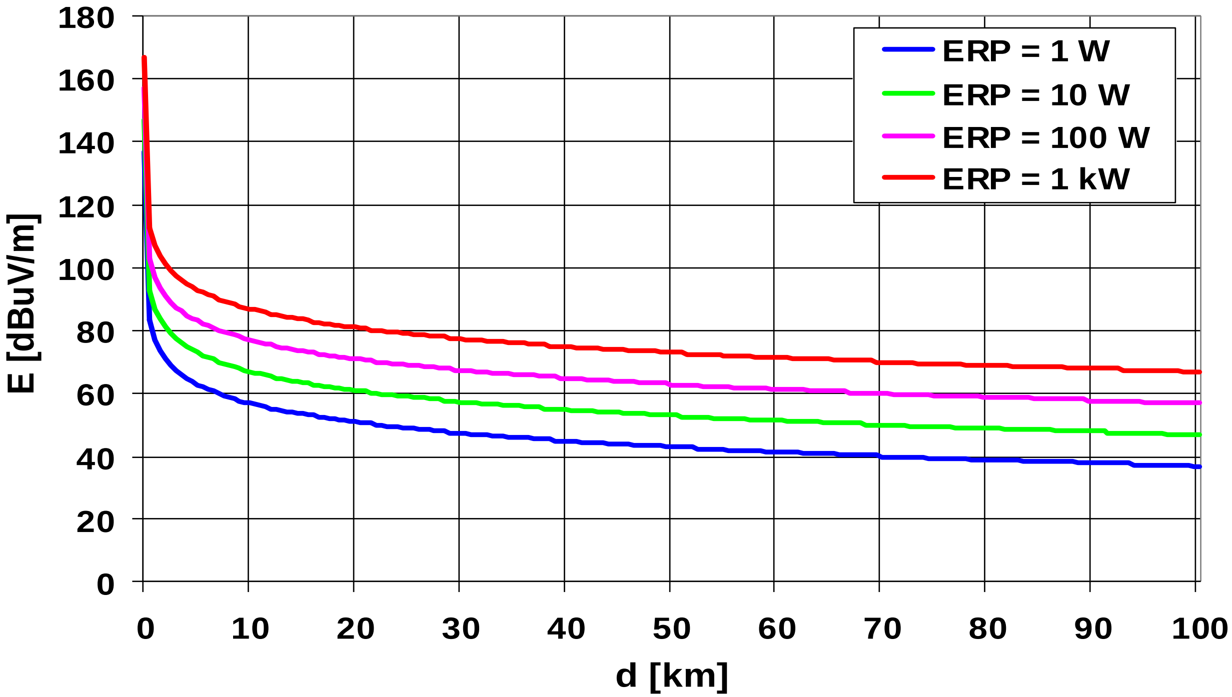
Free Space



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 ≤ d ≤ 15 km)
  - terrain roughness Δh = 50 m (10 km ≤ d ≤ 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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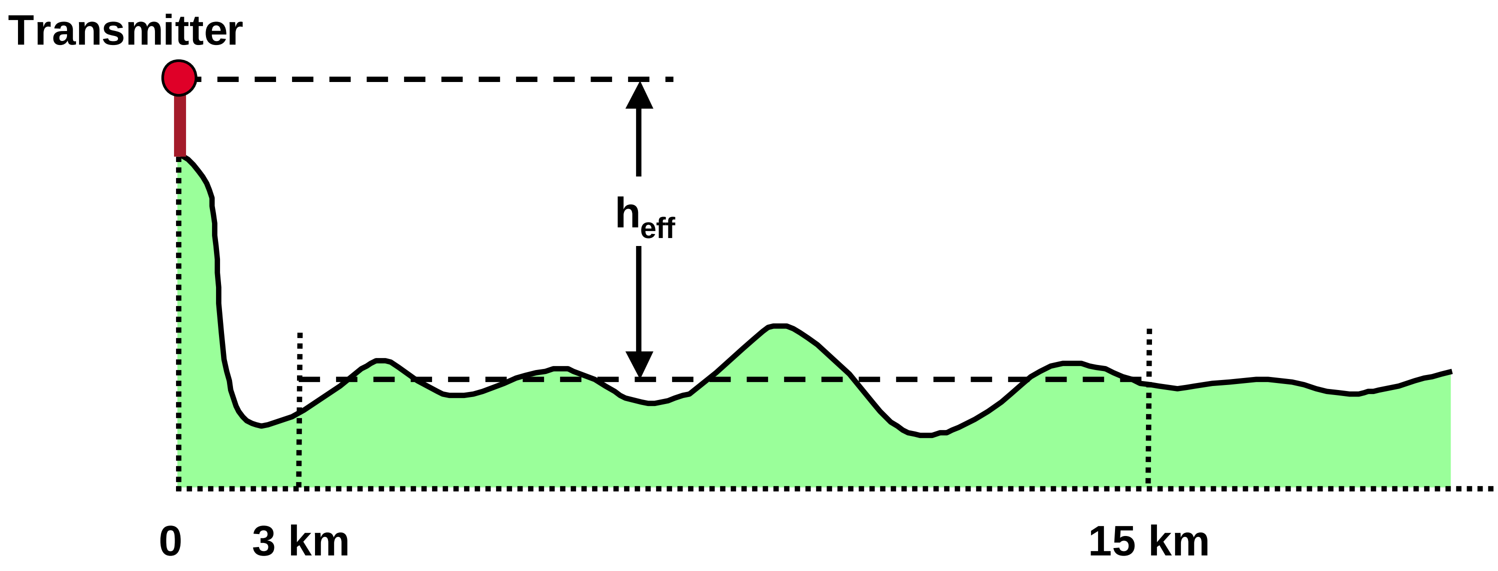
$h_{eff} = h_{site,\ asl} + h_{antenna} - h_{av}$

h_{av}: average terrain height between 3 km and 15 km from transmitter



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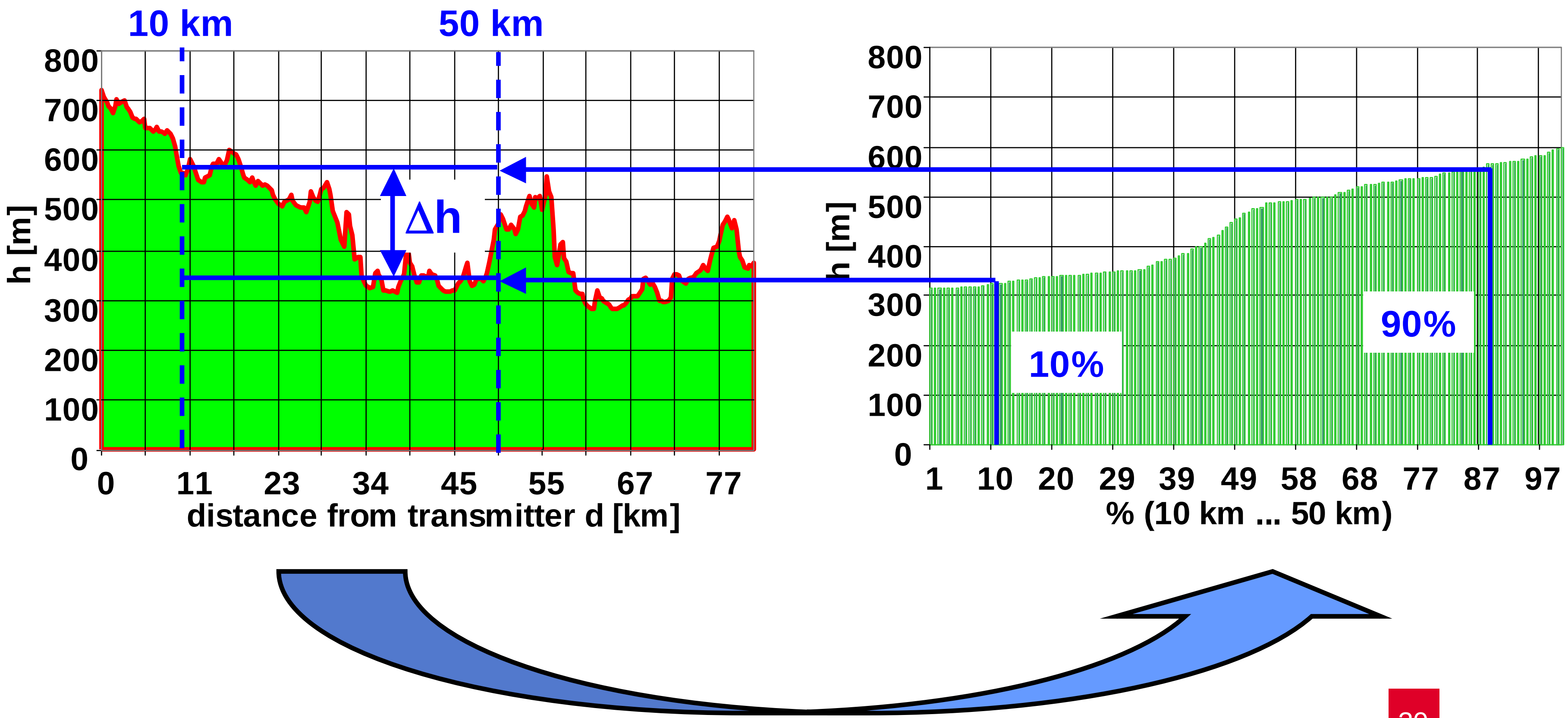
ITU-R 370 - Definition Δh

Δh is the difference between terrain heights exceeded by 10% and 90% of the values between 10 km and 50 km from the transmitter



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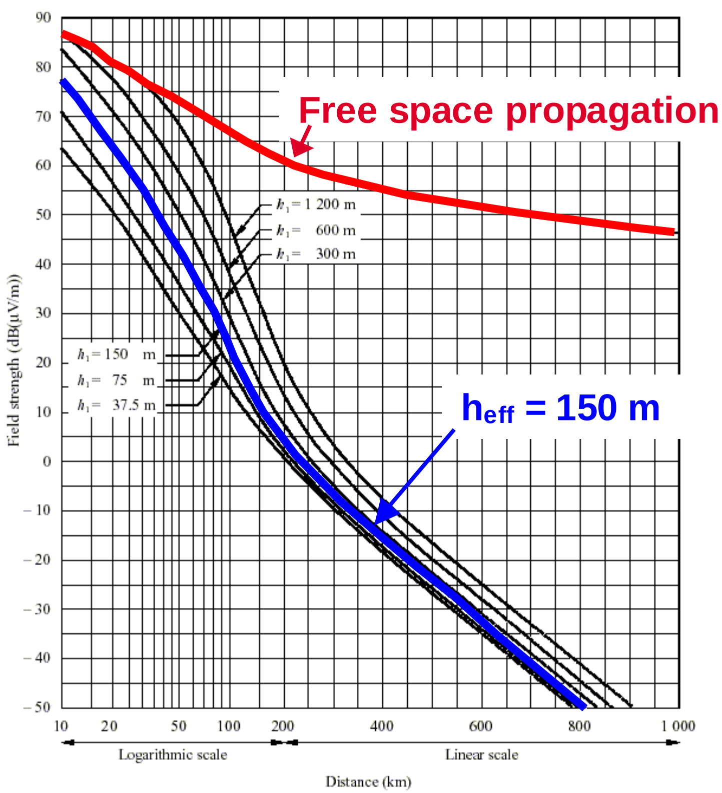
ITU-R 370 – Propagation Curves

Propagation Prediction

Field strength (dB(µV/m)) for 1 kW e.r.p.



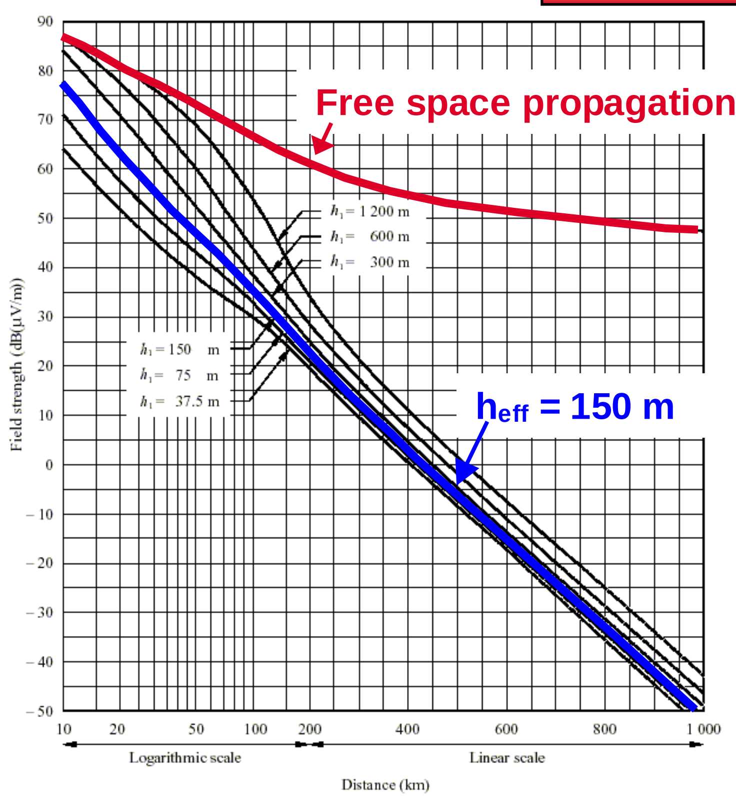
Frequency: 30-250 MHz (Bands I, II and III); land; 50% of the time; 50% of the locations; h_2 = 10 m; Δh = 50 m

——·——·—— Free space

propagation curve 50% time

(steady or continuous)

Field strength (dB(µV/m)) for 1 kW e.r.p.



Frequency: 30-250 MHz (Bands I, II and III); land; 1% of the time; 50% of the locations; h_2 = 10 m; Δh = 50 m

——·——·—— Free space

propagation curve 1% time

(tropospheric)

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3 different Implementations for ITU-R 370 Models

ITU-R 370 Database

effective antenna height from database

Δh = const. from user

ITU-R 370 Transmitter

effective antenna height from database

Δh dynamically from digital terrain data

ITU-R 370 Terrain

effective antenna from digital terrain data

Δh dynamically from digital terrain data

-> see Live Demo

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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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Model parameters for Extended Hata Model

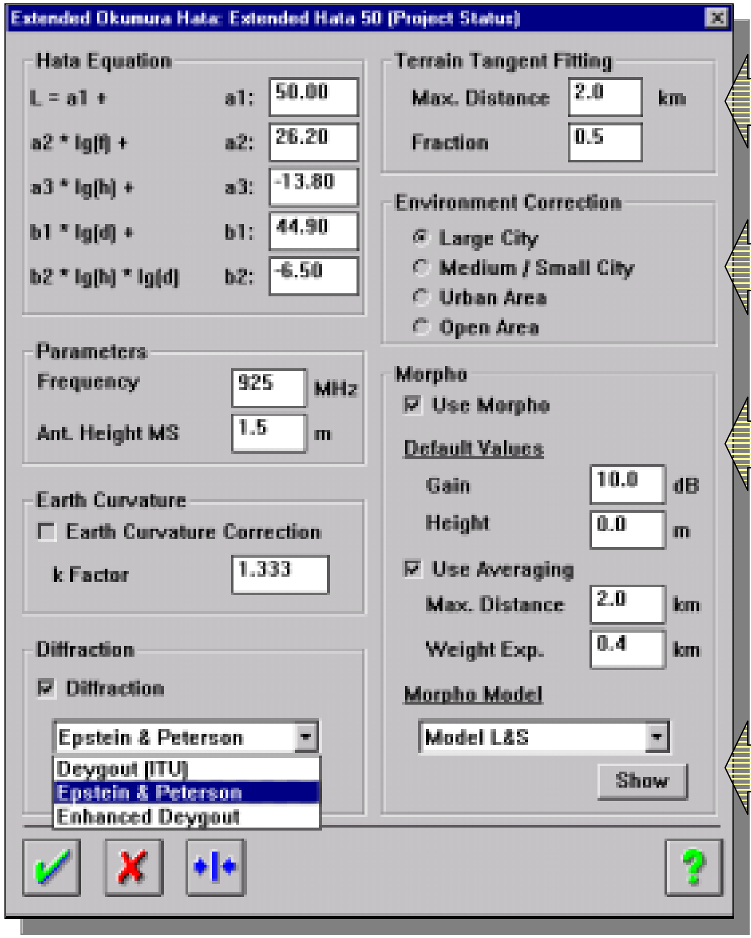
Propagation Prediction

Edit coefficients of hata equation

Set frequency and receiver heigth

Enable earth curvature correction

Enable diffraction model
-Deygout (ITU)
-Epsteint Petersen
-Deygout (enhanced for speed)



Edit parameter for tangent fitting

Select environment correction

Set parameter for morpho model

Select morpho model

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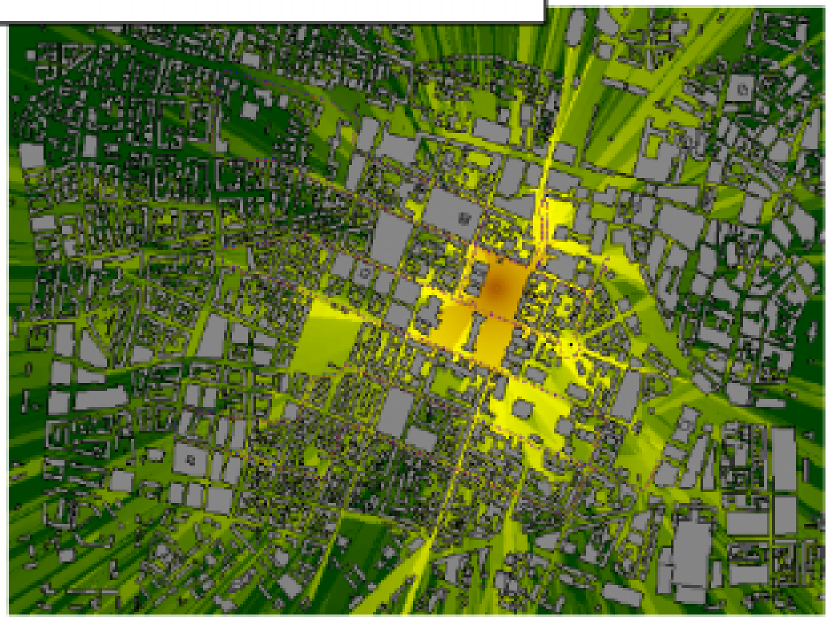
Micro Cell Model

Propagation **P**rediction

HIGH ACCURACY

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



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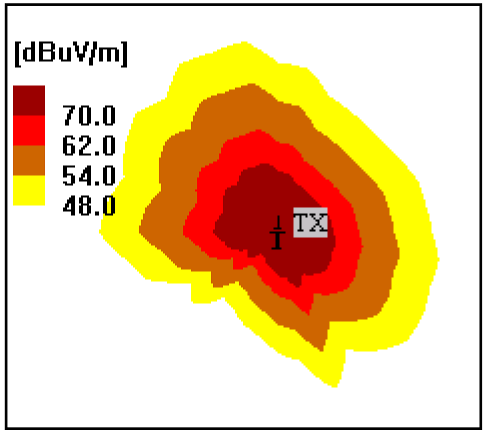
Propagation Prediction

Non-Terrain Based

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

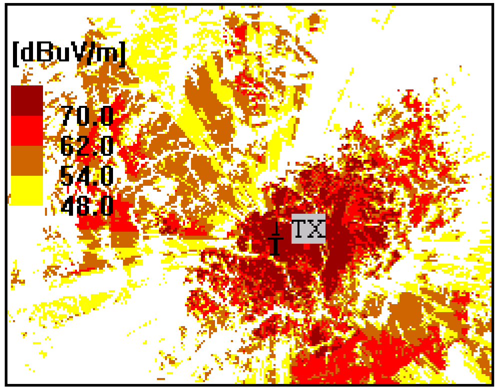
Example: ITU-R P. 370



DTM Based

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

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



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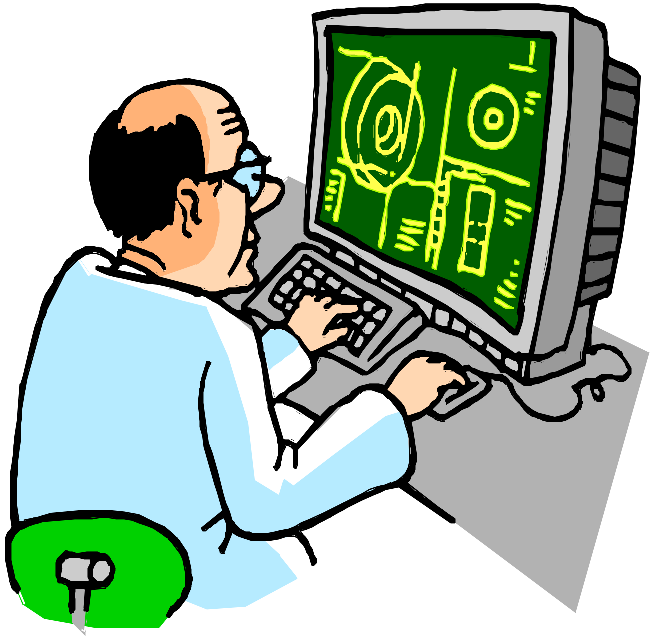

Live
Planning Tool Demonstration

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