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Radio Mobile

Software for Wireless Systems Planning

ICTP-ITU School on
Wireless Networking for Scientific Applications in Developing Countries

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What is Radio Mobile?

- It is a tool for the design and simulation of wireless systems.
- Predicts the performance of a radio link.
- Uses digital maps and GIS (Geographical Information Systems) as well as any other digital map, even the ones digitized by yourself.
- It is public domain software.
- Runs on Windows 95, 98, ME, NT, 2000 and XP.
- Uses Digital terrain Elevation Model for the calculation of coverage, indicating received signal strength at various point along the path.

Terrain Profile

- Radio Mobile automatically builds a profile between two points in the digital map showing the coverage area and 1st Fresnel zone.
- Digital elevation maps (DEM) are available from several sources.
- Different antenna heights can be tried to achieve optimum performance.

Features

- Works from 20 kHz to 200 GHz.
- Checks for line of sight.
- Calculates path loss, including losses due to obstacles.
- Creates networks of different topologies (net master/slave, PTP and PMP).
- Calculates coverage area from the base station in a point to multipoint systems.

Irregular terrain model

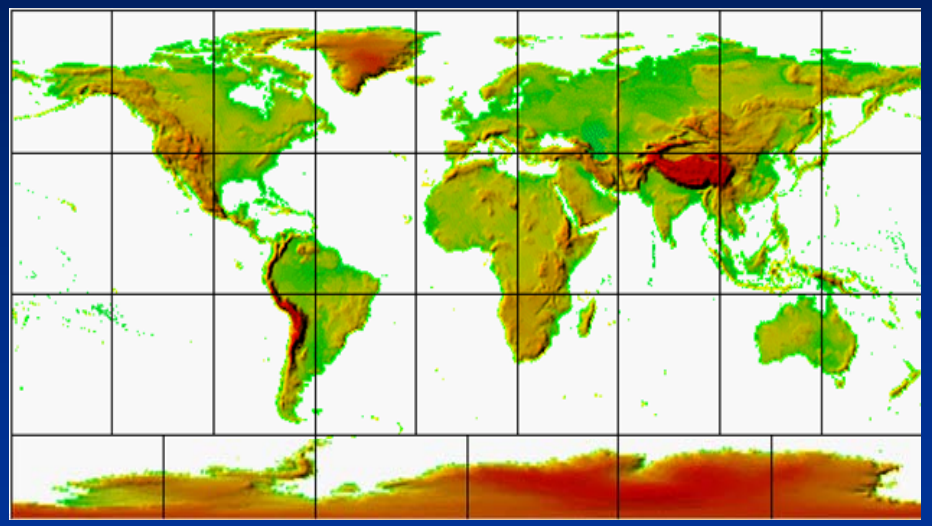
- **The ITS model of radio propagation for frequencies between 20 MHz and 20 GHz (the Longley-Rice model) is a general purpose model that can be applied to a large variety of engineering problems. The model, which is based on electromagnetic theory and on statistical analyses of both terrain features and radio measurements, predicts the median attenuation of a radio signal as a function of distance and the variability of the signal in time and in space**

ITM parameters

d	Distance between the two terminals.
h_{g1}, h_{g2}	Antenna structural heights.
k	Wave number, measured in units of reciprocal lengths;
Δh	Terrain irregularity parameter.
N_s	Minimum monthly mean surface refractivity, measured in N-units;
γ_e	The earth's effective curvature, measured in units of reciprocal length
Z_g	Surface transfer impedance of the ground—a complex, dimensionless number;
radio climate	Expressed qualitatively as one of a number of discrete climate types.

What do you need to create a Network?

- Download Radio Mobile from internet: http://www.cplus.org/rmw/english1.html
- Where to get elevation data?
  - New sources are coming up and usually reported at the Radio Mobile home page



Resolution

- Resolution is expressed in arc sec (1/3600) of a degree
- At the equator, earth circumference is about 40000 km, 1 arc sec ~ 30 m
- At the pole, earth circumference is zero
- Actual east-west resolution depends of latitude, whereas north-south is constant

DEM Sources

- **Free World at 3 arc second resolution (100m) SRTM version 2**
- Shuttle Radar Topography Mission (SRTM) data products - Africa
- Shuttle Radar Topography Mission (SRTM) data products - Australia
- Shuttle Radar Topography Mission (SRTM) data products - Eurasia
- Shuttle Radar Topography Mission (SRTM) data products - Islands
- Shuttle Radar Topography Mission (SRTM) data products - North America
- Shuttle Radar Topography Mission (SRTM) data products - South America

- **Free World and US in BIL format at up to 1/9 arc second resolution (3m)**
- **Seamless data distribution system**
- **Convert BIL to SRTM with BILxSRTM V2**

Pictures

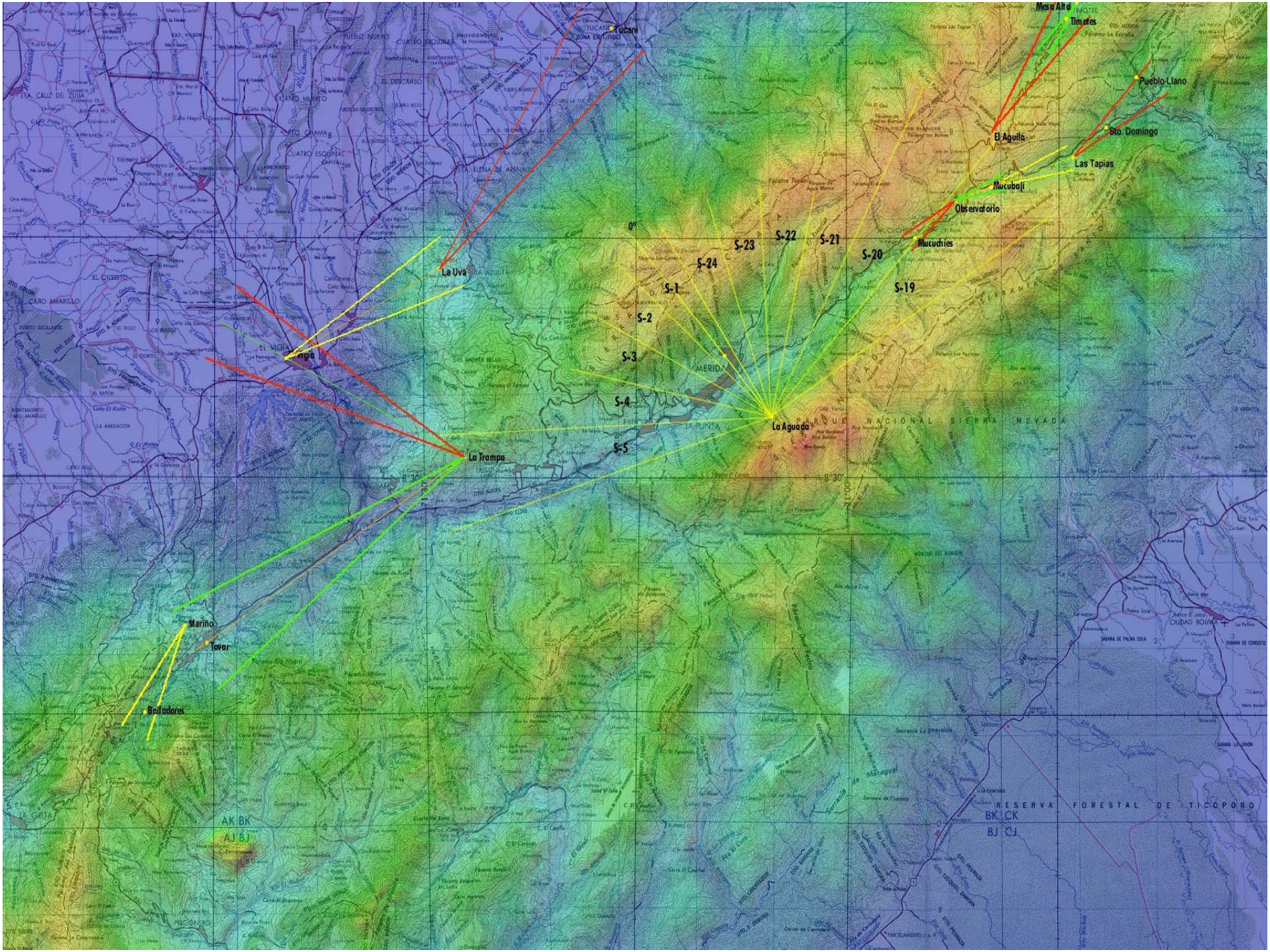
- DEM do not show coastlines or other readily identifiable landmarks, but they can be combined with other kind of data in several layers to obtain a more useful and readily recognizable representation.
- You can digitize your own maps and combine them with DEM

Datum as used here refers to a smooth surface somewhat arbitrarily defined as "zero elevation," consistent with a set of surveyor's measures of distances between various stations, and differences in elevation, all reduced to a grid of latitudes, longitudes, and elevations.

WGS 84. It is currently the reference system being used by the Global Positioning System. It is geocentric and globally consistent within ±1 m
From: Wikipedia

Terminology used in R.M.

- *A radio station is referred to as a **Unit**, there can be numerous Units defined to operate within a given **Network**. Each different type of station used in a network has to be defined with a separate Radio **System** which sets the parameters for that **type** of station, i.e. Transmit Power/receiver sensitivity/antenna gain/antenna height/cable losses.*
- *Thus each Unit will be allocated to an operating system within the network. Finally, all units are given a*
- ***Role**, which is either Command or Subordinate. The effect of this is to set which links are shown on the network display*


Mesa Alta
Timotes
Tucani
Pueblo Llano
Sto. Domingo
El Aguila
Las Tapias
Mucuboli
Observatorio
Mucuchies
La Uva
Virgia
La Trampa
La Aguada
MERIDA
S-1
S-2
S-3
S-4
S-5
S-19
S-20
S-21
S-22
S-23
S-24
0°
8°30'
Marino
Tovar
Bailadores
PARQUE NACIONAL SIERRA NEVADA
RESERVA FORESTAL DE TICOPORO
AK BK
AJ BJ
BK CK
BJ CJ

GPS tracking

- Opens a form in order to initiate GPS position acquisition via a serial port and enter Internet addresses at which position will be reported (see How to use a local GPS and report position)

Elevation grid

- The deployment area is a rectangular zone with horizontal coordinates for the center position and a size in kilometers that should be large enough to contain all units
- Opens a small window that shows 5x5 elevation data records centered at cursor position along with cursor coordinates

Deployment area

- The deployment area is a rectangular zone with horizontal coordinates for the center position and a size in kilometers that should be large enough to contain all units

Maps

- Maps are based on a matrix of up to 2000x2000 elevation records (meters above sea level), which can be saved in a file with a .MAP extension. Map data can be viewed with the Elevation grid.
- **Terrain Elevation Data**
- Digital Terrain Elevation Data (MIL-D-89020 AMENDMENT 1).
- Maps are based on digital terrain elevation data. The program can actually access a resolution of 1, 3, or 30 seconds of an arc, which corresponds to a spacing of approximately 30m, 100m, or 1 km between records.

What do you need to create a network?

- Obtain the coordinates of your stations.
  - From Maps, GPS, or database
  - For example: Site 1 (Main Repeater Galileo 13º43’11’’ E, 45º42’15’’N)
- Specifications of the system:
  - Topology of the network (Point to multipoint,PP).
  - Gain of antennas and type.
  - Max Transmit power (Watt or dBm).
  - Line or guide wave loss.
  - Received power level (dBm).
  - Antennas height in meters.
  - Frequency of operation.
  - Polarization used.
  - Other parameters of radio link and radio communications.

Acquire elevation data

Step by step

- 1. In View menu, select World map. On the world map picture, click on the desired position for the map center position.
- 2. In File menu, select Map properties. This will open a form with all the necessary controls to create a map. Click on Use cursor position button.
- 3. Optionally use city or coordinates in DMS (Latitude and longitude in degree, minute, second) to enter a more precise position for the center of the map.
- 4. Select the database and associated logical drive.
- 5. Select 400x400 pixels and 100 km size.
- 6. Click on the Apply button.
- 7. If an error message occurs, verify the database drive and redo from step 2.
- 8. In File menu, select New picture (See How to create a map picture).

Set up the network

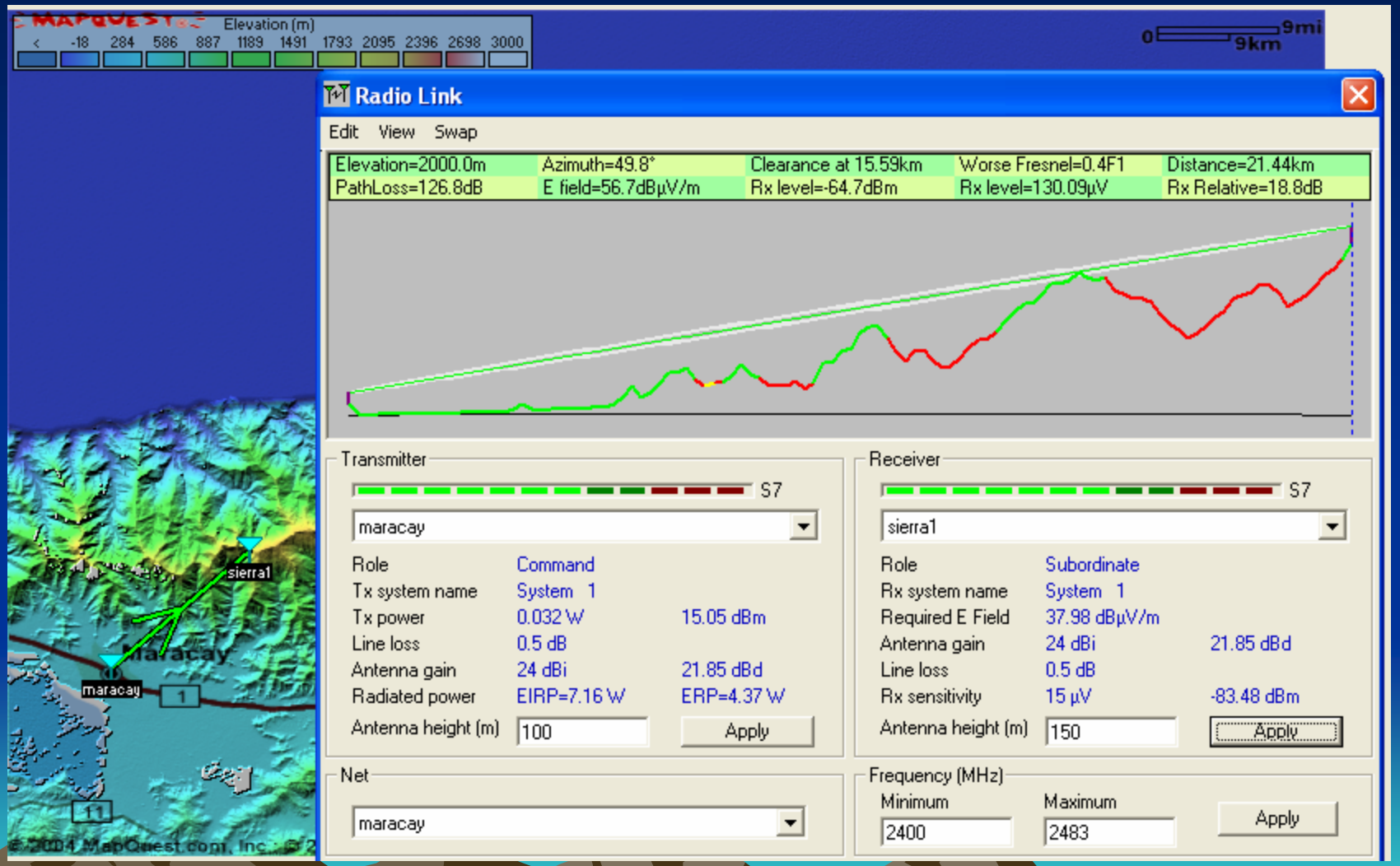
Step by step

- 9. In the file menu select Networks properties. Enter network name, frequency of operation, polarization and climate. Accept defaults for the other parameters.
- 10. Click the Systems tab. Enter System name, Tx power, RX Threshold, line loss, antenna gain, and antenna height. Then select add to radiosys.dat.
- 11. Repeat the previous step for the other site(s). You can have a different antenna gain in different systems. Then click Apply.
- 12.From the file menu, select unit properties. There are several methods for specifying the unit. If you enter the coordinates, the altitude will be calculated from the DEM. West and south coordinates will be negative.
- 13. Repeat for all the units involved

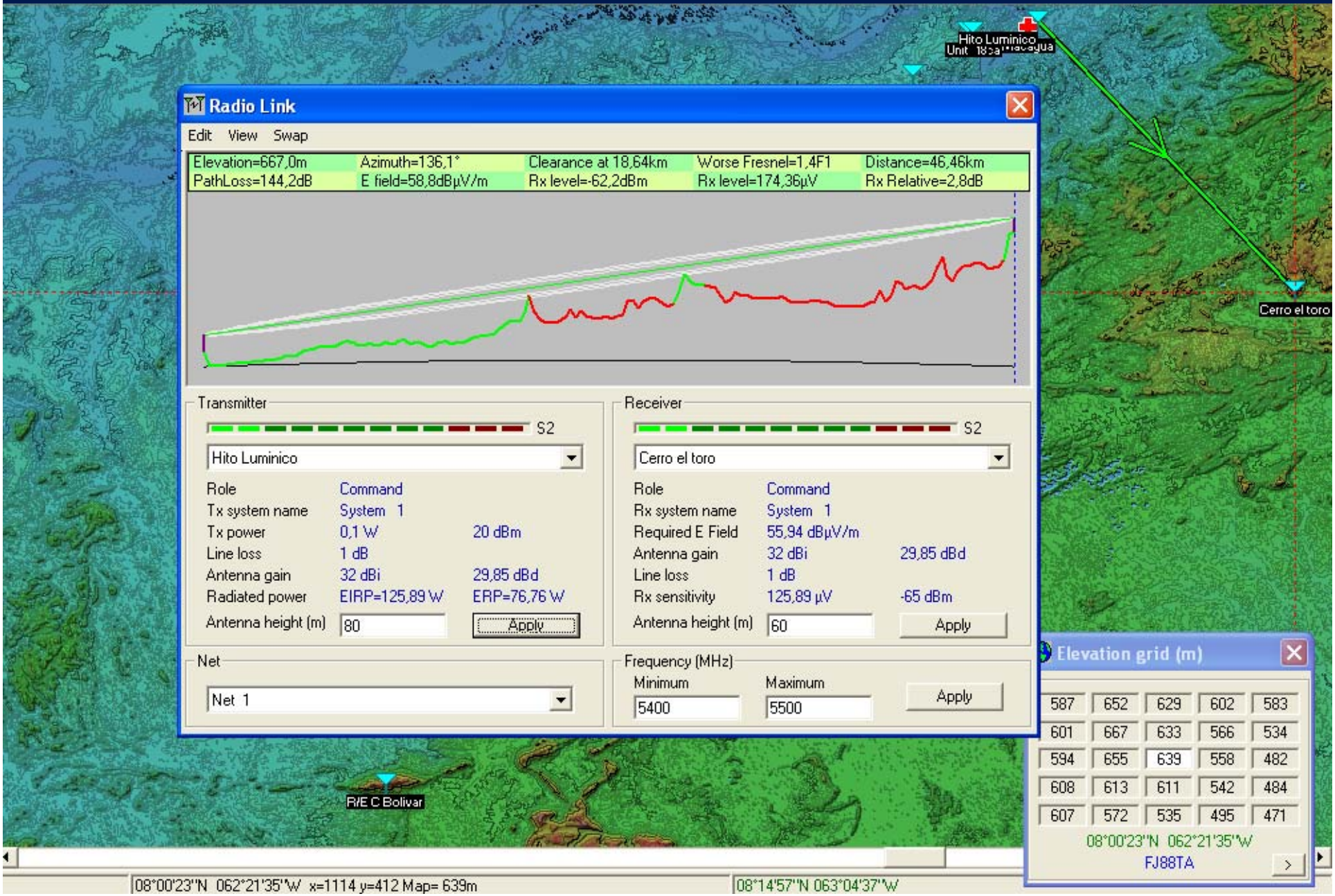
Radio Coverage

- **Radio link:**
  - Opens a form with a picture box that shows earth profile, radio performance, and observation features between each pair of units (see Radio link and system performance).
- **Visual coverage:**
  - Opens a form in order to initiate visual coverage drawing on a map picture (see How to perform visual coverage).
- **Radio coverage:**
  - Opens a form in order to initiate radio coverage drawing on a map picture (see How to perform radio coverage).

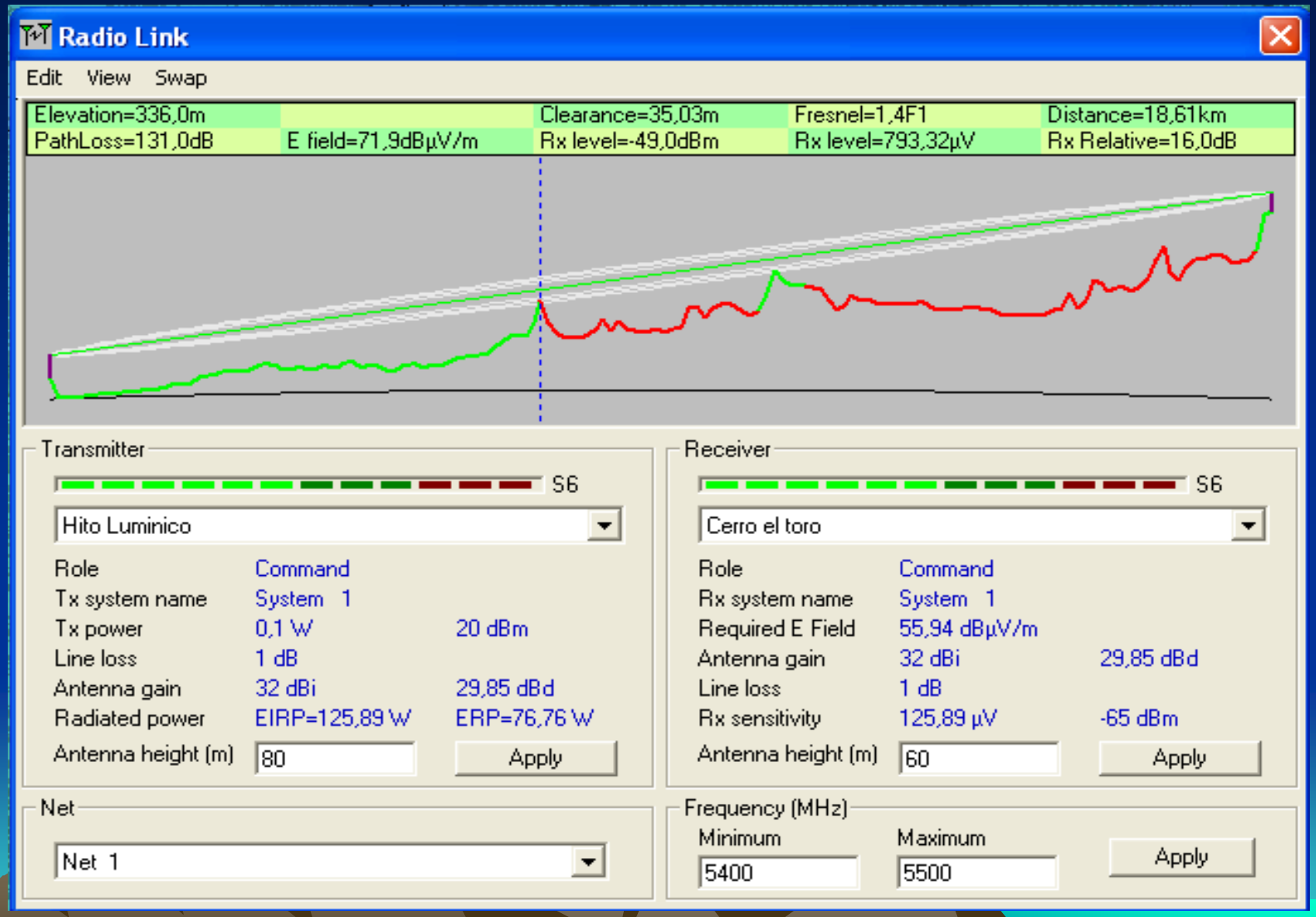
Example

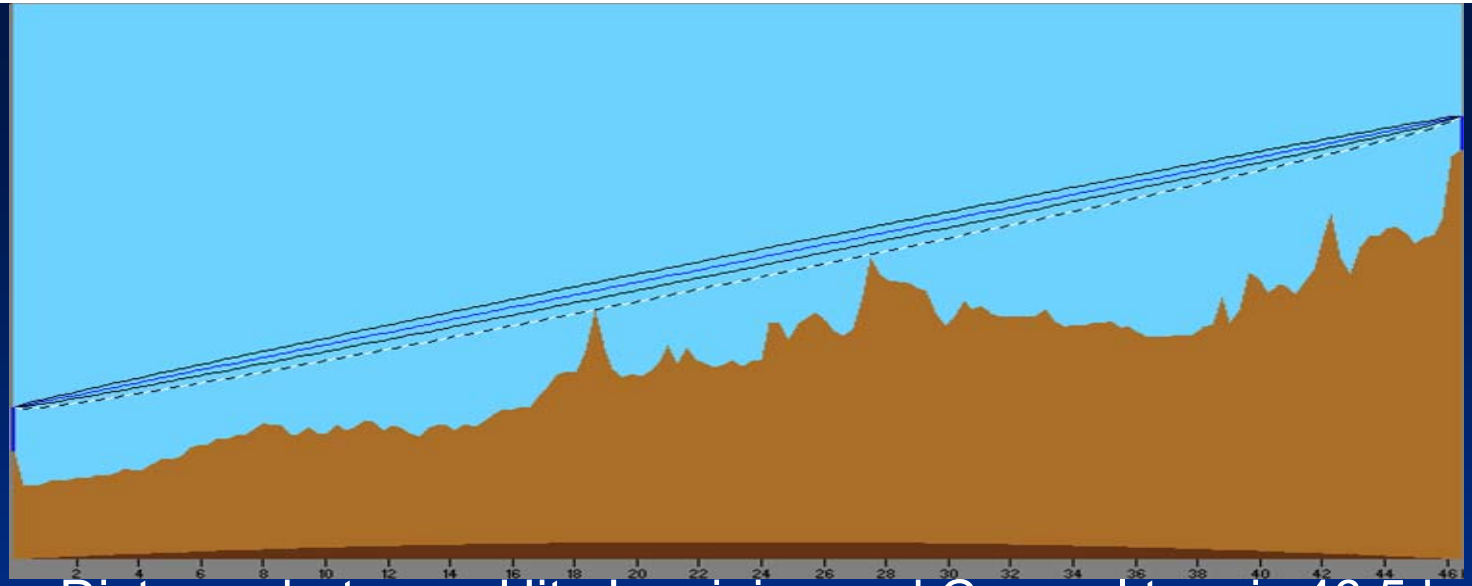

Elevation (m)
< -18 284 586 887 1189 1491 1793 2095 2396 2698 3000
0 9mi 9km
Radio Link
Edit View Swap
Elevation=2000.0m Azimuth=49.8° Clearance at 15.59km Worse Fresnel=0.4F1 Distance=21.44km
PathLoss=126.8dB E field=56.7dBµV/m Rx level=-64.7dBm Rx level=130.09µV Rx Relative=18.8dB
sierra1
maracay
maracay
1
11
Transmitter
S7
maracay
Role Command
Tx system name System 1
Tx power 0.032 W 15.05 dBm
Line loss 0.5 dB
Antenna gain 24 dBi 21.85 dBd
Radiated power EIRP=7.16 W ERP=4.37 W
Antenna height (m) 100
Apply
Receiver
S7
sierra1
Role Subordinate
Rx system name System 1
Required E Field 37.98 dBµV/m
Antenna gain 24 dBi 21.85 dBd
Line loss 0.5 dB
Rx sensitivity 15 µV -83.48 dBm
Antenna height (m) 150
Apply
Net
maracay
Frequency (MHz)
Minimum 2400
Maximum 2483
Apply

Another Example, 5.4 GHz



Another Example, 5.4 GHz





- Distance between Hito Luminico and Cerro el toro is 46,5 km (28,9 miles)
- True North Azimuth = 136,1°, Elevation angle = 0,4606°
- Terrain elevation variation is 615,0 m
- Propagation mode is line-of-sight, minimum clearance 1,4F1 at 18,6km
- Average frequency is 5450,000 MHz
- Free Space = 140,5 dB, Obstruction = 3,8 dB, Urban = 0,0 dB, Forest = 0,0 dB, Statistics = -0,1 dB
- Total propagation loss is 144,2 dB
- System gain from Hito Luminico to Cerro el toro is 147,0 dB
- System gain from Cerro el toro to Hito Luminico is 147,0 dB
- Worst reception is 2,8 dB over the required signal to meet
- 50,0% of time, 50,0% of locations, and 50,0% of situations

From theory to practice….

The site survey is always required!

From theory to practice….

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More Info.

- Radio Mobile Yahoo Group
- G8GTZ how to get started guide
- G3TVU Quick start guide
- Greg Bur alternative source of documentation
- Merging pictures
- Find best sites - Basics
- Find best sites - A field experience from Ian G3TVU
- Google Earth