

ITRAINONLINE MMTK OUTDOOR RADIO SIMULATION HANDOUT

Developed by: Alberto Escudero Pascual, IT +46
(Getting started with "Radio Mobile")

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1. About this document

These materials are part of the ItrainOnline Multimedia Training Kit (MMTK). The MMTK provides an integrated set of multimedia training materials and resources to support community media, community multimedia centres, telecentres, and other initiatives using information and communications technologies (ICTs) to empower communities and support development work.

1.1 Copyright information

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1.2 Degree of Difficulty

The degree of difficulty of this unit is Medium.

2. Introduction

In the unit “Planning and Budgeting” we discussed the need of a good site survey before purchasing any hardware. A typical site survey will include details about the existing physical and technical infrastructure, licensing, access to electricity and Internet, etc. A viability study of your network can/should include a radio simulation of your proposed design.

By simulating your wireless deployment, you will be able to evaluate the viability of a network architecture (topology) and estimate the number of nodes needed to cover a certain area. This unit serves as an introduction to the software “Radio Mobile”, a radio simulation tool for outdoor environments.

3. What is Radio Mobile?

Radio Mobile is a software tool written by Roger Coudé (VE2DBE) that it is used to predict the performance of outdoor radio systems. Although it was initially conceived for traditional amateur radio systems (voice and data communications in UHF and VHF), it allows calculations of link budgets in a wide frequency range. Radio Mobile uses the information from terrain elevation data (digital maps) to automatically compute the path profile between an emitter and a receiver.

The software uses the ITM (Irregular Terrain Model) for radio propagation. The ITM or Longley-Rice Model (1968) is a general purpose model based on electromagnetic theory and statistical analysis of terrain features. Radio Mobile implements ITM and because the model is valid in the range of 20 Mhz to 20 Ghz, the software can be used to predict the median attenuation of radio signals in WLAN and WMAN systems.

Radio Mobile does not only calculates link budgets but can produce a variety of virtual maps, 3D views, stereoscopic views, and even animations.

Unfortunately, for legal reasons the maps need to be downloaded at least “once” from the Internet as its relies on external sources for cartography.



If you are going to use Radio Mobile for your simulations, download all the required maps before going to the field. You might require 2-10 MB of digital cartography.

4. What is SRTM?

SRTM stands for Shuttle Radar Topography Mission and is a NASA project that provides free digital topographic data. This cartography contains data samples of heights obtained by radar in intervals of 30-90 meters¹.

For Africa, the images has a precision of 3 arcs of a second or 90 meters.

¹<http://www2.jpl.nasa.gov/srtm/>

5. Installing Radio Mobile 7.1.5

Radio Mobile is written in Visual Basic and requires you to install the Visual Basic Runtime (Service Pack 6). Download **vbrun60sp6**, install and reboot your computer.

Once you have the Visual Basic Runtime installed, download the following files:

- Radio Mobile Executables (**rmw715.zip**)
- Radio Mobile Supplementary (sup.zip)
- Radio Mobile Network Examples (net.zip)

Three extra libraries (DLLs) are needed for extra functionality:

- Enables saving pictures in jpeg, tiff and png formats: (freeimage.zip)
- Enables the automatic download of ZIP compressed SRTM files (unzip32.zip)
- Enables Azimuth relative to Magnetic North (geoStarsLib.zip)

As the software does not include an installer, the easiest way it is to create a new folder [C:\Radio Mobile 7.1.5](#) and unzip all files there.



You can find all the links to the software here:

<http://www.cplus.org/rmw/download.html>

Ensure that you have the Visual Basic runtime installed.

Radio Mobile does not include an installer, create a new folder [C:\Radio Mobile 7.1.5](#) and unzip all files there.

6. Radio Mobile Building Blocks

As a short tutorial to Radio Mobile, we focus on four basic tasks that will allow us to discover all the potential of the software.

1. Position and Cartography
 - Where is the **site**?
 - Which **maps** can we use (see Section 6.1)?
2. Radio Network Properties and Topology
 - What **type** of **equipment** do we want to use?
 - **Where** do we place the radio units (see Section 6.2)?
3. Radio Link Budget Analysis
 - What is the **performance** of each link (see Section 6.3)?
4. Coverage Areas.
 - What is the **maximum distance** that can we cover (see Section 6.4)?

6.1 Position and Cartography

File > Map Properties

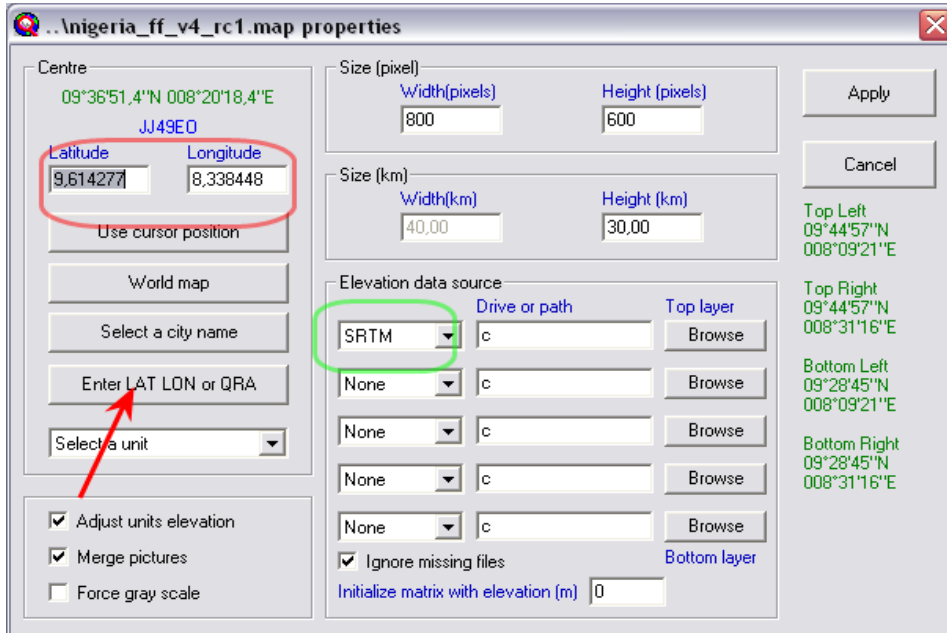


Image 1: Inserting your GPS position and the source of digital cartography

1. With the help of a GPS or the Internet, find out the **GPS position** of your site. Include the latitude (LAT) and longitude (LON) (red arrow)
2. Decide which **type** of digital maps you want to use, the SRTM (green highlighted area) is a good default value here. The NASA's Shuttle Radar Topography Mission (SRTM) contains elevation data on a near-global scale and is one of the most complete high-resolution digital topographic databases.
3. Define your map resolution and area of simulation (km)
 - Set the size [px] (good default value is 800x600)
 - Set the area [km] you want to display (good default value is 40 km x 30 km)

Now go to: **Options > Internet**

In this menu, you will select the default sources for SRTM digital pictures and what to do with them once they are downloaded locally. In the example, I am downloading the SRTM files from NASA from a ftp site (red highlighted area) and storing the files in C:\rms\maps\200601 when downloaded.

In our example, we are using SRTM as source of digital cartography.

1. Use one the predefined download sites for maps for SRTM or input your own URL (red arrow)
2. Store the files locally when downloaded, second check highlighted area and Local files path C:\rms\maps\200601 (green highlighted area)

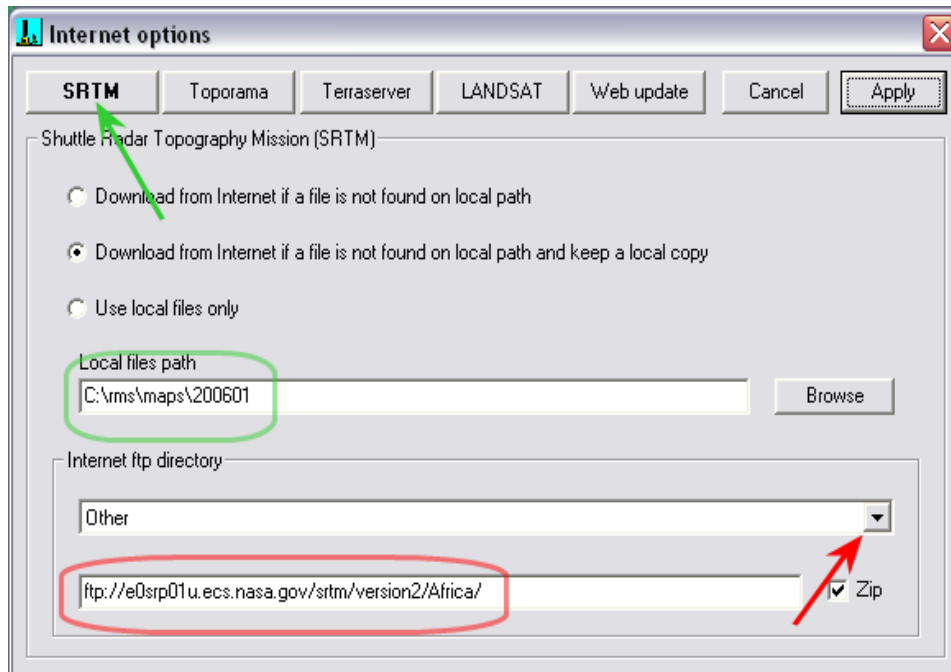


Image 2: Choosing the source for SRTM cartography



If you want to use the very latest SRTM version 2 maps, use the following website:

<ftp://e0srp01u.ecs.nasa.gov/srtm/version2/Africa>

If you have problems downloading the maps, make sure that you are not behind a firewall that blocks PASV FTP.

6.2 Radio Network Properties and Topology

It is worth to spend some time to understand the different terminology that Radio Mobile uses in the software:

- **Network:** a network is a group/cluster of radio units operating at a given frequency (range) under the same weather and terrain conditions.
- **System:** a specification of a system that includes a radio unit, antennas, cables, losses and height of towers. It is not the physical radio unit itself, it is a functional specification(s) that can be associated to physical units. In Radio Mobile, a “system” is a “predefined radio kit”.
- **Unit:** the equipment of certain “system” type that we place in a physical location.
- **Membership:** the act of defining which units that are member of a network and under which specification (system).

Imagine the following scenario:

- Place one repeater radio unit at the top of a hill and interconnect two clients (1 & 2) units. The network is composed by three units (Test Repeater + Client 1 + Client 2).
- We have two type of systems, one with an omni antenna antenna and high output power and a second type of system with a directive antenna and medium output power. We will call these systems (*Repeater 1 W System*) and (*Client 0,03 W System*).
- We want to use a unit of type (*Repeater 1 W System*) in the repeater, and two units (*Client 0,03 W System*) as clients.
- We are looking for the best place for the repeater. We will call this network (*Best Repeater*) and it will operate it in 2.4 Ghz. Members of this network include: Test repeater, Client 1 and Client 2.

The following settings take place under **Network and Unit Properties**

1. Creation of a new “logical network (Create Network: Best Repeater) (see Section 6.2.1)
 - File > Network Properties > Parameters
2. Define the types of systems that are going to be in this network (Create Systems: Repeater 1 W, Client 0,03 W) (see Section 6.2.2)
 - File > Network Properties > Systems
3. Create and Place units in a physical position (Create and Place: Client 1, Client 2, Test Repeater) (see Section 6.2.3)
 - File > Unit Properties
4. Associate Units to a network. Associate Units to a “system” specification. (see Section 6.2.4)
 - File > Network Properties > Membership

6.2.1 Creating a logical network

File > Network Properties > Parameters

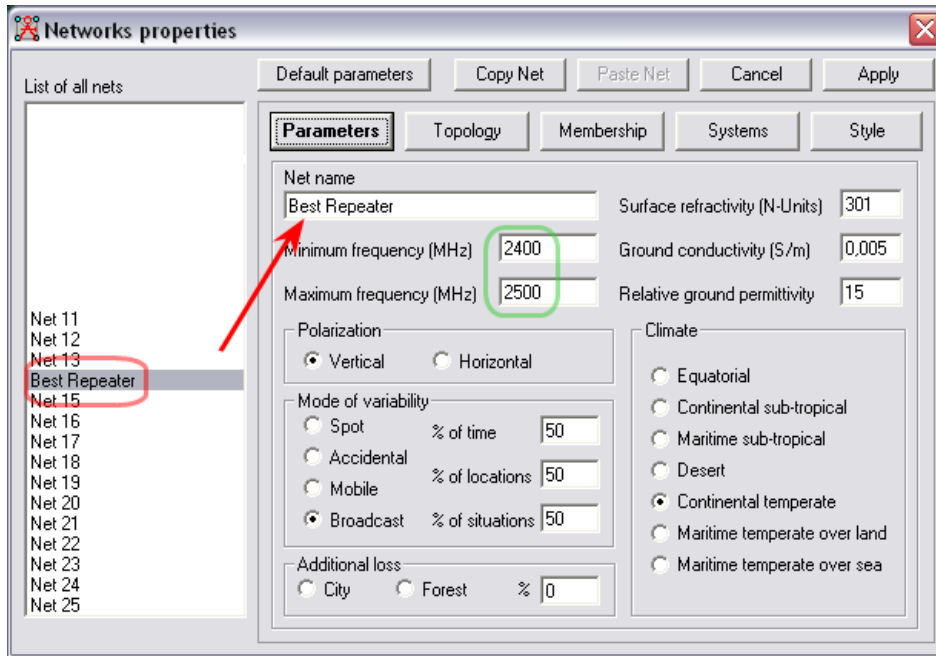


Image 3: Creating a new “logical network”

Creating a new logical network only requires that you specify the frequency range (green highlighted area) and the name of the network (red arrow)

Although there are many other parameters that you can set in this section, pay special attention to the *frequency of operation*.

6.2.2 Creation of systems specifications

File > Network Properties > Systems

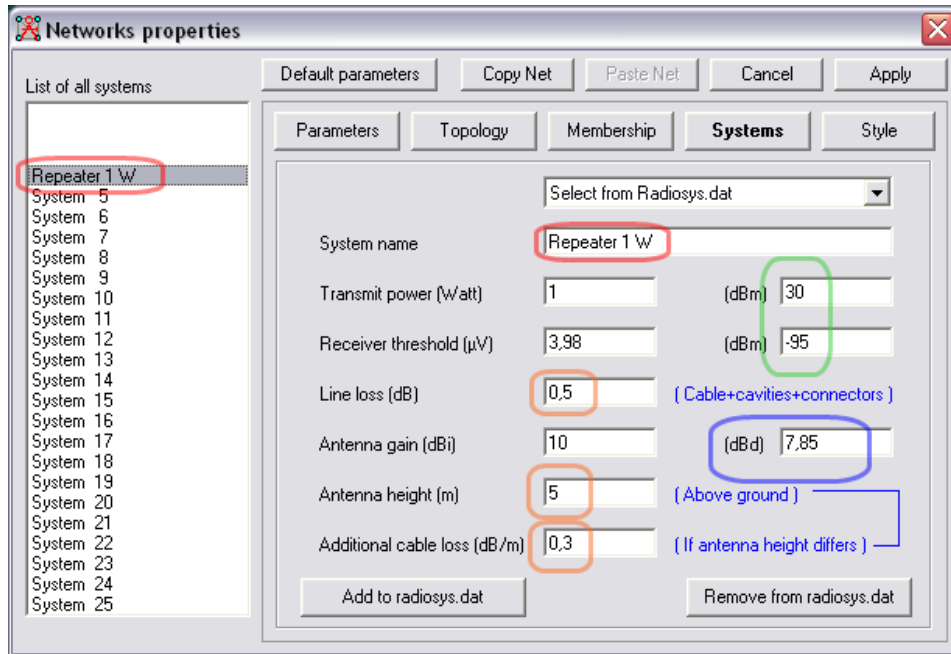


Image 4: Adding the new system "Repeater 1 W"

Take the data sheet(s) of the equipment that you plan to use and input the values accordingly.

We are going to create two very different types of systems: a repeater system operating with 1W and a client-type operating at 0.03W.

In this example we are considering a first system (Repeater 1W) with an output power of 30 dBm and a receiver sensibility of -95 dBm for 2 Mbps (green highlighted area).

For this specification we are considering a default value of:

- 0.5 dB in line loss (pigtail, cavities and connectors)
- 5 meters of cabling (orange highlighted area)
- an omnidirectional antenna of 10 dB (6,85 dBd) gain (blue highlighted area)

It is a good idea to always use very conservative values in your simulations.

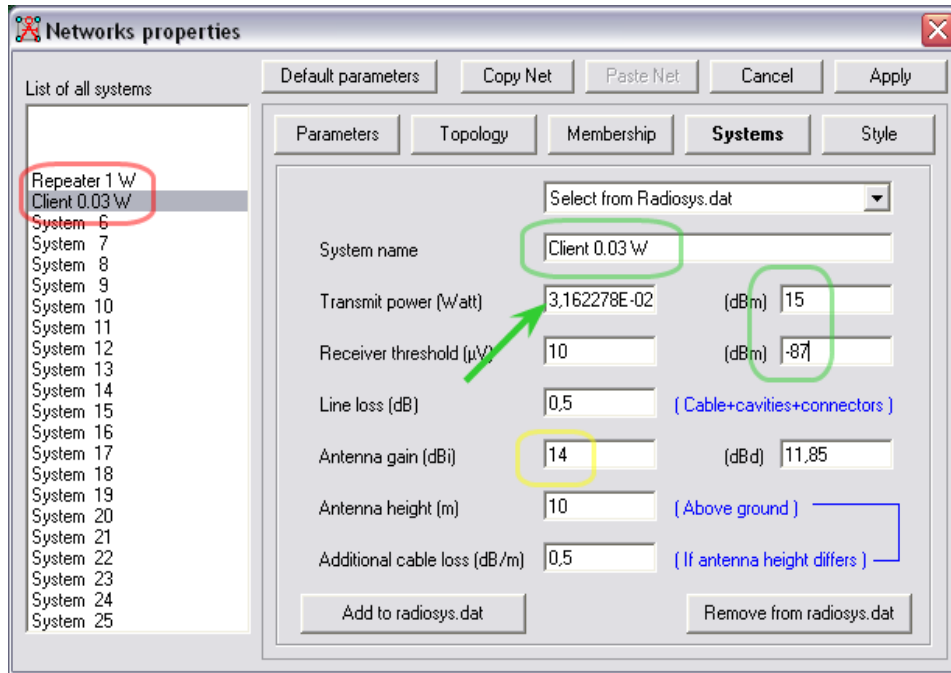


Image 5: Adding the new system "Client 0.03 W"

This second specification (Client 0,03 W) includes a more directive antenna (14 dBi) (yellow highlighted area) and a smaller output power (15 dBm).

Notice that you can input the transmission power either in dBm or in W (green arrow)

6.2.3 Create and Place Units

File > Unit Properties

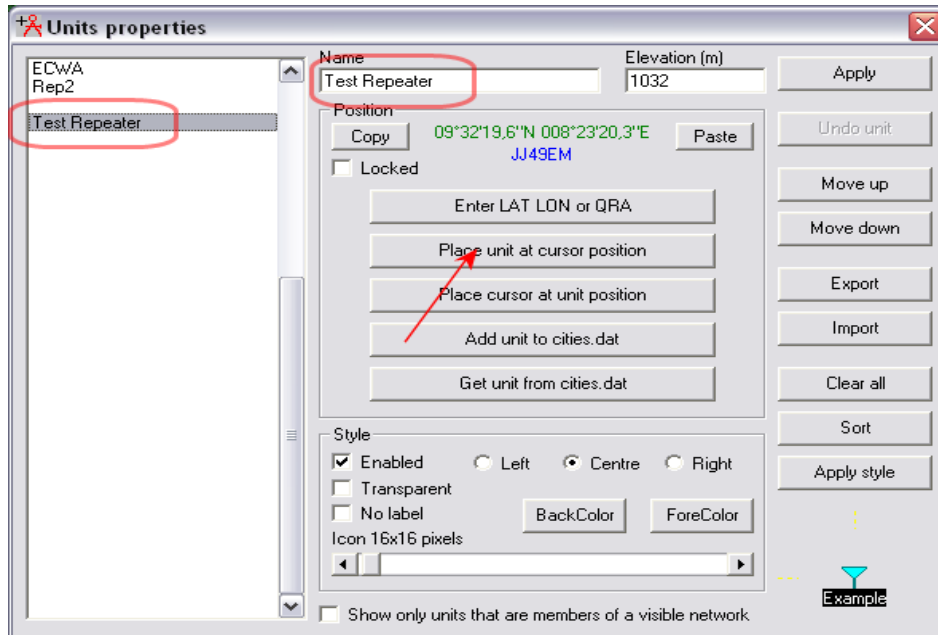


Image 6: Adding and Placing Units (in the cartography)

In this section we create (red highlighted area) and place the three units (red arrow). When placing the units (by using the cursor position), we can use the tool: Elevation Grid

View > Elevation Grid

The Elevation Grid gives us the altitude of a select place and provides information about the highest point in the surroundings. In the image, the grid shows that the "cursor" is at 1183m over the sea level. To get a better position for our repeater we can move the cursor to 1192 or 1197 m (yellow arrows).

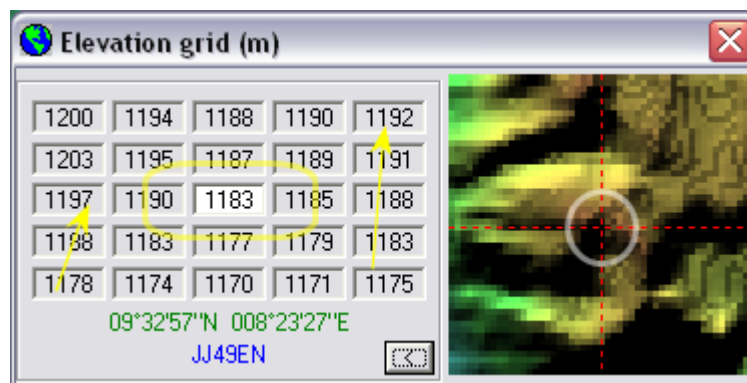


Image 7: Using Elevation Grid to place a unit on the cursor position

6.2.4 Network Membership

File > Network Properties > Membership

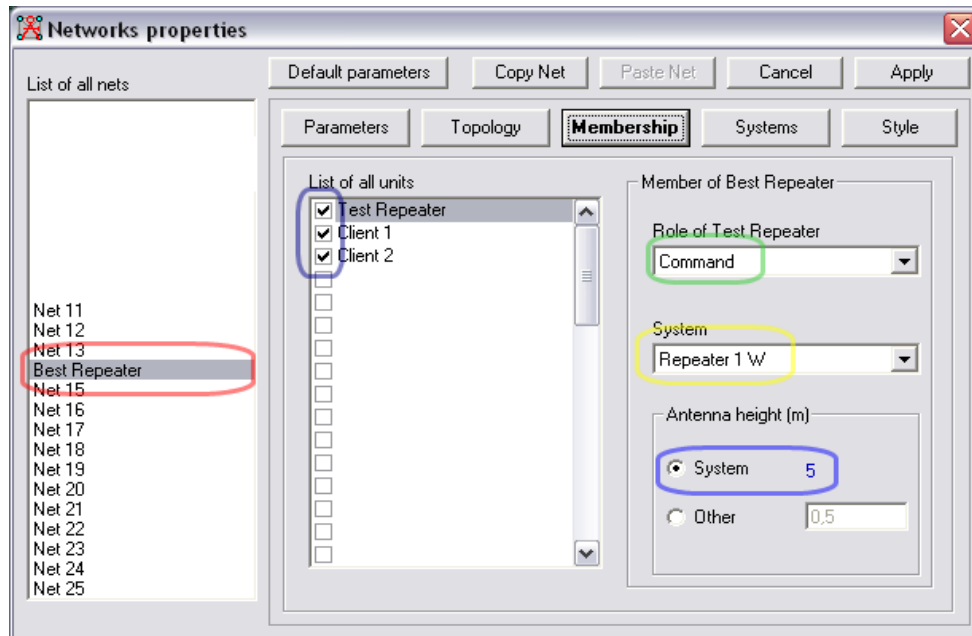


Image 8: Putting all elements together, Network with units of certain system type.

In the previous section we created three units; one repeater (Test Repeater) and two clients (Client 1 and Client 2). In the Membership section we associated these physical units to the network (Best Repeater) and to the different systems (Repeater 1W and Client 0,03W).

In this section we can also specify the role of the units in the topology. A default value is to set all the clients as **Subordinates** and the main coordinator (repeater, central access point) as **Command**.

Here, we can also change the default value of the height of the tower (blue highlighted area).

6.3 Radio Link Budget Analysis

After following the steps described in 6.1 and 6.2 you should have a diagram similar to this one. The picture shows two radio links from the Command Unit (Test Repeater) to the Subordinates (Client 1 and Client 2)

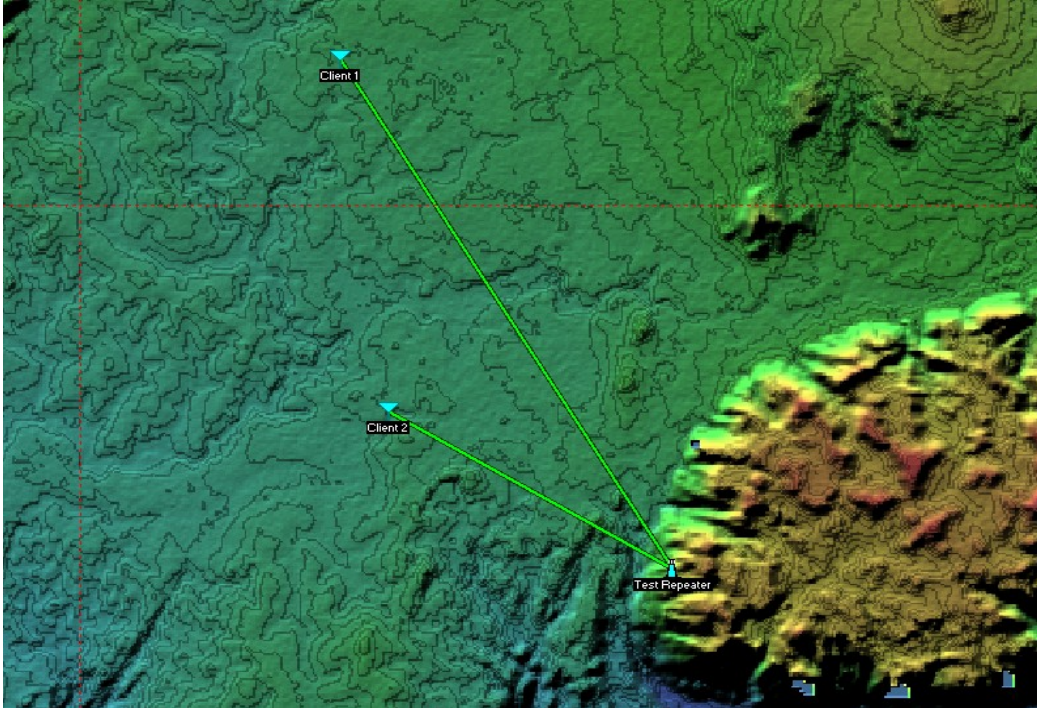


Image 9: First results of the simulation

To examine each of the links go to: **Tools > Radio Link**

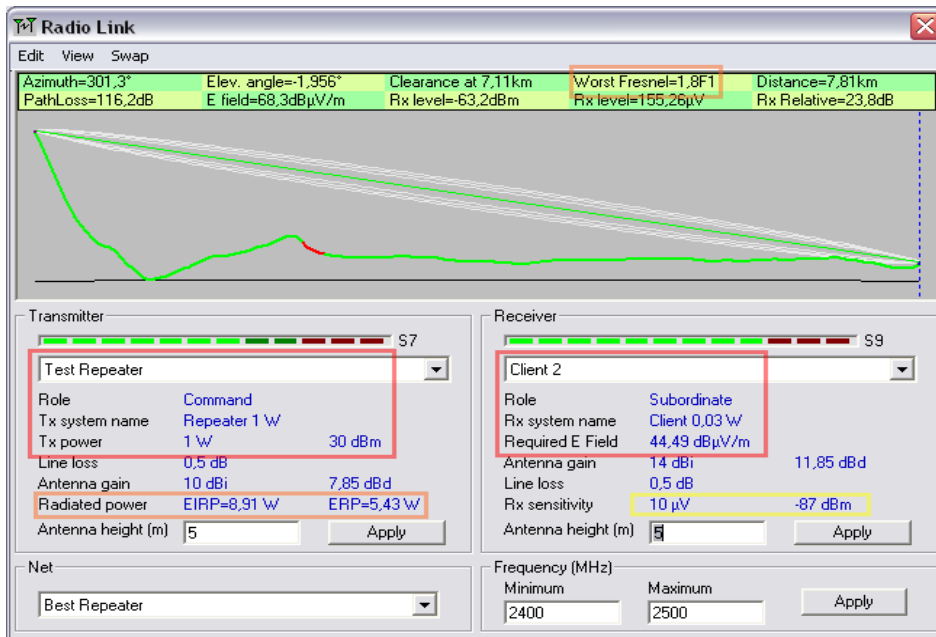


Image 10: Details of a one link budget simulation

Each of the radio links can be examined in detail. In the picture we see the radio link between the Test Repeater and the Client 2 (red highlighted frame). Among other information, Radio Mobile provides the TX radiated power (EIRP) (orange highlighted frame) and a measure of the signal received in the receiver (Rx Relative).

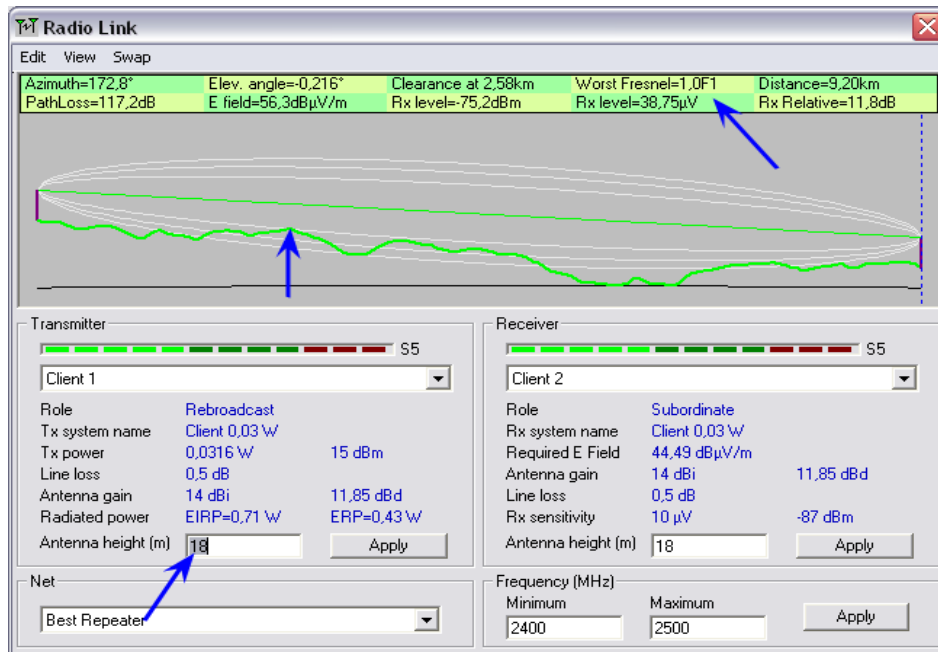


Image 11: Changing the tower height to adjust free the first Fresnel Zone (1.0F1)

The radio link budget analysis is very useful to design the height of our radio towers. In the example, we have change the default value of 5m to 18m in both sides of the radio link to be able to stay inside of the first Fresnel Zone.



Using a radio simulation tool like “Radio Mobile” will always require many iterations and fine tuning of your values.

The software provides the possibility to save your “systems” in a .sys internal database.

6.4 Coverage Area

If you are planning a point to multipoint wireless network, you are going to be interested in the coverage area of a given “access point” or repeater. Radio Mobile offers also the possibility to create single polar graphs.

Tools > Radio Coverage

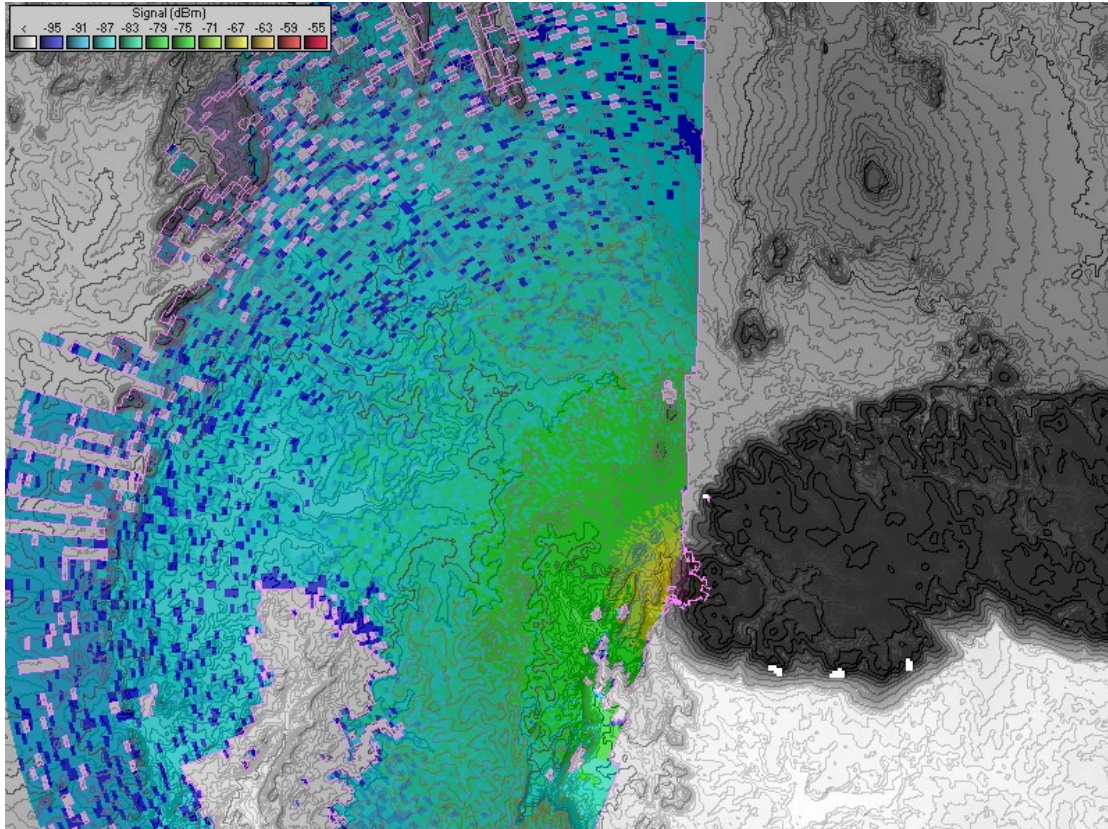


Image 12: X Ray background image with single polar coverage area graph

7. Conclusions

Consider including an “outdoor radio simulation” in your viability study. A simulation software can be of great help to create your first network design and plan your first field trials.

The five main tasks that you need to learn to perform a radio simulation with “Radio Mobile” are:

1. Input your position and select the source and type of maps you want to use
2. Define the “systems” that you want to implement in your network
3. Place the radio units in the target positions and associate a type of system and role to each and one of them
4. Study each of the simulated “Radio Link Budgets” and change your settings to optimize your design
5. Use the Radio Coverage Tools to see your coverage areas and potential sources of interference

