# Radio Mobile

#### Training materials for wireless trainers



The Abdus Salam International Centre for Theoretical Physics



Wednesday, March 6, 2013

This 60 minute talk gives an introduction on Radio Mobile, a free software for Windows that provide a detailed simulation tool for wireless networks using freely available Digital Elevation Maps.

Version 1.2, @2010-03-12 Version 2.2, @2013-03-5

# Goals

- To learn how to use Radio Mobile, a free software that provides a detailed propagation model for radio. It allows to simulate a radio link and perform "what if?" scenarios, by changing the link parameters. It can also show the area coverage from a given site.
- There are two versions of the program: an on-line application and a downloadable version that runs on Windows.
- We will also describe the use of Google Earth for building elevation profiles.

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#### Elev. angle=1.255° Clearance at 0.37km Distance=56.99km Worst Fresnel=3.7F1 Elfield=63.1dBµV/m Rx level=-65.3dBm Rx level=121.35µV Rx Relative=41.7dB 52.3dB Software for radio link simulation There are many programs that can be used to simulate radio links and base station coverage, some of which cost thousands of dollars. By using a link simulator, you can save considerable time during link planning and analysis. For example, if a link is proven to be impossible in simulation, there is little need to perform a site survey, and other options have to be considered (such as the use of repeater sites). Radio Mobile is a free program developed for radio ower 85 dBd loss. amateurs by Roger Coudè that is based on the well nna gain ated powe known Longley-Rice Irregular Terrain Model and predicts nna heighl Apply radio propagation from 20 MHz to 20 GHz, making use of several sets of freely available Digital Elevation Maps. Apply nba - Ulongwei 5100 3

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This program has been used for a number of years by radio hams and WiFi engineers with good results, provided that sound judgment is employed, since every model has limitations and in particular the free digital maps do not include buildings and other structures.

# Windows Vs Web Radio Mobile:

#### **On-line version (web)**

Pros: runs on any machine (Linux, Mac, Tablet); does not require big downloads; saves sessions; user friendly, will fetch the elevation data automatically Cons: requires connectivity; only certain frequencies Windows version Pros: runs offline; can use the GPS Cons: runs on Windows only; requires big downloads; user must select digital elevation maps; hard to learn It is advisable to start using the on-line version to get acquainted with the capabilities of the software and then move to the downloadable version for extra features.

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Point your web browser to

http://www.cplus.org/rmw/rmonline.html

- Register in the site (no cost) and create your account, you will receive your password in your email account.
- You can then start using the program.

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Radio M	1obile Onli	ine - Chromium		🛜 📢)) 8:16 AM 👤 m
6	Goog 🚼	le ×	Account creation confirm: × 🔛 Radio Mobile Online ×	
	← →	C www.cplus.c	.org/rmw/rmonline.html	☆ 🗢
	Rad	<u>io Mobile</u>	Par/By Roger Coudé VE2DBE	Inf
		Welcome mz		
	<b>0</b>	My Settings		
1	₩	New Site	Create a site (location)	
	Å	My Sites		
	۲	New Link		
	শ	My Links		
	ন্দ	Multiple links		
	•	New Coverage		
<u>^</u> _	•	My Coverages		
•	<b>•</b>	Multiple coverages		
	<del>  #</del>	New antenna type		
S	<b>##</b> #	My antenna types	N2,	
	⇒	Log Out		
?				
			6	



Radio Mob	<u>vile</u>		
🗚 New Site			
-			
	Loca	te	
Latitude		4 53535638	
Longitude		-73.66607666	
Zoom			9
Name		New Site 16	
Elevation (m)		2927.1	
Description			
Group			
	Add to M	y Sites	
Cancel			

If you happen to know the coordinates, you can modify the values on the screen. Check that the elevation provided by the program is reasonable.

Assign a name to the site and click "Add to my sites" Repeat the procedure for the second site.



#### A word on power

Electrical power in watts is  $P = v^2/R$ Telecommunication antennas have normally R = 50 ohm In that case,  $P = v^2/50$ , v = SQRT(50P)The received power level RP is frequently expressed in dBm:  $RP = 10Log_{10}$  (P/10<sup>-3</sup>), therefore  $P = 10^{-3}10^{RP/10}$ So, the received voltage corresponding to RP dBm is:  $v = SQRT(0.05 \times 10^{RP/10})$ Example: for RP -90 dBm,  $v = SQRT(0.05 \times 10^{-9}) =$ 0.00000707 That is v = 7.07 microvolts, this the RF voltage one would measure at the antenna terminals

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#### Radio Mobile

¥ New Link	
-	
From	Sitio 1
Antenna height (m)	2
То	(sitio 2 🗘
Antenna height (m)	2
Description	Radio link study 10
Frequency (MHz)	2300
Tx power (Watts)	0.1
Tx line loss (dB)	1
Tx antenna gain (dBi)	24
Rx antenna gain (dBi)	19
Rx line loss (dB)	0.5
Rx threshold (µV)	10
Required reliability (%)	70
Use land cover	
Use two rays	
Subm	nit
Cancel	

Input 2300 MHz as frequency when working at 2.4 GHz and 5825 MHz when working at 5 GHz, since in the on-line version they are the closest allowed frequencies. This will affect the propagation loss by a small amount.

"Rx Threshold" is the minimum received signal in microvolts, also called "Receiver sensitivity" Click "Submit".

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Radio Mobile	Par/By Rog	ger Coudé VE2DBE	Information
	Badio lin	k study 10	
Sitio 1 (1)			(2) sitio 2
Latitude	4.535356 °	Latitude	4.653080 °
Longitude	-73.666077 °	Longitude	-73.355713 °
Ground elevation	2927.1 m	Ground elevation	1082.5 m
Antenna height	2.0 m	Antenna height	2.0 m
Azimuth	69.15 °	Azimuth	249.18 °
Tilt	-3.03 °	Tilt	2.70 °
Radio system			Propagation
TX power	20.00 dBm	Free space loss	130.96 dB
TX line loss	1.00 dB	Obstuction loss	117.51 dB

# This link is not feasible because of the blocked line of sight

 $\boldsymbol{\mathsf{H}}$ 

#### Let's see another link:



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This link has a clear line-of-sight and a free Fresnel zone, shown as the white curved line surrounding the straight green line. Notice that the antenna tilt is negative at both ends, despite the fact that one end is much higher. This is because the radio beam is curved due to the refraction introduced by the atmosphere.

Radio Mobile	Par/By Roge	r Coudé VE2DBE	Information
Radio system			Propagation
TX power	20.00 dBm	Free space loss	151.26 dB
TX line loss	0.00 dB	Obstuction loss	16.58 dB
TX antenna gain	34.00 dBi	Forest loss	1.00 dB
RX antenna gain	34.00 dBi	Urban loss	0.00 dB
RX line loss	0.00 dB	Statistical loss	2.83 dB
RX sensitivity	-97.46 dBm	Total path loss	171.67 dB
Performance			
Distance			381.091 km
Precision			190.6 m
Frequency			2300.000 MHz
Equivalent Isotropically Radiated Power			251.189 W
System gain			185.46 dB
Required reliability			70.000 %
Received Signal			-83.67 dBm
Received Signal			14.68 μV
Fade Margin			13.79 dB



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#### Example of area coverage from another site



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In this area coverage, from a 12 m antenna in a Pacific island, one can see in green the area where the received signal strength is at least 1.58 microvolt and in yellow the area with at least 0.5 microvolt, covering a total of 667 square kilometers.

#### Elevation profiles with Google Earth

- I) In the upper menu, click "Add path"
- 2) Click to establish the first point and then the second
- 3) Assign a name to the link (for instance "Longest") and click OK in the pop-up window
- 4) The link will show up in the menu on the left.
- 5) Right click in the link name ("Longest" in our example)
- 6) Select "Show elevation profile"
- 7) The elevation profile will be shown on the bottom of the screen
- 8) Moving along the profile, a red arrow will show the position on the map.

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You can see that the earth curvature is not apparent in this graph, so this program is not very useful for long distances, but it can give valuable information for short distance links where the earth curvature is irrelevant.

# Why use downloadble Radio Mobile?

Radio Mobile runs in Windows but it can be used in Linux or Mac OS by means of emulators.

![](_page_17_Picture_2.jpeg)

It provides all sort of details for point to point links, including expected signal level at any point along the path, including diffraction losses due to obstacles.

Radio Mobile automatically builds a profile between two points on the digital map, showing Fresnel zone and earth curvature clearance, as well as required antenna heights. It is a wonderful tool for exploring "what if?" scenarios.

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### Download Radio Mobile

Download Radio Mobile here:

http://www.cplus.org/rmw/english1.html

Instructions are provided for how to download the digital elevations maps for your area of interest.

Digital elevation maps come in one degree longitude, X degree latitude tiles so you might need to download a few tiles for your application. Resolution of 30 and 3 arc seconds (or better!) are available for all regions of the world.

Once you have downloaded the maps, you no longer need Internet access (unlike using Google Earth).

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# Using Radio Mobile

- Let's assume Radio Mobile is already correctly installed on your computer (installation instructions are provided in the download page).
- We will now review the procedure to simulate a simple wireless network composed of a few nodes
- We will then use Radio Mobile to perform some simple link budget calculations, coverage analysis and "what if?" simulations

![](_page_19_Picture_4.jpeg)

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Radio Mobile does not come with an installer. The procedure for the installation is quite simple and doesn't require more than a few steps, and a minimum knowledge of Windows OS.

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The software comes in two parts, one zip file is common for all languages and it should be decompressed and moved to its final destination on the hard disk (you may choose any reasonable location). A second zip file is localized for different languages. You should select the languages you want to use, download the proper zip file, decompress it and move the resulting executable file into the same folder chosen before. Then double click on this last file to start the program.

#### Using Radio Mobile: example

We will use Radio Mobile to simulate a few radio links around the city of Trieste (Italy).

Coordinates of some locations are (approx.):

The Miramare Campus: N 45°42'15" E 13°43'13"

The Church (Muggia): N 45°36'10" E 13°45'10"

+ The Castle (San Giusto): N 45°38'51" E 13°46'21"

The Hotel (Grado): N 45°40'32" E 13°23'17"

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Trieste is a city and seaport in north eastern Italy. It is situated towards the end of a narrow strip of land lying between the Adriatic Sea and Italy's border with Slovenia, which lies almost immediately south, east and north of the city. Trieste is located at the head of the Gulf of Trieste. In 2009 it had a population of about 205,000 and it is the capital of the autonomous region Friuli-Venezia Giulia and Trieste province.

[from Wikipedia]

# Using Radio Mobile: DEMs

 Before you start working with Radio Mobile, you may want to download the Digital Elevation Maps of your area of interest. Radio Mobile can use a number of formats including SRTM.

Top layer
Browse
Bottom layer
n (m) 0

Radio Mobile screenshot

![](_page_21_Figure_4.jpeg)

http://eros.usgs.gov/#/Find\_Data/Products\_and\_Data\_Available/gtopo30\_info

![](_page_21_Picture_6.jpeg)

# Using Radio Mobile: DEMs

The simplest way to get elevation data is to let Radio Mobile download it automatically when needed. It will also store the data locally for

future use

ire use.	🕲 Internet options	
AI C USC.	Proxy Web update SRTM Landsat OpenStreetMap Terraserver Toporama	Cancel OK SRTM Download from Internet if a file is not found on local path Download from Internet if a file is not found on local path and keep a local copy Use local files only Local files path C:\Documents and Settings\Administrator\Desktop\SRTM Browse Internet ftp directory USGS Eurasia - 3 arcsecond http://dds.cr.usgs.gov/srtm/version2_1/SRTM3/Eurasia/
Radio Mobile screenshot	1	
		23

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To be sure that the software keeps a local copy of the DEMs and only download what is really needed, you should select the option "Download from Internet if a file is not found on local path and keep a local copy" in the menu "Options", submenu "Internet", for all different formats.

# Using Radio Mobile: create map

- Menu "File", select item "Map properties"
- Insert coordinates (center of map) and dimensions of the map
   Properties of ... Vvenice-wimax-map.map
- We use:

N 45.6 - E 13.5 640x480 pixels 64x48 km

"Extract"

Radio Mobile screenshot

Section 2 (1997) Sectio	x-map.map		$\mathbf{X}$
Centre 45°36'00.0''N 013°30'00.0''E JN65S0	Size (pixel) Width(pixels) 640 480	nt (pixels)	Extract
Latitude Longitude 45.6 13.5	Size (km)		Cancel
Use cursor position	Width(km)         Heigh           64.00         48.00	nt (km) D	Top Left 45°48'57''N 013°05'18''E
World map	Elevation data source Drive or path	Top layer	Top Right 45*48'57''N
Select a city name	SRTM inistrator\desktop\srtm	Browse	013°54'42''E
Enter LAT LON or QRA	None 💌 c	Browse	Bottom Left 45°23'02''N 013°05'18''E
Select a unit 🗨	None 💌 c	Browse	Bottom Right
	None 💌 c	Browse	45°23'02''N 013°54'42''E
Adjust units elevation	None 💌 c	Browse	Resolution
Merge pictures	Ignore missing files	Bottom layer	3.24 arcsecond
Force gray scale	Initialize matrix with elevation	(m) 0	

![](_page_23_Picture_8.jpeg)

### Using Radio Mobile: the map

![](_page_24_Picture_1.jpeg)

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The upper left corner looks like flat blue (that means sea level, see the legend with "Elevation" gauge, with different colors showing different ranges of values in meters). But if we look more closely, there are some fine details barely visible: in fact there is a lot of low-elevation terrain there (it's a lagoon area).

Sometimes Radio Mobile does not make it very easy to recognize cities and other geographic features (roads, etc.). You can add (superimpose) a topographic map with roads and other indications to make this task easier, though these maps may not be available everywhere.

# Using Radio Mobile: add map

- We can add road details using this procedure: menu "Edit" select item "Merge pictures..."
- Then select

OpenStreetMap

with Zoom=10

**Operation:Add** 

- click on "Draw"
- "Keep in picture"

![](_page_25_Figure_8.jpeg)

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OpenStreetMap creates and provides free geographic data such as street maps to anyone who wants them. The project was started because most maps you think of as free actually have legal or technical restrictions on their use, holding back people from using them in creative, productive, or unexpected ways.

[from OpenStreetMap website www.openstreetmap.org]

### Using Radio Mobile: new map

![](_page_26_Figure_1.jpeg)

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The result is the superimposition of two maps, the first one showing the digital elevation and the second one with details of roads, cities, borders, etc...

Now the lagoon area in the upper left corner is clearly visible (including the town of Grado)

# Using Radio Mobile: terminology

- Radio Mobile has its own special terminology. In order to create radio links we need to learn a few new terms:
  - a system: a particular choice of radio and antenna (TX power, gain, radiation pattern, ...)
  - a unit: a system installed in a particular location (coordinates, height of antenna, ...)
  - a network: a set of units, part of the same radio network (all at the same frequency)

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These terms are listed in the order in which we need to create them:

We will make a network composed of 4 units. They will be created using two different systems (radio+antenna).

# Using Radio Mobile: systems

- Let's create two different systems (WiFi@2.4GHz):
- SmallRadio:
   P<sub>TX</sub>=16dBm
   S<sub>RX</sub>=-90dBm
   omni 8dBi
- BigRadio:
   P<sub>TX</sub>=20dBm
   S<sub>RX</sub>=-96dBm
   dish 24dBi
- other: default

List of all systems	Default parameters Copy Net Paste Net Cancel OK
System 1 System 2 System 3 System 4	Parameters Topology Membership <b>Systems</b> Style
System 5 System 6 System 7 System 8	00  Sustem name Sustem 1
System 9 System 10 System 11 System 12	Transmit power (Watt) 10 (dBm) 40
System 13 System 14 System 15 System 16	Receiver threshold (μV)     1     (dBm)     -107       Line loss (dB)     0.5     (Cable+cavities+connectors )
System 17 System 18 System 19 System 20	Antenna type omni.ant View
System 21 System 22 System 23 System 23	Antenna gain (dBi)  2 (dBd)  -0.15 Antenna height (m)  2 (Above ground )
System 25	Additional cable loss (dB/m) 0 (If antenna height differs )
	Add to Radiosys.dat Remove from Radiosys.dat

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Select item "Network properties" from the menu "File", and go to the tab called "Systems".

Trick: to make things simpler at the beginning, for the system "BigRadio" you can just select an antenna of type "omni" and change the gain to 24dBi. This will be equivalent to a dish of 24dBi, working in all directions.

# Using Radio Mobile: units

- Let's create 5 new units, located in the 4 sites:
- Miramare I
- Miramare 2
- Church
- Castle
- Hotel

![](_page_29_Figure_7.jpeg)

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Select item "Units properties" from the menu "File".

Then you can enter the Name and the coordinates. The elevation of the point will be automatically retrieved from the DEM.

# Using Radio Mobile: units

- After creation, you should assign the proper system to each unit:
- Miramare I
- Church
- Castle are all "SmallRadio"
- Miramare 2
- Hotel are both
   "BigRadio"

List of all nets	Default parameters	Copy Net P	aste Net	Cancel	ОК
Net 1 Net 2 Net 3 Net 4 Net 5 Net 5 Net 5 Net 6 Net 7 Net 8 Net 9 Net 10 Net 10 Net 11 Net 12 Net 12 Net 13 Net 14 Net 15 Net 15 Net 15 Net 16 Net 17 Net 18 Net 19 Net 20 Net 21 Net 22 Net 23 Net 23 Net 25	Parameters         To           List of all units         Image: Construct of the state of the	oology Memb	ership Membo Role o Comm System Small Ante	Systems er of Net 1 f Miramare 1 hand N Radio N Radi N Radi N Radio N Radi N Radi N Radio N Radio N Radio N Ra	Style

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Select item "Networks properties" from the menu "File".

- Then go to the tab "Membership" and there you will be allowed to edit the system and role for each unit.
- Use the role of "Command" for Miramare I and Miramare 2, and the role of "Subordinate" for all other units.
- Before to make any change, you have to enable the unit in the list (by clicking on the small box in front of its name in the list).

# Using Radio Mobile: network

► To view your network on the map, just select "View" → "Show networks" → "All"

![](_page_31_Picture_2.jpeg)

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# Using Radio Mobile: network

- To be able to correctly calculate the loss due to
- propagation, you should set the correct frequency.
- We are using the 2.4GHz
   band, so let's
   set the range
   2400-2485.

List of all nets	Default parameters	Copy Net	Pastel	Net	Cancel	ОК
WirelessTrainingKit Net 2 Net 3 Net 4 Net 5 Net 6 Net 7 Net 8 Net 9 Net 10 Net 10 Net 11 Net 12 Net 13 Net 14 Net 15 Net 15 Net 16 Net 17 Net 18 Net 19 Net 20 Net 21 Net 22 Net 23 Net 24 Net 25	Parameters         Net name         WirelessTrainingKit         Minimum freque         Maximum freque         Polarization         • Polarization         • Vertical         • Mode of variability         • Spot         • Accidental         • Mobile         • Broadcast         • City       • F	Topology ency (MHz) 24 ency (MHz) 24 C Horizor % of tir % of locatio % of situatio	Membership	P Surface Groun Relativ Climate © Equ © Con © Mari © Des © Con © Mari © Mari	Systems e refractivity (N- nd conductivity ve ground perm atorial tinental sub-tropic ert tinental temper time temperate itime temperate	Style Units) 301 (S/m) 0.005 nittivity 15 pical al ate over land over sea

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We can leave the polarization vertical and anything else with a default value for now (but there is a lot of room for "playing" with all parameters later and seeing the results).

# Using Radio Mobile: results

Now that we have set our scenario, let's calculate the link budget for our links:"Tools" → "Radio link"

Azimuth=147.2	Elev. angle=0.180°	Clearance at 0.10k	m Worst Fresnel=1.6	6F1 Distance=7.49km
Transmitter			ceiver	
Miramare 1 Bole	Command	SO SO BO	stle e 9	Subordinate
Miramare 1 Role Tx system name	Command SmallBadio	SO SO Rol Rol	stle e 9 system name	Subordinate
Miramare 1 Role Tx system name Tx power	Command SmallRadio	S dBm	stle e 9 system name 0 nuired F. Field 4	Subordinate SmallRadio
Miramare 1 Role Tx system name Tx power Line loss	Command SmallRadio 0.0398 W 16 0.5 dB	S dBm Rei	stle e 9 system name 7 quired E Field 4 enna gain 8	Subordinate SmallRadio 47.47 dBµV/m 3 dBi 5.85 dBd
Miramare 1 Role Tx system name Tx power Line loss Antenna gain	Command SmallRadio 0.0398 W 16 0.5 dB 8 dBi 5.	S dBm S dBd + Line	stle e 9 system name 0 quired E Field 4 enna gain 8 e loss 0	S0 Subordinate SmallRadio 47.47 dBμV/m 3 dBi 5.85 dBd 0.5 dB
Miramare 1 Role Tx system name Tx power Line loss Antenna gain Radiated power	Command SmallRadio 0.0398 W 16 0.5 dB 8 dBi 5. EIRP=0.22 W E	S dBm 85 dBd H Rol Rad Rea Ant Brea Ant Rea Ant Rea Ant Rea Ant Rea Ant Rea Ant Rea	stle e 9 system name 2 quired E Field 4 enna gain 8 e loss 0 sensitivity 7	S0 Subordinate SmallRadio 47.47 dBμV/m 3 dBi 5.85 dBd 0.5 dB 7.0795μV -90 dBm
Miramare 1 Role Tx system name Tx power Line loss Antenna gain Radiated power Antenna height (m)	Command SmallRadio 0.0398 W 16 0.5 dB 8 dBi 5. EIRP=0.22 W EI 2 • •	Solution Sol	stle e 9 system name 0 quired E Field 4 enna gain 8 e loss 0 sensitivity 7 enna height (m) 0	Subordinate SmallRadio 47.47 dBµV/m 3 dBi 5.85 dBd 0.5 dB 7.0795µV -90 dBm 2 - + Undo
Miramare 1 Role Tx system name Tx power Line loss Antenna gain Radiated power Antenna height (m)	Command SmallRadio 0.0398 W 10 0.5 dB 8 dBi 5. EIRP=0.22 W EI 2 - +	S dBm S dBm S dBd Real Ant B5 dBd RP=0.14 W Undo Fre	stle e 9 system name   quired E Field 4 enna gain 8 e loss 0 sensitivity 7 enna height (m) 2 quency (MHz)	S0 Subordinate SmallRadio 47.47 dBµV/m 3 dBi 5.85 dBd 0.5 dB 7.0795µV -90 dBm 2 + Undo

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The software will now output a graph of the link profile and also the result of the calculation.

### Using Radio Mobile: results

You can switch to the detailed view, that gives you a textual description of the output of the simulation

🕅 Radio Link						×	
Edit View Swap							
Azim V Profile	Elev. ang	🕅 Radio Link					
Details Range Distribution Large window		Edit       View       Swap         Distance between Miramare 1 and Castle is 7.5 km (4.7 miles)       True North Azimuth = 147.2°, Magnetic North Azimuth = 144.7°, Elevation angle = 0.1800°         Terrain elevation variation is 64.5 m       Propagation mode is line-of-sight, minimum clearance 1.6F1 at 0.1km         Average frequency is 2442.500 MHz       Free Space = 117.6 dB, Obstruction = -1.2 dB, Urban = 0.0 dB, Forest = 0.0 dB, Statistics = 6.6 dB					
		Total propagation I System gain from M System gain from C Worst reception is 3 70.000% of situatio	oss is 123.1 dB Iiramare 1 to Castle is 121. astle to Miramare 1 is 121. 2.1 dB below the required ns				
- Transmitter							
Miramare 1		I — Transmitter			Receiver		
Role	Commar			S0	J	S0	
Tx system name	SmallR	Miramare 1		-	Castle	•	
Tx power	0.03981	Role	Command		Role	Subordinate	
Line loss	0.5 dB	Tx system name	SmallRadio	•	Rx system name	SmallRadio	
Antenna gain	8 dBi	Tx power	0.0398 W	16 dBm	Required E Field	47.47 dBμV/m	
Hadiated power	EIRP=0	Line loss	0.5 dB		Antenna gain	8 dBi 5.85 dBd 🛨	
Antenna height (m)	2	Antenna gain	8 dBi	5.85 dBd 🔶 🛨	Line loss	0.5 dB	
- Not		Radiated power	EIRP=0.22 W	ERP=0.14 W	Rx sensitivity	7.0795μV -90 dBm	
INEC.		Antenna height (m)	2 · +	Undo	Antenna height (m)	2 · + Undo	
WirelessTrainingKit					<b>F</b> (111)		
	_	Net			Frequency (MHz)		
		WirelessTrainingKit	3.	5 🖵	Minimum 2400	Maximum 2485	

# Using Radio Mobile: coverage

- This will start the calculation of the coverage area of a selected
  Image: A selected

station in	🕣 Single polar Radio coverage	🛛 🗔 🖓 🛞 🖓 🗔 🖾
Station III	Centre unit Castle	Draw
your net.	Mobile unit Church	Cancel
	Network WirelessTrainingKit	·
	Link Direction Radial range (km)	A A A A A A A A A A A A A A A A A A A
	Centre Tx - Mobile Rx     Centre Rx - Mobile Tx     O Vorst case	Maximum 50
	Plot Azimuth range (*)	
	Image: Contour line     Color       Image: Fill area     Minimum       Image: Solid     Minimum	mum Step
	□ Network style     □ Mathematical Antenna pattern       □ Rainbow     □ Antenna pattern	
	Color Use network anter	nna settings
	C S-Unit	View pattern
	● dBm From 36	

#### Using Radio Mobile: "what if?"

 With the help of Radio Mobile is very easy to simulate different scenarios, or just different values of the antenna height and/or gain, TX power, etc...

Azimuth=263.1*	Elev. angle=-0.171*	Clearance at 23.04km	Worst Fresnel=0.9F1	Distance=26.03km		
PathLoss=129.4dB	E field=39.1dBµV/m	Rx level=-82.4dBm	Rx level=17.07µV	Rx Relative=13.6dB		
Transmitter		S5 Receiver		S6		
Transmitter Miramare 1		S5 Hotel		S6		
Transmitter Miramare 1 Role	Command	S5 Hotel Role	Subo	S6		
Transmitter Miramare 1 Role Tx system name	Command SmallRadio	S5 Hotel Role Rx system	Subo n name Bigf	s6 ordinate Radio		
Transmitter Miramare 1 Role Tx system name Tx power	Command SmallRadio 0.0398 W 1	S5 Fole Role Rx system 6 dBm	Subo n name Bigf E Field 25.4	S6 ordinate Radio 7 dBμV/m		
Transmitter Miramare 1 Role Tx system name Tx power Line loss	Command SmallRadio 0.0398 W 11 0.5 dB	S5 Hotel Role Rx system 6 dBm Antenna g	n name Bigf E Field 25.4 gain 24 d	S6 ordinate Radio 7 dBμV/m Bi 21.85 dBd		
Transmitter Miramare 1 Role Tx system name Tx power Line loss Antenna gain	Command SmallRadio 0.0398 W 11 0.5 dB 8 dBi 5	S5 Hotel Role Rx system 6 dBm .85 dBd + Line loss	n name Bigf E Field 25.4 gain 24 d 0.5 d	s6 ordinate Radio 7 dBμV/m Bi 21.85 dBd dB		
Transmitter Miramare 1 Role Tx system name Tx power Line loss Antenna gain Radiated power	Command SmallRadio 0.0398 W 11 0.5 dB 8 dBi 5 EIRP=0.22 W E	S5 S5 Hotel Role Rx system 6 dBm 85 dBd + RP=0.14 W Receiver Hotel Rate Receiver Hotel Role Rx system Receiver Rx system Receiver Rx system Receiver Rx system Rx sensiti	n name Bigf E Field 25.4 gain 24 d 0.5 d vity 3.54	ordinate Radio 7 dBμV/m Bi 21.85 dBd JB 81μV -96 dBm		

![](_page_37_Figure_0.jpeg)

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Radio Mobile showing line-of-sight terrain profiles for good and poor links. Note the curvature of the earth in the 56 km example on the right.

Fresnel Zones are shown as white curved (ellipses) lines. The worst first Fresnel zone is reported.

#### Links

#### http://radiomobile.pe1mew.nl/?About\_Radio\_Mobile

Radio Mobile - RF propaga	ation simulation software		
<ul> <li>Welcome</li> <li>Quick reference</li> <li>About the website</li> <li>About Radio Mobile</li> <li>Datasheet</li> <li>Installation</li> <li>Calculations</li> <li>Geodata</li> <li>The program</li> <li>RMpath</li> <li>RMupdate</li> <li>How to</li> <li>Analysis examples</li> <li>RF Aids</li> </ul>	About Radio Mobile Radio Mobile software is a copyright of Roger Coudé VE2DBE. Radio Mobile is dedicated to amateur radio and humanitarian use. Although commercial use is not prohibited, the author cannot be he for its usage. The outputs resulting from the program are under the entire respon user, and the user should conform to restrictions from external date	Ads by Google Radio Home Installing Radio Mobile	Vertical HF Antenna       Ham Antenna       Short Antenna       Backhaul         Using Radio Mobile for Windows         Plotting a Point-to-Point Link
Message center [external-page] Links Search	(Copied from the website of Roger Coudé, January 2008)	Obtaining Elevation Data Installing Elevation Data	Previous: Point-To-Point Link Next: Home Creating a plot of a point-to-point (PtP) link is just as easy as creating a
Sitemap Print Version	Radio Mobile is for Windows 95, 98, Me, NT, XP, 2000	Creating a Map Systems and Networks	basic coverage plot but there are a couple more steps involved. First create a new map centered at -84.46554 W and 45.67827 N. With the pixel width and height set to 1000 and the height in KM set to 15 as
		Creating Antenna Patterns	before. The resulting map should look similar to Figure 31 below.
		RF Coverage Plot	
		Point-To-Point Link	
		RF Tools	
		Files	
		Useful Links	

#### http://www.pizon.org/radio-mobile-tutorial/point-to-point-link.html

Articles

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These links provide some good tutorials on how to use Radio Mobile.

# Conclusions

- Radio Mobile makes it possible to simulate one or more radio links and perform "what if?" simulations, changing various link parameters
- While it cannot prove that a link is 100% possible, Radio Mobile can prove that a link is not possible (or would be very difficult).
- By combining DEM data and free overlay maps, it is possible to make very informative reports about coverage, link quality, and other radio parameters.

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### Thank you for your attention

For more details about the topics presented in this lecture, please see the book **Wireless Networking in the Developing World**,

available as free download in many languages at:

http://wndw.net/

![](_page_40_Picture_4.jpeg)