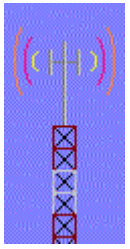
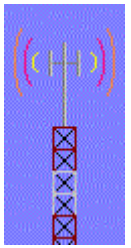
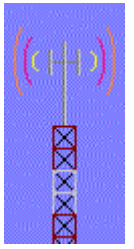
Radio Mobile

COS730

Network Topologies
&
Administration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WESTERN CAPE

Motivation / Goal

- Understanding of Radio Mobile basic concepts
- Free software (for the Windows platform)
- Provides a detailed propogation model for radio links
  - With the use of freely available **Digital Elevation Maps**

Radio Mobile

- Developed by Roger Coudè for radio amateurs
- Based on the well known Longley-Rice Irregular Terrain Model
- Predicts radio propogation from **20 MHz to 20 GHz**
- Simulate 1 or more radio links and perform “what if?” simulations
  - changing various link parameters

Radio Link Simulators

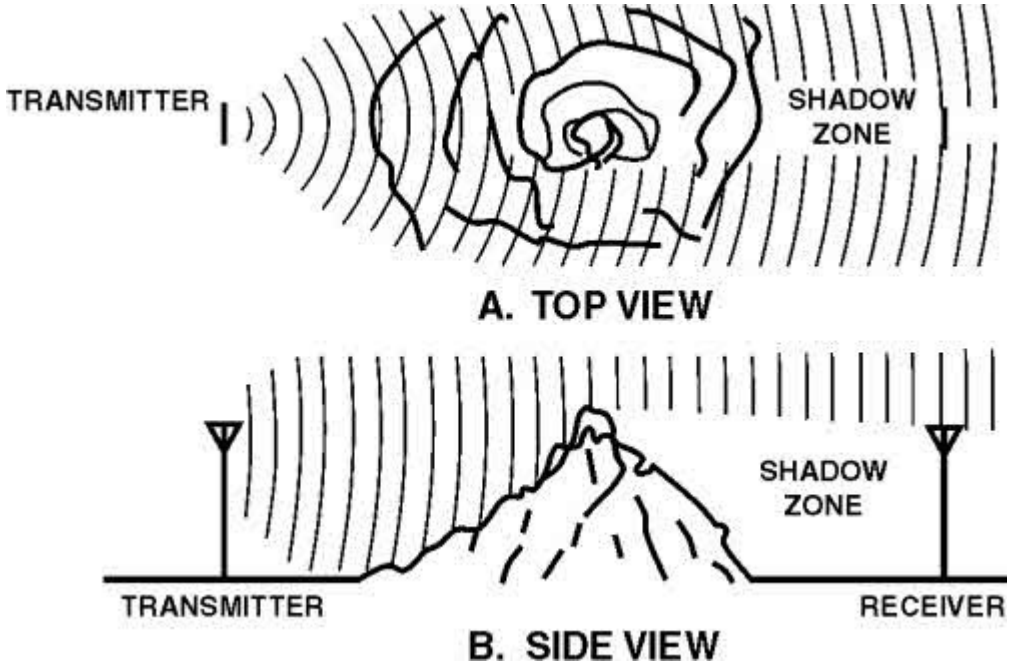
- A link simulator can save you considerable time during link planning and analysis
- e.g. If a link is proven to be impossible in simulation, there is little need to perform a site survey
  - other options will need to be considered
    - e.g. the use of repeater sites.

Radio Link Simulators

- There are many programs that can be used to simulate radio links and base station coverage
  - some of these programs cost...

Why use Radio Mobile?

- It provides all sorts of details for point-to-point links, including:
  - expected signal levels at any point along the path
    - including diffraction losses due to obstacles



Why use Radio Mobile?

- It automatically builds a profile between 2 points on a digital map, showing:
  - Fresnel zone and earth curvature clearance
  - Required antenna heights
- … a wonderful tool for exploring “what if?” scenarios

Downloading of Radio Mobile

- Older version:
  - http://www.cplus.org/rmw/download/download.html
- Self-extracting version (recommended):
  - http://www.g3tvu.co.uk/Radio_Mobile.htm
  - Will save you a lot of PAIN!
- Instructions are provided on how to download the digital elevation maps for your area of interest

Map info

- The Digital Elevation Maps come in 1 degree longitude, X degree latitude tiles
  - you might need to download a few tiles for your application
- A 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

Using Radio Mobile

- Assumption that Radio Mobile is correctly installed
- We will review the procedure to simulate a simple wireless network composed of a few nodes
- Radio Mobile will then be used to perform link budget calculations, coverage analysis and “what if?” simulations

Example 1

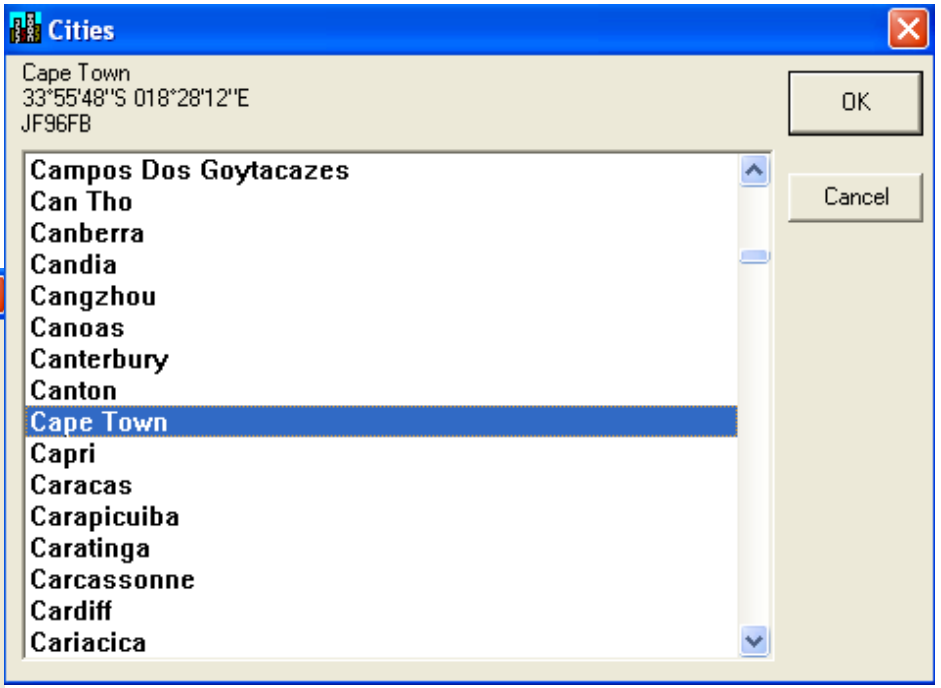
- Use of Radio Mobile to simulate radio links in the Cape Town area
- The **GPS** coordinates are (approximations):
  - UWC CS department 33° 56' 3.7788" **S**, 18° 37' 46.7292" **E**
  - Tyger Valley Shopping Centre 33° 52' 18.6780" **S**, 18° 37' 55.4124" **E**
  - Parow Centre 33° 54' 22.2264" **S**, 18° 35' 56.5368" **E**
  - Middestad Mall 33° 54' 14.1552" **S**, 18° 37' 48.8460" **E**
  - Canal Walk Shopping Centre 33° 53' 34.3140" **S**, 18° 30' 40.1940" **E**

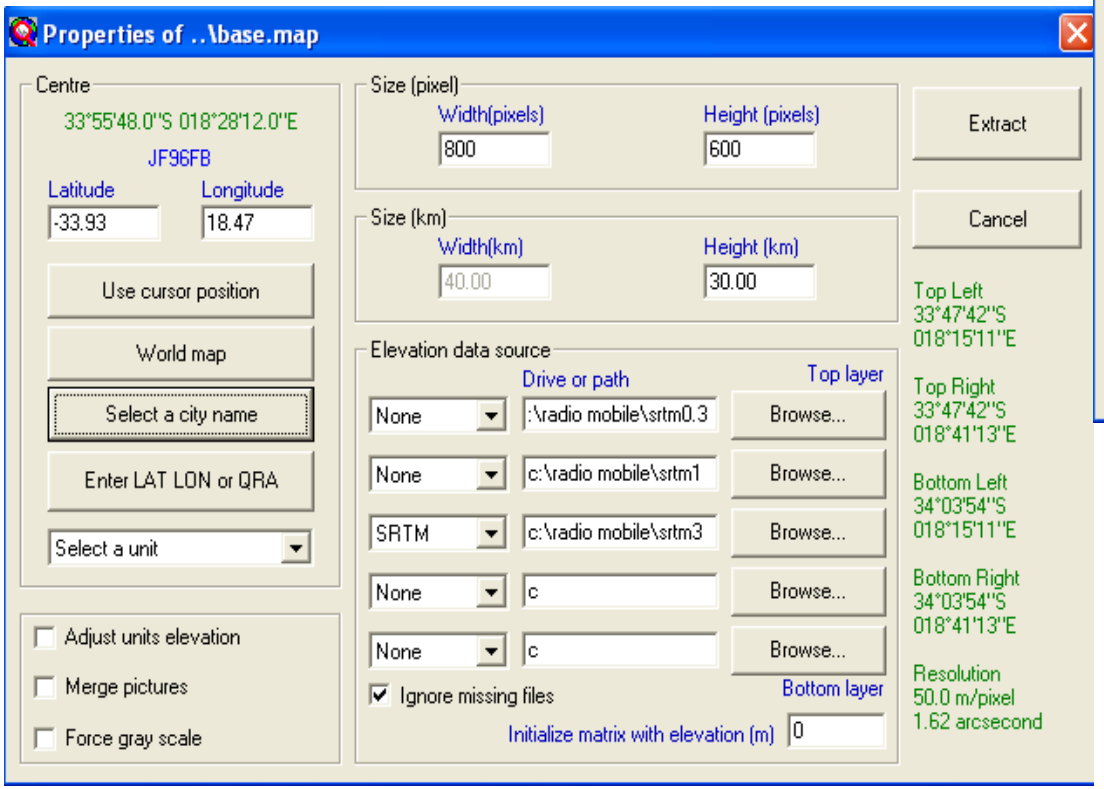
Using Radio Mobile: DEMs

- Download the Digital Elevation Maps of your area of interest
  - Cape Town
- The simplest way
  - Let Radio Mobile download it automatically
  - It will store the data for future use

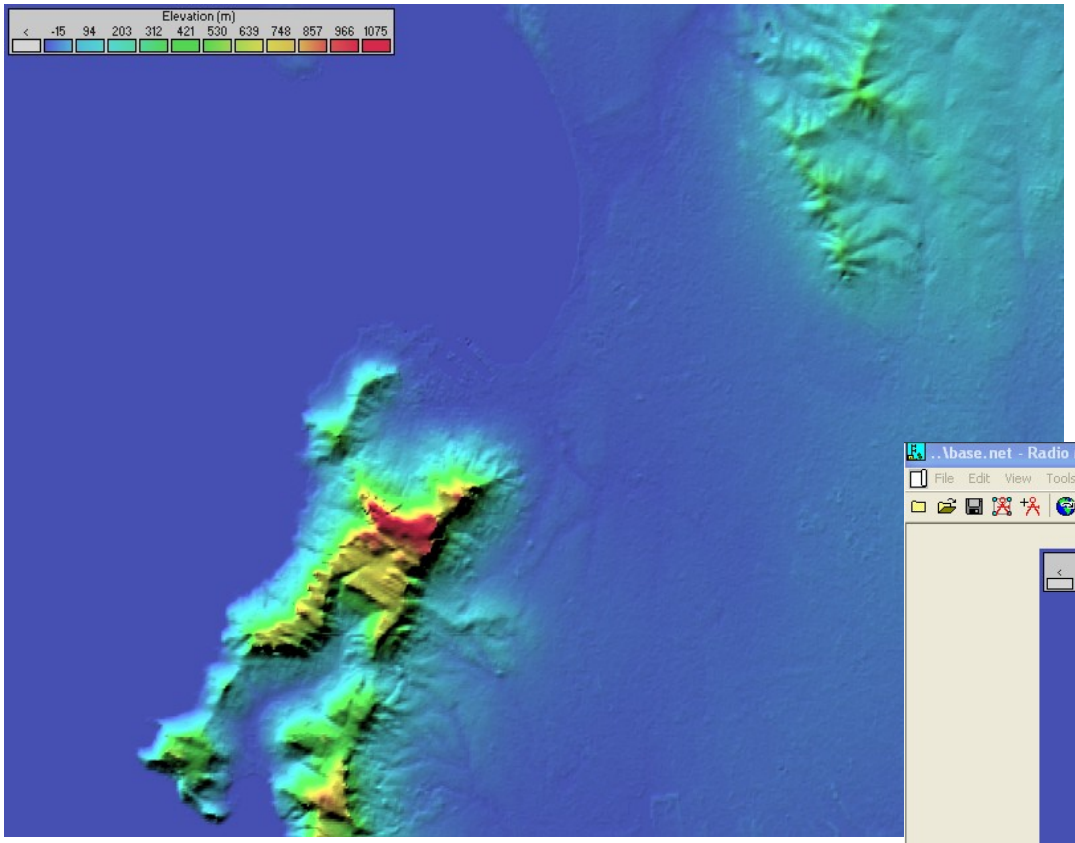
Cape Town DEM

- File → Map properties → Select a city name → Cape Town

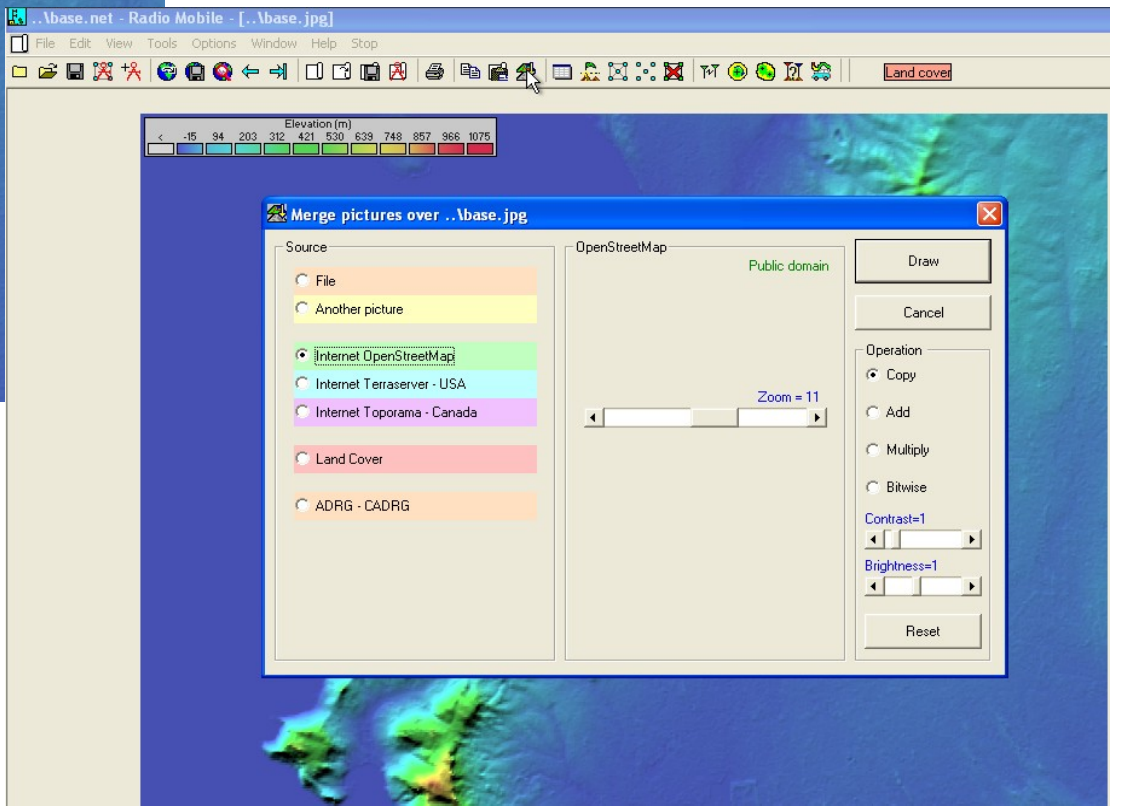




Cape Town Map

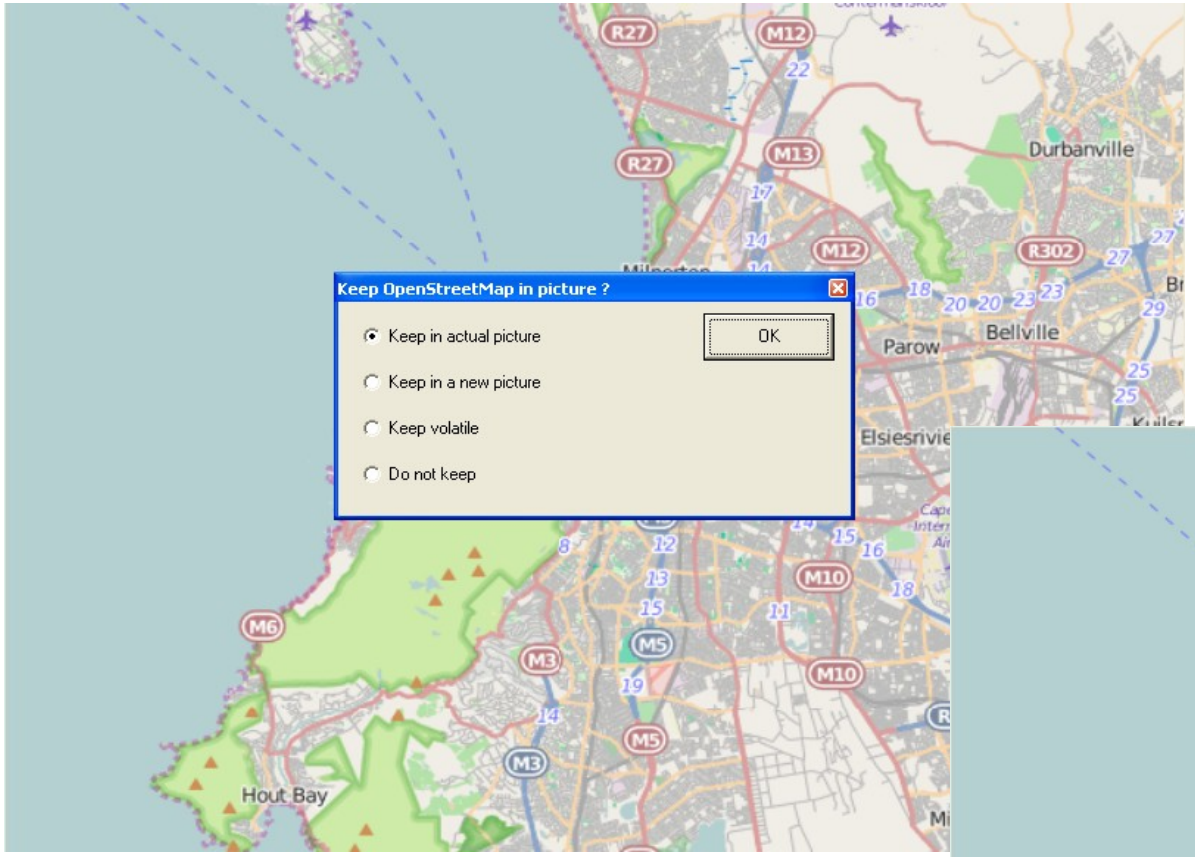


We can add road details by using the below procedure

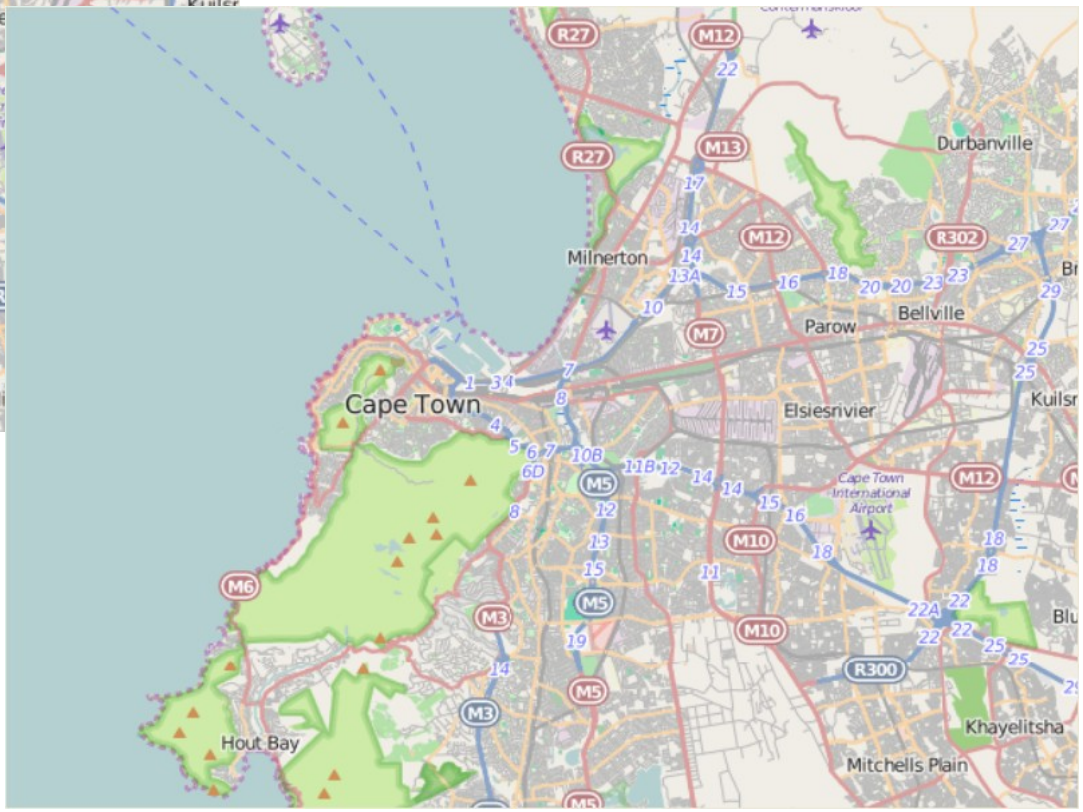


Menu “**Edit**” select item “**Merge pictures...**”
Select **Internet OpenStreetMap** with Zoom = 11
Operation: **Add**/Copy
Click on “**Draw**”
“**Keep in picture**”

Cape Town DEM



Road details

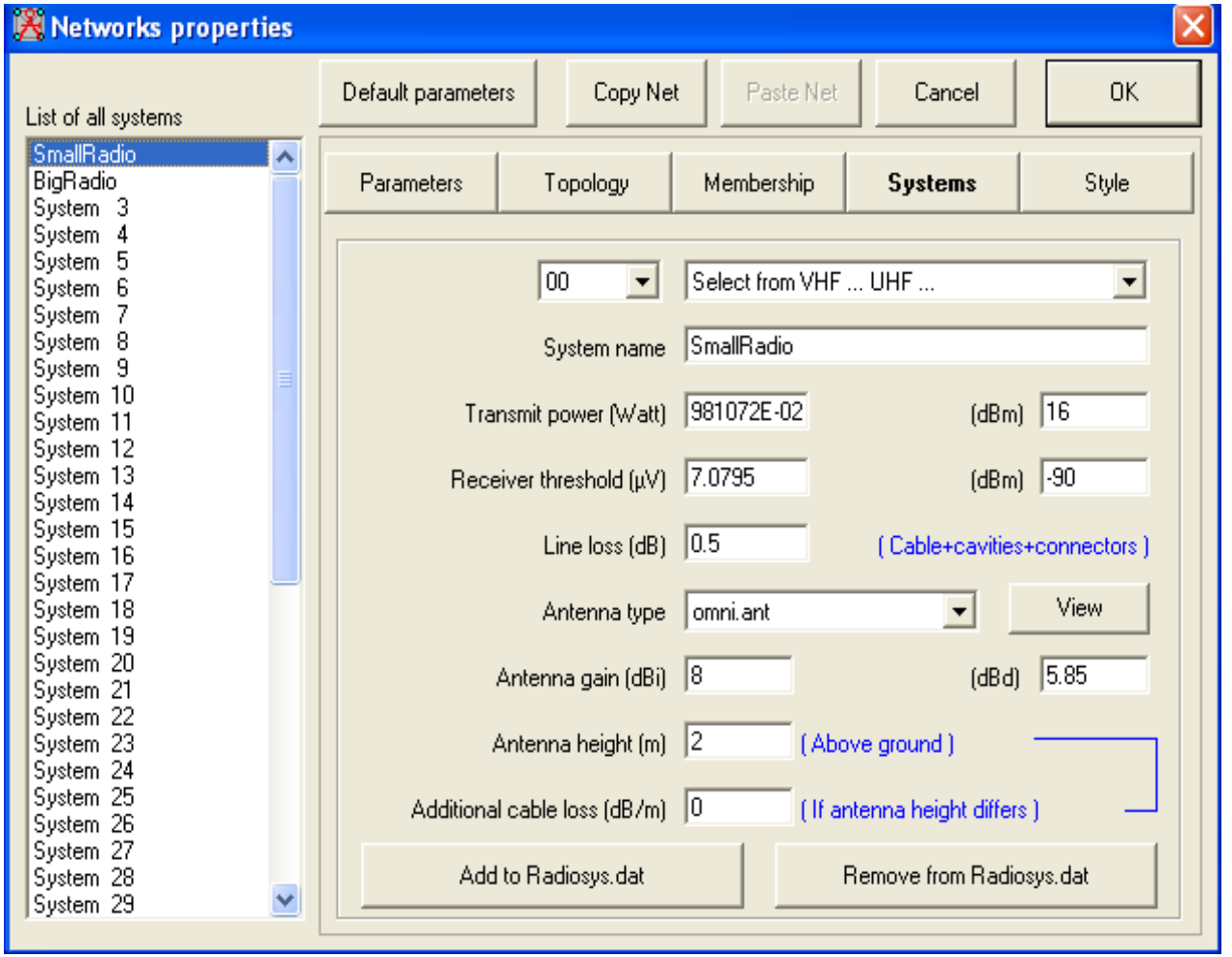


Radio Mobile Terminology

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

Using Radio Mobile: systems

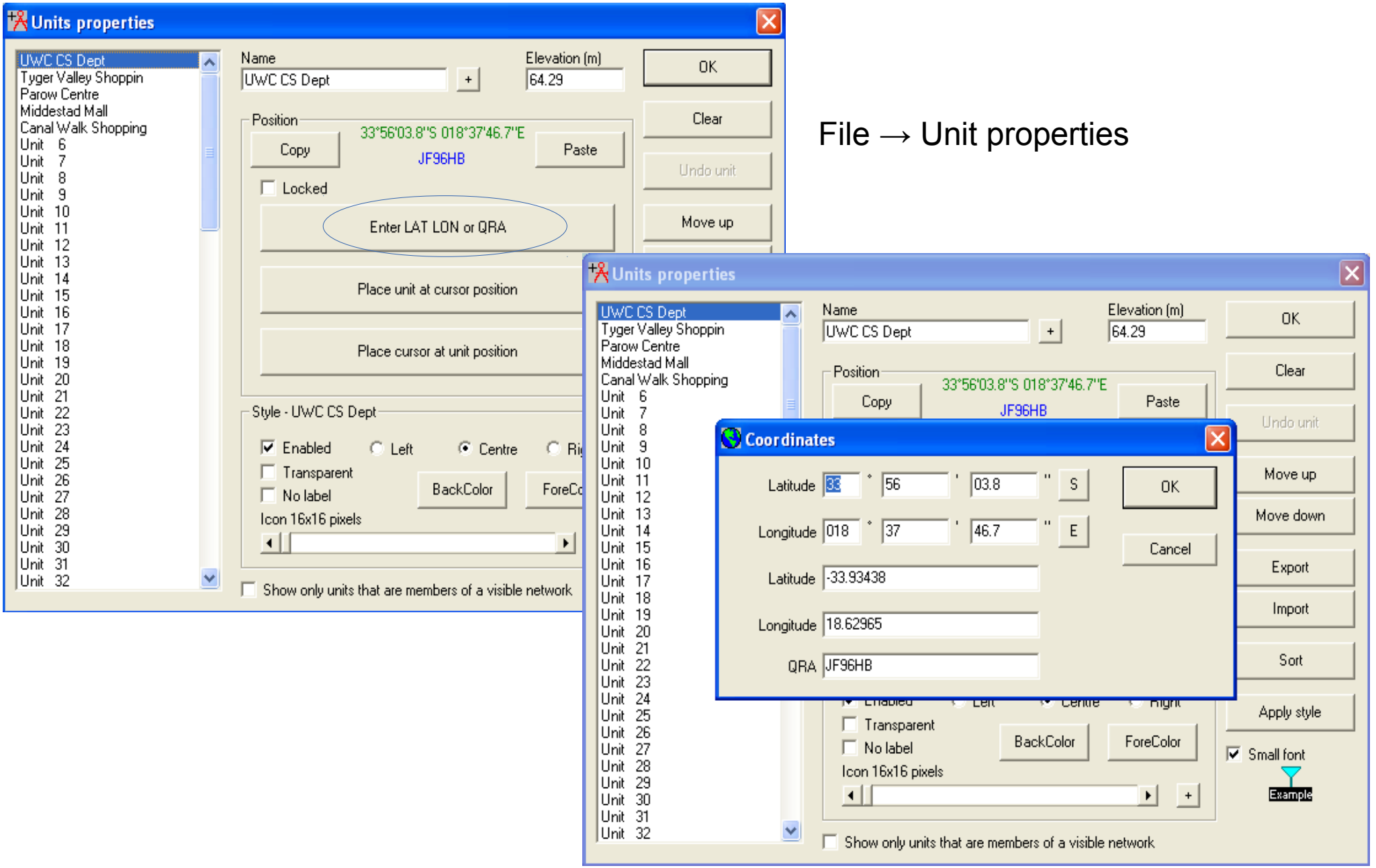
- Creation of 2 different systems (WiFi @ 2.4GHz)
- SmallRadio:
  - P_{TX} = 16dBm
  - S_{RX} = -90dBm
  - Omni 8dBi
- BigRadio:
  - P_{TX} = 20dBm
  - S_{RX} = -96dBm
  - Omni 8dBi
- Other: default



Using Radio Mobile: units

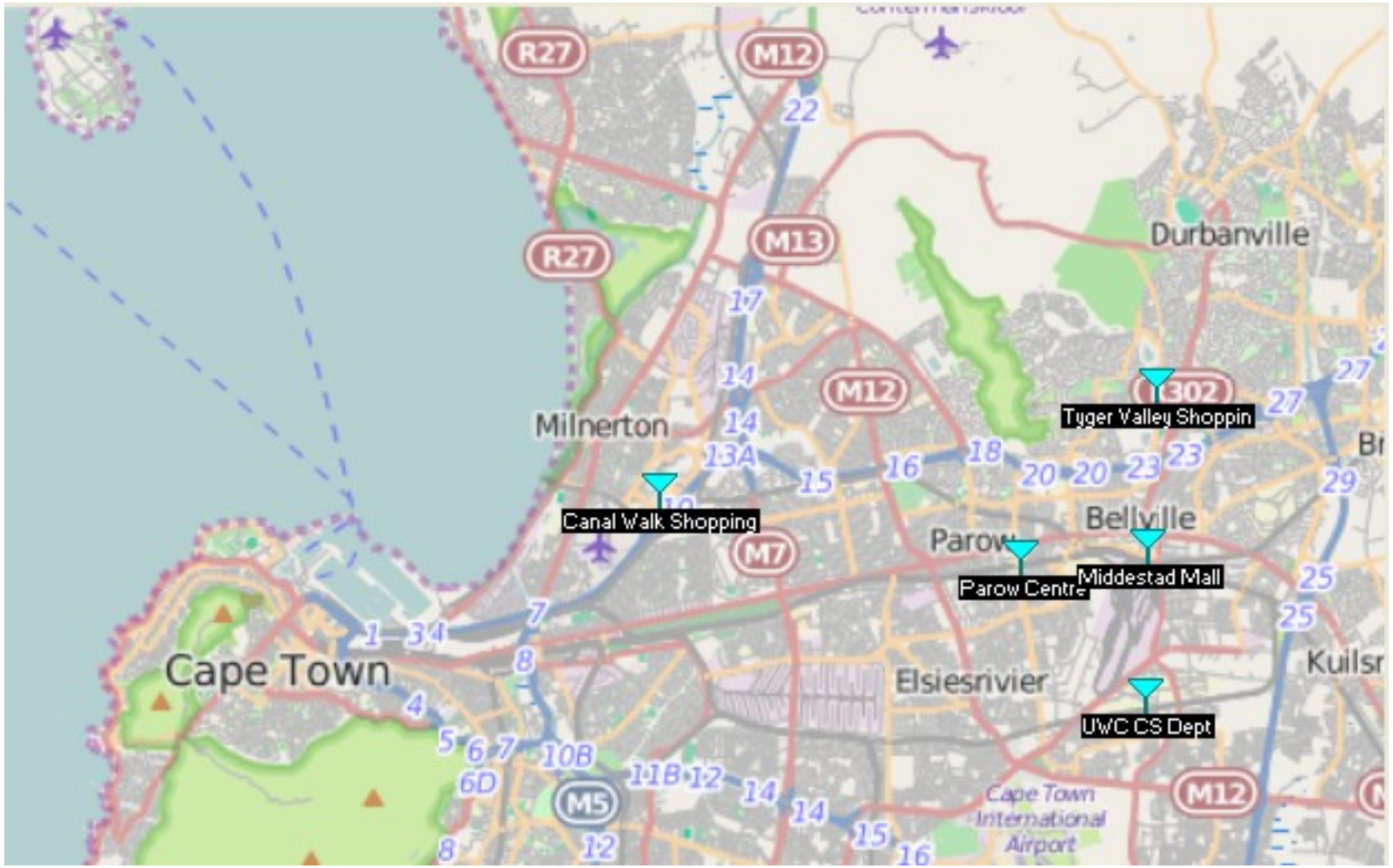
- Creation of **5 units** at the **5 sites**:
  - UWC CS department
  - Tyger Valley Shopping Centre
  - Parow Centre
  - Middestad Mall
  - Canal Walk Shopping Centre

Units



File → Unit properties

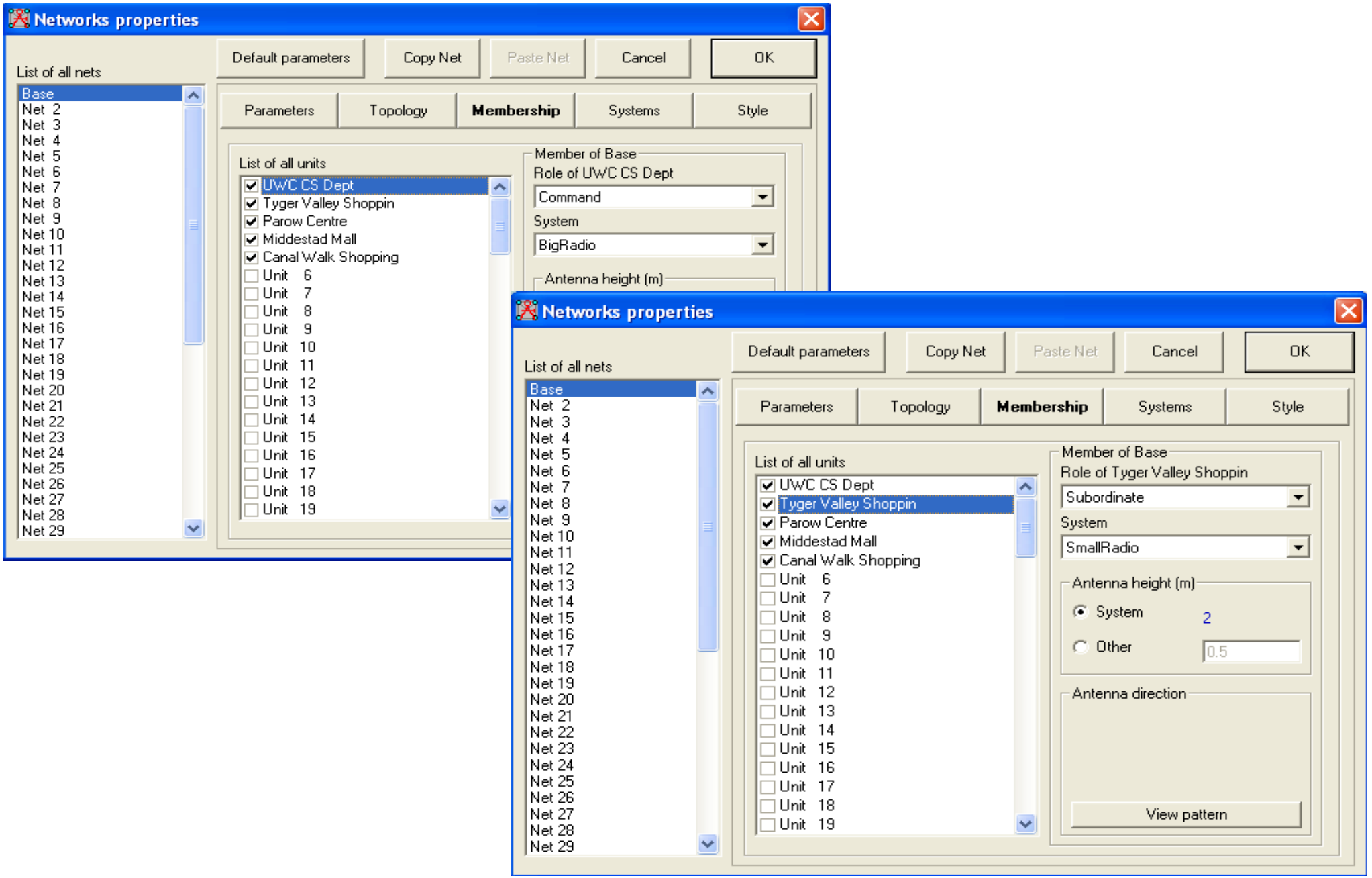
Units visible on map



Membership

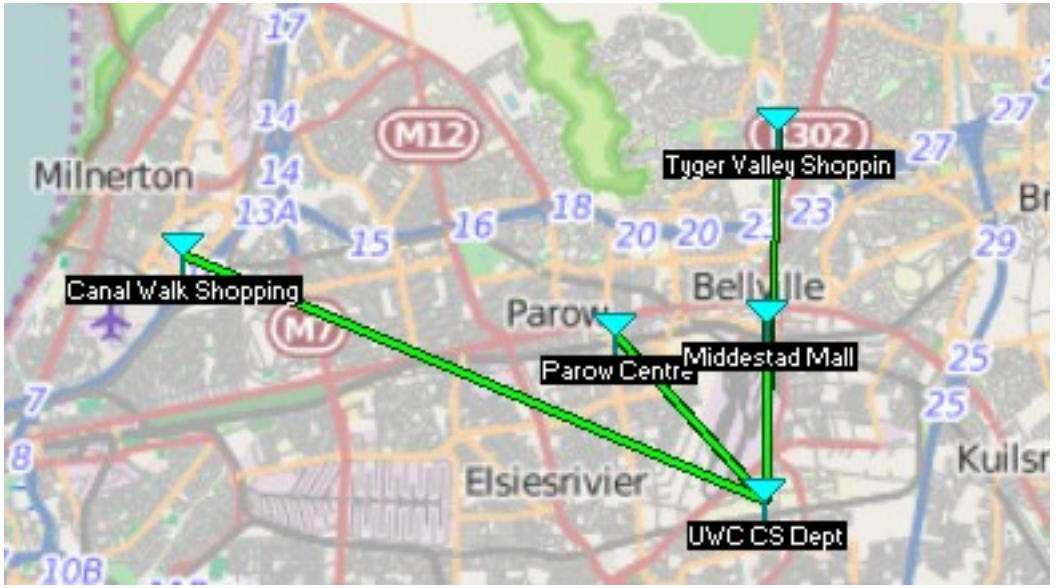
- After creation, assign the proper system to each unit:
  - UWC CS department → BigRadio
  - Tyger Valley Shopping Centre → SmallRadio
  - Parow Centre → SmallRadio
  - Middestad Mall → SmallRadio
  - Canal Walk Shopping Centre → SmallRadio

Membership

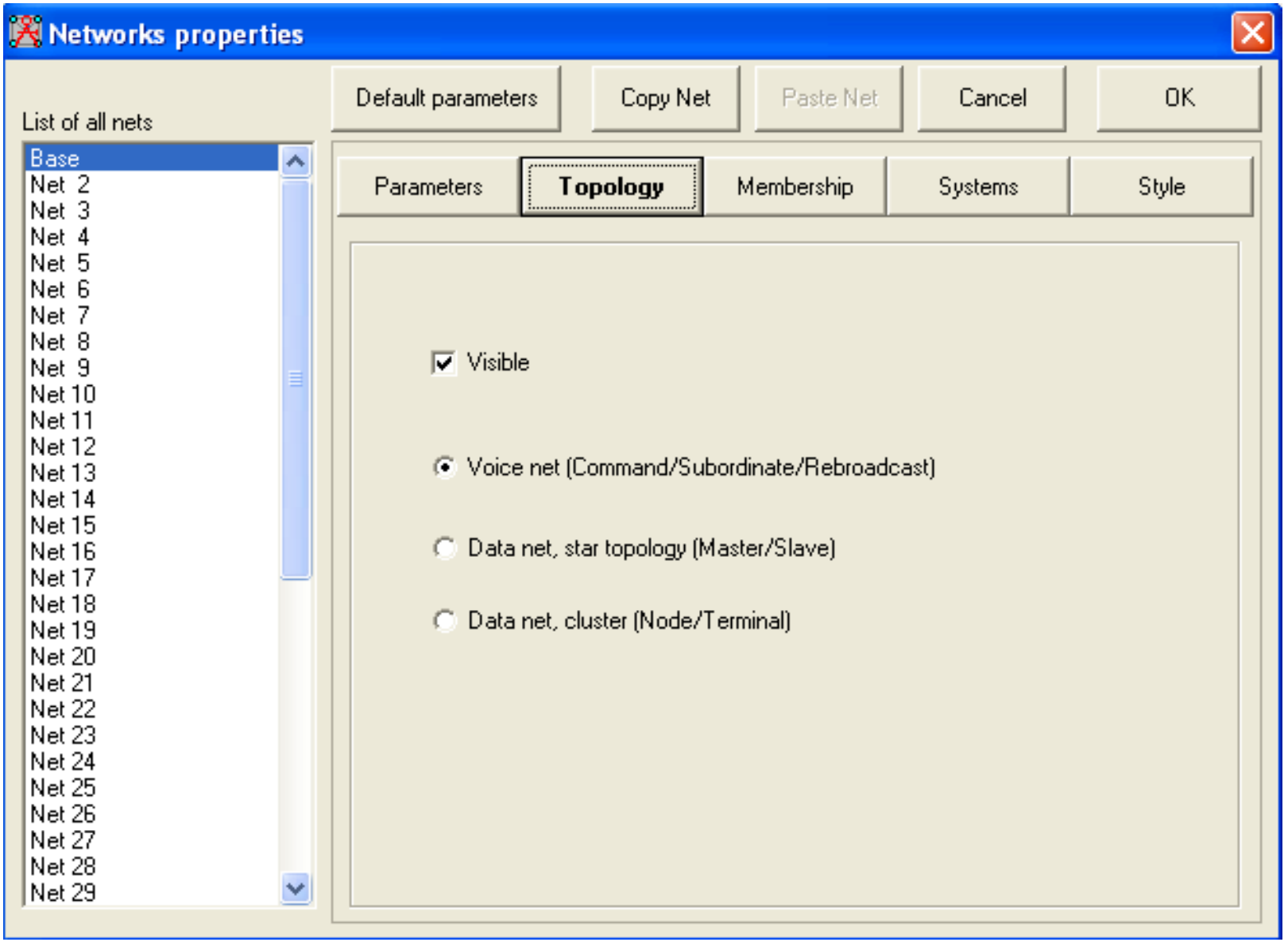

Networks properties
Default parameters
Copy Net
Paste Net
Cancel
OK
List of all nets
Base
Net 2
Net 3
Net 4
Net 5
Net 6
Net 7
Net 8
Net 9
Net 10
Net 11
Net 12
Net 13
Net 14
Net 15
Net 16
Net 17
Net 18
Net 19
Net 20
Net 21
Net 22
Net 23
Net 24
Net 25
Net 26
Net 27
Net 28
Net 29
Parameters
Topology
Membership
Systems
Style
List of all units
UWC CS Dept
Tyger Valley Shoppin
Parow Centre
Middestad Mall
Canal Walk Shopping
Unit 6
Unit 7
Unit 8
Unit 9
Unit 10
Unit 11
Unit 12
Unit 13
Unit 14
Unit 15
Unit 16
Unit 17
Unit 18
Unit 19
Member of Base
Role of UWC CS Dept
Command
System
BigRadio
Antenna height (m)
Networks properties
Default parameters
Copy Net
Paste Net
Cancel
OK
List of all nets
Parameters
Topology
Membership
Systems
Style
List of all units
Member of Base
Role of Tyger Valley Shoppin
Subordinate
System
SmallRadio
Antenna height (m)
System
2
Other
0.5
Antenna direction
View pattern

Network

- To view your network on the map, just select “**View**” → “**Show networks**” → “**All**”

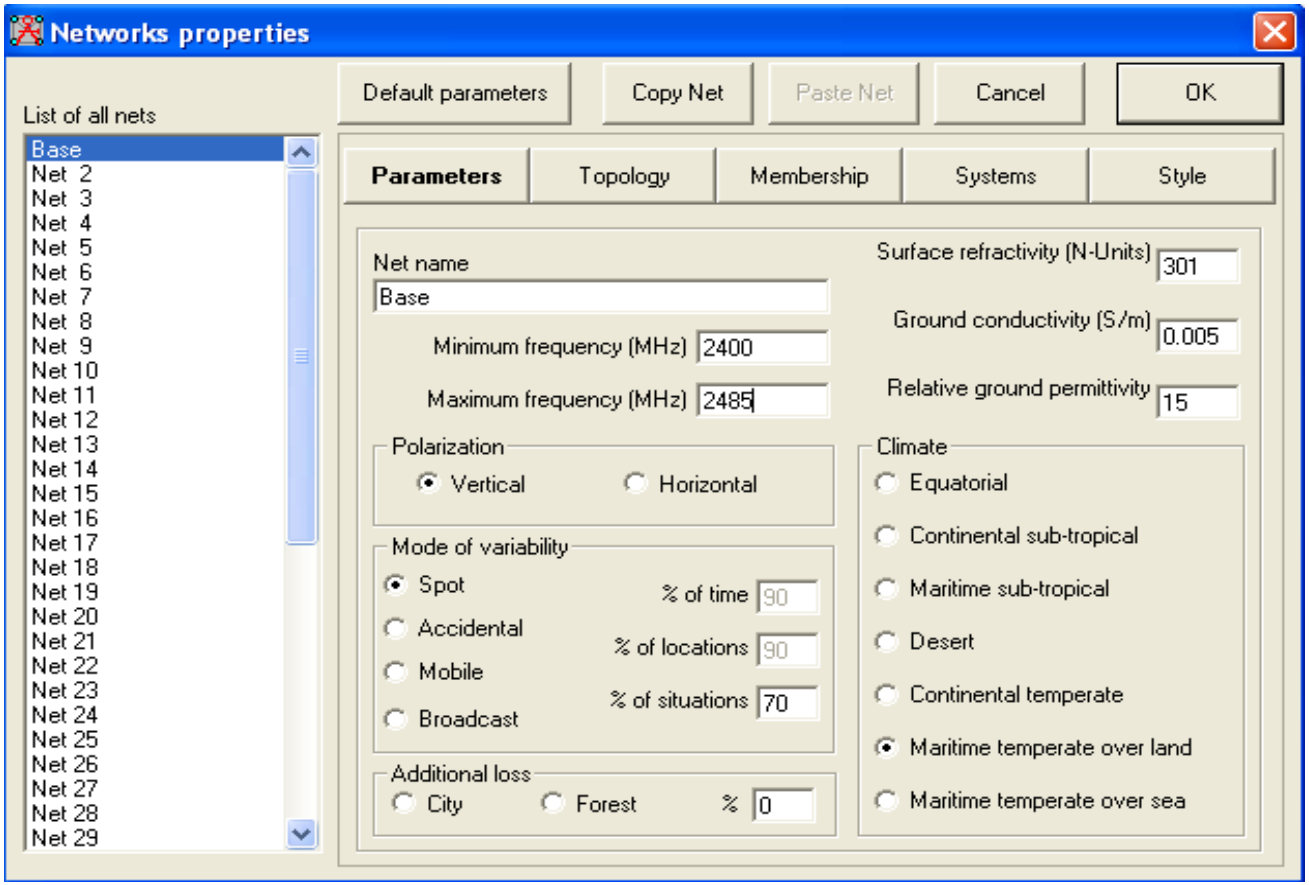


Topology


Networks properties
Default parameters
Copy Net
Paste Net
Cancel
OK
List of all nets
Base
Net 2
Net 3
Net 4
Net 5
Net 6
Net 7
Net 8
Net 9
Net 10
Net 11
Net 12
Net 13
Net 14
Net 15
Net 16
Net 17
Net 18
Net 19
Net 20
Net 21
Net 22
Net 23
Net 24
Net 25
Net 26
Net 27
Net 28
Net 29
Parameters
Topology
Membership
Systems
Style
Visible
Voice net (Command/Subordinate/Rebroadcast)
Data net, star topology (Master/Slave)
Data net, cluster (Node/Terminal)

Setting the correct frequency

- To be able to correctly calculate the loss due to propogation, set the correct frequency
- Since we are using the 2.4GHz band, set the range **2400-2485**

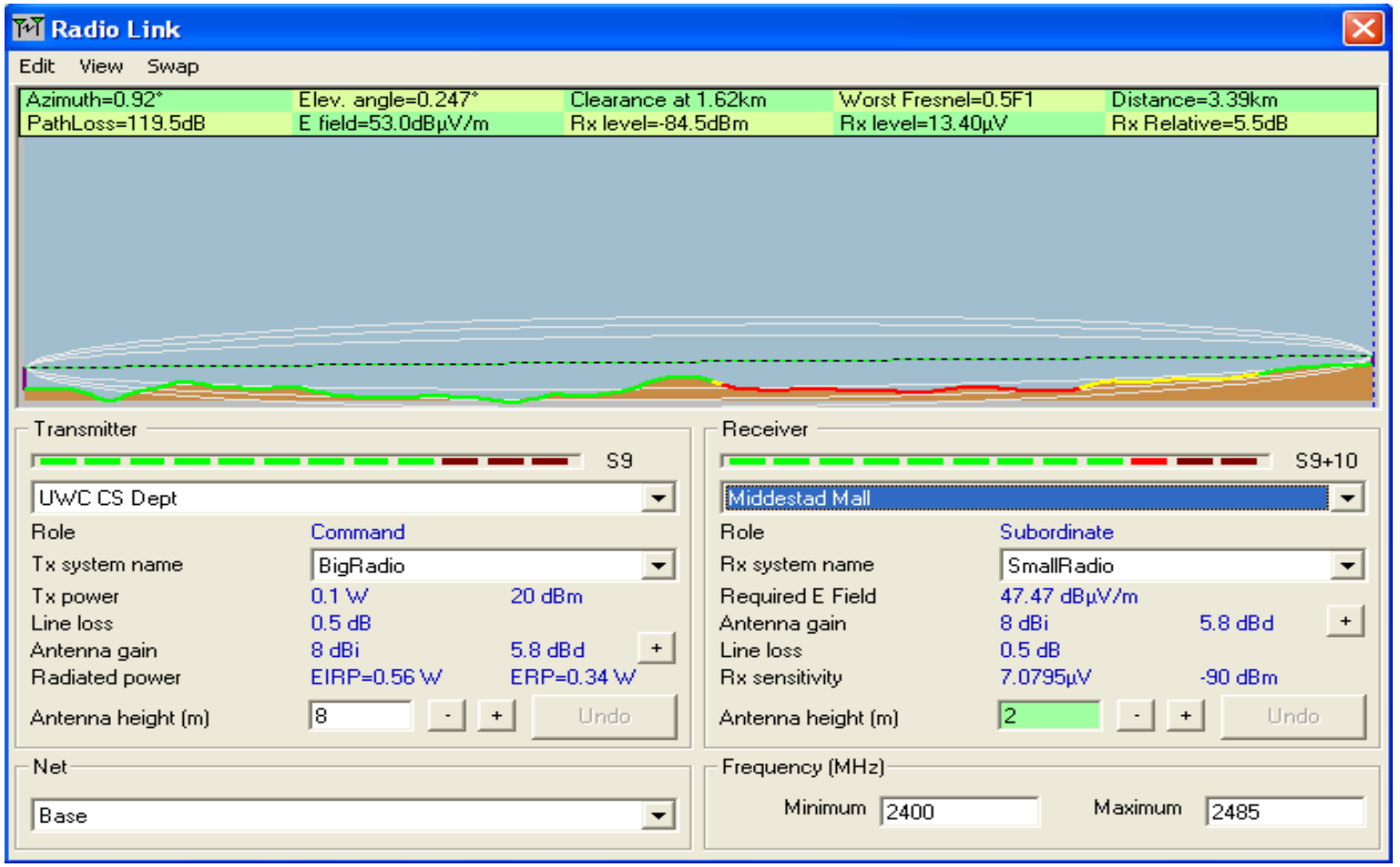


Network

Link colours have changed!

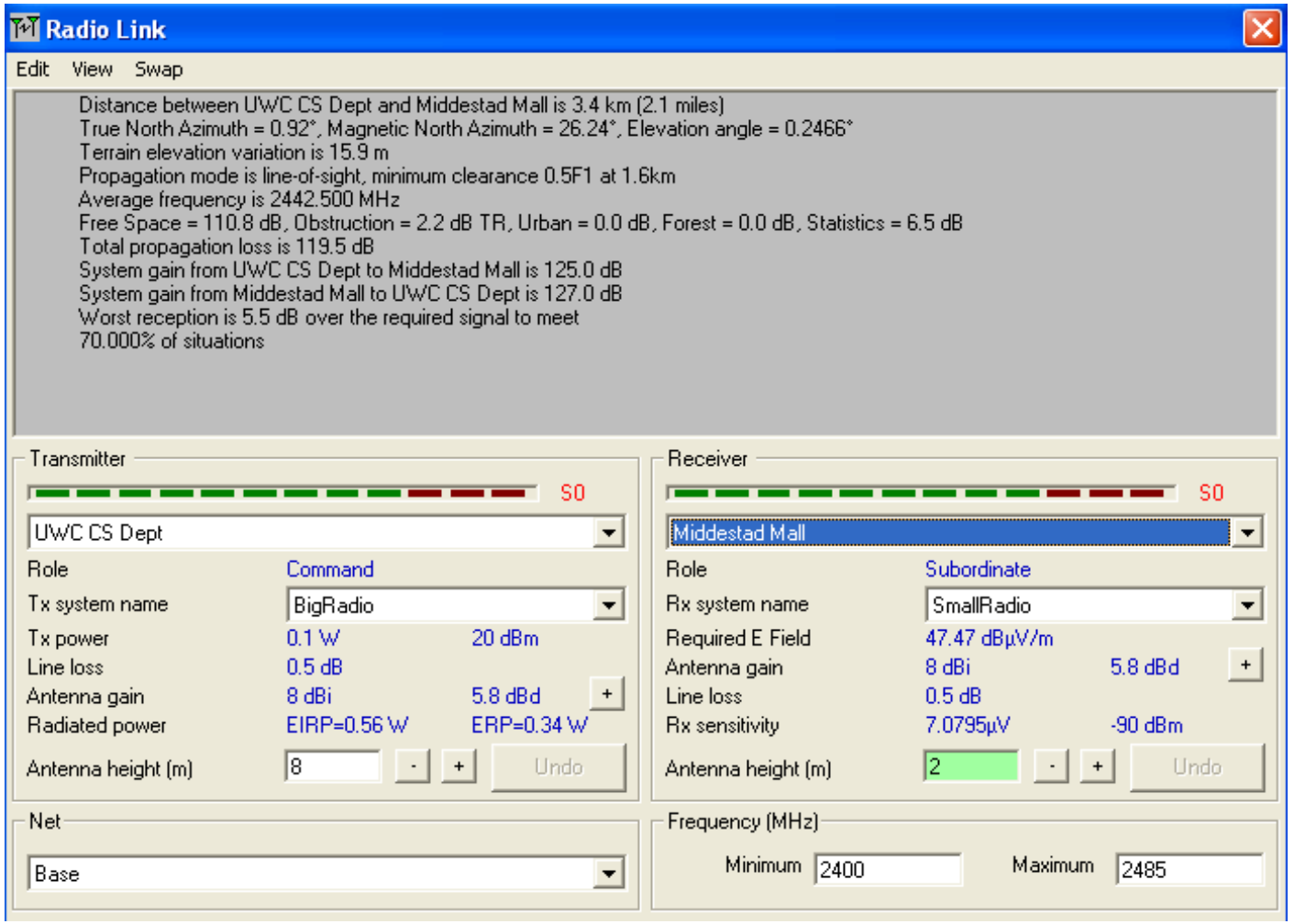
Results

- The scenario has been set...
- Calculate the link budgets
- "**Tools**" → "**Radio link**"



Results

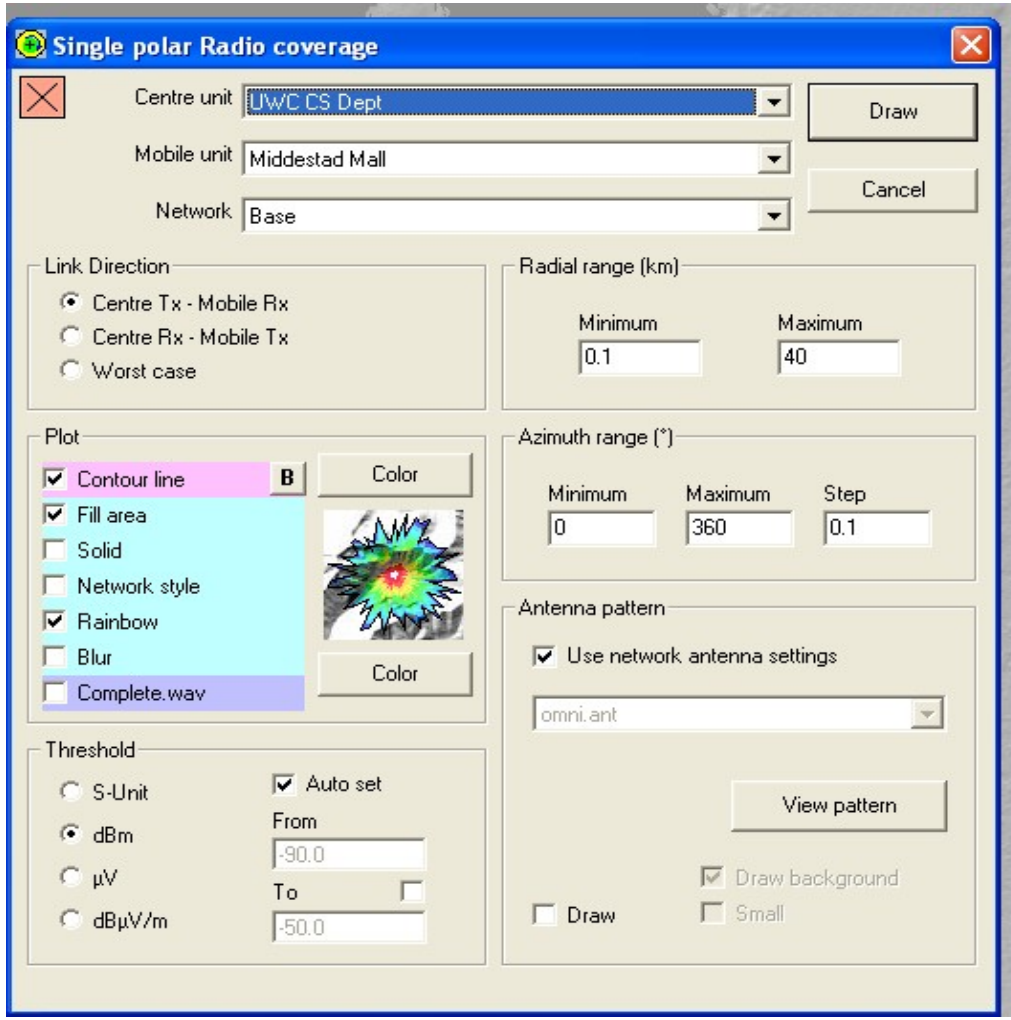
- You can switch to a detailed view that gives a textual description of the output of the simulation

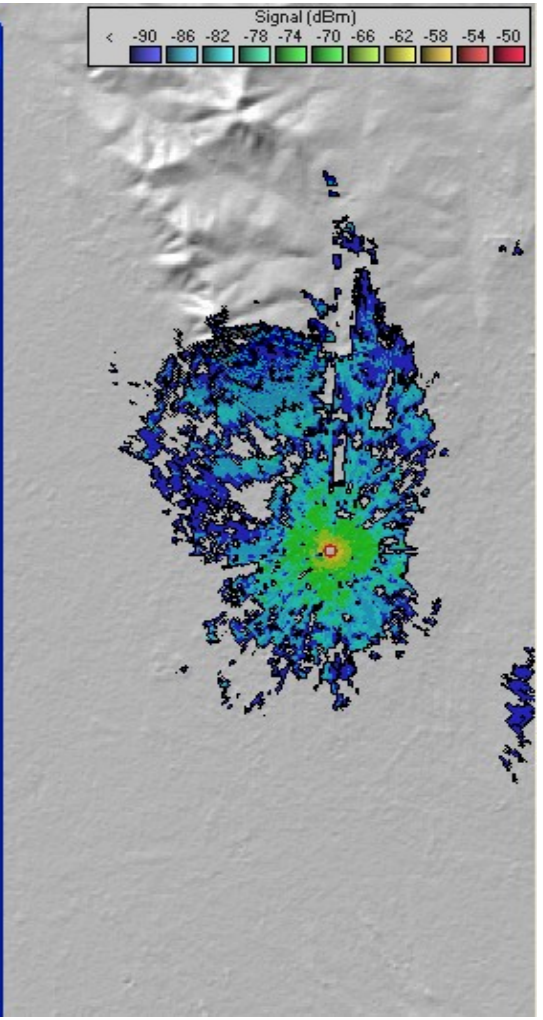


While on **Radio Link**, click "**View**" → "**Details**"

Coverage

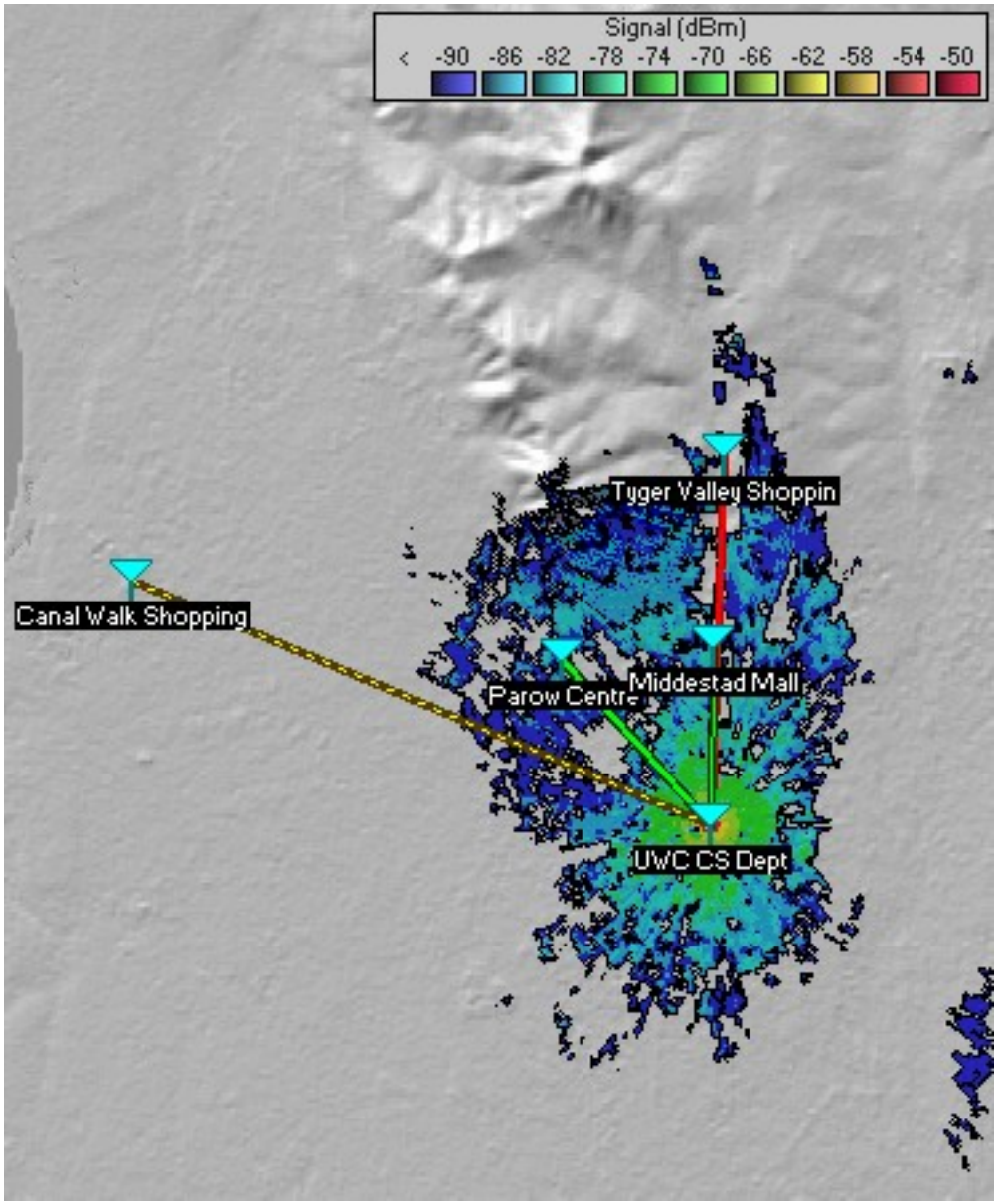
- “**Tools**” → “**Radio Coverage**” → “**Single Polar**”
- This will start the calculation of the coverage area of a selected station in your network





The lower the receiving sensitivity, the better the radio receiver.

Coverage with Network



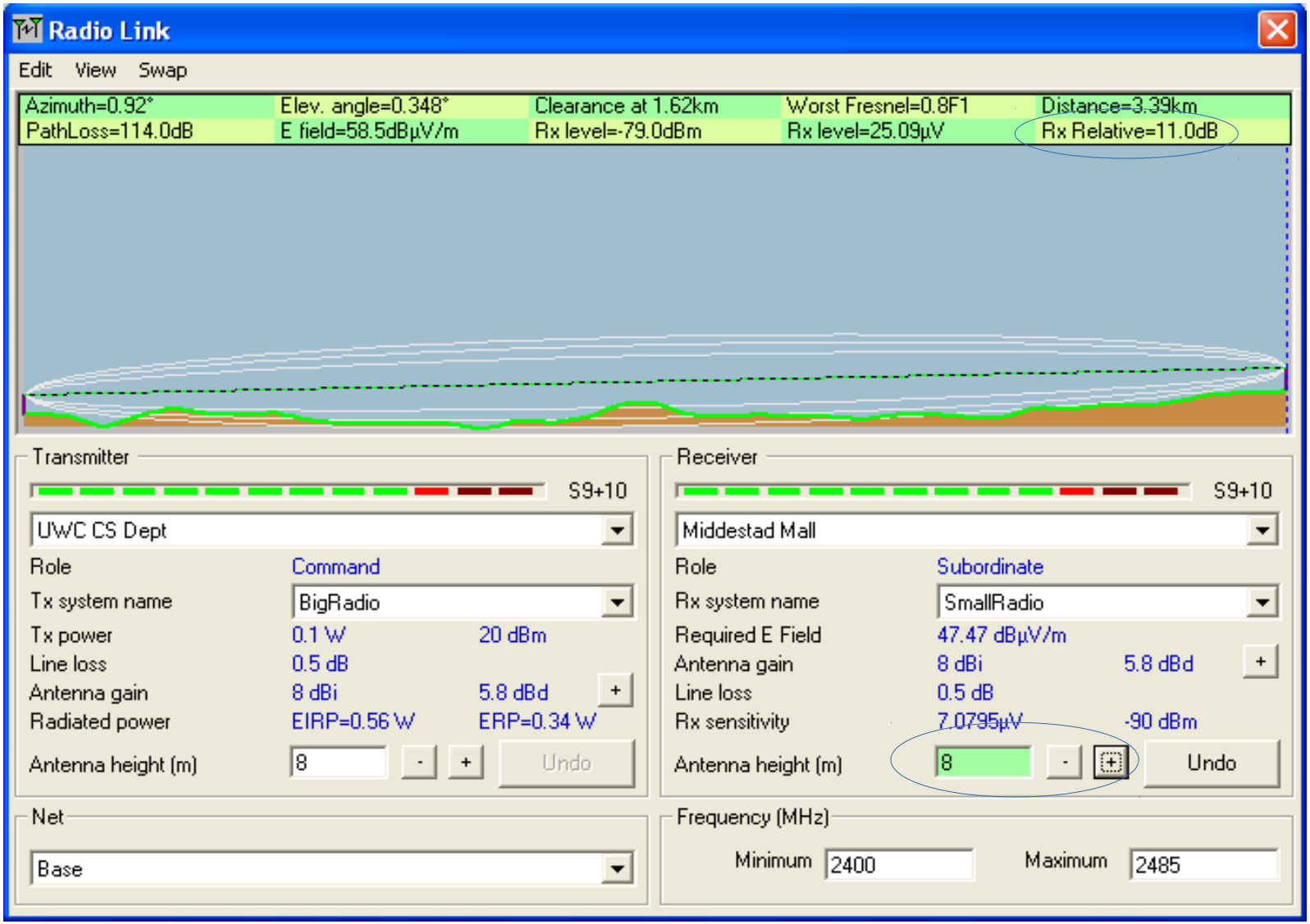
“What if?”

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

Note

- Keep in mind the following:
  - The link margin must be positive, and should be maximized
  - (should be **at least 10dB** or **more** for **reliable links**).

Results


Radio Link
Edit View Swap
Azimuth=0.92°
Elev. angle=0.348°
Clearance at 1.62km
Worst Fresnel=0.8F1
Distance=3.39km
PathLoss=114.0dB
E field=58.5dBµV/m
Rx level=-79.0dBm
Rx level=25.09µV
Rx Relative=11.0dB
Transmitter
S9+10
UWC CS Dept
Role
Command
Tx system name
BigRadio
Tx power
0.1 W
20 dBm
Line loss
0.5 dB
Antenna gain
8 dBi
5.8 dBd
Radiated power
EIRP=0.56 W
ERP=0.34 W
Antenna height (m)
8
Undo
Receiver
S9+10
Middestad Mall
Role
Subordinate
Rx system name
SmallRadio
Required E Field
47.47 dBµV/m
Antenna gain
8 dBi
5.8 dBd
Line loss
0.5 dB
Rx sensitivity
7.0795µV
-90 dBm
Antenna height (m)
8
Undo
Net
Base
Frequency (MHz)
Minimum
2400
Maximum
2485

Adjustments

Antenna heights
Antenna gains

Radiated Power
Terms and Concepts

- EIRP (Effective Isotropic Radiated Power) for

  2400 –2483.5 MHz

  - Maximum Radiated Power
  - **100 mW** (**20 dBm**) in Europe and **South Africa!**
  - 1 – 4 W (30 – 36.021 dBm) in other countries
- EIRP = Transmitter Power – (Losses in cables and connectors) + Antenna Gain (dBi)
- This leads to network **re-design** in our case

Antenna heights (Rooftop base)

- A rooftop base telecommunication station may not extend more than **3m** in height above the part of the building that it is attached to.
- Should it extend more than the permitted **3m**, prior approval from the City of Cape Town is required.

Antenna heights (Freestanding base)

- If a freestanding base telecommunication station is authorized as a **primary use** on a property, the freestanding telecommunication station may be as high as **25m**.
  - (City of Cape Town)
- Environmental affairs however kick in for antennas higher than **15m**.

Conclusions

- Radio Mobile makes it possible to simulate 1 or more radio links and perform “what if?” simulations, changing various link parameters
- While it cannot prove that a link is 100% possible, it 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

Thank you