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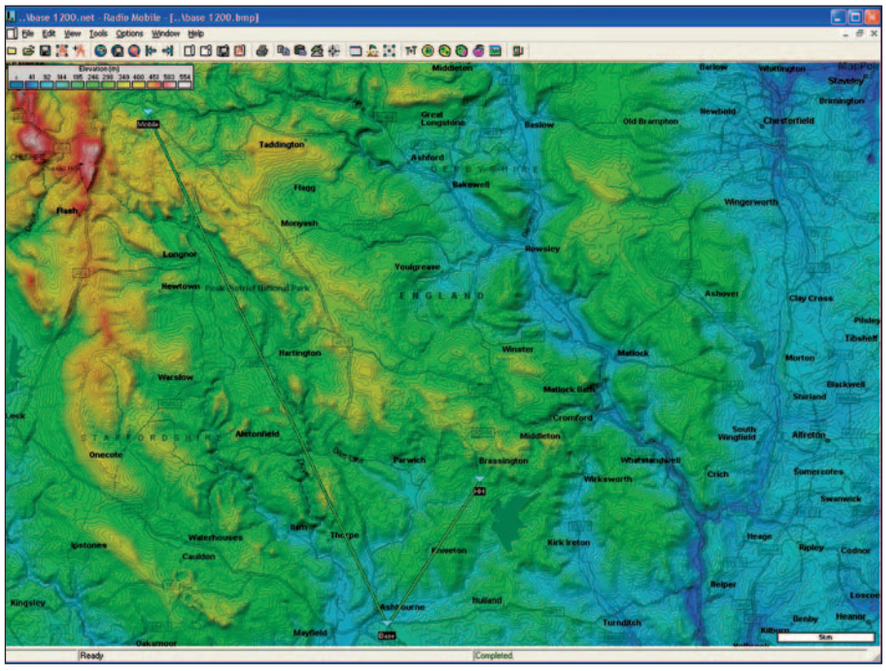


FIGURE 1: TOPOGRAPHICAL MAP OF THE PEAK DISTRICT SHOWING THREE RADIOS

An introduction to Radio Mobile

Working out probable radio paths for VHF and above used to call for an ordnance survey map and a lot of patience. That has all changed with the advent of the excellent free program Radio Mobile. Ian Brown gives us a flavour of what it can do.

INTRODUCTION. Radio Mobile [1] is a freeware radio propagation simulation program written by Roger Coudé, VE2DBE, which operates over the frequency range of 20MHz to 20GHz. It is based on the Irregular Terrain (Longley-Rice) propagation model [2]. It uses the principle of a radio 'network', ie you specify the performance parameters of two or more radio transmitters/receivers which need to communicate. The program enables elevation maps to be drawn of specified areas using Space Shuttle Terrain Radar Mapping Mission data downloaded from the internet. Elevation contours and roads can be merged with the maps, and then stations (Units) can be placed where required. Individual unit performances can be specified as a 'System' for frequency, transmit power, receiver sensitivity, antenna gain, height and feeder losses. All radio links between units can be examined for path profile and signal parameters. Signal coverage patterns can be produced for each separate unit if required. Another very powerful feature is the capability of finding the 'Best Sites' on a map to provide radio coverage to a number of specified unit locations. The performance of the radio link between a specified fixed unit and a second mobile unit which is traversing a route defined on the map can also be generated by a new 'Route Performance' feature.

The map in **Figure 1** shows part of the Peak District of Derbyshire and was produced by Radio Mobile. It shows 10m elevation contours, roads and the locations of the three radio stations in my Base VHF network. The radio links are shown as green, giving an immediate indication of good signal paths.

HOW IT ALL STARTED. When I first came across the program in 1999, it was limited by the elevation data only being available at 30 arc-second resolution – equating to a height grid matrix at 1km intervals – so not able to describe the Peak District valley folds in any detail. At that time the program was at version 2, and the elevation data had to be manually downloaded from the US Geological Survey (USGS) websites. This took considerable effort and time using the slow dial-up internet connections then available.

My main interest in the program was to be able to find suitable sites and predict station coverage for our UHF Raynet exercise event activities in the Peak District, but at that time the definition of the height data was insufficient for that purpose. We used maps to manually select possibly suitable high points, and then drew path height profiles to the event checkpoint locations to try and predict workable radio paths. This worked reasonably well, but was very labour intensive, and required a major effort from a lot of operators to check out all the locations for radio link performance on the ground.

GETTING BETTER. The situation changed considerably after November 2003 when the USGS released 3 arc-second data for Eurasia, which corresponded to a 90m gridded height matrix. With this new data I found that valleys were defined much more precisely. After placing stations (Units) at the locations we had previously used, I was then able to plot the ground profiles and radio performance with a few clicks of my mouse. The results were very close to the manual plots, and the radio performance corresponded closely to that previously experienced.

In order to cover an annual 18 mile charity walk we traditionally positioned the control station beside a triangulation pillar.

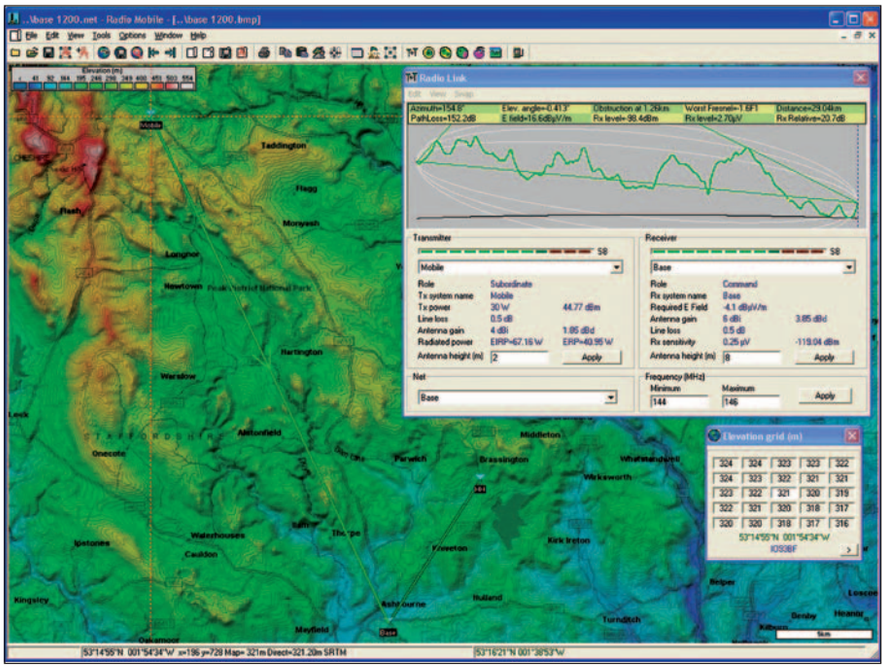


FIGURE 2: RADIO LINK QUALITY FROM BASE TO MOBILE

This location worked fine but it had its drawbacks, because access was via 2 miles of farm tracks and fields, including a half-mile climb at 30° across rough moor. The problem was compounded by the fact that the station was set up in the dark at about 0630. Thick mist and rain reduced visibility to about 5m, and the final 100 metres of the route was along a 10m wide shelf next to a 30m cliff edge! Whilst sitting in the mist operating the station, I realised that if my Land Rover had any problems, recovery could be rather difficult. Obviously a more accessible site was required.

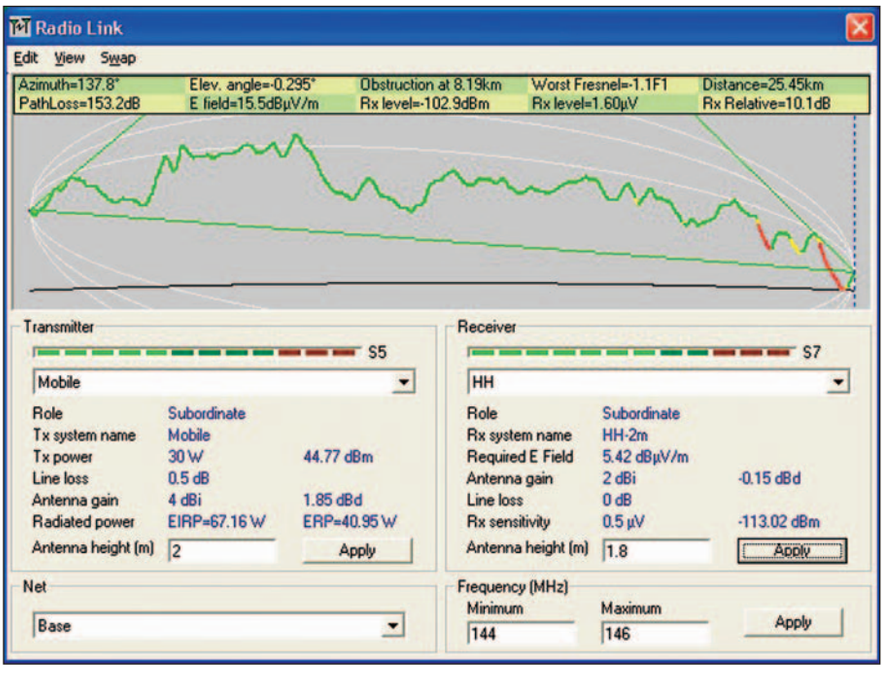
PRACTICAL APPLICATION. Using the ability of Radio Mobile to quickly relocate units then check network signal path properties, I was able to find a new location next to a farm road which improved signal coverage to the check points. On-site radio link checks were quickly performed and these confirmed the results obtained from Radio Mobile, and the new site was used successfully for the November 2003 event.

GETTING STARTED. I found that when introducing my friends to Radio Mobile, they had difficulty in setting up their first map and network, steps which are required to obtain an initial working display. This problem prompted me to produce a simple 'Base Network' setup, complete with a complimentary set of 'Quick Start' self-installing files (which include the required USGS height data) to produce a working network. This setup installer file is 2.5Mb and can be downloaded from [3].

To demonstrate some of the features available from the program I have used my Base Network, located in my local area, to generate the following screenshots. The network consists of a base unit, a mobile unit and two hand held units, with sensible operating parameters set up for each of them. **Figure 2** shows the radio links from the base unit to a mobile and also a hand held unit. The plot in Figure 2 also shows the Radio Link pane, which gives details of the base to mobile link.

On the main screen the link is shown in green, with the red 'cross wire cursor' located on the mobile unit. The small Elevation grid pane shows the ground height at the cross wires in the centre (white) box, while adjacent cells show the surrounding terrain heights. The Radio Link pane gives details of both stations and also path parameters between them, and also plots the Fresnel zones. Moving the cursor along the path by use of the arrow keys causes the movement to be reflected by the cross wire cursor on the main window. One further function of the Radio Link pane is to allow both antenna heights

FIGURE 3: POOR LINK QUALITY ALONG THE PATH IS SHOWN IN YELLOW, UNUSABLE QUALITY IS RED



to be varied from their individual 'System' settings, whilst displaying the signal path against ground profile. A reverse path can be shown by using the 'Swap' command.

Looking at the mobile to hand held unit link plot shown in **Figure 3**, there are some regions of the path (shown in red and yellow) where acceptable communication cannot be achieved.

TERRAIN VIEW. A further feature of the Radio Link pane is the capability of 'viewing' one unit from another. The view in **Figure 4** was obtained by relocating HH-2 to a convenient point closer to the base unit. If the viewed unit is visible, it is highlighted with a circle at its location as shown in Figure 4.

The colours of this display are taken from elevation data. However, if an aerial photograph of the map area is available, it can be imported into the program and laid over the elevation matrix to provide a relief photograph of the path. I am just waiting for Google Earth to add the Peak District with their high resolution photo coverage to try this out!

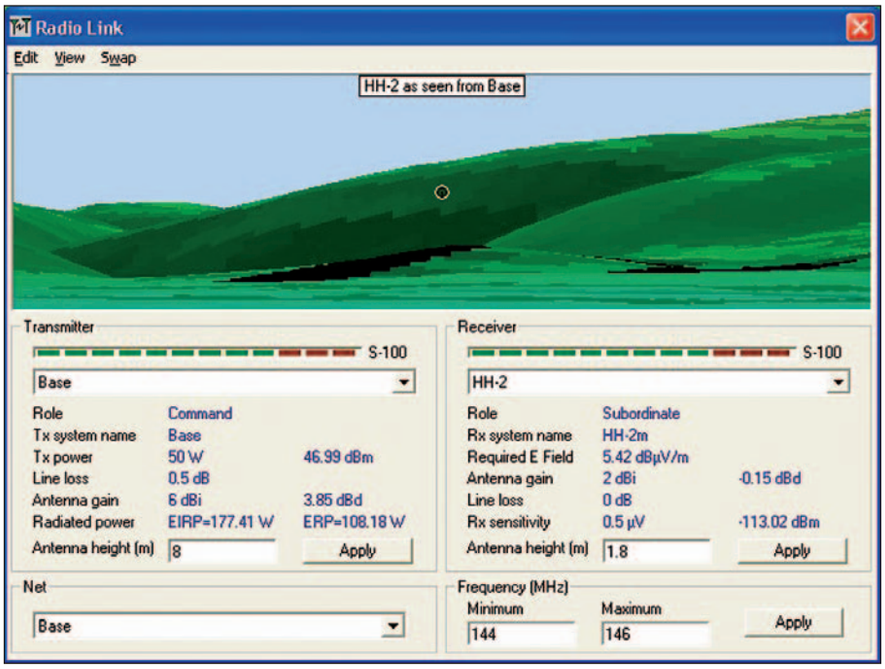
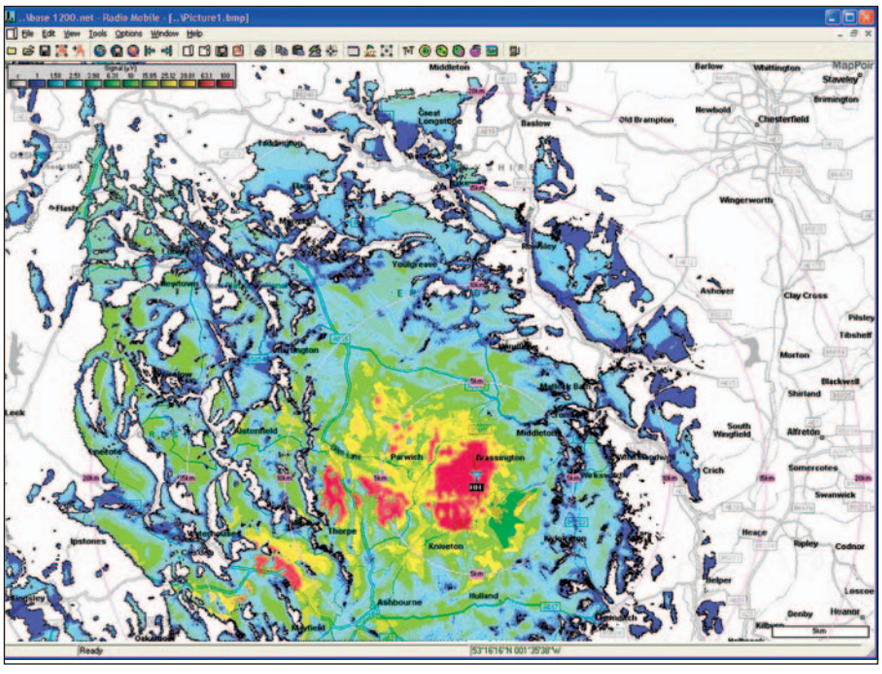


FIGURE 4: VIEWING A STATION ACROSS A VIRTUAL TERRAIN

FIELD STRENGTH PATTERNS. Another facility available in the program is the capability of plotting the radio coverage of a station in various measurement units. The best way to see the results is to perform a plot over a black and white roadmap, or a blank picture, either of which can be merged with another available picture as required. An advantage of this technique is that the rainbow colours of the plot are not confused with the underlying picture colours. **Figure 5** shows the signal coverage in μV from the first hand held unit to the second. Radial range rings have been added to give an idea of scale. The plot was performed in polar (radial sweep) mode with a step increment of 0.1° over a black and white map downloaded from MapPoint.

FIGURE 5: SIGNAL STRENGTH PLOT OVERLAID ON A ROAD MAP



BEST SITES. Where it is necessary to find a site which can communicate with several other units, the 'Find Best Sites' function can be invoked. To illustrate the point, in **Figure 6** I have moved the second hand held unit to a position in the north east of the map, and have requested the best site for a 'hand held' unit location as the central communication hub to communicate with the first hand held, the mobile and base units. The display shows areas with 50% to 100% coverage as per the legend, and the plot shows the positioned hand held unit as Command located on the side of a road. This plot was performed in Cartesian (X-Y) format, with a resolution of 5 pixels square on the ground.

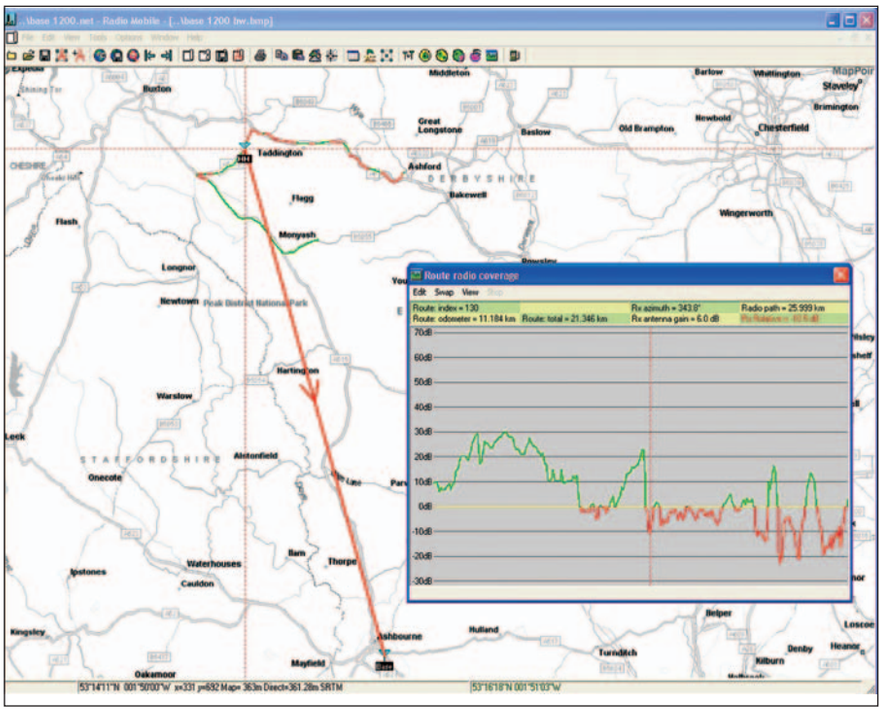
COMMUNICATING ALONG A ROUTE. 'Route Performance' is the latest feature to

be added to the program. Using the Radio Mobile 'Object Editor', a path can be drawn on the map and saved for later use. The Route Performance plot takes this path as the route to be taken by a defined mobile station communicating with a fixed unit, and calculates the communication quality for the length of the route. The linear step length along the route can be selected, and parameters of the radio link can be displayed at any location. The route is also displayed on the main map with Green showing good communications and Red for a poor link, as illustrated in **Figure 7**.

The detailed performance at any location on the route can be selected using the arrow keys, or by clicking on the grey window. The radio link on the main window shows the direction of communication, with its colour indicating performance.

FURTHER DEVELOPMENTS. The program has continued to evolve, driven mainly by requests for features from users. Roger puts these on to his 'Wish List', which is maintained in the Radio Mobile Yahoo group [4]. This group has over 2500 members, and by April 2006 the program had reached version 7.

FIGURE 7: COMMUNICATION QUALITY ALONG A DEFINED ROUTE



CONCLUSION. As with any simulation program, the output is only as good as the data input. For instance, great care is required to accurately assess both the transmit and receive performance of a hand held portable radio, where the stature and physical operating mannerisms of the operator can have a great bearing on the equipment performance. On-the-ground radio checks are required for confidence, but after using the program to select sites over a number of years, we now only feel the need to look at the poorer locations – and specify higher performance radios to be used in those areas.

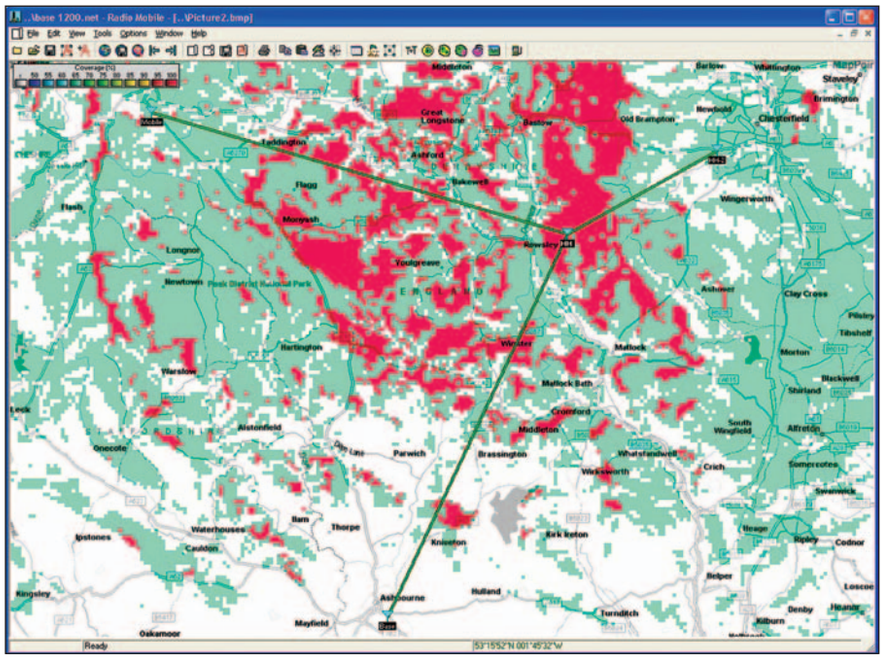


FIGURE 6: FINDING THE BEST SITE FOR A COMMAND LOCATION

With an emergency callout for Raynet it wouldn't be possible to select a suitable site for a station, but we are generating a local knowledge base of suitable sites and coverage as a spin off from the exercises to use in those circumstances.

Finally I would like to express my thanks to Roger, VE2DBE, for his work on Radio Mobile which is such an eye opening tool, and for releasing and supporting it so diligently as freeware.

REFERENCES

[1] Radio Mobile home page
http://www.cplus.org/rmw/english1.html
[2] ITM Model description
http://flattop.its.bldrdoc.gov/itm.html
[3] Quick Start files via
http://www.g3tvu.co.uk/Radio_Mobile.htm
[4] Yahoo Group
http://groups.yahoo.com/group/Radio_Mobile_Deluxe