■ White Papers

Area Prediction Tools Used for Site Planning of Fixed Link Networks

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April 2007

Solutions in Radiocommunications

Area Prediction Tools Used for Site Planning of Fixed Link Networks

Overview:

Radio propagation prediction tools have been long used for analysing links between nodes in fixed wireless networks and for relays used to link two mobile radio network base stations together. However, these offer little benefit for identifying suitable locations for these nodes and relays in the first place. It is possible to use area prediction simulations, more normally used in mobile network planning, to help in this process as illustrated in this white paper.

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Radio propagation prediction tools have long been used for analysing links between nodes in fixed wireless networks and for relays used to link two mobile radio network base stations together. However, these offer little benefit for identifying suitable locations for these nodes and relays in the first place. It is possible to use area prediction simulations, more normally used in mobile network planning, to help in this process as illustrated in this white paper.

A typical coverage prediction is shown in Figure 1. This is normally used to identify where a mobile subscriber will be able to communicate with a fixed base station (at 'Location 1'). S*o how can this help us to find suitable sites for fixed link networks?*

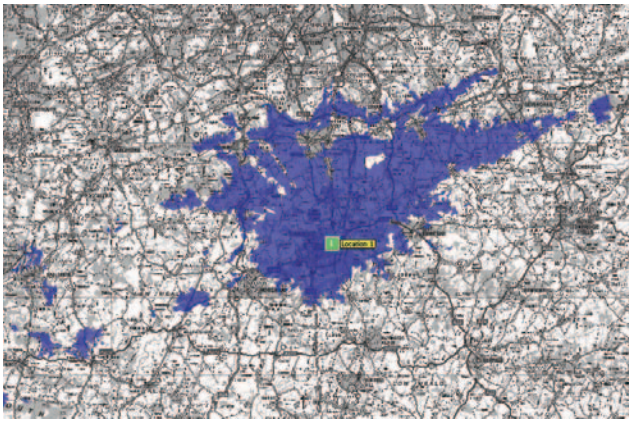

Figure 1: Typical coverage prediction as used in mobile engineering

If we start by looking at the relay (or re-broadcast link) scenario, then the situation is as illustrated in Figure 2. This shows two fixed base stations which require a radio link between them. However, in this case, the two stations are separated by a hill which precludes direct communication. A relay added in a position where links to both stations will allow messages to be passed from one base station to the other. The design requirement is to identify locations that fulfil the condition that it must be possible to link to both stations.

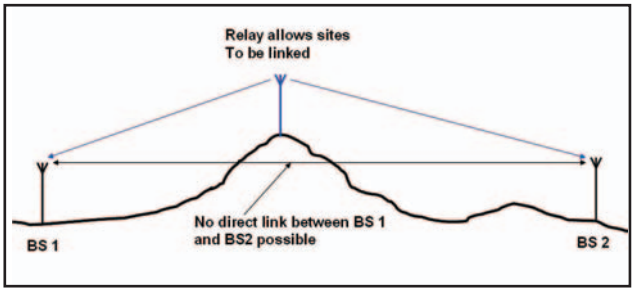

Figure 2: The need for a relay to link two fixed stations

We therefore need a search tool that identifies such locations. This is where the coverage-based prediction becomes useful. Normally, the link budgets and characteristics used in an area prediction are those applicable to the base station and the mobile. For relay site searching, these must instead refer to the characteristics of the base stations and the relay. In particular, we need to know the frequency of the proposed link, the effective radiated power and antenna height of each base station, and the proposed height of the antenna and minimum working signal level required at the relay system. Although the link will normally have directional antennas, we will assume an omni-directional antenna at this stage. This is broadly equivalent to assuming that when positioned correctly, the antenna can be pointing in any direction. For calculation of the minimum acceptable working signal level at the relay, it is important to ensure that fading is accounted for in a manner appropriate to the type of link that will be formed; in general Ricean fading would be more appropriate than Rayleigh fading in this case.

Only once the simulation is configured with the site characteristics, the necessary elements of the link budget and having selected an appropriate propagation prediction model can the 'coverage' from both base stations be derived. This is illustrated in Figure 3. Figure 3 also illustrates how the two coverage predictions can be combined to identify areas of overlapping coverage (in pink) and where communications with both fixed stations can be achieved. These are acceptable locations for a relay.

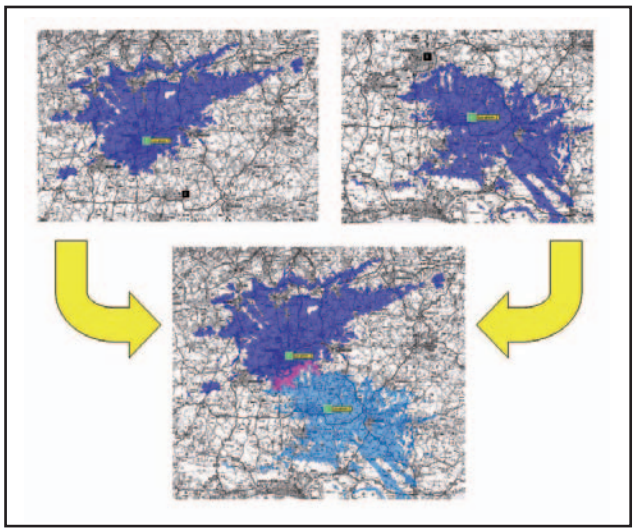

Figure 3: Using overlapping coverage to identify potential relay locations

The process now would be to focus on the overlapping areas and identify a suitable site based on whatever the selection criteria are, such as road access. An example is shown in Figure 4.

Now that the relay site has been identified, the actual link data, such as the direction antennas, azimuth and tilt of the link can be used to fully characterise the link.

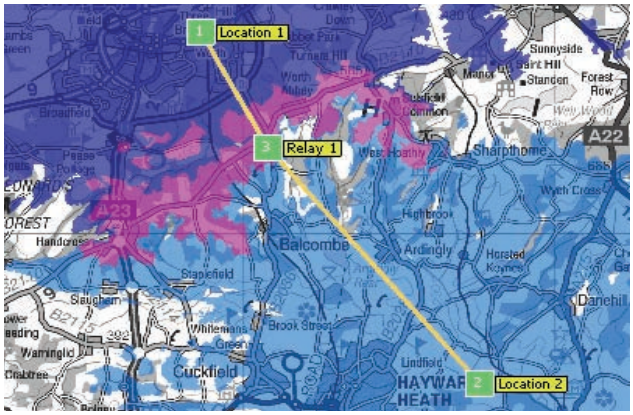

Figure 4: Establishing relay links

This basic method can be refined for identifying potential microwave link locations, both for the green field condition, and when sites are to be selected from a database of existing sites.

For microwave links, we will need to establish a clear line of site with full Fresnel clearance for the selected k-factor. With a suitable propagation prediction model that allows such factors to be configured, it is possible to reject any potential link that is diffracted or fails the clearance criteria. This model can also be configured to include the effects of rainfall so that the potential sites can be tested against the required reliability value. An example of this is illustrated in Figure 5, which uses the same site as in the first example. We have kept the frequency and other characteristics the same, so the two plots can be compared directly.

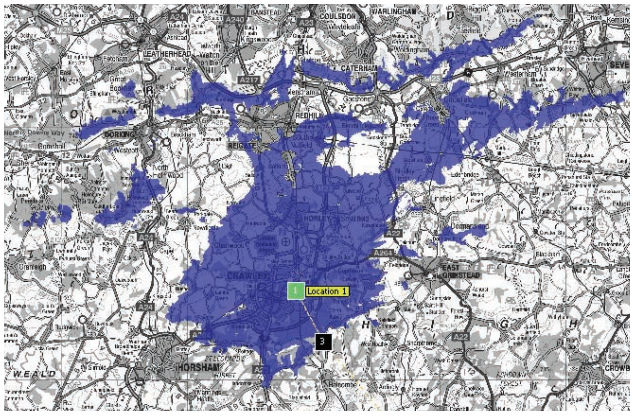

Figure 5: Coverage with diffraction and clearance criteria applied

The coverage seen is effectively a sub-set of the initial plot, but with unacceptable paths removed, even if the field strength is of an acceptable level. The remaining coloured areas are those that pass the criteria and have the highest probability of providing suitable sites. The same process as illustrated for the relay example can then be used to select candidate sites.

Often, the planner will be working with a list of potential sites, as illustrated by the hypothetical set of candidates shown in Figure 6. The existing network is shown with green icons, and the candidate sites are shown with mast icons.

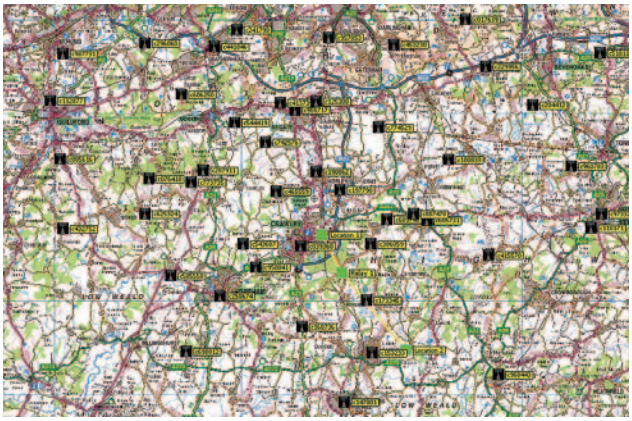

Figure 6: Hypothetical candidate sites

If we want to see which sites have the potential to provide a working link to Location 1, we can filter on those sites within the coverage area shown in Figure 5, as shown in Figure 7.

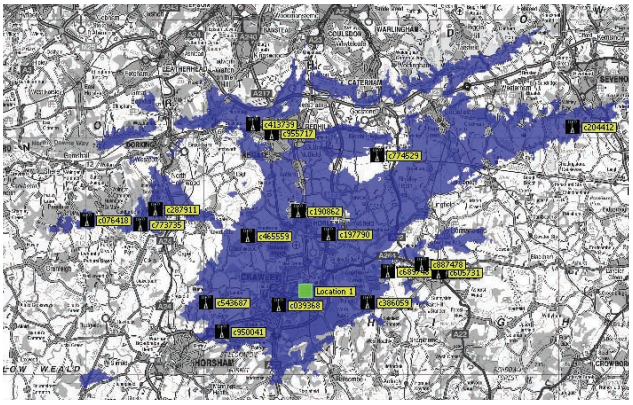

Figure 7: Candidate sites filtered for link potential with Location 1

Links to these locations are potentially feasible and thus may be considered in the network design process.

We can also use the same process for linking sites that cannot be directly linked. For example, suppose we want to link the site in Crawley with a site in Horsham. Figure 6 shows that there is a suitable site in Crawley, but since it is not in the coverage area of Location 1, a direct link is not possible.

We can however produce a plot of the Horsham site, combine it with the plot of Location 1 and then look for sites in the overlapping areas. This is shown in Figure 8.

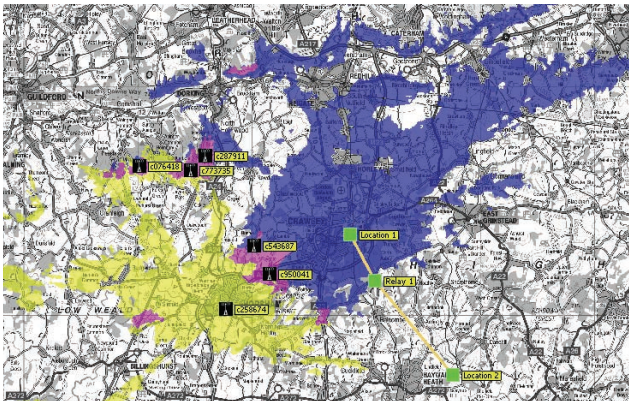

Figure 8: Sites filtered for the overlapping areas of the Crawley and Horsham sites

This approach can also be generalised to multiple overlapping areas, to identify single masts capable of providing links to several other masts in the area. This is illustrated in Figure 9. In this case, the display does not show where overlaps occur, but rather how many do. Where a site is shown as being in a specific coloured region, according to the key shown, it can link to that number of sites. This particular display does not allow us to actually identify which sites can be linked to, but this can be readily established by further analysis.

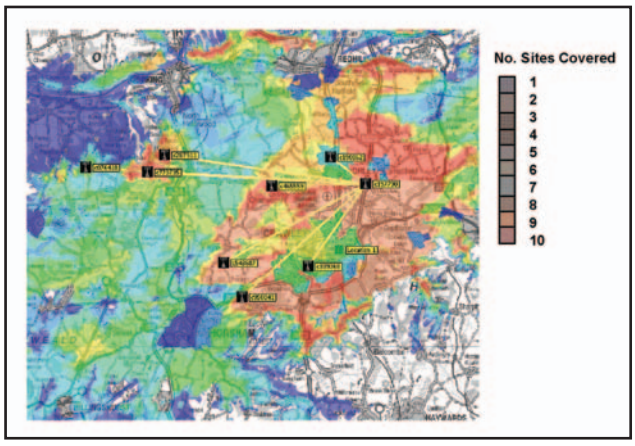

Figure 9: Multiple overlap analysis for selecting sites capable of links to many sites

Site cs197790 is actually capable of linking to all of the other sites, and would thus be a good candidate for a hub location.

The use of coverage-based tools in fixed network design can allow very speedy analysis of potential node locations, and an experienced operator can work through many potential links very quickly. As ever with simulation tools, the computer based work will never remove the need for individual survey of potential sites, but particularly in the case where there are many potential sites, it can be used to quickly categorise potential links as feasible or unfeasible. This speeds up the overall process greatly, leading to greater efficiency and generally better network designs.

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