Problems with Cell Phone Evidence tendered to 'prove' the location of a person at a point in time

By R.P. Coutts[1], H. Selby[2] [3]

Introduction

Some years ago, through our participation in a post conviction inquiry into a murder case in which the investigators and lawyers misinterpreted mobile phone records, we became concerned about the inaccurate use of mobile phone records to place the whereabouts of a phone (and its user) as evidence in criminal trials.[4]

In the years since matters have not improved. However, in 2015 the Commonwealth Government enacted new requirements [5] for the Telcos to keep data. With respect to mobile phone records it is useful to note that:

- there are over half a million requests per year for meta data (ACMA 2012/13);

- the Telcos keep call charge records [CCRs] for more than 2 years but there were commercial pressures to reduce this time to weeks in the case of IP addresses;

- there has been no legal clarity as to who can access these CCRs; and,

- there has been no standardised format for the content of CCRs. For example, the Telcos' algorithms for deriving a CCR and thereafter a client bill have been variable, so that some CCRs have not shown the initiating sector (being one of three, each covering 120 degrees, and each having a 'cell ID') of a transmission tower.

Under the recent legislation:

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[3] We would like to acknowledge the assistance and input from Dr Ted Buot , an experienced ex Nokia Cellular Planning Engineer and PhD student of Professor Coutts in the 1990s.

[4] Based on that experience Coutts and Selby presented a paper at the CPRF Conference in 2008 [Coutts and Selby 2008] and later at the NSW Public Defenders' Conference in 2009 [Coutts and Selby 2009].

[5] See Telecommunications (Interception and Access) Amendment (Data Retention) Act, No 39/2015

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- the Telcos must keep standardised data for at least 2 years (see Section 187C). That standardised data set includes, inter alia, the following (see Section 187AA) : subscriber ID; billing or payment information; source and destination of communication; date, time and duration; type of communication (e.g. voice, SMS, email, chat, etc); type of service (e.g. ADSL, VoIP, cable, etc) ; and the location of equipment (eg a cell tower, Wi-Fi hotspots, etc. at the start of the communication.
- there is third party access only for criminal cases (See section 110 et seq). It is not available in civil cases.
- owners of the service have the right to access 'personal data', though the extent of personal data is in dispute.

From both prosecution and defence perspectives these changes can contribute to less misuse of 'communication data' in those cases that post date the introduction of the 'new' standards.

However, those cases for which the relevant records predate the new legislative requirements will be adversely affected by the earlier vagaries and limitations of the stored data.[6]

Mobile Communications Basics

It is our experience that investigators and lawyers do not understand the mobile phone 'data' with which they deal. Hence the following information is intended to make the discussion in the rest of this paper more easily understood.

General

Public mobile telecommunications networks of which there are 3 in Australia (Telstra, Optus and Vodafone) are extensions of the main fixed network that is often referred to as the PSTN (public switched telephone network). The mobile networks are connected to the PSTN at POIs (points of interconnect) allowing mobile users to dial any other users based on an international numbering system.

Mobile Network

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[6] This paper is not concerned with issues of personal privacy; however, there are many organisations that have, or have applied for, authority to access the meta data stored by Telcos. Warrants are only required when the investigator is seeking to access the content of communications.

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Each mobile network consists of a large number of service areas of coverage (eg a city or town) that are interconnected to the PSTN at the proximate POIs.

A mobile user has a 'home location' (eg a city) and his/her subscription information is kept in a database known as the HLR (Home Location Register). When the user takes their mobile to another location (eg another city) and switches it on, then their subscription information is relayed to and kept at the corresponding VLR (Visiting Location Register) so that if a call is made to the 'roaming' mobile user, the call will be immediately routed to the VLR.

A large service area, (eg a city) is split into a number of location areas. Each location area contains a number of base stations that provide near continuous radio coverage. The association of base stations with a particular location area is stored in the Mobile Switching Centre (MSC) (eg 1 or 2 per city) which is in turn connected to all the base stations using a variety of transmission facilities called Backhaul Links.

A Mobile Originating Call

When a mobile user dials the number of another user in the global network, the mobile establishes a Signaling Channel to relay the dialed number to the MSC which (assuming the user is valid) analyses the number and sends a 'ring tone' to the dialed user via the PSTN and, if it is a mobile to mobile call, the MSC at the 'receiving' end which pages the mobile in the identified location area. It is only if the dialed user 'picks up' the call that the MSC then directs the set up of a Traffic Channel, usually to the 'best server' base station to the originating mobile user. Hence, it is only when a connection is established that a Call Charge Record [CCR] is established noting the Cell ID of the base station that was used to carry the start of the call. It follows that if a mobile user attempts a call that is not 'picked up' by the end user (the term 'pick up' includes an answering service) then no CCR is generally[7] created.

A Mobile Terminating Call

When a user in the global network calls a mobile user (as distinct from calling a fixed phone on the PSTN), a signaling message is sent to the relevant MSC and HLR associated with the mobile number being called. In the case of a 'roaming' mobile the message will go to the VLR. The MSC then pages (or 'pings') all the base stations within the location area associated in the HLR (or VLR) with the active roaming mobile (ie the mobile is powered on and away from home.) The receiving mobile detects its unique mobile identifier from the page (ie 'ping') indicating an attempted incoming call and uses the signaling channel to 'accept' the call and establish a traffic channel as mentioned above. It is only then when the receiving mobile call is accepted does a CCR get generated. The CCR gives the Cell ID of the cell site used to establish the

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[7] There are exceptions where a simple CCR can be generated.

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traffic channel marking the beginning of the call by each and both of the originating and terminating mobile phones.

Hand–Over

When a mobile (be that initiating or receiving) is moving within a service area or with cell congestion, then the mobile can message to change over to a different base station to assure continuity of the call. Only the cell ID at the point of the start of the connected call is retained in the CCR. Hence the CCR does not give any information about possible movement of either/both the initiating or receiving mobile during the currency of a call connection. No records are kept of such movements.

Implications

Recourse to the CCR Cell ID is useful only to establish a possible area in which a sending mobile was located when a call was made from that mobile and 'picked up' by a receiving phone.

The possible area within which a mobile call was initiated can be further analysed and delimited by the use of software predictive coverage maps combined with appropriate field testing.

Hopefully the above information will ensure that readers can readily grasp the following discussion. The price of not grasping those fundamentals is shown in the following example.

This is a report of a jury trial in NSW just a few years ago. The reporter was assigned to report on the advocacy seen and heard at that trial: -

> A prosecution witness gave evidence about mobile phone call records and the cell towers involved in transmitting specific calls. The mobile phone in question was that of the accused, and the location discussed was around the scene of the crime.
>
> Examination in Chief
>
> The examination in chief by the prosecution started out with little information on what topic was going to be examined and where the questions were heading. The prosecutor was having difficulties in phrasing questions to the witness, with his questions often confusing the witness and the judge. On several occasions the judge had to re-phrase the question for the witness, and I could see that the judge was getting frustrated with the prosecutor for his lack of clarity in his questioning. The prosecutor then attempted to tender several voluminous documents to the court (which were lists of call records and maps of cell towers in a particular area of Sydney), however he had failed to make adequate copies for the jury.

The judge adjourned the hearing for a short break while the prosecution made enough photocopies for the jurors. The prosecutor was also having difficulty managing the witness, who looked and sounded surprisingly uncooperative, talking over the prosecutor on several occasions. The examination in chief as a whole felt confusing and tedious, and it was not entirely clear what exact point the prosecutor was trying to establish.

Cross-examination

The defence advocate had a clearer style of questioning, and the witness was having much less difficulty in answering the questions. This made it much easier to follow the topic being pursued by the defence. Towards the end of the cross-examination, there was an interesting development. The defence cross-examiner asked what appeared to be a key question for the defence: whether or not a particular mobile phone call record put the accused in the vicinity of the location of the crime. The witness stated that he was not in a position to answer that question. This answer seemed to come as a surprise to the defence advocate, who then anxiously asked a few follow up questions to no avail.

After the jury and the witness left the courtroom, a discussion took place between the judge and the advocates, and it became clear that the witness had apparently changed his position on this key issue since the last meeting he had with the defence advocate. The defence had based most or all of its case on this witness's previous position that the phone record suggested the accused was likely not in the vicinity of the crime at the relevant time. Now that this witness had apparently changed his position, the defence advocate appeared to be nonplussed. The judge also sounded concerned, and suggested the issue be dealt with by way of voir dire the next day.

Against that background we now consider some ever present issues about mobile phone use that confront experts and trial advocates.

1. What experience and training is required to offer opinions in this field of expertise?

To be 'qualified' as an expert in this area requires:
- A knowledge gained from experience of what information is available from the mobile network operators [MNO's] such as the Call Charge Records and aspects of the mobile technologies (eg GSM, WCDMA, LTE);
- A knowledge and experience of the complexities of radio propagation around 1GHz;
- A knowledge of radio coverage in the mobile environment such as clusters of cells, use of multiple carriers per site, interaction of various technologies (GSM/3G/LTE) and radio resource management; and,

- A knowledge of the strengths and weaknesses of propagation prediction tools.

Some, but not all of this knowledge can be gained from tertiary training. The expertise is mainly acquired while working as a radio field-test engineer or radio optimiser dealing mainly with how cell coverage and traffic load are handled by various network technologies.

2. The technical information an expert would like to have when being asked for an opinion about where a phone was *likely* to have been located when used at a critical time(s).

- Call Charge Records [CCRs] must be obtained from the mobile carrier via a warrant. Current CCRs generated for all calls provide details of the base station and cell site for all calls for both originating and mobile terminating calls. However, there is considerable variability among the Telco's and even among different regions of the one Telco. Please note that Billing Records are derived from CCRs and have much less information, just that sufficient for resolving customer queries.
- For the layperson the initial indicator of mobile location is provided in the Billing Record where for each billable call, the 'call origin' is provided. The call origin encompasses calls from a cluster of geographically related base stations situated within one area and is usually insufficient to provide sufficient location detail for legal purposes.
- Generally in urban service areas, each base station has 3 sectors (identified by their cell ID). Directional antennae illuminate these three distinct sectors.
- While each sector ideally covers a 120 distinct degree arc (thus the three sectors cover the whole 360 degrees), a more reliable sector coverage can be gained by using several graphs of coverage from the operator's software prediction software tool[8] as follows:

    1. one plots how far the signal *should go* with adequate signal strength; An example is shown in Figure 1 below.

    2. the other takes into account all the surrounding cells and plots *the dominant cell coverage* in that area. The corresponding example is shown in Figure 2 below.

- Such software tools are useful for the expert in estimating the impact of terrain, obstructions and foliage that are parameters provided as inputs to the software prediction of coverage.
- In the absence of the graphical information mentioned above (ie from software prediction tools) an expert can only make a rough estimate based on idealised cell coverage.

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[8] This software tool uses the topographical data base and propagation formulae to plan coverage area.

- The expert would need engineering details of the base station and the antennae to substantiate such a rough estimate made by either method
- Such estimates of coverage are highly variable and their interpretation for the purposes of evidence needs to be challenged more often than it has been to date.
- If there is a suggestion that a particular cell was not working or that it was bypassed (because it was too busy), then the expert may need to look at other records with respect to that particular cell site and the traffic conditions at the time of interest.

Possible Coverage (Adelaide Airport)

Figure 1 – An example of 'possible coverage' prediction

Probable Coverage (Adelaide Airport)

Figure 2 – Example of 'probable coverage' prediction.

Following the Expert Witness Guidelines (which the litigation lawyer must provide to an expert at the beginning of the engagement), the expert needs all available data. The necessary data are:

- the CCRs: Calls *from* mobiles are listed in the CCR *as if* they originated from the mobile of interest. While the detail varies between the 3 mobile network operators (MNOs) they generally[9] give the following information:
  - o Commencement time & date of the call
  - o The duration of the call
  - o The cell ID used at the commencement of the call
  - o The number of the call termination
  - o Where the call is terminated by a mobile, the cell ID of the terminating mobile
  - o Other information (depending on the MNO) like voice mail etc.
    - ▪ Location Area of the cell
    - ▪ Switching Centre Information
    - ▪ Type of call (SMS, voice, data, diverted call, etc)

- When Vodaphone is the Telco ask for the CCRS of both the originating and terminating phones.

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[9] In the Northern Territory, the Vodafone CCRs were more limited until 2012 because they gave the base station but **not** the sector (ie cell ID), thereby limiting their usefulness.

- The software prediction plots of propagation (described above) for the various towers through which the calls of interest may have passed. Note that:

    o It takes several weeks for the Service Providers to provide this data. It follows that 'last minute' exercises are impossible. Moreover, only Vodafone and Optus provide this information in Coutts' experience. Telstra has not provided it.
    o Only in a recent case in late 2015 (see Section 10) have the results (ie the maps and their implications) of such software been challenged[10]. Such maps can be highly prejudicial against the client if presented unchallenged.
    o Other data might be relevant in different cases: for example, the actual propagation characteristics of a base station antennae are required to examine the possibility of a call being received close to the back of the recorded cell ID. The 'front to back' performance of the antenna can be less than ideal. This aspect of software prediction modeling can be particularly poor.

3. What instructions does the expert need from the lawyers?

☐ Because of the quantity of data available, the expert generally needs to know what day or days were thought to be significant;

☐ The expert needs to know the competing hypotheses of the parties, be the case civil or criminal;

☐ How much time is available to prepare the report; and,

☐ How much time and what budget is there for a preliminary assessment by the expert.

4. Variability among the Telcos, within regions of any given Telco, and different information at different times.

In one case Coutts was supplied by the client's lawyers with a large bundle of Telstra bill records. Their instructions were to explain the meaning of 'origin' as shown in the Telstra records. Telstra uses 'origin' to denote a cluster of base stations, covering a variable area. The 'origin' can, in some cases, be a very large area.

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[10] The software prediction charts were finally admitted for consideration by the jury in the full trial, but only after 'on site' validation occurred during the course of the voir dire at which their probative value was contested.

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In other cases Coutts has been given 'base station' data that is a component of CCRs. For the Northern Territory and WA the base station information does not come with any information as to which cell of the base station was used. This is an example of different data recording by the one Telco in different regions of Australia.

By contrast, Coutt's experience is that in some of his cases Optus and Vodafone have provided software coverage maps (that is a software prediction of the expected coverage of any particular cell.)

The date when an incident occurred will influence what data is involved. There may be more or less data available.

In the case of a 'data session' (as distinct from a phone call) the interpretation of the CCR is slightly different in that:

- As illustrated in Figure 3 below, the start time is several seconds after the start of the call; and,
- The duration of the data session as illustrated in Figure 3 depends on the technology (eg 3G, GSM) and the variation of noise and interference during the call.
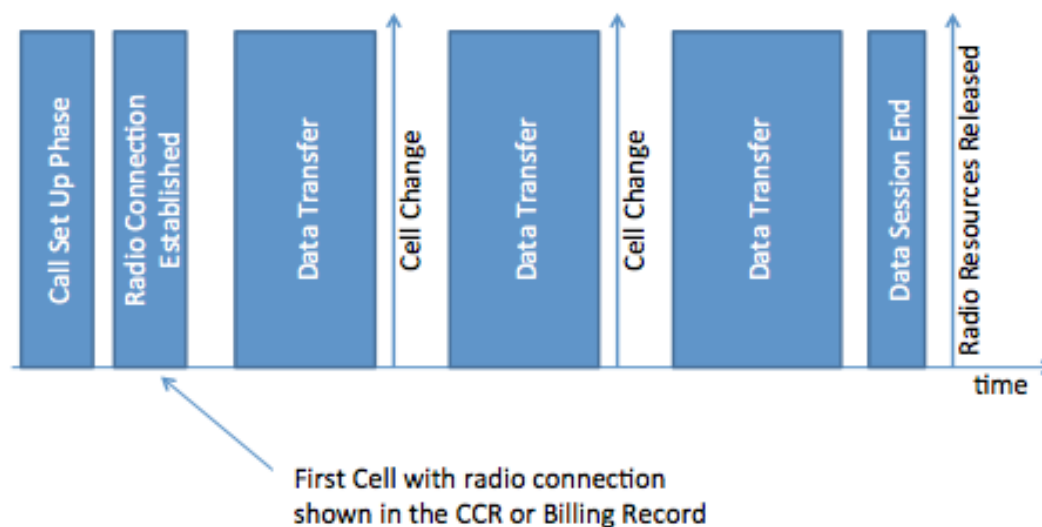
Example of a Data Session

First Cell with radio connection shown in the CCR or Billing Record

Figure 3 – A data session

5. Misuse of mobile phone evidence and how such errors mislead fact finders.

Broadly the misuses of mobile phone evidence as a means of 'accurately locating the phone and its user' result from the variability of reasonable inferences as to a mobile call location based on the data shown in the CCR that is associated with the call.

When an outgoing mobile phone call is made a CCR is created. Within that record is the identification of the originating and terminating cell/s (it can be the one cell for both) from which the call originated/received. This is called the Cell ID.

Mobile phone networks use many towers to create network coverage. Commonly the transmission from each tower is by way of one of three sectors – imagine a pizza on top of the tower cut into three slices or sectors. The Cell ID identifies the sector of intended coverage that in the case of a common 3 sector base station, covers a particular 120 degree sector emanating from the base station.

However, the 'dominant' area of coverage of the sector in practice is variable depending upon the network coverage design (ie the relationship with surrounding coverage provided by the other base stations to assure continuous service) at the time of the call. To respond to different levels of broadcast wattage (power), topography and usage demands there is some 'overlap' of sectors, but not nearly so much now as with early systems.

Topography, weather, usage load, broadcast wattage, and overlap of cell coverage entail that to go to point A and make test calls now with the result that some or all of those test calls go through a specified sector of a particular base station does not 'prove' that at some other earlier time calls from point A went through that same specified sector. At that other time they may have gone through another sector. When a user places a call, the cell phone connects to the cell site with the strongest signal. Indoor or outdoor use of the phone and cell phone orientation to the user's head can alter the strength of the signal. These are important considerations when attempting to recreate an alleged past event.

In general it is often easier to be more definitive about the converse proposition, *namely that from the Cell ID information it is unlikely that the call was made (or received) outside a specified area.*

Access from the Telcos to propagation prediction modelling (ie for both 'dominant' and 'possible' coverage of relevant sectors) is helpful but insufficient to be certain about phone location.

In this context of qualified uncertainty, it is highly misleading to infer positive location with the phrase '*the Cell ID identified with a call is consistent with the call being made in that location.*'

It is essential that lawyers, be they prosecutors or defence counsel, approach the use of CCRs and their component data from the following perspective: given that a person of interest/someone associated with that person is believed to have used a mobile phone, thereby generating call charge records, what is the strength of the evidence if the person of interest was in/around a defined area, versus, what is the strength of the evidence if the person of interest was in/around another area?

6. The three types of signal (that is analogue, and the two types of digital)

Broadly there are 3 generations of mobile technology that need to be distinguished when determining location from Cell ID data. They are:

- First Generation AMPS technology (analogue) from 1987 till closure in 2000. AMPS networks often had large cells of up to 50km in extent and the sectors from the adjoining base stations significantly overlapped.

- Second Generation GSM technology from early 1993 with smaller cells (eg < 20km) and more complex 'cell hand-over' methods between adjoining base stations to minimize cell overlap. For GSM systems, cells are strictly limited to less than 35km due to the technology architecture.

- Third Generation WCDMA technology that from early 2000s co-exists with GSM. WCDMA has even smaller calls (eg < 2km). A typical network would use GSM and WCDMA to cover mixed rural/urban service areas.

- Fourth Generation (Long Term Evolution, or LTE), since around 2009. Like 3G it uses small cells. It had a focus on data rather than voice calls; however, as its use for voice calls increases there is a decline in the use of the 2G technology for voice calls. Note that 4th Generation technology does not affect the cell size discussion.

Three important points are that:

- The rationale for placing towers has changed over the last 20 years, evolving from the 1st generation technology;

- Second to Fourth generations of technology can operate below 1GHz thus providing greater propagation distance. Both GSM and WCDMA also operate at 2GHz that can support more load capacity in smaller cells. It should be noted that WCDMA (eg Telstra's NextG™) uses a wide range of cell size depending on network requirements. Hence it would be wrong to assume 'standard' size sectors when offering opinions about a phone location; and,

- With GSM technology in particular, the system limits propagation to less than 35km. This limitation in one case has been used to refute claims of a witness as to his location at the time of a call.

7. Software propagation tools: what they are; what data they require; and, how their quality has developed.

Software prediction tools predict the extent of 'multipath' radio propagation from a base station, based on system factors and topographical data (eg. hills, trees, buildings, water) for a particular terrain. Base station system factors including power, frequency band, antenna configuration can be varied to optimise service area coverage.

From the mid 1980s of cellular mobile systems, software propagations tools have been used by the Telcos to plan coverage. Simplistic hexagon descriptions as used in the class room or court rooms overly simplify the complexities of coverage.

Four important points are that:
1. These tools are statistical in nature and are further limited by the modelling capability and quality of the 'inbuilt' topography;

2. The network configuration changes over time to allow for expansion. Hence the current modelling data may not be that applicable to the time of the questioned phone call;

3. Different software tools use 'prediction models' (eg Hata) and the correct input information (eg foliage description) should be tested by proper measurement to be used as evidence; and,

4. Such models do not account for anomalous propagation effects (eg impacts of weather and water reflections)

8. Why mobile vans are used to check coverage.

Actual measurement of the relationship between phone location and cell site used would seem to be a useful thing to do until one appreciates the scope of the problem (eg locations, movement, direction of the caller) aside from the random elements involved. A good illustration for the layman is the experience of observing that the base station name on the phone changes as they move the mobile phone about.

Measurements of actual phone calls and associated cell IDs are NEVER used (other than incorrectly in some Court rooms) to confirm an inferred location. This is because such 'confirmation' would require many measurements, done under a controlled situation, with consideration of various hypotheses to assess relative likelihood.

However, again from the earliest days of cellular mobile systems, operators have deployed vans with measurement equipment to investigate particular coverage or interference problems that the software prediction tools do not and cannot predict.

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As these measurements generate huge amounts of data to be statistically representative, they are done solely to validate modelling deficiencies and improve design.

In late 2015 mobile vans were used to test 'predictive coverage maps' that the prosecution intended to rely upon in a Victorian jury trial with respect to a specific base station. See discussion of this case below, 'another case of misuse of coverage maps'.

9. Current technology comes closer to indicating a position for a mobile phone than in the past because there are many more towers AND much less overlap than in past years.

As explained above, mobile technology has evolved through several generations to cope with the volume of mobile calls. Thus the AMPS mobile network to support a million customers in Sydney in 1994 has evolved to a hybrid GSM/WCDMA network in multiple frequency bands able to support 5 million people. This modern mobile network has smaller cells in the city with minimal overlap compared to the earlier AMPS network.

When there was only the AMPS network with considerable overlap of cell coverage there was a significant possibility that the Cell ID shown on the CCR might NOT be the cell site closest to the physical site of the phone making the call. With today's technology the cell ID is more reliable than was possible with AMPS.

Nevertheless, even today, inferring location from Cell ID with this finer cell structure is still fraught with potential errors of interpretation, just as it was in the 1990's for AMPS.

It has been a practice (how common we do not know) to proffer as prosecution evidence that a phone was in or around a location (supportive of the prosecution case) at a particular date and time because at some later date a number of calls are made in that location and one or some of them use a cell that has coverage of that location. This practice has the following significant deficiencies:

- It has no scientific credence unless it includes comparable testing of other places at which the phone may have been used (as the defence alleges) to ascertain if any such call uses the same cell; and,

- Beyond the simple making of numerous test calls and recording how many succeed and how many fail there is also a need to explain the basis on which it is claimed that such tests are a fair method of assessing the likelihood that the phone was at the 'desired' location.

10. Some examples of requests to comment upon CCR based evidence

Misuse and Misinterpretation of coverage maps.

The CCRs of mobile calls combined with the coverage maps from the Telco (shown below) appeared to show that an accused could not have been where he said he was, but that he was at the scene of the crime.

The Defence experts were not given these CCRs and maps, or the Crown witness's statement as to the interpretation of this material, until the end of the Crown case.

Upon examining these coverage maps it was clear that the strength of the Crown case was overstated. The experts noted that:
- ☐ The cell site shown as receiving the calls was very high above the ground and co-located with a broadcasting tower (very unusual) raising the possibility that the particular site was Line of Site (LOS). Subsequent evaluation was that both sites were possible. This was unlikely to have been modelled correctly in the software tool; and,
- ☐ The 'back lobe' performance was poor and inconsistent. 'Back lobe' means the measure of the front signal gain to the back signal attenuation which is typically better than 20dB. (ie 100 times)

The experts were retained too late to:
- ☐ Advise on the bases for objecting to the admissibility of the evidence (as was done in the following case); and,
- ☐ Settle appropriate instructions for the experts to provide a costs estimate and then write an expert report.

To understand the following explanation please refer as indicated in the text to the various maps below.

After viewing the CCRs and maps a non-expert (such as an investigator, prosecutor, defence lawyer or juror) would conclude that the accused was lying when he claimed to being at home (ie at home on Canning Rd) as *none* of the 25 calls used the Kalamunda Sth cell site (his 'most probable' coverage site – see Fig 2 below) but these calls used two of the Lesmurdie South sectors which have the site of the crime (ie 112 Pickering Rd) within their 'most probable' coverage prediction (Maps 3 and 5).

Closer examination of the propagation maps from the Telco and checking the ACMA site data base indicated:
- o The Lesmurdie South antennae were located on a broadcast tower and therefore very high (ie 60m compared to 14m for the Kalamanda site)
- o The 'back-lobe' propagation prediction for the Lesmurdie South antennae (Maps 4 and 6 for the 2 sectors) raised significant suspicions as to the software prediction tool reliability.

- It is plausible that the accused's home is within LOS of Lesmurdie suggesting gross errors in the software predictions

Here are the 6 Maps:

Figure 1: Plot showing Prediction of Probable Cell Coverage Area for **"Kalamunda-O:P0039-OU21-A-2"** on 26/10/2013.
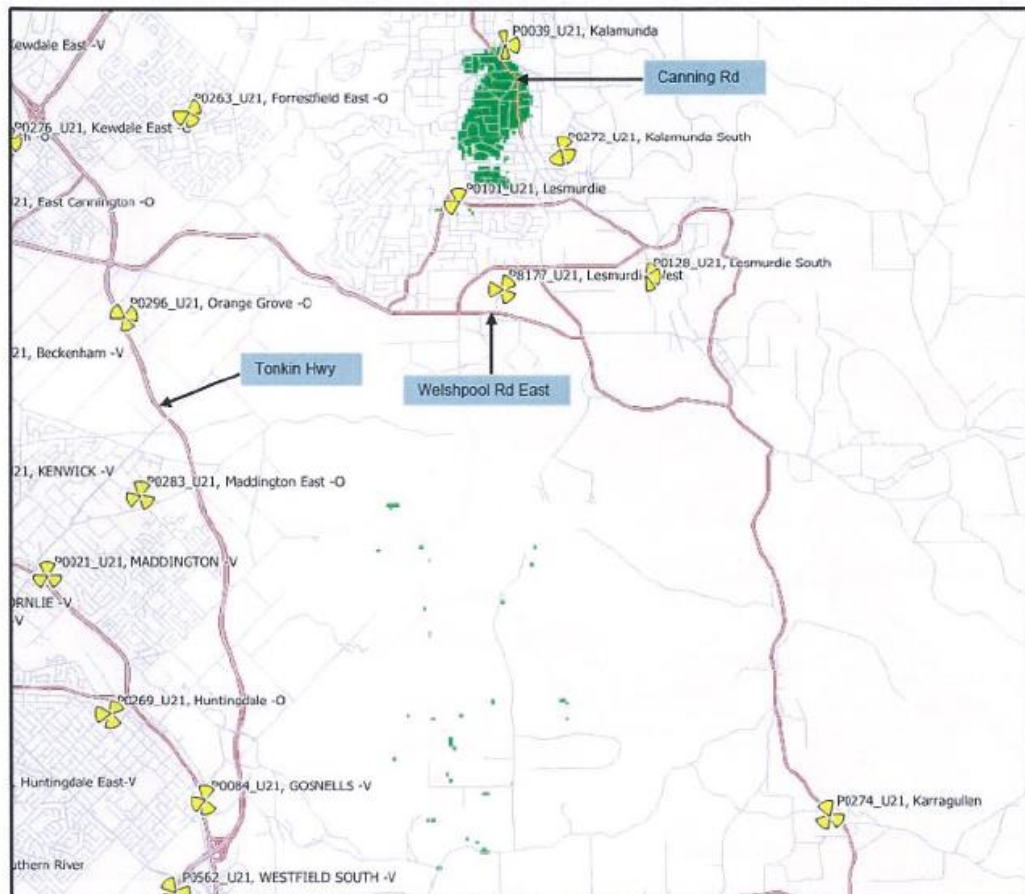
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Figure 2: Plot showing Prediction of Possible Cell Coverage Area for **"Kalamunda-O:P0039-OU21-A-2"** on 26/10/2013.

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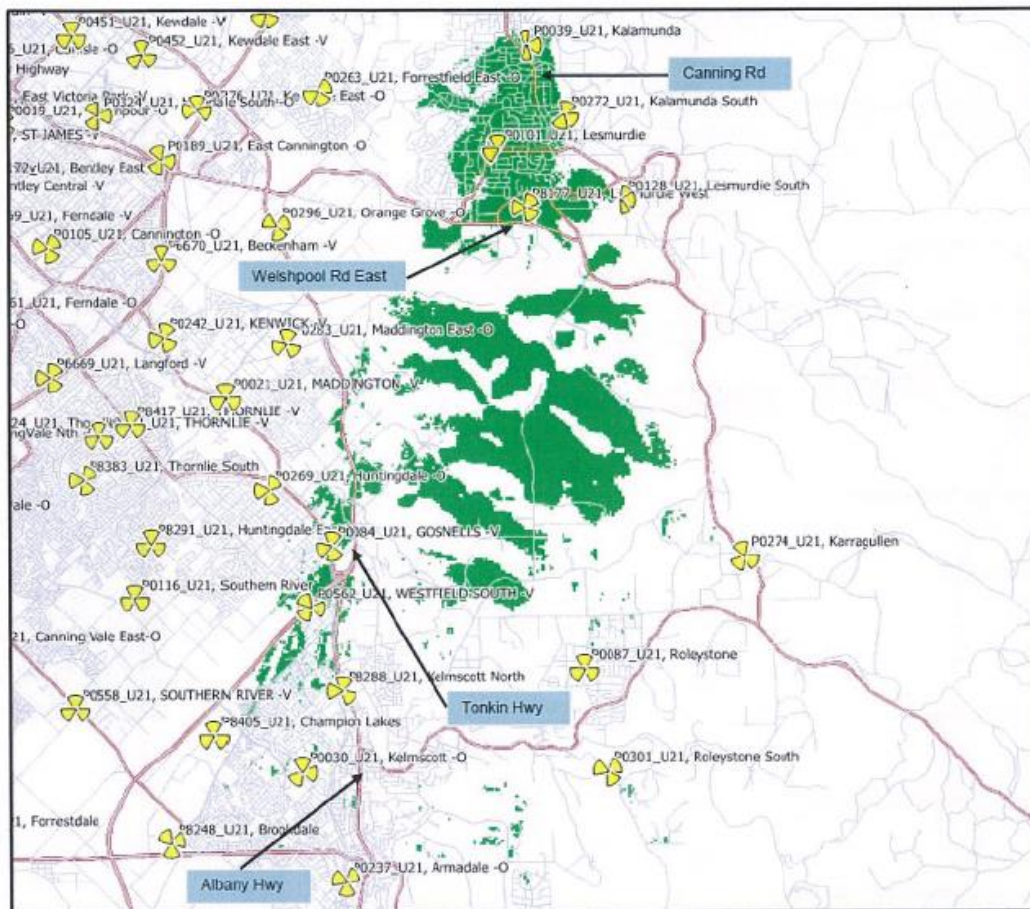
Figure 3: Plot showing Prediction of Probable Cell Coverage Area for **"Lesmurdie South-O:P0128-OU21-A-3"** on 26/10/2013.

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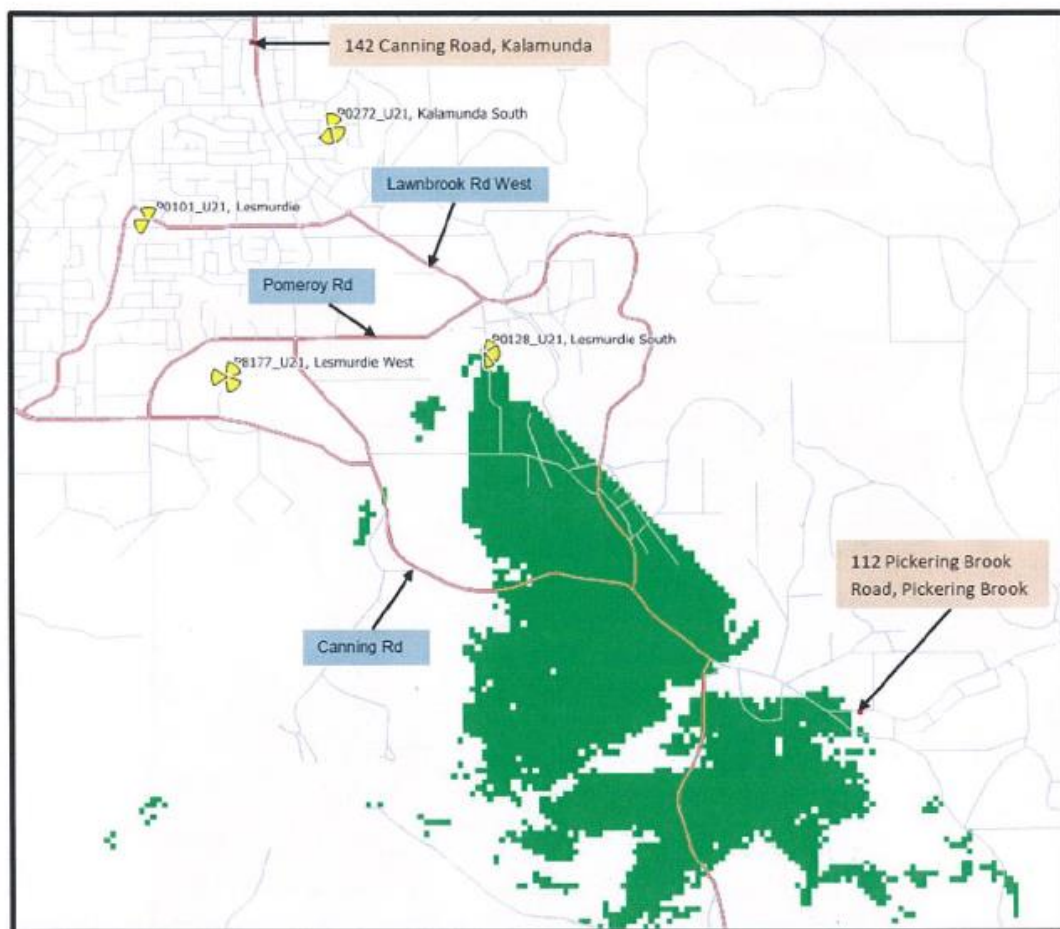
Figure 4: Plot showing Prediction of Possible Cell Coverage Area for **"Lesmurdie South-O:P0128-OU21-A-3"** on 26/10/2013.

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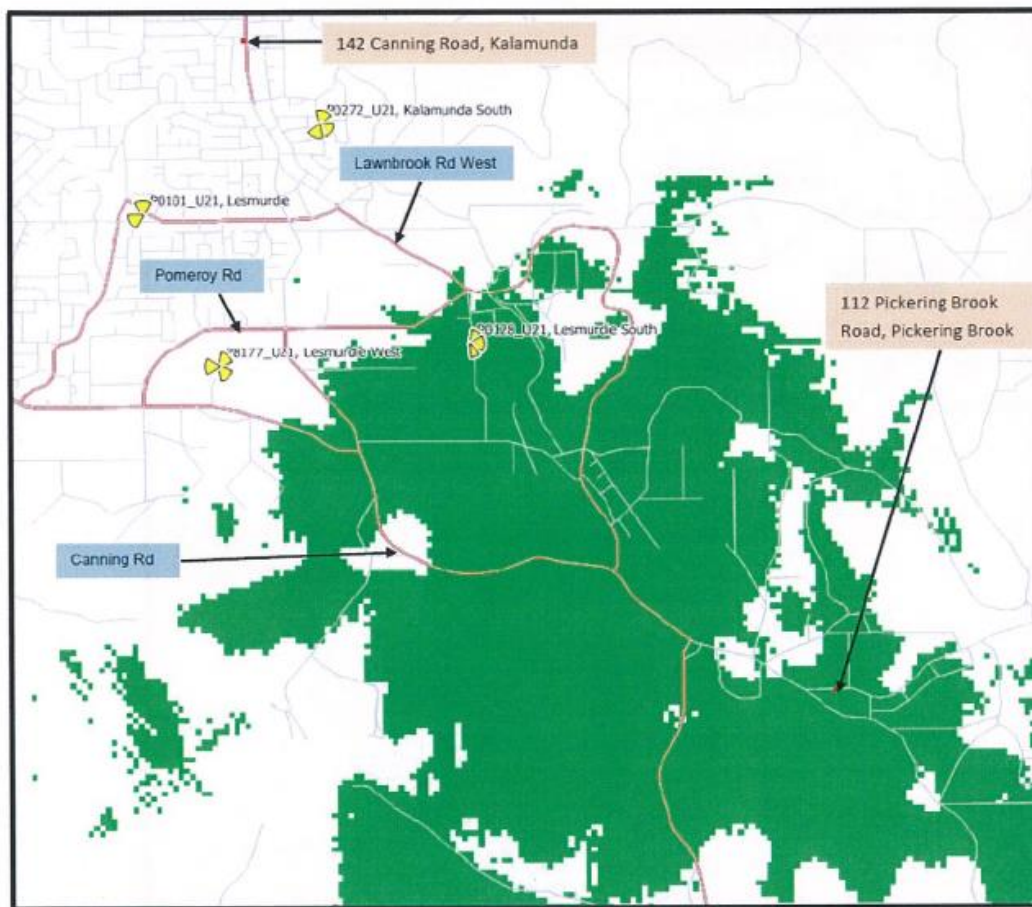
Figure 5: Plot showing Prediction of Probable Cell Coverage Area for **"Lesmurdie South-O:P0128-OU21-A-2"** on 26/10/2013.
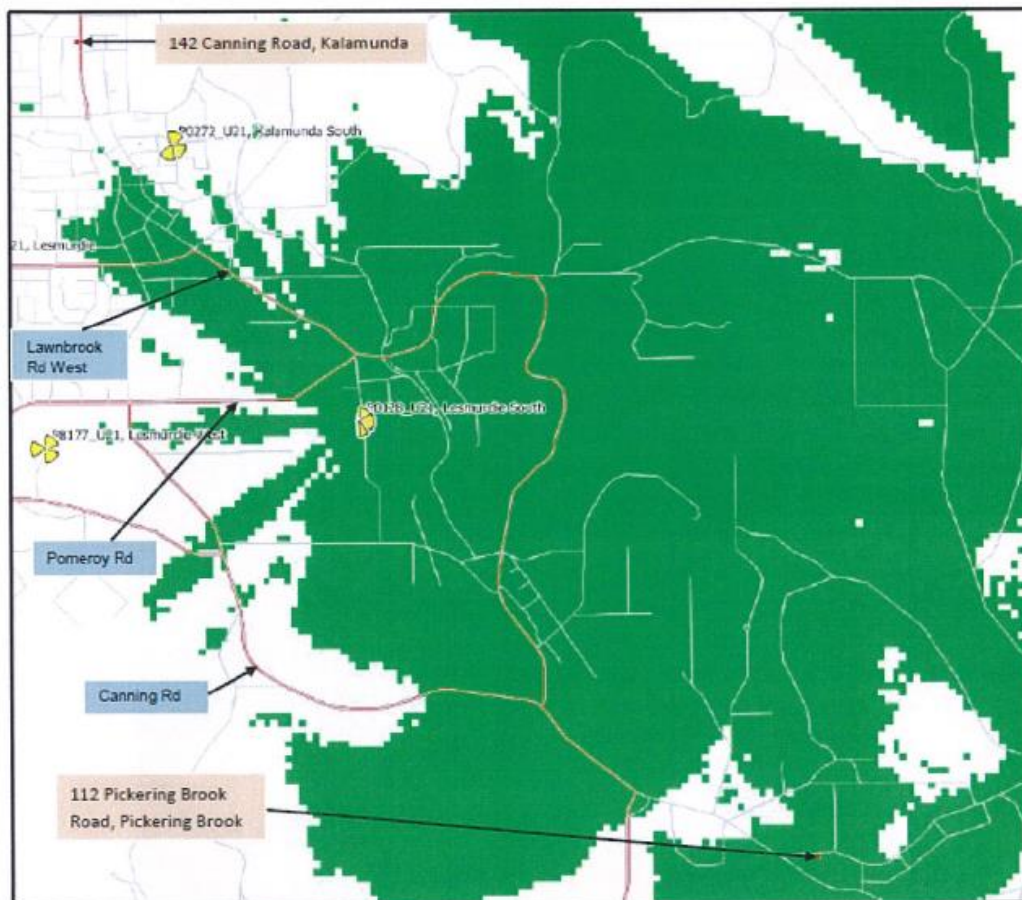
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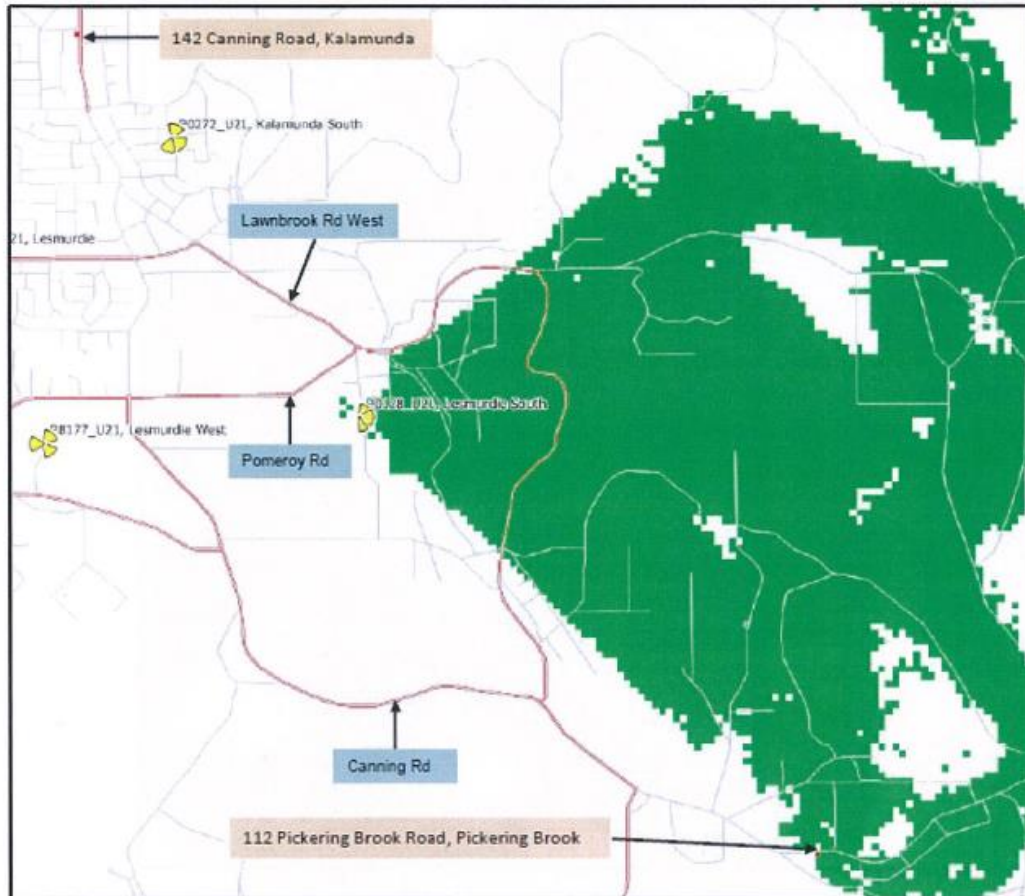
Figure 6: Plot showing Prediction of Possible Cell Coverage Area for **"Lesmurdie South-O:P0128-OU21-A-2"** on 26/10/2013.

Another case of misuse of coverage maps

Maps from the Telco based on their Software Prediction Tool were initially presented by the Crown as evidence of the accused being at the crime scene.

On the voir dire the prosecution first contended that *both* CCRs and coverage maps could be admitted as business records. The CCRs can be business records; however, it was argued for the Defence that the evidential weight of the coverage maps depends upon their measured reliability. Opinions as to the strengths and weaknesses of these coverage maps are matters of expert opinion.

Several Telco staff were called as it became clear that there was no factual underpinning to the claims that the software tool used to predict tower coverage had been validated by field tests.

It was asserted by a Telco witness during the voir dire that the Telco had provided hundreds of such coverage maps over the last decade, but this was the first time (late 2015) that they had been challenged.

It's important to grasp that coverage maps are based only upon a software theoretical prediction. Actual tower coverage has to be checked by field testing with appropriate equipment (eg a scanner, NOT a mobile phone – see Figs B4 and B5 below). Moreover, it does not follow from street testing that 'indoor' coverage will be the same.

Shown are a number of the coverage maps produced in the Telco Evidence, plus one (Figure B3) showing where the defendant was alleged to have been at the time of the call of interest. The first observation from Figure B3 is that the Telco evidence does not put the crime scene (Nepean St) in the dominance region for the Broadmeadows site where the Crown suggests the accused made the call from the CCR data.
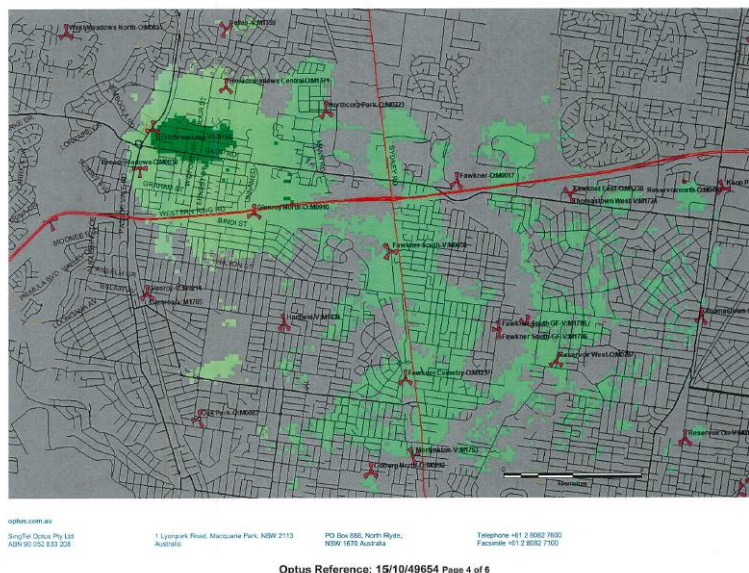

Figure B1 – Probable & Predicted Coverage for Broadmeadows

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Figure B2 –Broadmeadows Coverage 'Evidence'

Figure 2: Prediction of Probable (dark green) and Possible (light green) Cell Coverage area for Glenroy North-O M0910-OU21-A-1 Cell ID 15534 on 21122014

Figure B3 – Probable & Predicted Coverage for Glenroy South

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Figure 1: Validation Results from field tests (Overlay on Prediction plots). Probable (dark green line) and Possible (light green line) for Broadmeadows-V M1738-OU21-A-2 Cell ID 12535. Solid black line indicates dominance of other Optus cells in the area.

Optus Reference: 15/10/49654 Page 6 of 8

Figure B4 – 'Validated' Dominant Coverage for Broadmeadows

Figure 2: Validation Results from field tests (Overlay on Prediction plots). Probable (dark green line) and Possible (light green line) for Glenroy North-O M0910-OU21-A-1 Cell ID 15534. Solid black line indicates dominance of other Optus cells in the area.
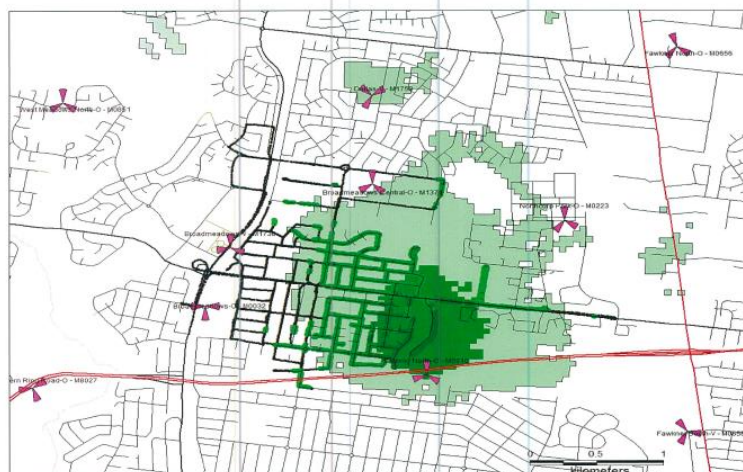
Optus Reference: 15/10/49654 Page 7 of 8

Figure B5 – 'Validated' Dominant Coverage for Glenroy South

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Incorrect information about coverage; misuse of "consistent with".

An area map showed the location of the base stations and associated cell ID. There were no coverage maps available. A prosecution 'expert' opined that certain matters were 'consistent with', thereby misleading all lay people. He also made a technical error in saying the coverage of WCDMA and GSM900 are similar as they are from the same base station. In fact the typical coverage areas are different. GSM900 coverage is generally greater than WCDMA but is strictly less than 35km due to the TDMA time slot limitation.

Misuse of the phrase "consistent with" to suggest "supportive of"

An area map showed the location in Victoria of the base stations and associated cell ID. The 'expert' used the 'consistent with' statement to infer that the Defendant was at the crime scene. Very weak evidence and no coverage maps provided which could have assisted interpretation.

Evaluating Competing Hypotheses

At a Coroners Inquest the police alleged a suicide but the parents of the deceased thought it was murder. The Coroner returned an open finding (ie. rejected the police view that it was suicide).

CCRs were provided by Optus along with coverage prediction information (ie maps) from their engineering group.

An area map showing the location of the Optus base stations in a part of NSW was provided; however, associated cell IDs were not provided - even after several requests.

The expert had to use 'radial coverage estimation', noting the significant coverage difference between 3G and GSM. None of the calls of interest could have originated at the person of interest's declared position without a catastrophic failure of the transmission towers. There was no such failure. The calls were, therefore, more likely to have been made in the area of the deceased's home.

Evaluating Alternate Hypotheses

An employee was provided with a mobile phone by his employer. He claimed that he was in bed on a particular date in the care of his mother-in-law recovering from an accident that was the basis of a workers compensation claim.

However, this did not accord with the Telstra record of calls from his mobile at the time.

The investigation tested the claims made by the parties under the 'balance of probability' that the mobile phone on that day was on the move rather than stationary beside his bed.

Telstra did not provide detailed CCR records in that the records provided gave no further information than the Telstra bill. While Telstra have been unwilling to provide reasons, it is assumed that Telstra restricted the detail because it was a civil case.

Testing an Hypothesis

A data session was intended to confirm the location of a user who claimed to be in one location (Location A). The data session based on Vodafone's CCR identified the mobile's location (Location B) to be over 20 km away from that claimed location (roughly an hour to drive). The claimant suggested that the session started from location B and ended in location A. Our analysis of the data session given the recorded data volume of 24 kbytes and using very conservative download speeds suggested it was very unlikely that the session that started in location B ended in location A. Minimum download speeds of mobile networks is in the order of 32 kbps. A simple calculation to calculate the download duration is:

DownloadDuration = DataVolume x OverheadFactor / MinDownloadSpeed

Using an overhead factor of 2 we have:

Download Duration = (24 kbytes x 8 bits per byte) x 2 / 32 kbit/s = 12 seconds

Over a duration of 12 seconds, the user likely started and ended the session in the same cell or just one cell change away.

11. Useful Articles

1. US Attorney's Bulletin, November 2011, vol 59, #6, special issue on 'Obtaining and Admitting Electronic Evidence'
    http://www.justice.gov/usao/eousa/foia_reading_room/usab5906.pdf
    See the paper by Thomas A O'Malley, at pages 16 - 34. It's clear and easy to understand: '*Using Historical Cell Site Analysis in Criminal Trials*'. (accessed October 2015)

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2. Aaron Blank, *'The limitations and Admissibility of Using Historical Cellular Site Data to Track the Location of a Cellular Phone'*, Richmond Journal of Law & Technology, Volume 18, Issue 1. (and seems to be late 2011 or during 2012). *http://jolt.richmond.edu/v18i1/article3.pdf*

This article is especially useful in pages 1 -12. But, see also, paragraphs 37 to 41 on who can give the evidence in the USA. (accessed October 2015)

3. Cherry, Imwinkelreid and others, '*Cell tower junk science*' , in Judicature, *www.ajs.org,* 'Viewpoint', *http://educatedevidence.com/Viewpoint_J-F.pdf*

It has a useful introduction followed by three short case examples. What is significant is that Edward Imwinkelried has put his name to it. Imwinkelried is the doyen of 'expert evidence' in the USA .

This article specifically condemns the use of single tower 'location'. It was precisely this kind of single tower 'locating' that was used at the two trials of Ngo for Newman's murder. (accessed October 2015)

12. References

Coutts and Selby (2008) "The Safe and Unsafe Use of Mobile Phone Evidence", Communications Policy Research Forum   (CPRF2008) September 29-30th, Sydney 2008

Coutts and Selby (2009) "The Safe and Unsafe Use of Mobile Phone Evidence", Public Defenders Conference, January, Sydney 2009 (available on the Public Defenders Web site: http://www.publicdefenders.nsw.gov.au/Documents/safeunsafemobilep   hones.pdf

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