

MAPPING CRIME SCENES AND CELLULAR TELEPHONE USAGE

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ABSTRACT

We have used successfully a desktop geographical information system (GIS) to plot cellular telephone conversations made during the commissioning of several crimes, such as car hijacking, hostage taking, kidnapping, rape and murder. The maps produced in this manner have been used in three court cases as part of the prosecution's evidence against the accused. Two of the cases resulted in successful convictions, while third case is still before the court. The first case involved the hijacking of a motor vehicle, hostage taking and the subsequent rape and murder of the victims. The second case involved the shooting of four victims by an individual. In both cases the maps were crucial for obtaining the conviction and sentencing of the accused. The third case involves the kidnapping of a businessman for ransom.

DETAILED DESCRIPTION

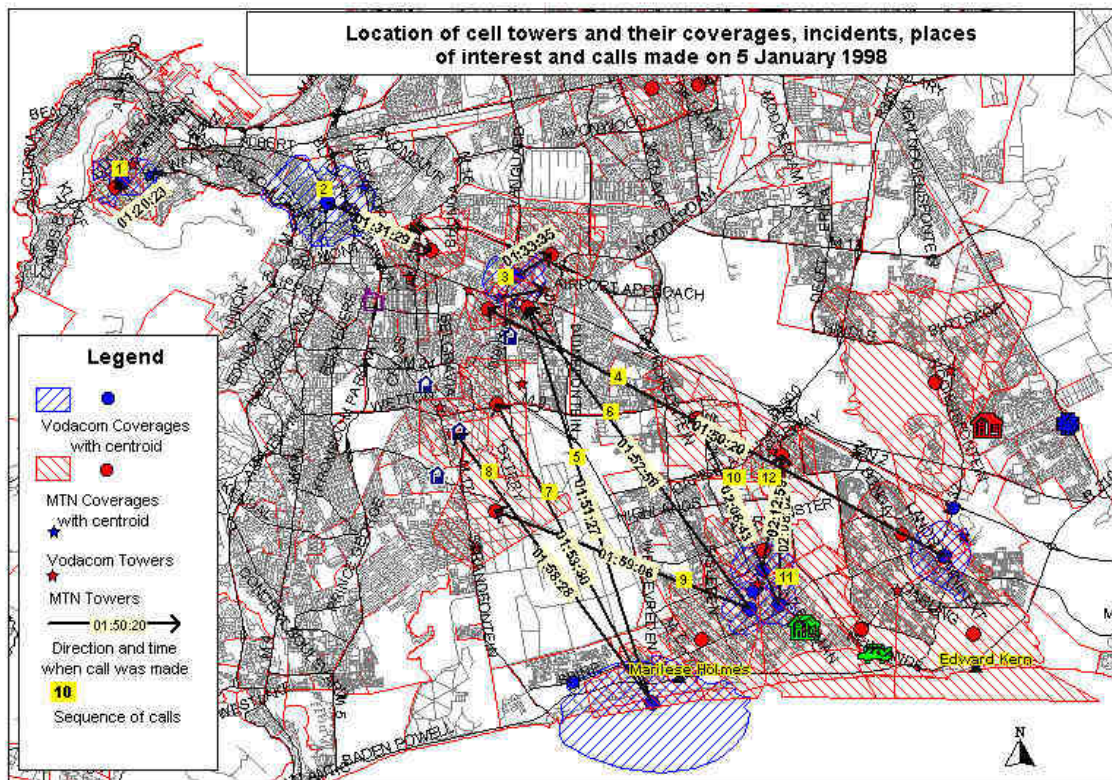
Introduction

This paper describes a method that uses a desktop geographical information system (GIS) to plot cellular telephone conversations made when crimes are committed, such as hijackings, hostage taking, kidnapping, rape and murder. The maps produced in this manner are used in court to help the court understand the sequence of events when the evidence is presented, which can be very difficult to understand without such visual aids. The maps can also be used as part of the prosecution's evidence against the accused. The billing records of the

relevant telephones are obtained through a search warrant and for each call made before, during and after the commissioning of crimes, the approximate locations of the two telephones are plotted on a map.

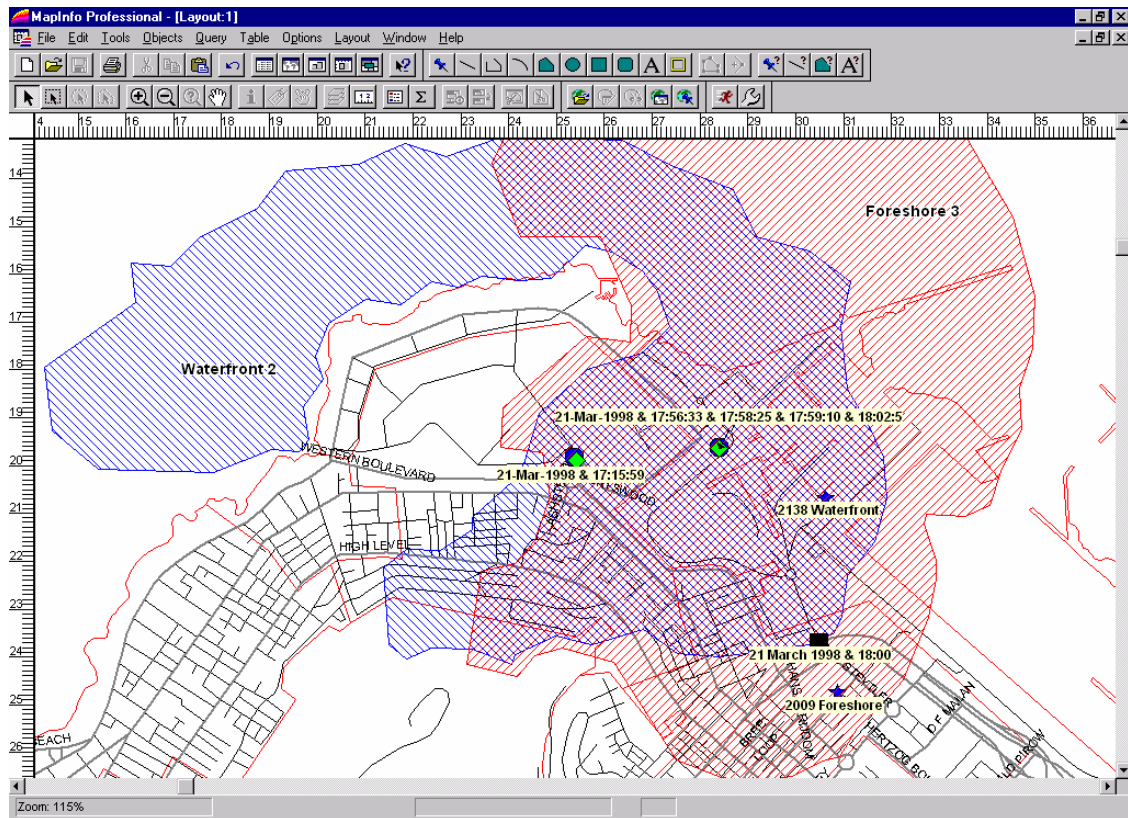
The three court cases

We have used this technique in three court cases in South Africa - to the best of our knowledge, the first time computer-generated maps have been used in a criminal case in South Africa. Two of the cases resulted in successful convictions, while third case is still before the court. The first case involved the hijacking of a motor vehicle, hostage taking and the subsequent rape and murder of the victims (see Map1).



Map 1. The map calls made after a hijacking incident

The second case involved the shooting of four victims by an individual. In both cases the maps were crucial for obtaining the conviction and sentencing of the accused (see Map 2). The third case involves the kidnapping of a businessman for ransom (see Map 3). The two completed cases occurred in Cape Town and the third in Durban, and in all three, cellular telephones were used before, during and after the commissioning of crimes.

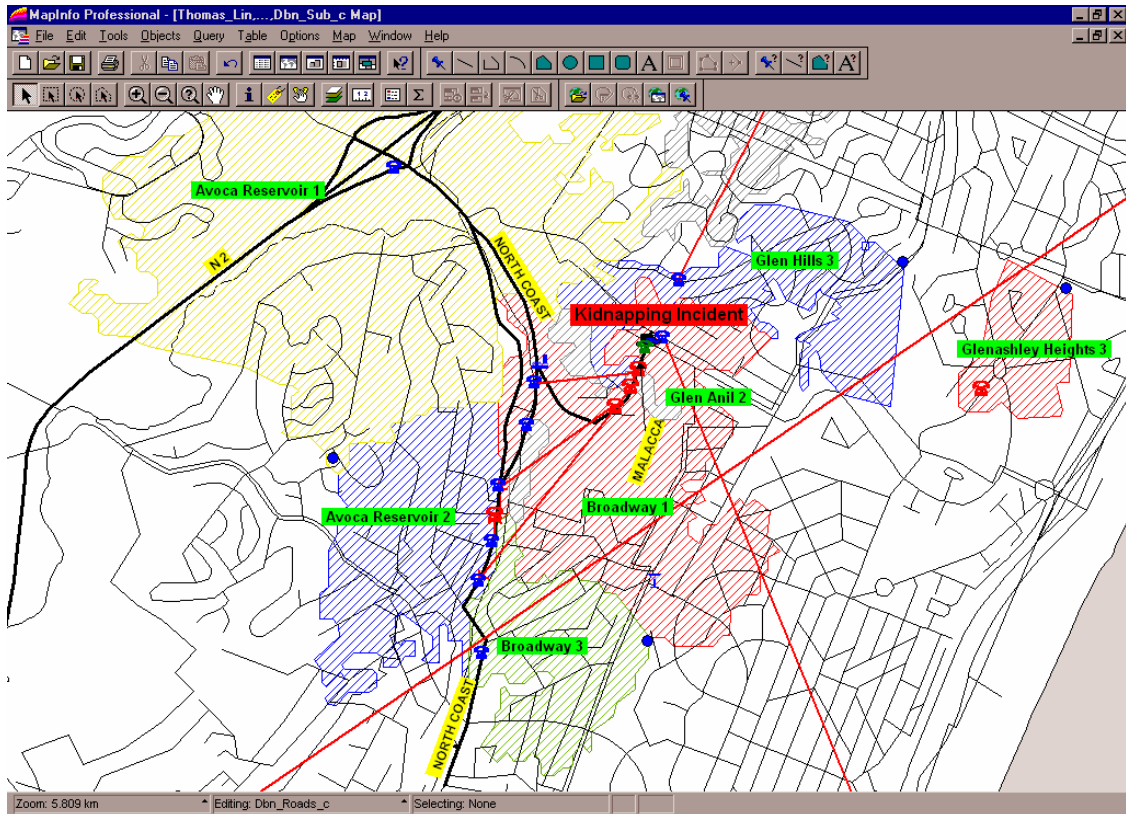


Map 2. The Waterfront shooting incident

Data used

In all three cases, the South African Police Service (SAPS) used search warrants to obtain billing records for the relevant cellular telephones, as well as the locations of the cellular-telephone base stations (transmitters) used and their areas of coverage. Using digital street maps of Cape Town and Durban, South Africa from MapStudio of the areas as the background, we mapped the locations of the telephones when the calls were made, together with the locations of the transmitters, their areas of coverage, from Vodacom and MTN (cellular service providers), and other places of relevance for the cases. For the two cases in Cape Town, we approximated the locations of each cellular telephone by using the centroid (centre of gravity) of the area of the coverage of the relevant transmitter the telephone was using during the call.

For the Durban kidnapping case, based on his knowledge of the events and the area, the investigating detective indicated the approximate position we should plot for the telephone when each call was made or received (see Map 3). For example, the service provider identified the possible location from where the last call originated. The police used information provided by the service provider to identify the house where the victim was being held and were able to free him and arrest the accused.

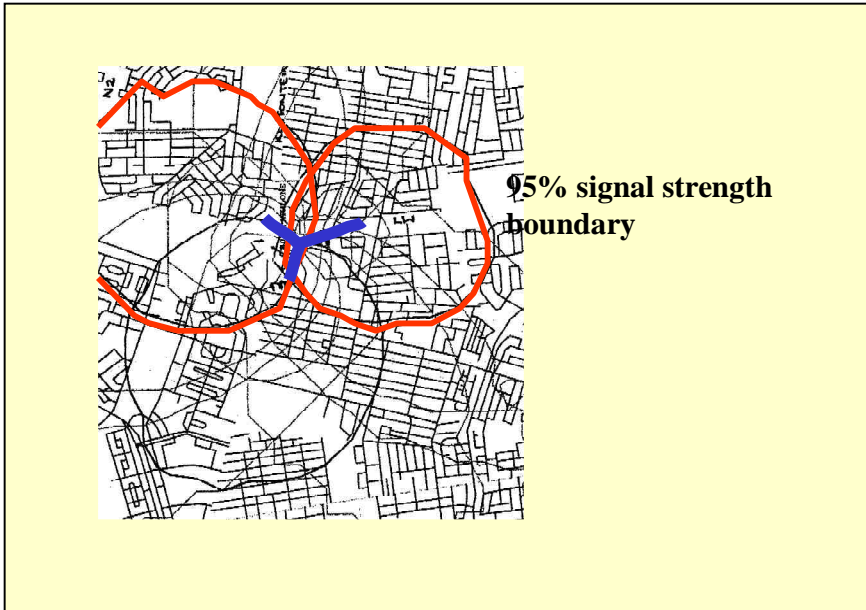


Map 3. The kidnapping incident

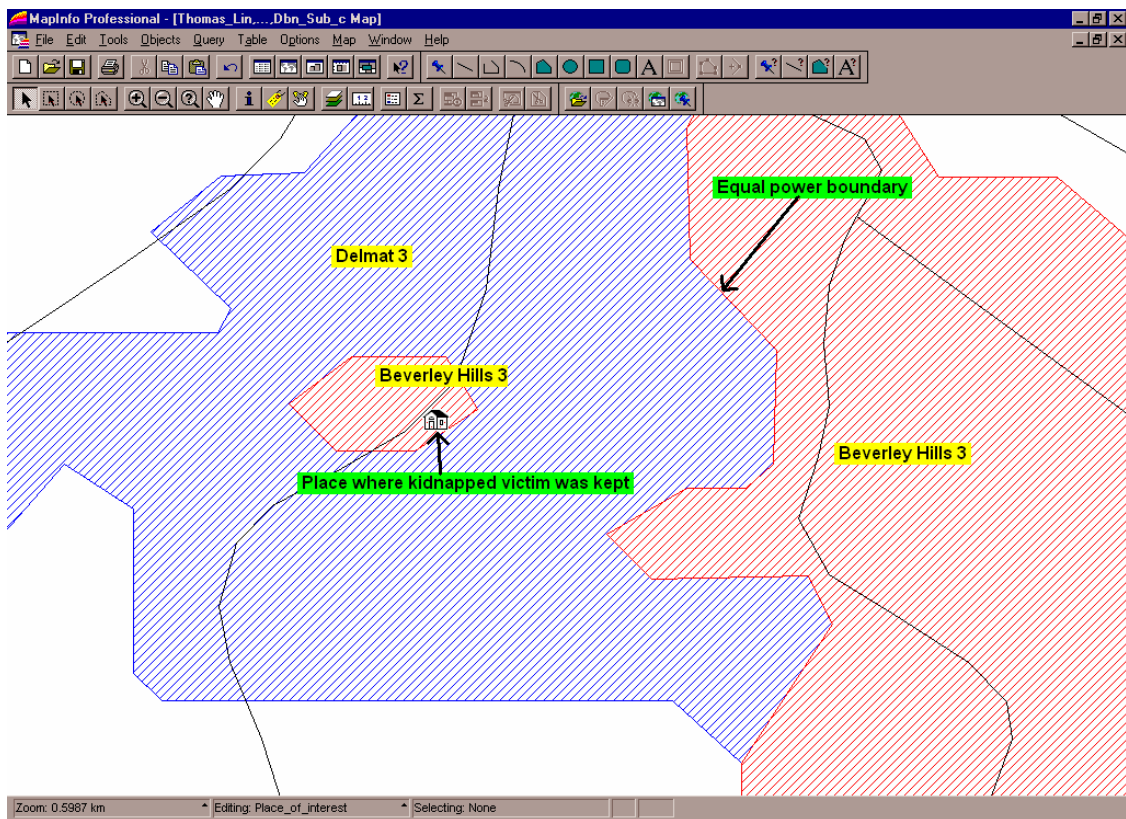
Equal power boundaries and the 95% probability boundaries

Two different boundaries for cellular base station coverage were used. In the two Cape Town cases the 95% probability boundaries (see Map 4) and the Durban case the equal power boundaries have been used (see Map 5). The 95% probability boundaries is produced by the planning tool used by the cellular service provider and shows the boundary in which the probability in which a cellular telephone will be in contact with a specific tower is higher than 95%.

The equal power boundaries are also generated by a planning tool such as Planet. The boundary is where the signal strength is equal between two cells. The equal power boundaries proved to be very useful in the Durban kidnapping case, since it showed small pockets of coverage in another cell from the cell in question (see Map 5). These pockets are due to the topography of the area and the topography in the KwaZulu Natal coastal belt is very hilly. We recommend that equal power boundaries should be used in the future, since these boundaries can be provided easily in digital form by the service providers. The coordinate system used by Planet (Vodacom's planning tool for locating base stations optimally) is UTM, thus making data integration within the GIS environment very easy.



Map 4. 95% signal strength boundary



Map 5. Equal power boundaries

Conclusion

For all three cases, for each call we show the approximate location of each telephone during the call and connected them with a line annotated with the time the call was made, its duration and a sequence number for the call, based on the detailed billing records provided by the two different cellular service providers. This enables the prosecutor to lead the court through the sequence of events, with the map providing a graphic, easy to understand picture of the case. It also enables the prosecutor to show where the person using the telephone was at the time of the call, which could be used to break an alibi.

We believe that the GIS provide a powerful, easy to use tool that can make a big impact on a court case. Indeed, we have been led to believe that in one of these cases, charges would have been dropped without the map.

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