

THE USE OF MAPPING TIME AND SPACE AS A FORENSIC TOOL IN A MURDER CASE IN SOUTH AFRICA

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Abstract

On the night of the 16th December 2006 Taliep Petersen, a famous South African musician and playwright, was murdered in his home. Initially it looked like a house robbery that went wrong but, when the detectives from the South African Police Service started to investigate, it became clear that it was premeditated murder. This was based on the fact that the crime scene did not indicate the *modus operandi* of a house robbery. The detectives obtained the data from records of the cellular telephone from the deceased's wife who was then identified as the prime suspect, and determined the person whom she contacted to arrange the murder. She tried to remove his name and calls made to him from her cellular telephone. This suspect turned state witness after intensive questioning by the detectives and identified three other persons who were involved in the murder. The detectives then obtained the cellular telephone records of the state witness and the other three suspects.

The deceased was tied up and killed by a single shot to the head but the firearm used was never found by the detectives, and they could not determine from the suspects who

had pulled the trigger of the fatal shot. The leading detective and the state prosecutor then requested the CSIR to analyse and map the movement and communication between the suspects and the state witness using the cellular telephone records. The aim was to use the mapped time and space information to corroborate the evidence given by the state witness with regards to the events leading up to murder. Data obtained from the cellular telephone records show the date and time of the calls made and received; the base station and cell involved; the other party involved and the duration of the call. The coordinates of the base stations were used as a geographic reference point to map the communication between the suspects and the state witness. From these records, the communication lines between the suspects and the state witness could be established. The lines of communications were that the deceased's wife only communicated with the state witness who in turn communicated with two of the other suspects. An interesting outcome of this analysis was that the deceased's wife had a one-way communication with the state witness. The state witness never phoned her during the period under investigation.

The cellular telephone records of the last suspect involved showed that there was no cellular telephone contact between him and the other suspects. The most important information that arose from the analysis of the cellular telephone records was that the deceased's wife made all the calls to the state witness. The state witness never phoned her back.

Using the sequence of the calls and the geographic location of the base stations involved, it was then possible to map the communication between and the movement of the suspects through time and space. The time period for the maps was between 13 and 17 December 2006 to indicate the build up to and aftermath of the murder in terms of the communications between the suspects and the state witness. There was a clear intensification of communication leading up to the murder on the 16th and very little communication between them after the murder had been committed. For ease of reference, each day was mapped separately and each communication was indicated by a line that connected the base stations involved during the calls. Each line was identified with a unique sequence number that could be linked to an accompanying table to determine the time of the call and who communicated with whom. The line of communication was also colour coded to indicate who communicated with whom, *i.e.* a red line was used to indicate the calls between the deceased's wife and the state witness. These maps were then handed in as evidence by the state as part of the court proceedings. These maps were one of the main contributors to the guilty verdict of the suspects and they were subsequently sentenced to imprisonment ranging from 7 to 28 years.

Introduction

The CSIR has been involved in crime mapping since 1997 as part of an Innovation Fund project. The Innovation Fund was made available by the then Department of Arts,

Culture, Science and Technology of the South African government. The first forensic application was the mapping of cellular telephone conversations between the notorious New Year's Gang members that were involved in the hijacking of motor vehicles, kidnapping, hostage taking and murder in 1998 (Schmitz, Cooper, Davidson and Roussow, 2000). The resulting map was used as evidence in the court case and it enabled the prosecutor to show to the court the series of events that took place that fateful night as well as to break the alibi of one of the accused (Schmitz, *et al*, 2000). The maps contributed to the successful conviction and sentencing of the accused (Schmitz, *et al*, 2000). Subsequent successes in the use of mapping the movement and conversations between suspects in space and time based on cellular telephone usage were: (a) the shooting incident at Cape Town's Waterfront (State vs. D Osman, Case No: CPV/98/0562H in the High Court of South Africa, Cape of Good Hope Provincial Division); and (b) the hijacking of trucks carrying cigarettes (State vs. S De Vries and 10 other, Case No: 67 / 2005 in the High Court of South Africa, Cape of Good Hope Provincial Division).

In both cases it led to the conviction and sentencing of the accused. Based on these successes, the detective and the prosecutor involved in the Taliep Petersen murder case requested the CSIR to map the communications between and movements of the accused through time and space during the build up to and the aftermath of the murder of Taliep Petersen.

With regards to the Taliep Petersen murder, the sequence of events as presented before the court can be summarised as follows (Desai, 2008): (a) the deceased's wife (Accused #1) contacted the state witness to arrange an assassination. The assassination was to be carried out when the deceased returned from London, where one of his musicals was running; (b) the state witness then contacted Accused #2 to arrange for a group of assassins who could do the assassination. It was arranged that the assassination should take the form of a carjacking in which the deceased would be shot and Accused #1 would appear as the innocent victim; (c) the carjacking would take place between the airport and the deceased's home (fate would have that the group of assassins would be without transport on the 14th of December 2006 when the assassination should have been made); (d) Accused #1 then suggested that the group of assassins should repeat the exercise on the 15th of December 2006 when the deceased and Accused #1 would be travelling from the Luxurama Theatre in Wynberg, Cape Town, to their home in Athlone, Cape Town, late that evening (fortunately for the deceased, the assassins still lacked transport and the attempt was abandoned); (e) on the same night Accused #2 introduced Accused #3 to the state witness as an alternative to the first group to do the assassination. The state witness then provided Accused #2 with the necessary information such as the location of the deceased's house and instructed Accused #2 to organise the assassination; and (f) on the evening of the 16th of December 2006, Accused #3 and Accused#4 went to the home of the deceased in Athlone, Cape Town, where the deceased was killed by a single shot through the back of the neck.

One of the most significant aspects to the murder case was the corroboration of the state witness' evidence through the use of cellular telephone records of the accused and the state witness. Accused #1 incessantly phoned the state witness in the run-up to the murder, including the botched attempts on the 14th and 15th of December 2006. There was also communication between the state witness, Accused #2 and Accused #3. Accused #1 only contacted the state witness. There was no cellular telephone communications between Accused #4 and any of the other accused and the state witness. The mapping of these calls between the accused and the state witness, which was used as evidence by the State, will be discussed in more detail in the remainder of this paper.

Objectives

The state witness in this case was an accomplice witness. An accomplice witness is one that through his/her own admission has participated in a crime and is willing to testify regarding the role of the co-conspirator. It is the role of the prosecutor to provide independent corroborating evidence to prove the evidence of the accomplice witness. In order to achieve this, the independent corroborating evidence must directly implicate the accused in the commission of the offence (Desai, 2008). The first objective was to indicate to the court through the use of mapping of time and space as a forensic tool to map the movement and communication between the suspects to illustrate that there was collaboration between the accused and the state witness that the deceased should be killed. The second objective was to use the same maps to contradict the evidence given by Accused #1. The third objective was to create the maps in such a manner that it was easily understood by the court. The methodology used to achieve these objectives will be discussed in the next section.

Methodology

The methodology used to map the communications between and movement of the accused and the state witness through time and space was as follows:

- the analysis of the cellular telephone records of the accused and the state witness and the isolation of the relevant calls to the case from the other calls using MS Excel;
- the sequencing of the isolated calls to determine the chronological movement through time and space using MS Excel;
- a time line using MS Visio was developed based on the previous activity;
- determining the nearest cellular base stations to the murder scene using ArcGIS;
- illustrating the various cells that could be triggered from the murder scene using MS Powerpoint since the building plan was a scanned image;
- determining the various cellular base stations used when the calls were made or received using ArcGIS;

- the creation of tables, using MS Excel, and maps, using ArcGIS, for each day based on the time line information; and
- a 3-D map, generated by ArcScene, showing movement of the suspects during the night of the 16th and 17th December 2006.
- The above tables, time-lines and maps were presented in a poster to the High Court and submitted as evidence in the court case.

The aim of analysing the cellular telephone records was to extract the communication between the accused and state witness from a plethora of calls made and received by each of the accused and the state witness. This is necessary to eliminate “noise” that may distract the court and to show to the court without a doubt the communication between the parties involved. The period of relevance of the case was from the 13th to the 17th of December 2006, which according to state and the investigating officer clearly indicated the run-up to and the aftermath of the murder with regards to the communication between the parties.

The next step was to sequence the communications between the parties involved to show the chronological order of the calls made and received. For ease of reference it was decided to colour code the parties involved as illustrated in Table 1 in the results section below. Once the various communications between the parties involved were placed in sequential order, a time line in MS Visio was created to illustrate clusters of calls in the run-up to and aftermath of the murder. The time line in MS Visio is scaled, *i.e.* if the day is given from 00:00 (start point on the graph) to 23:59 (end point), the call at 12 noon will be placed exactly halfway between these two points.

Accused #1 testified that she was at home during the incidents and thus it was necessary to determine the nearest cellular base stations (commonly known as cell towers) to the crime scene (the home). This was illustrated using an aerial photograph showing the crime scene and the surrounding area. The investigating officer made a few calls from various rooms of the house (the crime scene) using his own cellular telephone to determine which cell is activated when the call was made. The results were mapped using a plan drawing of the house. This was done to illustrate to the court where a person could have been in the house when the calls were made or received.

To illustrate to the court the movement through time and space, it was necessary to determine the geographical position of the accused and the state witness when these calls were made and received. If the cellular telephone is active, the position of the accused and the state witness can be determined through triangulation using the recorded signal strength from the cellular telephone to the surrounding base stations. This can only be done if the police have prior knowledge that a crime is about to be committed and the cellular telephone number of the suspect is known to them.

When creating maps for court purposes, the only geographical reference available is the cell and base station used. This is indicated in cellular telephone records by the base

station name followed by a number (see Table 1). To illustrate this concept, the call identified with Sequence ID 55 is a call made by Accused #1 (Najwa) and the state witness (Faheem) on the 16th of December 2006 at 10:16. Kewtown 3 was activated by Accused #1 and Sand Industria 1 by the state witness. Kewtown and Sand Industria are the names of the base stations and 1 and 3 are the cells used that are linked to the base station. Using the information given above, three geographical features can be obtained from the cellular service provider, namely:

- the extend of the cell coverage from their planning tool; or
- the centroid of the cell as used in Schmitz, *et al* (2000); or
- the coordinates of the base station.

For this particular court case, the cellular service provider only provided the base station coordinates. These were used to map the geographic position of the parties involved when they communicated with each other. It must be noted that these are only proxy locations since it is impossible to determine the exact location of the parties involved when the communication was done between them. Using base station locations it provides sufficient evidence of the spatial-temporal movement of the parties involved.

Once the geographic positions were established, the communication between the two parties is shown by a line linking the identified positions of the parties. The same colour coding scheme was used to differentiate between the callers as shown in Table 1. Figure 4 in the results section illustrates this methodology. To simplify the map for ease of understanding, the Sequence ID is given for each line and the name of the base station. The map reader needs to consult the corresponding table to determine the time of call and the parties involved.

To illustrate the convergence of the accused at the crime scene, a space-time graph was used based on the method used by the Swedish geographers in the 1960s and 1970s (Haggett, 1979) as well as the application of space-time graphs as a visualisation tool to illustrate the movement of persons or objects through time and space using GIS (Kraak, 2003a and Kraak, 2003b). The creation of space-time graphs to illustrate travel behaviour using cellular telephone data using cell centroids was illustrated by Krygsman, de Jong and Schmitz (2007). This method was used to create the space-time graph of each of the accused and the state witness using the base station geographical positions. The next section shows the results obtained using the discussed methodology.

Results

For the purpose of this paper only the communications between and the movement of the accused and the state witness on the 16th of December 2006 will be shown. The order of the results will be as discussed in the methodology section. Table 1 shows the communication between the various parties involved once the “noise” had been

removed from their respective cellular telephone records. The communication between two of the parties involved have been colour coded as explained in the methodology section

Figure 1 shows the time line for the 16th. The time line needed to be expanded on the 16th to accommodate the high number of calls between the parties involved in the run-up to the murder. Figure 2 shows the aerial photograph and the direction to the nearest base stations.

Sequence ID	Date	Time	Communication activity	Cells used	Faheem	Emjedi	Hassan
55	16/12/2006	10:16	Najwa P (082 566 7967) contacts Faheem (072 922 9617)	Kewtown 3	Sand Industria 1		
56		16:56	Emjedi (072 010 9819) contacts Hassan (078 169 8347)			Grassy Park 3	Symphony Secondary 3
57		16:58	Emjedi (072 010 9819) contacts Faheem (072 922 9617)		Mandalay 2	Retreat 1	
58		17:51	Emjedi (072 010 9819) contacts Hassan (078 169 8347)			Rylands 3	Symphony Secondary 3
59		20:11	Najwa P (082 566 7967) contacts Faheem (072 922 9617)	Kewtown 3	Westridge School 1		
60		20:15	Faheem (072 922 9617) contacts Emjedi (072 010 9819)		Westridge School 2	Ottery DCS 6	
61		20:19	Emjedi (072 010 9819) contacts Hassan (078 169 8347)			Neumans Farm 1	Symphony Secondary 3
62		20:20	Emjedi (072 010 9819) contacts Faheem (072 922 9617)		Rocklands 1	Neumans Farm 1	
63		21:20	Najwa P (082 566 7967) contacts Faheem (072 922 9617)	Kewtown 3	Mitchells Central 3		
64		21:23	Najwa P (082 566 7967) contacts Faheem (072 922 9617)	Crawford 1	Rocklands 1		
65		21:24	Emjedi (072 010 9819) contacts Hassan (078 169 8347)			Rylands 3	Symphony Secondary 3
66		21:25	Emjedi (072 010 9819) contacts Faheem (072 922 9617)		Mitchells Central 3	Rylands 3	
67		21:29	Najwa P (082 566 7967) contacts Faheem (072 922 9617)	Crawford 3	Mitchells Central 3		
68		22:06	Najwa P (082 566 7967) contacts Faheem (072 922 9617)	Kewtown 3	Mitchells Central 3		
69		22:20	Najwa P (082 566 7967) contacts Faheem (072 922 9617)	Crawford 3	Schaapskraal 1		
70		22:23	Faheem (072 922 9617) contacts Emjedi (072 010 9819)		Sand Industria 3	John Power Holiday Camp 3	
71		22:25	Emjedi (072 010 9819) contacts Hassan (078 169 8347)			John Power Holiday Camp 3	Symphony Secondary 3
72		22:26	Emjedi (072 010 9819) contacts Faheem (072 922 9617)		Lansdowne 1	John Power Holiday Camp 3	
73		22:27	Faheem (074 340 2038) contacts Hassan (078 169 8347)		Ellen Arthur Clothing		
74		22:36	Najwa P (082 566 7967) contacts Faheem (072 922 9617)	Kewtown 2	Rylands 1		
75		22:40	Faheem (074 340 2038) contacts Hassan (078 169 8347)		Rylands Primary School		Symphony Secondary 3
76		22:54	Faheem (074 340 2038) contacts Emjedi (072 010 9819)		Sunnyside Sportsfield	John Power Holiday Camp 3	
77		23:00	Hassan (078 169 8347) contacts Faheem (074 340 2038)		Sunnyside Sportsfield		Cravenby High School 3
78		23:03	Najwa P (082 566 7967) contacts Faheem (072 922 9617)	Kewtown 3	Crawford 1		
79		23:12	Faheem (074 340 2038) contacts Emjedi (072 010 9819)		Sunnyside Sportsfield	John Power Holiday Camp 3	
80		23:13	Emjedi (072 010 9819) contacts Faheem (072 922 9617)		Rylands 1	John Power Holiday Camp 3	
81		23:21	Faheem (074 340 2038) contacts Hassan (078 169 8347)		Sunnyside Sportsfield		Valkenberg Hospital
82		23:24	Hassan (078 169 8347) contacts Faheem (074 340 2038)		Sunnyside Sportsfield		Ledger House
83		23:26	Najwa P (082 566 7967) contacts Faheem (072 922 9617)	Crawford 1	Rylands 1		
84		23:27	Faheem (074 340 2038) contacts Hassan (078 169 8347)		Sunnyside Sportsfield		
85		23:27	Faheem (074 340 2038) contacts Hassan (078 169 8347)		Sunnyside Sportsfield		
86		23:31	Faheem (074 340 2038) contacts Emjedi (072 010 9819)		Sunnyside Sportsfield	John Power Holiday Camp 1	

Table 1: The sequence and time of communication between suspects and state witness.

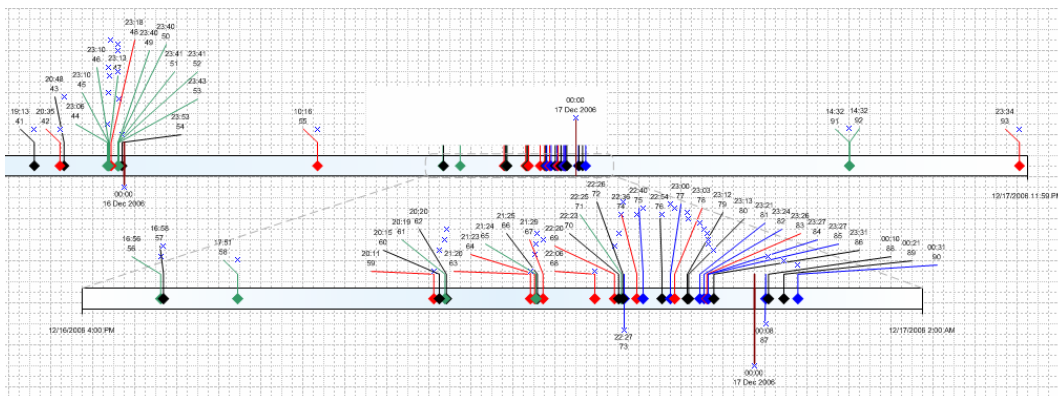


Figure 1: The time line showing the communication between the accused and the state witness on the 16th of December 2006.

Figure 3 shows the cells triggered when calls were made from selected rooms in the house where the murder occurred. This was included to illustrate to court that a person

could have made calls from the house triggering the cells as indicated in the accused cellular telephone records. It also indicates that a person has moved around the house when using the cellular telephone. Figure 4 shows the communication between and the movement of the accused and the state witness on the 16th when Taliep Petersen was murdered in his house. His body was found near “G” in Figure 3.



Figure 2: The directions from the crime scene to the nearest cellular base stations (image captured from Google Earth, 2008).

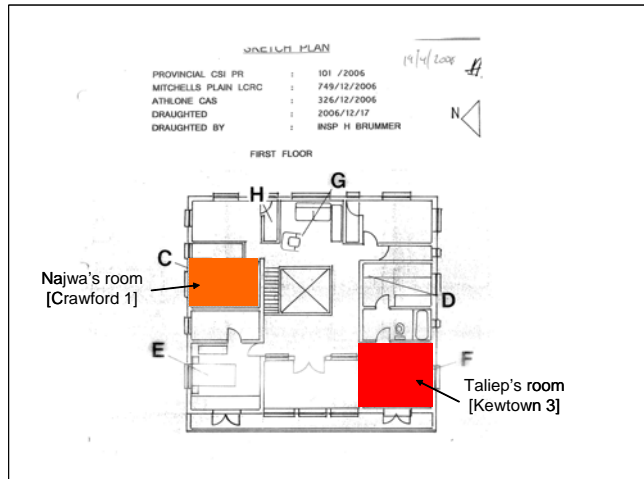


Figure 3: Cells triggered when calls were made from the two rooms indicated. Najwa is Accused #1.

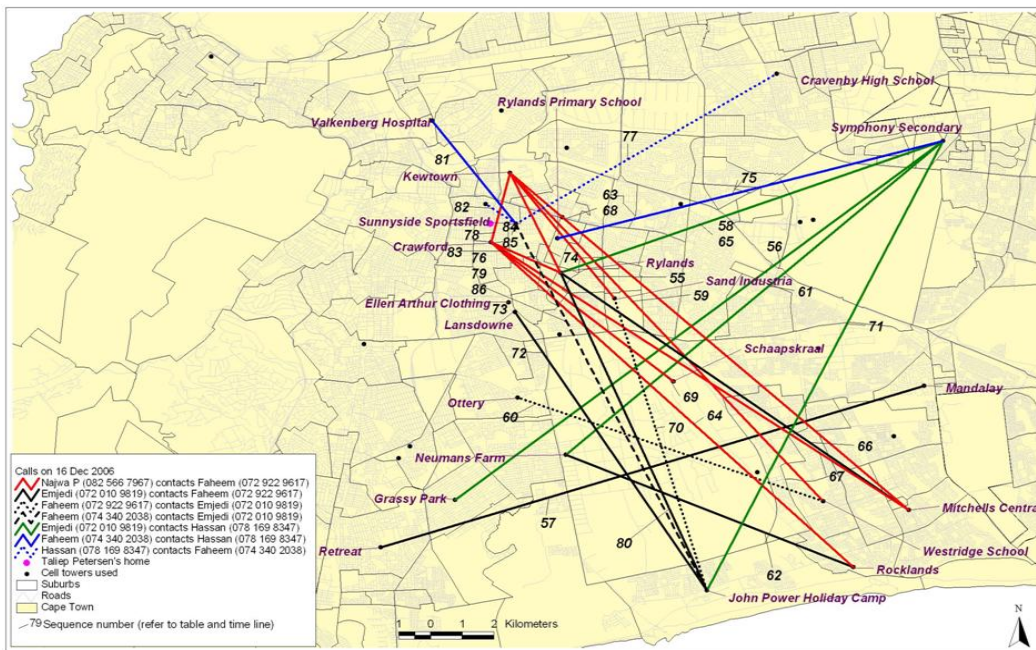


Figure 4: The communication between and movement of the suspects and state witness on 16 December 2006.

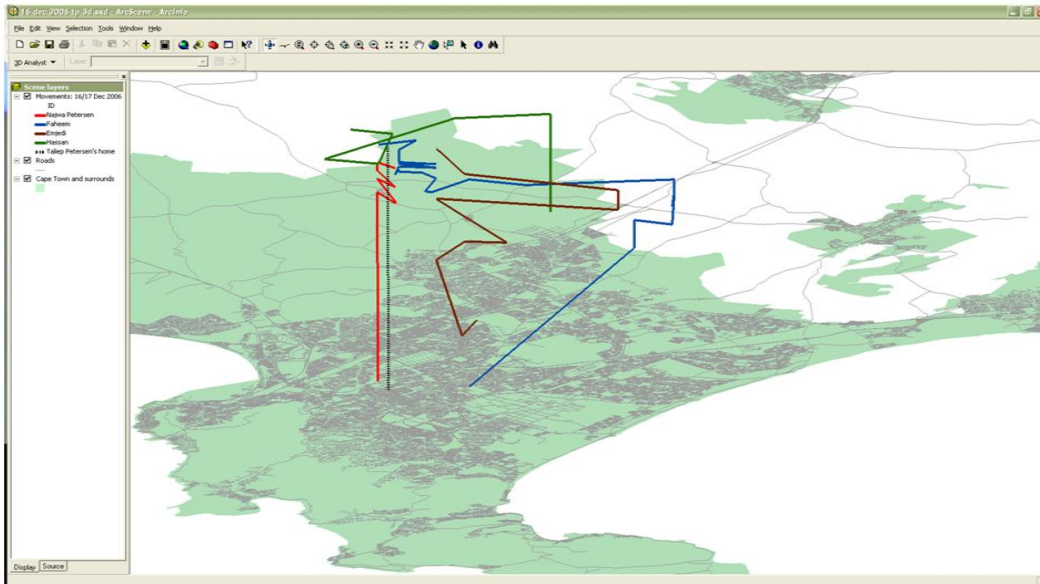


Figure 5: Space-time graphs of the accused and state witness on the 16th and 17th of December 2006.

Figure 5 shows the space-time graph of each of the accused and the state witness to indicate the movement before and after the murder was committed. The state witness and Accused #2 moved around the vicinity of the crime whereas Accused #1 was at home triggering the two towers that covers the house (red zig-zag graph) and Accused #3 moving to and away from the crime scene (green graph). The black dotted line shows the position of the house where the murder occurred. Accused #4 did not use his cellular telephone that evening.

Conclusions

The final presentation to court was in the form of a story board starting with the time line, then followed by the aerial photograph, the rooms that triggered the various cells ending with the tables, maps and the space-time graph. The principal author then testified in court as an expert witness guiding the court through the presentation and how each element of the story board linked to each other. This approach was very successful in showing the collusion between the accused and state witness to commit the murder.

This use of the mapping of time and space as a forensic tool contributed significantly to the guilty verdict and sentencing of the accused, since it corroborated the evidence led by the state witness, thus achieving the first objective. This is clearly illustrated by the judgement delivered by Judge Desai (Desai, 2008:184): [Paragraph] 378. *The cell phone records afford compelling corroboration of the State's case. It supports the evidence of*

Hendricks in several material respects. Its impact emerges graphically from the evidence of Peter Schmitz, a very competent witness whose evidence was not seriously challenged. This also indicates that the maps were presented in such a way that it was easily understood by the court thus achieving the third objective.

With regards to the second objective, the state through the use of the time-line in Figure 1 managed to contradict the evidence given by Accused #1. Accused #1 indicated in her evidence that she took medication on the evening of the 16th. The medication causes heavy sedation and she indicated that she went to bed at around 9 o'clock that evening. Her cellular telephone activity clearly contradicted her evidence since the cellular base station usage indicated that she moved around the house until up to the murder of the deceased as illustrated in Table 1, Figure 3 and 5.

To further highlight the successful use of mapping time and space as a forensic tool is illustrated in the following judgement made by Judge Bozalek in *State vs. S de Vries and 10 others* (Bozalek, 2008:74): [Paragraph] [120] *The maps present a damning picture of how the robberies were accompanied, preceded and followed by cell phone activity linking various cell phone numbers attributed to certain of the accused involved in the robberies. They both illustrate and confirm Aspeling's general account of the dates, timing and chronology of the robberies and much of his evidence concerning the role of a number of the accused therein.* Aspeling was the state witness in this particular case.

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References

Bozalek, 2008: Judge Bozalek's of the High Court of South Africa (Cape of Good Hope Provincial Division) judgement on matter *State vs. S de Vries and 10 other*, Case No 67/2005. The judgement was delivered in the High Court on the 10th of June 2008.

Desai, 2008: Judge Desai's of the High Court of South Africa (Cape of Good Hope Provincial Division) judgement on matter *State vs. N Petersen and 3 other*, Case No 02/08. The judgement was delivered in the High Court on the 1st of December 2008.

Haggett, P., 1979: *Geography: A Modern Synthesis, Third Edition*. Harper and Row, Publishers, Inc., 10 East 53rd Street, New York, NY 10022. ISBN 0-06-042578-4

Kraak, M-J., 2003a:

- Kraak, M., 2003b: The Space-Time Cube Revisited from a Geovisualization Perspective. In: Proceedings of the 21st International Cartographic Conference 'Cartographic Renaissance'. Durban, South Africa, 10 – 16 August 2003. Hosted by the International Cartographic Association. ISBN: 0-958-46093-0
- Krygsman, S., de Jong, T. and Schmitz, P., 2007: Capturing daily urban rhythms: The use of location aware technologies. In *10th International Conference on Computers in Urban Planning and Urban Management*. 11-13 July, 2007. Iguassu Falls, Brazil.
- Schmitz, P., Cooper, A., Davidson, A., and Roussow, K., 2000: Breaking Alibis Through Cell Phone Mapping. In LaVigne, N.G., and Wartell, J. (eds), 2000: *Crime Mapping Case Studies: Successes in the Field, Volume 2*. Police Executive Research Forum (PERF), 1120 Connecticut Avenue N.W., Suite 930, Washington, D.C. 20036, USA. ISBN 1-878734-71-1.