

Mapping Criminal Activity Space using Cellular (Mobile) Telephone Data

Presented by:

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Overview

- Activity space
- Proposed new method
- Example 1: Call data records
- Example 2: Active tracking of a suspect

Mental Maps

- **Activity space**

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- **Paths** – routes of travel that tend to dominate most people's images of cities such as freeways and railways.
- **Edges** – boundaries of lines that help to organise cognitive maps such as rivers, freeways and railways.
- **Districts** – subareas with recognisable unifying characteristics consisting of well established cores with fuzzy boundaries for example business districts or skid rows.
- **Nodes** – intense foci of activities such as intersections, shopping mall, corner shop, etc.
- **Landmarks** – symbols used for orientation but which typically are not physically entered such as high buildings, trees, structures (i.e. water towers), etc.

Journey-to-Crime

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- Crimes in most cases occur close to the offender's anchor point.
- The number of crimes committed by an offender decreases with distance from his/her anchor point.
- Crime types dictate the distance from the anchor points: violent crime tends to be closer to anchor points than property crimes.
- High crime neighbourhoods influence the crime trip pattern.

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Data from cellular (mobile) telephones

•Call Data Records

- The recorded use by the service provider of the cellular telephone when it receives and makes calls, (including SMS and MMS).

•Actively tracking the suspect

- The cellular telephone is actively tracked at predetermined time intervals such as every five or ten minutes.

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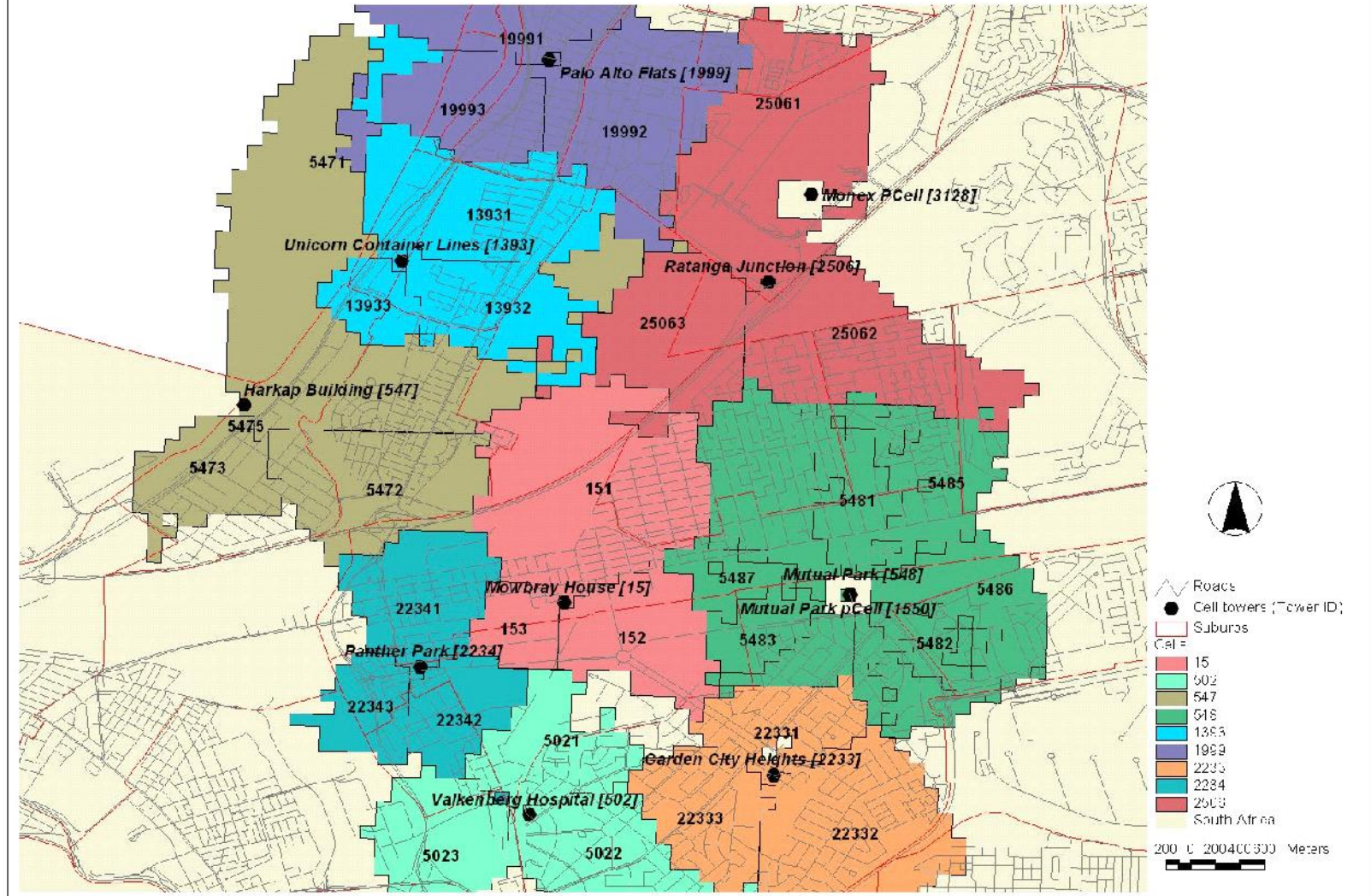
Call Data Records

| Date | Time | No.Called | No.Calling | Call.Dir | Call Dur | CELL_ID | TOWER_ID | Site location | Site suburb |
|------------|--------|-------------|-------------|----------|----------|---------|----------|-------------------------|---------------|
| 15/12/2002 | 000235 | 2773228250x | 2783765762x | I | 52 | 08393 | 839 | ATS | Millpark |
| 15/12/2002 | 000400 | 2783446106x | 2773228250x | O | 33 | 08393 | 839 | ATS | Millpark |
| 15/12/2002 | 000444 | 2783765762x | 2773228250x | O | 36 | 08393 | 839 | ATS | Millpark |
| 15/12/2002 | 000535 | 2783446106x | 2773228250x | O | 43 | 02772 | 277 | Auckland Park Telkom Ex | AUCKLAND PARK |
| 15/12/2002 | 001032 | 2773228250x | 2783765762x | I | 8 | 08392 | 839 | ATS | Millpark |
| 15/12/2002 | 001100 | 2783446106x | 2773228250x | O | 21 | 08393 | 839 | ATS | Millpark |
| 15/12/2002 | 001931 | 2783347574x | 2773228250x | O | 0 | 08393 | 839 | ATS | Millpark |
| 15/12/2002 | 001948 | 2773288063x | 2773228250x | O | 17 | 08393 | 839 | ATS | Millpark |
| 15/12/2002 | 002949 | 2772392694x | 2773228250x | O | 26 | 08393 | 839 | ATS | Millpark |

Cell Network

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Example of cell towers and cells as planned by a service provider



Determining the centroid of a cell

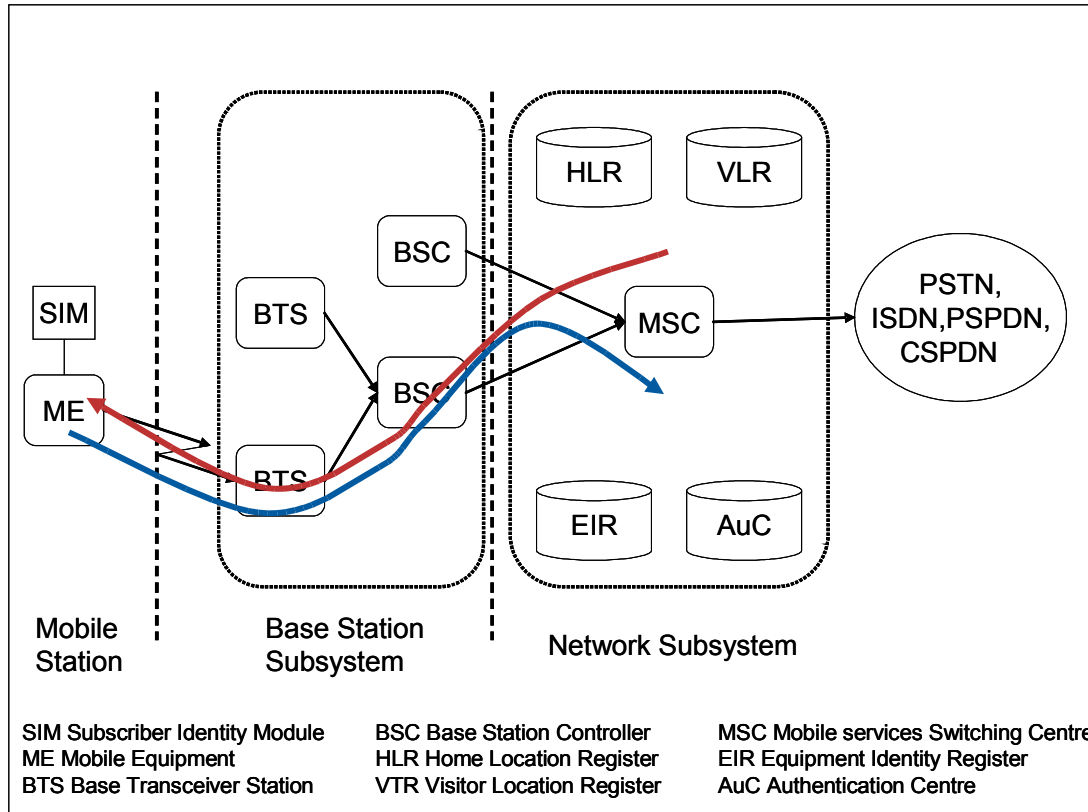
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Determining the x,y position of a cell used to locate a ping in an active track



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Actively tracking a cellular telephone



Send a blind SMS to the cellular telephone
Cellular telephone responds by giving the cell in which it is located

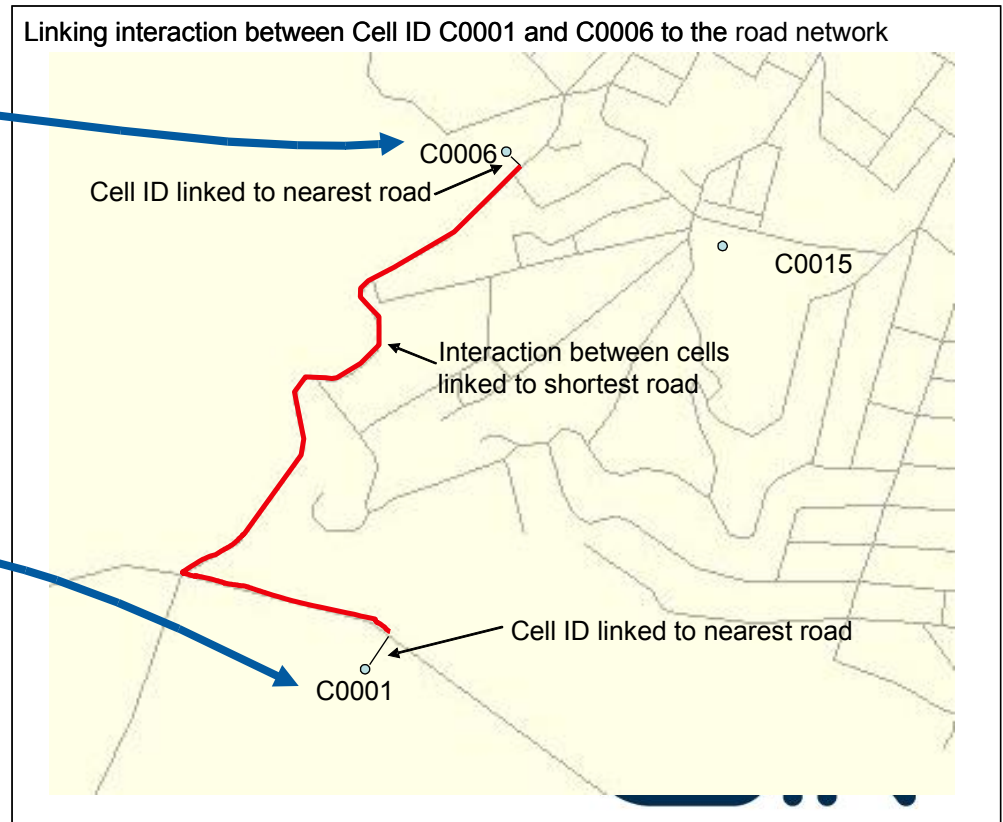
The cell is then linked to the centroid, which gives the geographic location

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Linking centroids to road network to determine activity space

Microsoft Excel - ping sum1.txt

| | A | B | C | D | E |
|---|-----------|---------|-------------|---|---|
| 1 | From_Ping | To-Ping | Interaction | | |
| 2 | C001 | C001 | 1 | | |
| 3 | C001 | C006 | 1 | | |
| 4 | C002 | C002 | 1 | | |
| 5 | C002 | C004 | 1 | | |
| 6 | C003 | C003 | 2 | | |
| 7 | C003 | C004 | 1 | | |



Use Flowmap to link the interaction to the road network.

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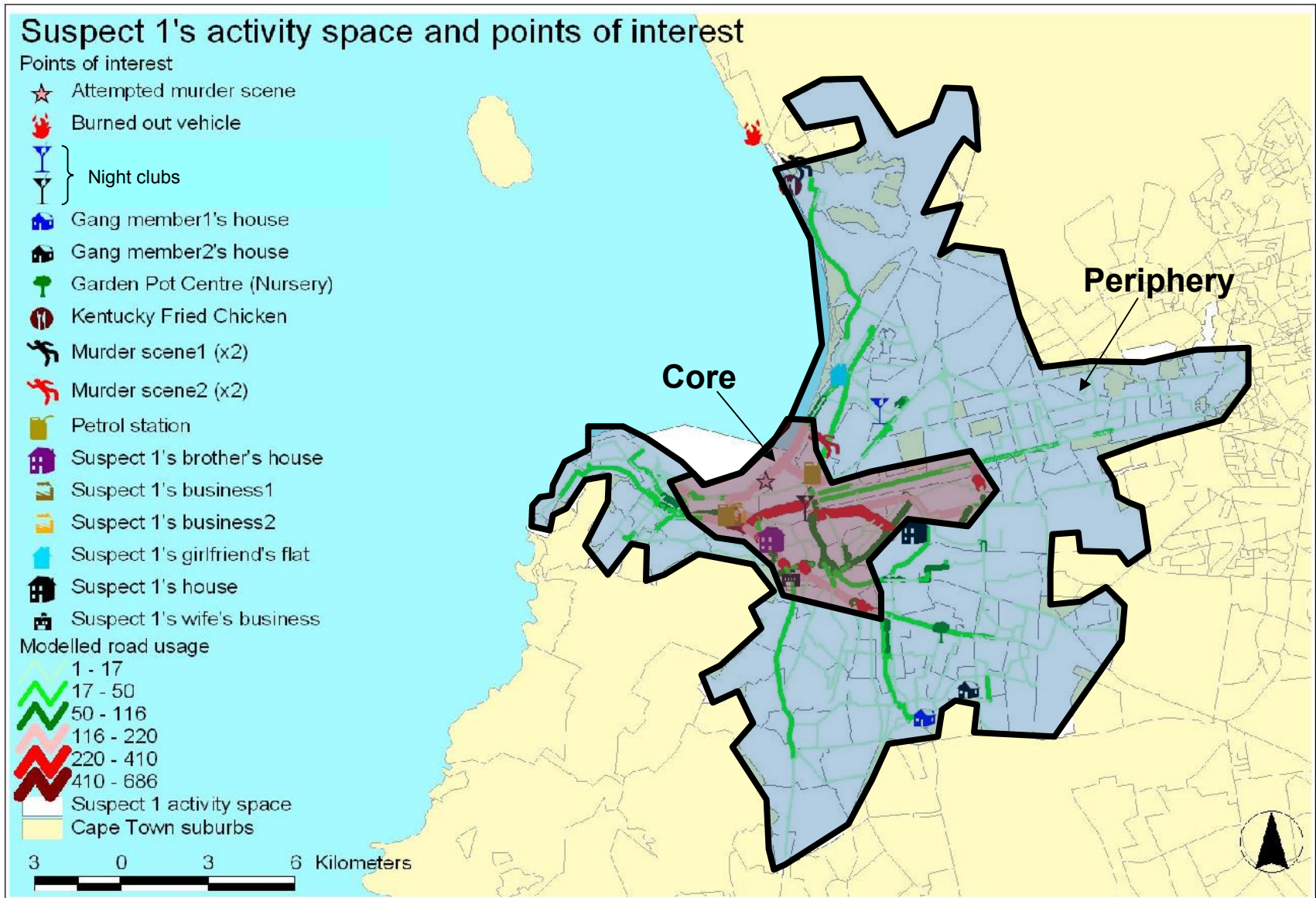
Call data records

- Drug boss and his gun runner
- Case was investigated by SAPS and NPA did the prosecution
- CSIR provided cellphone analysis, just showing linkages between the suspects for the court case
- Obtained permission by NPA to use the data for this analysis
- Reported back to both SAPS and NPA and was received favourably with possible future applications

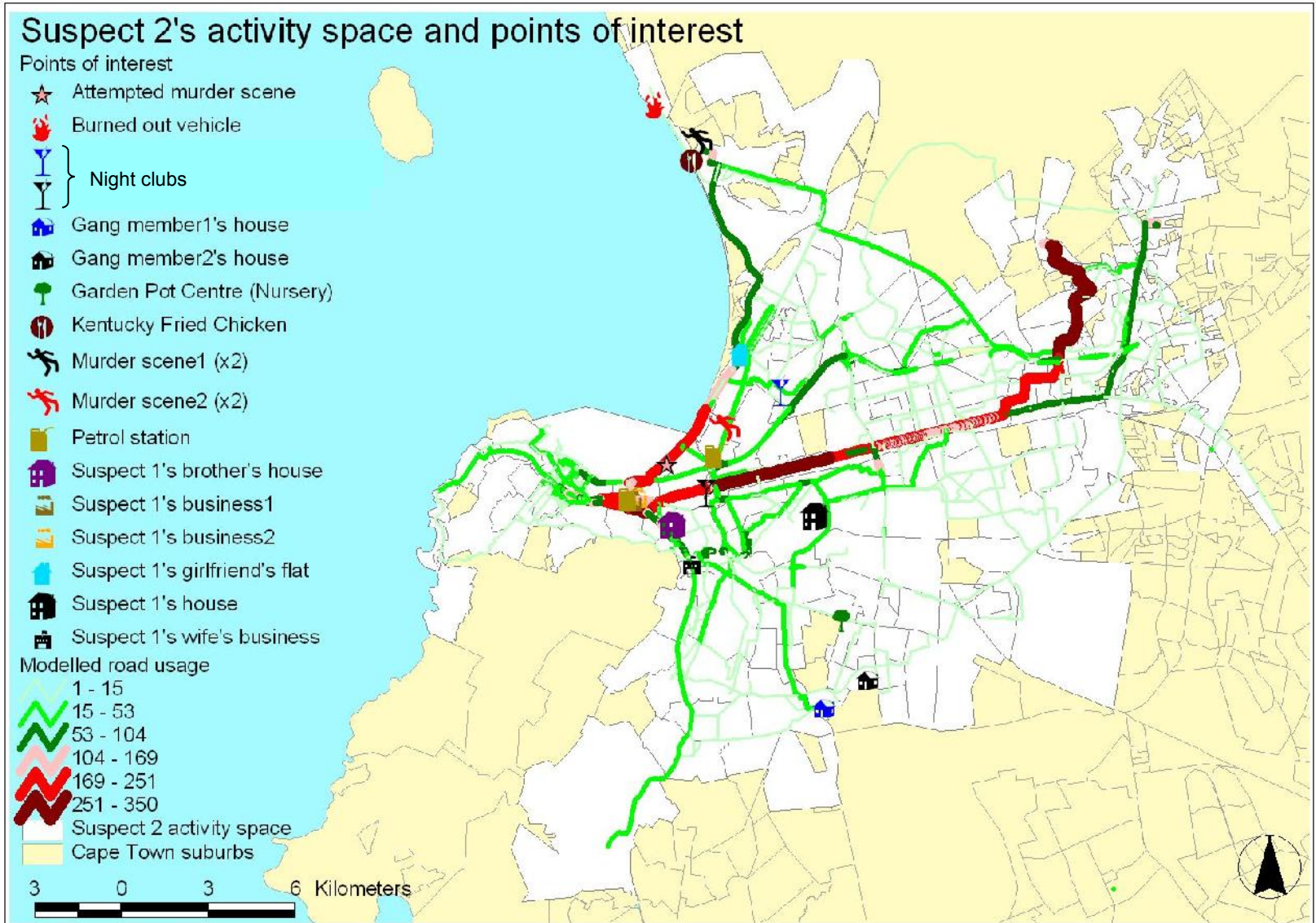
- SAPS = South African Police Service
- NPA = National Prosecution Authority
- CDR = Call data records

Call data records

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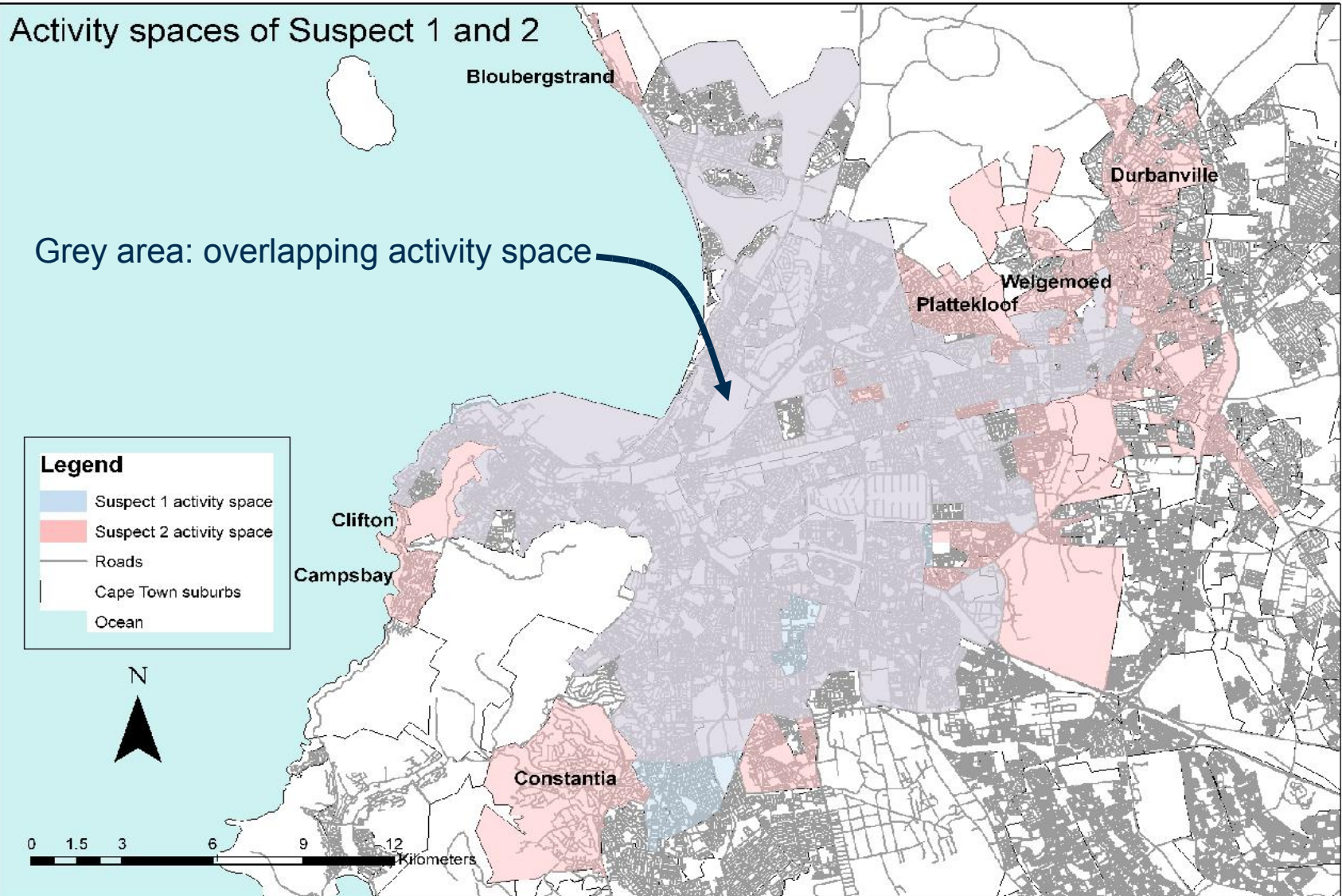


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Activity spaces

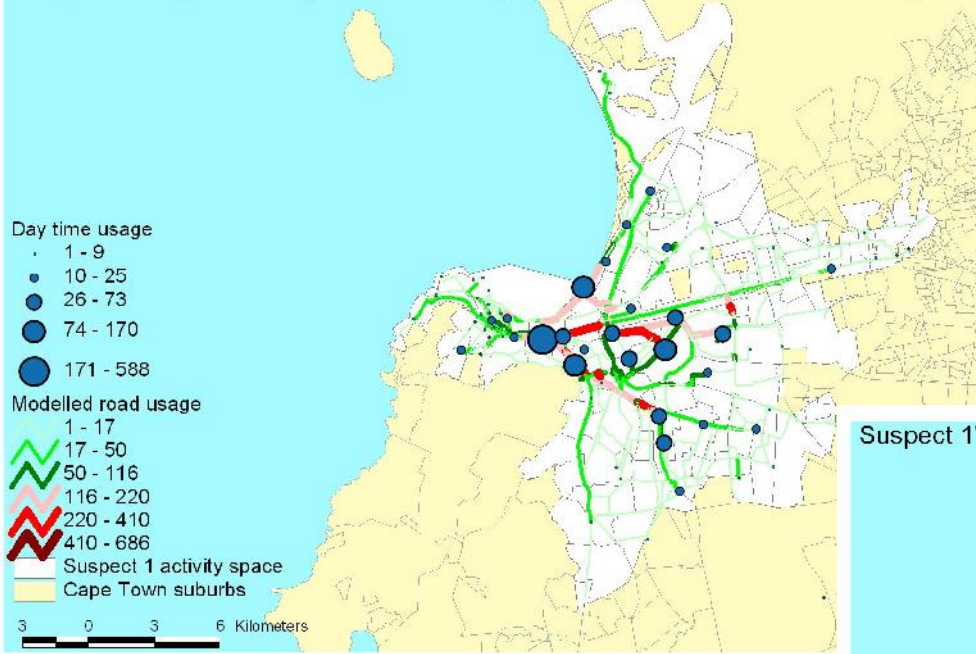
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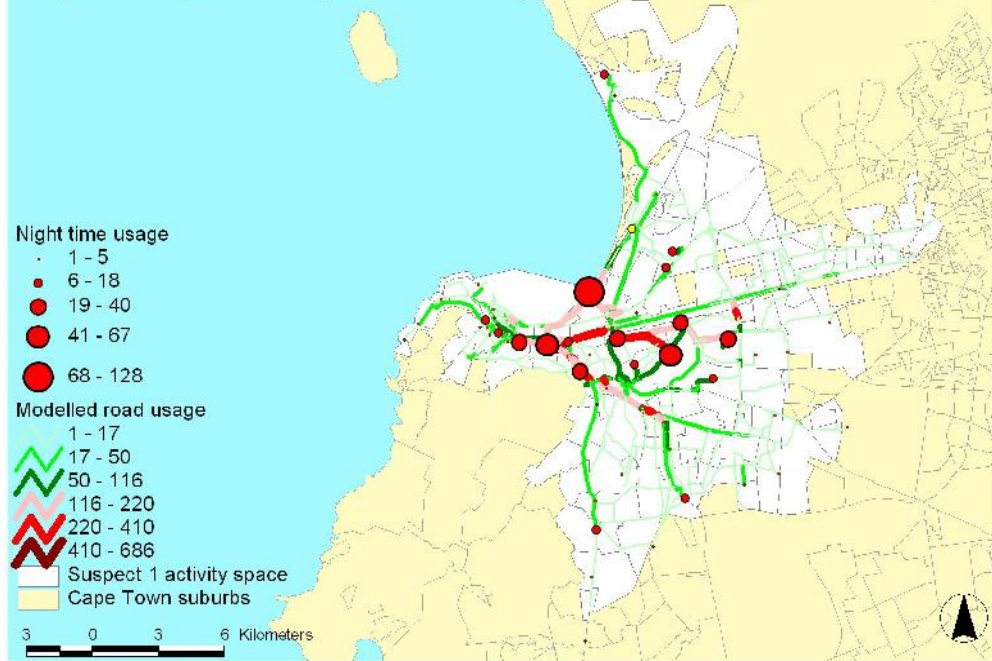
Diurnal patterns

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Suspect 1's day time usage of cell towers (number of calls logged at the tower)

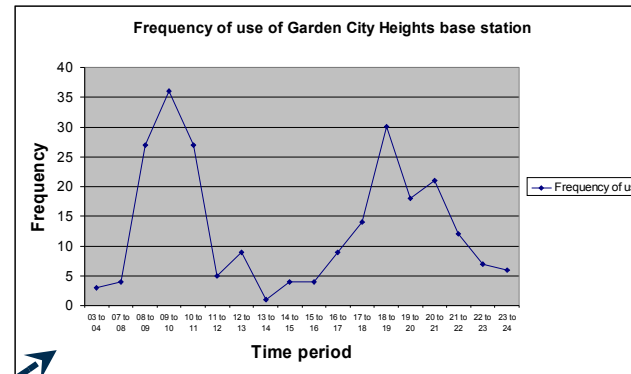
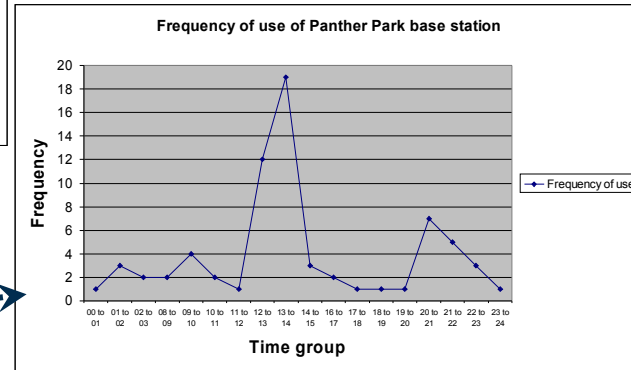
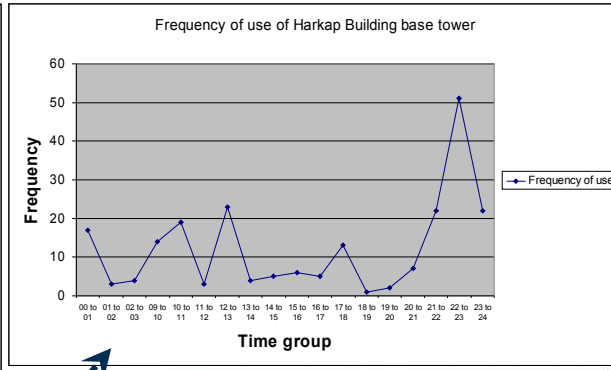
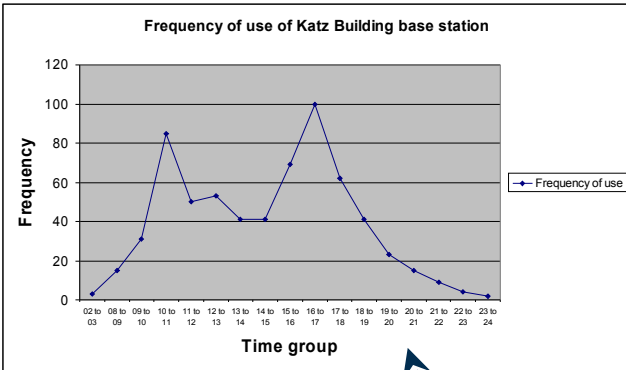


Suspect 1's night time usage of cell towers (number of calls logged at the tower)

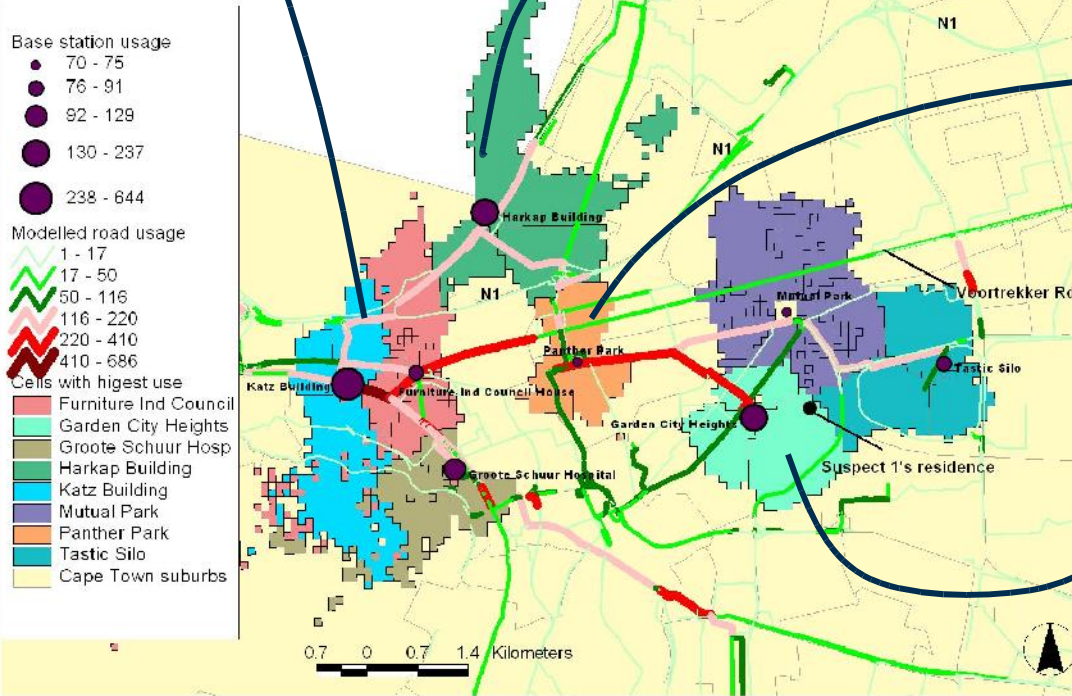


Frequency of use

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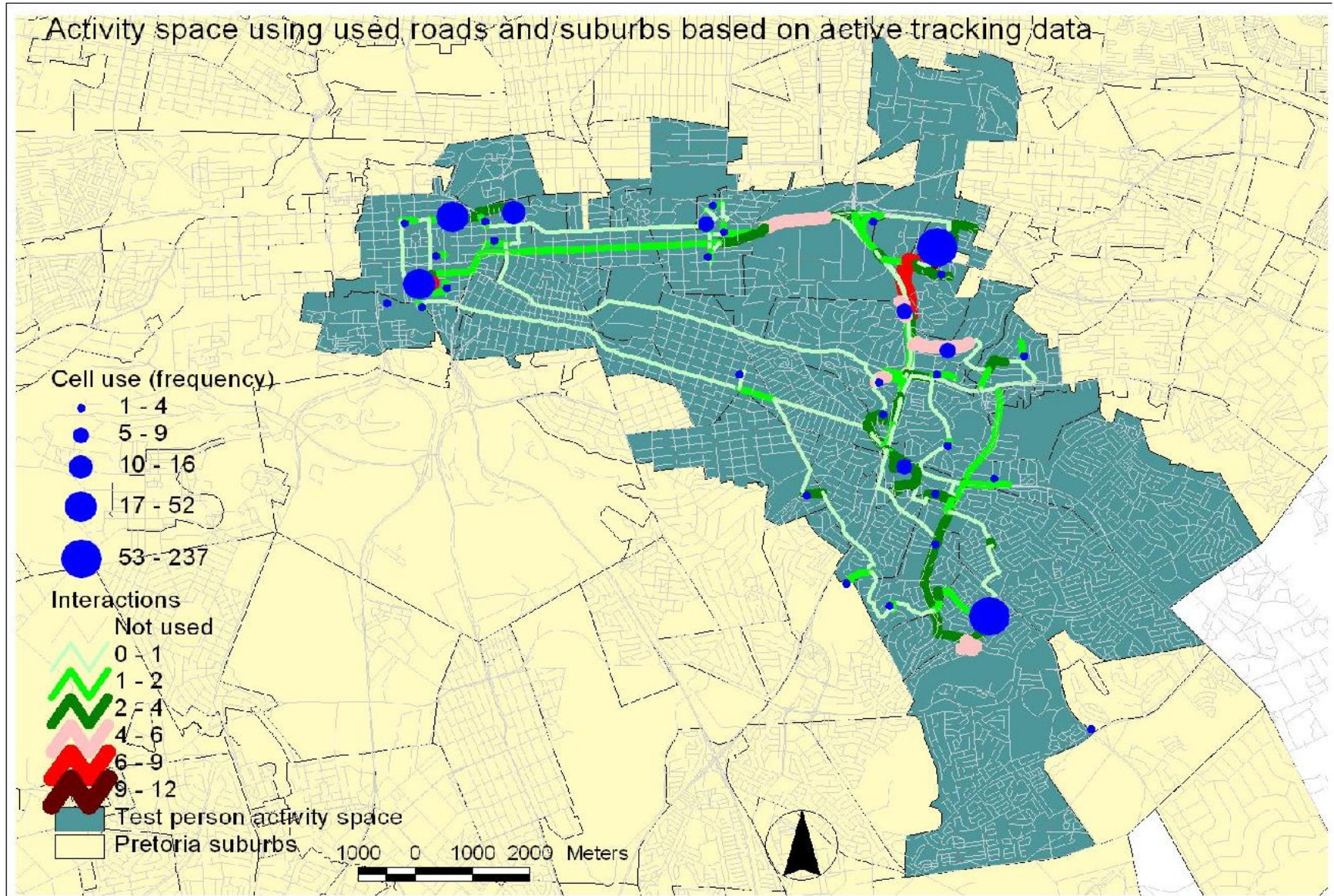


Suspect 1: Eight most used base stations and their cells

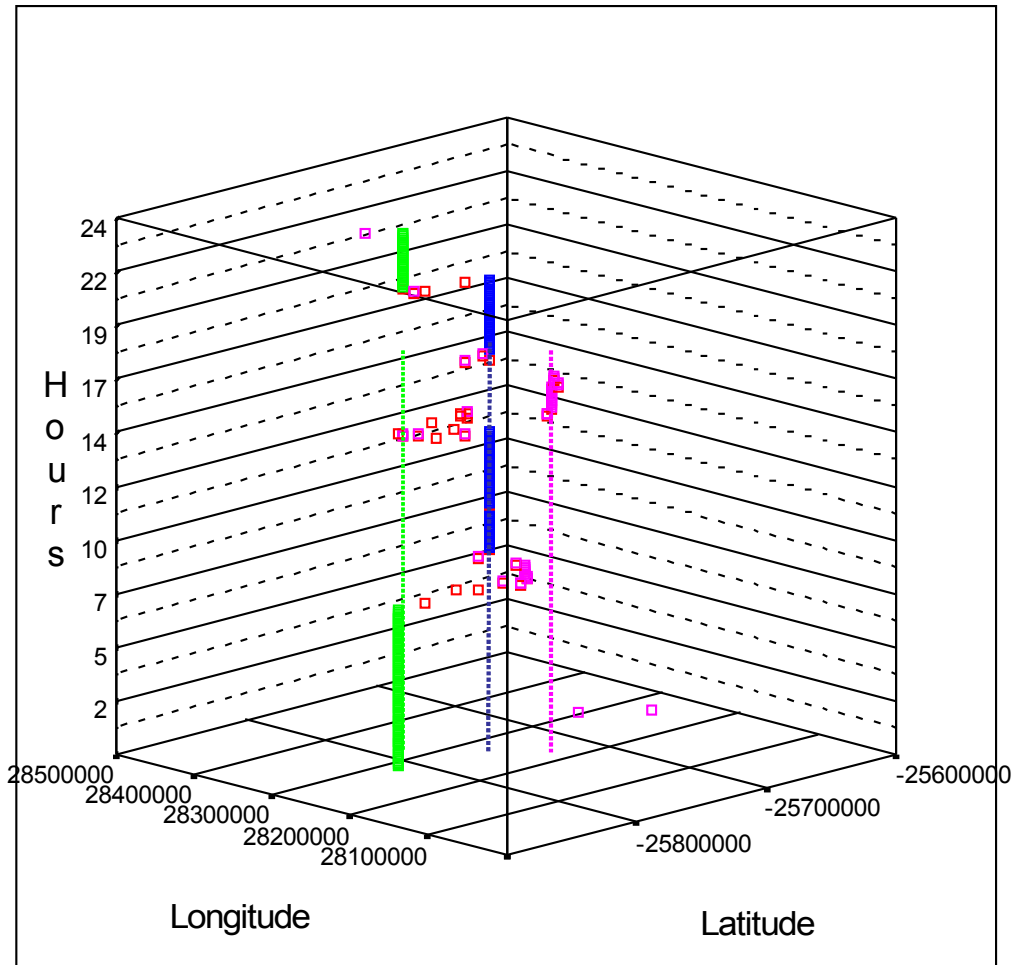


Active tracking

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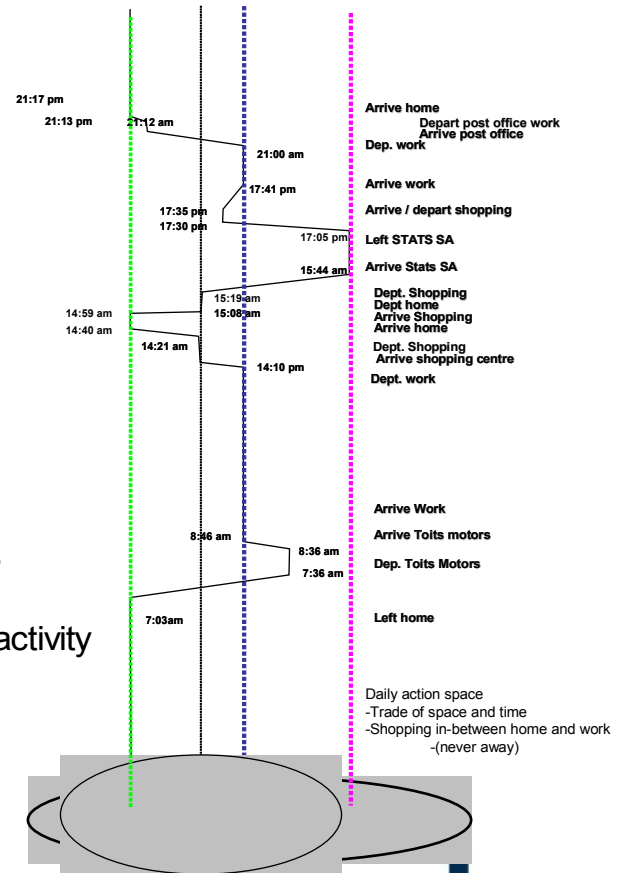


Space-time diagram



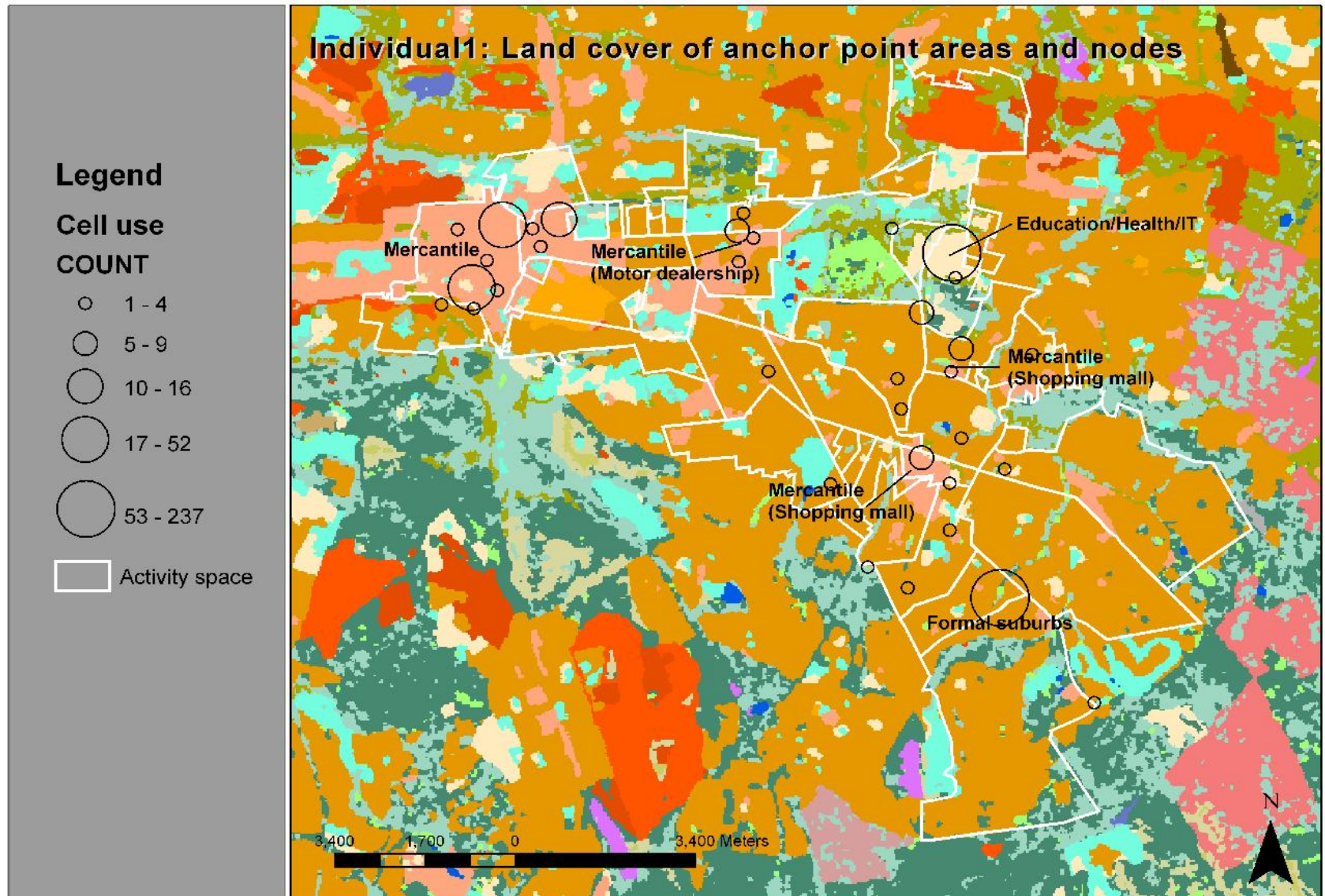
Activities

- Other activity
- Work
- Home
- Travel



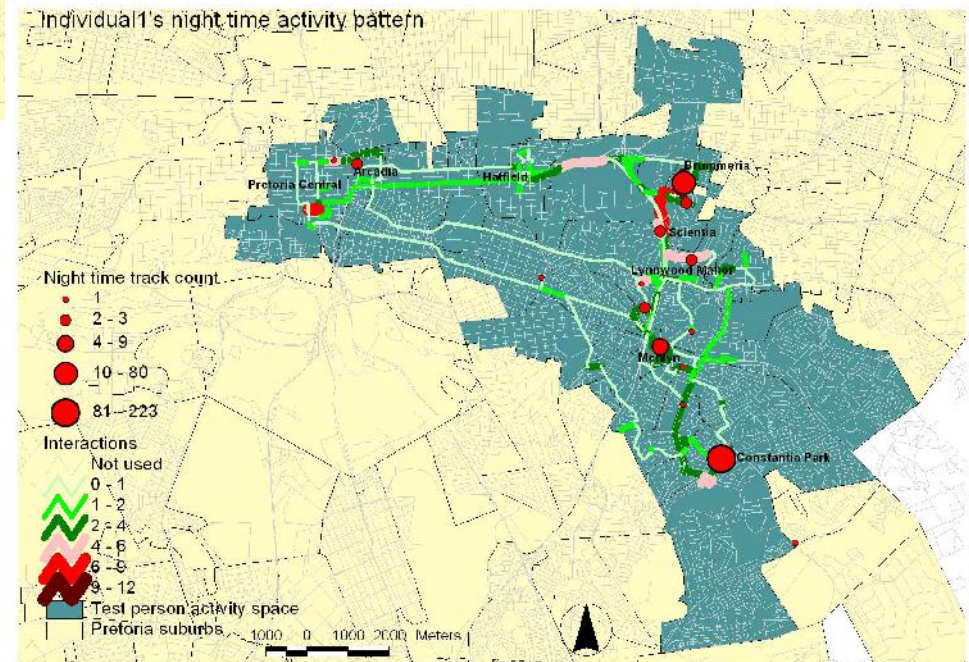
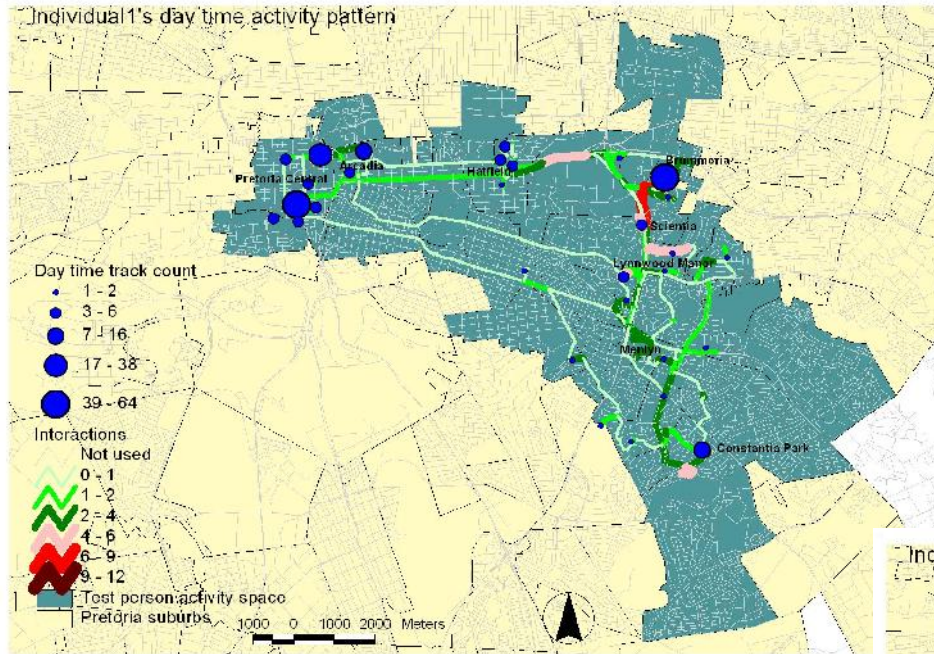
Land use/cover

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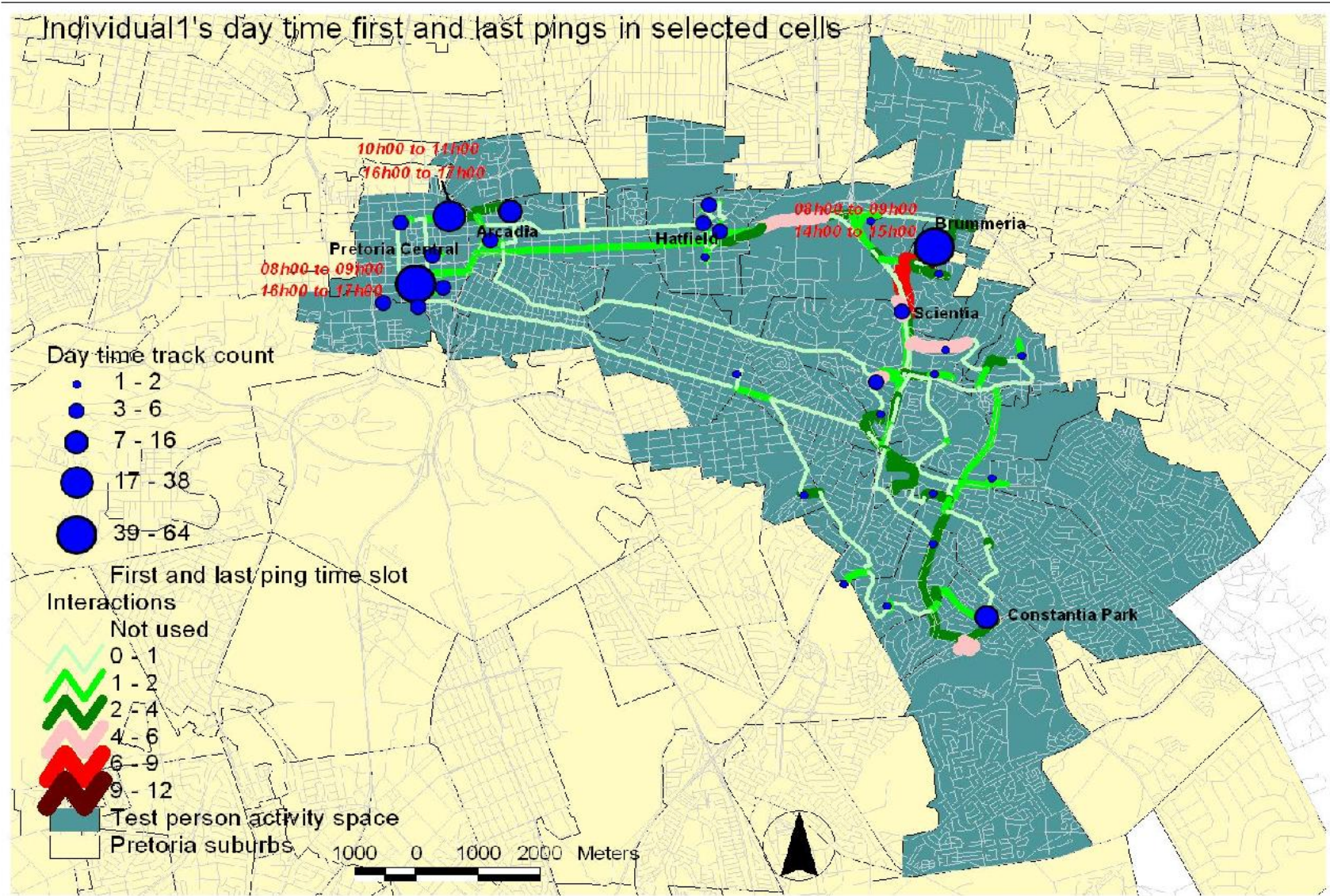
Diurnal pattern

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First and last pings

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Conclusions

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- Using call data records (CDR) and/or active tracking data it is possible to determine the activity space of an individual using cellular telephone data.
- The data alone is not sufficient and needs to be supported by local knowledge and gathered intelligence.
- SAPS indicates that it will drastically improve their targeted intelligence gathering based on the analysis done using CDR and/or results from the active tracking of the handset of a suspect.
- The analysis offers the investigating team an effective method to brief a new unacquainted investigating officer who joined the investigation with regards to the suspect's activity space, anchor points and the suspect's day/night activity.
- SAPS mentioned that the active tracking of a suspect can help the investigators to establish a finer detail on specific movements than what the CDR can provide.
- They will use the results of the CDR analysis to guide active tracking exercises.
- It is strongly recommended that the above should not be used for prosecution purposes, but only for assisting in solving a criminal case.

Acknowledgements

- CSIR for funding this research through its Strategic Research Panel, project number PPTH/2005/036, "GenDySI (Generation and Harnessing of Dynamic Spatial Intelligence)".
- The CSIR employee for the permission to use the 5 minute interval tracking data for this project.
- The National Prosecuting Authority of South Africa to use the suspects' data.
- The cellular service providers MTN and Vodacom for providing the necessary data to do the study.
- Capt Dreyden from the South African Police Services for input on the Cape Town suspects.

Thank you!



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