



# Is neo-cadastral surveying on your smartphone feasible?

Never Stand Still

Faculty of Engineering

School of Civil & Environmental Engineering

**Craig Roberts**  
**UNSW**

**Paul Davis-Raiss, David Lofberg, Greg Goodman**  
**LandTeam**

## 20<sup>th</sup> Century Jobs that are 'no more'

Switchboard Operator  
Typist  
Toll Booth Collector  
Book Binder



*Cartographer?*  
*Cadastral Surveyor?*



Van der Vlugt, 2012

## Cadastral Surveying

- The fundamental role of the professional cadastral surveyor is to re-establish a property boundary as per the intent of the original surveyor or a recent modern survey.



## Monuments over measurements



## Digital Cadastral Database (DCDB)

- In NSW, the DCDB was developed from Land and Property Information (LPI) paper maps and plans and is constantly updated based on registration of land transactions in NSW, as well as changes in administrative boundaries.
- The DCDB has differing accuracy depending on the origins of the data.
- It has no legal status and is simply a geographical representation of the tenure.



## Neo-Cadastral ?

- Term coined from “neo-geography” which refers to geography performed by non-experts using modern tools (Wikipedia, 2012).

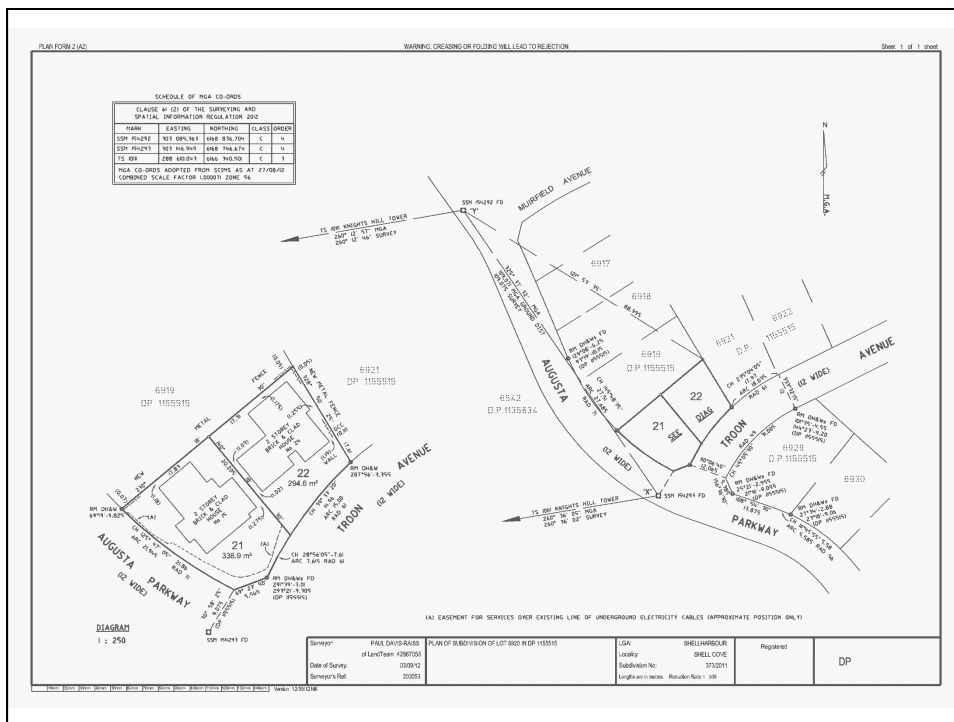
## Is neo-cadastral surveying on your smartphone feasible?

Let's find out with a case study

## Case Study: Augusta Parkway

- A small 2-lot subdivision in Shell Cove, Shellharbour, a metropolitan location, was chosen as a suitable case study.
- An iPhone 4 using the OS5 operating system was used throughout this project. It should be noted that this is actually a GNSS\*\* (Global Navigation Satellite System) enabled smart phone, as it uses a chip which tracks both GPS and the Russian GLONASS signals.

\*\*GNSS is an umbrella term comprising all modern satellite positioning methodologies.

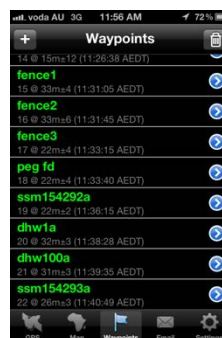
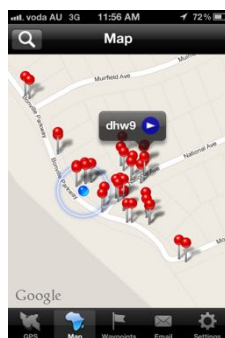


## Office Preparation

- ✓ Search the original plan and previous modern surveys that have defined the boundaries of the subject parcel.
  - Plans are called Deposited Plans or DPs and comprise a unique number, plan dimensions with connections to survey marks, some notes regarding the subject property and signature of the Registered Surveyor who takes responsibility for the legal definition of these boundaries.
- ✗ Search using the Spatial Information Exchange (SIX) Portal.
- ✓ Conduct a Cadastral Record Enquiry (CRE) report.
- ✗ Search for information about survey marks using the Survey Control Information Management System (SCIMS)
- ✓ The Certificate of Title (CT) for the land can be ordered within SIX.
- ? Often a boundary "model" is created in the office before visiting the field.
- ✓ Conduct a "dial before you dig" search
- ✓ Use Google Earth, Street View or SIX to indicate the terrain, the tree cover, vehicular access

## Office Preparation

- Various applications (Apps) were investigated that could be of some assistance in the field. "GPS Receiver" was chosen as it displays UTM grid coordinates in the field and overlays saved points onto a background map.



Marks that are measured in the field can be saved as waypoints and emailed as a text list, excel file or kml file to display on Google Earth. Also can be used upload coordinates of marks to assist location in the field.

## Fieldwork

- How is the mobile phone coverage in the area?
- Double occupations on all marks, as per the Surveyor Generals Directions # 9 are required
- SSMs, RMs (mainly drill hole and wings) as well as boundary occupation. Improvements or new building within 1m of the boundary, services, utilities, rights of way which may require easements.
- Boundary must be pegged at end of survey.
- After completing the survey fieldwork all calculations are performed in the office(usually using a CAD software) to confirm that the field work accords with the original survey plan and define the boundary.
- The GPS coordinates were therefore compared with the MGA coordinates derived from the previous conventional survey.



## Results

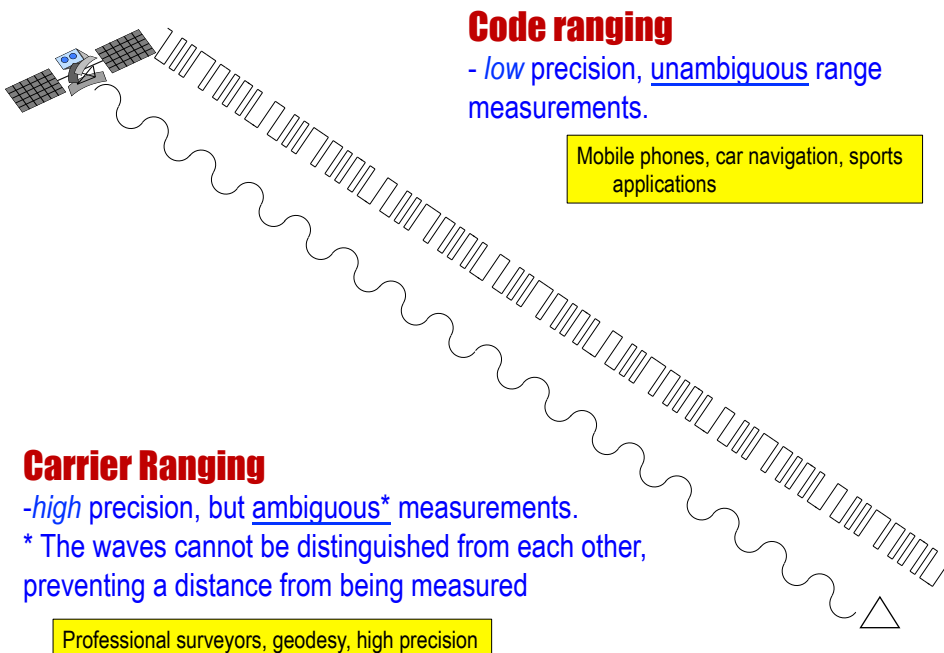
Point	H error (m)	East Diff (m)	North Diff (m)	East PDR (m)	North PDR (m)	Vector error (m)
ssm154292	5	-4	4	303085.363	6168836.704	8.501
dhw1	5	0	-2	303108.29	6168790.587	6.452
dhw100	5	0	-2	303124.693	6168763.774	5.235
ssm154293	5	1	6	303146.949	6168746.674	2.796
dhw3	5	3	0	303167.007	6168738.888	4.580
dhw4	5	0	1	303169.023	6168744.655	4.891
dhw5	5	1	2	303185.017	6168732.438	6.396
dhw6	5	-1	6	303187.268	6168738.211	7.015
dhw7	5	-3	2	303165.371	6168752.728	6.332
dhw8	5	-2	2	303159.622	6168755.306	1.736
dhw101	5	-1	-4	303173.228	6168773.582	2.525
dhw9	5	0	-4	303185.653	6168775.073	3.279
dhw10	5	0	-1	303184.76	6168781.636	6.122
ssm154294	10	6	-3	303219.823	6168706.913	1.869
fence1	5	14	-10	303167.56	6168778.494	5.641
fence2	10	-1	-10	303160.858	6168789.685	2.951
fence3	5	-5	0	303134.561	6168767.713	4.389
peg fd	5	-5	-2	303133.884	6168767.242	4.091

## **Regulations**

- The Board of Surveying and Spatial Information is constituted under the Surveying and Spatial Information Act, 2002 to provide for the registration of land and mining surveyors, to regulate the making of surveys and to advise the Minister on spatial information.
- “A surveyor must not use any equipment in making a survey unless the surveyor knows the accuracy obtained by its use.”
- “When making a survey using GNSS equipment, a surveyor must use an approved technique that provides appropriate accuracy for the type of survey being undertaken.” – Double occupation
- “In making a survey, a surveyor must measure all lengths to an accuracy of 10mm + 50 parts per million or better at a confidence interval of 95%.”

The current smart phone GNSS accuracy is of the order of 5 metres which far exceeds this limit. Indeed high precision, survey grade GNSS devices also exceed this regulation over short distances.

**Let' s focus on GPS/GNSS...**



**Code ranging**  
 - low precision, unambiguous range measurements.

Mobile phones, car navigation, sports applications

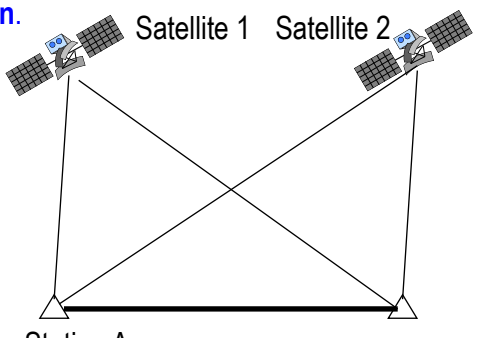
**Carrier Ranging**  
 -high precision, but ambiguous\* measurements.  
 \* The waves cannot be distinguished from each other, preventing a distance from being measured

Professional surveyors, geodesy, high precision  
 – requires differential techniques

(Courtesy A Jones)

**Differential GPS/GNSS**

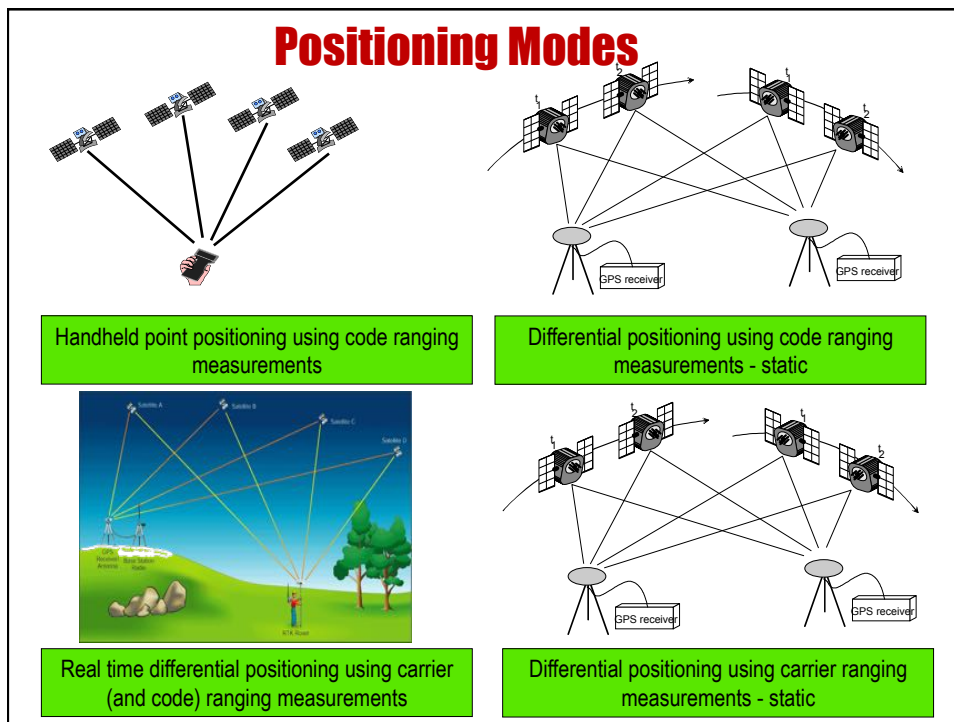
- Two or more receivers observe the same constellation of satellites simultaneously.
- Various system errors can be cancelled.
- The ambiguous number of integer carrier wavelengths can be estimated (“counted”).
- This process is called **Ambiguity Resolution**, or **Initialisation**.



Station A      Station B      Satellite 1      Satellite 2

Courtesy A Jones





## Current GPS/GNSS positioning in mobile phones

- Does point positioning, code ranging at present ~5m precision.
  - **Multipath is a large error source**
- Does not include correlators to enable carrier ranging.
  - **Would use lots of extra power**
- Does not have ability to combine GNSS signals from other receivers (maybe CORS base stations) to enable differential positioning.
- Does not have the computing power for initialisation.
- Does not have the battery power for initialisation.
- Antenna is low quality and limited.
  - **Difficulty with multi-GNSS signals**
- Only single frequency devices.
  - **Cannot mitigate ionospheric biases**

## Modern GPS/GNSS positioning modes

Method	Code	Carrier	Approx. Precision	Application
Point positioning	✓	✗	5 m	Smart phone, car navigation
Differential GPS	✓	✗	Sub-metre	Precision Agriculture, GIS
RTK	✓	✓	10-20 mm (hori)	Machine control, topographic surveying
SBAS	✓	✓	50 – 1000 mm	Precision Ag, GIS, etc
NRTK	✓	✓	10-20 mm (hori)	Machine control, precision Ag
Static	✓	✓	5 – 10 mm (hori)	High precision control surveys
PPP static	✓	✓	10 -20mm (hori)	Survey control in remote locations
PPP real time*	✓	✓	Decimetre level	Precision Agriculture

\* Still in research. Initialisation time is around 40 mins.

## Future GPS/GNSS positioning in mobile phones

- Smart phones are internet devices. What opportunities are there for SBAS, CORS, RT-IGS products to improve positioning accuracy?
- Chipping rate on the new Galileo E5 signal is 10 times finer than GPS codes leading to higher precision positioning.
  - Added power consumption an issue
- Faster processor to cope with AR or future RT-PPP
  - Computational load to be performed "in the cloud" to reduce power consumption
- Centring error at regulation requirements would need to be designed into mobile devices

The X90-OPUS is a one-button, dual-frequency GPS receiver that is specifically designed to use the National Geodetic Survey's free online OPUS post-processing service to achieve centimeter-level GPS positioning anywhere in the United States and surrounding countries.



Cost US\$2,450, including all software and accessories (except for tripod/tribrach)

<http://www.gpsworld.com/a-new-standard-for-l1l2-gps-static-receivers/>

## Concluding remarks

- From an accuracy perspective, current smart phones are nowhere near suitable for boundary determination purposes.
  - Survey regulations preclude the use of high precision GNSS over short distances.
- Internet connectivity can be a real timer saver.
- Cameras are great for documenting evidence.
- “Does accuracy equal quality?”\*
- “If clients can get less accurate data quickly, is this enough?”\*
- Property mortgage insurance is becoming increasingly used over a traditional identification survey.

Is Neo-Cadastral Surveying on your Smart Phone Feasible?

Not yet, but watch this space.

\*Basiouka & Potsiou(2012), Dasgupta (2012) & Van der Vlugt (2012)