



Multi-Constellation RTK GNSS Cadastral Test

Bruce Robinson 25/07/2018

Introduction

Goal: To speed up the process of the Cadastral GNSS survey.

Current Practice: To Visit the mark TWICE with an minimum of 1hour between fix's. The second visit is to obtain an independent fix by having different SVs in a different constellation.

Test Process: Visit the mark ONCE. Use the 4 constellations in 2 pairs to obtain 2 fixes (1 fix per pair). Test reliability of the results and their independence.

Advantage of Test Process: Shows savings of approximately 50% of the field capture time as only one visit per mark required. No loss of accuracy and independence maintained

Equipment

Leica Gs16 antenna SN:3702897 with Leica Cs20
Controller running fw 3.20
Date of Survey – 25/07/2018
Surveyed by Bruce Robinson

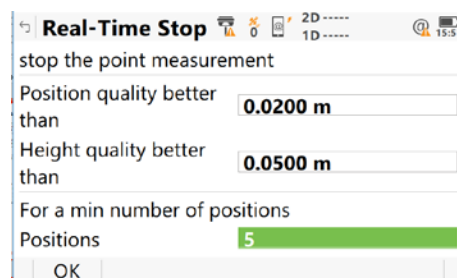
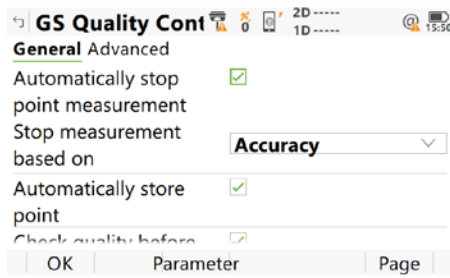




Quality Control and RTK Corrections

The Quality Control setting were set on the controller to automatically store results after 5 epochs, if the quality was better than 0.02 horizontally, as per the images below.

Internet based corrections used. Mountpoint was the Base station GSAL using single site RTCM corrections.



Observation Procedure

Each Point was occupied first using GPS & BeiDou the pole was then rotated approx. 180 degrees. The point was then reoccupied with a different point number using Glonass & Galileo.

After placing the pole on the Survey mark the measurements were NOT triggered until after a second SmartCheck indication was shown on the controller screen.

The Pole was only manually held vertical over the point (No bracing), using the pole bubble as the level indicator

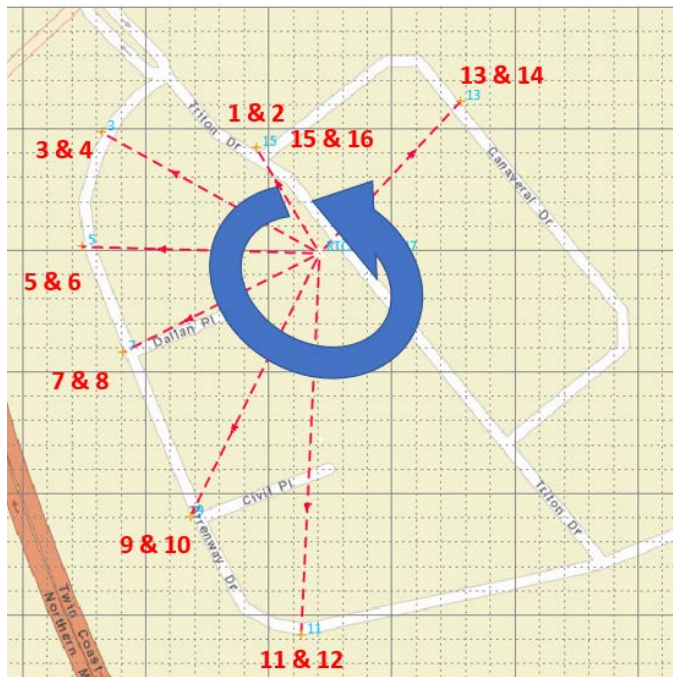
After each pair of observations on a point a COGO inverse was performed to check that the points were close to each other.

The starting pair of occupations (1 & 2) were repeated at the end (with new point numbers 15 & 16)



Plan of Surveyed Points

Points surveyed in numerical order
ODD numbers are GPS & BeiDou
EVEN numbers Glonass & Galileo





Raw Observation Results



Points report

Point ID ^v	Date/Time ^v	Easting ^v	Northing ^v	O.hgt ^v	E.hgt ^v	Class ^v	SubClass ^v
RTCM-Ref 0047	2018-07-25 10:28:48.78	396341.287	815395.006	53.722	88.258	REF	positionAndHeight
1	2018-07-25 10:29:30.42	396289.795	815484.040	39.322	73.860	MEAS	GPS phase
2	2018-07-25 10:30:28.56	396289.792	815484.044	39.310	73.848	MEAS	GPS phase
3	2018-07-25 10:36:52.32	396163.936	815496.954	38.694	73.231	MEAS	GPS phase
4	2018-07-25 10:37:41.61	396163.921	815496.939	38.665	73.201	MEAS	GPS phase
5	2018-07-25 10:39:54.45	396148.117	815401.920	44.014	78.547	MEAS	GPS phase
6	2018-07-25 10:40:36.54	396148.105	815401.914	43.991	78.524	MEAS	GPS phase
7	2018-07-25 10:42:32.65	396180.925	815314.009	49.424	83.955	MEAS	GPS phase
8	2018-07-25 10:43:18.45	396180.914	815313.998	49.405	83.936	MEAS	GPS phase
9	2018-07-25 10:45:51.46	396235.960	815177.455	56.239	90.766	MEAS	GPS phase
10	2018-07-25 10:46:35.44	396235.949	815177.450	56.230	90.758	MEAS	GPS phase
11	2018-07-25 10:49:39.50	396326.292	815080.866	54.302	88.827	MEAS	GPS phase
12	2018-07-25 10:50:50.42	396326.284	815080.857	54.295	88.820	MEAS	GPS phase
13	2018-07-25 11:01:44.52	396455.297	815520.513	46.566	81.108	MEAS	GPS phase
14	2018-07-25 11:02:36.48	396455.305	815520.515	46.541	81.083	MEAS	GPS phase
15	2018-07-25 11:05:52.72	396289.804	815484.041	39.323	73.861	MEAS	GPS phase
16	2018-07-25 11:06:41.46	396289.794	815484.049	39.323	73.861	MEAS	GPS phase

Time at Each Mark

On average the time between the auto storing of the first occupation, rotating the pole, dropping the current satellite pair, reacquiring the second pair ,initializing, SmartCheck (check initialization), manually triggering the occupation, obtaining 5 epochs and auto storing the 2nd set of data was LESS than 1 minute

Conclusion 1

The time taken to drop the 1st pair and reacquire the 2nd pair of satellites is not significant in terms of the survey time and far more efficient than having to do a repeat visit at a later time



Vector Pair Comparison, from raw Observations

GNSS Vector Report for Job name : 180725 GNSS CADT using Coordinate System : Mt Eden 2000										
NOTE : Azimuth does NOT apply the rotation (if any) from a 2step calculation										
NOTE : Stylesheet supplied with no warranty - please independently check your results										
Survey : 1										
Minimum Vector Distance reported upon : 1.000m										
Maximum Vector Distance reported upon : 35000.000m										
Rounding Bt	35000	5000	1000	200	100	50	10			
Rounding in	0.01	0.1	1	5	10	30	60			
From Name	From Code	Observation Date/Time	Class	To Name	To Code	Observation Date/Time	Class	Diff. in Observ	Az DD.MMSS	Ellips. Distance
1		25/07/2018 10:29	measured	3		25/07/2018 10:36	measured	0.1227 hrs	275.513	126.533
2		25/07/2018 10:30	measured	4		25/07/2018 10:37	measured	0.1203 hrs	275.5055	126.543
									35"	-0.01
3		25/07/2018 10:36	measured	5		25/07/2018 10:39	measured	0.0506 hrs	189.27	96.351
4		25/07/2018 10:37	measured	6		25/07/2018 10:40	measured	0.0486 hrs	189.27	96.342
									0"	0.009
5		25/07/2018 10:39	measured	7		25/07/2018 10:42	measured	0.0439 hrs	159.321	93.842
6		25/07/2018 10:40	measured	8		25/07/2018 10:43	measured	0.0450 hrs	159.321	93.847
									0"	-0.005
7		25/07/2018 10:42	measured	9		25/07/2018 10:45	measured	0.0552 hrs	158.0255	147.242
8		25/07/2018 10:43	measured	10		25/07/2018 10:46	measured	0.0547 hrs	158.0255	147.237
									0"	0.005
9		25/07/2018 10:45	measured	11		25/07/2018 10:49	measured	0.0633 hrs	136.55	132.26
10		25/07/2018 10:46	measured	12		25/07/2018 10:50	measured	0.0708 hrs	136.5505	132.266
									5"	-0.006
11		25/07/2018 10:49	measured	13		25/07/2018 11:01	measured	0.2014 hrs	16.2112	458.229
12		25/07/2018 10:50	measured	14		25/07/2018 11:02	measured	0.1961 hrs	16.2117	458.244
									5"	-0.015
13		25/07/2018 11:01	measured	15		25/07/2018 11:05	measured	0.0689 hrs	257.3415	169.482
14		25/07/2018 11:02	measured	16		25/07/2018 11:06	measured	0.0680 hrs	257.343	169.497
									15"	-0.015

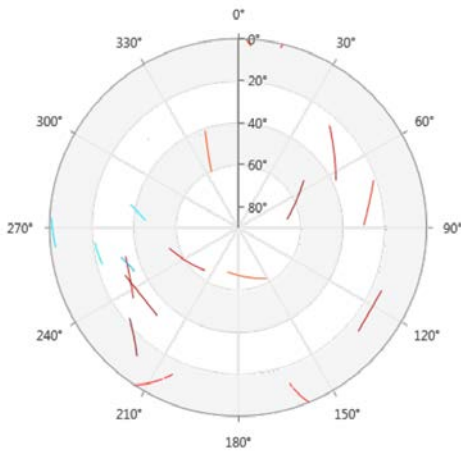
Conclusion 2

The vector pairs are in very good agreement and therefore no degradation in the quality of the survey within terms of the GNSS error

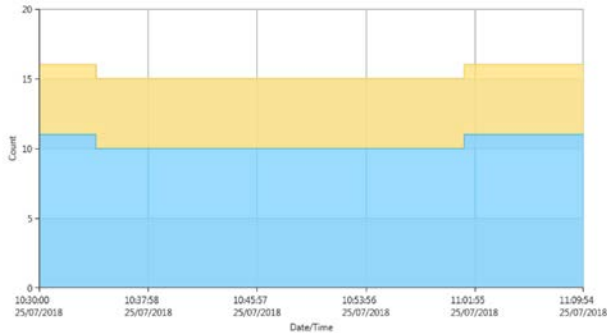
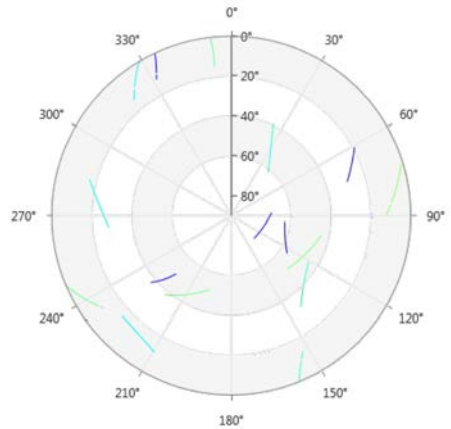


Sat Availability

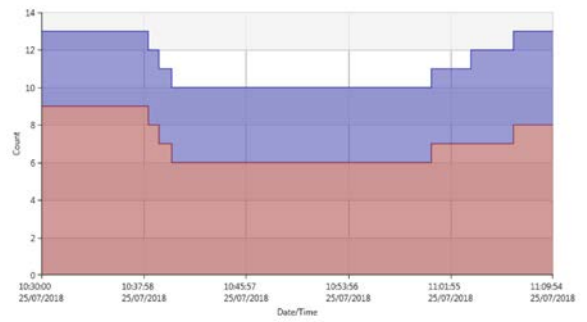
GPS & BeiDou



Glonass & Galileo



GPS GLONASS BeiDou Galileo QZSS



GPS GLONASS BeiDou Galileo QZSS

Constellation Independence

Point ID ▲▼	REF ▲▼	# Pos. ▲▼	Ant Ht. ▲▼	G ▲▼	R ▲▼	C ▲▼	E ▲▼	CQ Pos ▲▼	CQ Ht ▲▼	Mountpt ▲▼
RTCM-Ref 0047			0.000					--	--	
1	RTCM-Ref 0047	5	2.000	10	0	5	0	0.006	0.008	GSALsingleADV4
2	RTCM-Ref 0047	5	2.000	0	8	0	5	0.006	0.014	GSALsingleADV4
3	RTCM-Ref 0047	5	2.000	10	0	6	0	0.016	0.018	GSALsingleADV4
4	RTCM-Ref 0047	5	2.000	0	9	0	5	0.007	0.015	GSALsingleADV4
5	RTCM-Ref 0047	5	2.000	9	0	6	0	0.007	0.010	GSALsingleADV4
6	RTCM-Ref 0047	5	2.000	0	5	0	5	0.006	0.015	GSALsingleADV4
7	RTCM-Ref 0047	5	2.000	9	0	4	0	0.009	0.012	GSALsingleADV4
8	RTCM-Ref 0047	5	2.000	0	6	0	4	0.007	0.017	GSALsingleADV4
9	RTCM-Ref 0047	5	2.000	10	0	5	0	0.006	0.008	GSALsingleADV4
10	RTCM-Ref 0047	5	2.000	0	6	0	5	0.006	0.013	GSALsingleADV4
11	RTCM-Ref 0047	5	2.000	10	0	6	0	0.007	0.010	GSALsingleADV4
12	RTCM-Ref 0047	5	2.000	0	5	0	5	0.006	0.014	GSALsingleADV4
13	RTCM-Ref 0047	5	2.000	11	0	6	0	0.007	0.010	GSALsingleADV4
14	RTCM-Ref 0047	5	2.000	0	7	0	5	0.007	0.012	GSALsingleADV4
15	RTCM-Ref 0047	5	2.000	11	0	6	0	0.006	0.008	GSALsingleADV4
16	RTCM-Ref 0047	5	2.000	0	6	0	5	0.007	0.011	GSALsingleADV4

Elevation													
80-90													
70-80		1	1	1									
60-70	1	1	1		1	1	1						
50-60	1	1	1	1		1	1	1				1	
40-60	1	1		1	2		1	2		1			2
30-40	1	1						2+2	3	1			
20-30	1	1+1		1				1	1+1	1	1		
10-20		1	1	1	1+1	1	1	2+1		1	1	1	
	0-30	30-60	60-90	90-120	120-150	150-180	180-210	210-240	240-270	270-300	300-330	330-360	Azimuth
		SV per sector during Total observation period											
		GPS & BeiDou											
		Glonass & Galileo											
		Both GPS & BeiDou, &, Glonass & Galileo											

See Diagram above The sky was broken up into 96 blocks, 8 vertical blocks (10°) and 12 horizontal blocks (30°). If a satellite was in any block at ANY stage during the survey the block was counted. Count comes from predicated not observed. From the blocks above visually it can be seen that there was very little commonality (yellow) in the constellation pairs (approx. only 11% by blocks).

Conclusion 3

The pairs provided different satellite constellations and different geometry giving the same effect as having to do repeat visits.

The 2nd (Glonass Galileo) fix enabled the Real time verification of the 1st pair (GPS BeiDou) fix by the use of COGO