COMPARATIVE ANALYSIS OF SHORT, MEDIUM AND LONG BASELINE PROCESSING IN THE PRECISION OF GNSS POSITIONING

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Outline

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Introduction

➢ The fundamental technique of GPS is to measure the ranges between the receiver and a few simultaneously observed satellites to unknown positions on land and sea, as well as in air and space.

➢ Other satellite constellations beside the GPS have been developed such as GLONASS, Galileo, BeiDuo/COMPASS and QZSS. These have given rise to GNSS.

➢ There has been a paradigm shift from Passive base station to Active CORS

➢ In DGNSS positioning, the increase in the baseline between the Base station and the rover affects the accuracy of the determined position.
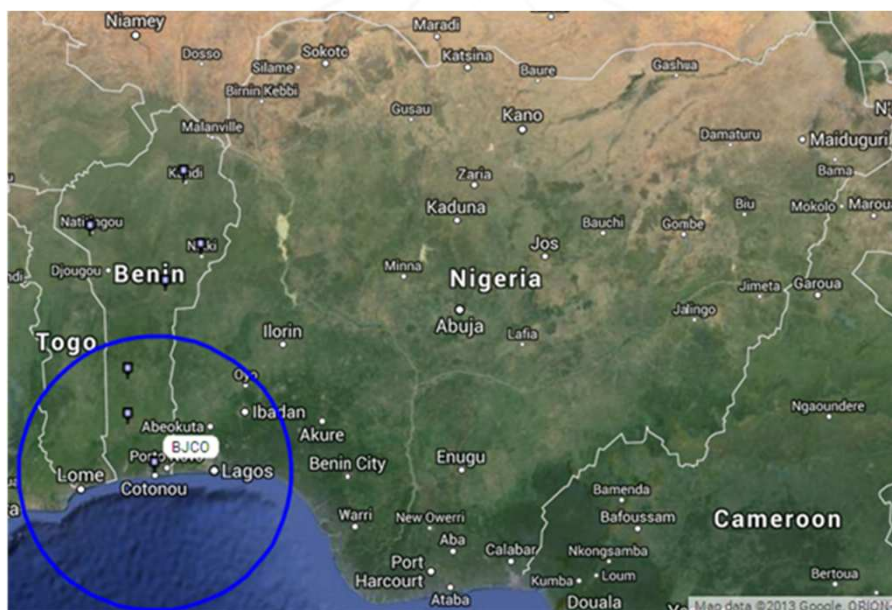
Objectives

i.   To carry out differential positioning on some selected controls within Lagos with respect to classical base station and CORS stations defining various baselines.

ii. To statistically analyse the horizontal and vertical precision of the three baselines under study.

iii. To determine baseline variation effects on the positioning accuracy.

Scope and Limitation

➢ The research scope covers GNSS observations on 19 selected controls within University of Lagos

➢ The short baselines were defined by first order control XST347 with maximum distance 1.5km from the rover stations

➢ The Medium baselines were defined by LAG 01 CORS with maximum distance 12km from the rover stations.

➢ The long baselines were defined by BJCO CORS with maximum distance 107km from the rover stations.

Study Area

Selected Stations

19 stations Coordinates within University Lagos CORS and Benin CORS

LAG 01 (Author's research)

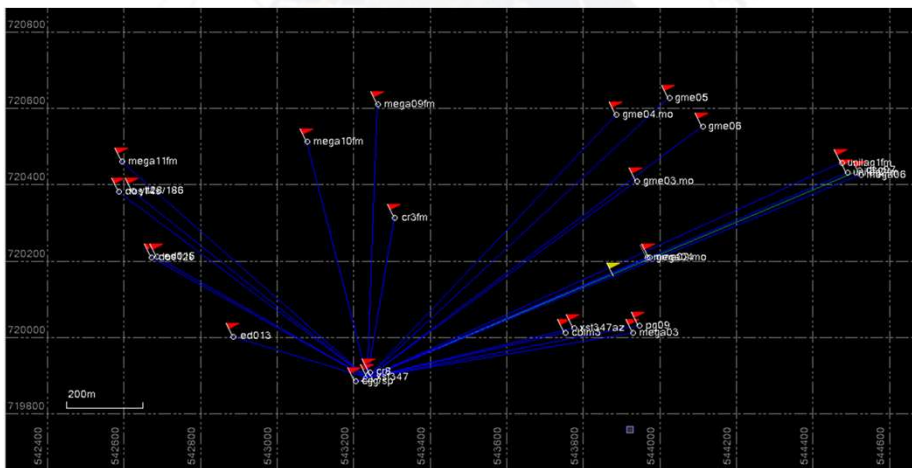| Stations	Eastings (m)	Northing (m)
Cr 8	543240.659	719908.825
Cblm 3	543750.878	720011.466
XST347az	543773.417	720023.868
Mega 03	543928.957	720011.221
PG 09	543944.031	720030.444
ED 013	542884.766	720001.874
ED 015	542684.951	720210.028
DOS 12S	542670.865	720209.530
DOS 14S	542584.668	720380.971
Ytt 28/186	542621.444	720382.246
Gme 02	543971.894	720208.622
Gme 03	543938.78	720408.336
Cr3 f	543306.243	720312.627
Mega 09	543261.651	720608.475
Mega 10	543077.216	720510.877
Mega 11	542592.889	720460.042
Mega 06	544435.929	720542.61
Unilag 1	544473.004	720456.463
Unilag 2	544488.197	720430.507
XST347	543235.430	719894.220
LAG01	539082.768	730769.148
BJCO	6333076.505	270973.252

BJCO (Source: IGS)

Data Collection

➢ The Trimble R5 GNSS Receiver was used to acquire satellite positional data using Fast Static survey style for all the selected stations

➢ The simultaneous observations of LAG 01 and BJCO CORS with respect to the Trimble R5 GNSS receiver at each station were collected for data processing.
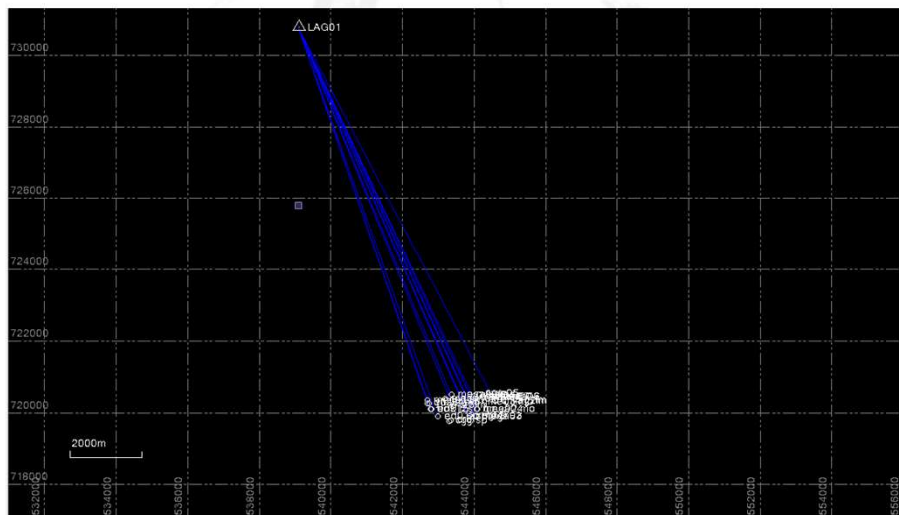
GNSS Data Processing

➤ The Trimble Business Center Advanced TBC was used in processing all the GNSS observation data for the short, medium and long baselines.
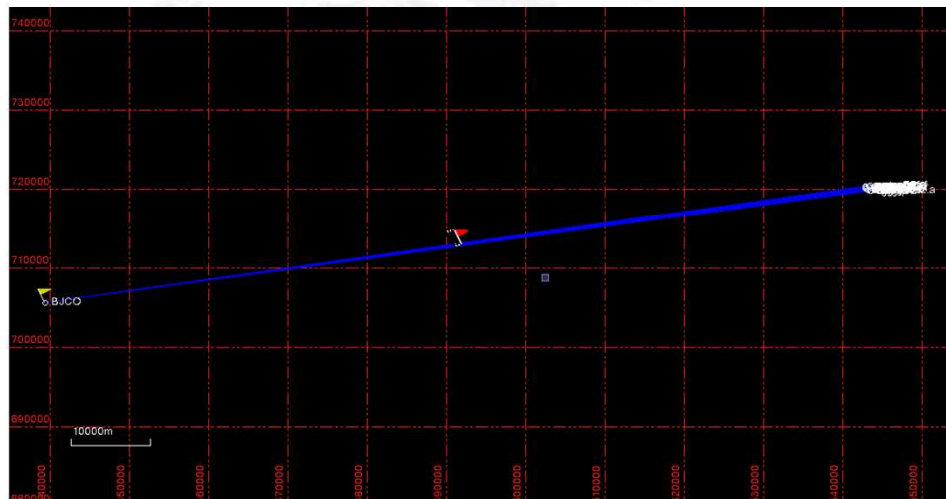

GNSS Short baselines

GNSS Medium Baselines

GNSS Long Baselines

GNSS Short Baselines Processing Results with Horizontal and Vertical Precision

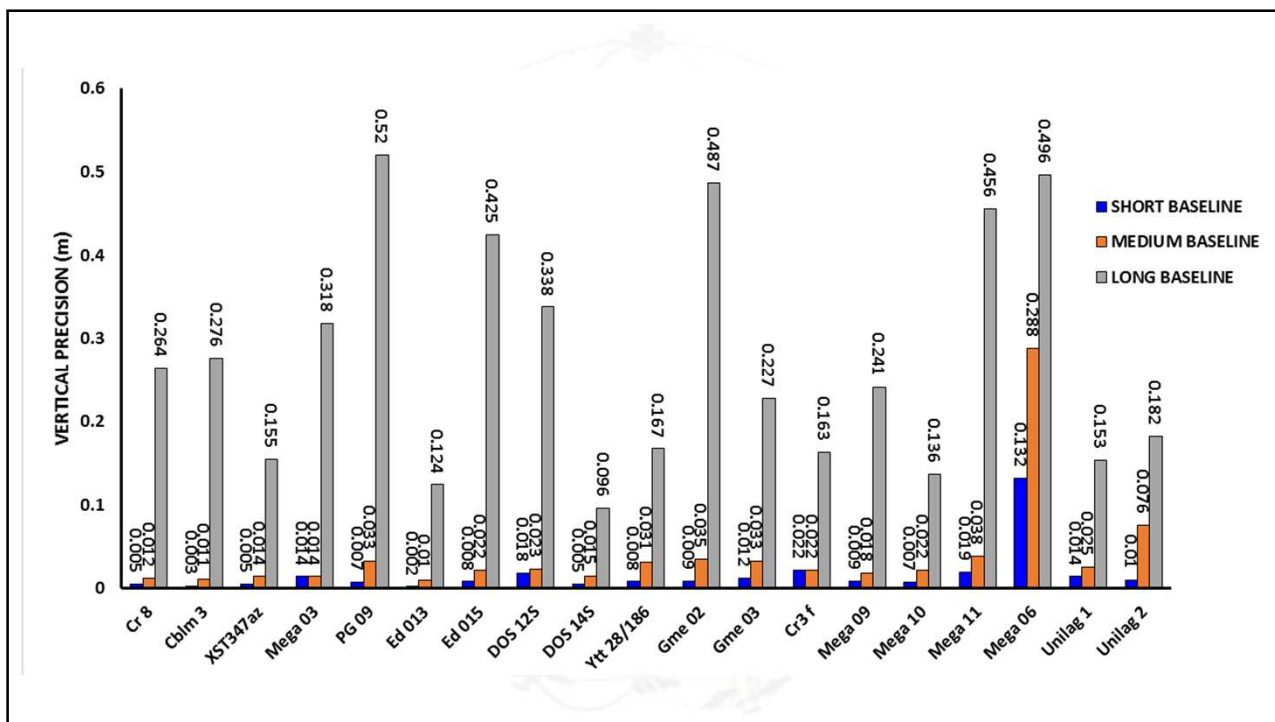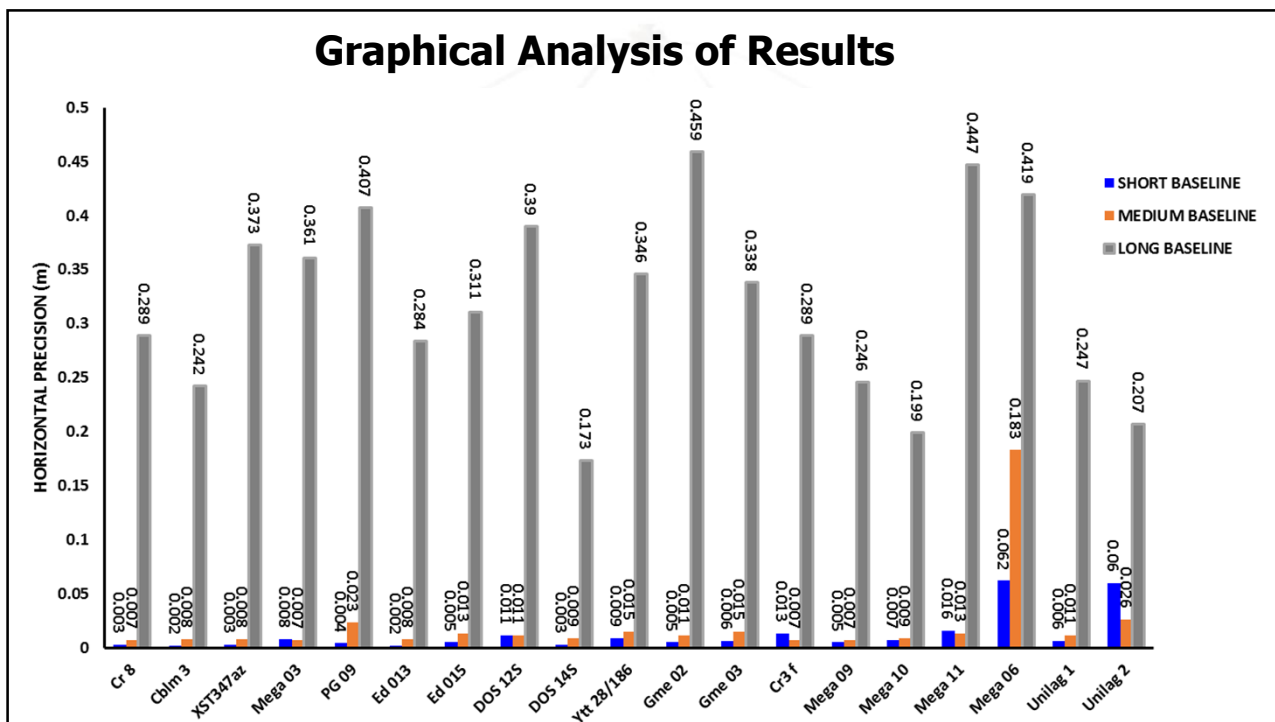| Stations	Easting (m)	Northing (m)	Height (m)	Horizontal Precision (m)	Vertical Precision (m)
Cr 8	543240.659	719908.825	6.247	0.003	0.005
Cblm 3	543750.878	720011.466	7.448	0.002	0.003
XST347az	543773.417	720023.868	8.157	0.003	0.005
Mega 03	543928.957	720011.221	9.848	0.008	0.014
PG 09	543944.031	720030.444	9.814	0.004	0.007
ED 013	542884.766	720001.874	7.855	0.002	0.002
ED 015	542684.951	720210.028	8.715	0.005	0.008
DOS 12S	542670.865	720209.530	8.622	0.011	0.018
DOS 14S	542584.668	720380.971	8.640	0.003	0.005
Ytt 28/186	542621.444	720382.246	8.847	0.009	0.008
Gme 02	543971.894	720208.622	8.076	0.005	0.009
Gme 03	543938.78	720408.336	8.306	0.006	0.012
Cr3 f	543306.243	720312.627	6.515	0.013	0.022
Mega 09	543261.651	720608.475	8.442	0.005	0.009
Mega 10	543077.216	720510.877	8.763	0.007	0.007
Mega 11	542592.889	720460.042	7.663	0.016	0.019
Mega 06	544435.929	720542.61	1.558	0.062	0.132
Unilag 1	544473.004	720456.463	3.962	0.006	0.014
Unilag 2	544488.197	720430.507	3.786	0.06	0.01

GNSS Medium Baselines Processing Results with Horizontal and Vertical Precision

Stations	Eastings (m)	Northing (m)	Height (m)	Horizontal Precision (m)	Vertical Precision (m)
Cr 8	543330.824	719790.447	6.569	0.007	0.012
Cblm 3	543841.038	719893.072	7.278	0.008	0.011
XST347az	543863.577	719905.477	7.983	0.008	0.014
Mega 03	544019.114	719892.834	9.667	0.007	0.014
PG 09	544034.197	719912.058	9.616	0.023	0.033
ED 013	542974.923	719883.486	7.862	0.008	0.01
ED 015	542775.055	720091.504	8.626	0.013	0.022
DOS 12S	542761.01	720091.148	8.619	0.011	0.023
DOS 14S	544062.056	720090.234	8.084	0.009	0.015
Ytt 28/186	542711.611	720263.866	8.63	0.015	0.031
Gme 02	544062.056	720090.234	8.084	0.011	0.035
Gme 03	544028.938	720289.958	8.31	0.015	0.033
Cr3 f	543396.388	720194.26	6.541	0.007	0.022
Mega 09	543351.809	720490.111	8.459	0.007	0.018
Mega 10	543167.367	720392.512	8.72	0.009	0.022
Mega 11	542683.089	720341.713	7.555	0.013	0.038
Mega 06	544526.948	720424.043	5.857	0.183	0.288
Unilag 1	544563.151	720338.086	3.886	0.011	0.025
Unilag 2	544578.369	720312.131	3.563	0.026	0.076

GNSS Long Baselines Processing Results with Horizontal and Vertical Precision

Stations	Eastings (m)	Northing (m)	Height (m)	Horizontal Precision (m)	Vertical Precision (m)
Cr 8	543329.842	719789.529	5.911	0.289	0.264
Cblm 3	543840.049	719892.159	6.487	0.242	0.276
XST347az	543862.474	719904.605	5.307	0.373	0.155
Mega 03	544018.315	719892.065	9.048	0.361	0.318
PG 09	544033.377	719911.232	9.315	0.407	0.52
ED 013	542973.912	719882.636	6.826	0.284	0.124
ED 015	542773.782	720090.569	8.358	0.311	0.425
DOS 12S	542759.58	720090.184	7.657	0.39	0.338
DOS 14S	542673.765	720261.667	7.698	0.173	0.096
Ytt 28/186	542710.519	720262.978	8.012	0.346	0.167
Gme 02	544061.121	720089.393	7.359	0.459	0.487
Gme 03	544027.785	720289.102	7.478	0.338	0.227
Cr3 f	543395.358	720193.368	3.864	0.289	0.163
Mega 09	543350.816	720489.253	7.762	0.246	0.241
Mega 10	543166.31	720391.624	8.065	0.199	0.136
Mega 11	542681.875	720340.629	7.192	0.447	0.456
Mega 06	544525.54	720423.329	2.161	0.419	0.496
Unilag 1	544562.093	720337.209	2.971	0.247	0.153
Unilag 2	544577.414	720311.303	2.835	0.207	0.182

Graphical Analysis of Results

Statistical Analysis Results

One Way ANOVA Result Summary

		Sum of Squares	df	Mean Square	F	P(<F)
Horizontal Precision (m)	Between Groups	1.147	2	.574	186.366	.000
	Within Groups	.166	54	.003		
	Total	1.314	56			
Vertical precision (m)	Between Groups	.780	2	.390	47.953	.000
	Within Groups	.439	54	.008		
	Total	1.218	56			

H_O: No differences between the means of the 3 groups
H_A: At least one of the means is not the same as other means   ($\alpha = 0.05$)

REJECT H_O at $\alpha = 0.05$
At least one of the means is not the same as other means

Scheffé Test Results

	SAMPLE TO SAMPLE		F	P(>F)	COMMENTS @ ($\alpha = 0.05$
Horizontal Precision (m)	Short Baseline	Medium baseline	0.11	0.90	
	Short Baseline	Long Baseline	143.65	0.00	Short Baseline Mean < Long Baseline Mean
	Medium Baseline	Long Baseline	135.78	0.00	Medium Baseline Mean < Long Baseline Mean
Vertical Precision (m)	Short Baseline	Medium baseline	0.30	0.74	
	Short Baseline	Long Baseline	39.11	0.00	Short Baseline Mean < Long Baseline Mean
	Medium Baseline	Long Baseline	32.52	0.00	Medium Baseline Mean < Long Baseline Mean

Key Points

- The horizontal and vertical precision is a measure of accuracy in determining the X, Y, Z position of the observed stations.
- The closer the precision value to zero the higher the accuracy of the differential GNSS positioning
- The results of the Scheffé test indicates that these is no significant difference in the results of the short and medium baseline but there is a significant difference in the results of the short and long baseline and the results of the medium and long baseline.

CONCLUSION

- The longer the baseline length the lower the attainable horizontal and vertical precision both for conventional base station and for CORS.

- The statistical tests indicate progressive error propagation in positional accuracy as the medium and short baseline results show no significant difference but they both statistically differ from the long baselines.

- The research justifies the importance of understanding the concept of baseline processing in GNSS positioning.

THANK YOU