

 **TS 3D – GNSS Reference Station**

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**Day vs. Night GPS Observations Performance
in Puerto Rico's RTK Network**


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Introduction

- Benefits of Positioning with an Island Wide Real Time Global Positioning System Network
 - Land planning
 - Economic planning
 - Political planning
 - Work schedule planning
- Used by different Positioning Professions and its Increasing
- Obtaining the maximum Benefits the Network System
- Identifying Today's existing Limitations

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Objectives

- Demonstrate accuracy differences by Day vs. Night Short Term GPS Observations (60 Sec.)
- Finding Different and Low Cost Methodologies for Positioning Practices
- Demonstrating the Needs, Importance and Accuracy of Ionosphere and Troposphere models for web-base RTK Services
- Obtaining Maximum Performance and Capabilities on GPS Network Equipment

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System Infrastructure

- GPS Receivers Spread Island Wide
 - Trimble NetRS
 - Leica 1200
 - Aztech
- Puerto Rico and US Virgin Island Coverage



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System Infrastructure

- Rinex data free of charge at www.vernixeng.com



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Methodology

- Selection of existing Bench Marks previously observed and published by NGS



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Methodology

- Observation during Day & Night Hours
 - Data Collection in a Short Time Span (60 sec.)



ARENAS 2 Control Point



MAGAS Control Point

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Methodology

- Using a Single Base RTK Solution



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Methodology

- Using a Network Imax Solution



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Methodology

- Monitoring Time for GIS and Survey Solution Qualities
- Compare Results obtained with Respect to Time and Accuracy



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Results

- Day vs. Night Observations analyzing Fixed Solution by Quantity using Single Base Solution

Distance	Analysis	Day		Night		
		GIS Quality	Survey Quality	GIS Quality	Survey Quality	
Less than 30 KM	Count	11.00	11.00	36% Less	7.00	Fix Solution
	Average	5.82	42.00	5.22	19.14	Delay (Sec)
30 to 60 KM	Count	15.00	9.00	36% More	14.00	Fix Solution
	Average	5.00	61.22	5.80	37.07	Delay (Sec)
60 to 90 KM	Count	9.00	3.00	67% More	9.00	Fix Solution
	Average	4.00	142.00	4.18	92.67	Delay (Sec)
90 to 150 KM	Count	9.00	4.00	50% More	8.00	Fix Solution
	Average	4.44	106.25	5.13	108.50	Delay (Sec)

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Results

- Day vs. Night Observations analyzing by delay for a Fixed Solution using Single Base Solution

Distance	Analysis	Day		Night		
		GIS Quality	Survey Quality	GIS Quality	Survey Quality	
Less than 30 KM	Count	11.00	11.00	9.00	7.00	Fix Solution
	Average	5.82	42.00	55% Less	19.14	Delay (Sec)
30 to 60 KM	Count	15.00	9.00	15.00	14.00	Fix Solution
	Average	5.00	61.22	39% Less	37.07	Delay (Sec)
60 to 90 KM	Count	9.00	3.00	11.00	9.00	Fix Solution
	Average	4.00	142.00	35% Less	92.67	Delay (Sec)
90 to 150 KM	Count	9.00	4.00	8.00	8.00	Fix Solution
	Average	4.44	106.25	2% More	108.50	Delay (Sec)

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Results

- Day vs. Night Observations analyzing Fixed Solution by Quantity using Imax Network Solution

Distance	Analysis	Day		Night		
		GIS Quality	Survey Quality	GIS Quality	Survey Quality	
Less than 15 KM	Count	3	3	Same	3	Fix Solution
	Average	14.00	26.67	11.67	19.00	Delay (Sec)
15 to 30 KM	Count	5	5	Same	5	Fix Solution
	Average	5.20	58.40	10.20	18.40	Delay (Sec)
30 to 45 KM	Count	2	1	50% More	2	Fix Solution
	Average	2.20	4.80	1.80	9.40	Delay (Sec)
45 to 60 KM	Count	2	2	Same	2	Fix Solution
	Average	1.20	39.40	0.80	4.60	Delay (Sec)

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Results

- Day vs. Night Observations analyzing Fixed Solution by Delay using Imax Network Solution

Distance	Analysis	Day		Night		
		GIS Quality	Survey Quality	GIS Quality	Survey Quality	
Less than 15 KM	Count	3.00	3.00	3.00	3.00	Fix Solution
	Average	14.00	26.67	29% Less	19.00	Delay (Sec)
15 to 30 KM	Count	5.00	5.00	5.00	5.00	Fix Solution
	Average	5.20	58.40	69% Less	18.40	Delay (Sec)
30 to 45 KM	Count	2.00	1.00	2.00	2.00	Fix Solution
	Average	2.20	4.80	49% More	9.40	Delay (Sec)
45 to 60 KM	Count	2.00	2.00	2.00	2.00	Fix Solution
	Average	1.20	39.40	88% Less	4.60	Delay (Sec)

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Results

- Data Retrieved After Observations at NGS Point F-1004

NGS Published Measurements				
Northing	Easting	Elev	Ellip. Elev.	GH
268,639.866	169,895.721	6.074	-37.583	-43.980

Base	RT Data (sec)		Day Observations				Analysis				
	GIS	Survey	Baseline	Northing	Easting	Elev.	Ellip. Elev.	Δ N	Δ E	Δ E	Δ Ellip.
PRMG	6	NA	33,802.254	268,639.728	169,895.863	6.363	-37.613	0.138	-0.144	-0.289	0.030
PRMI	4	NA	63,665.462	268,639.939	169,895.938	6.210	-37.766	-0.073	-0.217	-0.136	0.183
PRVE	5	18	30,422.836	268,639.969	169,895.723	6.470	-37.506	-0.103	-0.002	-0.396	-0.077
PRCG	4	NA	75,856.603	268,639.876	169,895.374	6.835	-37.140	-0.010	0.347	-0.761	-0.443
NET	3	47	Net Adj.	268,639.893	169,895.729	6.379	-37.597	-0.027	-0.008	-0.305	0.014

Base	RT Data (sec)		Night Observations				Analysis				
	GIS	Survey	Baseline	Northing	Easting	Elev.	Ellip. Elev.	Δ N	Δ E	Δ E	Δ Ellip.
PRMG	4	12	33,802.244	268,639.884	169,895.743	6.369	-37.606	-0.018	-0.027	0.023	0.023
PRMI	2	113	63,665.270	268,639.864	169,895.701	6.302	-37.674	0.002	0.020	0.091	0.091
PRVE	2	13	30,422.746	268,639.880	169,895.737	6.359	-37.616	-0.014	-0.016	0.033	0.033
PRCG	2	NA	75,856.338	268,639.908	169,895.663	6.489	-37.487	-0.041	0.056	-0.096	-0.096
NET	2	7	Net Adj.	268,639.883	169,895.733	6.357	-37.619	-0.017	-0.014	0.036	0.036

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Analysis - Single Base Solution

- Time Delays for GIS Quality results during Day and Night Hours are practically Similar
- Fixed Solutions for Survey Quality Data are averaging 59% more effective during Night Hours
- Time Delay for achieving Survey Quality results is averaging 31% more effective during Night Hours
- Accuracy using Single Base Solutions varies between 2-10 centimeters during Day Hours on Long Distances
- Accuracy using Single Base Solutions maintains an overall consistency under 2.5 centimeters in position and under 10 centimeters in elevation during Night Hours on Long Distances

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Analysis – *Imax Network Solution*

- Time Delays for GIS Quality results during Day and Night Hours are practically Similar
- Fixed Solutions for Survey Quality Data during Day and Night Hours are practically Similar also
- Time Delays for achieving Survey Quality results is averaging 34% more effective during Night Hours
- Accuracy using Network Solutions maintains an overall Consistency under 2.5 Centimeters in Position and under 3.5 Centimeters in Elevation

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Conclusion

- Night GPS Observations are an excellent source of obtaining Accurate Data with fewer Reference Stations
- The ability to achieve greater Distances during Night Hours for Baselines although time to Fix increases a bit
- Dominant Error Sources such as Ionospheric and Tropospheric Delays don't affect Positioning at Night as strongly as compared to Day Hours

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Conclusion

- Recommended for short period Projects with High Demanding Positioning Services, the Planning of GPS Observations during Night Hours when ever possible
- The use of a Imax Network Solution is Recommended during Day and Night Hours to obtain accuracy in 60 Seconds GPS Observations
- Will reduce investments of New Equipment