THE ACCURACY OF THE DGPS SYSTEM AFTER ANNULMENT OF SELECTIVE AVAILABILITY (S/A)

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ABSTRACT

This article presents the results of an assessment of position determination accuracy of a DGPS system. Correction signals were transmitted from Dziwnow and Hammerodde reference stations. The research, including six locations in the vicinity of Zalew Szczecinski (Lake Szczecin), aimed at the determination of how the elimination of selective availability affects position accuracy in a DGPS system.

1. ACCURACY OF POSITION DETERMINATION IN THE DGPS SYSTEM BASED ON SIGNALS FROM DZIWNÓW AND HAMMERODDE RADIOBEACON STATIONS

The research herein described aimed at the assessment of how the elimination of selective availability in a GPS system affects the accuracy of position determination in a DGPS system using signals transmitted by marine radio beacons. Relevant measurements were carried out at points with known geodesic coordinates, where such measurements had been previously performed. Of many points in which position determination accuracy tests were made before the elimination of selective availability, six locations in the area of Zalew Szczeciński (Lake Szczecin) were chosen for comparative measurements (Table 1).
In order to eliminate the effect of receiver type on the accuracy of position determination, the same receiver (Leica MX9212) was used in all measurements. Measurement data, such as latitude, longitude, altitude above the reference ellipsoid (WGS 84), signal strength and the signal/noise ratio were recorded every second. The length of measurement series varied from one hour to twenty four hours.

Table 1. Locations where the measurements of position determination accuracy were made before and after the elimination of selective availability

	Location	Reference station	Geodesic position
1	Glinki	Dziwnów, Hammerodde	φ = 53° 30'16,6000"N λ = 014° 36'14,8120"E
2	Warszewo*	Dziwnów, Hammerodde	φ = 53° 29'45,9400"N λ = 014° 31'52,8100"E
3	Widzieńsko	Dziwnów, Hammerodde	φ = 53° 39'50,3710"N λ = 014° 45'43,6410"E
4	Wrzosowo*	Dziwnów, Hammerodde	φ = 54° 00'29,1790"N λ = 014° 48'08,7390"E
5	Maritime University of Szczecin	Dziwnów, Hammerodde	φ = 53° 25'44,5980"N λ = 014° 33'49,0200"E
6	Żelechowo	Dziwnów, Hammerodde	φ = 53° 28'59,4259"N λ = 014° 35'22,1575"E

*** - geodesic marks where the position has not been verified**

2. RESULTS OF MEASUREMENTS MADE BEFORE THE ELIMINATION OF SELECTIVE AVAILABILITY (S/A) IN A GPS SYSTEM

Table 2. Displacement of the mean position relative to known geodesic positions

Location	Dziwnów			Hammerodde		
	Δφ [m]	Δλ [m]	M(95%)[m]	Δφ [m]	Δλ [m]	M(95%)[m]
Glinki	-0.8087	0.0697	3.46	-2.3643	-0.0183	2.83
Glinki	0.4784	-0.1578	4.25	-1.6235	1.2153	0.85
Glinki	-1.1698	1.4264	5.85	-1.2470	1.3438	13.56
Warszewo	19.3657	1.5754	2.49	-0.7716	1.6231	2.90
Warszewo	•	•	•	19.8935	1.4946	2.27
Widzieńsko	-2.9570	0.3292	3.78	-0.1605	0.2633	11.11
Widzieńsko	0.7531	-0.1060	12.45	2.1730	0.2304	2.38
Widzieńsko	•	•	•	-3.4755	0.1609	21.83
Wrzosowo	67.8603	14.2230	1.87	68.3758	14.0234	4.34
Wrzosowo	68.5054	14.5132	1.76	67.9190	13.8257	3.33
Wrzosowo	•	•	•	65.2522	11.2354	4.90
Żelechowo	0.5401	-0.1010	7.41	0.1080	0.2736	6.00
WSM	1.058	1.236	3.37	1.287	0.946	3.57

Table 3. Mean values of the signal strength (SS) [dBμ] and the signal/noise ratio (S/N) [dB] for Dziwnów reference station at specific measurement points

Location	SS	S/N
Glinki	37.3	12.4
Warszewo	35.6	12.6
Widzieńsko	36.6	13.8
Wrzosowo	39.3	14.1
Żelechowo	28.6	11.4
WSM	35.2	11.3

Table 4. Mean values of the signal strength (SS) [dBμ] and the signal/noise ratio (S/N) [dB] for Hammerodde reference station at specific measurement points

Location	SS	S/N
Glinki	35.6	12.7
Warszewo	36.9	12.2
Widzieńsko	36.8	13.3
Wrzosowo	38.1	12.8
Żelechowo	35.4	11.9
WSM	34.4	12.3

3. RESULTS OF MEASUREMENTS MADE AFTER THE ELIMINATION OF SELECTIVE AVAILABILITY (SA) IN A GPS SYSTEM

Table 5. Mean values of the signal strength (SS) [dBμ] and the signal/noise ratio (S/N) [dB] for Dziwnów reference station at specific measurement points

Location	SS	S/N
Glinki	37.1	12.6
Warszewo	37.3	12.8
Widzieńsko	38.9	14.1
Wrzosowo	44.3	17.4
Żelechowo	37.7	12.3
WSM	37.2	12.4

Table 6. Mean values of the signal strength (SS) [dBμ] and the signal/noise ratio (S/N) [dB] for Hammerodde reference station at specific measurement points

Location	SS	S/N
Glinki	36.7	11.5
Warszewo	36.9	11.9
Widzieńsko	37.8	12.9
Wrzosowo	37.3	14.5
Żelechowo	36.7	11.1
WSM	36.9	11.2

Table 7. Displacement of the mean position relative to known geodesic positions

Location	Dziwnów			Hammerodde		
	Δφ [m]	Δλ [m]	M(95%)[m]	Δφ [m]	Δλ [m]	M(95%)[m]
Glinki	-0.8797	-0.0862	0.51	-0.8210	0.0220	0.63
Glinki	-1.0031	0.5617	0.72	-1.1081	0.2239	0.81
Warszewo	19.3657	1.5754	1.03	19.3410	1.5754	0.89
Warszewo	19.3657	1.5846	0.84	19.3688	1.5864	0.98
Widzieńsko	0.1358	0.0073	1.73	0.1234	0.0128	1.42
Widzieńsko	0.1605	-0.0219	1.40	0.1419	-0.0018	1.51
Wrzosowo	67.8418	14.3445	0.62	68.0640	14.6910	0.59
Wrzosowo	67.6257	14.5132	0.50	68.1875	14.7146	0.51
Żelechowo	0.5617	-0.0587	1.17	0.4599	-0.0679	1.64
Żelechowo	0.4290	-0.0808	1.80	0.4846	-0.0569	2.00
WSM	0.9831	1.2311	1.31	1.2613	0.9843	1.42

CONCLUSIONS

1. The accuracy of position determination in the DGPS system increased after selective availability had been eliminated in the GPS system.
2. The accuracy of position determination increased two to six times (Tables 2 and 7) for the 3D position and Dziwnów station. In the case of Dziwnów radiobeacon it might be explained by the fact that earlier, in the 1990s, the station performance was not stable enough (signal strength varied considerably). After the station antenna was modernized (August 2002), the strength of the received signal grew noticeably (Tables 3, 4, 5 and 6).
3. The accuracy of position determination increased from over one to ten times (Tables 2 and 7) for the 3D position and Hammerodde station.
4. After the elimination of selective availability, the DGPS operation based on signals transmitted by radiobeacons has shown much higher stability. The system operates without previously short but frequent position 'shifts' that significantly affected the accuracy of position determination.
5. The examination of the changes in time of latitude, longitude and altitude values, both before and after the elimination of selective availability, shows that the amplitude of these changes is lower after the elimination of the S/A. This can be clearly seen at the limit of reference station range and at the presence of major industrial and atmospheric availability.
6. The improved accuracy of position determination in the DGPS system, based on the operating marine radiobeacon stations, has led to the expansion of applications of this version of the system in inland water areas.

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