THALES

MobileMapper™ CE

Achieving Sub-Foot Accuracy

With the GPSDifferential™ Module

WHITE PAPER

Introduction

Following the recent release of MobileMapper™ CE on the GIS[1] market, Thales introduces a new software extension to the MobileMapper CE unit called "GPSDifferential™ Module".

This software extension is an easy-to-integrate and easy-to-use module that enables MobileMapper CE users to enhance the precision of their field data through post-processing. The post-processing phase relies on the use of Thales MobileMapper™ Office software.

The aim of this white paper is to present the level of performance users can expect from their MobileMapper CE units when embedding the GPSDifferential Module into their MobileMapper CE-running GIS applications.

This paper also demonstrates that MobileMapper CE combined with the GPSDifferential Module is capable of achieving sub-foot accuracy (30 cm), a performance level that is becoming a standard requirement for GIS professionals in such areas as utility management, forestry or agriculture.

1. Geographic Information System

Test Conditions

All the tests presented in this document were conducted in the following environmental and operating conditions:

- Sky view: Open Sky
- Number of received satellites: > 6
- PDOP: < 3
- SBAS: Enabled (EGNOS was used)
- While collecting features in the field, raw data files were logged using the GPSDifferential™ for ArcPad® software extension and post-processed by the MobileMapper™ Office software.

Figure 1: Open Sky View

Point Feature Collection

Test Description

In this test, four control points about 50 meters away from each other were collected as point features with different averaging time settings.

The test was conducted on each control point with two MobileMapper CE receivers used concurrently, one with its internal antenna and the other with an external antenna (a Thales precision GPS antenna).

Results

The two tables below provide the average position error obtained for different occupations times and different baseline lengths with the two different antenna configurations. Each measurement was repeated 10 times.

Table 1: Position Error (m) vs. Baseline Length, With Internal Antenna

	Occupation time				
Baseline	**30 s**	**60 s**	**90 s**	**120 s**	**300 s**
150 - 200 m	0.672	0.440	0.410	0.376	0.306
20 km	0.877	0.772	0.552	0.453	0.363
75 km	0.832	0.826	0.757	0.567	0.469

Table 2: Position Error (m) vs. Baseline Length, With External Antenna

	Occupation time				
Baseline	**30 s**	**60 s**	**90 s**	**120 s**	**300 s**
150 - 200 m	0.187	0.175	0.152	0.143	0.133
20 km	0.235	0.225	0.215	0.194	0.170
75 km	0.452	0.370	0.337	0.306	0.250

Comments

This test clearly demonstrates the consistency of the precision level which steadily increases with the occupation time on each point. It also steadily decreases as the baseline length increases but the gradient is so modest that the position appears as almost insensitive to the baseline length, at least up to the 75 km of baseline length that was tested.

Quite predictably, the external Thales precision GPS antenna gives better results. Yet the precision level obtained with the internal antenna consistently remains under 50 cm as long as the occupation time is 90 seconds or more, and for baselines up to 20 km.

The results also show that passing from the internal to the external antenna causes an average leap of 35 cm on precision results.

Area & Line Feature Collection

Test Description

This test was conducted on a soccer field. This flat, horizontal surface offers the following advantages for benchmarking:

- It has standardized, known dimensions that we can immediately use as reference for qualifying the results.
- Its size is representative of the line and area features GIS operators usually have to measure in their everyday work.
- It benefits from an open sky view.

Figure 2: View of the surveyed soccer field

Again, two MobileMapper CE units were used concurrently during this test. One was operated with its internal antenna and the other with an external antenna (the Thales precision GPS antenna).

To enable the field operator to easily and accurately follow the different lines drawn on the ground, a range pole was used on which both units were attached.

The perimeter of the soccer field was surveyed three times, the half-perimeter twice and the center circle once. To accurately survey the half-perimeter, the operator had to walk along the halfway line (see diagram below).

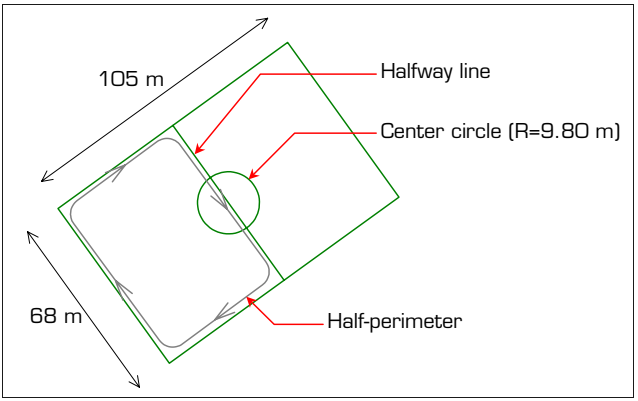

Figure 3: Soccer field ground layout

The real dimensions of the soccer field are summarized in the table below:

Table 3: Soccer field standard dimensions

Perimeter	Area	Half-perimeter	Half-area	Center circle circumference	Center circle area
346 m	7140 m²	241 m	3570 m²	61.57 m	301.72 m²

The baseline used in this test was 12 km long.

Results

The two tables below summarize the line and area measurements (M1, M2, M3) and their corresponding relative errors obtained for a particular configuration of the antenna.

Table 4: Area and line measurements, with internal antenna

Field				
*	Perimeter (m)	Relative Error (%)	Area (m²)	Relative Error (%)
M1	347.52	0.43	7127.94	0.17
M2	345.30	0.20	7037.91	1.42
M3	346.16	0.05	7197.86	0.8
Half-field				
*	Half-perimeter (m)	Relative Error (%)	Half-area (m²)	Relative Error (%)
M1	240.55	0.19	3490.03	2.24
M2	243.91	1.21	3608.65	1.08
Center Circle				
*	Circumference (m)	Relative Error (%)	Area (m²)	Relative Error (%)
M1	62.25	1.10	305.88	1.38

Table 5: Area and line measurements, with external antenna

Field				
*	Perimeter (m)	Relative Error (%)	Area (m²)	Relative Error (%)
M1	347.38	0.39	7126.13	0.19
M2	345.51	0.14	7103.02	0.52
M3	345.06	0.27	7111.82	0.39
Half-field				
*	Half-perimeter (m)	Relative Error (%)	Half-area (m²)	Relative Error (%)
M1	240.69	0.12	3553.70	0.46
M2	240.15	0.35	3566.47	0.09
Center Circle				
*	Circumference (m)	Relative Error (%)	Area (m²)	Relative Error (%)
M1	61.77	0.32	300.23	0.49

* M1=Measurement #1; M2=Measurement #2; M3=Measurement #3.

Comments

Most of GIS applications tolerate a relative error of maximum 1% on line measurements and 3% on area measurements (as per the requirements from the European Commission's MARS[2] Unit).

MobileMapper CE used in conjunction with the GPSDifferential Module exceeds these requirements as the observed relative error is about 1% on average with the internal antenna and less than 0.5% with the external antenna. In addition, this level of precision is maintained for areas as small as 300 m².

2. Monitoring Agriculture with Remote Sensing.

Conclusion

Figure 4: MobileMapper CE Unit

The GPSDifferential Module significantly improves the precision level of GIS data collected with MobileMapper CE. The degree by which the precision is enhanced through post-processing mainly depends on two factors, regardless of the baseline length:

1. The occupation time on point features. The longer the occupation time, the better the precision.
2. The antenna used. Using an external antenna rather than the internal antenna will boost the precision on point features by 35 cm on average.

MobileMapper CE delivers sub-foot accuracy on baselines up to 20 km, with occupation times of 30 seconds or more and an external Thales precision GPS antenna. For longer baselines (75 km), it delivers sub-foot accuracy with only 2 minutes of occupation time, which is a standard occupation time in precision measurements.

The post-processing of distance and area measurements results in relative errors of about 1%, regardless of the antenna used. This is much better than the 3% usually required in most GIS applications.

MobileMapper CE and its GPSDifferential Module constitute a very flexible solution for GIS professionals who need meter to sub-foot accuracies depending on their applications:

- Switching from meter to sub-meter accuracy is obtained by simply enabling the data collection function in the MobileMapper CE unit.
- Another step toward more accuracy (sub-foot) can be achieved by simply switching from the internal to an external antenna.

MobileMapper CE

GPSDifferential™ Module White Paper

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