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MobileMapper™ 6

White Paper

Meter-Level Mapping Accuracy With Post-Processing

Introduction

Since its introduction in February 2008, the Magellan® MobileMapper™ 6 has been welcomed by the market as the only GIS data collection instrument in its class:

- Ruggedized,
- Open Windows Mobile 6 platform,
- 2-5 meters real-time accuracy at a price point well below 1,000 $/€.

In September 2008 Magellan introduced a post-processing option for the MobileMapper 6, along with the new MobileMapper 6 Office software with BLADE™ technology.

With the post-processing option, Magellan again disrupts the market by providing this same ruggedized open platform with a post-processed accuracy that is meter level (1-2 meters).

This paper describes the tests that validate this claim, and describes how the user must use the MobileMapper 6 to achieve this accuracy.

With this new feature, the MobileMapper 6 becomes a true replacement for the MobileMapper Pro, delivering meter-level accuracy for less than €1,200 ($1,500).

Materials and Procedures

All tests were performed in Carquefou, France in July 2008. The receiver used was the MobileMapper 6 with Mobile Mapping software V2 with the Post-Processing Option activated, and the new MobileMapper 6 Office software (PN 990603-53).

The data were collected over a course of known points which have previously been surveyed to 1-cm horizontal and 1.5-cm vertical accuracy. *Fig. 1* shows a satellite image of the test course with the points labeled.

Fig. 1. Satellite image courtesy of Google Earth. The points that are referred to in this paper are labeled. Point P110 is in the upper right corner, partially obscured by the Google Earth navigation tool.

During data collection, the operator walked between points with the MobileMapper 6 held away from the body, elbow against the waist, and at a 45° angle, collecting well-defined lines and areas.

To collect the point coordinates, the operator stopped with the receiver held away from the body, elbow against the waist, directly above the point at a 45° angle. The operator then logged the point by collecting data for 10 seconds (the default period in the Mobile Mapping software) while holding the receiver as still as possible.

In some tests the receiver was carried in a pocket to create poor signal tracking conditions between points. Data were collected in 3D mode or 2D mode. When collected in 2D mode, the 3D rms accuracy value is missing from the tables.

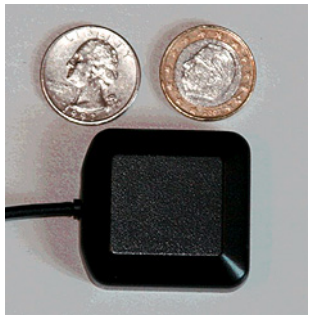
To achieve the specified accuracy, the following criteria must be met:

- A user must hold MM6 device always during the whole field session at 45 degrees to the horizon (the internal antenna requires this).
- Any interruptions (like putting the device into Suspend mode, GPS Reset in Mobile Mapping, Cold reset, putting the device into the pocket etc.) decrease the quality of post-processing. Such actions are not compatible with good post-processing results.
- The raw data file must be at least 10 minutes duration even if a user wants to log just one point feature, and 1 minute would be enough to collect the feature. In such a case, a user must start raw data logging beforehand or collect more raw data after the point is collected. Note that the more raw data you have within one field session, the better the post-processing results will be.
- Continuous tracking of GPS satellites is important. Loss of lock is a reason for bad post-processing results. If satellite lock is lost, the user must again collect at least 10 minutes of data for any points to be post-processed.
- Multipath condition is important. The fewer the objects nearby, the better post-processing results will be.
- It is better if the distance from the reference station does not exceed 200 km. However, in MM6 Office it is allowed to download a base with a baseline distance up to 500 km.

In some tests, an external antenna (PN 700-0015-001) was used. This antenna has a magnetic mount and is normally used on the roof of a vehicle for rapid data collection. The magnetic-mount antenna is not a precision antenna, and therefore is not expected to improve the results compared with the internal antenna.

In the tests described here it was mounted on a pole to make it easy to carry and to hold over the points. The antenna is shown below in *Fig. 2*.

Fig. 2.
The magnetic-mount external antenna is not a precision antenna



Reference L1 raw data were collected during the tests with a ProMark 3 survey system (PN 990569-01) set up on a known reference point. Data were collected in a variety of coordinate systems, including WGS-84, NTF/Lambert 2, RGF/Lambert-N93, and WGS-84/UTM Zone 30.

In the office the data were downloaded into MobileMapper 6 Office software V1.0 (PN 990608). The real-time results were displayed and recorded. For post-processing, the ProMark 3 L1 GPS data were downloaded and used for reference. In some cases, we used the MobileMapper 6 Office software feature to download a CORS station from the Internet as a reference point. The baselines in these tests were 53, 57, 107 or 188km, depending on which CORS was selected.

For tests in shaded conditions, points were collected under light canopy (point S009) and heavy canopy (point P110). *Fig. 3* shows the environment around point S009, and *Fig. 4* shows the environment around point P110. *Fig. 5* is the view directly overhead of point P110.

Fig. 3.
Point S009 being collected in "Point Logging" mode.

Fig. 4.
Point P110 is located in a tree-lined lane. The trees are 20-meter oaks. The sky directly above is relatively clear.

Fig. 5.
An overhead view from point P110.

Open Sky

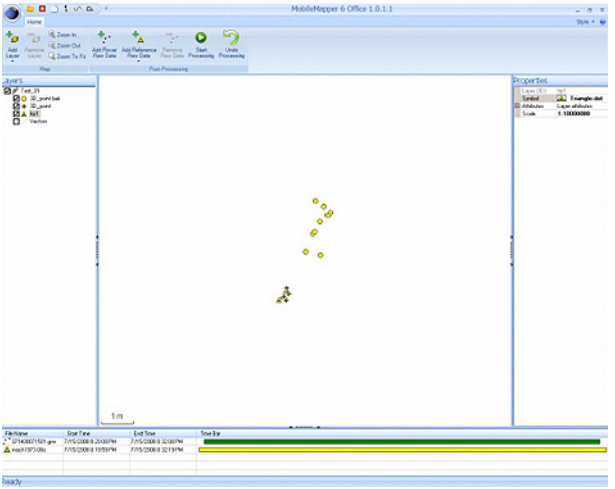
Table 1 shows the results of real-time and post-processing using the internal antenna in open-sky conditions. The specification for the MobileMapper 6 is 2-5 meters rms real time with SBAS and 1-2 meters rms post-processed. All the data in this and the following table are reported in rms values in meters. Ten separate point collections were used to calculate the rms values.

Table 1. Open-sky results using internal antenna in real-time and post-processed.

	Real-Time		Post-Processing	
Test-Point	2D	3D	2D	3D
1-S009	2.74	6.07	0.17	0.84
2-S001	1.93	4.06	0.28	0.59
2-S002	1.86	4.18	0.25	0.55
2-S009	1.94	4.54	0.26	0.53
2-S010	1.96		0.26	
3-S009	1.75	3.26	0.35	0.45
3_redo-S009	1.91	2.02	0.48	0.57
4-S001	1.16	3.82	0.60	1.06
4-S002	1.02	2.15	0.53	0.96
4-S009	1.34		0.54	
4-S010	1.33	3.73	0.54	0.91
5-S001-S010	1.75	2.63	0.34	0.46
6-S009	2.13	2.54	0.13	0.45

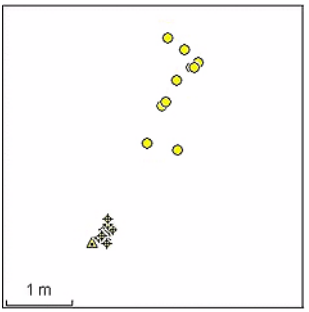
The effect of post-processing is clearly seen in the following two figures. *Fig. 6* is a screen capture of the new MobileMapper 6 Office software that shows the easy-to-use interface. Despite this apparent simple appearance, this office software contains Magellan's BLADE technology, which is the means by which meter-level accuracy is achieved with L1 measurements.

Fig. 6. Screen capture of MobileMapper 6 Office software showing real-time (yellow dots) and post processed (crossed dots) collected at point S009.



The data plotted are individual measurements collected at point S009. *Fig. 7* is a zoom of the data itself. The yellow dots are the real-time points, the crossed dots are the post-processed points, and the triangle is the surveyed point. The improvement with post-processing is clearly evident.

Fig. 7. Zoom of the previous screen showing the same data with higher resolution. The triangle is the surveyed point.



Shaded

The results in shaded conditions are shown in *Table 2*. Point S009 is a partially shaded point, and point P110 is heavily shaded, although not completely covered in canopy (the sky is relatively clear directly overhead).

Trials 9 and 10 were performed with the receiver held out at 45° while walking between points.

Trials 13 and 14 were performed with the MobileMapper 6 in a pocket between points, simulating heavy shading between point collection.

Table 2. Shaded point results using internal antenna in real time and post-processed

	Real-Time		Post-Processing	
Test Point	2D	3D	2D	3D
9-P110	3.17	3.74	0.66	0.77
10-P110	1.61	3.43	0.62	1.72
13-S009[a]	1.68	3.73	0.96	1.68
14-P110[a]	1.85	5.41	1.20	2.54

a. Receiver placed in pocket between point collections.

Line Features and Area Features

Fig. 8 and *Fig. 9* illustrate the effect of post-processing on lines and *Fig. 10* and *Fig. 11* show the effect of post-processing on areas. The operator walked the perimeter of a parking lot three times using the "Collect by Time" feature collecting a single position along the line at the rate of every 1 second. The operator also used the "Vertex Logging" mode. In this mode the operator occupied the vertices of the area to be measured and logged these points for the period of 10 seconds.

Fig. 8 shows the variation in the results of these three circumnavigations. These data were then post-processed yielding the lines and areas displayed in *Fig. 9*.

The triangles indicate the location of surveyed points along these lines. The improvement from the real-time accuracy specification of 2-5 meters to the post-processed specification of 1-2 meters is clearly visible.

Fig. 8.
Real time line features collected by logging a position every 1 second while walking.

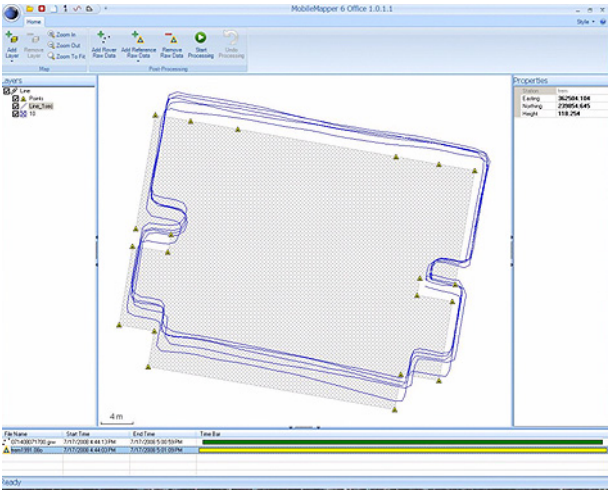


Fig. 9.
The effect of post-processing the data shown in Fig. 8. The triangles indicate surveyed points accurate to 1 cm.

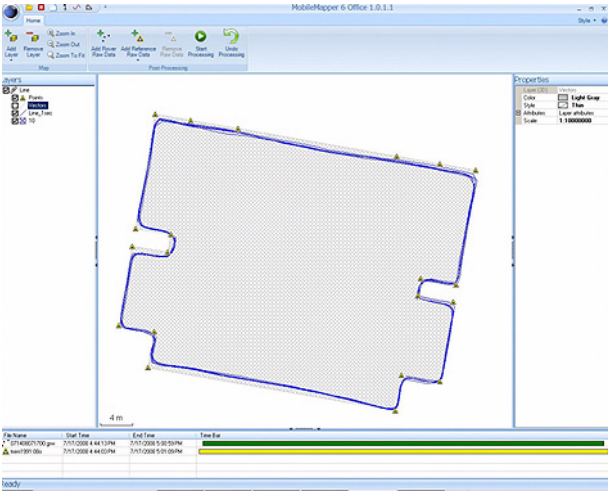


Table 3 shows the results of the real-time line collection vs. the post-processed results for the three trials.

The table indicates the difference between truth and the real-time solution and between truth and the post-processed solution.

Table 3. Real-time and post-processed line features.

Trial	True length, in m	Real-time length, in m	Post-processed length, in m	Truth-RT, in m	Truth-PP, in m
1	160.4	161	161.0	-0.6	-0.6
2	160.4	162	161.6	-1.6	-1.2
3	160.4	164	161.2	-3.6	-0.8

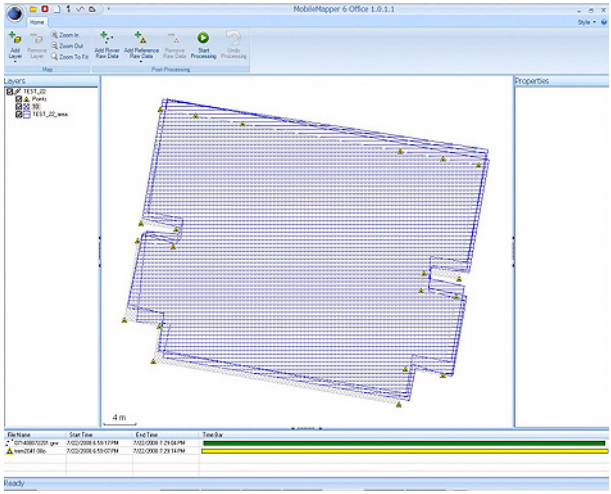


Fig. 10. Three areas collected in real time using the "Vertex Logging" method. The operator occupied each surveyed point for 10 seconds to collect the vertices of the area.

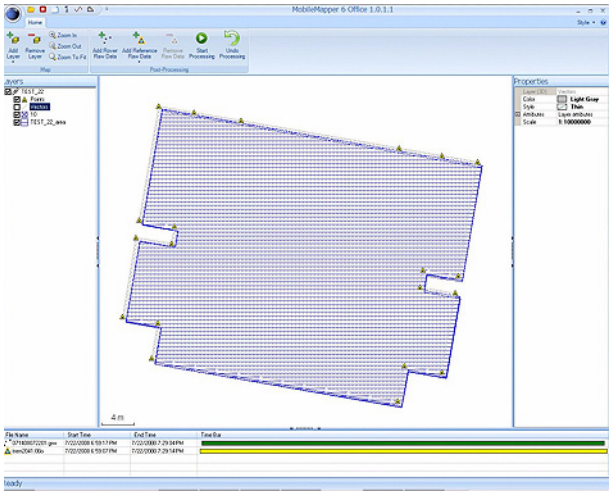


Fig. 11. The collected areas in Fig. 10 after post-processing. The triangles indicate the collection points, which are surveyed with an accuracy of 1 cm.

Table 4 shows the results of the real-time area collection vs. the post-processed results for three trials. The table indicates the difference between truth and the real-time solution and between truth and the post-processed solution.

Table 4. Real-time and post-processed area feature.

Trial	True area, in sq. m	Real-time area, in sq.m	Post-processed area, in sq. m	Truth-RT, in sq. m	Truth-PP, in sq. m
1	1192.2	1223.1	1201.6	-30.9	-9.4
2	1192.2	1192.7	1209.9	-0.5	-17.7
3	1192.2	1221.2	1203.1	-29	-10.9

External Antenna

Magellan offers a low-cost external antenna with magnetic mount, which is intended to be used attached to the roof of a vehicle for rapid data collection. This is not a precision antenna.

We tested the accuracy using this antenna in both real time and with post-processing on one open-sky point (S001) and on one shaded point (P110). *Table 5* shows the results.

Table 5. Open sky and shaded results using external antenna in real time and post-processed.

External Antenna, Open Sky				
	Real-Time		Post-Processing	
Test-Point	2D	3D	2D	3D
20-S001	2.99	5.09	0.76	0.84
External Antenna, Shaded				
	Real-Time		Post-Processing	
Test-Point	H	3D	H	3D
	3.78	6.61	0.62	1.40

Discussion

We have demonstrated here that the MobileMapper 6 easily meets its specification for post-processed accuracy of 1-2 meters rms. In fact, in open sky conditions the results are often sub-meter.

Even in heavily shaded conditions with only a partial view of the sky directly overhead, the MobileMapper 6 is capable of delivering meter-level accuracy.

We have demonstrated that it is possible using BLADE technology to post process MobileMapper 6 measurements to the meter level. These results make the MobileMapper a very compelling offering for GIS data collection in low-end GIS market segments where high-precision GIS/GPS receivers are not requested.

MobileMapper™6 With Post-Processing Option

White Paper

Mobile Mapping Contact Information:
In USA +1 408 615 3970 ▪ Fax +1 408 615 5200
Toll Free (Sales in USA/Canada) 1 800 922 2401
In South America +56 2 273 3214 ▪ Fax +56 2 273 3187
Email mobilemapping@magellangps.com

In France +33 2 28 09 38 00 Fax +33 2 28 09 39 39
In Russia +7 495 980 5400 Fax +7 495 981 4840
In the Netherlands +31 78 61 57 988 Fax +31 78 61 52 027
Email mobilemappingemea@magellangps.com

In Singapore +65 983 842 29 Fax +65 677 798 81
In China +86 10 6566 9866 Fax +86 10 6566 0246
Email mobilemappingapac@magellangps.com
www.pro.magellanGPS.com

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