THALES

MobileMapper

Best Practices for Sub-Meter Accuracy with MobileMapper

The MobileMapper system will deliver reliable sub-meter accuracy using its post-processed differential correction option. However, you can increase the probability of sub-meter accuracy by following a few procedures. They can be summarized by the acronym L.E.V.E.L - standing for:

- **L**ogging Interval — Set it to one second, if you have the memory.
- **E**xternal Antenna — Required on the reference station, recommended on the rover
- **V**ertical — Hold the receiver vertically
- **E**ye — Hold the receiver at eye level or higher
- **L**evel

The following explains the advantages of following the LEVEL rule when your intent is to achieve the most accurate GPS positions possible. It also offers some other pointers for getting the most out of the MobileMapper post-processed differential correction option. But first, here are some basics.

Differential correction software removes some of the error inherent in the standalone GPS position determined by a roving GPS receiver. A reference station with known coordinates records GPS satellite data at the same time as the rover receiver. Because the true coordinates of the reference receiver are known, the differential correction software can use this information to "correct" the raw measurements of the distance to each satellite that were recorded by the rover receiver. The corrected GPS measurements at any time are common to all GPS receivers within a few hundred kilometers of the reference receiver. If you combine the adjustments calculated for the reference receiver with the measurements recorded by the rover receivers, you can improve the accuracy of the rovers. Such techniques for improving GPS accuracy are called "differential correction."

You can calculate and apply differential corrections in two ways. You can broadcast the corrections as they are calculated by the reference receiver in "real-time" to any rover receiver that is equipped with a radio to pick up the corrections. The rover uses a radio to receive these corrections and internal software to apply them to the GPS measurements it receives. It then differentially corrects its positions in real-time. This is how real-time systems such as WAAS, EGNOS or Coast Guard systems work. Most GPS-for-GIS receivers are equipped with an internal WAAS/EGNOS receiver and firmware to

apply the corrections. They can also use beacon-type receivers such as the MobileMapper Beacon to pick up Coast Guard or other national differential GPS broadcasts.

You can alternatively download the data recorded by both the reference and rover receivers and use differential correction software on your PC to apply the corrections. This is called "post-processing" because the accuracy is improved after everything is recorded. Real-time correction systems are essentially transparent to the user but are limited in the level of accuracy they can provide. Although post-processing requires more effort and does not produce the results in real time, it is more accurate because post-processing software runs on more powerful computers and can go forwards and backwards through the data to provide more accurate solutions.

ROVER RECEIVER USAGE TIPS

- Record at a one-second **Logging** interval. This will give you better detail when moving slowly. Be sure that you have enough memory available on the MobileMapper receiver's SD card to collect the data for the length of time you will be working. At a 1-second interval you can record 4 hours per megabyte when recording a real-time job or 40 minutes per megabyte for a post-processing job. If you are recording data in a vehicle, adjust the recording interval according to your speed. The default is 5 seconds. If you record a road at 30 mph (or 50 kph) logging a position every 5 seconds, the map of the road will consist of points 216 feet (or 70 meters) connected by straight lines. If you wish to change the recording interval while recording a feature, we recommend that you pause the feature, reset the interval and then resume logging. The command sequence to do this is: MENU>Pause>ENTER, MENU>Logging Interval>By Time>[select logging interval]>ENTER, MENU>Resume>ENTER.
- Using a survey-grade **External** antenna will achieve the highest level of accuracy, although such an antenna is not required to achieve sub-meter accuracy in normal conditions. Contact your Thales Navigation dealer for information on obtaining such an antenna.
- MobileMapper's internal antenna works best when **Vertical**. This is not true for other GPS receivers that use a "patch" style of receiver that work best when horizontal.
- The human head makes an effective obstacle for GPS signals. Therefore, for maximum accuracy, you should hold the rover receiver at **Eye Level** or higher. While you can still obtain accuracy less than one meter from a receiver held below eye level, the higher you hold the receiver above the ground, the easier it will be for the receiver to track a maximum number of satellites and achieve the best accuracy. Conversely, holding any GPS/GIS system close to your body or demonstrating it to people standing close by will effectively block GPS signals and will make sub-meter accuracy almost impossible to achieve.
- MobileMapper is the lightest GPS/GIS receiver you can buy, but holding anything away from your body for hours can be tiring. Therefore, when recording long jobs on foot, you might consider attaching MobileMapper to a bracket on a range pole. Although the pole adds weight, it also allows you to elevate the receiver over your head while keeping your arms by your sides. . Contact your Thales Navigation

dealer for information on obtaining a range pole and bracket. Remember that you can always pause a long feature while you take a break.

- Under no circumstances should the user allow curious co-workers to form a group around the receiver and thereby cut off all view of the sky.
- Absolute accuracy may be sub-meter after post-processing but relative accuracy between consecutive epochs is closer to 5 centimeters. When the user turns a corner, great care must be taken to move the receiver over the feature being mapped. If you swing your shoulders while turning your body, you will easily see this arc in MobileMapper Office. When mapping a trail, it is important to keep the receiver over the middle of the trail at all times. You should be careful when moving the receiver from one hand to another or the resulting map will have jumps in it. Using a range pole is one way to keep the receiver from swinging around.
- For the best looking map, it helps to imagine that drops of water are coming out of the receiver and that where these drops fall on the ground is where the individual positions will appear on the map. If you do record positions that are obviously caused by uneven tracing of the receiver over the feature being mapped, you can use MobileMapper Office to delete unwanted positions making up line and area features. Refer to the MobileMapper Office documentation for information on removing unwanted lines and areas.
- If it is unrealistic to restrict the movement to straight lines and smooth arcs, leave the recording interval for line and area features at the default interval (10 sec). This will remove small deviations that might make the resulting feature positions look erratic on large-scale maps.

REFERENCE STATION USAGE TIPS

If you want the best accuracy, here are some tips for obtaining reference station data for post-processing:

- The reference station may use any receiver that records Thales Navigation "B-, D- and E-files" or any receiver that can output GPS measurements in RINEX format. There are many public sources of reference station data in North America and Europe, as well as in some other parts of the world. The (US) National Geodetic Survey's CORS site (http://www.ngs.noaa.gov/CORS/) is a popular source of free data in the United States. Experimenting with the data from different sites is a good way to find the reference stations – called "CORS" sites - that give you the best accuracy in your work areas. You can conduct accuracy tests by collecting data over known control points and then comparing the known coordinates with those obtained using MobileMapper.
- Publicly available data is usually free but often the operating site is under no obligation to record GPS measurements all day, everyday. The best way you can be sure of obtaining reference station data is to operate your own site. Any Thales Navigation survey or GIS system can be used to record reference data. The Thales Navigation iCGRS (Internet-Enabled Continuous Geodetic Reference Station - http://products.thalesnavigation.com/en/products/product.asp?PRODID=163) offers full automation and Internet connectivity, and the ProMark2 surveying

system (http://products.thalesnavigation.com/en/products/product.asp?PRODID=43) provides a rugged and affordable option for collecting reference station data in the field. You can also use a second MobileMapper receiver as a reference receiver – as long as you have activated the post-processing option in it.

- When setting up your own reference station in the field, make sure you first locate a control point within 100 km of the work area. The closer the reference receiver is to the work area, the better the accuracy will be. After you download the reference data into MobileMapper Office, be sure to click on the Edit Reference Station Properties icon and type in the actual, surveyed coordinates of the control point. If you do not do this, MobileMapper differential correction module will use the average position recorded by the reference receiver and this will almost certainly be less accurate than the surveyed coordinates. Any error in the reference station's coordinates will be transferred to all the positions recorded by the rover receiver(s).
- Make sure you enter the reference receiver's antenna height above sea level in the Reference Station Properties window.
- Make sure the coordinate system indicated in the Reference Station Properties window is the same as that used for the surveyed coordinates of the control point and that of the rover data. If you only know the reference station coordinates in one coordinate system, first use MobileMapper Office to adjust to this system and then select this system in the Reference Station Properties window.
- The reference station antenna should be at least 2 meters off the ground and in a location where it has an open view of the sky. Real post-processing purists will add the antenna's height off the ground to the orthometric height (Mean Sea Level elevation) of the reference station's control point. They should then subtract the height that the rover receiver is typically held above the ground. However, people who adhere to the Eye Level rule for recording rover data can usually assume that the height above the ground of both the reference receiver's antenna and the rover's antenna is roughly the same.
- You must use a survey-grade antenna for the reference receiver in order to achieve sub-meter accuracy. A Thales ProMark2 external antenna works very well. The magnetic antenna sold as a MobileMapper accessory is intended for use with a rover receiver that is inside a vehicle and cannot "see" enough satellites to calculate a position. This antenna is not intended for use with reference receivers.
- If a MobileMapper receiver with internal antenna is used as a reference station, the receiver must be vertical and 2 meters off the ground. And the user must understand that accuracy will not be quite as good as with a survey-grade antenna.
- The reference receiver must be able to see all the satellites seen by any of the rovers. Therefore, the reference receiver must be in an area far from buildings and hills and with a completely open view of the sky. A fact of differential correction is that the rover receiver must not "see" any GPS satellite not seen by the reference receiver. Note: it makes *no difference* to the post-processed differential correction module if either the reference or rover receiver ever "sees" a WAAS or EGNOS satellite or if the rover ever receives RTCM corrections from any real-time beacon.