CORS - A Case Study of a 1-Man GPS Crew

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Before becoming Editor of Professional Surveyor, I was the Survey Manager for Greenhorne & O'Mara in Rockville, Maryland. My job included constantly looking for ways to apply technology to increase productivity and profitability. In 1992, Bill Strange spoke to the Potomac Chapter of the Maryland Society of Surveyors. Although the topic was High Accuracy Reference Networks, Strange touched on NGS activities in general. One of the subjects he discussed was the NGS plan to develop a system of Continuously Operating Reference Stations (CORS) that would enable one person with a GPS receiver to establish horizontal positions. In the fall of 1995, Greenhorne & O'Mara won a contract with CellularOne to provide horizontal and vertical positions on their equipment to meet a FAA/FCC requirement. Since Strange's presentation I had dreamed of trying the one-man approach, and because the FAA/FCC requirements were rather loose (15 feet horizontally and 3 feet vertically), I decided that this project would be ideal.

We started by performing several experiments in which we ran single vectors from the CORS in Gaithersburg, Maryland to various HARN points in Maryland and Virginia. The results of these tests showed us that we could easily meet the spec, even out to 40 or 50 miles. Since most of the CellularOne facilities were within the Washington, D.C. metropolitan area, we knew we had a tool we could work with, both horizontally and vertically. In fact, based on our experiments with the HARN points, we knew that the horizontal accuracy would far exceed the spec. For those few sites outside the metro area, we adopted a procedure of observing on the closest HARN point to determine the variance between the known elevation and the single-vector GPS elevation. As expected, our horizontal values were within a few centimeters of the published values. The largest variance vertically was one meter and this was for a site on the east side of the Chesapeake Bay in northern Virginia. For that site we simply adjusted the derived vertical value at the site by the difference at the nearby HARN point.

We knew that our GPS software would import Receiver Independent Exchange Format (RINEX) data so the next step after observing was to retrieve the CORS data. The data is stored on an NGS UNIX server named Proton. We used the Internet FTP capability of America Online to access Proton at ftp://proton.ngs.noaa.gov. As with most new computer experiences, Proton and UNIX were a bit daunting until we learned the ropes. All startup problems we had were quickly handled by a phone call to NGS personnel. The first thing we did was download all of the documentation including the readme.notice and the news.let in the CORS subdirectory. News.let is updated every Sunday so it is a good idea to monitor it. Remember that UNIX allows more than 8.3 characters in a filename. When a file with more than 8.3 characters is downloaded, DOS will truncate the extra characters. More about this later.

Several utilities are needed to use the data. The observations are stored by date in one-hour increments. From the UTILITIES subdirectory under the CORS directory retrieve either CATO.EXE or JOIN24PC.EXE. If your data spans hourly files you will need either CATO or JOIN24PC to append these files. CATO will join two or more observation files and JOIN24PC will join either observation files or navigation files. Download the documentation (.TXT) files for explanations on how these programs work. The last utility needed is GZIP386.EXE. More about that later.

Because CORS data is gathered at either a 5-second rate or a 30-second rate, depending on the sampling rate for a particular CORS, the sampling rate of your receiver, and your software, you might need DECIMATE.EXE. This program will allow you to match data collecting rates by interpolating data sampled at a higher rate into a slower rate. Obviously, five second data cannot be decimated from 30 second data but 15 second data can be decimated from five second data. However, the software we used (Trimble's GPSurvey) did not require 15 second data to be decimated to 30 second data but rather handled it automatically.

The subdirectory STATION_LOG contains ID and antenna information about each CORS site. The subdirectory COORD contains the position data for each CORS site. Download the appropriate file to get the x,y,z information for the CORS site. This information is supplied as latitudes, longitudes and orthometric heights. Both ITRF and NAD 83 values are given. The NAD 83 values have been adjusted into the surrounding HARN so this is the one you will probably want to use.

The observation data itself is stored in the RINEX subdirectory which contains two subdirectories, CORS1 and CORS2. Both contain the data by date. CORS1 contains sites A through L and CORS2 contains the rest. Once in the appropriate subdirectory, pick a date and then pick a CORS site. Then download the appropriate hourly files. The file for midnight to 1AM is named A, the file for 1AM to 2AM is named B, and so on. The best way to keep straight on which hourly files you want is to prepare a chart because the hours referred to are in GPS (UTC) time which, for the east coast, is minus five hours (minus four hours during Daylight Savings time). The filenames include station name, GPS day, and hour, for example, GAIT015A.96N.GZ. Each hourly group actually consists of three files, an N(avigation) file, an O(bservation) file and a S(ummary) file. You will need both the N file and the O file. For many of the Cell sites we needed only one hourly file because we were able to make our observations in less than an hour. However, if our observations spanned two hourly files then we needed to download both hourly files.

Because of the 8.3 limitation, expanding and renaming UNIX files downloaded from Proton can be a little tricky. For example, when you download the file gait015o.96o.gz you will end up with gait015o.96o. GZIP386 requires the letter Z be the last character of the filename. For the example file, you would rename it to gait015o.96z, then run GZIP386 (with the -d switch for decompress) to expand it. Do the same for the n file. Be careful not to overwrite a file you want to keep. GPSurvey required the following naming convention for the RINEX files: again using the example, gait015o.96o and

gait015o.96n, so we had to rename them again. Once the procedures became routine we were able to quickly determine which files we needed, download them, rename, unzip and rename them and use the RINEX import option to input them right into GPSurvey.

Because Greenhorne & O'Mara has several receivers, we used the following approach: set two control points on site and perform GPS observations on both. Next, set up a total station, backsight the second point and using trig levels, obtain the vertical information on the antennas. One man was able to survey two sites per day using this approach. The advantage of performing simultaneous GPS observations on both points is that gave us a closed loop of sorts between the CORS site and our site. However, the single vector approach worked just as well because the GPS software provides statistical information that will identify anything screwy with the measurements.

All in all, the process of obtaining and using the CORS data was very easy and the ability to field a one-man crew gave us the competitive advantage we needed to win the contract in the first place. Our approach was profitable and the one-man crew concept provided increased flexibility in personnel assignments.