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UHF RADIO ALTERNATIVE - SPREAD SPECTRUM RADIOS

Many of us surveyors using radio links for data transfer are familiar with UHF radios and their limitations. UHF radios are used for many types of data transfer, but in this article I am primarily concerned with the application of radio links to RTK GPS.

If you are using cell phones for data links from your own base stations, or from Continuously Operating Reference Stations (CORS), or are using correction signals from other proprietary subscription services, this article doesn't apply. But if you work in places that may not have cell coverage, or you need a local base for your rover control, the info below might help.

First, let's get my disclaimer out of the way. If I mention products or manufacturers by name, it is not an endorsement or a criticism. There are many other products and manufacturers of radios and data link equipment. I mention any products by name only because I have experience with them. In fact, all the radios I use operate very well. But they all have advantages that can be exploited for different field conditions. You'll have to do your own research on radio types and manufacturers that will work for you.

The UHF (Ultra-High Frequency) band of the radio spectrum covers several frequency ranges that are assigned by the Federal Communications Commission (FCC) to various user groups for different purposes (http://www.jneuhaus.com/fccindex/spectrum.html). The UHF frequencies used, generally, by the land surveying and geodetic control community in the US are between 460 MHz to 470 MHz. I refer to radios using these frequencies as UHF. Each of us who use UHF radios are required by law to obtain a license to use very specific frequencies, with a specific call sign. My base radio for RTK GPS work broadcasts my call sign in digital form on a regular interval to let any listeners know who it is that is transmitting the data. The positional corrections are transmitted from my base station at a one second interval (1 Hz) and give my rover GPS the corrections needed for navigation and location, in real time, down to sub-decimeter accuracies.

The UHF radios I use for base and rover radios are made by Pacific Crest Corporation (PacCrest) (http://www.paccrst.com). My base radio is a PDLHPB (Fig. 1) and my rover radio is a TM32, one of the older rover radio modems (Fig. 2). The TM32 is similar to their popular rover radio, model RFM96W (2watt). These radios are rugged and work well, and the technical support from Pacific Crest is first rate.

Fig 1 – PDLHPB 2/35 watt base radio - note external antenna cable and external battery (in camo pack). Data & power use same Lemo connector, antenna uses BNC connector.

Continued on page 34

Continued from page 32

Fig 2 – TM32 2 watt rover radio - note data & power feed (from GPS receiver) and extension cable for small whip antenna.

THE PROBLEM – Too Much Traffic on the Radio Highway

The fourteen frequencies for which I am licensed range between 461.025 and 464.75 MHz. The *frequencies* can be assigned to any available channel on a given radio, but the frequencies remain the same. But therein lies the problem. Every other civilian user is licensed for the same frequencies and voice (vox) transmission has priority. Your radios must be set up to suspend transmission when vox communications are being made. That makes sense: voice comm could be emergency communications or other higher priority transmissions. However, during one of my jobs in a very busy part of southern California, near the intersections of two interstate highways, during the latter part of December, I encountered constant "chatter" on EVERY channel – mostly delivery drivers keying the microphone next to their AM radio speaker and re-broadcasting Christmas carols! (Silent Night it was not.) There was absolutely no way to get a decent, consistent link for RTK use. I tried changing frequencies, changing sensitivity, adding a "privacy code", all to no avail. So I told my client I would pull off the job and return when I had the problem solved.

ONE SOLUTION – Get off the Highway

The solution: spread spectrum, frequency hopping, 900 MHz radios. Technically, these are UHF radios as well, but these radios are generally lower power output, low power consumption and don't need an FCC license. So I did some quick research on the web and found radio pairs from about $1200 to $4000, a little more than I wanted to spend on a one-project solution. Then I talked to the folks at MaxStream, Inc. (http://www.maxstream.net), who had a 900 MHz spread spectrum (SS), frequency hopping, 1 watt output radio with a serial connection (RS232), their model DigiXtend, an RS-232 RF Modem. It has an omni-directional, low gain antenna that attaches directly to the radio itself (Fig. 3), and both radios can be configured easily for either base or rover. They can be powered from the GPS receiver through the DB9 serial port or from an external power supply. As well, they can be configured to be repeaters.

The frequency is the same as used by some cordless telephones and pagers and the frequency hopping means that packets of information are sent over constantly changing (hopping) frequencies. If one packet is "stepped on" (interfered with), error checking will retransmit the data on another frequency at an over-the-air-rate faster than the data baud rate for the GPS units. I was told by tech support that these radios would "solve my problem, just plug 'em in". They were right, and for less than $300 per radio. After a quick overnight of two radios to my office, a test RTK trial (successful!) at my office, I returned to the project in southern California and completed the job.

But these radios do have limitations. The SS radios are strictly line of sight. My project was a survey of a 370-acre lake, most of which was visible from one control point, so line of sight was not a problem. But if I went out of sight only slightly, the radio link was lost. I needed to set up an additional control point to "see" the remaining portions of the lake. Fortunately, these radios have repeater capabilities, just like UHF radios, and one can be set where it can "see" the base and the rover in order to relay (repeat) the radio signals. The PacCrest radios, however, seem to "saturate" an area better, so the radio link can be received much longer when there are line of sight obstructions. Also, since the SS radios are only 1 watt output, antenna cables can eat away at power, so the antenna really needs to be attached directly to the radio. The power and data feed can use the same serial cable, although you can use an external power source as well.

Fig 3 (next page) – MaxStream Spread Spectrum 1 watt radio, same for base or rover. Note small omni directional antenna attached to the radio and the standard serial cable used for power and data feed. Radio is attached with hook & loop strips to a mounting bracket clamped to a prism pole.

Some advantages and disadvantages I have experienced with the two systems (460 MHz and 900 MHz) are summarized below. I continue to use either system, depending on field conditions, and both have suited my purposes quite well.

Continued on next page


Fig 3

TECH TIPS

Continued from previous page

	PDL35W	RFM96W/TM32	XTend SS
output [1]	2/35watt	2watt	1watt
range [2]	5-7 mi	1-2 mi	40mi
area saturation [3]	very good	good	poor to none
weight (no battery)	3 lb	< 1 lb	< 1 lb
transmit/receive	both	both	both
repeater ability[4]	yes	yes	yes
interference [5]	possible	possible	less likely
connections [6]	proprietary (Lemo)	proprietary (Lemo)	serial DB9pin or barrel
power	9-16v	9-16v	5-13v
power source	external	from GPS unit	external or from GPS
antenna connector	BNC (common)	BNC (common)	RPSMA (exotic)
tech support	excellent	excellent	excellent

[1] optimal output - depends on MANY variables (antennas, cables, etc.)
[2] optimal – manufacturer spec, HIGHTLY dependant on MANY variables
[3] ability to cover areas out of line of sight – my opinion based only on my experience
[4] ability to act as repeater in data link chain
[5] susceptibility to others on same frequency – dependent on area and local radio "traffic"
[6] onboard connector for data or power supply ❖