Aldert Kluft

Radio Technology in the Field

Get the Best out of your Radios

Although UHF telemetry systems are often used to transmit RTK corrections from a GNSS base to a rover, many surveyors don't have the time to master the physics of radio technology. Despite the sometimes complicated theories behind propagation of radio signals, there are a few good hints and tips that can help non-experts get as much range and data throughput out of their RTK telemetry systems as possible, explains Pacific Crest's Aldert Kluft.

By Aldert Kluft

It's common to hear: 'If you want more range, get a more powerful radio'. But while it's true that the greater the output power, the longer the range, this may not be the best solution – just as shouting at someone not familiar with your language may not help them understand what you are saying. The question radio users should ask is not how much power they need for a certain range but what system do they need.

Before going out in the field, an RTK surveyor should ask himself two basic questions:

1. What is the best location to set up my base?
2. What is the maximum distance from the base I need to survey?

These two questions are linked. If you do not need to get a maximum range out of the system, there is no need to be very fussy about the optimum base location. But if you do need the best performance, you must choose a base location that is as high as possible and offers the clearest view of the survey area. Radio signals in the UHF band that are used for the RTK link can travel through buildings and trees, but the signals can be highly attenuated which will limit range. So the fewer obstructions there are between the base station and the survey location, the better.

If the operating area is larger than the radio range can offer, then there are two choices available. The surveyor can either decide to break up the area and move the base station toward the rest of the job, or he can use a radio repeater. The extra cost of the repeater is often paid for by the increased efficiency gained from not having to re-establish a base station. (Just keep in mind that RTK accuracy goes down as a function of baseline length.)

Antennas

When setting up the radios on the job site, the most important thing to remember is that

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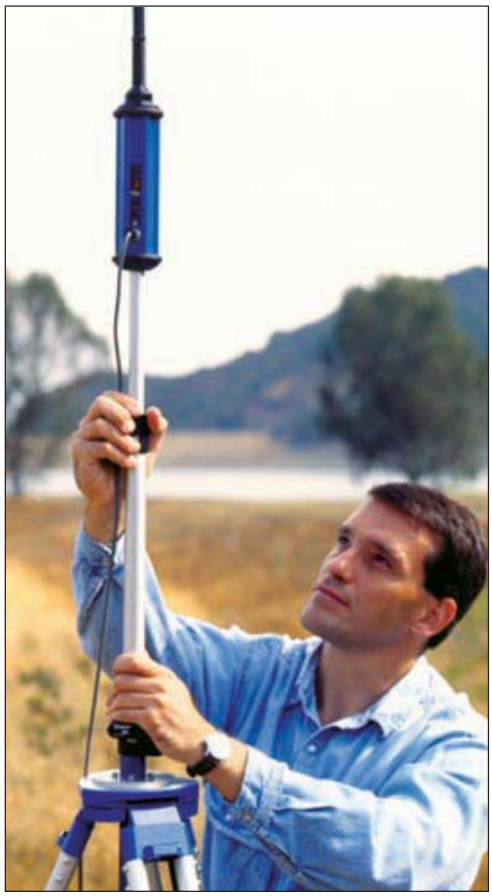
changing the elevation of the base antenna has more effect on radio range than varying the output power. First of all, antennas are designed with radiation patterns that are optimized when the base and rover antennas are at the same elevation. If you know that the base and rover antennas will not be at the same elevation, and if you do not require maximum range, you should use 'unity gain' antennas. Their radiation patterns are roughly spherical.

In addition, it is of paramount importance to keep both the base and the rover antennas as high off the ground as is practical. Low antenna elevation reveals a serious obstacle to radio performance: the earth absorbs radio energy with great efficiency. Even in an area with no topographic relief, if you install both the base and rover antennas two meters above the ground, your theoretical maximum range will be no more than 13.5 km - regardless of the transmitter's output power. The reason for this is that UHF radio signals are line-of-sight waves that do not follow the curvature of the earth.

You should also make sure that the radio antennas are vertical. When the transmitter's antenna is mounted in a slant position, some of the radio energy is directed into the ground or into the sky. When the receiving antenna is slanted, it cannot pick up the signal with maximum efficiency. So keep the antennas vertical!



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If your radio antennas are optimally located and the transmitter is at its maximum power setting, you can still increase range by switching to antennas with a higher gain setting. Using a 5 dB gain antenna rather than a 0 dB or 'unity gain' antenna will increase the radio's effective radiated power by a factor of 3. Of course, you must make sure that your radio license will permit this higher effective output.

When possible, do not use long antenna cables since all cables and connectors installed between the radio and the antenna contribute to attenuation and thus loss of range. For example, when using standard small coaxial cable (e.g., RG-58), every 10 extra meters of cable length will reduce your output power by half. It would be better to mount the antenna directly on top of the radio thus minimizing the cable's attenuation of the signal.

Radio Firmware Tool

Even if you have done your homework in the office and set up your base station in an optimal location, you might find the area is a large construction site crowded with

LPB on hike

other users. Ideally you should select a channel that is not being used by others because multiple transmissions on the same channel will cause poor reception by all users. One useful tool for determining if the channel is already being used is to simply look at the base radio's Rx LED. If it is blinking somebody is already using this channel. An even better solution is using a radio firmware tool called AutoBase. When selecting this option the radio will methodically scan every programmed channel and automatically select the quietest. The base radio displays this channel to the surveyor who can then select this channel on his rover radio also.

It is well known that radio signals transmitted on the same frequency will interfere with each other. But it is less known that these signals can be generated by a lot of sources other than another RTK transmitter using the same frequency. For example, the GPS receiver, a switching power supply (common in many electronics) or a nearby cell phone can all 'jam' RTK communications. The UHF radio receiver is designed to cope with a lot of these interfering signals, but if they are too strong, the radio will have to filter out the unwanted noise and this will reduce range. If possible, try to keep these sources of radiation away from the receiver.

The 'silent killer' of radio range is a weak battery. Over time, all batteries will fail to take a full charge – typically after 300 recharge cycles or 2-3 years – less in extreme climates. When a radio fails to obtain sufficient voltage from its battery, the first effect is reduced transmission range. It is best to replace the battery after recharging it 300 times or after 2-3 years. The cost of a battery is usually much less than the loss of on-the-job time.

Lastly, it is very important to keep all the connectors clean in order to maximize range. Never let connectors drop on the floor and get damaged or dirty. Use cable bags to wind up excess cable length so that it will stay protected. A small amount of dirt or corrosion on an antenna connector can block RF signals dramatically and substantially limit range. Even the smallest amount of maintenance will go a long way to protecting and maintaining range.

Much can be said about radio technology and its practical use in the field. The above article only touches on the easiest and most obvious elements a surveyor can control in his endeavour to get the most out of his range.

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Column

Keep It Simple

Traditional GIS web mapping is characterized as complex, slow, and mired with over-designed applications. The GIS world is adept at writing GIS applications for GIS professionals but often stumbles when attempting to design applications for non-professional end users. GIS professionals have long taken their desktop applications and attempted to replicate them on the Internet often resulting in complicated solutions that missed their target audiences. There seems to be a tendency in GIS development to throw in tools and functions that are not needed and in turn get in the way of the true functionality of the application. In addition to being a waste of effort and money, over-engineered GIS tools foster the reputation that GIS is expensive and complicated.

Simplicity is on the way. The arrival of Google Maps has brought a visual mapping front end to users without all the cumbersome baggage associated with GIS applications, namely toolbars, SQL queries, and slow performance. Now everyone everywhere is looking at deploying spatial applications that are custom designed to address for the end user.

The key to success is to really understand who the needs and expectations of the end user. Developers and users sometimes draw the conclusion that proprietary tools such as ESRI cause these complicated applications, but it is possible to develop clean, straightforward solutions using these tools. The challenge for developers is to resist the temptation to add features that aren't part of the project scope. Much of the magic that makes Google Maps and Virtual Earth such great visualization tools is their simplicity. Making simplicity a goal of every GIS solution will give end users tools that they want to use and that make everyone on the project happy.

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