An Automated, Real-Time, Search and Rescue Team Tracking System

Jeff Lehman
619-461-6177
jeff.lehman@gcccd.net

A six-month progress report to the Mountain Rescue Association grant program.

Summary of Progress

Since the last report we have conducted two more field tests. One test was over a large region in hilly desert terrain, and the other was over a relatively small area in steep canyons. In both cases all six tracking devices were deployed in standard radio chest harnesses. In each case the portable digipeater was deployed with a Handspring Visor Deluxe running PocketAPRS, and the base station displayed the data on a personally-owned laptop running APRS+SA APRS software. In both tests, teams were tracked effectively, and the necessity of the roving digipeater has been firmly established.

Hardware

The hardware has not changed since the last report. The TigerTrack TM-1 encoder is proving to be a useful platform. To make it better adapted for SAR use, the following suggestions have been made to the manufacturer.

- Provide a housing that will accommodate a 9 volt battery.
- Some kind of voltage meter or battery “gas gauge”
- Use a detented dial to change profiles rather than the push-button method now used.
- Provide the ability for each profile to have a different callsign[1]. This would allow different tactical call signs to be selected in the field rather than having to program them via the computer interface.
- Provide for the ability to change modes and lock all the buttons from the front panel. Right now, the front panel buttons can only be locked from the computer interface.

This means that in order to change the mode of a locked encoder it must be connected to a computer.

We have not tried “Mic E” encoding, and will probably try this on future tests. Mic E encoding sends a short binary position report at the end of a voice communication.

ENCODER PACKAGING

We continue to revisit the container issue, and continue to use the radio harness. This seems to put the radio and GPS in the best orientation and it requires no custom manufacture. If we were to use an integrated GPS and radio, the overall package could be made much smaller, but our goal was to use existing team hardware. We may pursue custom harnesses that will be waterproof for carry. In a recent meeting I was approached by somebody who custom sews chest harnesses, and he suggested he could make a waterproof harness for this hardware. This may provide an all-weather option. Still, since we are looking at the viability of using whatever GPS and radio a team owns, the packaging will be dictated by those two items.

ROVING DIGIPEATER

The use of at least one digipeater to fill in radio coverage is important for the success of APRS in wilderness environments. Using an HT for radio communications in the wilderness is a compromise, at best. For most search areas two roving digipeaters should be sufficient. However, there is a large caveat to this statement. Our tests have been conducted in the amateur spectrum allocation; we are using the APRS frequency of 144.390 MHz. This means that we have benefitted from the extensive amateur digipeater infrastructure. While our tests have shown that we can exist without this infrastructure, we have also found the extreme benefit of having these resources available. For example, we have been able to track our progress via the Web at the site www.findu.com. We have found that in every test (Yes, even the one in the middle of the desert!) we have hopped onto the Net via a mountain-top digipeater that heard our signals. We have had team members who watch our test progress from their homes hundreds of miles away on the Internet.

For the volunteer search organization, using the amateur frequency allocation is not a problem as long a a few licensed amateur radio operators are involved. A tracker worn by a non-licensed searcher seems to be legal under the unattended operation requirements for packet radio operation. There is precedent in this regard. This changes when an agency attempts to deploy with paid responders who are provided communications as part of their daily activities. In this environment, the use of amateur radio is not legal. However, our studies show one or more roving digipeaters will work fine in most wilderness situations.

The roving digipeater operator does not have to know anything about the radio hardware. Their job is to find a location in view of both the command post and search area and take a nap. This changes, however, if the digipeater also attempts to plot locations. We have done this using a Handspring Visor Deluxe and PocketAPRS software. We have found that this is very useful in the roving digipeater in that it allows the operator to view position reports to make sure that he is hearing all of the stations in the field.

1. The encoders have the capability to store and use different profiles. A profile consists of a data path and icon. In this manner by selecting different profiles a different data path can be used, but the call sign and any comments will remain the same across all profiles.

This is not a requirement, as this can also be accomplished through communication between the command post and roving digipeater. In our first test, we moved the roving digipeater upon prompting by the command post. They would tell the digipeater the direction to head, and the digipeater driver would find a location in that vicinity. The use of PocketAPRS has streamlined this process because the roving digipeater operator can adjust his position "on the fly" to optimize digipeating. The use of PocketAPRS, however, greatly increases the technology skill level requirements for the digipeater operator.

DIGIPEATER TNC SETTINGS

We have set up the encoders to use a "To Call" of "SAR" and to use a path of RELAY, WIDE3-3. The digipeater (Kantronics KPC-3+) is set to digipeat all packets with RELAY or WIDEn-N in their paths.[2] It is important to use the WIDEn-N path in our area, but also in the event of the use of additional roving digipeaters. In short, the WIDEn-N path reduces, and in many cases, eliminates additional repeating of packets that can clog a network. We have left the RELAY in the path in the event that a team is not heard by the command post or roving digipeater. In that case it may be heard by another amateur station that will digipeat RELAY packets. If this system were moved off of amateur frequencies the use of RELAY would not provide any benefit.

The use of the "To Call" of SAR was to help in filtering the position reports of the teams. Since we are operating on amateur spectrum near a major metropolitan region, there are hundreds of stations that will appear on our maps. With the software we can filter by either the "To Call" (also called the "unproto path") or the call sign attached to the packet (to be legal, every packet must be sent with a valid amateur call sign). We have chosen to use the tactical call signs of SAR01–SAR06, since the software is set-up to display call signs. We placed the amateur call sign in the comment field of the position packet to keep the transmissions legal.

Software

The software continues to be the linchpin of the operation. We are fully aware of the requirement for topo maps to display positions, but there is little interest by commercial electronic topo products in adding this component. We have called topo vendors such as MapTech and National Geographic's Topos (Formerly TOPO!), and they have not been receptive to the addition of the APRS feature set. MapTech said that they get many requests and "may add APRS support in future versions". After field testing, however, we have found that one of the most useful features is an ability to display a table of position reports in a variety of coordinate systems and datums. In fact, if this author had to choose between topo support and the ability to display positions in different datums and coordinate systems, he would NOT choose topo support. Of course, both would be helpful and should be the goal.

2. This is a non-technical discussion. For details specific to the Kantronics KPC 3+ TNC and related components feel free to contact the author.

APRS+SA

For the two tests performed in this cycle, the APRS software used in the command post was APRS+SA[3], and the roving digipeater used PocketAPRS.[4] APRS+SA is an APRS front-end for the DeLorme StreetAtlas[5] series of maps. While the maps are not well suited for wilderness search and rescue, APRS+SA has a feature that other packages don't have: It can easily do datum and coordinate system transformations. A position report can be highlighted and it can be quickly converted to UTM and to different datums. Also, it has better data logging abilities than does APRSPoint in that it plots paths a bit better (The author of APRSPoint says that this will change soon, however.). APRS+SA is not without its usability issues, however. It is not as tightly integrated into StreetAtlas as APRSPoint is with MS MapPoint, so it suffers from some usability issues. The ability to transform datums and coordinate systems puts APRS+SA into a much more useful category than similar products.

POCKETAPRS

PocketAPRS was used in the roving digipeater. This tool runs on PalmOS 3.0 and plots positions on rudimentary maps. It also has useful tables of positions and relative distances from its location. That is, it will tell you that a team is on an azimuth of *x* degrees and *y* miles from your location. This program helped greatly in positioning the roving digipeater. The driver could quickly tell which stations he was hearing, and plot the location of the next move of the digipeater. The use of this tool also greatly impacts the user-friendliness of the digipeating hardware.

Upon start-up PocketAPRS makes changes to the TNC configuration. So, each time it is started, certain configuration parameters of the TNC need to be changed back. This means that the user must be familiar with the TNC commands. Also, for some reason, the software will cease to gather reports. We are not certain if it is a cabling, hardware, or software issue, but occasionally the Palm needs to be restarted. This problem, with the TNC reconfiguration problem, do not make the Palm PDA/PocketAPRS combination in the digipeater "field ready" for the non-technically savvy. Without PDA and software, anybody that can drive a vehicle could run the digipeater as it is a "hands-off" operation.

The author of PocketAPRS is working on a table that will do coordinate and datum conversions. Currently he is running into some trouble, but is interested in solving the problems with its implementation. I hope that this gets deployed soon as I think it will be one of the more SAR-useful platforms for APRS.

Field Test

CHALLENGING DESERT

Our second test involved a team on land navigation training in the middle of the East Mojave National Preserve. The navigation course was spread out over several square

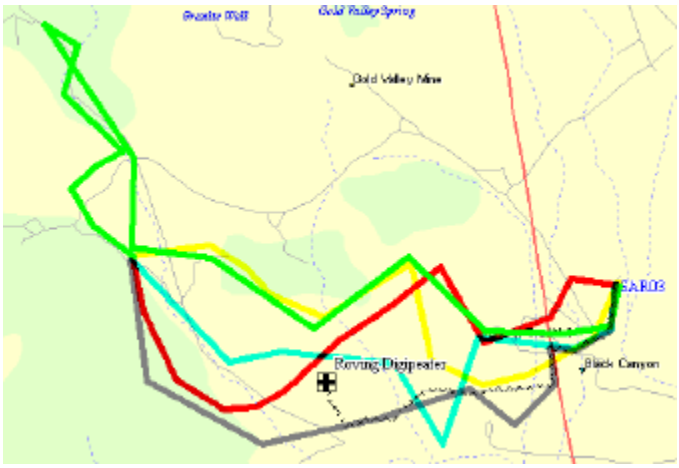
3. www.tapr.org/~kh2z/aprsplus/
4. www.pocketaprs.com
5. The latest version of StreetAtlas can be found at www.delorme.com, but APRS+SA only runs on certain versions, so make sure you read the information found in footnote #3 above.

miles and twelve teams of two or three were deployed that day; six of them had tracking devices. The start point was a few miles from the command post back at the camp site. Most of the course was separated from the command post by a large hill (those on the East Coast may call it a “mountain”). In addition the command post was at the bottom of a hollow in the terrain. An HT could not communicate between the start point and command post; a mobile radio could make the trip, however. The digipeater was deployed on a rise near the start point and did not need to move throughout the operation.

Each of the 6 teams was tracked throughout the operation. Most of the position reports received by the command post were the result of digipeating by the roving digipeater, but as teams made it past the large hill the command post was able to receive their signals directly. As in the first test, there are interesting anecdotes with respect to the use of APRS during the operation.

Early in the day, the command post notified me that a team was heading in the opposite direction of the other teams. In fact, they were travelling very quickly out of the course area. I passed this information along to the Operations Chief for the training, and he wasn’t convinced that our reports were correct. In fact, we gave him a set of UTM coordinates, and he said something to the effect that this team wouldn’t be way up there, and that the coordinates didn’t make sense. A while later we began to lose radio contact with the errant team and I showed him their last position report in relation to the other teams using the PDA and PocketAPRS. All of the other teams were within a mile or two of our location, but this team was nearly 5 miles away in the opposite direction. Now, his interest was piqued. Another call to the command post gave us updated UTM coordinates for their last known position (It would have been nice if the PocketAPRS could do coordinate transformations.). The Ops Chief ventured to this location and found them very close to where we had last placed them. Another triumph for team tracking! We also found that in many cases our data communication worked better than the voice communication since many times teams could not be heard effectively on the radio, but we were still getting valid position reports for them. A few of the teams that were tracked can be found in Figure 1 on page 6. Notice the track (green in a color display) of the team that is north of the other teams.

FIGURE 1.



STEEP CANYONS

The third test involved a short search, and long rescue in a steep canyon near Mount Baldy, CA (Ice House Canyon). We deployed our trackers with five teams initially in the field. The canyon was very steep and narrow, so the roving digipeater did not rove much. In fact, the searchers found the patient within a mile of two of the command post, so most of our position reports came in directly, and the digipeater was not necessary. To be honest, this scenario did not yield much new information or ideas for our effort. The search area was relatively confined and the patient was found relatively early in the effort. We were able to track the progress of the litter that was sent when the patient was found. From a management perspective knowing the location of this additional gear was helpful.

Budget

We are still waiting to license our software pending some version changes, and we are seeking additional funds to construct another roving digipeater. Also, we need additional funding for incidental items such as batteries, as there is no money left for these items. It is our hope that our department will fund these additional items, but with the current California budget problems, we are not counting on continuing support.

Continued Efforts

We will continue to field test the trackers as the opportunity arises. We are looking to deploy them in an actual search, and are currently working on the best way to do this. Also, we will continue to work with the software authors and hardware manufacturers to perfect their products towards SAR use.

Once again I would like to thank my teammates, Tad Gallistel, Mark Kern, and Mark Kinsey. Without their continued help and guidance this work could not continue.