Staying on Course with Packet Trackers

An ARES® group designs and implements a location tracking system for a 100-mile bike ride.

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The rolling hills of southeastern Williamson County, Tennessee are home to the annual Harpeth River Ride, a premier cycling event with routes ranging from a semi-leisurely 22 miles to a strenuous 100 miles with almost 5000 feet of elevation change. Each year, this event draws up to 1500 riders of all ages and skill levels. Previous participants include Lance Armstrong, Chris Horner, Ben King, and Levi Leipheimer. Even Tennessee Governor Bill Haslam has participated in the ride.

A cycling event covering 350 square miles requires event planners to prepare for unpredictable weather conditions, mechanical failures, and medical emergencies. To best serve the riders, reliable communication and rapid response are key.

Unfortunately, the same beautiful rolling hills that make the ride so enjoyable interfere with reliable communications. In the hills, the rest stops and SAG (support and gear) vehicles often cannot communicate with one another, making this a perfect opportunity for Amateur Radio to demonstrate its usefulness.

The Challenge

For the past 2 years, ride event officials have partnered with the Williamson County Amateur Radio Emergency Service (WCARES) to help connect rest stops and SAG vehicles with the command post.

During the event last year, it became apparent that voice communications alone were not meeting riders' needs. Event officials needed a way to accurately track the SAGs and dispatch the nearest vehicle to pick up distressed riders or provide mechanical

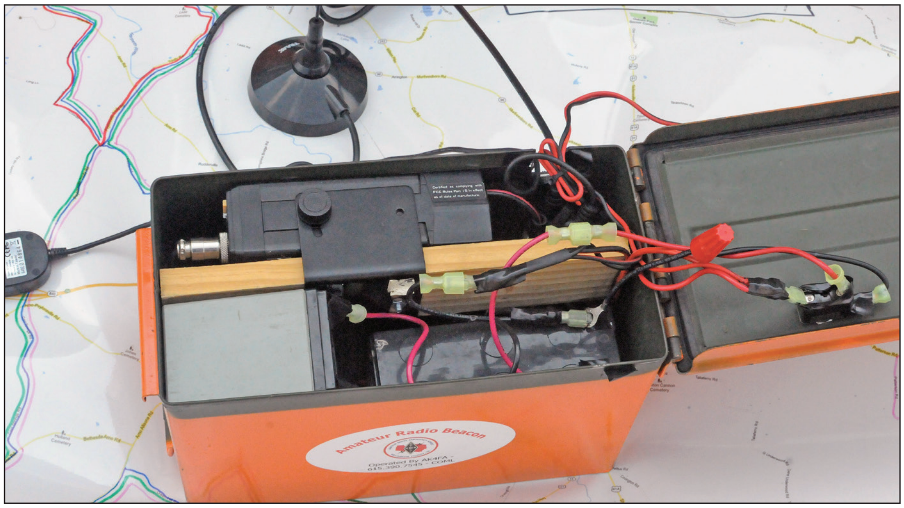

Figure 1 — An APRS tracking unit in its bright orange surplus ammunition can. In order to fit two 7 Ah batteries, one has to stand on its end (bottom left of the can) and the other lies flat (bottom right of the can). The radio is mounted on scrap wood with its mobile mounting bracket.

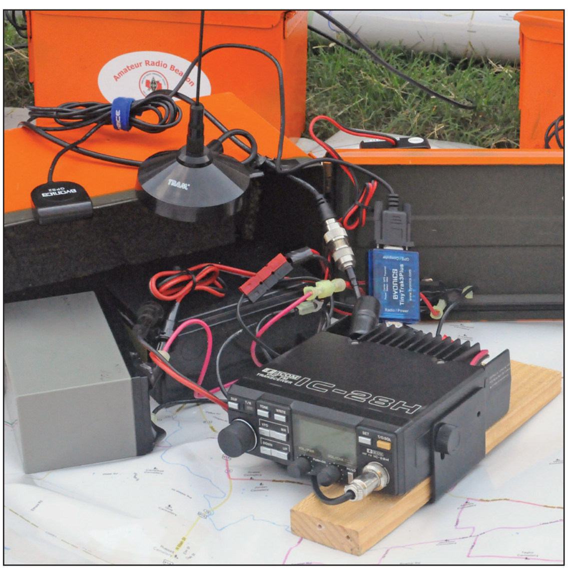

Figure 2 — The GPS receiver and antenna, along with the radio, batteries, and TinyTrack3.

Figure 3 — The last leg of the APRS infrastructure that bridges radio to the Internet is the iGate. The iGate remained at my home, where it picked up packets from the event digipeaters and forwarded them to the APRS servers using my Internet connection. The Microsat WX3in1 Plus 2.0 iGate performed flawlessly during the event.

Figure 4 — The 75 W digipeater in the back of a vehicle during testing. The Microsat PLXdigi (small white box on the left) provided reliable digipeating for the event.

assistance. In previous years, riders had to wait 30 minutes or more to receive assistance due to "guesstimation" of where the nearest SAG was located. Officials wanted to reduce this delay significantly.

While a linked repeater network already provides reliable V/UHF voice communications throughout the county, accurate position reporting was not readily available. APRS (Automatic Packet Reporting System) was the obvious choice for providing real-time location updates.

Because WCARES uses this event as an ARES training exercise, they adhere to the FEMA ICS reporting methodology. It would be terribly inefficient to sort through ICS logs to try to determine a potential responder's availability and location on the fly. The group needed an accurate way to display the position of the event's eight SAG vehicles and six rest stops on a map, using tactical call signs, without the unnecessary clutter of other regional APRS traffic.

Tracking Progress

After settling on APRS as our tracking solution, we realized that not all of our event volunteers had APRS trackers. Dave Mann, N4CVX, had started the project of building APRS trackers in surplus ammo cans, and passed the project to me to finish in time for the event. The final APRS trackers used 2 meter mobile radios, Byonics TinyTrack3s, Byonics GPS receivers, and 2 meter mag-mount antennas. Two 7 Ah batteries, wired in parallel, ensured that each tracker unit had enough power for the full 12-hour event (see Figures 1 and 2).

Not only did we need to test the APRS trackers, we also needed to determine if there were any APRS coverage gaps in our region. With this is mind, a small caravan of WCARES team members drove the full 100-mile course to test current digipeater coverage using various power levels ranging from 5 – 50 W.

Using the **aprs.fi** website to plot the results, we noticed a significant gap in the far eastern reaches of the county. Dallas Clements, K7DCC, analyzed the gaps, calculated the APRS frequency saturation, and determined potential sites for auxiliary digipeaters or iGates (Internet gateways, see Figure 3). Following his recommendations, we constructed a digipeater using the PLXdigi APRS digipeater from Microsat (**microsat.com.pl**) and a 75 W mobile radio (see Figure 4). We secured permission from the county to set up our digipeater at one of their tower sites, which just happened to be the second highest tower in the county — and almost exactly where we needed the boost in coverage! Through testing, we found that a 90-second beacon interval did not overload the network and provided accurate positioning even with occasional dropped packets due to sporadic coverage in some areas. With the trackers ready, the software solution was completed.

Computer Aided Dispatch

Looking to the public safety arena, I customized the open-source *TicketsCAD* (Computer Aided Dispatch) software suite (**ticketscad.org**) for WCARES. *TicketsCAD* connects with the APRS global servers and displays the position of a tactical unit on screen in real time. In addition, we could upload a Google Maps KML file and overlay it on the dispatch system. For the ride, each route was mapped, color-

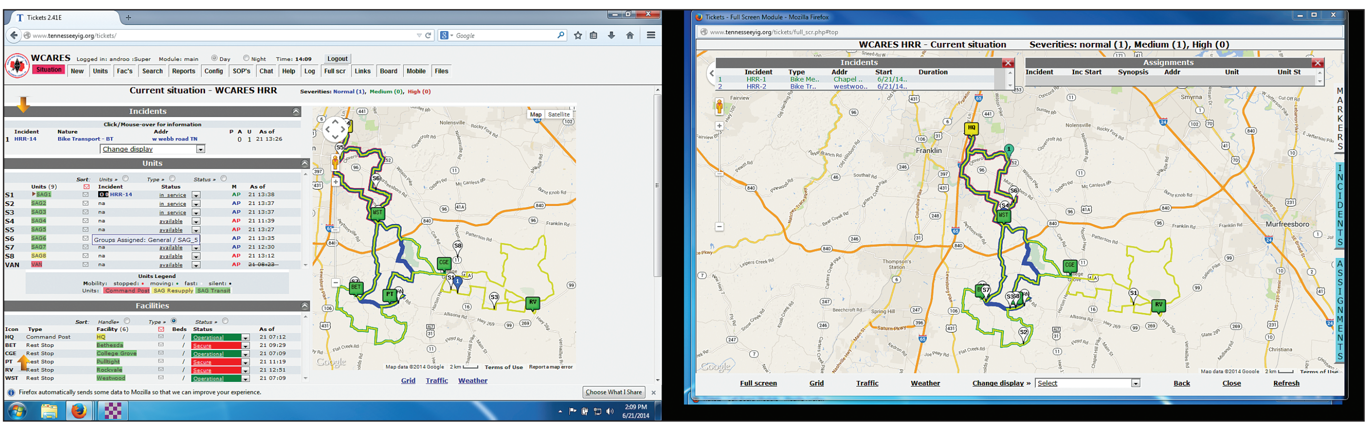

Figure 5 — This screenshot of the dispatch software shows the status and location of each incident, SAG vehicle, and rest stop. The route map is overlaid with a Google Maps KML file. To overlay the routes, we used different thicknesses and colors for each route in Google Earth before importing the file into the *TicketsCAD* system.

coded, and stacked in *TicketsCAD* interface to show where each SAG vehicle was located along each of the four event routes (see Figure 5). The *TicketsCAD* software also displayed facility locations, which aided in keeping track of which rest stops were open.

Whenever an incident was reported, the software showed which SAG vehicles were closest. The *TicketsCAD* user was then able to immediately dispatch the closest unit to the incident. While e-mail-based dispatch may work well when there is Internet access, the SAG vehicles and rest stops in this rural area did not have reliable voice or Internet coverage via cellular networks. I modified the standard *TicketsCAD* software to automatically generate Winlink messages and send them out with each dispatch. Net control notified the SAGs of a dispatch by voice repeater and a Winlink copy of the incident description and directions was sent to the Winlink capable units. Similarly, rest stops could e-mail supply orders via Winlink or a voice repeater, which were then filled and delivered via SAG.

The Big Event

Installing the APRS trackers and 2 meter mobile radios for voice communications in the SAG vehicles proved somewhat tricky. Instead of using personal vehicles with permanent antenna and radio mounts, the corporate sponsor, Nissan, provided a selection of their newest SUV models. Due to high temperatures, a chance of thunderstorms, and a desire not to destroy antenna cables by pinching them in the door, we utilized water pipe insulation, fitted over the top of the window glass, to create a path for cables to come into the vehicle while keeping rain and heat outside (see Figure 6).

With a successful test run and the APRS trackers installed, it was time for the big event. At the command post, I ran the APRS dispatch; Robin Patty, K4IDK, was communications unit leader (COML), and Scott Gray, KD4VVC, was Net Control. We partnered with the Tennessee Emergency Management Agency (TEMA) and the Williamson County Emergency Management Agency to test interoperability and our communications systems. Setting up shop in the TEMA mobile command unit, we thoroughly enjoyed the air conditioning and proximity to the public safety dispatch team.

Figure 6 — Routing antenna and GPS cables in borrowed vehicles can be challenging. To avoid shorting the coax by closing the door on the cable, we used pipe insulation over the window glass to create a moisture and air barrier without damaging the cables.

Our first major incident occurred when we discovered that someone had thrown tacks on the steepest downhill section of the course, resulting in a few dozen flat tires and one injury wreck. We dispatched SAGs to sweep the roads with brooms and quickly relayed the need for medical assistance through EMS. We then relayed reports from riders through the SAG vehicles to the Sheriff's office so that they could locate the perpetrator. *TicketsCAD* allowed us to quickly pinpoint the incident location, determine the nearest SAGs available to respond, and keep track of all of the open incidents on the dashboard — a feat that was previously relegated to pages of paper logs.

TicketsCAD not only helped the hams locate riders, it provided a superior location service for first responders as well. Riders needing assistance during the event only gave general descriptions of what mile marker they had reached on the course, making EMS response challenging. By using the overlaid route maps from *TicketsCAD*, we were able to pinpoint locations for the EMS dispatcher, who then relayed the exact location to first responders. This was interoperability at its finest.

The Finish Line

After 12 hours of operating, hundreds of verbal communications, position reports, and Winlink messages, the event was over. Event officials were pleased with our performance. We significantly improved response times, provided better resource tracking, and minimized the distance SAG vehicles traveled to reach a rider.

The experience that we gained from this exercise helped us to plot the limits of our county's current APRS infrastructure. It also brought increased awareness of the benefits of APRS tracking for emergency response scenarios. Many of our WCARES members have now installed permanent APRS equipment in their personal vehicles.

Building on what we learned this year, we are already looking ahead to next year's event, when we plan to build out our APRS infrastructure to increase the precision of our tracking in our most rural areas. We also expect to raise the bar, using two-way APRS messaging instead of one-way APRS trackers.

All photos courtesy of Andrew Gossett, AK4FA.

Andrew Gossett, AK4FA, an ARRL® Life Member, was first licensed in 2011. Andrew passed his tests all the way up to Amateur Extra class in one session. While attending the University of Tennessee Law School, he joined the Amateur Radio Club of the University of Tennessee, AA4UT, eventually becoming president. Bobbie Williams, W1BEW, the club's advisor and call trustee, was Andrew's first Elmer and spurred his interest in moving beyond ragchewing. After moving to Nashville, Andrew became active in Williamson County Amateur Radio Emergency Service (WCARES). Today, his main interests are disaster communications, APRS, MESH networks, and satellite work. Andrew is a practicing attorney in Nashville with a spouse, Allison, and a miniature schnauzer named Bailey. Andrew can be reached at 2122 Kidd Rd, Nolensville, TN 37135, **ak4fa@arrl.net**.