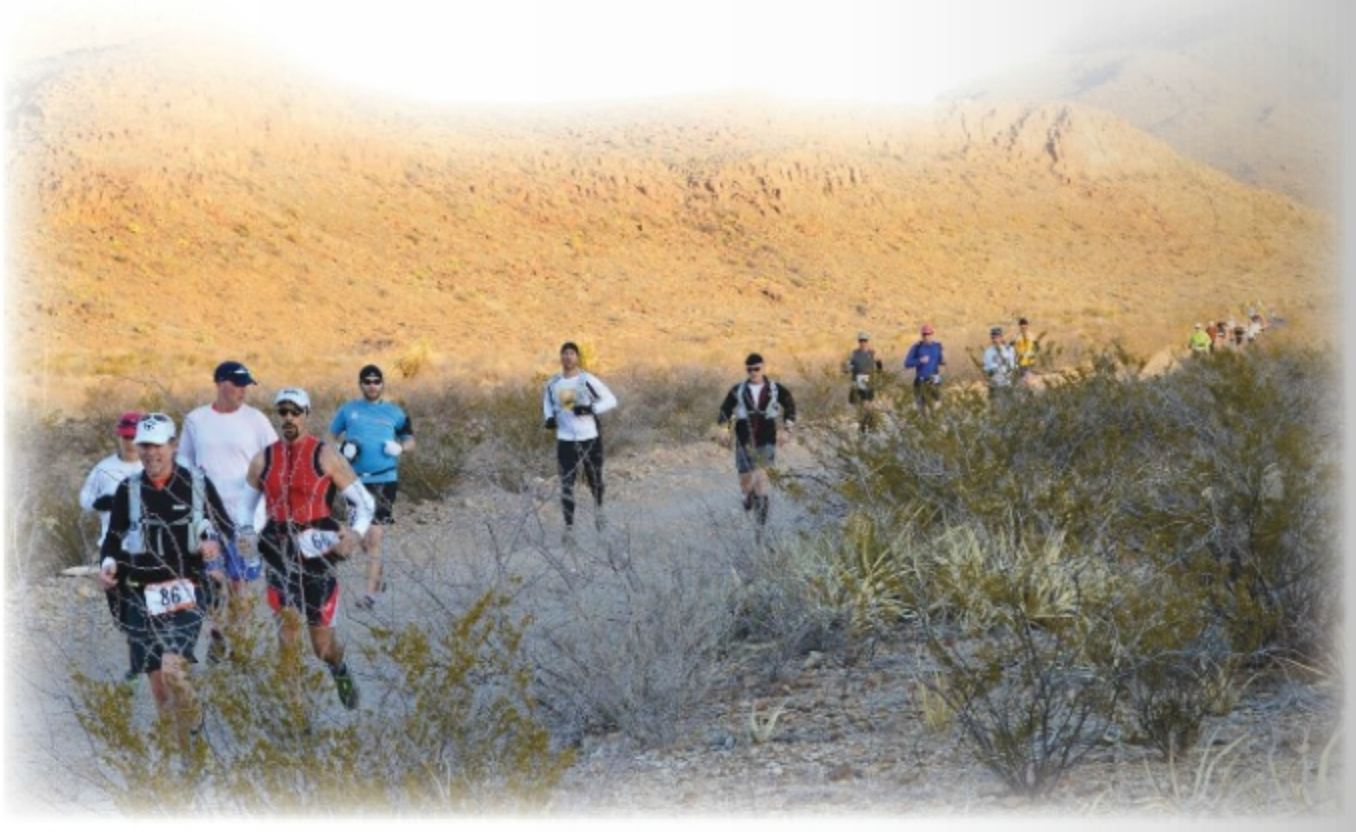
A Broadband Ham Network Crosses the Finish Line

A broadband ham network brings long-range video to the Big Bend 50 Ultra Marathon's finish line.

Lynn Jelinski, AG4IU



Big Bend National Park is located north of the Rio Grande River, which separates the United States from Mexico. Big Bend, which is larger than the state of Rhode Island, is a remote and dramatic wilderness located within the harsh Chihuahuan Desert.

Each year in the cool weather of January, Big Bend National Park hosts the Big Bend Ultra Run, a 50 kilometer (31 mile) marathon that is limited to 150 runners to minimize environmental impact. Athletes come from around the world to compete.

The Challenge

To support the marathon, hams from the Big Bend Amateur Radio Club, the Austin Amateur Radio Club and the San Antonio Radio Club established a race control and safety net on 2 meters. The race net had been used during previous races and had proved very effective both for coordination of race activities and runner safety. However, for the spectators, something was missing.

The friends and family of race participants couldn't watch their runners cross the finish line because they were cordoned off in an amphitheater at Rio Grande Village about 10 miles away.

The Solution — a Finish Line Cam

A group of hams from the Austin ARC (Joe Jelinski, KC2KG; Paul Kinney, KD5VRU; Mitch London, KD5HCV, and Alan Russell, KE5DTR) got the idea to deploy a high-speed multimedia mesh (HSMM-MESH) network to broadcast a live video feed from an Internet protocol video camera (similar to those used in security applications) at the finish line for spectators gathered in the remote amphitheater. The network is easy to set up, battery powered and far less expensive than a satellite link.

The Equipment

HSMM-MESH nodes are made from readily available consumer Wi-Fi routers (see **www.hsmm-mesh.org** for model numbers that are supported by the software). No internal hardware modification is needed; it's simple to re-

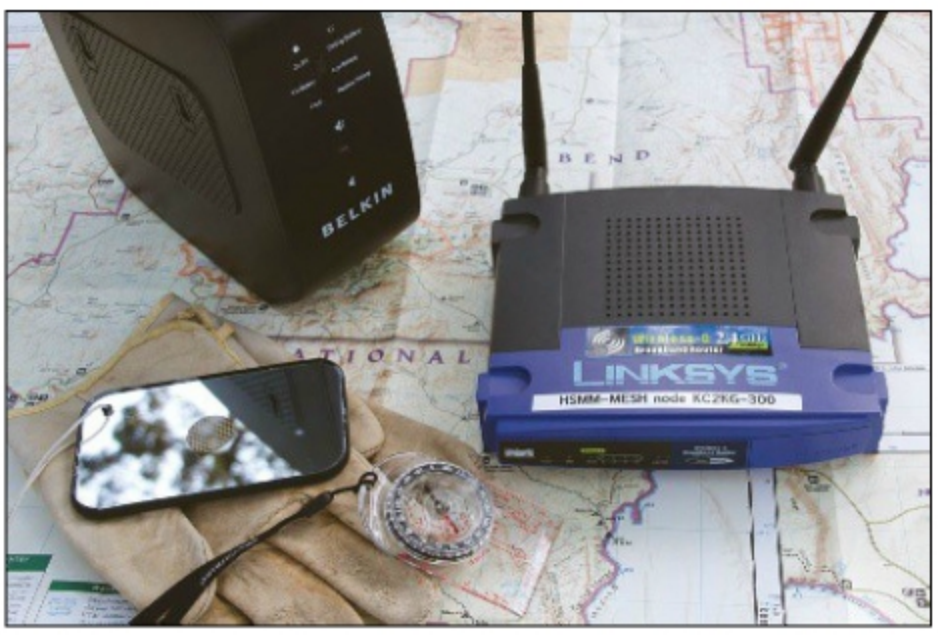


Figure 1 — The equipment used to establish the HSMM-MESH nodes are the Linksys router, a 12 V battery-powered UPS, signal mirror, compass and leather gloves. [Lynn Jelinski, AG4IU, photo]

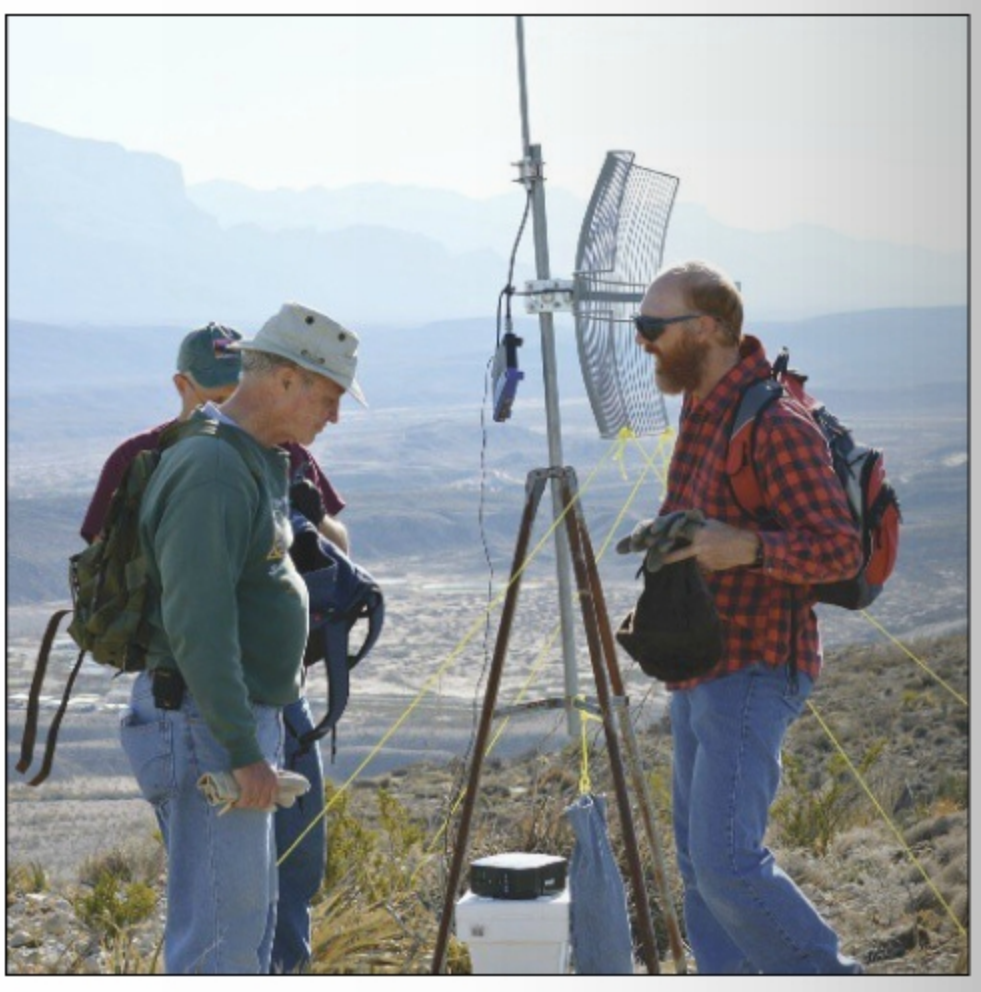


Figure 2 — From the left are Mitch, KD5HCV; Joe, KC2KG, and Alan, KE5DTR, who used a compass to aim the antenna and a signal mirror to confirm the orientation. The antenna is secured with guy wires attached to 10 inch steel spikes. The cooler is to keep the battery-powered UPS warm during the night. [Paul Kinney, KD5VRU, photo]

Figure 3 — Alan Russell, KE5DTR (L), and Joe, KC2KG, are looking out from the HSMM-MESH node location atop Ernst Ridge to the finish line 9.1 miles away. [Mitch London, KD5HCV, photo]

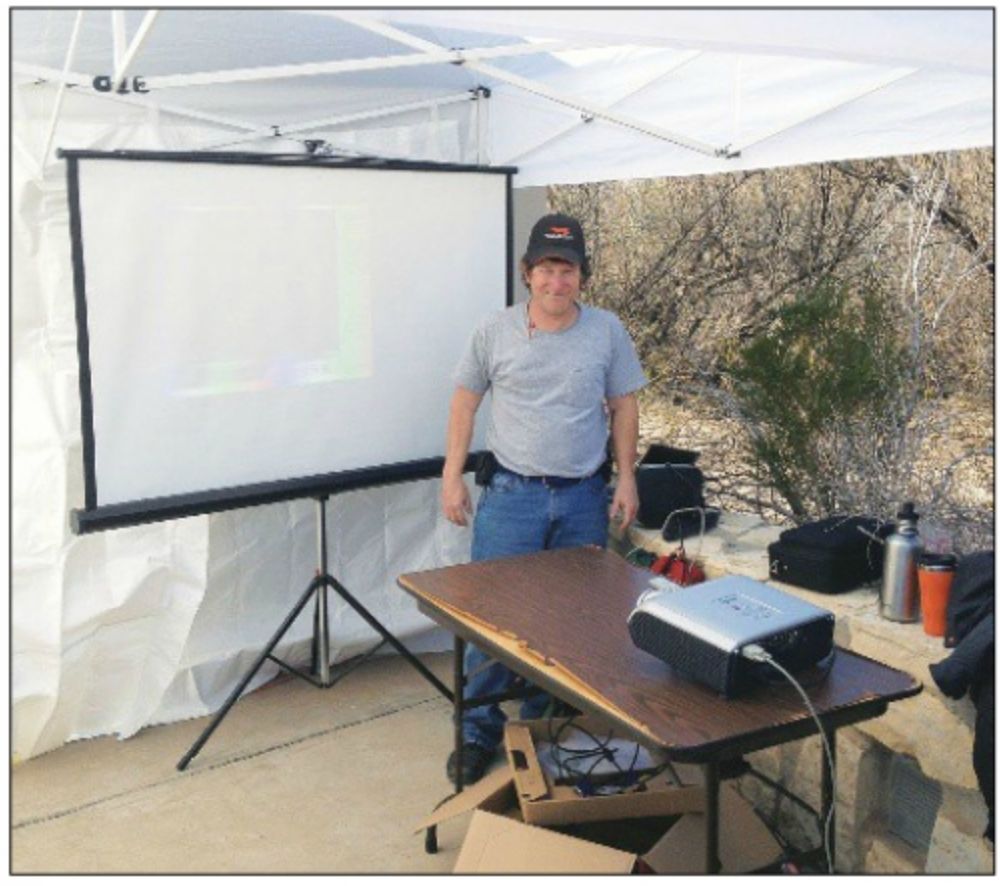


Figure 4 — Paul Kinney, KD5VRU, adjusting the video display and dealing with the bright Texas sun. [Joe Jelinski, KC2KG, photo]

program the router with free software downloaded from the site. The software converts the standard router to a microwave mesh node. [A mesh node operates within a mesh network. Each node in the mesh network can acquire data from an external device (such as a video camera) and also relay data acquired by other nodes. — *Ed.*] The converted router will still use the factory transmit power of about 80 mW.

As the nodes are powered up, the software enables each node to discover other nodes within range, form network paths and transfer data automatically.

Two of the nodes, the finish line camera node and the Ernst Ridge relay node, were in locations so remote that they didn't have electricity. We chose to use lightweight (6 lb) 12 V battery-powered uninterruptable power supplies (UPS) to power these nodes (see Figure 1).

The Amateur Radio Advantage

These routers normally deliver only household distance operation. This is where Amateur Radio comes in. Some of the 802.11B/G (2.4 GHz) channels overlap the Amateur Radio bands. If you hold a Technician class or higher license you may attach an amplifier, antenna or both to the node to increase its useful range. Remember, only the operating software (firmware) in the Wi-Fi router is changed to convert it to a mesh node.

Deploying the Network

Using microwave path analysis software, we determined we needed two nodes, one for a 9.1 mile path (see Figures 2 and 3) and another for a 1.8 mile path. For the 9.1 mile path from Ernst Ridge to the finish line, we used a 24 dB dish antenna at both locations. For the 1.8 mile path to the Rio Grande Village, we used a 12 dB omnidirectional antenna paired with a 12 dB Yagi. With these antennas and clear signal paths, we didn't need an RF amplifier.

Network Performance

Thanks to careful placement of the nodes, good antennas and the low RF noise floor at Big Bend National Park, we were able to get 100% copy. We placed backup batteries at each remote node in case we needed them, but the original batteries lasted for the entire 10 hours of the race. The batteries powering the video camera lasted for 6 hours and needed to be changed during the race.

Prior Planning and Testing Payoff

Our group spent many of our Digital Wednesday meetings planning the operation. We studied topographical maps, tested the nodes and checked the cold-temperature performance of the batteries. Having planned the antenna locations, we performed a microwave path analysis of the terrain to see how reliable the paths would be.

Once at Big Bend we validated our planning with on-site testing. We set up the network, checked antenna stability and battery integrity 2 days prior to the event. In preparation for the event each of us had climbed Ernst Ridge with heavy backpacks at least three times, clawing for handholds in the rocks while hoping the temperature was too cold for scorpions and rattlesnakes. Each ascent was the equivalent of climbing 400 stairs.

Hot Wash-up

It was dark by the time the final runner, who was by then a walker, hobbled across the finish line. Under the light of the stars we reviewed what went well and what could be improved.

The major glitch of the event was that we underestimated the intensity of the setting Texas sun. It was so bright that it overpowered the video projector. Despite our having erected a canopy over the screen, using a projection screen with a highly reflective surface and a high-powered projector, the finish line video projection was hard to see (see Figure 4). Next year we will use a TV screen or a CRT to display the live video feed.

Next Year — Audience Cam

Spectators loved seeing their runners cross the finish line, but the runners themselves didn't hear the cheers or share in their exhilaration. Next year we plan to place a second video camera in the audience — an "audience cam" — so we can provide a live video feed to the athletes at the wilderness finish line. HSMM-MESH is up to the task!

Joe Jelinski, KC2KG; Paul Kinney, KD5VRU; Mitch Lodon, KD5HCV, and Alan Russell, KE5DTR, contributed to this article.

Lynn Jelinski, AG4IU, an ARRL member, was first licensed in 2000. Lynn and her spouse, Joe, KC2KG, were members of the East Coast Waterway Net during their 11 years operating maritime mobile. Lynn helps universities write grants for research funding. Lynn and Joe can be contacted at 6406 Hopkins Dr, Austin, TX 78734, **kc2kg@earthlink.net**.