Past, Present, and Future: HPWREN and First Responders

Since 2001, the High Performance Wireless Research Network (HPWREN) team has been working with San Diego County first responders to better understand how high-speed wireless ad-hoc networking can assist with incident management in hard-to-reach areas. The NSF-funded HPWREN team has worked with the community to establish connectivity at three California Department of Fire and Forestry (CDF) pre-designated Incident Command Posts (ICPs): Dos Picos, Puerta La Cruz, and Potrero. Additionally, HPWREN researchers deployed high-speed network communication capabilities at five major wildfire ICP sites: Coyote Fire (July 2003), Eagle Fire (May 2004), Mataguay Fire (July 2004), Volcan Fire (Sept 2005), and the Border 50 Fire (October 2005).

Permanent CDF sites currently connected to HPWREN include the following: Red Mountain Fire Station, La Cima Fire Camp, Ramona Air Attack Base, Gillespie Helitack Base, and Puerta La Cruz Conservation Camp.

In addition to high-speed network access, ICP and permanent CDF sites connected to HPWREN also have access to real-time video and still cameras as well as meteorology sensors at Mount Laguna and Lyons Peak. Included with the suite of meteorology sensors is a real-time alert system that automatically pages first responders when concerning environmental conditions are present.

(photos - left to right: Volcan Fire relay site, helo-drop, and ICP site - Sept 2005)

2001

The HPWREN team worked with CDF firefighters to demonstrate an ad-hoc rapid response mobile wireless access point at Dos Picos Park, a pre-designated Incident Command Post.

February

August

- Along with several governmental agencies, the HPWREN team tested the feasibility of using real-time images and maps during a pre-simulated incident management situation.

"This exercise allowed us to evaluate an Internet-based data sharing scheme, where multiple agencies could view tailored perspectives of the same incident in real-time," said Dr. Steve Murray of SSC San Diego (Aug 2001)

- Three HPWREN antennae were also mounted on CDF's tower near Fallbrook.

2002

May

HPWREN participated in a UCSD activity that demonstrated an ad-hoc and temporary multimedia installation of seismic and visual instrumentation at the Coronado Bridge.

June

The HPWREN team transitioned its Mount Laguna backbone site to a County facility, which also enabled the creation of a new link to Toro Peak.

July

A feasibility check was conducted for the CDF's Red Mountain fire station link.

September

"The Mt. Laguna HPWREN backbone site was instrumented with several real-time meteorological sensors, with the data being made available to various parties and via public web sites.

"Administrators of the Sheriff's Department managed Regional Communications System believe that the HPWREN sensor project may eventually lead to the development of more widespread wireless technology in mountainous East County areas that will assist in general public safety tasks such as search and rescue missions and the prevention and containment of wildland fires," says Curt Munro, manager of the San Diego Sheriff's Department's Wireless Services Unit and Regional Communications System. (Sept 2002)

2003

July

- For research and prototyping, a central San Diego Sheriff's Department location is connected at 45Mbps to HPWREN's backbone.

- Firefighters at the remote Coyote Fire operations site were provided with HPWREN connectivity for the week-long incident so that they could update wildfire status reports, images, and weather information in real-time.

- In addition to a 45 Mbps link, HPWREN installed high-resolution remote-control cameras for the San Diego County Fair wireless demo.

September

Real-time wildfire images are now collected via motion-detect HPWREN-connected cameras atop Laguna Mountains and the Ramona CDF Air Attack base.

October

HPWREN cameras captured about 150,000 still images of the Cedar and Paradise Fires. Many were turned into DVD-quality MPEG2 time lapse animations.

December

The CDF La Cima Fire Camp's comms were restored with voice (VoIP), fax, and Internet access via HPWREN after the Cedar Fire devastated their phone lines.

- The CDF's Ramona Air Attack Base is connected to HPWREN *(shown here during the Cedar Fire of October 2003)*.

2004

Above: CDF's Eagle Fire ICP in Riverside was connected to HPWREN via the Santa Margarita Ecological Reserve.

May

Four HPWREN video cameras were installed to improve firefighters' with a 360-degree-view from Lyons Peak to observe wildland fuel areas along the US/Mexico border area. Another HPWREN camera was installed at Red Mountain, which views Palomar Mountain, Valley Center and the northern Santa Margarita River area.

July

The HPWREN team provided ad-hoc connectivity for the Mataguay Fire Incident Command Post. This marked HPWREN's first experience with incident response deployment at night-time.

October

Scripps Institution of Oceanography Visualization Center produced a DVD from HPWREN Cedar Fire images - as narrated by Retired CDF Fire Captain Ron Serabia.

November

New software was developed by HPWREN, in collaboration with the CDF, atop Mount Laguna and Lyons Peak that allows first responders to be paged by real-time data when humidity and fuel moisture levels as well as wind speed and direction reach alarming levels.

December

CDF's Dos Picos pre-designated Incident Command Post site received a pre-installed wireless communications setup for easy access as needed.

2005

HPWREN researchers worked with CDF and San Diego Sheriff's Dept for airdrop-based network relay demo at Lake Hodges fire exercise.

May

July

The San Diego County Sheriff's Department and the California Department of Forestry and Fire Protection airlift replacement sensors for HPWREN real-time weather alerts.

August

CDF's Gillespie Field Helitack Base was connected to HPWREN.

September

HPWREN establishes high-speed connectivity at the Volcan Fire ICP.

October

CDF's Incident Command Post for the Border 50 Wildfire was connected to HPWREN.

December

CDF's Puerta La Cruz Fire Camp and designated Incident Command Post was connected to HPWREN in collaboration with SDSU and TDVNet. This enabled first responders at Puerta La Cruz to have access and high speed connectivity via the network.

I just wanted to let you know how invaluable the internet connectivity was at the Incident Command Post. It amazed the personnel in the Planning section that we were able to have such a great internet service, while we had little to no phone and FAX service. The data connection allowed us to send digital maps of the incident all the way to Sacramento with ease. During the demob phase, the internet connection was a lifesaver. Without reliable phone or FAX communication with expanded dispatch, we were able to set up a live MIRPS terminal to communicate the resources that were being released from the Incident.
- Firefighter with Incident Command Team 10, Volcan Fire (Sept 2005)

2006

HPWREN Goals for First Responder Activities

- HPWREN researchers continue to conduct experiments with Voice over Internet Protocol (VoIP) that may be useful for incident management scenes where and when high-speed Internet connectivity is available.

- The HPWREN team continues to work with the San Diego County Sheriff's Department on ways in which the 4.9 GHz public safety spectrum can be utilized for county-wide incident management.

-Again this spring, the HPWREN team expects to participate in this year's multi-agency wildland fire exercise. Last year's activities at Lake Hodges provided the team with great insights into new ways to deploy high-speed networking at remote wildfire scenes.

The Utilization of HPWREN for Incident Management

May 2005 Joint Exercise with CDF and San Diego Sheriff's Department at Lake Hodges

(photos - left to right: relay equipment preparation at ICP, heli-drop of HPWREN equipment to relay site, deployed wireless relay and sensors, equipment return to ICP)

Lessons Learned

Working with first responders allows HPWREN researchers to experiment with and demonstrate rapid deployments of networking technologies, as well as how best to create and maintain high-speed data connectivity under difficult circumstances (e.g., wildfires). While the team continues to explore ways in which incident management applications can continued to be added to the research portion of the network, the following lessons have already been learned:

Basic Needs. The need for digital data (Internet) communication is substantial for both Incident Command Posts (ICPs) and remote fire station/camp deployments. Furthermore, this need for digital communication access appears to have increased over the past few years. Further recognition and understanding of applicable requirements would appear useful along the agency management chain.

Service Integration. There is an increasing requirement for more service integration including Voice-over-IP, such as phone and FAX across the data network. Additionally, video conferencing as well as real-time sensor telemetry and data integration may soon provide significant value to the first responder community.

The ability to create ad-hoc expansions of the network via a high-speed data connection is of great value in its potential for an array of incidents. This can support ICP-local wired and wireless networks for activities such as an expanded dispatch. Example uses are relaying video downlinks, IR mapping from aircraft of the incident, and many others. Providing a "big" pipe to an ICP will enable more that we can probably envision at this time. The connectivity could furthermore be useful to conduct remote Computer Assisted Dispatch (CAD).

Multiple-Agency System. While it is reasonable to utilize a National Science Foundation funded research project (e.g., HPWREN) to get things under way, for long-term availability and expansion potential the first responder agencies need to develop a systemic plan over time about how to sustain high-performance data communication for ad-hoc and persistent settings. Specifically, it is desirable to work together to make ONE system that everyone can share and have access to, because when large-scale incidents such as big earthquakes or wildfires happen, it doesn't matter who's area it is in

Leveraging across multiple agencies is possible if people are willing!

First Responders Comment on HPWREN

In 2002, Hans-Werner Braun asked the CDF if he could use its radio repeater towers, scattered across mountaintops around the county, to install his system. "He put cameras there to make sure his antennas faced the right way. We saw those cameras and that started us thinking, 'Could we use that?'" Tom Gardner (Emergency Command Center Chief) said. "Then we asked: 'Could you install weather stations up there? Could we get Internet data access in the fire camps?' And that's how it started."

In addition to giving them sweeping looks across miles of the county, the system also gives firefighters high-speed Internet access in areas too remote even to use cellular phones. It also can transmit vital weather data such as wind speed and relative humidity from a fire zone to an incident commander.

There are now 24 remote cameras mounted on peaks and hilltops across the county, and discussions are under way with property owners to erect more, Braun said. Each camera is sharp enough to see up to about 70 miles away. Some of the cameras are mounted in fixed positions, while others can be panned, tilted and zoomed remotely. The cameras are activated by motion or any other change in the image. "It sees motion and automatically transfers images to the server," Braun said. The cameras are fast enough to freeze images such as lightning strikes or birds in mid-flight. "It's like having a lookout out there," Gardner said. "We can look north, south, east and west." - San Diego Union Tribune

(November 8, 2004)

"The HPWREN connection at Puerta La Cruz camp has increased productivity to all of our personnel that use it. Prior to having this break-through technology, the camp used dial-up connections for it's inter and intra-net communications. On many occasions connection speeds were less than 20 kbps. Because of these incredibly slow connection speeds, the requirement to be continually connected while working specific CDF intra-net programs, reduced production of all of our employees to a snails pace at times.

I have also had the opportunity to use HPWREN at an incident base. The Border Incident in southern San Diego County in the fall of 2005 was connected to HPWREN early on in the incident. As the Incident Commander of a CDF Incident Command Team, the team that assumed command of the Border Incident, it is truly remarkable what high speed connectivity can do to increase productivity at an emergency incident! And speed is of the essence at a large, fast moving wildland fire. From planning, to public awareness, to intelligence dissemination for the internal and external CDF command structure, all of these were greatly improved because of this technology.

HPWREN has and will continue to be a great asset to our normal workday at Puerta La Cruz camp as well as emergency incident management. CDF and all emergency managers coast to coast can use this type of technology and what is to come out of this technology. It is a great tool now and may become indispensable in the future."
- Rick Henson, Division Chief, Puerta La Cruz

(Dec 2005)

"Until recently, Puerta La Cruz Camp, like many outlying CDF facilities, suffered with a slow dial-up Internet connection. Our hookup speeds ranged from 22 to 28 Kbps, slow even by Dial-up standards. With larger and larger emails being sent out, just going through our email took 1 to 2 hours, doing Epay was an exercise in frustration, better bring a lunch! In addition, the Fax machine was hooked up to the same line, so faxes could not be sent or received while someone was online. Often, if a fax came in, you would get disconnected. Office functions were scheduled around time on the Internet and the phone bill bordered on excessive.

On Thursday, December 8, 2005, with the help of Hans-Werner, Ron Serabia and Rick Buffington, Puerta La Cruz was hooked into the HPWREN network. The connection at Puerta La Cruz is now running at 4.3 Mbps! This is three times faster than the T-1 line at Monte Vista or 190 times faster than our old dial-up connection! Needless to say all Internet related operations are occurring in minutes instead of hours! Also, our fax line is doing just that, Faxes.

Another benefit of the HPWREN linkup is that a separate line has been run out in front of the camp exclusively for ICP/Fire Camp use. It is ready to be tapped into for immediate use to the Comm Unit and onto the rest of a Fire Camp."
- Bob Edman, Administrative Fire Captain, Puerta La Cruz

(Dec 2005)

"Your team has done a fantastic job developing the package into a nearly self-contained and readily deployable by air system," said Steve Shoemaker, CDF Fire Captain, and Gillespie Helitack Base. "With many of the suggested changes and additions, the system continues to become more users friendly. I also appreciate the inter-agency approach to the mission: HPWREN/SDSO/CDF." (May 2005 Lake Hodges Fire Exercise)

"Wildland Fire Fighters know that a good size up begins early in the morning when we see what the new day will bring us weather-wise," says Randy Lyle. "With these remote sensors we can now get a big jump on that information, and even in the middle of the night know that wind speed and direction, humidity and fuel moistures are becoming critical. The sensors allow us to verify the fire weather forecasts in real time, so we can begin to plan for fire events much earlier now." (Nov 04)

"I'm sure there will be a great deal of collaboration between HPWREN, the San Diego Sheriff's Office and CDF in the future," says Steve Shoemaker. CDF Fire Captain at Gillespie Helitack Base. "HPWREN has been a good partner to Public Safety Agencies and has been creatively supporting and enhancing our capabilities. I eagerly look forward to working together on technologies like airborne imaging systems and data links for air-to-ground applications." (Aug 2005)

"The deployment of meteorological sensors and imaging equipment throughout the county's back country and remote mountaintops, coupled with real-time access and a user-friendly web interface, will aid in the understanding of weather patterns and help refine meteorological models," explains Pablo Bryant, SDSU Field Stations Program research technologist. (Sept 2002)

"As the science of HPWREN technology continues to be proven and expanded upon, so does the CDF partnership with HPWREN. CDF and many other agencies respond year round to emergencies requiring a temporary, field located ICP and the associated infrastructure. As my own personal satellite phone has repeatedly shown me, satellite technology is still relatively expensive and remains critically dependant on reliable satellite coverage. My attempts at integrating my sat-phone and lap-top computer have been met with not even a marginal success rate. For over 3 years I have been plagued by bad sat-phone uplink connections, computer software/ hardware problems or e-mail compatibility issues. Yet I have never had any problem whatsoever using the HPWREN system. The development of pre-deployed HPWREN connections like the PLC connection is an exciting new prospect for emergency responders. As I travel throughout the state each summer from one emergency ICP to another, I have made many repeat trips to the same county fairgrounds, regional park or CDF/CDC Conservation Camp. Each County or CDF Administrative Unit tends to use these same locations year after year. Whether it is the Tehama County Fairgrounds or the Eel River Conservation Camp, these locations consistently lack reliable high speed internet access. The ability to pre-deploy HPWREN type technology throughout the state, would be of great benefit to all stages of the emergency response process". - Matt Streck, Fire Apparatus Engineer

"As part of our National Science Foundation funded project, we would like to stimulate a vision of high performance ubiquitous data networking," says HPWREN principal investigator Hans-Werner Braun. "As such, we are collaborating with various agencies on demonstrating various values that can be supported by real-time data networking, examples of which being sensor networks and an ability to rapidly deploy 'anywhere' ad-hoc networks." (Sept 2002)

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HPWREN is an interdisciplinary and multi-institutional UC San Diego research program, led by Principal Investigator Hans-Werner Braun at the San Diego Supercomputer Center and Co-Principal Investigator Frank Vernon at the Scripps Institution of Oceanography. HPWREN is based on work sponsored by the National Science Foundation under Grant Numbers 0087344 and 0426879.