The Wireless Communications Alliance's eCLIC participates in the Naval Post-graduate Schools Maritime Interdiction Networking Project

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The premise of the 2008 Naval Postgraduate School Maritime Interdiction exercises, as they were held in San Francisco Bay in March 2008, was simple; someone enters San Francisco Bay in a boat, large or small, with radioactive contraband on board. How will you find out that is has happened?

Is it an atom bomb? Is it a dirty bomb? Is it fissionable material being smuggled in, or out? Is it a load of steel from a third world source that included too much scrap from a decommissioned nuclear power plant?

If you do find out that something dangerous is in progress, what will you do about it? In the modern world, unfortunately, the answers to these questions are not of merely academic interest.

The now yearly interdiction exercises provide a forum in which US and international military, police, and other emergency agencies can test and develop detection technologies, search tactics, communications technologies, and rehearse the inter-agency communications protocols that will be required to handle such an event.

That the exercises could lead to the avoidance of a terrorist catastrophe is reason enough for their existence, but the exercises also provide spin offs of benefit to many disaster scenarios and these technical spin offs may soon become part of normal police, fire, and ambulance operations.

eCLIC's Interest

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Wireless Communications Alliance. The Wireless Communications Alliance is an educational non-profit organization (www.wca.org). The information presented is in this report for the benefit of those who are attempting to understand and advance the state of the art of emergency broadband deployment and readiness.

Of specific current interest to eCLIC is the broadband wireless communications techniques used to set up instant, ad hoc intranets for the various agencies involved in disaster recovery. The interdiction exercises provide a forum in which various types of equipment can be realistically tested. The Naval Post Graduate School has been both testing various new types of wireless equipment and creating new types of equipment as needed. The results are of immediate interest to the military, but are also of interest to emergency managers in a full spectrum of emergency scenarios.

Going forward, eCLIC would like to see this type of wireless broadband equipment made available to municipal agencies such as fire, police, and etcetera and etcetera. Although some types are still new technology, in this era of massively integrated digital electronics, little of the equipment is inherently expensive. Because they can be used in FCC-designated unlicensed frequency bands, classes teaching students about the wireless technologies involved are suitable for inclusion in school curriculum. Within some limits, these technologies are open for use by individual experimenters and nonprofit service organizations similar to the Amateur Emergency Radio Services (ARES) organizations historically organized by licensed amateur radio operators.

What Actually Happened during the San Francisco Interdiction Exercise?

As eCLIC's designated observer I joined the interdiction exercises for two days in San Francisco bay. The full interdiction exercise took place across the globe and involved the navies of several governments over a period of at approximately 2 months. ***The full scope these exercises are well beyond the scope of this report.*** eCLIC's focus was on emergency wireless communications, particularly mobile or abruptly established

fixed-wireless broadband.

Day One

On day one, March 12, I joined the event at the coast guard station on Yerba Buena Island where I went aboard an Alameda county sheriff department's boat. This police boat is an 85-foot ex-coast guard cutter with .50 caliber machine-gun mounts. It is larger than many of the coast guards boats in the bay. This boat served as the command center for the days exercise. The day's event consisted of a sequence of radiation sensor tests involving numerous small boats provided by various agencies around the San Francisco bay. Three of these boats where loaded with different radioactive sample sources and several other boats were loaded with radiation detectors and broadband wireless gear.

The 85-foot Alameda County Sheriff Department's cutter, not your average county cop car.

The boats equipped with radiation detectors for this day were also provided with **Wave Relay 802.11 based mesh-network** wireless gear. This provided Internet-Protocol based broadband video and data links to the Alameda county Sheriff department's cutter, and to a fixed post in the Yerba Buena Island Coast guard station. Coordinated by a controller on the Alameda county sheriff's boat, the various boats filed past each other while the radiation intensity and spectra sensed by the detector boats was relayed in real time for analysis by personnel also located on the sheriff's boat.

The object was to try and identify which boats contained radiation sources, and identify which radiation sources where on which boats by looking only at the radiation intensity and spectra information sensed by the detectors on the detector boats. The question was not only, "Is there something radioactive on this boat?" but also, "Is the radioactive thing on this boat Cesium, Uranium, or Plutonium or etc.?

This is not a straightforward task, even if you are and the radiation-detector, are on the same boat with the radioactive material in question. It is made much more difficult by the fact that the detector is on a different boat than the radioactive material, and the analysis of the radiation spectra is being done in yet another location. Wireless broadband connections are key to making the whole remote radiation detection effort work at all.

Wave Relay wireless equipment was used on this day. This equipment is mid-range 802.11-based mesh system using 3-sectored antennas. There are no moving antenna elements and the each unit operates as a virtual omni-directional 802.11 based system, but the sectored antennas and automatic signal steering provide better network range and speed. The mesh networking capability allows traffic to be relayed even when source and destination nodes maybe out of radio range.

Wave Relay 802.11 antennas. Both have 3-sectors. The compact version (inset) has all three sectors included in a single white plastic tube. This version was used on the Alameda County Sheriff's cutter on day one. The open frame version shown on the right was in use at the fixed communications center on Yerba Buena Island. Both are fed with three separate COAX cables.

For this calibration exercise the boats were kept in relatively close proximity on the East side of Yerba Buena Island. One of the detector

boats was an unmanned remotely controlled vessel called the Sea Fox. The Wave Relay equipment allowed this boat and all the detector boats to broadcast a remote video feed to show the operators, in the command boat, what boats were near the detector boats at any time. The individuals interpreting the radiation spectra were below decks and not in visual contact with the detector boats.

The first day's events provided calibration information on the remote radiation detection scheme and provided practice in managing the ad hoc wireless mobile wireless networking equipment and software. Day two would offer a more challenging repeat of the same.

The "Sea Fox" remotely piloted boat fitted with Wave Relay mesh Wi-Fi and a radiation detector on day one.

Alameda County Sheriff's boat's galley turned radiation spectra-analysis-post on day one. The ships bridge provided a second post.

Day Two - IEEE 802.16 Fast, Mobile, Long Links

I spent day two in the event command center located *in* the coast guard station on Yerba Buena Island. Since the day two scenarios included longer-range operations, the big guns came out. Fixed IEEE 802.16 links provided high bandwidth links to a point in the Alameda naval air station and to a relay point in the Berkeley hills. This single high point in the hills provided line-of–sight high-speed data links to the boats and fixed assets engaged in the days exercises. (Note: IEEE 802.16, also called Wi-Max, is uniformly called just "OFDM" by the Naval Post Graduate school.)

Day two, inside tactical operations center on Yerba Buena Island.

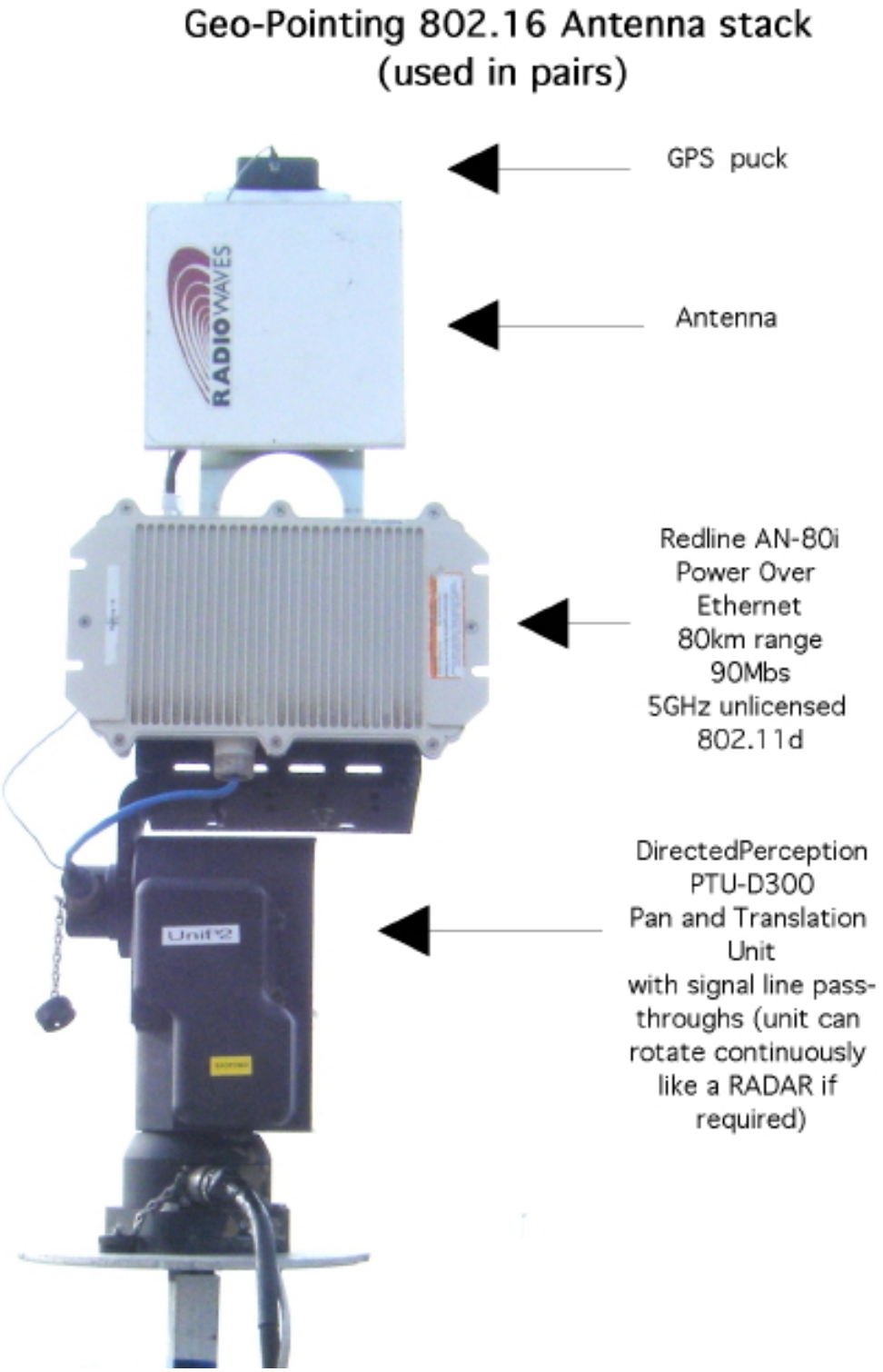
On this day, two separate events played out at the same time; an exercise on the Sacramento River, and an event carried out on the museum ship the Jeremiah O'Brian in the bay. The O'Brian was to have been maneuvering just outside the Golden Gate, but due to logistics issues remained tied to the dock at Fisherman's Warf instead. Radiation detectors were hand carried through the compartments of this ship by boarding crews. Ultra-wide band radios were used to blast data, from the depths of the ship, to nearby radio units and then on to the command center at Yerba Buena via 802.16 long links.

The Sacramento River scenario involved detector and source boats maneuvering near Rio Vista on the Sacramento River. An antenna was lofted briefly by balloon to complete the high-speed data link back the command center on Yerba Buena Island.

The Alameda County Sheriff Department's boat used two tandem mounted flat directional antennas for IEEE 801.16 links. These where

located high on either side of the flying bridge and dynamically pointed at their corresponding target antennas by exchanging GPS coordinates. They remain pointed at their corresponding distant target antennas regardless of how the boat maneuvers or rolls. (They resemble the ears of an avid cat or dog on a hunt.) The presence of two antennas on the boat allows the antennas to maintain two independent fast data links at the same time.

These antennas can provide the equivalent of a direct 100Mbs Ethernet connection in the unlicensed 5GHz RF band. Actual transfer rates are a function of the distance between antennas, interference levels present, and the pointing accuracy of the highly directional antennas used. The antennas and radio equipment used on this day was from **Redline Networks.** To provide dynamic geo-pointing, the antennas and radios where integrated with fast **Pan and Translation Units** (PTU's) from **Directed Perception**. The technology behind these antennas is of major significance in providing the long point-to point links (1/8th mile to 80 miles) needed in many emergency network scenarios, particularly for mobile platforms.



The Naval Postgraduate Schools "OFDM" (IEEE802.16) automatic geo-pointing antenna stack.

Broadband antennas used on the Alameda County Sheriff's boat for the day. Green arrows point out two geo-pointing 802.16 "ears", the red arrow point to the Wave Relay 802.11 antenna.

In mobile scenarios, both antennas of a link must find and track each other's location by constantly exchanging GPS coordinates. A lingering practical problem is how to exchange initial GPS coordinates before the main data link is up. In general some other low speed wireless IP link must be made to exchange coordinates. In some cases this may still require voice radio communications. Also in mobile situations inertial compensation may also be required to avoid disrupting the link while a boat rolls or a plane bounces in turbulence. In all cases the data links are limited to line of site situations and the antenna beam widths are relatively narrow, thus fast-automated antenna pointing is a priority.

The Global Satellite Links

The overall interdiction event, coordinated by the Naval Postgraduate School in Monterey California, included elements carried out in several ports around the world by elements of several navies and other agencies. To provide global data-links that could be set up quickly and reliably, the equipment at the fixed command center included a **"SWE-DISH" satellite dish antenna**. The "SWEDISH" is carried by hand to a site in a

carrying case that resembles a large suitcase. The top cover pops off, and snapping together 3 loose dish elements carried inside the case completes the dish. Power and Ethernet-data connections are made, and with the push of a single external button, the SWE-DISH wakes up, and finds its target satellite. This suitcase system can be setup by an experienced user in as little as 5 minutes.

"SWE-DISH" satellite dish antenna

The SWE-DISH can be used with several different geo-synchronous satellite systems. I was not briefed on the details of the satellites or the data rates achieved on this day. The system can provide 4Mbs of Internet

Protocol data or 10Mbs in TDMA mode (apparently symmetric rates for both modes). The SWE-DISH needs a clear view of the equatorial plain, that is to say, a Southern view in the Northern hemisphere and a Northern view in the Southern hemisphere, in order to see its geosynchronous satellite targets. The roof of the command centers building on Yerba Buena Island did the trick. And, yes, the SWE-DISH is made in Sweden.

Conclusion

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My observation of the interdiction exercises was limited to two days in San Francisco Bay. The complete set of interdiction exercises lasted approximately 2 months and involved several nations around the globe and numerous agencies in each nation.

Neither eCLIC nor any other agency mentioned in this report in anyway endorses or approves the equipment or brands of equipment mentioned in this report. In general the brands are mentioned to provide further technical references for the reader. The Naval Post Graduate School, and other involved agencies, experiment with a broad range of equipment and inclusion of a certain brand of gear in the interdiction exercises on any day, per se, is meaningless.