

## Tactical Data Radio System Enhances Combat Effectiveness

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CrossTalk

*The Enhanced Position Location Reporting System (EPLRS) is a tactical data radio employed by the U.S. Army, Marine Corp, Air Force, and Navy to move key information quickly and efficiently on the battlefield. The EPLRS's layered system software controls all of the communication networks and provides routing services between these networks. The software also performs position location and tracking for EPLRS radios within each network.*

The emerging digitized battlefield holds exciting potential for greater operational flexibility to meet evolving tactical objectives. Among innovations on this front is the Enhanced Position Location Reporting System (EPLRS), the ground tactical data radio system employed in the U.S. Army's Tactical Internet, the U.S. Marine Corps' Tactical Data Network, the U.S. Navy's Amphibious Assault Operations, and the U.S. Air Force's Situational Awareness Data Link.

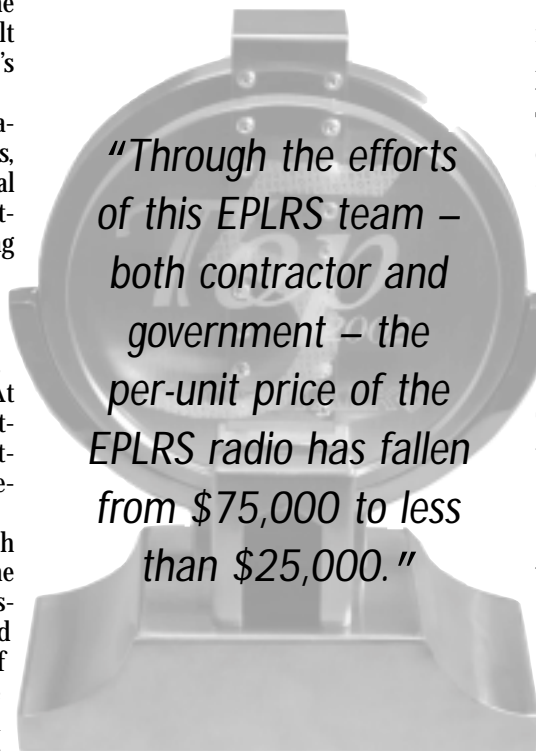
The EPLRS provides a communications backbone for situational awareness, command and control, and other digital messaging. It consists of a dedicated network of radios that move war-fighting information quickly and automatically. The EPLRS was developed at Raytheon Company's Networked Communication Systems (NWCS) in Fullerton, Calif., using a spiral development approach. At the heart of the EPLRS is its system software, comprised of C-based radio software and Java-based network management software.

In 1999, Raytheon initiated a research and development effort to convert the legacy software and custom operating system (OS) to an Internet-standard layered baseline using a commercial off-the-shelf (COTS) real time OS. "The challenge was to try to make this software, which was running on a hardware platform geared specifically for wireless communications, to run on a generic platform with growth potential," says Michael Born, EPLRS lead systems engineer.

"The software had to support new wireless communication protocols," says Amy Liu, EPLRS system and software project manager. "We had to re-architect the entire radio software and still meet the functionality and performance of the legacy software," says Liu. "This was basically like starting a new project, including documenting and verifying requirements and scheduling to meet completion dates. We had to have a good handle on risks

and risk communication."

According to the Raytheon team, the layered architecture facilitates both the use of COTS software and the incorporation of existing software products, such as Raytheon's STAR Router. This ensures interoperability with COTS systems that



interface with the EPLRS network, and eases the porting of EPLRS software to other operating systems and hardware platforms.

"EPLRS benefits from mature size estimation processes and historical data for growth profiles," says Sally Cheung, software technical director for the site Engineering Process Group. "We have the benefit at Fullerton of a solid process infrastructure to draw upon. With that infrastructure, we have baseline data capabilities to compare EPLRS performance and product quality."

Software size estimates are made for

all major software work activities. Estimates of new, modified, and reused source lines of code (SLOCs) are based on historical data collected from past projects with similar functionality and knowledge of the language being used. These estimates are then verified using the SEER-SEM Software Estimation Tool. Actual counts are collected per build from the output of a SLOC counter. Analysis of size trends in conjunction with other metrics is performed monthly. The total EPLRS software growth did not exceed the established plan by more than 4 percent during the 21-month EPLRS software development cycle.

To meet the customer's need, the EPLRS radio software is required to run on multiple hardware platforms with different operating systems. These platforms include the existing family of radios, future radios (Micro-Light, Joint Tactical Radio Systems) and modeling/training platforms.

### Measured Project Value

"Raytheon enabled the radio layered software baseline to be easily ported to multiple platforms, which more than offsets the cost for productization" says Bohdan Kowaluk, senior system engineer at the Tactical Radio Communications Systems Project Management Office, Ft. Monmouth, N.J. The layered software baseline has also enabled new functionality to be added/changed for less than a third of the cost compared to the previous versions of the software.

The continued use and implementation of value engineering changes have reduced cost and made it possible to keep the EPLRS radio hardware design current with respect to the wireless communications industry. Through this process, significant system performance enhancements have been realized, particularly in the areas of data rate and communication services. The latest version is a fully software programmable radio. This enables



*The EPLRS team at Raytheon's Fullerton, Calif., site is part of a Capability Maturity Model Level 5 organization.*

lower production and logistics costs by allowing future upgrades without requiring new hardware. "The value engineering process has saved the government more than \$25.8 million dollars," says Kowaluk.

"Through the efforts of this EPLRS team – both contractor and government – the per-unit price of the EPLRS radio has fallen from \$75,000 to less than \$25,000," he says. At the same time the capabilities of the system have continued to grow, leveraging the use of COTS hardware and software. As a result of the layered software and the software-programmable hardware, the cost of future upgrades will be a fraction of previous upgrades.

### Raytheon Processes Bring Success

The EPLRS program is part of a Capability Maturity Model® (CMM®) Level 5 organization with mature software processes. "There are built-in standard software processes we perform as a CMM Level 5 organization to assure success on all programs," says Cheung. "But on top of that, we apply innovation from a technology standpoint to assess where the product needs to go, and from a process standpoint to assess what innovation must be in place to make things happen."

In addition, the EPLRS program uses the Team of Four (ToF) concept, which is a teamed approach to project leadership, process control and deployment, and metrics analysis. "The Team of Four looks over project performance to suggest improvements and to improve the quality of processes," says Cindy Ruhlman, assistant system and software project manager.

The ToF consists of key stakeholders: the software project manager, the engineering functional manager, the software

process engineer, and the software quality engineer. Program management sponsors the ToF and subject matter experts provide support as needed. The ToF meets monthly to analyze metrics, helping to improve process and product quality. Lessons learned are collected, reviewed, and incorporated in future development and test activities.

The EPLRS program achieves delivery of a quality product through configuration control and extensive software testing, says Born. The EPLRS program provides on-site engineering support at customer field locations to ensure a smooth transition when a new software product is released. Field engineers channel feedback to the software team, logistics specialists, depot services, and manufacturing. They generate Test Incident Forms (TIFs) based on user inputs and operational observations as required. Field advisory reports are written to ensure that updated information is disseminated to the field in a timely fashion.

"By using the ToF to manage proactively," says Ruhlman, "analysis showed the TIF cycle time was taking longer than the team would like to resolve problems; improving the TIF process could reduce cycle time." This entailed automating the on-going status of software builds and testing activities. Three separate reporting databases were made relational to automate report generation, streamline TIF review meetings, and enable users to track TIF status on-line, from approval to software build release to test completion. Cycle time measurement has shown a 366 percent improvement with the more efficient process, down from 120 hours to about 30 hours," she says.

The EPLRS team also recognized the opportunity to increase versatility, portability, and maintainability by implement-

ing a Raytheon Six Sigma team, a corporate initiative focused on process simplification and product reproducibility. "It's an opportunity for us to look at areas for improvement. The product, process, the whole thing," says Liu.

Emerging technology is continually monitored for insertion into the product, resulting in design simplification and reduced cost to the customer. "Every time the government procures more radios, we've been able to insert technology and make it simpler and a lower cost with more performance," says Born. "This is possible through a close working relationship with the customer, a long work history, and trust," he says.

### Summary

As a CMM Level 5 organization, the Raytheon EPLRS program utilizes proven processes, which quantitatively controls process and product quality through carefully monitored metrics. The EPLRS benefits from continuous process improvements, from taking actions to prevent recurrence of defects, and an effective software estimation process.

In addition the company benefits from an experienced and highly motivated team, says Ruhlman, "This is key to our success."

"We are structured as an integrated process team, which allows the cross communication critical for achieving success," says Born. With this, the use of mature processes, risk mitigation, and the organization's metrics, we are able to achieve a high level of customer satisfaction and deliver a quality product, on budget and on schedule, he says. ♦