SAND2012-6819P

Lab News: PK
Slug: telemetry
Target issue: August 24, 2012
Reviewed by: Michael Forman, Kathleen Hughes, Jennifer Clark, Rex Eastin, Matt Johnson, Jim Lund, Peter Davies

Words: 1,200
Photos: yes, Dino Vournas

Telemetry innovates to keep pace with new challenges

Can you do more with less? This seems to be the question heard round the world these days.

In Sandia's Telemetry Systems groups (8133, 8135, and 8136), the answer to this question is a resounding yes, driven by a transformed process for developing Joint Test Assembly (JTA) telemetry (TM) systems that has enabled several game-changing innovations.

The roots of this change can be traced back to the 2010 Engine Room experiment, in which Ryan Layton (8133) led a group of interns and new hires to deliver a new instrumentation system in 10 weeks (see the August 13, 2010 issue of *Sandia Lab News*). This project evolved into a next-generation light electronics and prototyping laboratory that supports fast design, fabrication, and testing in a setting that enhances teamwork through staff colocation.

As a result, California's TM groups have gained visibility and opportunity, evidenced by an increase in new projects including aircraft compatibility tests, vibration fly around units, and a B61 Davis Gun test series. They have also kept pace with customer demands for high reliability-instrumentation that is smaller in size, produces more data, and costs less.

"Increasing the fidelity of JTA flights in an environment that asks more for less without sacrificing reliability requires innovation," says Michael Forman (8136). "These constraints have manifested themselves in a firmware development and verification process and a new TM architecture called the Micro Modular Telemetry (MMT) architecture."

Firmware Verification

Lead by Yalin Hu (8136), the firmware verification team successfully executed a functional verification of the B61 JTA Modernization firmware, earning the team 2011 NNSA Defense Programs Award of Excellence award. This was the first verification of a JTA telemetry system's digital hardware using state-of-the-art techniques employed in industry and academia.

"The team acts as independent reviewers to validate that the firmware design functions as intended in both normal and abnormal scenarios. With the addition of the firmware verification process, we increase the reliability of the firmware design," says Kiet Tieu (8133), project lead of the B61 Modernization.

The team verified subsystem components, improved the firmware development process, and with high-performance computing (HPC) resources, identified low-probability critical errors using hardware fuzzing. This effort improved the quality and reliability of the B61 TM system and could potentially change the qualification process of future digital, high-consequence NW systems.

"With each correction to an edge-case anomaly or low-probability error, the verification effort improves the quality of the flight recorder, and lowers risk to the program," says Ryan.

Micro-Modular Telemetry

The Micro Modular Telemetry (MMT) architecture is an instrumentation package implemented as a set of cards that can be rapidly modified, combined, and assembled into a multitude of configurations. The MMT has been a catalyst for making telemetry in California more nimble, efficient, and collaborative.

"MMT is both a design philosophy and architecture to implement data collection and transmission for flight and ground tests," explains Matt Johnson (8136). "It grows and changes each time we use it."

MMT was the result of an NNSA Stockpile Stewardship Readiness project, led initially by Mike Bell (8135) and completed by Brett Chavez (8135) and Matt. "The initial goal was to create a fundamentally robust, modular, and small instrumentation package to cover typical telemetry applications," explains Matt. "For the Level 2 Milestone, we completed a study of all stockpile instrumentation and environmental requirements. The goals of MMT were to monitor 80% of the typical channels while surviving an envelope of mechanical environments."

MMT has reduced costs and turnaround time and increased reusability. It's also allowed different weapons groups to team in ways never before possible. "With design continuity, it's much easier for the engineers to talk across the bench," says Rex Eastin (8135). "We can build upon the lessons learned from the last implementation."

This also simplifies design reviews and adds value to that process. "When I go into design reviews, I have a better understanding because MMT is the basis," he adds. "I can learn from that team's work and issues to plan forward."

B61 JTA Modernization

The B61 First Insertion Unit was developed as a pilot for the B61 JTA Modernization. MMT was initially designed as a series of distributed modules, but it quickly became apparent that the cables and connectors were a hindrance in the highly collocated design of the B61 Data Recorder.

"The design evolved to place the circuit designs from each MMT module onto a single printed circuit board. Instead of a cabled bus, the cards are connected with a backplane system, using the same communication architecture," says Matt. "So now MMT can be a collection of distributed modules or a single enclosure of multiple instrumentation cards."

Like the firmware-verification team, these innovations earned theB61 JTA Modernization TM team a 2011 NNSA Defense Programs Award of Excellence award.

The MMT enables design reuse between different weapon systems. "Every implementation will have distinct design specifications based on the mechanical envelope, environmental design specifications, margins, and other factors," says Matt. "With design reuse of our mechanical architecture, we have a suite of environmental qualification data to draw upon."

W88 Alt

The W88 Alt team, led by Rex, is adapting the MMT to fit inside a tight volume. "Because of space constraints, we're adapting it to small circular boards using the same design philosophy and MMT interface," he explains.

The telemetry system for the W88 is being designed to capture "first motion", a first for any JTA telemetry system that is flown in a reentry body configuration. Previously, batteries for the telemetry system could not be turned off and turned back on again. This meant not turning on the telemetry system until the missile launch was already underway.

"There is a lot of shock, acceleration, and pressure when the missile first begins to move," Rex says. "Capturing of this data will give our customers the ability to confirm their models."

The engineers plan to use lithium batteries to power the W88 Alt JTA telemetry system, something that has never been done before for Navy systems. This is possible because of advances in lithium battery technology — one of the options being considered are 2/3 A-cells that have been previously certified for use on NASA manned space flights.

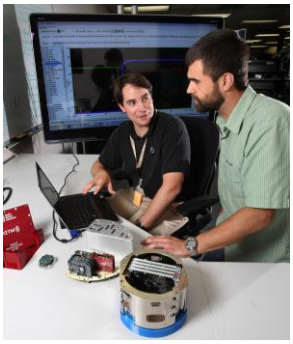
Another change for the W88, enabled by MMT, is a multiple-configuration JTA. Multiple configurations allow for more specialized data collection than within a single configuration.

"This will be a big deal within the W88 community," says Rex. "Because of the MMT and the use of lithium batteries, we can configure our telemetry system smaller and place them in areas within the warhead or reentry body that was unachievable just a few years ago. The recent march on technology allows us to offer these options to the Navy and NNSA."

The Future

Today there are 30 engineers and technologists working to support the telemetry mission, up from approximately 20 a few years ago. "As we continue to respond to different needs with this architecture, people come back to us and begin considering our telemetry products for needs beyond JTAs." Michael adds, "It's not just Handling Gear, Telemetry Systems, or Cyber-Physical Systems. Our product is also the culture and innovation necessary to thrive in a changing laboratory environment."

--30--



Ryan Layton and Doug Stark (both 8133)