

Leveraging ACTS Circuitry, Firmware, and Concepts for the T-STAR Tracking and Reporting System

The Authenticatable Container Tracking System (ACTS), developed by the US Department of Energy's Packaging Certification Program, is an extensible, secure container tag that can be used to optimize chain-of-custody monitoring for packaged nuclear materials as they are being stored, processed, and transported. Based on the ultra-low-power TI MSP430 mixed-signal microcontroller, ACTS is an active device that uses an almost-universal core platform that can be appropriately configured with expansion modules to provide the application specific data acquisition, data logging, container sealing, and communications functions needed for 21st century material accountancy, monitoring, and tracking applications. This core architecture enables appropriately designed modules to be easily interfaced with the basic system, thus providing an integration path for current and new technologies. ACTS contains a built-in set of sensors and supports an expansion bus for up to six additional communications, tracking, authentication, encryption, sealing, location, or sensing modules that may enhance the monitoring and tracking of particular containers for specific applications.

The Transportation–Security, Tracking and Reporting System (T-STAR) was developed by the National Nuclear Security Administration, NA-21, Office of Radiological Security (ORS) to provide a transportation security system for detection and tracking during transport of Category 1 and Category 2 radiological material. While many off-the-shelf systems provide asset tracking of the conveyance, few offer detection of a breach into the cargo compartment or the removal of cargo from the conveyance. Systems that do offer this capability need to be permanently installed on the conveyance, requiring drilling holes and running cables through the conveyance itself. This means that dedicated shipping containers or vehicles are required, which is not sustainable in many countries where ORS is building capacity for the security of radioactive materials in use, storage, and transport. ORS has built two iterations of T-STAR, “Gen 1” and “Gen 2,” and the lessons learned from the development and deployment of those systems are being used in the development of the new “Gen 3” system. Gen 3 of T-STAR leverages various Oak Ridge National Laboratory technologies to improve the communications capability and reduce power requirements, including the multimode communications module developed by the Unmanned Aerial Systems Research Center and the low power and extensible Authenticatable Container Tracking System tag. Gen-3 of the T-STAR head unit is based on the ACTS circuitry, firmware, and concepts. T-STAR uses a cell phone and an Iridium modem to communicate the configuration and alert a server monitoring the shipment, incorporates a wireless security system allowing various intrusion detection sensors to be located in the conveyance, a hardware security module for digitally signing communications messages and various built-in environmental sensors.

Leveraging the ACTS technology has allowed the design of the Gen-3 T-STAR head unit to proceed very quickly. Software development for T-STAR will build on the existing ACTS code base. T-STAR will also have ACTS expansion capabilities and sensors. Using the same sensor set incorporated with ACTS will allow certain lower power consumption reduction techniques to be used by T-STAR. The ACTS IEEE 802.15.4-2011 ultra-wideband– compliant wireless transceiver expansion module that has additional capabilities for indoor positioning and proximity location and the ACTS GPS expansion module can be plugged into and used by the T-STAR head unit if needed. ACTS will also be able to use the multimode communications module developed by the Unmanned Aerial Systems Research Center for T-STAR. This

communications module will provide cellular, Iridium, Wi-Fi, and long-range line-of-site communication capabilities to ACTS.

With both ACTS and T-STAR using a common peripheral expansion bus, a system for tracking multiple items of a shipment can be easily deployed using ACTS tags on the shipped assets and a T-STAR unit being used as a gateway for ACTS tags to report status. The T-STAR unit will still perform the shipment tracking and security sensor functions while aggregating and reporting ACTS tags data. The ACTS ultra-wideband (UWB) radio will be used as the communications means between the ACTS tags and the T-STAR unit. The UWB transceivers support location services allowing the ACTS tags to be accurately located within the shipping conveyance.