Advancing the Transportation-Security, Tracking, and Reporting System (T-STAR)

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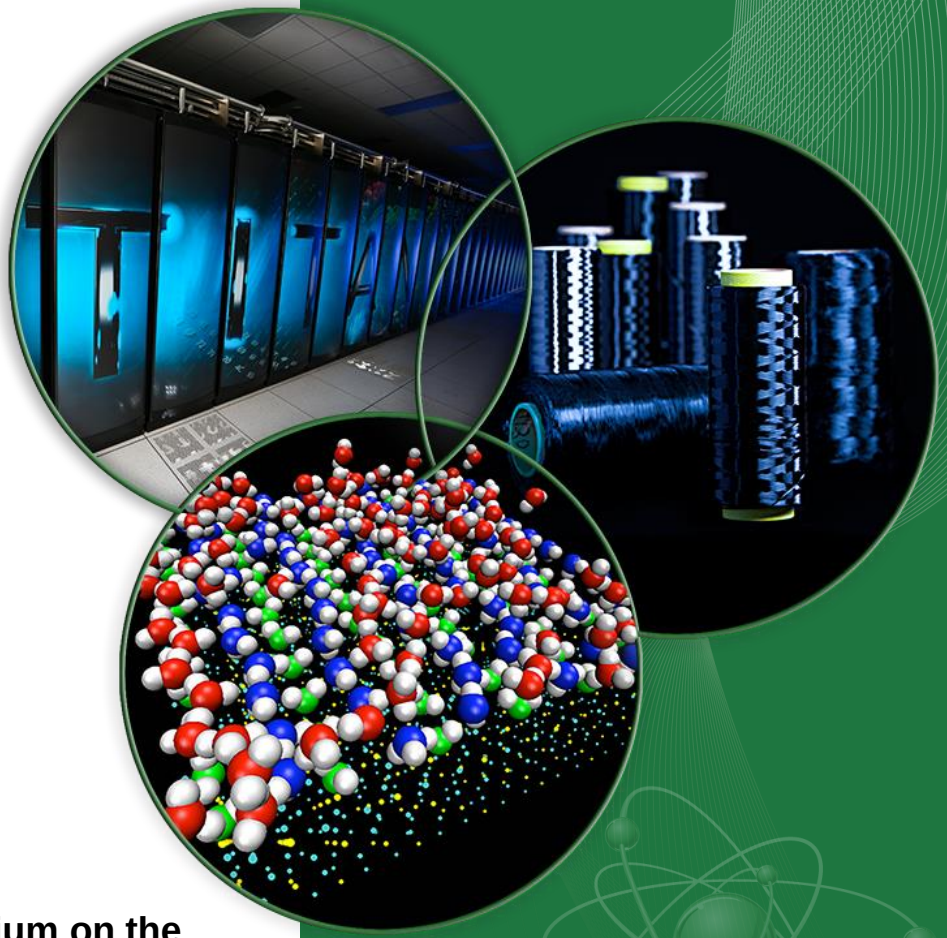

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Agenda

- Concept
- General Capabilities
- TSTAR Gen 3 Design Goals
- Gen 3 Elements
- MAVNet Multi-Channel Communnications
- Expansion capabilities
- Data Authentication
- Conclusion

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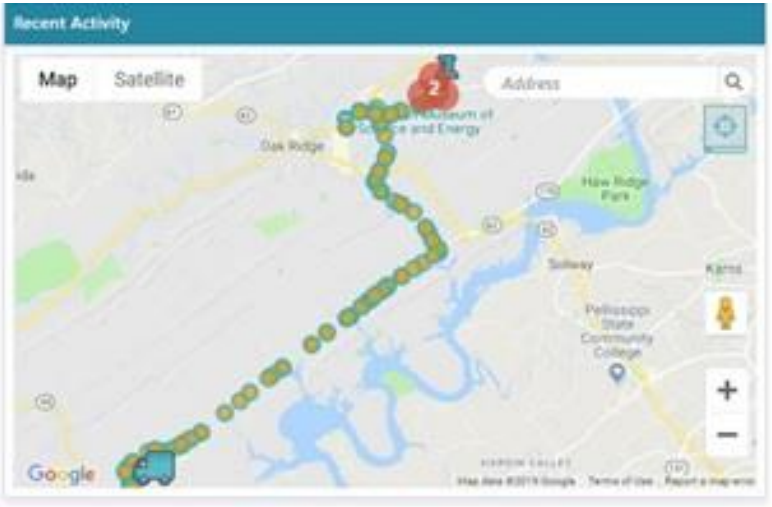
The T-STAR web application running on computers and smartphones provides views that allow assessment of the shipment's status. Via the web application, a user may opt to receive SMS messages of the system notifications.



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User Interface

- Newer backend technologies including an enterprise class database – postgres
- Has been up and running for a month in a development environment
- Being deployed in Azerbaijan
- Lots of testing using multiple units and multiple teams

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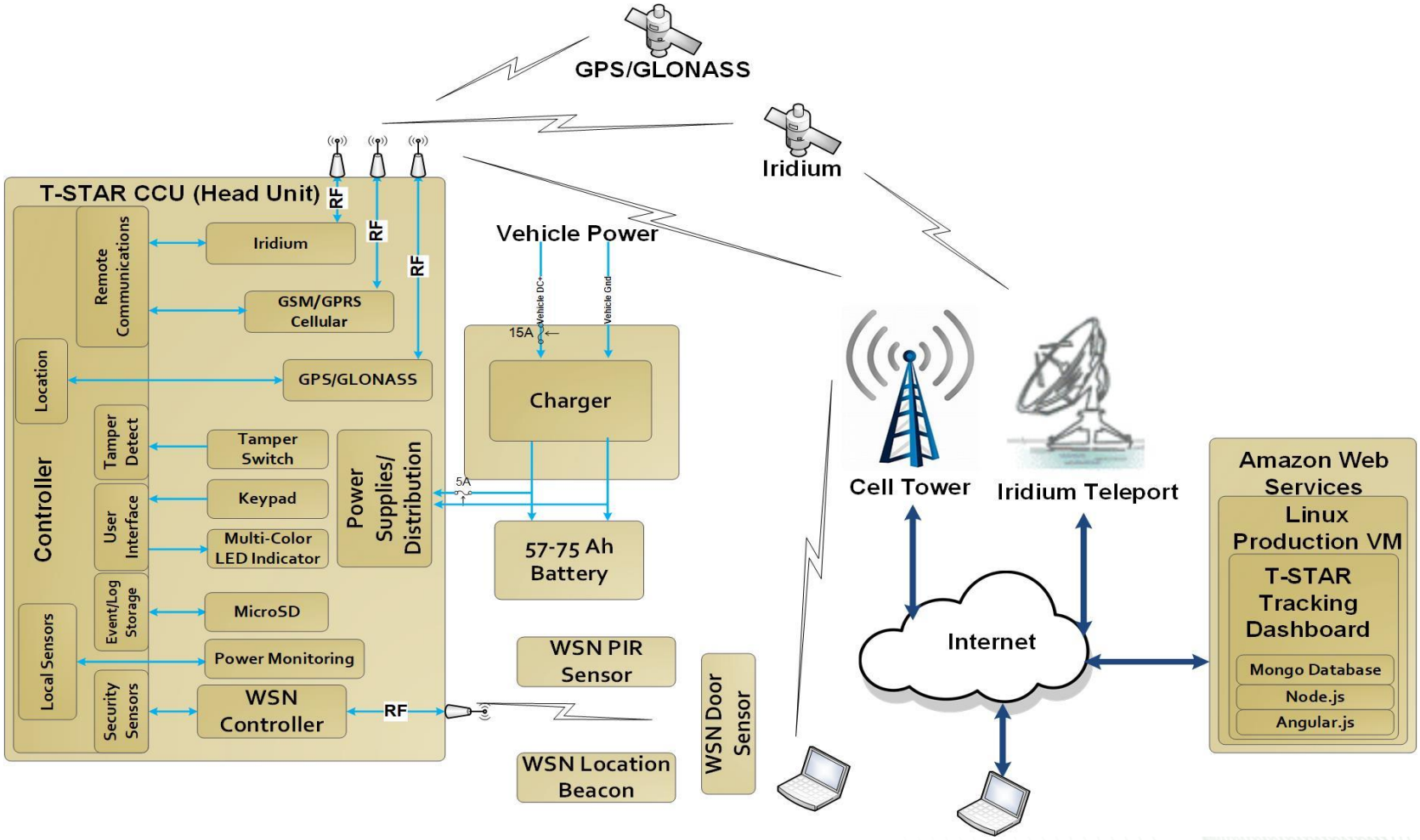
The T-STAR block diagram showing multiple communication modes, onboard and offboard wireless sensors, network infrastructure, and website services to monitor and assess the security of the shipment.



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Design Goals

- Reduce power consumption
  - For extended battery life
- Leverage existing technologies
  - UAV communications
  - ACTS low power and design concepts
- Use COTS
  - Wireless Sensor Network (WSN)
    - Custom built Moteino vs. Commercial Zwave
  - Vehicle power, circuit modules
- Data signing for data authentication

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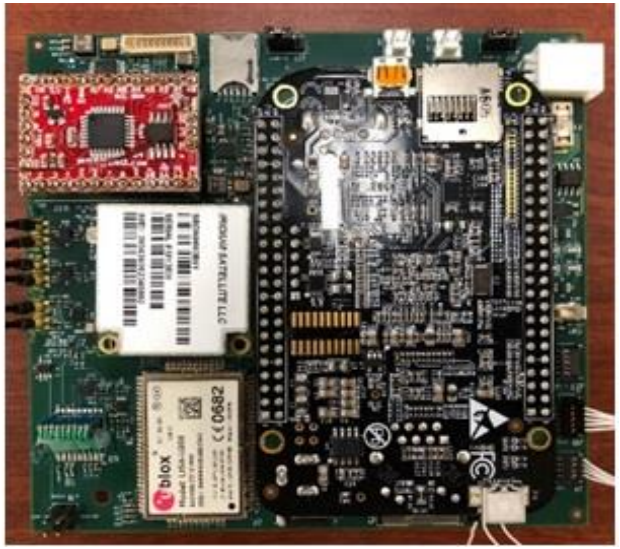
The Gen 2 variations include the ability to independently switch between two antennas for each RF device, control the GPS device's low-noise amplifier, and altering component placement to facilitate inserting the SD card and SIM cards and enclosure cable routing.

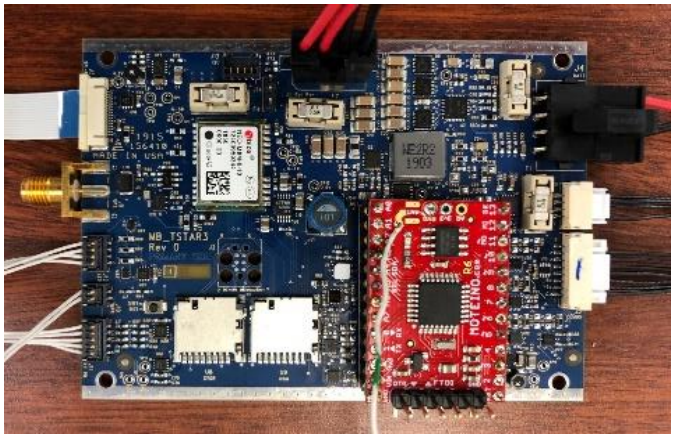


The current implementation is based on the Beaglebone Black controller.

The low-power ACTS circuitry with sensor suite and peripheral expansion slots extends capabilities, while the inertial measurement unit senses motion to reduce power consumption and allow smarter control of the communication device's power.

- Low Power processor
- Use MSP FET programmer serial back channel for console/debugging
- Existing on board sensor suite – temperature, humidity, barometric pressure, ambient light, tamper switch inputs, Inertial Measurement Unit – 3 axis each accelerometer, gyrometer, magnetometer
- Existing firmware

The T-STAR Gen 3 board controls the operation of the T-STAR head unit. A suite of onboard environmental sensors; an IMU; and interfaces to the MCM, HSM, microSD card, keypad, LED indicator, GPS unit, peripheral expansion slot, and WSN are included.



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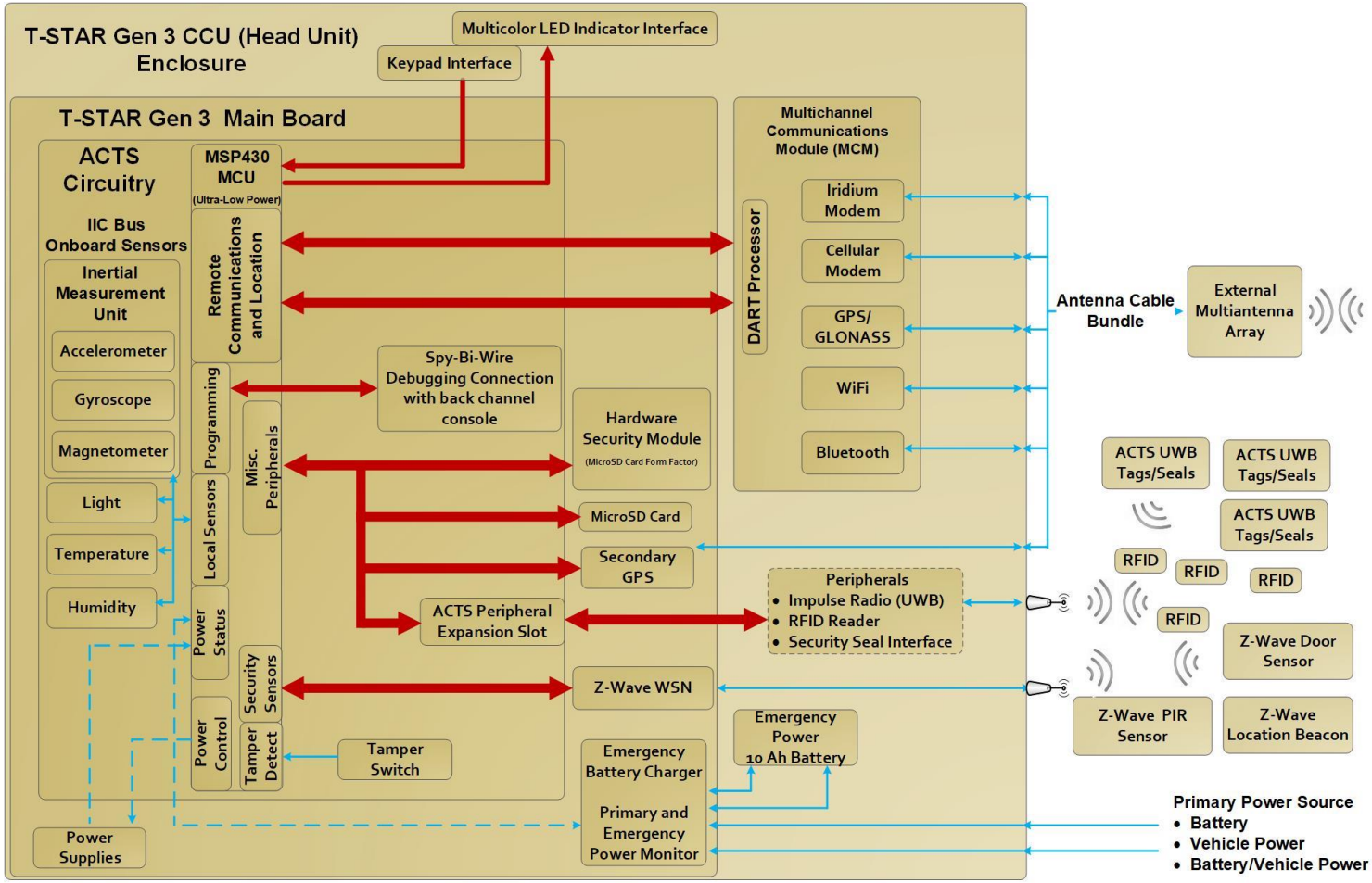
ACTS circuitry, with its onboard sensors and expansion peripheral slot implementation, is fused into the T-STAR Gen 3 design. A significant enhancement to the design is the multichannel communications module.



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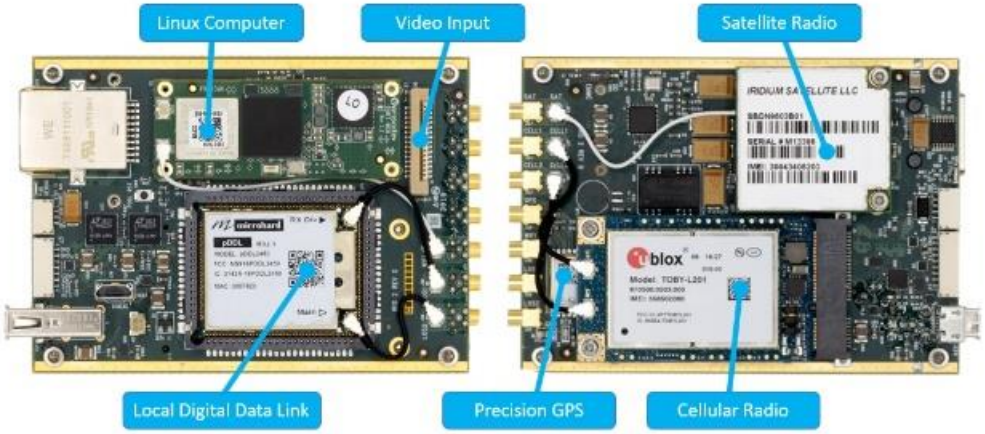
The multichannel communication module offloads the communications tasks from the controller and autonomously determines the optimum communication channel. The next generation multimode communications module based on earlier technology used for UAV telemetry is being developed.



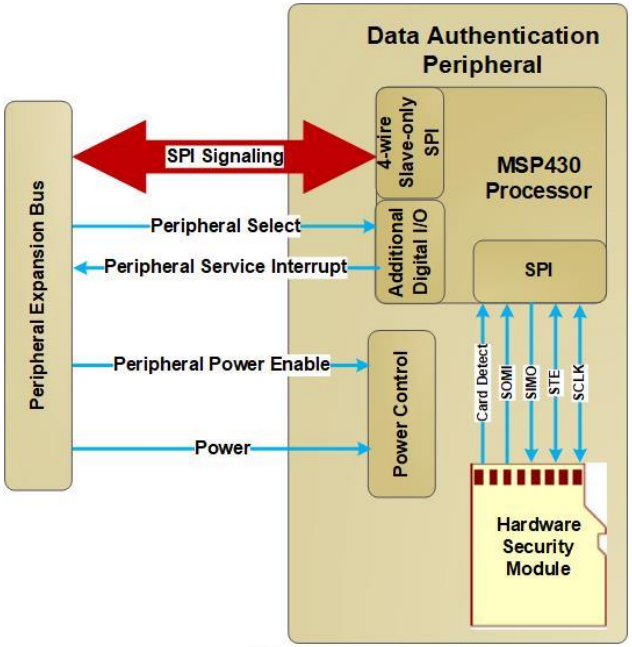
- GPS
- Cell
- Iridium
- Wi-Fi
- Existing firmware
- Off loads communications operations from controller
- Autonomously determines optimum communication channel

A data authentication peripheral performs public key infrastructure data authentication for digitally signing data to ensure nonrepudiation of transmitted data.

SC-HSM (smart card hardware security module)
- PKI Infrastructure
- Encrypt and or sign data

Sign transmission packet on the head unit

Validate received packet on the server



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Existing Moteino VS commercial ZWave

- Home security market driving availability of a vast ensemble of easily attainable sensors
- Don’t necessarily want to be in the Moteino sensor fabrication business
- ZWave needs to be tested in extreme multipath environment
- Door and PIR sensors are available
- Can the same beacon capability be accomplished using ZWave

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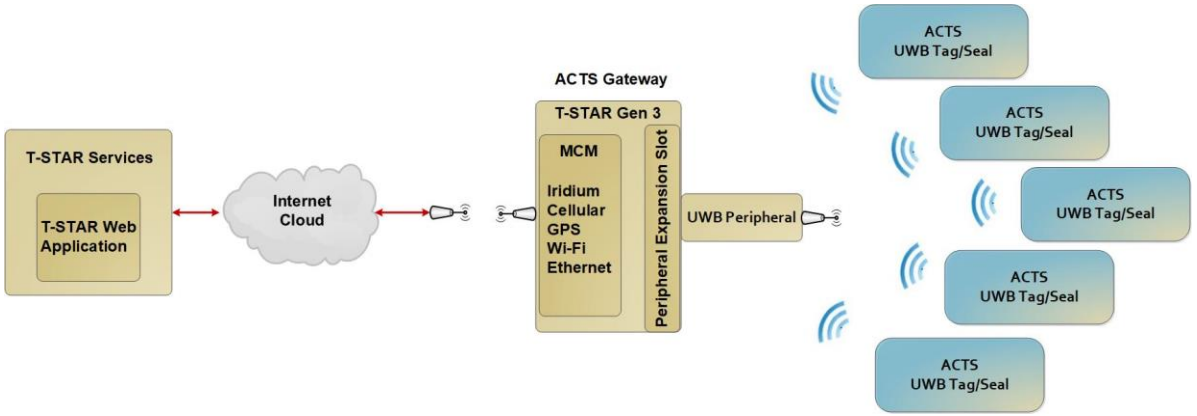
With a UWB impulse-radio peripheral in the T-STAR peripheral slot, ACTS tags/seals on containers being shipped can be continuously inventoried and reported during the shipment.



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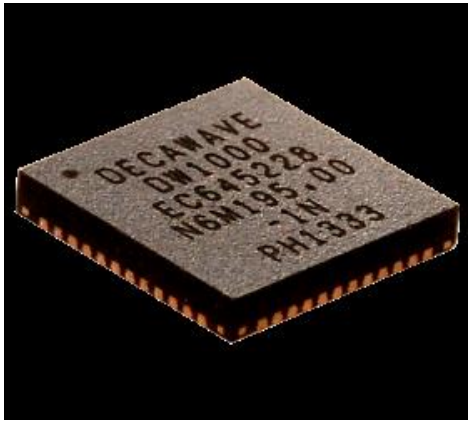
DecaWave DW1000 IR-UWB



- Single chip UWB transceiver
- IEEE802.15.4-2011 Standard
- Real Time Location capabilities (10cm indoors)
- Up to 6.8 Mbps
- Coherent receiver (300m range)
- Short packet durations (11,000 devices in a 20m radius)
- Highly immune to multipath fading
- Low power consumption (mode dependent)
- Two-way ranging

Source: decawave.com

Summary

- T-STAR Gen 3 leverages hardware and firmware from ACTS and MAVNet to reduce power consumption (extend longevity when operating on battery power) and improve and extend communications capability and reliability.
- MAVNet's robustness is requisite for controlling unmanned aerial vehicles anywhere in the world from anywhere in the world.
- T-STAR Gen 3 replaces the custom wireless security sensor network with COTS security sensors and protocols.
- The expansion slot and additional communications channels of the MCM allow interfacing of any number and types of instrumentation and sensors to collect more pertinent data for providing better situational awareness for the entire journey of sensitive cargo.

Summary (cont.)

- TSTAR is a unique platform that can be tailored to a variety of package tracking applications
- Can support a variety of communications, location services, and containment monitoring needs
- An ACTS data security peripheral would allow data acquired by ACTS sensors to be digitally signed
- The IR-UWB peripheral enables two-way ranging for locating ACTS tags in 2D or 3D space to facilitate an inventory or to detect the repositioning or movement of ACTS tagged items.