

RFID JOURNAL VIRTUAL EVENTS

RFID in Harsh Environments

ARG-US Remote Monitoring Systems for Hazardous Radioactive Materials

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What We Do

- **Packaging** certification and life cycle management for nuclear & other radioactive materials (RAM)
- **ARG-US** remote monitoring systems enhancing safety security and safeguards (3S) of nuclear & other RAM

Two Platforms:

1. **RFID Tag/Reader/CommBox**
2. **Wired and Wireless RAMM/TRAVELER**



ARG-US RFID Surveillance Tags (433MHz)

Patented, licensed and commercially available from Evigia Systems, LLC.

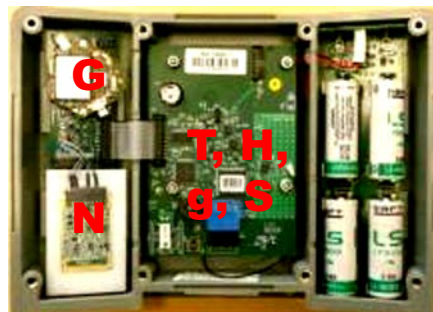
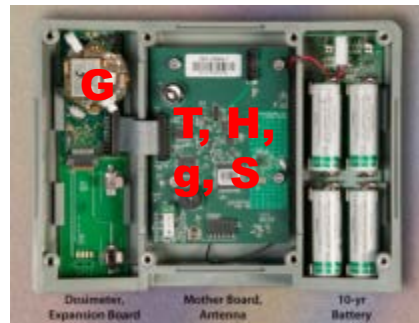
Flexible Sensor Suite



Tactile Seal Sensor



Long-life batteries > 10 y



Modular Design / Universal Form Factor



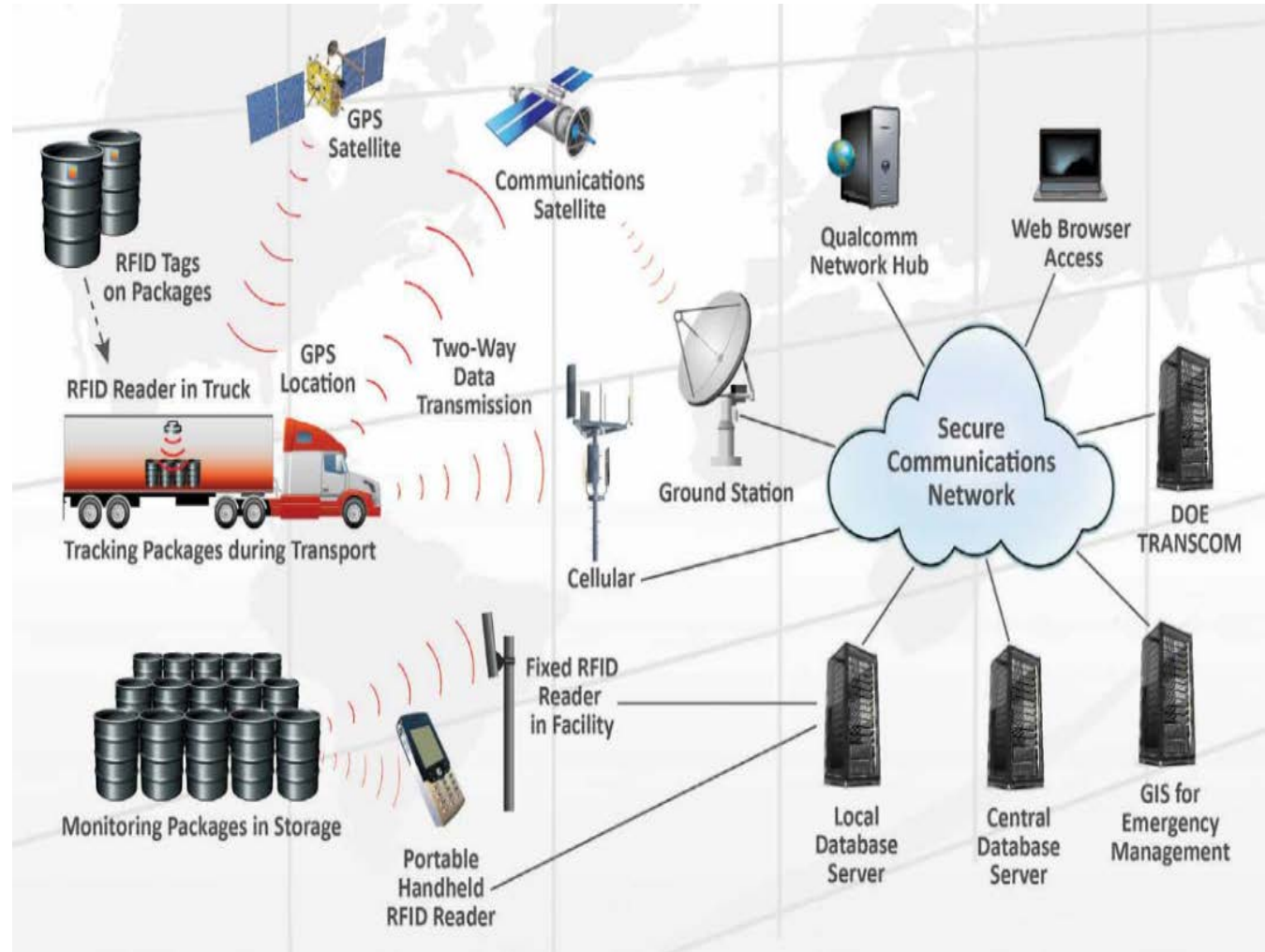
Tags approved as Tamper-Indicating device (TID) for DOE-Certified RAM Packages

ARG-US RFID/READER/CommBox: Smart Drum

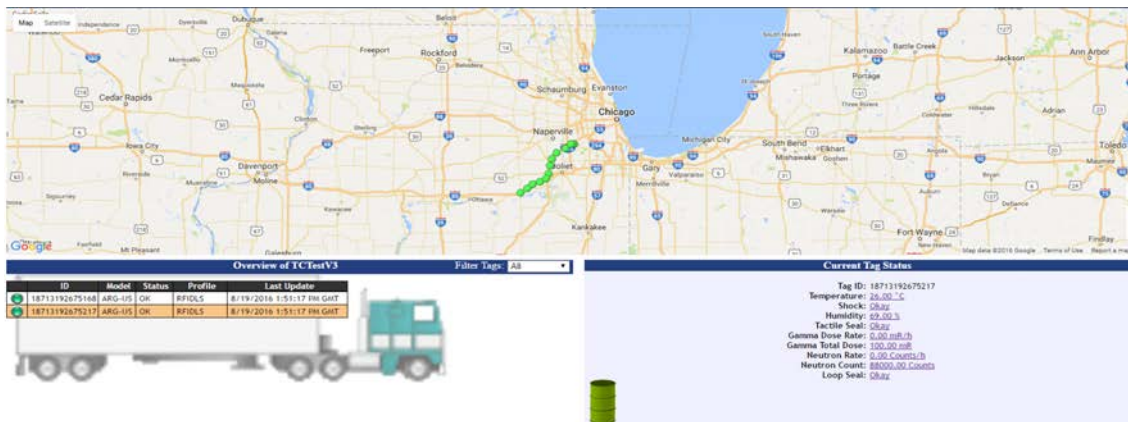
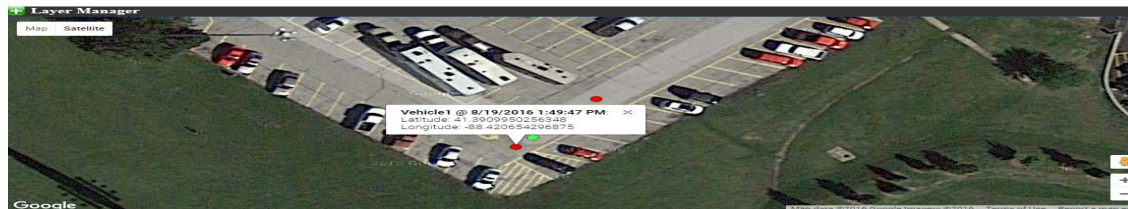
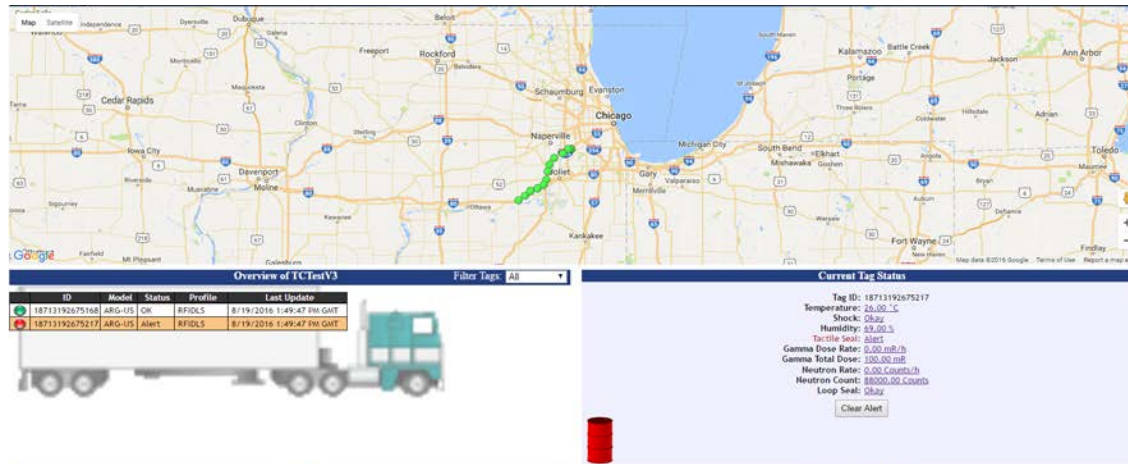
Reader



CommBox All-in-One



ARG-US RFID/CommBox Automatic Tactile Seal Alarm during Transportation



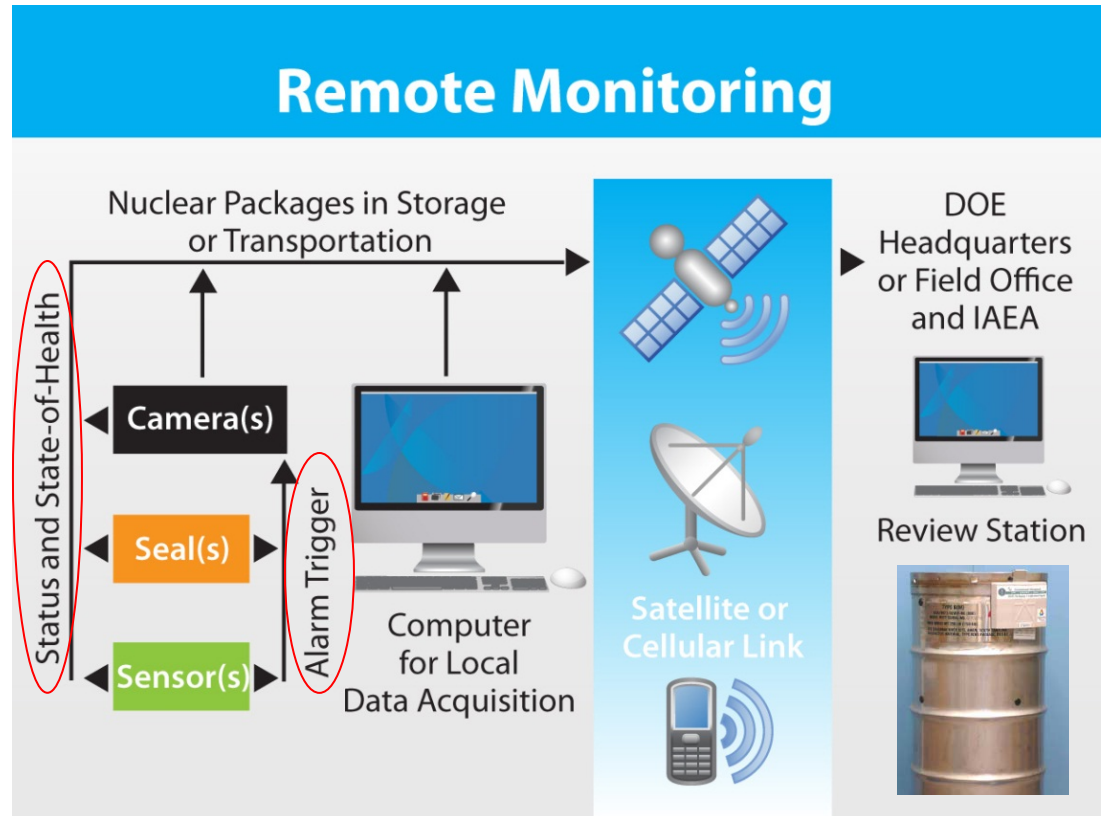
Remote Monitoring: Safeguards and Security

- Materials Control & Accounting (MC&A)
- **VERIFICATION**



During Life Cycle, Maintain:

- Chain of custody (COC)
- Continuity of knowledge (COK)
- Confidentiality, integrity, availability (CIA)



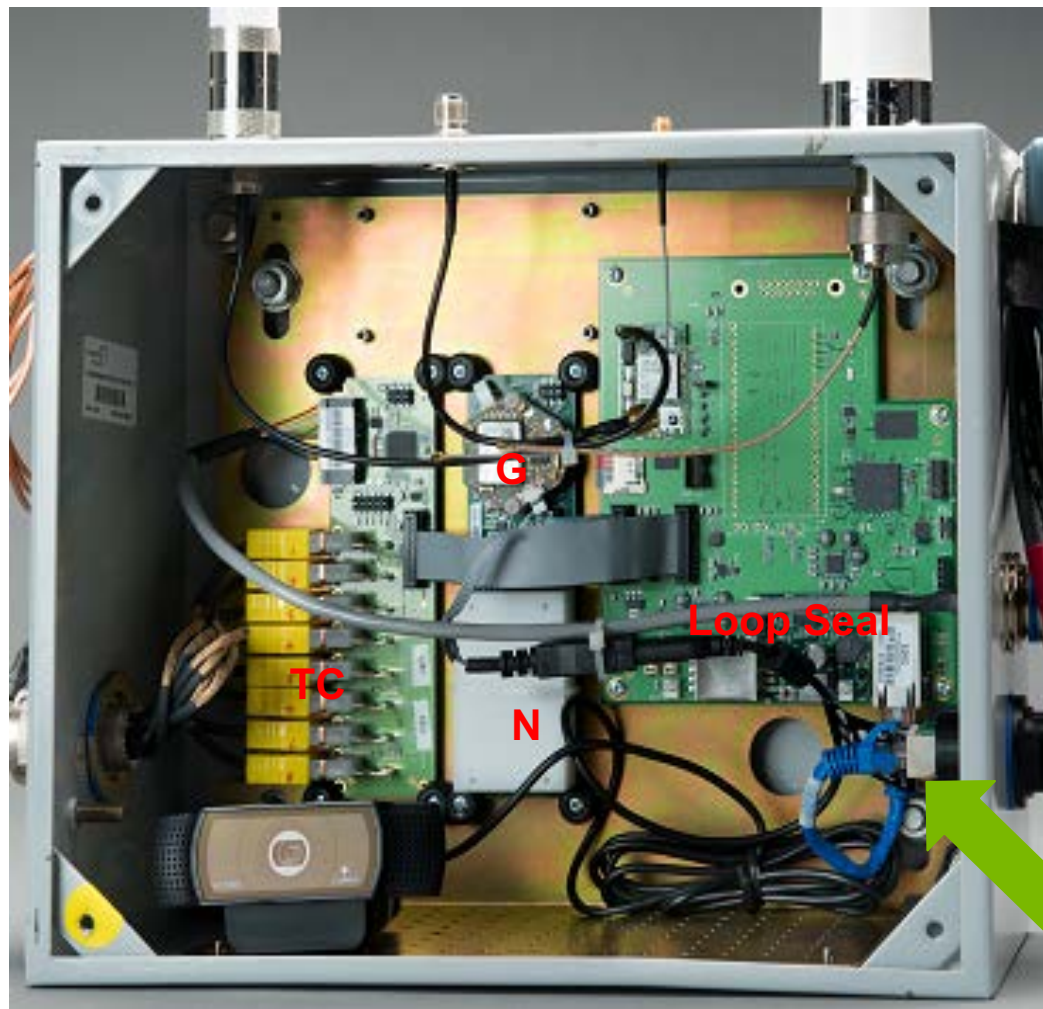
Remote Area Modular Monitoring (RAMM) of a Critical Facility

Wired and Wireless (WSN)

- Self-forming
- Self-healing



ARG-US RAMM with Digital Camera



Multiple Sensors

- Customized suite of sensors
- Adjustable alarm thresholds



Temperature
Sensors



3-axis Digital
Accelerometer



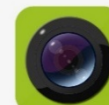
Gamma
Sensor



Neutron
Sensor



Electronic
Loop Seal



Digital Video
Camera

Power Over Ethernet (POE)

Alpha-Gamma Hot Cell Facility (AGHCF) – Category III Radiological Facility under D&D

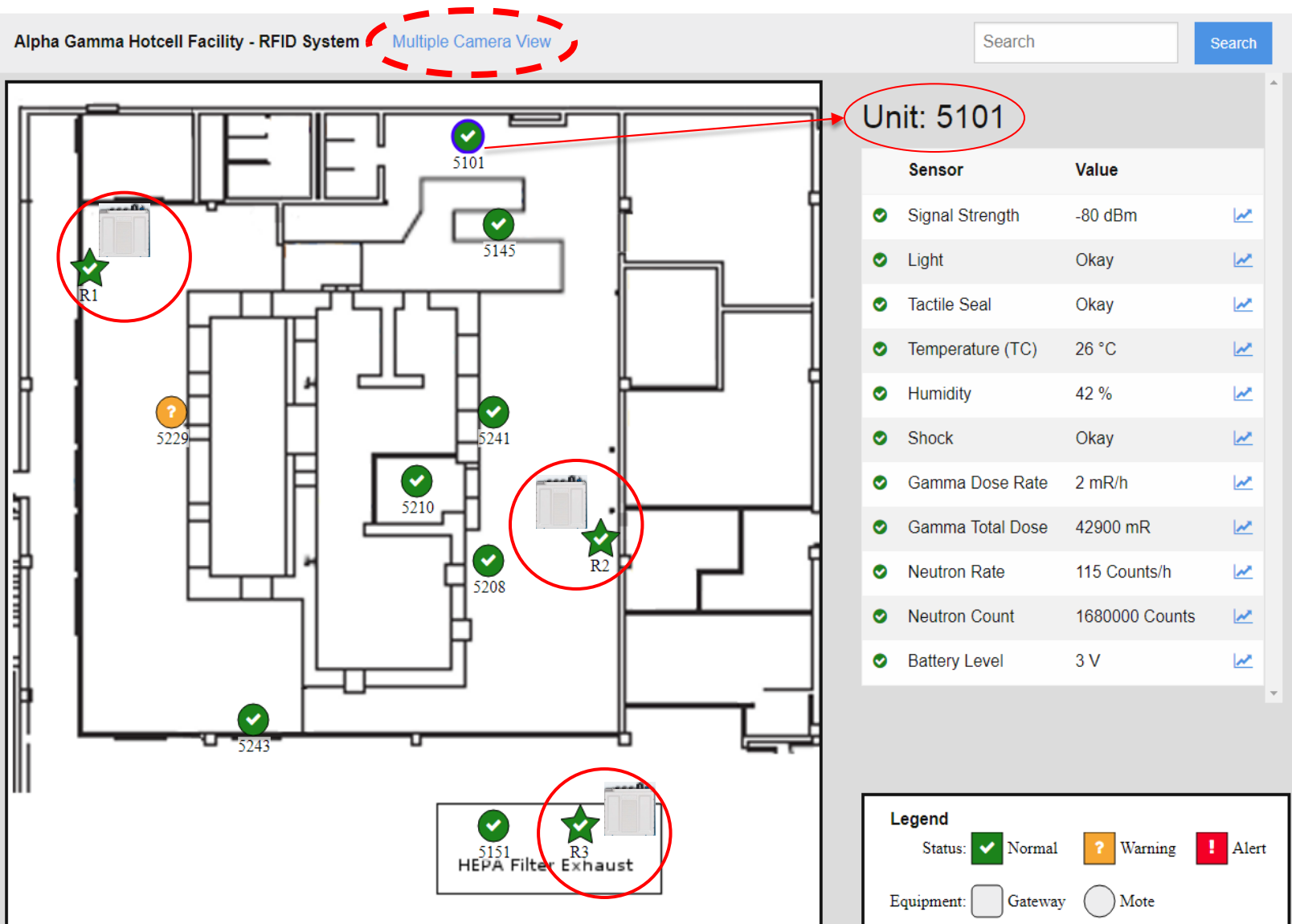
- ARG-US RFID system (2013 – present) →



- ARG-US RAMM system (2018 – present) →



ARG-US RFID in AGHCF



ARG-US RAMM Near Real-time Surveillance in AGHCF


Multiple Camera View

Today

Archive


Unit 1101 (clear)

Thu May 03 2018 13:29:36 GMT-0500 (CDT)




Unit 1102 (clear)

Thu May 03 2018 13:29:41 GMT-0500 (CDT)




Unit 1114 (clear)

Thu May 03 2018 13:29:45 GMT-0500 (CDT)



Unit 2107 (clear)

Thu May 03 2018 13:30:16 GMT-0500 (CDT)



Collection:

All

Units (hide)

1101

1102

1114

2107

2018-05-03 12:34

2018-05-03 12:36

2018-05-03 12:38

2018-05-03 12:40

2018-05-03 12:42

2018-05-03 12:44

2018-05-03 12:46

2018-05-03 12:48

2018-05-03 12:50

2018-05-03 12:52

2018-05-03 12:54

2018-05-03 12:56

2018-05-03 12:58

2018-05-03 13:00

2018-05-03 13:02

2018-05-03 13:04

2018-05-03 13:06

2018-05-03 13:08

2018-05-03 13:10

2018-05-03 13:12

2018-05-03 13:14

2018-05-03 13:16

2018-05-03 13:18

2018-05-03 13:20

2018-05-03 13:22

2018-05-03 13:24

2018-05-03 13:26

2018-05-03 13:28

2018-05-03 13:30

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Event Detection by ARG-US RAMM in AGHCF

- By comparing successive images for changes in pixels intensity



Wed, May 02 2018 08:44:52 GMT-0500 (CDT)

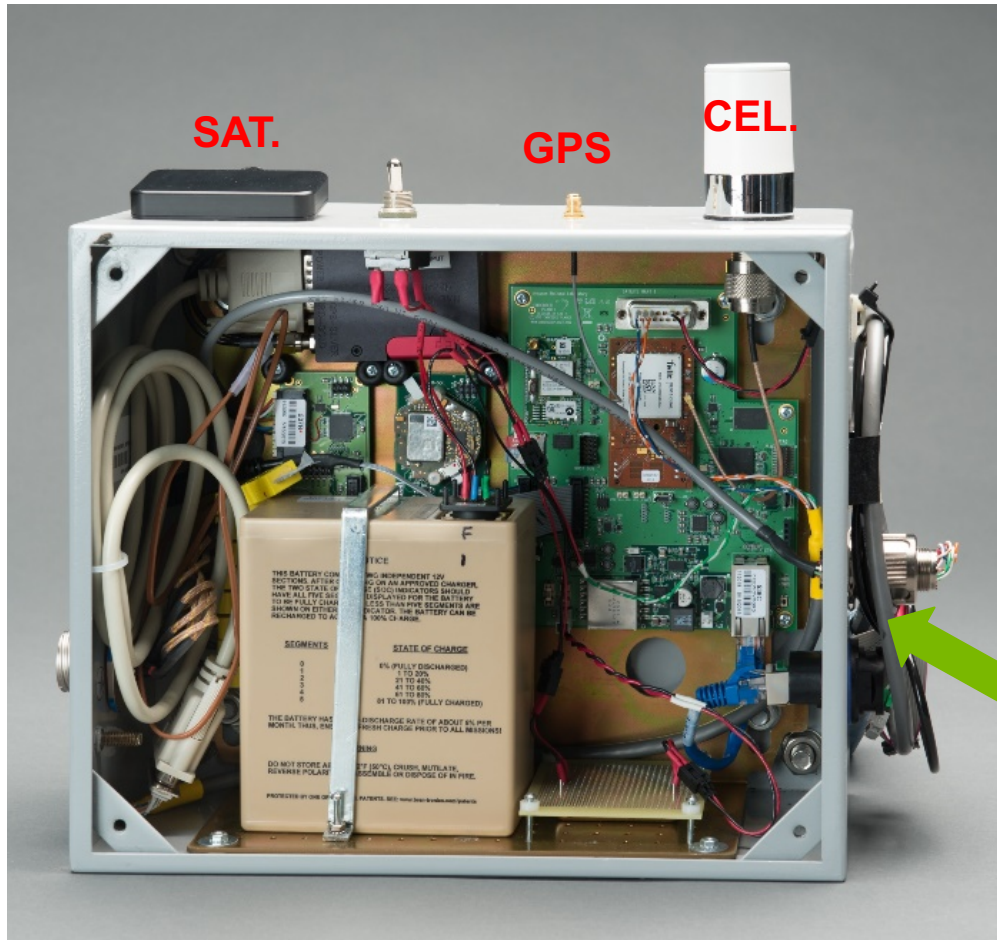


Wed, May 02 2018 08:46:52 GMT-0500 (CDT)

ARG-US TRAVELER for Tracking and Monitoring Cargo Conveyance

Cellular/Satellite Communication

- Adjustable transmission interval
- Two-way communication



Multiple Sensors

- Customized suite of sensors
- Adjustable alarm thresholds



Temperature
Sensors



3-axis Digital
Accelerometer



Gamma
Sensor



Neutron
Sensor



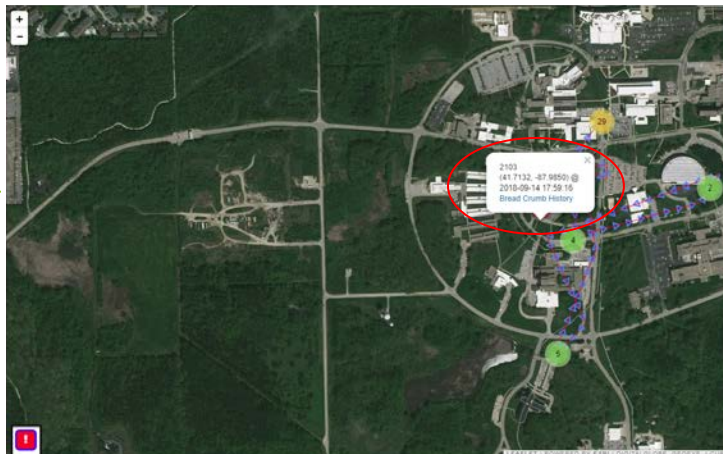
Electronic
Loop Seal



Rechargeable
Li-ion Battery

ARG-US TRAVELER Loop Seal Alarm during an In-Transit Stop

- “Instantaneous” cellular alarm received after loop seal disengagement



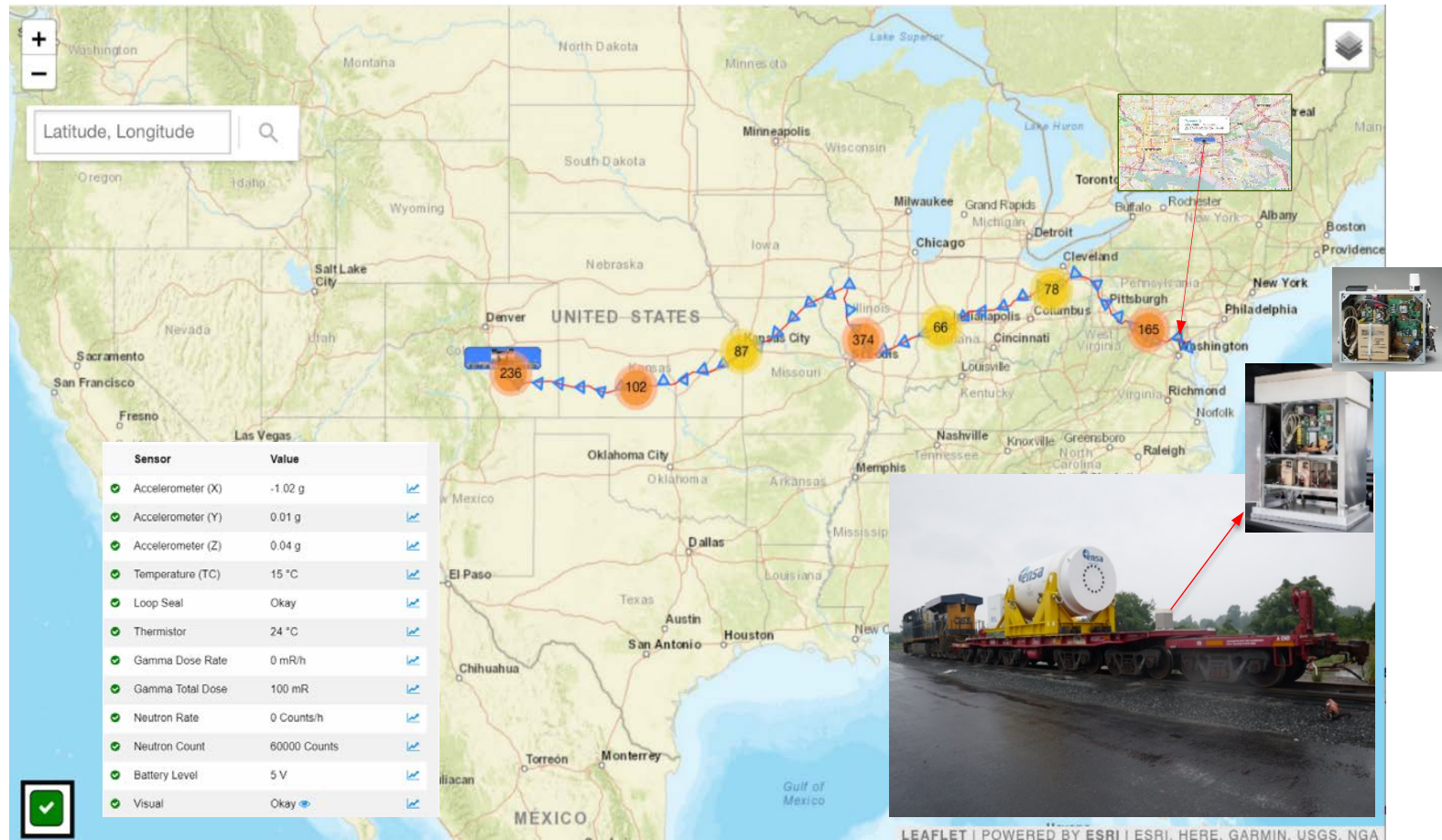
Sensor	Value
Accelerometer (X)	-0.02 g
Accelerometer (Y)	0.03 g
Accelerometer (Z)	1.00 g
Temperature (TC)	21 °C
Temperature (TC)	24 °C
Temperature (TC)	21 °C
Loop Seal	Alert
Thermistor	33 °C
Gamma Dose Rate	0 mR/h
Gamma Total Dose	600 mR
Neutron Rate	0 Counts/h
Neutron Count	336000 Counts
Battery Level	5 V
WSN	Okay



Electronic Loop Seal

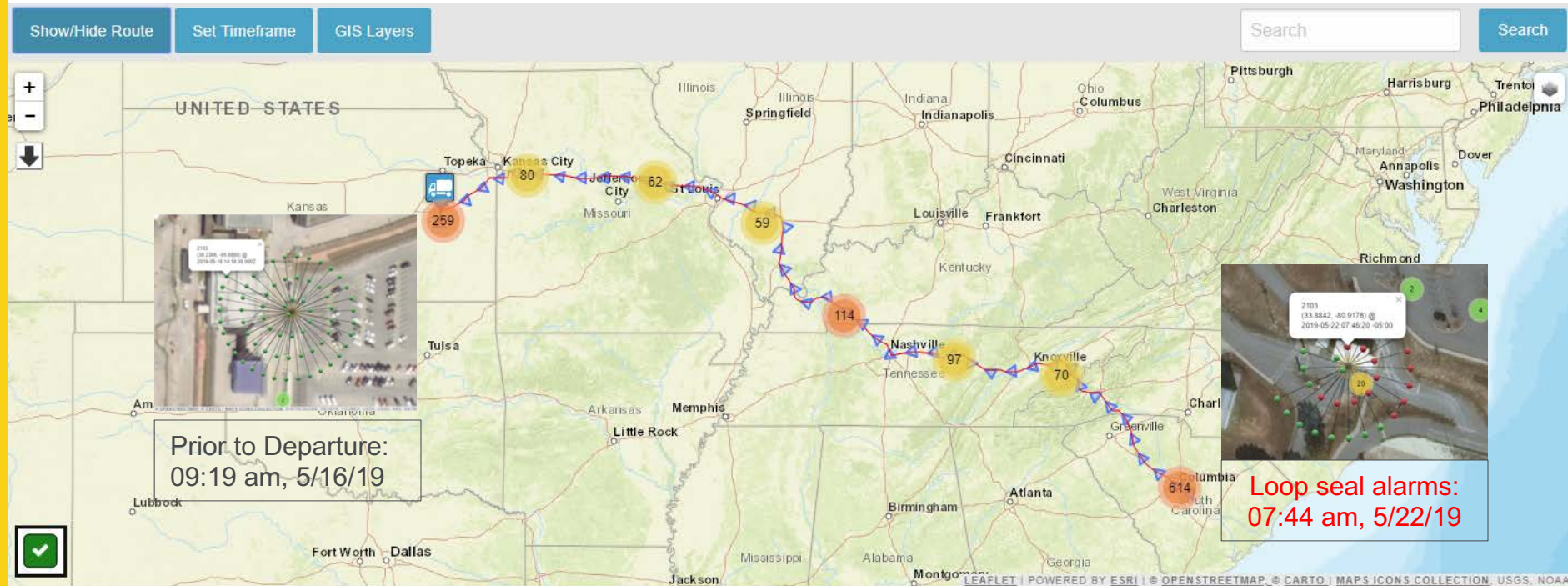
- 6-mm sealing wire dia, 110 cm to 40 m long, allowing looping of many items in a cargo conveyance
- Multi-strand wire embedded sensors preventing any attempt at detaching, bypassing, or tampering with the seal

TRAVELER DEMO in Rail Shipment, July 27–August 3, 2017



- Iridium satellite tracking of rail shipment from Baltimore, MD, to Pueblo, CO
- Shipment monitored in real time on a public-accessible webpage in the United States and Europe for 6 days
- 1,108 satellite transmissions (5-min intervals)

TRAVELER DEMO in Vehicle Shipment, May 15-23, 2019



Performance and Reliability

- Real-time tracking and monitoring
- Automatic sensor alarms
 - Loop seal
 - Geo-fence
- Redundant communication
 - Cellular
 - Iridium satellite



TRAVELER Demo in Truck Shipment

PWR Fresh Fuel Assembly Containers

- Set sensor thresholds (Max/Min)
- Set polling interval
- Clear alarms
- Switch cellular to Iridium satellite and vice versa

Command		Unit
Set Poll Interval	Seconds	180
		2103
		<input type="button" value="Submit"/>
Poll Now		Select Unit
		<input type="button" value="Submit"/>
Clear Alarms		Select Unit
		<input type="button" value="Submit"/>
Set Communication	Type	Satellite with Cellular Backup
		2103
		<input type="button" value="Submit"/>
Update Sensor	Slot ID	Sensor
	Min	Threshold
	Max	Threshold
	Enabled	<input checked="" type="checkbox"/>
		Select Unit
		<input type="button" value="Submit"/>

- “INSTANTANEOUS” sensor alarms via cellular communication – When, Where and What
- Electronic loop seal alarm shown below



TRAVELER DEMO (Geo-fencing) in Vehicle Shipment (1/3)

- A server-based geo-fence program establishes a virtual geographic boundary for vehicle/truck/rail shipment
- GPS location and travel time defines geo-fence for a trip; constraints can be dynamically adjusted by Admin

Zone: region of interest

Leg: zones and window
– Inclusive or Exclusive

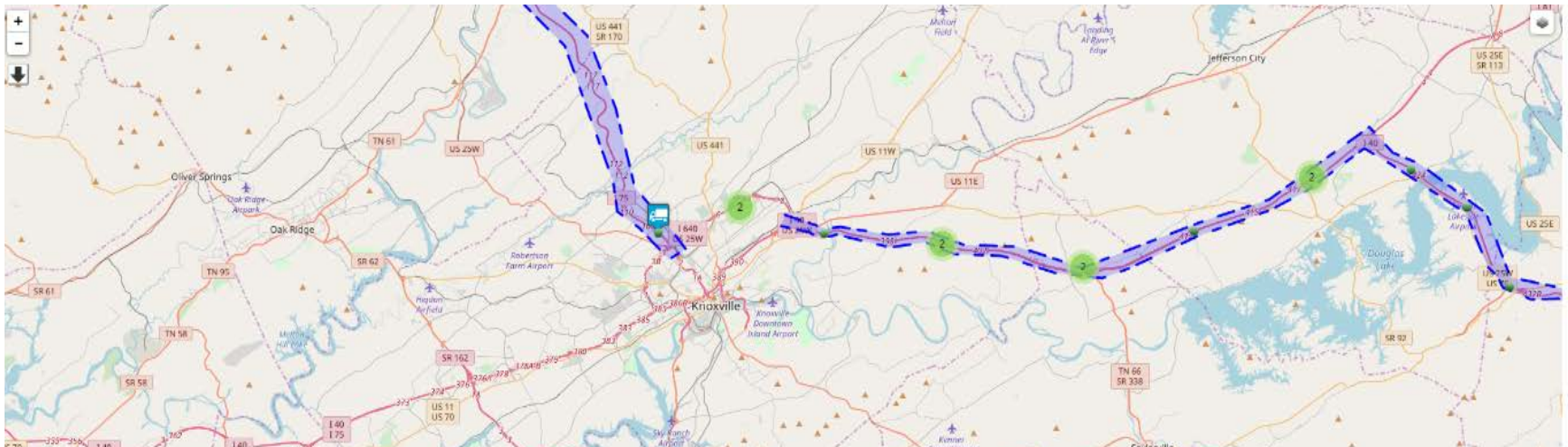
Route: collection of leg(s)

Trip: route with start/end date and time

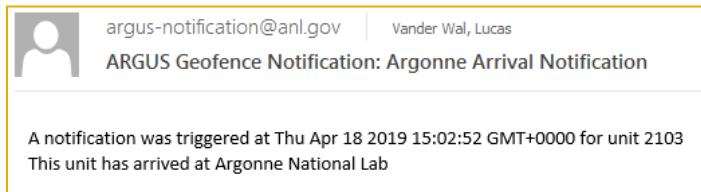
ARG-US Admin					Monitor	Commands	Subscriptions	Logout
Zones Routes Notifications Trips								
Monitor Trips								
Unit	Collection	Active Trip(s)	Future Trip(s)	Current Location	Communication Type	Alarm Status		
2102	2102			41.713957, -87.980540	Cellular	OK		
2103	2103	2103 at Argonne		41.715448, -87.983635	Cellular	OK		
2105	2105			41.715244, -87.982010	Satellite	OK		
2112	2112		2112 Zone Test	41.715244, -87.983584	Cellular	OK		
2113	2113			41.715449, -87.983633	Cellular	OK		

TRAVELER DEMO (Geo-fencing) in Vehicle Shipment (2/3)

- Advanced notification of arrivals (destination and border crossing)
- Alarms (sensors or geo-fence violations) sent automatically to personnel on a subscriber call list

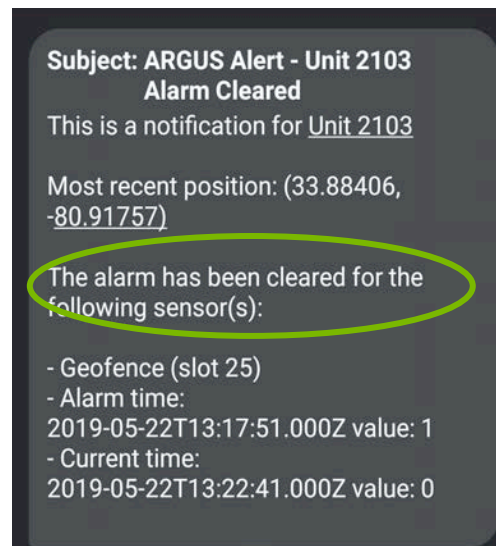
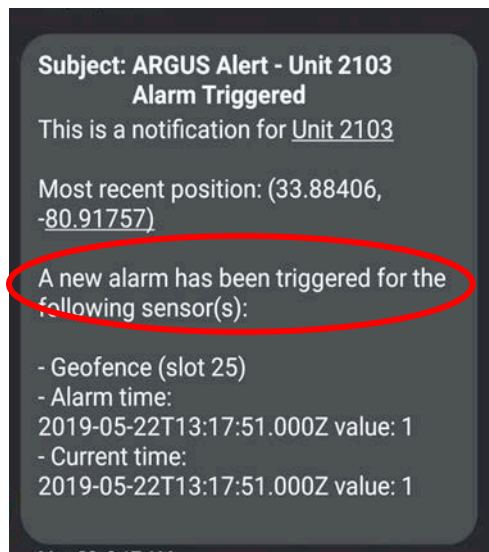


TRAVELER DEMO (Geo-fencing) in Vehicle Shipment (3/3)



Notifications

- Arrivals
 - Destination
 - Border crossing
- Alarms
 - Clearance
- Subscriber call list
 - SMS
 - e-mail

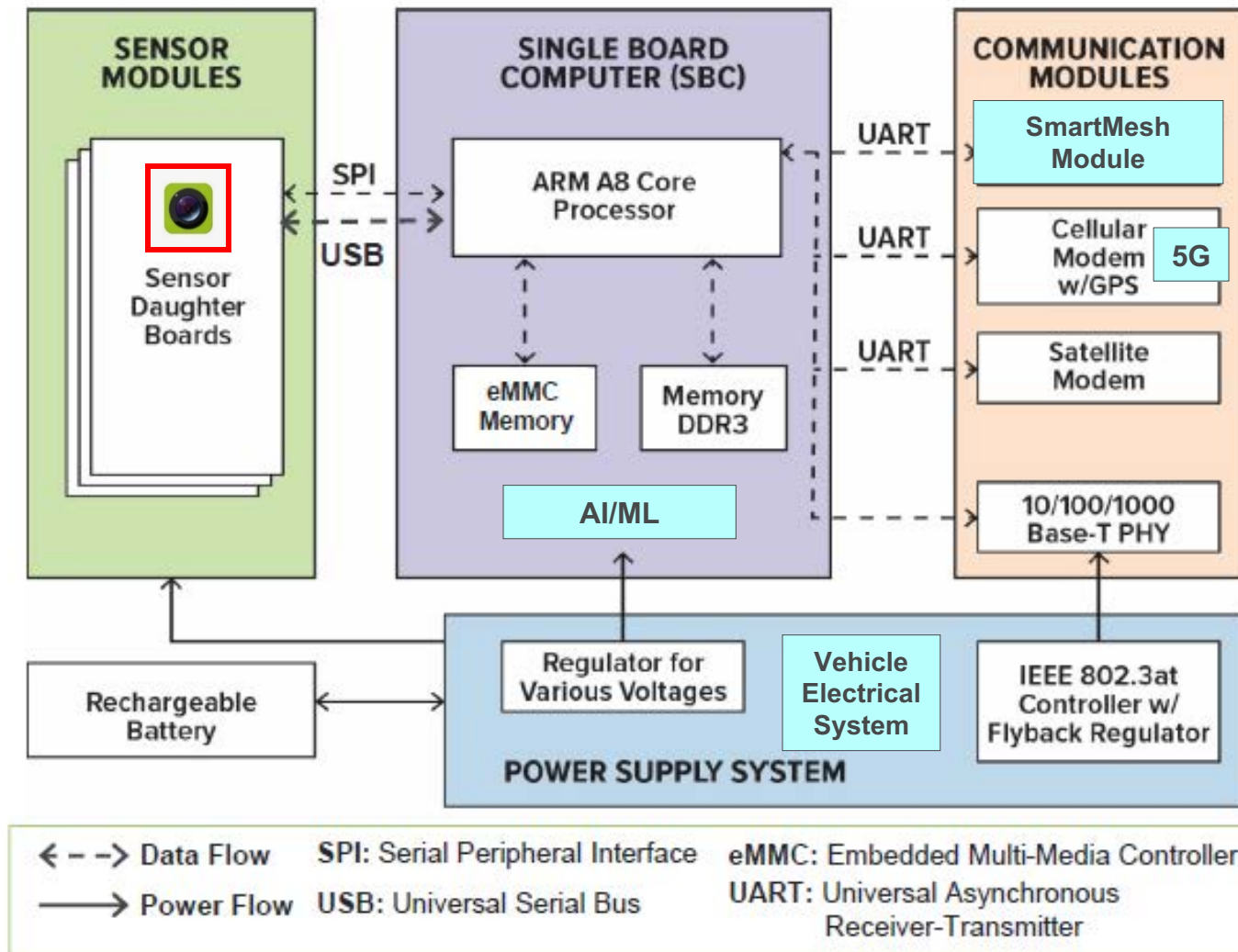


Geo-fencing and Transport Security Plan (TSP)

TSP Topic	RAM			NM	
	DOT	NRC	ICAO/IMO	NRC	INFCIRC/225
6. Information Management					
a. Information Security		X	X	X	X
b. Records Retention	X	X		X	X
c. Confidentiality		X	X	X	X
d. Protection of Information	X	X	X	X	X
7. Operational Transport Security / Physical Protection Measures					
a. Primary and Alternate Routes, Intermodal Transfers, Storage in Transit, Stopping Places	X	X	X	X	X
b. Description of Security System	X	X	X	X	X
○ Equipment and Modes of Transport	X	X	X	X	X
○ Operations Communications, Command and Control; Shipment Tracking	X	X	X		X
○ Escort, Guards and Response Force Personnel	X	X	X	X	X
○ Additional Security Measures	X	X	X	X	X
○ Maintenance and Testing of Systems and Equipment	X	X	X	X	X
8. Emergency Response					
a. Non-tactical Emergency Response				X	X
b. Tactical Emergency Response				X	X
c. Incident Communication					X
d. Notification of Relevant Agencies					X

- **RAM:** Radioactive Material **NM:** Nuclear Material **X: Required/Recommended**
- **DOT:** U.S. Department of Transportation **NRC:** U.S. Nuclear Regulatory Commission
- **ICAO:** International Civil Aviation Organization **IMO:** International Maritime Organization
- **INFCIRC/225:** IAEA The Physical Protection of Nuclear Material

Future Work



Block Chain-DLT

Summary

- Real-time, remote monitoring using **ARG-US RFID/Reader/CommBox and RAMM/TRAVELER**, with sensors and automatic alarms,

not only enhances Safety, Security and Safeguards (3S), but also offers tremendous cost savings over the life cycle of nuclear and other RAM in facilities and during transportation.

- Argonne and U.S. Department of Energy are fostering technology commercialization via various avenues, including IP licensing, Strategic Partnership Project, and Cooperative R&D Agreement (CRADA)

Partners:

- Evigia Systems LLC
- Westinghouse Electric Corporation
- Embedded Planet, Inc
- Central Research Institute of Electric Power Industry (CRIEPI), Japan
- International Atomic Energy Agency (IAEA)



Questions?

To Learn More, Contact yliu@anl.gov

Acknowledgment



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