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ARG-US Remote Monitoring Systems for Enhancing Safety, Security and Safeguards (3S) of Nuclear and Other Radioactive Materials



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U.S. DEPARTMENT OF
ENERGY



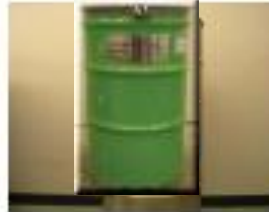
EM Environmental Management
safety ✦ performance ✦ cleanup ✦ closure
DOE Packaging Certification Program

What we do

- Conduct technical review for certification of DOE transportation packages of nuclear & other radioactive materials.
- Conduct packaging QA program approvals and audits/inspection.
- Provide training on packaging design, QA and transport security.
- Develop/deploy ARG-US remote monitoring systems for enhancing safety security and safeguards (3S) of nuclear & other radioactive materials

Two platforms:

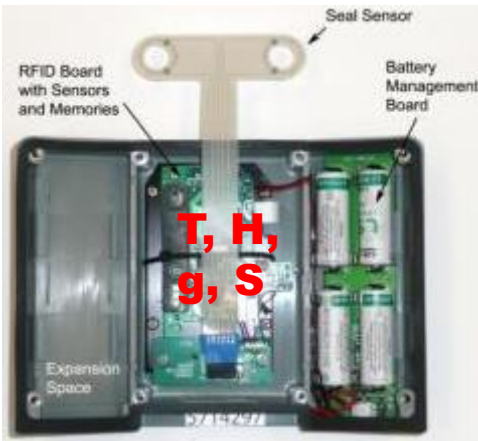
1. RFID tags/readers/CommBox
2. Wired and Wireless RAMM/TRAVELER
3. Web Application User Interface



ARG-US RFID Surveillance Tags

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

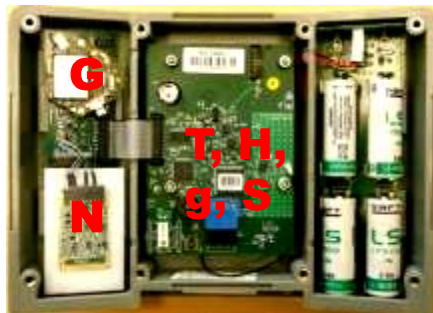
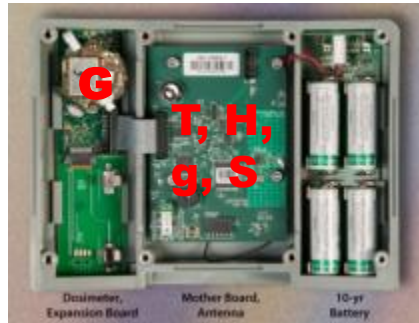
Flexible Sensor Suite



Tactile Seal Sensor



Long-life batteries > 10 y

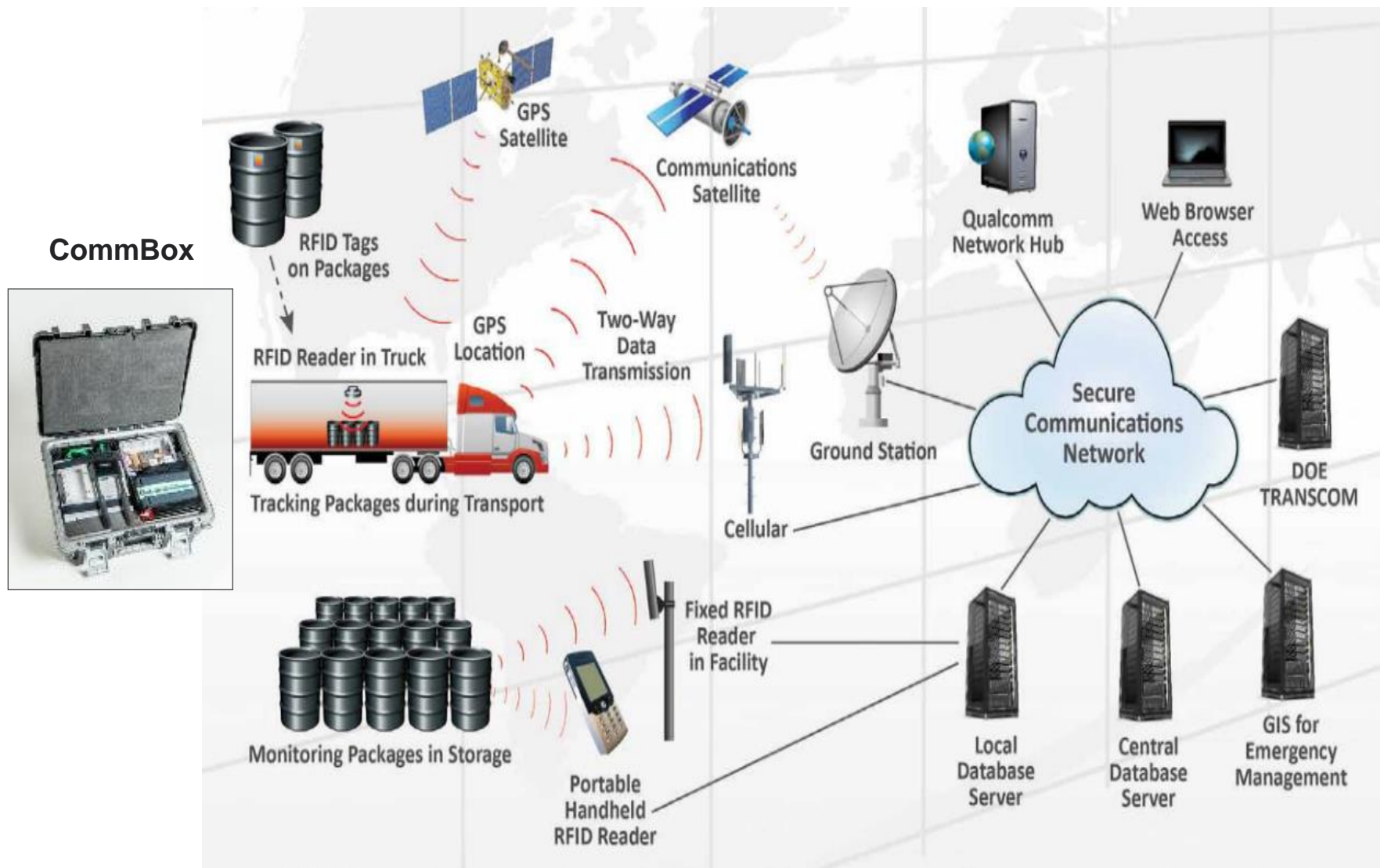


Modular Design / Universal Form Factor

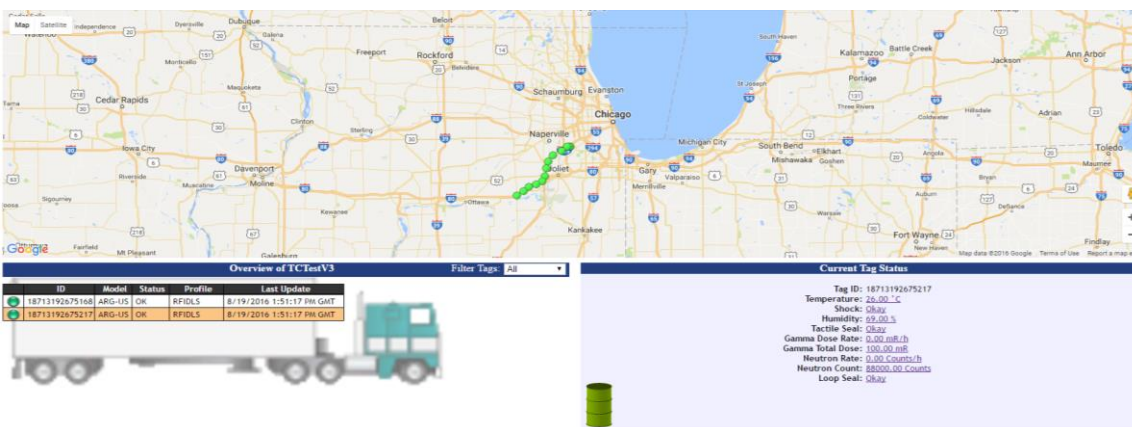
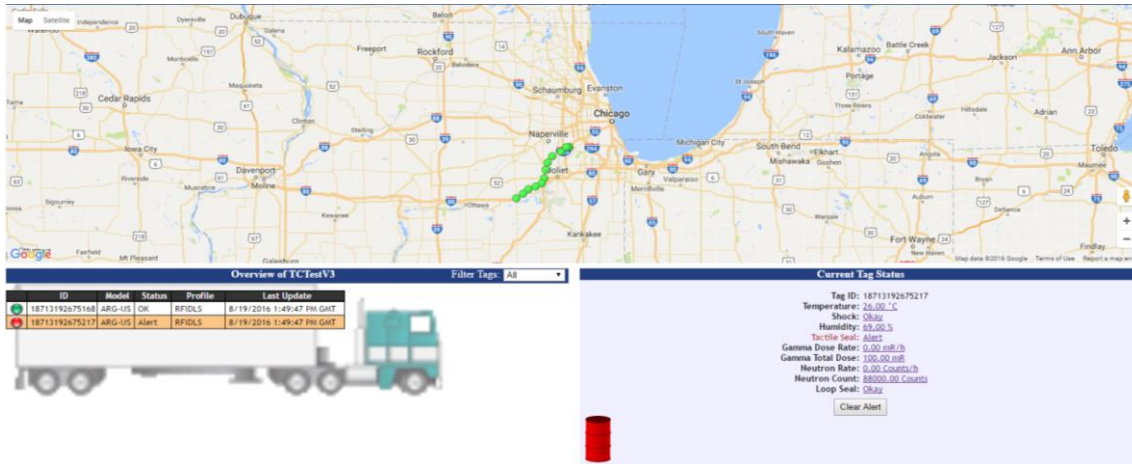


Tags approved for use in DOE-certified Type B and AF packages

ARG-US RFID/CommBox: Smart Drum Technology



How does ARG-US RFID/CommBox enhance security & safeguards of RAM package during transportation?

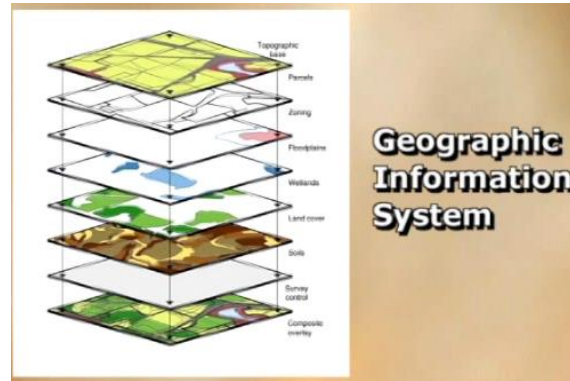


- Vehicle road test of cellular communication of tactile seal alarm, ~39 miles round trip from Argonne to Morris, IL, August 19, 2016
- Tactile seal alarm at 1:49:47 pm GMT, 8/19/2016
- Satellite view of truck stop and vehicle where tactile seal was violated in the “staged” incident
- Tactile seal alarm cleared remotely from the ARG-US Command Center at 1:51:17 pm GMT, 8/19/2016
- Response time seen on the webpage **< 2 min**

ARG-US Command Center

Information for Action

Platform/Protocol Development

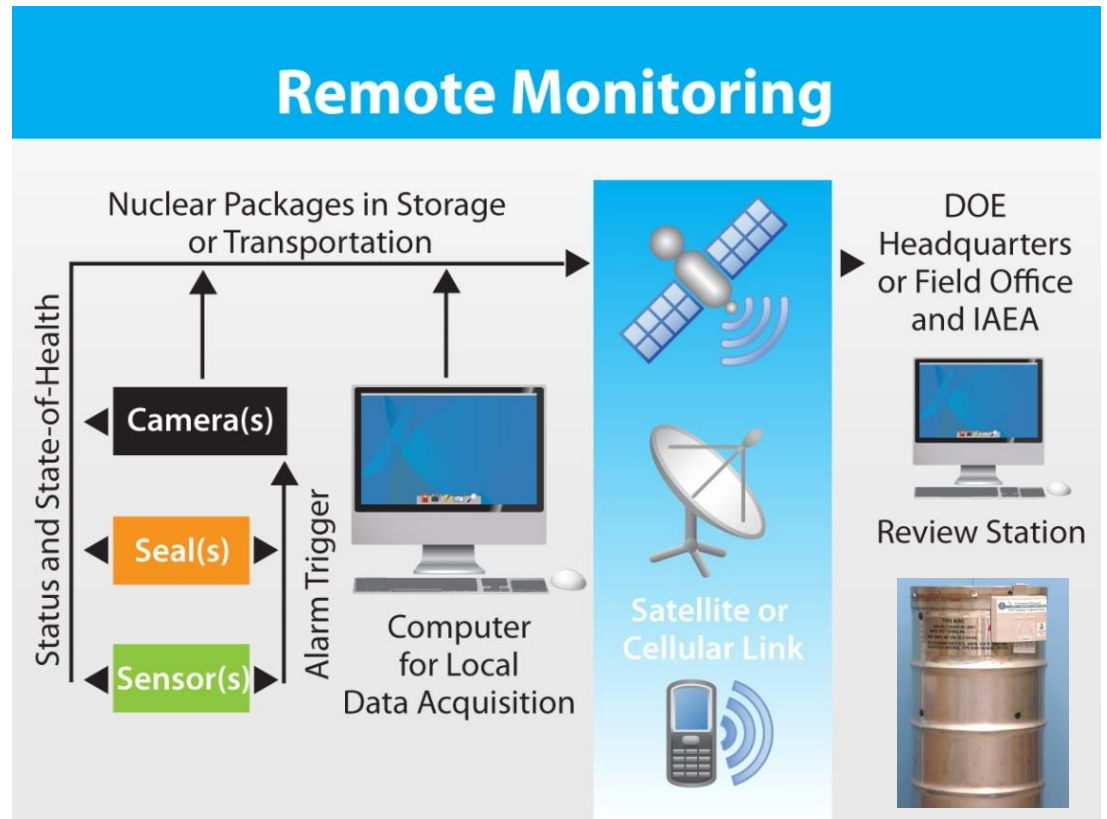


Training/Certification



Safeguards and Security

- Materials Control & Accounting (MC&A)
- Non-Proliferation



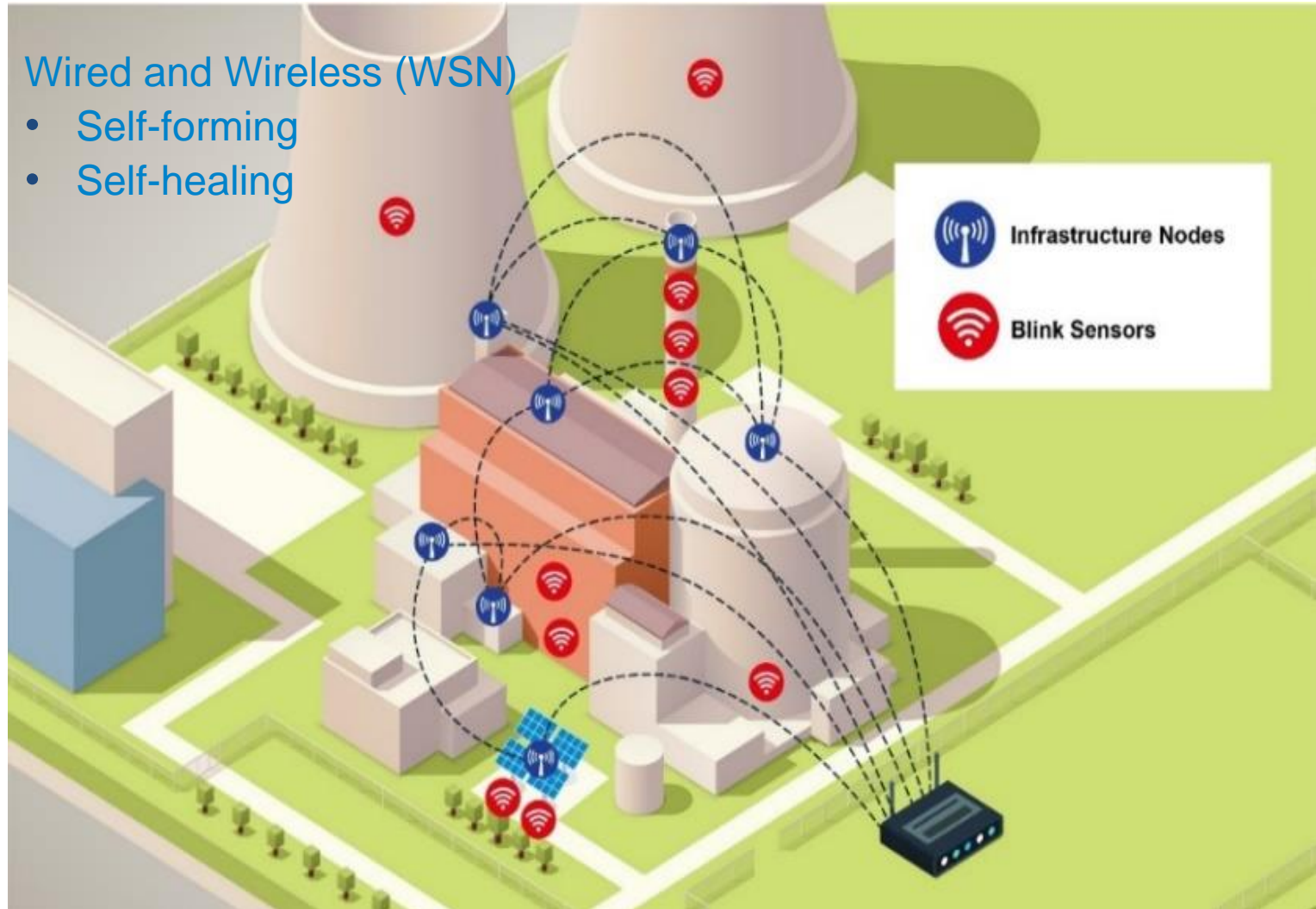
- Chain of custody
- Continuity of knowledge
- Confidentiality, integrity, availability

ARG-US Command Center 24/7 remote monitoring of RFID tagged containers

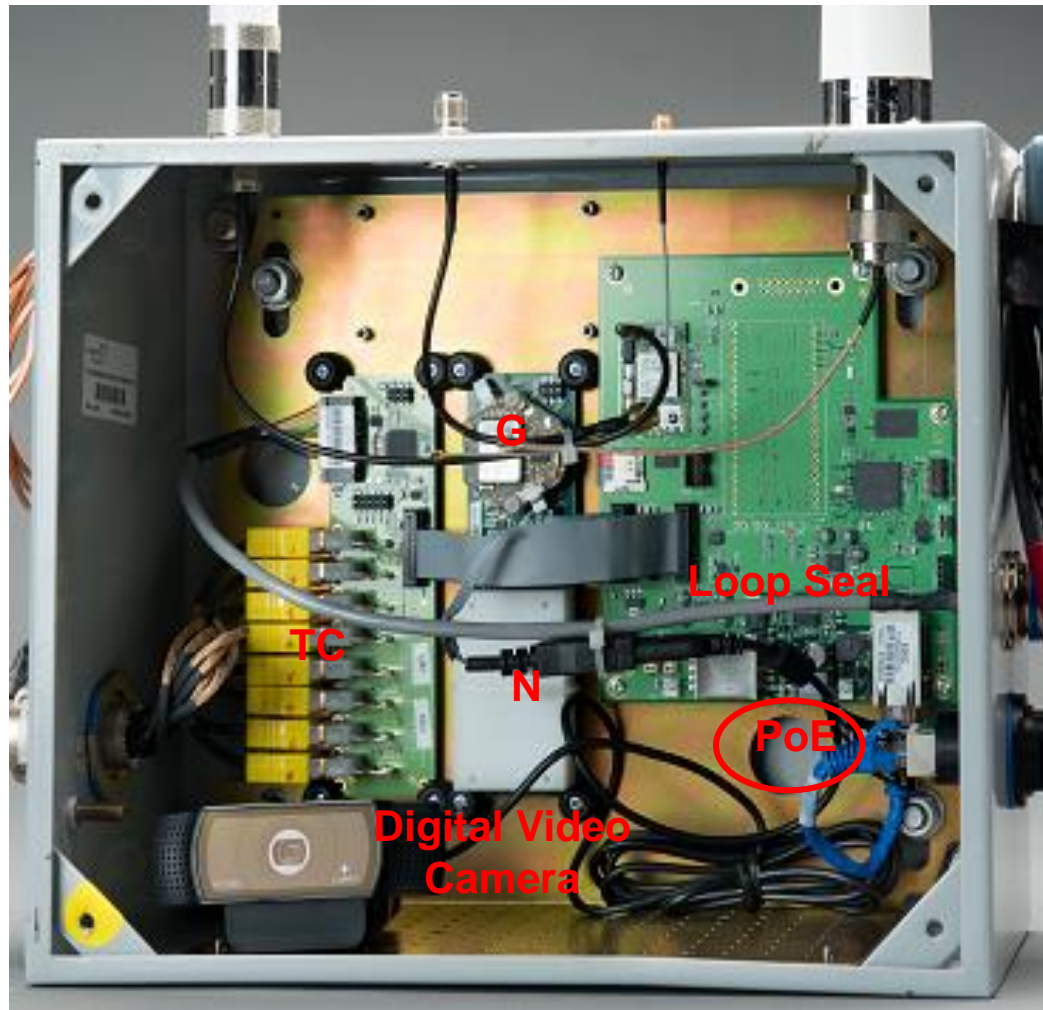
Remote Area Modular Monitoring (RAMM) of a Critical Facility

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



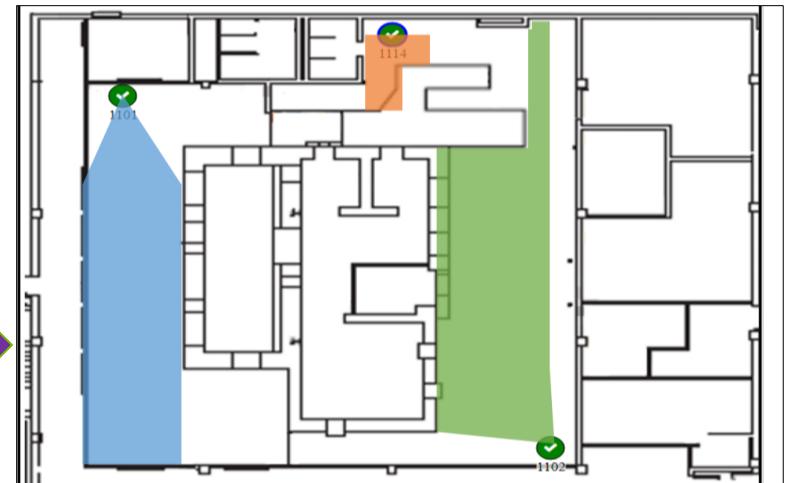
Digital Video Camera

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) →



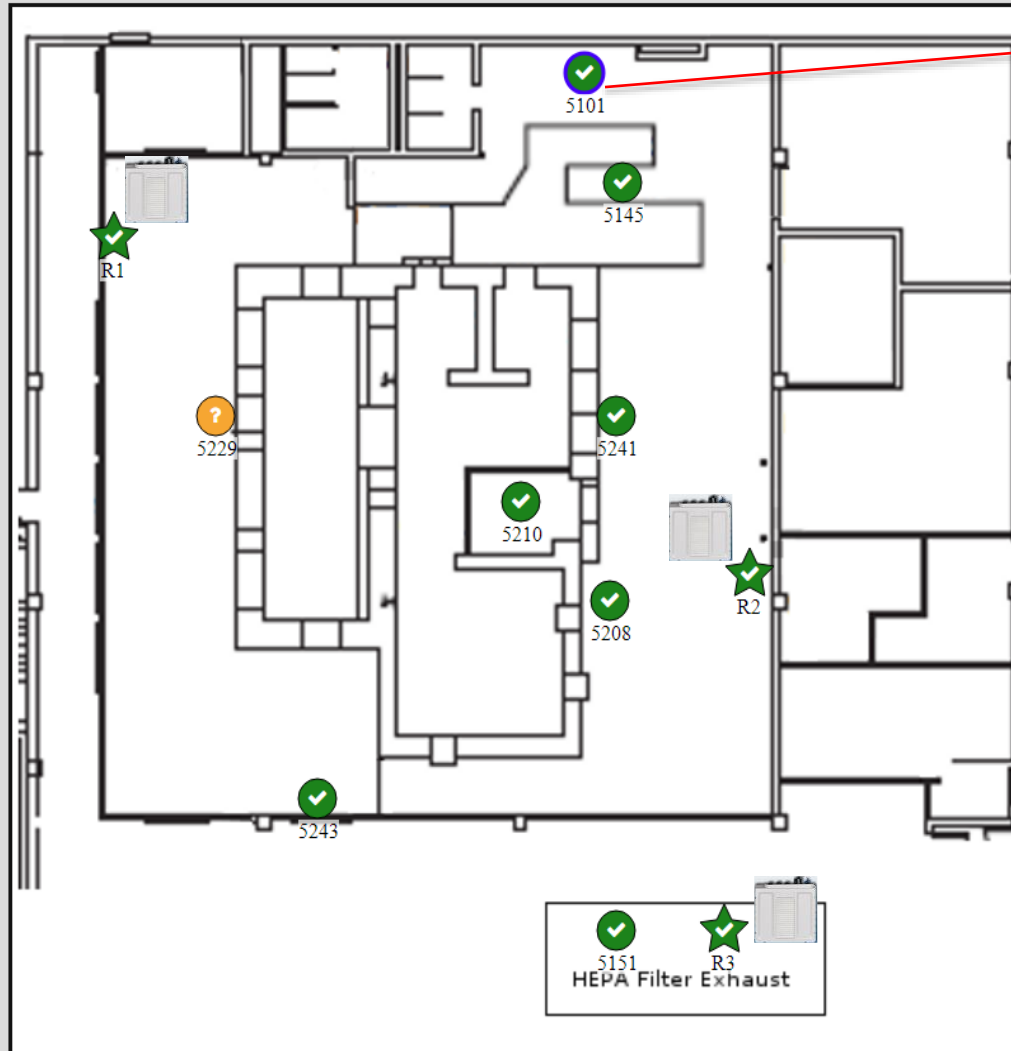
ARG-US RFID in AGHCF

Alpha Gamma Hotcell Facility - RFID System

Multiple Camera View

Search

Search



Unit: 5101

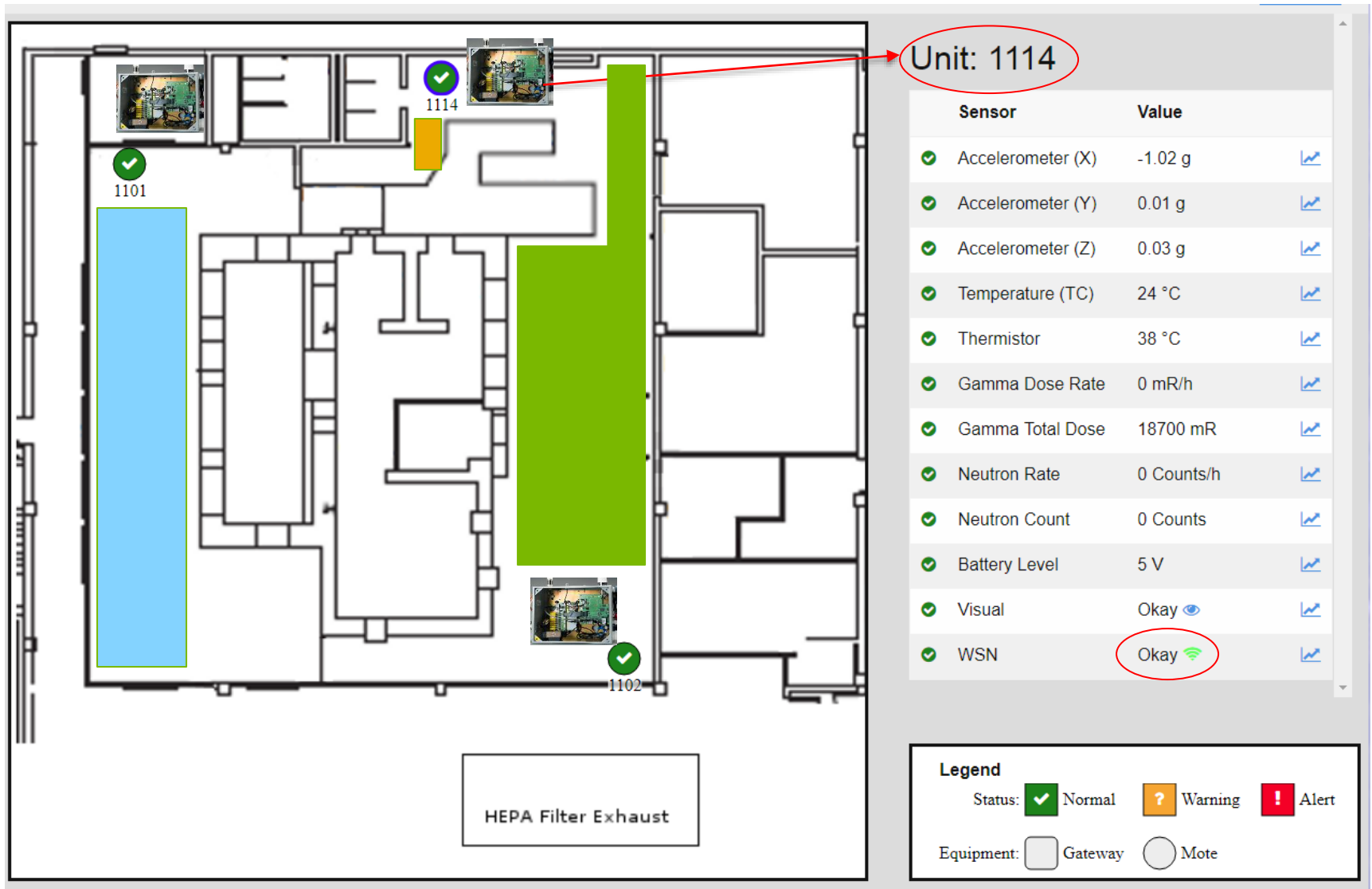
Sensor	Value
✓ Signal Strength	-80 dBm
✓ Light	Okay
✓ Tactile Seal	Okay
✓ Temperature (TC)	26 °C
✓ Humidity	42 %
✓ Shock	Okay
✓ Gamma Dose Rate	2 mR/h
✓ Gamma Total Dose	42900 mR
✓ Neutron Rate	115 Counts/h
✓ Neutron Count	1680000 Counts
✓ Battery Level	3 V

Legend

Status: ✓ Normal ? Warning ! Alert

Equipment: □ Gateway ○ Mote


ARG-US RAMM with digital cameras in AGHCF (PoE)




How does ARG-US RFID/RAMM enhance safety, security & safeguards (3S) of RAM in a facility?

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

Navigation: ⏪ ⏩

How does ARG-US RFID/RAMM enhance security and safeguards of RAM in a facility?

- RAMM Unit 1114 monitoring glovebox in AGHCF
- Compare successive frames of images to detect changes in intensity in pixels



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

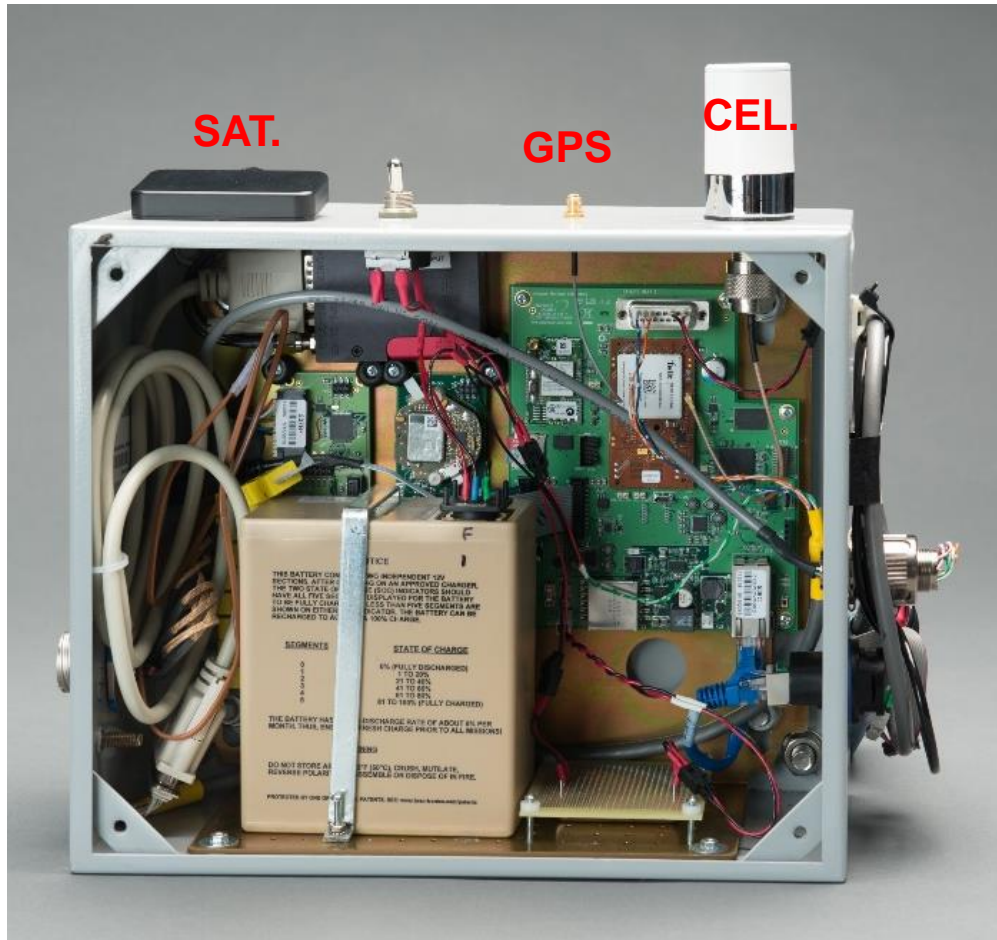
Wed, May 02 2018 08:46:52 GMT-0500 (CDT)

- Detection of an event in < 2 minutes

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



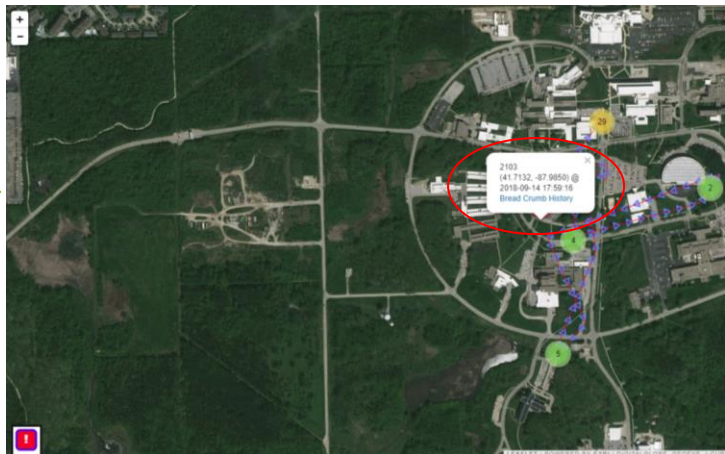
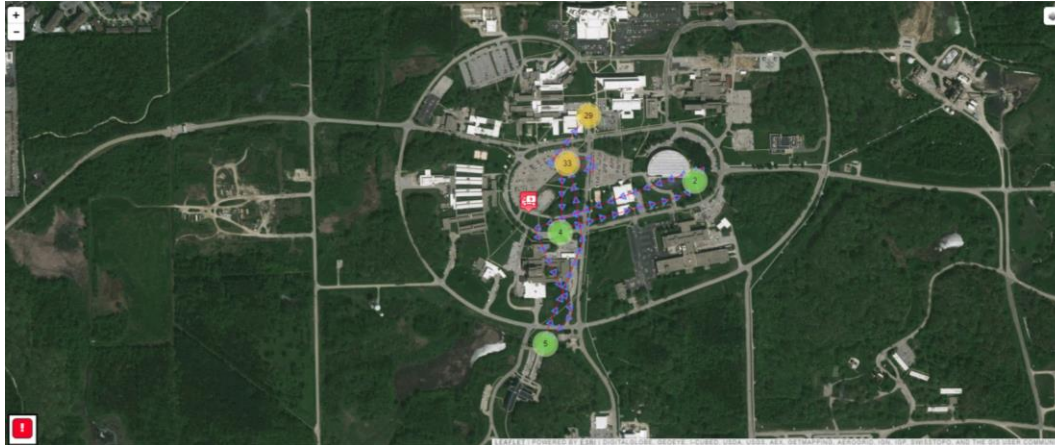
Electronic
Loop Seal



Rechargeable
Li-ion Battery

How does ARG-US TRAVELER enhance security & safeguards of RAM during transportation?

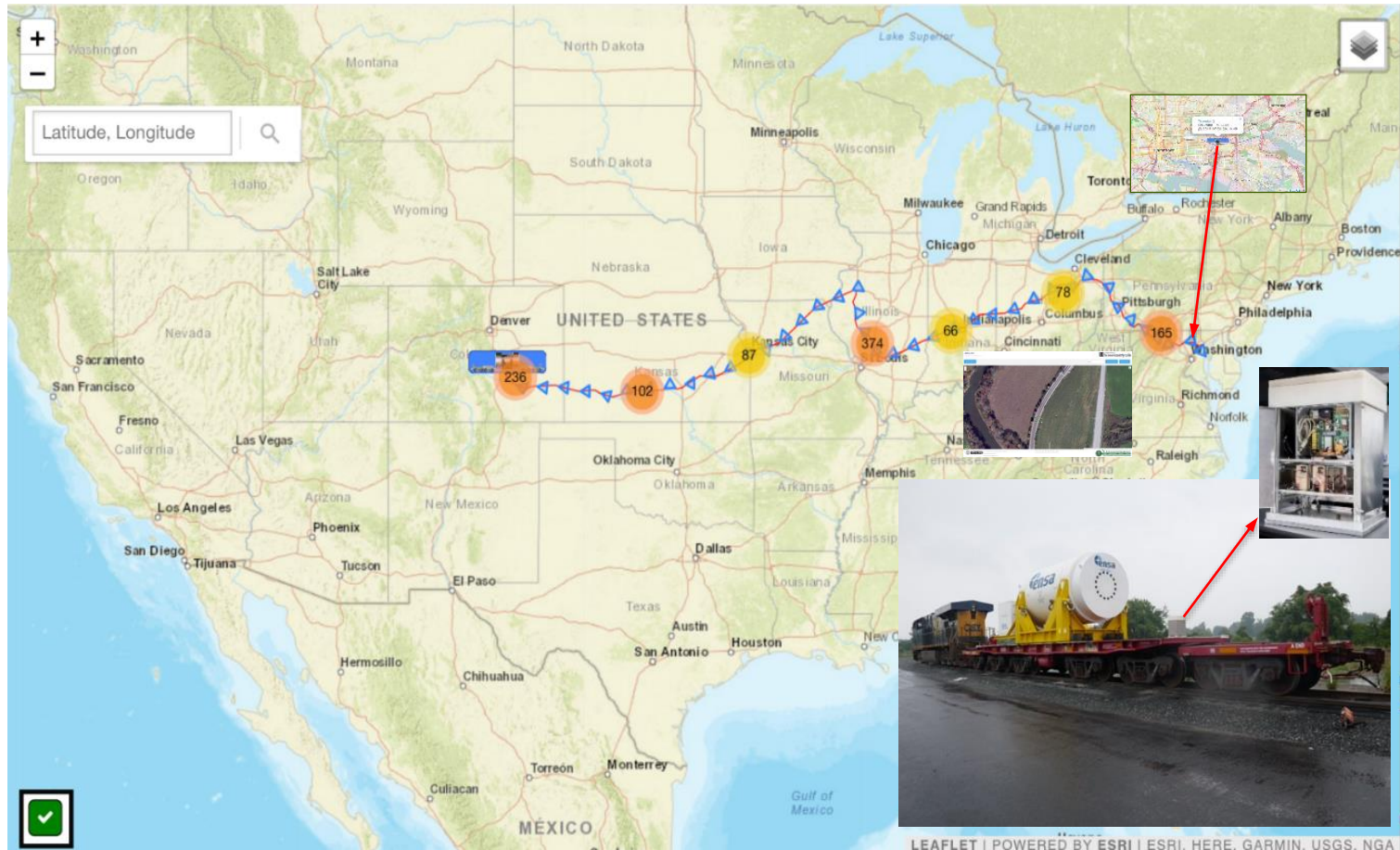
- Testing electronic loop seal inside Argonne campus, 09/14/2018
- “Instantaneous” cellular alarm received after loop seal disengagement



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
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
Loop Seal	Alert

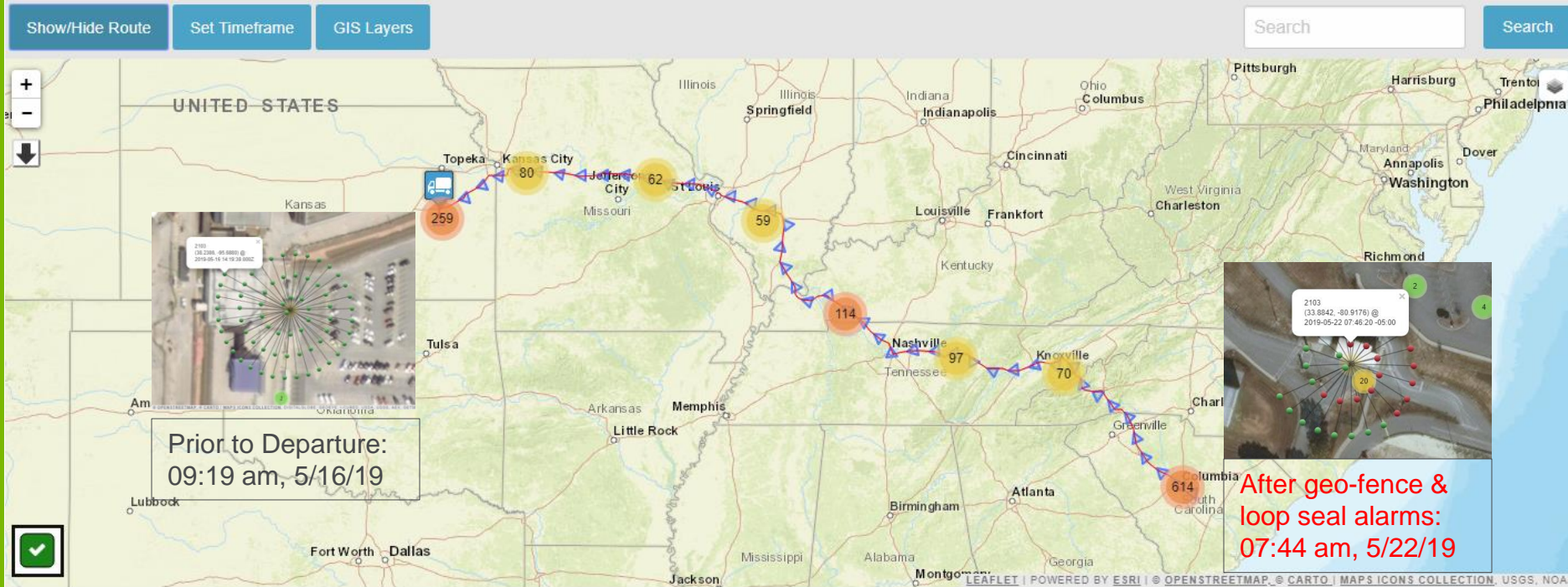
- Multi-strand wire embedded sensors prevent any attempt at detaching, bypassing, or tampering with the seal
- 6-mm sealing wire dia. (10-mm sealing wire plug dia.)
- Wire lengths: 110 cm to 40 m allowing looping of many items in a cargo conveyance

TRAVELER Demo in Rail Shipment, July 27 - August 3, 2017



- Iridium satellite tracking of rail shipment from Baltimore, MD, to Pueblo, CO, 07/27 - 08/03/2017
- Shipment monitored in real time on a public-accessible webpage in the US and Europe for 6 days

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



Performance and Reliability



- Real-time tracking and monitoring
- Sensor Alarms
 - temperatures
 - loop seal
 - Geo-fence
- Communication
 - cellular
 - Iridium satellite



Future Work

Web Application User Interfaces

- Sensors Control
- Data Analytics
- GIS
- Dynamic Weather Maps

Sensors Modules

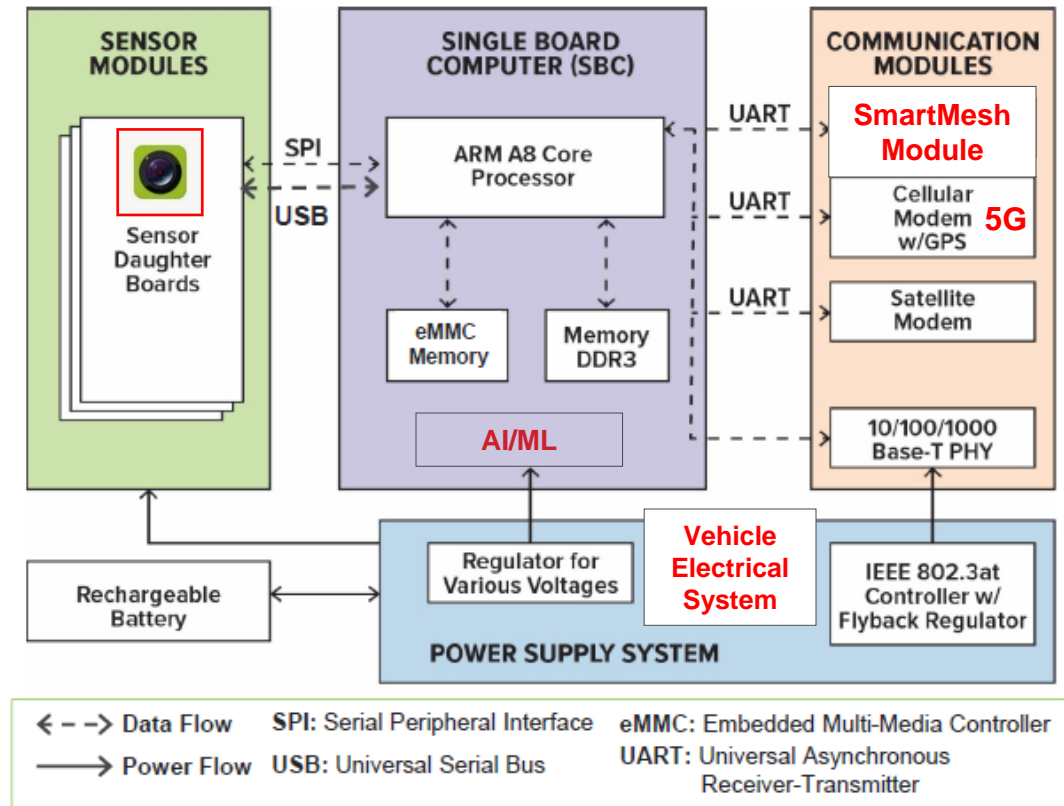
- SoC/SoM/Edge

Communication

- SmartMesh
- 5G/Satellite

Power Supply

- PoE/battery/vehicle electric system/energy/harvesting



CIA –Block Chain-DLT

Summary

- Real-time, continuous surveillance using ARG-US remote monitoring systems:

RFID/CommBox and RAMM/TRAVELER

with sensors and automatic alarms help enhance 3S of nuclear and other risk significant materials 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)



Acknowledgment

This work is supported by the U.S. Department of Energy, Office of Packaging and Transportation, Office of Environmental Management under Contract No. DE-AC02-06CH11357.

QUESTIONS?

References:

1. Smart Drum Technology for Radioactive and Other Hazardous Materials, <https://rampac.energy.gov/docs/default-source/rfid/rfid-wm2018.pdf>
2. ARG-US "TRAVEER" for Tracking and Monitoring Conveyances, https://rampac.energy.gov/docs/default-source/tracking/inmm59-liu_traveler.pdf
3. ARG-US Remote Area Modular Monitoring: Digital Cameras for Enhancing Safety and Security https://rampac.energy.gov/docs/default-source/tracking/inmm59-craig_ramm.pdf
4. ARG-US Remote Monitoring Systems for Enhancing Security of Radioactive Material https://rampac.energy.gov/docs/default-source/tracking/CN269-319_Liu_101418.pdf