

# RFID JOURNAL VIRTUALLY LIVE!

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

Dr. Yung Liu

Program Manager, Packaging Certification and Life Cycle Management

Decision and Infrastructure Sciences Division



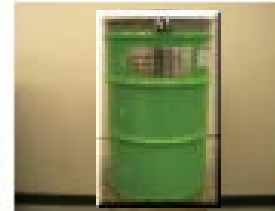


# What We Do

- **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 Tag (433MHz)

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

## Flexible Sensor Suite



**Tactile Seal Sensor**



**Long-Life Batteries >10 yr**



**Modular Design/Universal Form Factor**



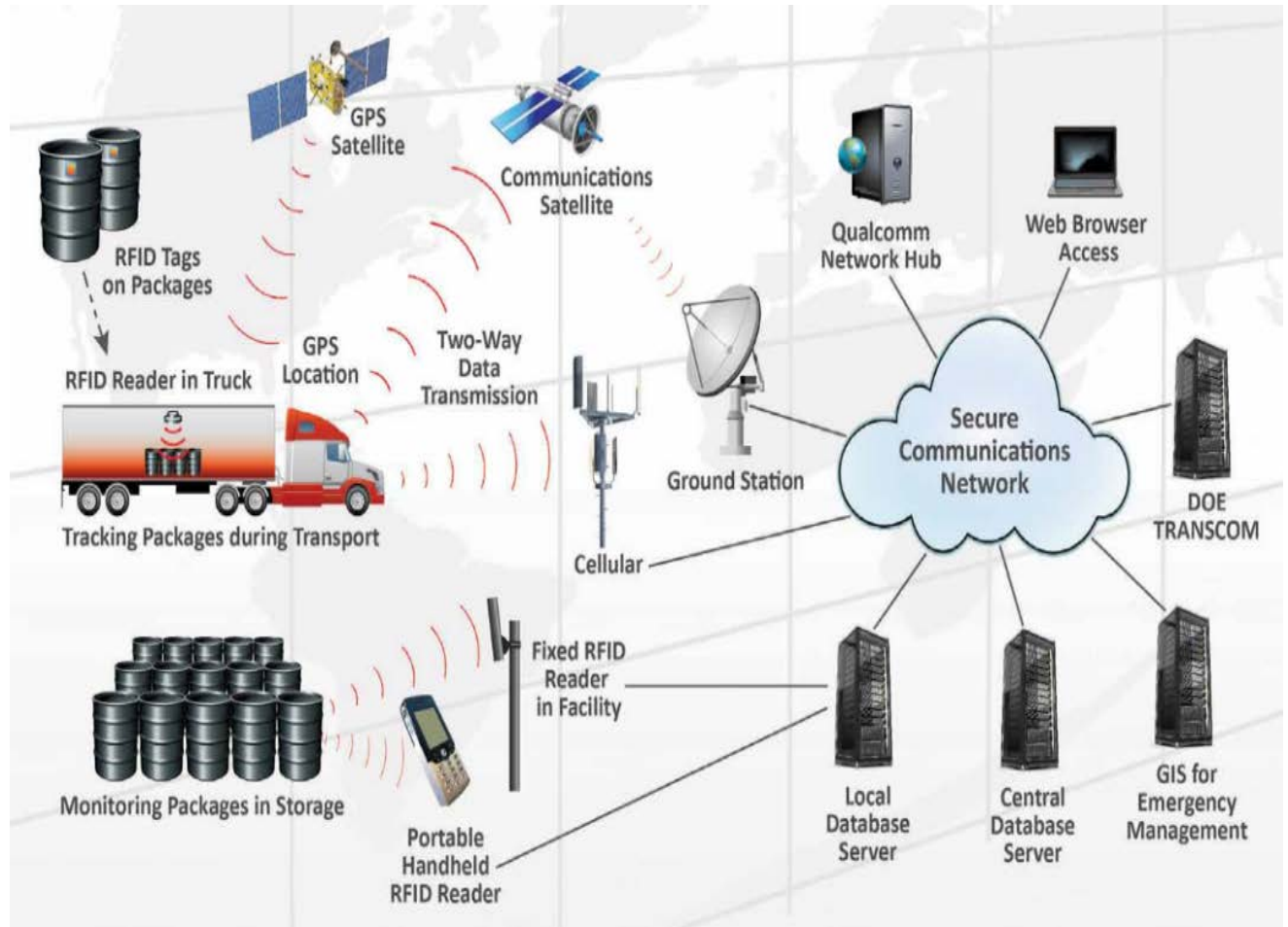
**Tags approved as Tamper-Indicating device (TID) for DOE-Certified RAM Packages**

# ARG-US RFID/Reader/CommBox: Smart Drum

Reader

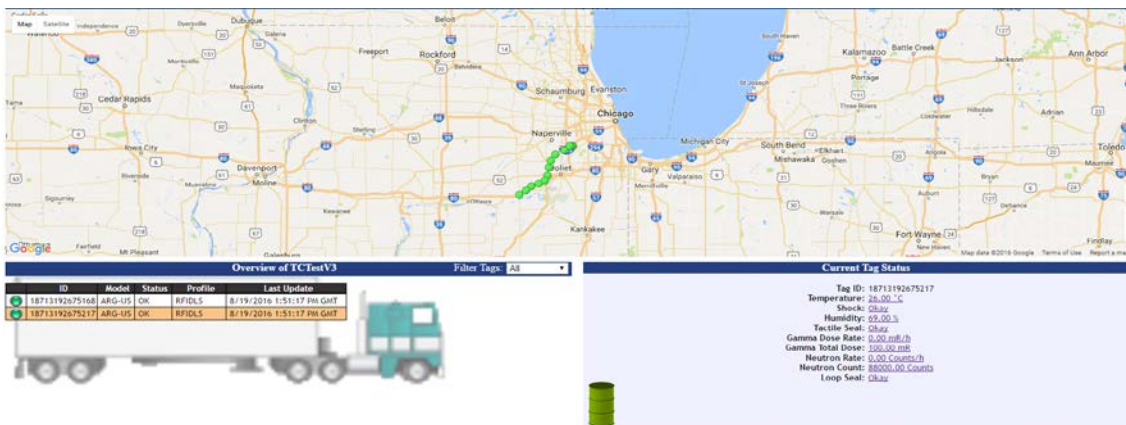
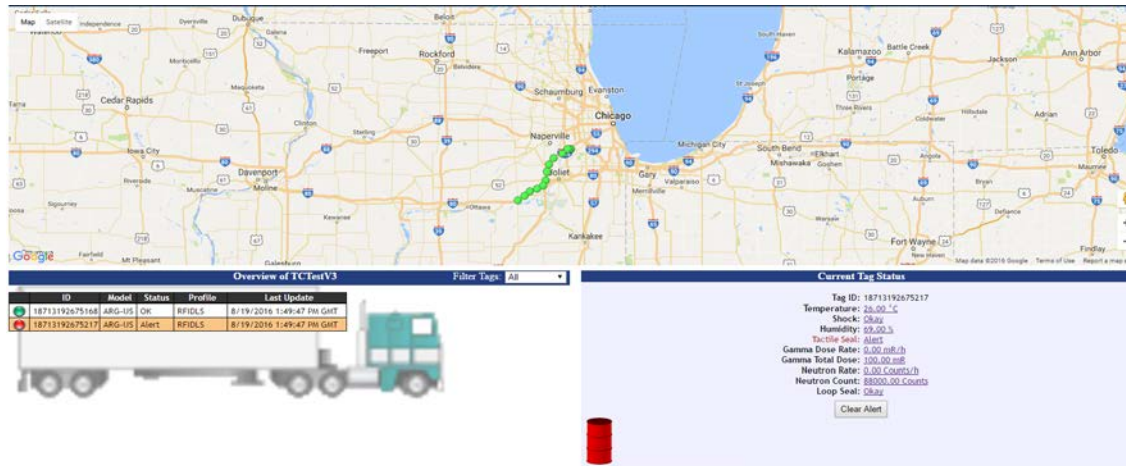


CommBox  
All-in-One



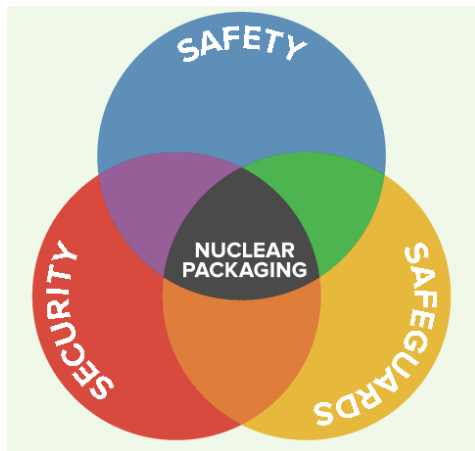


# ARG-US RFID/CommBox Automatic Tactile Seal Alarm during Transportation



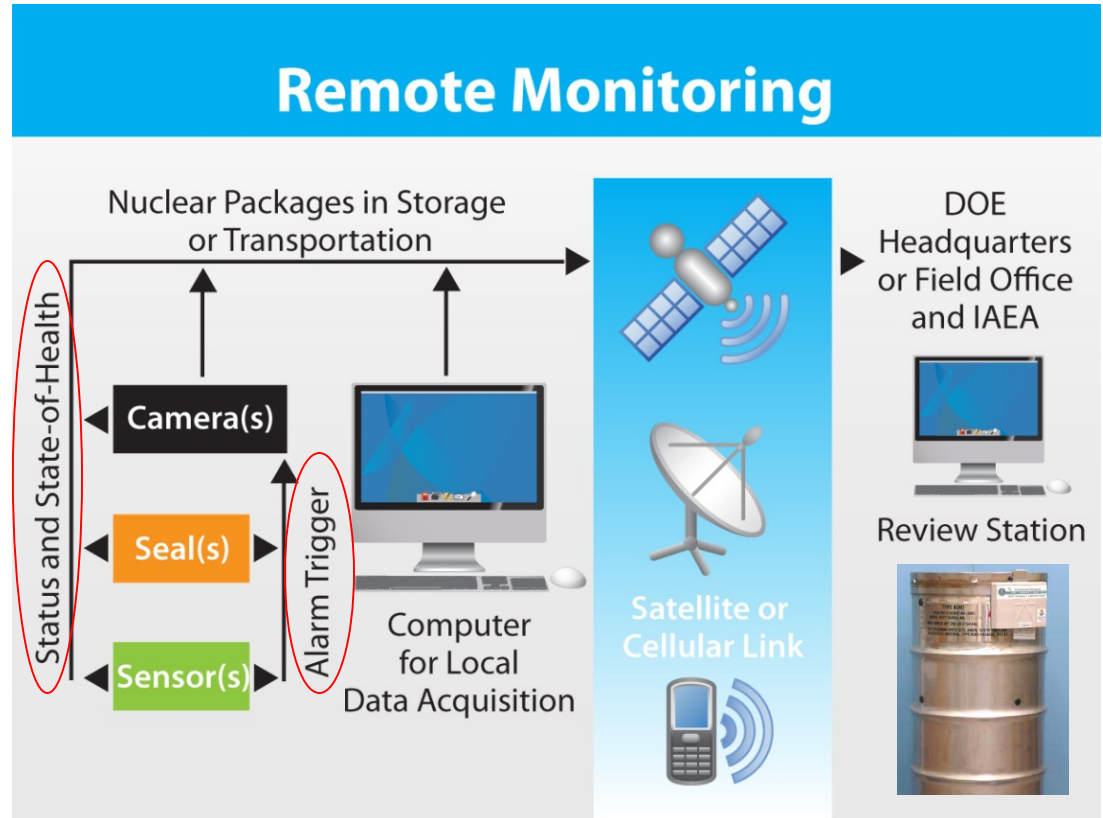
# Remote Monitoring: Safeguards and Security

- 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



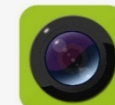
Gamma  
Sensor



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

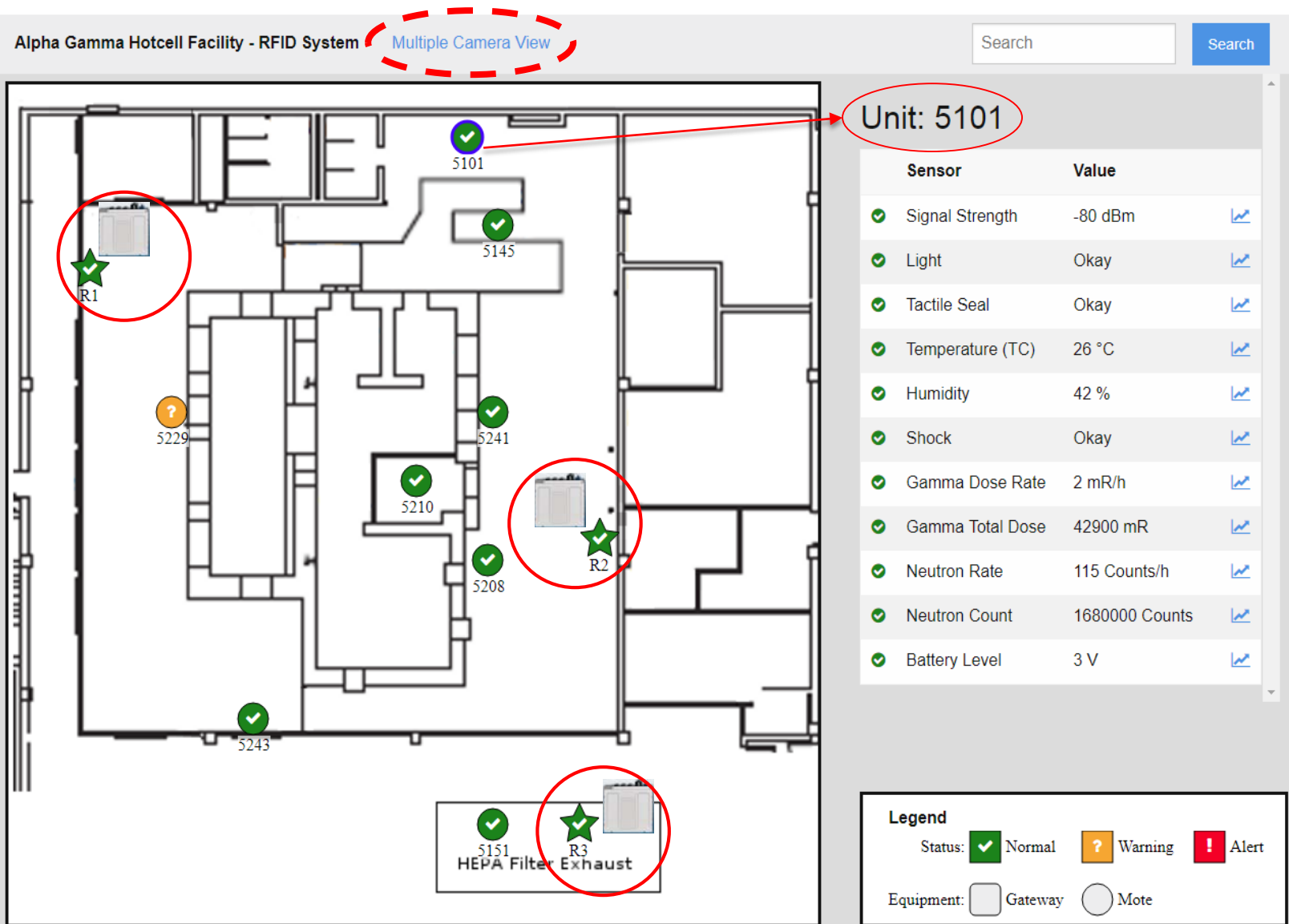
- ARG-US RFID system (2013 – present) →



- 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 13:29:35 GMT-0500 (CDT)




Unit 1102 (clear)

Thu May 03 2018 13:29:43 GMT-0500 (CDT)




Unit 1114 (clear)

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



Unit 2107 (clear)

Thu May 03 2018 13:30:15 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

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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 Shipment during Transportation

## Cellular/Satellite Communication

- Adjustable transmission interval
- Two-way communication



## Multiple Sensors

- Customized suite of sensors
- Adjustable alarm thresholds



Temperature  
Sensors



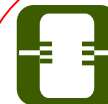
3-axis Digital  
Accelerometer



Gamma  
Sensor



Neutron  
Sensor



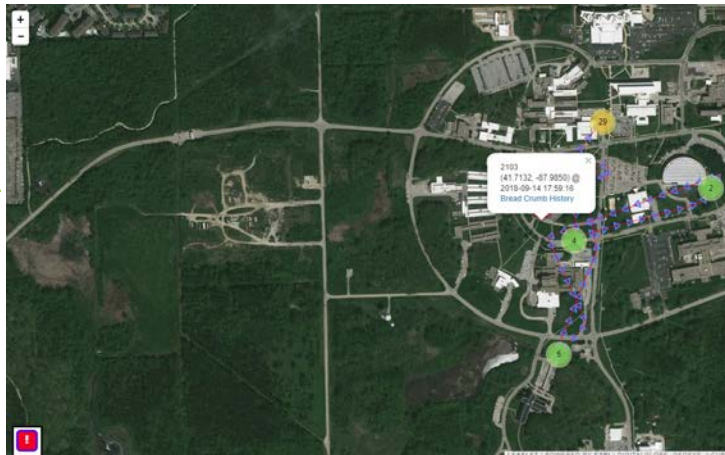
Electronic  
Loop Seal



Rechargeable  
Li-ion Battery



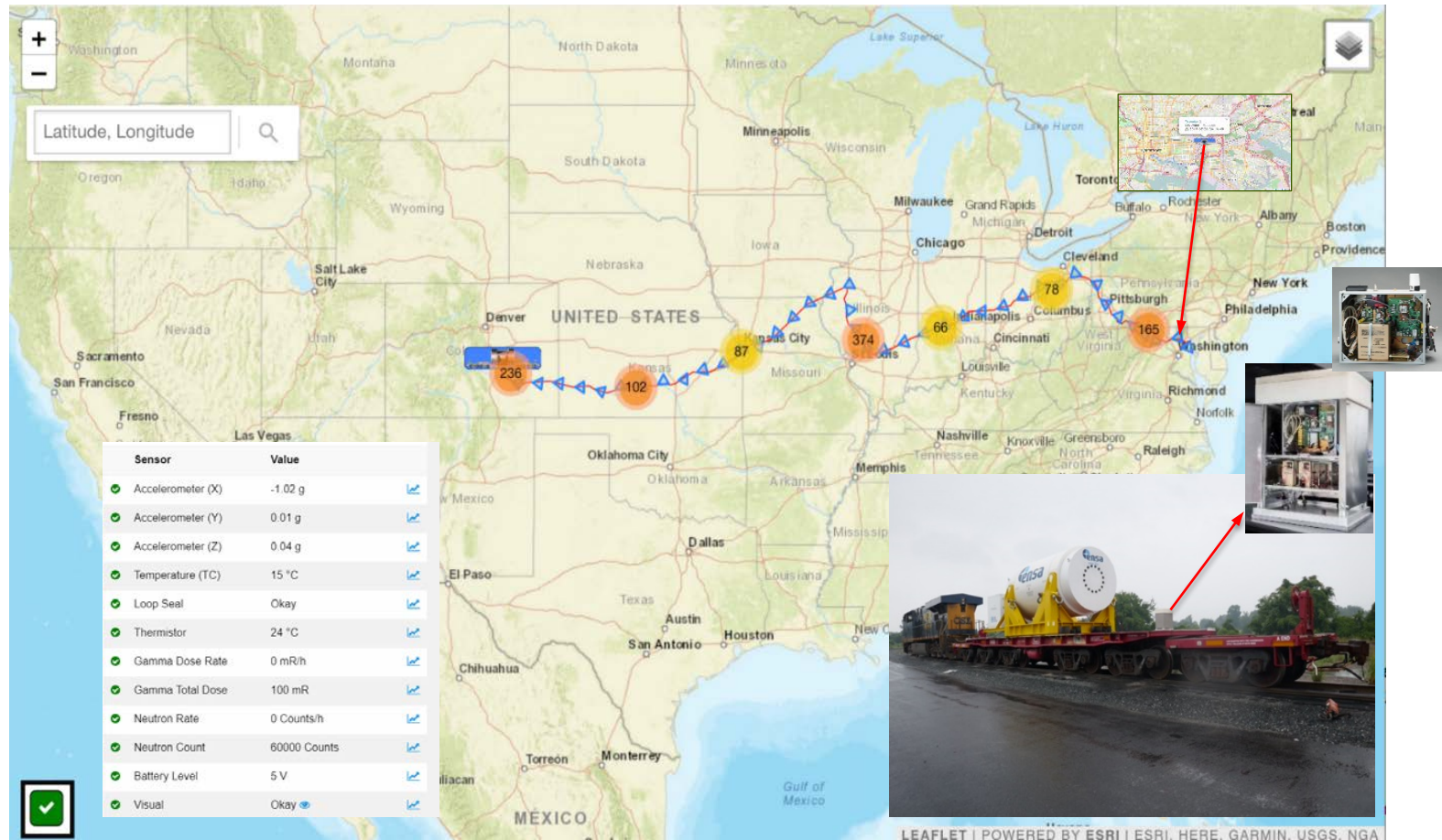
# ARG-US TRAVELER Loop Seal Alarm during a In-Transit Stop



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	330000 Counts
✓ Battery Level	5 V
✓ WSN	Okay

- 6-mm sealing wire dia;  
110 cm - 40 m long
- Multi-strand wire  
embedded sensors  
prevent detaching,  
bypassing, or tampering  
with the seal

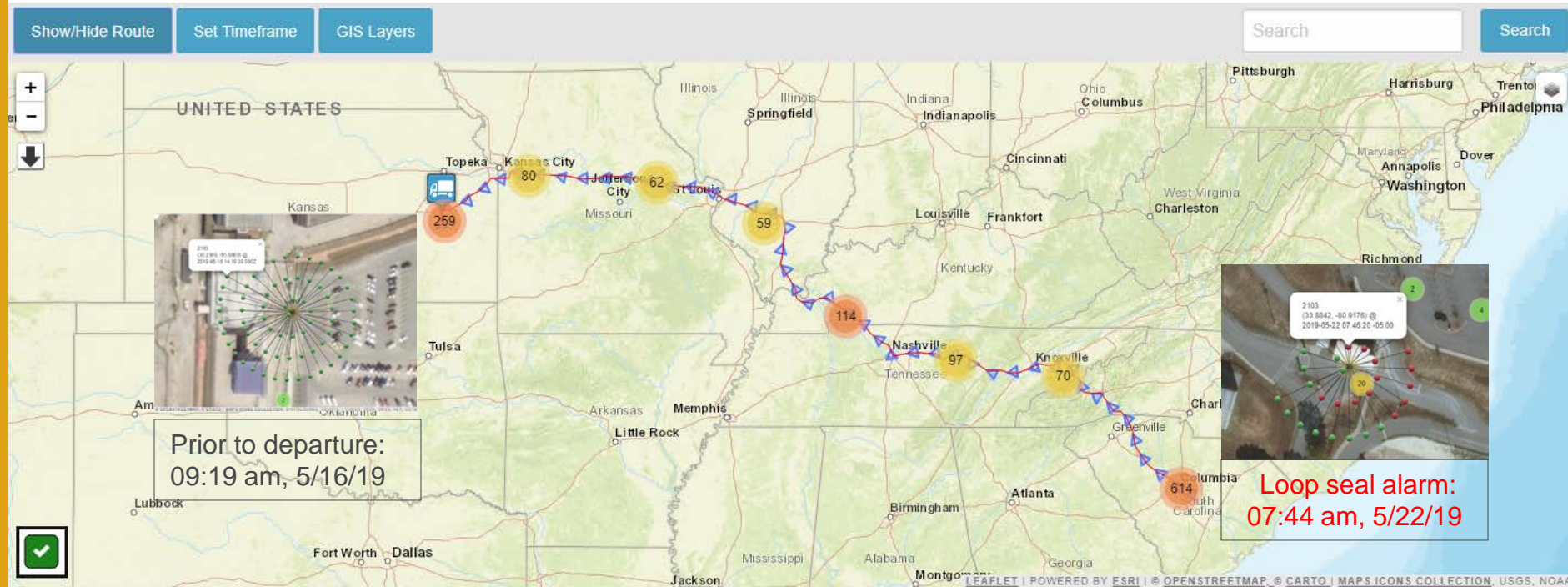
# TRAVELER DEMO in Rail Shipment, July 27–August 3, 2017



- 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





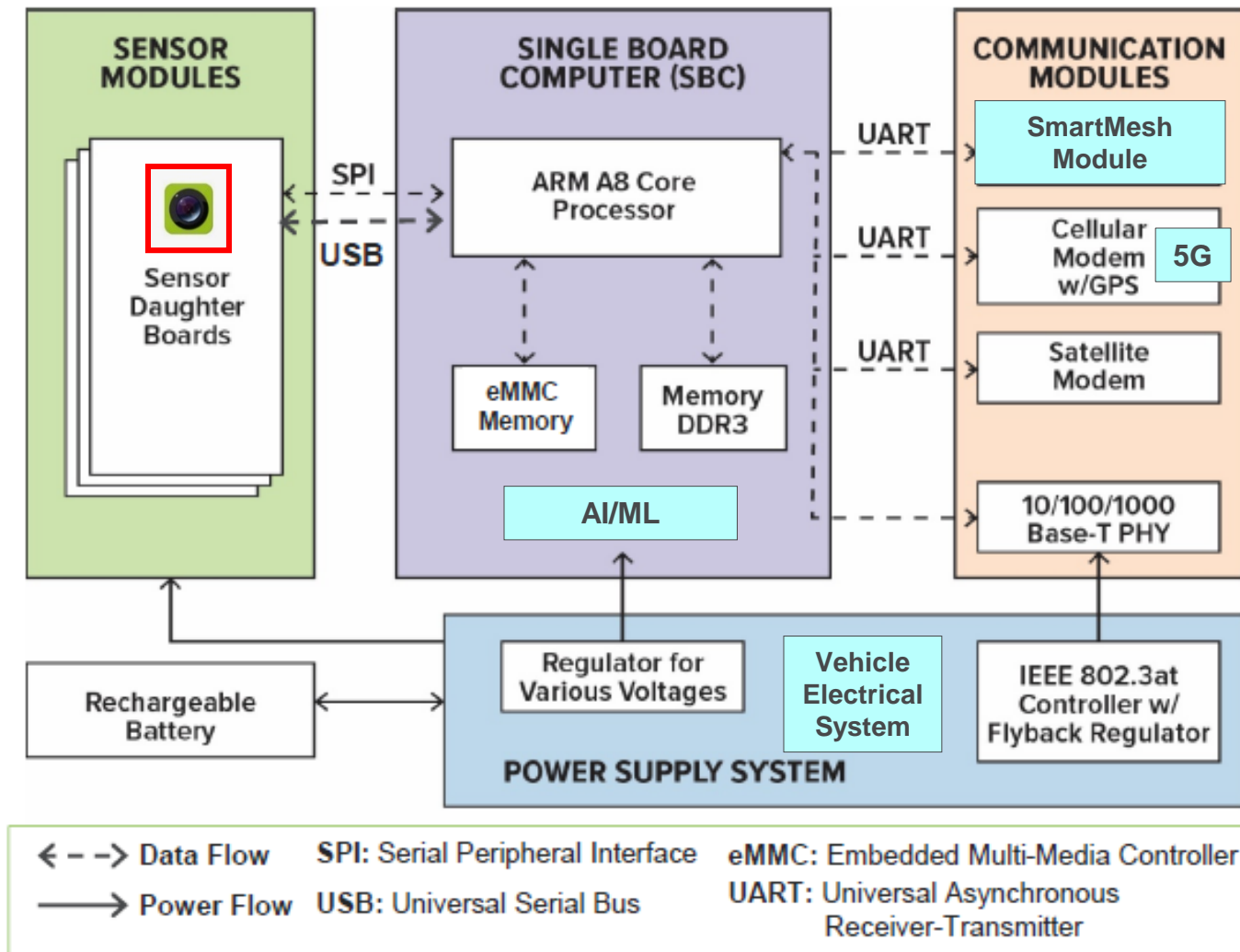
# Summary

- Real-time, remote monitoring using **ARG-US**

**RFID/CommBox and RAMM/TRAVELER**, with sensors and automatic alarms, not only enhances 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)

# Future Work



Block Chain-DLT



# Questions?

## To Learn More, Contact [yliu@anl.gov](mailto:yliu@anl.gov)

### Acknowledgment



**EM** Environmental Management

safety ♦ performance ♦ cleanup ♦ closure

**DOE Packaging Certification Program**

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