

Real-Time Tracking of Nuclear and Radioactive Material Packages in Transport

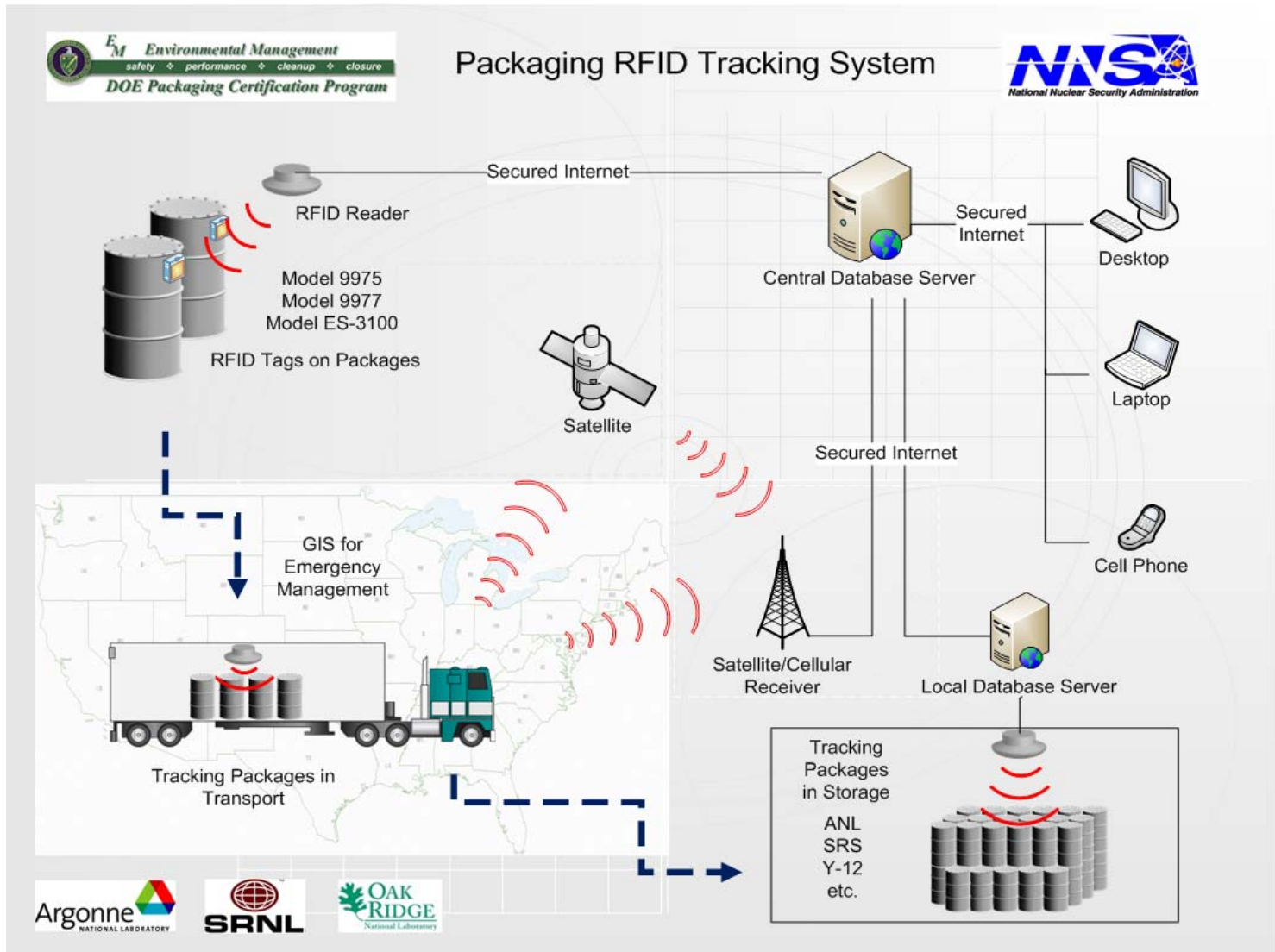
Yung Liu and Jim Shuler

PATRAM 2010
London, UK
October 3-8, 2010



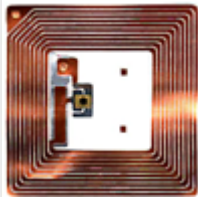
Work sponsored by Office of
Packaging and Transportation

Real-time tracking and monitoring – based on RFID



What is RFID (Radio Frequency Identification)?

- **Tags:** to collect and send signals autonomously or when prompted



- **Readers:** to communicate with tags and receive signals



- **Application software:** to process data into information for action

ARG-US RFID for DOE nuclear materials management

■ Potential benefits of RFID

- enhanced safety, security, safeguards and materials accountability
- reduced radiation exposure and need for manned surveillance
- real-time access of status, i.e., State of Health, and event history data, including continuous monitoring of environmental conditions of packaging for aging management
- Overall cost savings

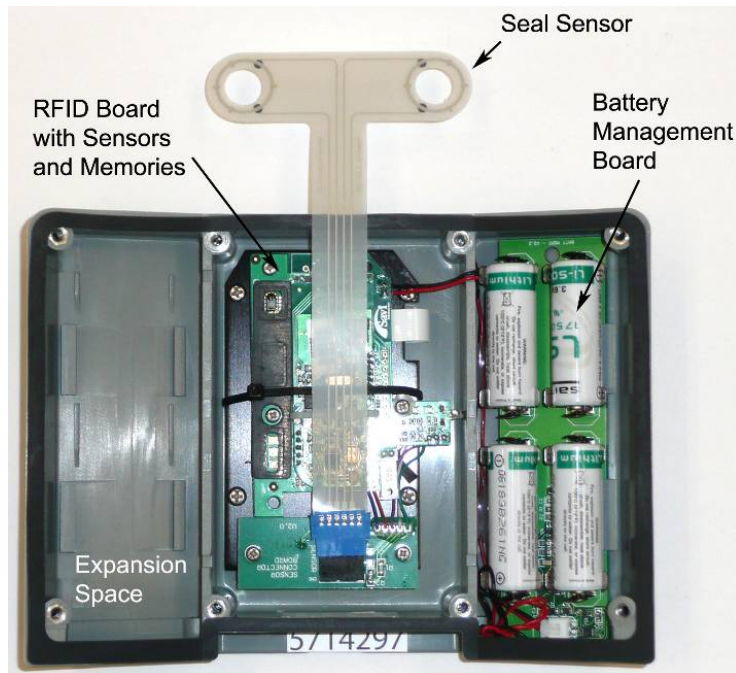
■ Sensors and on-board memories are the key; RF acts as carrier of messages

■ 433 MHz active RFID selected for development in 2006

- low-power,
- acceptable communication range (100-m), and
- non-linear, effective communication near metal



ARG-US RFID surveillance tags — patent pending



- **Universal form factor**
- **Full sensor suite (seal, shock, temperature, humidity, dosimeter, etc)**
- **Good radiation resistance (>17 yr at 200 mrem/h)**
- **Long battery life (>10 yr)**
- **Clock and non-volatile memory**

ARG-US OnSite — copyright asserted

ARG-US OnSite (Administrator Privileges)

File Administration Help

Logout

Drum: DV005
 Model: Virtual
 Status: **Alarm**
 Seal: OK
 Shock: OK
 Temp: **61 °C**
 Humid: 23 %
 Tag: V005

Detail
 Contents
 History
 Location
 Query Status
 Clear Alarm
 Sensor Setting
 Sensor Log

Current Status

Total Drums:	10
Warning/Alarm:	2
Last System Query:	1 min. ago
System Has Run:	1 min.

History

Tag ID	Drum ID	Event	Time
V005	DV005	Arrives at NTS - - (Zone 1, Q, 8, Bot)	3/3/2009 9:03:45 PM...
V005	DV005	Leaves location NTS - - (Zone 1, N, ...)	3/3/2009 9:03:45 PM...
V011	DV011	Arrives at NTS - - (Zone 1, K, 8, Bot)	3/3/2009 9:03:44 PM...
V011	DV011	Leaves location NTS - - (Zone 1, Q, ...)	3/3/2009 9:03:44 PM...
V005	DV005	Arrives at NTS - - (Zone 1, N, 7, Bot)	3/3/2009 9:03:42 PM...
V005	DV005	Leaves location NTS - - (Zone 1, K, ...)	3/3/2009 9:03:42 PM...
V002	DV002	Arrives at NTS - - (Zone 1, H, 8, Bot)	3/3/2009 9:03:21 PM...

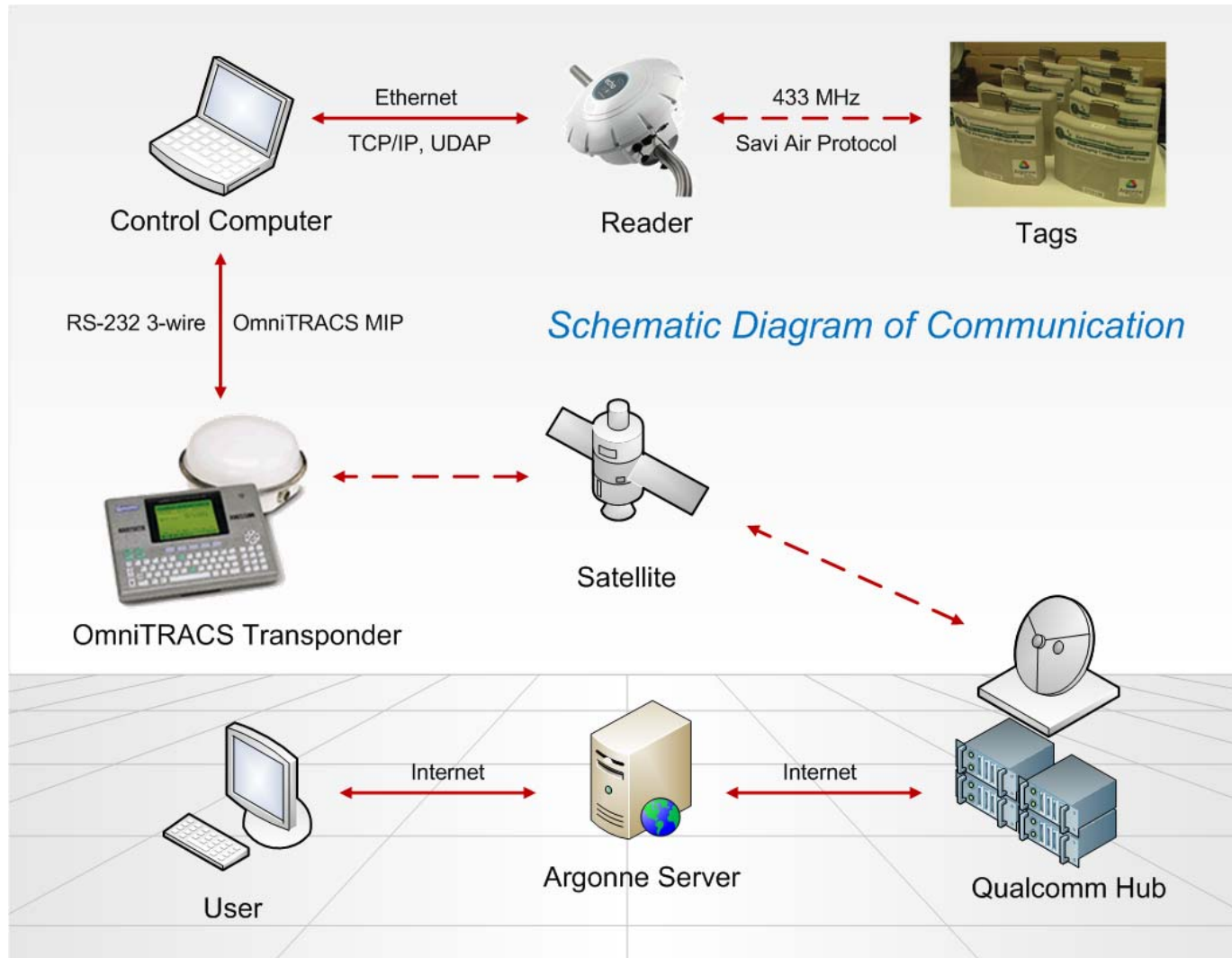
Search Drum By Drum ID

Search << >>

Web-based ARG-US platforms

Storage and Disposal ↓ Transport →

ARG-US TransPort — RFID equipment integration with Qualcomm OmniTRACS satellite communication module



Enabling vehicles with RFID — NNSA's OSRP/GTRI

(1) The “Bid Bird” LANL truck with Qualcomm OmniTRACS satellite module



- Install RFID equipment in truck
- Integrate with Qualcomm OmniTRACS



Reader in trailer



RJ45 line in cab

(2) Dodge Sprinter van with Qualcomm OmniTRACS satellite module



- Install RFID equipment in van
- Integrate with Qualcomm OmniTRACS



Process took <1 day to complete

Enabled "Big Bird" in 300-mile road rest (3/24/2010)

Packageings RFID Tracking System - Windows Internet Explorer

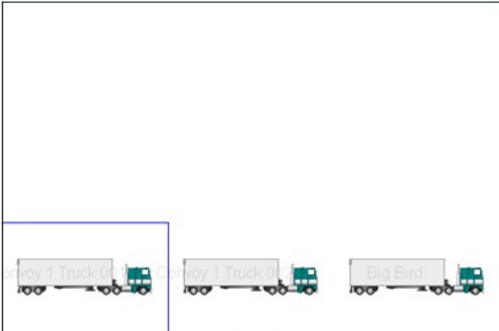
https://rfid.dis.anl.gov/pcp-test/webform1.aspx

File Edit View Favorites Tools Help


Windows Live Bing What's New Profile Mail Photos Calendar MSN Share Sign in

Packageings RFID Tracking System

Trucks in Big Bird

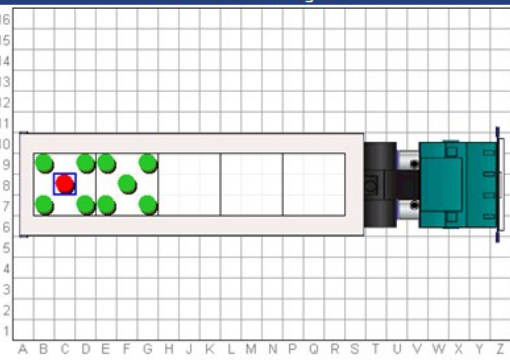


U.S. Map



Location: Big Bird U.S. Map Google Map

Overhead View of Big Bird



Drums in Big Bird

Drum ID: 5714258
 Tag: 5714258
 Model: 9977
 Originator: LANL
 Tag Last Queried: 3/24/10 15:53 GMT
 Sensor Status: **Alarm**
 Seal: **Open**
 Shock: OK
 Temperature: 5°C (-50 to 60°C)
 Battery: OK
 Humidity: 36% (0 to 100%)
 Radiation: N/A
 Contents: TBD

Summary Status of Big Bird

Total drums: 10 Database updated: 3/24/10 15:53 GMT
 Alarm / No Response: 1 Page refreshed: 3/24/10 15:54 GMT

Event History of Drum 5714258

Event Time (GMT)	Event
3/24/10 15:54	Seal is Open

<https://rfid.dis.anl.gov/pcp-test/webform1.aspx>

“Big Bird” road test (3/24/2010, 19:28 GMT)

Packageings RFID Tracking System - Windows Internet Explorer

https://rfid.dis.anl.gov/pcp-test/webform1.aspx

File Edit View Favorites Tools Help

Windows Live Bing What's New Profile Mail Photos Calendar MSN Share Sign in

Packageings RFID Tracking System

Summary Status of Big Bird

Total drums: 10 Database updated: 3/24/10 19:28 GMT
 Alarm / No Response: 0 Page refreshed: 3/24/10 19:31 GMT
 Warning: 0

[Change to location Big Bird](#)

Drum ID	Tag	Model	Sensor Status	Tag Last Query	Seal	Shock	Battery	Temperature	Humidity
5714152	5714152	9977	Normal	3/24/10 19:28 GMT	OK	OK	OK	13°C (-50 to 80°C)	36% (0 to 100%)
5714152	5714152	9977	Normal	3/24/10 19:23 GMT	OK	OK	OK	13°C (-50 to 80°C)	37% (0 to 100%)
5714152	5714152	9977	Normal	3/24/10 19:18 GMT	OK	OK	OK	12°C (-50 to 80°C)	37% (0 to 100%)
5714152	5714152	9977	Alarm	3/24/10 19:13 GMT	Open	OK	OK	12°C (-50 to 80°C)	38% (0 to 100%)
5714152	5714152	9977	Alarm	3/24/10 19:08 GMT	Open	OK	OK	11°C (-50 to 80°C)	37% (0 to 100%)
5714201	5714201	9977	Normal	3/24/10 19:28 GMT	OK	OK	OK	12°C (-50 to 80°C)	38% (0 to 100%)
5714201	5714201	9977	Normal	3/24/10 19:23 GMT	OK	OK	OK	12°C (-50 to 80°C)	38% (0 to 100%)
5714201	5714201	9977	Normal	3/24/10 19:18 GMT	OK	OK	OK	12°C (-50 to 80°C)	38% (0 to 100%)

Overhead View of Big Bird

Drums in Big Bird


Drum ID: 5714152

https://rfid.dis.anl.gov/pcp-test/webform1.aspx

GIS (Geographical Information System) Reports


- Issues in seconds
- Assists first responders

EMS Report for Big Bird Page 1 of 3



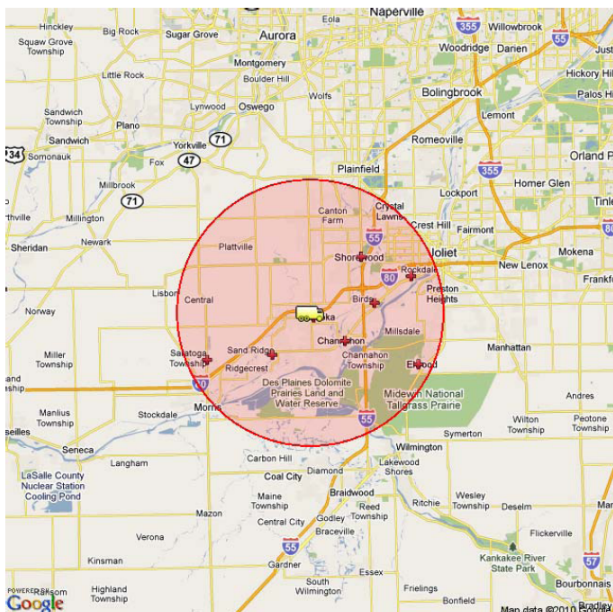
Environmental Management
safety • performance • cleanup • closure
DOE Packaging Certification Program

**Packagings
RFID
Tracking
System**



NNSA
National Nuclear Security Administration

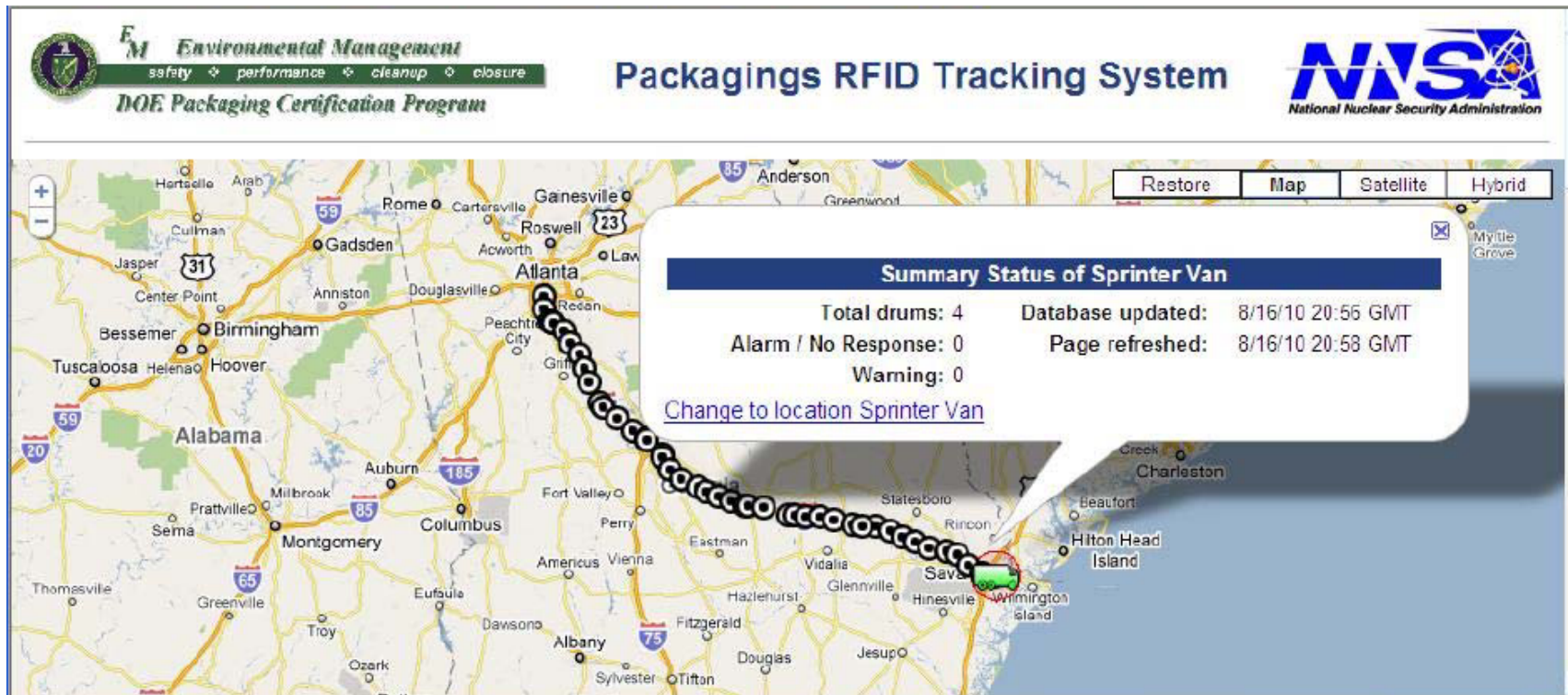
GIS Report for Big Bird



Map data ©2010 Google

EMS Facilities within 10 Miles of DEMO Vehicle (41.486389, -90.334167) (As of 8/28/09 17:17 GMT)
<p>Name: MOLINE FIRE DEPARTMENT STATION 3 Description: AMBULANCE AND FIRE SERVICE COMBINED Phone: 309-797-0713 Address: 4700 38TH AVENUE, MOLINE, IL 61265 County: ROCK ISLAND Directions: SOUTH SIDE OF 38TH AVENUE BETWEEN 48TH STREET AND 47TH STREET Approximate Distance from DEMO Vehicle: 7.2 miles</p>
<p>Name: SILVIS FIRE DEPARTMENT Description: AMBULANCE AND FIRE SERVICE COMBINED Phone: 309-792-9553 Address: 1040 1ST AVENUE, SILVIS, IL 61282 County: ROCK ISLAND Directions: ON THE SOUTH SIDE OF 1ST AVE BETWEEN 10TH ST AND 11TH ST. Approximate Distance from DEMO Vehicle: 4.47 miles</p>
<p>Name: MOLINE FIRE DEPARTMENT Description: AMBULANCE AND FIRE SERVICE COMBINED Phone: 309-797-0401 Address: 1630 8TH AVENUE, MOLINE, IL 61265 County: ROCK ISLAND Directions: SOUTH SIDE OF 8TH AVENUE BETWEEN 16TH STREET AND 17TH STREET Approximate Distance from DEMO Vehicle: 9.3 miles</p>
<p>Name: ORION AMBULANCE SERVICE Description: AMBULANCE SERVICES, AIR OR GROUND Phone: 309-526-3365 Address: 501 11TH AVENUE, ORION, IL 61273 County: HENRY Directions: LOCATED ON NORTH SIDE OF 11TH AVENUE BETWEEN 5TH STREET AND 6TH STREET. Approximate Distance from DEMO Vehicle: 9.46 miles</p>
<p>Name: GENESEO FIRE PROTECTION DISTRICT/AMBULANCE SERVICE Description: AMBULANCE AND FIRE SERVICE COMBINED Phone: 309-944-5544 Address: 124 EAST 2ND STREET, GENESEO, IL 61254 County: HENRY Directions: LOCATED ON SOUTH SIDE OF EAST 2ND STREET BETWEEN SOUTH OAKWOOD AVENUE AND SOUTH STATE STREET. Approximate Distance from DEMO Vehicle: 9.62 miles</p>
<p>Name: EAST MOLINE FIRE DEPARTMENT Description: AMBULANCE AND FIRE SERVICE COMBINED Phone: 309-752-1503 Address: 1523 MORTON DRIVE, EAST MOLINE, IL 61244 County: ROCK ISLAND Directions: NORTH SIDE OF MORTON DRIVE APPROXIMATELY .05 MILES WEST FROM THE INTERSECTION OF 19TH STREET AND MORTON DRIVE Approximate Distance from DEMO Vehicle: 5.45 miles</p>
<p>Name: COAL VALLEY FIRE PROTECTION DISTRICT Description: AMBULANCE AND FIRE SERVICE COMBINED Phone: 309-799-5534 Address: 103 WEST 18TH AVENUE, COAL VALLEY, IL 61240</p>

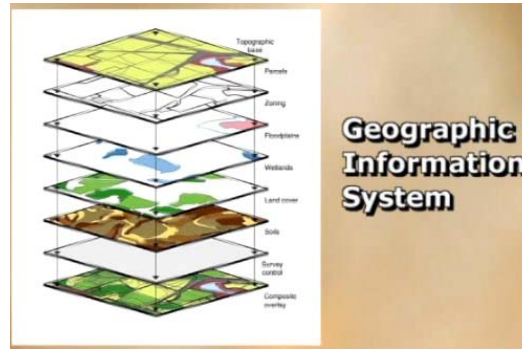
Sprinter van road test (8/16/2010, 20:55 GMT)



- Viewed from a remote laptop during a DOE meeting in Savannah, GA via wireless Internet (<https://rfid.dis.anl.gov/pcp-test/webform1.aspx>)
- Tracking and monitoring performance similar in a 1-h road test conducted for a large audience on 8/18/10 across the city of Savannah and onto expressways

Argonne Pilot RFID command center — Information for Action

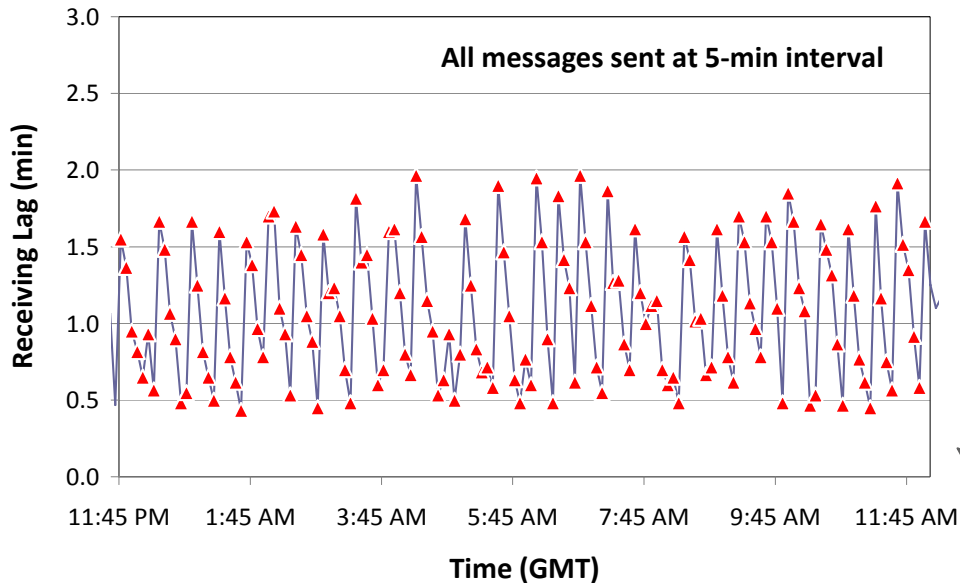
- Platform and protocol development



- Training and certification



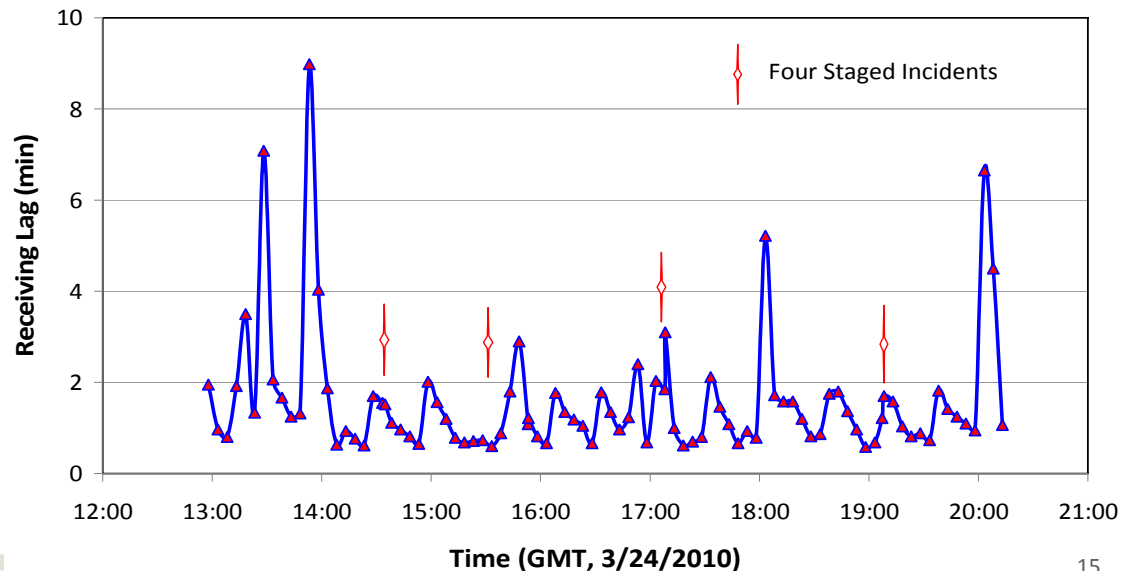
What is real time tracking?



- Inherent latency of satellite transmission of send and receipt signals from a moving vehicle
- Signals affected by weather, nearby tall trees, buildings, bridges, obstructions, interferences — even sharp turns

Stationary and road tests

- Signal delay ≤ 2 min in stationary test (15.3 h) and alerts/alarms during road test (7 h; 4 staged incidents)
- All messages received (regular and alarms)

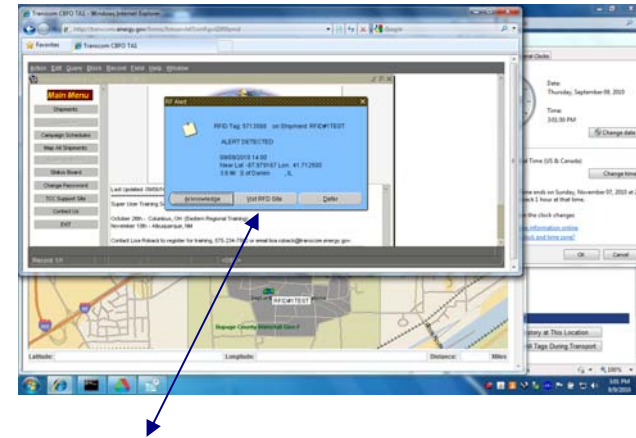
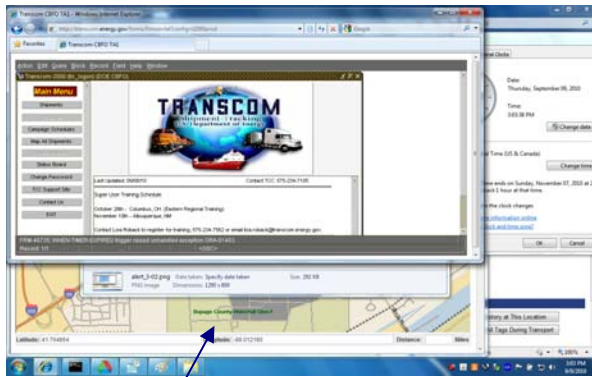


Summary and conclusions

- Argonne has developed the ARG-US TransPort system for “real-time” tracking and monitoring of nuclear and radioactive materials packages during transportation.
- ARG-US TransPort combines active sensor-based RFID with OmniTRACS satellite module, GPS and GIS technologies, secure database and web servers, and a pilot command center at Argonne for end-to-end continuity of knowledge and chain of custody tracking and monitoring.
- Extensive testing conducted on multiple transportation platforms demonstrated that ARG-US TransPort has worked as designed, and will significantly enhance safeguards, security and safety of nuclear and radioactive materials packages during transportation.
- Future development of ARG-US TransPort will (1) complete its integration with DOE TRANSCOM, and (2) consider a cellular-satellite hybrid communication device for better overall signal coverage, (3) further automation by eliminating the control computer in the data pathway and incorporating its functions directly into the RFID reader.



ARG-US RFID and DOE TRANSCOM — acceptance testing

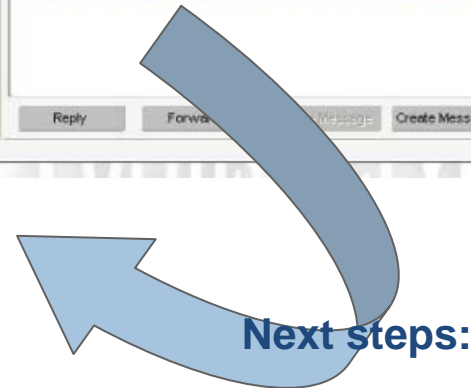
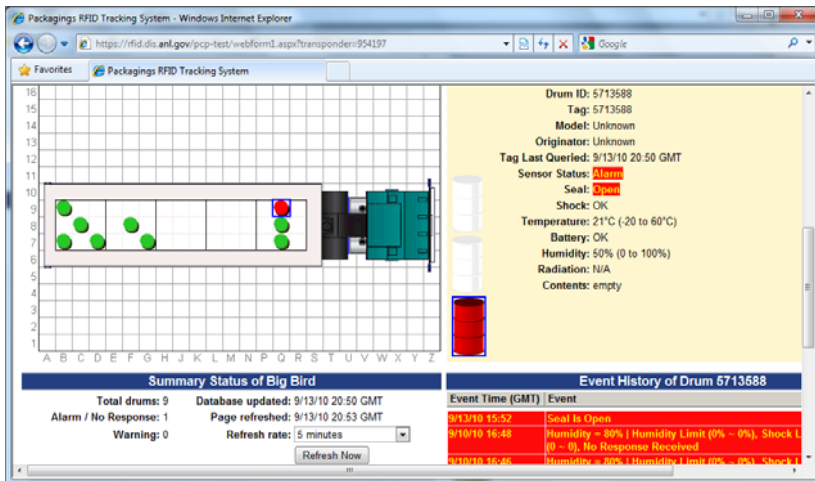
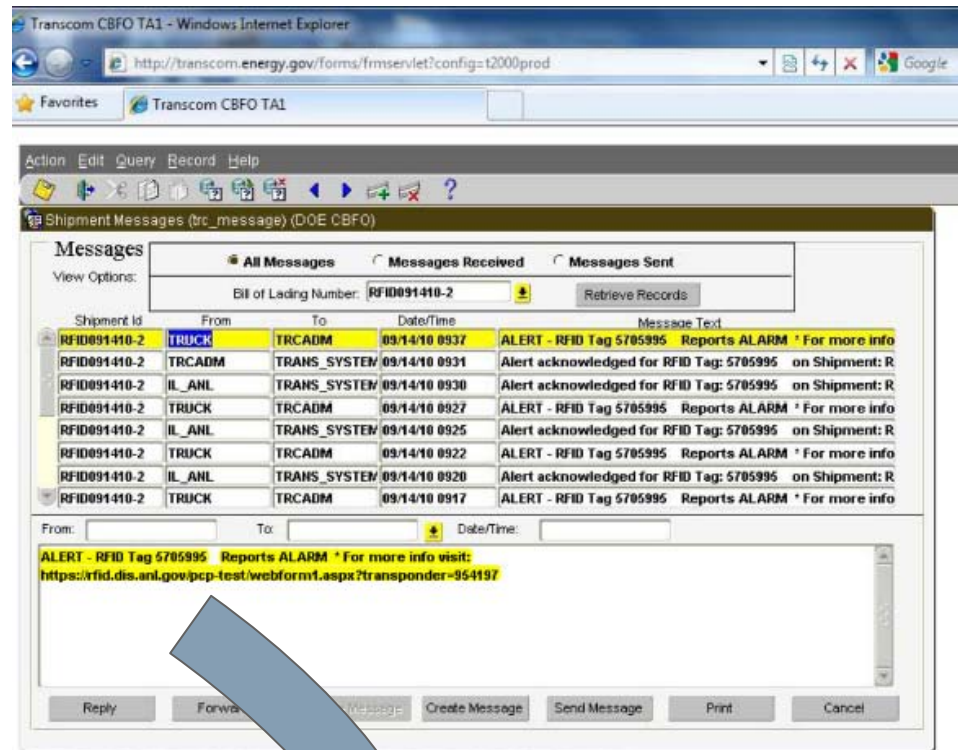
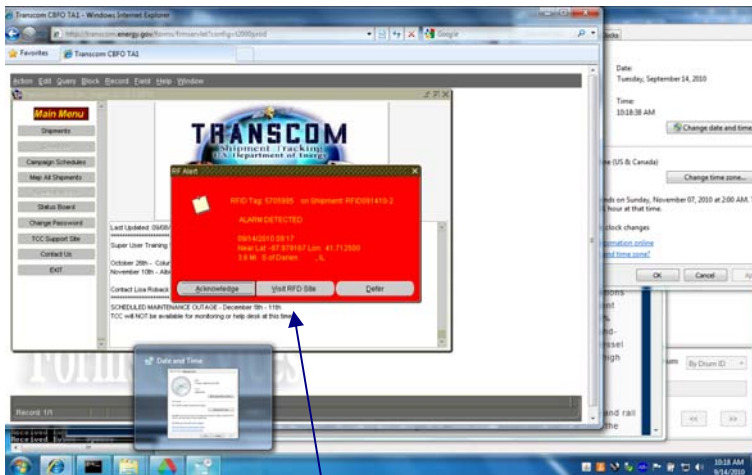


- Sent alarm signals from one or 2 stationary transponders from Argonne at 15 min intervals
- Alarm window (TRANSCOM) popup ≤ 2 min
- Traffic directed to Argonne pilot RFID command center

Event Time (GMT)	Event
9/9/10 15:33	Seal is Open
9/9/10 15:31	Seal is Open
9/9/10 15:18	Seal is Open
9/9/10 15:17	Seal is Open
9/9/10 00:00	Arrived at location



ARG-US RFID & DOE TRANSCOM — acceptance testing

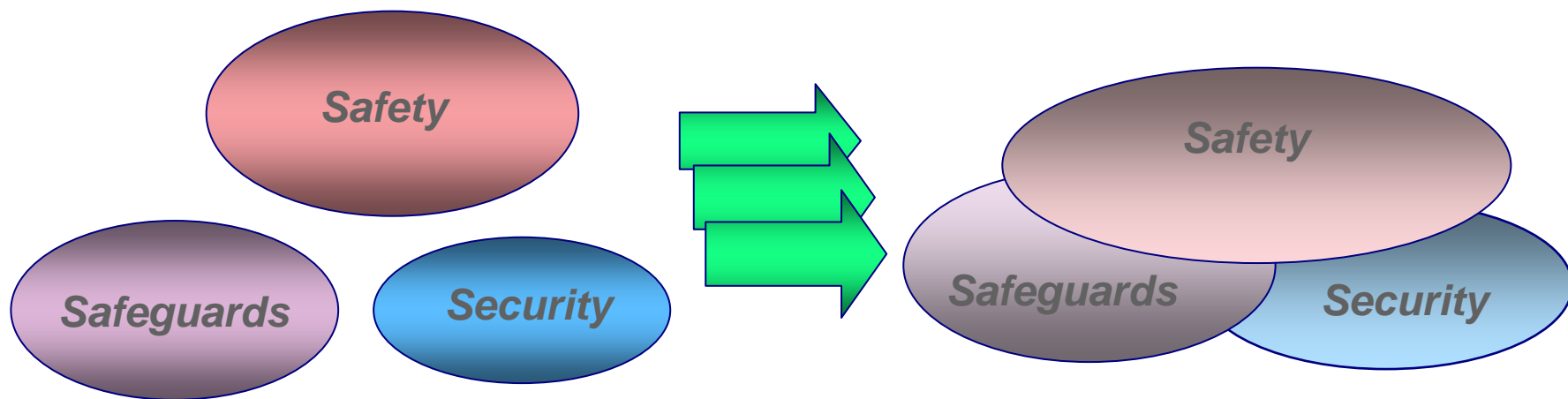


- Testing with multiple vehicles
- OSRP shipment



Safety, security and safeguards of nuclear and radioactive materials

- Nuclear Safety – Accident Prevention
- Nuclear Safeguards – Non-proliferation
- Nuclear Security – Physical Protection



A robust container-based RFID system, e.g., ARG-US, with tamper-indicating seals, 24/7 remote monitoring, and automatic alarms notification via secured Internet.

