System Assessment and Validation for Emergency Responders (SAVER)

In-Vehicle Inventory Systems Using RFID Technology Application Note

November 2013

Homeland Security
Science and Technology

U.S. Department of Homeland Security
SAVER
System Assessment and Validation for Emergency Responders

Prepared by Space and Naval Warfare Systems Center Atlantic

The *In-Vehicle Inventory Systems Using RFID Technology Application Note* was funded under Interagency Agreement No. HSHQPM-12X-00031 from the U.S. Department of Homeland Security, Science and Technology Directorate.

FOREWORD

The U.S. Department of Homeland Security (DHS) established the System Assessment and Validation for Emergency Responders (SAVER) Program to assist emergency responders making procurement decisions. Located within the Science and Technology Directorate (S&T) of DHS, the SAVER Program conducts objective assessments and validations on commercial equipment and systems and provides those results along with other relevant equipment information to the emergency response community in an operationally useful form. SAVER provides information on equipment that falls within the categories listed in the DHS Authorized Equipment List (AEL). The SAVER Program mission includes:

- Conducting impartial, practitioner-relevant, operationally oriented assessments and validations of emergency responder equipment; and
- Providing information, in the form of knowledge products, that enables decision-makers and responders to better select, procure, use, and maintain emergency responder equipment.

Information provided by the SAVER Program will be shared nationally with the responder community, providing a life- and cost-saving asset to DHS, as well as to Federal, state, and local responders.

The SAVER Program is supported by a network of Technical Agents who perform assessment and validation activities. Further, SAVER focuses primarily on two main questions for the emergency responder community: "What equipment is available?" and "How does it perform?"

As a SAVER Program Technical Agent, the Space and Naval Warfare Systems Center (SPAWARSYSCEN) Atlantic has been tasked to provide expertise and analysis on key subject areas, including communications, sensors, security, weapon detection, and surveillance, among others. In support of this tasking, SPAWARSYSCEN Atlantic produced this application note about commercially available in-vehicle inventory systems using RFID Technology. In-vehicle inventory systems using RFID Technology fall under AEL reference number 04HW-02-RFID, Devices, Radio Frequency Identification.

Visit the SAVER section of the Responder Knowledge Base (RKB) website at http://www.rkb.us/saver for more information on the SAVER Program or to view additional reports on RFID in-vehicle inventory systems or other technologies.

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1. INTRODUCTION

Emergency response vehicles contain an extensive inventory of gear such as medical supplies, uniforms, firearms, and firefighting and life-support equipment. The manual inventory process for emergency vehicles is time consuming and can be inaccurate due to lost or damaged paperwork, miscounted items, or illegible handwriting. Radio Frequency Identification (RFID) in-vehicle inventory systems streamline and automate the inventory process by decreasing overall processing time and increasing efficiency and accuracy.

RFID in-vehicle inventory systems:

- Reduce the time to inventory responder vehicles and increase inventory accuracy;
- Assist responders by verifying all gear is accounted for prior to leaving a scene;
- Help responders quickly locate gear requiring maintenance or inspection; and
- Help responders maintain supply levels in emergency vehicles.

2. TECHNOLOGY OVERVIEW

RFID is an identification and tracking technology that uses radio frequency (RF) waves to transmit and receive signals between an RFID tag and one or more RFID readers. RFID in-vehicle inventory systems typically include RFID tags, RFID reader(s), and RFID in-vehicle inventory software.

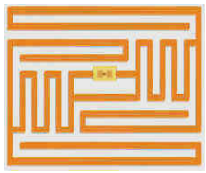

Figure 2-1. RFID Tag

Courtesy of SMARTCODE Corporation/Wikimedia Commons/CC-BY-SA-3.0

First, gear to be tracked is entered into the RFID in-vehicle inventory software, either manually or by uploading data from existing inventory systems. Next, the gear is tagged with an RFID tag, scanned, and the RFID identification code is assigned to the appropriate entry in the software. Once this is accomplished, if a reader scans a tag, the entry on that gear can be accessed and displayed.

The following sections briefly discuss how the individual components operate and their various configurations as applicable to RFID in-vehicle inventory systems. The following information is not a comprehensive discussion of RFID inventory systems, but provides an introduction to RFID technology commonly used in in-vehicle inventory systems. Agencies should carefully research each product's overall capabilities and limitations in relation to their agency's operational needs.

2.1 RFID Tags

RFID tags can vary in design but most consist of an integrated circuit imprinted with a unique identification code and an antenna for communicating with an RFID tag reader. Tags are available in a variety of configurations ranging from a laminated label that can be used in most computer printers to ruggedized plastic casings that are designed to endure exposure to harsh environments.

RFID tags are broadly classified as passive, active, or semi-active. Passive tags are the most common, have no battery, and can be very small. Passive tags cannot transmit a signal and rely upon reflecting a signal from an RFID reader back to the reader to communicate. As such, passive tags only transmit information if queried by a reader and have a limited read range, which is usually less than 10 feet.

Active tags, on the other hand, have an onboard battery used to increase read range and power any onboard sensors. Active tags transmit data on a regular schedule without being queried. In addition, active tags can support small sensors that can monitor the environment, such as the temperature. It can also support various security features that, if tampered with, can provide an alert. An example of this is a security strap, which is an RFID tag that is similar to a zip tie, but once tightened will emit a signal if cut or stretched.

Semi-active tags have a battery but, like passive tags, only transmit when queried by a reader. Semi-active tags can support sensors just like active tags.

Figure 2-2. Examples of RFID Tags

(From left to right: Passive, Active, and Active Tag with a Temperature Sensor)

Passive tag is courtesy of Grika/Wikimedia Commons/CC-BY-2.5 and active and active tag with a temperature sensor is courtesy of Ver4point5/Wikimedia Commons/CC-BY-SA-3.0

2.2 RFID Readers

RFID readers communicate with RFID tags and are capable of reading multiple tags very rapidly. Readers are classified into two general categories: handheld readers and fixed readers. Handheld readers are portable, and usually used with passive tags, but are capable of reading active and semi-active tags as well. Handheld readers will store the information from read tags in internal memory until the reader is connected to the inventory system, at which point the stored data will be uploaded into the system software. Alternatively, some readers are capable of communicating on a wireless network to upload data. Handheld readers will also have a display screen to allow responders to view the data read from the tag and to input additional information as necessary.

Figure 2-3. Handheld RFID Reader

Courtesy of the Wikimedia Commons

Fixed readers are permanently mounted and are used when continuous monitoring is desired. Fixed readers rarely have a user interface on the reader and instead are directly connected to a computer running the system software. Fixed readers are often paired with active tags due to

their ability to constantly monitor the signals of active tags. This allows the system to notify responders if tagged gear is not onboard the vehicle or if a fault or alert is detected by any sensors attached to an active tag.

2.3 RFID In-vehicle Inventory Software

RFID in-vehicle inventory software provides real-time asset tracking information. Reader data is forwarded to the inventory software, which then updates the inventory counts. Using the software interface, the responder can tell what and how many of each item is available on the vehicle. Some systems can send e-mail notifications for low inventory, missing gear, or gear maintenance.

The inventory software can either be a stand-alone program, or a translation tool between the RFID system and an existing agency database. The translation tool implementation is more common, as most agencies are comfortable with their existing inventory systems and this approach utilizes their existing investments.

2.4 Emerging Technologies

RFID technology has been available since the 1970s and is considered proven technology; however, improvements to RFID systems are constantly emerging. Spatial location technologies are being developed that will allow a handheld reader to determine the range and direction to a selected RFID tag. Also, specialized printers are being developed, which will allow agencies to create new passive RFID tags on demand.

2.5 Standards/Regulations

RFID systems are subject to Federal Communications Commission (FCC) regulations that govern the frequency allocation for RFID systems used in the United States. The FCC allows RFID communications in four frequency bands:

- Low frequency (LF)–30 kilohertz (kHz) to 300 kHz;
- High frequency (HF)–3 megahertz (MHz) to 30 MHz;
- Ultra high frequency (UHF)–300 MHz to 3 gigahertz (GHz); and
- Super high frequency (SHF)–3 GHz to 30 GHz.

In addition to FCC regulations, RFID systems are subject to the following standards established by the International Organization for Standardization (ISO) regarding RFID technology:

- ISO/IEC 18000–RFID for item management;
- ISO/IEC 18046–RFID device performance test methods for the system, reader, and tag; and
- ISO 18185–industry standard for electronic seals (e-seals) used to track cargo containers; utilizes the 433 MHz and 2.4 GHz frequencies.

The European Telecommunications Standards Institute (ETSI) produces globally applicable standards for Information and Communications Technologies (ICT), including fixed, mobile, radio, converged, broadcast, and Internet technologies. Their Task Group (TG) 34 represents the

RFID industry within ETSI for all RFID products and devices to ensure the interoperability of RFID devices with other product groups.

3. APPLICATION

Responders are often issued a large amount of gear to perform their duties. While this gear enables responders to perform their assigned duties during emergency situations, it also adds a workload burden to the responders to manage the gear. Expendable items must be constantly inventoried and restocked. Some gear has maintenance cycles to track and all property has the risk of being accidentally left behind after an incident. RFID systems reduce the time to perform inventories, increase the accuracy of inventories, assist in managing maintenance cycles, and mitigate the risk of leaving gear on scene.

RFID in-vehicle inventory systems can be configured using both passive and active tags. Passive tags are less expensive than active tags. In addition, a passive tag system is more portable, as handheld readers can be shared or reassigned between multiple vehicles. A passive tag system requires that the responders initiate the inventory, and that they move the reader throughout the area to be inventoried in order to ensure that the RFID reader can read every tag. This is a much faster process than visual or manual inventories. However, since inventories must be initiated by the responder, a passive tag system will not alert responders that gear is being left behind.

Active tag systems are usually only used on reusable or high value gear, as active tag costs are notably higher than passive tags. In active tag systems, fixed readers are mounted inside the vehicles so that they can constantly monitor tagged gear. These systems will usually have a graphical display of the tagged inventory, which will continuously display the status of the gear such as onboard, not onboard, or onboard but not assigned to that vehicle. This gives the responders in the vehicle a one-look, real-time inventory of all critical gear assigned to the vehicle, and substantially mitigates the risk of accidentally leaving gear behind. In addition, the capability of active tags to host sensors or intrusion detection capabilities means that an active tag system can also monitor temperature sensitive supplies or provide intrusion alerts.

In-vehicle inventory systems are capable of assisting in monitoring gear maintenance cycles using the system software. Maintenance information and schedules for each piece of gear can be entered in the system software, and alerts generated when maintenance is required. In addition to tracking maintenance cycles, RFID in-vehicle inventory systems can also assist in locating gear by indicating the last reader that read the gear's RFID tag. This can prevent searching through multiple vehicles for the gear requiring maintenance, which is especially helpful for gear that is often shared between multiple vehicles.

3.1 Law Enforcement

The average patrol vehicle carries an extensive inventory of gear to allow officers to respond to a variety of situations. RFID in-vehicle inventory systems can speed up the inventory process routinely performed at the start and end of a shift, and when an officer is leaving a scene where they have deployed gear. These systems can be especially helpful in situations where multiple officers have responded and deployed gear that needs to be recovered. In addition, much of the

gear issued to officers requires periodic maintenance. RFID in-vehicle inventory systems can aid agencies in ensuring that maintenance is up-to-date.

The Richardson Police Department in Richardson, Texas, began using an RFID inventory system in 2011, as part of a U.S. Department of Homeland Security initiative to track uniforms. This was required to ensure that police uniforms did not get misplaced. They are now using the system to track all police gear assigned to an officer at the beginning and end of a shift, in order to accurately track and store the gear.

3.2 Fire Rescue

RFID in-vehicle inventory systems for fire rescue have unique challenges. Fire rescue gear is often subjected to extremes of the environment. Extreme heat, water, high vibration, and shocks are common environments for fire rescue gear. RFID tags engineered for environmental extremes are necessary for fire rescue applications. Fire rescue agencies need to investigate potential vendors to ensure that they can provide RFID tags designed to meet usage conditions.

Seminole County, Florida, rolled out a county-wide RFID in-vehicle inventory system in 2011 to augment their inventory tracking, including their fire rescue department. This allowed the county to have a greater awareness of their inventory while reducing hours required managing it. They realized inventory management improvements even during the rollout phase by identifying under-utilized gear that could be reassigned for better use. The county has also performed tag testing to determine the best tag type for various items.

3.3 Emergency Medical Services (EMS)

Ambulances carry a huge array of gear, the majority of which are subject to routine maintenance and refresh cycles. Much of this gear is deployed out of the vehicle when responding to an event, and there is ample opportunity for the urgency of the situation to result in leaving gear behind. Passive RFID in-vehicle inventory systems can reduce inventory time, but active systems are a good fit to manage the costly gear that is commonly deployed from an ambulance. In addition, ambulances often have medications onboard that require temperature controlled storage, as well as narcotics which require locked storage. Active RFID tags with temperature or intrusion detection sensors can monitor the environment and provide security for medications.

Action Ambulance, a contract ambulance service in Wilmington, Massachusetts, implemented an RFID inventory management system in 2010 to assist with beginning-of-shift inventories. These inventories were required by state health codes and mandate that all medicines and gear be rigorously inventoried prior to starting a shift. The RFID inventory system greatly reduced the time necessary to fully inventory the ambulances and improved the company's ability to ensure they had supplies on hand to restock the ambulances.

4. CHALLENGES

RFID in-vehicle inventory systems have challenges. Some concerns are:

- RFID in-vehicle inventory systems are information technology (IT) systems, and can have substantial start-up costs. If an agency does not have a significant amount of inventory to manage, RFID solutions may not provide a suitable return on investment

to justify implementation. Careful consideration of actual costs against expected returns is important;

- System maintenance, replacement equipment, tag supplies, software maintenance, and upgrades are ongoing costs that should be considered in an RFID in-vehicle inventory system purchase; and
- RFID in-vehicle inventory systems use RF to operate and interference from other RF systems may impact RFID performance. Agencies need to ensure that vendors perform an appropriate survey of the RF environment to determine any conflicts and to select RFID technologies that minimize those conflicts.

5. CONCLUSIONS

Emergency responders require a lot of gear to perform their duties. Having the proper gear on-hand and in good condition is critical to the completion of responder missions. RFID in-vehicle inventory systems can reduce the time responders must spend on inventory tasks, provide greater inventory visibility to the agency, assist in maintenance, and reduce the risk of gear loss.

6. VENDOR CONTACT INFORMATION

Table 6-1 contains a list of vendors who provide RFID in-vehicle inventory systems. Additional information can be found on their websites.

Table 6-1. Vendor Contact Information

Vendor	Address/Phone Number	Website
Falken Secure Networks	15 Dekker Street Suite 101 Everett, Ontario, Canada LOM 1J0 (647) 930-7373	http://www.falkensecurenetworks.com/index.html
GAO RFID Inc.	93 S. Jackson Street #57665 Seattle, WA 98104 (877) 585-9555 (Ext. 601)	http://www.gaorfid.com/index.php?main_page=RFID_Asset_Tracking
GlobeRanger™	1130 E. Arapaho Road Suite 600 Richardson, TX 75081 (877) 744-9977	http://www.globeranger.com
Impinj®	701 N. 34th Street, Suite 300 Seattle, WA 98103 (206) 517-5300	http://www.impinj.com/applications
inLogic™ Inc.	3162 Johnson Ferry Road Suite 260-502 Marietta, VA 30062 (770) 427-0102	http://www.inlogic.com/products/products.aspx

Vendor	Address/Phone Number	Website
MobileFrame®	101 Blossom Hill Road Los Gatos, CA 95032 (408) 885-1200	http://www.mobileframe.com/Solutions/healthcare.html
OATSystems Inc.	309 Waverley Oaks Road Suite 306 Waltham, MA 02452 (781) 907-6100	http://www.oatsystems.com/industries/healthcare.php
Portable Technology Solutions	221 David Court Calverton, NY 11933 (877) 640-4152	http://www.clearstreamrfid.com/aboutpts.htm
RadiantRFID™	12912 Hill Country Boulevard Suite #F-245 Austin, TX 78738 (512) 351-4915	http://www.radiantrfid.com
Silent Partner Technologies	218 Crystal Grove Boulevard Lutz, FL 33548 (888) 428-5301	http://www.silentpartnertech.com/rfid-solutions-applications/asset-tracking-for-ems
ThingMagic, A Division of Trimble	4 Cambridge Center 12th Floor Cambridge, MA 02142 (866) 833-4069	http://www.thingmagic.com/home
VerdaSee Solutions Inc.	The Radnor Building 771 E. Lancaster Avenue 2nd Floor Villanova, PA 19085 (847) 265-9441	http://www.verdasee.com/VITALApparatus.aspx