Total Asset Visibility

The Future of Asset Management

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The Vision

Can the latest advances in Radio Frequency Identification Device (RFID) and Local Area Positioning (LPS) technology be joined with Global Positioning Satellite (GPS) systems to identify, locate and track fixed and moveable assets in and around a federal facility? Laboratory results say yes and the Department of Energy (DOE) wants to put the combined technologies to the test. This exciting application of cutting edge technology is the latest example of DOE's leadership in finding solutions to the issues which face asset managers within its complex of laboratories and production facilities.

Recently, Battelle Memorial Institute has agreed to partner with DOE to conduct a precedent-setting demonstration of the Total Asset Visibility (TAV) concept at the Oak Ridge National Laboratory (ORNL). Battelle and the University of Tennessee established a separate company – UT-Battelle – to manage ORNL. Battelle also manages Pacific Northwest National Laboratory for DOE.

The Pilot

To assist in the movement of the technology from the laboratory to the marketplace and to apply leading edge technological solutions to everyday problems facing DOE property and, potentially, security and environmental, safety and health managers, a pilot project has been proposed which will, for the first time, link LPS technologies to ensure TAV in a DOE facility. The unique combination of LPS applications will permit DOE managers to periodically inventory all property assets located in the facility, monitor the migration of property assets that are moved, track the movements of all or selected personnel as they move within or near a selected building and monitor the location, condition and environmental conditions of stored hazardous and waste materials

In today's economic environment, with the constant pressure to operate more effectively and efficiently, public and commercial organizations are demanding TAV, which enables them to locate and identify property and personnel assets in real time. TAV can enable property custodians and potentially others to conduct periodic and real time inventories of varied assets with greater accuracy and at lower cost than has been previously achieved.

Not too long ago, DOE transport vehicles left the loading facility and except for radio communications, "disappeared" until arrival at their final destinations. Today, GPS equipment in the vehicle can determine the truck's location at any time. However, while knowing the "trucks" location is important to transportation managers and others associated with its contents, the asset visibility equation is not complete until property managers are able to track the movement of all component assets on an ongoing basis within facilities.

To this end, technologists have been attempting to advance RFID technology to go beyond the simple monitoring of assets as they transit between facilities. Commercial vendors have designed simple systems to identify tags on inventory or parts as they pass or are scanned by a handheld reader. By returning energy transmitted by the reader, the tag responds with its identification. While the readable distances have been limited, the current RFID tags still are an improvement over traditional bar codes in the following ways:

- RFID systems are not limited to line of sight.
- RFID tags are insensitive to sunlight, moisture, cold, dirt, grease and corrosive chemicals.
- Readers can be programmed to scan many RFID tags per second.

The primary limitations inherent in past RFID technology has been in the limited readable distances, the problems associated with metallic shielding and the fact that RFID tagging only tells a manager where things were, not where they are now.

Advances in Technology

Attempts to link GPS and RFID technology have presented an incomplete solution to the TAV problem. The limitations of the two systems, individually or as interconnected elements, make them unsuitable to track the range of equipment, materials and components which constitute the varied inventory of today's manufacturing and research institutions. For example, despite significant advances in GPS technology, satellites cannot be used to track the movement of inventory or human beings as they move within an indoor space or any situation where there is an overhead environment. The reality is that within DOE, the greatest part of our business is conducted under circumstances that obviate the utilization of either GPS or current, commercially available, RFID technology. Examples are:

- Specific pallets or containers of stored hazardous materials cannot be located when needed, delaying shipment and disrupting carefully planned logistical arrangements. The same example can be applied to the failure to locate components needed in a manufacturing facility causing delays in final assembly or, in the case of perishables or "expiration" items, the loss of inventory, delays, and reacquisition cost.
- High-security facilities have no real time knowledge of personnel movements (other than dedicated escort) after individuals clear check points.

- DOE and other organizations have thousands of high-value mobile assets subject to the inefficiencies of location determination, loss, destruction and pilferage. DOE employees waste valuable time searching for such assets.

After decades of waiting, the technology to achieve TAV has advanced to the point where it can be transferred from the laboratory to the commercial world. While examples are available which show that early forms of wireless asset tracking were possible, the line-of-sight limitations inherent in GPS and the readable range limitations of RFIDs precluded the use of such technology in overhead environments or shielded conditions. Fortunately, a new solution has been developed with federal funds at PNNL which has become known as Local Positioning Systems (LPS).

LPS can fill the bridge between other systems in that it reverses the principles of GPS technology to overcome the limitation of satellite signals to be received indoors. Typically, GPS involves the triangulation of satellite signals by interrogator receivers on the ground. LPS works in the opposite mode. The emitter, a property tag or personnel badge, transmits a signal, and the LPS receiver identifies the location of the tagged item by timing the transmission from the emitter to one or more receivers located at various locations within or near a selected building.

Technical Approach

All DOE assets to be located in the building that is used in the pilot will be inventoried and monitored by a LPS system. That requirement will be met by using commercially available or other systems that satisfy the operational and performance requirements. The key element of the specification will be that the installed system will be capable of providing TAV. It is anticipated that DOE will need to apply the full range of RFID technologies in a first ever synergistic application.

RFID tagging and tracking systems used for property management will build upon past property management system methods and will add the capability of real time updates on the location of tagged items. The aspect of RFID that adds new property management capabilities is the ability to read the tags at an increased distance that is not limited by line of sight.

All RFID systems have the same base set of components that function together as an integrated system to provide the functions of a specific RFID application. Those base components are tags, readers (interrogators), and a user interface.

- **Tags** – electronic modules attached to the item of interest for the purpose of uniquely identifying that item. For each tag implementation method the user requires a reader with a specific protocol to receive and display the tag information. See tag types below.
- **Readers** – electronic devices that perform the wireless data transactions with the RFID tags and provide data to the user interface.
- **User Interface** – consists of the operational interface, a maintenance interface, and the data interface that provides a key link for a fully integrated system.

RFID tags used in asset tagging and tracking applications employ two types of wireless radio frequency (RF) data transition; Active and Passive. Within active and passive groups there are many different frequencies, signal modulation schemes, and digital wireless communication protocols in use.

- **Active Tag** is the term used to describe RFID systems that use an active RF transmitter in each tag to transmit data back to receivers.
- **Passive Tag** is the term used to describe a system that uses "backscatter" wireless communication links between the reader (interrogator) and the tag. A "backscatter" communication reader transmits microwave frequency RF signals. The RF energy in the transmitted signal is received in the tags and powers up electronics in the tag that respond by modulating the reflected (backscatter) signal. There are two types of backscatter systems in common use; Fully Passive or Beam Powered and Semi-Passive.
- **Fully Passive and Beam Powered Tags:** All energy needed to power the internal circuits is derived from the received microwave energy. Because all energy must be provided by the interrogating signal source, the range on this tag is limited to 3 to 5 meters in ideal conditions.
- **Semi-Passive Tags** were created to increase the read range to over 100 meters in good conditions. Semi-passive tags contain a small battery much like a wrist watch. These tags are designed to only use battery power when the wake-up circuit on the front end detects the correct RF signal. Internal circuits are then powered up by the internal battery. The result is a tag that operates in much lower RF energy levels and, therefore, longer distances between the reader and the tag.

Within Active and Passive groups there are many potential frequencies, signal modulations and digital wireless communication protocols which can be adapted to specific requirements. However, PNNL has developed designs which have advanced the most desirable system attributes of transmission life, readable range, information storage, size and, potentially cost.

The designated facility will require an antenna node in portal antennas at each door and at selected locations distributed throughout the building. These changes in combination with CAD-like software will permit the inventories already described but, in addition, track the movement of selected assets as they move within or near the designated facility and monitor the location, weight, physical and environmental conditions of stored hazardous and waste materials and conduct remote inventories of radioactive source materials. In the last example, using this technology DOE can eliminate staff exposure to potentially hazardous levels of radiation.

DOE believes that the installation and testing of the technologies in the designated facility should produce data that will shape the course and development of TAV initiatives in the future. The results of the demonstration project will be analyzed and used primarily for the design of prospective applications in DOE but the same data may have broad utility to other organizations and institutions. ◆