Use of Radio Frequency Identification Technology for International Space Station Inventory Tracking

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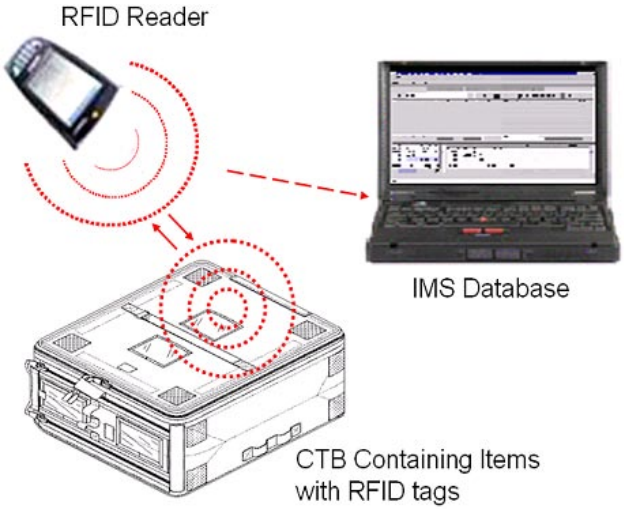
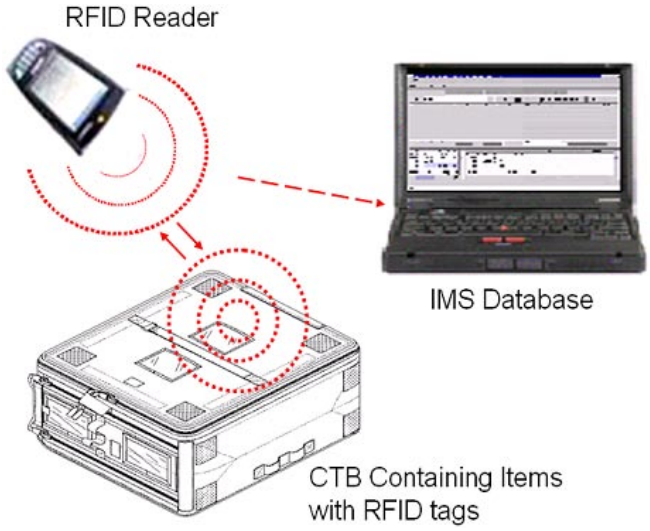
Members of NASA's Mission Operations team, looking to apply state-of-the-art advancements in technology, have been pursuing the use of radio frequency identification (RFID) to assist in the management of large-scale inventories in the space environment. RFID has been called the "next-generation barcode," but it is already widely in use with current applications ranging from libraries to toll booth e-passes. The greatest advantage in RFID systems, which are composed of an interrogator (reader) and transponders (tags), is that they do not require a line of sight between the reader and the tags. Successful application of this technology could revolutionize today's barcode-based inventory system aboard the International Space Station, in which thousands of items are kept track of with manual database updates or line-of-sight barcode scans, one item at a time. With an RFID system in place, entire bags of items affixed with RFID tags could be audited in seconds without ever having to open the bag, saving both astronaut and ground support time. A group at Johnson Space Center (JSC) composed of flight controllers and program office representatives, in conjunction with both industry and university researchers, is actively working to define the requirements for a prototype system for operation onboard the Space Station. Such a system will be essential for efficient logistic support of future lunar and Mars base operations.

The current inventory management system (IMS) has been successful in keeping track of 96.84% of more than 8,000 items on the Space Station, and is used to locate hardware required in the crew's daily activities, audit consumables to ensure adequate



The current ISS barcode system requires a line-of-sight between the tagged item and the barcode reader.



An RFID system does not require line-of-sight between tagged items and the RFID reader, and could track additional individual items.

resupply, and plan future stowage locations. Barcode labels are attached to Space Station stowage rack locations, each cargo transfer bag (CTB), and individual items aboard the Space Station—with the exception of items that are too small to be tagged and consumables such as food, clothing, and office supplies, which are not individually tracked.

In an RFID system, the antenna of the reader emits radio signals. The signals are received by the tag's antenna, which can be powered via a battery or by the radio frequency energy from the reader's pulse. The tags respond with a unique code, which is pre-programmed in the tag's microchip. After the reader antenna receives and decodes the signal, the antenna sends the information to a computer via a standard interface; this information is accessed through a database. Since RFID systems do not require a line of sight between the tag and the reader, a Space Station crewmember could potentially wave the reader in the general vicinity of a cargo transfer tab that is full of tagged items and record an accurate count of all items within that bag in seconds. Upon downlink, these data would be available to the ground team for analysis. Less time spent on logistics means more time for crewmembers to conduct science activities. With better predictions of what the crew uses and at what rate, the ground can plan resupply missions more efficiently and accurately to ensure food and other essential supplies are delivered to the Space Station. In addition, without launching excess supplies, more space can be allocated to payloads and critical hardware.

Since 2002, JSC's Inventory and Stowage Team has collaborated with other groups within NASA that are seeking to use RFID in a variety of applications; the team has also had contact with industry, universities, and the Japan Aerospace Exploration Agency regarding the use of RFID. The team's goal is to develop an RFID inventory tracking system using commercial off-the-shelf (COTS) hardware with the desired reader accuracy, speed, and tag size. In July 2004, Invocon, Inc. presented its Small Business Innovative Research Phase I results, which included an evaluation of different RFID systems and a demonstration using commercially available tags, readers, and software systems for Space Station inventory tracking at JSC. A year later, the RFID and Supply Chain Logistics Lab (RSCL) at the University of Nebraska, Lincoln, working with the Space Station program office and representatives from the Inventory and Stowage Team, began researching a COTS RFID system that would meet NASA's future inventory and stowage needs. The RSCL researchers are now working to develop a system that would enable tracking of food, clothing, and general supplies within soft canvas CTBs or metal containers. In future, NASA may pursue testing of a system derived from this research aboard the Space Station. Using RFID technology, JSC expects an exciting advancement in the way inventory is managed in space today—a demonstration of the next generation of spaceflight technology.