Return to Menu

Radio Frequency Identification for Space Habitat Inventory and Stowage Allocation Management

Project Manager(s)/Lead(s)

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Sponsoring Program(s)

Marshall Space Flight Center/Center Management and Operations
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Project Description

To date, the most extensive space-based inventory management operation has been the International Space Station (ISS). Approximately 20,000 items are tracked with the Inventory Management System (IMS) software application that requires both flight and ground crews to update the database daily. This audit process is manually intensive and laborious, requiring the crew to open cargo transfer bags (CTBs), then Ziplock bags therein, to retrieve individual items. This inventory process contributes greatly to the time allocated for general crew tasks.

Radio frequency identification (RFID) technology is currently certified for the ISS in the form of next generation barcode handheld readers and specific RFID tags. Although the next generation handheld reader results in significant savings in crew time, it falls far short of a fully automated inventory management and tracking system that would save crew time.

This project integrated NASA's in-house RFID innovations as well as those spawned from other agencies, commercial, and academic communities to automate payload stowage and logistics. RFID tags are revolutionizing processes across commercial and government sectors because the tags can be scanned without having a direct line of sight with the label, unlike barcode tags. RFID tags placed on consumables can assist with autonomously updating inventory which reduces the amount of man hours spent conducting audits. For example, the on-orbit handheld reader is not able to discern which CTBs contain a specific tagged item unless the CTB is placed in an isolated (tag-free) environment on the ISS. Contents in CTBs buried two or three deep are likely to be missed unless CTBs are manually pulled and individually scanned.

Conversely, a CTB equipped with an RFID tag can be scanned in about 10 s, reporting all of the internal contents without opening the bag. In addition, many other contents kept within conductive containers that normally reflect the RFID signal (such as International Subrack Interface Standards (ISIS) drawers on Expedite the Processing of Experiments to Space Station racks, freezers, and middeck lockers) will not be detected by the handheld readers. So even though the mobile handheld reader is a very useful RFID tool for space-based habitat environments, it is only one of several RFID subsystems that will be required to assure high inventory accuracy and to altogether remove the crew from audits and from the task of searching for missing items. Location tracking algorithms and software from previous NASA-funded studies were utilized. All of the RFID readers are based on the EPCglobal class 1, generation 2 protocol, which is currently the standard targeted by the ISS international partners. It is estimated that crew time savings may be in the ballpark of 2 hr/day at an ISS rate of $2 million/hr. Time is an expensive commodity and similar concepts can be put in place for future operations.

Anticipated Benefits

NASA Marshall Space Flight Center's (MSFC's) Engineering Directorate will identify RFID tags and a handheld reader for scanning crew provisions, and is supporting the concept of operations for international partners to use RFID for crew provisions. The Human Research Program has modified an RFID reader to

outfit one of their pantries for use on the ISS. This same technology with a few enhancements can also benefit the broader payloads community. The Payload Operations Integration Center's Laboratory Training Complex will serve as a test bed for the RFID concepts and can afford future testing and human factors usability analysis opportunities for payload developers that may desire to use RFID tags for their payload needs.

This effort is, in large, about ensuring that NASA fully leverages the technology with the potential to transform its mission operations, enhance safety, and promote mission success. The ultimate outcome is to provide recommendations for producing an integrated RFID system that minimizes crew involvement in inventory management and localization of equipment and consumables for future missions that involve space habitation.

Potential Applications

The objectives target advancement of the technology readiness level for integrated RFID-based automated inventory management, both for flight and ground applications. Other candidate RFID technologies expected to be required in an integrated and automated RFID environment include RFID-enabled enclosures, smart shelves, and portal/zone readers. These technologies have all been demonstrated in laboratory environments at the component level and at a subsystem level with simple RFID applications. Utilizing these core technologies and modifying them for Advanced Exploration Systems payloads specific use will help reduce the real-time errors that occur as a result of improper location callout for equipment/items. Longer term projects that can potentially evolve from this development are RFID soft stowage racks and preprogramed hovering readers.

Notable Accomplishments

The following goals were accomplished: (a) Integrated core RFID technologies at the component level and a subsystem level to demonstrate a modified application for spaceflight use (fig. 1); (b) demonstrated an RFID system that optimally automates processes associated with habitation (recycling, reusability, inventory management, localization, and science sample tracking); and (c) demonstrated RFID middleware and network technologies for payloads stowage allocation.

The objectives of a follow-on project target the integration of these technologies into ISS facilities and building an internal Wi-Fi RFID-enabled CTB that not only reports its internal contents but can be located via triangulation through Wi-Fi access points. Another objective of the follow-on project will result in a significant time savings for the Microgravity Science Glovebox project by automating the inventory audit process for their three ISIS drawers on orbit and allow them to locate their own CTBs via Wi-Fi enabled tags. By strengthening MSFC's inventory tracking and asset management capability, this technology can be used to make living and working in space easier for future long-range missions where autonomous crew operations will be necessary.

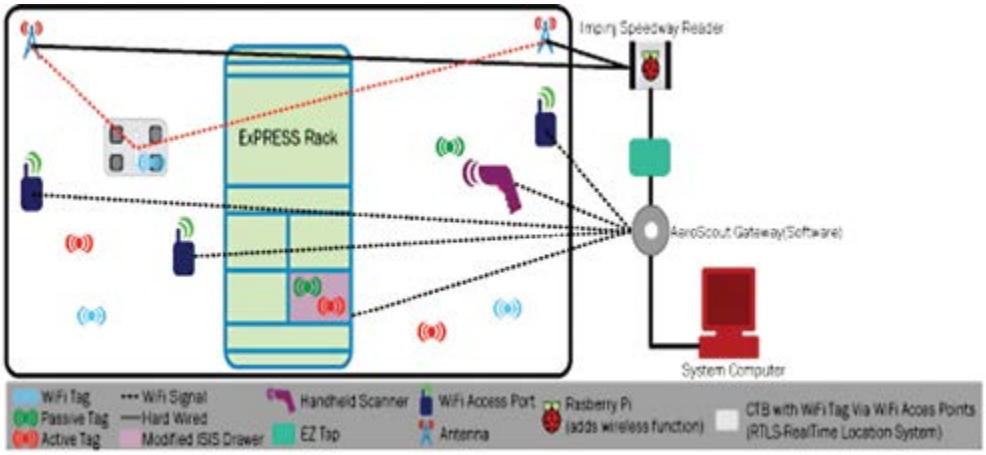

Figure 1: Integrated core technologies.