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Experiences in Implementing the VTLS RFID Solution in a Multi-vendor Environment

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About the Author



Dr. Vinod Chachra, Chairman and CEO of VTLS Inc., is an internationally recognized lecturer, consultant and innovator in the field of information system planning. Beginning in 1975, he designed the original library system that was responsible for the creation of VTLS Inc. - Visionary Technology in Library Solutions. VTLS is an international leader in integrated library automation, digital imaging services and radio frequency identification (RFID) technology. The company provides state-of-the-art library automation systems to more than 900 libraries worldwide.

1. Overview

Radio Frequency Identification (RFID) is the technology that is slated to replace barcodes in library applications. It is a form of identification that is contact-less and does not require line of sight. The technology, though new to libraries, has been in use in other sectors for more than 20 years. The RFID tags are placed in books and generally covered with a property sticker. Antennas of different sizes, based on application, are used to read the tags and manage the various library functions.

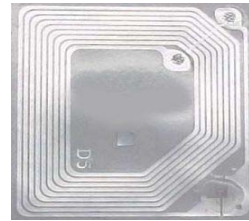
The RFID Solution is a revolutionary application of automatic identification and data capture (AIDC) technology. In a library environment, RFID technology resembles a traditional barcode system in that it provides a means of assigning an ID to an item and reading that ID to perform circulation transactions or to take inventory. But while RFID technology resembles a traditional barcode system in application, the VTLS RFID Solution is far superior in performance—plus it offers built-in security.

The problem with technical acronyms, like RFID, is that they tend to make all products or solutions that use the technology sound alike. In this paper we will discuss both the similarities and differences among different RFID solutions. We will also share some experiences in implementing these systems in multi-vendor environments.

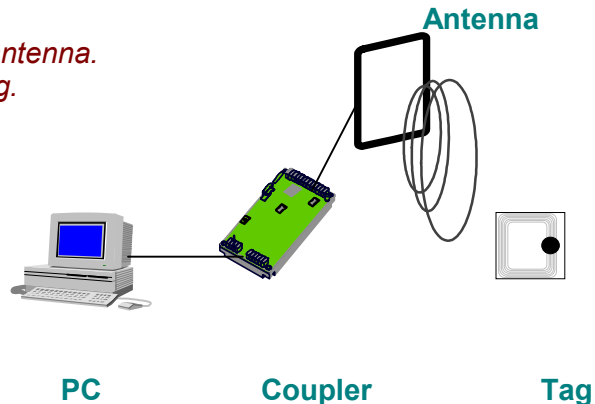
How the VTLS RFID Solution Works

VTLS has partnered with TAGSYS, a leading manufacturer of RFID hardware, to bring you the latest in RFID technology. A standard RFID system consists of four main parts:

- **RFID Tags** - Flexible, paper-thin smart labels that are applied directly to library items. Each RFID tag contains a tiny chip, which is both readable and writable and can store information to identify items in your collection. In library applications, it also stores a security bit and if needed, information to support sorting systems.
- **Antenna** - A conduit between RFID tags and the coupler. RFID antennas emit radio waves that activate RFID tags as they pass through the activation field. After a tag is activated, it can send information to or receive information from the coupler.
- **Coupler** - The link between RFID tags and the PC. The coupler can send information in two directions: It can read information from a tag and send it to the PC (read mode), or it can read information from the PC and send it to an RFID tag (write mode).
- **PC** - The link between the coupler and your library automation system. VTLS has developed software that runs on your PC to provide an interface between the RFID hardware and your library automation system.



1. *Tag enters RF field created by the antenna.*
2. *Antenna's RF signal activates the tag.*
3. *Coupler sends a modulated signal.*
4. *Tag demodulates the signal and returns its data to the reader.*
5. *Coupler sends data to the computer.*
6. *Computer transmits new data through the coupler to the tag.*



The VTLS RFID Solution can be implemented with *any* library automation system that uses the Standard Interface Protocol (SIP) for circulation transactions. Together, VTLS and TAGSYS have installed over 2.5 million tags into libraries worldwide.

Advantages of an RFID System Over a Traditional Barcode System

The VTLS RFID Solution provides numerous advantages over traditional barcode systems. Here are just a few of the benefits:

- RFID tags can be read without contact, line-of-sight, or a particular orientation. This reduces materials handling, speeds inventory control tasks, and makes circulation activities fast, easy and accurate.
- Several RFID tags can be read at one time, further accelerating all scanning activities. This means that you scan multiple items simultaneously when performing check-ins or taking inventory.
- In addition to the space required to store the item-ID, RFID tags contain re-writable space for additional data. In the VTLS RFID Solution, this additional space is used to store a security setting. This means that your library can manage circulation AND theft deterrence with a *single* technology.

RFID System Components and Applications

In a basic RFID system, RFID antennas and couplers are used to read the tags affixed to each item in your collection. At various administrative points within your library, you can implement specific read/write stations, each of which uses an RFID reader. Virtua offers the following components in its RFID Solution:

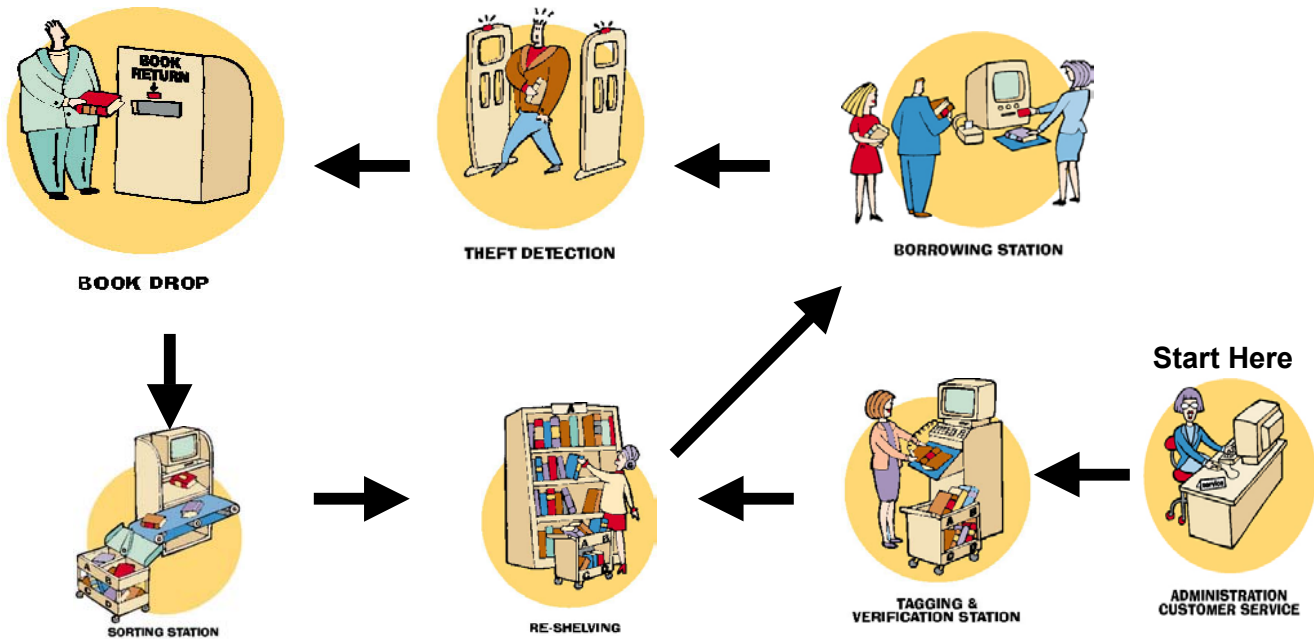
- **Technical Services Workstation** - Serves as a central RFID workstation, where staff members attach RFID tags to items in your collection, program the tags with the RFID item-ID, and activate the security bit for the theft detection system.

Patron Self-Checkout Station - Allows patrons to check out items without assistance from the library staff. Complete with a touch screen and receipt printer, the Patron Self-Checkout Station helps you reduce staff workload and improve customer service.



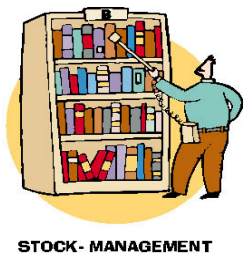
- **Security Gates** - Positioned at library exits, they read the security setting that is stored in RFID tags and determine whether or not items should be permitted to leave the library. If items have not been properly checked out, an alarm sounds to alert library staff.
- **Staff Circulation Station** - Provides seamless integration with your ILS while reducing materials handling and streamlining workflows.
- **Self-return Book Drop** - Provides a return chute that interfaces with your library automation system so that the loan status of returned items is reset as soon as the items are returned.
- **Sorting Station** - Provides a workstation where staff can reactivate the security bits of checked-in items and scan items to determine their shelving locations.
- **Inventory Control System** - Lets you take inventory and locate missing items. The RFID Inventory Control System consists of two parts: 1) a hand-held RFID reader that you can

use to scan items on your shelves and 2) software developed by VTLs that lets you generate inventory reports about the collected data. The RFID Inventory Control System speeds up the inventory process, locates misshelved items, and improves inventory accuracy.



Shelf Management and Inventory Control

Perhaps the most difficult and disliked function in libraries is inventory control and shelf management. This function becomes extremely simple with RFID technology and associated software from the ILS system.



The components necessary for inventory management consist of a Reader and a Wand with an IPAQ (hand-held personal digital assistant) at the end. The Reader weighs only 607 grams (1.34 lbs) and the Wand 435 grams (0.96 lbs), making the weight of the entire unit approximately one kilogram. A shelf can be inventoried in a matter of a few minutes as the units can read up to 20 tags a second. The system allows for two different methods for taking inventory.

The first method for taking inventory is to run the Wand across the shelf. This process captures the RFID data to the IPAQ unit, which can store data for more than 6 million books. This data is uploaded, through wired or wireless connections, to the ILS system, where the software program performs the inventory management functions.

The second method involves a pre-processing step where data is downloaded from the ILS system to the Reader. This method is more effective when there is a need to search for specific books or to identify misshelved or missing books. The unit comes with an audible alarm to provide appropriate feedback to the user.

All in all, this technology converts the otherwise tedious task of managing inventory to a convenient technique for helping libraries gain control over their collections.

2. Similarities in RFID Solutions

Indeed, there are some significant similarities between the various RFID product offerings. All RFID products store item-related data on digital tags rather than barcode labels. RFID antennas access this data much faster than barcode readers, speeding inventory, weeding process and similar operations. In addition, because placement requirements for label reading are not as exacting, all RFID solutions simplify check-out and check-in for staff and patrons.

Since the migration to RFID solutions is done progressively, several RFID systems are designed to accommodate both bar code labels *and* RFID tags. These “dual mode” systems make the transition to RFID tags a smooth one as the old system can co-exist with the new during the transition period. For some libraries this transition period can be several years long.

Whereas barcode requires strict, line of sight access, all RFID tags can be read through a variety of substances, irrespective of orientation. Several RFID tags can be read at one time, further accelerating all activities through “bulk” check-ins and check-outs. Barcode systems do not allow for “bulk” activities. Because the properties of barcode systems are so different from those of RFID systems, “dual mode” systems become harder to design and implement.

All RFID solutions, including VTLS’, are also compatible with any automated library system that supports the SIP or SIP2 protocol, which most major systems do. Similarly, all RFID solutions support third-party technologies such as book drops and automatic sorting stations.

3. Differences in RFID Solutions

Beyond these similarities, however, critical design decisions made by RFID vendors dramatically affect performance and usability in the field. This document discusses the various types of solutions available from RFID suppliers. Generally speaking, there are three types of RFID solutions for libraries with the distinguishing features shown in the table below.

	Type A	Type B	Type C
RFID Tag Type	Read Write	Read Only	Read Only
Inventory management based on	RFID	RFID	RFID
Security management based on	RFID	RFID	EM
Integrated Security Bit in RFID tags	Yes	No	N.A.
Query the ILS system at exit to determine security status	No	Yes	No
Example system	VTLS	Checkpoint	3M

Type A systems use a read/write tag, whereas Types B & C use write once and read only tags. The Type B solution is distinguished from the Type C solution by the fact that the Type C solution uses EM (magnetic strip) technology for security and RFID for everything else. The most significant and unique benefit provided by Type A solutions is the use of an RFID tag with a separate read/write “security bit” containing the security status. Used in conjunction with Theft Deterrence Gates, these tags are more convenient than traditional EM solutions (Type C) and produce fewer false alarms than Type B systems. Type B solutions poll the central database or a copy thereof for each item’s security status, a less efficient approach that may even allow patrons to leave with materials that are not checked out. In addition, if the materials are taken to another branch by the patron, such a solution may cause false alarms.

4. Working in Multi-vendor Environments

The simplest of all possible RFID solutions is one in which there are just two parties – the library and the RFID vendor. The library contracts with the RFID vendor to provide all the necessary hardware, software, installation and training for all parts of the system. The installations at New Hanover County Public Library in North Carolina and the Jewish Public Library in Montreal are examples of such installations. More typically though, there are other parties that get involved in the process.

Main Players and Processes

The main players in this multi-vendor environment are listed below.

Library is the customer.

RFID System Vendor is the system integrator with the primary responsibility for the RFID solution. Typically, this vendor provides the systems software, the system hardware and the integration services. Typically, the RFID vendor also supplies the RFID tags.

ILS Vendor is the provider of the integrated library system for the customer. In particular, the ILS vendor is the provider of the circulation system and the data for the inventory management system.

RFID Tag Installer is the group responsible for putting tags on the books. The library may choose to install the RFID tags on the books using their own staff or using volunteers. The library may contract for these services to an external third party. More typically, the library may ask the book supplier to place the RFID tags in the books prior to shipping. The RFID vendor may also act as the RFID tag installer.

RFID Hardware Installer is the group responsible for the installation of the self-checkout stations, security gates, book drops and staff stations. The RFID vendor may act as the RFID hardware installer. Due to construction laws, in some situations it is necessary for the construction crews or architects to get involved in this process.

Sorting System Installer is the group responsible for the installation of the mechanical sorting system if such a system is included in the configuration.

The main processes involving multiple vendors are:

- a) Interfacing the RFID system with the ILS system
- b) Installing RFID tags
- c) Installing RFID hardware
- d) Installing the sorting system.

The library is involved in all four of these processes.

Interfacing the RFID System with the ILS System

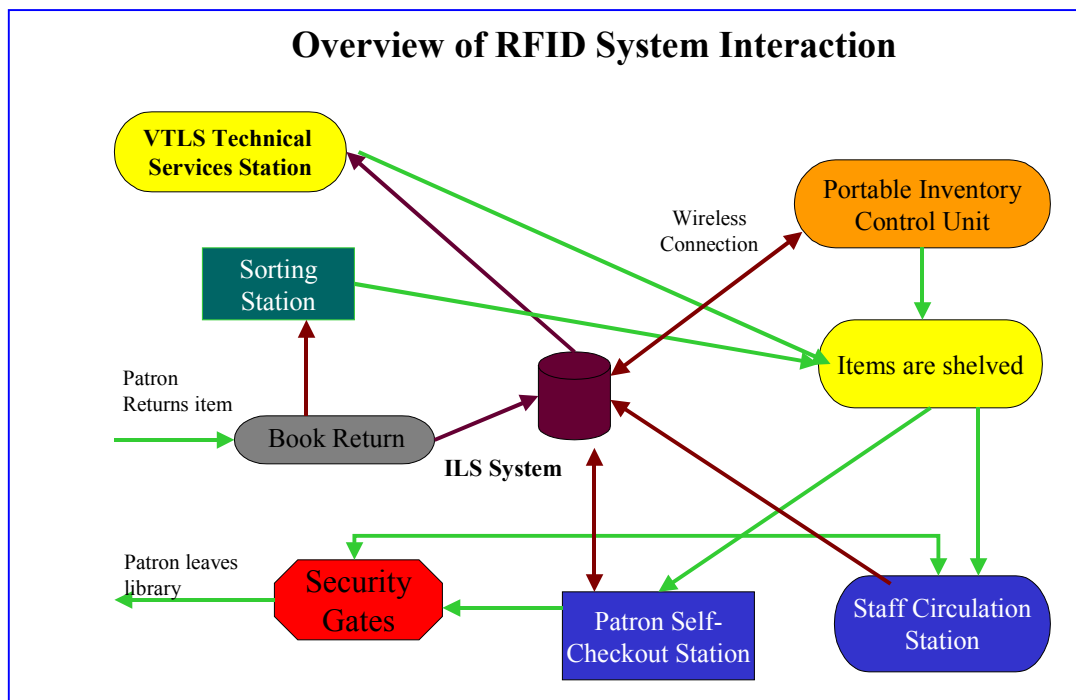
The simplest situation for interfacing the RFID system with the ILS system is when the RFID system supplier is also the ILS system supplier. At present, the only ILS system vendor that also provides the RFID solution is VTLS Inc. Unless your library is already a VTLS customer, it is likely that the RFID solution and the ILS solution for your library will come from different vendors. The two systems will therefore need to be interfaced. This interfacing is done using the SIP (SIP, SIP-2 and NCIP) protocol. Libraries using the 3M self-checkout stations with barcode technology may already be familiar with the SIP protocol.

When the RFID system supplier is not the ILS system supplier, things get more complicated. First, whenever there is a failure of any sort, there is the possibility of the usual finger pointing among the vendors involved, but more on this later.

Second, the SIP protocol is sequential in nature and has no “trial” transactions. For example you cannot do a “bulk” check-out in one step using the SIP protocol. The RFID system may read six books at the self-checkout station and immediately check them out in a “bulk” mode, but internally it must process these six books one at a time with the ILS system. Further, there are no “trial” transactions in the SIP protocol. You cannot ask the ILS a question like, “If I were to try and check out this book (these books), am I allowed to do so?” The ILS system either checks out the book or denies the request. This poses special problems for “bulk” check-outs that the RFID system has to deal with.

Our early experience showed that the typical problems in self-checkout stations in the field were:

- a) Network failure or power failure.
- b) ILS system not responding or responding incorrectly.
- c) Slow response times.
- d) System disconnects requiring logons by staff.



To address these problems, VTLS developed a “test” suite for the SIP protocol. This test suite consists of about 30 different test situations. Prior to installation of the RFID system, VTLS works with the ILS system supplier to see if their SIP protocol responds correctly to these tests. These tests are convenient in two ways. First, prior to installation, we can tell if the ILS will work correctly in the various conditions. Second, each time the ILS vendor updates its software, the same tests can be run again to insure the integrity of the system.

The ILS vendor reaction has been mixed. Some ILS vendors have taken the enlightened approach and use the test suite to insure that their system interoperates with the RFID systems correctly. Other ILS vendors are dragging their feet on this. And one vendor insists on being paid each year to run these tests. It is important for libraries to recognize this situation and open a dialogue with the ILS suppliers and insist upon interoperability.

Finally, in order to permit quick resolution of any perceived or real problems, VTLS Inc. has built some intelligence into the self-check units. The units are designed to be self-monitoring. Periodically, the unit polls itself to determine 1) if the network is still functioning, 2) if the ILS system is still responding and 3) what the time delays are in each of the processes. This problem resolution is accomplished in two ways. The system is designed to automatically re-connect if a connection is lost. The system also has extensive logging capability, which logs not only the transactions that are performed, but also the status of the system and the events that are generated as a result of the changing status. This extensive information is extremely valuable in pinpointing the exact problem so that the responsible parties can address the issues at hand.

Installing RFID Tags

The use of volunteers is the least expensive way to install tags on books. The process is simple and requires less than 10 minutes of instruction. In some cases it is necessary to go to an outside source for this task. For new libraries and for new branches that have a first day collection to be processed, it makes more sense to have the book supplier do this processing as this minimizes the book handling.

Experience with this multi-vendor situation has been very positive. Book jobbers are usually eager to handle this additional task. VTLS now has experience with several book suppliers. In each case, the book supplier acquired the administrative station from VTLS and attached the RFID tags to the required specifications with few problems.

There are two important steps in the installation of tags. First, it is essential that the tag supplier (manufacturer or distributor) do 100 percent QC on the tags. RFID tags may work at close proximity to the antenna, but they may not work in the field when the distances between the tag and antenna are greater in the field. Second, after the tag is installed in the book, there should be an immediate quality control check to make sure that the tag works correctly. The additional cost of doing this check at the time of installation is very low whereas a later discovery can be very frustrating to the users. Our experience on this has been very positive. The volunteers and the book jobbers are doing this task without any concerns about quality.

Installing RFID Hardware

The easiest option for installing the RFID hardware is to have the RFID system vendor install it. However, there are times when the installation has to be performed by the construction contractor under the supervision of an architect. Since a third party has to do the installation, it is

necessary to produce good equipment specifications. At the very least these specifications should include dimensions, weight, color options, power requirements and thermal load generated. In addition, complete step-by-step installation instructions need to be a part of this package. This package should also include a performance test that ensures that all equipment is operating at the required levels.

There are environmental conditions such as metal or aluminum doors or other materials that can act as antennas, thereby interfering with the proper operation of the RFID antennas. The equipment, therefore, needs to be isolated from these environmental conditions. This can be done by re-orienting the equipment, creating RF shields or fine-tuning the antennas.

Installing the Sorting System.

The installation of the sorting system is a large project and requires that requires the involvement of the builders and architects. Space and location considerations are paramount in the proper installation and application of a sorting system. Consideration has to be given to the amount of noise generated by the equipment in order to ensure that it does not become a liability for the readers and staff. It is best that the architect be involved in the location and construction so as not to compromise the overall effectiveness of the reading room.

5. Conclusions

The RFID industry for libraries is still very new. Several libraries have successfully installed the RFID solution. Some, such as the Sarasota Public Library System in Florida, are expanding their installations to include additional libraries. Since traditional security systems have proved to be less effective than libraries desire them to be, and RFID is more effective in material management, one can safely conclude that the RFID solution is here to stay. As more libraries install these systems vendors will gain greater experience in the field and use this experience to refine the solutions.

So far, it appears that Type A solutions, where a single RFID read/write tag is used for circulation and security functions, is the preferred solution and the most cost effective one.

It is best to have a single vendor provide the entire RFID solution. This may not always be possible. In a multi-vendor environment we recommend the following precautions:

- a) The ILS vendor should provide a SIP interface test suite and its results.
- b) The self-checkout unit should have extensive logging and self-diagnostic capabilities.
- c) The installation of RFID tags should have a test cycle built in. Only tags that are properly tested for quality control should be used.
- d) The installer should check for environment interference at different times of day and at different traffic patterns to make sure that the antennas function correctly at all times.
- e) The architect should be involved as early as possible in the whole process.
- f) The RFID supplier should have good specifications and installation instructions.

If these precautions are followed, a successful RFID system implementation will be assured.

References:

Section 1 Overview is adapted almost entirely from VTLS marketing publications that have appeared on the VTLS website www.vtls.com, starting in January 2002.

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http://www.checkpointsystems.com/library/lib_tour.html, sensors window, which states: "Sensors....query materials that pass through the sensors for proper checkout. Materials are verified against your library circulation system."

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