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White Paper

Business Action Group
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Work Stream Practice Briefings

Scaling from Pilot to Implementation

Enu Waktola, Strategy Manager
Texas Instruments Radio Frequency Identification (TI-RFid™) Systems

Vijay Sarathy, Product Marketing Director
Sun Micro Systems, RFID Business Unit

Executive Summary

This paper addresses relevant hardware and software considerations that companies will have take into account when attempting to scale from a small RFID pilot to a full-blown RFID deployment.

With respect to hardware, emphasis is given to the tag value chain that users should anticipate in moving from pilot-level implementation to rollout-level implementation. In order to ensure scalability of the implementation, customers and end users should look to their suppliers' delivery of high quality, highly reliable tags to provide the best performance in the intended end use application environment. Additionally, this paper describes key considerations for printers/encoders, including interoperability and migration to EPC Generation 2 solutions.

With respect to software, emphasis is placed on considerations that will drive the ability to seamlessly and on a scalable level, integrate the real-time data flowing from RFID readers and other compute infrastructure with traditional enterprise systems such as warehouse management systems (WMS) and enterprise resource planning (ERP) systems.

Another key consideration is planning for the timely diagnosis and rectification of any compute infrastructure failure. This is quite likely in a real-world deployment where equipment may have to operate in remote harsh locations such as warehouses with no readily available IT support resources.

End users are encouraged to first, start with an assessment of the current information process for data gathering, analysis and actionable trigger process within their 4 walls, and then extend to their retailer trading partners to determine areas where RFID data capture improves the business process and ultimately the business ROI.

Preface

RFID technology is not new and is not untested. Established RFID manufacturers have been successfully driving the implementation of hundreds of variety applications where implementation of RFID technology is proven around the world since early 1990s.

What is new and exciting is the industry-wide effort aimed at applying RFID technology to help facilitate timely tracking of physical assets as they move across the global supply chain and the sharing of this tracking information with all relevant business partners to improve supply chain efficiency. This application is known in the industry as "open-loop" supply chain tracking and it is expected to eventually drive demand for RFID devices globally and across virtually all industries.

RFID technology enables some key benefits that other traditional tagging and data capture mechanisms, such as barcodes or magnetic stripes, readily provide. They also provide numerous features not available in these mechanisms such as no line-of-sight requirements. As with barcodes and magnetic stripes, RFID technology provides unique data such as identification of individual items.

And just like barcode, RFID provides for the automated reading of data without physical handling. However, RFID allows for the reading of data with out line-of-site connectivity as needed with barcode. This, coupled with the ability to read multiple tags at the same time, will enable more efficient and accurate data capture than what is commonly achievable today with existing data capture mechanisms.

More efficient data capture alone, however, is just one facet of the overall value that RFID will bring to companies. In order to fully realize the benefits of this technology and maximize the ROI from implementing it, companies will need to consider how to seamlessly integrate this timely flow of data from RFID systems into their existing business systems – such as their WMS or ERP systems.

Supply Chain Considerations

The puzzle diagram below is a pictorial summary of this white paper. The diagram represents pieces of the puzzle tied to key participants in supply chain and the individual participants' needs and requirements as they move from pilot-level adoption to rollout-level implementation.

This paper addresses each of the areas characterized by the puzzle pieces and attempts to define the context of end user requirements, the challenges faced from current trial experiences, and the solutions that can be utilized to drive successful implementations today and in the future.

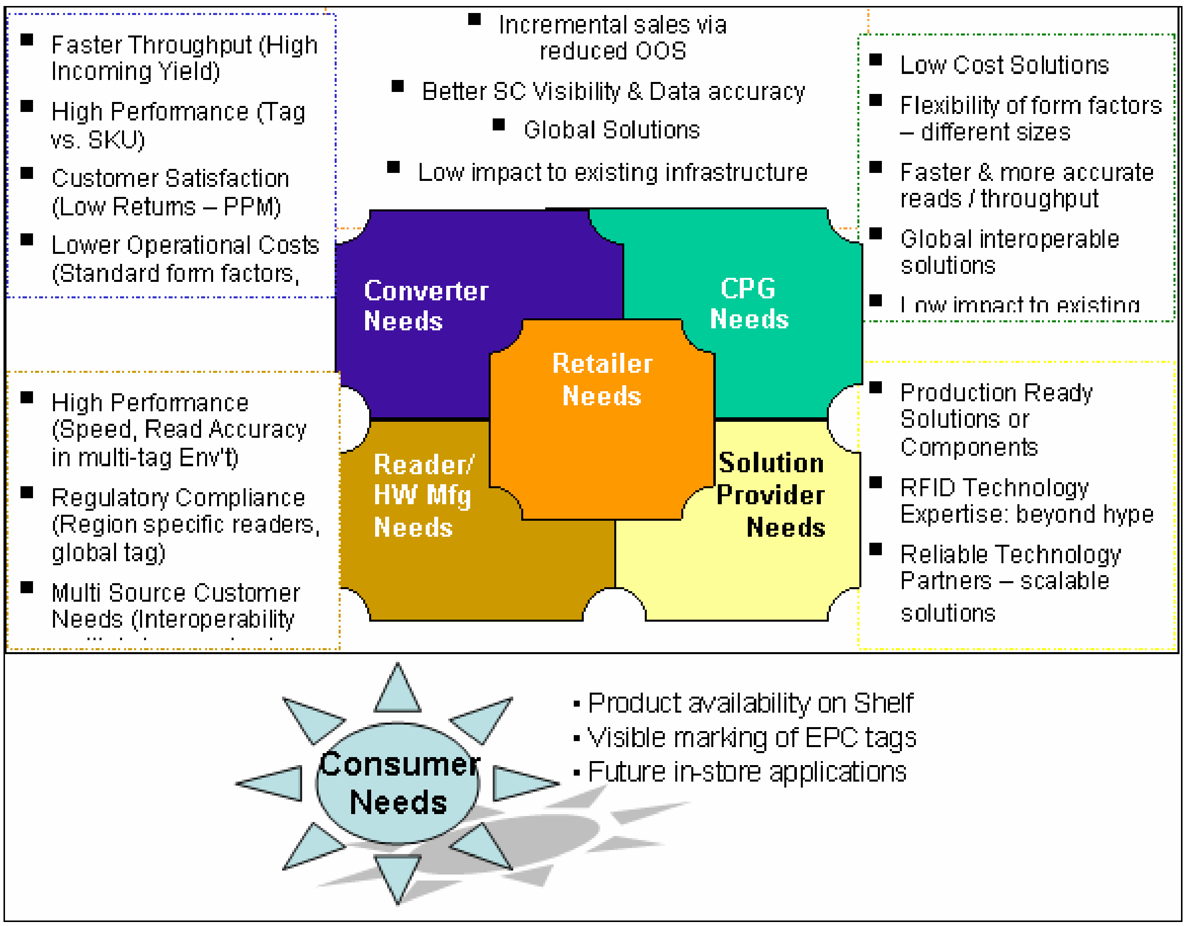

Figure 1: Supply Chain Considerations – Pilot to Implementation

EPC Tagging Considerations

State of Industry in Smart Label Production

The application of EPC tags in the supply chain needs to consider various components of the tag value chain that impact the end use application of the tag on cases and pallets at the consumer product goods manufacturer.

An EPC smart label is composed of an RFID chip (or interposer), substrate, antenna, and label stock. In the following figure, an inlay constitutes material where silicon (alternatively, silicon on strap interposer) is attached to an antenna that is printed or etched on flexible substrate. A smart label describes the integrated label that contains inlays.

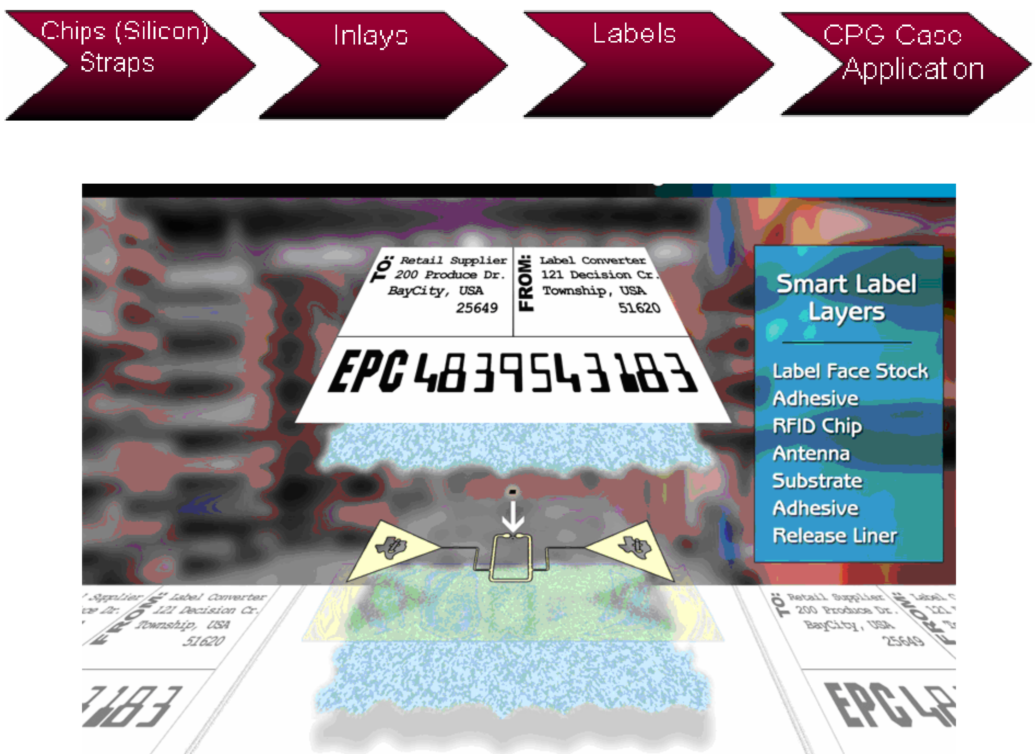

Figure 2: EPC Tag Value Chain

Strap Applied Vision- 'Smart Things'

Emerging methodologies that enable application of strap (or interposer) on "smart things" are underway whereby "smart things" can represent smart labels, smart packages, smart substrates, smart materials, smart boxes, or other.

The application of an interposer on various packaging media introduces a level of flexibility to allow end users to customize antennas at the point of package-level manufacturing that provides for scalable solutions for high volumes of SKUs in multiple tagging environments. End users can additionally benefit from breakthrough efficiencies from the overall smart label make process that can be achieved in higher throughput, maximum capacity utilization, and overall high efficiencies in the applications of tags on cases.

Strap-attach equipment for label conversion process is being introduced for Gen 2 smart label market. Furthermore, research and development efforts are underway to providing solutions for "smart things" where the strap (or interposer) can be attached to various packaging media.

Key Tagging Challenges from Pilots

Current examples of tagging challenges, faced by end users as an outcome of pilot testing environments, can be found to be linked to three key areas:

- Quality & reliability of inlays to label converter: incoming yield of inlays at 80% or less per reel received, too many non-working inlays in sequence, bad inlays are not marked or if marked inconsistent marking methodology.

- Quality & reliability of smart labels applied on cases or pallets: labels that have passed through the tag value chain, as characterized by Figure 1, still have relatively high portion of non-working tags at the end use environment post application of label on cases and pallets

- Performance: insufficient antenna design considerations of the end use application environment (product types, SKU types, application specific solutions).

Scalable Tagging Solutions for Rollouts

The first key step to enabling scalable, rollout solutions is to remove the hurdle of manufacturing quality as an issue that end users have experienced in piloting solutions. High-quality chips, straps, inlays, delivered in tag value chain are critical to reducing total cost of label conversion for best read reliability in end application environment.

This involves the following solutions that vendors can deliver for most efficient scalable EPC smart label solutions:

- The delivery of high quality (95% or higher) yield of inlays to converters,

- The identification of bad marked units (or the removal thereof through splicing)

- Outgoing and incoming quality inspection principles between inlay manufacturer and label manufacturer (or backwards in the chain between the silicon manufacturer and the assembly manufacturer)

- Antenna design for critical tag vs. SKU considerations: properties of product case (dry goods, plastic, liquids, metal) that can affect the label's readability. These considerations include the hardware (readers, printers, applicators) as well as elements of the software (firmware, middleware) components that tie together the final system.

EPC Printing / Encoding Considerations

In a "closed-loop" environment, the end user typically uses read-only tags, which are encoded or serialized by the tag manufacturers. In "open-loop" applications however, the ability to encode data to the tag will likely be required.

To meet this need, the market now has a new generation of printers that combine RFID with barcode capabilities. These printers use labels embedded with RFID transponders. Not only do these printers encode EPC data to the transponder and verify the encoded data, they are able to print bar code, text and graphics on the label.

In selecting a printer, there are several considerations:

Interoperability

UHF printers are designed to encode and print UHF tags. Furthermore, the printer needs to match the communications protocol that has been selected for the RFID system namely: Gen 1 (Class 0/0+, 1) or Gen 2. Thus, a Class 1 printer is used with a Class 1 RFID system (i.e., tags and readers). As more manufacturers introduce multi-protocol printers, end users will be able to enjoy the convenience of buying one printer that operates Gen 1 and Gen 2 protocols. Such convenience will likely need to be evaluated against the intended applications for possible compromises in performance.

Anticipating ubiquitous use of Gen 2 protocol, applications requiring only Gen 2 solutions need only select Gen 2 printers to encode and print UHF Gen 2 tags.

Interoperability test assurance is part of EPCglobal Hardware Certification Program. Under a set of standard laboratory conditions, Gen 2 tags programmed by printers/encoders that are submitted by different manufacturers are tested using Gen 2 readers and different printers/encoder solutions. The test results are intended to provide confidence to end users that these tags (although produced by different manufacturers and encoded from different hardware devices) are able to "talk" to the various readers within their class and adequately perform their functions.

Error Detection

Printers/encoders should automatically test each RFID tag and write EPC data to the tag before it is printed. This is the most reliable method to encode an RFID tag. When the printer/encoder detects that the RFID chip failed to record the data, it should alert the end user. Depending on the design and user instructions, a printer could overstrike the tag with a faulty chip, re-try with another tag, and alert the end user only if successive faulty chips are encountered.

Migration to Gen 2

Another factor to consider is the ease of upgrading to Gen 2. Generation 1 end users, desirous of leveraging the latest technology, will require an upgrade. To meet this demand, end users should work with those printer/encoder manufacturers who can provide and guarantee a seamless migration.

Yield of Usable Encoded Tags

Depending on the printer design, end users need to consider the factor of cross-talk, where the resident encoder addresses more than one tag at a time. Cross-talk leads to data corruption of the adjacent tags. End users might ask the printer manufacturer for performance data and assurance that only the desired tag will be correctly encoded and that other tags will not be corrupted in the process.

The ultimate purpose of an RFID printer is to produce encoded tags that perform reliably. To this end, there are two considerations related to consumables:

Inlay Positions in Printers

Because inlay positions differ among printers, currently there is no "one-size-fits-all" RFID label that works across all printers. EPCglobal Tag Label Standards WG is working towards standard solution that allows for multiple RFID labels that can be used across multiple printer manufacturers. Currently, end users should not assume that any RFID label with any RFID inlay would automatically work for any RFID printer.

What Goes In Impacts What Comes Out

The yield of usable encoded-RFID tags is directly dependant on the quality of tag stock used. Manufacturing and quality control processes adopted by label producers are important to insure a high yield of usable RFID stock labels.

In the short time period that RFID has been embraced by the industry, a great deal of innovation has been developed and announced. For optimal implementation, end users need to consider RFID printers and tags as an integral system.

Software Considerations – Middleware & System

The scope of pilots is typically very limited and hence the criteria for software or system selection can be minimal. However, when scaling to a large-scale rollout or deployment, a number of other factors come into play including data exchange and business process change that are needed between CPGs and retailers. While delving into details may be beyond the scope of this paper, at a very high level, some of the key considerations to include are:

1. Scalability: Ability to filter high data volumes
2. Modularity: Ability to be independent of readers and applications
3. Manageability: Remote/central management capabilities
4. Availability: Redundancy, failover and self-healing
5. Identity and Security: Who has access to what data

Scalability: Ability to Handle High Data Volumes

With state-of-the-art RFID readers capable of read rates in excess of 400 reads/second, a real deployment is likely to generate a fair bit of incremental network traffic. The RFID middleware system architecture should be capable if sorting through this data efficiently without burdening the network. One current idea is for readers to become more intelligent and the filtering of data to be already done at that reader level. Only higher-level filtered events that are meaningful to the business should be passed onto the network as opposed to the stream of read data generated by RFID readers.

Modularity: Ability to be Independent of Readers and Applications

RFID middleware should be capable of handling requests for the dissemination of higher-level filtered events to multiple applications. Care should be taken to make sure that the infrastructure is not designed just for the current set of applications as it is likely that a new application will arise in the future. Selecting RFID middleware that implements EPCglobal's ALE (Application Level Events) specification will help ensure that your software infrastructure is flexible.

Manageability: Remote/Central Management Capabilities

In a RFID roll out, users will see readers and other infrastructure distributed across remote locations such as warehouses, retail stores, distribution centers etc. These locations will most likely not have adequate IT support at most times. Hence, this infrastructure will need to be centrally managed from a corporate or central IT location.

Some local maintenance capability is needed, however. The ability to centrally or remotely diagnose failing equipment and then take corrective action such as upgrading software or resetting the reader will be a necessity.

Availability: Redundancy, Failover and Self-Healing

Once an RFID system is deployed, users will start depending on the real-time data flows to drive or control business process and to achieve improved efficiencies. Failure of the RFID infrastructure providing this real-time data could prove costly. Hence it is imperative that the software and infrastructure be able to function with a high degree of availability. Since RFID software and infrastructure will be operating in harsh environments such as warehouses or distribution centers with no IT support, the ability to automatically take corrective or compensatory action will be crucial. The system should be able to fail over to alternate back-up systems or re-route/re-allocate compute tasks in order to keep the data flowing to the business processes that need it.

Identity and Security: Who has Access to What Data

Who has access to the data collected from RFID systems is a critical consideration in any real-world deployment for RFID. Access to the information should be limited to those entities that are authorized. Even RFID readers or other infrastructure pieces may need to be authenticated. For example, if a new RFID reader joins the user company's wireless network, then it needs to be authenticated and verified before it is allowed to send data.

Conclusion

In the above section, we have tried to highlight some of the key general consideration for software and systems when scaling from a pilot to a large rollout. There are however, likely to be considerations specific to a company and it business processes that may also come into play. This is where the right RFID vendors and partners might be best able to help.

About the Authors

Enu Waktola
Retail Supply Chain Marketing Manager
Texas Instruments RFid Systems

Enu Waktola is a marketing manager for retail supply chain at Texas Instruments RFid Systems. In this role, she is responsible for developing and executing TI's marketing strategy for EPC™ and UHF RFID applications in the growing retail supply chain sector. Enu is also actively involved in the development of globally accepted, interoperable standards, currently serving as a co-author to an EPC-related standard through her participation in EPCglobal Inc™.

Enu joined the RFID group as a product marketing engineer in 1998. She then worked on UHF-based research projects as UHF product manager, offering early experience in retail supply chain applications for RFID. Enu launched TI's Team Tag-it™ program, what has now become a network of more than 125 RFID hardware and software suppliers, printer, reader and antenna manufacturers and systems integrators. Prior to her current position, Enu supported TI's development of ISO/IEC 14443 compliant technology.

Enu earned a B.S.E. degree in chemical engineering from Rensselaer Polytechnic Institute (RPI) in Troy, New York, and a B.A. in chemistry from Lawrence University in Appleton, Wisconsin. She is completing coursework to earn her M.B.A. from Southern Methodist University which is anticipated in the spring of 2005.

Vijay Sarathy
Director, RFID Product Marketing and Strategy
RFID Business Unit
Sun Microsystems, Inc.

Vijay is the director, RFID product marketing and strategy for Sun's RFID Business Unit. In this role he is helping define and drive Sun's overall RFID strategy as it pertains to solutions for EPC and non-EPC applications. Just prior to this current role, Vijay was a part of Sun's Java Marketing organization where he was responsible for the product Management of J2EE integration technologies and also helped drive overall J2EE adoption. Before that Vijay held various engineering development and management roles in the system software area both inside and outside of Sun. Vijay is a Mechanical/Industrial Engineer by training with 14+ years of industry experience with software technology. He has an MS from Texas A&M University and an MBA from Santa Clara University, California.

About Texas Instruments RFid Systems

Texas Instruments is an industry leader in radio frequency identification (RFID) technology and the world's largest integrated manufacturer of RFID tags, smart labels and reader systems. With more than 500 million tags manufactured, Texas Instruments RFid Systems' technology is used in a broad range of applications worldwide including automotive, document tracking, livestock, product authentication, retail, sports timing, supply chain, ticketing and wireless payment. TI is headquartered in Dallas, Texas and has manufacturing, design or sales operations in more than 25 countries. Texas Instruments is traded on the New York Stock Exchange under the symbol TXN. For more information, contact TI-RFid Systems at 1-888-937-6536 (North America) or +1 972-575-4364 (International), or visit the Web site at http://www.ti-rfid.com, or the main company site at http://www.ti.com

About Sun Micro Systems

A singular vision -- "The Network Is The Computer" -- guides Sun in the development of technologies that power the world's most important markets. Sun's philosophy of sharing innovation and building communities is at the forefront of the next wave of computing: the Participation Age. Sun can be found in more than 100 countries and on the Web at http://sun.com

Additional Contributors

- Roseanne Woo, Vice President, International Marketing for Bar Code Pricing Solutions Group at Paxar Americas, Inc.
- Dr. Ulrich Wertz, METRO Group
- Juup Willemson, Global Customer Development Manager, Unilever
- Jim Southwell, Director of Product Technology and Development, Packaging Corporation of America
- Frasier Jennings, Vice President Standards and Regulatory Activities, Savi Technology
- Eric Lam, Marketing Manager, Asia Pacific, Avery Dennison