Building a Case for Active RFID ROI: Cost-Benefit Analysis

The decision to deploy RFID technology in a company is a business and not a technology decision. For this reason it is vital that the decision to implement RFID be justifiable in terms of its economic value to the company.

A cost-benefit analysis can assist a company in analyzing the impact of an RFID deployment on its business and activities. It is critical to this decision-making that a company take an enterprise-wide view since every decision taken will impact future deployments and the net ROI. An enterprise-wide system deployment requires that multiple and varied performance criteria be met simultaneously and inoperably. In this analysis we consider certain fundamental attributes of the analysis to be fundamental to success. We have coined the expression “absolute truths” for such findings.

The interoperability criterion is key. Consider the case where a need exists for a tag that is controlled and operating at a particular frequency. Add to this environment a need for a different functioning tag that responds to an entirely stimulus and must be “on the air” simultaneously. Such a scenario requires that the two tags operate at different core frequencies yet share the data. Add to this scenario a passive system which also must be operating simultaneously and you will have complete chaos unless the Enterprise’s requirements were scooped during the ROI–benefit analysis phase. This is a critical consideration even if the full deployment is a 10-year project. An example of this would be the use of Zigbee for a networking application where primary power is available, coupled with the eventual desire to have a personnel tracking system that cannot use Zigbee due to battery life considerations.

Absolute Truth #1: A pilot should not be undertaken unless the entire /enterprise is involved and the future deployments rationalized at this point in the decision-making process.

Absolute Truth #2: Most of the cost-benefits will come from process improvements, not just short term direct labor savings.

In fact, many of these process changes cannot be accounted for upfront. If the benefits are labor-saving, then the operators themselves will find ways to use the technology to the future process change, making their tasking less intensive and faster.

Based on the results of this type of analysis, the company may then structure its project to capture immediate, short-term benefits first, and later on modify the scope of the project to reap the long-term benefits.

Many factors contribute to calculating RFID costs and benefits. In terms of costs, they can be either fixed, such as investment in new tools or processes, or recurring, such as the cost of the tags and costs associated with applying them and establishing the benefits of data harvesting. As for the benefits, they can be direct, such as reduction in labor cost and shrinkage, or indirect, such as improved customer service or increased In-Transit Visibility (ITV).

Now let’s look at what types of benefits a company should expect and how various components of an RFID deployment can drive overall project costs.

Areas of analysis:

RFID deployment benefits may be measured over time (short-term versus long-term) or based on tangibility (direct versus indirect). In certain cases, a network effect may also be present: the value of an RFID deployment may be minimal when only a few participants deploy RFID (tagging containers), but the

value will increase significantly if the majority of participants (upstream and downstream participants) deploy RFID and the data is shared/utilized by all the participants. Finally, other less tangible benefits such as quality assurance, compliance to governmental regulations, and competitive positioning must be factored in.

The types of benefits brought by RFID deployments are presented in the matrix below, along with a sample list of applications that fit the characteristics of the given quadrants. Some applications may provide both types of benefits – direct and indirect, or short- or long-term. Some applications may even move from one quadrant to another based on changes in regulatory, competitive or other drivers.

Undoubtedly one of the fastest paybacks to RFID is in the reduction of direct labor costs**.** However, this is only valuable when such reduction is tied to increased throughput and the elimination of redundant, error-prone manual tasks such as data entry, bar-code scanning, and paperwork. An enterprise can realize labor savings in the following areas, as an example:

1. reduced time to find, sort or warehouse
2. automation of recordkeeping with data written to and derived from a tag
3. automatic location keeping
4. real time ITV
5. real time condition monitoring

Expanding upon the first item in this list is the ability to attain real time, automatic inventory and location or in process tracking. Active RFID Systems can provide an accurate item count of what enters and exits a facility through controlled portals. The ability to capture a continuous accounting of this inventory enables a reduction in manual labor to obtain the same information, a reduction in errors and the benefit of knowing the actual value at any instant it is required.

RFID can increase process throughput. Faster processing allows greater efficiency, which allows a company to do more with the same amount of **resources**. This is especially important during peak seasons when companies tend to staff up to handle greater volumes. If you do not have to add extra hours, or to hire the temporary workers you needed before RFID, then savings are easily measurable. Faster through-put also means reduced order lead time for your customers, which may lead to more orders. In fact, additional sales are often an overlooked variable in the ROI equation.

Perhaps the most important aspect of RFID is that enables **process change**. With continuous process improvements, all of the benefits described in this document plus many not yet discussed are possible. As an example, if the contents of a forklift of deliverable items is known as it is unloaded, the receipts, invoices, inventory/item count and time and place of delivery can be printed on the spot for the delivery person. If the customer has a similar system, then they can both derive the automatic, real time delivery information and immediately issue orders for further disposition of this material.

Another example, for instance, reusable containers need to be sorted upon incoming receipt. With active RFID tags, this can be accomplished by searching for a particular data field (product, customer etc.) and the tagged items that respond to such a search will be instantly visible to the operator. This immediately reduces the direct labor associated with handling and changes the process by allowing the sorted items to be stored in a particular designated location rather than randomly placing them on the loading dock. For hospital tracking, the ability to record precisely (not which wing, but which *bed*!) where both equipment and personnel are located is extremely valuable in minimizing the capital expenditures for equipment but also in ensuring an improved level of care a patient is receiving by recording the patient-care giver interactions.

Absolute Truth #3: Cost sharing of recurring costs and interoperability of systems can often produce the ROI not available when a single entity deploys an active RFID system.

Supply chain is often limited to the shipping and storage (warehousing) of goods. However, the cost of RFID is often too high for a single handler to pay. The value in ROI can be attained and shared if the supply chain model is extended from manufacturer to retailer. For instance, if a tag was placed into all high value goods (such as high-priced televisions, for instance) at the point of manufacture, then the producer gets supply chain and manufacturing visibility, the shipper gets ITV and security, the distributor gets all of the above plus higher throughput, and the retailer gets it all including real-time presence detection and general location as well. Sharing the cost of a $10.00 tag over 5 separate enterprises results in a $2.00 tag price for each of the end users.

Absolute Truth #4: It is necessary to have visibility in the mobile environment and not just in fixed installation chokepoints.

Many organizations say that handling errors and exceptions is a disproportionately costly part of their business. RFID improves exception handling. The ability to quickly identify and track exceptions, including special orders, saves time and money. If you are looking at a work-in-progress tracking application, then RFID can help track at what point products are pulled off the line and help guarantee they go back to the right cell.

What's more, having automated methods of capturing the location of assets leads to more accurate physical inventory, which means less time spent looking for lost, or misplaced items, improved accuracy in internal systems, and better forecasting.

Long term, Direct	**Long Term, Indirect**
Application Examples: • Real-time visibility of supply chain • Monitor temperature and other attributes of goods in transit *Benefits:* • Improved inventory visibility and monitoring • Reduction in inventory safety stock • Reduced shrinkage • Better decision-making	*Application Examples:* • Compliance with DoD mandate for its non-top suppliers • Sensor-tagging of patients and hospital personnel to track the spread of a given infectious disease Benefits: • Insurance policy against industry-wide losses in the event of widespread failure (e.g. bird flu) • Socially responsive business practice • Preparatory work to derive direct benefit over time
Short Term, Direct	**Short Term, Indirect**
Application Examples: • Container tagging • Automatic continuous inventory • Location tracking • Tagging medical equipment in a hospital environment *Benefits:* • Reduced labor cost Process change enabled labor redeployments • • Higher through put • Higher Enterprise wide accuracy	*Application Examples:* • Compliance with mandates via pallet and case level tagging • Compliance with TAV in international container shipping • Higher accuracy of availability • Exacting Governmental compliance • Process change-enabled labor reemployments *Benefits:* • Compliance with mandates • Preparatory work to derive direct benefit over time

Finding the Right Benefit Level

To make the right cost-benefit decisions an organization needs to look at its business environment and organizational readiness for innovation. Calculation of the benefits due to RFID deployment requires a compilation of the savings across the enterprise-wide business process. The proper calculation means breaking down the result into components. For example, in a container-tracking environment it is necessary to break down 'better supply chain visibility' into its components such as reduction in safety stock, reduction in (inventory) pipeline, reduction in service charges, administrative savings, and reduction in pilferage/losses.

In analyzing the ROI, it helps to think outside of the box. It is not sufficient to think of what items should be tagged. Rather it is important to describe the process items undergo and then to think about how a modified process would save money. Does the enterprise require field data? Do choke points exist where data can be obtained? Is pallet-level aggregation and tracking useful in addition to item level tracking? Is environmental data useful? Here is a brief list of some specific places to look for ROI:

- Labor intensive processes or processes with a bottleneck: Consider how RFID's non-line of sight capability or the ability to scan more rapidly, or even non-sequentially, can reduce the time required for various routine processes. Consider the ability to achieve singularity of tag reads as a means of improving the information gleaned. Active RFID enables both area and singular overages.
- Areas of product loss and high shrinkage. In this instance, can costs be shared?
- Tracking in rugged, harsh environments where bar-codes do not hold up. Especially true of outdoor usage. In fact, consider the cost of bar code replacement which is not a few cents. The total costs involve labor to find the item, ensure the correct replacement ID and re-entering the data into the system.

Since one primary benefit to RFID is asset visibility, a logical start is to focus on the order fulfillment processes. Anytime anyone touches a product, are they touching the right product for the right reason, at the right time, doing the right thing with it, and putting it in the right place? One company going through this process had facilities with more than 100 truckloads of outbound product per day, so their goal became to accelerate the order fulfillment processes. Another goal was to ensure that their customers are getting what was ordered with an even lower error rate than their current low rate.

But the challenge is not with putting RFID tags on every shipping container, pallet, and case traveling around the world. The challenge is building the systems that make decisions based on asset visibility events. Such events occur not only in your own company's supply chain, but in your trading partners' supply chains, and all the ripple effects those events create.

One difficult to measure, yet common by-product of most RFID compliances is brought about by the people doing the work. The longer they have been there, the more ideas for improvement they have. Time and time again, once they understand how RFID technology works, they gain a new perspective on work process. The best ideas for RFID technology often come from 10-year operations veterans who are ready for a change for the better.

Now that the benefit considerations of an RFID deployment have been addressed, the decision maker will also need to address the cost issues involved.

Elements of Cost

The costs involved in implementing an RFID system can be broken down into three categories: hardware (tags, readers, antenna, and software); creation or upgrade of middleware and other applications, and services (installation, tuning, component integration, training, maintenance and support, and business process re-engineering).

Tag cost can be a considerable issue in an RFID deployment, as the actual cost of a tag depends on its configuration features and capabilities. With active RFID, tags should not be considered recurring cost as tags can last 5-12 years with indefinite re-use. If you can realize a $40.00/hour cost reduction over a year, then the savings amounts to $10,000.00 annually!

In a closed-loop environment the tags are re-used again and again, and so the initial cost of a tag must be factored in with the number of times or the number of years the tag will be used. So, for instance, instead of purchasing a 15-cent passive tag that can be used just once, a decision maker decides to purchase active tags at a cost of around 15 dollars each. Although the acquisition cost of the active tag is initially 100 times higher than its passive counterpart, the active tag can be used thousands and even tens of thousands of times, over a period of often more than ten years, which therefore brings the cost of the active tag down to just a fraction of what the passive tag actually costs.

Too often we have heard stories about the mythical 5-cent tag, and one can only wonder why so few industry experts until now have recognized the implicit tremendous cost savings tied to these types of tags and their applications.

If the decision to use active tags is taken at the enterprise level, then it is essential to plan for the growth of usage over a long time period. One way to realize the potential is too ensure that a single function tag is not considered. For example, if the usage first recognized is for a beacon tag which merely “transmits” once every several seconds, then it is likely that a reader to receive these signals can be purchased and installed at a very low cost. However, if the future applications may require that the readers be transceivers for bi-directional RF communications, then cost will increase only fractionally but the future is secured. Taking this even further, one installation incorporated beacon tags and then added bi-directional RF and then added WiFi connectivity. We strongly recommend that such fixed infrastructure decisions be made with the growth in communication needs accounted for at the beginning.

The consideration for mobile devices to enable operation at any point in the supply chain must also be considered at this point. For instance, the ability to retain bar code reads, to read/write data to tags, to obtain RF communications remotely, the ability to achieve singularity of operations as well as wide-area modality and the ability to affect either docked, WiFi or cellular data linkages should be considered. Some suppliers offer the totality of such operations by combining proprietary tag communications with ubiquitous PDT/PDAs.

Having installed fixed infrastructure the need for middleware/software must then be considered. Enterprises will often utilize third party providers for the maintenance of the database and IT apparatus. If this is the case, then the only requirement for the RFID provider should be the ability to provide a proper Software Interface Specification from which reader/data control can be realized. However, in the case where third party software is not installed and running it is essential to purchase the system with the essential data and protocols inherent in the system. Such basics would include the tag, reader, interrogator/trigger ID, time and date stamp and data payload. Be sure and factor in the cost of software licenses and data/tag recurring costs which will not be offered up front by all suppliers.

ROI Case Study

A global Enterprise needs to reduce enterprise-wide costs while increasing the accuracy of its database. The products used generally survive 10+ plus years of life and are therefore reusable.

- **ROI bar code replacement**: this system employs one or more bar codes to currently implement the tracking of assets. These bar codes need to be read in direct sunlight (requires 1-25 attempts) as well as in freezing temperatures in which human operators cannot sustain long durations. A primary consideration of all bar coded schemes for asset tracking is the requirement to replace the bar codes as they are damaged in every day use or completely removed. Most people do not realize the cost of bar code replacement considering this cost to be restricted to the actual paper cost of $0.01. This is fallacious. The first cost incurred is the actual cost of a paid employee to find

the item, print and affix the correct bar code and return for yet another assignment. This cost is equal to your employee hourly rate x company overhead rate x actual time spent. A typical cost is $15.00/hour x 200% x .25 hours = $11.25. But a more sinister cost is lurking in this simple example. If an error is made and the incorrect bar code is assigned to the item, and that item is delivered to the correct customer but is the incorrect material, the cost can be immeasurable.

By simple measures the ROI for an active RFID tag to replace a bar coded item is: replacement costs x frequency of replacement x cost of an error = $11.25 x 4 x priceless.

- **Automatic inventory**: this attribute has several sides to it. It is often necessary to gather inventory in a warehouse or staging area so that the precise quantity and type of item are known. By installing infrastructure mounted read/illuminator combination units, an inventory can be obtained without any human intervention. The inventory is simply scheduled periodically via a network or conducted at will remotely thru the network or it can be obtained manually by a person walking the inventory and "triggering" the RFID tags. Note: in this mode the resulting RF responses are simply "filtered" to be correlated with the infra-red trigger assembly used to trigger the tags for inventory. It should also be noted that an approximate location is generated in the automatic inventory mode as the tags respond with not only their ID but the trigger ID as well. The trigger ID is correlated with its fixed location. The ROI for this capability is determined by less tangible measurements. For instance, knowing what is in inventory and where it is located can be measured in terms of eliminating human methodologies which it replaces. In this case the ROI would be: Hourly rate x overhead rate x hours spent = ROI. This might be $15.00 x 2 x 8 hours = $240.00/ inventory. However what is missing here is the cost of human errors (rare but they do occur), Once again the error accuracy cost is priceless.

- **Find functionality**: This capability is best explained by imagining that an enterprise has over one thousand items in the warehouse and seldom more than 20-100 are of interest. The problem is to determine which of the 100 items the correct items are and which are of no interest. If the only method is bar code scanning then cost is very high as all 1000 items could potentially be scanned before locating the correct 100 the employee needs. Now imagine a scenario where the overhead infra-red illuminators are commanded to "search" for a particular data field such as "30-inch wide screen TV with DVD". In this scenario the RFID tags corresponding to the search for data field begin to blink the visible LED, thus enabling the operator to quickly, easily and rapidly isolate 100 items from a field of 1000.

  The ROI in this example could be: hourly rate x overhead rate x hours spent manually scanning bar codes. $15.00/hour x 2 x 8 hours x 260 days = $62,400.00/year

- **Issue/Receipt**: In this example the tagged items are in constant motion between customers and enterprise. When a driver prepares a shipment he can select the items by "triggering" each tag with laser precision. Each item is then automatically checked against a delivery order on the PDT. Upon delivery the driver executes the reverse action and can print a precise delivery ticket. Upon delivery the items are placed in a reception area where a fixed overhead reader/illuminator "reads" the items and notifies the customer automatically that the requested and invoiced items are in place at the receiving area. This action ensures accuracy, timeliness and enables virtually instant use of the items delivered. A true "Just in Time" system can be implemented.

  The ROI in this example is difficult to estimate since the benefits are not just in process time improvements but priceless in terms of accuracy and customer satisfaction. An element of competitive superiority is generated which will result in increased business.

- **Quality Assurance**: This attribute results from the automatic record generation and verification that a manufacturing process has been conducted properly. As an example, if an automotive assembly is being processed it requires that certain details be accomplished at each process location. By having such an active tag in each vehicle and an infra-red trigger located at each processing step, then a record of the vehicle/the process performed and the technician performing the process can

be automatically gathered and entered into a database. If the incorrect process station is being utilized the tags can automatically issue an “alert” preventing incorrect operation.