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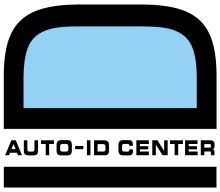

WHITE PAPER

Change Readiness Guide: Project Management Edition

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ABSTRACT

An Auto-ID implementation involves many areas of an organization. Most often, these areas are complex and involve intricate relationships within the various functional and technical groups in an organization. When preparing for an Auto-ID implementation there are many considerations a company must review. The project manager, who is ultimately responsible for the success of the project must have a comprehensive understanding of the impact Auto-ID technologies will have to the organization, its processes, and people.

The purpose of the Change Readiness Guide is to act as a guide for project managers as they prepare for their Auto-ID implementation. This guide will assist in assessing the change readiness of their organization for Auto-ID, as well as outline potential operations, functional, and technological considerations. The guide also provides a few basic project management tools specific to Auto-ID.

This guide is a tool and will be revised periodically with gathered experiences of implementations. This version of the change readiness guide primarily focuses on the supply chain. A further version may expand to applications outside of the supply chain. If you have any suggestions or comments, please contact the Auto-ID Center.

WHITE PAPER

Change Readiness Guide: Project Management Edition

Biography

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Sandra Gross is PhD student at the University of St. Gallen, research assistant for the Institute of Technology Management and for the M-Lab. She holds a master degree in informatics (computer science) from the University of Karlsruhe and was working for SerCon, an IBM service and consulting company, before she joined the M-Lab. Her work at the Auto-ID Center focuses on adapting new technologies and product lifecycle management.

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Joyce Lo leads the Auto-ID Center's Business Case Action Group. The group is charged with examining the business benefits of Auto-ID applications that will ultimately drive the adoption of Auto-ID standards and technology. Joyce has spent over six years consulting as a project manager and change agent in various ERP and eMarket implementations and other transformational initiatives. She specializes in the consumer goods sector and more recently focused on supply chain management. Joyce received her undergraduate degree in accounting at the University of Illinois.

WHITE PAPER

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Contents

1. PURPOSE OF THE PAPER

The **Change Readiness Guide's primary objective** is to act as a handbook for the Auto-ID project manager. This paper highlights some of the important considerations when beginning to implement Auto-ID. It helps to organize the intricate components of Auto-ID and outlines the areas directly and/or indirectly touched by Auto-ID in a given company – both cross-organizationally and cross-functionally. The templates and considerations provided are on a generic application level making it relevant to most pilots and/or Auto-ID applications. The project manager may accept or customize the information that is provided here. Since many Auto-ID implementations and pilots are underway, this guide will be updated periodically as new learnings are developed.

This paper is specifically **addressed** to the Auto-ID project manager, whose sole responsibility is to successfully implement Auto-ID for a given application or area within his/her organization.

This paper **assumes** the following:

1. A positive business case has been established and accepted for a given Auto-ID application.
2. The project has been approved and funded.
3. The business benefits and performance metrics are clearly defined.
4. The Auto-ID project manager has comprehensive knowledgeable of Auto-ID technology.
5. The implementation team has began to be assembled.
6. Objectives, critical success factors, and a work plan are being assembled.

Each of the **following five chapters** highlights certain aspects specific to an Auto-ID implementation. Within the chapter, there is a subject introduction, possible tools and/or deliverables, and additional considerations. The appendix (chapter 6) covers some considerations for Auto-ID technology that are more technical in nature and should be referenced by an individual who has a deeper understanding of applications and RFID.

First, chapter 2 outlines specific **project management** considerations when beginning an Auto-ID implementation including the project scope, assembling an Auto-ID team, and the project's cross-organizational and functional challenges.

The Auto-ID project manager is responsible for implementing a large scale change that will impact many areas of the organization. It is the suggestion of this guide, as outlined in chapter 3 to implement a change management program, by facilitating **commitment** in your organization, communications, and training. More information on change management programs can be found in Lo's 'The Auto-ID Transformation'.

Chapter 4 continues to show how Auto-ID may effect some of the supporting **business processes** throughout your company and your trading partners. The process most reengineered due to the Auto-ID implementation is not regarded in this chapter as those changes are already outlined in the business case.

The **Auto-ID technology** components crucial for the implementation are briefly discussed in chapter 5. It is important for the Auto-ID project manger to be familiar with the different components of the technology. Vendor selection is also discussed in this chapter.

2. PROJECT MANAGEMENT

This chapter concentrates on the assembling of the **Auto-ID team**, the evaluation of the **project scope**, and finally a few specific **Auto-ID challenges** and suggestions on how to handle them. Other management tools like rollout strategy, work plans, budget, or key success factors are subject to further editions of the Change Readiness Guide.

2.1. Auto-ID Team

Selecting the Auto-ID team should be done with careful consideration. Since Auto-ID experience may not be readily available from earlier implementations, the Auto-ID project manager will need to consider who he will need from inside the organization, who he may need to hire or train, and what subject matter experts or outside contractors are needed to complete the implementation.

When assembling the team, a **core team**, and an **extended team** should be considered:

The **core team** will be full-time who's sole day-to-day responsibility is managing and delivering the new Auto-ID system. Depending on the size and complexity of the implementation the management of the core team, at a minimum, should be comprised of the following people with the appropriate skillsets as described:

- **Auto-ID Project Manager:** The Auto-ID project manager must have large-scale implementation experience and extraordinary good project management experience and should be knowledgeable of the Auto-ID components.

- **Change Manager:** The change manager should be experienced in process reengineering projects, change management, communications, and some level of organization design.

- **RFID Engineer(s):** The RFID engineer must be familiar with RFID infrastructure and hardware such as readers, tags, their attributes and purchase, installation and use. He should have RFID implementation experience and be familiar with the Auto-ID network infrastructure.

- **Data Applications Manager:** The data applications lead should be well versed in the product markup language (PML) and in the data models affected by the Auto-ID application. He will lead the integration of Auto-ID data into existing business information systems (BIS).

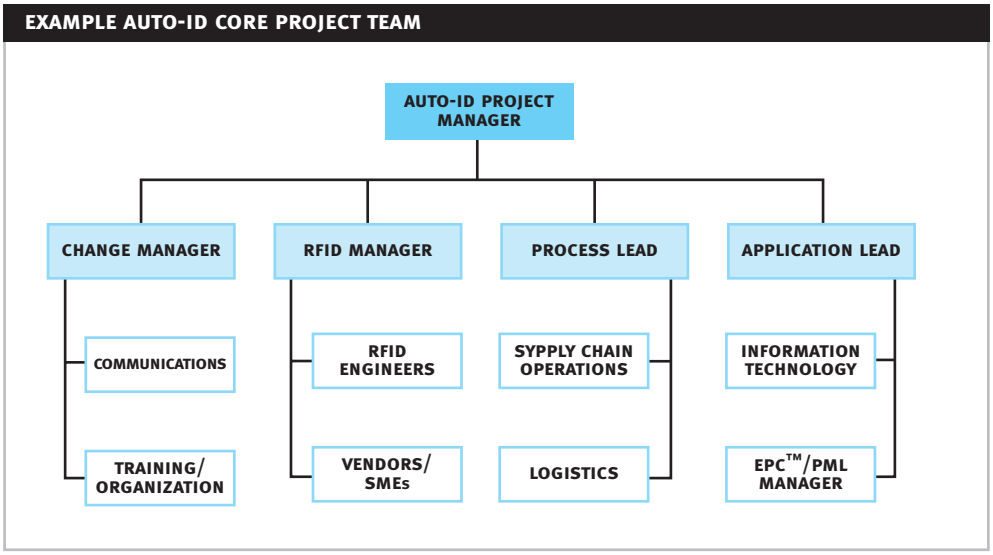
- **Process/Operations Lead:** The process/operations lead will be dependent on the business benefit selected. For instance if you are implementing an Auto-ID system for supply chain track and trace, you should have a supply chain lead who is familiar with your entire supply chain.

- **Subject Matter Experts:** They should possess hard specification knowledge such as antenna or package design and can come from selected technology vendors.

- **Others:** Other members of the team will be selected based on the scope of the project as defined by the Project Manager and Leads.

Figure 1 illustrates an example of an Auto-ID core project team for a supply chain management project.

Figure 1: Example Auto-ID Core Project Team



The **extended team** will be comprised of individuals who either have functional or operational responsibilities that will be affected by your implementation. The team can also consist of subject matter experts outside of your company, trading partners, or other individuals. Their expertise is used only when needed.

The extended team may include a:

- Packaging Expert,
- Operations Expert,
- Quality Manager,
- Director of Information Technology,
- Sales Representative,
- Marketing Representative,
- Human Resource Representative,
- Legal Representative,
- Vendors,
- Customers,
- Other Trading Partners,
- R&D Representative,
- Transportation Expert,
- Technology Partner.

2.2. Project Scope

The desired business benefits will have already been established in your business case. Based on the benefits described in the business case, it is the responsibility of the Auto-ID project manager to define the scope of the Auto-ID implementation.

The scope of the project will be defined by:

- the applications selected,
- inter/intra – organizational dependency,
- local, regional, national, or global implementation, and
- the level of system integration (local, operational, or enterprise systems).

How Auto-ID is rolled-out within a company will be dependent on the scope of the project. As more applications are added, we expect the shared costs of Auto-ID to be more distributed while the benefits increase.

2.3. Auto-ID Challenges

There can be many unexpected challenges when installing a new system. Through our interviews and the experience of Auto-ID sponsors, we have compiled an initial list of some of the challenges you may face, as well as common risks that occur during a project. Figure 2 lists some of the potential challenges and suggested actions.

Figure 2: Special Auto-ID Challenges when adopting Auto-ID

SPECIAL AUTO-ID CHALLENGES	ACTION PLAN
Not all of your suppliers, trading partners, and customers use Auto-ID in the value chain. Also, not all objects in the same application are tagged. For instance, there are tagged and non-tagged pallets in your warehouse.	Define a plan that incorporates legacy and new system needs. Work with trading partners on what the implications of the new technology are.
Bar code and Auto-ID will co-exist.	Understand interference issues and solutions, how the two systems will interact with one another, and where the two systems may be repetitive.
Auto-ID will replace bar code for object identification.	Create a transition plan for replacement.
Cross-organizational challenges in the style of [Relevant 2003]: – Security by company, – Multi-company access to data, – Shared databases but separate records by company, – User-defined company and department assignment, – Separate vendors by company, – Separate customers by company, – Separate and consolidated financial statements.	Define the role of each trading partner and the data confidentially levels in advance. Implement overall functions as forecasting or scheduling, which will work out for every trading partner.
Consumer privacy concerns	Stick to privacy and security standards promoted by the Auto-ID Center and the UCC. For further information refer to [Sarma et al. 2003].

2.4. Additional Considerations

- What and when are internal/external resources available for the Auto-ID project?
- How will your core team be trained with general Auto-ID knowledge?
- What abilities do you have to hire outside contractors if internal resources do not fulfill the skillsets needed for successful implementation?
- What subject matter experts (SMEs) can you leverage from your vendors?

3. COMMITMENT

Auto-ID is a revolutionary technology. It could change how your current company operates and has the potential to impact a number of key processes and personnel. It is important that the Auto-ID project objectives, goals, impact, and timing is well communicated so that your project does not become disruptive to the other areas of the business or your trading partners' businesses. This chapter walks through the types of **internal and external support** needed and the role of communication in order to **facilitate the commitment**.

3.1. Internal and External Support

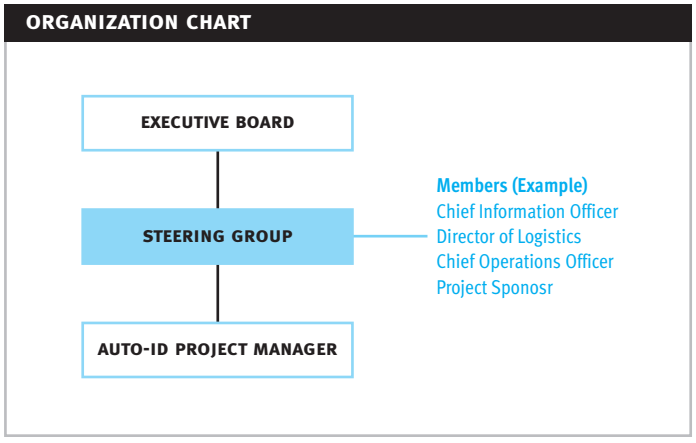
The Auto-ID project manager has to ensure the ongoing support of the **internal organization** and all **external organizations** which will be effected by Auto-ID.

3.1.1. Internal Organization

Assuming that you have a business case established and approved, you have already received initial support from your Board. It will be important, to periodically update your Board throughout the life of the project, as described in subchapter 3.2.

More importantly, you will need the support of the executive management team to ensure cooperation throughout the life of the project. Since Auto-ID is a system wide implementation, various aspects of your executive managements' areas will be affected. The areas which will be most effected by Auto-ID should belong to the **steering group**. How the Executive Board, the steering committee, and the Auto-ID project manager interact is shown in figure 3.

Figure 3: Organization Chart

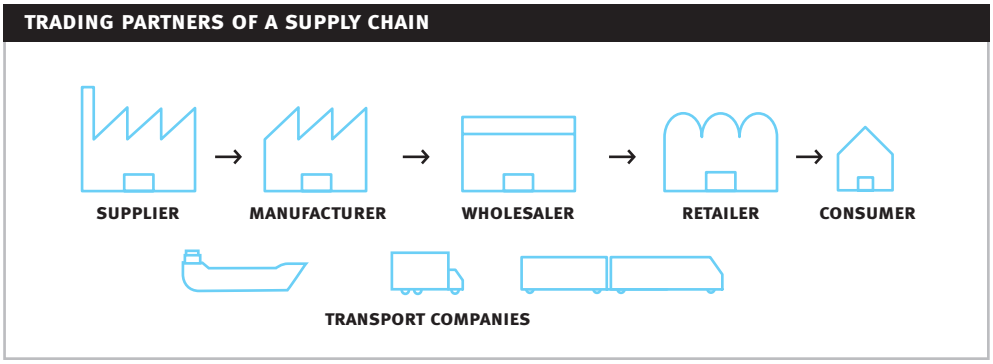


3.1.2. External Organization

When the Auto-ID implementation is extending beyond the four walls of the internal organization, it is important to have a clear agreement with the effected partners in the value chain. Figure 4 is an example of a simplified supply chain with just one instance of each partner type. Typically, there are multiple suppliers, manufacturers, etc. involved.

The Auto-ID project manager should start his cross-organizational Auto-ID efforts with selected trading partners. He will need to agree on timing, requirements, and clearly define individual and shared responsibilities regarding resources, costs, data, and other specific Auto-ID requirements. The participating trading partners should also be clear and knowledgeable of the Auto-ID standards.

Figure 4: Trading Partners of a Supply Chain



3.2. Facilitating Commitment

The success of the project will not only be dependent on the successful installation of the technology, but also the cooperation and support of the organization. To ensure the lasting support of stakeholders – the individuals who can have a positive or negative impact on the success of the project – the Auto-ID project manager or change manager must carefully manage all **stakeholders**. A thorough understanding of the stakeholders coupled with a targeted **communication strategy** will enhance the project success.

Since there will also be organizational changes, roles that will be impacted will need to be redefined in the organization. Some roles will also need to be defined as there will be new opportunities to manage the new technology. For instance, there may need to be an EPC™ manager or full-time RFID engineers who are responsible for the running and maintaining of the new Auto-ID technologies. It is important to plan ahead and work within your HR policy. Other individuals will be minimally impacted, however may need to be trained to operate within the new Auto-ID environment. A **training concept** will need to be developed to ensure proper execution of the new technology.

3.2.1. Stakeholder Groups

The Auto-ID project manager should first identify the areas in his company that are directly or indirectly affected by Auto-ID. Once the stakeholders are identified, a stakeholder management tool as shown in figure 5 can be used to manage their support. In order for the tool to be useful, it will need to be updated regularly. By analyzing relationships, opportunities and threats, the Auto-ID project manager will be able to create action plans (i.e. a communication plan) to gain support for the project.

Figure 5: Example Stakeholder Management Tool

STAKEHOLDER GROUP	NAMES	LEVEL OF INFLUENCE	LEVEL OF SUPPORT	LEVEL OF REQUIRED SUPPORT	ACTION
Executive Board					
Steering Committee					
Auto-ID Project Team					
Operations					
Operational Staff					
Customers					
Suppliers					
Other					

3.2.2. Communication Strategy

The communication strategy consists of the **communication messages**, the **communication plan**, and a formalized way of integrating **feedback** about the Auto-ID project.

The **communication messages** must include the Auto-ID benefits known from the business case to the appropriate stakeholder groups. They must be customized to the appropriate stakeholder group – some examples can be found in figure 6.

Figure 6: Auto-ID Benefits in a Supply Chain

BUSINESS BENEFIT	DESCRIPTION	COMMUNICATION MESSAGE	MESSAGE IS CUSTOMIZED FOR STAKEHOLDER GROUP
Reduction in Inventory	The ability to reduce excessive inventory held due to lack of inventory and demand information visibility. This can be achieved by increasing the accuracy of real inventory at hand (in contrast to information on available inventory from information systems).	The implementation of Auto-ID technology will deduct our company's inventory level , thereby reducing total inventory cost significantly.	Executive Board
Physical Inventory Counting Efficiency	Labor cost savings of not having to physically count inventory.	Auto-ID technology will reduce the labor costs significantly as it will minimize the need for physical inventory counts.	Executive Board
Shipping Efficiency and Accuracy	Matching goods and the quantity of goods to exactly what was ordered and the terms of sale. Increased efficiency and accuracy safeguards against the incorrect shipment of products that would lead to direct losses associated with shipping products not ordered.	Auto-ID technology speeds up the shipping process, saves time for checking and correcting outgoing deliveries, and increases the accuracy of deliveries. The technology will also be able to better predict demand allowing our orders to be more precise.	Suppliers
Improved Stock Visibility	The ability to see backroom inventory levels, so that restocking/replenishment can be performed quickly and effectively.	Auto-ID technology will help enhance your work by making it easier for you to search for products in your facilities.	Operational staff
Reduction in Out-of-Stock	When a product is not present for a consumer to purchase. An out-of-stock is equivalent to a lost sale.	By implementing a new technology products will be on the shelves and available for purchase.	Consumers

In order to handle expectations of Auto-ID both internally and externally throughout the duration of the project the Auto-ID project manager should establish a **communication plan** as shown in figure 7.

Figure 7: Sample Communication Plan

STAKEHOLDER GROUP	MEDIUM	OBJECTIVE	CONTENT	FREQUENCY
Executive Board	Presentation	Ensure their ongoing support	Status report	Every 6 months
Executive Management	Information Workshop	Ensure their ongoing support	Auto-ID business benefits	Every 2 months
Steering Committee	Meeting	Enforce decision making	Required Auto-ID resources	Monthly
Operational Staff	Leaflet	Promote Auto-ID benefits to ensure acceptance and cooperation of the new system	Promoting Auto-ID benefits in their daily work	Once a month
Key Customers, Key Vendors	Report	Notify customers and suppliers of changes, in order for customer and/or vendor to comply with new system.	Interface description and process changes	If required

The communication strategy should also include a formalized way of receiving **feedback** from certain stakeholder groups about the Auto-ID project. Facilitating commitment at the operational level will be especially important as they will be the group most affected. The change manger should work closely with the operations managers by using feedback to make sure that commitment is being facilitated at this level of the organization appropriately. Using an FAQ (Frequently Asked Questions) throughout the organization is also recommended as it will keep messages about the implementation consistent.

3.2.3. Training Concept

The training concept is targeted to stakeholders whose jobs will be impacted by the new technology. Certain employees will need to learn how to operate in their new environment. Objectives and training modules will be individually defined per stakeholder group. For example, the operations managers and the operational staff should be trained for devices, software, and applications.

The **training program** may consist of train-the-trainers, in-house training staff, third parties, or the project team. The trainers are responsible for the training methods, materials, and learned success control. They should have experiences with change management and be sophisticated in the Auto-ID technologies according to their trainees' needs.

The training **roll-out schedule** has to account for the fact, that the training concept has to be established before the completion of the Auto-ID project and that the training should accompany the whole duration of the project and longer. It must cover to teach the abilities for setting up the Auto-ID applications, running and maintaining them.

3.3. Additional Considerations

– Are the Auto-ID project team and all stakeholder groups clear about the project's objectives and goals?
– Are metrics to measure project performance established?

4. BUSINESS PROCESSES

A careful process re-engineering with Auto-ID is of paramount importance as Auto-ID involves the coordination and standardization of tasks and functions in multiple departments and companies as already described in figure 2. Operational process changes were already examined in the business case however, the supporting processes should also be examined if subject to change or enhancement due to the installation of Auto-ID.

4.1. Business Process Changes

Figures 8 through 15 illustrate some of the potential impacts Auto-ID may have to supporting processes. After making a full assessment of what processes will be effected, the Auto-ID team and the appropriate process/system individuals should work together for seamless integration.

Figure 8: Financial

TASK	CHANGED OR NEW FUNCTIONS	CONCERNED DEPARTMENTS (INTERNALLY & EXTERNALLY)
Billing	Implementation of an automated reorder system with Auto-ID to establish Just-In-Time: the supplier now takes charge of the complete C-Parts-Management and contracts with the sub-suppliers so that the company just has to pay accumulated bills instead of separate bills.	Finance
Orders	Automated order assembling at the distribution center.	Finance

Figure 9: Marketing and Public Relations

TASK	CHANGED OR NEW FUNCTIONS	CONCERNED DEPARTMENTS (INTERNALLY & EXTERNALLY)
Relations	Extension of the marketing communication plan to the public, trading partners, customers and consumers by – communicating Auto-ID benefits , – informing about the Auto-ID project progress, – clarifying proactively privacy concerns, – formulating your interests in adopting Auto-ID e.g. image, innovation or technology enabler.	Public Relations

Figure 10: Sales

TASK	CHANGED OR NEW FUNCTIONS	CONCERNED DEPARTMENTS (INTERNALLY & EXTERNALLY)
Forecasts	Define data requirements and data aggregation levels for automated forecasts.	Sales, sales representatives

Dealing with privacy concerns at the sales floor	Deploy extra measures as:
	– communicate that the tag is killed after selling the product,
	– keep an active dialogue with the consumer e.g.
	  – put up signs in the store which explain the killing of the tags,
	  – extra product labeling,
	– explain how the consumer can access to his profile and activity protocols,
	– ensure privacy security objectives as data security, data confidentiality, access control, availability, and reliability,
	– ensure and communicate that the collected data is just used for its original purpose and that secondary usage is prevented.
		Marketing, Retailer, Package vendor (for extra product labeling)

Figure 11: Manufacturing

TASK	CHANGED OR NEW FUNCTIONS	CONCERNED DEPARTMENTS (INTERNALLY & EXTERNALLY)
Material waste	Optimized container management	Operations, Suppliers
Tool Management	Automated tool tracing or smart tool dispensers	Operations, Tool Vendor

Figure 12: Human Resources

TASK	CHANGED OR NEW FUNCTIONS	CONCERNED DEPARTMENTS (INTERNALLY & EXTERNALLY)
Personnel Management	Define new roles and decide if they have to be hired: – facility manager checking the Auto-ID relevant areas in a regular time frame, – EPC™, ONS, and PML manager, – experts e.g. in RFID, SCM, business systems integration.	Human resources, SME

Figure 13: Legal

TASK	CHANGED OR NEW FUNCTIONS	CONCERNED DEPARTMENTS (INTERNALLY & EXTERNALLY)
Privacy Policy	Establish a privacy policy dealing with Auto-ID, which sticks to the UCC/Auto-ID privacy policy.	Legal department internally, legal departments of your suppliers and customers, as they have to stick to the policy as well.
Legal Regulation	Ensure, that you comply to legal regulations such as: – track & trace laws, – legal regulations of transmitting power & frequencies, or – data protection.	Your organization, your trading partners

Figure 14: Supply Chain Management

TASK	CHANGED OR NEW FUNCTIONS	CONCERNED DEPARTMENTS (INTERNALLY & EXTERNALLY)
Check-in and check out	No manual read anymore, because the fork lifter passes the read locations, and the system is automatically updated.	Operations
Order tracking	Automatic match between load and electronic order.	Operations, Transport Company
Inventory management	Part and product tracking in the warehouse instead of manual inventory counts.	Operations

Figure 15: Customer Relationship Management

TASK	CHANGED OR NEW FUNCTIONS	CONCERNED DEPARTMENTS (INTERNALLY & EXTERNALLY)
Recall	Simplified search for retailers and customers.	Reclamations department, retailers, marketing

4.2. Additional Considerations

– Are business process and specific IT system resources secured to make changes to the current system?

5. AUTO-ID TECHNOLOGY

A major requirement for the upcoming Auto-ID implementation is that all company Auto-ID applications (worldwide) should be compatible (e.g. frequency and data models). This will help you to use tagged objects cross-organizationally and within different application scenarios.

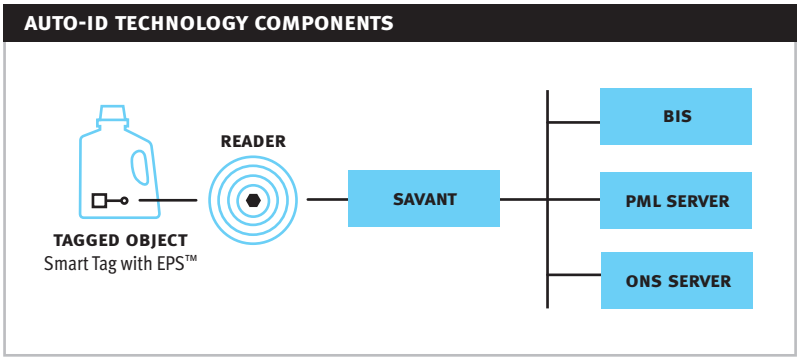
For the specific pilot or Auto-ID application the Auto-ID project manager needs specific vendors that are knowledgeable of the Auto-ID technology. In order to be able to choose them, chapter 5.1 briefly describes the **Auto-ID components**. Based on your individual requirement and or each Auto-ID implementation you will need specific **technology vendors**, which will be discussed in chapter 5.2.

5.1. Auto-ID Components

The description of the Auto-ID Components is based on [Auto-ID Center 2003]. For more specific information on each of the Auto-ID components, please visit the Auto-ID website at **www.autoidcenter.org** under research.

Figure 16 shows how the Auto-ID technology components interact (in the style of [McFarlane 2003]).

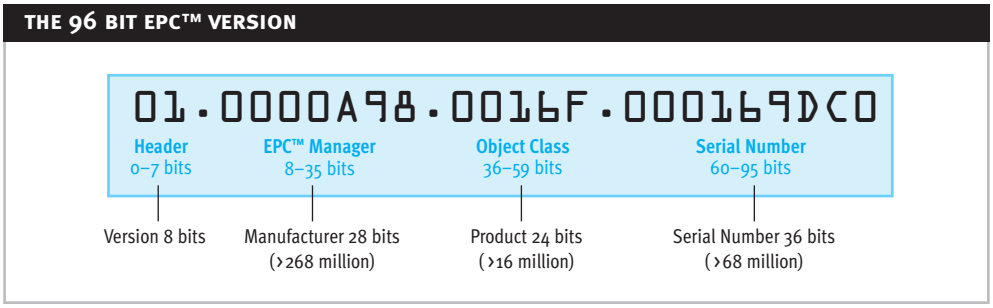
Figure 16: Auto-ID Technology Components



5.1.1. Electronic Product Code™ (EPC™)

The EPC™ uniquely identifies a tagged object. The code is stored on the tag, which is attached to the object. The EPC™ is a number made up of a header and three sets of data, as shown in figure 17. The header identifies the EPCs'™ version number – this allows for different lengths or types of EPC™. At the moment there are the 64 bit, the 96 bit and the 256 bit version available, depending on the size and cost of the used tags. For more information about the EPC™ versions please refer to [Auto-ID Center 2003]. The second part of the number identifies the EPC™ manager – most likely the manufacturer of the object the EPC™ is attached to. The third, called object class, refers to the exact type of object, most often the stock keeping unit. The fourth is the serial number – this allows each object to be uniquely identified.

Figure 17: The 96 bit EPC™ Version



For further information e.g. refer to [Engels 2003], [Brock 2002a], [Brock 2002b].

5.1.2. Savant

The readers pick up a continual stream of electronic product codes. The software technology Savant will distribute the data across the network and is organized in a hierarchy that manages the flow of data. For further detail about the tasks of Savant, please refer to [Auto-ID Center 2003].

On top of the Savant you will also need additional configurable software, that incorporates logic into the RFID data. This software converts the data into business events that can then be used and integrated into business information systems. For further information on Savant e.g. refer to [Oat Systems 2002], [Goyal 2003].

5.1.3. Object Name Service (ONS)

To fulfill its task, the Savant sends a query over the Internet to an Object Name Service (ONS) database, which acts like a reverse telephone directory and provides the PML server address, on which the objects

information resides. ONS is a directory service similar to the Domain Name Service (DNS). As ONS will have to handle a lot of requests, probably in real time or near real time, companies will need to maintain ONS servers locally.

5.1.4. Product Markup Language (PML)

With the help of ONS, Savant can retrieve the PML information of the tagged object from the appropriate PML server. PML information will be represented by the objects' characteristics and movements, which are essential for the business information systems.

Your company will need to maintain a PML server for all your manufactured objects. It allows your organization to trace the history of a tagged object through distributed databases. So it is possible to access the object's history throughout the whole supply chain. For further information e.g. refer to [Harrison/McFarlane 2003].

5.1.5. Business Information Systems (BIS)

Certain process changes may need to be integrated into existing business information systems (BIS). Depending on the applications selected, the level of integration can occur at an operational or enterprise wide level. Since Auto-ID technology will allow companies to have more information about the location of their products real-time, quicker benefits may be achieved at the operational level while even more benefits may be achieved by integrating data into ERP systems.

The level of system integration can be as low as minor configuration changes to current systems or system reengineering projects due to changes in business rules or data collected. The integration could be a new project by itself. Based on conducted interviews with some Auto ID Center sponsors (technology vendors and end users), we expect that the business information systems that will need to be adapted include:

- Human resource systems,
- Asset management and tracking,
- Financial systems,
- Decision support systems,
- Logistic systems,
- Manufacturing execution systems,
- Supply chain planning and execution systems,
- Transportation systems,
- Collaboration planning,
- Product catalogues,
- Forecasting systems,
- Retail systems,
- Distribution systems,
- Enterprise resource planning systems (ERP),
- Sales systems,
- Warehouse management systems,
- Inventory systems ,
- Ordering systems.

5.1.6. Tags

In our discussion of tags, we only reference passive RFID tags as they currently comply to the cheap tag requirement [Sarma 2001]. Of course, Auto-ID technology can also be applied to more active identification systems.

There are many components to choosing the right vendor for your specific requirements. The following figure outlines some of the tag requirements you should be most concerned with. The appendix provides more technical details such as read range.

Figure 18: Tag Requirements

TAGS MUST ...
– be able to be affixed on objects with minimal disruption to packaging and/or branding, – have the appropriate read range for the application, – have as much bits as necessary to store the electronic product code of the object, – be Auto-ID compliant.
TAGS SHOULD...
– be independent of the readers, – fulfill other application dependent requirements such as de-active-ability.

5.1.7. Readers

The reader hardware detects the tags through the presence and unique identity of the tag. In order for the application of the new technology to be considered successful the reader must be able to recognize the tag and transmit the location and identification information.

The readers consist of a case, electronics, the power supply, and the antenna. Certain reader requirements depend on the physical layout of the facility – these components are described in the appendix. Figure 19 describes the reader requirements which are not physically influenced.

Figure 19: Reader Requirements

READERS MUST ...
– ensure tag protocol compatibility, – have a configurable reader set-up, – stick to the legal regulations of all relevant countries regarding transmitting power levels & frequency, – fulfill the requirements regarding performance, read-range, read-speed and software interface, – use and open protocol between reader and tag (Auto-ID compliant).
READERS SHOULD...
– be independent of the software vendor, – be pre-configured.

5.2. Technology Vendors

The Auto-ID project manager should carefully choose the technology vendors. The **tag** and **reader vendors** should work closely together and adhere to all the Auto-ID open protocol standards. Assuring open protocol will allow your hardware to work in a plug and play manner. For large scale applications (such as tagging a huge quantity of products in retail), it may be necessary that the tag vendor delivers huge quantities of tags in a short period of time. It is also important to know if your tag vendor prefers to work with preferred antenna providers and packaging companies. The customizing of the tag and the integration into the package should be done in a cost efficient manner and most importantly in a minimally disruptive way.

If a large scale business information **system integration** is necessary, you may want to consider system integrators. System integrators should have knowledge of Auto-ID, RFID, and the intricacies of the system that you will be integrating with.

In order to assure open protocols and standards of hardware and software, there are a number of vendors who have products following Auto-ID specifications. To ensure standardization please ask your vendor if they are compliant to Auto-ID standards.

5.3. Additional Considerations

- Which security measurements do you have against counterfeit tags and readers?
- What, if tags get damaged? If it can't be tolerated, do you have error handling processes? One work-around would be to print the EPC™ codes additionally to the tag onto the packaging.

6. APPENDIX

The appendix includes considerations for the Auto-ID project team members specifically the data applications manager and the RFID manager. This section includes specific technology considerations, which are of secondary relevance to the Auto-ID project manager and may elaborated in further editions.

6.1. Considerations for the Data Applications Manager

The data applications manager will be charged with integrating Auto-ID from a data point-of-view. The following considerations were based on interviews with Auto-ID sponsors and are posed in a question format for review by the data applications manager.

6.1.1. Events and Tasks

- Did you determine where and which data needs to be written on/read from the tag and by whom?
- Did you specify the rules that create the workflows, based on the read data?
- Did you define the business rules based on Auto-ID data?
- Do you know which reporting rules you have to establish? For instance, do you want to have reports on real time inventory by
  - location,
  - shipment information,
  - alert on theft or out of stock,
  - status of devices and applications?
- Did you define example reports? The authors [Albano/Engels 2002] defined a sample report structure based on reader data from the Auto-ID Field Test .
- Do you have an archiving concept?

6.1.2. Data Application Requirements

- Did you specify the object information that shall be described by the Product Markup Language (PML)?
- Do you know which applications need to see Auto-ID data?
- Do you know what data you need to support your business processes and decision-making?

6.1.3. Data Aggregation and Data Paths

- Do you know exactly how the collected data will have to be interpreted, managed and filtered? Probably your organizational structure will help you to define data aggregation paths and filter rules. Try to define which data must be collected at the store level and which data has to be stored at the various corporate levels. Please keep in mind, that the rules should also try to reduce the amount of transferred data.

6.1.4. Real Time Data Requirements

– Are your real time data requirements dependent on your data aggregation levels? For instance, for transportation of goods a batch of freight information every 3 hours may be sufficient. The theft prevention application could need time stamps about each tagged object every other second. Thus describe which data needs to be read how often and how fast the read speed has to be (real time, near real time).

6.1.5. Data Accuracy Requirements

– How high is the accuracy of object identification in your actual processes ? And which accuracy level do you want to reach with Auto-ID?
– Do you have an error-handling concept to handle miss reads in case the read detection rate of 100 percent is not reached?

6.1.6. Database Requirements

– Do you know what level, if any you need to do data-mining?
– How many data sets have to be written into the database at one time?
– Did you ensure scalability?
– Do you know what data from sensory devices such as RFID readers, barcode scanners, temperature, and weight sensors has to be integrated?

6.1.7. Application and Data Security

– Have you defined the **levels of confidentialities** that have to be maintained throughout the process? This means:
  – Did you specify what data and aggregation level must be protected?
  – Do you have a user concept for employees, customers, consumers, trading partners and competitors?
  – Did you identify trustable communication partners as EPC™ readers and how do you distinguish them from untrustworthy ones?
  – Do your tagged objects just communicate to authorized communication partners?
  – Did you secure the tag to reader security?
  – Is the data on the tags protected by encryption?

– Do you **protect your Auto-ID data** from unauthorized parties by securing:
  – all IT-applications which see Auto-ID data as servers (e.g. savant, fax, and WWW), databases, or E-Mail,
  – all networks which transfer Auto-ID data,
  – all IT-systems which see Auto-ID data as server supported networks, PC's, laptops, or mobile handheld,
  – all physical access points to Auto-ID data such as buildings, stores, or server rooms?

Have you thought through further **security concepts** such as data back-ups, server maintenance, virus protection, handling of security incidents, or personnel?

6.2. Considerations for the RFID Manager

The RFID manager has to understand all the technical details of the Auto-ID implementation. The manager should have an RFID engineering background and thorough knowledge of RFID infrastructure and installation.

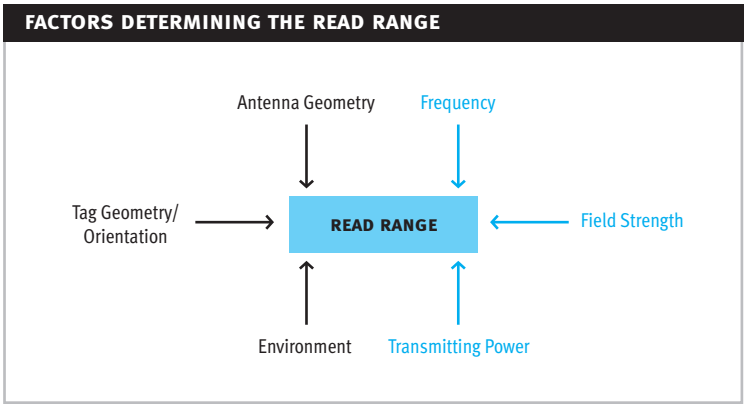
6.2.1. Read Range and Frequencies

There are multiple factors that influence the **read range** as shown in figure 20. Some of them are subject to legal regulation in different countries. This is important as your Auto-ID application will probably have to operate worldwide within your own global organization and with your trading partners.

Figure 20: Factors determining the Read Range

Influence factors which determine the read range

Influence factors which are subject to regulations



The **tag geometry**, especially the tag size depends heavily on the size of the object to be tagged. How the objects aggregated (such as on a pallet) determine the distance to the antenna and the **antenna geometry** and therefore the read range. **Environmental factors** are shielding, conductive metals such as metal, absorption, reflection, refraction, or penetration into liquids. Some **frequencies** are transmitting **power dependent** as the 915 MHz frequency.

6.2.2. Tagged Object

The Auto-ID implementation highly depends on the kind of tagged objects that are managed by the pilot or Auto-ID application. This chapter examines **object features** and defining management of the tagged **object's lifecycle**.

6.2.2.1. OBJECT FEATURES

The objects to be tagged for a particular Auto-ID application must be identified and classified. This must be done in order to determine the tag requirements as described in figure 21.

Figure 21: Object Features and their Implications

YOU NEED TO KNOW...	SO THAT YOU CAN...
all **object types**	define the technical requirements for each object type – there can be hundreds of individual objects of each type later
the **quantities** for the pilot, the first year of operation and the estimated quantity in the following 5 years	estimate which data volumes will probably occur and how scalable the application has to be
the **tagging level** you are addressing in your application, for instance, are you tagging individual objects, and/or containers, which contain tagged objects.	figure out, if your application includes hierarchies of tagged objects, which is important for distributing the right data (all tagged objects in a tagged container or just the tagged container information) in the network.
the **tagged object** value.	determine how much your tags may cost – high valuable objects allow more costly tags in order to fulfill the objectives of the business case.

Continuation of Figure 22

YOU NEED TO KNOW...	SO THAT YOU CAN...
special features, such as size, a rough surface, or if the object contains metal or water which could disturb the read process.	take special tags as shielded tags which reduce the problems caused by water or metal.
the **tag location and the tag arrangement,** which describes: – the exact position of the tag on the tagged object and how the tag is integrated in the object e.g. if it is integrated in the packaging, or in the product itself, and – the position of the objects towards the antenna.	fix the antenna geometry and the read range – the appropriate tag arrangement is tested in pilot implementations and often it can't be determined in advance.

6.2.2.2. OBJECT LIFECYCLE

The Auto-ID applications will be used to identify objects. Objects will have a life span and may be regarded at many stages in their life to gain the full Auto-ID benefits. In order to manage the object (not just at a single read location), figure 22 shows some tasks and management considerations throughout the whole object's lifecycle.

You should estimate if your object's life span is longer than your estimated tag life span and what this may mean for your application. For example, is re-tagging necessary and suitable, and how do you know when the tag is not functional anymore.

Figure 22: Example Tagged Object Lifecycle Management

TASK	WHO?	WHEN?	HOW?
Tag customizing	Tag vendor	Tag production	Programming
Tag affixing	Packaging dept. or company	Before delivering, just new objects (alternatively e.g. objects which are already in the process flow)	Integrated in the packaging (alternatively e.g. integrated in the product itself, detachable, non-detachable)
Object and tag recycling	Recycling company	End of live of tagged object	Tags are removed and parts of the object are re-used

6.2.3. Facility Management

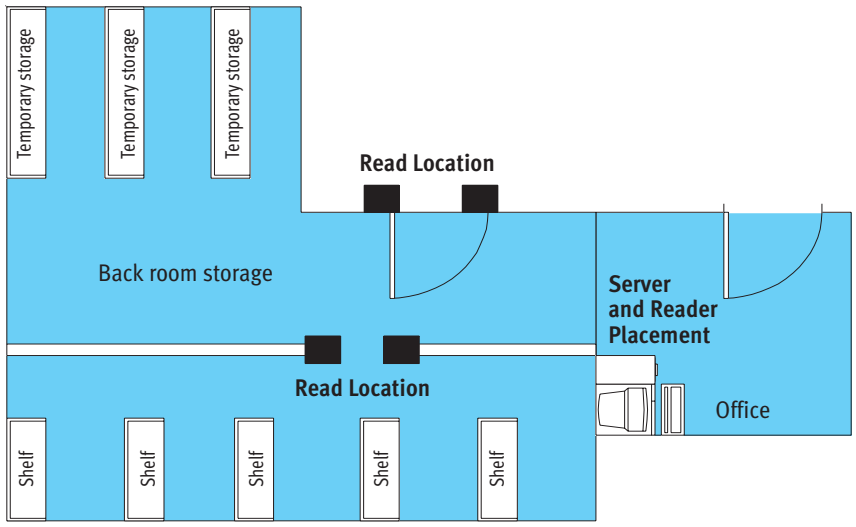
In order to set up, run, and maintain your Auto-ID application, it is important to identify and describe your Auto-ID application **read locations** in each facility. The physical layouts of all Auto-ID effected facilities and read locations have influence on the choice of the Auto-ID hardware and operating processes. Influence factors usually originate from existing applications, which cause **interference, antenna features**, the **antenna to reader connection** e.g. cabling, the **power supply**, and the **network capability**.

6.2.3.1. READ LOCATIONS

In order to manage your new Auto-ID infrastructure, it important to document read locations. By mapping facilities and documenting the environmental details, you will better understand where breaks or system breakdowns are occurring or use similar structure when rolling out to other facilities. A read location map is provided in the figure 23.

Figure 23: Read Locations

READ LOCATIONS



6.2.3.2. INTERFERENCE WITH EXISTING SYSTEMS

Before addressing the frequency you will have to examine if your Auto-ID application's frequency interferes with already existing systems at all facilities (indoor and outdoor; at your site and at your trading partner's sites) and its read locations. This is important to guarantee a smooth operation of your Auto-ID system that has a close to 100 percent read detection rate.

Figure 24: Read Location Analysis

READ LOCATION NO.	INDOOR OR OUTDOOR	READ LOCATION TYPE	ENVIRONMENTAL INFLUENCES
For identification.	For the read range and environmental conditions.	For antenna placement as door, shelf, portal, or truck.	For tag type as darkness, dirt, metal or water in the immediate environment.

If there are competing systems in place, which operate at the same frequency you have to describe them and the disruption that they cause. Competing systems could include:

- WLAN,
- handheld, or
- wireless telephone lines.

Then, test how you can minimize interference. Possible solutions could include:

- operate the competing system at different frequencies,
- operate one system at one time e.g. by modifying the software to allow time sharing,
- change the physical installation of antenna type and location,
- shield the tags,
- change the read range and the performance of the system.

6.2.3.3. ANTENNA FEATURES

Please check if your antenna complies to the following requirements:

- **frequency requirements and required read range:**
  depends on the technical antenna features (e.g. antenna beam width, directive gain, antenna size),

- **the antenna meets the real time requirements of your Auto-ID application**:
  depends on
  - the volume of read tags: the more tags have to be read at one antenna the slower the system,
  - how long the tagged objects are in the range of the antenna e.g. how fast a fork lifter passes a portal antenna,
  - the number of tagged objects which are read at the read location at one time,
  - the arrangement of the tagged objects (tag and antenna orientation have to be tuned),

- **physical antenna design requirements:**
  the antenna's size and quantity must be suitable for the application. Antennas may need to be customized, for instance.
  - fork lifters have to be able to pass the antenna without interruption,
  - smart shelf applications require antennas which can be integrated into shelves,

- **low installation work:**
  the antenna vendor delivers all necessary equipment such as hangers so that the installation can be easily done,

- **antenna robustness:**
  the antenna has to be protected against physical hits, for example hits by any machinery in a warehouse like fork lifters or pallet movers.

6.2.3.4. ANTENNA TO READER CONNECTION

The reader antennas and the readers must be connected either by cabling or wireless. Figure 25 shows the pros and cons of cabling versus wireless connections. Figures 25 and 26 will help you to organize the antenna to reader connections.

Figure 25: Cabling versus wireless Antenna Connection

CABLING	WIRELESS CONNECTION
+ Robust and secure against failure	+ Flexible if you want to change the facility layout and therefore the read location positions + No cable funnels required
– Has to be protected against physical hits e.g. against diggers – Space for cabling	– Not so secure against failure – Interference

Figure 26: Read Location Cabling List

READ LOCATION NO.	READER PLACEMENT	CABLING REQUIREMENTS	REQUIRED CABLING
1	Server room 503 in building 5A	Portal antenna at the entrance of the warehouse is fixed and has to be always functional. The cable can be lead through the portal inside.	Cable Type XY, 500 m, cable funnel already exists

Figure 27: Read Location wireless Antenna Connection List

READ LOCATION NO.	READER PLACEMENT	WIRELESS CONNECTION REQUIREMENTS
2	Server room 503 in building 5A	The containers are used in halls 5, 6 and 8. To ensure that there are always enough containers in all three halls, WLAN antennas have to be installed in all three halls.

6.2.3.5. POWER SUPPLY
For each reader sufficient power supply must be made available. If there is a potential for disruption, it is important to have back-up generators or a back-up system.

6.2.3.6. NETWORK CAPABILITY
Figure 29 helps to list all read locations and to consider which systems need to see Auto-ID data at that point (data access requirements). The third column examines which network requirements exist in order to transfer Auto-ID data from the tag to these systems. If the actual network capability is insufficient it will need to be adjusted.

Network connection requirements could be:

- fast internet connection at the site e.g. in the warehouse, or in the store,
- local area networks (LAN),
- remote access,
- GPRS e.g. during transport,
- wireless LAN e.g. for workers' handholds, camera systems, or motion detectors.

Figure 28: Data Access Requirements and Network Capability

READ LOCATION NO.	DATA ACCESS REQUIREMENTS	NETWORK CONNECTION REQUIREMENTS
1	ERP-system	LAN connection in the warehouse

6.2.4. Auto-ID Systems Security

The security of an Auto-ID complete system must be maintained throughout its lifecycle. Breaks in the system could lead to unauthorized individuals or companies having sensitive company data. Figure 30 shows what considerations are needed for a tag's lifecycle. This is just one component of the security measures. Of course, for each Auto-ID technology component the appropriate measures should to be taken. These will be elaborated further in future editions of the guide.

Figure 29: Security throughout the Tag Lifecycle

Life-cycle stage of the tag	People, who have to have access to the tag	People, who have access to the tag	Systems, which have to have access to the tag	Systems, which have access to the tag	Measurements to protect tag data (organizational, technical)
Production					
Customizing					
Usage					
Recycle					

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