An Overview of Automatic Identification (Auto-Id) in the Supply Chain

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ABSTRACT

Radio Frequency Identification (RFID) has been in existence for decades. Extensive research, new innovation and initiatives anchored by MIT's Auto-ID Centre as well as key advancements in the information communication technology (ICT) infrastructure, has set the stage for a phased adoption and eventually mass scale embracement of this technology, communally termed as Automatic Identification (Auto-ID). This is further reinforced by the fact that businesses have obtained extensive and concrete evidence that this technology will produce a high return on investment in the short and long term. This paper commences with an introduction to Auto-ID and proceeds to highlight the key forces that are driving the embracement of this technology. It will then discuss the architecture of Auto-ID that enables it to serve as the underpinning infrastructure and mechanism for dynamic information generation. Next, the discussion is framed around the key applications and advantages of Auto-ID within and external to the supply chain. Finally, an explanation on how Auto-ID is bridging the transition to the fourth information revolution is put forward, where through the use of dynamic information, supply chain efficiency will be amplified and organizational agility will be enhanced significantly.

Keywords: *Automatic Identification (Auto-ID), Supply Chain Management (SCM), Dynamic Information, Supply Network, Radio Frequency Identification (RFID), Information Generation Three (IG3)*

1.0 INTRODUCTION

Over the past decade, management has come to realize that one of the primary enablers of crafting a competitive advantage to ensure long-term sustainability is the efficient and effective management of their supply chains. The global plane that organizations are operating in today has necessitated most if not all businesses to collaborate and form partnerships with various other organizations around the globe and this has created an even more complex supply chain network. The trend towards business process outsourcing puts further pressure on the supply chain and its processes. Enterprises have started to disaggregate, spinning off assets and departments so that they can focus on what they perceive are their core competencies. Disaggregation means supply chains need to be even more agile and flexible (Peterson, 2003). Gartner research further emphasizes that during the next five to ten years, business structures and processes will evolve radically. Enterprises will begin to blend internal processes with those of their trading partners, revealing the inefficiencies of enterprise boundaries.

As a consequence of all the above factors, the efficient and effective management of this complex network is imperative to ensure sound financial performance. Infact, this has been confirmed by a vigorous study jointly undertaken by team members from Accenture, INSEAD and Stanford who analysed corporate disclosure data from more than 600 Global 3000 companies. One of their key findings was that senior executives at leading companies view supply chains as critical drivers of shareholder value and competitive differentiation. The research shows a strong connection between superior supply chain performance and financial success (Dik et al, 2003).

2.0 OVERVIEW OF RFID AND AUTO-ID

Radio frequency identification (RFID) enables the electronic labelling and wireless identification of objects using radio frequency communications. RFID tags can be attached to physical objects which enable the objects to be tracked and identified remotely. It will offer a standardized and scalable approach that can be deployed across the extended enterprise to suppliers, manufacturers, distributors and logistics partners to provide very reliable and cost-effective visibility at the item, case or pallet level (Linster et al, 2003). In the near future, companies will use this dynamic information to collaborate more effectively and achieve new levels of efficiency and responsiveness (Kambil & Brooks, 2002). Tags range in functionality, size, and price, and have varying amounts of storage capacity. An RFID tag is made up of a microchip attached to an antenna. The tag stores an EPC that will be transmitted as a radio frequency signal when the object is in the vicinity of a suitable reader (Chappell, 2002). There are several categories of these tags ranging from the high end ones, namely active tags and read-write tags, semi-passive tags and finally passive and read-only tags that are at the lower end, which are being used the most at present in the corporate world due to its competitive price.

Automatic Identification (Auto-ID) is the technology that encompasses the complex information communication technology infrastructure (ICT), in combination with RFID (Schuster et al, 2003). Auto-ID hinges on various homogeneous standards which enable the interaction and integration of partners along the supply network. Auto-ID incorporates hardware, software and a multitude of standards such as Electronic Product Code (EPC), Savant, Object Name Service (ONS) and Product Markup Language (PML), which are forming the building blocks for the overall infrastructural setup. Auto-ID is setting the groundwork for the next wave of supply chain management that is built on the pillars of dynamic information and real-time decision making.

3.0 MAJOR DRIVING FORCES FOR AUTO-ID ADOPTION

There have been various driving forces that have brought Auto-ID to the forefront especially in terms of its application in the supply network. They are as follows:

- Auto-ID Center, which is anchoring the global Auto-ID initiative together with UCC and EAN International (EPCglobalinc, 2004),
- The creation of a common set of governing standards namely EPC, Savant, ONS and PML (Roberti, 2002),
- Diminishing costs of RFID tags and readers (Ferguson, 2002),
- Significant advantages over barcodes (Mitchell & Chappell, 2003),
- Adoption by the US Department of Defence and Wal-Mart (Hickey, 2004) and
- Maturing ICT infrastructure & enterprise resource planning systems (Adams et al, 2001).

4.0 AUTO-ID ARCHITECTURE – PLATFORM FOR DYNAMIC INFORMATION GENERATION & MANAGEMENT

The current internet platform will serve as a backbone to the Auto-ID network which will connect computers to "intelligent products" as they traverse through the global supply network. Each item will be distinguished by a unique EPC that would be assigned to it. It is important to note that the EPC will be the only information stored on the tag that is attached or embedded in a product. The EPC is a number made up of a header and three sets of data. The header identifies the EPC's version number which allows for different lengths or types of EPC for use in the future. The second part of the number identifies the EPC Manager which usually is the manufacturer of the product that the EPC is attached to. The third, called object class refers to the exact type of product, which is usually the Stock Keeping Unit (SKU). The fourth is the serial number, unique to the item (Roberti, 2002). When a product comes into the read range of a reader, the electromagnetic waves would trigger the tag to give the EPC of the product and this would be picked up by the reader (Tobolski et al, 2003). Figure 1 illustrates the basic layout of the Auto-ID architecture.

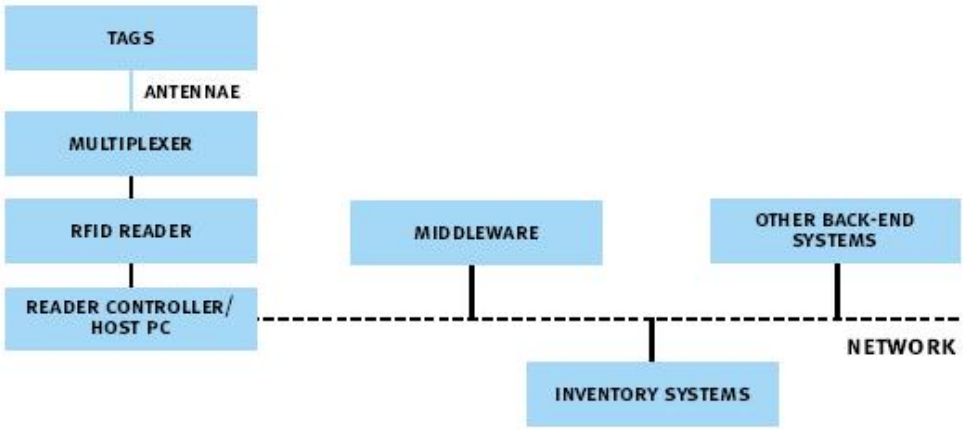

Figure 1: Basic Layout of the Auto-ID Architecture (Tobolski et al, 2002)

The middleware is an important segment in the overall Auto-ID network layout. The most vital component in the middleware is the savant, which is a software system that fundamentally functions as the central nervous system of the RFID network. The RFID network will be receiving an avalanche of information collected from the continuous streams of EPCs. The savant would have the critical task of managing the flow of information and directing information to the designated recipients in the supply network. The next important component of the middleware is the Object Name Service (ONS), which is similar to the Domain Name Service (DNS) in the internet world. It will point the requesting savant to a server where a file with information about that product is stored. That file can then be retrieved by the savant, and the information about the product in the file can be forwarded to a company's inventory or supply chain application (Roberti, 2002).

As described above, information about the products associated to an EPC are stored on servers and these are called product mark-up language (PML) servers. These dedicated servers furnish information to requesting savants. They will be maintained by manufacturers and will store files for all items a manufacturer makes. Information is stored in the form of PML which is based on XML. PML is broadly hierarchical and will cover all industries. In addition to product information that doesn't change (such as material composition), PML will include data that changes constantly (dynamic data) and data that changes over time (temporal data). Dynamic data might include the temperature of a shipment of fruit, or vibration levels from a machine. Temporal data changes discretely and intermittently throughout an object's life. A good example is an object's location as it traverses through the global supply network (Roberti, 2002).

5.0 GENERAL APPLICATIONS OF AUTO-ID

A few of the applications of Auto-ID are as below:

- counterfeiting,
- theft elimination and prediction,
- shrinkage,
- check-out less stores,
- baggage handling,
- smart recycling,
- parcel logistics and
- automotive manufacturing.

6.0 AUTO-ID IN THE SUPPLY CHAIN

The advent of Auto-ID in the supply network is set to unfold an array of capabilities that was not thought to be possible with the use of current technologies. Some of the most tangible benefits are listed below (Kambil & Brooks, 2002):

- it will give companies the ability to track materials, assets and goods across the entire value chain network,
- significant benefits will be reaped by improved visibility across the entire supply chain,
- businesses would be able to achieve significant inventory reductions and more efficient distribution which would lower inventory and distribution costs across the value chain,
- businesses could leverage on improved supply and demand visibility to become more responsive to changing customer wants and needs,
- collaborative forecasting using supply and demand planning could also be undertaken to balance anticipated supply and demand within the entire supply chain,
- significant labour costs reductions on laborious and time consuming distribution centre processes. The US retail industry alone revealed potential savings of between 5 and 40 percent (Tobolski et al, 2002),
- with the ability to know the location of every case and/or item and the potential for human error greatly reduced, the integrity of the data pertaining to inventory will be significantly increased. Analysis revealed that location inventory accuracy would approach 99 percent and that aggregate inventory errors would all but be eliminated (Tobolski et al, 2002),
- a host of cost savings for transportation which is the segment of the supply chain that consumes the most resources in the form of capital and expenses (Tobolski et al, 2002) and
- significant reduction of the "bull-whip" effect in the supply chain as per figure 2 and 3

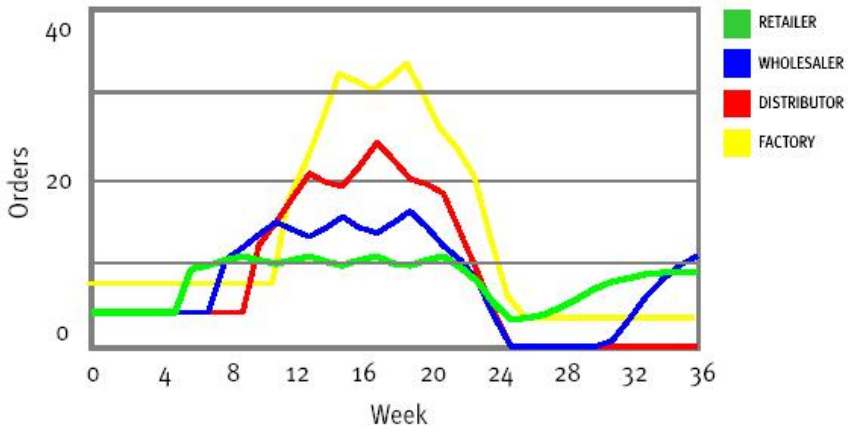

Figure 2: The "bull-whip" effect in the supply chain today (Schuster, 2004)

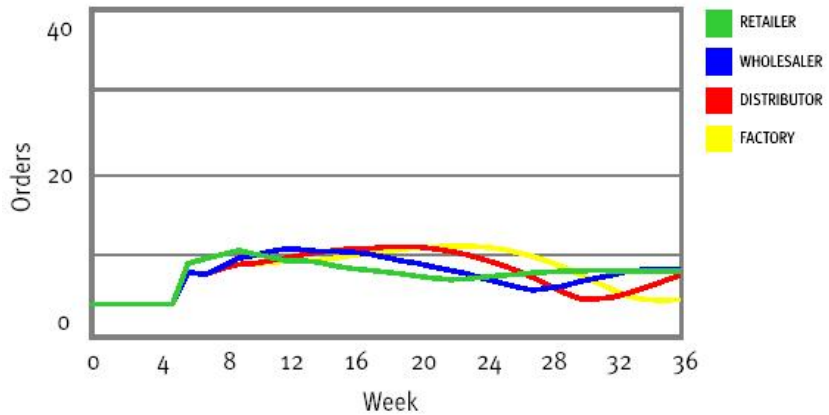

Figure 3: The "bull-whip" effect in the supply chain with Auto-ID (Schuster, 2004)

7.0 GENERAL CHALLENGES

Although Auto-ID is being piloted exhaustively by numerous corporations across the globe and the results have been significantly positive, there are still some challenges that need to be resolved to ensure a seamless and flawless adoption. Some of the most formidable barriers are:

- item level data management (Mitchell & Chappell, 2003),
- integration with current middleware and enterprise systems (Whiting, 2004),
- management of a mixed architecture (Mitchell & Chappell, 2003),
- lack of radio frequency communication standards (Chappell, 2002),
- upfront infrastructure, hardware and software cost (Kambil & Brooks, 2002) and
- end user privacy concerns (Claburn, 2004).

8.0 AUTO-ID AND THE FOURTH INFORMATION REVOLUTION

In "The Next Information Revolution", Drucker (1998) explained that the human race is currently undergoing the fourth information revolution. He goes on to state that this current information revolution has the greatest impact on the corporate world as it forces a redefinition of businesses and thrusts it to a new paradigm of focus, which is framed around business strategy. The ultimate goal is to create value and wealth for continued profitability and sustainability. Information is to be used in a strategic manner, and with geographical boundaries fading, it is beyond doubt that the nature of information has undergone a significant transformation from "global rather than local and dynamic rather than static" (Barker et al, 2004). It is also crucial to note that evolving technological solutions form a fundamental building block toward the goal of creating value and wealth. Drucker (1998) reinforces this argument by quoting examples from prior information revolutions. He goes on to conclude that the real role of technology is to have an impact on the significance of information as it is the underpinning basis of value creation for businesses.

In a similar argument, Barker (2004) states that although we have theoretically moved into information generation three (IG3), most present day systems, including the current barcode systems are still operating within the realms of information generation two (IG2). It is crucial to comprehend that the dynamics of information has undergone a significant transition. Although most corporations have placed grave importance on supply chain management, present enterprise resource planning (ERP) systems and supply chain management (SCM) software has not been truly successful in managing the typically intricate and multifaceted nature of supply networks that exist today. One of the flaws that need to be addressed is the reliance on older information retrieval methods and "static" information that yields relentless disparities between what is being done and what can be actually done throughout the entire supply chain (Barker et al, 2004).

Current barcode systems are only able to provide "semi-dynamic" information to enterprise systems as information can only be obtained at limited, designated segments in the supply chain. There is a severe information deficiency at many portions in the supply chain due to the lack of visibility and ability to capture real-time information. This consequently creates bottlenecks and places various limitations on the efficiency and effectiveness of managing these supply networks.

Auto-ID is set to fundamentally change this as it is capable of providing enterprise systems with truly dynamic information throughout the supply chain network. With proper planning and an underlying architecture in place, real-time information can be captured throughout the entire global supply chain irrespective of its scale and complexity. This is a significant step change and it is going to be the underpinning pillar for the complete evolvement of current systems to IG3. A Metagroup study reveals that organizations have realized the critical importance to institutionalize the ability to have real-time information on the status of items traversing their global supply chains at all times, as it would enable them to make instant and timely changes based on consumer demand, company forecasts, and global market conditions (Poe, 2003). Auto-ID would be the silver bullet in this case as it would give exactly the above ability to companies and their supply chains.

In the short to mid-term time frame, Auto-ID will provide greater visibility through more accurate, detailed and timely information about the supply network operations. Auto-ID will collect information about physical movements of goods in a more cost-effective way. It will augment and eventually replace bar-coding methodologies and will enhance and simplify data collection in the supply network. Collecting information about warehouse receipts, shipped goods, components used in the manufacturing process, manufactured goods, cycle counts and a host of other information will be mostly automated (Linster et al, 2003). The information that is collected will be in real-time and collected more frequently and at more points in the various processes in the supply network.

It is important to note however, that Auto-ID will still not significantly change the business process or the role that the supply chain management systems play today. The full benefits of Auto-ID will be realized when it is complemented by the EPC network that will be operating in the public domain as per the internet is today. It will permit partners in the supply

network to manage and retrieve real-time, dynamic information about products and their state in the supply network. When a product is received at a distribution centre, the distribution centre's warehouse management system will query the public EPC network for information about this product, instead of relying on the ERP to provide this information beforehand. A public information service of this nature would supplant proprietary information exchanges between partners in the supply network and will introduce a whole new level of flexibility in the supply chain (Linster et al, 2003).

At present, the cost of setting up the information exchange with a new trading partner is very high, which results in below-par partner performance to be usually accepted, instead of selecting a higher-performance partner which will require reintegration. Thus, in the long run, Auto-ID combined with EPC services will provide a public, real-time information exchange platform that greatly enhances the interoperability of the supply network (Linster et al, 2003).

This would however become commonplace only when the cost plummets further and some of the challenges that were discussed in the previous section are ironed out. The adoption would need to ensure that the businesses attain a significant return on investment (ROI) and return on information (ROInf). For the time being, tagging would be engaged at the case and pallet level. As the benefits and experience of implementing this technology is accrued, businesses would migrate to a complete Auto-ID enabled enterprise. It should take another 3-5 years before item level tagging for high costing products is employed in the supply chain. Tagging would eventually become a norm on all products (even a can of coke for example), but this would become a reality in about 8-10 years' time (Whiting, 2004). Gartner's research reinforces this with an indication that corporations will need to reengineer their business processes across the value chain around the time frame of 2008 to 2012, due to the paradigm change that Auto-ID will initiate (Harris & Nelson, 2003).

It is most likely that the adoption of Auto-ID technology will pervade to small and medium enterprises (SME) over a longer time span due to the simple fact of cost constraints that would not be inline with the corresponding returns. SMEs would most likely take the position of followers and observe the evolvement of this technology before joining the bandwagon. SMEs that are however, already piloting this technology and contemplating possible adoption could be doing so due to the below factors:

- pressure from their larger counterparts in the supply chain,
- creating or maintaining a competitive advantage,
- providing significant returns (ROI) that are justifying the use of this technology.

9.0 CONCLUSION

Auto-ID will fundamentally change the business landscape of many industries in the foreseeable future as it is not a mere extension of barcodes as many people depict it to be. It will take supply chain management to the next level of efficiency using dynamic information and the provision of real-time decision making capabilities. Although its initial stronghold will be applications within the perimeters of supply chain management in particular, it is set to ripple through the realms of virtually everything we do today in the foreseeable future. Its applications are going to be pervasive in every imaginable industry across the corporate and government sectors. Corporations in the retail, pharmaceutical and fast moving consumer goods (FMCG) industry are already piloting this technology at various segments in the supply network. It will deliver benefits that were not thought to be possible and will consequently reinvent the way we live and do things.

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