White Paper

RFID: Aerospace and Defence

Potential of RFID in the Aerospace and Defence Market

This white paper describes for C-level executives and line-of-business managers the opportunities and business benefits of RFID in the aerospace and defence sector. It looks at various scenarios where RFID is and can be used to solve business problems.

Highlights of this white paper include:

- The need for automation of the Pedigrees to solve the counterfeit issue.
- The need for support for compliance with US Department of Defense mandate and the commercial impacts of the Boeing-Airbus initiative.
- The use of RFID technology to:
    - Provide visibility in the supply chain and production line
    - Reduce risks in employee health and safety
    - Verify plant maintenance

Executive Summary

The aerospace and defence (A&D) industry is always on the move and changing. Technologies and processes that worked yesterday might not work today. That is why A&D companies are constantly seeking better ways to manage complexity, cut costs and boost productivity. Enter RFID technology. Whether it is the US Department of Defense or the commercial airline industry, one thing is clear: A&D vertical market RFID initiatives implicate a broad range of contributing parties and are driving both investment and implementations.

The requirements for tracking and tracing parts, mobile assets and people, as well as the need for authenticity of parts is driving the aerospace and defence industry to use RFID as a technology solution to provide visibility. Industry organisations are looking at:

- Streamline production: it is not unusual to have six or seven tiers between your systems integrator and the lowest member of your value chain. Most aerospace and defence companies lack the necessary infrastructure to seamlessly integrate the growing network of external partners and suppliers in their value chain.
- Increase in quality control: it is of vital importance to ensure the quality of materials provided by contractors as well as to be sure of their authenticity.
- Improvement of MRO processes: integrated MRO strategies based on RFID tagging can deliver marked efficiencies to the processes of locating parts, tools and materials, and to producing the significant amounts of documentation required to meet regulations in the aerospace and defence industry.
- The US Department of Defense's (DoD) 43,000 suppliers will be required to put RFID tags on practically everything shipped to the organisation by 1 January 2005.

Active and passive tags attached to parts, bins and finished aircraft elements are able to give organisations virtual real-time insight into the moving parts involved. When you know where everything is and how it has been used, you can speed assembly processes, locate products in a fraction of the time and manage your inventory more effectively.

It is important to remember that RFID on its own with business process improvement adds little value. Therefore it is important to understand where you need to increase visibility and to be prepared to do things differently.

Current Issues in the Aerospace and Defence Marketplace

RFID is not a new technology.

The aerospace industry is heavily influenced by the economy, politics, government regulations and consumer confidence. Significant emerging trends include the growth of the Asian and, in particular, Chinese markets, the continued Airbus / Boeing rivalry, outsourcing of maintenance, repair and overhaul (MRO), and the rise of low cost regional carriers. The resulting business environment has:

- Modest revenue growth: rising military spending (mainly in the USA) has not been enough to offset the severe decline in the purchase of new commercial aircraft. This is expected to change in the next decade with the launch of new aircrafts (A380, A350, B787), growth of low cost airlines and forecasts of doubled passenger demand by 2020.
- Competitive pressure to eliminate waste: aerospace companies are creating corporate-wide lean enterprise programmes to improve priority setting and magnify benefits.
- Better R&D performance: industry investors and boards want to see greater ROI from their R&D investments; new product innovation is a cornerstone of this process.
- Co-opetition is expected to increase as companies collaborate on programmes.
- Changing business practices: business approaches such as demand-driven supply networks (DDSN) address the needs of the newly outsourced manufacturing sources.
- Aftermarket sector: MRO will experience a shake-up

The acceptance of global standards is making the adoption of RFID more effective.

Aerospace companies need to reduce the long product development cycle times while continuing to focus on delivering high quality products. This means:

- Increase the number of design iterations and eliminate bad designs before moving on to detailed design and prototype production.
- The need to deliver new products to market faster, better and cheaper through the use of real-time global collaboration.
- Vault engineering data (BOM), capture design intent and approval process.

Aerospace manufacturers need to increase their operations performance by improving cycle times, output and overall effectiveness in the following areas: control systems; execution and tracking; quality; maintenance, and visibility. Visibility provides a layer above the manufacturing systems that gathers and aggregates data from many sources: it contextualises, analyses, summarises and formats information into dashboards and Key Performance Indicators (KPIs) with real-time / historical data.

Aerospace manufacturers need to reduce non-value added work from their manufacturing processes, reduce inventory costs, eliminate stock outs and provide a software backbone that allows manufacturers to sustain their Lean, Six Sigma and ISO programmes. Four critical areas need to be addressed:

- Value stream mapping and analysis (VSM&AD).
- Project and programme management (PPM).
- Collaborative electronic Kanban (CEK).
- Demand-driven scheduling (DDS).

As aerospace companies outsource more of their manufacturing, the need for real-time visibility, agility and accuracy are of paramount importance to deal with demand fluctuations, supply chain disruptions and expectations of the well-informed customer. The value is getting the right decisions on short notice to coordinate a complex range of activities among a multitude of partners. This has a direct influence on productivity, profitability and the ability to stay competitive.

Airline CEOs and CFOs have an increasing focus and pressure on maintenance as a source of process improvement, cost savings and sometimes even revenue generation. Ageing fleets mean higher maintenance costs. Growing maintenance needs aside, facility and personnel reductions occur and outsourcing is the fastest way to cut maintenance costs. This means that there is a need to:

- Increase supply chain velocity and customer satisfaction.
- Increase productivity and accuracy.

- Optimise inventory and lower operating costs.

The MRO market faces distinctive issues. This is partly driven by the large percentage of low-cost carriers, increased outsourcing and smaller average fleet sizes. Maintenance activities are also beginning to move east as airlines try to take advantage of lower labour rates / high technical skills that can be found in Eastern Europe, plus there is a steady growth in the use of parts manufacturer approval (PMA) parts and continued consolidation in the market triggered by overcapacity and declining margins. Europe accounts for almost one-third of the $36 billion global commercial and regional / business jet MRO market. Based on 4.7% per annum growth rate the world market for civil aircraft above 80 seats could be worth up to $1600 billion over the next 20 years[1].

Many manufacturing companies are adopting lean manufacturing principles, but the maintenance department is often not included in the process. Alongside the lean phenomenon, there is a move away from corrective maintenance to predictive maintenance strategies. The benefits of predictive maintenance are too numerous to mention, but include: minimising costly downtime; minimising catastrophic machinery failures; reducing maintenance costs; reducing spare parts inventories; increasing machinery safety, and increasing the speed at which machinery can be operated, if desirable.

RFID in Aerospace and Defence

The application of RFID technology in the aviation industry has many proven benefits, with the ultimate objective being continued air safety. RFID will:

- Improve airline configuration control by increasing the accuracy of the known “as-delivered” configuration.
- Reduce ownership costs by identifying rogue parts and will help minimise airline inventories.
- Provide reliable part traceability.
- Reduce internal processing and cycle time to solve service-related problems.
- Improve the accuracy of information exchanged between the airline industry and suppliers.

In addition, RFID technology offers a competitive advantage through support for:

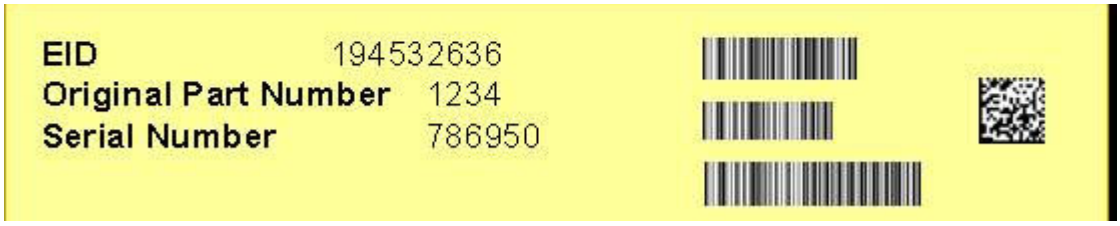
- No line of sight requirement.
- Dynamic read / write capability.
- Simultaneous reading and identification of multiple tags tolerance in harsh environments.

With the need for strict safety and therefore identity, the industry has been looking at ways to uniquely identify parts and assemblies.

Unique Identity (UID) – US Department of Defense Initiative

UID is the set of data for tangible assets that is globally unique and unambiguous, ensures data integrity and data quality throughout life, and supports multi-faceted business applications and users.

Figure 1: Different ways to display a UID



The first thing the Standards Team accomplished was to define the UID in plain terms, giving it requirements that must hold up during all aspects of its life. The strategic purpose of UIDs is to:

- Integrate item data across government and industry asset management systems, resulting in:
  - Improved data quality and global interoperability
  - Rationalisation of systems and infrastructure
- Improve item management and accountability.

[1] MRO in Aerospace – Trends and Changes, Libbie Hammond

- Improve asset visibility and lifecycle management through lifecycle traceability.
- Enable more accurate audit opinions on the property, plant, equipment and operating materials, and supplies portions of financial statements.

US Department of Defense (DoD)

The US Department of Defense introduced a mandate for the use of RFID by its suppliers in 2005. This was based on the trials in the Iraq conflict around logistics support.

Today's US military is a dynamic, rapidly moving force designed to be effective in an asynchronous battle space. The enhanced mobility and speed of a combat force capable of performing in austere theatres with limited infrastructure creates a new class of challenges for military logisticians. The performance of logistics during the combat phase of Operation Iraqi Freedom created a compelling case for change to fast, accurate, flexible and mobile sustainable support. To summarise, the challenges that face the US DoD in the logistics sector are:

"To win the global war on terror, the armed forces simply have to be more flexible, more agile, so that our forces can respond more quickly."

United States Secretary of Defense Donald Rumsfeld, 6 March 2003

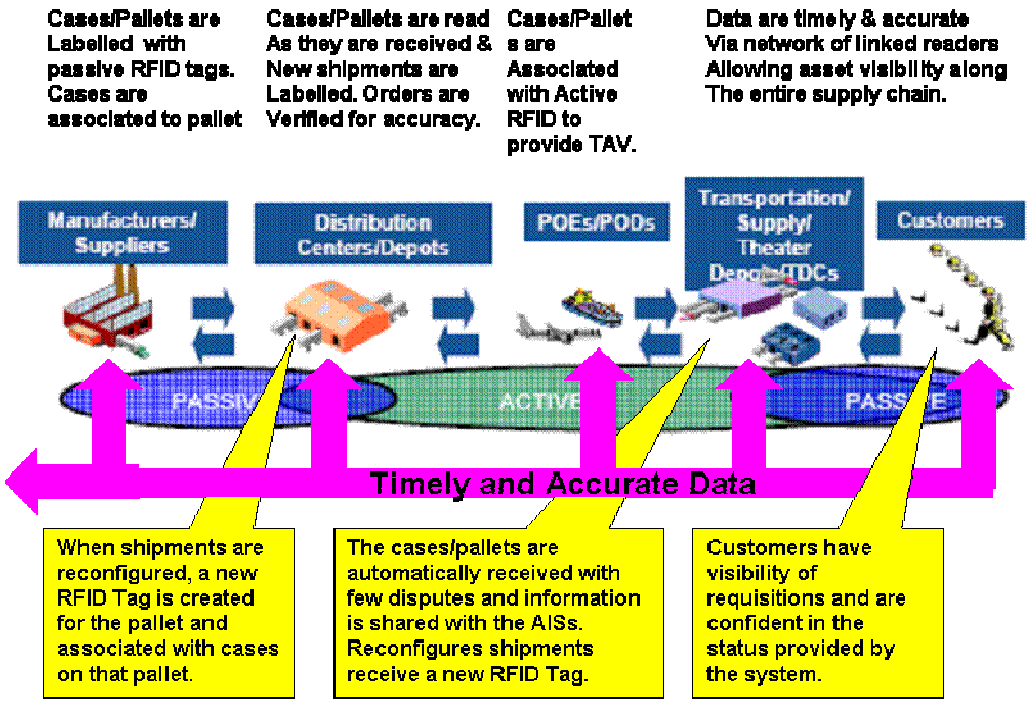
- Almost half of DoD's $63.3 billion inventory as of September 2001 exceeds war reserve or current operating requirements.
- DoD is unable to maintain adequate accountability over material shipped between contractors and DoD.
- The services all experience operations and maintenance problems because of a lack of key spare parts, specifically aviation spares.
- The services are not adequately monitoring, reporting or getting reimbursement for defective spare parts received from contractors.

The DoD RFID vision is to implement knowledge-enabled logistics through fully automated visibility and management of assets in support of the Warfighter. The DoD RFID goals are:

- Increase Warfighter / customer confidence in the reliability of the DoD supply chain.
- Improve visibility of information and assets throughout the DoD supply chain.
- Improve process efficiency of shipping, receiving and inventory management.
- Reduce cycle time.

The end state for the DoD supply chain is to be a fully integrated adaptive entity that leverages enabling technologies and advanced management information systems to automate routine functions and achieve accurate and timely in-transit, in-storage and in-repair asset visibility with minimum human intervention. RFID is a foundational technology on the path to achieving this vision. DoD will ultimately operate a single, seamless, responsive visibility network, accessible across the backbone and usable by people and systems across the end-to-end supply chain. The DoD vision is for RFID to facilitate accurate, hands-free data capture in support of business processes in an integrated DoD supply chain enterprise as an integral part of a comprehensive suite of automatic identification technology (AIT) applications. DoD will leverage these AIT applications, where appropriate, in the supply chain to improve Warfighter support, as depicted in Figure 2.

Figure 2: US Department of Defense Supply Chain



Source: Department of Defense RFID: A Business Revolution, Maurice Stewart, RFID World: 29 June 2005

"Visibility is critical to effective logistics support"

Alan Estevez, US Assistant Deputy Under Secretary of Defense

The primary actions performed by the physical nodes to move materiel through the logistics chain are the shipping / receiving / transportation processes. Figure 2 shows materiel movement that physically "touches" each node throughout the logistics path. But materiel can start, end and move through different paths between logistics nodes:

- Manufacturers / suppliers to defence distribution centre for stock replenishment.
- Defence distribution centre to supply depots / theatre distribution for stock replenishment outside the United States.
- Defence distribution centre to supply depots for stock replenishment in the United States .
- Supply department / theatre distribution to customer; direct vendor delivery.

RFID impacts on all these segments. Materiel movement includes moving retrograde back through the supply chain in the opposite direction. RFID (active and passive) read and write capabilities will be required at the farthest point in the supply chain delivery system to support retrograde. The return / retrograde process is the same as the shipping process.

The standards that DoD has evolved are:

- Active RFID for freight containers, air pallets based on SAVI readers and tags working at 433 Mhz where suppliers will not be asked to tag.
- Passive RFID – case and pallet (all items), item packaging (UID items) using standard EPCglobal UHF readers and tags where suppliers will be contractually obligated to apply tags at case and pallet level.

The reasons given by the US DoD for the adoption of EPCglobal standards for passive RFID were:

- Leverage of the marketplace.
- Government and commercial sectors on same standard.
- Consistent standard anywhere the department operates in the world.
- Consistent standard with all suppliers.
- Drive for consistent standards and interoperability with allies.

Figure 3: Passive RFID Implementation Plan for Department of Defense Suppliers

Source: Enabling the Supply Chain with RFID Technology, Alan Estevez, RFID Live (Europe), 11 April 2005

DoD at a conference in 2005[2] talked about the implementation lessons it had learnt from the use of RFID in its supply chain:

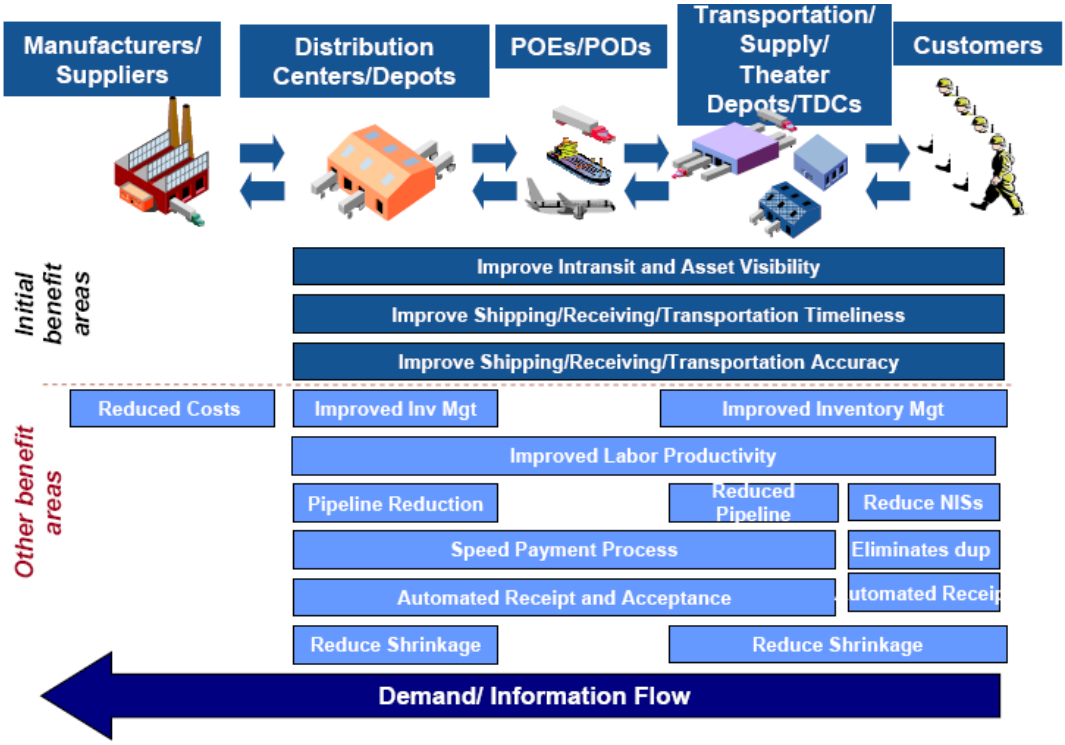
- Business process changes required to capture real benefit and business value:
  - RFID improved timeliness and accuracy of receiving and shipping by 3%
  - User training improved performance
- Technology is reliable:
  - Read rates around 96%
  - Equipment ready to use just 33 days after decision on technology
  - Equipment operational 100% of the time

RFID and bar codes will coexist for several years as both technologies have their merits. However, RFID brings several benefits over bar codes:

- Eliminates human error.
- Improves data accuracy / asset visibility.
- Performs in rugged, harsh environments.
- Allows for dynamic, multi-block read / write capability.
- Facilitates source data collection.
- Allows for simultaneous reading and identification of multiple tags.

[2] Enabling the Supply Chain with RFID Technology, Alan Estevez, RFID Live (Europe), 11 April 2005

Figure 4: Benefits of RFID Across the US Department of Defense Supply Chain



Source: Enabling the Supply Chain with RFID Technology, Alan Estevez, RFID Live (Europe), 11 April 2005

For further information on DoD compliance, the reader is recommended to visit: http://www.dodrfid.org

UK Ministry of Defence – JAMES Project

As an example of other defence ministries working in the RFID space, the UK Ministry of Defence (MoD) has been looking at the defence engineering and asset management capability gap. They found:

"Asset management is a key component of the Recognised Theatre Logistic Picture (RTLP) and the Joint Logistic Picture (JLP)."

Lt Col Tony Bridges

- Poor or no visibility of equipment:
  - Location and ownership
  - Usage and future tasking
  - Configuration / modification state
  - Maintenance and repair loops
  - Spares and consumables consumption
  - Defects or reasons for failure
- Inefficient / ineffective MoD engineering practices.
- Poor use of technology.
- Few effective partnerships with OEMs / industry.

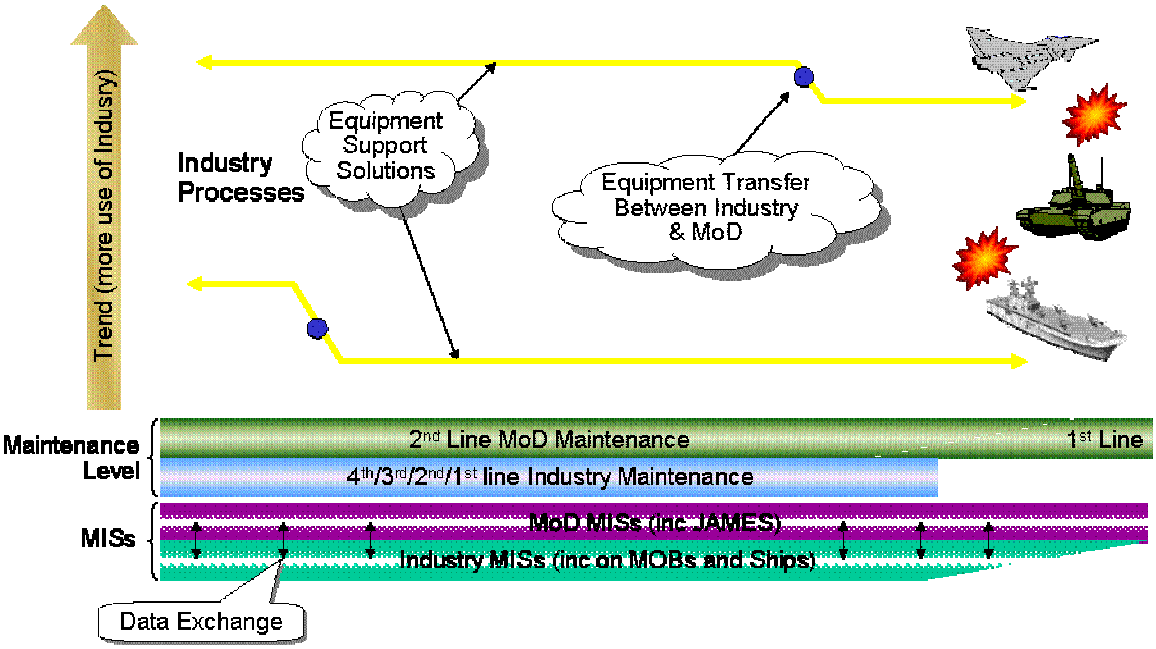
UK Ministry of Defence has been working on the use of RFID as part of the JAMES Project.

MoD has derived a defence logistics vision that states *"The defence logistics vision envisages a highly effective, agile and networked logistic capability that underpins the operational commander's ability to execute his mission successfully. This capability will be derived from joint, integrated and interoperable support concepts, which have been tested and developed to provide the military commander with confidence in his ability to deliver effect at the desired tempo. Success will be built on adaptable systems and force elements combined with standardized logistic processes and procedures."*

A project was set up to produce a solution to these issues based on the vision. The project is called Joint Asset Management & Engineering Solutions (JAMES) and consists of:

- Operational innovation: business (process and policy) change (at least convergence to best practice).
- Convergence to common processes across equipment and environments where possible.
- Where required, new management information systems (MIS) that absorb multiple existing systems.
- COTS software and open data standards (if required MoD will change processes to use the COTS software).
- Incremental implementation with achievable benefits.
- Solutions that meet both MoD and industry requirements for all CLS arrangements.

Figure 5: MoD / Industry Interface – Working with CLS



Source: Transforming Engineering and Asset Management in the UK MoD, The JAMES Programme, Lt Col Tony Bridges, Engineering & Asset Management Capability Change Team, Defence Logistics Organisation

The JAMES Programme for Land Force was rolled out during 2004 and 2005. The JAMES Sea Programme has been accepted and is awaiting the completion of the rollout of its current system. The JAMES Air Project will converge tri-service helicopter E&AM processes and provide a single MIS; it is being implemented in three stages running in parallel:

- Stage 1: convergence to “best of breed” to meet urgent requirement for a single deployable MIS.
- Stage 2: convergence of process and policy.
- Stage 3: A full JAMES with optimised processes and policies.

For more information on the JAMES Project, the reader is referred to: www.eamcct.dlo.mod.uk

Boeing and Airbus have worked together to produce a single set of standards for RFID in the commercial aerospace space.

Boeing and Airbus Initiative

Boeing Co and Airbus S.A.S. are using RFID technology to tag individual airplane parts so it is easier to track, maintain and replace them. In 1999, Boeing began using RFID in aircraft tool management and equipped all of its tools and toolboxes with RFID microchips that contained history as well as shipping, routing and customs information. Similarly, Airbus began RFID tagging its ground equipment and tools in 2000.

Boeing and Airbus are working together to promote the adoption of industry standard solutions for RFID on commercial airplane parts. The two companies held industry forums in 2004. The invitations were sent to all of the world's airlines, parts suppliers, regulatory agencies and third-party maintenance repair and overhaul shops, which do contracted maintenance on behalf of airlines. The goal was to educate, inform and unite the industry around standard requirements for identifying parts.

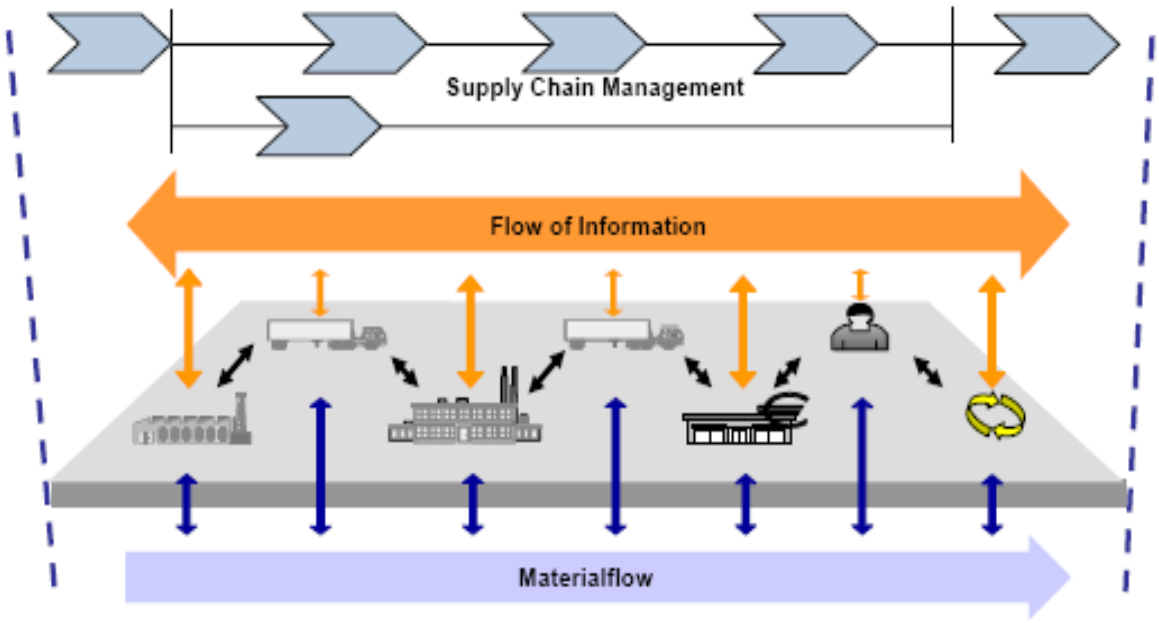
Both companies:

- Recognised the necessity of permanent parts marking.
- Saw the need for an industry standard for automatic data capturing based around standardisation of RFID in ATA Spec2000.
- Are aware of the different requirements on permanent parts marking depending on the part and its environment.
- Support the application of the appropriate marking technology (human readable nameplate, bar code, RFID) for each type of material.

"This technology is changing quickly, so we want to set the stage with our customers and suppliers. Boeing and Airbus are not going to provide conflicting requirements to common airline suppliers. That would be costly and foolish. We're rising above competition because this is so important."

Kenneth D. Porad, Program Manager, Boeing Commercial Airplanes

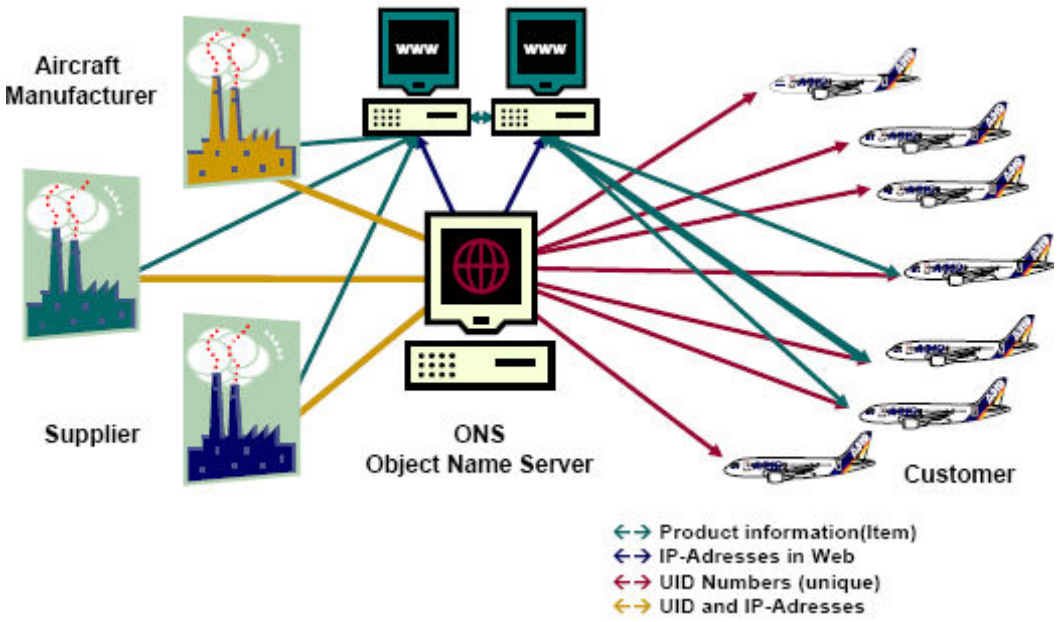
Figure 6: Primary Supply Chain Management Factors



Source RFID in Commercial Aviation, Jens Heitmann, RFID World, June 2005

The companies stated that they did not want to issue a mandate. Rather they believe that RFID could provide major benefits for the entire industry. The manufacturers will get more accurate information about their demand for parts. They will be able to reduce their parts inventory and cut the time it takes to repair planes. Suppliers will also be able to reduce inventory, improve the efficiency of their manufacturing operations and use the technology to verify to Boeing and Airbus that parts they get are genuine, thereby reducing the amount of unapproved parts that enter the supply chain.

Figure 7: The Information Flow of the Future



Source: RFID in Commercial Aviation, Jens Heitmann, RFID World, June 2005

Standards are already in place. The Air Transport Association recently added a RFID standard to its SPEC2000, a comprehensive set of e-business specifications, products and services for the aviation parts industry. The standard calls for the use of IS0 15693 passive, read-write tags, which operate at 13.56 MHz. The RFID transponders will be integrated with existing bar codes, which will still be required.

Boeing has a RFID project under way in its 787 Dreamliner programme, where time-controlled, life-limited parts and replaceable units have been identified with RFID smart labels. These smart labels contain a microchip and an antenna and store data, including part and serial numbers, manufacturer codes, country of origin, date of installation and maintenance and inspection information. This information can be particularly useful in the maintenance of airplanes because the service history of a part is stored on the RFID label as it goes through different stages of its lifecycle.

Airbus has already begun using RFID on jigs and tools, which it loans to airline maintenance centres. The tags are used to track the items as they are sent out to the maintenance centres and returned. Airbus will have 10,000 passive RFID chips on removable parts on the A380, which are replaceable units with short lifecycles. For example, a wing of an airplane is a non-removable part with a 30-year lifecycle, whereas a passenger seat has a five-year lifecycle, and brakes are usually changed every 1,000 landings; both are considered removable parts.

Airbus and Boeing are also looking at having their suppliers tag transport containers and other shipping conveyances used in the aviation industry supply chain. These will likely be tagged with passive UHF tags carrying electronic product codes. Boeing may migrate to EPC tags on containers of parts as soon as EPCglobal finalises its specifications.

Boeing and Airbus unveiled in January 2006 a joint initiative with product lifecycle management vendor, Sopheon plc and Siemens Business Services to provide an industry-wide Internet portal to selected reference sources for RFID implementation. The Siemens Compliance Direct Service is designed to promote standardisation around RFID use. But the partnership between Sopheon, Airbus and Boeing has even larger implications. It means vendors like Sopheon are beginning to see a place for RFID in product lifecycle management applications, which present new possibilities for using RFID in product development, maintenance and end-of-life recycling of aircraft and automotive parts.

"RFID without business process re-engineering adds little value."

Steve Georgevitch, Supply Chain Management, Boeing

"When we put RFID chips on parts, we want to increase the quality of the data handling. Airbus will continue to use text and bar codes to keep track of parts data, but we would also put in a RFID chip with the history of the part, that can be quickly accessed with handheld scanners. We could use RFID to do routine checks before a flight, for example, making sure that a lifejacket is under each seat."

Jens Heitmann, Airbus

University of Cambridge Auto-ID Aerospace ID Technologies Programme

Focus for common research and development issues in aerospace RFID deployment.

The first in a series of sector-based research programmes was launched in mid-2005 by the Cambridge Auto-ID Lab, focusing on the challenges and potential benefits presented by identification (ID) technologies. The programmes will provide companies with the opportunity to support and steer key research into the adoption of appropriate ID technology in their area. It has been driven by the Boeing-Airbus initiative.

Consultations with major aircraft manufacturers, their suppliers and customers developed the initial themes for this research programme. More themes will be added as sponsors join the Programme, bringing their own specific issues. Current themes are:

- Lifecycle ID management: managing the evolution of a component or piece of equipment through its lifecycle.
- ID application matching: guiding the selection of the best ID delivery solution to suit production processes and operating environment.
- Sensor integration: evaluating methods for integrating ID data with other sensor information.
- Tag and data synchronisation: evaluating methods and strategies for the synchronisation of ID data between components and networked resources.
- RFID enhanced track and trace: designing and evaluating methods for integrating ID data into existing and new track and trace strategies.
- Security.

The Programme will be driven by the end users of the technology: the aircraft manufacturers and their suppliers; the operators; the owners, and the MROs.

Federal Aviation Authority (FAA) and RFID

FAA is the main body in the world that sets standards for the aviation industry. The current position of the FAA with regard to RFID is that it has a policy in draft status.

The challenge facing the Federal Aviation Authority (FAA) is to develop a policy to allow active and passive RFID technology on aircraft. Some of the concerns that are faced are due to emissions:

- Can multiple passive RFID devices be a source of interference to required aircraft systems (examining both fundamental and harmonic frequencies)?
- Can a strong, undesired, on-channel / off-channel signal “light up” all devices simultaneously?
- If so, what are the effects on aircraft systems?

This means that in addition to a flight test, a ground EMI test may be required to ensure RFID equipment does not interfere with required aircraft avionics and electrical systems.

The FAA policy is currently in its draft stage but it is close to final agreement on passive portion of policy. The intent of the complete policy is to allow for installation of active and passive RFID devices on a variety of aircraft and equipment. The key points of the policy memo are:

- RFID tags must be interrogated ***on ground only.***
- ***Active*** tags should go through formal FAA certification process, e.g. supplemental type certification (STC) process.
- Fundamental frequency and harmonics of the RFID system must remain out of aviation assigned frequency bands.
- ***Active*** tags should receive full failure modes and effects analysis / hazard analysis (FMEA / HA.) This must be accomplished showing no risk to required aircraft systems.

"Passive RFID can now be used; 2.45 MHz, 915 MHz and 13.56 MHz passive RFID can all be used as long as they are only interrogated when the plane is not in the air."

Kenneth Porad, Principal Engineer for Reliability and Maintainability, Boeing Corp.

Using RFID to Solve Current Business Issues

How (and where) can RFID be used to solve business problems in the aerospace and defence industry.

Identification technologies are changing rapidly. The advent of cheap RFID tags and other data storage techniques means that significant amounts of information can be stored on tags fixed to components or consumables. Major challenges now exist for the use of such ID technologies in both civil and military aerospace industries. Many industries dependent on aircraft can benefit from RFID.

- Airports
- Logistics
- Air freight
- Defence
- Catering
- Maintenance and repair organisations
- Aerospace / suppliers
- Aerospace / OEM

Duncan McFarlane, Director of the Cambridge Auto ID Labs[3] saw the current situation with RFID in the industry in these terms:

- The industry had looked at passive / active RFID and on board memory with many functional developments, ID programmes and PLM systems developed.
- The applications involved included asset based, typically single application vendors working with single company or private cluster trial.
- Standards focus was on low cost, passive solutions, off network data.
- Prices: stable at active level, high class tags not receiving focus.
- R&D: deployment research but predominantly in other fields focuses on short life tags.

Product Authentication

The need to authenticate that the part is what it says it is.

Let's use an example to illustrate the problem of product authenticity. Airbus is responsible for every part fitted onto an aircraft. More to the point, it cannot afford for a product that has not passed rigorous tests to be placed on an aircraft. Every product is certified for its quality. But one of the issues faced by Airbus is that in remote locations such as some African countries, and even farther a field, maintaining an aircraft becomes a monumental challenge as does tracking that the parts fitted are only those certified. For one thing there's the volume. About 1,000 new aircraft are manufactured each year and another 25,000 are currently in service.

"Without master data automatic decisions are difficult."

Doug Clark, Leader IBM S&A Solutions

Airbus has estimated that around 3,500 parts lend themselves to RFID-based tracking per aircraft - that equates to a tag requirement approaching 92 million and an inventory beyond measure. It is not that engineers will purposely fit unsuitable parts, nor that the substitute products are poor quality, but it can be hard to tell the difference and as Airbus is responsible for the aircraft, it cannot afford to take any risks. At around $10 per tag, 20 times the cost of more common read-write tags, it adds up to too many trailing noughts to contemplate. But it is expensive for good reason. The tags used in the exercise, which has now passed its pilot phase, incorporate 20 times the capacity of normal tags because of the service information requirements of the industry. The hope is that during the next two years this capacity will be increased to 6kb, 60 times the normal capacity rating. This is because the tag will carry the history of the part and its usage through its entire life.

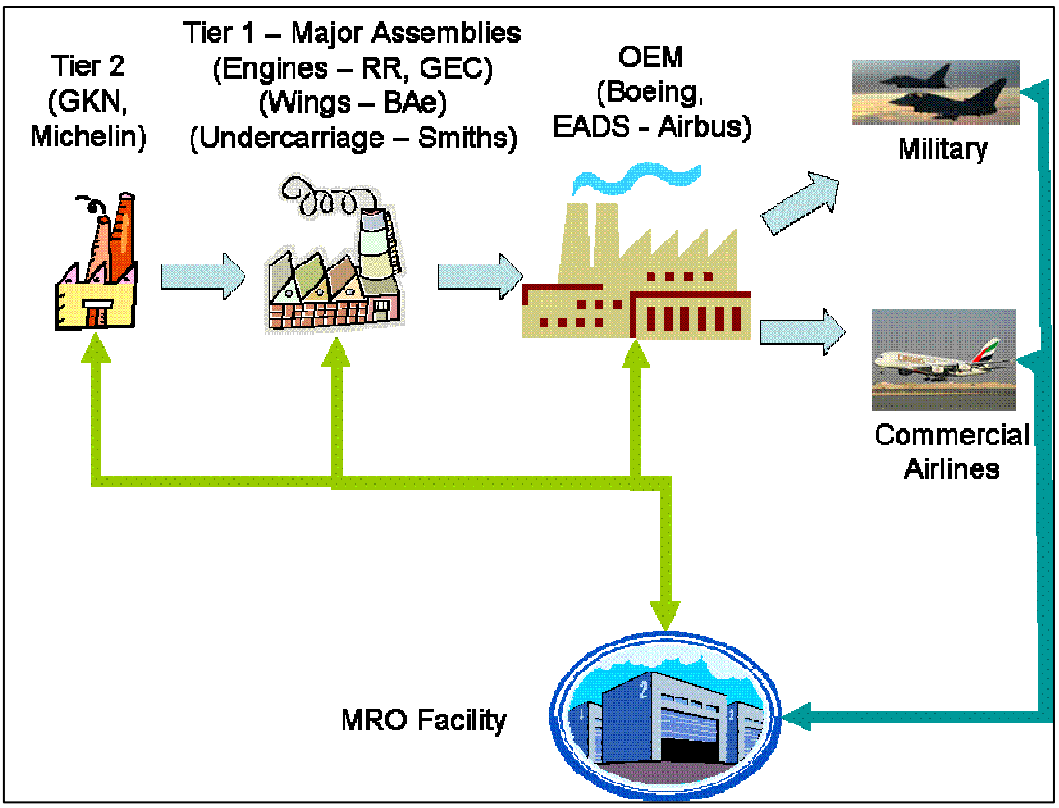
An alternative approach to storing the information on the tag would be to use a product information system. Here the tag would only hold its unique identity. When an inspector came to look at a part he would be equipped with a mobile reader which would interrogate the tag and pick up its unique identity. It would then use this as a key to call a web transaction.

[3] Aerospace ID Technologies Programme, Duncan McFarlane, Cambridge Auto ID Labs, June 2005

Production and Supply Chain Visibility

AMR Research[4] estimates that there is between $16 billion and $30 billion of waste still in the US aerospace and defence supply chain – approximately double if considered globally.

Figure 8: The Complete Aerospace Supply Chain



Aerospace, like the automotive industry is a global industry with a tiered structure from OEM to Tier 1 to Tier 2 suppliers and so on. To improve supply chain efficiency there is need for greater visibility.

Today's consumers are becoming increasingly demanding and this is causing supply chains to have to adapt into demand chains. At the same time there is increased complexity with scope for new problems. Out of stock is a major concern with lack of visibility in the supply chain and increased pressure through lean manufacturing of less inventory / stock being held. Consumers, be they wholesalers, retailers or healthcare providers, want to know where their goods are. Good, user friendly and now familiar environments already exist (e.g. Amazon and DHL). There are more participants in the supply chain, which is leading to more shrinkage, counterfeiting, copying, damage and tampering. Most organisations see that these issues lie outside their boundaries with their suppliers or logistics companies. However in practise it has been found that these issues are also prevalent within organisational boundaries, particularly where there is movement from physical site to site locations or where a site covers a large geographical area. Therefore production visibility is just as important here as it is for the supply chain; real data for management is necessary.

"Tracking is just knowing WHERE the part is.

Tracing means having all the part history on the part. It is not the same as tracking."

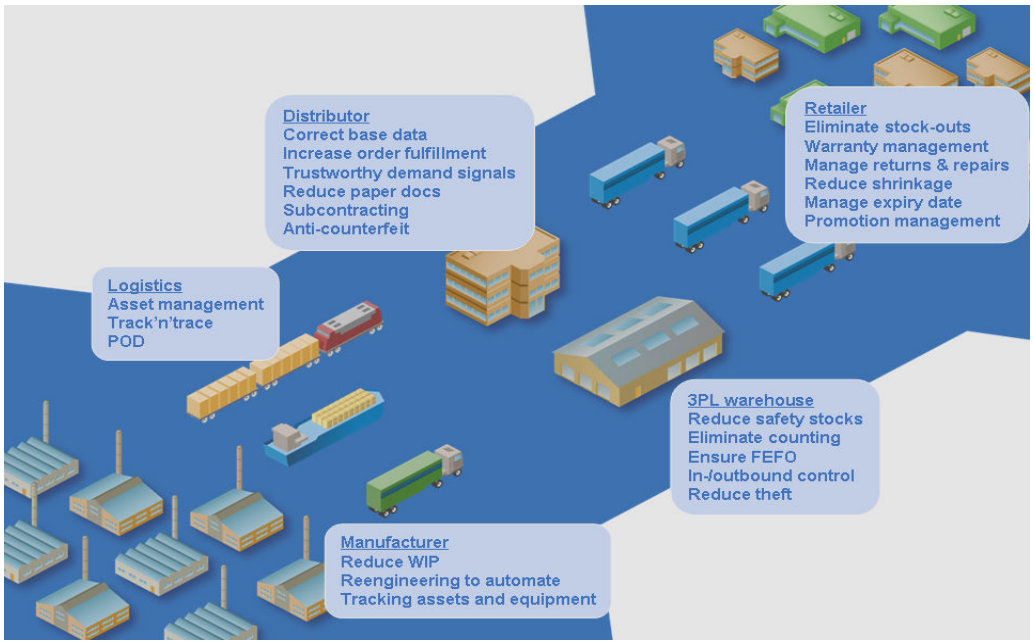
Jens Heitmann, Airbus

Modern warehouses have complex requirements. Fast product cycles, the need to decrease inventory and increase the flow through the supply chain mean that warehouses cannot remain static. Virtual real time data must match the supply to demand. Furthermore, many light manufacturing operations, such as final assembly, customised packing, labelling and engraving have been moved from shop floors to warehouses and distribution centres (DC).

Javed Sikander, Microsoft's Director of Industry Architecture, in an article[5] on MSDN stated, "Businesses strive to make their supply chains more efficient by improving the information sharing throughout the supply chain. At each node in the supply chain, forecast and actual sales from the next node are collected, and planning may be done on what and how much to make, which drives what and how much to buy from the previous node. Today large demands are placed on manufacturers, distributors and retailers along the chain to maximise efficiency, minimise cost and provide the best value to the end-customer."

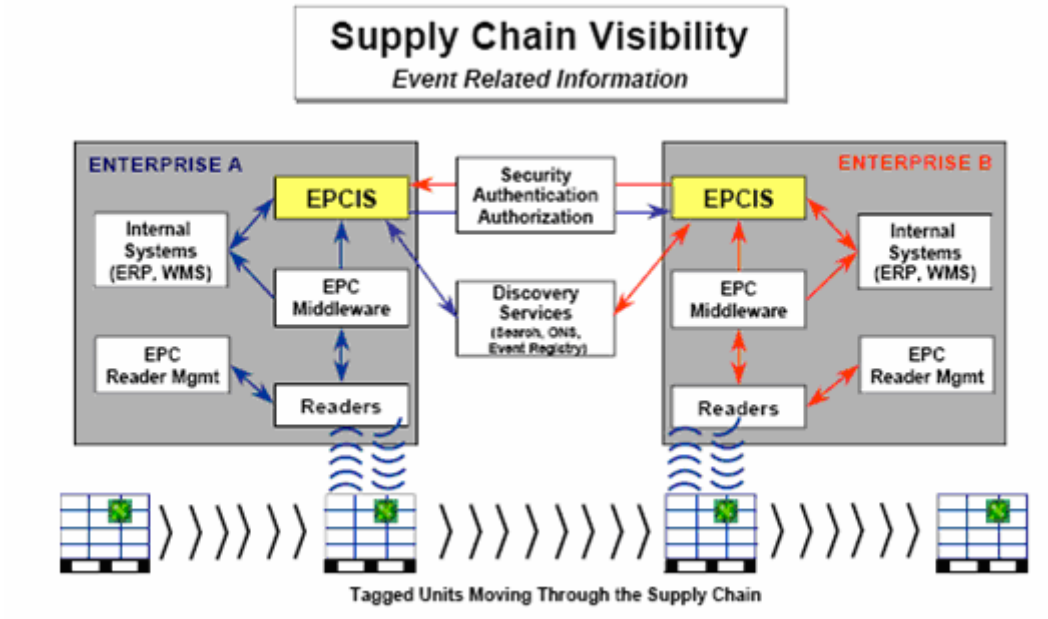
[4] Aerospace and Defence Industry Outlook, AMR Research
[5] RFID Enabled Retail Supply Chain, Javed Sikander, Microsoft Corporation, April 2005

Figure 9: Supply Chains are Complex Networks



EPCglobal's stance is that RFID provided the mechanism to provide the visibility necessary in today's complex supply chains. It envisages a sharing of information between companies.

Figure 10: EPCglobal Network



Source: EPCglobal

But to handle this network effectively, you have to tackle the biggest issue; that during the supply chain the same product may be referred to by different product codes. The benefits of synchronised data are far-reaching, both from an internal and an external perspective. The sharing of data between trading partners is now one of the most important supply chain processes, as the integrity of the information is critical for the uninterrupted flow of goods. The term used to describe this phenomenon is Global Data Synchronisation (GDS). (For more information on GDS please refer to the Microsoft white paper entitled Global Data Synchronisation).

Maintenance, Repair and Overhaul (MRO)

MRO is the sector in the industry where aerospace companies make their most revenue. But like all reverse logistics operations it suffers from time delays and visibility issues.

Every day airlines face the challenge to reduce operation and maintenance costs and they are forced to look for better options. Advances in information technology (IT) have leveraged the development of enterprise resource planning (ERP), business process management (BPM), corporate process management (CPM), and computerised maintenance systems (CMMS). Although these solutions have been designed for general purposes, some of their features can be applied to very specific organisations. Yet, though the number of solutions is increasing there are currently only a few CMMS systems that can be used specifically in the aviation industry.

"Rolls Royce - MRO RFID goals:

1. Reduce cycle-time: approx. 17k components managed across third parties repair sites – warehouse – final assembly
2. Ensure SLA is achieved"

Ivano Ortis, IDC European Vertical Markets, May 2006

CMMS or maintenance, repair and overhaul (MRO) systems for the aviation industry have evolved, and now include modules or applications that can provide reports containing summarised information or can communicate with other systems. Juan Francisco Segura, professor in the aviation industry at Universidad Iberoamericana, Mexico 6, identified that the need for a CMMS system depended on the size of the fleet and the maintenance control requirements. There are small airlines or air taxi fleets that control their operations using Microsoft Excel or Access and use Microsoft Project for their forecasting or maintenance planning.

The requirements of the MRO events (standard maintenance activities, problem resolution, directives) are generally the same:

- Identify problem
- Access the logbook
- Locate required parts
- Retrieve proper docs
- Locate certified personnel
- Locate required tools
- Complete checklists / history log
- Obtain release certificate

There is no doubt that cost (both escalating and varying) provides one of the first signs that more information is required about the maintenance processes. Why does the cost of maintenance service vary when it is applied to two aircraft of the same type? IT is also given that interchangeable parts on aircrafts are replaced regularly, representing a huge ongoing administrative task for manufacturers whose job it is to ensure airworthiness of aircraft in service. But with up to 70% of a mechanic's time spent locating parts, the process is strewn with inefficiency. RFID technology, or more rightly the solutions which incorporate RFID, can greatly reduce these inefficiencies and ensure due diligence in terms of maintenance.

When a RFID tag is assigned to a component in order to record every stage of its repair work, one is able to track the process from its removal from the aircraft to its subsequent reinstallation. By linking this tracking and tracing RFID-enabled system to an organisation's CMMS/MRO, this system can have automated input of location information to enable engineers to locate it and to know exactly what type of repair work was performed and by whom.

RFID tags can also be assigned to materials (rotational and consumables) for their distribution to the stations, warehouses or maintenance bases. Information regarding what components were sent, received or are in transit, as well as their description, part number, serial number and lot, is able to be maintained and recorded.

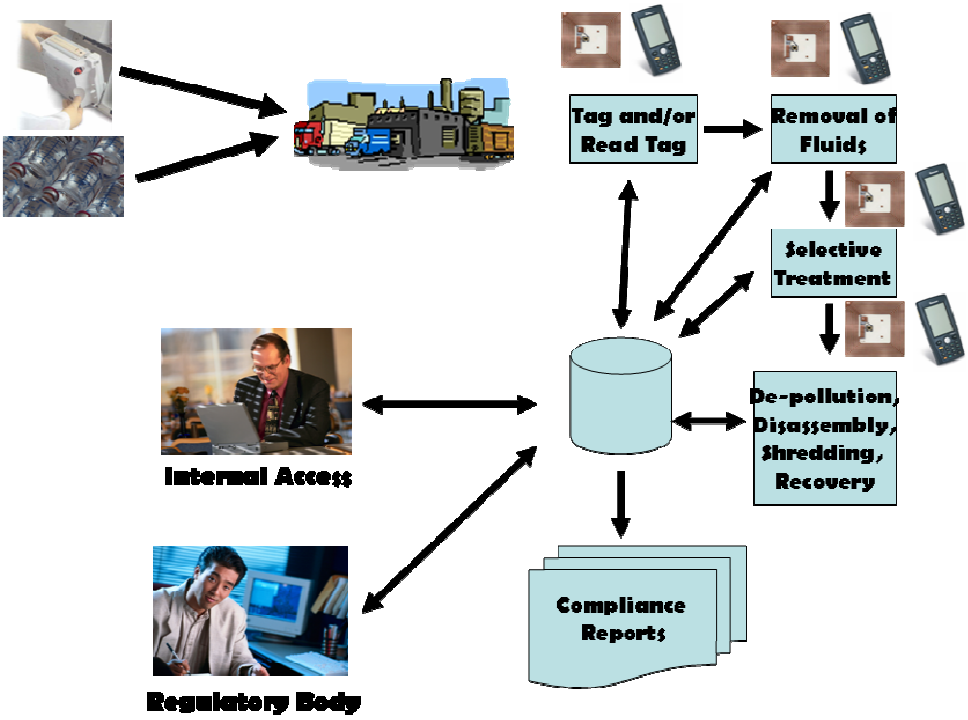
RFID tags can also be used on tools used for the disassembly process so to control who is using the tool and since when. A particular use with gauging tools is that the system will associate identity code on the tag to its description, manufacturer and the date of its next gauging, in order to attract the necessary anticipated attention to the tool.

MRO shops just like any factory have goods receipt and despatch areas where inventory is stored. The use of RFID to provide detailed tracking and tracing information to manage a warehouse is well known from automotive and CPG industries.

[6] CMMS in the Aviation Industry, Juan Francisco Segura, Technical Evaluations.com, 9 June 2005

All the situations just described involve a great amount of documentation. Links between RFID and document management systems are in their infancy at the time of writing. With the aerospace and defence industry involving also a large amount of regulatory documentation as well, I can see RFID being used to automatically trigger the production or updating of compliance documentation.

Figure 11: RFID with Document Management and Workflow Management Solution for Compliance



Source: Microsoft Corp, 2006

However, we must understand that these information benefits are medium term, because it takes time for the system (or the database) to collect all the records that are necessary to perform an analysis. The results of this analysis will allow us to know the maintenance times, the materials used, etc. which will have to be interpreted by those employees who have enough knowledge and experience.

Analysing the information should be helpful for:

- Maintenance planning.
- Material planning.
- Personnel planning.
- Financial planning.

Of course, the economic and man hours benefits will vary for every case and system.

One benefit that has already been realised from a project at Airbus is the assurance of legitimate replacement parts used in place of possibly inferior counterfeits. It is estimated that the use of counterfeits was costing Airbus over $8 billion in replacement costs.

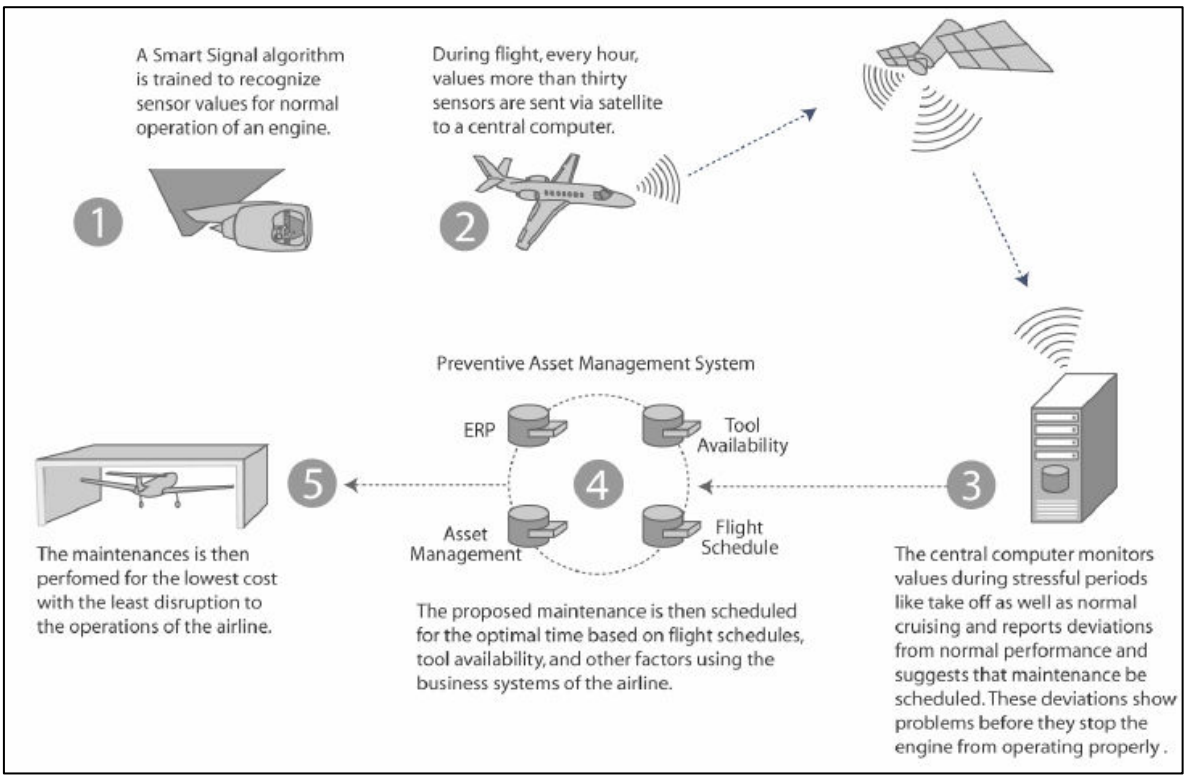
- Solutions:
  - Minimise unplanned maintenance
  - Manage revisions
  - Optimise inventory (out of stock)
  - Rapid identification of the right parts in the optimal location
  - Mechanic can access doc, task and parts info via RFID HH devices; locate and track approved spare parts
  - Identify and track tool location, usage history and repair requirements

"MRO supply chain is about safety and security, as well as efficiency. A&D companies have evolved a new supply chain equation: maintenance strategy + supply side strategy = supply chain strategy. RFID can fulfil many MRO event requirements by enabling real-time track-and-trace and unique identification."

Michael Liard, Research Director, ABI

- Benefits:
  - Overall reduction in maintenance costs
  - Minimise time out of service - more seats in the air
  - Improve customer and regulatory compliance
  - Improve quality and safety
  - Auto-completion of required maintenance forms
  - Full fleet health monitoring
  - Improve worker productivity and reduce human error factor

Figure 12: Automated MRO Scenario



Source: SAP

Virgin announced in August 2005 that it had started trialling RFID to track parts at its Heathrow Airport warehouse. Gareth Lewis, IT services director at Virgin Group[7], stated that RFID was helping Virgin Atlantic to keep its planes in the air longer. Every part of the aeroplane is tagged with RFID. A mobile reader is used to interrogate the tagged aircraft to get a snapshot of all its component parts, thus providing a quick and efficient way of seeing what is in the plane. Virgin can call up all the details of the engine of a plane and see whether it can keep it flying for another day or week before it has to service it. This boosts efficiency.

RFID is very useful in monitoring the performance of the aircraft maintenance process and in tracking components and operations in the technical warehouse.

This technology speeds up the data recording processes in a maintenance system, making them reliable and avoiding human error, and brings savings in the number of man hours used in paperwork. However, to install a wireless network and radio frequency antennae, the safety and integrity of the data must be ensured - this subject will become more important as the use of wireless networks spreads worldwide.

[7] RFID keeps Virgin planes in the air, Graeme Wearden, ZDNet UK, February 21, 2006

Plant Maintenance

Plant engineers are beginning to identify opportunities for RFID by considering areas where timely and accurate data collection and access to readings are important. Asset maintenance is one function in particular that can benefit from using RFID to access and update important information.

Every manufacturing organisation has to plan the maintenance of its plant resources. The maintenance of plant is a cost in terms of lost production time. The biggest issue is the amount of unplanned maintenance that can occur and its serious impact on tight production schedules. So how ca RFID be used to help control and manage plant maintenance?

I will use the example of some work done in BP[8]. BP tackled the plant maintenance issue at two levels. Firstly, it digitised operator rounds to improve efficiency and avoid unplanned maintenance. This supported the refining business's drive for a "highly reliable organisation" by capturing the complex work rules into mobile applications. The processes followed are the same each time and are based on best practice. RFID is used to give a unique identification of the assets. As the operator checks the asset so an audit trail is automatically produced. The mobile applications are used to automatically generate work orders. The result is that instead of the work being to respond to breakdowns, it has been transformed to preventing them.

To reduce unplanned maintenance, BP is also trialling mote technology with a combination of RFID and wireless technologies used to capture "secondary readings" and environmental data in their refineries. Mote / sensors cost a fraction of the cost of wired sensors. Drawing upon BP's experience in using this technology in one of its ships, Loch Rannoch, BP worked out how to bring motes / sensors together with intrinsically safe requirements into a fully packaged solution.

Where in the aerospace and defence industry are there similar circumstances relating to plant maintenance? Well from a product side we have talked about the use of RFID to provide more automated MRO already. On the production line and in the testing beds RFID could be used in the same way as it has been used by BP.

> The cost of maintaining a machine is a direct function of the maintenance frequency and failure interval for the machine and major components, the time and labor required to complete unscheduled maintenance actions, and the time and labour required to complete routine maintenance tasks.
>
> National Institute of Occupational Safety and Health

Hazardous Waste Disposal (RoHS and WEEE)

The new EU directives around waste management provide a new opportunity to use RFID for tracking and tracing visibility in a compliance arena.

The European Commission worked for a number of years to understand the environmental impact of electrical and electronic waste, and concluded that the volume, the toxic content and the relative ease of recovering and recycling important materials justified EU wide action. The environment is defined as the 'surrounding in which an organisation operates, including air, water, land, natural resources, flora, fauna, humans and their interrelation.'[9]

The WEEE directive and RoHS directives pass into law throughout the EU in August 2004. In spite of the fact that this process is well advanced in the UK and elsewhere, many commentators have observed that there is a lack of understanding of the issues for EU businesses. There are also key details of the legislation that even at this stage are not fully finalised - yet the legislation effectively contains retrospective elements, so many businesses are already substantially affected!

The practical upshot of this is that the equipment you are purchasing now is already adding to your problems under WEEE legislation, unless you have established asset management programmes to ensure that every major asset is fully tracked and every minor asset is trapped at time of disposal. The cost of implementing such policies at the last minute will be prohibitive for most companies, and the recycling industry is predicting major problems as companies that have left it too late find themselves on the front page portrayed as environmental vandals. The scope of WEEE includes:

- Large and small household appliances.
- IT and telecommunications equipment.
- Consumer equipment.
- Lighting equipment.
- Electrical and electronic tools (with the exception of large-scale stationary industrial tools).
- Toys, leisure and sports equipment.
- Medical devices (with the exception of implanted and infected products).

[8] Sensory Networks in BP, Mike Haley, BP, Chief Technology Office, RFID Networking Forum, May 2005
[9] ISO

- Monitoring and control instruments.
- Automatic dispensers.

Under the directive there is a dual focus: the producer pays the cost of recycling schemes (a producer is, for instance, a computer hardware or medical equipment manufacturer), and businesses are obliged to implement appropriate disposal policies or face penalties.

Creating automatic systems that provide the user organisations with the process of disposal and also the ability to prove compliance is what is required. Using RFID either when the goods are produced to show when end-of-life occurs or when goods are returned to the original supplier can help with the tracking and tracing of the goods through this special version of reverse logistics. There is a major requirement to prove that a company has complied with procedures for the safe disposal of material. Therefore RFID in conjunction with workflow management and document management provides a solution to this problem.

Health and Safety – Hazardous Conditions

All manufacturing organisations have a remit to provide a safe environment for their employees. Safety is linked to environment issues as well. HSE provides another area where RFID can provide visibility.

All major organisations have a key corporate responsibility for the safety and health of their employees. For instance, in Rolls Royce Statement of Accounts for 2005[10]: "Rolls Royce recognises that exceptional HS&E performance makes sound business sense. Our strategy is to protect our employees, contractors and the wider community; attract and retain a motivated workforce; maintain business continuity; avoid asset damage; and reduce overall costs. We also aim to have zero injuries and environmental incidents and to minimise the environmental impact of our operations."

Boeing is committed to providing a safe and healthy workplace for its employees, and to protecting the environment. Safety, health and environmental improvements are an integral part of the company's efforts to become more efficient and productive.

Smiths Group is committed to ensuring that, as far as is practicable, any detrimental effects of its activities, products and services upon the environment are minimised. Smiths Group is committed to conducting all activities in a manner which achieves the highest practicable standards of health and safety. It has been working hard to give EHS issues a high priority in the way it does business in Smiths and our performance derives from integrating EHS responsibilities into our day-to-day management activities.

How can a company ensure that an employee when entering a hazardous operating zone is authorised to enter that zone, and if not authorised is accompanied by an authorised person? How can the employer ensure that the appropriate safety clothing is being worn by that employee?

Let us look at how one organisation, BP has tackled this problem. In 2005 at a BP refinery, there was a major incident in which a number of people were killed or seriously injured. BP set out to see how RFID could be used to improve safety and operations efficiency at chemical plants, refineries and E&P facilities by locating workers[11]. They wanted:

- To be able to track workers who perform tasks in large, remote or dangerous environments and to quickly locate workers in an emergency.
- Warnings to be provided to workers in hazardous environments.

BP set up some trials to prove the concept, with the aim of refining them to prove operational feasibility by addressing intrinsically safe, form factor, size and cost issues.

One of these trials involved the use of RFID tags to check that protective clothing and equipment was being used correctly. This check occurred as the employee was about to leave the control (safe) environment and enter the hazardous zone. The RFID reader in the confined entry point checked for the following:

- Is correct clothing being worn?
  - Safety equipment – hard hat, goggles, gloves, etc?
- Is breathing apparatus detected?
- Is there a "permit to work"?
- Is there more than one person present and who are they?
- Do those present have valid training certificates?
- The trials also involved integration with local handhelds or back-end systems.

[10] Rolls Royce Statement of Accounts 2005, Rolls Royce Web Site
[11] Sensory Networks in BP, Mike Haley, BP, Chief Technology Office, RFID Networking Forum, May 2005

Figure 13: Safety Equipment Check

Source: Sensory Networks in BP, Mike Haley, BP, Chief Technology Office, RFID Networking Forum, May 2005

Implementation Challenges of RFID

Besides the technology, RFID projects, because of their close relationship to business process improvement and effectiveness require a high degree of change management skills to achieve successful implementation.

Implementing RFID involves a multitude of challenges. Multiple goals of a RFID deployment can lead to a complex project. It's better to focus on a few clear objectives. "The fragmentation of the business case is forcing people to be more cautious and more analytical in how they approach the technology", Overby of Forrester Research said in an interview.

The other big challenge she says, "continues to be cost" although Overby predicted that the adoption of the EPC Class 1, Gen 2 standard will put downward pressure on pricing. The Gen 2 standard makes the use of one secure tag possible worldwide and it is expected to aid adoption of RFID across all industries. Other challenges include:

Resistance to change. Many organisations today rely heavily on manual processes or bar code scanning to track goods. In any organisation, moving from the familiar to new technology poses a challenge especially when it requires process change.

Established bar coding infrastructure. In many manufacturing facilities and distribution centres, bar code systems have been used for many years. Since bar code systems are efficient and represent a substantial investment, it can be difficult to justify a change to RFID.

No one size fits all. Today's RFID systems are customised for each deployment. "In fact, a successful implementation typically requires considerable experimentation to achieve adequate read rates and the delivery of actionable information to appropriate recipients" says Alok Ahuja, Microsoft's Senior Product Manager, RFID.

Environment. The physical properties of the products to be tagged, the antenna design and other environmental factors can make it difficult for readers to work reliably. Liquids absorb radio frequency signals, metal reflects them. As a result, performance can be affected by the item on which the tag is attached. External factors like RF noise from nearby electric motors can also impact on performance. However, as RFID technology matures and experience increases, tag and reader placement will become less an art and more of a science.

Lack of integration. Lack of integration and isolated islands of automation can pose other problems for those considering RFID. Manufacturers' enterprise resource planning systems may not be linked in real time to shop floor systems. Currently, integration with back-end systems generally requires creation of custom interfaces, an often time-consuming and expensive undertaking.

Lack of skilled personnel. RFID-knowledgeable IT personnel are hard to find. Many organisations, regardless of size, will discover they have no qualified IT personnel in certain locations.

"RFID represents both a major IT modernization and a major investment for organizations. While the initial costs of implementation are substantial, companies should leverage the opportunity for cost-saving process improvements by embracing the technology's ability to give near real-time visibility into inventory, asset locations, and operations."

Cougaar Software

"In the final analysis, it's not about the cost of the tags. It's about staying in - and ahead of - the game."

Association of Automatic Identification and Mobility

Evolving standards. Managing multiple readers and related hardware can be a challenge, especially across multiple facilities. That's because global standards governing how RFID devices communicate with higher level systems are evolving. At present, communication between hardware and software requires custom configuration. The situation is similar to that found in the early days of personal computing when a specific vendor driver was required to link a printer to a PC and print documents. For those moving forward with RFID deployments, the fluid standards situation makes it imperative that system components provide an easy, inexpensive upgrade path.

Data overload. A RFID reader will continuously scan each tag several times per second as long as it remains in its read range, so the potential for data overload must also be considered. Some readers can be programmed to eliminate duplicate information, but data volume still can be overwhelming to the network. The reason: RFID systems can capture information at more points than were practical with manual or bar code systems. Because few ERP systems were originally built to accept a high volume of low level data, RFID system designers typically include some data filtering at the edge (device level).

Data noise. The torrent of RFID data (called "noise") can overwhelm readers or cause ambiguity, especially in dense reader environments where scanning areas may overlap. Read rates are improving but are often not anywhere near 100% due to unreadable, damaged or missing tags. In addition, because reading is based on proximity, mistakes can happen. A reader, for example, may read the tag on an item passing by on a forklift rather than on a stationary target. To prevent inaccurate data from being transmitted to enterprise applications, a successful RFID solution must be able to deal with erroneous or missing information.

Multiplicity of vendors. No single vendor does it all, so most RFID systems must be assembled from multiple sources. This can create integration obstacles if hardware and software don't work together.

Resistance to information sharing. In systems that depend on information from various trading partners, information sharing issues must be resolved to achieve maximum benefit.

Privacy issues. Finally, some privacy advocates claim RFID will violate consumer privacy and have become vocal opponents of the technology. Although much of what they fear isn't currently practical (or in some cases, technically feasible) these critics are being heard. Of particular concern is the use of RFID technology without advising the consumer of its presence and how it is being used. Vendors and users of RFID should be committed to using the technology responsibly and be vigilant about any perceived or actual misuse of personal data.

While companies have to justify an acceptable ROI for the costs associated with implementing RFID, they often overlook the price of not implementing it. Some considerations are:

- Will profitability eventually decrease if the status quo is maintained?
- Will the company lose a potential competitive advantage?
- Will the company eventually lack sufficient accurate information about its processes or inventory to effectively manage its business?
- Will customers' perception of the company suffer?
- Will the company be able to catch up once competitors implement RFID?
- Will existing inefficiencies become unmanageable as the pace of business continues to increase?
- Not to be entirely negative, you also want to ask this question:
- Will RFID enhance your company's ability to serve its customers? Improved customer service and customer loyalty are sometimes difficult to quantify. Sometimes it is easier to look at the negative side to understand the value of customer service. In other words:
    - What is the cost of losing a customer to a competitor that offers better service?

When you look through all the scenarios described in Section 3, it becomes very apparent that the solutions involve not just the use of tags and readers but also support for integration with ERP solutions that run company's businesses, collaboration with supply chain partners both up and down the chain, and security / privacy support. This requirement plus all the issues discussed above, mean that the architecture in question must be both agile as well as heterogeneous in nature.

How does Microsoft BizTalk RFID Address the Business Needs?

Microsoft has entered the RFID market with a view to reduce the costs and provide an environment that allows ease of operation and use.

To encourage widespread adoption of RFID technology and address the customer pains of managing multiple devices, smoothing the data, translating data into meaningful events and combating costly integrations, Microsoft is developing a layered RFID infrastructure, named BizTalk RFID, using an open building block approach. It relies on related Microsoft applications platform products and a growing number of integrated partner solutions. This approach provides a wealth of solutions for any size organisation or industry vertical, including manufacturing, pharmaceutical or aerospace. Also, the combination of Microsoft's technology platform plus partner solutions offers a multiplicity of applications reflecting the broad potential of RFID.

"The idea is for Microsoft, together with its partners, to provide one-stop shopping for a RFID solution."

Anush Kumar, Program Manager, BizTalk RFID, Microsoft

BizTalk RFID enables compliance, automation and business process transformation while shielding users from changing standards / regulations. Toward this end Microsoft is developing core infrastructure components to support RFID applications and solutions. It is also RFID-enabling select systems within its family of Microsoft Dynamics enterprise applications products. The infrastructure provides a base set of tools for device abstraction and management, event processing and applications integration.

Independent hardware, software and systems integration partners play a key role in developing RFID applications based on the Microsoft .NET® foundation technologies and Microsoft's applications platform products such as BizTalk Server, which provides data integration services for supply chain operations. BizTalk RFID can be embedded within third party applications or used on its own to capture and interpret data from sensors and manage business events in an easy-to-deploy, user-friendly environment.

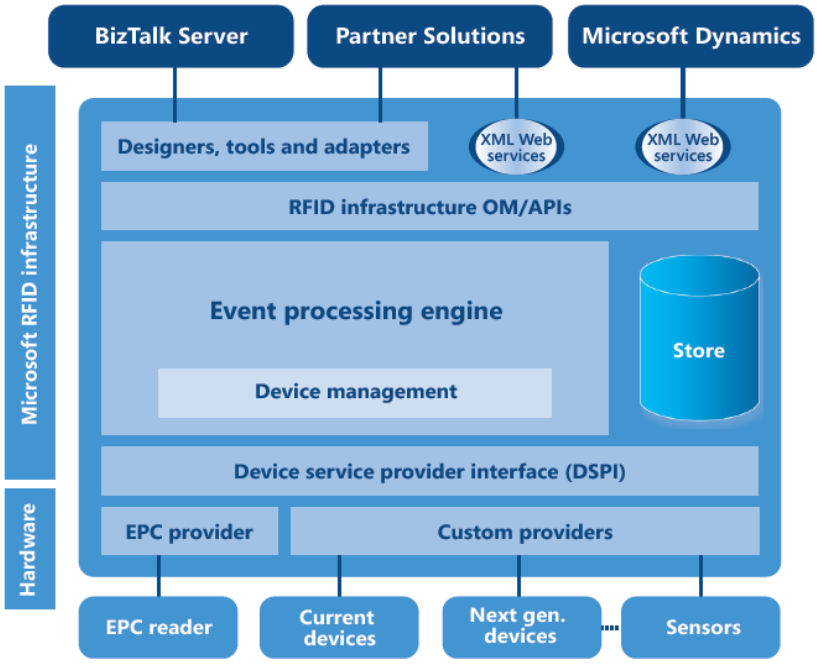
Microsoft's Layered Approach

The approach is based on a layered architecture.

BizTalk RFID platform consists of layers (see Figure 14):

1. Devices, such as readers and sensors
2. The Device Service Provider Interface
3. Event processing engine
4. RFID APIs
5. Tools and adapters

Figure 14: Microsoft's BizTalk RFID Architecture



Source: Microsoft Corp., 2006

Data transmissions from EPC readers and other devices from multiple vendors are processed via a Device Service Provider Interface included in BizTalk RFID. It provides a platform for independent software vendors and system integrators to install hardware in a plug-and-play fashion, resulting in a complete and seamless RFID solution.

Because the layers are tightly integrated, applications and devices can seamlessly interconnect. Here's how the layers work together:

Devices layer

The bottom devices layer consists of hardware such as RFID readers, printers, sensors, bar code scanners, 802.1X access points for wireless local area networks, handheld terminals and Pocket PCs, which are provided by partners.

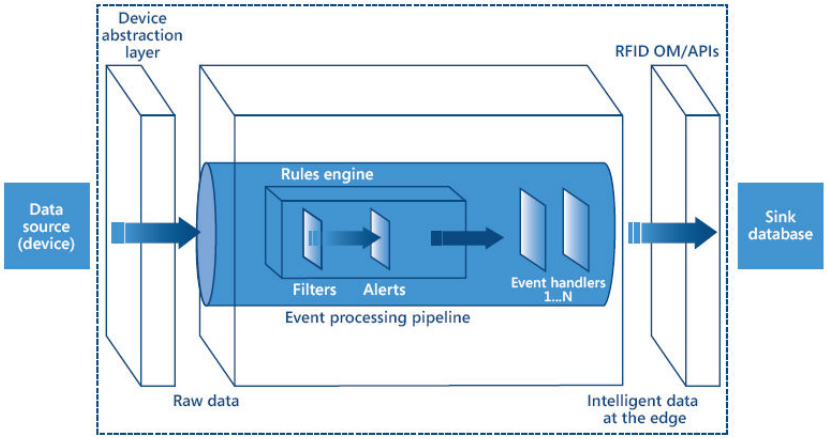
Data collection and management layer

To accommodate the potentially large variety and number of devices that could be resident in a RFID implementation, a Device Service Provider Interface (DSPI) provides a consistent way for devices from multiple hardware vendors to expose their device services to the Microsoft platform. DSPI provides a scalable, extensible infrastructure that allows customers to read data through any standards-based or non-standards-based sensor regardless of format, thereby reducing dependency on a specific technology and protecting RFID investments long term.

Event processing engine

This layer includes event and workflow management, messaging and a business rules engine. The event engine enables context-based or rules-based processing of RFID data to provide information directly to line-of-business applications. Information also can be delivered to business processes that span applications via Web services integration and orchestration products such as BizTalk Server. This layer provides the structure for integration across multiple facilities and partners. It includes device management, to convert data into business process relevant information (see Figure 15).

Figure 15: The Event Processing Layer



Source: Microsoft Corp., 2006

An event, such as the movement of a box with a RFID tag from a conveyor belt to a pallet, triggers a data transmission that is processed by the rules engine. The rules engine determines which enterprise application is updated about the box movement and also automatically triggers any alerts that were incorporated into the business rules.

"This enhances flexibility, reduces the expenses related to building applications and simplifies integration, particularly when legacy systems are involved." Alok Ahuja, Programme Manager, BizTalk RFID, Microsoft

Services layer

The services layer includes product information resolution lookup, business process management, analytics / reports / notifications and enterprise content solutions.

BizTalk RFID makes it easy for partners to embed functionality directly into their application or build applications on the infrastructure. Open application programming interfaces (APIs) and .NET-centric tools allow partners to quickly create specialised vertical solutions across a wide range of applications.

The services layer also provides lookups to EPCIS servers where data about a tagged object resides.

Application solutions layer

This uppermost layer relies on services, data and tools from the lower layers to implement application solutions that drive business processes for the end user. Microsoft relies on its partners to build out many of the solutions, which are divided between two classes of applications: real-time enterprise / point applications and batch-oriented enterprise applications. In addition, BizTalk RFID also supports the Microsoft Dynamics family of enterprise applications.

Business Benefits

BizTalk RFID offers many potential business and technology benefits to those considering RFID systems today. In all cases, careful attention has been placed on open standards and overcoming the shortcomings of today's custom systems. Thus, BizTalk RFID is designed to lower total cost of ownership, simplify integration end-to-end from the device level to back-end applications, convert data into actionable information and provide a platform where Microsoft and its partners can build applications that take advantage of the volume and real-time nature of RFID data.

Lower total cost of ownership

One of the most significant potential benefits is helping clients leverage existing investments in Microsoft Windows Server 2003, SQL Server and BizTalk Server as well as popular ERP and CRM systems, including Microsoft's own integrated ERP systems; Microsoft Dynamics. "The idea is for Microsoft, together with its partners, to provide one-stop shopping for a RFID solution," says Anush Kumar, Program Manager, BizTalk RFID. These familiar tools also shorten the learning curve and make the applications easier to use.

Simplified integration

BizTalk RFID allows for seamless integration of devices with provisions for discovery, configuration, communication and management. Essentially, it provides ways "to integrate data from disparate sources from the physical layer such as shop floor, warehouse floor and trading partners and governs how information flows through the stack and ends up in business solutions that partners or Microsoft Dynamics provides," says Alex Renz, RFID Program Manager, Microsoft Dynamics.

Because DSPI basically makes hardware such as readers and printers plug and play, it helps system builders assemble the optimum solution and focus on larger project issues without worrying whether a driver exists. Meanwhile, organisations deploying RFID are better positioned to take advantage of the hardware innovation and falling prices that DSPI promotes.

Firmware updates can be performed remotely across an enterprise to eliminate the need for physical intervention. "With potentially hundreds of readers on a network, you want to be able to update firmware remotely," says Overby of Forrester Research. "You don't necessarily have IT staff at the distribution centre to configure hardware so the network recognises it."

Hardware health can also be monitored remotely. "The platform sends readers health monitoring events to confirm they are working," explains Microsoft's Renz. If a reader doesn't respond as expected, an administrator receives an alert so corrective action can be taken.

Converting data to actionable information

Above Microsoft's devices layer, an event processing engine filters incoming noise while providing alerts and transformations. It reduces the data "noise" created by the volumes of redundant data it receives and converts it into actionable information. This functionality is enhanced by the use of English-like vocabularies for rule creation and a high degree of built-in configurability, making it easy for users to modify. Similarly, performance and scalability are built in so large volumes of irregular event streams can be handled and deployment can be distributed.

Built-in edge processing includes a highly flexible and configurable rules engine that addresses potential business problems. For example, if a shipment of 24 cases is expected but only 20 tags are read when it arrives, the system can send an alert so the operator can check the pallet. The operator can then confirm the presence or absence of the four unread cases and transmit accurate receiving information to the enterprise application. Whether done at the edge or centrally, processing of data is transparent to the user.

Data management also requires context. Is the object arriving? Departing? This information can be provided by sensors on the device layer that show the direction of movement, or it can be done by a combination of history and rules. For example, if the system has seen an object before, it would suggest it is departing rather than arriving. Adding the context of pending orders provides further confirmation of status.

Application platform

Open APIs and a rich object model make it easier for partners or users to build new RFID-enabled applications or integrate RFID data with back-end applications. "This enhances flexibility, reduces the expenses related to building applications and simplifies integration, particularly when legacy systems are involved," explains Microsoft's Ahuja. Tools include a centralised dashboard for device monitoring and configuration and a tag data simulator which permits RFID events to be simulated without input from actual devices. Tight integration with BizTalk Server and existing enterprise software make it possible for partners and clients to convert RFID events to BizTalk Server messages and build closed loop "RFID aware"' business processes.

Details of a sample of Microsoft's key partners who are developing RFID-based solutions can be found on www.microsoft.com/partners

Building RFID Applications with GlobeRanger iMotion

Solidsoft has recognised the need to provide support for RFID applications to exploit the RFID data. Solidsoft has teamed with GlobeRanger to offer the iMotion suite.

Widespread RFID deployments, increasing numbers of other Edge devices and high transaction volumes are exposing the limitations of existing infrastructure and applications. Compliance with customer mandates drove many initial RFID deployments; however, today's deployments are moving beyond mere compliance to involve more processes, applications, readers and higher transaction volumes. Users who met compliance mandates with minimal investment are now encountering problematic system limitations:

- Insufficient system scalability.
- Performance bottlenecks.
- Inadequate support for management of tens, hundreds or thousands of discreet Edge devices.
- Inflexible Edge architectures and Edge platforms.

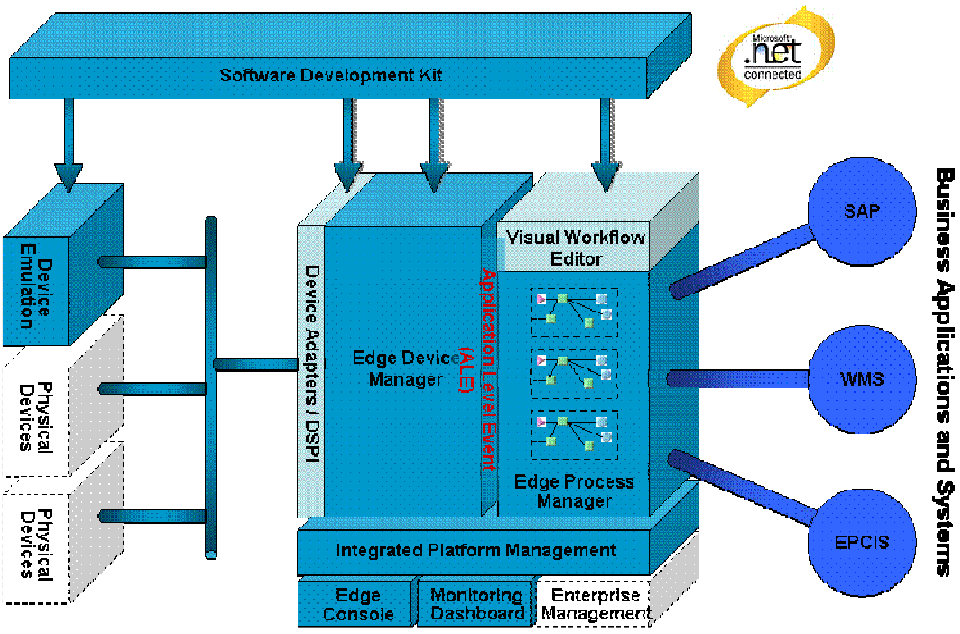
Companies must acquire the ability to effectively extract meaningful and actionable information from this growing sea of data generated by a collection of Edge devices in order to put the information in a business context and then access other integrated existing systems to take appropriate action.

"The market increasingly demands ready access to shipment information at the item level. GlobeRanger provides us with the ability to meet our customer requirements while addressing our need to capture transaction information for real-time decision making."

Kai Timmermann, VP, Gilbert USA

To this end Solidsoft has partnered with GlobeRanger to offer the iMotion® Edgeware™ platform. This platform is built specifically for these production-scale implementations of RFID and sensor technologies. iMotion system management and device monitoring enable operation staffs to instantly monitor and manage equipment locally or centrally throughout the network of facilities from a single location. iMotion maintains optimum functionality across the entire network of devices, including: passive RFID readers; motion sensors; light stacks; printers and handhelds, and the flexibility to quickly adapt and integrate new technology as it become available. iMotion serves as the foundation for edge solutions, providing a platform runtime for managing devices and Edge processes, a software development kit (SDK) for easy extensibility, pre-build process components for rapid implementation, and comprehensive tools for rapid solution development, production deployment and on-going operation. Based on Microsoft's .NET Framework, iMotion enables business consultants, application developers and systems engineers to easily create, configure and manage RFID solutions.

Figure 16: GlobeRanger iMotion Component Architecture



The iMotion Edge Management Console (EMC) provides graphical real-time monitoring and control of device networks and allows Edge processes to be executed, both locally and on a global basis from a single management console. iMotion abstracts the physical device layer, isolating applications from device configuration details. This capability enables the sharing of RFID and sensor infrastructure across multiple applications, maximising ROI. Operation and performance information for devices is available through industry-standard SNMP and WMI interfaces, allowing for integrated monitoring of RFID solutions through standard network-management and system-management systems.

"We've taken the first steps towards providing our customers with the most secure and protected pharmaceutical supply chain."

Robert Kashmer, VP of Information Technology, H.D. Smith

Data delivered through the EPCglobal standard Application Level Events (ALE) interface, provides immediate interoperability with any ALE-conforming application. iMotion is EPCglobal ALE 1.0 certified. The iMotion platform includes components that enable connection to RFID and sensor data streams through the industry-standard ALE 1.0 interface. Configuration capabilities give solution developers the ability to easily select and utilise the desired data.

iMotion enables the rapid evolution of software systems by leveraging modern, agile software frameworks and technology. iMotion extends the state-of-the-art rich, rapid application development (RAD) environments provided by Microsoft with equally flexible technologies specific to sensor-based environments.

Standard support is available for major HF and UHF RFID readers: Class 0, 0+, 1 and Gen 2. New readers are easily supported by downloading new reader adapters.

RFID data must be combined with business context to create actionable events for consumption by upstream systems. iMotion's functions enable rapid development and deployment of Edge process workflows. Business logic flows are constructed by drag-n-drop of process components, minimising the cost and time required for updates and business rule changes. The Event Workflow Editor provides the benefits of customised solutions without the expense of custom development.

Bundled, pre-built workflow components enable rapid solution development. Components for standard notification methods such as e-mail, file and database logging, HTTP POST, audio alerts and visual displays are provided. Adapters to other data sources and upstream systems can easily be developed using iMotion's software development kit.

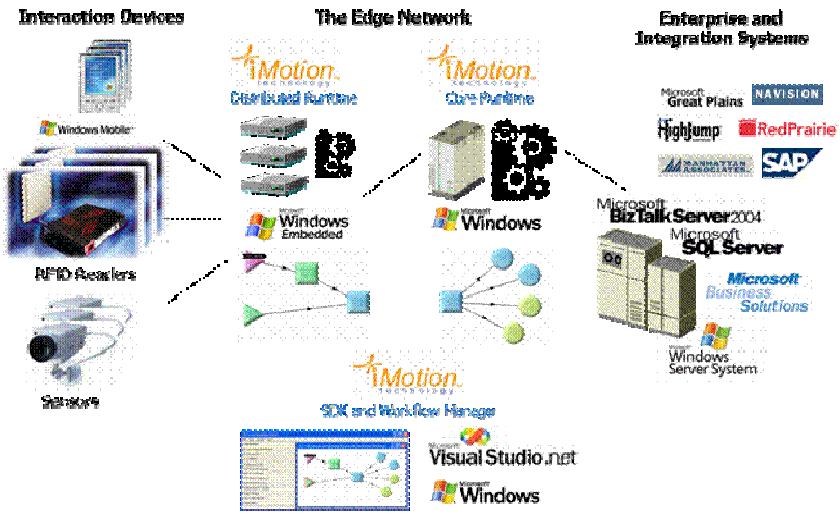
Edge Process Runtime and Management provides reliable and controllable execution of Edge processes, fully distributable to enable scaling across a site or an entire enterprise.

iMotion visual tools address all stages of solution development and delivery, maximising productivity and ROI. The Visual Device Emulator simulates real-world behaviour of RFID readers, printers, tags and other sensor devices, providing solution developers with the ability to model physical deployment scenarios prior to actual equipment purchase. In addition, iMotion's Visual Device Emulator eliminates the dependence on physical hardware for development, testing and integration of RFID systems. The Event Monitor displays an accurate, real-time view of RFID tags being read. It captures history and analysis of tag-read events for application tuning and optimisation.

Software Development Kit (SDK) provides a comprehensive set of .NET classes and APIs that enable rapid development of custom workflow components. These components drop into the Event Workflow Editor (EWE), providing the same drag, drop and connect configuration as built-in components. The SDK is fully integrated with Visual Studio .NET, providing templates for rapid ramp-up with minimal training. Sample components and applications are included to jumpstart development efforts.

When looking at Edge to centre processing requirements then Solidsoft exploits the capabilities of Microsoft BizTalk Server to provide the necessary links to ERP and other central applications being updated with Edge application data.

Figure 17: GlobeRanger iMotion Scalable Solution



Conclusions

The business benefits of using RFID in the aerospace sector can be summarised as:

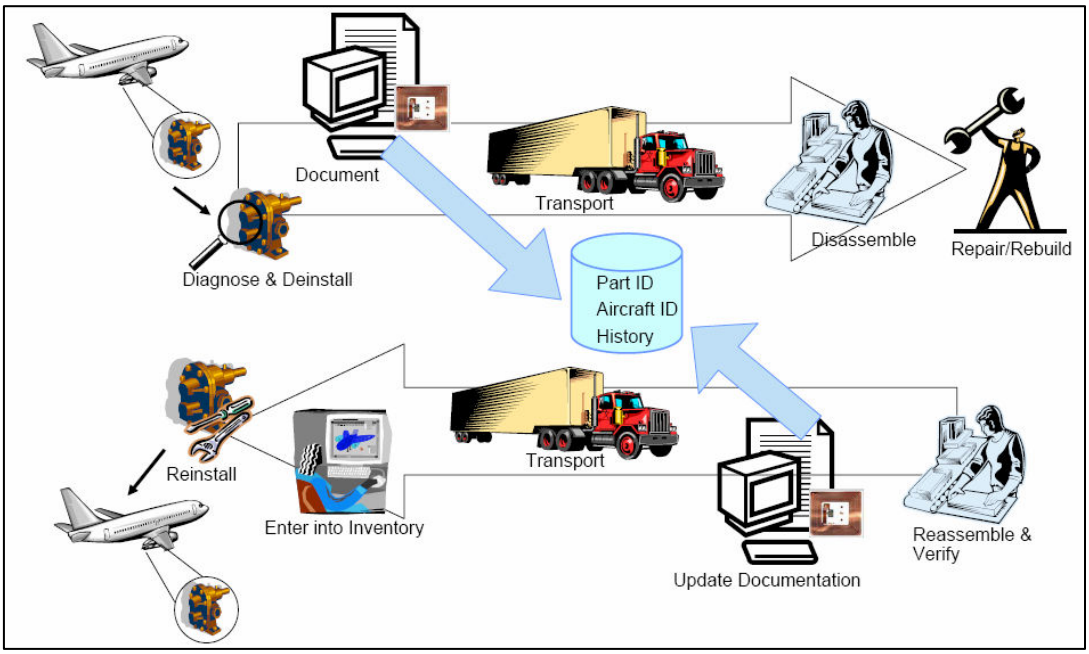
- Safety and security - authenticating assets.
- Improving track and trace, reducing shrinkage.
- Improving field maintenance and spares supply.
- Managing and reducing airline parts inventories.
- Establishing audit trails for each uniquely identified object.
- Real-time component performance information.
- Early malfunction detection.
- Real time aircraft / system usage.
- Real-time subsystems monitoring.
- Confirmation that the correct part is being used in the right place according to specifications.
- Warranty-related data also can be collected with RFID.
- RFID can be used as a quality management tool.

University of Cambridge Auto-ID Aerospace ID Technologies Programme, in a recent presentation, showed post 2006:

- Technology: clearly specified, cost effective, logical mix of ID technologies and low and high class RFID.
- Applications: moving asset based, multiple application, multi company pilots, public demonstrators.
- Standards: tags, product data, network management and support (interfaces).
- Prices: at pre 1999 ratios for all classes.
- Vendors: vendors focussed on industry as a whole.

In the longer term, what will we see? A number of organisations have talked about the RFID enabled aircraft. This environment would provide the best conditions for cutting costs in the MRO scenario, as well as providing ePedigree authentication of parts, as shown in Figure 18.

Figure 18: The RFID-enabled Aircraft: Pipe Dream or Real Possibility



Source: Aerospace ID Technologies Programme, Duncan McFarlane, Cambridge Auto ID Labs, June 2005

This scenario is based on there being a limited number of readers, but a large number of antennas, which cover seats, maintenance spaces, crew areas, holds and doors / hatches, supported by the use of Intelligent software to provide not only automatic collection and correlation of data, but also business intelligence information.

The potential of RFID technology is enormous. Realising the value however, requires a business-wide approach:

- Maximise the value through understanding the full breadth of the implications and opportunities presented by the technology
- Minimise the risk of failure through appreciation of the pitfalls involved in RFID technology selection, integration and implementation in the end to end supply chain
- Bring the right skills to bear, including:
    - Supply chain process reengineering
    - RFID physical layer implementation
    - Technology integration
    - Enterprise systems
    - Finance and tax planning
    - Regulatory implications
    - Program management
    - Change management
    - Corporate and social responsibility

Solidsoft's experience of designing, developing, testing and successfully implementing Business Process Management and Integrations solutions using Microsoft Technologies provides Solidsoft with the ideal credentials to assist organisations in getting the best ROI from RFID. Solidsoft utilises a framework approach to the delivery of solutions in one or more of the following:

- Product information management.
- Track and trace, especially for reverse logistics.
- Agile delivery.
- Maintenance, repair and overhaul.
- Authentication.
- After service.
- Health and safety.

Through a network of world class partners, including ISVs, hardware vendors and specialist business consultancies, Solidsoft delivers RFID solutions, on a Microsoft platform, that add value to businesses and enable fast returns on technology investments.

Solidsoft is playing a leadership role in RFID through participation in a number of industry initiatives. Solidsoft is a leading member of the Microsoft Partner Advisory Council for RFID, which includes future releases of Microsoft BizTalk Server, including the future RFID platform.

Microsoft recognises Solidsoft's ability and agility to deliver innovative business solutions based on Microsoft technologies. This culminated in Solidsoft being chosen as Microsoft's Global Technology Innovation Partner of the Year 2006 in the Business Process & Integration Solutions category.

The key to realising the benefits of RFID technology is treating it as true enabler of business re-engineering – a step change in improving both integrity and efficiency.

Author

Simon Holloway, Solidsoft's Principal Industry and RFID (Radio Frequency Identification) Consultant is responsible for the development of all RFID-based solutions within Solidsoft. He is a valued member of Microsoft's Partner Advisory Council for RFID and has written numerous white papers on RFID in a Microsoft environment, from general to industry specific perspectives (aerospace and defence, pharmaceuticals, supply chain and construction).

Before joining Solidsoft, Simon spent three years in the role of Manufacturing Industry Architect and RFID Lead at Microsoft EMEA. Prior to that he worked for five years as the iPlanet Product Marketing Manager for Northern Europe at Sun Microsystems, and additionally spent over 15 years working as a principal consultant for a number of IT strategy houses.

Simon has written a number of books on data management, methodologies and CASE (Computer Aided Software Engineering) tools. He is also a regular speaker at events and a contributor to articles.