Project IST-034144: SToP
Stop Tampering of Products

Deliverable 4.4

Analysis, Design, And Preparation Of Production, Assembling And Training Processes For The Production Of Smart And Verifiable Products Using RFID

Leading Partner: SPC

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Executive Summary

The mission of SToP is to develop secure, comprehensive, usable, cost effective and convenient product authentication mechanisms to reduce the trade of illicit products. The project has developed a distributed, collaborative, ambient and intelligence-based network-oriented system that enables enterprises, including producers and distributors, as well as customers to manufacture, deliver and purchase authentic products.

The platform developed during the project now provides for the first time a proven solution of for successful integration and deployment of the novel RFID applications that achieved the consortium's anti-counterfeiting objectives, that have been tested in real life settings, and that ar ready for wider scale deployment.

Using the experience and outputs of the SToP project, this report 4.4 focuses on how to definitely use, integrated and deploy RFID as the cornerstone technology for next generation anti counterfeiting solutions.

1 Introduction

1.1 Project Description

SToP is an EU subsidised project that has developed an anti-counterfeiting solution for companies concerned with or affected by fake products, including luxury goods companies, pharmaceutical companies, and aviation companies. These companies, with a central role in the fight against counterfeiting, require a solution that achieves their objectives and requirements in a cost effective manner.

To achieve these end users requirements, the solution developed by SToP since project inception now combines advanced smart identification hardware technologies (primarily RFID, and other technologies) with scalable software and architecture components, in a comprehensive secure network infrastructure.

For society, application of the completed solution will ensure product safety where fake products (such as pharmaceuticals, aviation spare parts, toys, etc can be potentially dangerous or even lethal) are eliminated or reduced.

For companies, deployment of the completed solution company wide will significantly contribute to eliminating counterfeiting and its adverse consequences on the companies' brand, sales, market share, revenue, operating profit, litigation costs, and working capital.

The completed SToP platform enables immediate implementation and integration into the particular companies' product portfolio, offerings, and processes to eliminate counterfeiting and its consequences for the respective companies, customers and partners; as well society as a whole and national authorities.

1.2 Objective of Deliverable 4.4

Deliverable 4.4 is the fourth and final report generated in Workpackage 4 which related to Solution Engineering and hardware research and development to achieve SToP anti-counterfeiting objectives.

This document summarises and revisits the Workpackage 4 outputs and deliverables in their entirety, and provides a definitive guide to preparation for implementation and deployment of the SToP RFID based anti-counterfeiting solutions. The paper focuses on providing clear directives on what is required for successful adoption and deployment of the SToP technology.

1.3 Relation to Tasks, Deliverables and Workpackages

Workpackage 4: This deliverable summarises and updates the other Workpackage 4 deliverables following the real life pilot experience and testing. Deliverable 4.1 analysed the most promising anti-counterfeiting technologies and approaches from a SToP perspective (including RFID). Deliverable 4.2 focused more specifically on RFID analysis for selection, deployment and implementation of RFID solutions. Deliverable 4.3 concentrated on integration of smart RFID tags in products. Deliverable 4.4 pulls everything together from this workpackage as well as Workpackage 5, providing the analysis, design, preparation, training, and deployment of the SToP RFID based anticounterfeiting solution.

This deliverable leverages real life implementation experience and learnings to provide final recommendations for the project generally, as well as Workpackage 4 tasks specifically.

1.4 Document Structure

The paper commences with a recap of the important factors to consider when deploying and RFID system. Thereafter the theoretical analysis prior to the live pilot trials (ie Deliverable 4.2 and 4.3) is comprehensively compared with the practical findings post live pilot trials. The report then goes into detail regarding the likely required specifications for companies and industries considering using RFID for anti-counterfeiting solutions for use by companies and other interested parties planning or exploring the deployment of RFID enabled anti-counterfeiting solutions.

2 General Considerations For Companies

A number of variables were proposed for consideration in Deliverable 4.2 prior to deployment of the real life pilot trials. These are again described here in view of the completed trials, and validated and updated as to their relevance and importance to successfully deploying RFID based anti-counterfeiting solutions.

2.1 Performance

Companies need to consider a number of trade-offs between performance, cost, read range, read speed, impact of metal, and tag placement overt versus covert etc. No single RFID frequency/solution can ubiquitously satisfy a customers requirements – the correct technology needs to be selected for the correct application.

2.2 Standards

There are currently no specific global anti-counterfeiting standards in place or under development. This is for good reason since there is an inherent conflict between making solutions widely available for end-users on one hand, while on the other needing to keep the solution from being exploited, undermined and breached by counterfeiters.

2.3 Security

Companies should implement privacy and security of anti-counterfeiting systems that include but are not limited to frontend ie tag and reader security measures such as “kill command”, PKI, the integrated usage of alternate IDs, tag-level encryption, prevention of tag reuse, randomization of IDs, etc; as well as backend ie software and enterprise infrastructure security.

2.4 Tag Design

There is a vast permutation of tag form factor characteristics such as size, shape and materials; and how they are to be integrated into or affixed to the product. It is essential companies consider and finalise tag integration early in the project. Successfully integrating a technology into a product is almost as, if not more, important than the technology itself.

2.5 Process Integration

Companies must identify the point at which RFID based anti-counterfeiting solutions are implemented. The earlier in the supply chain implementation occurs, the more secure the supply chain and the more control can be exerted over products to reduce illicit trade.

2.6 Economics

Cost is a major factor in deploying RFID, but must be considered from a total cost perspective rather than on individual tag unit costs, and the threshold level at which positive NPV and ROI is generated.

2.7 Reader Selection and Deployment

Deployment of the optimal system for end users require substantial engineering time and effort regarding i) frequency and technology selection ii) design of read points infrastructure including antenna height/angle/size, protective shielding, and electromagnetic radiation interference. Project planning must take this into account

2.8 Tag Selection and Deployment

Tags must be analysed in detail to ensure that the selected inlays provide the requisite performance, are easily integratable, and capable of withstanding the full production and distribution challenges and environments of the application including shipping wear, temperature extremes, and material handling machinery. Specific factors considered must of essence include [KCSJ04]:

- sensitivity: selected tags must be sufficiently sensitive to both receive and send signals irrespective of the application, process or environment
- orientation: selected tags must be read irrespective of the orientation of the tag in the read volume
- tag proximity: selected must not interfere with each other when placed close together.
- form factor: selected tags must be easily integratable into products
- read speed: selected tags must be capable of being read sufficiently quickly for the respective applications
- memory requirements: selected tags must have sufficient memory size for use as (depending on the application) either ‘license plates’ that point to central databases, or memory banks that store the complete tag history and data
- global regulations: selected tags must comply with global standards where relevant
- collision avoidance: selected tags must be capable of dealing with multiple tag replies

- security: appropriate security measures/encryption must be supported by the tags
- form factors: selected tags must be appropriately and simply integrated into the products or packaging for respective anti counterfeiting purposes

Thus additional specific questions that must be answered prior to adoption and deployment included:

- size of tag necessary for the application
- overt or covert placement
- maximum read range for the applications
- multiple tags (how many) or single tags only to be read simultaneously
- minimum time available to read products eg on conveyor belts
- tag affixed or integrated into the product
- environmental conditions including minimum & maximum temperatures, humidity, water, chemicals, solvents, metals, or mechanical impacts
- read only or read-write tags
- anticipated tag life required
- target price for the tags

3 Results and Outputs of Real – Life Trials

Deliverable 4.2 outlined pre live trials – ie theoretical - analysis, design, and preparation of production, assembling and training processes for the production of smart and verifiable products using RFID. Following completion of the live trials, Deliverable 4.4 compares and updates those outputs with the practical benefit of having actually deployed the solutions in real-life pilot settings. This section provides a confirmation or update of pre – and post – pilot findings.

3.1 Aviation

The main learnings from the aviation trial were:

3.1.1 Performance

With the FAA approval of the use of passive UHF RFID tags on individual airplane parts for commercial aircraft, it opened up a number of potential RFID-based applications for airlines.

Low data density is mostly used for simple information listing, i.e. informing the RFID reader of the number of identical items within one package. Long distance reading for total data capture is possible. Communication with several tags simultaneously under an anti collision system is also possible. The anti collision system enables the reader to receive data from each tag on a one-by-one basis. When multiple tags are in the same radio frequency and transmit data together, the reader communicates with the tags to prevent the collision of data.

High data density is used for tracing of goods when a complete, unambiguous part history is needed - important in the aviation industry. Each component that is traced has a unique identification and history. It is not sufficient to know the number of units received, but more specifically: where did the part come from, where was it installed, how many hours was it operated, who repaired it, who installed what type of software last and so on. It requires short distance reading to ensure accurate readings, with communication taking place exclusively with a single tag at a reading distance within centimetres. The chips used in Airbus applications are set today at a capacity of 4 kilobytes with dimensions of just 8 millimetres (0.31 in.) in diameter and can be flush metal mounted.

Both HF and UHF passive RFID tags can be deployed, depending on the part being tagged and its location. An HF tag can operate in the same single frequency around the world, which gives it an advantage over a UHF tag because different nations of the world have assigned a different UHF frequency in which a UHF tag can operate. But if UHF tags were available that could be read across a range of frequencies, much of the incentive for HF tags would be lost because a single UHF tag could then be read anywhere in the world.

3.1.2 Cost

The cost of RFID tags will fall further in the next few years due to the anticipated increase in volumes – an important consideration for the aviation industry. The deployed solution cost will depend of the complexity of the tag (with or without sensor), memory requirements, and the method to access the tag data.

3.1.3 Standards

The following standards are recommended based on airworthiness regulations, authentication application requirements and ATA standards in line with Airbus vision [KHE08] :

3.1.3.1 Technical Standard

ISO 15693 passive, read-write operating at 13.56 MHz
ISO/IEC 18000-3 (parameters for air interface operating at 13.56 MHz) RFID for item identification air interface
ISO/IEC DTR 24729 information technology - RF system implementation guidelines for item-level tagging

3.1.3.2 Conformance Standard:

ISO17367 supply chain applications of RFID for item level tagging; provides proposed guidelines for the verification and qualification of design and manufacture for RFID tags

3.1.3.3 Data Standard:

Spec2000 chapter 9, memory description for high memory RFID (64kbit) + unique ID: SSN (Social Security Number)

3.1.4 Security

The recommended secure RFID tag in aviation anti-counterfeiting application is a secure and unique RFID tag and reader specially created for aviation industry specified as following:

– for HF 13.56 MHz, 64kbit (high memory) tag operating – passive mode complying with ISO/IEC 18000, ISO/IEC 18000-3-2, ISO/IEC DTR 24729, ISO17367, ISO 15693 and ATA Spec2000 chapter 9 standards and authenticated PKI-enabled RFID reader.

– equipped with kill command, microwire, and digital signatures complying with the IEEE's PKI encryption standard.

3.1.5 Business Integration

Special read/write software for RFID applications is required to read, write, and add data on the chip. As the software is independent, it can be used with any system allowing integration into all existing data processing systems. Special software is also required to transfer the data into companies Enterprise Resource Planning system. Airbus uses a specially developed interface for RFID data exchange with Airbus' ERP system.

Figure 1 : Aviation Secure Chain

3.1.6 Tag Integration

Many alternatives exist for tag integration. The destruction of a tag needs to be ensured if removed from a part or tool. It is essential to prevent counterfeit parts equipped with tags from scrapped components. Each tag must have a valid serial number. Manufacturers can use the chip to prevent unapproved parts entering the supply chain.

Safety tests with RFID tags were performed to identify any risk of defect or interference in the hostile environments common in commercial aircraft operation. Tags were exposed to severe conditions followed by read and write experiments. Safety tests to be satisfied include temperature changes, chemical liquid exposure, humidity, lightning induced transient susceptibility, electrostatic discharge, shock and vibration as well as fire impact. None of the physical impacts had negative effects on the read write functionality or data integrity. Neither did the hostile test environment cause defects in the tags. The tag is resistant against a temperature range from minus 50°C to plus 70° C, safe against aggressive Liquids and safe from electromagnetic interference (EMI).

Figure 2 : RFID Tag Integration For Aviation Industry

3.1.7 Reader Selection

A mobile solution is preferred to allow authorized person to update data on the RFID tag and for example to walk in the cockpit to check and update the tag information.

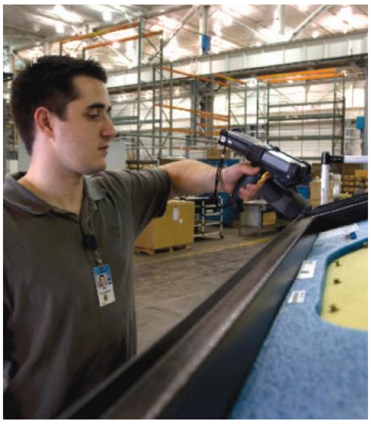

Figure 3 : Handheld Reader In Action

3.2 Luxury Goods

The main learnings from the Luxury Goods trial were:

3.2.1 Performance

The product authentication is based on the product information recorded in the PVI from the manufacturing point to the point of sale and in some cases at the after sales point for the maintenance procedure. In order to increase the confidence of the product authentication, other events must be recorded in the PVI along the supply chain. The watch authentication is based on the information recorded at the manufacturing point and checked at the point of sale or after sale. This requires a 100% reliable data feed from the products, using RFID technology irrespective of the heavy presence of metal in the watches.

By ensuring the performance of the RFID system, automatic data collection is possible during the supply chain. The system must read up to 10 RFID codes embedded in the metallic back case of the watch.

The RFID tag will be used for both individual item product authentication as well as supply chain management when multiple watches are transported using dedicated boxes.

Figure 4 : Watch Transportation Boxes

3.2.2 Cost

The cost analysis of the authentication solution must include:

- the RFID tag cost (chip, antenna assembly, test)
- the integration cost (during the watch manufacturing, test and PVI record)
- the reader cost at each step (manufacturing point, supply chain, point of sale, after sale)

The main part of the cost will be the integration study of each watch. This study will define the RFID tags parameters, performance and integration depending on the material used in the watch and the size of the watch.

3.2.3 Standards

For watch products, the RFID standards ISO 18000-x are actually not usable for the watch use cases if the tag is embedded in the metallic part of the watch. To secure a specific brand supply chain, a standard is not necessary and in fact introduces a vulnerability or weak point for product authentication or reduce the performance.

However, for leather good applications a standard UHF Gen 2 protocol can be use due to its ability to read a box of several items. The security of the protocol must be improved by adding a security layer in the RFID chip.

3.2.4 Security

In order to increase the data security, a combination of technology (optical, RFID and numbering) can be used on the product, and recorded in the PVI. Incorporating RFID tags into product labels or even into the product itself provides a valuable tool for brand owners. A tag inserted at the point of manufacture can identify a products source. The tag's unique ID certifies that the product is authentic and also makes it possible to identify and control counterfeits. Grey market imports can be controlled through the use of source identity. RFID tags enable inventory visibility throughout the supply chain, reducing shrinkage and out-of-stocks.

3.2.5 Business Integration

Recorded data in the PVI must be available at every point of reading in order to validate the product authenticity. A secure network based on the EPCIS must be available at the watch manufacturing point, the global and local distribution centre and the point of sale.

3.2.6 Tag Integration/Selection

During this project, several exhaustive tests have been performed to select the best RFID tag function for the use cases and application/environmental conditions. Leather and metal have an important impact on the radio frequency field - RFID technology, position and size must be carefully analysed.

For watches, proprietary RFID technology is required.

For leather goods, the tag is based on the EPC UHF Gen 2 using a propeller inlay

3.2.7 Reader Selection

Following end user requirement, specific reading stations have been developed to allow RFID tag reading throughout the supply chain for both watch and leather goods items.

Depending on the type of products to be identifying (leather goods or watches) the authorized person needs to use the right reader equipment. The reader (base station) must be able to read any kind of tags (LF, HF, UHF), and needs to work at the right frequency or needs to be able to work at all appropriate frequencies and protocols. That kind of agile reader does not exist right now but might be developed in the near future to solve this aspect of scalability and usability when 2 or 3 types of readers may be required.

3.3 Pharmaceutical

The main learnings from the Pharmaceutical trial were:

3.3.1 Performance

Read and encoding rates are a key point for RFID adoption in the pharmaceutical industry, especially when the authentication features must by applied on the packaging line. Encoding HF item-level tags on packages cannot achieve the packaging line speeds over 120 bottles per minute. The HF protocol simply cannot accommodate a higher speed. A company could split the line, but that is very expensive and invasive. Using UHF tag packaging a line can run at 250 bottles a minute but the errors rate is still too high.

For these reasons, the barcode technology is required to be used until RFID technology can achieve the packaging line requirement. From a barcoding perspective, 2D Data Matrix or composite code is preferred for its robust structure and the volume of data that it can encode in a very small space.

RFID and 2D variable data matrix codes are both capable of providing mass serialization on pharmaceutical packaging. In fact, many pharmaceutical companies may well begin with 2D and progress towards RFID.

3.3.2 Cost

Currently a pre-printed label with a blank RFID inlay is about €0.20 per label. Pre-encoded RFID inlays in labels have a price of approximately €0.35 per label.

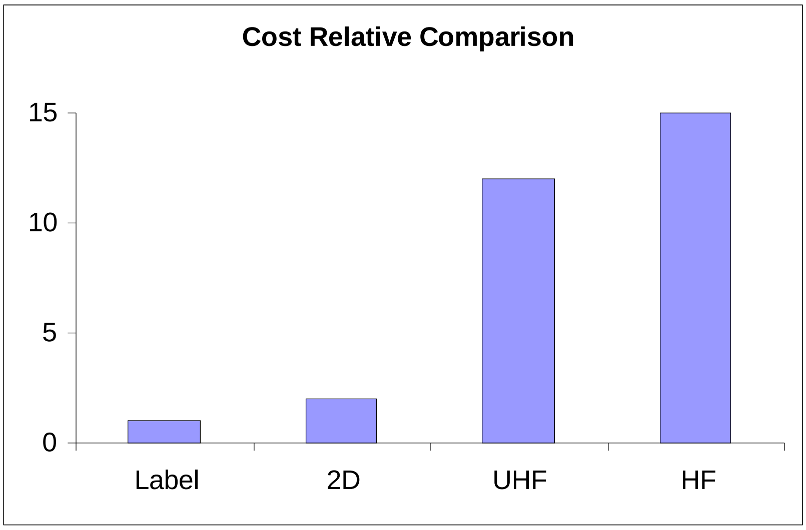

Figure 5 : Cost Comparison

Supporting several data carriers multiplies costs and complexities for all trading partners, while also imposing operating inefficiencies.

Synchronization of serial numbers between multiple data carriers ALSO adds complexity and overhead.

Barcodes continue to be the most cost effective, but performance, automation and usability remain limited

3.3.3 Standards

The FDA ePedigree (ie full audit trail and chain of custody from manufacture to retail) mandate for all drug packages explicitly requires package serialization. This is best done with RFID technology, but it is also possible with either a 2D or RSS barcode. For RFID, the radiofrequency identification tag is placed underneath the label on the drug container or embedded in the package.

EPCglobal standards are in place for the fundamental components of the serialization architecture, such as tag data formats, data filter and collection, EPCIS and ePedigree.

Many companies are effectively working with their trading partners to agree on interoperability standards in lieu of a final word from the industry.

The information included within the data carriers is compliant with all current global standards as required by the national pharmaceutical regulators and FDA, incorporating information such as Expiry Date, Lot Number and Product Identifier (GTIN) and with the capacity to include a unique serialized number or code such as an EPC number

3.3.4 Security

Using the RFID tag, information can be added and updated through the supply chain. Security or encryption-based technology protectS the data on the tag.

The presence of a RFID tag should be clearly indicated by text or symbol.

With respect to data storage, the 2D variable barcode is, in effect, static after the code is first created and information can't be added once the code is created.

3.3.5 Business Integration

Until RFID can achieve the speed requirements, mixed technology solutions may be required. 2D and RFID-enabled printed packaging and packaging line systems technology can be combined to provide the necessary serialization and ePedigree solutions - and is integrated into existing ERP and enterprise applications to verify product authenticity throughout the pharmaceutical supply chain.

3.3.6 Tag Integration/Selection

The RFID tags can be integrated with several methods:

Figure 6: RFID Tag Within Vial Seal

Figure 7: RFID Tag Within Cavity Of Plastic Bottle

Figure 8 : 2D Barcodes On Vials

The combination of 2D barcode and RFID can be achieved (and was evaluated) using a converted label as follow :

Figure 9 : Label Of Pharmaceutical Samples Used In The Trials

The layout of the label must be well defined to avoid RFID failure during the datamatrix printing process

The quality of the RFID inlay conversion into a label to the integration into packaging material requires focus

Phase / Failure Rate				
	IC / Inlay Manufacturing	Converting	Packaging/Delivery	Application/Use
Range	1% to 30%	1% to 10%	1% to 6%	1% to 30%
Typical	5% to 6%	4% to 5%	3% to 4%	5% to 6%

Table 1: Failure Rate For RFID Inlay In Supply Chain Phases

Analysis of RFID production results (Table 1) has revealed two distinctive RFID inlay failure modes. One mode was mechanical stress; the other was electrostatic discharge

Depending on the materials and methods used in production of the transponder antenna and the chip bonding method and orientation of the transponder on the substrate, every transponder has a minimum allowed bending radius (radius of curvature). Flexing or bending the finished Passive RFID transponders media to a radius smaller than this minimum radius at any point in the application process may result in RFID failure either from antenna fracture or breaking of the chip-antenna bond. The RFID label manufacturer should be able to provide the value for the minimum-bending radius. In absence of specific information, one practical rule is to never bend the Passive RFID transponders labels to a tighter radius than that of the core on which the labels were supplied.

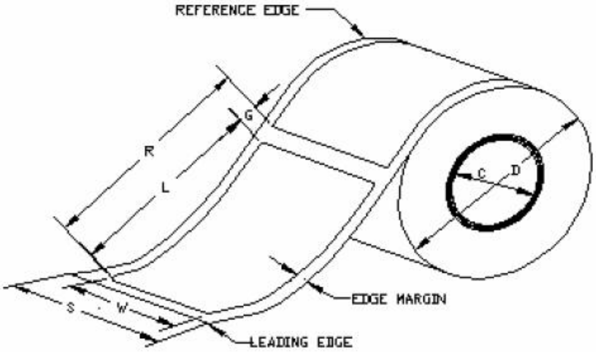

Figure 10 : RFID Label Media

In the electronics industry, a controlled manufacturing environment is critical for successful production. For example, manufacturers of semiconductors, flat panel displays, and mass storage devices rely on production in clean rooms to control airborne contamination, and on stringent static control practices to eliminate unwanted ESD. Lack of proper static control reduces production yields and creates conditions for catastrophic failures, or result in “latent defects” where ESD-damaged parts pass production testing, but fail prematurely in use.

The printing tools and reader must be carefully selected and installed to allow high-speed printing at good quality because packaging machines are using production rates up to 200 units per minute. Packaging lines are prone to dust and vibration which leads to an even more challenging environment for printing barcodes in high quality and for verifying codes.

3.3.7 Reader Selection

In order to achieve encoding of the RFID tags, antenna geometry need to be carefully chosen.

RF Antenna settings need to be adjusted individually per station to ensure proper function

RFID or barcode reader must be deployed and integrated all along the packaging line to print, encode, read and verify the data validity (as depicted graphically below).

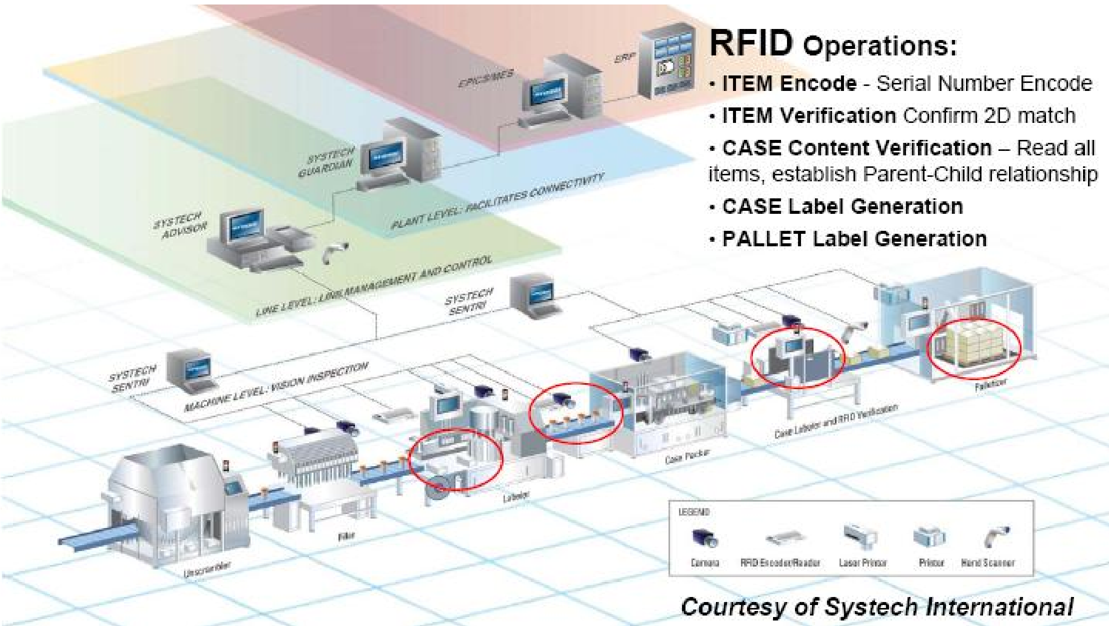

Figure 11 : Pharmaceutical Packaging Line

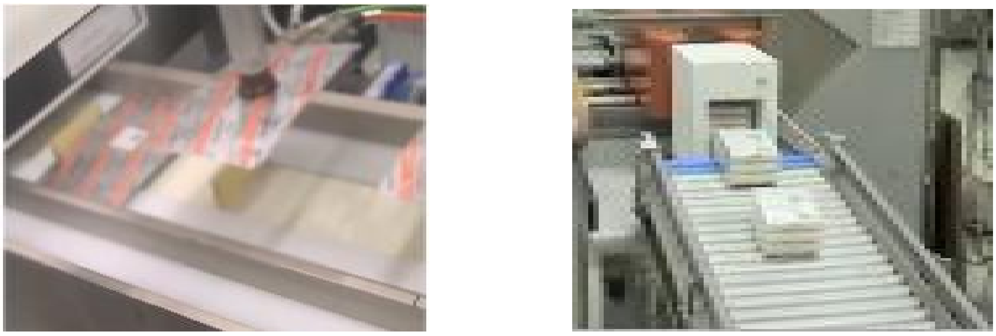

Figure 12 : RFID Blister Packaging Line

4 Finalised Anti-Counterfeiting Specifications for End Users

Following the live pilot trials results above, this section lists the likely required specifications for companies and industries considering using RFID for anti-counterfeiting solutions.

These outputs can be used by prospective companies planning or exploring the deployment of RFID enabled anti-counterfeiting solutions.

4.1 Aviation:

The focus of the aviation industry is on suspected unapproved parts (SUP - defined as aviation part, device, or material that is used in the production process of an aircraft) which does not meet the requirements of an approved aviation ie fake or recycled part, and is thus a major threat to passenger safety. The goal of the industry is to have an electronic pedigree for each line replaceable unit (LRU - ie aviation parts that have to be replaced during the lifecycle of an aircraft) that documents its origin and its lifecycle, thus addressing the SUP threat to aircraft safety.

4.1.1 Business Requirements:

For the Aviation industry, the recommended anti-counterfeiting solutions specifications are as follows:

CRITERIA	SPECIFICATION
PERFORMANCE REQUIREMENTS	
Description	Updatable RFID tag based data storage capacity of LRU UID and historical data is mandatory; including the reliability of tag writing, and tag reading (during interaction with a mobile device) Historical data written to tags and correctly signed, including in an ambient working environment Easy usability of the system Failsafe operation of the synchronisation procedure between tags and the central database.
Operation	Passive RFID system with fast read write functionality and 100% read rate and long lifespan despite extreme conditions. Ability to read and authenticate metal aviation parts in random orientation over a read range from a few centimetres up to 2m while stationary/moving slowly, despite heavy presence of metal in the environment. Life time 20 years with a long lifespan capable of operating in robust conditions without interfering with aircraft systems Full history and audit trail of the items
Compliance	Conformity with aviation industry requirements and no interference with aircraft equipment
Security	Use of cryptographic tags preferred High degree of confidence greater than Sigma 3 Tamper proof and resistant, should break upon detachment
Business Process Integration	Introduced on production line
Economics	Relative to parts being tagged, costs are not a showstopper for tags that provide the requisite functionality.
RFID SYSTEM SPECIFICATIONS	
Tag form factor	Epoxy, inlet mixed ferrite epoxy
Tag size	Diameter: 5 mm (half lens form), thickness: 1.7 mm
Read range	0 – 5mm
Memory	RFID tags must have high storage capacity (at least 64 kbit) as a significant amount of maintenance event records have to be stored on them. 64 kb of data of which 60 kb are user data; and 4 kb are reserved for EPC and memory management. The header information (256 bits) will be completely EPC Class 1 Gen 2 compliant. An audit section for maintenance event

	records will be required as per the Traceability Specification in Spec 2000) *[ATA00]*. Each maintenance event will be no more than 170 characters long on the chip, and will start on an integer block boundary location to allow fast read access later.
Security	Permalocked data on the chip (password-protected) - the data cannot be over-written nor changed. Security between the different user zones (multi application card), and that each zone can use a different set of passwords. The full complement of security includes data security features (PKI): segregation between manufacturer, first user, second user, follow on users, controller capability on tag, and data management on tag.
Tamper proof	Strong integration required to avoid tag falling off, self destructible if removed
Standards	Spec 2000 aerospace industry standards essential (more important than EPC/GS1 standards). Although UHF tags are needed to fulfill certain requirements in the areas of logistics, for anti-counterfeiting purposes HF tags (13.56 MHz – ideally based on ISO 15693) are needed as most tags offering cryptographic features are of this type. In the future the vision is also to use active tags in certain scenarios Airworthy tags must comply with DO-160 (test certificate: IO83A-TB-09/01) to be certified as airworthy
Placement	Metal mount, surface insensitive packaging
Environment	DO 160E requirements; RFID tags must withstand all kinds of operating conditions within an airplane, both in pressure ventilated and not pressure ventilated areas and thus be durable for many years. In addition, they have to be lightning resistant. Temperatures -45°C – 180°C

Table 1 : Aviation Criteria

4.1.2 Selected Solution Providers

A limited number of companies provide the necessary RFID technology for aviation anti-counterfeiting applications.

Depending on the data density and the security level requested, two technologies can be used.

For tracking with low data density, when just listening information is required then long distance reading for data capture is possible.

Intelleflex provide a solution based on UHF Gen 2 protocol Class 3 (battery assisted) having 60Kbits of rewritable non-volatile user memory. This tag can be read up to 50m and can be applied on parts and air freight cargo containers. The Intelleflex passive Class 1 Gen2 high memory chip is a platform upon which a variety of tags and labels will be developed. Boeing chose Intelleflex because they already had a 64 Kb total (60 Kb user configurable) high-memory chip in their Class 3 battery-assisted passive solution. To facilitate global availability of tags in customized form factors, Intelleflex will offer its chips to tag partners who will design and deliver finished product.

For tracing with high data density, when complete unambiguous part history is needed, then short distance communication is needed.

Kortenburg Inc. specializes in RFID systems for managing products, tools and equipment in the total logistics process. It offers solutions to manage products by the customer's personally defined databank. It has a great deal of knowledge in the application of identification systems or both central, local and mobile data collection and data management, by client server systems. In the case study provided here, Kortenburg provided the RFID chips based on the ISO14443 protocol including 16Kbits of EEPROM. The tag is moulded in a combination of special plastic and black epoxy resin, resistant against most difficult liquids.

Symbol is one of a few potential reader providers. It has developed the MC 9000G Handheld reader RFID handheld mobile computers with RFID readers and Symbol wireless LAN switches and ports. The MC9000-G mobile computer enabled precise real-time scanning, data entry and inventory control. The MC9000-G mobile computer is a high performance RFID mobile reader, supporting Microsoft® Windows Mobile operating system, for both RFID and bar code applications. The "hybrid" operation is essential to combine existing barcode technology and RFID. This reader can read either UHF EPC Gen 2 tag or Omni-directional 1D and 2D imaging barcode.

Figure 13 : Symbol MC9000-G Mobile RFID Reader

4.2 Luxury Goods:

The focus of the luxury goods industry is on fake and diverted goods. Counterfeiting and diversion of luxury goods products will continue to be a problem due to the increasing sophistication of technologies for duplicating products and packaging, numerous wholesalers in the supply chain, weak legal penalties and lack of enforcement, and abundance of internet sites selling illicit products. RFID addresses these issues and is critical to the success of companies in this industry worldwide.

4.2.1 Business Requirements – Leather Goods:

For the leather goods industry, the recommended anti-counterfeiting solutions specifications are as follows:

CRITERIA	SPECIFICATIONS
PERFORMANCE REQUIREMENTS	
Description	Authenticity of the leather goods is determined by the track and trace parameters of the products during their movement through the supply chain The RFID tag is integrated in the lining or in a pocket of the product.
Operation	Passive RFID capable of deep covert integration within leather products, without compromising aesthetic design of goods
Compliance	Compliance with standards is not essential since this is primarily a closed loop anti-counterfeiting application
Security	High security required
Business Process Integration	As early as possible so that RFID technology can be used throughout manufacture; distribution, POS, and customs
Economics	Costs are important but not critical relative to expensive product costs themselves
RFID SYSTEM SPECIFICATIONS	
Tag form factor	Pliable and easily integrate tag
Tag size	32mm*18mm: satellite inlay 30mm*50mm: web inlay 94mm*7,8mm: propeller inlay
Read speed	100 items per second
Read range	Ability to read and authenticate leather luxury goods with read range from few cm up to 50cm in structured arrangement. Depending on the tags used, the following read ranges are achievable: 32mm*18mm: 1.8m air; 1.4m placed leather product 30mm*50mm: 4.0m air; 3.5m placed leather product 94mm*7,8mm: 4.5m air; 3.5m placed leather product
Memory	Read only functionality is sufficient eg 94mm*7,8mm tag; if read write required then 30mm*50mm tag required
Tamper proof	Tags can only be removed by visibly damaging the product.
Standards	For bulk reading (eg in shipment container), UHF Gen 2 would be the most appropriate technology. Standard not essential since application is closed loop with limited requirement to be integrated with other supply chain partners.
Orientation	Random orientation
Multiple tags	Single and multi items identification and authentication
Placement	Tags are placed covertly inside the lining of the leather product

Table 2 : Leather Goods Criteria

4.2.2 Selected Solution Providers

Many RFID companies provide the standard technology described; some of these are listed.

Impinj is an RFID company has patented Self-Adaptive Silicon® technology for high-performance RFID solutions. A leading contributor to the RFID standards for high-volume supply-chain applications worldwide, Impinj delivers the GrandPrix™ solution, comprising tags, readers, software, and systems integration.

The portal and the picking station used during the leather goods trial was design by **Spacecode** based on a Speedway reader connected to four far field antenna from Impinj and one Impinj brickyard near field antenna.

UPM Raflatac offers a range of RFID products for the apparel and brand protection market segment.

- Dry inlay: continuous web, no adhesive
- Wet inlay: die-cut web with adhesive, filmic face
- Tag: die-cut web with adhesive, paper face

Hana RFID designs, develops and manufactures RFID products. This includes manufacturing services for wafer thinning/dicing, HF and UHF inlays, COB, COF, cards and reader assemblies. Hana has more than 10 years experience in the design, development, and manufacture of products for the RFID industry. We have experience building products for frequencies ranging from 125 KHz to 2.45 GHz and are in production with several different technologies for producing RFID inlets for our customers

4.2.3 Business Requirements – Watches:

For the watch industry, the recommended anti-counterfeiting solutions specifications are as follows:

CRITERIA	SPECIFICATIONS
PERFORMANCE REQUIREMENTS	
Description	Covert integration of an RFID tag into a watch such that the RFID tag can be read through the metal casing (irrespective of metals used that may have different electromagnetic properties) Tag lifetime should cover lifetime of product – could be greater than 20 years for watches
Operation	Passive RFID capable of deep covert integration within metal products without compromising aesthetic design of goods Performance essential to be maintained in 'RFID hostile' metal casing
Compliance	No compliance with standards is necessary since this is a closed loop anti-counterfeiting application, and standard RFID technologies do not function adequately with metallic products such as watches
Security	High security required
Business Process Integration	As early as possible so that RFID technology can be used throughout manufacture; distribution, POS, customs, sales and after sales team

Economics	Costs are important but not critical relative to expensive product costs themselves
RFID SYSTEM SPECIFICATIONS	
Tag form factor	Circular tag integrated inside watch backing
Tag size	Various, depending on watch sizes
Read range	Ability to read RFID tags embedded in watches with read range up to 10cm
Memory	Read only functionality is sufficient. IC should operate at non resonant frequency, hence cannot be detuned by presence of metal.
Security	High level of security, with encryption and probably additional multiple combined security features. Proprietary system makes counterfeiting and cloning almost impossible. Unique code combined with the serial number of the watch provides high security.
Tamper proof	Tag will be integrated inside of the back case of the watch thus avoiding any possibility to tamper, damaged, destroy, or remove
Standards	For communications protocol and frequency, proprietary solutions capable of reading through metal casing of watches will be required. Data standards company specific
Proximity	Close proximity of metal requires ability of RFID tags to manage this aspect
Anti-collision	Limited requirement since most identification will be a single object at a time
Placement	Tag integration in a small available space, surrounded by metal
Multiple tags	For logistic application
Environment	System typically required operating in normal environmental conditions.
Costs	Low but not project decision critical; tagged products are typically very expensive relative to tags themselves

Table 3 : Watches Criteria

4.2.4 Selected Solution Providers

Very few companies provide the necessary RFID technology capable of functioning in metal.

The RFID solution developed by **Spacecode** is unique in its ability to operate within metal. The technology is developed at 125kHz and allows reading of a tag or multiple tags embedded in the metallic part of the watch. This solution doesn't modify the external aesthetic of the watch and allows automatic data capture during the life of the product from the watch manufacturing point to the point of sales and after sales.

Winwatch, a Swiss supplier of RFID solutions for a variety of watch brands, has developed a UHF-RFID tag that can be embedded in watch glass. The major issue in development is to enable a transparent tag to be integrated on the sapphire or mineral glass of a wristwatch.

4.3 Pharmaceutical:

4.3.1 Business Requirements:

For the Aviation industry, the recommended anti-counterfeiting solutions specifications are as follows:

CRITERIA	SPECIFICATIONS
PERFORMANCE REQUIREMENTS	
Description	Reliably detecting whether pharmaceutical products are authentic or fake, or even diverted Complete reliability of data and technology Correctly and fully determining the audit trail of a product Accessibility, completeness, and relevance of information Usability
Operation	Passive RFID capable of reading RFID tags affixed to primary packaging of products Hardware response time - RFID tags (and possibly 2D barcodes) must be read within reasonable time Items must be read moving at speed on a conveyor belt Tag lifetime is one year after the expiry date of the product (up to 6 years)
Compliance	Open loops supply chain and ePedigree requirements require standards compliance
Security	High security required
Business Process Integration	Throughout entire supply chain as early as possible as per ePedigree recommendations
Economics	Low costs essential due to high volumes required
RFID SYSTEM SPECIFICATIONS	
Tag form factor	Tags are to be flat (for cardboard packaging) and bent (for bottle packaging)
Read speed	Very high 250 products/second
Read range	Ability to read and authenticate products by up to 2m for pallets and closer for item level, using fixed or handheld readers
Memory	Read write that are written to once at initialisation – the unique identifier shouldn't be modified after production. The only information stored on the tag should be an Electronic Product Code (EPC) in the SGTIN 96 format. Tags are be initialized and verified at production lines.
Security	Cryptographic requirements required; tags must not be clonable. Combine global ISO/IEC standards for RFID and Public-Key Infrastructure (PKI) technologies. Data structure approach will result in a hierarchy 'nomenclature', so that a particular item-level tag can be associated with its original case or pallet.
Tamper proof	Required – tag should not be removable from the packaging without damaging it
Standards	EPC Gen 2 preferred due to lower encoding errors and reject rate. EPC/GS1 Standards preferred for open loop supply chain and scalability.

	EPC compliant tags with 96 bit serial number
Anti-collision	No requirement for bulk reading
Placement	Covert preferred (although overt acceptable) placement on primary packaging, due to security and privacy reasons. Tags automatically placed on production line.
Environment	Normal environmental conditions
Costs	Target price of €0.03 cent tag

Table 4 : Pharmaceutical Criteria

4.3.2 Selected Solution Providers

Some companies that provide the necessary technology are listed below.

Nosco is a leading producer of pharmaceutical printed packaging with core products including folding cartons, packaging inserts/outserts, and labels. Nosco offers pre-serialized 2-D Data Matrix codes with HP® Security Publishing Solution, and RFID-enabled printed packaging with data certification produced under cGMP/QSR-based processes. It is a certified supplier to several manufacturers.

- Design of 2D Data Matrix and RFID-enabled packaging components
- Pre-serialized 2D and UHF, UHF NF, and HF RFID tags incorporated into labels and folding cartons
- Layered overt, covert, and forensic brand protection features through a Life Cycle Management approach

Domino offers a full range of coding solutions specific to the pharmaceutical, medical devices, wound care, vision care, veterinary and consumer healthcare industries. Domino assists you with meeting all legislative requirements in each individual country. Domino’s pharmaceutical specialists are trained to understand these specific needs and identify the coding and traceability solutions required for each customer.
Domino offers a range of solutions specific to the pharmaceutical including :

- Ink jet and laser technologies print Data Matrix codes
- IFAH compliant package coding
- Covert UV-readable and copy protected inks

5 Conclusion

Companies need to accurately identify their requirements, select a technology, and then analyse, design and plan for production, assembling and integration into their products and processes. The right planning and strategy will give a company the best chance to achieve successful adoption and rollout, and a substantial return on investment. The implementer who blindly and superficially starts tagging will miss most of the benefits of this technology. A methodical approach is required for the implementation and execution of RFID rollout including a detailed understanding of the processes and environments where the system will be installed and integrated, as well as an in depth analysis of requisite RFID infrastructure - readers and tags.

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