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"If Tesco Can Do It, Why Can't We?": The Challenges and Benefits of Implementing RFID and Mobile Computing in Upstream Environments

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Abstract

We live in a fast moving consumer world where pocket PCs are common place and auto-identification technology is everywhere - mainly barcoding but increasingly Radio Frequency Identification (RFID). So why isn't Upstream Oil and Gas adopting these technologies at a faster rate to improve business performance? "If Tesco can do it, why can't we?"

This paper examines the major applications for the use of hand held devices (HHDs) and auto-identification within supply chain, maintenance and operations. It describes the benefits in terms of the ability to link offshore and onshore operations more effectively and accurately pass real-time or near real-time information between assets, support organisations and supply chain partners, to allow earlier and improved decision quality, as well as the traditional efficiency gains. Upon detailed analysis, moderate investment yields high potential returns.

One of the fundamental differences between the supermarket chains and the Oil and Gas industry in this area is the lack of agreed technical standards in terms of RFID hardware and data transfer standards, acting as a barrier for supply chain integration. This paper touches on the work that is underway to address this issue, but goes on to explain how an appropriate application of technologies and attention to process and change management considerations can deliver robust solutions for operations and maintenance today.

Introduction

Most of us live two lives. At work we see things in terms of people, process, technology, strategies and targets. We go home and we see things as consumers, usually seeing only the finished product. We sometimes forget that behind the scenes are the same people, process and technology issues.

Whenever discussions take place around supply chain and asset tracking improvements within Upstream Oil and Gas, the discussion touches on mobile computing, Radio Frequency Identification (RFID) and barcode technology. At the same time, the inevitable comparison arises: "Why can't we learn from the supermarkets? If Tesco can do it why can't we?" The answer is that the industry can and is. However, it sometimes pays to follow rather than lead.

This paper examines the major applications for the use of hand held devices (HHDs) and auto-identification within supply chain, maintenance and operations. It describes the benefits in terms of the ability to link offshore and onshore operations more effectively and accurately pass real-time or near real-time information between assets, support organisations and supply chain partners to allow earlier and improved decision quality, as well as the traditional efficiency gains.

Business Problems to Solve

The Upstream Oil industry has a number of well known challenges. Many of these challenges are common to other large process and manufacturing industries, but tend to be far more extreme in their nature:

- A failure within the supply chain of a critical component can result in oil production grinding to a halt, resulting in millions of pounds of losses
- When operating from an offshore environment, the shipping of emergency spares involves sea or air intervention

- The shipping of equipment and spares necessitates the availability of the correct containers and crates for handling, usually supplied by a third party
- The harsh environment means that it is not always possible to physically identify the spare that is required due to corrosion
- Maintenance intervention planning can be complicated by the need to hire specialist plant and equipment, not readily available
- The ageing workforce means that much of the knowledge of how to operate and maintain the installations will diminish over time

If planning can be improved within the logistical constraints of the supply chain to ensure that the correct plant, equipment and spares are on the platform at the right time, then production efficiency will increase. A key factor here is time. If through improved visibility of the asset condition, potential problems with drilling or production equipment can be identified prior to failure, this provides more time to respond. When a problem does materialise, the first hour of diagnosis is critical. If the work can be correctly scoped in the field and is error free, then the process to fix the equipment is generally a simple case of following standard process.

There are two essential ingredients to achieve these improvements:

- Positive identification of assets, sub-components and spares, so that when an operator or technician is at a skid or in the stores they are 100 percent certain that they are handling the correct replacement component

- Improved supply chain visibility of what is on the platform and what is going to be on the platform and when

Whilst effective conventional asset management and stock management systems are fundamental technology enablers, auto-identification technologies such as RFID can tie the physical equipment and materials to the data flow much more effectively and automate specific processes, fundamentally reducing errors.

Follow my leader

Auto-identification technologies are not new. Barcodes have been widely used commercially for decades. RFID has been around for more than 60 years when it was first introduced during World War II by the allied forces who needed to identify "friend or foe" aircraft. RFID has the edge over barcodes, which are a line-of-sight technology requiring a scanner to "see" the barcode to read it. It uses radio waves to automatically identify tagged objects. Tags can be read as long as they are within range of a reader. RFID readers can be built into hand held computers or else be built into key entry and exit portals in loading bays for example.

The majority of initial implementations have been within the area of supply chain management where benefits have been seen in reducing stock-outs and gaining better inventory visibility. The Fast Moving Consumer Goods (FMCG) sector has been leading the way, with Tesco and Wal-Mart acting as pioneers and using RFID technology for tracking at a pallet and cage level. FMCG manufacturers such as Proctor and Gamble are using RFID to distinguish genuine and counterfeit products, and Tesco have trialed anti-theft systems, taking advantage of the RFID tagging of high value goods. Outside of the FMCG sector, Boeing are now tagging aircraft parts to improve handling and tracking efficiencies. The Ministry of Defence are also using active RFID tags with a 60m range to track military supplies in operational zones, as well as the use of passive technologies in their standard supply chain operations.

Today more and more companies are adopting or at least investigating these technologies. But for the early adopters it has not been an easy road. There has been a litany of mistakes and issues. There have been horror stories of investment in expensive tags, expensive readers and a resulting read accuracy of 20 percent. There have been fundamental issues around a lack of standards and even consumer outcries at item level tagging and accusations of spying.

Applying Auto-Identification Technologies in Upstream Oil and Gas

There are lessons learned and numerous case studies that can inform the Upstream Oil and Gas industry of the potential benefits and the applications for the industry. So what might some of these applications look like?

It is useful to differentiate between “internal” applications and “external” applications. Internal applications are those that can be implemented without recourse to any third party organisations. Crudely, internal applications tend to be related to asset tracking and external to supply chain management, although there is a blurring at the edges. As expected, it is the external applications that are more complex and time consuming to plan and implement. It has taken the supermarkets several years to implement RFID through their supply chain, despite the monopsonistic nature of the market, where the supermarkets can largely mandate the use of specific processes and technologies. The supply chains within Upstream Oil

and Gas deal with lower volumes and less frequent shipments, but typically high unit price values and tend to be more co-operative in nature. There is a view that the introduction of new supporting technologies needs to deliver a return to all members of the supply chain, through increased supply chain efficiency, and not just to the operator.

The following describes some of the potential applications of auto-identification within Upstream Operations and Maintenance, focused on surface equipment.

Internal Applications:

1. *An enabler in the formalisation of Operator Routine duties on installations*

When designing new installations, it is normal these days to fully instrument the plant, so that minute by minute analysis and diagnosis is possible. On older platforms, decisions were inevitably taken around what was to be instrumented and what was to be manually gauged. However, regardless of the level of instrumentation, operations still perceive a need to physically "walk the plant" at regular intervals during the day. The use of four senses checks is still best practice in identifying potential threats to the installation's safety and producing capability. On the older installations, execution of these Operator Routine duties is a no brainer, since the operators need to take specific readings as well as perform condition checks. On newer installations, where under normal operating conditions the operators can manage from the control room, it is necessary to create a need to go outside.

In the past, the use of paper checklists was the usual way of logging the results of checks. Today, the use of handheld computers is common, although not widespread. The operator checks are codified into logical physical routes that are downloaded to HHDs at a set frequency, usually every shift. The operator takes his HHD and performs all the checks on the route – typically a variety of equipment running status, gauge and sight glass readings and condition checks. Set-point alarms can be configured that are typically pre-alarms providing an early warning of things to look out for. Some systems have the ability to indicate the consequences of an alarm status and to advise the operator of follow-up actions and inspection checks. The operator can add additional notes at a route level, machine level or point level. Once complete, the data is uploaded into proprietary systems where trending and analysis can be performed and the capability typically exists to synchronise with data historians such as PI, to allow more sophisticated trending of SCADA type data and HHD acquired data together. The operator routine cycle is shown in figure 1.

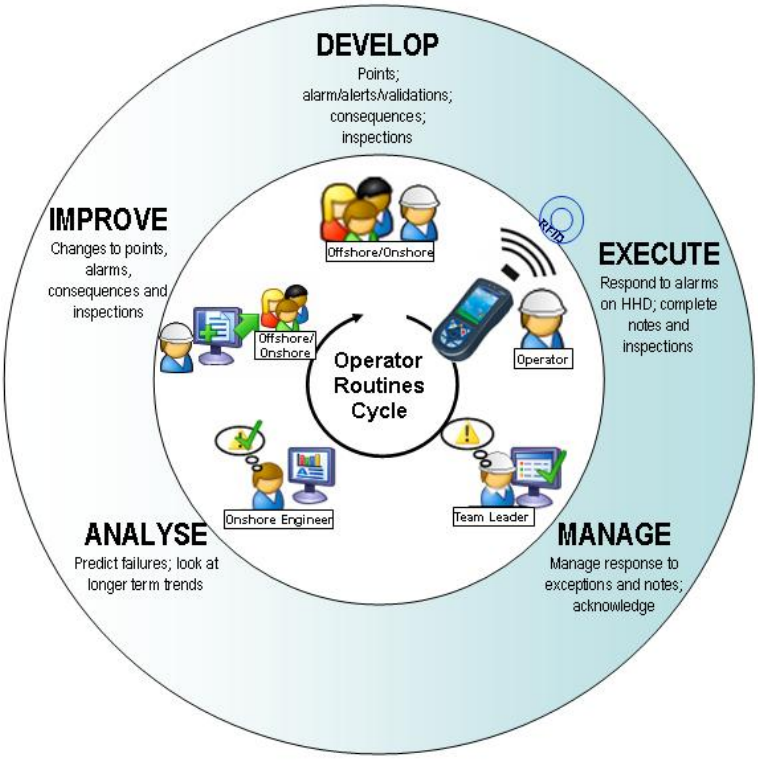

Figure 1.

So what about RFID? The use of handheld computers adds discipline and rigour into the process since each transaction is date, time and user stamped. It also provides real-time or near real-time visibility of issues and operator comments to other offshore operators, team leaders, maintenance staff and onshore support engineering staff, but the operator could simply have performed his route in the tea shack, using previous readings as a guide. Whilst not suggesting for a minute that this would happen in real life, there is no positive proof of physical proximity to the equipment. Also, the route is a set of sequenced measurement points. However, individual operators may choose to perform the route in a different order. This is not an issue, but does involve a great deal of scrolling through screens on the HHD and, as a result, errors can be made in the selection of the correct measurement, leading to spurious readings and potential unnecessary interventions or a lack of intervention. RFID tagging of equipment measurement and check points, either at a point level or a panel or skid level, does provide better control and accuracy of the process. It is also ideal for new and inexperienced operators that might not be familiar with the plant. They simply need to swipe the RFID tags and the appropriate set of points will be presented.

2. *Positive tracking of safety critical inspections such as EX inspections*

Both handheld and RFID technology can be effectively employed to improve the processes around equipment integrity and EX inspections. Safety critical work order can be downloaded to an HHD in line with agreed inspection intervals. The EX equipment can be tagged with RFID tags to ensure that the checks are performed against the correct equipment, reducing potential errors and potential safety and compliance issues. The checks can be performed and the results captured in the HHD. If problems are identified a further work order can be generated from functionality within the device. At the same time the list of installed equipment and the equipment name plate data can be checked and corrected to ensure that the EX register accurately reflects the installed equipment and that equipment specifications are totally up-to-date. Once docked and synchronised the data can either be uploaded directly to the asset management system or quality checked prior to upload.

3. *Making it easier to raise defects on plant and equipment and ensuring that work order execution is correctly completed*

An extension of the EX inspection application is to extend RFID tagging to all process equipment on an installation. When a problem is identified a plant operator or technician can simply scan the equipment tag to positively identify the equipment, translating the physical asset into the asset management tag and pre-populating the core data for raising the defect. It might also be feasible (dependent on the amount of data or access to a wireless network) to pull through the Bill of Materials onto the HHD whilst still at the equipment to ensure that any spares required are listed and correct. The linkage between the physical equipment and the dataflow through the use of RFID technology whilst outside on the plant dramatically reduces “sent in error” logistics issues and wasted planning and rescheduling time and effort. The best person to identify the part for the job is the technician. It is about empowering them with the information to correctly scope the job within the first 10 minutes of a problem arising. Once correctly scoped, logistical mistakes at the picking and packing stage are surprisingly rare.

When the materials do arrive, the work order can be scheduled to the HHD and the RFID tags used to positively match the equipment to repair or replace to the work order.

External Applications:

1. *RFID enabled supply chain*

The supply chain in Upstream Oil and Gas is not overly complicated. However, due to the nature of onshore and offshore operations, there is a high degree of uncertainty and reactiveness that impacts supply chain efficiency. If there is a production failure, then hire equipment may be required, spare parts and equipment may need to be shipped, and repair work may need to be completed. This impacts the operator, product providers, hire companies, container providers, logistics companies and transport companies.

In addition, planning is sometimes not as effective as it should be. For example, the flow of containers is at times erratic with dozens of units being shipped back at the same time, despite many of them being empty for weeks.

The key is to provide visibility of movements through the supply chain from information providers to an appropriate set of information consumers at each stage, so that a level of advanced planning can be done, even if that means only a matter of a few hours notice. By RFID tagging at a container level and sharing the physical scan events in real-time, containers and

container contents can be tracked as they move to installations and are returned back from installations.

Critically, there are benefits for all supply chain members of knowing what is where and having advanced visibility of inbound goods and containers. However, to provide this level of interaction between parties, it is essential to have an agreed set of standards for the RFID tags and readers, but even more importantly for the exchange of high frequency information. EPCglobal provides an internationally recognised service for guiding, managing and maintaining the RFID and dataflow standards between industry partners. Subscription to EPCglobal provides partners with a unique Global Location Number (GLN) for each physical location that acts as a key to the location of materials, equipment or containers. In the case of containers these are uniquely identified using a Global Returnable Asset Identifier (GRAI).

As an example, a UK North Sea operator might issue an order to purchase a item of equipment. The product provider would then issue a request to the container provider to deliver a container to transport the equipment offshore. The following key RFID enabled physical events could then be tracked through the supply chain, described below and in figure 2:

- The physical despatch of the container as it leaves the container company on the way to a product provider
- The arrival of the container at the product provider
- The loading of equipment into the container – effectively creating an accurate manifest for the container contents
- The despatch of the container from the product provider on the way to the logistics company. The equipment contained within the container is electronically tied to the container and made available to pre-determined parties within the supply chain
- The arrival of the container at the quayside
- The container inspection at the logistics company that takes place hours before loading and shipment
- The loading of the container onto the vessel bound for the drilling rig or platform
- The container inspection as it arrives at the operator's installation and is offloaded
- The unloading of the equipment from the container – confirming that the equipment has arrived
- The loading of equipment (to be returned onshore) back into the container
- The visual inspection of the container as it is sent back onshore
- Discharge by the logistics provider
- Receipt by the container company
- Visual inspection of the container by the container company

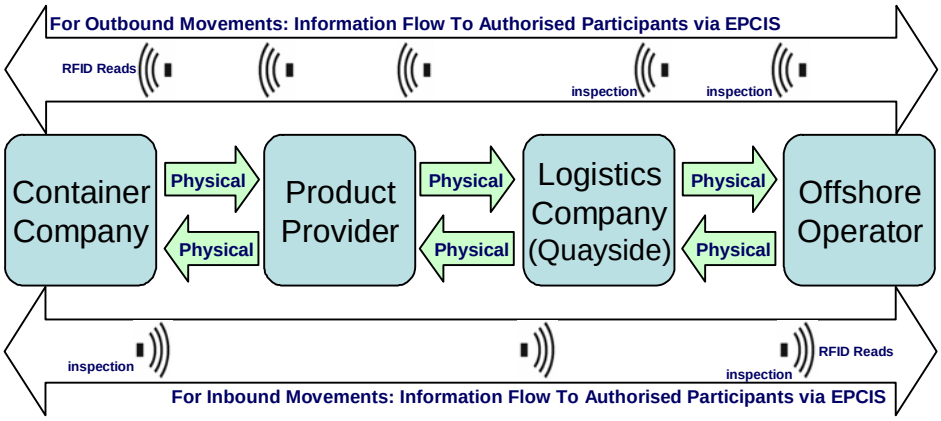

Figure 2.

Whether using HHD, readers on forklifts or fixed readers at the quayside or on loading bay doors, the physical movement of the goods and containers can be tracked. The benefits are huge. The container company benefits from improved asset visibility, improved work planning and increased utilisation, resulting in lower capital costs. The product provider can plan their work better. The logistics company benefits from reduced administration, increased data accuracy and visibility. The operator can better predict and plan when goods are going to arrive and whether plans need to be adjusted as well as deck planning benefits and error reduction.

2. *Tracking high value rental equipment to improve availability and reduce non value adding on-hire costs*

An extension of the RFID supply chain example involves the tracking of high value rental items within the supply chain. The

same process described above would be followed, but the service company would load and receive back containers. This is a specific area where there is huge cost benefit to both the service provider and the operator who rents the equipment. The service company benefits from improved planning in the areas of maintenance and equipment utilisation. They can better identify when a piece of rental equipment is being returned from hire and can adjust maintenance plans accordingly to maximise rental availability. If another operator urgently needs the same item of equipment or else the iem of equipment has been on hire for a long period and requires re-certification, the precise location of the equipment can be tracked to the specific installation, allowing appropriate enquiries to be made about the duration of continued hire. For the operator, RFID tracking provides a ready inventory of hire equipment on their installations, which should help to avoid unnecessary hire charges for "forgotten" rental equipment and to allow equipment already onboard to be re-used on new jobs.

3. Original Equipment Manufacturer data books

During installation design and through the life of an asset, new plant and equipment is ordered from original equipment manufacturers (OEMs). Traditionally, a complete databook is collated based on design and build data, and is presented to the operator at the end of commissioning, to line library shelves both onshore and offshore. The databooks typically contain the bill of materials, critical spares lists, maintenance schedules and history, operating history logs, design data, manuals and drawings. Throughout the manufacturing lifecycle, from design and specify, materials scheduling, goods receipt and build, the databook is pulled together. Typically multiple copies are printed requiring enormous volumes of paper and considerable effort and time to collate the documentation and, in the event of modifications to the equipment, keep up to date.

The next step is that the operator updates his asset management systems, replicating elements within the databook into his systems and possibly making some transcription mistakes at the same time.

What if…alongside the nameplate on the equipment (or else embedded in the nameplate) there was an RFID tag that uniquely identified the equipment. Both operator and OEM share information using the EPC standards. A swipe of the RFID tag on the equipment on an installation provides immediate access to key equipment databook information located on the network of the operator. At set intervals, a system request is sent from the operator to the OEM for an update of any potentially dynamic data such as available spares and alternative spares, using a standard data format, and any manufacturers' notices and updates, using the authorisation and authentication built into data exchange protocols. Data such as the bill of materials could remain with the OEM as the master copy. The technology might drive new and innovative support models tying the manufacturer to the user much more closely and elevating the neverending issue of equipment data management.

The optimised supply chain for product and service companies, container companies and logistic companies means that operating costs can be reduced through improved efficiencies and removal of wastage.

It is a win win situation all round. So what is preventing making the overall vision a reality?

Practical Barriers to Implementation

In the case of the internal applications outlined above, not very much, and a number of offshore operators in the North Sea are currently rolling out RFID-enabled operations and maintenance systems. Technically though, there are some pitfalls. RFID tends not to operate effectively when in close proximity to water, salt and metal, which is not ideal when implementing at offshore platforms. However, low frequency ATEX-rated RFID tags can be used for offshore equipment to guarantee consistent read results. One limitation is that the read distance is limited to only 50mm which might, in certain circumstances, result in practical limitation in siting tags, but has been proven nevertheless, to be quite workable. Alternatively, some UHF tags have been designed to overcome these limitations, but have other limitations, but might not be as easy to secure to the equipment and are not proven offshore. In the case of container tagging, a greater read distance is required, so a combination of tags (both low frequency and UHF or even Wifi) might be necessary to allow a variety of readers to access the tag information.

Tags can be of the read only or read/write variety, but whilst it initially seems attractive to add additional information to the tag (such as safety data), this results in hundreds of uncontrolled databases located around the plant. Best practice suggests that the unique serial number, embedded at manufacture within the tag, is the only data that must reside on the tag. It is this identifier that provides the real-time link between the physical equipment and asset management data, the link being maintained in the systems of record themselves and not on the tag. The possible exception to this might be in the case of container tracking where read/write tags could be used to embed the container GRAI.

The safety requirements of offshore installations require ATEX certification of handhelds to either zone 1 or zone 2 classifications. There is only a limited choice of certified handheld devices - the i-ROC 620 made by eCOM or the Symbol unit from Bartec. Both run the Windows Mobile operating system and are therefore interchangeable, although there are some practical differences. The i-ROC HHD supports a built-in RFID reader, and is primarily stylus driven as opposed to the

Bartec that has a numeric keypad and does not support a built-in RFID reader. Whilst having a keypad may initially appear advantageous, when working in the North Sea where external operators and technicians always wear gloves, a HHD that is solely stylus driven actually becomes an advantage. However, both units have been proven in the field, so the availability of technology is not an implementation barrier.

This is also true of the software available to assist operators with their routine duties. SAT's Intellatrac is possibly the standard within process industries, but Arnlea System's Integrity Watch product is increasing in popularity in the North Sea due to its simple yet systematic approach to problem identification, determination of consequences and tracking of inspections. IT implementation is also fairly straightforward, even when integrating with real-time data historians. There are also a number of mobile systems available to implement paperless work orders between the range of asset management solutions. The majority, but not all, of these have an RFID solution as part of the product suite.

The key issue when implementing internal RFID and mobile applications is data. In the case of operations, developing the route data is not an insignificant task. It involves not only identifying the equipment and the route points to measure, but alarm and alert setting for digital and multi-state points, consequences, inspections, the correct ordering of the route points (although easier when using RFID) and also the logic of what equipment and points to skip, based on run status of the equipment. In the case of implementing RFID and mobile enabled work order management systems, even if all of the data around equipment, cause and damage codes and the master data elements is clean, there will still need to be a level of standing instruction and work order restructuring to benefit from the ability to capture equipment history in a structured and searchable manner.

However, the barriers become more acute when we consider the external applications. The implementation of the RFID enabled supply chain, the high value rental tracking, and indeed the electronic databook concept, require a level of alignment and co-operation that is difficult to achieve in short timeframes. The alignment can be regarded on two fronts:

1. Technology alignment: i.e. implementing common RFID technology standards across the industry, such that a tag can be read by multiple parties across the supply chain. EPCglobal's GEN2 RFID protocol is set to become a standard within retail, but has still to be tested offshore in an ATEX environment.

2. Information exchange alignment: i.e. allowing supply chain partners to share and exchange information efficiently, through a standard interface that allows trading partners to use the same functions or methods for querying data across the supply chain. The EPC Information Service (EPCIS) is a standard that provides a data layer where business logic can be mixed with read 'events' coming from RFID readers. EPCIS is designed to allow both on-demand polling access and a 'push' model for data querying, the interface allowing access for trading partners to different underlying databases. EPCIS data falls into two broad categories:

    a) Time-stamped event data collected throughout the lifecycle of an object within the supply chain. For example, the following data may be required to allow a container and its contents through a fully RFID enabled supply chain:

        - The GRAI of container
        - The read point GLN for specific loading bay
        - The GLN for business location
        - A business step e.g. receive, inspect, load
        - A disposition e.g. container full and condition
        - An associated transactions list such as purchase order, delivery note numbers, etc.

    b) Quasi-static attribute data defined at serial-level, but not continuously updated, such as the information that would be required within the electronic databook example.

Whilst the standards exist to provide for business level exchange of RFID data in real-time, it still remains for each industry supply chain to define the transaction steps and the security model, preferably on a global basis. There is currently an active Upstream RFID consortium working out of Aberdeen assisted by EPCglobal. This is a part-time cross supply team that is dedicated to help guide the standards development process for the use of RFID within the Upstream supply chain, consisting of representatives from operating companies, container companies, service and rental companies, logistics companies and experts from the field of RFID and mobile computing. According to EPCglobal, this is the only group operating in the

sector, known to be actively working to develop the standards for Upstream Oil and Gas. Currently a small scale pilot is being developed by Arnlea using EPCIS to validate the viability of tracking containers and equipment through the supply chain, offshore and back again, initially using HHDs as the read technology. The anticipated timescale to test and establish a set of standards that can be rolled out is 18 months.

The final set of barriers is concerned with implementation. RFID and handheld computing are disruptive technologies that have a fundamental impact on business processes and the way in which people approach and perform their work. Both the internal and external applications require a high degree of re-engineering to integrate into the business and great attention to change management issues. Surprisingly, although the work force is a mature one, experience has shown that both operators and technicians are exceptionally technology aware and have few problems adapting to handheld computing and RFID. However, the real-time nature of these technologies and the ease with which compliance type reporting can be developed, means that resistance is not uncommon and appropriate monitoring and interventions need to be planned to ensure that the new ways of working get embedded within the organisation to fully deliver the business benefits.

Conclusions

The future within Upstream Oil and Gas might look something like this. Plant operators will be using HHDs to perform their RFID enabled duties, whilst technicians respond to identified plant problems raising plant notifications and work orders through their HHD aided by the RFID tagging of the equipment. They can access information from the original equipment manufacturer, ensuring that the correct spare part is being ordered. They can accurately verify equipment integrity by performing EX inspections and update work order status using their HHD. In the meantime, materials and rental equipment arrives through the RFID enabled supply chain. Instances where the wrong materials have been shipped due to identification problems have been dramatically reduced and since advance visibility of what will arrive on the installation is better, maintenance planning has improved, the work order backlog and mean time to repair (MTTR) has been reduced, and the total maintenance costs have reduced – helping to extend the economic life of the installation. Time can be devoted to analysing plant performance rather than re-planning and chasing spare parts, improving production. Since RFID tags are acting as a common key to both process data held in data historians and the equipment register in asset management systems, it becomes easier to bring together both time series data in the form of instrument readings and transactional data in the form of work orders and notifications to provide an equipment centric view of potential threats and opportunities on the plant in the form of a set of decision tools. The RFID enabling technologies span and mesh together Operations, Maintenance and Supply Chain functions to positively impact business performance, shown in figure 3.a

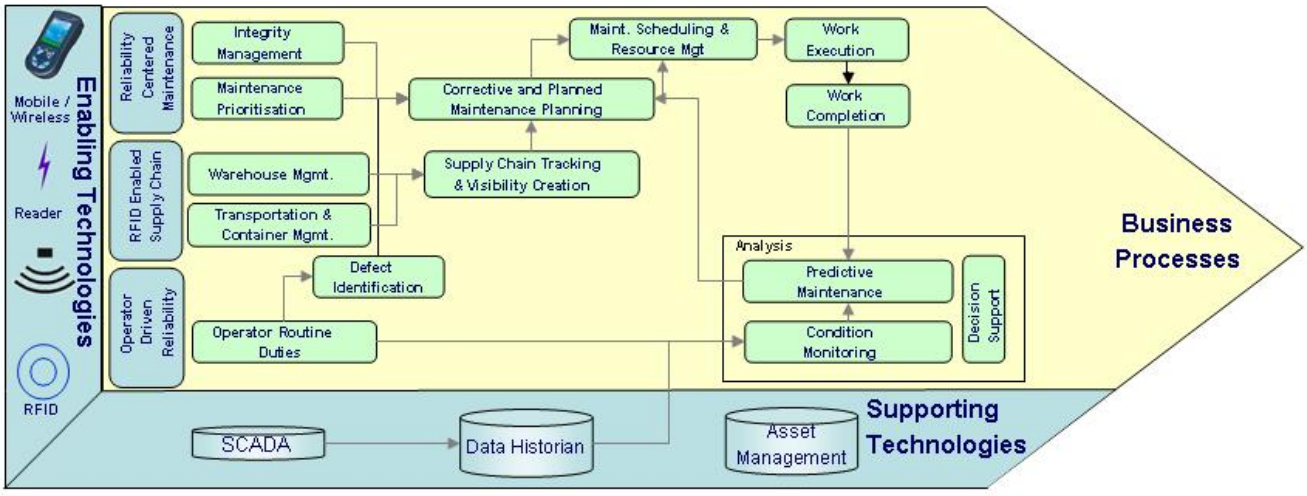

Figure 3.

So… if Tesco can do it, why can't we? Well, actually Tesco have had to modify their RFID programme several times. Originally, they intended to implement RFID tagging at a product level. This has since been modified to a cage level. Originally they were going to have the roll-out completed in 2006, but by the middle of 2006, only 30 to 40 stores and one distribution centre had been completed, equating to approximately 3 percent of its assets. They have stated that they do not want to enforce the adoption of the technology amongst their supplier base. These sorts of technology innovations simply take time to implement.

In reality, Oil and Gas companies are not that far behind. There is active take-up within Upstream of both RFID and handheld computing technologies, with several operators currently rolling out internal type projects, and some experimenting using RFID within their own internal supply chains. However, consultation and agreement of other members of the supply

chain is essential if the solution is to be robust, long-term and provide the anticipated efficiencies to the whole of the supply chain. The RFID supply chain paradox is that first mover advantage does not exist, and yet it is very difficult to agree on the standards without first piloting the technology throughout the supply chain and validating that the technical barriers can be overcome. The answer is to use some of the internal initiatives that are underway in several oil and gas operators and service companies as a springboard to a wider consultative deployment, and also to closely watch and learn lessons from Tesco as they head out of pilot mode and into a full RFID supply chain operation.