RFID Based IT Asset Tracking: Options for South Australia Water

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Abstract

Adoption of RFID technology in Australia is only recently escalating, due mainly to the new standards that have emerged which have more acceptance as opposed to the previous ones which were application specific and had narrow usability. This paper provides an application of RFID technology in tracking IT assets of a large size organisation in Australia. RFID technology is often touted as a global technology; however, each geographic location operates on specified frequency spectrum and on top of this there are legislations governing the use of this technology. The paper provides use cases based on different technological options permissible in Australian paradigm. These use cases illustrate different ways RFID could be implemented in different settings. The paper thus provides better understanding of the benefits of RFID adoption and for making decisions in RFID investment and adoption to create value for the business.

Keywords: RFID, item tracking, security, integration.

1. Introduction

Barcodes have traditionally been used for the purpose of item tracking and warehouse management. However, barcodes only identify a class of items and cannot identity particular items. For example, a barcode identifies a 500 ml of a coke bottle but it is insufficient to identify the exact location of that bottle. Similarly, information on origin and manufacturing of an item could be related to its barcode, but barcodes cannot provide information regarding its movement after manufacturing or commissioning, and current condition. Another of their drawback is that barcode technology is only effective in line of sight with the reader, such that each item has to be scanned individually. Hence for the purpose of item location and tracking, Radio Frequency Identification (RFID) is a suitable alternative. This technology has been successfully deployed in different parts of the world for various applications using its tracking and identification allowance. The significant level of interest in RFID technology's development and uptake has made it cost-effective and scalable (Wyld 2006). RFID was first used in World War II by the British Air Force to distinguish allied planes from enemy aircraft. Recent interest in this technology is owed to its adoption by the United States Department of Defence and retailers like Wal-Mart and their suppliers. This interest has, however, transcended into other parts of the world and to more sophisticated and specialised applications.

This paper presents the case of RFID adoption for IT asset tracking at SA Water Corporation in Adelaide South Australia. The main purpose of this paper is to provide different option to SA Water to track and manage their IT assets which are highly prone to loss or misplacement. It is, therefore, necessary to ensure that only authorised personnel are allowed to move the assets from the premises and if this is not the case, then an alarm condition should be raised in order to notify the security systems. Tracking of the assets will give way to improved tractability and thus reduce and even prevent loss of the technology assets. However, different parts of the world operate on different frequency spectrum; therefore, technology from one part f the world is not compatible with another part that operates on a different frequency spectrum. The novelty of this is that it provides different options to SA Water that are applicable in Australian paradigm. This paper starts with an introduction of the problem, which is followed by the applications of RFID technologies in various industries. The paper then discusses the frequency allocations for RFID technologies in Australia. It then develops the use cases of various options that are available to SA Water for using RFID to track their IT assets.

2. IT Asset Tracking at SA Water

SA Water has a major problem in tracking the location of all SA water owned IT assets as well as finding out the exact number of working IT assets in SA Water. As a result not only that the organisation keeps on procuring redundant IT assets, but it also uses a rounded figure in signing support and software licensing agreements. Knowledge of exact number IT assets will bring these costs down substantially. For example, if SA Water's current IT asset inventory states 5000 assets then the support and licensing agreements are signed for the same number regardless of the condition of the assets. Knowledge of exact number of assets, their condition, and their location will help in reduction of costs of support and licensing agreements, as well as the man hours spent in locating these assets. In addition, it will also

eliminate the chance of redundant purchase of IT assets. Apart from improved security for removable/mobile devices used by SA Water staff, the company is also looking for integration of IT asset movement information with the staff access card and associated systems currently in use in SA Water. It is worth pointing out that the IT assets include laptops, desktop computers, printers, servers, hubs, scanners, plotters, data loggers, UPS units, switches, routers, projectors, and smart boards.

3. RFID Applications

The versatility of RFID technology means it has numerous applications. For example, the technology is being used vastly for supply-chain management and asset tracking (at cartons, crates, pallets or item level). However, it is also being used for authorisation and access control, as well as for document tracking and library services management. These days RFID enabled smart cards are used to store employee data for access control at gateways to buildings, for opening secure vaults, and even charging the employee's account after a purchase at the canteen. Such smart cards have become the person's fingerprint for the entire building. These cards can also help proper fire evacuation procedures. RFID can thus be used to create what can be termed as intelligent buildings (Craig and Sommerville 2005). RFID technology is becoming quite popular for tracking of luggage at airports. It has helped reduce baggage handling errors considerably and thus leading to higher customer satisfaction. Lost luggage can now be tracked easily and returned to the passengers with the provision for RFID enabled tracking (Jones *et al.* 2005). Similarly libraries all over the world have employed RFID to improve their services and information handling to minimise errors. It reduces queues at the counters due to self service counters enabled by RFID. It also increases security and reduces handling and material costs as the single RFID enabled label can store a lot of information. It also aids automatic sorting and updating of databases and assists in easy search of lost books (Yu 2007). In transportation, RFID is being used in highway toll-booth systems as smart ticketing. RFID tags are also being used on the windshields of rental cars to store vehicle identification numbers to enable automatic inventory via readers installed in parking lots (Nath *et al.* 2006). HF RFID tags specially created for metallic equipment were used along with mobile application modules for maintenance and asset management activities in a pilot at the Frankfurt airport in Germany. During the project, the tags were placed on fire shutters in the air-conditioning and ventilation system. The benefits of the project included better planning, control, and documentation of technicians' works as well as improved process quality (Legner and Thiesse 2006).

It is evident that RFID technology has an edge over barcodes. Retailers like Wal-Mart have successfully deployed RFID with the help of their suppliers and this application has rendered barcodes obsolete in the retailing industry (Attaran 2007). RFID tags enable tracking of a product from the production lines to warehouses to the shelves in supermarkets and finally the checkout counters. The technology not only helps the easy capture of data but also help to reduce labour costs. They also help with reordering, stocking, and keeping track of purchases and curb theft (Burgess *et al.* 2007). Dynamic ordering and shelving of perishable goods is possible due to RFID tags. This can also be used to dynamically price the perishable items which are nearing their use-by dates for quick sale (Liu *et al.* 2008). According to an estimate, Wal-Mart can save $6.7 billion in labour costs alone from RFID implementation (Attaran 2007). In manufacturing, RFID can be used in order to track individual parts along the production line. This can aid manufacturers in scheduling just-in-time assemblies (Li *et al.* 2006). Information about the parts can be stored on the tags which can help keep track of usage, availability, location and even maintenance requirements. Procter & Gamble (P&G), for example, believes that RFID technology can help the company to track where every item is in the manufacturing process and supply chain. P&G expects the cost saving of up to $1 billion in working capital and $200 million in inventory carrying costs. The savings on inventory will offset the cost of the RFID infrastructure and tags, and other savings will help P&G's bottom line (Attaran 2007).

Tagging and tracking of patients becomes easy with the help of RFID tag enabled wristbands. Information, like medical records, allergies, etc., about the patient can be stored using such wristbands. RFID systems can help automate the admission, screening and treating processes for patients, enhance communications between caregivers and support teams, and reduce medical errors (Chen *et al.* 2008). Medical centres are also using RFID technology to track and manage assets, such as medical devices, and wheelchairs. Medications and dosages are tagged so that doctors and nurses can ensure that the right medicine is given in the right amount at the right time to the right patient (Attaran 2007).

Regulations about traceability of food are very stringent in the U.S and European Union. RFID technology can be applied for this purpose. The technology also reduces recall costs by increasing the ability of the manufacturers to identify and recall only the affected items (Clarke-Hill *et al.* 2005). The tracking of livestock has been one of the most successful applications of RFID. Over 40 million

animals around the world are implanted with RFID tags (Li *et al.* 2006). Other areas where RFID technology has been used successfully are Shipping and distribution (Attaran 2007; Ranky 2006); pharmaceutical industry (Attaran 2007); gaming industry (Attaran 2007).

4. Standards and Australian Environment for RFID

The International Telecommunication Union has developed the ITU Radio Regulations. These regulations form the basis of the Australian Radiofrequency Spectrum Plan. The Radio Regulations divide the different radio frequencies into bands and allocates services to each band according to three geographic regions. These regions are defined as Region 1, 2 and 3 (Australian Communications Authority 2005). Region 1 is composed of most of Europe, Africa and the Middle East. Region 2 is composed of the Americas. Region 3 is made up of the Asia-Pacific region. Thus, Australia is located in Region 3 (Australian Communications Authority 2005).

ISO/IEC 15693 is a global standard for 13.56 MHz HF RFID tags (Class 1) and reader electronics. The ISO/IE C 15693 protocol conforms to FCC (USA), ETSI (Europe) and MPT (Japan) regulations worldwide. The standard allows tags to travel around the world under optimal conditions for operation with region specific RFID readers (Attaran 2007). Hence the standards for HF radiolocation are accepted all over the world. However, for UHF radiolocation, although, the frequency band assigned is from 860 to 960 MHz, not all the frequencies in this band are usable. Both U.S. and Europe have different frequencies in this band for radiolocation. In Australia (Region 3), most of the frequencies in this UHF band are used by mobile phone service providers. Hence, the available frequency band that may be used is from 915 to 928 MHz so that the operation does not interfere with other applications (Australian Communications Authority 2005). The EPC has developed two standards, Class 0 and Class 1 for the UHF RFID tags. In December 2004, in order to promote interoperability, they introduced the Generation 2 standard to replace Class 0 and Class 1. These Gen 2 tags are now being promoted world-wide for their interoperability and their higher memory capacity (Li *et al.* 2006).

The other regulation in Australia has to do with the power output of the RFID readers. Current Australian RFID services are governed by the ACMA through the class of license for Low Interference Potential Devices (LIPD). These regulations limit the RFID services operating in the 915 to 928 MHz frequency band to a maximum power of 1 watt EIRP (effective isotropic radiated power). No licenses are required for applications up to 1 Watt but anything between 1 and 4 Watts requires a scientific license from GS1 Australia (GS1 Australia 2008). Read range for RFID tags depends on the power output of the RFID readers, and the difference between 1 Watt and 4 Watt is approximately a 300% improvement in read distance and efficiency (i.e. improving the average read range from 1 metre to 3 metres). Much of the World now uses 4 Watt (GS1 Australia 2008). However, this means that services operating at 4 Watts EIRP may interfere with other services like mobile communications which also operate in the same area and around the RFID UHF frequency band. Both 1 Watt and up to 4 Watt have been used by GS1 Australia in various RFID pilots; with 1 Watt suitable for shorter range applications, such as hand held devices, and up to 4 Watt more suited to RFID gateways or other applications where accurate reads at a distance are needed (GS1 Australia 2008).

5. RFID Technology for Asset Tracking and Management at SA Water

There are four different options available to SA water for tracking its IT assets. These options are explained in the following sections.

Using HF Tags for Asset Tracking

High frequency tags can be used for asset tracking in SA Water. The tags operating at the frequency of 13.56 MHz are very cost effective and flexible. They are available in paper as well as filmic inlays which makes embedding with the assets very convenient. The ISO/IEC 15693 standard for 13.56 MHz is accepted worldwide and the protocols conform to FCC (USA), ETSI (Europe) and MPT (Japan) regulations which constitute the three Regions determined by the International Telecommunications Union (ITU). The standard allows tags to travel around the world under optimal conditions for operation with region specific RFID readers (Attaran 2007). Australia being in Region 3, according to the Australian Communications Authority, the HF frequency band can be used for radiolocation (Australian Communications Authority, 2005). The tracking of assets using HF tags may be done in two different ways:

Automatic scanning

In this case, there are two RFID tags. One attached to the IT asset and the other enabled on the staff access/identity card. In this scenario, HF readers are either mounted on the doorways or at convenient locations similar to the ones present in the anti-theft systems at supermarkets may be installed before of after doorways (see figure 1). Since the access/identity cards assigned to staff are also

equipped with HF tags, details like IT assets assigned to them, asset configuration, maintenance history, special operating requirements, and other details can also be stored on the tags. In this scenario, when staff enter or leave the room equipped with RFID readers, the readers will automatically read staff as well as IT asset tag. The information captured will be compared against the existing record to see if the IT asset being carried by the staff members actually belongs to them or has been issued to them. Upon confirmation, it will be considered a valid 'check-out' event and relevant information will be entered in the 'asset movement database'. This database will obviously be related to employee/staff database and IT asset inventory database. In case, the asset does not belong to the staff member who is trying to take it out of the room. They will need to make appropriate changes to IT inventory database before leaving the room. In case these changes are not made, the system will generate an alarm and inform the security system.

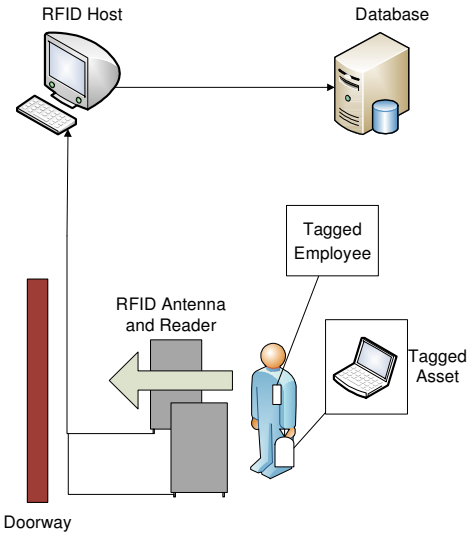

Figure 1: Automatic scanning using HF RFID technology

When the employee returns with the asset to the room, the same reader will be read the staff as well as the asset tag, and the relevant 'check-in' event will be recorded in the 'asset movement database'.

Manual Scanning

This system is similar to the self-service counters available at supermarket check-out or the check-out systems available in many libraries. In this case, the access/identity cards may not be equipped with RFID tags, however, the assets are to be tagged with HF tags. However, an RFID station consisting of a reader and an access card scanner needs to be present next to the door on the way out of the room. When a staff member wishes to leave the room with an asset, he/she will need to swipe his card through the card scanner so as to invoke an instance of the check-out event. Once his card has been read, he will present the asset to the reader which will read the HF tag and transmit this information to the computer system. The system will tie the employee data to the asset tag data and create a 'check-out' entry in the 'asset movement database'. At the same time, the HF asset tag will be deactivated and the employee can then leave the room after the asset is 'issued' to him. If the employee decides to leave without deactivating the tag at the RFID station, an alarm will be raised and the security system will be notified. The employee can leave the room at anytime without going through any scanning procedure if he is not carrying any asset.

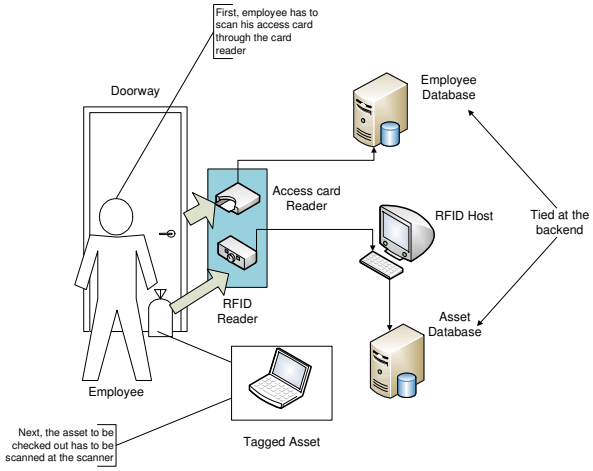

Figure 2: Manual scanning using HF RFID technology

When the employee wishes to return the asset, he will have to scan his card which will bring up the existing record and when the asset is presented to the reader, the 'check-out' entry will be cleared as part of the 'check-in' process. Also the tag will be reactivated and ready for its next check-out event. It should be noted that the HF tags and readers have low read ranges and hence the automatic scanning method might not be feasible unless the placement of the antennas and readers is tested and the optimum position is determined.

Using UHF tags for Asset Tracking

Due to the read ranges provided by UHF (EPC Gen 2) tags, the automatic scanning method is feasible when these tags are used for asset tracking. The tags operate between the frequencies of 918 and 926 MHz in Australia and are available in many different formats like paper, film, hard tags, discs and even tamper-proof tags. Although these tags are designed

to operate in the frequency band of 860-960 MHz, the Australian frequency spectrum plan only allows operation in the 918 to 926 MHz range as the remaining frequencies on either side of this band are utilised by mobile service operators (Australian Communications Authority, 2005). Various pilots have been carried out in Australia to test the Gen 2 tags by GS1 Australia. One such pilot entailed the implementation of EPC Gen 2 tags in the supply chain of Patties Foods in Victoria along with their logistics partners, Montague Cold Storage (GS1 Australia, 2008).

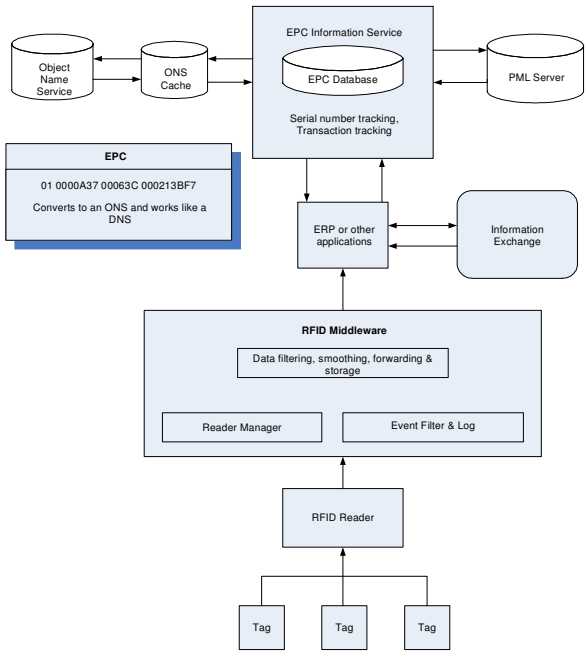

Figure 3: The EPC framework for RFID tags

(Adopted from Brock 2001)

These tags only have provision for storing the EPC which can be used as an identifier for the asset to which the tag is attached. The EPC has been designed to enumerate all objects and accommodate all current naming methods. The EPC serves as a reference to information on the computer network. In order to describe the physical objects that the tags are connected to, a language called the Product Data Markup Language (PDML) is used. PDML is based on XML and it uses a schema describing the common aspects of physical objects. Using PDML, data about the assets like configuration details, service or maintenance history, physical attributes, special operating requirements and so on can be stored in a database. In this scenario (Figure 3), tags attached to each IT asset are read by a reader fixed at the convenient location, which passes the EPC information to the middleware or savant. A savant acts as buffer between the reader and other organisational information systems, and consists of various modules or sub programs with each module performing specific functions. The savant remains connected to the readers and act as a router of the RFID network with the primary functions of EPC related data smoothing, data forwarding and data storage; along with reader coordination, and task and event management. Savant need to be based on open standards so as to provide for easy information interoperability.

Since the EPC is the only information stored on the tag, it has to be used in such a way that it provides additional information about the IT asset that EPC is attached to. Data exclusive to IT asset could be stored on a server located on a connected local area network or the Internet, by an application of the concept of domain name service (DNS). The EPC stored in the savant is interpreted into a unique address of an object naming service (ONS), which is basically an automated network service which when given an EPC number, returns a server address where the corresponding PDML file is located. The ONS service thus behaves similarly to the DNS used in IP networks, in the way that DNS converts the IP address of a computer connected to a network into a domain name for communication with other computers on the network (Brock, 2001). The PDML file corresponding to the EPC can contain any type and length of information about IT asset.

Automatic scanning

For automatic scanning, the staff access card needs to be equipped with RFID tags as well as the IT asset. In this scenario (figure 4), when an employee leaves a room with an asset, the UHF reader will scan the staff as well as the asset tag. This data will be sent to the middleware and onwards to the PDML files and 'asset movement database'. The data from staff will then be related to the data from the asset and a 'check-out' entry will be created in a database that can be interfaced with other existing systems so that this information is available to all the related systems. As mentioned in the earlier scenario, the identity of the staff will be matched with the IT asset and if they don't match then alarms will be raised and relevant procedures invoked. When the employee enters the room with the asset, the staff and asset tags will be scanned again and a 'check-in' entry will be made.

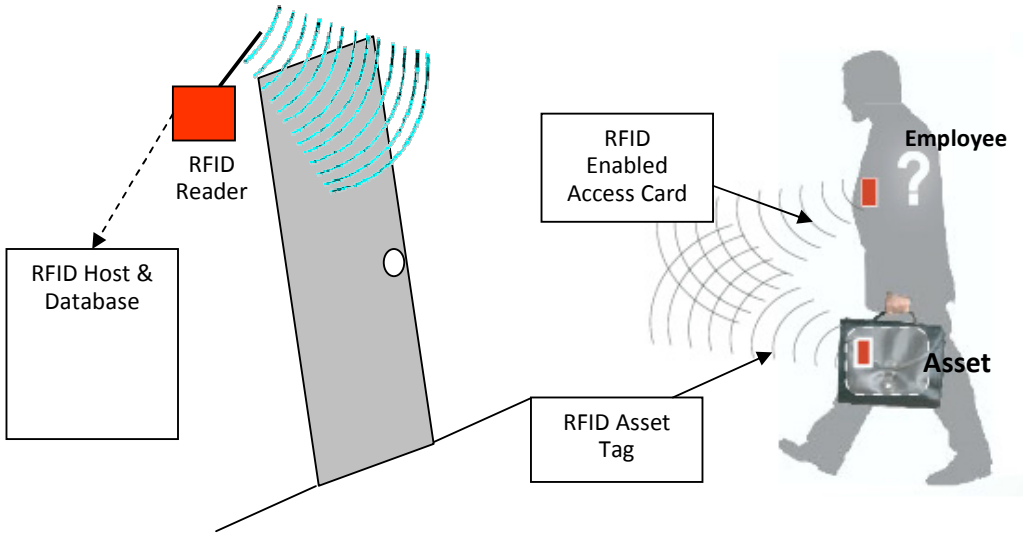

Figure 4: Automatic Scanning using UHF RFID technology

The UHF paper and filmic inlays are very thin and their compact nature makes their application very flexible. These tags have been used successfully for baggage identification in the airline industry. As mentioned earlier, due to their compact nature, it is possible to enclose the tags in the barcode labels such the tags are concealed and the barcode is visible. This will prevent possible tampering of tags.

Manual scanning

As explained in the manual scanning option for HF tags, there need to be a RFID reader and an access card scanner available at the exit door. When a staff member exist the room with an IT asset, he/she will have to manually scan the access card and the RFID reader will automatically read the card. The data thus captured will be matched to see if the person carrying the IT assets is the one whom the asset has been assigned. If not, an alarm will be raised. Therefore, anybody who wants to take the asset out of the room will have to ensure that the asset is 'issued' to them.

Microwave tags:

The UHF range microwave tags operating at the frequency of 2.45 GHz can also be used for asset tracking. They have longer read ranges than the UHF 860-960 MHz range tags. The use of the 2.45 GHz frequency for the purpose of radiolocation is permitted in Australia according to the Australian Communications Authority. Due to the long range nature of tags, the tags may be read in multiple positions. Using this feature of the long-range tags and with multiple antennas connected to readers at appropriate positions, tracking of assets on the entire floor is possible. This will result in real-time tracking of assets and staff who take those assets. These tags also employ the EPC standard and so, all the information about the personnel and assets has to be stored in a database separately and identified using the EPC. Hyper-X and Balogh RFID solutions offered by Electro-com in Australia use these long range tags.

Active Tags for Asset Tracking

Active tags are powered by batteries and can be automatically activated at control points in a building. They can broadcast non line-of-sight to small receivers networked on the existing corporate LAN/WAN, VPN or Internet over IP. They operate on dual frequencies, one to activate the tag and the other for transmission of data. They can be used for real-time tracking of assets in the building. The read points can also be grouped into zones to locate an asset or person within a specific zone, as well as monitor movement between zones. The memory on these tags allows storage of a unique code and other information like location, status information, etc. In this scenario (figure 5) a tagged personnel enter the premises, access may be granted without swiping a card or entering a code using active tags embedded

on their access/identity cards. The active tags, using their battery power, transmit data at every control point like a beacon, which is forwarded to the reader. So when an employee enters a room, the tracking system will detect him based on the data transmitted by his access card.

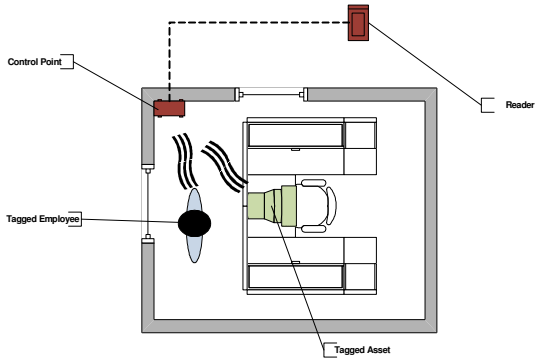

Figure 5: Active tags for automatic access for tagged personnel and automatic beaconing of tagged assets

Using the asset tracking system, assets can be assigned to authorised staff. A work-request system may be employed for this purpose. As that employee moves with his asset in or out of the room, the access card as well as the tag on the asset is read by the control point and the data is sent to the system. The system compares the data with the records created by the work-request and when a match is found, confirms that the employee is an authorised user of the asset. Tamper-proof tags are available which raise an alarm if removal of the tags is attempted. If an employee other than the authorised user attempts to take the asset, the system senses the mismatch between the personnel tag data and asset tag data and an alarm is raised. Also, if an employee leaves his personnel tag behind (say in his cabin) and attempts to take the asset, he has to go through the coverage area of many different control points. The control points relay the movement of the asset to the system and the system senses that the asset is being moved without its authorised user. So an alarm is raised in this event as well.

The active tags can also be used for populating automatic inventory. The tags broadcast their data periodically at predetermined intervals to the control points like beacons. This allows the system to maintain an inventory of all the assets currently available. In this way, employees can check on availability of assets in real-time and if an asset has been checked-out, the status can be displayed on the system. Active tags however are the most expensive and cost in the range of 30 Australian dollars to 75 Australian dollars each.

6. Conclusion

RFID technology can be used in different ways for the purpose of asset tracking and management at SA Water. However, there are many different considerations to be made while deploying such technology so that the potential risks and benefits of those technologies are clear from the outset.

RFID could also be used for more specialised tasks. For example, SA water could tag equipment like pipelines, pumps, valves, heat-exchangers, wires, etc. The tags can store information about the equipment like manufacturer, model number, equipment ID, description, last repair date, inspector, etc. The maintenance staff can read these tags using handheld readers and obtain the required information without referring to computer workstations or related paperwork. Using read-write tags, work-requests, special maintenance remarks and other details may be provided to the maintenance staff when they are in the location, which makes the maintenance process more efficient. Besides, tags also provide validation that the maintenance personnel are in the correct location, performing inspection and maintenance on the correct equipment. If a work permit exists on any equipment and hence it should not be operated, the personnel may be able to view this information instantly by scanning the tag on the equipment using a handheld reader.

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