THE INTERNET OF THINGS: PRACTICAL THOUGHTS FOR BUSINESS

A White Paper from CoreRFID

This White Paper has been developed By CoreRFID as an aid for businesses contemplating the opportunities potentially presented by the Internet of Things.

CoreRFID has over twenty years' experience of deploying systems and technologies involved in the sensing of things in data networks and was a pioneer in the use of RFID in industrial inspection and maintenance applications.

CoreRFID offers their customers access to RFID tag and sensing technologies. The company develops, delivers and supports complete business applications that work with these technologies and exploit the capabilities provided by mobile data networks.

To learn more about CoreRFID and our capabilities, visit our web site: www.corerfid.com.

To discuss how your company might be able to exploit the ideas suggested by this White Paper contact us on +44 (0) 845 071 0985 or by email: info@corerfid.com.

HYPE OR HOPE?

Almost every sector of business is being told that the "Next Big Thing" is going to be the Internet of Things (IoT). Cloud computing providers, consultants, network technology companies and others all have their views. There is no doubt that things are becoming more connected but is that all that is happening? Is the IoT simply a proliferation of intelligent, connected devices or is there something more to it?

As a company involved in some of the key technologies associated with the IoT we are keen to help customers see the wood for the trees. This White Paper is an attempt to look beyond the hype at some of the reasons why businesses should be thinking about the IoT and what practical plans can be made to exploit it.

We declare an interest. We design, develop, implement and manage systems that use some of the IoT's technologies. In this White Paper, we've tried to look at real world things that companies are doing today, to see how they can relate to the trends that will affect longer term developments in this field.

WHAT IS THE IOT ANYWAY?

One of the problems with new technology ideas is that a catchy name often gets talked about without everyone agreeing what it means. That is certainly true of the IoT.

Broadly speaking the IoT is a term used to describe the extension of the Internet from linked computers and other electronic devices largely used by people to include devices that talk to one another, often without human interaction. The "Things" that the IoT is concerned with can be anything from a remotely controlled switch that can turn on your heating from your mobile phone through to a food container that can announce if its contents have exceeded a permitted temperature.

It is best understood, in the first instance, through examples. Perhaps the best known is the "imagine if your fridge knew when you had run out of milk or your milk was out of date and could order some more" scenario. That may seem far-fetched but it is very similar to a real-world application in use today where intelligent drug cabinets sense when medication is removed and re-order replenishment stocks automatically.

Systems like this depend on technologies that allow things to talk to computer systems. Some of these technologies may convey very simple information such as the identity of a specific thing, others may convey something more complex such as location, temperature, or acceleration. In their most complex form things may embed intelligent components that talk across networks to their peers. In the example of the medical cabinets mentioned above, the cabinet could ask others in the same hospital (probably via an intermediary, cloud-accessible application) if they had stocks of the item required before ordering more.

Some of the technologies associated with the IoT include:-

- Embedded communicating, sensing and computing devices that become a part of things.

- Radio Frequency Identification (RFID) tags that can be attached to things, allowing them to report their identity and other data to computer networks when contacted (a very simple and low-cost example of a communicating and computing device).
- Data networks – wired and wireless – that ensure things can connect to systems
- Sensors and tag readers that allow data to be collected from things.
- Coding and addressing systems that allow specific things to be found and uniquely identified
- Security systems that prevent network disruption, things impersonating other things, application impersonation, data interception and other threats.
- Tools for handling the mass of data created and collected by IoT networks.

All of these technologies are deployed in systems of various kinds today. For example, tens of millions of RFID tags are already in use around the world for tasks as different as identifying pets and providing electronic tickets for events or travel. Are these examples of the IoT?

Some would say not. Generally, these are very localised applications, where the "thing" in question interacts only rarely with other systems and usually only for a single purpose. The IoT is more properly concerned with regular interactions and with multi-purpose ones too. Some consider that true IoT applications are those where objects are exchanging data with one another, independently of central systems, but that can be thought of as a long-term goal.

Irrespective of whether or not today's localized applications of IoT technologies are "real" IoT applications, these systems are important for the growth of the IoT – they help to drive down costs through establishing economies of scale and creating cost justification for the necessary infrastructure upon which more complex applications will eventually run. (More importantly these "today" IoT applications deliver real benefits in their own right for business and can form an important part of any organisation's productivity improvement approach.) For example, the growth in cellular networks, driven by consumer demand for mobile telephony, has made it practical for mobile devices in vehicles to communicate driver behaviour to insurance companies, allowing them to create new insurance products for safer drivers.

What is clear, though, is that increasing numbers of devices are being connected to the Internet (and so, potentially, to one another). Estimates of the number of connected devices vary but technology industry analysts Gartner believe[1] that by the end of 2017 8.4billion devices will be internet connected, more than one device for every person on Earth. By 2020 that figure is expected to climb to over 20 billion, and it is this issue of scale that is creating the need new infrastructure and the opportunity for new types of applications. In the area of sensed devices, IDTechex[2] believe that the 2017 market for RFID tags is worth around $4billion.

[1] Gartner: "Forecast: Internet of Things – Endpoints and Associated Services Worldwide 2016."
[2] IDTechex: "RFID Forecasts, Players & Opportunities 2017 – 2027"

WHY DOES THE IOT MATTER?

Many businesses are recognising the opportunities that can be found in using these technologies. The problem is that the opportunities are as individual as each business and each market in which it operates.

The IoT matters because those businesses that identify ways to exploit it have the chance to establish competitive advantage as a consequence, offering customers improved product quality, lower costs or even new ways of consuming products or services as a result.

While it is difficult to create an abstract model that allows businesses to identify opportunities presented by the IoT, CoreRFID's experience as a technology and solutions provider points to a number of different types of system that can be worth exploring. The main categories are:

Systems that reduce the asset costs required to run a business. Examples here included systems that save cost by reducing the loss of valuable assets by enabling them to report their location, and systems that reduce the costs of identifying assets, especially where regulation imposes a detailed level of asset control, as is the case for IT assets in some industries.

Systems that save labour costs in production, service or administration. For example, automatic identification of items can reduce inspection costs in a warranty process. Products that automatically report their whereabouts can reduce the effort needed to locate costly assets and reduce administration costs associated with managing them.

Systems that make new products possible. We are used to the fact that our computer printer can sense when an ink cartridge is empty but a network connected printer could communicate that fact, allowing it to order its own replacement cartridges, offering the user a new "never run out of ink" service and providing the manufacturer with user tie-in benefits and the ability to cut out middle men in the cartridge supply chain. (Hewlett Packard offer this service today on certain devices as their "Instant Ink" service.)

Systems that can take advantage of "big data" collected from the real world. Collecting data directly from things allows applications that consolidate and interpret such data the opportunity to optimize the use of resources such as skilled labour, expensive plant or geographically distributed facilities. A simple application of this can be found in CoreRFID's own CheckedOK applications which collate the results of safety inspections on plant. This data is collected electronically more cheaply hand accurately than was possible with manual systems and, because the data is available electronically it can be used to more efficiently plan the use of inspecting engineers.

Systems that change the shape or economic structure of businesses. These are the most disruptive systems which will have the effect of creating (and destroying) existing business models.

Think again about the "intelligent drug cabinet" application mentioned earlier. Where might the business benefits be found in such a system? At least four areas of benefit can be explored:-

1. The automatic ordering of new supplies would seem to offer the opportunity for administrative cost savings and reduction in re-stocking lead times.

2. The ability to optimize stocks of drugs across a site could mean reduced stock holding over all, saving the costs of stocks and delivering just-in-time benefits to an area which has not previously had them.
3. The ability to collect accurate data on drug usage could allow better modelling of demand, ensuring that replacement stocks are ordered in line with future likely usage.
4. Such a system could even be used to reshape the drug supply chain; creating a business model where the drug company supplies the cabinets and their contents and only charges the hospital for the drugs at the point in time at which they are used.

These may sound like visionary systems. However, looking at shorter term can have benefits too. CoreRFID's experience is that even a simple system using IoT technologies, for example, to check medicines into or out of a store rapidly and accurately provides benefits of stock level control, control of the use of consumables, better accountability for usage and improved cost management, and without major infrastructure investment.

It is certainly the case that implementing straightforward applications that benefit from IoT technologies today can be an effective way of gaining experience. In the case of one motor vehicle importer, for instance, an early application of RFID technology to identifying imported vehicles in storage has allowed the business to build experience in a raft of technologies for identifying objects that is dramatically changing the way in which they can track (and thus get value from) the multitude of vehicles under their management. In a container tracking application delivered by CoreRFID it was realised after implementation that the same technology could be easily extended to improve the efficiency of safety inspections. But such systems do not only deliver experience. They can deliver benefits that result in rapid investment payback in their own right.

A recent survey[3] by the Economist Intelligence Unit points to the areas that businesses fell have so far seen the greatest benefits. Of these the three clear winners were sparking innovation as a result of better insights from the data provided by IoT systems, unlocking new revenue opportunities from existing products and services and enabling a change in business model or strategy. However, only 85 of respondents claimed to have implemented IoT features in several products or services. Itwould seem that the benefits are there to be had, but that most organisations have yet to explore them.

[3] The Internet of Things Business Index 2017, available free from ARM

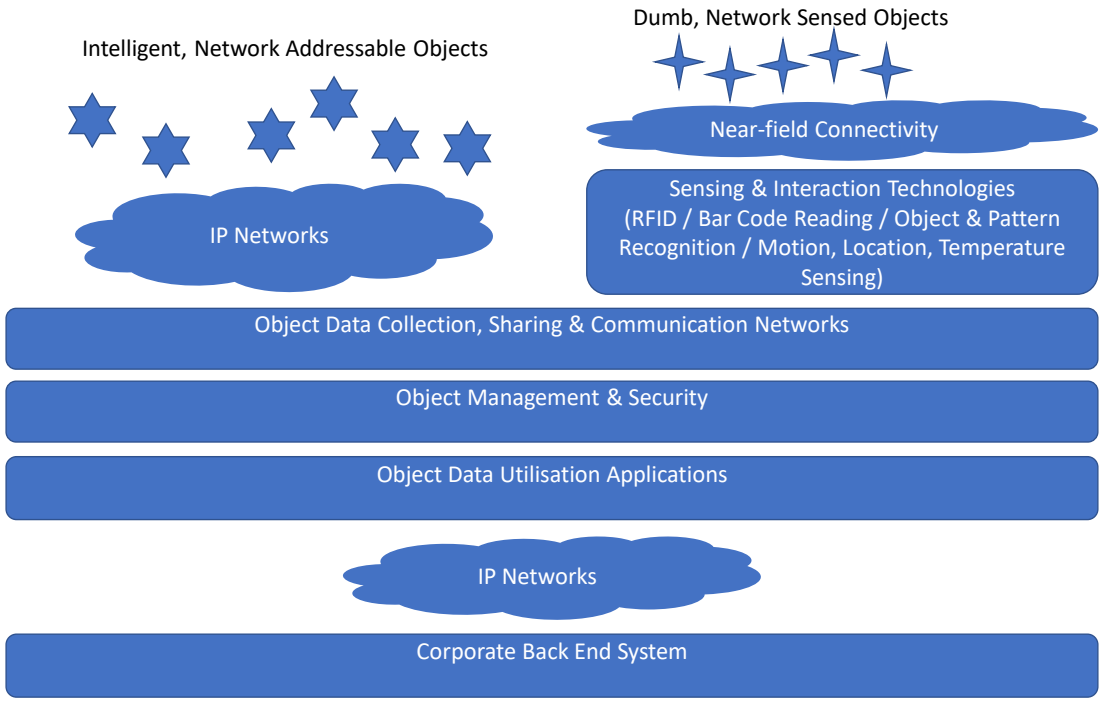
AN ARCHITECTURE FOR THE INTERNET OF THINGS

Today it is possible to identify the main elements that will go to make up an architecture of the Internet of Things. However, it is much more difficult to identify all the instances of products and services that will be deployed in these applications.

There is also the problem that vendors and standards bodies talk of the Internet of Things as though it is simply a more extensive version of today's IP (Internet Protocol) networks. While this in itself is challenging enough (due to the volume of devices and variety of applications envisaged), the reality is made more complex by the fact that the IoT has to cope with two different classes of devices attached to it.

This concept is illustrated in the diagramme below. Firstly, there are the intelligent devices that can be connected with over IP networks. Ten years ago, the family of "IP Connected intelligent devices" was effectively limited to personal computers, servers and laptop computers. Today that family includes mobile phones and tablets, hi-fi systems, televisions and set-top boxes, games consoles. It also includes a growing number of other types of devices; the network communicating refrigerators and medicine cabinets mentioned above, smart meters in the home, smart lightbulb fittings; security cameras and access control mechanisms and so on. We can expect a strong growth in the number and variety of these.

There is however a second class of "thing" that has to be accommodated. These are the things that, while not intelligent themselves, can be sensed by other devices which are themselves IoT connected. Examples of objects like this include the packets of medicines stored in the drugs cabinet. The cabinet needs to sense their existence, what type and dose of drug they are, their expiry date. To do this the cabinet needs its own near field sensing and data collection network. Such local sensing networks use different technical standards (usually RFID) from the networks that most businesses are familiar with.



The technologies of the RFID sensing networks follow a wide range of standards depending on the technologies of the identity tags involved. The most widely used tags to date are based on high frequency (HF) standards including the popular NFC (Near Field Communications) standard used in contactless payments. Ultra-High Frequency (UHF) tags are increasingly popular in the industrial space because of the ability of UHF RFID systems to read tags from greater distances (typically up to 10 metres) and to read thousands of items a second. A recent industry initiative, RAIN RFID, seeks to combine the various standards in the UHF RFID space to produce interoperable UHF RFID applications.

RFID based networks have different capabilities and limitations from traditional wireless IP and GSM networks which require different skills in systems design and integration but their inclusion in IoT applications greatly extends the range of technically and commercially viable business and consumer applications.

As well as the challenges of the two classes of IoT connected objects or "things" there is the need for different software within the layers of the architecture and the need for different ways of addressing IoT connected objects.

To achieve widespread applications which involve things interacting with one another, the problems of devices being able to identify each other have to be solved. Our everyday experience of shopping tells us that those can be solved at one level: we are used to a bar code identifying a tin of beans or a packet of cereal. But now imagine the scale of the challenge if a system needs to identify a specific packet, with a defined original batch number and a specified "best before date". The scale of the problem of uniquely identifying objects electronically is vast. For intelligent, IP-connected objects the IPv6 protocol provides sufficient address space. For near-field connected, network-sensed, objects however, IPv6 does not apply. Luckily work done over the last thirty years in article numbering standards provides the mechanisms. The GS1 organisation provides the same measure of standardisation for article numbering using RFID that is familiar to users of barcodes and the EPC Global and IEEE provide standards for RFID connectivity (UHF and LF/HF respectively), although some forms of device sensing such as temperature, and motion are subject to proprietary standards.

Beyond the connectivity layer (data collection, sharing and communication, object management and security and object data utilisation), the user is faced with identifying an appropriate architecture or by creating user specific applications that span these layers. For many users in the industrial space, today, this second approach will turn out to be the most commercially and technically practical, until industry-standard architectures become generally deployable.

WHO IS CREATING THE INTERNET OF THINGS?

A number of actors including vendors, standards bodies and end-users are contributing both to the infrastructure needed and the thinking that is behind the IoT. In this section we have collected up a list of some of the most important with links to their web sites.

Standards bodies and international consortia include:-

The Industrial Internet Consortium : a body seeking to promote the use of internet technologies for industrial uses.

IEEE P2413 : the working party within the Institute of Electrical and Electronics Engineers focused on creating standard for an architectural framework for the IoT.

The Open Connectivity Foundation : intends to overcome the problems of the multiplicity of standards and networks and to certify products as conforming to interoperability standards for IoT style applications. Has a particular focus on consumer applications.

IoTivity: a project by the Linux Foundation to create an open-source device to device connectivity framework.

GS1 : are responsible for the widely used Gen2 interface standard for UHF RFID tags and for the EPC Global family of item coding systems that includes unique identifiers for Individual or Returnable Assets., Locations, Document Types, Shipping Containers, Consignments and Trade Items.

RAIN : is a consortium of RFID manufacturers and solutions providers working together to promote the use of UHF RFID technology, an important component of many IoT solutions.

Alliance for Internet of Things Innovation (AIOTI) : an EU initiative to promote the use of the IoT across Europe as an aid to economic growth.

Vendors worth watching on IoT applications include:-

Nest: a Google subsidiary company focused on home automation applications including energy management and home security.

Apple's IoT applications range from partnering with software vendors to creating its own proprietary home automation infrastructure and software development platform with compliant products marketed under the umbrella brand of HomeKit.

Industrial automation vendors such as Siemens and Honeywell, who are exploiting IoT technologies to make smart production lines and other IoT enabled industrial applications.

IoT platform vendors include IBM, Amazon (with their AWS offerings), GE Digital (with Predix), Microsoft's Azure IoT Suite.

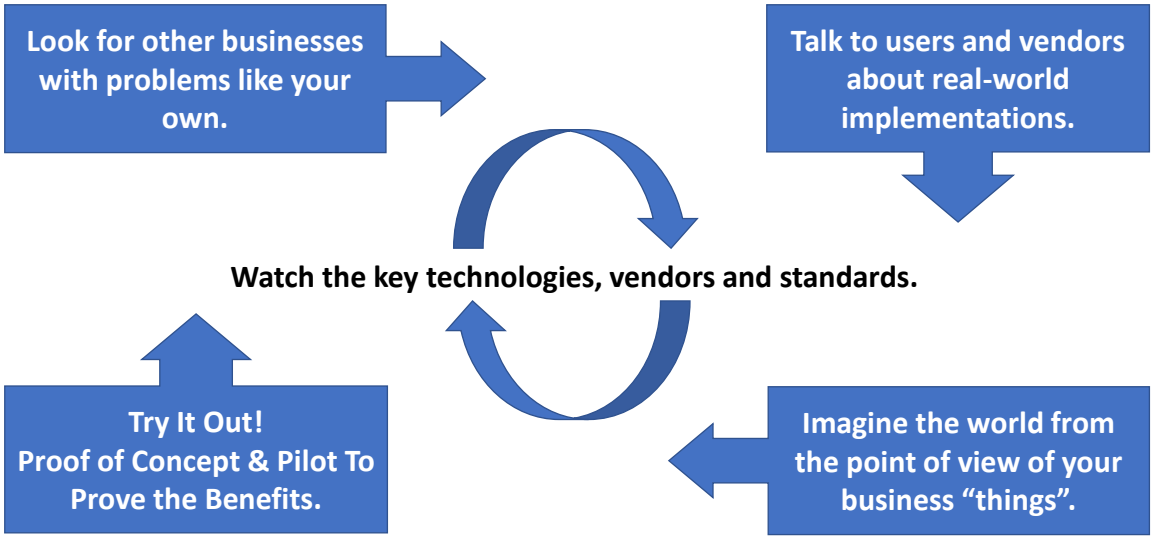
RAIN RFID technology vendors such as Alien Technology Inc, Caen, Impinj, Nordic-iD, Omn-ID and many others.

HOW SHOULD YOU MOVE FORWARD?

Managing innovative IoT solutions in business is much like any other form of innovation. It has to start from the perspective of solving a business problem.

Perhaps your business already has an application that might benefit from some of the technologies and ideas identified in this White Paper? If so, talking with other companies like yourselves that have already tried them can be a great way to progress.

"Innovation flourishes best when you look to solve a problem.." Richard Branson.



Alternatively, find a vendor that has implemented solutions in your industry or in applications like the one you envisage. Industry conferences may provide insights from existing users and some media can be helpful. In the area of sensed objects, the RFID Journal provides many detailed user experiences and has an area of its website dedicated to IoT news. For manufacturing, logistics, asset management and lifting safety & inspection in particular you may find what you are looking for in the case studies on our web site.

If you haven't already started to think about applications, then perhaps we can invite you to carry out a thought experiment.

Albert Einstein's insight into the theory of relativity came about when he asked himself the question, "What would the world look like if I was riding on a beam of light?"

A business considering the Internet of Things might find it helpful to ask itself the question "What does the world look like from the point of view of the things that my business produces or manages?"

What things and people do your business "things" interact with? How do those interactions get recorded? How much time could be saved in those interactions could be automated or eliminated?

How much would that benefit your business? How many resources are used in your business simply to keep track of things, so as to avoid loss, control availability or allocate accountability?

By taking a thing-centred view of what goes on, you may suddenly identify was of saving costs in the management of things or of reducing the number of things that your business needs to function.

In any case, many of the simpler technologies associated with the Internet of Things are (relatively) low cost. As a result, it is often possible to design relatively low-cost "proof of concept" applications to see if the technology can be made to work for you. Proof of concept applications can also be designed to allow a business to make an accurate assessment of likely costs and probable benefits that will arise as the application is scaled up to business wide deployment.

HOW CORERFID CAN HELP

CoreRFID is a technology vendor and solution provider that delivers systems benefiting from the Internet of Things.

CoreRFID specialises in RFID, one of the key technologies used in IoT applications. We have provided RFID based solutions in engineering, construction, manufacturing, transport, healthcare and many other industries. The CheckedOK system used for lifting safety inspections is widely used and demonstrates how large-scale deployments collecting data from tens of thousands of objects can be made to work effectively and to the benefit of businesses and their customers.

CoreRFID supplies the underlying RFID technologies through relationships with many of the most innovative companies in this arena.

Through its software development and implementation team, the company is able to offer practical support to companies implementing pilot and proof of concept systems. Our consultants can help with assessment and trouble-shooting of existing implementations.

You can find out more about CoreRFID's track record and see examples of the work we have done for clients at the web site: www.corerfid.com.

Or, you can contact CoreRFID as follows:-

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