®

What is RAIN RFID?

Detailed information about the technology, markets using RAIN RFID, and the Alliance

$29.95

Aware Innovations

Intelligent Tracking – Powerful Results

Give your things a Voice.

Gather information anytime about the quantity, location, conditions and history of your assets anywhere in your logistic system.

One System Multiple Technologies — Leverage one or multiple tracking technologies to such as:
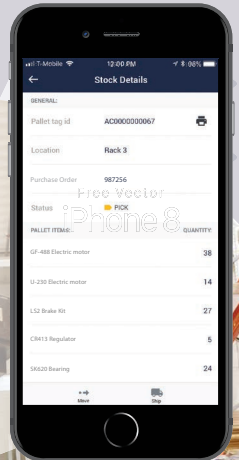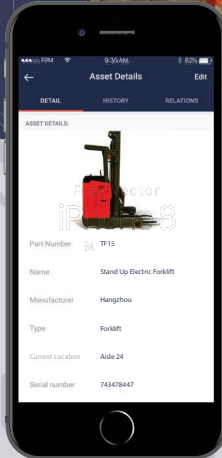
- RFID
- GPS
- BLUETOOTH
- INTERNET OF THINGS
- BARCODE
- WI-FI

Gain Operational Efficiencies:

- Improve asset visibility
- Automate business processes
- Make decisions on actionable data
- Improve allocation of resources
- Reduce process waste

Leverage current and evolving tracking technologies with ItemAware:

- Integrate with existing ERP, WMS, SCM, TMS, and other enterprise systems
- Scalable, customizable and accessible from any device anywhere
- Cloud (SaaS) or on-premise deployment

ItemAware

powered by Aware Innovations

Intuitive Tracking Software

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INTRODUCTION

JEREMY SCHENOF
CHAIRMAN OF THE BOARD, RAIN RFID ALLIANCE
SENIOR DIRECTOR OF GLOBAL RFID SOLUTIONS, AVERY DENNISON

Thank you for your interest in RAIN RFID!

I have been actively involved with the RAIN RFID Alliance since 2015 and have been the Chairman of the Board since April 2018. The Alliance is focused on growing the RAIN RFID market worldwide across many industries, by educating end-users and supporting vendor collaboration.

Since the Alliance was founded in 2014, it continues to grow steadily, adding more industries, and meeting in person three times a year globally - in Americas, Asia, and Europe.

This "What is RAIN?" book is comprehensive, will answer a lot of questions, and help you identify the companies you should talk to about using RAIN RFID for your business.

STEVE HALLIDAY
PRESIDENT, RAIN RFID ALLIANCE

Welcome to the RAIN RFID Alliance perspective on how to use RAIN RFID to solve problems for your business!

By getting this RAIN book, from our website (RAINRFID.org), at industry tradeshows, and at our meetings, you can learn about RAIN RFID technology, what end-users are doing with RAIN around the world, and meet all types of companies and organizations – our members and partners.

I recommend that you subscribe to our newsletter (link on the bottom of our homepage) and contact us with a Request for Help if you want to contact our members to help you solve a problem.

Let me know if you have any questions or suggestions for this book!
Steve@RAINRFID.org

RAIN IS AN ALLIANCE OF AIM INC.

WHAT IS RAIN?

RAIN is a brand name for passive Ultra High Frequency Radio Frequency IDentification (UHF RFID) wireless technology. It was adopted in 2014 when several companies working with passive UHF RFID technology began to see that the term "RFID" was being used very broadly – to represent multiple types of sensor technologies – many of which did not have the same cost-effective, transformational capabilities of passive UHF RFID. This created a concern that the expanding use and meaning of the term "RFID" might confuse the market for passive UHF RFID solutions.

At the same time, these companies saw the growing importance of passive UHF RFID technology in enabling the Internet of Things. Powered devices like mobile phones, TVs, or fitness watches can connect to and exchange information via the internet to improve existing processes and drive new opportunities for businesses and consumers. But what about the billions of unpowered "things" in the world that make up the majority of the Internet of Things? Everything has a story to tell – whether it be a shoe in a department store, a box on a warehouse shelf, or a surgical tool in hospital.

UHF passive RFID technology gives voice to the many billions of assets that are unpowered, enabling each to have its own individual identity and send vital information – anywhere at any time - to systems and users who would benefit: name, description, status, location, etc. Given the increasingly important role of passive UHF RFID to expanding the value of the IoT – as well as the increasing importance of RFID to businesses and the consumers they serve, it became even more clear that passive UHF RFID needed to be easily differentiated from other wireless technologies with a simple, business friendly term.

Much like the term "WiFi" has simplified the way we talk about technology used for unplugged internet access, and the term "Bluetooth" has simplified the way we talk about exchanging data with a mobile device, the goal is that the term RAIN can simplify the way we talk about passive UHF RFID and how it enables visibility into the billions of unpowered assets that make up the bulk of our world.

The technology conforms to the GS1 EPC UHF Gen2 air interface protocol or to ISO/IEC 18000-63 standard "Parameters for air interface communications at 860 MHz to 960 MHz Type C" and connects billions of everyday items to the internet. RAIN RFID is used in many markets and industries worldwide to identify, locate, authenticate, and engage these items. RAIN RFID provides benefits for the end-users, depending on the applications.
RAIN RFID solutions use tags, readers, and software for a variety of applications. The tags have a unique identification number, some memory for additional information, and are attached to or embedded in the items. Readers can read and write the tags, initiate activity, and can be connected to a server (local or in the cloud).

WHAT IS THE RAIN RFID ALLIANCE?

The RAIN Alliance is an industry organization that was formed in 2014 – in parallel with the establishment of the RAIN brand – in order to represent its many global member companies (160 and growing) who have an interest in growing and expanding the use and value of RAIN RFID technology.

You can find more information about the technology and the RAIN RFID Alliance later in this book.

WIRELESS TECHNOLOGIES

We live in a world where wireless technologies surround us. We take them for granted and we are unaware of the impact they are having on us. Whether it is Wi-Fi or 4G our lives revolve around the connectivity that they bring. And unless we are in the IoT industry, we are probably unaware of the many other wireless technologies that are all around us. Bluetooth, Zigbee, 5G, NFC, LoRa, SigFox, UWB and many others are all fighting for space in the frequency bands, looking for their place in our lives.

RAIN is another of these wireless technologies, using the airwaves to communicate the data that enables our everyday lives and makes business more efficient.

The term wireless is not new. We have all enjoyed the transmission of signals to a radio or television for a long time. But now we are finding ways to use "wireless" to connect everything in our lives. Many of us are dependent on the connectivity that our mobile phones give us, from news, to maps, to email and beyond. The IoT is also dependent on wireless technologies and they will all have a place in the future.

RAIN RFID is the leading wireless technology providing input data into the IoT. In 2017, almost 13 billion tag ICs were sold. That's almost 30 billion things identified in 2015-2017 time period. Other technologies bring other values, but none can match RAIN RFID for cost, simplicity, and availability.

DIFFERENT TYPES OF RFID

RFID comes in many different forms. It works at different frequencies, in different applications, and with different characteristics. It is always important to select an RFID system (and frequency) that gives the best performance for the application. In many cases this will be RAIN RFID, but not always.
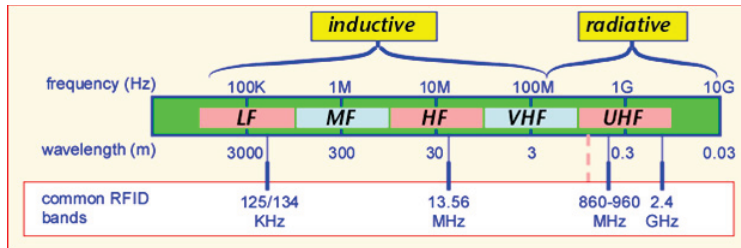
LF	HF (NFC, ETC.)	UHF (RAIN, ETC.)

RFID SYSTEM FREQUENCY RANGES

There are five major frequency ranges that RFID systems operate at. As a rule of thumb, low-frequency systems are distinguished by short reading ranges, slow read speeds, and lower cost. Higher-frequency RFID systems are used where longer read ranges and fast reading speeds are required, such as for vehicle tracking and automated toll collection.

This table gives examples of the use of the various frequencies of RFID. It is meant as a guide and is not comprehensive, nor are the applications listed specifically and solely at that frequency.

FREQUENCY	RANGE	APPLICATIONS
Low-frequency 125 - 148 KHz	up to 80mm	Pet and ranch animal identification; car keylocks; factory data collection
High-frequency 13.56 MHz	up to 1 metre	Library book identification; smart cards; NFC; transit tickets
Ultra-high frequency (UHF) 433 MHz	up to 100 metres (with active tags)	Container identification with active tags
Ultra-high frequency (UHF) 860 - 930 MHz	up to 15 metres	Supply chain tracking: item identification; apparel; healthcare;
Microwave: 2.45 - 5.8 GHz	up to 2 metres	Highway toll collection; vehicle fleet identification

In the UHF band RFID systems operate in the 860 – 930 MHz range. This is a very wide band and it is because the frequency available to any application is controlled by the Radio regulations in the part of the world that the system is operating in. For example, in the USA, the frequency and power are controlled by the FCC and are defined as 902-928 MHz at 4W EIRP power (ERP and EIRP are defined below and are different methods of measuring power). Traditionally in Europe this has been 865.6 – 867.6 MHz at 2W ERP. The performance from these two systems is very different with the European regulations controlled by ETSI only allowing a much smaller band and less power. Recently RAIN and others have been working with the European Community to get more bandwidth and power for RFID. This has resulted in space in the 915 – 921 MHz band becoming available in 2019.

UHF RADIATED POWER – EIRP VS. ERP

- **Terminology:**
  - o EIRP: equivalent isotropic radiated power
  - o ERP: equivalent radiated power

- **Allowed power:**
  - o EN 302 208: 2W erp
  - o US (FCC): 4W eirp

- **Relationship eirp-erp:**
  - o Peirp = Perp x 1,64 => 2 Watt erp = 3,28 Watt eirp
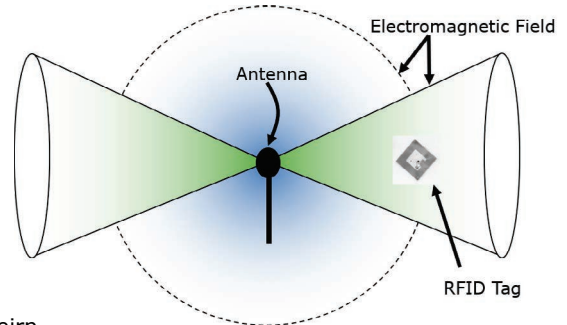
ITU RADIO REGULATION REGIONS

There are three regions defined by the ITU Radio regulations. In broad terms they are the Americas, Europe and Asia (see map below). Other countries have also changed their original allocations for RFID which brings the original bandwidth that the systems used down from 860 – 960 MHz to 860 – 930 MHz. GS1 published a document that lists all of the frequencies and power availability around the world. This can be downloaded from here (https://www.gs1.org/sites/default/files/docs/epc/uhf_regulations.pdf).
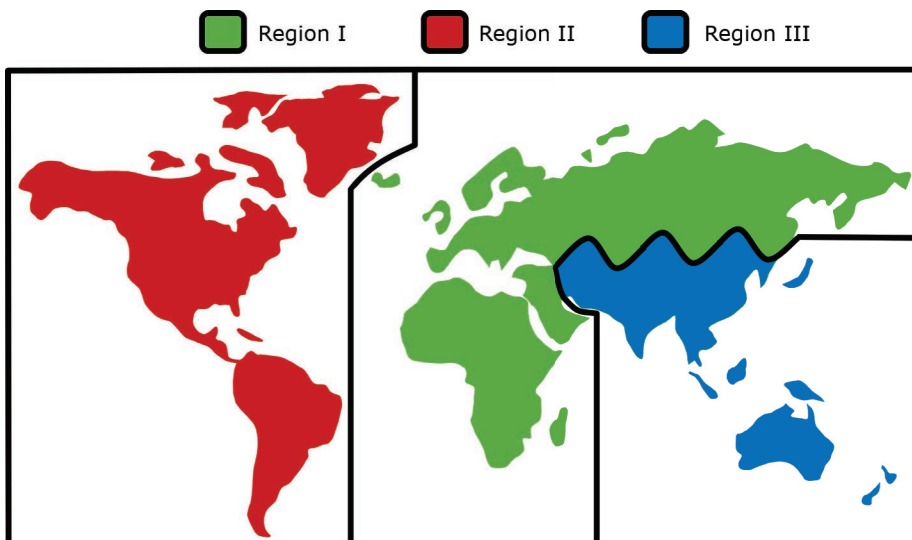
PASSIVE VS ACTIVE

Passive tags work by backscattering the signal from a reader, modulating it to give the data that is expected. The tags require no power supply, all of the power is harvested from the transmitted signal from the reader.

With no power supply, the life of a passive tag is virtually unlimited, and they require no maintenance. The tag uses the reader signal to power up and respond to a request for data. The tag modulates the carrier signal from the reader and reflects (backscatters) the signal. This very low amplitude signal is detected and decoded by the reader. Another advantage of passive tags is that with no transmitter they can be carried on aircraft with no issues.

Some tags have a battery associated with them but still backscatter the signal back to the reader. These tags are called Battery Assisted Passive (BAP) tags. Some companies also refer to these tags as Semi-Active or Semi-Passive. The battery is used to provide power to the tag and/or any sensors attached to the tags.

BAP tags are still passive tags, in that they backscatter the signal to the reader. The extra power supply means that they typically have greater range as they do not need as much power from the reader. They can also collect and store data from sensors that attach to them.

Active tags are often described as tags with a power supply. While this is true, the real definition of an active tag is that it has an independent transmitter. This transmitter requires more power than a reader can supply and so it needs a power source, usually a battery. As these tags have a transmitter it may mean that transporting them on aircraft cam be a problem. Not all tags have a power off switch, and even then, there is always a risk that a problem may cause them to transmit. If the power can be completely turned off (remove the batteries) there is no problem.

Active tags usually have very long range (maybe more than 100 meters) and because of the extra power, they have less problems with close proximity to metal.

Both BAP tags and active tags need maintenance or have limited life. The replacement of the battery in these tags may or may not be possible.

RAIN
RFID

MARKETS/
INDUSTRIES/
APPLICATIONS

Get a better read on your business

Uncover what you don't know but should.

Even if you're using RFID devices, unless you connect them all, you'll have plenty of operational disconnects. Those profitability-killing communication gaps hurt your real-time asset visibility, utilization and control. On the other hand, a fully-integrated RFID solution will streamline your operations and inspire more intelligent decision-making via faster, more accurate data collection. Then, your employees will know what they need to know, when they need to know it.

Make Your Business as Smart and as Connected as the World You Work In.

Discover the end-to-end simplicity of Zebra UHF Passive RFID Solutions.

Improve ROI
in retail, manufacturing, transportation & logistics and healthcare, with numerous cross-industry applications.

Ensure Hardware and Data Interoperability
through an industry-leading, high-performing portfolio of readers, printers, supplies, software, services and solutions.

Control What's Inside Your Business
to elevate customer service and impact sales.

Implement Better Asset Management,
while increasing your inventory accuracy and decreasing operating costs.

Cover Every RFID Need
from devices to systems to deployment.

Access World-class Services with a Global Reach
that maximize uptime and provide the highest visibility.

Ready to get a better RFID read on your business?

www.zebra.com/RFIDSolutions

ZEBRA

ANIMAL IDENTIFICATION

Animal identification has been used for many years for the purpose of identifying and tracking specific animals as a part of a certain farm. The original reason was for branding the animal for verification of ownership. Later, animal identification was developed and used for the purpose of feeding, weighing, tracking and tracing, disease management and breeding practices.

Traditional animal tags typically use either visual tags (barcode or numbers) or low-frequency (LF) RFID technology, which limits the range at which data can be read and is also vulnerable to signal interference from outside sources.

RAIN RFID tags offer superior readability at distances of up to 15 metres. RAIN RFID is also less susceptible to radio interference from farm machinery like tractors and other signal-producing equipment.

Each unique RAIN RFID tag can be linked to a database including animal-specific information history such as birth date, inoculation history, and breeding details.

Animal management practices, including feeding, weighing and disease traceability, are automated and streamlined.

RAIN BENEFITS FOR ANIMAL IDENTIFICATION

- Full "farm-to-fork" animal identification
- Longer read range, less stress to the animal
- More robust signal, less interference

Learn more about ANIMAL IDENTIFICATION - https://rainrfid.org/resources/videos/

NEXT GENERATION OF LIVESTOCK MANAGEMENT TADBIK'S RAIN RFID EAR TAGS

Automate animal management with Tadbik animal identification tag

Tadbik's RAIN (UHF) RFID ear tags automate animal management by quickly collecting data, tracking and identifying animals at a distance thus reducing stress to livestock.

The visual UHF Cattle and Sheep Earring Tag demonstrates top performance, designed to withstand harsh outdoor conditions. Farm management becomes automated and streamlined for the purposes of feeding, weighing, tracing, breeding and disease management. The tags have been tried and verified worldwide in rigorous field tests, utilizing its flexibility and the unique shock absorber mechanism for outdoor impact.

Each unique RAIN RFID tag can be linked to a database, including animal-specific information history such as birth date, inoculation history and breeding details. Animal management practices, including feeding, weighing and disease traceability, are automated and streamlined.

RUGGED TAGS STAND UP TO LIFE ON THE FARM
Sheep and cattle ear tags must withstand changing weather conditions. Tadbik tags are water-resistant and durable, with a flexible yet rigid structure that resists breakage.

NUMEROUS TAG DESIGN OPTIONS
Tadbik uses a unique, cost-effective manufacturing process that enables a wide range of size and color options. Tags can be further customized with the industry's highest-quality printing for a rugged, easily identifiable tag.
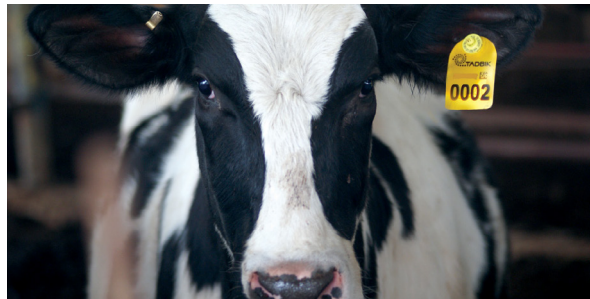
FULL "FARM-TO-FORK" ANIMAL IDENTIFICATION
Today's food systems have an increased focus on food origins and safety, due to regulatory requirements as well as consumer demands. Farmers can gather precise, readily-available information about their livestock that contributes to product quality and safety.

LONGER READ RANGE, MORE ROBUST SIGNAL
Traditional animal tags typically use either visual tag or low-frequency (LF) RFID technology, which limits the range data can be read and is also vulnerable to signal interference from outside sources. RAIN RFID tags offer superior readability at distances of up to nine meters. RAIN RFID is also less susceptible to radio interference from farm machinery, like tractors and other signal-producing equipment.

Tadbik's Animal Identification Benefits:
• The tag allows a full Farm-to-Fork identification
• Industrial, large scale manufacturing
• The tag is printed and encoded with the animal ID
• RAIN RFID is less susceptible to interference
• Unlimited options for the size and shape of tag

ABOUT TADBIK
Tadbik RFID is a leading convertor of smart labels and tags for the supply chain and logistics, sports timing, healthcare and event people tracking, animal identification, NFC and other customized wristbands, labels and tags.

Watch Tadbik Animal Identification video here:
https://www.youtube.com/watch?v=xM-9AJEr_6U&t=8s

CONTACT
🖥 Tadbik.com/RFID   ✉ Michaly@tadbik.com

TADBIK

ASMET TRACKING

Asset tracking - Track and Trace" (abbreviated to "T&T"). The process of tracking and tracing things has caught on and evolved as companies find that it improves their bottom line through improved efficiency and control of shrinkage. Regulators have begun requiring certain industries to implement extensive track and trace systems for the protection of consumers and the environment. For example, regulators have adopted variations on the basic T&T system to deter counterfeiting, identify the origin and/or destination of a product with a recall involved, and protect consumers and the environment. In the case of medical device manufacturers in the USA, there are legal requirements to use automatic identification and data capture (AIDC) technology along with appropriate systemization to provide for T&T and unique device identification (UDI) requirements. In the case of food producers, the Food Safety Modernization Act (FSMA)

requires T&T from providers. Although AIDC is not legally required by FSMA, it is the only practical method of compliance. For many businesses which must meet various other compliance requirements or consider the potential cost of recalls and product liability, T&T just makes good business sense.

Track and Trace in, and of, itself does not do anything of great value. It is a protocol for developing and collecting data. It is the use of that data that is the benefit of track and trace and it can be of great value. Once collected the data can be used for many purposes. The best-known example is the "where is my package" application. This started because small package carriers needed to be able to roughly locate every package they were handling. T&T enabled the efficiency needed to meet their goal of 100% next-day delivery. Once they started collecting this data, they found that allowing
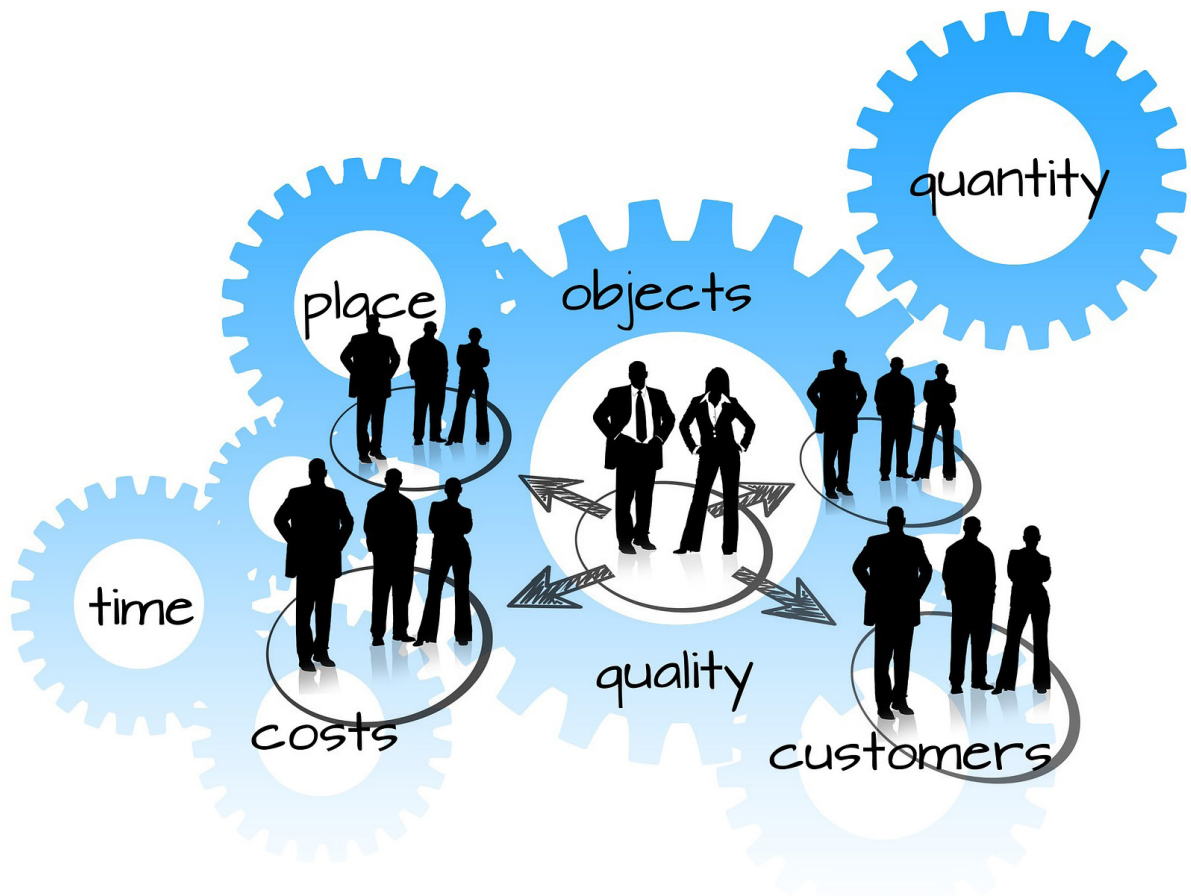
customers to view this data was a great advertising benefit. Analysis of the customer requests show that most people check on a package once and do not check again. Just the knowledge that they could check on the package status sends the message that the carrier knows where the package is, and they do not have to worry about the package delivery. The reality is that most of the inquiries are made when packages are lost. At this point the T&T data provides exceptionally good information for claims resolution.

The above examples are only a small part of what T&T systems are capable of accomplishing. The scope of what a T&T system can do is limited mostly by your own imagination. T&T systems have been around for much longer than the "where is my package" application noted earlier. Manual record-keeping was used to record locations, quantities and identity for decades before automation was available. These manual processes have, for the most part, been automated using bar codes or radio frequency identification tags. What is important is that Automatic Identification and Data Capture (AIDC) technologies allow business owners to collect more data, more accurately and faster than ever before. Data specifically configured for automated collection is often referred to as machine readable data, as it is collected and interpreted often without any human intervention.

T&T requires three pieces of data. Identity, location, and purpose. Add an automated information storage and retrieval capability, some software, and a communications link, and you have a T&T system. Obviously full-blown T&T systems can become much more complicated, but they all contain these basic elements, plus the bells and whistles added to support business processes. Since a T&T system is going to deal with a lot more than one thing, we must have a way to know exactly which of the "things" we are dealing with at any moment in time. We refer to this as identity. The only requirement for identity is that it be unique. If there is even a small chance that two things could have the same identity, then our system integrity is in serious jeopardy.

The purpose of T&T is often just assumed. Things (e.g., packages) tendered to a transport carrier are either in motion from one place to another or awaiting onward movement. Likewise, things (e.g. chips and video cards) at a computer assembly facility are being assembled into higher level things (e.g. computers or servers). The purpose is important because the nature of the thing being monitored may change while at a particular location. The video card installed in a laptop computer is no longer discretely tracked. Rather we now track the finished laptop while the assembly company maintains record of which parts went into

each laptop. Thus, if a certain batch of video cards is found to have a fault, the assembly company can identify which laptops were affected and notify the retail stores or purchasers to return the laptop for repair. This same relationship is true for virtually any commodity such as pharmaceuticals, food, or even automobiles.

T&T enables identification of "things", their location and purpose. When you design a T&T system, think about who will need to use the recorded data and what their requirements are in terms of frequency and granularity of that data.

This article was excerpted from an AIM whitepaper: https://www.aimglobal.org/store/ViewProduct. aspx?id=11416071

U.S. PATENT AND TRADEMARK OFFICE TRACKS IT ASSETS

Over 130,000 items tagged, improving inventory efficiencies and reducing costs using RAIN technology

The United States Patent and Trademark Office (USPTO) spent 7,700 hours annually managing assets. To meet the Department of Commerce's (DOC) annual asset inventory mandate, USPTO conducted inventory counts quarterly.

Tom King and Vickie Bryant oversee the Chief Administrative Office's (CAO) property- and asset-management programs at USPTO. In 2014 they assessed time spent inventorying assets. King says, "Most government agencies consider asset management secondary to their main mission. We saw that automating the location and movement of our assets with RFID technology would allow us to spend more time fulfilling USPTO's main goals."

In September 2016, USPTO deployed an RAIN RFID asset-tracking solution monitoring 130,000 IT assets at multiple locations, spanning 180 floors where 15,000 federal employees and contractors work. The expected return on investment for the $2.8 million project was 18 months.

The U.S. House of Representatives used RAIN RFID in conjunction with Remedy (now BMC Software) enterprise-resource planning (ERP) software, which USPTO also employed. They were tracking its treasure-trove of historic furniture, and King figured their system would work to monitor USPTO's assets. The team of Digital Technologies, Inc. and Evanhoe & Associates, Inc was selected. Evanhoe provided expertise and DTI had a contracting relationship with USPTO.

The project was divided into four phases: site surveys and cost estimates, choosing tags and testing software offsite, installing hardware and tagging assets at the Alexandria Campus, and then at other USPTO locations.

Site surveys and cost estimates identified existing RF environmental factors and business-process issues requiring specific equipment and tags.

RAIN RFID asset tags, designed for metal, plastic and wood surfaces were chosen. These RAIN tags have a read range of 5 to 9 meters, depending on the material to which they are affixed. A written guide helped the support personnel tag USPTO assets. IT support contractors completed the nationwide asset-tagging project inside 90 days.

ItemAware, developed by Evanhoe as a comprehensive AIDC based track and trace software solution, is an enterprise-level application residing on USPTO's network servers. The system is integrated with Remedy ERP, capturing data from tag reads and providing real-time visibility into assets' locations. Its seamless integration with the existing system was key. Training was provided for asset managers and inventory support team members.

Prior to the RAIN solution, field technicians manually updated asset-location information. Currently, as assets travel around the USPTO's facilities, the RAIN solution automatically monitors their movements and property custodians' assignments. Monthly, workers use handheld readers, verifying each asset's location and updating the ERP system without errors. "The handhelds can read hundreds of tags in a matter of seconds," King says.

By the end of fiscal year 2017, USPTO expects to halve asset-management hours, from 7,700 to 3,850. By end of fiscal year 2018, this will be 800 hours with inventory cost savings of over $1,000,000 annually. In 2018, an additional RAIN solution was implemented in the USPTO consumables warehouse to enable more efficient inventory management.

Evanhoe offers commercial customers its ItemAware software and services solutions under the trade name Aware Innovations.

Aware Innovations

Intelligent Tracking – Powerful Results

AUTOMATED INVENTORY MANAGEMENT WITH INJECTION MOLD RAIN RFID TRACKING

Injection molding companies use a large number of molds and need to reduce the amount of time spent searching for the correct one. In addition, a mold is a big investment. For example the injection molds used at HARTING facilities typically cost tens of thousands of dollars and get depreciated over multiple years. Therefore, it is necessary to keep strict inventory, which takes a lot of time and ties up resources.

Additionally, one cannot simply install any mold on any machine. This could result in serious damage to the mold or machine. Proper mold identification is necessary to reduce the risk of mounting molds on the wrong machines. HARTING, a leading global supplier of industrial connectivity technology, used RAIN RFID-based Mold Tracking to solve these problems and minimize the time spent searching for molds. They also use this technology to check that molds are appropriate for the machine where they are being installed.

THE SOLUTION

Cutting-edge RAIN UHF RFID technology lets you meet these challenges and to be ready for the future. Simply tag your molds with RAIN RFID transponders, install HARTING ruggedized readers and antennas on the machines, and connect them to your EMS or inventory systems. If you need assistance, a number of MICA.network partners are ready to help.

Stay ahead with RAIN RFID Mold Tracking!

CONTACT

HARTING Technology Group

✉ Auto-ID@harting.com

🖥 www.harting.com

HARTING

Pushing Performance

AVIATION

RAIN RFID connects billions of everyday items to the internet, enabling the aviation industry around the world to identify, locate, authenticate, and engage with each item—no batteries required. In an increasingly globalized world, enterprises need accurate, real-time data to provide accurate and timely information on location of the passenger's bags, tracking vital components on the airplane, running accurate maintenance checks within the worldwide network of RAIN enabled airlines, airports, and other vendors of the aviation industry.

RAIN BENEFITS FOR AVIATION

From the moment the bag is presented to the airlines and enabled with the RAIN technology, the bag now has a unique identification and can be tracked through its whole journey. With RAIN RFID in baggage tags, the aviation industry will face the following benefits:

• Increased read rate up to nearly 100%
• Allows passengers to track baggage in real-time by getting notifications on their mobile
• Lower the number of mishandled baggage by 25-50%, which has a potential savings of at least $100/bag
• Decrease manual operations which helps free-up staff for other value-adding tasks
• Full compliance of IATA R753 done in the most cost-effective way
• Improve operational transparency
• Reduce fraud

AVIATION SUCCESS WITH RAIN
DELTA AIRLINES
Millions of people benefit from worry-free traveling thanks to RAIN-supported baggage tracking.

"RAIN RFID IS A COST EFFICIENT AND HIGHLY EFFECTIVE METHOD OF DATA CAPTURE FOR RESOLUTION 753, AS IT ALLOWS A HIGH DEGREE OF AUTOMATION AND THEREFORE CONSISTENCY OF DATA PROVISION FOR THE OPERATION. THIS IS ESSENTIAL AS BAGGAGE TRACKING IS ONLY EFFECTIVE IF YOU CAPTURE DATA ON ALL THE BAGS AND CAN USE THIS EFFECTIVELY." – *IATA*

Link to more AVIATION documents -
https://rainrfid.org/resources/documents/

ELECTRONIC VEHICLE IDENTIFICATION *(EVI)*

RAIN RFID connects billions of items to the internet, enabling various stakeholders in a number of eco-systems to **identify, locate, authenticate**, and **engage** with each item. RAIN RFID provides worldwide, robust electronic vehicle identification for various applications including vehicle licensing, tolling and congestion management, vehicle access control, parking, fleet management, fuel management and car-wash loyalty programs.

EVI BENEFITS OF RAIN

RAIN RFID has proven itself in many applications, providing automation, supply chain visibility, stock management, anticounterfeit, chain of custody and more. RAIN RFID is the ideal technology to provide electronic vehicle identification in smart cities, including automated logistics and various localised vehicle-related applications ranging from vehicle access control to loyalty programs.

• Excellent read range
• Fast read speed
• Carries additional data
• Secure – authentic, private, and untraceable

More information in the EVI white paper.
https://rainrfid.org/wp-content/uploads/2018/03/RAIN-RFID-EVI-whitepaper.pdf
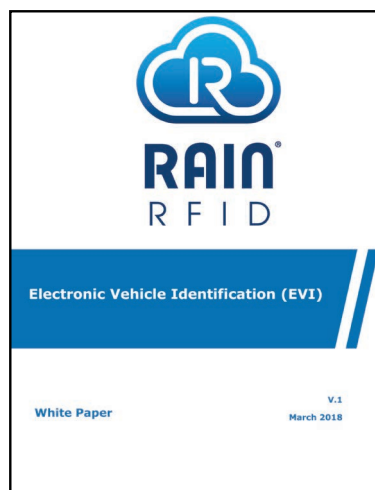
THE IDePLATE SYSTEM:

Electronic Vehicle Identification
From Germany

Around the globe there are more than a billion motor vehicles on the roads. According to the Energy Outlook 2017 from BP, the world's vehicle fleet should double until 2035. In 2017 alone, around 73.5 million passenger cars as well as around 23.8 million commercial vehicles were produced. This translates into: In every second of the next 18 years about two cars will be produced (172,800 new vehicles every day). Even though during the same period some vehicles will be scrapped, and even though new usage patterns are being created in favor of public means of transport, in the short and medium term, the intelligent administration and control of the vehicle mobility is the challenge of the future.

And more vehicles mean increasingly challenging intelligent traffic planning and monitoring, higher fraud related to vehicle registration and insurance, as well as ramping up of crime such as vehicle theft.

To cope with all these challenges, we need to manage vehicle identification effectively. It the past we have relied on visual methods, but they have severe limitations, especially when we want to automate processes.

In both stationary and flowing traffic there is the problem of reliable vehicle identification. With manipulations and abuse of the vehicle plate holders can escape official registration at border controls, speed measurements or vehicle checks. The reason: In most states, the identification is done analogously by means of visual security features in combination with alphanumeric sequences. Even though video technology is widely used, the weakness of this method lies in the detection rate of camera-based vehicle identification since its reliability is reduced in harsh weather and visibility conditions, and originals cannot be easily distinguished from fakes.

Today Tönnjes E.A.S.T. has developed a RAIN RFID-based system which permits the reliable, electronic identification of vehicles. Centerpiece of the innovation is the RFID license plate IDePLATE. At first glance, the security license plate looks like a normal license plate, however, the integrated, cryptographic RFID chip UCODE DNA from NXP Semiconductors contains secure private keys which are used for encryption and electronic authentication of the license plate thereby enhancing the visual license plate alphanumeric. Authorized readers can transmit these then via a secured data link to a database and collate them. This is possible with mobile or stationary readers and works both in stationary and moving traffic.

Furthermore, IDeSTIX, which is RAIN RFID tag based on the same UCODE DNA chip, is integrated in the windshield label and can be used in addition or alternatively to the IDePLATE. It is additionally secured against fraud and theft since it will self-destruct when removed.

IDeTRUST Verification System works with a smart phone app to help government officers or other staff identify and authenticate vehicles in various traffic situations incl. toll collection, parking access, boarder controls, consumption of vehicle related services such as car wash, gas pumping etc.

The IDeTRUST vehicle registration software completes the total solution into one unified system for vehicle registration and vehicle fleet management.

Governments in Peru, Kenya, Honduras, the Philippines and other places already rely on UCODE DNA powered vehicle identification solutions from Tönnjes. Commercial entities such as Saudi Aramco, which is the world's largest oil producer, also depends on the same technology for managing access of vehicle fleets at their premises.
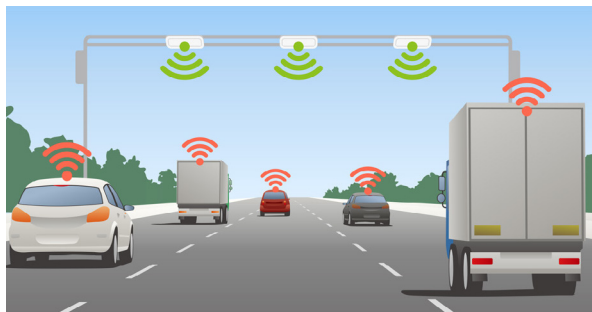
CONTACT

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Toennjes.com   j.betz@toennjes.com

HEALTHCARE

RAIN RFID connects healthcare items to the internet, enabling caregivers, administrators and patients to **identify, locate, authenticate,** and **engage** with each item. Batteries not required. Healthcare and life sciences enterprises are challenged to deliver the best possible patient care while reducing costs and improving outcomes.

RAIN RFID provides an automated and reliable data capture system that helps enable hundreds of healthcare applications to improve patient safety, manage surgical instruments, support staff and patient workflow, automate replenishment and billing, authenticate quality and sterilization processes, manage medical equipment location and automate supply chain management.

HEALTHCARE BENEFITS OF RAIN

RAIN RFID is revolutionizing the healthcare industry and transforming how hospitals and healthcare professionals manage their inventory, people, assets and supply chain to reduce costs and provide high-quality patient care.

- Higher inventory visibility and accuracy
- Effective recall management
- Improve patient safety and care
- Automate payments and increase profitability
- Reduce product expiration, shrinkage and waste
- Decrease supply chain and equipment costs
- Reduce hospital-acquired infections
- Prevent medical errors due to misidentification

"RAIN RFID IS AN ENABLING TECHNOLOGY THAT SAVES LIVES, PREVENTS ERRORS, SAVES COSTS AND INCREASES EFFICIENCIES. MANY PARTS OF THE HEALTHCARE INDUSTRY HAVE ALREADY EXPERIENCED THESE BENEFITS AS SHOWN BY THE MARKET GROWTH RATE OF 35% EACH YEAR THROUGH 2020." *-IDTECHEX*

HEALTHCARE SUCCESS WITH RAIN

Healthcare companies around the world are achieving compelling results and ROI from RAIN RFID deployments

EMS ORGANIZATIONS	RADY CHILDREN'S HOSPITAL
Automated inventory management using RAIN RFID resulting in an average 40% gain in efficiency.	Decreased staff time by 15 minutes/tray for daily medication tray restocking of 200 trays.
HANMI PHARMACEUTICAL	**RESTON HOSPITAL**
Improved inventory management by tracking 60 million items annually.	Completed UDI requirements, and streamlined tissue and implant management using smart freezers.

More HEALTHCARE information – Success Stories, Presentations, News - https://rainrfid.org/markets/healthcare/

Over 40 healthcare providers are using RAIN RFID - https://rainrfid.org/markets/healthcare/rain-in-healthcare/

MEDICAL SUPPLY AND SERVICES – CASE STUDY BY HID GLOBAL

MediReva Revalidatie integrates RAIN RFID in rental process and stock management of medical aids. The company's activities are rental, sale and stock management of medical aids to private persons, hospitals and healthcare institutions throughout the Netherlands.

THE CHALLENGES

MediReva Revalidatie processes thousands of orders every week containing both consumable goods and rental equipment. After each rental period, every piece of equipment follows a tedious process; cleaning, disinfected, inspected, repaired if necessary and returned to inventory for future use.

MediReva Revalidatie engaged with HID Global's partner Aucxis to streamline and eliminate many of the manual operations during the administrative rental and stock management processes. The goal is to achieve higher efficiency, and an accurate overview of all products' status. The project contained two challenges for Aucxis, namely the selection of the most suitable RAIN RFID tag for the application and the development of a compact warehouse management system (WMS) that seamlessly connects to Microsoft Dynamics NAV.

The RAIN RFID tag must be safe for patient interaction. Moreover, the tag needed to be easy to apply, yet durable to resist heat and waterproof. Additionally, the WMS system link required a transparent communication layer via Microsoft Dynamics Services to communicate the processing, feedback and offline synchronization of the order status of RFID tagged products.

THE SOLUTION
PROCEDURE

All service materials and a majority of the products are equipped with a RAIN tag. When an order is registered, an entry is created in the ERP application and immediately available for the warehouse to process. A warehouse worker retrieves the order using a handheld RAIN wireless scanner that reads barcodes and RAIN RFID tags. All
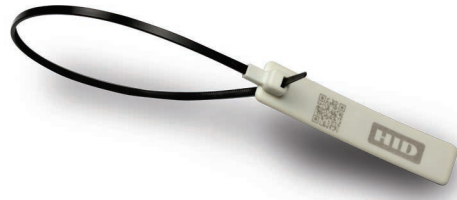
required data of the item appears on the display: product, serial number, and warehouse location. RAIN RFID equipped items are individually scanned, confirming the serial number to eliminate mistakes. After the warehouse finishes picking, orders are placed in the transport-zone for delivery. Orders are scanned again upon customer delivery.

HARDWARE AND SOFTWARE

Aucxis selected the HID Seal Tag Mini RAIN UHF tags that met all of the requirements including flexibility, secure tamper evident functionality, durability and easy to use. Unique product information is programmed into each tag. To scan the articles, Aucxis recommended the Nordic ID Medea RAIN reader, a future-oriented handheld allowing scanning via 3G. Aucxis developed a WMS package that offers a visually managed, intuitive registration for picking, transport, delivery, return, cleaning, control and reparation.

All process steps link back in real time to the ERP application to immediately alert workers of the order status. In addition, the service material return process uses RAIN RFID; they are collected, cleaned and returned to the warehouse using a return order. Furthermore, all employees receive a HID RAIN badge to register and identify who processes the order and executes the required action.

THE OUTCOME

The RAIN RFID solution delivered by Aucxis and HID Global grants a clear and accurate status overview of all products sold and delivered by MediReva Revalidatie. Using an efficient solution powered by RAIN RFID, minimal mistakes occur. Process steps are simplified and report into the back-office system, providing a clear and accurate view of articles' status.

CONTACT

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HEALTHCARE
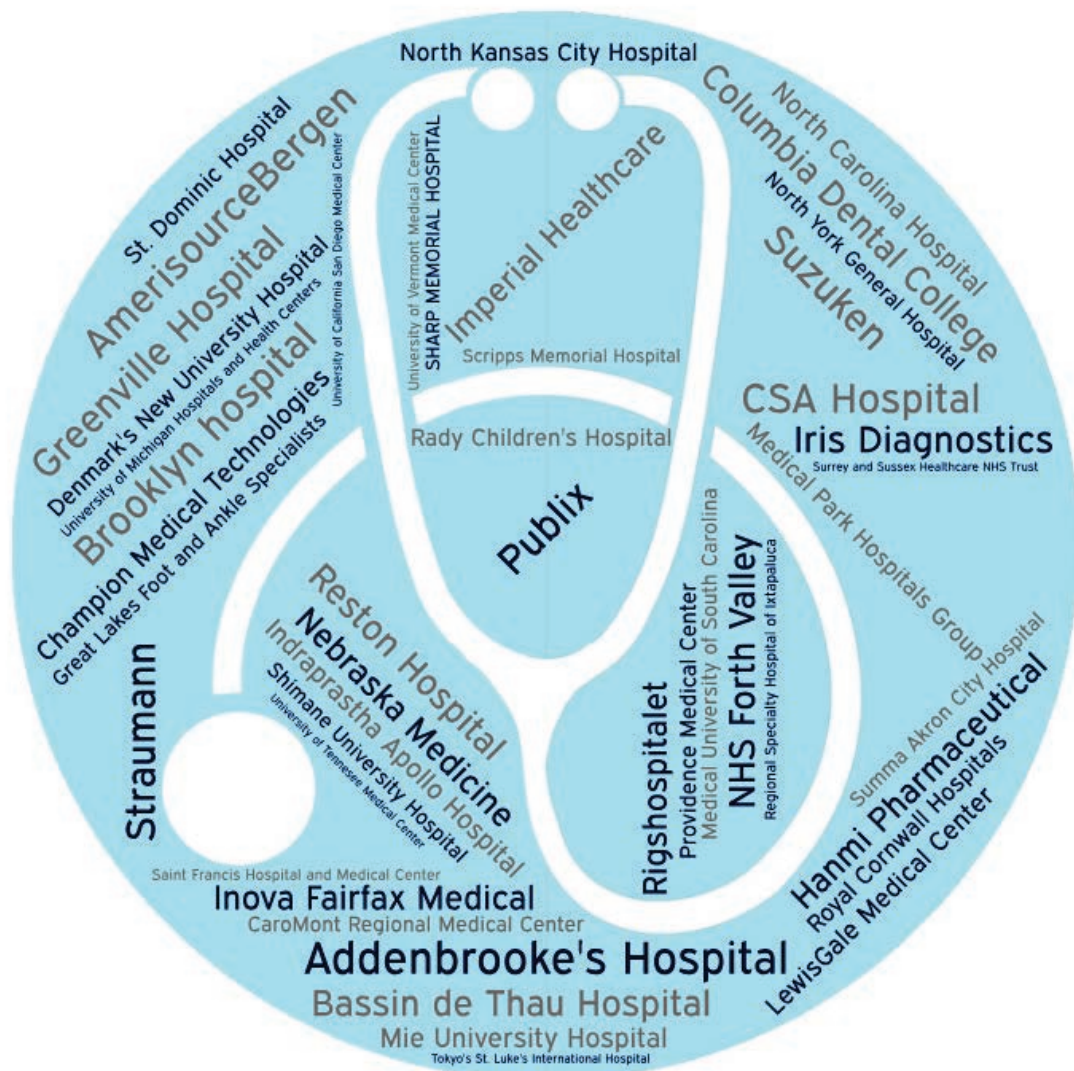
OVER 40 HEALTHCARE PROVIDERS ARE USING RAIN RFID TECHNOLOGY.

MORE INFORMATION
HTTPS://RAINRFID.ORG/MARKETS/HEALTHCARE/

INTERNET OF THINGS *(IOT)*

RAIN RFID connects billions of everyday items to the Internet of Things (IoT), enabling consumers and businesses to **identify, locate, authenticate,** and **engage** each item. IoT applications require a data connection between the physical and digital world, and RAIN RFID is the ideal technology to bridge these realms with the ability to bring low cost, unique identification to everyday items.

- **AIRLINES**
- **AUTOMOTIVE**
- **FOOD**
- **HEALTHCARE**
- **LOGISTICS**
- **MANUFACTURING**
- **RETAIL**
- **SMART HOMES & CITIES**
- **SPORTS**
- **TRANSPORTATION**

RAIN BENEFITS FOR IOT

RAIN RFID adds intelligence to the IoT value chain and facilitates new applications for connected things. RAIN RFID is the only technology capable of providing a cost-effective and unique digital ID to everyday items.

- RAIN delivers IoT item-level value
- RAIN offers a wide variety of IoT applications
- RAIN brings additional sensor connectivity
- RAIN can be embedded in things
- RAIN complements other IoT technologies

IOT SUCCESS WITH RAIN

Over 20 billion items in industry and consumer applications have been successfully connected with RAIN RFID.

RAIN CONNECTS THINGS	RAIN CONNECTS PEOPLE
Millions of people benefit from worry-free traveling thanks to RAIN-supported baggage tracking by Delta Airlines.	Millions of runners benefit from accurate RAIN performance measurement, including the New York City Marathon and Wings for Life.
RAIN CONNECTS SUPPLY CHAINS	**RAIN CONNECTS SENSORS**
RAIN can help supermarkets reduce in-store waste by 20%, improve efficiency and track goods from farm to store.	Mercedes and VW use RAIN sensors to measure environmental conditions including temperature and moisture during production.

Link to more IOT information – Success Stories, Presentations, News - https://rainrfid.org/markets/iot-market/

WHAT HAPPENED TO THE "THINGS" Steve Halliday

We are all very caught up in the "Internet of Things" phenomenon. There isn't a day goes by when we don't see an article (or sixteen) on the topic. We see statistics quoted here, there and everywhere about how this is going to/already is affecting our lives, yet almost none of these articles seems to see the big picture.

In "How to Fly a Horse" by Kevin Ashton (http://www. amazon.com/How-Fly-Horse-Invention-Discovery/ dp/0385538596) we learn that Kevin coined the phrase "Internet of Things" (IoT) in 1999 when he was trying to present a solution to the problem of tracking the sales of lipsticks. Kevin worked at Procter & Gamble and the misplacement of lipsticks in the display case was causing a sales issue when the required colour was in stock, on the display, but in the wrong place and not easily found. Kevin put an RFID tag in the lipstick and an antenna under each location, monitored the display unit, uploaded the information to the internet and used it to make decisions about the actual sales stock position.

Since then the term has been broadened to include almost anything that is in some way connected to the Internet and is providing information that can be used. The term has almost become a part of everyday use, though it seems the understanding of the term has morphed. In 2013 the Oxford English Dictionary included a definition for the IoT – "The interconnection via the Internet of computing devices embedded in everyday objects, enabling them to send and

receive data" (http://www.oxforddictionaries.com/ us/definition/american_english/Internet-of-things). While this definition is fine, it does not capture the real essence of the concept.

In 2013-4, Special Workgroup 5 under ISO/IEC JTC 1 (International Standards Organization/International Electrotechnical Committee Joint Working Group 1) spent a lot of time looking at the definition of the IoT and found over 30 definitions in common use. The group reviewed all of these and created a new definition that is currently being used in ISO – "The Internet of Things (IoT) is a global network infrastructure, linking physical and virtual objects through the use of interoperable data capture and networking methods. Standards-based object identification, sensors, controls, actuators, and connection capability provide for the development of independent cooperative services and applications supported by data analytics and characterized by a user-defined degree of autonomy." The work of this group can be found in a report and annexes to be found at http://www.iso.org/iso/jtc1_home.html.

So, when did we become enamoured with the thermostats and fitness bands that the public seems to think is the IoT and how is this leading us astray? The idea of wearing a band that tells us how "healthy" we are being or monitoring the temperature of the house from our smartphones are things that we view as "cool and sexy", so naturally we want to be involved and the manufacturers are keen to oblige. The possibility that we can somehow control our lives in a new way is something that is driving us forward, and with all the talk of the Internet of Things it makes us feel that we are a part of the modern world.

Obviously, this is only a very small part of the IoT and yet the market for the devices is very large, hence the interest to provide us with the technology. My fitness band talks to my phone and if I have the correct brand of fitness band it will even talk to the app that connects me with my medical records and my doctor would be able to see how good (or bad) I am at making sure I walk my 10,000 steps every day. So, I am connected, and I have a chance that the information can be used to better my life.

Now we need to think about all of the other things that can be connected, and we see that it is not always as simple as the fitness band. After all, I have to be an active part of the system, making sure the band is near the phone, maybe I have to force a sync occasionally,

make sure the band is charged, etc.. If this IoT thing is going to work, then we need to look at ways to make it less invasive in our lives

If we go back to Kevin's problem, we can see that he was interested in locating something that does not have electronics embedded, that does not have an IP (Internet Protocol) address, that does not have an electrical connection to anything, AND may only cost a few dollars. The problem of identifying, locating, authenticating and engaging with these "things" is very real and needs to be addressed.

The answer to many of these problems lies in a technology that has grown massively over the past few years. Passive UHF radio frequency identification technology (now called RAIN RFID) is small, inexpensive, does not need batteries, and can communicate with a host portal over a distance of many meters. The technology is standardized by ISO and there are many companies providing the various parts of the technology. The group is represented by an industry alliance (RAIN RFID Alliance) in the same way that Wi-Fi and Bluetooth are represented by their industry groups.

The concept behind RAIN is that the individual items are "tagged" with a small RAIN tag that has a unique number associated with it. This number describes the identification of the items that it is attached to, maybe a shoe, a pair of jeans, a clock, a manufacturing part or maybe even a person. The tag is interrogated by a reader, interrogator and the identity and location of the thing is logged into the system. This information (or possibly lack of information) is then used to make decisions about the thing.

RAIN RFID
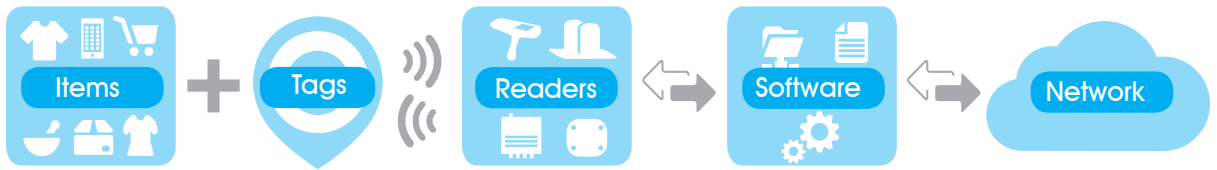
For example, let's suppose the thing is a pair of jeans. When I buy jeans, I know what I want, what brand, what size etc. I go to my favourite store and I look for "my" jeans. I don't find them! What do I do? The chances are that I leave, and the store just lost a sale. But what if the pair I want was actually two shelves over because someone had misplaced them? What if my size had been sold but there were three more pairs in the back room?

By using RAIN RFID, the store can have an instant notification of the jeans being removed from the shelf, being placed on the wrong shelf, or being sold. The jeans could be replaced within minutes of the event and they might have been sold me the pair I was looking for. This is exactly the premise that some retailers have been using with shoes in some of their stores. There has been a report of uptick in sales of 7% based on the fact that the store was able to keep the shoes on the floor in sight of the person who might want to buy them.

Now take this to the next level. Let's think about a manufacturing plant. Think of the value to the plant to have instant sight into all their stock, whether it is in their warehouse, on a truck, or sitting at the suppliers waiting for delivery. Most companies operate in what I will call silos. Visibility into the status of the manufacturing process is limited specifically to those who "need to know", but in many cases the need to know philosophy does not work.

I was recently made aware of a large manufacturing company that uses a very well-known enterprise management product, but they only use it to generate pieces of paper to process the receipt, inventory, and shipping of items. The purchasing folk have no sight into the status of the items that are ordered after they make the purchase. This causes many headaches with frequent calls from receiving to the purchasing agents to identify badly labelled products and recently the misplacing of several very expensive parts. These parts

became the critical point in the manufacturing process and had to be reordered and shipped express at many times the original cost because they were lost. RAIN RFID is an example of how using the right technology can eliminate these kinds of issues.

The key to the success of the Internet of Things will be the ability to identify, locate, authenticate and engage with "Things", not just expensive, IP-based devices. RAIN RFID exists today and is already starting to provide this "thing" based information. Research companies like IDTechEx (https://www.idtechex.com/research/reports/rfid-forecasts-players-and-opportunities-2017-2027-000546.asp) have published that by 2020 we will have over 100 billion RAIN tags in use. This is about five times the numbers being quoted related to IP-connected devices. See the Gartner report – "Forecast: The Internet of Things, Worldwide, 2013"; Gartner, Inc. Research Report; Dec. 12, 2013: www.gartner.com/newsroom/id/2636073

Completely compatible with existing technologies that provide IP-connectivity to devices, RAIN allows us to identify, locate, authenticate and engage with everyday things. RAIN has the capability to interface with sensors on the things and can provide the information we need.

The Internet of Things is here to stay, it is not a university research project, and the data shows that we are engaged in the concept. The next time someone talks about connected devices, remind them that IP-connected devices are a small part of the system and that we must not forget the "Things".

Originally posted to the CISCO IoT Blog, June 2015 http://blogs.cisco.com/perspectives/what-happened-to-the-things and updated for this document.

The RAIN Alliance publishes data that shows growth in Tag IC sales each year *(see below)*

Tag IC Sales Billions
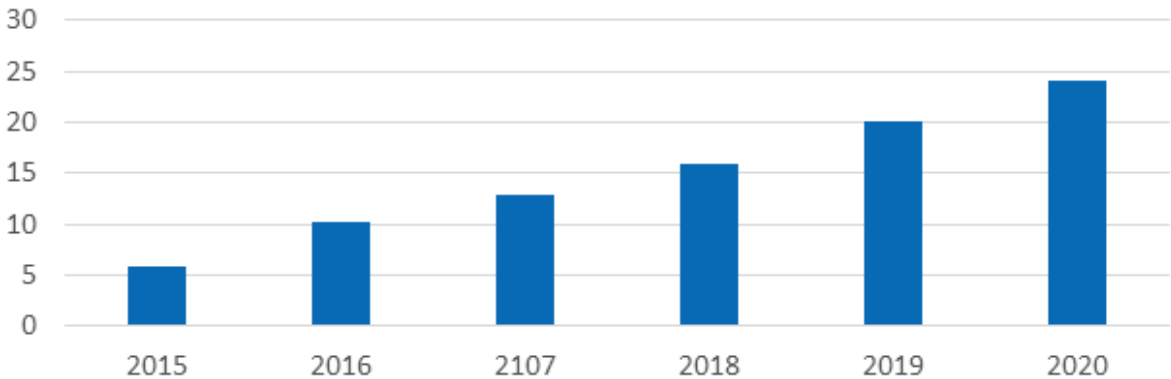
DATA COLLECTED BY RAIN RFID ALLIANCE
2015-2017, FORECAST 2018-2020

THIS GRAPHIC SHOWS HOW RAIN TECHNOLOGY ACTS AS THE LOWEST LEVEL PROVIDING THE CONNECTIVITY TO THE "THINGS" IN OUR LIVES.
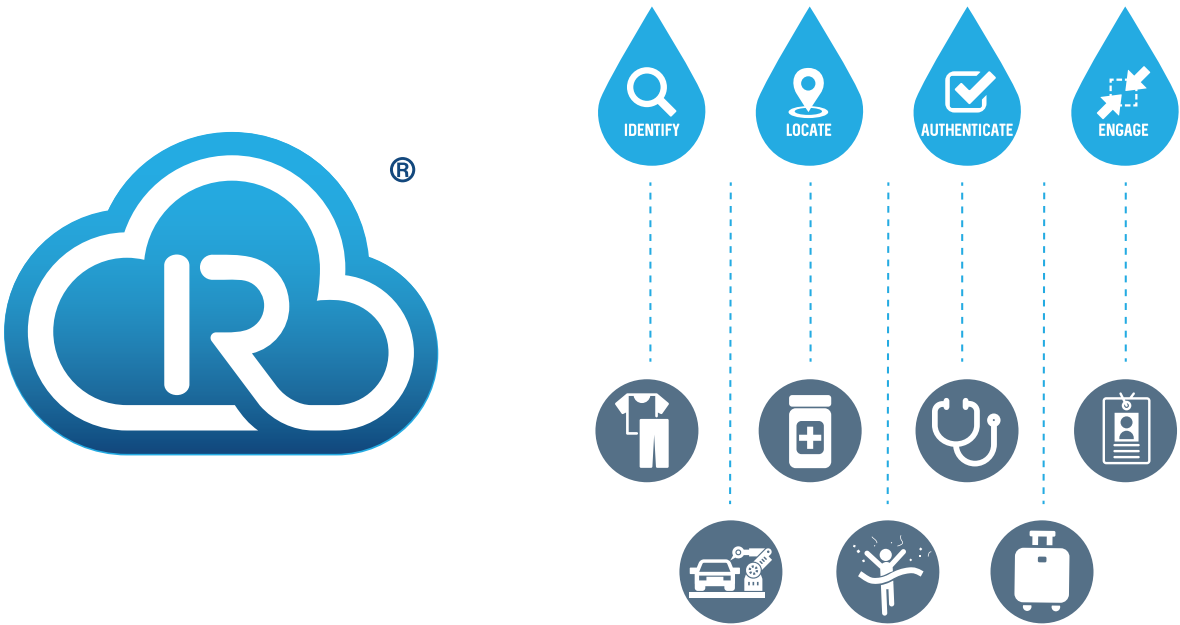
RETAIL

RAIN RFID that connects billions of retail items to the internet, enabling brand owners, retailers and consumers to identify, locate, authenticate, and engage with each item. A consumer-led revolution for omni-channel commerce has placed huge demands on retailers, but RAIN RFID is helping to make it easier, faster and more secure for brand owners and retailers to improve inventory management from manufacturing and supply chain to point-of-sale online and in the stores.

- 98% inventory accuracy results
- Up to 20% sales boost with item availability
- 96% improvement in labour productivity
- 9% decrease in shrinkage
- 50% reduction in out-of-stocks
- 96% time reduction with smart inventory

RETAIL BENEFITS OF RAIN

For omni-channel retailing, inventory visibility and returns processing is more important than ever. RAIN technology provides the best inventory management to increase sales, reduce out-of-stock and overstock, and improve employee and customer satisfaction.

"(RAIN) RFID PROVIDES FOR NEARLY 100% ACCURATE, REAL-TIME INVENTORY INFORMATION." *-GARTNER*

RETAIL SUCCESS WITH RAIN

ZARA Improved accuracy and visibility with faster inventory counts.	**LULULEMON** Increased e-commerce sales by improving inventory accuracy to 98%.
TESCO Reduced costs by 10% with better replenishment.	**HERMAN KAY** Optimized supply chain process to 100% accuracy.

Link to more RETAIL information – Success Stories, Presentations, News - https://rainrfid.org/markets/retail-2/

Over 100 RETAILERS use RAIN RFID - https://rainrfid.org/markets/retail-2/rain-in-retail/

UNDIZ MAKES SHOPPING EFFORTLESS, INVENTORY MANAGEMENT A BREEZE

Trend-setting French lingerie retailer, Undiz, uses RAIN RFID and space-age pneumatic tubes for a revealing shopping experience. Undiz has headquarters in Clichy, France and sells lingerie, swimwear, and sports apparel via 180 physical stores and an innovative digital shopping experience.

By utilizing Retail Reload's Fashion Tracking solution and Impinj's RAIN RFID platform, Undiz created an innovative shopping experience that engages tech-savvy customers and streamlines store operations. After deploying the solution at one location, Undiz benefits included:

• 10% increase in sales
• >55% increase in stock handling productivity
• >40% increase in check-out productivity
• 98.6% stock accuracy

COMBINING COOL AND CONVENIENCE WITH INNOVATIVE SHOPPING

Undiz is the "cool lingerie" brand for digital-savvy millennials. Undiz wanted to provide millennials with an effortless digital and store shopping experience that lived up to the "cool factor" embodied in its brand. In addition, Undiz wanted to drive efficiencies in its customer fulfillment and inventory management systems. The retailer's stores each carry 800 items and sell 200,000 items annually.

The answer was clear: an innovative RAIN RFID-based retail management solution that breaks down the barriers between online shopping and physical stores.

"UNDIES" IN SPACE-AGE CAPSULES ZIP AT HIGH SPEED TO STORE KIOSKS

Now, Undiz shoppers can use their smartphones to browse entire inventories and select items even before they get to the store.

When shoppers walk into stores, beacons detect their selections from the Undiz app on their devices. Ninety seconds later, space-age capsules shoot the "undies" via pneumatic tubes from the store's stock room to a kiosk. Shoppers pick up their merchandise at the kiosk and try it on in a fitting room or simply pay on the spot without having to wait in line for a cashier.

SALES GO UP, COSTS GO DOWN

The new RAIN RFID retail management solution provides higher sales and lower inventory management costs. With increased visibility of online and in-store inventory via their wristwatch-like mobile devices, sales associates find merchandise and have it in-stock for customers more easily, which drives up sales. And rich sales data generated by the RAIN RFID system helps sales associates find new ways to cross-sell items.

In fact, Undiz was able to achieve a nearly 10 percent increase in sales at one store by understanding buyer behavior and improving customer service using RAIN RFID data.

Further, RAIN RFID lets Undiz count all items in one store with nearly 100 percent accuracy in just one hour. Undiz is now able to keep more inventory in stock rooms rather than on the sales floor, which reduces footprint and lowers rent and operational costs.

CONTACT

impinj.com   brandfolder.com/impinj

IMPINJ™

SMART MANUFACTURING

SMART MANUFACTURING BENEFITS OF RAIN

From the manufacturing of goods, to ensuring the right product is in the right location, RAIN has a place at every stage of the supply chain. With RAIN, businesses gain access to the real-time data use to optimize operations, improve consumer and worker safety, and reduce costs. Benefits include:

- Higher inventory visibility and accuracy
- Effective recall management
- Improve patient safety and care
- Automate payments and increase profitability

- Reduce product expiration, shrinkage and waste
- Decrease supply chain and equipment costs
- Reduce hospital-acquired infections
- Prevent medical errors due to misidentification

> **"ROUGHLY 64% OF MANUFACTURERS BELIEVE THAT APPLYING IOT TO PRODUCTS WILL INCREASE PROFITABILITY OVER THE NEXT FIVE YEARS"** –MPI GROUP

SMART MANUFACTURING SUCCESS WITH RAIN

INDUSTRY 4.0	MERCEDES-BENZ
RAIN RFID, is reshaping how manufacturers produce, deliver, and manage their products.	Using tags with moisture sensors, RAIN RFID may be the most viable future method for leakage testing of vehicles.
DANA INCORPORATED	**MICHELIN**
Using RAIN RFID for 100% traceability through the manufacturing process, despite the rigors of temperature washes, painting, and handling.	RAIN RFID tags embedded in tires for unique identification, allows cradle to grave traceability.

More SMART MANUFACTURING information – Success Stories, Presentations, News - https://rainrfid.org/markets/smart-manufacturing/

SMART PACKAGING

WHAT IS SMART PACKAGING?

Smart Packaging adds integrated sensing, identification, and communication functionality to how things are packaged.

Packaging already serves an important role in the marketing, protection, and compliance of an item. Implementing RAIN in packaging offers the lowest application cost and greatest duration of value – the benefits of RAIN can be utilized from the point of manufacturing through shipping, distribution, sales, and end use.

WHY IMPLEMENT RAIN RFID SMART PACKAGING?

TODAY'S SUPPLY CHAIN – The pace is faster. Volumes are larger. There's a greater diversity of products. Customer urgency and expectations are on the rise. Enhanced speed and flexibility are essential to respond to omni-channel retailing imperatives.

RAIN RFID Smart Packaging benefits the end-to-end supply chain:

- Locate items for efficient fulfilment
- Enable near-perfect inventory accuracy
- Reduce inventory-taking time by **90%** or more
- Authenticate products throughout the supply chain
- Reduce merchandise loss and deter theft throughout the supply chain
- Track & trace to target scope and increase speed of product recalls
- Supply item level information to retailers and government agencies for compliance reporting and customs processing

WHY USE RAIN RFID?

RAIN RFID makes a big impact on Smart Packaging:

- **Read range flexibility** – long range >10 meters, down to short range of a few millimetres
- **High speed** – Rapidly count things – 10's or 100's at a time
- **Orientation insensitive** – read tags without visibility, regardless of reader/tag angle
- **Invisibility** – embed tags inside the package to preserve packaging appearance and branding
- **Low cost** – tag requires no battery and offer a long life
- **Improved process control and efficiency** – drastically expedited receiving, picking, and shipping – improves speed and lowers operational cost
- **Improved reliability & security** – integrated structure more robust and immune to tampering

WHY NOW?

RAIN RFID is a proven technology, with industry standard products, used in many vertical markets.

- RAIN RFID tag market grew to over **12 billion** tags sold in 2017 and expecting over **20 billion** tags sold per year by 2020 across many markets.[1]
- Comprehensive and affordable solutions are available: tags, readers and software leverage RAIN RFID to improve reliability and reduce cost.

Complete solutions with compelling ROI's are transforming businesses with huge boosts to visibility of enterprise-wide operations. RAIN RFID tags are being attached to many things and are being read by a combination of powerful mobile and fixed readers.

SMART PACKAGING

RAIN is a vital element of the Internet of Things (IoT) and plays a crucial role in the success of omni-channel retailing.

RAIN RFID USAGE[2]	2015	2017
Manufacturers	48%	87%
Retailers	57%	86%

[1] Source: IDTechEx, RFID 2018-2028: RAIN and NFC Market Status, Outlook and Innovations (https://goo.gl/Ssd9a1)

[2] Source: GS1 US survey for Apparel and General Merchandise Industry in 2014 (http://goo.gl/fz490K)

More SMART PACKAGING SUCCESS STORIES using RAIN RFID -
https://rainrfid.org/resources/documents/
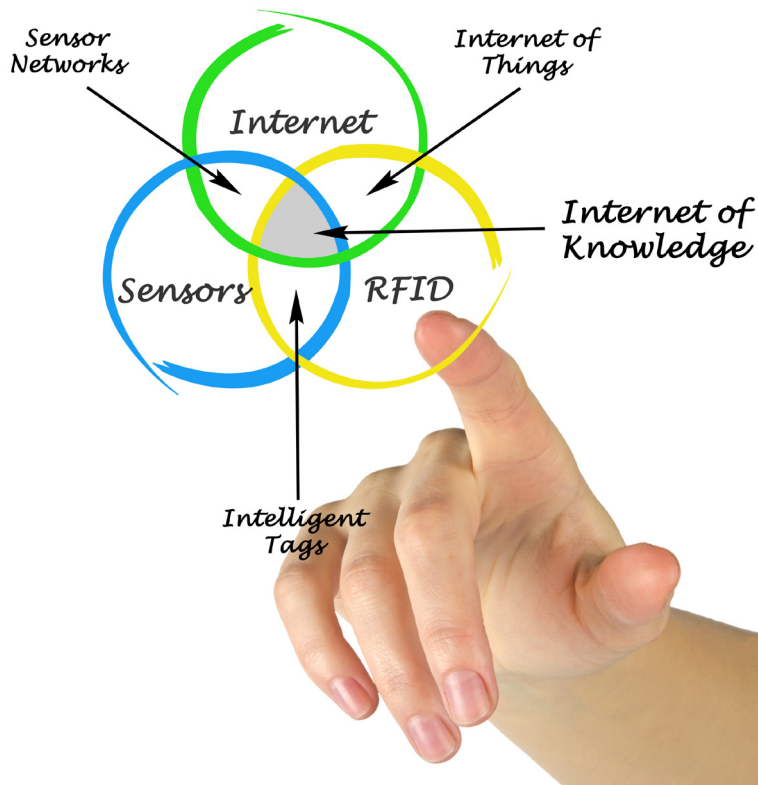
RAIN
R F I D

TECHNOLOGY

RAIN RFID TECHNOLOGY

A RAIN RFID solution uses a reader to read and write a tagged item, manage the data and take action.

RAIN RFID is a wireless technology that connects billions of everyday items to the internet, enabling businesses and consumers to identify, locate, authenticate, and engage each item. RAIN technology is based on the UHF RFID protocol standard developed by GS1 and ISO and published as GS1 EPC Gen 2 UHF air interface and ISO/IEC 18000-63 860-960 MHz Air Interface.

ISO/IEC link - https://www.aimglobal. org/store/ListProducts. aspx?catid=&ftr=18000-63.

GS1 link - https://www.gs1.org/standards/epc-rfid/ uhf-air-interface-protocol.

RAIN tags contain an integrated circuit (chip) and are attached to or embedded in items, boxes, pallets, or other things. RAIN readers send a wireless signal to identify, locate, authenticate, and/or engage the tags. Readers can be embedded in devices, held by a person, or installed in doorways or ceilings.

RAIN software collects the tag data and can connect this information with networks or clouds to enable inventory management, asset tracking, and many other applications.
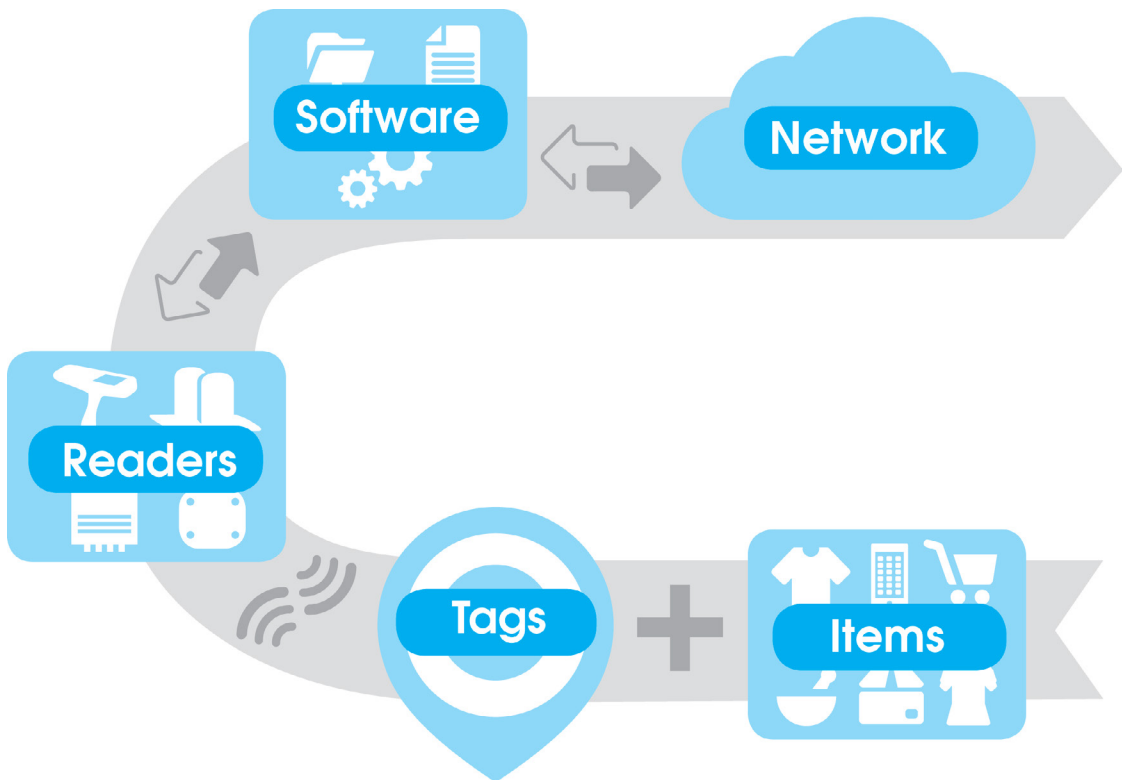
RAIN RFID TAGS

- Are either attached to or embedded in items
- Tagged items store and send information
- Thousands can be identified simultaneously and do not have to be visible to the human eye

RAIN RFID READERS

- Have antenna(s) for either short or long-range communication
- Can be small and portable, or larger and installed, or embedded in other devices

RAIN RFID SOFTWARE APPLICATIONS

- Identify – Locate – Authenticate – Engage
- Use the tags and readers to create, collect, and use the item's data – locally, or on a server, or on a cloud
- Authentication starts with determining an item is genuine
- Engage can involve sensors, or other means of interacting with the item

RAIN RFID DOCUMENTS

Here are some of the documents the RAIN Alliance has published that can help you to understand the technology and its use.

RAIN Terminology

History of RFID

RAIN Radio Protocol

RAIN RFID Relevant Standards

The Anatomy of a RAIN RFID Solution

RAIN Communication Interface Guideline (RCI)

RAIN RFID Reader Sensitivity Testing

What RAIN Brings to the Internet of Things

RAIN Q&A with Kevin Ashton and the Internet of Things

Electronic Vehicle Identification (EVI)

New Opportunities in Usage and Challenges to Embed RAIN RFID Tags into Product & Packaging

Link to the RAIN RFID Documents - https://rainrfid.org/resources/documents/ (click on RAIN tab)

RAIN RFID TAGS

RAIN tags are the items that are attached to the "thing" that needs to be identified. The tag is made from an integrated circuit (tag chip) and an antenna mounted on a substrate.

Tag chips are made by several companies and they offer a variety of different features. The basic feature set is common to all chips, but the standard that defines the air interface (how a tag chip talks to a reader) has many options in it that a manufacturer can choose to implement or not. Options include security, file management features, user memory, and the ability to add "battery assist".

The most common form factor for a tag is a paper label, but there are many other form factors available, as well as different configurations of the various form factors.

Tags use a technology called "passive backscatter" to talk to the reader. They use the power transmitted from the reader to energize and respond to the reader. They do not transmit the information but are able to modulate the reader signal as a response. This backscatter technique means that the tag needs to be in the "read zone", an area that receives a good signal from the reader. It also means that replies from tags are very low power and so they can easily be lost if the reader is not focused on the tags, or there is a lot of other radio noise.

Tags antennas are designed to be used in specific applications – for example, a tag may be designed to be used on a bottle of shampoo. This tag will be specially designed and tuned to consider the properties of the shampoo and the effect that it has on radio waves. Other examples might be a tag to be used on a metal object, or on a bottle of water. Size is also a factor when designing a tag. A tag that must be read at large distances will typically be larger than one that is only read close by.

OTHER FORM FACTORS MAY INCLUDE:

- A hard shell around the tag chip and antenna for a more rugged application.

- This form factor may or may not include adaptions to allow the tag to be mounted on metal surfaces

- Flexible shells to allow attachment to curved surfaces while still affording the extra protection of a shell

- Embedded in a plastic surround such as an ID card

- As part of a thread used in the manufacture of garments etc.

RAIN RFID
TAGS

GENERAL TAG TYPES

The following general tag types may be present in the read zone:

SIMPLE: Access to these tags are limited to reading the UII/EPC during inventory.

READ: Additional tags reads are required. This requires additional commands to be sent to the tag and more data to be sent by the tag. It takes longer to complete a tag interrogation. Often these actions reduce the read range of the tag.

WRITE: This requires additional commands and data to be sent to the tag. The tag needs more electric power to store the data permanently. It takes longer to complete a tag interrogation. Write actions reduce the read range of the tag.

BAP: Battery assisted tags may be in the read zone. The battery provides electric power for the tag intelligence (and sensors), so ensuring the optimal read range for all types of interrogations. Battery assisted tags have dedicated commands and modulation to optimise the use of such tags.

SIMPLE SENSOR: Tags may provide simple sensor data. Simple sensor data is added to the UII/EPC during inventory as indicated by the protocol.

SENSOR: Tags may provide sensor data.

CRYPTO: These tags offer extra security to the transaction and may reduce read range.

TAG MEMORY ORGANISATION

Information in the tag is stored in specific locations. RAIN tags have the following memory map:
Note: MB and MemBank is an abbreviation of memory bank.
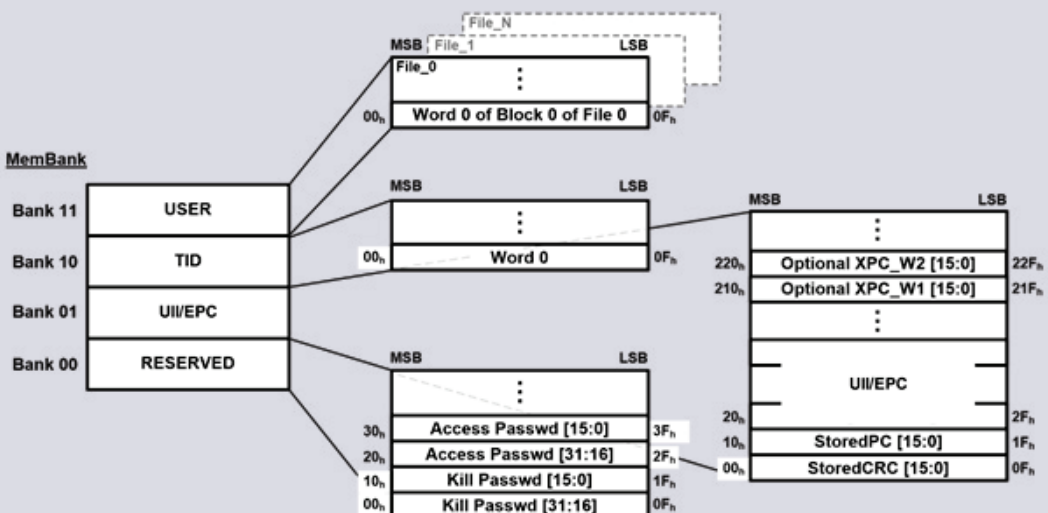
SIMPLE ISO TAG WITH 128 BITS UII

MB-01 PC Bits					MB-01 UII
UII len	UserMem	XI	Standard	AFI	UII as specified by the AFI
01000	0	0	1 (ISO)	8 bits	128 bits as per UII len

SIMPLE GS1 TAG WITH 96 BITS EPC

MB-01 PC Bits					MB-01 UII
EPC len	UserMem	XI	Standard	RFU	EPC as specified by GS1
00110	0	0	0 (GS1)	0x00	96 bits as per EPC len

GS1 OR ISO TAG WITH ISO/IEC 15961 & 15962 DEFINED USER MEMORY DATA

MB-01 PC Bits					MB-01 UII	MB-11 User Memory	
UII/EPC len	UserMem	XI	Standard ISO|GS1	AFI/ RFU	UII/ EPC	DSFID	Data fields according to ISO/IEC 15961 & 15962
00110	1	0	1 or 0	0x00	96 bits	8 bits	≥ 0 bits

ISO TAG WITH ISO/IEC 20248 DEFINED USER MEMORY DATA

MB-01 PC Bits					MB-01 UII			MB-11 User Memory
UII Len	UserMem	XI	Standard	AFI	DAID	CID	Optional company assigned fields	signature, timestamp Optional company assigned fields
00110	1	0	1 (ISO)	0x92	32, 40 or 48 bits	16 bits	48 bits	≥ 256 bits

GS1 TAG WITH ISO/IEC 20248 DEFINED USER MEMORY DATA

MB-01 PC Bits					MB-01 UII	MB-11 User Memory			
EPC len	UserMem	XI	Standard	RFU	EPC	DSFID	DAID	CID	Signature, timestamp & optional company assigned fields
00110	1	0	1 (GS1)	0x00	96 bits	0x11	32 or 40 bits	16 bits	≥ 0 bits

ISO TAG WITH A SIMPLE SENSOR

MB-01 PC Bits					MB-01 UII	MB-01 Simple Sensor Data	XPC
UII len	UserMem	XI	Standard	AFI	UII as specified by the AFI	As specified by ISO	Simple sensor bit set

The Protocol Control (PC) word and eXtended PC (XPC) words 1 and 2 provide information on the data received and available on the tag. It also indicates the security access methods for the tag. The PC and optional XPC words are transmitted to the reader during inventory.

Memory Bank 11 (user memory) may be organised in separate data blocks called files. The default configuration is one file, called file 0. The Tag manufacturer chooses where a Tag stores its FileType and FileNum data. The Tag manufacturer also chooses the file-allocation block size (from one to 1024 words). User memory and the files in it may be encoded according to the GS1 EPC Tag Data Standard or to ISO/IEC 15961/15962 and ISO/IEC 20248.

The data stored on the tag is protected by a Cyclic Redundancy Check (CRC) digit. This means that a reader can calculate a CRC for the data received and check it against the stored value, helping to ensure that the data transmission was accurate.

GS1 tags and ISO tags have the same memory bank structure. They do differ in the content of banks 01 (EPC/UII) and 11 (User Memory). The following examples illustrate the differences.

RAIN RFID READERS
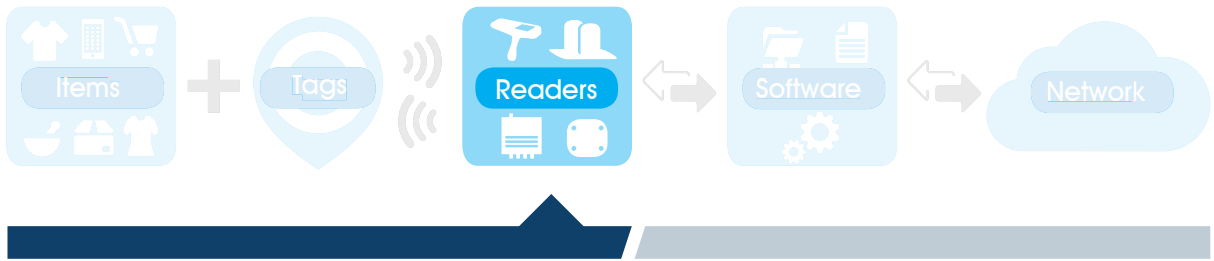
RAIN Readers are available in many different configurations. All readers accomplish some basic tasks and then may have additional features. All RAIN readers can communicate with the RAIN tags and learn their identity. Most can also write to the tag. There are two basic types of reader, though these come in many different variations: fixed and portable (sometimes called hand-held).

FIXED READERS

Fixed readers typically mount to a fixed location (near a door, on a fork lift truck etc.) and can communicate with one to many antennas. They usually require a power supply and are connected to a network with an Ethernet cable, though some use power over Ethernet and some have wireless communications capabilities. Some readers have the antenna(s) built into the reader module. Some readers offer the ability to control the antenna to allow steering of the radio beam.

PORTABLE READERS

Portable readers can be dedicated devices, incorporated with barcode readers, or sleds to allow the attachment of a mobile computer or mobile phone. The form factor can range from a "gun" type device with an antenna attached to small devices not much bigger than the phone they carry.

PORTABLE READERS

FIXED READERS
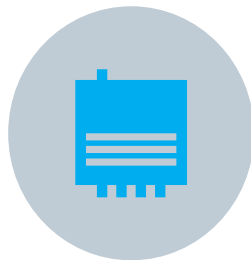
READERS MAY SUPPORT MANY ADDITIONAL FEATURES SUCH AS:

- Working in dense reader mode
- Providing access to the user memory part of a tag
- Enabling file management in the tag
- Providing secure communications with the tag
- Providing commands to the tag to take other actions such as read a sensor or activate a switch or actuator

ANTENNAS

THE TAG ANTENNA

The first antenna is the one connected to the tag chip. This antenna can be of many different shapes, sizes, and capabilities. As with all wireless systems, the design and size of the antenna help to specify the performance of the system. Many tag antennas are designed specifically with the end use in mind, e.g. mounting on metal or liquids, or to provide a specific range for an application.

Tag antennas may be designed to work globally (over the full 860 – 930 MHz band) or locally in a specific country or regulation band. They are usually linearly polarized so that a reader needs to be designed to take this into account for optimum performance. Tag antennas can be near-field (operating close to the reader only), far-field (operating at a greater distance from the reader) or a combination of both antennas in one design. The far-field tags are typically linearly polarized (vertical or horizontal) although a few tags are dual-polarized. Antennas are typically made from copper or aluminium but can also be printed with conductive inks. The choice of tag and its antenna is one of the critical decisions to ensure good performance of a RAIN system.

THE READER ANTENNA

The second antenna is associated with the reader and again can be of various shapes and sizes. Reader antennas can be large, in a hard case and mounted inside a doorway, or can be very thin to allow their incorporation into a shelving system. Reader antennas on handheld devices are designed to give the best performance from the compromises that require them to be portable.

Reader antennas are classified as near-field and far-field antennas, sometimes also mid-field. Far-field antennas are typically electric field radiators and are unidirectional. They can be horizontally linearly, vertically linearly, or circularly polarized to provide the best performance for the application. Far-field antennas can detect tags in the range of up to 15 metres or more depending on the RAIN RFID reader's output power and the antenna's gain.

Near-field antennas, on the other hand, create a proximity RF magnetic field enabling RAIN RFID tag detection in challenging environments like metals and liquid. The far-field antennas' RF energy would be absorbed and reflected by the liquid and metal assets, respectively and thus near-field antennas are preferred to obtain a reliable tag read performance without having any false reads.

Each antenna has its own physical and electrical characteristics, which control the way the antenna radiates the RF energy. The 3-dimensional transmitting range of an antenna can be perceived through its radiation pattern, also known as the beam plot. The beam plot helps to identify the read range, in which tags will be detected. The reader antenna's read range can be extended or contracted by adjusting the power levels from the RAIN RFID reader.
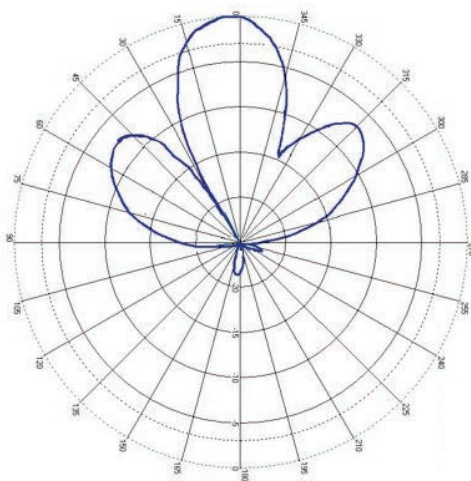
XZ-plane
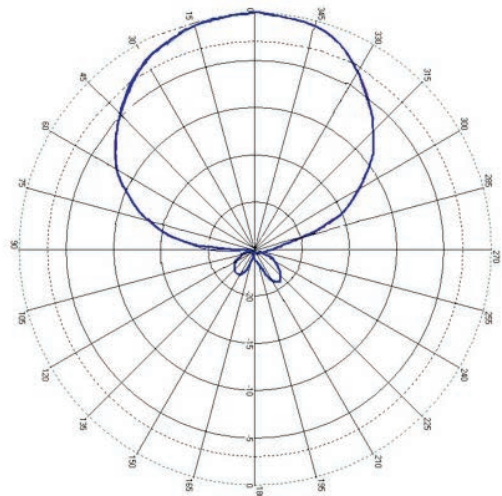
YZ-plane

Some reader antennas can operate in a wide frequency range that covers all the RAIN RFID regions – called wideband antennas - whereas others are specifically tuned for one of the two major frequency bands (ETSI and the FCC). Some may be tuned for specific regulations other than these.

Some fixed reader antennas offer steerable beams to allow better location capabilities for the system. The reader can control the positioning of the broadcast beam and so determine the location of tags that it sees.

The antenna selection should be determined by the use case or application, the choice of tag and the relative geometry of the tagged objects required to be read.
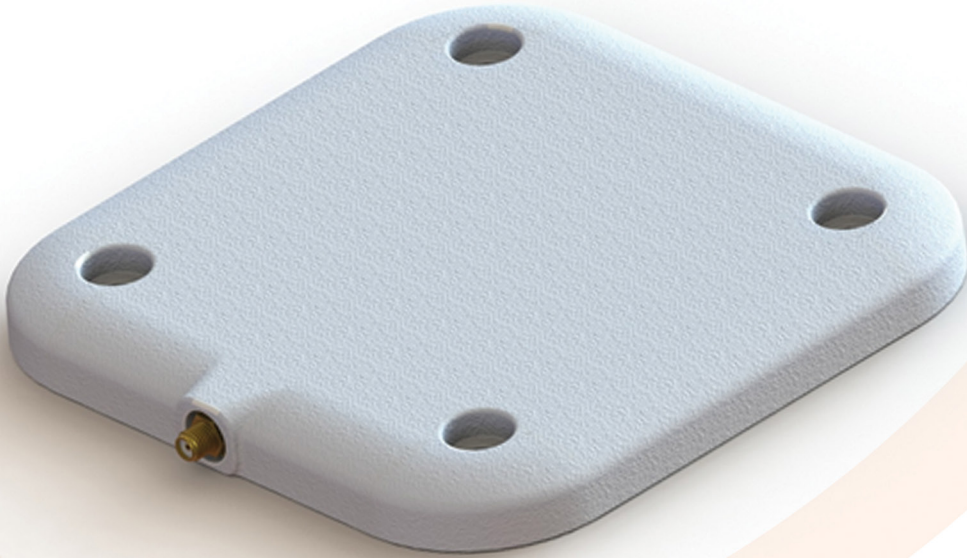
The RAIN RFID Antenna Company

We design and manufacture fixed UHF RFID reader antennas with a global distribution and support network.

For more information visit www.times-7.com
Contact us at sales@times-7.com
USA/Canada : +1 408 769 5025
New Zealand : +64 4 974 6566

RAIN RFID SOFTWARE APPLICATIONS

The software used to control a RAIN system is tailored to suit the application that it serves. It can range from small standalone programs that are simply detecting a RAIN tag and storing that information to systems that use large databases contained in the cloud to collect information and make decisions.

There is no "right way" to setup a software system for a RAIN application and the provider analyses the best way to satisfy the needs of the user and the application. Software is broken into several types; first there is the software that may reside on the reader as the interface to the user. This software may only provide the structure to talk to the reader or it may include the ability to make higher level decisions based on the data that is reported. The RAIN Communications Interface (RCI) is an example of a protocol in the software that sits in the reader and helps the user to get to the information that is needed. The RCI software accepts commands that allow the building of complicated actions including filtering the output.

RAIN Communication Interface Guideline
Version: 2018-09

RAIN RFID Alliance Guideline

V.1.0
September 2018

link - https://rainrfid.org/wp-content/uploads/2018/09/RAIN-RFID-RCI-v1.pdf

SESSIONS AND TAG TARGETS

Sessions are an expert air protocol method to add an additional layer of tag separation where readers are located close together. Other methods are RF shielding and frequency separation. Sessions may also be used to limit the number of times you read the same tag.

Targets are an expert air protocol method to silence tags already inventoried. This is very useful in helping to prevent problems due to too many tags in the portal trying to answer at the same time. It is also very useful to control battery assisted tag responses, since battery assisted tags may have substantially longer read ranges.

AIR INTERFACE PROTOCOL PARAMETERS

The air protocol parameters are used to optimize the speed and reliability of the over-the-air communication channel from the reader to the tag and from the tag to the reader. The over-the-air communications are influenced by various environmental and use factors in the read scenario. It must be noted that tags have very little power available (since they harvest electric power from the reader radiation) and have a small chip and are therefore limited in the speed and intelligence they can apply to decode reader radio messages. Readers, on the other hand can have all the electric power and intelligence they need to decode the tags radio messages.

The following air protocol parameters can be specified:

1. Q: The Q value is used to optimize the reading speed in relation to the number of tags simultaneously under the field. The higher Q values are good for large number of tags while lower values are good for small population of tags. Valid Q values are between 0 and 15 but typical values range between 3 and 7. Reader vendors typically implement an automatic Q value adjustment algorithm to adapt the reading speed dynamically to the tag population.

2. Tari: Tari is a factor used to determine the data link speed to the tag.

3. BLF: BLF is a factor used to determine the data link speed from the tag.

4. Modulation: The modulation specifies the method used to put data on the RF carrier. RF environments and use cases differ requiring different modulations methods.

5. Data encoding: Data encoding specifies the method for encoding the data onto the carrier (as specified by the modulation parameter).

6. Preamble: Long or Short; Long for noisy areas.

Parameters 2 to 6 specifies the radio modulations. These parameters influence the air link speed and robustness against radio noise. Typically, a higher speed will result in a reduced robustness. Each read scenario should be evaluated carefully for the optimal settings. This evaluation is often automated by the reader vendors.

These parameters are read only but may be very helpful in a system:

1. RSSI: Receive Signal Strength Indicator - An indicator of how well the reader has seen the tag. Should be interpreted with read count.

2. Phase: An RF indicator to assist in the optimisation of the read scenario.

AIR-INTERFACE PROTOCOL SUMMARY

Tags are energised by the reader. Once energised a tag will listen for a command from the reader. If the command is intended for the tag, the tag will respond by modulating and reflecting the signal received from the reader. The ability to recognize these commands is called the air-interface protocol and the standard defines the various commands and responses available.

The commands form part of three basic operations:

1. Select. The operation of choosing a tag population for inventory and access. A Select command may be applied successively to select a particular tag population based on user-specified criteria.

2. Inventory. The operation of identifying tags. Inventory comprises multiple commands. The result is the PC/XPC word(s), UII/EPC, and CRC from the tag. The PC/XPC bits inform the reader on the availability and access methods of additional information (e.g. sensor and crypto tags).

   Crypto tags inform the reader that they have encrypted information and which crypto suite is to be used to access the information. The application must provide the keys and use the indicated crypto access method to gain access to the protected data and/or verify the tag and/or the data.

3. Access. The operation of communicating with (reading from and/or writing to) a tag. An individual tag must be uniquely identified prior to access and a tag access handle obtained. Access comprises multiple commands (using the tag access handle) with multiple results and directed by the application.
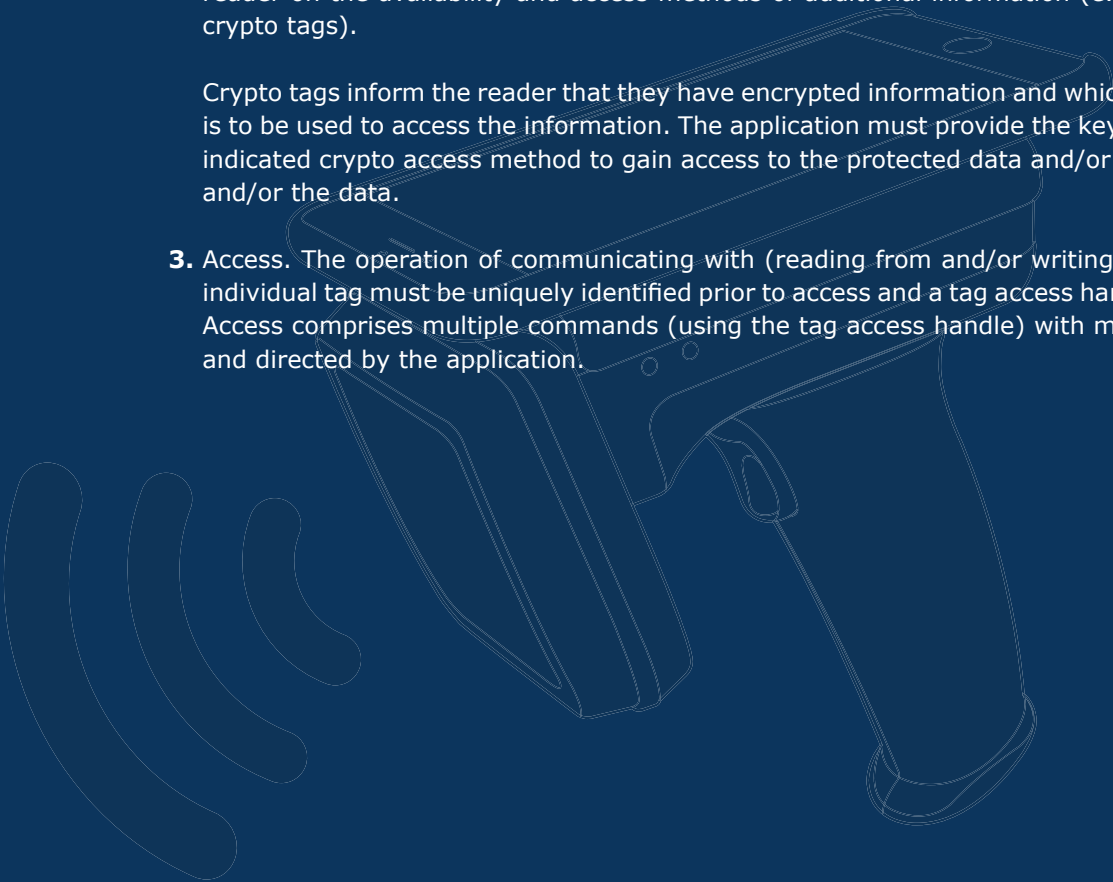
STANDARDS

There are many standards that are relevant in the RAIN RFID world. The use of these standards is voluntary, but they mean that the system implemented can conform to well-known and agreed practices.

The main standard for RAIN RFID is the air interface standard. This standard has been published by both GS1 and ISO and the although the basic command sets are identical, there are differences between the two standards. The GS1 standard is "EPC™ Radio-Frequency Identity Protocols Generation-2 UHF RFID Standard" and can be downloaded from https://www.gs1.org/standards/epc-rfid/uhf-air-interface-protocol. The ISO standard is ISO/IEC 18000-63: Information technology — Radio frequency identification for item management — Part 63: Parameters for air interface communications at 860 MHz to 960 MHz Type C and can be downloaded from your local ISO National Body or its agent (in the USA this standard is available from AIM - https://goo.gl/HQktCd. There is a separate erratum available for the ISO document to clarify some ambiguities.

The air-interface standard is not the only relevant standards that can apply to the use of RAIN RFID technology. There are many other types of standards including numbering systems, data format, data identification, conformance and performance, cryptography, system architecture and application specific. These are all detailed in the RAIN RFID Alliance Guideline – "RAIN RFID Relevant Standards" (https://goo.gl/btNwxy) and the reader is advised to be aware of these standards. Standards are available from the publisher.

The table shows how the ISO standards are used together to help create a standardised numbering scheme.

Other standards that are useful in defining and testing a RAIN RFID system include:

GS1 TIPP - specifying tagged item performance grades. Utilized by retailers in USA.

ARC Categories - practically same test methodology to TIPP, but different analysis and utilization of test results. Program run and administered by the University of Auburn in USA.

AS5678 (Spec 2000) for aerospace. A requirements specification created by SAE International for the production and test of passive only Radio Frequency Identification (RFID) tags for the Aerospace industry. This specification is also related to the Air Transportation Association SPEC2000 specification. http://www.spec2000.com/10.html

THE ISO 18000 SERIES

STANDARD CODE	DESCRIPTION
ISO/IEC 15961	RFID for Item Management: Host Interrogator; Tag functional commands and other syntax features
ISO/IEC 15962	RFID for Item Management: Data Syntax
ISO/IEC 18000	**RFID FOR ITEM MANAGEMENT: AIR INTERFACE** -1 Generic parameters -2 below 135 kHz -3 at 13.56 MHz -4 at 2.45 GHz -5 at 5.8 GHz -6 at UHF frequency band (-63 for RAIN RFID)
ISO/IEC 29161	Data structure — Unique identification for the Internet of Things

If the system being designed is using the GS1 system, then the following graphic shows the inter-relation between the GS1 standards.
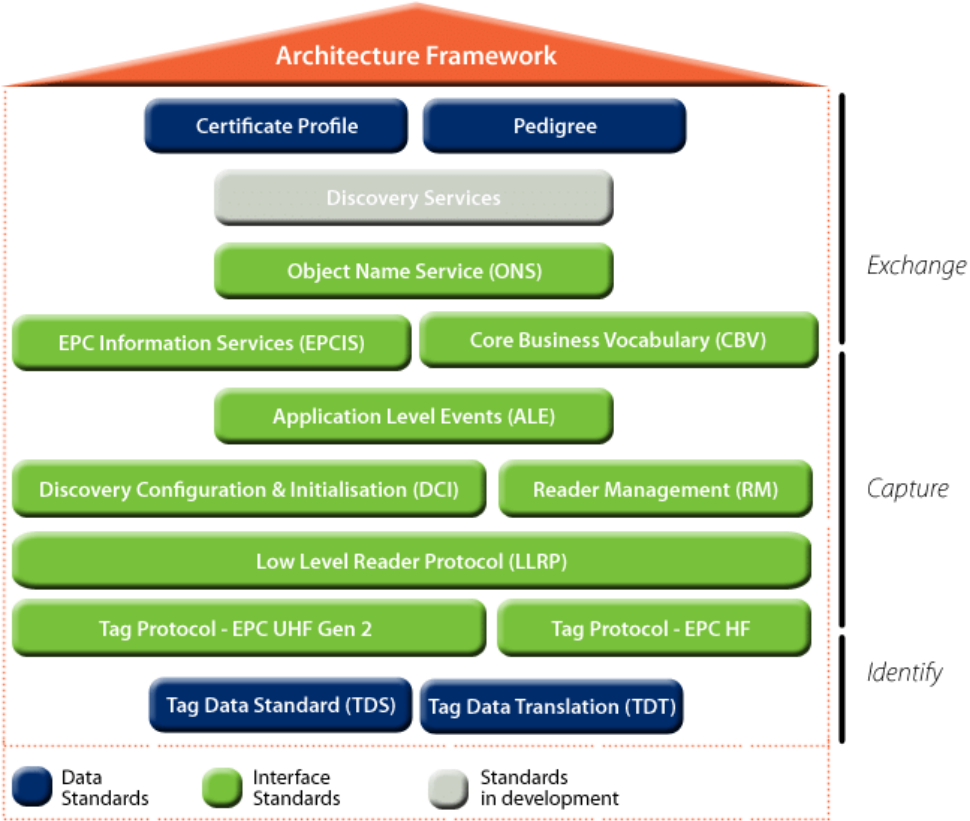
NUMBERING SYSTEMS
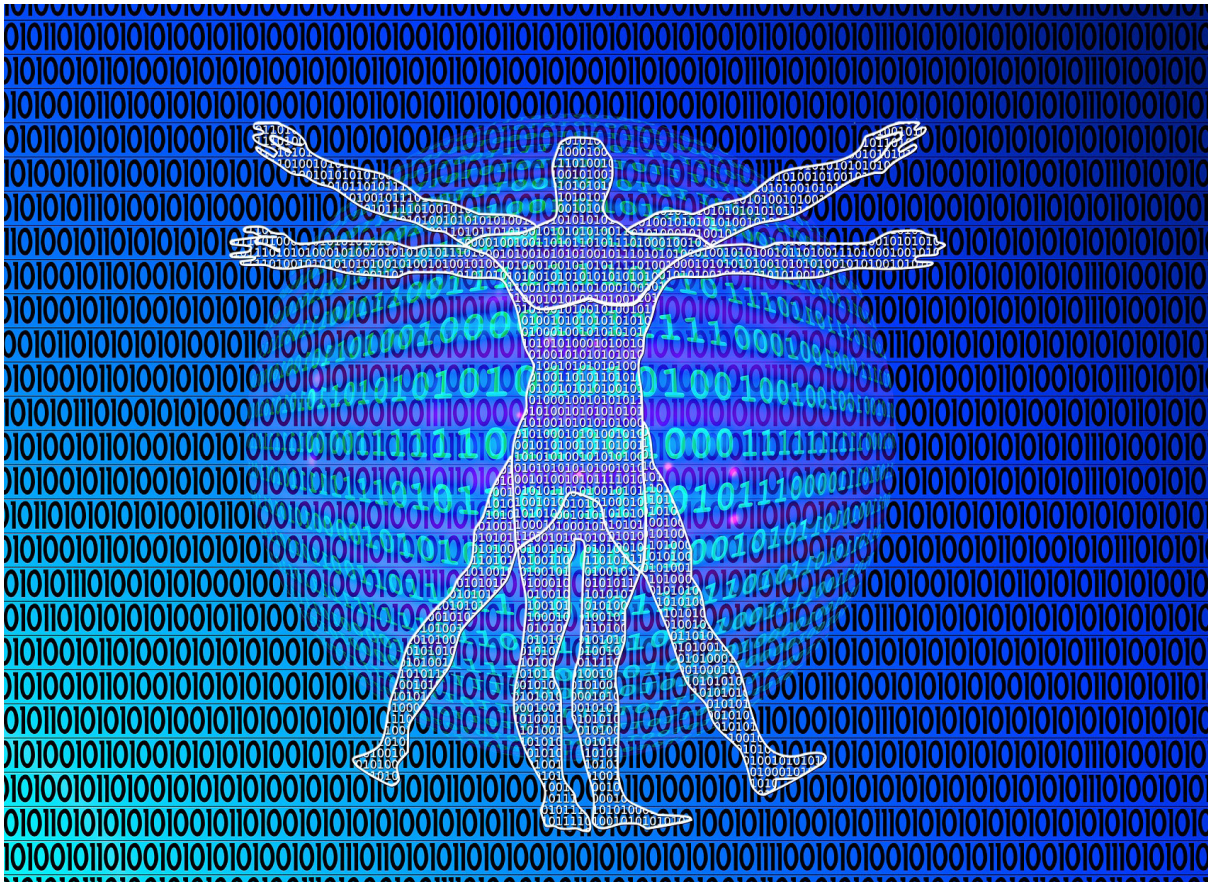
RAIN RFID AND THE IOT – THE UNIQUENESS OF THINGS

There are many reasons why the IoT is important, but the underlying issue is that in order to identify a particular thing it has to be uniquely identified. These "things" can then be tracked, sensed, modified etc. and provide information that is used in the "system" to make the IoT work.

The underlying issue is the uniqueness of the "thing". There are several ways to help define that uniqueness.

NUMBERING SYSTEMS

There are currently two principle numbering systems being used within the RAIN RFID "world".

- The EPC numbering system. This requires you to purchase a number (company prefix) from GS1 and then gives you the ability to define a unique number. This has been widely accepted in the retail world it but it does not have as much traction in other vertical markets. For more information contact the GS1 member body in your country.

- The ISO system. This uses an AFI (Application Family Identifier) to help define the uniqueness. An AFI is available at no charge from the ISO Registration Authority. The process for obtaining an AFI requires that it is being used in a global application and that the data structure that will be used is predefined for more information contact RAIN (info@rainrfid.org).

IDENTIFIERS

Once a numbering system is chosen, then there are other issues within that system when trying to identify not just the thing but what the thing is doing. Many of these identifiers are defined (and standardized) by the issuing body.

In the GS1 world, the uniqueness is defined by a company prefix that defines a particular organization followed by a product code and a unique serial number. This information makes what is called the EPC number. Further data can be provided by using Application Identifiers (AIs) to identify the type of data being stored (e.g. name, address, size, date etc.). The AIs are all available in the GS1 General Specification available from the GS1 web site (https://www.gs1.org/standards/barcodes-epcrfid-id-keys/gs1-general-specifications).

The ISO world offers a similar method of ordering a unique number. The AFI allows an application to be identified and a controlling organization will define the method to guarantee uniqueness. As mentioned above, an application form for an AFI is available from the registration authority.

ISO has published a standard that talks about the needs of the Internet of Things and how we can approach unique identification. The ISO/IEC 29161 standard "Information technology — Data structure — Unique identification for the Internet of Things" gives a great introduction to the issues. The standard talks about the 'Identification of an "entity"':

"For the purpose of this International Standard, the terms "entity", "item", "object" and "thing" are considered synonymous. An entity may be a person, object, or location."

When one considers the Internet of Things (IoT), the definition of the "Thing" is most often coloured by the perspective of the person undertaking the consideration.

- If one is coming from the world of sensors, the Internet of Things (IoT) is simply an expansion of a sensor network.

- If one is coming from the world of RFID, the Internet of Things (IoT) is simply an expansion of an RFID infrastructure.

- If one is coming from the world of geospatial data the Internet of Things (IoT) is simply an expansion of a location-based network.

- If one is coming from the world of telecommunications, the Internet of Things (IoT) (IoT) is simply an expansion of a telecommunications network.

In truth, all are correct.

The "questions" below underpin the very heart of the traceability, tracking, and chain of custody.

TABLE 1 – TRANSACTIONAL IDENTIFICATION

WHO	Individual	Identification of the individual
WHAT	Product code	Identification of the product (SKU)
WHICH (ITEM)	Unique item	Globally unique item serial number
WHICH (GROUP)	Specific group	Identification of the lot or batch
WHICH (CONTAINER)	Package ID	Globally unique transport unit identifier
WHERE	Location (Storage/Postal/ Latitude, Longitude, Altitude)	Unambiguous identification of the location
WHEN	At what time	Unambiguous time stamp
HOW	Method	Unambiguous identification of the process
WHY	Authority	Purchase Order/ Work Order

A single transaction may need to capture several identities as it progresses from origin to destination (and return). For example, there may exist a need to capture, each time a transaction is recorded, the following:

• Item identification
• Sensor identification
• Node identification
• Gateway identification
• Target resource identification
• Location of data capture
• Time of data capture
• Identification of the individual

These items help us to understand the details of identifying a "thing". Not all of these will be applicable in every case, but the concepts presented above give a good starting point in the data needed to make an IoT numbering system work.

OTHER IDENTIFIERS

There are also other standards that contain information about "identifiers" that should also be considered.

THESE INCLUDE:

• ISO/IEC 15434 Syntax for high capacity ADC media
• ISO/IEC 15459 Unique identification (multiple parts)
• ISO/IEC 15418 GS1 Application Identifiers and ASC MH 10 Data Identifiers and maintenance
• ISO/IEC TR 29162 Information technology -- Guidelines for using data structures in AIDC media
• GS1 Identification keys (GTIN, GLN etc.)

WHAT DOES THIS MEAN?

If the Internet of Things is to flourish, then we need a numbering system that is going to work for everyone. We need a system that uniquely identifies an object but also has the flexibility to change as an object (thing) changes during its life. We need to better understand what data is required from that thing and work to create a system that has the flexibility to offer the data we need.

WHAT CAN WE DO?

RAIN has established a pre-eminent place in the Internet of Things as the identifying technology. With over 12 billion items identified in 2017, there is no other technology that has provided so much unique information about things. Members of RAIN are talking about the system that will take this information and move us forward with the information we need.

For more thoughts on the system, read
TOMORROW'S IOT FORECAST: RAIN
https://goo.gl/FwaL4N
Chris Diorio, CEO, Impinj.

REQUEST FOR HELP

If you are looking for help to implement a RAIN RFID system, use this link (https://rainrfid.org/resources/request-for-help/) and fill out the Request for Help form. The details will be sent to the RAIN members who will respond directly to you.

The **RAIN RFID** Alliance members are contacted by end-users to help solve business problems!

RAIN RFID ALLIANCE

The RAIN RFID Alliance is a global organization promoting the universal adoption of RAIN technology solutions. Currently there are over 160 members of the Alliance worldwide. Members include vendors, organizations, academics, and end-users.

WORKGROUPS
The members of the Alliance support multiple workgroups, working together to focus on specific markets or technical topics. The workgroups have monthly conference calls and meet face-to-face at the RAIN RFID Alliance meetings.

CURRENT WORKGROUPS

Aviation | Developers | Healthcare | IoT | Retail
Smart Products & Packaging | Technical

WORKGROUP MEMBERS AT A RAIN ALLIANCE MEETING.

RAIN RFID ALLIANCE MEETINGS

There are three face-to-face meetings each year – Americas, Asia and Europe. At these meetings, the workgroups work on projects, and non-membere are invited to an Open Day for presentations and discussions. During Open Day, end-user speakers describe how they use RAIN RFID and discuss their needs with the audience.

RAIN RFID ALLIANCE MEMBERS' CATEGORIES

CATEGORIES	DEFINITIONS
Tag Chip Manufacturer	Companies that manufacture semiconductor chips for RAIN RFID tags.
Inlay/Tag Manufacturer	Companies that use tag chips to manufacture inlays or industrial tags.
Tag/Inlay Antenna Manufacturer	Companies that manufacture antennas for tags and/or inlays.
Reader Chip Manufacturer	Companies that manufacture semiconductor chips used to read, write and initiate a transaction with tags.
Reader Manufacturer	Companies that manufacture readers.
Reader Antenna Manufacturer	Companies that manufacture antennas for readers.
RAIN Printer Manufacturer	Companies that manufacture printers with embedded RAIN RFID readers.
Industrial Equipment Manufacturer	Companies that manufacture industrial equipment that includes embedded RAIN RFID readers.
Independent Software Vendor (ISV)	Companies that develop and sell software separate from hardware. Software which is used for RAIN RFID solutions. Including software on readers, and/or in a network/cloud using the RAIN RFID data.
System Integrator / Solution Provider	Companies that put together a complete RAIN RFID solution, including tags, readers, antennas and software.
Consulting / Services	Individuals and companies that provide expert advice regarding RAIN RFID.
RAIN RFID Test Equipment	Companies that manufacture test equipment used for RAIN RFID technology.
Reseller / Distributor	Companies that buy and sell RAIN RFID products.
Standards Organization	Organizations which are developing, coordinating, promulgating, revising, amending, reissuing, interpreting, or otherwise producing technical standards that are intended to address the needs of RAIN RFID adopters.
Research Facility / Academic Centre	Organizations that do research and/or provide resources for RAIN RFID.
End-user	Businesses or consumers that use RAIN RFID.

CAEN RFID offers a wide range of RAIN RFID readers and temperature loggers to enable the design of outstanding RFID solutions. We are also specialized in product customization and custom product development.

www.caenrfrid.com | info@caenrfid.com

CYBRA Corporation is a leader in RFID, RTLS and barcode software products and solutions. We serve a wide range of industries including retail, apparel, distribution, healthcare, pharmaceutical, manufacturing, safety, security.

www.CYBRA.com | Info@CYBRA.com

EM's expertise, including standard and custom RFID, NFC and dual-frequency tag ICs, provides unparalleled opportunities to industries, retailers, and public sectors to connect, track, trace, and control their assets with greater security, increased productivity and cost-savings.

www.emmicroelectronic.com
rfidsupport@emmicroelectronic.com

HID Global is the partner of choice delivering contactless identification and sensing components and solution enabling cloud technologies to address the dynamic requirements across multiple industries – identify, collect and manage data across IoT applications.

hid.gl/RFID | tagsales@hidglobal.com

Impinj is a founding member of the RAIN Alliance and pioneer of RAIN RFID solutions. Impinj provides a comprehensive platform, spanning endpoints, connectivity, and software, that connects items to business and consumer applications.

www.impinj.com

We are solution enablers transforming the way we use IoT in our daily lives by connecting everyday items.
INVENGO. TRANSFORMING IOT

www.invengo.com | sales@invengo.com

Logopak

Logopak has 15 years of experience with applying RAIN RFID-Tags to products and packages. Combining field-proven solutions with our unique Know-How to put your tags in the right place. Reliably so.

www.logopak.de | lthuring@logopak.de

TADBIK

Tadbik RFID is a leading convertor of smart labels and tags for the supply chain and logistics, sports timing, healthcare and event people tracking, animal identification, NFC and other customized wristbands, labels and tags.

www.tadbik.com/RFID | michaly@tadbik.com

TIMES-7
INTELLIGENT TRACKING | SMART TECHNOLOGY

We design and manufacture fixed RAIN RFID reader antennas for all industry applications with a global distribution and support network.

www.times-7.com | sales@times-7.com

voyantic

Voyantic enables companies to utilize RFID technology to its fullest potential by offering quality control, performance testing and encoding systems, training, expertise and insights.

www.voyantic.com | sales@voyantic.com

信达物联 XINDECO IOT

China TOP 3 RFID tag designer and manufacturer with over 30 manufacturing equipment and 1.5 billion annual capacity.

www.codetagrfid.com | export@codetag.com.cn

ZEBRA

Zebra offers a complete enterprise asset intelligence portfolio - including RAIN readers, labels, antennas, services and software - enabling businesses to quickly transform data into actionable business information.

www.zebra.com | rain@zebra.com

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LIST OF
MEMBERS

LIST OF RAIN ALLIANCE MEMBERS

LINKS BELOW FOR MORE INFORMATION.

Company	Tag Chip Manufacturer	Tag/Inlay Manufacturer	Tag/Inlay Antenna Manufacturer	Reader Chip Manufacturer	Reader Manufacturer	Reader Antenna Manufacturer	RAIN RFID Printer Manufacturer	Industrial Equipment Manufacturer	Independent Software Vendor (ISV)	System Integrator / Solution Provider	Consulting / Services	RAIN RFID Test Equipment	Reseller / Distributor	Standards Organization	Research Facility / Academic Center	End-user
7iD Technologies GmbH									X	X	X					
Advanced Wireless Technology Group (AWTG)										X	X					
AdvanIDe											X		X			
Alien Technology	X	X			X	X					X					
American Barcode and RFID, Inc. (AB&R)											X		X			
Arcadian Inc./RFMAX						X							X			
AsReader, Inc.					X											
Auburn University RFID Lab															X	
Avery Dennison		X					X									
Aware Innovations										X						
AXEM Technology		X			X			X								
Axzon	X	X								X						
Beijing Hwa-Tech Information System Co.											X					
Bekaert Bekintex NV			X													
BoingTech		X														
BSN		X							X	X	X					
BW Papersystems								X								
C&A																X
CAEN RFID srl					X											
Cardinal Health										X						
CEITEC S.A.	X															
Cellotape Smart Products		X														
Checkpoint Systems		X			X					X	X					
CISC Semiconductor GmbH											X	X				
Cisper Electronics											X		X			
Clairvoyant Technology LLC															X	
Confidex		X														
Convergence Systems Limited		X			X	X					X					

Company	TAGS			READERS						SOLUTIONS						
LINKS BELOW FOR MORE INFORMATION.	Tag Chip Manufacturer	Tag/Inlay Manufacturer	Tag/Inlay Antenna Manufacturer	Reader Chip Manufacturer	Reader Manufacturer	Reader Antenna Manufacturer	RAIN RFID Printer Manufacturer	Industrial Equipment Manufacturer	Independent Software Vendor (ISV)	System Integrator / Solution Provider	Consulting / Services	RAIN RFID Test Equipment	Reseller / Distributor	Standards Organization	Research Facility / Academic Center	End-user
Crocus Nano Electronics LLC	X															
CYBRA Corporation									X	X						
Data2 Corporation		X														
DATALOGIC					X											
Decathlon																X
DENSO ADC					X											
DeRoyal										X						
Digilogics S.A. de C.V.										X						
Donald E. Ray LLC											X					
eAgile Inc		X								X						
Ecartes Technology Private Ltd.		X		X		X				X	X		X			
EM Microelectronic	X															
Enterprise Connected Solutions Group (ECSG)										X						
Fast Value Global inc.		X														
FedEx Freight																X
FEIG Electronics Inc.					X											
Fraunhofer Institute for Photonic Microsystems															X	
Fresenius Kabi										X	X					
Graphene Security Limited		X														
GS1														X		
GS1 Canada														X		
Hanmi IT										X						
HARTING		X			X	X										
HID Global		X														
Identiv, Inc.		X														
IDRO Co. Ltd.		X			X	X										
Impinj, Inc.	X			X	X	X										

	TAGS			READERS						SOLUTIONS						
LINKS BELOW FOR MORE INFORMATION.	Tag Chip Manufacturer	Tag/Inlay Manufacturer	Tag/Inlay Antenna Manufacturer	Reader Chip Manufacturer	Reader Manufacturer	Reader Antenna Manufacturer	RAIN RFID Printer Manufacturer	Industrial Equipment Manufacturer	Independent Software Vendor (ISV)	System Integrator / Solution Provider	Consulting / Services	RAIN RFID Test Equipment	Reseller / Distributor	Standards Organization	Research Facility / Academic Center	End-user
Indution										X	X					
Infratab, Inc.		X							X	X						
Innovoi Ltd											X					
Intel										X	X					
IntelliGuard										X						
International Technological University (ITU)										X	X					
Invengo		X			X	X				X	X					
ITL Group		X								X	X					
JX Instrumentation Co., Ltd.								X					X			
KAR-MIL A/S													X			
Kathrein Solutions GmbH					X	X				X	X					
Kirk-Rudy, Inc.								X								
Korea Testing Laboratory											X					
Lab ID srl		X								X	X					
Laxcen Inc.		X														
Linxens		X														
Logopak								X								
L'Oreal																X
Lyngsoe Systems Ltd										X	X					
MAXIM		X														
Metalcraft, Inc.		X														
Microelectronics Technology Inc.					X											
Mighty Cube Corporation										X						
Mojix Inc.					X											
MonsoonRF, Inc.					X			X								
Mozaiko									X	X						
Muehlbauer, Inc.								X								

LINKS BELOW FOR MORE INFORMATION.	Tag Chip Manufacturer	Tag/Inlay Manufacturer	Tag/Inlay Antenna Manufacturer	Reader Chip Manufacturer	Reader Manufacturer	Reader Antenna Manufacturer	RAIN RFID Printer Manufacturer	Industrial Equipment Manufacturer	Independent Software Vendor (ISV)	System Integrator / Solution Provider	Consulting / Services	RAIN RFID Test Equipment	Reseller / Distributor	Standards Organization	Research Facility / Academic Center	End-user
Multigate Medical Products										X						
Murata Manufacturing Co.		X														
Nedap Retail					X				X	X	X					
NedCard BV		X														
NextPoints RFID													X			
Nordic ID					X						X					
Nossamae, Inc.		X								X	X					
NXP	X															
Omni-ID		X									X					
PAL Co., Ltd.		X								X			X			
Paragon ID		X								X	X					
PDC - A Brady Business		X														
Pervasid					X					X	X					
Phoenix Solution Co., Ltd.		X														
PHYCHIPS Inc.				X												
Primo1D		X														
race result AG																X
RADAR										X	X					
RADIENTUM Oy											X				X	
RAKO Security-Label Produktscherungs GmbH		X			X					X						
RFID Global Solution, Inc.										X						
RFLocus Inc.										X						
RFRain LLC					X				X	X	X					
Rice Microelectronics Inc.	X	X														
RR Donnelley		X														
RTV Engineering, LLC										X	X					
SAG - Securitag Assembly Group Co., LTD.		X														
SAIT Poly															X	

	TAGS			READERS						SOLUTIONS						
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SAIT SRL										X	X					
SencorpWhite										X						
Sensify Holdings Limited											X					
Shanghai HUAYUAN Electronic Co., Ltd		X			X											
Silent Sensors Ltd		X								X						
SimplyRFiD										X						
Smart CellCo, Inc.											X					
Smart Label Solutions					X											
SMARTRAC		X														
SML Group Limited		X								X						
SPF-Inc											X					
ST Microelectronics International N.V.				X												
Star Systems International											X					
Stealth Matrix					X					X						
Stora Enso Oyj																X
Strato Innovations, Ltd.										X						
Symbology, Incorporated											X					
Syndicate RFID		X														
Tadbik RFID		X									X					
TAGEOS		X														
TagMaster AB					X											
Takipsan										X	X					
Technologies ROI		X														
Tele-Group Co. Shenzhen, China							X									
Temera Srl										X	X					
Terso Solutions, Inc.										X						
Teslonix Inc					X											
ThingMagic, A Jadak Brand					X											

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Times-7 Research Limited						X					X		X			
Toennjes ISI Patent Holding GmbH											X					
Trace ID		X								X	X					
Tyco International		X			X	X				X						
University of Parma - RFID Lab											X					
University of Texas at Arlington, RAID Labs (RFID & AutoID)											X					
US Department of Defense, Information Assurance Research Organization																X
VAIZVA INC									X		X					
Vilant										X						
Voyantic Ltd.											X	X				
Walki			X													
WeRain SRL		X														
Win.Win Digital Security Pte. Ltd.										X						
Winson RFID Technology		X	X										X			
Wistron NeWeb Corporation		X	X		X	X		X		X	X					
Wuxi Pinguan IOT Technology Co., Ltd.		X			X					X						
Xerafy		X														
Xiamen Innov Information Science & Technology Co. LTD (XMINNOV)		X														
Xiamen Xindeco IoT Technology Ltd. (Codetag RFID)		X														
Yeon Technologies (Yangzhou) Co. Ltd.		X			X					X	X					
Zebra Technologies		X			X	X	X									
Zhejiang Junmp Technology Inc., Ltd.		X														
Zhongguancun Industry & Information Research Institute (IDcode)											X			X	X	

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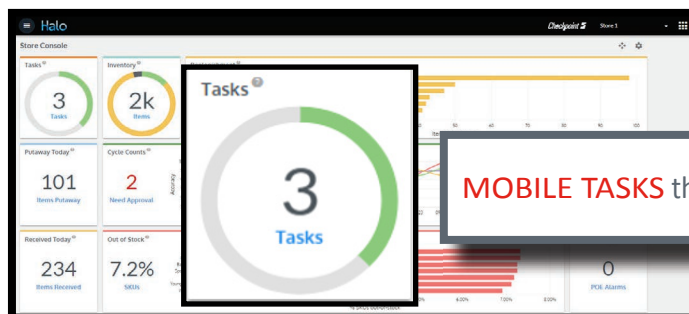
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ABOUT RAIN RFID ALLIANCE

The RAIN RFID Alliance is an organization supporting the universal adoption of RAIN RFID technology. A wireless technology that connects billions of everyday items to the internet, enabling businesses and consumers to identify, locate, authenticate and engage each item. The technology is based on the EPC Gen2 UHF RFID specification, incorporated into the ISO/IEC 18000-63 standard. For more information, visit www.RAINRFID.org. The RAIN Alliance is part of AIM, Incorporated. AIM is the trusted worldwide industry association for the automatic identification industry, providing unbiased information, educational resources and standards for nearly half a century.

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RAINRFID.org. If you are interested in learning more about the RAIN RFID Alliance, contact us at **info@rainrfid.org**.