RFID and the Supply Chain of Today

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ABSTRACT: *This research paper explores the history behind RFID and its early uses. It will go on into the current uses in warehouse operations and assets tracking and application. Finally, the research paper will also discuss theprojects possible avenues for future use in any supply chain and especially global complex ones.*
Keywords: RFID, RADAR, warehouse operations, warehouse management systems, blockchain

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I.   RFID WHAT IS IT AND THE HISTORY OF THE TECHNOLOGY:]

RFID or radio frequency identification has its origins in the 1940's where it was used to identify friendly aircraft from the enemy. In an article from RFID Journal dated January 2005, Mark Roberti indicated that the roots of radio frequency identification technology can be traced back to World War II. (Roberti,2005) The United States, Britain, Germany and Japan were all experimenting with RADAR which had been discovered by Sir Robert Watson-Watt a Scottish physicist in the late 1930's. RADAR had been applied to the problem of seeing approaching aircraft while still beyond visual range. The unfortunate problem was there was no way to identify which planes belonged to whom.

It was Germanythat discovered that if pilots rolled their aircraft as they returned to their bases, the signal would change slightly as it was bounced back to the German RADAR controllers. Roll is the counterclockwise rotation of y about the x –axis. The rotational matrix is given by …

$$R_x(\gamma) = \begin{pmatrix} 1 & 0 & 0 \\ 0 & \cos\gamma & -\sin\gamma \\ 0 & \sin\gamma & \cos\gamma \end{pmatrix}.$$

Figure 1. Rotational matrix for roll

This early method would thus allow the Germans to know who was approaching and it can be stated that this was the 1st passive RFID implementation (Lengerich, 2007, p. 3).

During the Second World War – Great Britain, under the guidance of Watson-Watt developed and tested the first identify friend or foe or IFF system. This was accomplished by placing a transmitter into each aircraft. British ground crews would send a signal to the approaching aircraft that would trigger the onboard transmitters. When the signals for the transmitters were seen by the British radar operators,they were able to seed that the approaching aircraft were theirs. Today's RFID works under this same basic concept. Today a signal is sent to a transponder that will either reflect the signal back (passive RFID) or trigger a return signal (active RFID). The system designed to identify incoming aircraft would later become instrumental in protecting business and stores from theft.

[Watson-Watt with original radar System 1931]

II.   RFID IN POST WAR YEARS

It was after the war that nations turned their minds from military uses to developing and expanding the fledgling radar and radio frequency (RF) communication systems to peaceful uses. The big advancement was that of companies' commercializing on the idea of using RFID as a theft deterrent system. RFID became the door guard and checked to see if an item had been purchased or not. This was accomplished using electronic article surveillance tags
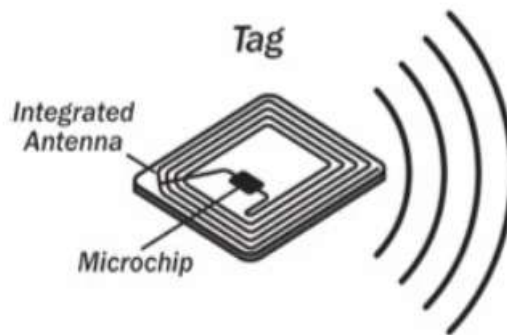
**[Passive tag used in EAS or electronic article surveillance]**

Electronic article surveillance tags or EAS using technology pioneered 60 years ago are still in use today. These are 1-bit tags, the 1 –bit is either on or off so when a person buys an article the bit is turned off allowing them to pass though the scanners located at the doors. If an article attempts to go through the scanner without being set to off – an alarm will sound.

During the computer revolution of the 1970's there were huge advancements in the science of RFID and an explosion of patents for the technology. According to RFID Journal (Roberti, 2005) Mario W Cardullolays the claim to having the very first U.S. patent for an active RFID tag with rewritable memory. Thispatentdated January 1973 shares the date of another invention by a California resident by the name of Charles Walton. Walton is attributed as the inventor of a passive transponder that was used to lock a door without the use of a key.

Walton's keyless entry method used a card with an embedded transponder to send a signal to a reader adjacent to the door. By use of the identification number within the signal the reader would unlock the door. This technology and the associated system were sold to the company Schlage Lock and other companies. This is still very much in use today and can be found throughout the world opening doors everywhere.

From the 1930s through today there has been an enormous refinement and expansion to the technology.RFID by the miniaturization of both the active and passive tag technology has found uses in everything from ladies'high-end fashion to medical and surgical uses. As time passes the uses will no doubt expand into areas that were never considered when Watson-Watt first demonstrated his invention.

III.   . RFID IN MANUFACTURING
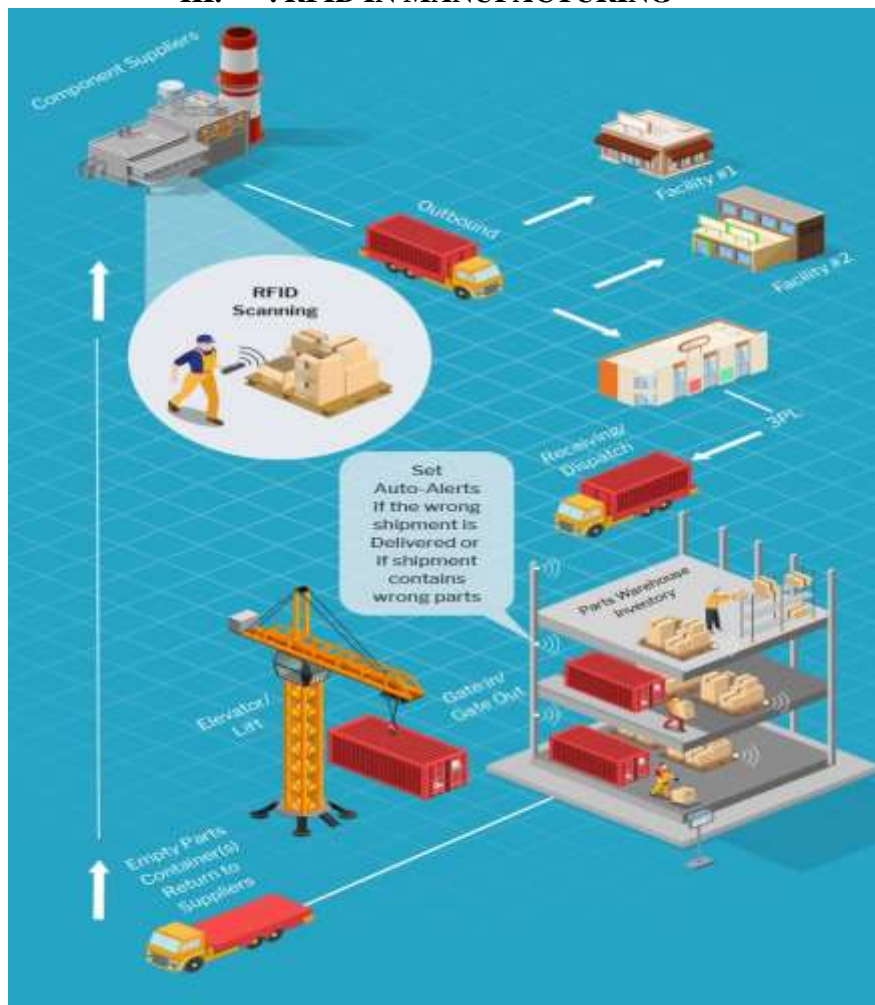
[RFID Lifecycle of operation during shipping]

Fast forward to today, RFID as stated can be found in numerous areas but in one its uses are legion. As with any technology time allows for a decrease in cost. As the cost of RFID tags and technology decreases there has been an expansion of use. Smaller companies that previously found the technology too expensive to integrate are experiencing the benefitstoday. RFID is more and more becoming the technology of choice in today's warehouse. By use of RFID technology goods and materials are tracked entering and exiting the environment.RFID belongs to a group of technologies referred to as Automatic Identification and Data Capture (AIDC). AIDC methods automatically identify objects, collect data about them, and enter those data directly into computer systems with little or no human intervention

According to the online site supplychainbrain.com "Speed and understanding are the promises of RFID in warehouses and DCs. Inventory accuracy is typically so high that warehouses can't improve much, but they can improve in the speed of process activities and understanding of each process step and each shipment: speed of inbound receiving RFID-enabled product, speed of conducting cycle counts, and speed of outbound processing. The other promise is understanding how an organization can better understand error rates, conduct root-cause analysis, and challenge chargeback rates using RFID scan data." (Wood, 2019)

The identified advantages can be seen in improvements in these areas …

1. Inbound operations: with proper adaptation and understanding, materials can be loaded into a conveyance or vehicle, pass through a reader area and the tagged items will be added to inventory in seconds. This is accomplished without the need of removing the items from the conveyance or vehicle.
2. Processing operations: with the use of RFID workers will have the ability to locate items, find lost or misplaced items and can increase the speed of quality control of packages and loads.
3. Outbound operations: utilizing RFID on outbound traffic will guarantee that errors at the package level will be captured prior to transit and delivery.
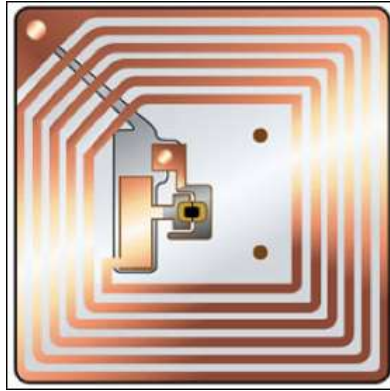
[RFID Passive Tag with antenna and microchip]

RFID is a standalone technology that has the added benefit of integrating with other current and emerging systems and tools. Blockchainwhere RFID events can trigger to development of large data sets. RFID currently works well with ERP (Enterprise Resource Planning) or current WMS (Warehouse Management System) to name two. It stands to reason that as the technology matures and prices decrease the popularity will increase. As supporting technologies are developed to assist the expanding retail and transit environment RFID will become more integrated.

IV. RFID TECHNOLOGY BEHIND THE MAGIC

RFID tag consists of an embedded transmitter and a receiver. RFID is comprised of two basic parts...
1. Integrated circuit: used for storing and processing the information.
2. Antenna: - used to transmit and receive signals.
RFID tag also has a non-volatile memory storage which includes either programmable or fixed logic for sensor data and transmission.

RFID Tags can be broken down into the following types …
1. Passive: tag remains dormant since it has no battery. It uses reader's signal energy to turn on the tag along with reflecting a signal back to the reader that carries the information.
2. Active: tag have a battery in it that transmits signals periodically. These tags have range up to 100 meters due to the presence of a battery. Due to this, active tags are useful in location tracking applications.
3. Battery Assist Passive: These tags do contain a battery, but it doesn't transmit signals periodically like that of active RFID tags.The battery is used to enhance the reflective bounce back of a signal when activated.

RFID reader

RFID reader consists of an interrogator which is basically a two-way radio transmitted receiver also known as transceiver.The prime function of transceiver is to transmit an encoded signal that activates the tag.In response the tag transponder initiates the conversion of radio signals into usable power along with responding to the reader.

V. CONCLUSIONS

RFID continues to mature as a technology and is rapidly integrating itself into numerous operations and areas. As discussed, these areas are as diverse as agriculture to ensure that the food supply is safe and correctly processed to defense applications where the weapon and solider movement is tracked. Yet possible the most importantis that of tracking goods and materials as found in supply chain and manufacturing. As the need for accuracy and time become more imperative, RFID will continue to expand and enhance the operations where it is used.

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