Non-transferable RAIN RFID tags

RAIN RFID Alliance
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1 Introduction

RAIN RFID has been used for many years to enable fast and accurate inventory of goods in retail stores, track goods in supply chains and to manage assets at universities, hospitals, and financial institutions, just to mention a few. In some applications, preventing the transfer of a tag from one asset to another is vital to maintain the integrity of the system. For example, in the case of vehicle identification for tolling applications, the RAIN RFID label on each vehicle is connected to the owner's bank account, so clearly, allowing the transfer of a label from vehicle to vehicle would open the doors to fraud, financial loss and compromising of the entire solution.

With the importance of preventing transfer of a RAIN RFID label from one vehicle windshield, or other asset, to another, RAIN RFID tag manufacturers have developed various type of tags. A so-called **tamper proof** tag will cease to read following any sort of attempt to remove it; the connection between the antenna and chip physically breaks.

A variation of tamper proof labels allows the system to still read the tag data; but show evidence of tampering, either through visual mechanisms or through changes to the IC. These **tamper evident** tags are still able to interact with the intended system whilst ensuring tags cannot be physically transferred fraudulently. Some tamper-evident tags use a tamper sensor to detect if a tag is physically being detached from its location. If desirable in the application, a portion of the chip's memory can be used to record the tamper event and make that status available for future use. Tamper-evident information can be used by the tag in several ways. Some vendors propose to let the system to 'know' if the tag has been compromised by reporting tamper status in the tag response, e.g., by reporting tamper status in the GS1 Gen2v2 standard alarm bit provided during inventory, or alternatively through a separate memory access operation. Other implementations allow for digitally lowering the read range by lowering the chips' sensitivity. Some products even allow for muting the chip reply in case of tampered tags.

Since the introduction of RAIN RFID tags with the ability to indicate tamper events, several use cases have surfaced. One example is the identification of corporate IT assets. Being able to move the RAIN identification label from your old or cheap laptop to a new more expensive one owned by a colleague should of course not be possible. Tamper tags can ensure both the identity of the assets is known and the integrity of the system can be trusted.

In this paper, several examples of use cases that are made possible using non-transferable tags are discussed. Starting with one of the original drivers for tamper proof tags, vehicle identification, then moving onto looking at some of the benefits of applying this kind of technology to aircraft life vests and shipping containers.

2 Electronic Toll Collection

Electronic Toll Collection (ETC) systems have become a common way for drivers to pay for their tolls on roadways throughout the world. These systems allow drivers to simply drive on toll roads without the need to stop to make manual payments and have become very popular for the numerous benefits for both drivers and operators. ETC systems reduce operating costs and infrastructure, including the very costly requirement for more lanes, whilst at the same time increasing speed, safety, throughput, and security.

Central to any ETC system is the ability to identify each vehicle. So-called, automatic vehicle identification (AVI) technology accurately identifies a specific unique vehicle at typical highway speeds using in-vehicle transponders.

RAIN RFID has proven itself to be reliable choice of solution providing a fast and secure method of vehicle identification. Typically, RAIN RFID AVI systems involve the transmission of an identification code between a transponder in the vehicle and a reader positioned on a gantry or roadside. The transponder, which consists of an Integrated Circuit (IC) and antenna, contains basic information, including an identification number, toll facility, vehicle type, etc. To complete tolling transactions, the roadside electronic readers emit radio frequencies via antennas to communicate with the transponders. For ETC, the vehicle identification number is linked to the customer's account from which the appropriate toll is automatically deducted, or the customer is billed.

Since the vehicle identification number contained in the RAIN RFID transponder is linked to the customer's account, it is vitally important that the security of this information is protected. The communication between the reader and the tag are typically protected using cryptographic encryption, but the protection of the tag itself is also critical. A RAIN RFID transponder in the form of a non-transferrable windshield label is the ideal solution

ensuring the tag cannot be removed and used on a different vehicle protecting both the owners account and the integrity of the system.

A popular, reliable, and cost-effective approach is something called Break-on-Removal (BOR). With a BOR tag, if removal of the RAIN RFID Windshield Label is attempted, the antenna will tear, thus severing the connection to the chip rendering the label no longer functional.

Specialized manufacturing methods are employed to achieve this BOR feature. These same methods can be leveraged to achieve tamper-proof functionality in many other applications.

3 Anti-tamper tags for life vests

"Every seat on every plane must have a life vest". This statement is assumed by passengers and is a requirement within the aviation regulations, but the amount of effort required by flight operators to ensure a fully operational life vest is present for every passenger for each and every flight over water is mammoth!

Believe it or not, vests sometimes disappear as some passengers take them as souvenirs. So, as part of the preflight checks before each flight over water, a member of the cabin crew takes responsibility for ensuring each life vest is present. But just checking that the vest is under each seat is not enough; it's essential that the seal of each vest is physically inspected to guarantee it has not been tampered with since its installation. In addition to the day-to-day operations, each life vest must be audited for safety on a regular basis, a job that can take airline ground staff significant time.

This crucial job performed before every take off adds significant time to a flight attendant's responsibilities; and in critical situations, can be on the critical path impacting short turnarounds. Missing a take-off slot can result in significant cost to an airline.

There is, however, a better way to manage all these life vests. By attaching a RAIN RFID tag to each life vest or pouch the whole counting exercise can be reduced to simply walking up and down the aisle with a handheld RAIN reading device. But not only this; by using anti-tamper tags, the integrity of the life vest seal can also be established without a physical check. Each tag contains a chip that includes a tamper loop; once the physical loop is broken, an indicator bit changes within the silicon. When the tag is read next time, the tag's ID number is returned along with the status of the tamper loop.

In practice, this means that if a life vest's seal has been broken, during the inventory process the status of the seal integrity will be transmitted and displayed to the operator without the need for any further action or investigative work. This innovative use of RAIN RFID allows the operator to know exactly which life vest needs attention and is only possible by using the tamper loop feature available on some RAIN RFID ICs.

So, this process is easy for the operators, it's significantly faster and it's less error prone. It also has the benefits of being completely digital so there is no need for paperwork, therefore, the audit trail can be automatically recorded proving the security of every life vest.

But, ultimately, using anti-tamper RAIN RFID technology allows airlines to ensure a safe life vest is present for every passenger.

4 Shipping containers

While the container shipping industry is poised to show steady single-digit CAGR over the coming years, its operating margins have been heavily challenged. Market commoditization, increasing taxes, competition by rail and excess capacity have resulted in difficult operational conditions. With the backdrop of this difficult operating environment companies have turned to RAIN RFID technology to help reduce operating costs, improve service performance and help deter theft.

Indeed, RAIN RFID has become the technology of choice for supply chain management and track and trace applications. Applying RAIN RFID tags to containers enables exact knowledge of on-boarding and off-boarding of containers, enabling logistics companies to have real-time knowledge of the whereabouts of each of their containers and its cargo. This results in a direct reduction of misrouting incidents resulting in associated charges and possibly perished goods while at the same time improving customer experience and satisfaction. While the former result in reduced operations costs, the latter allow for long-term customer loyalty and potentially higher shipping fees. Adding seals encompassing RAIN RFID tags with some form of tamper proofing or that show evidence of tampering can help deter theft and guarantee the authenticity of the cargo in each container.

Shipping containers are typically sealed using bolt seals. Such bolts undergo a visual inspection during unloading and loading as well occasional spot checks; this demands the person checking is in close proximity. Traditional bolt seals are sometimes subject to being re-sealed and are relatively easy to counterfeit; therefore, they require even more detailed checks. In case of a suspect seal, a manual cargo inspection may be triggered, resulting in a significant amount of human labor and law enforcement services.

Operations such as those described can only be performed whilst the container is on the ground, not during handling or enroute. Of course, all of these activities are labor-intensive, expensive and slow; limiting the port throughput.

The use of non-transferrable electronic seals (e-seals) can solve all of these issues. Such e-seals utilize the RAIN RFID chip to detect and store the status of the seal enabling fast and efficient tamper detection through the fully passive RAIN RFID tags. The energy required for interrogating the chip for the status of the seal is directly harvested from the RAIN RFID reader field, resulting in zero-maintenance tags. e-seals are robust against re-sealing and counterfeits, significantly improving tamper resistance. Thanks to the long

read-range of RAIN RFID tags, interrogation can be done during handling; for example, using a RAIN RFID equipped crane. Identification and seal status can also be automatically determined during inbound and outbound activities of trucks and rail freight, all enabling dynamic visualization of container locations. This results in automated and centralized end-to-end track & trace information, virtually eliminating the risk of misleading or misrouting of containers.

RAIN RFID e-seals bring a significant number of benefits to the container shipping industry. The technology enables significantly increased automation in terms of anti-counterfeiting, anti-theft, and traceability which leads to an overall improvement in port operations with increased customer and staff satisfaction and, crucially, an overall reduction in processing delays.

5 Summary

RAIN RFID has enabled many use cases over the course of its rich history, improving accuracy, speed, and authenticity in a variety of activities that were previously considered impossible or were prone to error. The introduction of non-transferable tags has provided RAIN RFID solution designers the ability to protect system integrity. Mechanisms range from the *tamper proof* tags that physically break if an attempt to remove the tag is made to *tamper evident* tags where the tag chip can be used to communicate the status of tag allowing a complete flexibility.

Used within the appropriate solution, non-transferable tags can enable new use cases and give confidence to all stakeholders within a systems ecosystem of a tag's status. This paper has discussed several use cases demonstrating the benefits of non-transferable RAIN RFID tags, many of which would not be possible without this innovative technology.

ABOUT RAIN RFID ALLIANCE

The RAIN RFID Alliance is an organization supporting the universal adoption of RAIN UHF 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.

Join the RAIN RFID Alliance to enable connectivity for your business and consumers: identify, locate, authenticate, and engage items in our everyday world. For more information, visit www.RAINRFID.org.

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