CAIRO UNIVERSITY
INSTITUTE OF STATISTICAL STUDIES
AND RESEARCHES, CAIRO UNIVERSITY
EGYPT

Using Radio Frequency Identification for Storage Optimizing based on Objects Distance

By

Ahmed Adel

Under The Supervision of

Dr. Mervat Gheith
Computer Science Department
Institute of Statistical Studies and Researches
Cairo University

Dr. Mostafa Ezzat
Computer Science Department
Institute of Statistical Studies and Researches
Cairo University

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Abstract

Controllership Department of ASEC El-Minya Cement Company needs to locate the items/spare parts in the warehouse right on time to conduct many operations, such as counting, handling and monitoring through retrieving required and available information from the real world to save time, cost and effort. In addition, it can help preventing fake stocking process to improve general logistics. UHF passive RFID solution is suitable for ASEC El-Minya cement Company and is designed according to the specification of the spare parts warehouse and company needs. We have designed a software program able to determine the tagged object's location by using fixed RFID antennas connect with the reader by using radio waves that can read item information and then automatically interfaces with the warehouse inventory software system to update the appropriate databases. This would have tremendous benefits in terms of tracking and identify a product, making ubiquitous identification possible. The outcomes relate emphatically to the readability of the tagged items in genuine practice. Thus, this methodology serves as a solution to the problem of item tracking with the use of RFID tags in the warehouse.

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Abbreviations

Auto-ID	Automatic Identification
BAP	Battery-Assisted Passive
EAS	electronic article surveillance
EPC	Electronic Product Code
HF	High-frequency
IC	Integrated Circuit
NVM	non-volatile memory
RFID	radio frequency identification
UHF	Ultra High Frequency
UID	unusual identity
UPC	Universal Product Code
LF	Low-frequency

Chapter 1: Introduction

1.1. Introduction:

Automatic identification of objects by systems enables the operation of warehouse management, makes it more efficient and reduces the cost. Many of technologies such bar codes, smart cards, voice recognition, biometric technologies, optical character recognition and radio frequency identification called as Automatic Identification (Auto-ID). Barcodes have been the primary means of identifying products for a long time. RFID offers many compelling advantages over barcodes, including non-line-of-sight operation, minimizing human interference, and faster identification [87]. Customary bar-coding technology has an essential limitation: each barcoded item must be scanned one by one, consequently restricting the checking speed. Additional expenses are incurred through the use of manual labor or automating the scanning process. What's more, when the scanning is manually executed, there is the added probability of human blunder. As a result of these constraints, RFID technology has been making advances in AIDC applications [39]. RFID offers more noteworthy adaptability, higher information stockpiling limits, expanded information gathering throughput, and more noteworthy instantaneousness and exactness of information accumulation [39]. Some of the worldwide giant organization like Food and Drug Administration has started employing RFID vastly [95] [96]. This has caused RFID to become vital to an outsized range of individuals who were unaware with the technology.

RFID allows objects to be unambiguously known while not the necessity for line of sight [97]. Employing RFID and computers will sense objects and collect the info related to objects. RFID can enable firms to trace and trace individual things. Which means an item can be traced all the time. Thus the companies will be able to know exactly where every item in their warehouse is at any moment of time. Basically, RFID is uprising the way items are tracked and traced within the warehouse. The RFID technology improved precision and security make it a perfect data gathering platform for an assortment of business sectors and applications, including medicinal services, pharmaceutical, manufacturing, warehousing, logistics, shipping and retail [39].

ASEC El-Minya Cement Company approves to implement a tracking system to produce active control for their warehouse spare parts. This system is not only including items tracking, monitoring but also combined with a control system through a continuous update of quantities. An RFID stock tracking system is designed to help ASEC El-Minya Cement Company to locate the items for handling and monitoring the stock by retrieving useful and available information from the real world for time-saving, cost-effective manner. In addition, it can help preventing fake stocking process to improve general logistics. Thus the solution additionally permits the user to simply verify the item.

UHF (Ultra high frequency) passive RFID solution is suitable for ASEC El-Minya Cement Company by design RFID system according to the specification of the spare parts warehouse and company needs. We have divided the warehouse into some sub-areas; choose appropriate geometry parameters that make the antennas easier to discover the tags. Then, applying the (Ultra High Frequency) UHF technique between each transmitter and receiver in each sub-area. The object tracking system makes it potential to mechanically monitor the position of stored objects and process standing on a real-time at a comparatively low price in the warehouse environment. The RFID system employs electromagnetic field to show or gets back information from the tags or cards when they are close to a certain range. Each tag is used to reference any type of unique information on it such as person's full information.

Our work able to determine the item location by using distributed RFID tags, distributed group of antennas connected with a reader and an applicable algorithm (our Application).

1.2. Problem definition:

Asec El Minya Cement Company needs to identify, locate and trace the spare parts easily as well as updating the quantities by capturing real-time data to carry out the stocktaking fairly, that finally leads to the preservation of the resources of the company. We have gotten numerous protests during the yearly inventory, for example, the area of the selected spare part which the stock activity is performed on it is obscure and its actual quantity isn't matching. Thus, the item location must be discovered by guessing and relying on memory and the quantity must be counted by the traditional and manual way which consumes more effort and time. So our main goal was to solve the problems of searching and tracing the spare parts, and to solve the problems of space and time control. GPS seems to be the fine strategy to develop outside place systems, however the overall performance of these systems isn't accurate sufficient to find items within indoor environments, mainly if accuracy and precision are required [98]. So we have utilized the modest and solid innovation as RFID to develop a passive RFID-based indoor location system that can precisely find self-governing entities, like spare parts. This system is applied to solve the spare parts tracking problem through stick passive RFID tag on every item in a warehouse, cover the entire warehouse with fixed antennas and share over an RFID network. The objective of the thesis was to examine the present state of warehouse and to create guidelines for improving stock tracking process. The best practices include, for instance, RFID solution, tracking and control systems, stock-taking methods and an efficient warehouse. This thesis focuses on factors that affect stock exactness and on the conceivable outcomes of enhancing warehousing tasks.

1.3. Motivation:

ASEC El-Minya Cement has many problems in the annual stock-taking confined to the consumption of a large amount of time in stock-taking of the spare parts and traces their locations, especially if the location was changed unintentionally or intentionally. Using RFID, proposed inventory system can track and collect the data associated with spare parts. RFID system will enable the company to track and trace individual items inside the warehouse if used in conjunction with the associated infrastructure. Thus, our goal is to provide the visibility and transparency for stock-taking staff.

1.4. Objectives:

The main objective of stock-tacking processes to have the necessary inventory items at the right time, at the right quantity, and at the right place. Since not all inventory items are of high value, tight tracking of them may not be desired. On the other hand, critical inventory items may require a tighter control. Due to the variety of items in a typical environment, inventory items can be categorized into different classes according to its importance and price value, since monitoring of all inventory objects may not be economically feasible. while carried out well, radio frequency identification (RFID) technology can provide item-degree visibility wherein digital tags programmed with unique identity information are attached to “objects” that need to be monitored, tracked, or identified easily when needed.

1.5. Thesis Organization:

The thesis gives a complete description on expected performance evaluation aspects for the proposed system. The design and development of the algorithm and the results on different products are shown. More specifically, Chapter (2) discusses basic components of RFID system giving the history and classification of the RFID system. It also offers an in depth description of numerous components of RFID system. Chapter (3) offers with the benefits and disadvantages of the RFID system. It illustrates the previous and related works. Chapter (4) talks about challenges and opportunities. Chapter (5) discusses the technology used, the problems, system integrity, system building and finally the proposed model. Chapter (6) analyses the data collected from our experiment and summarizes the contribution of this work and also presents direction for the future work.

Chapter 2: Basic Components of RFID System

2.1. Introduction:

The application of Auto-ID technology provides enterprises with significant gains in their operational efficiencies by enabling an unprecedented real-time view of their assets and inventories. Auto-ID technology has applications in any industry that can benefit from better objects tracking, tracing, and management. Radio Frequency identification is one of the oldest, yet not widely used, technologies onboard as far as automatic data capture technologies are concerned. RFID is utilized to characterize the systems which could transmit and get hold of the ID of an object wirelessly utilizing Radio waves. The maximum not unusual identity method to save a serial number is referred to as electronic Product Code that identifies the item on a microchip. This microchip is attached to an antenna and together the structure formed is call and an RFID tag. The reader reads the content of the microchip using Radio wave communication. Thus, the stored number on the tag forms the basis of identification technology. This number is attached to the backend information system which does the required processing on the data attached to the identification number.

Enterprise worries concerning RFID can broadly be labeled into security and privacy. Protection troubles address legitimate readers getting facts from illegitimate tags, while privacy problems deal with illegitimate readers getting information from legitimate tags.

In this thesis, a stocktaking of sensitive spare parts using RFID system is presented using simulation. A usage of the suggested model is exhibited in a simulation surrounding, which shows the advantages and viability of RFID technologies in giving a low-cost solution, diminished blunder levels, and lower general waste.

2.2. Basic Components of RFID System:

A common RFID reader is a microcontroller-based radio transceiver that powers an RFID label utilizing the time-differing electromagnetic fields produced from an RFID antenna. Once an RFID tag is powered, it can receive commands from an RFID reader. An RFID tag is made out of two fundamental parts: an antenna and a PC chip. The PC chip is utilized to store information while the antenna permits data communication between an RFID tag and an RFID reader through a wireless signal transmission. Every RFID tag has unusual identity (UID), which may be used to uniquely identify an RFID tagged object. The gathered RFID data information by an RFID reader can be exchanged to a host PC as a database for information preparing and capacity. Thus, the hardware of the proposed RFID-based stocktaking management system consists of the following key elements:

1) RFID Readers

2) RFID tags

3) A host computer

Two types of RFID tags (active and passive RFID tags) can be used depending on a range of RFID reading performance [93].

RFID tags are delegated either inactive or active. Inactive tags don't have an incorporated power source and are controlled by the signal conveyed by the RFID reader. Active tags have an internal power source, and their functioning may be related to a beacon. Because of the implicit battery, active tags can work at a higher range and at higher data rates in return for constrained life driven by the lifespan of the internal battery and higher expenses. For a lower cost of execution, passive tags are a more beautiful solution [39].

The RFID tag contains a combined circuit (IC) inserted in a light layer medium. Information saved in the memory of the RFID tag is sent by the aerial circuit installed in the RFID inlay by means of radio wavelengths, to an RFID reader. The execution properties of the RFID tag will then be managed by factors, for example, the kind of IC utilized, the read/write ability, the radio frequency, control settings, circumstances, and so on [39].

The information saved in an RFID tag is characterized by its read/write features. For a read-only tag, the information saved necessity be inserted during the manufacturing process and can't be typically adjusted or deleted. The data saved regularly represents an individual serial number which is employed as a source to look up more aspects of an appropriate object in a host system database. Read-only tags are accordingly helpful for distinguishing an object, much like the “tag” of a vehicle [39].

For a read/write tag, information can be documentary and deleted on request for the purpose of utilization. Since a rewritable tag can be updated several times, its reusability can help to decrease the number of tags that should be acquired and add higher adaptability and knowledge to the application. Furthermore, information can be included as the item moves through the supply chain, giving better traceability and refreshed data. Ahead advantages also add locking, encryption and crippling the RFID tag [39].

RFID systems are produced to work at various selected wavelengths, contingent upon the application specifications and limited radio-frequency regulations [39]:

- Low Frequency (125 kHz): Low-frequency tags are ordinarily utilized for pass control and security, producing processes, severe environments, and creature identification applications in an assortment of businesses which require short read ranges. The low-frequency range is the most versatile to high metal substance environments, despite the fact that with some loss of execution. Read ranges are commonly several inches to few feet [39].

- High Frequency (13.56MHz): High-frequency labels were made as an economical-cost, little profile alternative to low-frequency RFID labels with the capacity to be printed or embedded in substrates, for the case, paper. Traditional applications incorporate library tracking and identification, healthcare patient ID, gets to control, clothes identification, item-level tracking, and so forth. Metal presents impedance issues and requires unique contemplations for mounting. So also to the low-frequency innovation, these tags have a reading scope of up to few feet [39].
- Ultra High Frequency (860-960 MHz): UHF tags have more noteworthy read distances and excellent anti-collision abilities, expanding the capacity to recognize a bigger number of tags in the area at a given time. The main application imagined for UHF tags is supply chain tracking. The capacity to recognize great numbers of objects as they are moving through an office and later through the supply chain, has a large chance for ROI in retail, for example, reduction of spent dollars in inventory, lost deals incomes due to out of stock inventory, and the disposal of the human factor required today for successful barcode information collection. There are big numbers of extra markets with interest for UHF RFID innovation, for example, transport, social insurance, aviation, and so forth [39].
- Microwave (2.45 GHz): Microwave tags are usually applied as a part of active RFID frameworks. Giving long range area and high information exchange speeds at an essentially higher cost per tag making them fitting for railroad auto tracking, container tracking, and mechanized toll gathering type applications as a reusable resource [39].

2.3. RFID power:

Numerous different developments guarantee an exciting development in RFID's close term deployment:

- Many suppliers have as of late started inserting RFID tags in boxes and pallets of customer goods sent to Wal-Mart and the US Military to make products scan-able via automatic inventory-control systems [6].
- Inside a couple of years, RFID tags will be inserted in vehicle tires to enable exact tire tracking in case of a recall. This tracking ability was mandated in the November 2000 Transportation Recall Enhancement Accountability and Documentation (TREAD) Act, go in the wake of the Firestone/ Ford scandal [6].
- Zebra Technologies, one of the world's pioneers in the label and standardized tag printing, has created a "print engine" that can implant an RFID transponder specifically into an item label [3].
- Hitachi has created 0.4mm-square RFID tag called the "_-chip" planned to be inserted into printer paper to empower automatic report following [4].

2.4. Benefits:

The essential advantages of RFID technology over standard scanner tag (barcode identification) are [39]:

- Information put away on the tag can be refreshed on request.
- Large data storage capacity (up to 4k bits).
- High read rates.
- Ability to collect data from multiple tags at a time.
- Information collection without need to line of sight.
- Longer read scope.

- Extra reliability in inflexible environments.
- More prominent precision in information recovery and decreased blunder rate.

2.5. Caveats:

Describe the challenges involved in simultaneously protecting the privacy of users and supporting the many beneficial functions of RFID. In particular, we suggest straightforward approaches like “killing” and encryption.

2.5.1. RFID Cost:

On account that RFID tags need to be connected to every product, it's far highly-priced to installation RFID if the RFID tags are costly. The primary caveat of RFID is the cost of the bodily RFID tag. A standard barcode tag charges approximately $zero.02, though an RFID tag label can costs upwards of $0.25 or more relying on quantity. The initial execution costs for RFID are additionally higher, contingent on prerequisites and material specifications [39].

Although first RFID execution may as of now cost more, the cost will step by step drop to a focused level in the following years as organizations embrace the technology. In the meantime, organizations that can employ the important benefits of RFID today reach to gain important benefits over their rivals slower to use RFID. Early adopters can plainly profit by cost reserve funds and elusive long-term competitive advantages which exceed the cost of the RFID implementation [39].

2.5.2. RFID privacy and security risks:

RFID technology postures unprecedented security and security concerns since individuals can't identify the RF radiation utilized to scan labels and the labels themselves commonly have no history of past readings. Subsequently, labels are befuddled: they can be scrutinized by substances other than their proprietors and without their proprietors’ mindfulness. Moreover, both tags and readers can be secretly implanted in the environment; short-range readers can be sufficiently small to fit into a cell phone [5].

Most individual privacy dangers emerge from the way that tags with unique IDs can be effectively connected with a person's identity [6].

2.5.2.1. Preference Threat:

A tag interestingly distinguishes the manufacture, the product type and the object's unique identity. This demonstrates the consumer preferences requiring little to no effort. In the event that the attacker can without much of a stretch decide the item's financial value, this risk can turn into an esteem danger [6].

With the EPC network, the tag on an item uniquely recognizes the producer, the product type, and the item's unique identity. This uncovered generally inaccessible customer inclinations to competitive powers at low minimal cost. This is likewise a value threat if the attacker can without much of a stretch decide the item's financial value. A typical case of this risk is a robber who targets victims in view of their preferences (for example, for high-value RFID-containing observes instead of low-cost ones) [6].

2.5.2.2. Corporate espionage threat:

Tagged objects in the supply chain make it simpler for competitors to remotely collect supply chain information, which is some of the industry's most secret information. For instance, a specialist could buy a competitor's products from a few areas, and afterward, monitor the locations' replenishment dynamics. In a few situations, they could read tags in a store or even as the stock is emptied. Because tagged objects are extraordinarily numbered, it's accessible for adversaries to unobtrusively collect large amounts of information [6].

2.5.2.3. Competitive marketing threat*:*

Tagged objects make it accessible for contenders to obtain an unauthorized way to consumer preferences and use the data in competitive marketing situations [6].

2.5.2.4. Location threat:

Placing secret readers at particular areas makes two sorts of privacy threats. First, people conveying remarkable tags can be observed and their location uncovered if the checking organization knows the tags related to those people. Second, a tagged object's location-regardless of who (or what) is carrying it is conveying to unapproved disclosure [7].

2.5.3. Security precautions:

2.5.3.1. Authentication:

When Authentication is done, the character of a man or a program is checked. At that point, on that premise, authorization happens, i.e. rights, for example, the privilege of access to information, are allowed. In the case of RFID systems (frameworks), it is especially essential for tags to be authenticated by the reader and the other way around. What's more, readers should likewise authenticate (verify) themselves to the backend, however, for this situation, there are no RFID-specific security problems [32].

2.5.3.1.1. Checking the Identity of the tag:

When the RFID system recognizes a tag, it must check its identity to make sure if the tag has the privilege to be part of the system at all. A worldwide and clear rule for issuing ID numbers, as proposed, for instance, as the Electronic Product Code (EPC), offers a specific protection from fake labels. At the very least, the presence of numbers that were never issued or of duplicates (cloning) can be perceived in specific applications [32].

Furthermore, authentication may occur by the challenge-response system, in which the reader sends an arbitrary number to the tag (challenge) which the label returns in encoded shape to the reader response (reaction).

The key utilized in this case is a mutually known secret by methods for which the tag demonstrates its identity.

The conclusive point in this strategy is that the key is never transmitted and that an alternate random number is utilized for each challenge.

Accordingly, the reader can't be misled by the correspondence being recorded and replayed (replay attack). This unilateral authentication procedure is defined as a "symmetric-key two-pass unilateral authentication protocol" in ISO Standard 9798 [32].

An attacker would need to get hold of the key which is kept both on the tag and in the backend of the RFID system. To do that, it is important to decode the reaction information that was transmitted in encoded (encrypted) frame, which is a complicated if not impossible task, contingent upon the length of the key.

On a fundamental level, the key could likewise be perused by physical means from the capacity cells of the chip; however, this would require exceptionally muddled research facility strategies, for example, the "Engaged Ion Beam" (FIB) strategy. In this method, a particle bar expels thin layers (a couple of layers of atoms) in discrete advances with the goal that the substance can be examined minutely [32].

A challenge-response method can likewise be utilized for the correlative authentication of reader and tag. For this situation, the tag is supposed to be able to generate random numbers [32].

2.5.3.1.2. Checking the Identity of the reader:

The easiest technique for verifying the reader in connection with the tag is to utilize password protection, i.e. the reader distinguishes itself to the tag by transmitting the password. The transponder contrasts this password with the password kept in memory. If they are indistinguishable, the label allows full access to the stored information. Some products concede password protection for particular areas of memory [32].

In basic systems, all tags contain a similar secret word in a secured area of their memories. In more complex read-only systems each transponder is assigned an individual password word by the producer, which is then kept in its memory by methods for a laser. Variable passwords are able to provide better protection, yet they just work with read-write transponders. The length of a normal password would be 8, 24 or 32 bits [32].

Password systems without encryption are considered as a feeble technique for distinguishing proof since they permit eavesdropping on password transmission by means of an insecure air interface. Likewise, short passwords can be cracked simply by systematic trial-and-error [32].

Password systems without encryption may be satisfactory in situations where the tag is addressed just once or where the risk of a password being found by spying is low. If access is required just a limited number of times, a rundown of once-only passwords are kept in the transponder and in the back-end can likewise be utilized rather than a solitary secret password [32].

Contrary to cryptographic methodology, such password systems make few requests on the tags and can be executed with simple read-only tags [32].

Enhanced security against unapproved readouts is accomplished by the hash-lock procedure. For this situation, before a tag is composed of interestingly, an alleged Meta ID is created from a key as an alias the tag. This is finished with the guide of a hash function, the count of which is basically irreversible, and the Meta ID is kept in the tag. From that minute on the tag is locked, in other words, it responds to the signs of a reader exclusively by transmitting the Meta ID. To open the tag, the reader must recover from a backend database the key that belongs to the meta-ID and after that transmit it to the tag. The tag applies the hash function to the key it has gotten and checks whether the outcome is indistinguishable with its Meta ID. In that case, the reader is authenticated and the tag permits get right of entry to its records [32].

It would be practically not possible for an attacker to check (calculate) returned to the first key. Therefore, numerous practical utilization territories a Meta ID are adequate security against unapproved readout.

Nevertheless, during transmission by means of the air interface, the secret key belonging to Meta ID can be spied out by an attacker who can later trick the tag into recognizing a reader as approved (replay attack). The hash method can be executed for transponders even without utilizing complex crypto processors [18], so this system can be utilized for economical transponders.

Most extreme protection against unapproved access to the tags is provided by authentication methods with encryption according to the challenge-response principle (strong cryptographic procedures) said above. Yet, these techniques assumed that the tag can't execute cryptographic algorithms as well as produce irregular (random) numbers. On account of tags which fulfill these prerequisites and can therefore check the approval of the reader at a high security level, it is not advantageous to make compromises when the reverse problem issue happens (authentication of the tag to the reader), because the processing limit of the reader or of the backend does not constitute a bottleneck. Thus, on account of high-performance transponders strong mutual authentication procedures are fitting [32].

2.5.3.1.3. Strong mutual authentication:

ISO Standard 9798 characterizes different challenge-response procedures for solid confirmation on account of contact smart cards and RFID systems, including common verification as indicated by the “three-pass mutual authentication protocol” [32].

At the point when a tag receives a "get challenge" order from a reader, it produces an arbitrary number A and sends it to the reader. The reader thusly creates an arbitrary number B and with it and the random number A generates an encrypted data block (token T) on the premise of an encryption algorithm and a secret key K. The data block is then come back to the tag. Since the two sides utilize a similar encryption algorithm and since the key K is kept on the tag, the tag is able to fit for decrypting the token T.

When the original random number A and the random number A’, which has now been decrypted, are identical, this assures the authenticity of the reader. The system is currently rehashed keeping in mind the end goal to confirm and authenticate the tag, the system repeats the procedures.

For this situation, a second token S is produced in the tag and is transmitted to the reader If the decrypted random numbers B and B’ are identical (indistinguishable then the authenticity of the tag via the reader has moreover been established [32].

In this procedure, no secret keys are ever transmitted via the insecure air interface. Rather just encoded random numbers are utilized, which gives a high level of high degree of protection against unauthorized access. Nor can recording and along these lines replaying the initializing sequence (replay attack) access the tag or the reader [32].

Aside from the authentication techniques in view of symmetrical cryptography, which are presented here, procedures based on asymmetrical cryptography are additionally possible for use inside RFID frameworks [32].

2.5.3.2. Encryption:

Encryption of the data being transmitted is one strategy for protecting against anybody spying on correspondence by means of the air interface. Encryption is firmly connected with confirmation. When a transponder is designed for solid cryptographic procedures, solid mutual authentication, as well as secure encryption of the information that is subsequently transmitted, can be completed. Specifically, the three-pass authentication procedure presented above can be utilized to create a joint impermanent key (session key) from the random numbers of the initialization sequence to encrypt the data which will, therefore, be transmitted [32].

Assuming, however, the transponder does not bolster strong cryptographic strategies, just frail authentication conceivable. For similar reasons, reliable encryption of subsequently transmitted information is then not possible either [32].

The best defensive measure against an attack including eavesdropping at the air interface is, nonetheless, not to store any contents on the tag itself and rather to read only the ID of the tag. The data related to the tag are retrieved from a backend database. This measure, which is frequently suggested in the technical literature and which is accepted by EPC global, offers the extra merits that more affordable tags can be utilized, the memory for the related information in the backend is essentially boundless, and the typical procedures for information management and IT security can be utilized [32].

The issue of securing the air interface against eavesdropping is subsequently constrained to the authentication procedure and the transmitting of the ID number. The authentication issue is fathomed by applying the authentication procedures, and eavesdropping to get the ID does not constitute a threat in numerous applications, for instance in a production process.

In the case of widespread applications, however, eavesdropping on the ID may debilitate the area privacy of the people carrying tagged things and may in this way raise information protection issues. In such circumstances countermeasures, for example, eavesdropping-proof anti-collision protocols and pseudonym zing of the tags could offer a solution [32].

For applications where significant contents must be kept on the tags themselves, just solid encryption systems can give dependable protection against eavesdropping [32].

2.5.3.3. Anti-collision protocols those are safe from eavesdropping:

With anti-collision protocols in light of a binary tree search, the ID numbers of the tags can be concluded from the signs of the reader, even from a considerable distance [8]. Consequently, other options to the tree-taking procedure process had been proposed which could block the extraction of identification numbers via eavesdropping on the downlink (data transmission from reader to tag).

Neither of the measures specified has any effect on the potential outcomes that exist for getting ID numbers through eavesdropping on the uplink (data transmission from tag to reader). Their value is gotten from the fact that, as a result of the low transmitting energy of the detached transponder and in view of the superimposition of the solid signs from the reader, the uplink can regularly just be monitored at a shorter distance than the downlink.

However, this assessment is called into query with the aid of extra latest investigations performed with the aid of the BSI, at least for inductively coupled transponders within the 13.56 MHz range [9].

2.5.3.3.1. Silent tree-walking:

His modification of the tree-walking procedure was recommended by Weis et al. [10]. Instead of effectively "calling out" in clear text the following branch in the binary tree, the reader simply transmits to the tags in the reading field the demand for them to transmit the next bits of their ID number. The reader interrogates the areas of corresponding bit sequences of all tags in dropping orders until the point that a crash happens at the point I. At this point, the reader branches off the question of the sub-trees by methods for a SELECT summon. At that point, as opposed to ordinary tree walking, it is not the whole definitely known section of the address space that is transmitted, but instead, an XOR value is made up of the current bit at the point I together with the previous bit. The tags shape an XOR value out of this specific value and their own bit and contrast the results and the following digit of their ID number. In case that there is a match, they are chosen and transmit the next bit. An attacker working from a distance, who can just eavesdrop on the downlink from the reader to the tag, does not discover the complete ID number. Those zones of the ID numbers where no crash happens stay covered up to him so that the attacker cannot find out the selected sub-tree, nor can he, by reversing the XOR function, learn the bit values transmitted by the reader [32].

Rather than typical tree walking, this strategy can't be implemented with read-only tags, in light of the fact that a dynamic memory is required. This makes silent tree-walking more costly than basic tree-walking.

2.5.3.3.*2*. Aloha procedure with temporary IDs:

The determinations of the Auto-ID Center for Class 0 tags contain an alternative procedure to tree walking in which the ID numbers of the tags are not transmitted on the forward channel (downlink), which is subject to eavesdropping [11]: Instead of distinguishing themselves with their ID numbers, the tags at first recognize themselves with random number which is recently created in each reading cycle and serves as an ID number. The reader utilizes this number to mute a recognized tag independently.

When all the tags in the reading field have been recognized, their real ID numbers are questioned by transmitting temporary ID. With this procedure, an attacker eavesdropping on the downlink can recognize the random numbers utilized for temporary identification. As condition that must be achieved before this procedure, tags have to have a random variety digit generator and furthermore possess a characteristic for being muted [32].

2.5.3.4. Pseudonymization:

Pseudonymization can veil the personality of a tag with the goal that exclusively authorized readers can discover the "genuine" identity of the tag. The hash-lock procedure depicted above depends on pseudonyms (Meta IDs) being assigned. Nonetheless, since a tag retains the same Meta ID over its whole lifetime, this system does not offer any insurance against the tracking of tags. The hash-lock procedure would thus be able to add to the security of information (data privacy) protection but it does not help to improve location privacy. Therefore numerous extensions of the hash-lock procedure have been recommended [32].

2.5.3.4.1. Randomized hash-lock:

This procedure, proposed by Weis et al. [10], depends on the dynamic generation of a new Meta ID every time a readout event happens. For this reason, at each initiation, the tag creates a random number r which is hashed with the genuine ID number of the tag. The random digit and the hash Val are sent to the reader via the tag. To calculate the genuine ID number of the tag, the operator of the reader must know (recognize) all ID numbers belonging to the application in question.

The reader or its server now generates the hash values of all known ID numbers, using the random number generated by the tag, until a corresponding hash value is found. By then the ID number of the tag has been discovered [32].
In case of having a large number of tags, this procedure is not really practicable. In spite of these impediments, it is of enthusiasm for use with an RFID system since it can be implemented (actualize) with insignificant cost. Anyways, it supposes that the tags have a random digit generator [32].

2.5.3.4.2. Chained Hashes:

Ohkubo et al. [12] suggest the chained hash procedure as a cryptographically vigorous option. At every activation the tag computes a new Meta ID, utilizing two diverse hash functions. First, the current Meta ID is hashed in order to generate a new Meta ID which is then hashed again with the help of the second function. It is this second Meta ID that is transmitted to the reader to decode, the reader must hash until a match with the Meta ID transmitted from the tag has been found. The benefit of this procedure is that it is not sensitive to repeated attempts to spy out the Meta ID amid transmission through the air interface. An attacker would not have the capacity to back-calculate the Meta IDs that have been spied out, with the result that the anonymity of all preceding database entries (log entries) of the tag in question is preserved [32].

2.5.3.4.3. Procedure by Henrici and Müller:

Henrici and Müller [13] propose a strategy which makes conceivable the mutual authentication of tag and reader, and encryption of communication, and which additionally guarantees the protection of "location privacy". Also, no keys or other useful information are put away for any time span on a tag, in this way making physical attacks on the chip hardware uninteresting. The method gets by with a minimum exchange of information and is additionally resistant to interference on the transmission channel (air interface) [32].

With a specific end goal to guarantee location privacy, the tag ID is changed frequently. The tag never reveals the present ID however just its hash value.

The latter is calculated by the tag on the premise of for each situation new exchange numbers which are synchronized with the back-end of the reader.

These highlights prevent attacks, for example, replay attacks detect information losses. Two entries for every tag are put away in the backend database because the likelihood of losing the last message from the backend to the tag must be considered. The more data management and synchronization in the backend area do not, however, represent any significant limitation, because sufficient resources exist here.

By contrast, moderately unassuming requests are made with respect to the hardware of the tag. The chip has to be able to calculate hash values, even as a random digit generator is not wanted [32].

The scalability of the procedure makes it intriguing for mass deployment. Expecting mass production, the authors of the system estimate the execution costs at 0.5 euro cents per tag. This implies the procedure can be executed financially even for low-end tags [32].

2.5.3.5. Preventing readout:

Unlike most other regular electronic items, RFID tags don't have an on/off switch. Consequently, they can be actuated from outside at any time without the owner even noticing that this has happened. So-called blocker tags were developed [14] as a method of temporarily preventing the authorized or unauthorized reading of a tag.

2.5.3.5.1. Use of blocker tags:

(Utilization of blocker tags): A blocker tag is a transponder or equipment with a high level of usefulness that claims to be a transponder and recreates all possible ID numbers to a reader. By always answering to each request by the reader to transmit information (data), a blocker tag makes it difficult to examine the tags that are simultaneously present in its environment. The tags that are really present are viably covered up inside a mass of virtual tags (in practical terms, several billions of tags).

Jules et al. have recommended equipping blocker tags with two aerials so any prefix singulation can be answered at the same time with 0 and 1. This sort of blocker tag can viably block readers that that function according to the binary tree procedure [32].

To maintain blocker tags from causing a complete blockage of all RFID programs in practice, techniques were proposed which could permit blocker tags to block only particular areas of the identification address space [14]. In this way protected address spaces can be set up where reading is blocked without different applications being impaired [32].

The reliability of passive blocker tags is poor. As a passive blocker tag is initiated through the energy of the electromagnetic field of the reader to be blocked, the reliability of the protection is limited by the random spatial orientation, by shielding effects and by the distance between the blocker tag and the reader. Furthermore, the user can't discover that the blocker tag is working effectively [32]. Undesirable interference from desired RFID applications in the region can't be avoided and furthermore can't be straightforwardly identified.

2.5.3.6. Permanent deactivation:

Permanent deactivation of a transponder at the end of its utilization stage is the most solid strategy for protecting it from future abuse of any sort. On the other hand, permanent deactivation additionally keeps any points of interest from being determined at a later date from RFID – e.g. in the case of smart labels the use of data for exchange, repair, reselling or recycling [32].

2.5.3.6.1. Kill command:

A kill command permits the anonymization of transponders by using making the readout of tags all time hopeless. This protects people conveying labeled things from being surreptitiously distinguished and consequently from being followed.

A kill command was already incorporated into the Auto-ID specification [15] distributed in 2002. The current EPC global specification of the Auto-ID Center characterizes an 8-bit kill command protected by a password.

According to the specification, once they have been deactivated by the password-protected kill command, accommodating tags may never again respond to the signals of a reader [11].

The techniques examined so far depend on deactivation by software technology. This implies hypothetically the future reactivation of a tag would be conceivable.

The kill command is being presented as a conceivable method for deactivating smart labels on buyer products for the purpose of sale. Nevertheless, it is difficult for consumers to check if the labels have been forever deactivated. From the perspective of data protection, the adequacy of the kill command remains controversial, because kill procedures used up to now delete merely the variable memory cells in the transponder but not the unique ID number. Furthermore, deactivation by methods for a password is not very useful if, after shopping, consumers must deactivate the tags one by one and manually [32].

2.6. Challenges and Opportunities:

The general objective of stocktaking management is to have the necessary items at the right time, at the right amount, and at the right place. Since not all items are of high value, tracking of them may not be desired. On the other hand, critical items may require a tighter control. Due to the variety of items in a manufacturing environment, the items can be categorized into different classes, such as ABC classification, since chasing of all items may not be financially reasonable. At the point when executed appropriately, RFID can supply objects visibility in which electronic labels programmed with unique identification information are stuck to objects that should be monitored, followed or distinguished effectively when required [92].

However, there are many difficulties in the implementation, particularly on the security and protection aspects and we have to target on gaining efficiency and accuracy and stability. Another challenge must be mentioned that overcoming the physical and other barriers of radio frequency. There are key issues that present a host of challenges for the successful implementation of RFID technology in the warehouse system. Some of the challenges relating to RFID implementation in the warehouse system are as follows:

- Privacy issues loom as one of the biggest concerns to the success of RFID implementation in a warehouse system. Concerns have been raised about the right to privacy being compromised by the emerging technology. An intruder with unauthorized readers can intercept the communication between the spare part tags and RFID readers, between readers and the back-end database system in the warehouse, and can access sensitive company information (such as spare part ID, name, and so on) [99].
- Security of communication channel- Most of the security threats in a warehouse are attributed to the security of the communication channel between authentic RFID readers and the item tags through the air interface (i.e., wireless communication). An RFID item tag reading occurs when a reader generates a radio frequency “interrogation” signal that communicates with the tag (e.g., a tagged spare part), triggering a response from the tag [100]. Unauthorized readers can trigger this response by revealing the item information and it is subject to misuse by hackers and criminals. Further, with respect to Read/Write (reprogrammable) tags, unauthorized alteration of item data is possible in the warehouse information system.
- The concern of correct traceability and localization of the spare parts in the RFID-based warehouse system. There is a main factor such as human errors that not only add unnecessary cost to the warehouse system; they also affect the overall public performance of the system.

- Implementation Cost – A recent survey shows that high cost remains the primary roadblock to greater RFID implementation in warehouse [101]. The cost of warehouse infrastructure (RFID hardware- tags and fixed antennas, readers, IT system, network infrastructure, system integration, process redesign, organization change, and so on) is high. The cost of RFID-tags is far more than a barcodes system. Even though the cost of tagging is decreasing, it is still significant.
- Data security issues - Data security is a major issue for wireless due to the nature of the transmission mechanism (electromagnetic signals passing through the air) in an RFID-enabled warehouse system. The security of the item database repository from unauthorized users (e.g. hackers, and others) is a major issue in RFID-based warehouse systems. The transmission of the collected item data from an RFID reader over an intranet to a remote database is vulnerable to the interception, alteration or destruction of signals [102].
- Item tag frequency and Serialization - Frequency and serialization is also a significant issue in RFID–enabled warehouse system. Such as warehouses are very concerned as to which tag frequencies to use and where. With the serialization issue, they are concerned about what to include in an item tag's serial number. Some want the tag serial number to contain intelligence (e.g., product ID) information; others do not want the tag intelligence information, rather a random serial number.
- Another area of interference is unrelated wireless networks. Communication between tags and readers are inherently susceptible to the radio frequency interference, especially when other systems are using the same frequency range within the warehouses.
- Tags Read Rate - RFID readers are not always able to read tags (e.g., spare parts) on a 100% basis [101]; this becomes one of the major obstacles to RFID deployment in warehouse sector. Local electromagnetic

interference (EMI) is one of the features, which affect tags' accuracy [103].

- Presence of Metal Objects and/or Liquid Containing Items – warehouse management system is an area of operations that normally teeming with metal, liquid and harsh environments. Interference from metal objects that generate electromagnetic energy [103], disrupts the RFID signal and liquids absorb radio frequency signals make it challenging to tag and track with their RFID. The RFID tag is also affected by objects surrounding it especially metallic objects [100].

2.7. Summary:

We focus here on basic RFID tags of the type poised to supplant optical barcodes over the coming years, initially in industrial settings, and ultimately in consumer environments. RFID system consists of three basic components: transponders, readers, information (computer) system/middleware. The transponder is attached to the item to be identified or tracked, the reader is used to identifying the items, and the information system which can also contain middleware processes the data to make it useful. Middleware is basically a bridge between readers or a reader and the information system to facilitate proper communication [91].

There are some significant challenges and obstacles with the deployment of an RFID-based system in the warehouse. We have outlined challenges relating to RFID implementation within the warehouse system. We have proposed an RFID model chapter (4) to help and overcome most of challenges by providing accurate, automatic and real-time information on the spare parts or assets as they move to the value chain.

Chapter 3: Literature works

3.1. Introduction:

RFID technology offers the great economic potential for distinguishing items in chosen business systems. RFID tags are being utilized as a part of an everyday life. Particularly Especially high-value products and ones defenseless against forging are being equipped with RFID transponders. Examples include products in the pharmaceutical industry, the (vehicle business) automobile industry and the textile and fashion areas. Improvement of the technology will not cover all areas before the Year 2010. The expenses of utilizing RFID will presumably drop moderately; standardization will proceed in some areas. RFID technology will not penetrate broad sectors until the Year 2010 because of a level of standardization which is still unsatisfactory [32].

In addition to RFID systems, assistant applications will keep on expanding which are adding to a development of customer-based data stocks. One case example of this is the loyalty card which is giving retail companies and large supermarkets exhaustive access to singular client behavior and which is being accepted by clients for their cost incentives. The proceeding with the spread of RFID technology in the region of identification of products is growing the possibilities of data collection and processing. Different potential misuses are coming about because of this which is difficult to monitor because of an absence of transparency. The danger exists that as the labeling of products spreads further, greater correlations will be built up between the RFID labels and the customers i.e. users of the products, and stored. This is a topic in the current discussion of data and consumer protection [32].

3.2. Previous Work (Solar Wave company solution):

The firm wishes to proactively execute a security structure for the safety of their pricey product: solar panels. They hope to produce active protection, which means every solar panel enables to be identified, tracked and monitored. The elemental layout of the RFID solution is needed to include asset identification, tracking, and observance on an orderly foundation.

Passive RFID tags have been utilized in property monitoring and inventory control for several years. And considering tag charges are one of the key issues in an RFID deployment, passive RFID tag solution, which isn't any-battery, less highly-priced and with the favorable form factor, is the preliminary choice for the solar panel [89].

Various systems use several frequency bands, low frequency (125 kHz, 135 kHz), high frequency (13.56 MHz), ultra high frequency (860 – 950 MHz) and microwave frequency (2.45 GHz). The different frequency bands have different qualities. There are four primary factors that are influenced by the frequency: the operating range, the transfer rate, the ability to penetrate materials and the ability to withstand electromagnetic background noise. In this case, the initial RFID system primarily approaches the general asset tracking system. The passive tag is planned to be hidden in the junction box of the solar panel, which is nearly 43 mm × 43 mm. The substrate, which the tag is attached to, is electrical insulation material. Thinking about the environmental conditions of the tag and searching for the best types of various passive RFID tags in open market, UHF RFID is determined to apply in the solution.

Europe standard UHF (865 – 868 MHz) RFID solution:

The entire RFID framework includes 3 most important components: passive UHF tag, UHF RFID reader, and data management system which are the software to obtain and administer the RFID data.

Passive UHF EPC tags comply with EPC class 1 Gen2 standard. This preferred is class 1 generation 2 UHF air interface protocol standard. It determines the materialistic and legitimate requirements for a passive-backscatter, Interrogator-talks-first, RFID system running in UHF range [81]. EPC (Electronic Product Code) is a numbering scheme that allows assignment of a unique identifier to any physical object and allows for encoding of much more detailed item data than UPC (Universal Product Code) used in barcode systems. In this system, Passive UHF EPC tags are attached to every solar panel.

Every solar panel can be identified by an electronic product code in an automatic hands-free manner. The antenna is installed away from the reader unity and placed strategically to improve the fineness and domain of the radio signals.

Normally RFID antennas are set up at wherein indicate as 'choke factors' consisting of doorway, paths or tunnels. All tagged products can be automatically monitored and recorded the location. Data management system is used to manage and manipulate the data transmitted between the tag and the reader and between the reader and the host computer [89].

UH113-MZ3 passive tag is designed by LAB-ID Company. The tag has 96 bit EPC memory and optimized performance when attached to different nonmetallic materials. It also has the very small shape component and perfect read range. Common programs are clothing and emblem protection as well as object-level logistics [82].

UHF RFID reader R600 is prepared with the aid of Sirocco organization. The reader has highly dependable reading/writing overall performance. Up to 4 antennas can be linked. The reader also conforms to the ISO 18000-6C (an international standard that describes a series of diverse RFID technologies) UHF standard, which guarantees interoperability with EPC Class 1 Gen 2 well-matched tags [83]. UHF RFID reader antenna A100 is prepared by way of Sirocco business enterprise. This antenna has surround’s rectangular, symmetrical design. It can be mounted for vertical or horizontal polarization without restriction to how the front cover is oriented [84].

On the other hand, since the passive RFID tag does not have its own power source, such as a battery, it responds to the signal sent by the reader by taking power from the reader’s signal. How to bring required power to remotely control the switch of the solar panel turns into the biggest problem in passive RFID solution. Designing special structure and big size tag antenna or adding another power supply to the control system may solve this problem. However, it'll increment complication in industrialization solar panel and it is not extensible or changeable for future implementation.

3.3. Related Work:

It is an essential to present an overview to understand related work. This will include existing approaches for alignment of technology.

3.3.1. RFID Technology in Libraries:

The idea of RFID can be simplified to that of an electronic barcode and can be used to identify, trace, arrange or detect library stocks at the circulation desk and inside the everyday stock upkeep. This framework, together with smart RFID labels, hardware, and software, provides libraries with an extra powerful manner of managing their collections while presenting greater customer service to their patrons [88].

The technology works thru bendy, paper-thin clever labels, around 2x2 in size, which permits it to be placed inconspicuously on the inner cowl of each book in a library's collection. The tag includes an excavated antenna and a tiny chip which saves crucial bibliographic data which includes a completely unique accession wide variety to become aware of each object. This contrasts with a barcode label, which does not store any records, but simply points to a database. Those clever labels are applied without delay on library books and may be examined with an RFID interrogator/scanner. The line of sight is not important for reading the tags with the scanner, therefore, the books require much less human managing to be examined and processed. Middleware or Savant software integrates the reader hardware with the existing Library Automation Software for seamless functioning of circulation [88].

The data contained on microchips within the tags affixed to library materials is examined using radio frequency era no matter object orientation or alignment. It provides a contactless data link, without the need for line of sight, for example, the documents in the shelves or cardboard boxes can be checked without removing or opening. RFID has no concerns approximately harsh environments that restrict other auto-ID technology which includes barcodes. Tags have a discrete memory ability that varies from 96 bits to 2kbytes. similarly to tags, an RFID system demands away for reading or "interrogating" the tags to obtain the saved information and then some means of communicating this tag records to library data managing system [88].

RFID-based systems have been applied for effective file tracking purpose throughout the libraries that integrate, less complicated and quicker charging and discharging of files, protection of substances, inventorying, stock verification and shelf managing. RFID tag’s transponder listens for a radio inquiry from the reader and responds via transmitting their specific id code. Most RFID tags haven't any batteries; they use the energy from the initial radio signal to transmit their response [88].

How RFID Works?? In a standard system, tags are stuck to items. Every tag has a certain amount of inner memory wherein it stores data about the item, together with its unique id, or in some instances greater details of bibliographic data and product composition. While these tags pass through a Radio range generated by using a reader, the transponder within the tag transmits the stored information returned to the reader, thereby figuring out the item [88].

The connection process among the reader and the tag is via wireless. The major differences between the different types of waves are the distances covered by one cycle of the wave and the number of waves that pass a certain point during a set time period. The wavelength is the area blanketed by one cycle of a wave. The frequency is the variety of waves passing a given point in one second. For an electromagnetic wave, the wavelength multiplied by the frequency equals the rate of light. The frequency of an RF indicative is typically expressed in units known as (Hz). One Hz equals one wave per second. Essentially what occurs is that when the reader turns into it starts emitting a signal at the chosen frequency band (in library case HF band is used with 13.56 MHz). Any identical tag within the range of the reader will discover the signal and use the strength from it, to awaken and supply operating power to its inner circuits. Once the tag has decoded the signal as valid, it replies to the reader and indicates its presence by modulating (affecting) the reader field [88].

If any tags are existent in a row of books then they'll all reply on the same time, which on the reader end is visible as a signal collision and an indication of a variety of tags. The reader manages this hassle through the use of an anti-collision algorithm prepared to permit tags to be isolated and individually picked. The number of tags that may be recognized relies upon on the frequency and protocol used and normally ranges from 50 tags for HF and as much as 2 hundred tags for UHF. As soon as a tag is selected the reader is capable of performing many operations including reading the tags identifier digit, or in the case of a read/write tag write data to it. After finishing dialoguing with the tag the reader can then either remove it from the list or put it on the standby until a later time. This procedure keeps under the monitoring of anti-collision algorithm until all tags had been decided on [88].

In reality, very actual challenges for the IC exist consisting of attaining very low power consuming, managing noisy RF indicators and maintaining inside strict emission guidelines. Another critical characteristic of the circuit is to allow the chip to switch strength from the reader signal domain, and convert it via a rectifier right into a supply voltage. The chip clock is also normally extracted from the reader signal. Most RFID tags contain a certain amount of NVM (non-volatile memory) like EEPROM in order to store data [88].

The quantity of data saved depends on the chip specification and can range from simply easy identifier numbers of around ninety-six bits to greater data on the product with up to 32Kbits. In 1999 the automobile-id center (now EPC global) based totally at the MIT-America, together with the range of leading organizations advanced the idea of a completely unique electronic identifier code called the EPC (Electronic Product Code). The EPC is similar in concept to the UPC utilized in barcodes these days. Having just a simple code of up to 256 bits would lead to smaller chip size, and hence lower tag cost, which is recognized as the key factor for widespread adoption of RFID. Like a barcode, the EPC is a 96-bit unique number which is divided into numbers that identify the manufacturer, product, version and serial number [88].

3.3.2. Supply Chain Management:

Important difficulties looked by organizations in their supply chain is the clarity, tracking and traceability of materials and items as well as the quality and amount of information gathered continuously. RFID’s capacity to improve data collection throughput and exactness empower organizations to recognize materials, products and aims in the supply chain with more prominent precision progressively, contrasted with information accumulation technologies used to date. When RFID technology is completely coordinated, negligible human exertion is required in this process hence lessening mistakes and expenses. By giving precise, real-time data and information, RFID arrangements empower organizations to catch “live” data, changing it to important information and automating all related transactions and processes [39].

3.3.3. Healthcare:

Wrong patient data, including giving incorrect medicines or dosages, is a central point ending in a grave and now and again, deadly therapeutic incidents. As indicated via the Institute of Medicine [39]:

- Between 44,000-98,000 Americans die from medical mistakes every year (Institute of Medicine, 2000; Thomas et al., 2000; Thomas et al., 1999)
- Only 55% of patients in a current irregular specimen of grown-ups got prescribed care with little distinction found between care recommended for stopping to address acute episodes or to treat endless conditions (M.C. Glynn et al., 2003)

- Medication-related mistakes for hospitalized patients cost generally $2 billion every year (Institute of Medicine, 2000; Bates et al., 1997) these statistics have dramatically expanded the interest for fail-safe accuracy in overseeing patient care; RFID is giving a successful solution.

In RFID-prepared hospitals, patients wear wristbands with RFID tags carrying encoded therapeutic information. Every single medicine sack includes an installed RFID tag containing points of interest of the prescription. Prior to any pharmaceutical is regulated to a patient, an RFID reader checks the information between patient's tag and the remedy sack's tag. Data about the patient's medical hypersensitivities or other related patient care standards are likewise highlighted on the RFID host PC. This safe patient-information system extraordinarily lessens the likelihood of human blunder in this way limiting a plurality of additional medical accidents [39].

3.3.4. Auto immobilizers:

In certain systems, the car key includes a passive RFID tag that the controlling column confirms, in this manner empowering vehicle operation. The tags are normally factory programmed and can't be rewritten in the field. A few variants incorporate cryptographic interchanges between the key and the controlling column [6].Immobilizers have a short read range (normally 5 cm), work in the low-frequency end of the electromagnetic spectrum (in the vicinity of 125 and 134.2 KHz), and cost a couple dollars each. Broadly credited with decrease auto crime by as much as 50 percent3 these systems are likely the best-known examples of RFID deployment converting into a quantifiable end-client advantage [6].

3.3.5. Animal tracking:

Organizations and people are progressively preparing pets, domesticated animals, intriguing creatures, and jeopardized species with RFID tags to facilitate tracking, retrieval, and control. In the US, numerous local feline and pooch proprietors have RFID chips embedded in their pets. In August 2000, the Los Angeles City Council embraced a measure requiring that all pets adopted from the city's animal refuges have a microchip implanted at a cost of US$15 per pets [1]. Because the shelters additionally have RFID readers, lost animals collected by a sanctuary can be facilely returned to their proprietors. RFID chips are likewise being progressively inserted into ear tags fastened to cattle [6]. As another case, analysts have tracked dolphins and other marine animals with systems connecting a GPS receiver with a radio transmitter that can be grabbed up by satellite (which costs approximately$4,000 per tag) [6].

3.3.6. Payment systems:

RFID tags are being utilized as a credit card- similar payment tokens that include a serial number. A reader transfers the number across a network and a remote PC debits value from the user's account. To make cheat more complex, some systems consolidate the serial number with a straightforward challenge-response protocol.

One of the most common RFID payment systems is Texas Instrument's Speed pass pay-at-the-pump system, presented in Mobil stations in the mid-1990s. Quite a while prior, the European Central Bank purportedly considered inserting RFID tags into currency [2].

3.3.7. Automatic toll collection:

Highway authorities in several metropolitan areas now let passengers pay tolls utilizing RFID tags connected to debit accounts. A standout amongst the most prominent is E-Z Pass, first utilized generally in New York. E-Z Pass depends on a 921.75 MHz semi-passive tag with a time span of usability of around five to seven years and a reading scope of a few meters. The tags can be read as cars move up to 100 miles per hour, making it conceivable to utilize the tags for transportation monitoring and different applications. A few million US users are presently utilizing these tags across the nation [6].

3.3.8. Inventory control:

Separately serialized RFID tags are now being attached to some consumer products' packaging at the factory and after that employed to track packages as they get on the truck, go by boat, arrive in a different land, leave the boat, enter the supply chain, travel through distribution, and finally come to their in-store destinations. Tags can guarantee that products produced and sold in one market are not wrongfully redirected to another. Moreover, "smart shelves" implemented with RFID readers could coordinate with inventory systems, tracking all goods and warning store personnel when items are misshelved. RFID tags may even be utilized after the sale, for instance, to guarantee that buyers really purchased items that they're endeavoring to return or have serviced [6].

3.4. Advantages of RFID systems:

1- Fast charging/discharging: using RFID decreases the actual amount of time wanted to execute circulation processes. The most important time savings are due to the facts that data may be read from RFID tags a whole lot quicker than from barcodes and that different items in a stack can be read on the same time. Even as first of all unreliable, the anti-collision set of rules that allows an entire stack to be charged or discharged now appears to be running well.

2- High reliability: The readers are especially reliable. Some RFID structures have an interface between the exit sensors and the circulation system to specify the objects transferring out of a specific zone. Were a person to run out of the warehouse and not be intercepted, the warehouse would at least know what had been stolen.

3- High-speed inventorying: the unique gain of RFID systems is their capability to look into items at the shelves without tipping them out or removing them. A hand-held inventory reader may be moved swiftly throughout a shelf of objects to examine all the specific identification information. The usage of wireless technology, it is possible now not best to update the inventory however also to discover items that are out of proper order.

4- Automated materials handling: the second implementation of RFID technology is automated materials handling. This includes conveyor and sorting systems which can circulate materials and classify them by using category into separate containers or onto separate carts. This appreciably reduces the amount of personnel time required to ready substances for re-shelving. Given the high cost of the equipment, this application has not been widely used.

5- Long tag life: eventually, RFID tags continue longer than barcodes due to the fact, not anything comes into contact with them. Most RFID sellers claim a minimum of one hundred thousand transactions before a tag can also need to get changed.

6- Fast Track Circulation Operation: the usage of RFID decreases the amount of time wanted to perform circulation processes. The most important time savings are due to the facts that information may be read from RFID tags lots faster than from barcodes and that numerous items in a stack can be read at the identical time. Whilst first of all unreliable, the anti-collision algorithm that allows a whole stack to be charged or discharged now seems to be working well.

3.5. Disadvantages of RFID Systems:

1- Excessive value: The main drawback of RFID technology is its fee.

2- Vulnerability to compromise: it is liable to compromise an RFID system by way of wrapping the household foil to block the radio signal. It’s also viable to compromise an RFID framework by using placing items in opposition to each other in order that one tag overlays every other. That may cancel out the signals. This requires knowledge of the technology and careful alignment.

3- Removal of exposed tags: The RFID Tags cannot be hidden in both backbone and gutter of the objects and are exposed for removal. It could insert the RFID tags inside the spines of all except skinny objects; however, no longer all RFID tags are flexible sufficient. A warehouse can also imprint the RFID tags with its company logo and make them appear to be item plates, or it can put a printed cover label on each tag.

3.6. Summary:

RFID studies in warehousing fields have been less eminent than in different application domains. many works here are presented covering RFID in warehousing and other fields focusing on its applications, perceived benefits, obstacles to its adoption and future trends. This is gone for clarifying the existing situation of RFID in the warehouse and giving experiences to specialists to build up new research motivation and for professionals to consider and evaluate the adoption of RFID in warehousing functions.

Chapter 4: Proposed Model

4.1. Introduction:

The general picture is that the warehouse inventory that previously took weeks or months to execute can now be shortened to minutes using RFID tagging. Using fixed RFID antennas connect with the reader, staff needs only to check the quantities of the products available. The RFID reading device reads item information from the products' IC chips and then automatically interfaces with warehouse inventory software systems to update the appropriate databases. In addition, it can notify the operator immediately if an item is out of stock or not. Every product in the warehouse can be uniquely identifiable with some electronic tags. This would have tremendous benefits in terms of tracking and identify a product, making ubiquitous identification possible. RFID systems are being used as the automated identification system for the products in the warehouse.

The passive RFID tag is employed within the experiment so as thereto doesn't have its own power supply, like a battery, it responds to the signal sent by the reader by taking power from the reader's signal. In this manner, it is the less expensive than some other kind. The fixed antennas are distributed in the warehouse to provide the required energy to tags, cover all area and take into consideration reading angle of the antenna and the cost. Designing special geographic structure and control system may solve this problem.

4.2. The technical problems:

4.2.1. Count one tagged item in several locations:

Make each tagged item in the warehouse is belong to one reader or more according to its location(s) to account its real quantity without duplication. Taking into account found an item in a shared area between two adjacent antennas or found it in a non-shared range between two non-adjacent antennas or more.

4.2.2. Reader-Reader Interference:

What about the tagged item that located in a common range for more than one reader? Thus, there is a problem in calculating the quantity of the product and determine its location accurately inside the warehouse.

4.2.3. Reader-Tags Interference:

What about the multiple tags are in a range of the reader? That means different tags will be found in the same area and at the same time and that makes it very difficult to distinguish between these tags.

4.3. The technology used and the system integrity:

RFID may be a generic term that's accustomed describes a system that transmits the identity (in the shape of a singular serial number) of the object or person wirelessly, utilizing radio waves. It's classified beneath the broad class of automatic identification technologies. The auto-ID technologies are accustomed to decrease the time and labor required to input data manually and to boost data accuracy [31].

UHF RFID system consists of five basic components:

1- UHF RFID Passive tags containing the information.
2- Cable
3- RFID reader.
4- Antennas.
5- Application Software.

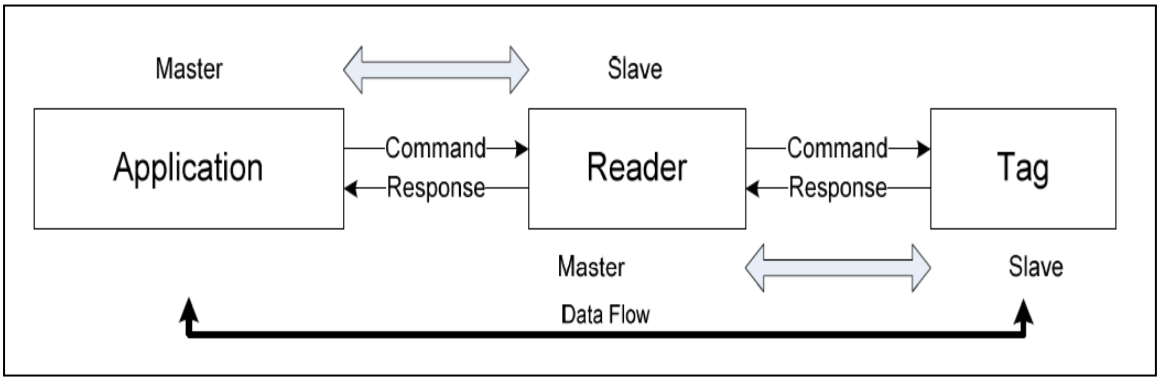


Figure4.1: integration between basic RFID system components [36]

RFID systems must offer at least the following features:

1. Identifying the transponder (tag) within a specified range.
2. Reading the data of the transponder.
3. Selecting the transponders relevant for the particular system
4. Providing guarantee that more than one transponder can be managed within the range of the reader.
5. Recognizing errors in order to guarantee operation security [32].

The integrity of RFID system depends on the following three relationships:

1. The relationship between the data stored on RFID tag and the tag itself. This must be a unique relationship because the tag is identified only by the data. The most important part of the data is a unique ID number (serial number). It is imperative to prevent the existence of two tags bearing the same identity.

2. The relationship between the tag and the tagged item which it is meant to identify (mechanical connection). This relation, too, must be unique in the sense that a tag must never be assigned to different items while it is in use.

3- The relationship between tag and reader (air interface). This relationship must be established in such a way that authorized readers can correctly access the data, while access by unauthorized readers is barred [32].

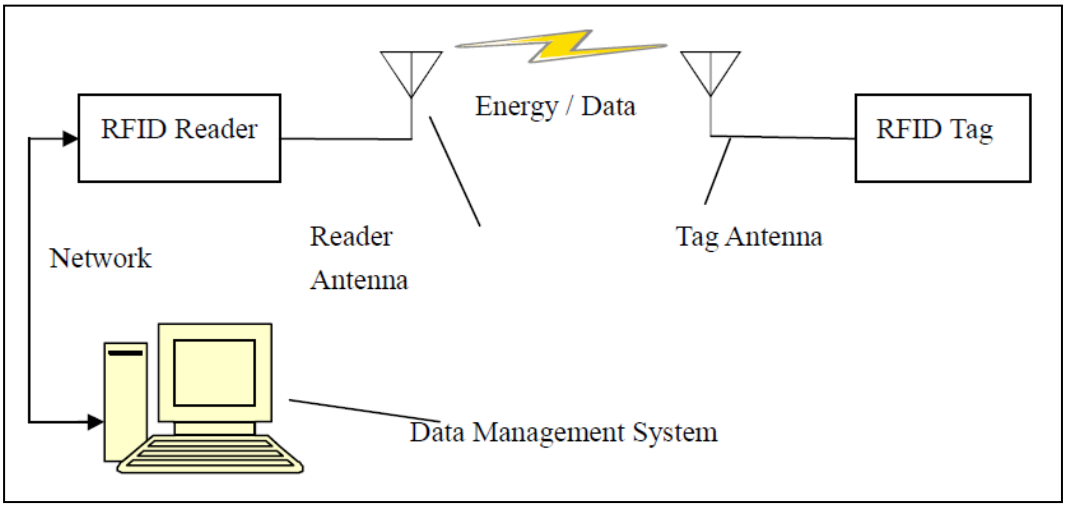


Figure4.2: The frame of RFID system [73]

The RFID tag part can also be subdivided into two parts, antenna, and tag chip. Each tag contains a singular identification code to spot and recognize the appended objects. once the tag receives the RF signal from the reader, the tag can "wake up", and in keeping with directions of the reader to finish the corresponding action, and so send back stored target info to the reader. The storage unit of the tag will be over and over read and written over 10,000 times [73].

The reader can likewise be divided into 2 elements, antenna, and reader. It sends RF signal to the tag for the wake up by utilizing reader antenna and gets the target info from the tag. once the initial filtering and signal processing, the reader can extract and analyze the tag info. The important data will be sent to data management systems through the network [73].

Data management system is often simple software, and can furthermore be the distributed Enterprise Resource Planning management software that integrated into RFID management module [73].

In quickly, tag and reader are liable for distinguishing and capturing info, data management system is liable for managing and manipulating the info transmitted [73].

One key element of operation in RFID is data transfer. It happens between a tag and a reader. There are two main communication techniques, coupling and backscattering [73]:

4.3.1. Communication through coupling [74]:

Coupling, in general, is the process of transferring energy from one medium to another similar medium, such as a metallic wire or an optical fiber. There are two common types: capacitive (electrostatic) coupling and inductive (magnetic) coupling.

Inductive coupling is the transmission of power from one circuit to every other thru a shared magnetic domain due to the mutual inductance among the 2 circuits. Inductive coupling is utilized by low-frequency or high-frequency

RFID frameworks. Due to the long wavelengths of the lower frequency waves, the length of traditional dipole would be too long. So the tag and the reader use a loop-style coil for an antenna, see Figure 5.3.

The power transfer among tag and reader incredibly depends on the operating frequency, the angle made with the antennas, and the space between the antennas.

The primary factors of inductive coupling RFID framework are as beneath:

- Short read/write range, for best works within the close to the field of the RF signal.
- Low costing
- large antenna size
- Low transmission speed

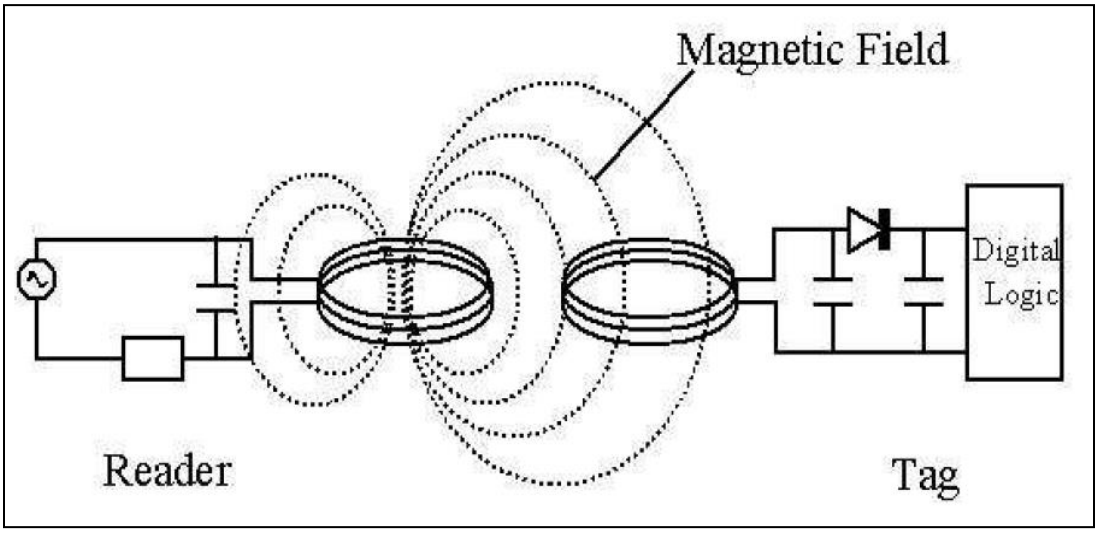


Figure4.3: An inductive coupling RFID system [73]

4.3.2. Communication through backscattering [74] [75]:

Backscattering is the communication technology used by UHF or microwave frequencies RFID system. it's the operation of accumulating an RF signal in other words energy, processing the signal with the info it contains, and reflecting it again to wherein it originated from. Within the RFID framework, it really works like a reader sends the electromagnetic wave to a tag at a selected frequency; the tag receives the wave, encodes the records into the wave, and scatters it again to the reader. A charging device such as a capacitor contained in the tag makes this reflection possible.

The backscatter modulation RFID system is shown in Figure 4. The main character of such system is as below:

- Long read/write range
- Small antenna size
- High transmission speed

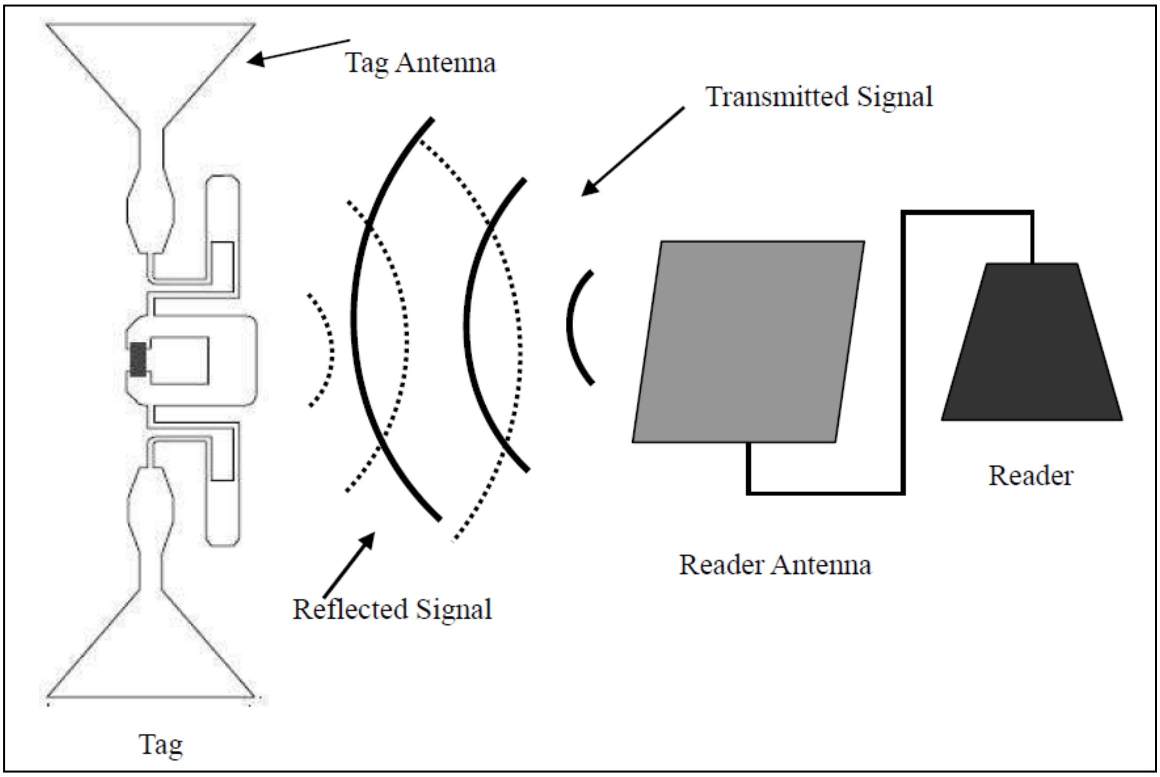


Figure4.4: The backscatter modulation RFID system

4.3.3. REID tags:

It is a tag, label or card that can exchange data with a reader using radio frequency (RF) signals. It usually has a built-in antenna and an integrated circuit IC. The antenna can send and receive radio waves, while the IC takes care of modulating and demodulating the radio signals, as well as processing and storing data [33].

Another definition of the tag is a distinguishing feature of an RFID system that is attached to objects to be identified; the data stored can include product identification, expiration, warranty, handling and storage instructions, and service history [56].

A radio-frequency identification system uses tags, or labels attached to the objects to be identified. Two-way radio transmitter-receivers called interrogators or readers send a signal to the tag and read its response [28].

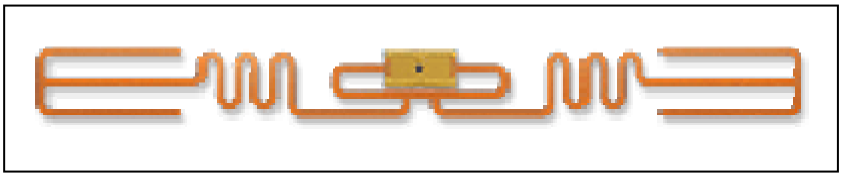


Figure4.5: A Tag [56]

Instead of visible light used in barcode labels, these tags use radio waves to communicate with the readers. To produce radio waves tags require a few source of power to energize its electronics [56].

RFID tags comprise no less than three components: an included circuit for storing and handling data that modulates and demodulates radio frequency signals; a way of gathering direct current power from the reader signal; and an antenna for receiving and transmitting the signal. The tag data are stored in a non-volatile memory. The RFID tag incorporates either fixed or programmable logic for processing the transmission and sensor data, respectively [28].

Three important component differences among RFID Tags [68]:

- IC Type: The IC (Integrated Circuit) is the brain of the RFID tag and stores the unique information on the tag. Some IC sorts will store a lot of data than others. As a rule, most ultrahigh-frequency RFID tags cling to the Class 1 Generation 2 standard (ISO 18000-6C) and utilize ninety-six bits of memory to store the Electronic Product Code. This is suitable space to store twenty-four hexadecimal characters. In any case, a few tags are more costly in order to they have expanded user memory to store more data on the RFID tag.

- Antenna: For general functions, the dimensions of the tag's inner antenna will be a powerful pointer of the tag's read field. Small RFID tags contain small antennas which lead to shorter read ranges, while large RFID tags (with larger antennas) will have longer read ranges. Moreover, RF antennas can be unequivocally affected by their close circumference.
- Water and metal absorb and reflect RF power sequentially and, in doing as such, may diminish an RFID framework's execution (scan ranges and read rates). But, the properties of metal can be utilized as a benefit if the right tag is utilized. Metal RFID labels, which have extraordinary backings, use their metallic surroundings to harness reflected power and increment read ranges. Background insensitive tags have foam material around the antenna apparatus with the goal that they can be placed both on and off metal. An extra factor with respect to tag antennas that influences how they act in an RFID framework is the number of dipoles the tag includes. In short, a dual dipole RFID tag will be readable from more orientations, whereas a single dipole RFID tag may need to be read in a more controlled orientation.
- Encasement: When we're indicating to encasement, we're discussing the physical shape part of the RFID tag. Contingent upon the application, RFID tags appear in an assortment of shapes and sizes.

  The most primary delivery of an RFID tag is the RFID inlay. The inlay gives the RF functionality of an RFID tag but just includes the IC and antenna. Inlays can be wet, which means that they have glue on their backs, or dry, which implies they contain no glue.

The subsequent stage up in complexity is the RFID label. The most ideal approach to clarify the distinction between an RFID inlay and an RFID label is that the label contains an RFID inlay, however, could likewise work alone without RFID. Regardless of whether the RFID inlay was truant, the label would, in any case, contain a barcode or human-readable information. The label can be paper or anything relying upon what sort of use the client wants.

In conclusion, the RFID inlay can be put in some sort of encasement. This is the most costly and differing method for delivering an RFID tag. The case can shield from effect, temperature, water or metal environments. Particular encasements can moreover produce unusual attachment options like embedding or bolts or rivets.

One helpful manner of characterizing tags is to split them into active and passive categories [56]:

- Active tags which read and write for a long extent.
- Passive tags with shorter range.

Table4.1: Comparison between Active and Passive Tags [27]

	Active RFID	Passive RFID
Tag power source	Internal to tag	Energy transferred from the reader via RF
Tag battery	Yes	No
Availability of tag power	Continuous	Only within the field of the reader
Required signal strength from reader to tag	Very low	Very High (the tag must power)
Available signal strength from tag to the reader	High	Very low
Communication range	Long range (100m or more)	Short or very short range (3m or less)

Sensor capability	Ability to continuously monitor and record sensor input; data/time stamp for sensor events	Ability to read and transfer sensor values only when the tag is powered by the reader; no data/time stamp
Data storage	Large read/write data storage (128KB) with sophisticated data search and access capabilities available	Small read/write data storage (e.g. 128 bytes)

However, passive tags are much cheaper than the active tags and are therefore more widely used. Tags appear as a major part of the cost in an RFID execution. One tag may cost anywhere between 0.2 and 10 dollars depending on factors like form, operating frequency, data capacity, range, presence or absence of a microchip, and read/write memory [56].

Common barcode labels cost not as much a cent on normal. But they quickly become dirty, ripped, marked over and need to the sight line orientation. Accurate orientation needs additional human effort to make the barcode legible. RFID tags don't suffer from these problems. Moreover, unique points, for example, the ability to be written to and long extent possibly can spawn a whole new set of applications and drastically enhance the execution of applications such as inventory management and supply chain management. The probability of automatically identifying and following items guarantees significant diminishments in expenses and time required for stock administration. In short, applications built around this technology can provide both operational and strategic benefits to adopting organizations [56].

Contrasted with passive tags, active tags are more costly (regularly more than US$20 each) however they give a more extended read and write range (up to 100 feet or more), offer more noteworthy usefulness and their battery life is up to a year:

1- Inactive (Passive) tags, for example, the one appeared in Figure 6, are generally economical that may cost somewhere in the range of 20 cents to a few dollars. Since they don't contain a battery inside them; rather they draw power from the reader's signals that generate a current in the tag's antenna utilizing either inductive coupling or electromagnetic capture. This power is utilized both for chip operation and for communication. Passive tags basically reflect back the radio waves from the reader so as to communicate that generally known as backscatter. However, their signal range is very low, usually less than 10 feet [56].

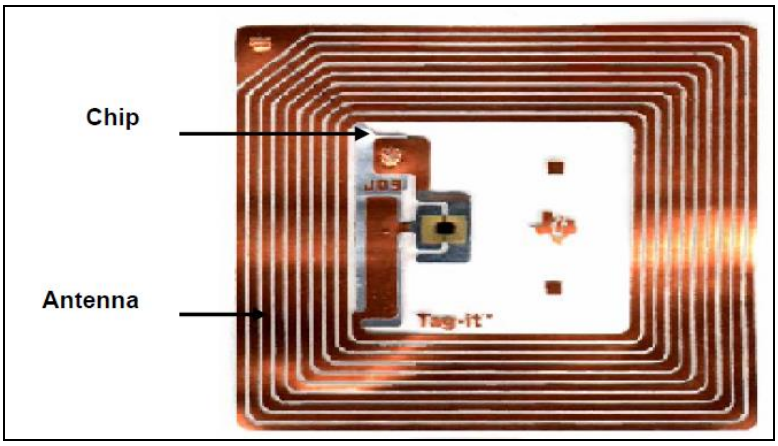


Figure4.6: Passive Tag [56]

2- Semi-passive tags fall somewhere between the two; they use a battery for a chip’s standby operation but draw energy from the reader during active communication sessions [56].

3- Active tags use a tiny battery, a microchip, and a tiny antenna built into them (Figure 7) [56]. Active tags are usually bigger than passive tags because they are usually meant for extended reuse and rugged environments; for example, to be mounted on ship containers or railway carriages [56].

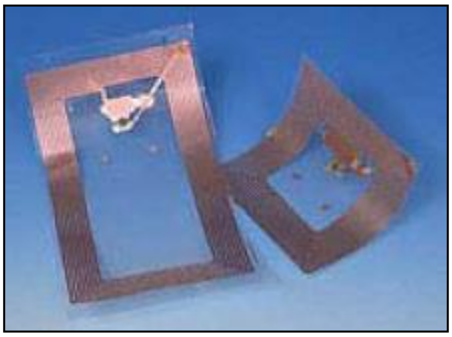


Figure4.7: Active Tag [56]

4- Chipless tags, on the other hand, maybe cheapest of all because they do not contain silicon-based chips and memory. They can be produced for about a cent each for bulk quantities of millions. They offer many benefits over different sorts, for example, slim physical profile, less sensibility to interference, and work over a more extensive range of temperature. Since their physical profile is very thin they could be embedded in paper labels, producing what is commonly known as smart labels. Many technologies are utilized for chip less tags, including inductive resonance and magnetic resonance. The former type uses transistor-less circuits made up of conductive polymers as a substitute for silicon-based microchips. Magnetic resonance tags utilize extraordinary sorts of microscopic magnetic particles that produce signature radio waves once bombarded with electromagnetic radiation by the reader. The reader picks up the radio emission from these particles and converts the signal into bits. This kind of tag can be used for authenticating sensitive documents like intelligence reports and currency notes [56].

   On the other hand, their storage capacity is still quite low, typically 24 to 32 bits compared to up to several kilobits for chip-based tags. Their operating range is only about one meter. Being without silicon memory, they cannot store unique serial numbers. That is why they are not suitable for supply chain applications. Chipless tags are modified versions of RF-based electronic article surveillance (EAS) tags that contain only a single inductance-capacitance circuit usually printed with conducting ink. EAS tags can only indicate their presence or absence by reflecting back radio waves beamed at them, essentially exhibiting a one-bit storage capacity. chipless tags achieve multi-bit capability by using multiple circuits that are layered on top of one another. At present, they represent about 2.5 % of RFID market, but this share is expected to grow to 30% in the next decade [71].

The tags can also be distinguished from each other based on their intended use, size, and shape and whether or not data can be written to them. Read-only tags are less expensive than read-write tags because they do not require rewritable memory used in read-write tags, such as flash memory [56].

RFID tag memory [34]:

A Read-only tag which means tag ID is specified at the industrial facility during manufacturing and assembling and subsequently can never be replaced and no extra information can be inserted into the tag. The second sort is writing once, read many (WORM) tags which means information recorded once, e.g., amid packing or producing and hence the tag is locked once information is created and like a DVD, At last, the last kind is Read/Write which means Tag information can be replaced after some time and therefore part or all of the data section can be locked.

RFID tags come in many forms, including glass capsules, disks, cylindrical tags, wedge-shaped tags, smart cards, and keychain fobs [56].

Figure4.8: Examples of Tags [56]

Different form factors are suitable for different applications. For example, small glass capsules (2mm by 1cm) may be injected directly under the skin through large-gauge hypodermic needles to tag cattle, as the glass is non-reactive and non-biodegradable [72].

An RFID reader transmits an encoded radio signal to interrogate the tag. The RFID tag receives the message and then responds with its identification and other information. This might be just a one of a kind tag serial number or possibly item related information, for example, a stock number, batch number, creation date, or other particular data. Since tags have singular serial numbers, the RFID system configuration can segregate among many tags that may be inside the scope of the RFID reader and read them at the same time [28].

RFID tags and readers must be tuned to a constant frequency so as to communicate. Thus RFID systems can be broken down by the frequency band within which they operate: low frequency, or LF, (125 – 134 KHz), high frequency, or HF, (13.56 MHz), and ultra-high frequency, or UHF, (433, and 860-960 MHz) [70]:

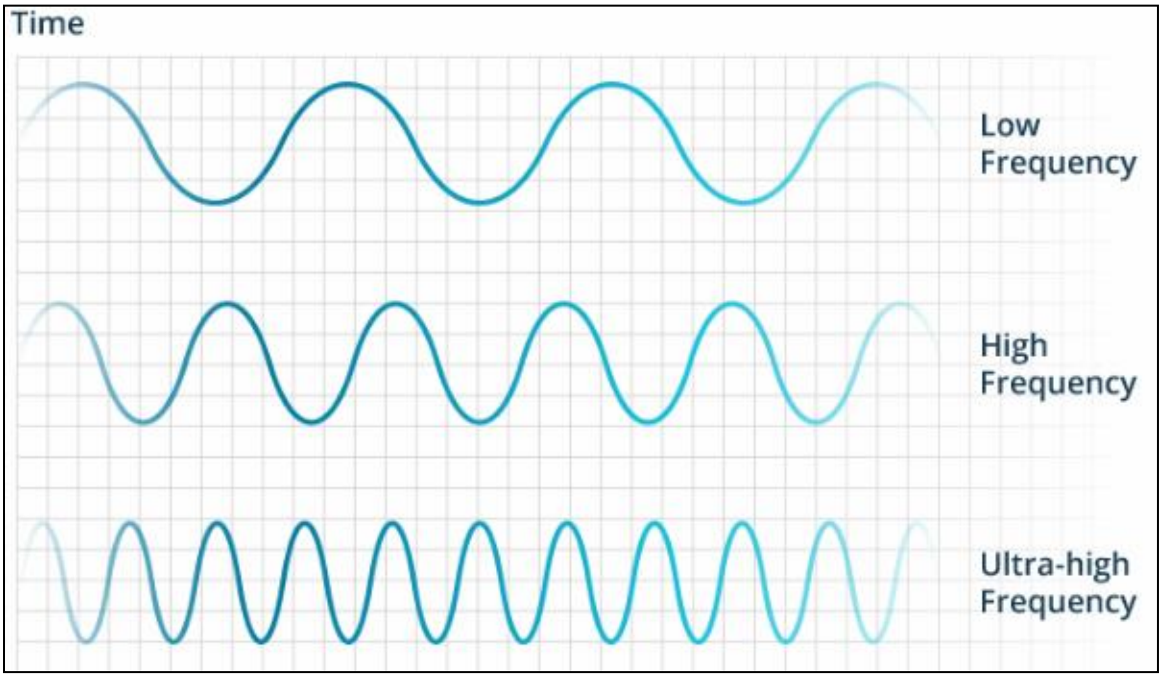


Figure4.9: RFID Frequencies [70]

Similarly, various operational frequencies are fit for multiple goals and there is no perfect frequency for all applications. For instance, while higher frequencies may be needed in the shipping industry for longer range, low frequencies may be more suitable for access control purposes [56].

Frequency alludes to the span of the radio waves used to contact between system components. RFID systems all through the world work in low frequency, high frequency, and ultra-high frequency bands. Radio waves behave diversely at every one of these frequencies and there are points of interest and impediments related to utilizing every frequency band [70].

For instance, if an RFID system works at a lower frequency, it has a slower information read rate, yet expanded abilities for reading close or on metal or fluid surfaces. On the off chance that a system works at a higher frequency, it by and large has speedier information exchange rates and longer read ranges, however greater sensitiveness to radio wave interference caused by fluids and metals within the environment. However, technology innovations in recent years have made it possible to use ultra-high frequency RFID systems around liquids and metals [70].

- Low Frequency RFID: LF RFID applications incorporate access management and livestock trailing. The LF band covers frequencies from 30 KHz to 300 KHz. Ordinarily LF RFID frameworks work at 125 KHz, in spite of the fact that there are some that work at 134 KHz. This frequency band gives a short scan scope of 10 cm and has slower scan speed than the higher frequencies, however, isn't extremely sensitive to radio wave interference [70]. Standards for LF animal-tracing systems are defined in ISO 14223, and ISO/IEC 18000-2. The LF band isn't viewed as a genuinely worldwide application as a result of slight variations in frequency and power levels all through the world [70].
- High-Frequency RFID: HF RFID is usually utilized for ticketing, installment, and information exchange applications. The HF band ranges from 3 to 30 MHz, Most HF RFID systems work at 13.56 MHz with reading ranges between 10 cm and 1 m. HF systems experience moderate sensitiveness to interference.

  There are many HF RFID standards, for example, the ISO 15693 standard for tracing objects, and the ECMA-340 and ISO/IEC 18092 standards for Near Field Communication (NFC), a short-range that is ordinarily utilized for information transfer between devices. Other HF standards incorporate the ISO/IEC 14443 A and ISO/IEC 14443 standards for MIFARE technology, which utilized as a part of smart cards, and the JIS X 6319-4 for Felicia, which is a smart card system regularly utilized as a part of electronic cash cards [70].

- Ultra-high frequency RFID: The read scope of passive UHF systems can be the length of 12m, and UHF RFID has a faster information transfer rate than LF or HF. UHF RFID is the most delicate to interference, however, numerous UHF producers have discovered methods for designing tags, antennas, and readers to keep execution high even in troublesome conditions. Passive UHF tags are easier and cheaper to manufacture than LF and HF tags [70].

  UHF frequencies regularly present much better read scope up to 50+ ft. depending upon the RFID framework setup and can exchange information faster than low-and high-frequencies. That means read numerous more tags every second. Notwithstanding, on the grounds that UHF radio waves have a shorter wavelength, their signal will probably be weakened and they can't go through metal or water. Because of their high information transfer rate, UHF RFID tags are appropriate for many items immediately, for example, boxes of commodities as they go through a dock entryway into a distribution center or racers as they cross a finish line. Also, due to the longer read range, other common UHF RFID applications include electronic toll collection and parking access control [69].

Table4.2: Comparison between UHF, HF and LF [70]

UHF	HF and LF
Single worldwide Gen2 standard	Multiple competing standards
20x the range and speed of HF	HF-based NFC for secure payment
Labels cost 5c - 15c in 2017	Labels, cards, inlays cost 50c - 2$
The technology for item tagging	Used in access control, ticketing, payment

Passive, Active, and BAP RFID Systems [70]:

1- Passive RFID Systems (we will use this system in our solution): In passive RFID systems the reader and reader antenna sends a radio signal to the tag. The RFID tag then uses the transmitted signal to power on, and reflect energy back to the reader.

   Passive RFID systems can work in the low, high or ultra-high frequency radio bands. As passive system ranges are restricted by the radio signal reflected from the tag back to the reader, they are regularly under 10 m. Since passive labels don't require a power source or transmitter and just require a label chip and antenna, they are less expensive, littler, and easier to fabricate than active tags. Passive tags can be used in various ways, contingent upon the particular RFID application requirements. For instance, they may be mounted on a substrate, or sandwiched between an adhesive layer and a paper label to create smart RFID labels. Passive tags may likewise be installed in an assortment of devices to make the tag resistant to extraordinary temperatures or hard chemicals.

2- Active RFID Systems: Here tags have their own particular transmitter and energy source. For the most part, the energy source is a battery. Active tags broadcast their own signal to transmit the data stored on their microchips.

Active RFID systems ordinarily work in the ultra-high frequency band and offer a scope of up to 100 m. All in all, active tags are utilized in rail cars, huge containers, and different resources that should be tracked over long space. There are two primary sorts of active tags: transponders and beacons. Transponders are woken up when they get a radio signal from a reader, and after that power on and respond by transmitting a signal back. Since transponders don't actively radiate radio waves until the point when they get a reader signal, they keep battery life. Beacons are frequently utilized in real-time locating systems, keeping in mind the end goal to track the exact area of an asset ceaselessly. Unlike transponders, beacons are not powered on by the reader's signal. Rather, they emanate signals at pre-set intervals. Contingent upon the level of locating precision required, beacons can be set to radiate signals at regular intervals, or once every day. Each beacon's signal is gotten by reader antennas apparatuses that are situated around the circumference of the zone being monitored and communicates the label's ID data and position. The wireless ecosystem for clients is substantial and developing day by day, there are utilize situations where Active RFID and Passive RFID are deployed at the same time for an additive approach to asset or sensor management.

3- Battery-Assisted Passive (BAP) Systems: A Battery-Assisted Passive RFID tag is a kind of passive tag which includes a crucial active tag advantage. While most passive RFID tags utilize the power from the RFID reader's signal to control on the tag's chip and backscatter to the reader, BAP tags utilize an inserted power source (normally a battery) to control on the chip, so the greater part of the captured power from the reader can be utilized for backscatter. Not at all like transponders, Battery assisted passive tags don't have their own particular transmitters.

Signaling: An Electronic Item Code (EPC) is one popular sort of information put in a tag. At the point when written into the tag by an RFID printer, the tag includes a 96-bit string of information. The initial eight bits are a header which distinguishes the version of the protocol. The following twenty-eight bits recognize the company that controls with the information for this tag; the association number is allowed by the EPC Global consortium. The following 24 bits are an object class, distinguishing the sort of item; the last 36 bits are an interesting serial number for a specific tag. These last two fields are set by the association that issued the tag. Or maybe like a URL, the aggregate electronic item code number can be utilized as a key into a global database to extraordinarily recognize a specific item [25].

4.3.4. REID Readers:

Readers are set up to make a particular inquiry zone which can be firmly controlled. This permits an exceedingly determined reading zone for when tags go all through the inquiry zone. The reading device – regularly called essentially a reader, which comprises a read or read/write unit and an antenna contingent upon the technology utilized. The reader reads information from the tag and for some situation command the tag to store more information. The reader also checks the quality of the data transmission, in order to pass on the received data to some other systems (a PC, a machine control) and to process them there [32].

The reader additionally alluded to as the interrogator, is a device that obtains, pick up and processes tag information, and is likewise in charge of interfacing with a host PC [75]. Readers read the tags. In reading, the signal is conveyed constantly by the (active) tag while, in interrogation, the reader sends a signal to the tag and listens to it. To read passive tags, the reader sends radio waves to them, which empower them and they begin broadcasting their information. The reader reads every one of the tags inside its read scope in a snappy succession. This programmed procedure lessens read times. In a field test, Marks & Spencer, UK, tagged 3.5 million bins with RFID tags. While it used to take 17.4 minutes to read 25 stickers with barcodes, on 36 dollies, RFID decreased that to only three minutes. This result was in an 83% reduction in reading time for each tagged dolly [76].

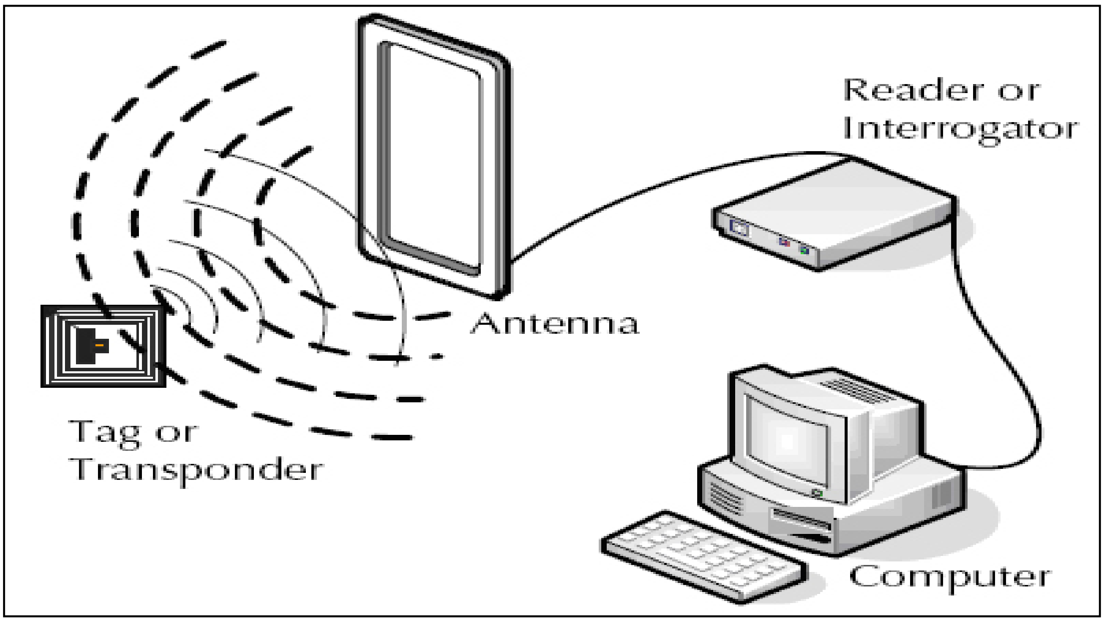


Figure4.10: RFID Overview With a passive UHF system [60]

In this situation with passive and semi-active tags, the reader gives the power required to enact or empower the tag in the reader's electromagnetic field. The reach of this field is for the most part specified by the volume of the antenna on the two sides and the strength of the reader. The size of the antenna is generally defined by application requirements. In any case, the ability of the reader, which determines the strength and reach of the electromagnetic field produced, is for the most part constrained by regulations. Each country has its own set of standards and regulations relating to the amount of power generated at various frequencies [75].

If more than one tag is present within the range of a reader, various techniques are available to read them all sequentially. These techniques, grouped under the name of 'singulation', identify individual tags by allowing only the tags with a specific serial number to respond. The scheme where the reader controls the response timing of the tags is known as reader talk's first method.

Conversely, the scheme where tags start beaming their data as soon as they are energized by the reader is known as tag talk first method. The former method is more accurate but is slower compared to the latter [56].

The readers are usually connected to a remote antenna; some readers may work with multiple antennas and use a device multiplexer [77].

The reader is scanning and checking each antenna attached to it so that once a tag enters the field of one of the antenna it is first powered up. Once fully powered, the tag "backscatters" its information which the antenna can then pick up. This is the most delicate part of any system [52].

The readers also come in various form factors ranging from huge frames that cover an entire entrance to the smallest reader which is the size of a quarter [78].

Generally, one central feature of RFID systems is the storage technology used, some of which are of the read-only type and others of the read/write type of system [32]:

- Read-only tags that can only be read by the reader once they have been programmed by the manufacturer are cheaper to produce. Variable information that is supposed to be associated with the tag must be stored in a database in the backend of the RFID system. When the tag is read, this information is retrieved from the database using the ID number (serial number) of the tag.
- Read/write tags are more costly to produce because their memory advantage. They can execute strong security mechanisms and record data on the tag itself.

RFID systems can be categorized by the kind of tag and reader.

- Passive Reader Active Tag system has a passive reader which just gets radio signals from active labels. The reading scope of a PRAT system can be set and adapted from 0– 600 m, permitting flexibility and adaptability in applications, for example, resource insurance, asset, and supervision.
- Active Reader Passive Tag system has an active reader, which transfers reader signals and furthermore gets validation (authentication) replies from passive tags.
- Active Reader Active Tag system utilizes active labels awoken with a signal from the active reader. A variety of this system could likewise utilize a Battery-Assisted Passive (BAP) tag which acts like a passive tag yet has a small battery to force the tag's return reporting signal [28].

Readers work at different frequencies, from a low of about 100 KHz to a high of about 5.8 GHz. The Tris S2000 reader used in our laboratory experiments works at 134.2 kHz, which is at the low end. Read ranges for lower frequency systems are smaller but the systems are less susceptible to performance degradation in presence of metal or water in the environment.

4.3.5. Antennas:

Antennas also come in a diverse range of form and technical factors. They are used in both the tags and the reader. The size could vary from under a square centimeter to several square meters. Actually, UHF reader antennas can be categorized around a circular-polarized or linear-polarized antenna. The first type sends and gets radio waves from all directions, while the later work best in one specific direction. Hence circular-polarized antennas are less sensitive to the transmitter and the receiver orientation and work bestead around corners. In any case, the working scope of a linear-polarized antenna is more than that of a circular-polarized antenna [79].

The working scope of an antenna additionally relies on its gain which is its capacity to concentration radio waves. Higher gain antennas can work at a longer range than the lower gain counterparts. However, there is always a tradeoff between gain and coverage area (reader field). Therefore, Omni-directional antennas have smaller gain and the ones that cover a narrower area will have a higher gain [56].

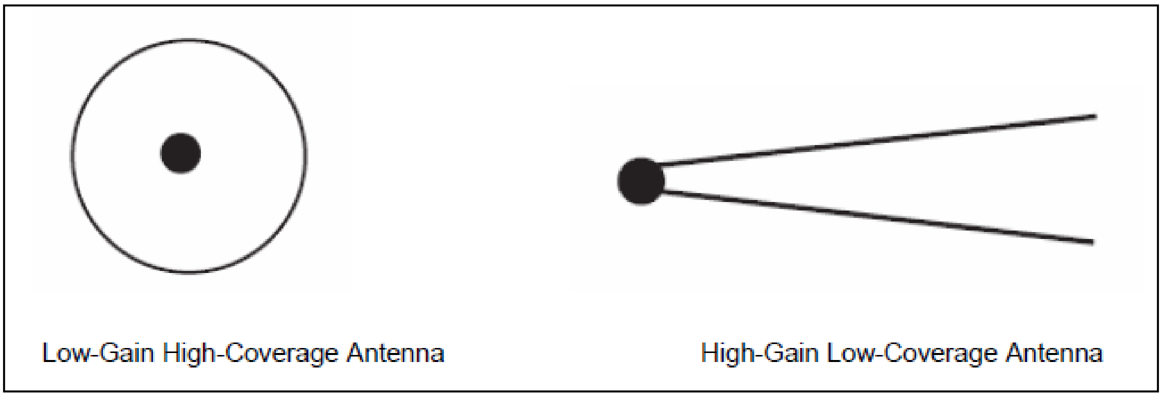


Figure4.11: Antennas

At the point when a tag speaks with an antenna apparatus, the radio frequency part of the circuit between the tag and the antenna is known as the air interface. This radio communication takes place under a certain set of rules called air interface protocol. Propriety protocols may cause problems with equipment from various sellers [56].

The tag antenna is usually manufactured with the tag chip on the same surface and packaged as one single unit. Since the tag chip can be exceptionally small, less than 1 square millimeter, the size of the whole tag is normally set by the size and form of the antenna. The packaging characteristics for the antenna reader also vary greatly depending on application requirements. In specific cases, for example, handheld readers, the antenna is manufactured specifically on the reader. In other cases, several antennae can be mounted away from a reader unit and positioned strategically to enhance the quality and range of the radio signals [74] [75].

4.3.6. RFID operation frequency:

The operation frequency is a very important element in RFID system. The advantages of various operation frequencies are required cautious study in designing an RFID solution. The most popular RFID frequency ranges are Low Frequency among 120 and 140 kHz. It is the near-field propagation which offers an operating range between 0 and 1 m. To achieve a higher operating range, it is necessary to raise the system frequency in order to take advantage of the far-field propagation characteristics, which as high frequency at 13.56 MHz, ultra-high frequency at 860-950 MHz, and microwave frequency at 2.45 GHz. All in all, the frequency characterizes the working scope and the information transmission rate between the tag and the reader. The lower the frequency, the shorter the operating range and the slower the transfer rate. Be that as it may, the rate and the operating scope are not by any means the only two considerations in designing an RFID solution. Environmental conditions, such as the substrate that tags are attached to and the presence of other radio wave producing devices, also play a significant role in determining the optimal operating frequency for a particular application. Table 3 describes most popular radio frequency ranges of RFID systems and the corresponding properties [80].

Table4.3: Radio frequency ranges of RFID systems and the corresponding properties

Frequencies	low frequencies 120-140kHz	high frequencies 13.56 MHz	ultra high frequencies 860-950 MHz	microwave frequencies 2.45 GHz
Operating range	Up to 1 meter	Up to 1 meters	Up to 3 meters	4-12 meters
Advantages	Simple and robust technology	Good anti-collision Large	Good anti-collision Fast speed	Good anti-collision Very fast data

	Lots of shapes and sizes Insensitive to disturbances Good penetration Works best around metal and liquid	assortment relatively transponder Common worldwide standards Longer read range than LF (low frequency) tags Lower tag costs than LF tags	Long read range Cheap price Good standards	transfer rates Very long transmit ranges Commonly used inactive and semi-active modes
Disadvantages	Limited anti collision Slow data transfer	Unable to read through liquid Poor performance around metal	Incompatibility issues related to regional regulations Susceptible to interference from liquid and metal	Poor performance around liquid and metal
Examples of usage	Animal identification Industrial automation Access control	Payment and loyalty cards (Smart Cards) Access control Anti-counterfeiting	Supply chain and logistics such as: inventory control, warehouse management,	Access control Electronic Toll collection Industrial automation

		Various item level tracking applications such as for books, luggage, Garments, etc. Smart shelf People identification and monitoring	asset tracking	

RFID systems use frequency ranges made available originally for Industrial, Scientific and Medical applications (so-called ISM frequencies) for one thing. In addition to that, in Europe the frequency range below 135 kHz and in the United States and Japan that below 400 kHz can be used for RFID applications. Worldwide the frequency ranges below 135 kHz, 13.56 MHz, 869 and 915 MHz respectively (the EU and the USA respectively) are available for the commercial use of RFID systems. The 2.45 GHz frequency range has still not reached a high degree of product maturity. The 5.8 GHz frequency range is also under discussion, but thus far there has not been much demand for it. In summary, the frequency ranges below 135 kHz and around 13.56 MHz appear to be proven and harmonized worldwide [32].

Frequency regulation is one of the principle issues holding back the improvement and development of internationally usable RFID systems in light of the absence of worldwide uniformity. In addition to the deviations in committing frequency ranges, different specifications regarding the transmitting output of readers are second important limiting factors. In the range between

869/915 MHz, for instance, in the USA a maximum transmission output of four watts is permitted; in Europe however, only 0.5 watts are allowed. That gap causes a significant difference in the range: in Europe, data may be transmitted only from a distance of approximately one meter to 2.5 meters. Even with RFID systems having the same design the range in the USA is only about six to eight meters [22].

4.3.7. The factors that affect RFID read range:

[85]The RFID reader is connected to the antennas, adjusting the power settings, and applying the RFID tags to the items that we want to track. The following key hardware specifications will assist in determining the optimum setup for our proposed solution.

1- Antenna: If we need more read range, we will use higher gain antennas. If we need less read range, we will use lower gain antennas. If we have to read tags at a very close range, we will utilize low gain proximity antennas [85].

A- High gain antennas: a higher gain antenna increases the power received from the reader. If we need to ensure that our antennas have a longer scope, at that point, we require high gain antennas (e.g. 9 dBi, or higher) [85].

B- Proximity RFID antenna: is perfect for systems where the tag will always be the same short distance away from the antenna, a high gain antenna simply isn't needed. In short the higher the gain, the higher the range of the antenna, and vice-versa. Additionally, lower gain antennas are smaller in size than high gain antennas [85].

2- Antenna Polarization: If tags are aligned with the antenna's polarization, linear polarized antennas will read farther than circularly polarized antennas. If tags are not aligned with the antenna's polarization, then circularly polarized antennas will read farther than linear polarized antennas [85].

Polarization refers to a type of electromagnetic field the antenna is generating. The choice between circular polarization antennas and linear polarization antennas can make a significant difference in an RFID system [85].

Linear polarization refers to radiation along a single plane see figure 12. Linear polarization occurs when electromagnetic waves broadcast on a single plane (either vertical or horizontal). Linear polarized antennas must have a known RFID tag orientation and the RFID label must be settled upon an indistinguishable plane as the antenna in order to get a steady read. A few cases of linear polarized antennas are the MTI MT-263003 Outdoor Antenna, and the Times-7 A5531 Indoor Antenna [86].

Circular Polarization refers to antennas that split the radiated power across two axes and then “spins” the field so as to cover as many planes as possible see figure 13 [85].Circularly polarized antennas, such as the Laird S9028PCR Indoor RFID Antenna and the MTI MT-242043 Outdoor RFID Antenna, emit electromagnetic fields in a corkscrew-like fashion. Technically speaking, they are broadcasting electromagnetic waves on two planes making one complete revolution in a single wavelength [86].

Because of the nature of the antenna’s field, tag orientation very more significant with linear antennas than with circular antennas. Moreover, in light of the fact that the power is not divided across more than one hub, a linear antenna’s field will expand more remote than a round circular antenna with similar gain, thus allowing for longer read range when aligned with the RFID tag, circularly polarized antennas will have a shorter read range because they lose about 3 dB splitting their power across two separate planes [85].

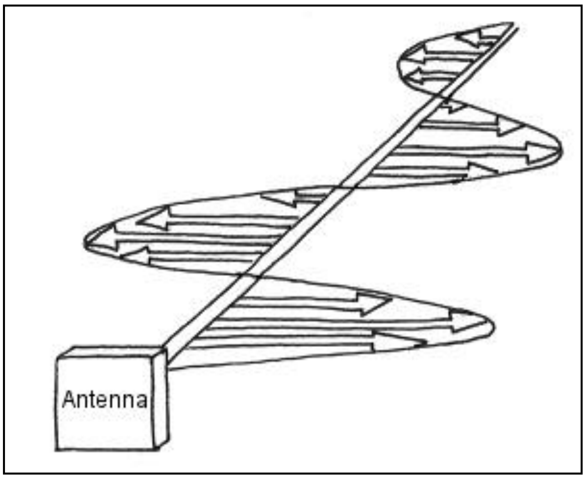


Figure4.12: Linear Polarization (horizontal) [86]

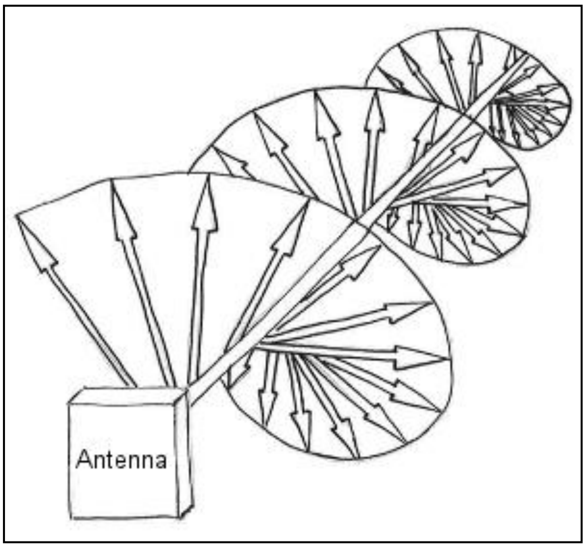


Figure4.13: Circular Polarization [86]

3- Tag size: Passive can vary in reading range from a few inches to 50+ feet. RFID tags include antennas and because bigger antennas will communicate more distant than smaller antennas, as a rule, the bigger the tag, the more extended the read range [85].

4- Tag orientation: this point only matters for antennas with linear polarization. If you have got a circularly polarized antenna, the tag's orientation shouldn't make any difference. But unlike so, with linear antennas, tag orientation does make a difference. With a linear antenna, if the tag is oriented from 9-3 and you aren't selecting it up, attempt rotating it to 6-12. This can be a fast take a look at that which basically applies to tags with a single dipole. Some RFID tags have double dipoles which will help relieve issues caused by this movement [85].

5- Read angle: Reading an RFID tag from an angle (versus straight on) will negatively effect on reading range. In order to employ the most power conceivable from the RFID antenna, the RFID tag should straight face the antenna. Hence, we’ll get the best range when you read the tag face-on – the steeper the read angle, the more the read range will decrease. Some RFID tags, such as the embeddable RFID wire tag, have a 360-degree read profile which mitigates the read angle concern [85].

6- Tag placement: UHF RFID tags are strongly affected by objects containing metal (a reflection of RF energy) or water (absorption of RF energy). In the event that we don't pick the correct tag for the item we wish to tag, we may have enormously reduced read range or we will most likely be unable to read the tag at all [85].

There are metal-mount RFID tags with an uncommon support designed to be applied on metal or items containing water. These sorts of tags will repeatedly perform better on metal than they do off metal.

Each object generally contains a special spot that will augment the reading scope when the tag is placed inside it. Special spots differ highly from object to object and must be distinguished by means of testing [85].

7- Reader settings: Higher power settings will bring about a greater noteworthy read range, while bring down power settings will bring about reduced read range. Likewise, with a specific end goal to increase read range, guarantee that your reader is set to its highest receive sensitivity [85].

All RFID readers can control how much power they send out of the cables to the reception apparatuses (antennas). We tend to should check the reader’s settings to perceive and envision how much transmit power we are transmitting (in dB); the higher the number, the additional we'll expand scan and increase range and vice-versa. It is essential to take note of that, in light of the fact that the power is measured in decibels (dB), the power will twofold or be cut in half for each 3 dB you increase or decrease [85].

In conclusion, check the reader’s receive sensitivity settings. Regularly, these are set to maximum by default, yet it is worth double checking to know without a doubt. If the reader is set to maximum sensitivity, it will report weaker tag signals which commonly originate from tags that are more distant away, along these lines expanding read range. a lower sensitivity setting will ignore the weaker signals, in this way decreasing read range. Main concern: the fastest and easiest approach to maximize read range is to guarantee your reader is set to its full power and highest receive sensitivity [85].

8- Length of cables: The antenna cables connecting the antennas to the RFID reader “leak” energy. The longer the cable, the more energy it will lose, eventually losing so much that the antenna won’t receive enough power to generate a strong RF field (regardless of the antenna gain). If we are looking to maximize read range and the RFID reader is a significant distance away from the antenna (i.e. 20 feet or more), you should look into using a cable with a higher insulation rating. If your application doesn’t call for much read range, a cable with a lower insulation rating should be okay even for longer cables [85].

9- Environmental Factors: Different environmental conditions can affect the performance of UHF RFID systems. Water, metal, large machinery, and other radio waves may adversely affect UHF RFID read ranges. The best way to maximize read range is to note the various possible forms of interference and attempt to mitigate that interference by testing, making changes to our system, and retesting [85].

4.4. System solution for the company (proposed Model):

In this development project, the company needs to implement a system to locate their expensive spare parts. They hope to have an inventory system to produce active protection, which means every item enables to be identified, tracked and monitored. One of the viable technologies to realize this requirement is RFID technology and the identification of the tagged object is recognized by the RFID reader. The item will become active in presence of the correct ID. The design of the RFID solution is required to include item identification, tracking, and monitoring on a regular basis. And it also needs to be extensible so that further functionality can be added later. Both passive and active RFID solution can achieve the purpose.

4.4.1. Passive UHF RFID solution for spare parts:

Passive RFID tags have been utilized as a part of objects tracing and stock management for a long time. Furthermore, considering tag costs are one of the key contemplations in an RFID deployment, passive RFID tag solution, which is no-battery, more affordable and with the good shape factor, is the appropriate selection for the spare parts.

Different systems use different frequency bands, low frequency (125 kHz, 135 kHz), high frequency (13.56 MHz), ultra high frequency (860 – 950 MHz) and microwave frequency (2.45 GHz). The different frequency bands have different qualities. There are four most important elements which might be affected by using the frequency: the working range, the transfer rate, the ability to penetrate substances and the ability to face up to electromagnetic background noise.

The passive tag is planned to be attached to every Carton of spare parts or item itself Depending on the size of the object. UHF RFID is decided to use in the solution.

The whole RFID system contains three main parts: passive UHF tags, UHF RFID reader, and data management system which is the software to collect and manage the RFID data.

Passive UHF EPC tags comply with EPC Class 1 Gen2 standard. This standard is class 1 generation 2 UHF air interface protocol standard. It defines the physical and logical requirements for a passive-backscatter, Interrogator-talks-first, RFID system operating in UHF range [81].

EPC (Electronic Product Code) is a numbering scheme that allows assignment of a unique identifier to any physical object and allows for encoding of much more detailed item data than UPC (Universal Product Code) used in barcode systems.

In this system, Passive UHF EPC tags are attached to every object in the warehouse. Every object can be identified by an electronic product code in an automatic manner.

The antennas are mounted far from the reader unit and situated strategically to upgrade and enhance the quality and scope of the radio signals. All tagged products can be automatically monitored and locate its location

The software system is used to manage and manipulate the data transmitted between the tag and the reader and between the reader and the host computer. The brief structure of RFID System is shown in Figure 12.

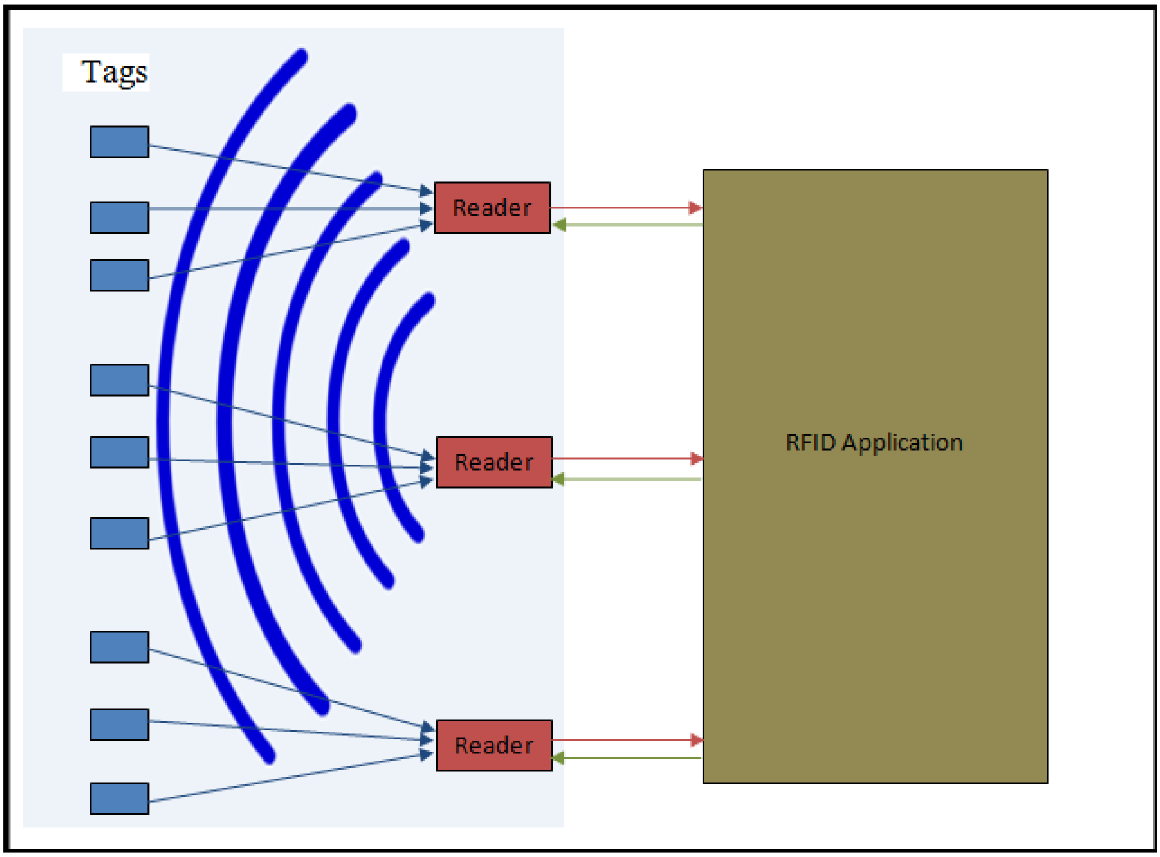


Figure4.14: Communication between RFID system components

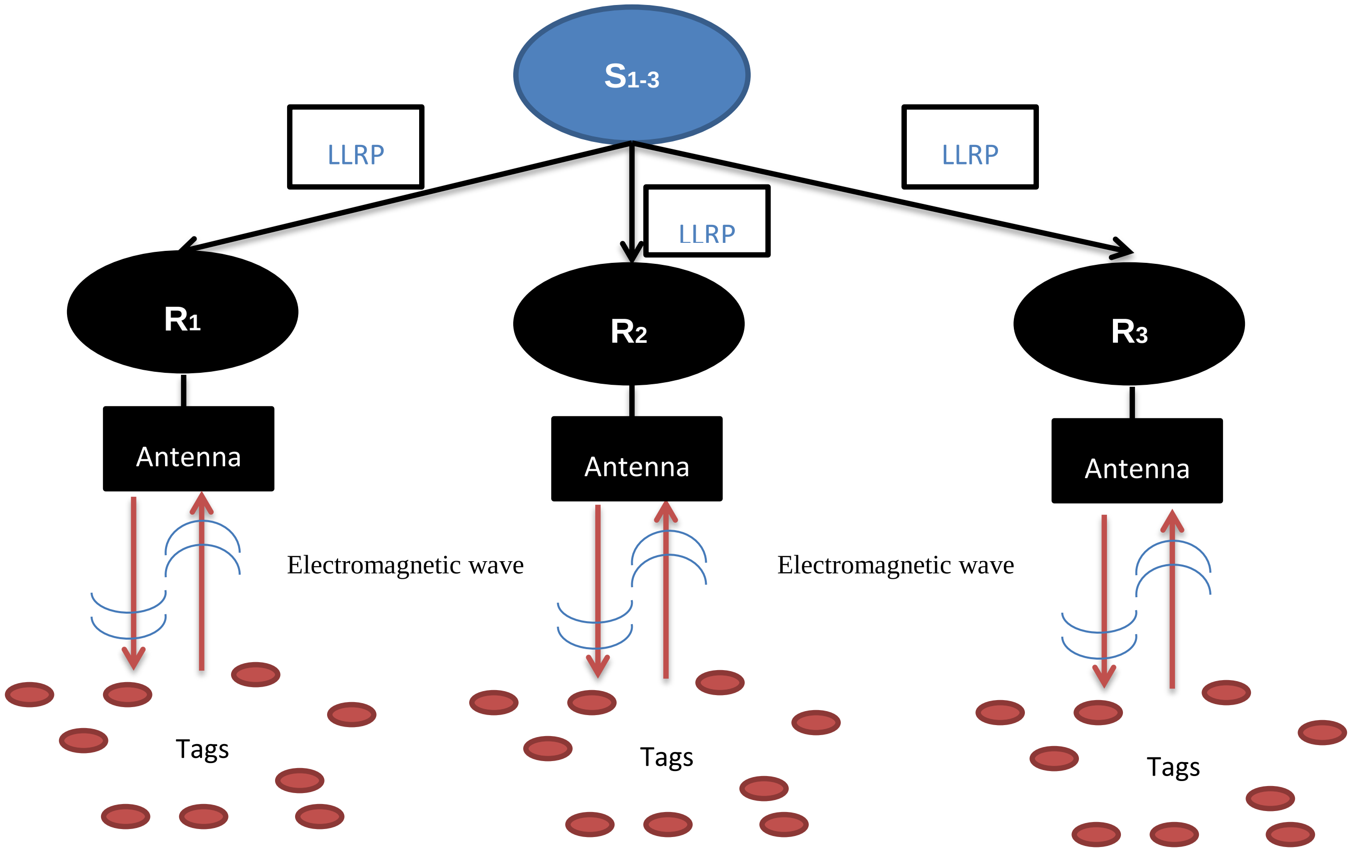


Figure4.15: Interaction between RFID system components

The UHF RFID system components are shown below:

Here we must mention that our system is built from two main parts (hardware and software).with RFID system we can track any product in a particular warehouse in an automatic way and with a greater accuracy.

In this section, we will describe the hardware components which are selected based on effectiveness, precision, and low cost and the system software.

4.4.2. Hardware components:

Generally speaking, four main parts make up in a passive UHF system: an RFID reader or interrogator, an RFID antenna, and RFID tags and host PC. Unlike active RFID tags, passive RFID tags only have two main components – the tag’s antenna and the microchip or integrated circuit (IC) [41].

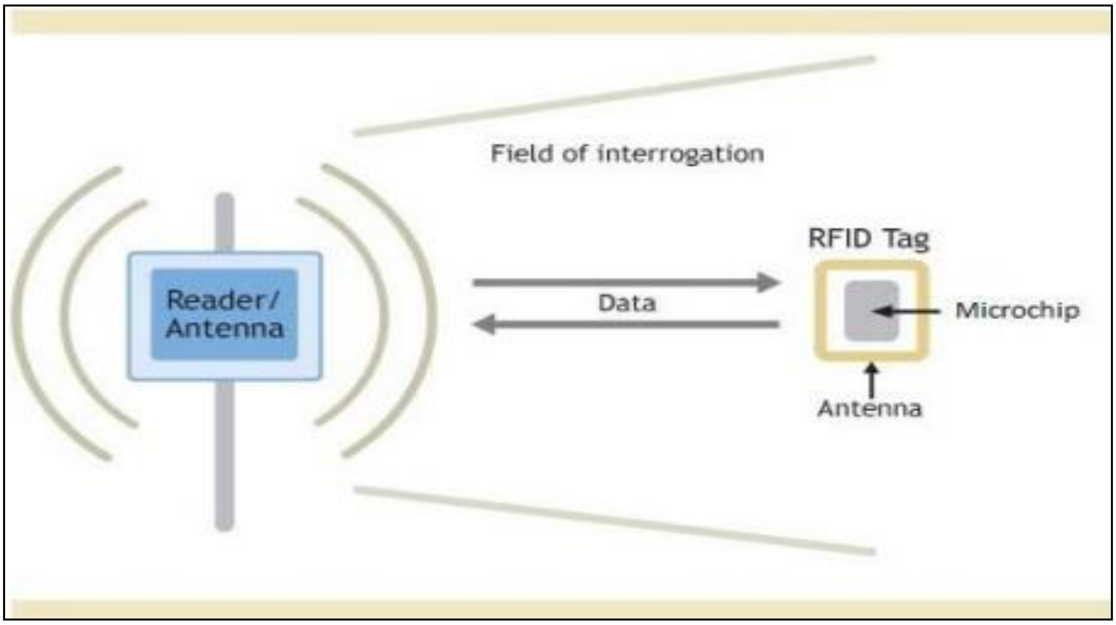


Figure4.16: an overview of RFID passive UHF system [41]

As the name implies, passive tags wait for a signal from an RFID reader. The reader sends the power to an antenna which converts that power into an RF wave that is sent into the reading zone. At the moment the tag is read inside the reading area, the RFID tag’s inner antenna attracts (receive) the energy from the RF waves. The power moves from the tag’s antenna to the IC and powers the chip which produces a signal back to the RF system. This is called backscatter.

The backscatter, or change in the electromagnetic or RF wave, is distinguished by the reader by means of the reception antenna, which explicates the data [41].

As said above, passive RFID tags have no inward power source, and a standard passive RFID tag comprises just of an IC and inner antenna; this essential structure is usually alluded to as a RFID inlay. Innumerable different kinds of passive RFID tags exist available; however, all tags ordinarily fall into two classifications – inlays or hard labels. Hard RFID labels are strong and made of plastic, metal, and even rubber. They come in all shapes and sizes and are typically designed for a unique function, material, or application [41].

When tracking small or large items. Size is one of the more important requests, so RFID tag has many different sizes available.

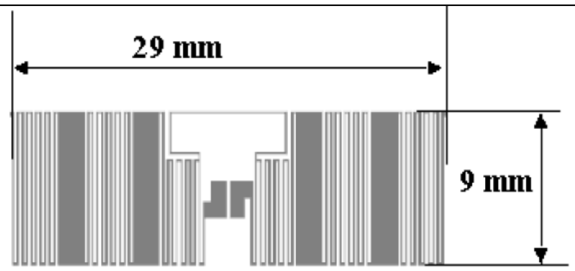
If the application requires tracking metal assets, UHF metal-mount tags may be the only option. These tags are particularly intended to decrease the problems UHF RFID faces around metal.

The main components can be summarized in the following

1- RFID tags used:

   Tags attached to each product (Per carton). We will use in our system UH113-MZ3 passive tag is designed by LAB-ID Company. The tag has 96 bit EPC memory and optimized performance when attached to different nonmetallic materials. It also has the very small form factor and good read range. The main features of the tag are shown as below in Table 4[82].

Table4.4: the specification of the tag UH113-MZ3

UH113-MZ3 passive tag	
Inlay Specifications	
Standard compliance:	ISO 18000-6C (EPC Class 1 Gen 2)
Operating frequency	860 -- 870 MHz
Operating temperature	-40 °C to +65 °C
Storage temperature	-40 °C to +85 °C
EPC memory	Impinj Monza™ 3 + 96 bit EPC memory
Application area	Inventory management and item-level logistics
Dimensions	37.5 x 20.32 mm
Antenna	28.8 x 9.1 mm – aluminum
Delivery format	dry inlay, wet inlay, label

Passive RFID tags do not all operate at the same frequency. There are three main frequencies within which passive RFID tags operate. The frequency range, along with other factors, strongly determines the read range and attachment materials [41].

- 125-134 KHz – Low Frequency (LF) – An extremely long wavelength with usually a short read range of about 1 – 10 centimeters. This frequency is typically used with animal tracking because it is not affected much by water or metal [42].

- 13.56 MHz – High Frequency (HF) & Near-Field Communication (NFC) – A medium wavelength with a typical read range of about 1 centimeter up to 1 meter. This frequency is used with data transmissions, access control applications, DVD kiosks, and passport security – applications that do not require a long read range [42].

- 865 – 960 MHz – Ultra High Frequency (UHF) – A short, high-energy wavelength of about one meter which translates to long read range. Passive UHF tags can be read from an average range of around 5 – 6 meters, only bigger UHF tags can accomplish up to 30+ meters of reading scope in perfect conditions. This frequency is regularly utilized with race timing, resource, and asset tracking, document, and file tracking as every one of these applications normally requires in excess of a meter of reading range. As a general rule, higher frequencies will have shorter, higher-energy wavelengths and, in turn, longer read ranges [42].

  Pros of Passive RFID: Smaller tags, substantially less expensive tags, more slender and more adaptable labels, the higher scope of tag options and tags can endure forever without a battery.

2- Long Range UHF RFID Reader:

In general, RFID readers use a standardized language called Low-Level Reader Protocol or LLRP. LLRP is a standardized protocol that any application can use to support RFID readers. Based on research there are many types of Readers like:

A- R2000 Long Range TCP/IP Reader 30M, which achieve high-speed processing operations, the stable reading distance could reach 30M, multiple tags reading ability and High sensitivity to tag [44].And the most important characteristic of its performance that high scanning speed of RFID reader up to 300 tags/sec and read distance of RFID reader reads up to 30 meters. The specification of the reader is shown in Table [5].

Table4.5: Specification of the Reader R2000 [44]

Item No:	
JT-9292A	RS232,RS485,Wiegand
JT-9292B	RS232,TCP/IP
JT-9292W	RS232,WIFI
JT-9292W	RS232,GPRS
Performance parameters:	
Working Frequency	902~928 MHz or 865~868MHz
Protocol	ISO18000-6C(EPC C1 GEN2)
Chip	Impinj R2000
RF power	0～30dBm(Adjustable)
Software & SDK	DEMO and C#, VC, Java
Industrial lightning protection	6000V
Low-temperature protection	Northeast, Northwest extremely cold region, low-temperature protection
Reading range	stable reading range 25 M(Depends on tag & environment)
Tag handling volume	0-200 tags
Storage space	1M or 8M Flash save without power supply(customized)
Real-time clock	without power supply, real-time clock save and working(customized)
Frequency modulation	hopping or fixed frequency
Input/output port	Two-way relay output(customized), two-way I/O

	input(customized)
RSSI	RSSI numerical test
Antenna gain	12dBi polarization
Working way	Buzzer
Power	12V/3A Adaptor
Ethernet power supply	POE(customized)
Physical parameters:	
Item size	450x450x50mm
Package size	600x480x110mm
Net weight	5KG
Shell material	ABS
Working temperature	-20℃~+65℃
Storage temperature	-45℃~+95℃

B- UHF RFID reader R600 is designed by Scirocco Company. The reader has highly dependable reading/writing execution. Up to 4 antennas can be linked. The reader likewise conforms to the ISO 18000-6C (an international standard that describes a series of diverse RFID technologies) UHF standard, which ensures interoperability with EPC Class 1 Gen 2 suitable tags. The specification of the reader is shown in Table 6[83].

Table4.6: the specification of the reader R600 [83]

UHF RFID reader R600	
Interfaces	Ethernet TCP/IP, RS232/485, 2+2+2 parallel I/O, relay
Dimensions	160 x 218 x 46 mm
Antenna connection	4 TNC female
Transmitting frequency	4 channels within 865-868 MHz
Radio frequency protocol	ISO 18000-6C (EPC Class 1 Gen 2)
Read/write range	5 m reading, 3.5 m writing
Data speed	170 reads/sec (EPC), 40 reads/sec

	(TID)
Power input	10 -- 30 Vdc, 12 W reading/writing
Weight	1.5 kg
Protection class (IEC 60529)	IP 65
Temperature	operating -20 to +50 °C
Radio certification	EN 302 208-1, -2
Electromagnetic compatibility	EN 301 489-1, -3
Vibration IEC 60068-2-6	0.01 g2/Hz, 0.5h x3 dir, 10-2000 Hz
Cover	Aluminum housing

3- Antenna:

UHF RFID reader antenna A100 is designed by Scirocco Company. This antenna has enclosure's square, symmetrical design. It can be mounted for vertical or horizontal polarization without restriction to how the front cover is oriented. The specification of the antenna is shown in Table 7 [84].

Table4.7: the specification of the antenna A100

UHF RFID reader antenna A100	
Polarization	Linear
Dimensions	212 x 212 x 46 mm
Antenna connection	TNC female, 50 ohms
Frequency range	865-868 MHz
Gain	8 dB
Weight	0.5 kg
Protection class	IP 65
Temperature, operating	-40 to +55 °C
Radio certification	EN 302 208-1, -2
Electromagnetic compatibility	EN 301 489-1, -3
Vibration IEC 60068-2-6	0.01 g2/Hz, 0.5h x3 dir.10-2000 Hz
Cover	Polycarbonate/aluminum housing

Thus we must keep in mind the following:

A- Shape and size of the antenna depend on warehouse environment
B- Distribution of the antennas in the store must cover and ensure the minimal errors in tags localization.
C- Take into consideration the distance between tag and antenna to get a good connectivity.
D- Estimate tag position based on reader path
E- The orientation of tag influences signal energy, Less energy might leading to a no-response
F- The gap between the physical and the "virtual" world must be bridged by design a geometric structure of a warehouse environment in the software program that simulates the real world.
G- For RFID tags are placed in the potential detection range of readers.
H- Several positions of same tags in one warehouse.
I- Shape and size of tags can be customized
J- An algorithm can accurately localize tags in case of intersection between two readers range.

By that representation can handle ambiguities in which location of the tag cannot be determined uniquely

4.4.3. Software system:

First, we must mention that the manufacturer may have a built-in conversion application that uses Low-Level Reader Protocol (LLRP). This is not often the case so we should always ensure that our middleware application will support LLRP and RFID readers [45].

We will present inventory tracking software that will put all of the RFID tag information to some specific purpose and utilizes the data obtained from the readers in some useful manner, therefore, multiple read cycles have to be performed in order to achieve a high-performance rate. The system with passive tags is a powerful tool for products identification so locate a specific item in the shortest possible time. When queried, the platform communicates with REID Readers which connect with RFID tags. The RFID reader reports the received tag ID to application software which can interpret the information contained in the tag ID.

We need to only know how many items we have on hand and where those items are located.

Functionalities of system Software: the major functions of system software are usability, the ability of data collecting, information management, monitoring and following warehouse items, identify products locations accurately and integration with all hardware parts of the system. It can be summarized in the following:

i. Efficient inventory tracking**:** meaning it the system allows tracking the inventory without having to be actively involved in the traditional process and will allow querying an item and immediately getting insights into product locations and quantities.
ii. Easier item location: Because we are automating the inventory system, we no longer need as much staff on hand to actively manage the inventory.
iii. Procurement forecasting: We can know how much we have on hand and how much we need to be ordered to meet the needs.
iv. Minimization of theft and loss based on improved visibility of stock counts and movement histories that make forensic inventory loss analysis easier to conduct and allowing to track authorized and unauthorized movement of inventory or assets within the facility.

4.4.4. Software modules:

Inventory Modular: Functionality required in the inventory module was as follows:

1. The ability to create, modify and enquire on stock items.
2. The ability to make stock adjustments.
3. The ability to determine the value of stock-on-hand for accounting purposes.
4. The ability to enter results from stock tracking (first time).
5. The ability to record the received items, adjusting the relevant stock levels accordingly.
6. The ability to freedom of transferring items from one location to another with an easy-to-use transaction interface.
7. The ability to distribute the items in many locations as you require.
8. The ability to update item's position.

4.4.5. System building:

1- Split and divide the warehouse into a group of areas that are covered from antenna's ranges which are distributed in a specific way as shown in Figure 4 below, then design approximate program screen illustrates the warehouse layout and RF readers' distribution that simulates the real world in the warehouse as shown in Figure 5 below.

2- The nearest neighbor antenna works to shorten the distance significantly between the transmitter and the receiver by creating several electromagnetic fields to cover all areas of the warehouse and thus make the signal between them as short as possible. Which is reflected positively on the factor of speed and therefore, of course, the time factor.

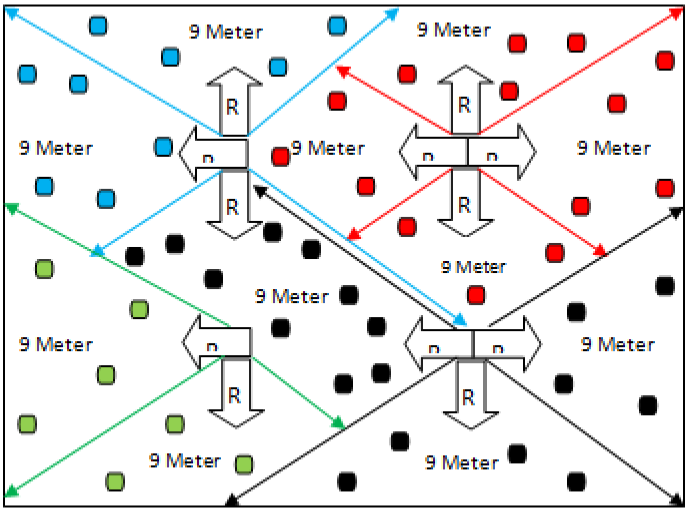


Figure4.17: A way to distribute RF readers inside the warehouse

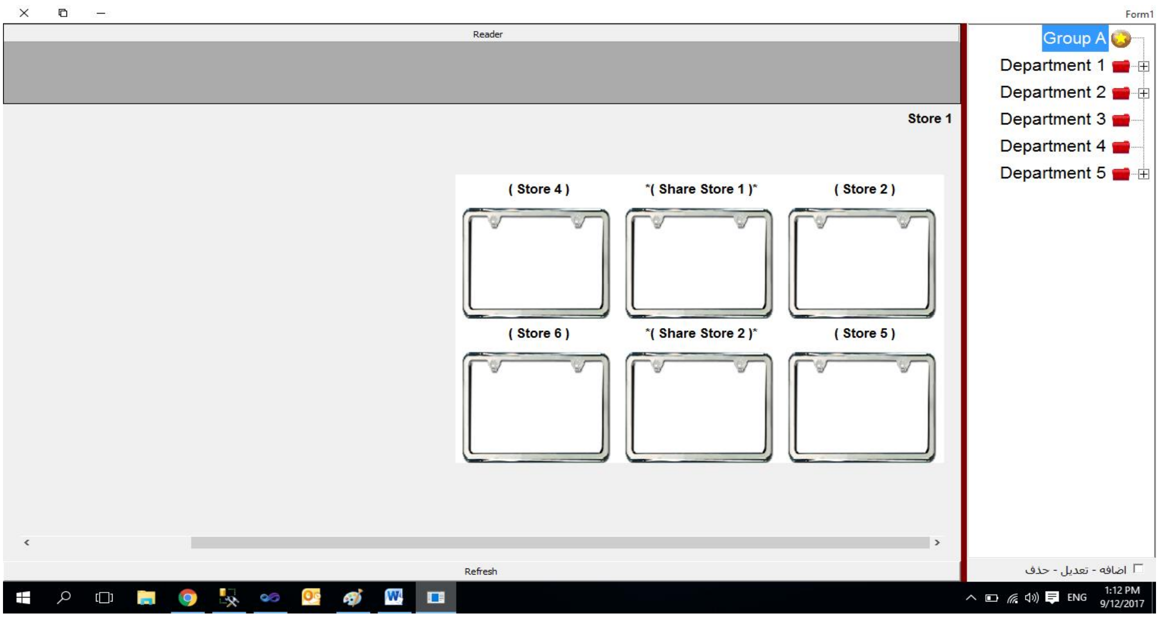


Figure4.18: approximate layout of the warehouse areas

3- There are places within the warehouse located in a common range for more than one reader (Reader-Reader Interference). Thus, there is a problem in calculating the quantity of the product inside the warehouse, and there is another problem with the product location. Solving this problem lies in naming the readers with ascending alphabetical letters and using this alphabetical order to prioritize the location of the product within the store and calculate its quantity.

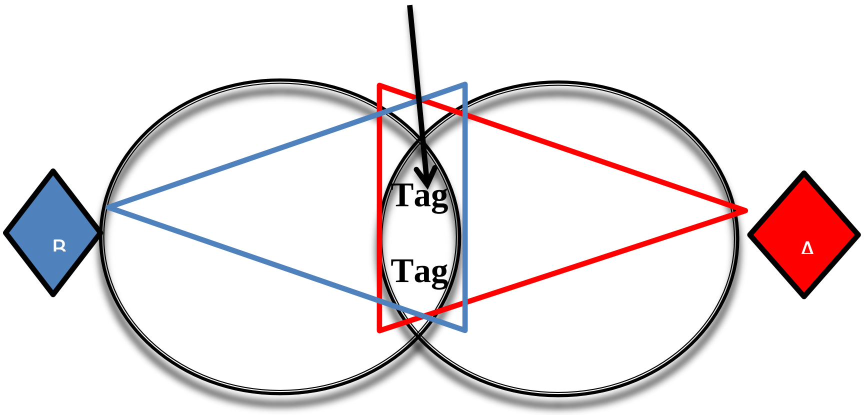


Figure4.19: intersection area between two readers

4- Stick the RFID labels for every item in the warehouse and supply each tag with particular data about item, for example, stock number, batch number, generation date, or other extraordinary data along these lines it turns into a unique label serial number, Since labels have singular serial numbers, the RFID system design can segregate among a few labels that may be inside the scope of the RFID reader and read them at the same time. Frequently in excess of one tag will react to a tag reader, for instance, numerous individual items with labels might be shipped in a box or on a pallet. Collision detection is imperative to permit reading of information. Two unique kinds of protocols are utilized to "singulate" a specific tag, enabling its information to be read amidst numerous identical labels. In a slotted Aloha system, the reader broadcasts an initialization order and a parameter that the labels exclusively use to pseudo-randomly delay their reactions (responses). When utilizing an adaptive binary tree protocol, the reader sends an initialization symbol and after that transmits one bit of ID information at a time; just tags with coordinating bits react, and in the end, just a single tag matches the complete ID string [26].

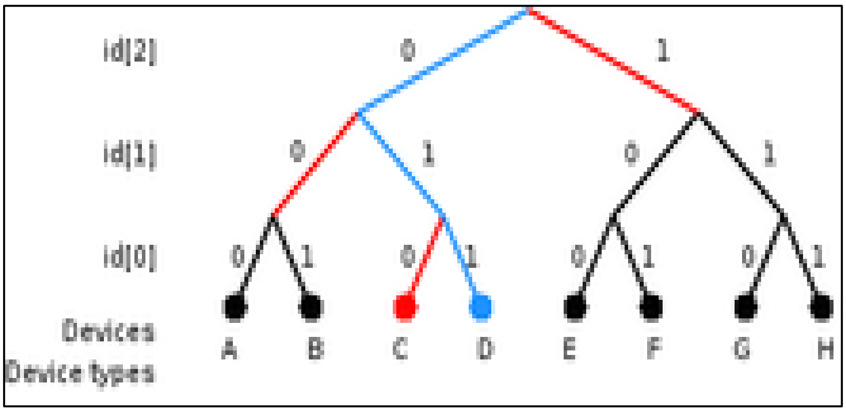


Figure4.20: describe an example of a binary tree method of identifying an RFID tag [28]

Both methods have drawbacks when used with many tags or with multiple overlapping readers. Bulk reading is a technique for questioning numerous labels simultaneously yet needs adequate accuracy for stock control [28].

5- Design an software that is able to locate the products in the warehouse and account its quantity through the areas that are covered from RFID Readers.(Each product belongs to (€) a specific reader(s))

4.4.5.1. Databases: ERD diagram

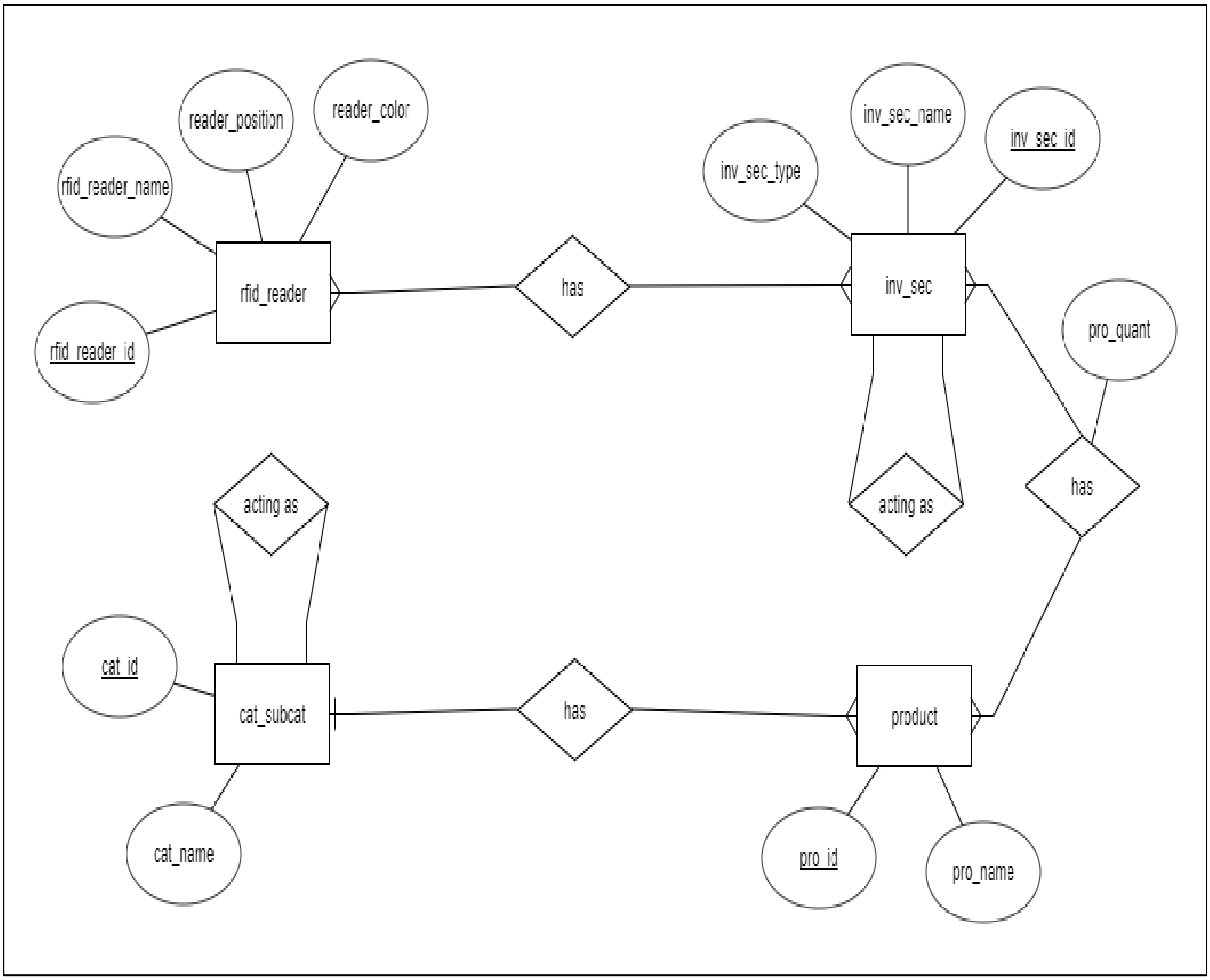


Figure4.20: ERD diagram of database

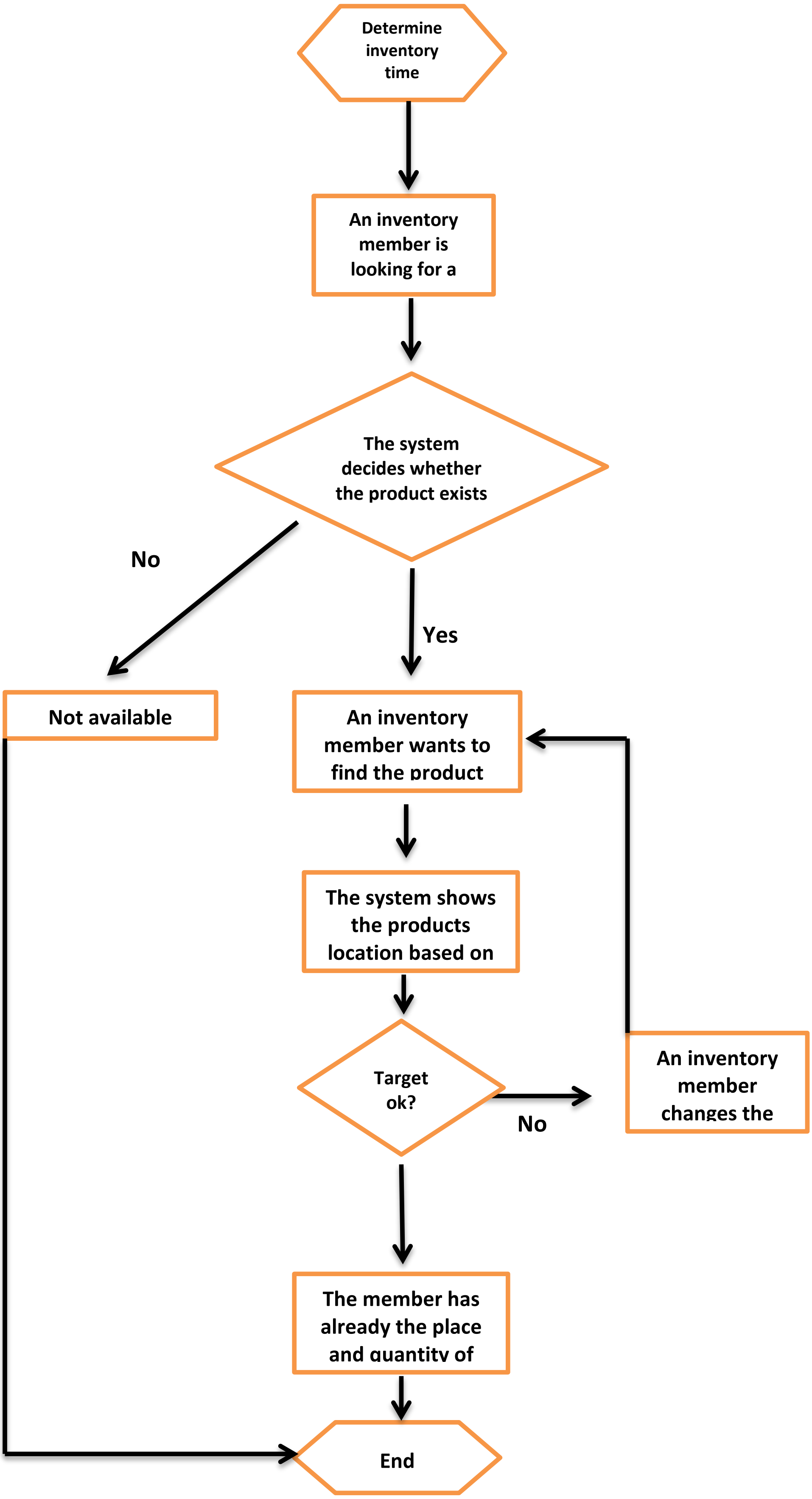


Figure4.21: flow chart

4.4.5.2. Use cases:

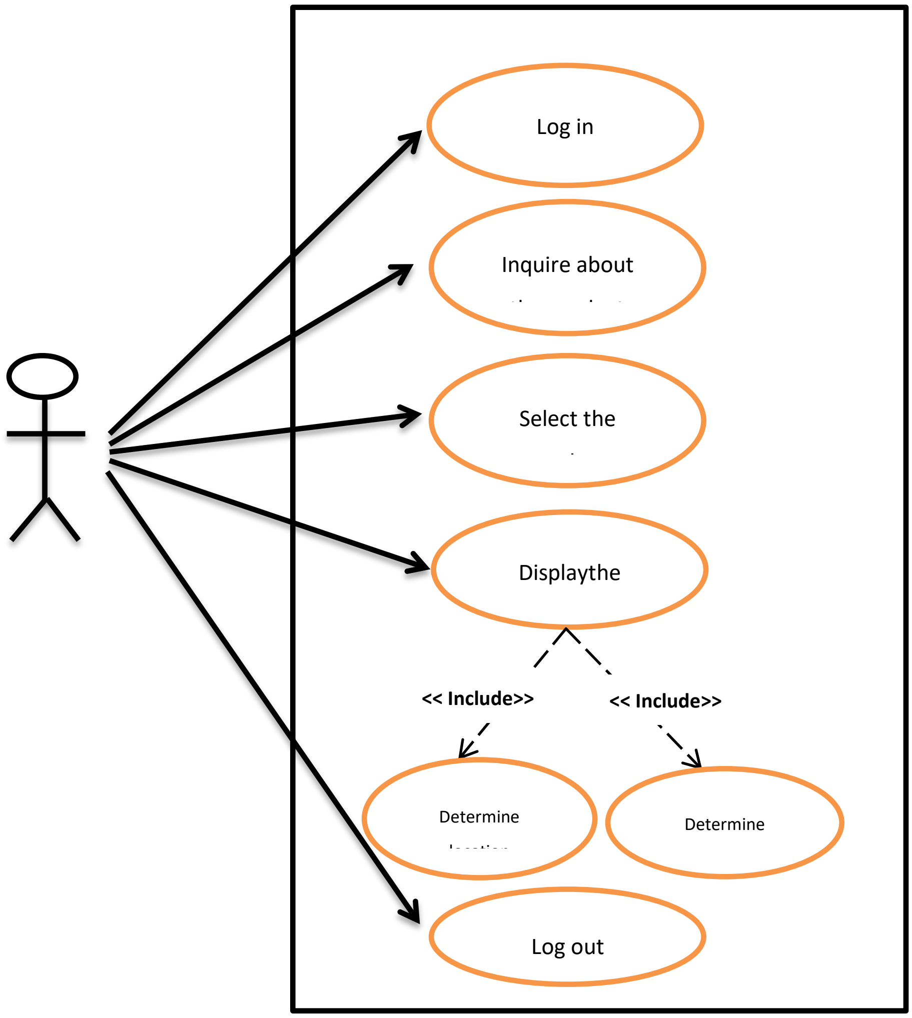


Figure4.22: Use cases

4.4.5.3. Software Application (screenshots):

1- Login into the program:

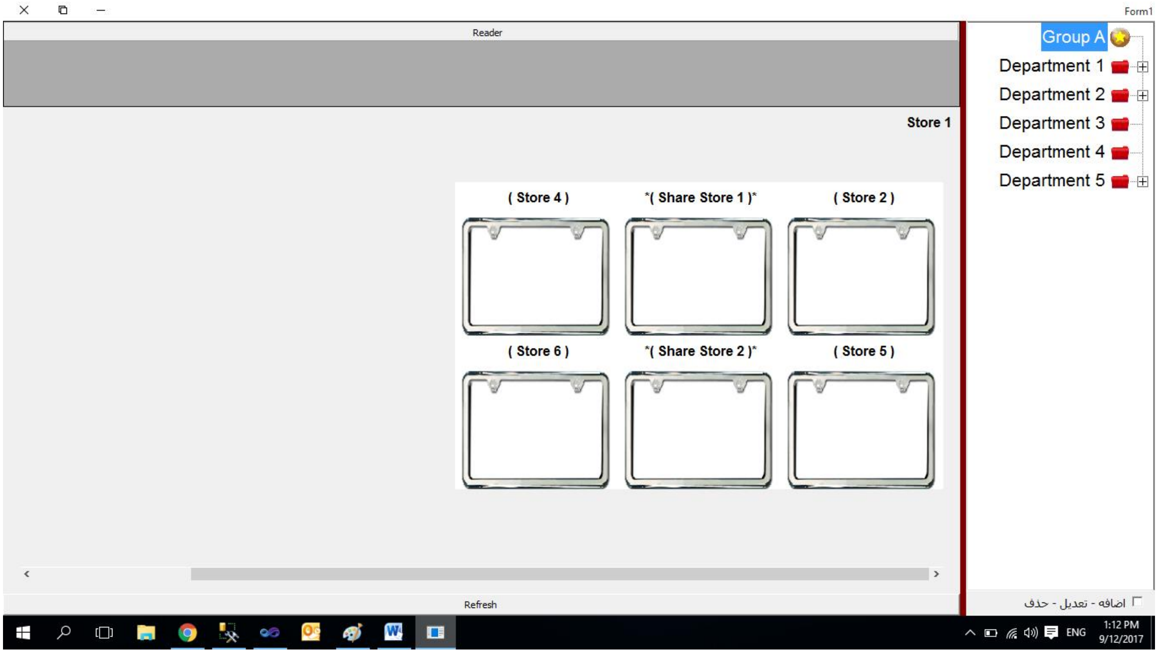


Figure4.23: illustrate the basic screen after login

2- Select a department:

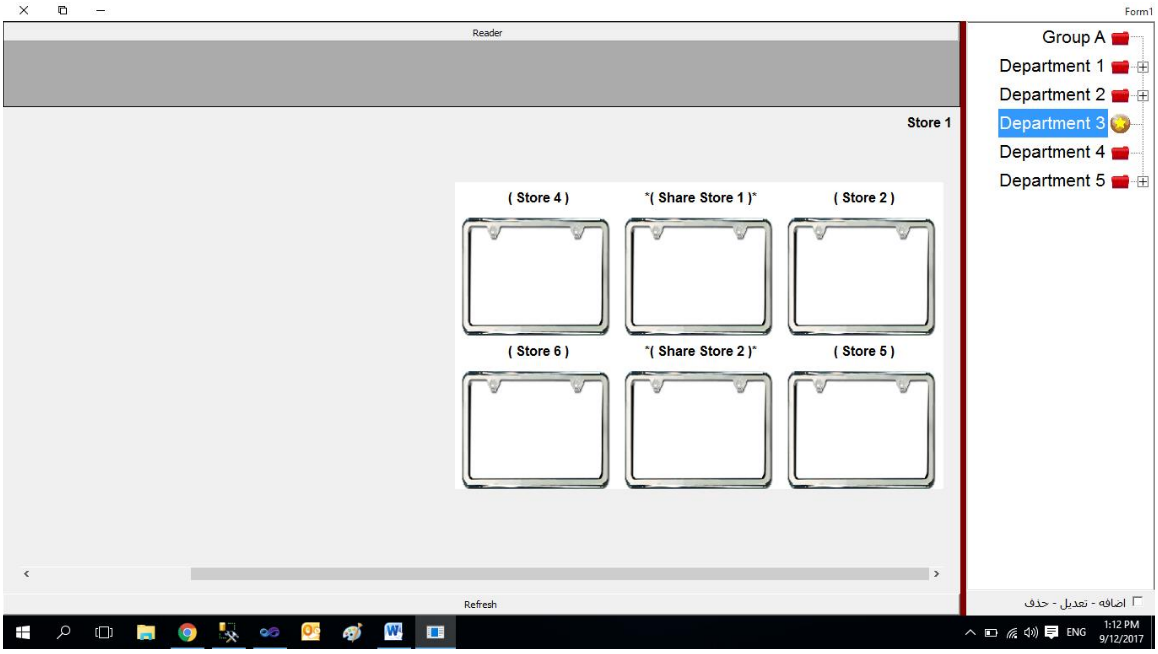


Figure4.24: selection a department

3- Select a product:

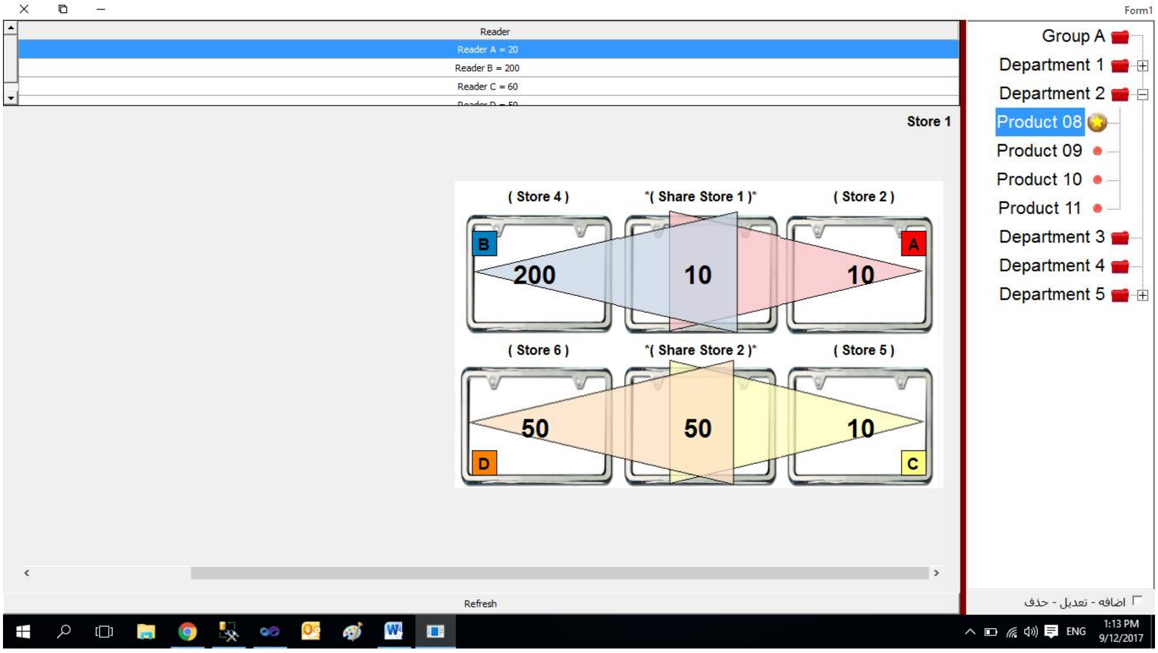


Figure4.25: showing the Places of the selected product in the warehouse

4- Show the result:

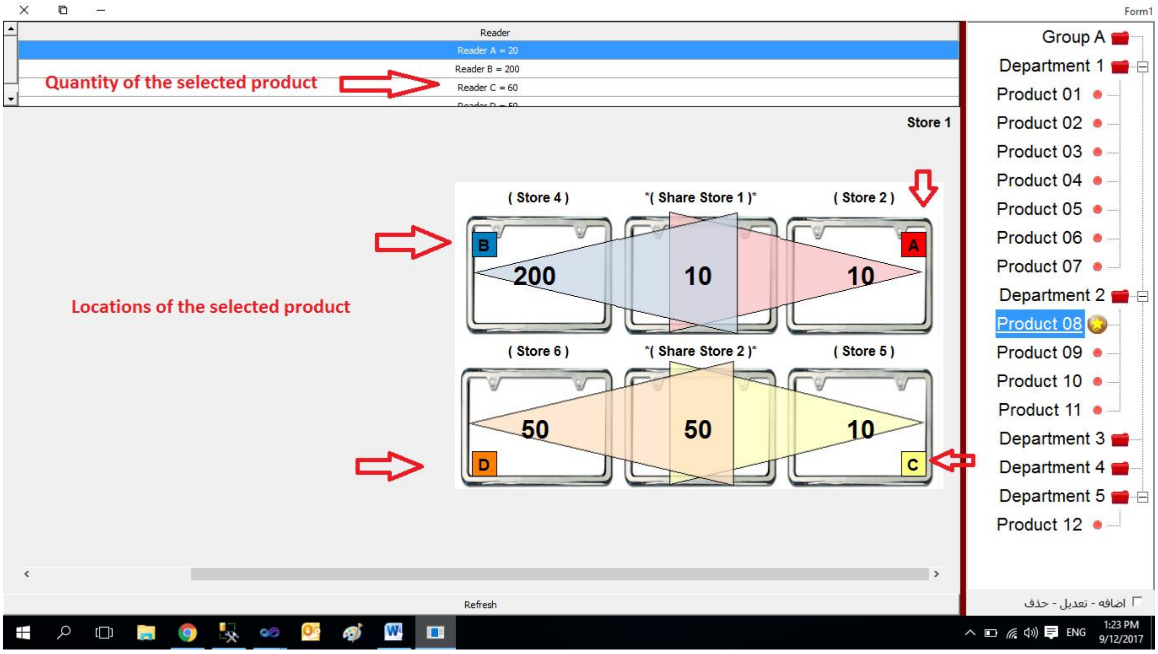


Figure4.26: showing the quantity based on each location

5- Steps of Change the product location in the warehouse:

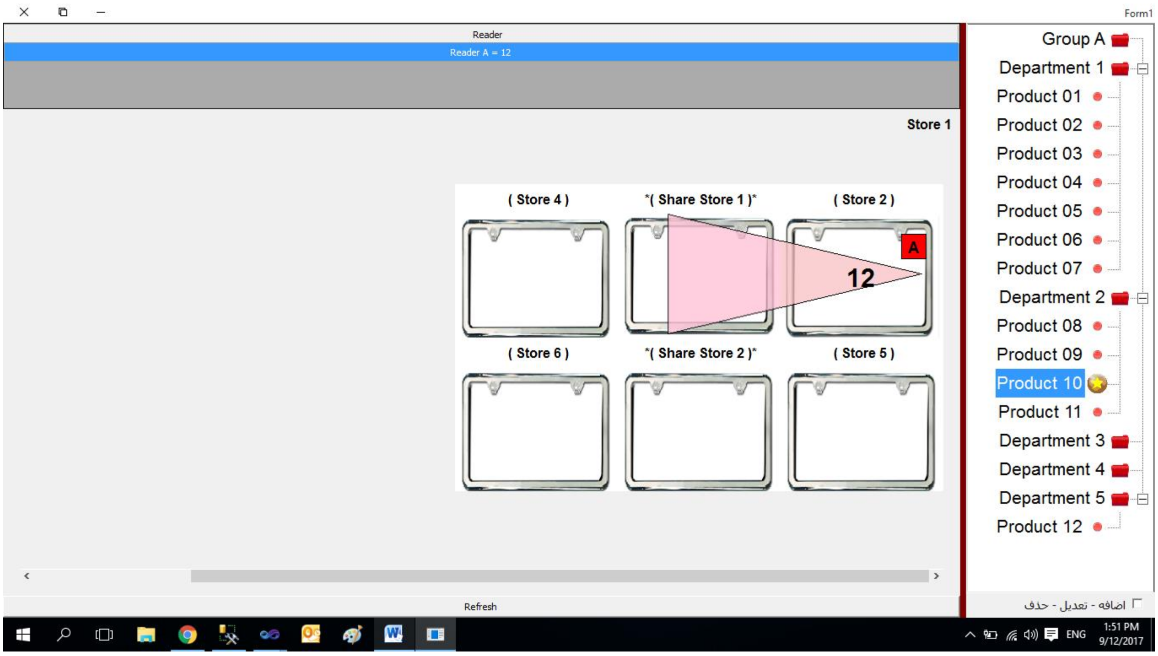


Figure4.27: First location of the selected product

Note: Change the product location(s) based on (according to) the reality new location in the warehouse.

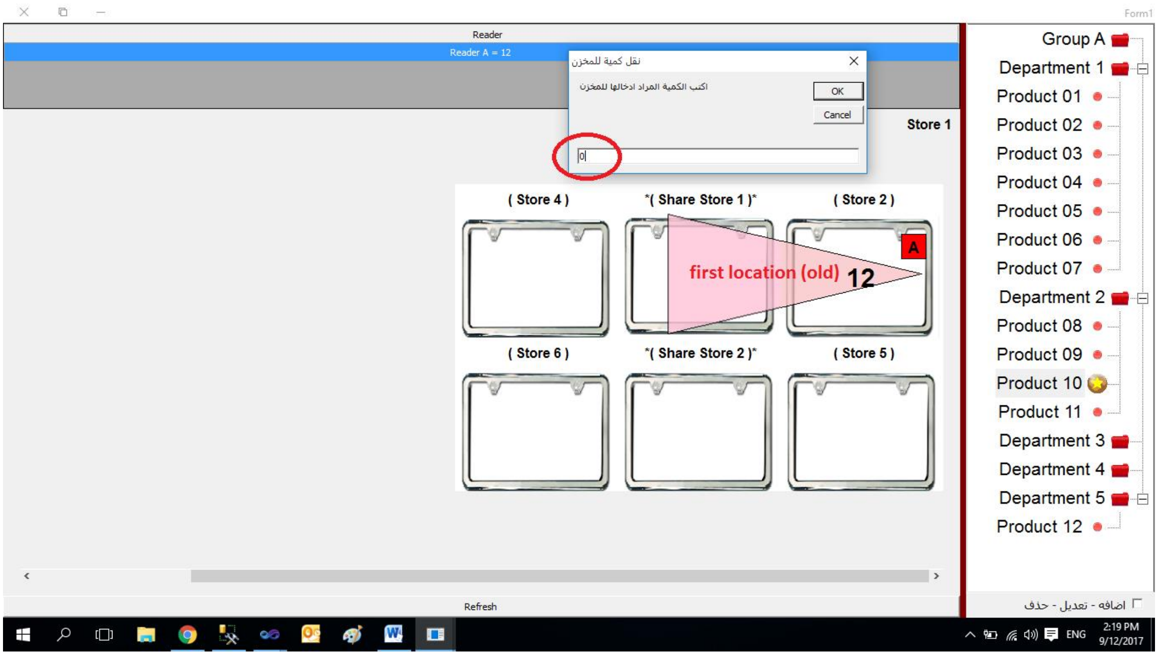


Figure4.28: reset the value (by zero) for the old location of the product

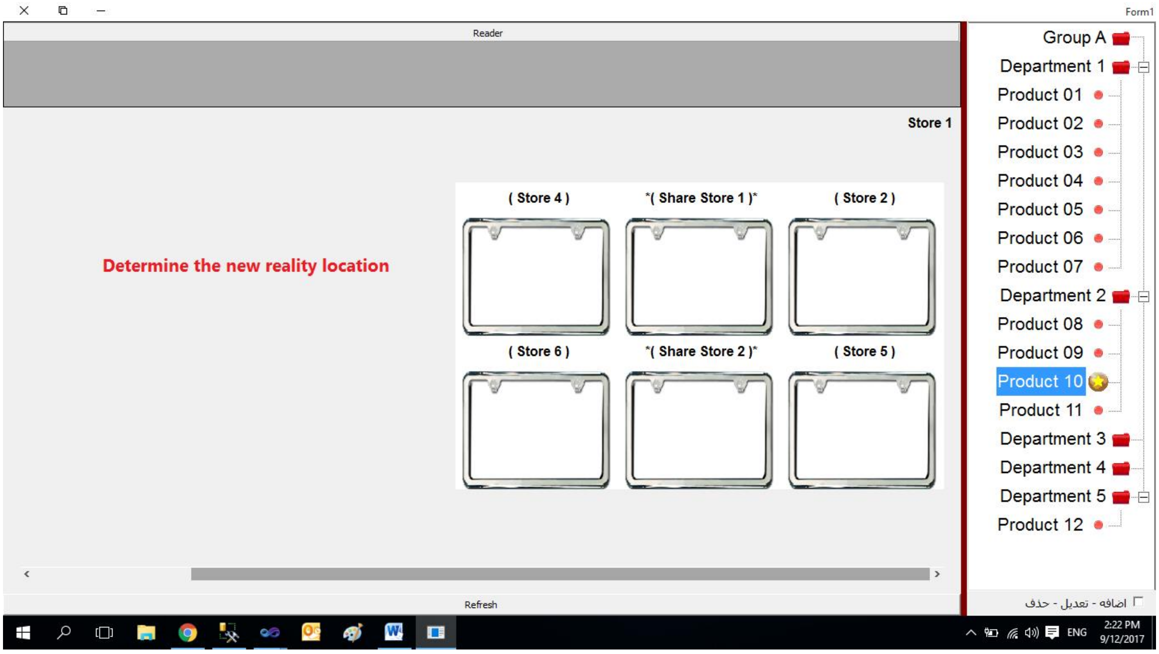


Figure4.30: determine the new reality location

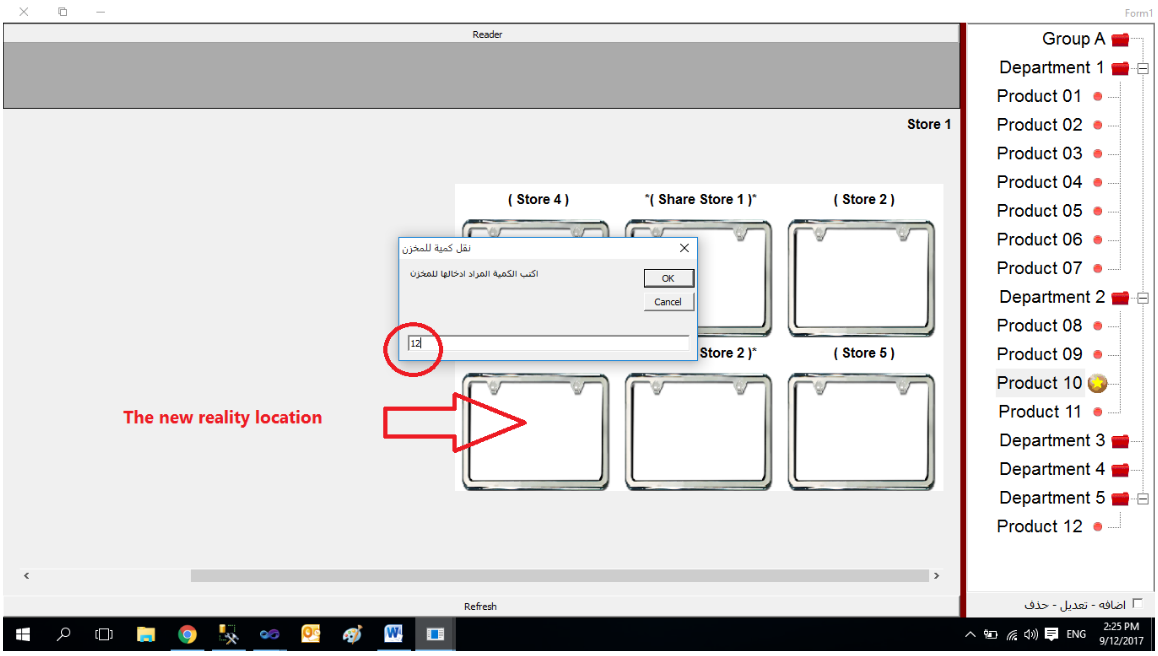


Figure4.29: insert the same value in the new location

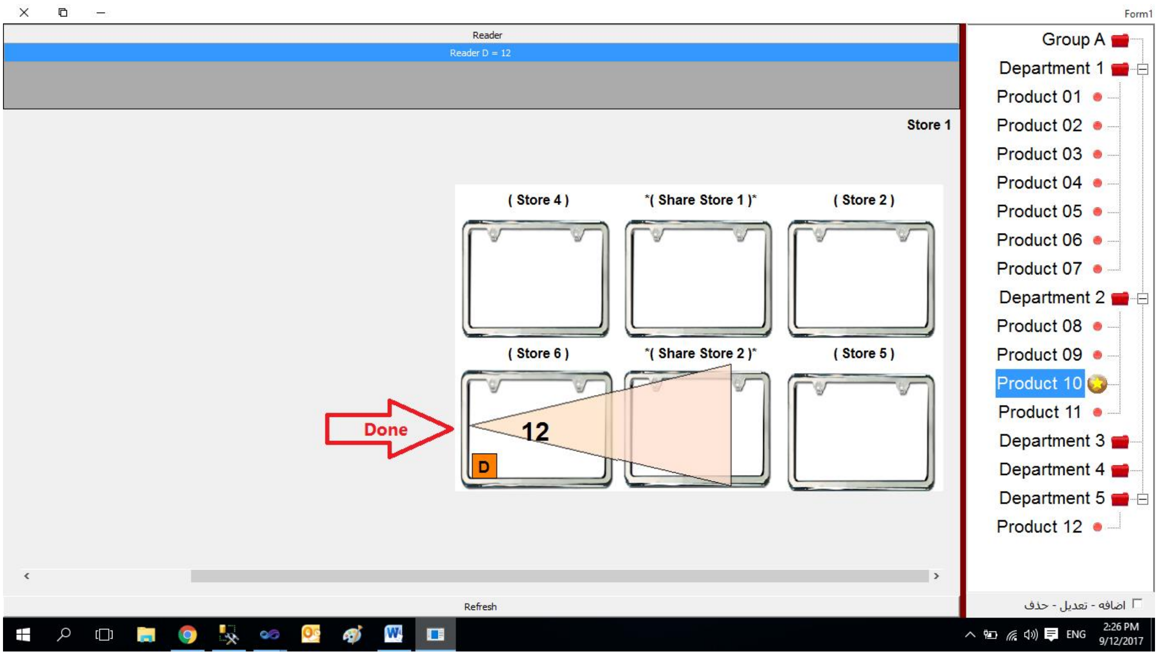


Figure4.30: Drag and drop the product from the index in the new reality location(s) with the same value

4.5. Summary:

Make an approximate picture of the warehouse area after the inspection (rectangle shape or square ....), divide the main warehouse into a set of sub-warehouses to facilitate the work of inventory employee and to paint a more accurate picture of the warehouse, the installation of readers in the warehouse by a form that ensures coverage of the entire warehouse space taking into account the scope and the number of used readers and the budget of the company.

Is it possible to dispense with the readers and divide the main warehouse into several small sub-warehouses and connect with them directly?

The traditional idea that used in the field of warehouses is to divide the main warehouse into several sub-warehouses and to arrange and classify the products in those sub-warehouses without relying on technology. Available financial capabilities determine the type and number of readers within the warehouse and the extent of their scope (The higher the range, the higher the cost).

The reader with wide range divides and covers the main warehouse into several sub-warehouses less than the traditional way because it represents a specific area depending on the scope (range) of coverage of this reader Thus; the main warehouse was divided into several areas based on the extent of the reader's coverage.

When an update is made to the data stored on the tags (the manufacturer-quantity - date of expiration – etc.) readers read the new data and stored in the databases in addition, it can easily locate a particular product. In the traditional case, the data must be modified through the manual adjustment in the databases

We are talking about Automated Data Collection technology that utilizes radio frequency waves to transfer and exchange the information, it is quick, does not require physical contact amongst reader and the tagged object, and implements the task utilizing minimal cost components.

How Does an RFID Reader Energize Passive RFID Tags? How is this accomplished? One way to do this is to create a magnetic field and send energy through a tag via inductive coupling [53]:

Passive low-frequency (LF) and high-frequency (HF) tags use this method. The reader antenna has a coil, and the tag antenna also has a coil. Sending energy through the coiled wire in the reader antenna enables the two coils to form an electromagnetic field. Changes in voltage in the reader antenna coil induce a voltage in the coil of the tag antenna, thereby powering up the tag [53].

Passive ultrahigh-frequency (UHF) tags do not have a coil. They operate in the far field, meaning the tag is usually interrogated from more than one wavelength away. The reader antenna sends out electromagnetic waves, which then reach the UHF tag's antenna, causing an electrical current to flow through that antenna. This charge can be boosted using a charge pump on the chip, and it is then used to power the tag chip. This method of receiving energy from the UHF reader is sometimes called energy harvesting [53].

Chapter 5: Results, Analysis, and Evaluation

5.1. Introduction:

Since we cannot do an actual experiment with the high cost for us, we recommend that the experiments will be carried out by at least two kinds of readers. The aim of the project is to test the performance characteristics of different Passive UHF RFID tags when attached to different products. There are 2 different tags on which the tests will be performed, with different kinds of products. The tests will be carried out with the tags in front of the different products. Both the Backscatter analysis and Electromagnetic field threshold will be carried out on the tags with and without the products. All the tests will be carried out for two different environmental conditions. All the tests will be carried on all the products in the same setup and similar fashion and at the same time so as to maintain the uniformity in the test results.

Firstly, we will clarify the difference between RFID technology and barcode. RFID technology had already been trialed and implemented in the warehouse environment and in operation alongside barcoding systems. Generally, radio-frequency identification (RFID) is a wireless data capturing technique that utilizes radio frequency (RF) waves for automatic identification of objects. RFID relies on RF waves for data transmission between the data carrying the device, called the RFID tag, and the interrogator [48].In other words, consists of readers (also called interrogators) and tags (or transponders). A typical system has a few readers, either stationary or mobile and many tags, which are attached to objects, such as pallets, cartons, etc. A reader communicates with the tags in its wireless range and collects information about the objects to which tags are attached [49]. On the other side, Barcode labels have been used to track items and stocks for some time after their inception in the early 1970s. Though barcodes are printed in marks and spaces and are very cheap to implement, they present undeniable obstacles in terms of their short-range readability and no automated tracking. These limitations currently cost large corporations millions of dollars per annum [47].

Secondly, we will clarify the difference between this solution and other techniques. When the relatively high cost of GPS devices is a preventing factor, RFID technology becomes a possible solution to obtain object location information since the RF signal between a reader and a tag reflects the information between them. Location is kind of important information's, which plays an important role in many awareness applications, such as monitoring parts and inventory in an organization, tracking the products flow in the warehouse. Obviously, object location based on RFID technology is a convenient and valuable addition to the applications. On the other hand RFID technology with the object, distance consideration is used in real-time data collection and efficient interfacing with the management control system in the warehouse. That creates an integrated framework for inventory management.

RFID functions as a medium for numerous tasks including managing supply chains, tracking livestock, preventing counterfeiting, controlling building access, supporting automated checkout, developing smart home appliances, locating children, and even foiling grave robbers [51].

When we talk about the accuracy of the inventory process which is based on object distance consideration using passive RFID tags, we must mention first that locating the product more accurately in the warehouse leads to a more accurate inventory. This is achieved through communication between three main parts the Application software, the RFID readers, and the RFID tags are attached to all items that are to be tracked. Application software sends control commands to connectivity RFID readers and receives data (quantity) from RFID attached tags and through information that is coming from the readers, the location of the product is determined by naming (A-z) and distributing the antennas in the warehouse. If the product is in an intersection place between two nearby antennas the product location is determined based on the priority of the alphabetical order of the antennas. Thus no duplication occurred in the quantity or location of the selected item, taking into account the existence of multiple

RFID tags in multiple ranges of readers. RFID technology itself becomes a possible solution to obtain object location information.

Thus, a number of questions were answered:

1- When multiple RFID tags are detected, how to differentiate one item from another?
2- Is the item located within the range of any reader (belongs to an antenna(s))?
3- In case of more than one antenna detects the item, what will it do?
4- Finally, are these readers close or distant?

The gained time and the gained space optimization using this solution: Tracking the location of the tagged items enables effortless progress monitoring and supports real-time sensing of stock status. We developed an RFID tracking system for improving the inventory process in the warehouse through developed a method to locate products. The method requires the warehouse be equipped with an RFID reader, group of antennas and groups of a tag. This system provides the absolute position information of the product in the shortest possible time.

A technique of the nearest-neighbor reader (Antenna) works to shorten the distance significantly between the transmitter and the receiver by creating several electromagnetic fields to cover all areas of the warehouse and thus make the signal between them as short as possible. Which is reflected positively on the factor of speed, therefore, of course, the time factor. This technique uses the largest possible number of products in the smallest possible space for the storing in the warehouse where the location and quantity of the product can be determined accurately and speedily.

There is the main problem faced by my company in the past to manage inventory process without the traditional way that how to improve the accuracy of the inventory process? And how to have a more organized warehouse with time and money saving?

We can say that through this system most problems can be solved because it performs the following tasks:

1- Determine the exact position of the selected item with thousands of items in a warehouse.
2- Automatic update of currently item quantity.
3- Prevent product shortages and allowed to keep just enough stock without having too much in the warehouse.
4- More organized warehouse.
5- Save time and money.
6- Use a suitable system at the lowest possible cost.
7- Increases efficiency and productivity.
8- Reduce the chance of misplacement, and also can help the operators to find the misplaced items in the event of such incidents, so can significantly reduce the time to retrieve the misplaced items in a warehouse.

5.2. RFID versus. Barcodes

Barcodes are usually printed on paper labels or on the outside of the packaging. The paper might damage resulting in bad reads from the barcode scanner. This means a person will have to manually type the number corresponding to the barcode [54].

RFID uses radio frequency, which allows the tags to be attached to items inside boxes or pallets. RFID will even work behind walls. The tags do not have to be visible in contrast with barcodes, an optical technique. Barcodes can store unique identifying numbers usually on class level, while RFID can store instance level identification numbers: a number for every unique product. Next, to that, there is space available for additional information like expiration, use-by, and sell-by dates or instructions. RFID systems are automated able to consecutively read out a lot of tags at nearly the same time. These advantages show us the potency RFID has to bring the global supply system a lot of efficiencies [54].See the table below for a direct comparison of the two technologies.

Table4.8: Comparison of RFID & Barcode [55]

	RFID	Barcode
Read Rate	High throughput. Multiple (>100) tags can be read simultaneously.	Very low throughput. Tags can only be read manually, one at a time.
Line of Sight	Not required. Items can be oriented in any direction, as long as it is in the read range, and direct line of sight is never required.	Definitely required. The scanner must physically see each item directly to scan, and items must be oriented in a very specific manner.
Human Capital	Virtually none. Once up and running, the system is completely automated.	Large requirements. Laborers must scan each tag.
Read/Write Capability	More than just reading. Ability to read, writes, modify, and update.	Read-only. Ability to read items and nothing else.
Durability	High. Much better protected, and can even be internally attached, so it can be read in very harsh	Low. Easily damaged or removed; cannot be read if dirty or greasy.

	environments.	
Security	High. Difficult to replicate. Data can be encrypted; passwords protected, or include a “kill” feature to remove data permanently, so information stored is much more secure.	Low. Much easier to reproduce or counterfeit.
Event Triggering	Capable. Can be used to trigger certain events (like door openings, alarms, etc.).	Not capable. Cannot be used to trigger events.

RFID (Radio Frequency Identification) is an emerging technology intended to complement or replace traditional barcode technology to identify, track, and trace items automatically. RFID is claimed to add intelligence to and to minimize human intervention in the item identification process by using electronic tags. The tags are significantly different from printed barcodes in their capacity to hold data, the range at which the tags can be read, and the absence of line-of-sight constraints [56].

Ordinary barcode labels cost less than a cent on average. However, they easily become soiled, dirty, torn, marked over, hidden in frost, and need line-of-sight orientation. Correct orientation requires extra human intervention to make the barcode readable. RFID tags do not suffer from these disadvantages. In addition, unique features such as the ability to be written to and long-range potentially can spawn a whole new set of applications and radically improve the performance of applications such as inventory management and supply chain management. The possibility of automatically detecting and tracking items promises substantial reductions in costs and time needed for inventory management. In short, applications built around this technology can provide both operational and strategic benefits to adopting organizations [56].

5.3. RFID with object distance consideration vs. other technologies:

A variety of methods have been developed for the purpose of locating the object. They can be classified into RF-based techniques and non RF-based techniques. The non RF-based localization techniques include audio-visual localization, ultrasonic localization, infrared localization, and laser localization. Meanwhile, RF-based localization techniques include GPS technology, wireless local area network (WLAN) localization, and RFID localization. The pervasive nature of RF signals provides these techniques certain advantages over the non RF-based ones [50].

Non RF-based localization techniques: include Audio, vision, ultrasound, infrared and laser techniques have been widely applied to object localization for a long time. Typically, localization is realized based on time-of-arrival of signals and the multi literation algorithm. The bat location system [57] is a good example.

A pulse of ultrasound is emitted from a transmitter attached to the target object, and the signal is received by receivers. The distance from the transmitter to each receiver can be calculated based on the time-of-flight and the speed of sound in air. The 3D position of the object can be determined by the multi literation algorithm if three or more such distances are given. Object orientation information can also be obtained by finding the relative positions of two or more Bats attached to the object. Other examples include the localization of high-speed mobile robots based on laser light source [58] and the localization of badges in a building based on the infrared communication between badges and sensors in the building [59]. In general, these localization techniques are relatively mature, but they are vulnerable to environmental disruptions. For instance, audio systems are sensitive to noises, and vision and laser systems can be easily blocked by the obstacles in their application space.

RF-based localization techniques include GPS technology, wireless local area network (WLAN) localization, and RFID localization [50].

A- GPS: Global positioning system (GPS), developed by the United States, is a localization technology based on a constellation of about 24 satellites orbiting the earth at altitudes of approximately 11,000 miles. Similar systems are being developed by other countries. As the most widely used localization system, GPS employs time-of-arrival of RF signals for localization. It measures the time delay between transmission and reception of each GPS radio signal to calculate the distance to each satellite and applies the principle of multi literation to determine the position [50]. GPS has been used in resources investigation, transportation navigation and monitoring, electronic mapping, and military operations. A GPS system mainly consists of GPS satellite constellation, a ground control network, and user equipment (often called GPS receivers). There are two levels of service, namely, a standard positioning service (SPS) for general civil use; and a precise positioning service (PPS) for military use which demands higher position accuracy [50]. While GPS works well outdoors, it performs poorly or even cannot work in indoor environments. This is because the radio signals are blocked by buildings, and thus the transient time of- light is rather difficult and costly to measure [60].

B- WLAN localization: This technique uses WLAN devices as localization sensors and beacons, and localizes the object according to the signal strength information between the object and the beacons. Compared with the non RF-based localization sensors, such as cameras and laser range-finders, WLAN localization has several advantages. First, the devices are inexpensive and light-weight and have low power consumption. Second, an increasing number of environments are pre-equipped with suitable beacons in the form of WLAN access points, which provides a convenient infrastructure for localization. Nevertheless, WLAN devices are usually required to wire with a computer or a controller, and this makes WLAN localization systems not very portable and only good for indoors environments [50].

Numerous studies on localization using WLAN devices can be found in literature, and we only cite a few instances here [50].

1- Smaliagic and Kogan developed a localization system using IEEE 802.11b wireless network by using the multi literation algorithm, as well as a quadratic polynomial representing the distance-signal strength relation [61].
2- Similarly, Castro et al. (2001) developed a wireless localization device that uses Bayesian networks to infer the location of objects covered by IEEE 802.11 wireless network [62].
3- Ladd et al. (2002) conducted a series of localization experiments with a laptop and a PCMCIA wireless Ethernet card. The localization precision of less than 1mwith a probability of 0.64was achieved [63].
4- Howard et al. (2003) studied the use of WLAN as a localization sensor for mobile robots. It shows that given a sufficient number of beacons and a signal strength map, robots can be localized to a resolution of 0.5 m [64].
5- Yu et al. (2006) investigated the performance of different position estimation methods by using the time-of-arrival of ultra-wideband signals. The low cost/low complexity system

was successfully tested in a ski field where skiers were tracked and localized [65].

C- RFID localization: RFID localization is similar to WLAN localization in principle. It typically employs the RF signal strength, instead of time-of-arrival of the signal, as an indicator of distance. Its main advantage over the WLAN technique is the easiness of deployment—RFID tags are portable and do not require cables for communication. Due to the nature of RF signals, the algorithms developed for WLAN localization are also suitable for RFID localization [50].

Most of the RFID localization research has been on active RFID devices to date. However, passive RFID localization is attractive because the cost of a passive tag is only an insignificant fraction of an active tag. Frequency determines the core characteristics of RFID systems. Among the passive tags of different frequencies, LF and HF tags are generally less effective for localization in that their typical read ranges are less than 2m, while UHF and microwave tags are preferred due to their longer read ranges (up to 6 m). On the other hand, for many instances, HF tags could be chosen over UHF tags because they have greater tolerance of water [50].

An extension of WLAN and RFID localizations is the localization based on wireless sensor network (WSN), which consists of a number of sensor nodes (devices) with transceivers. The basic function of a sensor node is "sense and send"—the data will be collected, passed through the network, and sent to a server computer for processing. Similar to RFID tags, the sensor nodes do not need a wired connection, and thus WSN localization can be easily deployed in many applications [66].

5.4. Proposed solution:

RFID = Radio Frequency Identification. An ADC (Automated Data Collection) technology that uses radiofrequency waves to transfer data between a reader and a movable item to identify, categorize, track..., is fast and does not require physical sight or contact between reader/scanner and the tagged item, performs the operation using low cost components, attempts to provide unique identification and backend integration that allows for wide range of applications. Other ADC technologies: Barcodes, OCR. Tags can be attached to almost anything: Items, cases or pallets of products, high-value goods, vehicles, assets, livestock or personnel.

We can summarize our suggestion to install overhead antennas that are always on and constantly interrogating tags. The readers can tell you roughly where a tagged item is, or the location where the tag was the last read. Overhead readers often cannot interrogate every single tag within a warehouse every time, because one or more tags might be blocked by metal shelving. But it should provide a general location where an item is located or was last seen. And in case of multiple close readers that try to read the same tag which cannot respond selectively to a particular reader.

By this system that is based on distributing a group of antennas in the warehouse by a specific way (divide the main area into several sub-area) we will cover the entire warehouse area, so it can read the locations of tagged items inside the warehouse to facilitate the inventory process.

5.5. Solution implementation:

Making an approximate picture of the warehouse area after the inspection (rectangle shape or square ....), through dividing the warehouse into a set of sub-warehouses. This can be done to facilitate the work of inventory employee and paint a more accurate picture of the warehouse, and the installation of readers in the warehouse by a form that ensures coverage of the entire warehouse space taking into account the scope and the number of used readers and the budget of the company. This can be done by using the following steps:

1- Designing layouts for RF Interrogators: Split and divide the warehouse into a group of areas that are covered from antennas ranges which are distributed in a specific way.
2- Sticking the RFID tags for each product in the warehouse and supply every tag with specific information about the product.
3- Designing an application that simulates the reality, be able to locate the tagged products in the warehouse and calculates its quantity through the areas that are covered from RFID Readers.

5.6. Feasibility study:

1- Implementing RFID is not as straightforward as implementing an off-the-shelf solution. Significant physical issues are involved in RFID implementation such as the details of antenna configuration, environmental conditions (including electromagnetic interference and issues of radiation absorption and obstruction) and interaction of product materials with tag materials. Other operational decisions include deciding the best location to place the tag on a case or pallet, the best locations for placing antennas, and locations within the value chain where data should be captured automatically. Thus, considerable engineering skills are required for RFID implementation. Similarly, no packaged solutions are available for software that will be needed to run the RFID infrastructure [56].
2- Since every organization will use a unique process model, it may become necessary to develop low-level software to handle data communications from the readers to enterprise applications. Configuring middleware may involve some programming. Specialized troubleshooting and maintenance

skills may also be required to keep RFID hardware, software, and electrical and radio systems running [56].

5.7. Advantages:

For the future which would be providing advantages like cost reduction by maintaining adequate stock levels, reducing the out-of-stocks, counterfeit protection, anti-theft protection, and real-time tracking of items [94].

5.8. Disadvantages:

1- RFID technology may offer operational benefits, but the cost of their complexity still needs to be examined.
2- RFID devices are generally more challenging because the communication between the tag and the reader is more sensitive to environment settings such as the tagged materials and the orientation between the tag and the reader antenna. Therefore, most of the RFID localization research has been on active RFID devices to date.
3- One or more tags might be blocked by metal shelving.
4- The accuracy of some readers is well below 90 percent. The ranges of most readers drop drastically if the tags are near metal or water because both these substances absorb radio waves. When more than one tag is present in the reader's range, tag collision can result in misreads or no reads. Since passive tags do not contain their own energy source, power consumption constraints are imposed on chip design.

Conclusion and Future Work:

Conclusion:

In the thesis, we developed a methodology for the performance evaluation of RFID tagged objects. The methodology developed to calculate the actual quantities of the spare parts, tracking, locating, and tracing it. This experiment is performed by readers and tags in a simulation environment. The outcomes relate emphatically to the readability of the tagged items in genuine practice. Thus, this methodology serves as a solution to the problem of item tracking with the use of RFID tags in the warehouse.

In addition to the characterization of the tag performance, the methodology allows reader installation to specify the maximum range needed to achieve the required performance at a location. This information can be used to choose the minimum costing tag for serving the requirement thus saving a huge amount of investment on tags.

In addition to the performance evaluation of a tag, the methodology can also be used for comparisons of different readers. The thesis also shows the comparisons of two different RFID readers based on the same methodology.

Future Work:

The idea will be presented to the chairman of the board of directors for its implementation in the next year. This is done before making the general budget of the company. This can be achieved after presenting and agreeing on it through the warehouse manager and general manager of the factory.

The idea has already been presented to the warehouse manager and warehouse supervisor during the past few days. They found it is productive and can solve problems of warehouse from which we suffer few years ago. The idea was also presented to inventory team of financial department. They found that the idea is valuable and they are the first beneficiaries after implementing the idea of remotely inventory especially after their suffering that they found in each stocktaking.

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نبذة مختصرة:

تقنية تحديد الهويه باستخدام موجات الراديوهى عباره عن تحديد الهويه بشكل تلقائي بالاعتماد على جهاز يسمى .(RFID Tags) هذا الجهاز عباره عن شريحة صغيرة يمكن ادراجها بالمنتجات أو الحيوانات أو الإنسان. وتحتوي على شريحة مصنوعه من السيلكون وهوائي (انتينا) لكي يستطيع استقبال وإرسال البيانات والاستعلامات من خلال موجات الراديو.

نشأت فكرة الرقاقات اللاسلكية في بداية السبعينات، ومع التقدم التكنولوجى الكبير في مجال الشرائح الإلكترونية وانخفاض ثمنها في السنوات الأخيرة أصبحت الرقاقات الإلكترونية البديل الأمثل في نظم التعريف الآلية، حيث تعمل الرقاقات على إصدار إشارات رقمية تنتقل عبر موجات الراديو القصيرة والطويلة ويقوم جهاز المسح(reader) أو الأقمار الاصطناعية على إيجاد هذه الإشارات وتحديد مكان ونقطة صدورها، ولهذا السبب يطلق على هذه التقنية "التعريف بترددات الراديو Radio Frequency) " Identification(واختصاراً تعرف(RFID) ، وفي السنوات الأخيرة ازداد انتشار تطبيقات أنظمة RFIDبشكل واسع.

و في السنوات الأخيرة أصبحت وسائل التعريف الآلية منتشرة في العديد من التطبيقات العملية لتأمين معلومات كافية عن الناس أو السيارات أو المنتجات الصناعية وهي في حالة حركة عادية دون إيقافها.

للتعرف على مبدأ عمل رقاقات RFID علينا أن نتعرف على أجزائها أولاً. تكنولوجيا RFID تتكون من ثلاثة أجزاء رئيسية هي:

١. البطاقة التي تحتوي على جهاز الإرسال والمعلومات.
٢. جهاز القراءة والإرسال.
٣. برامج الحاسوب وقواعد البيانات.

رقائق الـ RFID تكون على شكل بطاقات يمكن لصقها أو تثبيتها على الأشياء، وهذه الرقائق الصغيرة جداً تحتوي على هوائي لاستقبال الموجات والذي يكون على شكل سلك رفيع ملفوف داخل البطاقة. يقوم هذا الهوائي باستقبال الموجات المغناطيسية الصادرة من جهاز القراءة ويشغل الدائرة الإلكترونية الموجودة داخل البطاقة والتي بدورها تبدأ عملية البث اللاسلكي للقارئ وتصل المعلومات عند نقلها إلى جهاز الحاسوب أو الشبكة في النهاية .

ويلاحظ أن هذه الرقاقة لا تحتوي على مصدر طاقة خاص بها (بطارية مثلاً) وذلك يسهل وضعها على البضائع، ولكن هذه التقنية تعمل على مبدأ دوائر الرنين والتي تقوم باستخدام طاقة الموجات

الكهرومغناطيسية الصادرة عن جهاز القراءة ، تتكون الدارة بشكل بسيط من ملف ومكثّف وتصل الدارة إلى مرحلة الرنين عند توافق تردد موجات القارئ وتردد الدارة فتستخدم الطاقة الناتجة لإرسال المعلومات للقارئ. يقوم القارئ بدوره بتحويل الإشارات اللاسلكية الواصلة من البطاقة إلى بيانات رقمية قابلة للتعامل بالحاسوب حيث تتم معالجتها بالبرامج

وفى هذا البحث سوف نتعرف على كيفية الاستفادة من هذه الكنولوجيا وتفعيلها فى تحديد اماكن وكميات المنتجات داخل المخزن وذلك تسهيلاً لعملية الجرد التى تحدث فى الشركات بصفة دورية لتأمين موارد الشركة والحفاظ عليها من الهدر او السرقة.

جامعة القاهرة
معهد الدراسات والبحوث الاحصائية - جامعة القاهرة
مصر

نظام إدارة المخازن باستخدام التعرف بموجات الراديو

إعداد

أحمد عادل محمد رأفت

تحت اشراف

د/ مصطفى عزت
قسم علوم الحاسوب
معهد الدراسات والبحوث الإحصائية
جامعة القاهرة

د/ ميرفت غيث
قسم علوم الحاسوب
معهد الدراسات والبحوث الإحصائية
جامعة القاهرة

رسالة مقدمة للحصول على درجة

ماجستير فى هندسة البرمجيات من معهد الدراسات والبحوث الاحصائية - القاهرة

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