RFID Based Intelligent Warehouse Management Solution

1. System Overview

1.1. System Background

Global commercial competition of the 21st century is not only the individual contend of technology, cost and management etc, but also is comprehensive competition of the global supply chain in the balance. It is essential for the enterprise to improve their production efficiency and reduce their operating cost.

The problems found quickly in the warehouse management can be improved, designed and establish a complete set of warehouse management flow, so storage turnover rate can be enhanced, the occupancy of working capital can be reduced, the freeze assets can be changed into cash, and the cost caused by warehouse elimination can be decreased. Business retails titans of the multinationals make considerable investment on the supply chain strategy, program, operation management, distribution centre planning, warehouse planning etc. and utilizing the state of the art technology to build up the rapid and efficient operation system.

Using RFID technology managing the warehousing of goods, identify the pallets, simplify the operational flow and improve the working efficiency, so that it can relieve the labor intensity of workers.

1.2. Situation and Analysis

Existing warehouse management systems always use bar code technology, or manually write warehousing management documents etc. But bar code is easy to copy and non-moisture proof, as well as the complexity of manual writing, which can easily cause human loss and other problems. Human-based warehouse management is inefficient, and it is time-consuming and exhausting to sort goods, search goods and check the inventory, so that there are the defects in the warehouse management.

Using RFID technology manage intelligently warehouse solution, firstly each items should be attached RFID tag, RFID fixed reader installed at the sides of passway will identify tag data to judge the operating flow, such as check-in, check-out, transfer, allocation, inventory etc.. Tag data can be automatically captured via RFID reader , which will guarantee the data inputting rate of every step and accuracy, ensure company timely/accurately know the real data of storage, and realize high-efficient goods seeking and real-time stock-taking, improve the working efficiency of warehouse management and bail out the time-consuming and exhausting, which reasonably keep and control the warehouse, so as to make the enterprise revolved efficiently. Scientific code can manage conveniently the items batch, quality guarantee period etc. Location management function can query all the current location of the inventory.

2. System Introduction

2.1. System Principle

The design of warehouse management system adopts the following three structures:

- Information Acquisition Layer

Each items will be passed with rfid tag, goods can be identified by tag unique ID number and user code. Reader can capture automatically tag information, so as to realize the information acquisition function of goods.

- Data Transmission Layer

Tag information captured by RFID reader will be uploaded to back-up system for analysis via related communication interfaces, such as RS-232, RS-485, Ethernet, WIFI or GPRS etc. And its communication interface also can be customized as user's specific requirements.

- Goods Management Layer

After PC terminals or background data center receive the data from reader, it will analysis these data, so as to estimate the goods entrance, exit, transfer, inventory etc. In the meanwhile, the detailed list of table will be generated correspondingly and processed in the system.

2.2. System Structure

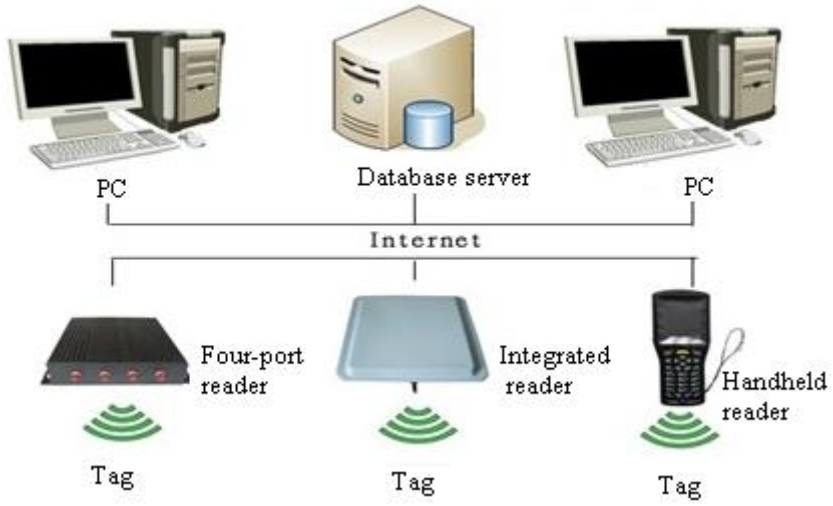


Figure 1: System hardware structure

RFID warehouse management system hardware mainly consists of RFID tag, fixed reader, handheld reader, server, personal computer etc, which can achieve the interconnection and data exchange by the network.

RFID warehouse management system software includes the supply chain management system, RFID tag issuing system and RFID tag identification acquisition system, these systems will be connected with each other and completes every flow of goods management together. Back-up database management system is the center of the whole system, RFID identification acquisition is the foundation and method of realizing management function.

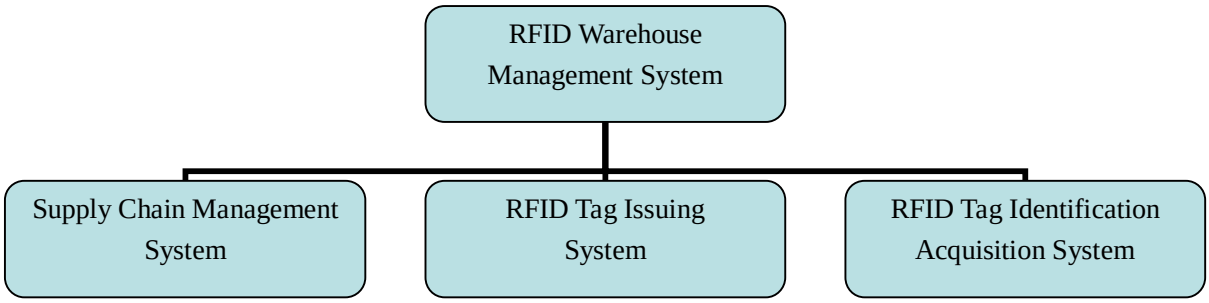


Figure 2: System software structure

2.2.1. Supply chain management system

The supply chain management system consists of database server and management terminals, which is the data

center of system and responsible to communicate with reader data, converting the data uploaded by reader and inserting into database of the supply chain management system, so that tag management information, issuing tag and capturing tag information can be saved and processed.

2.2.2. Tag issuing system

RFID tag issuing system is composed of RFID desktop reader and tag information management software, which is responsible for information writing of location tag, items tag and package tag, as well as modification, authorization and encryption of tag ID number etc. Tag information management software is embedded into the backup system to achieve the one-to-one correspondence of the supply chain system.

2.2.3. RFID tag acquisition system

RFID tag acquisition system is composed of fixed reader, handheld reader and tag. Tag information of goods can be identified automatically by fixed reader and handheld reader, which will be uploaded to backup system for analysis and sorting, so as to judge the goods check-in, check-out, allocation and maintain flow etc.

2.3. System function module

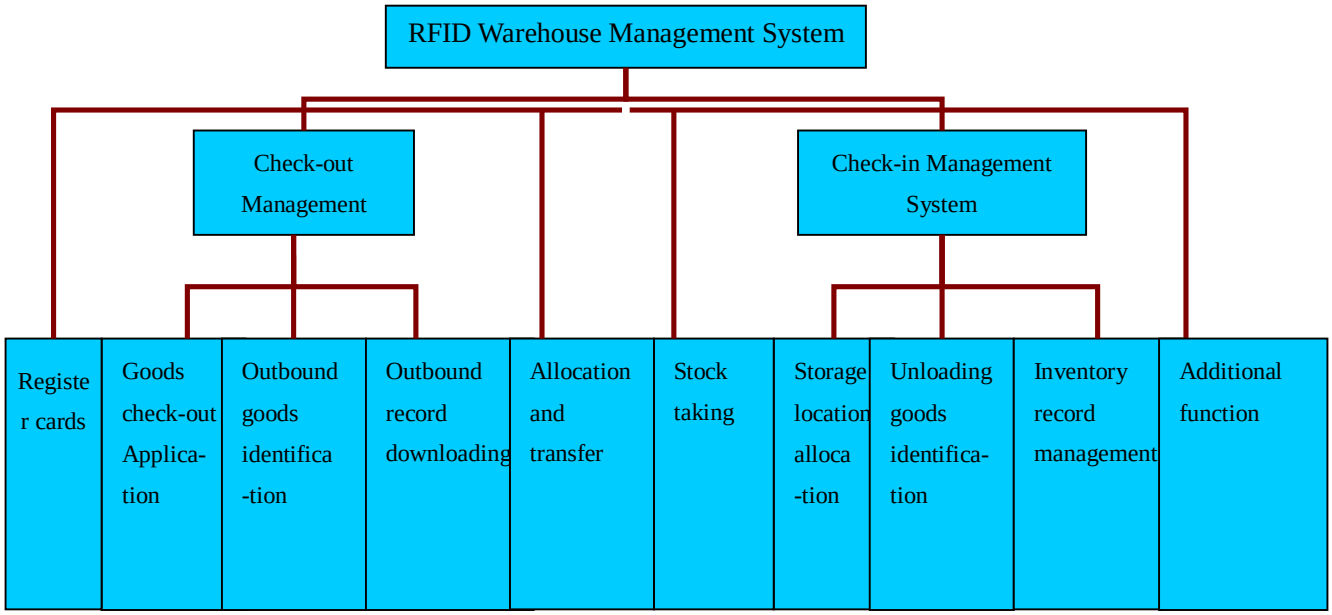


Figure 3: System function module

RFID warehouse management system is composed of registering card, check-out management, check-in management, allocation, stock-taking and addition functions. Check-out management system consist of outbound goods application, outbound goods identification, outbound record downloading. Check-in management system contains location distribution setting, unloading cargo identification and check-in record management.

2.4. Working Process

2.2.1. Registering and attaching tag

Each new item is affixed to the match RFID tag. The unique tag ID or user writing data can be regarded as the goods identification number, and these data can be recorded as item name, purchasing time, warehouse number, goods attribute etc. When RFID reader installed at each passway identifies tag data, all information will be captured

automatically.

2.4.2. Goods check-in

Firstly goods entered into the warehouse should be arranged the storage location in the system, such as items type, warehouse number, the shelves number; Secondly all goods attached RFID tags will be sent to the stockroom region, then deliver to warehouse from the passway. When passing through the passway, RFID reader will identify automatically tag information, if the tag information and quantity identified by RFID reader are right, these goods will check in; if tag information identified by reader are wrong or the quantity are less, the system will be prompted; When goods check in, the operator will put goods into the corresponding warehouse area according to the tag information and accurate system prompt, meanwhile the system will automatically update goods information(date, material, classification, quantity etc.) and generate the details list of check-in.

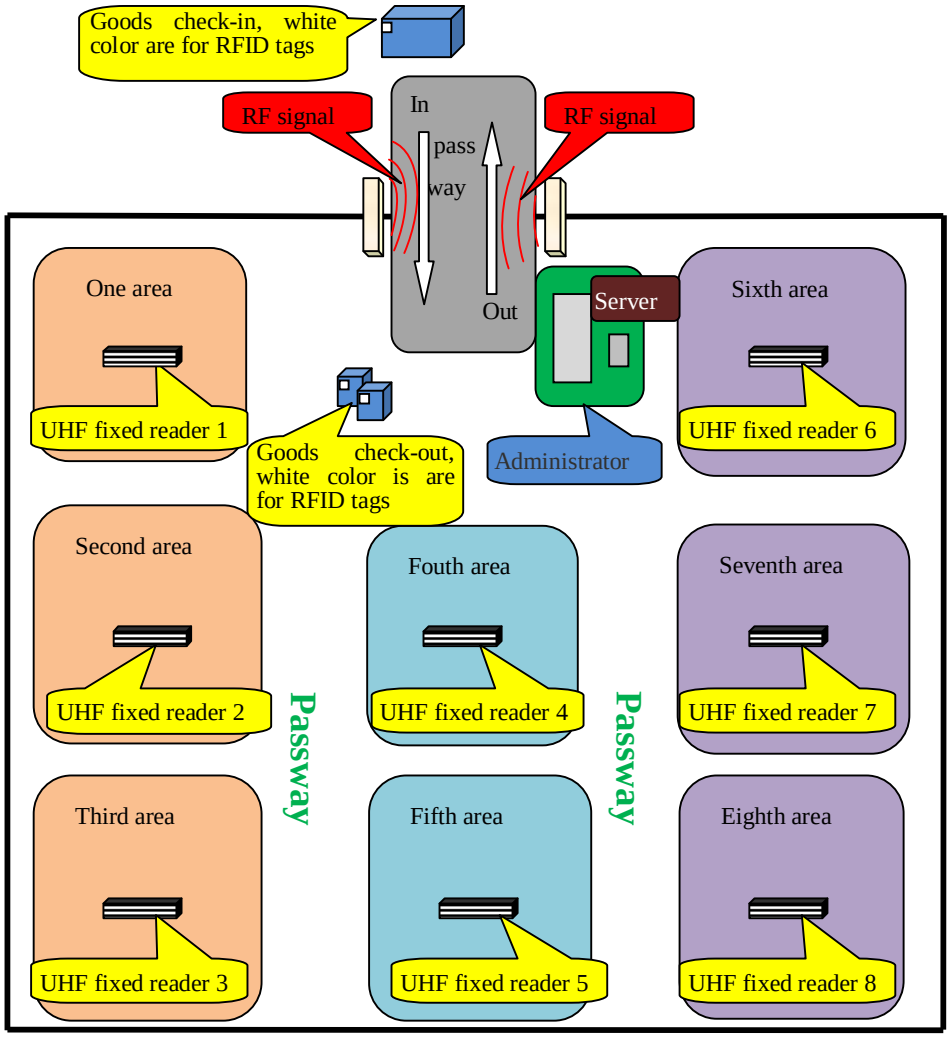


Figure 4：Check-in sketch map

2.4.3. Goods check-out

- When applying check-out, the application form of outbound goods should be filled in on the personal computer.
- After the stock clerk receive the outbound order, they can search the corresponding items by RFID handheld

reader or query server, and put the items in the outbound area.

- Outbound goods attached RFID tags will be identified by RFID fixed reader installed at the passway, then load on the truck.
- RFID fixed reader will identify RFID tag information and check with the application form of check-out, then confirm if the goods loaded on the truck are match, if not, RFID reader will identify repeatedly or add the stock out.
- The system will updates automatically goods information (date, materials, classification, quantity etc), and generate the detailed list of check-out.

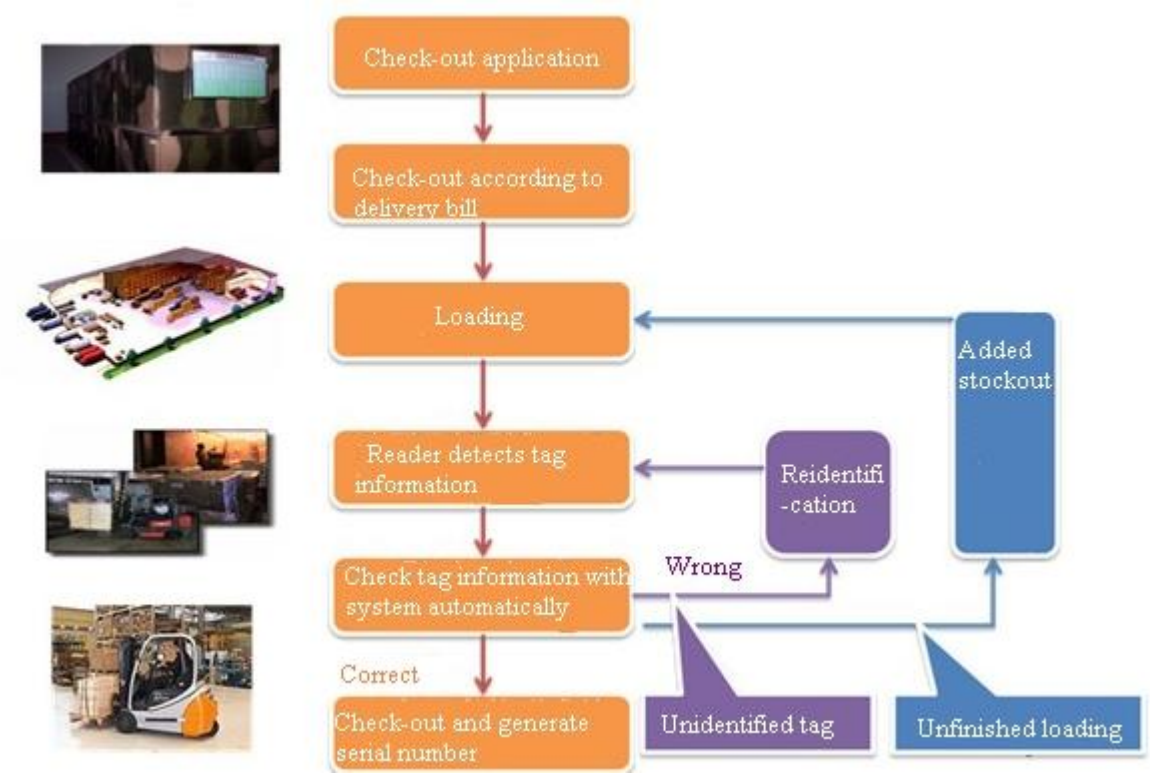


Figure 5：Check-out sketch map

2.4.4. Allocation and transfer

For the allocated and moved goods, when goods are passed through the passway, it will be identified by RFID reader installed at the sides of passway, and current tag information will be recorded by reader for uploading to back-up center. According to the sequencing of the identified tag, the back-up center can estimate it as check-in, check-out or allocation etc.

Using RFID handheld reader can operate the moved goods, when the goods are put in the wrong place, the stock clerk will put them in the right place manually. At the same time tag information can be modified by RFID handheld reader and sent to the server, so that it can realize the rapid and convenient movement function.

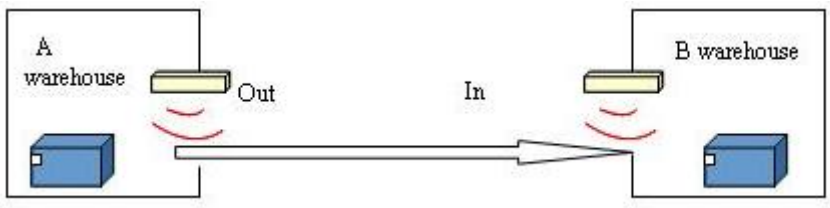


Figure 6：The sketch map for goods allocating and transferring

2.4.5. Stock-taking

- Checking tag information of goods allocation with system

Tag information attached on goods allocation can be captured by RFID handheld reader, then this information will be checked with the information in warehouse management system; stock clerk only need hold the handheld reader and go through the goods allocation to complete the inventory.

- Checking tag information of specified goods with system

Through checking the tag information of the specific goods with the stocking information in the warehouse management system, the detailed operation as below,

After the host machine generates the inventory operational instruction, operator will take the inventory in every goods allocation using handheld reader. When all items put on the goods allocation be scanned by handheld reader, this reader will confirm and get all inventory data, these data including the operating journal will send back the host machine. Compared the current inventory information from the host machine with the tag information of shelves and original stockage information, then the balance among them will be processed.

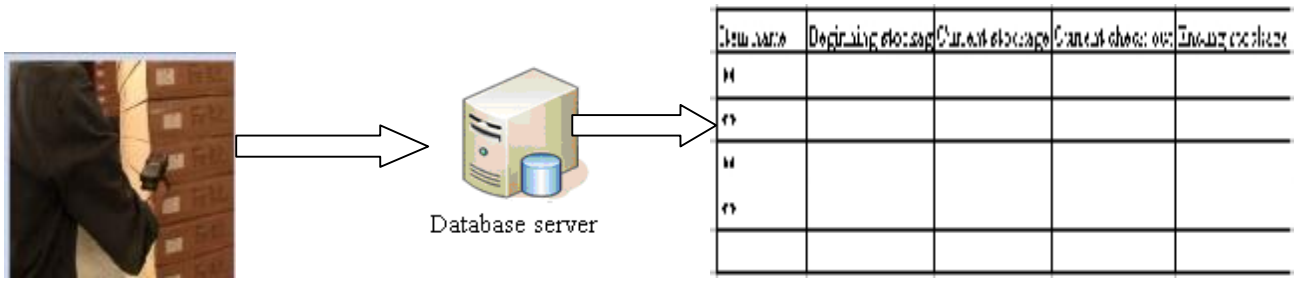


Figure 7: Inventory sketch map

2.4.6. Additional functions

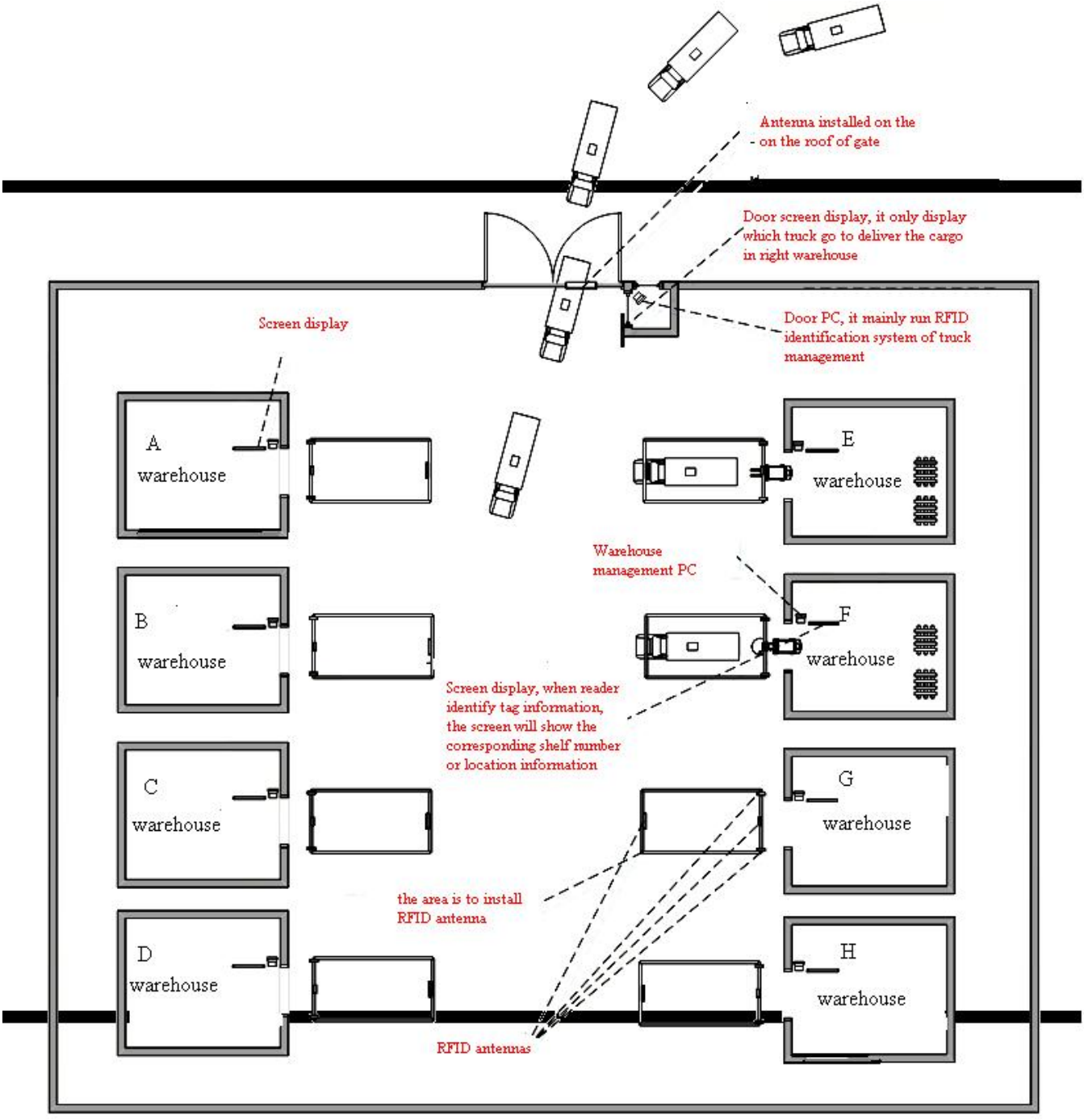
- Inventory warning

When the stock in inventory is less than the normal stock, the system will prompt to add the stock to avoid the condition of insufficient inventory.

- Warning will be alert once the goods are removed or taken without any permission

When goods are removed or taken away without any permission, reader identify these information and send to the system for alarm, so as to avoid the goods lost or stolen.

3. Reader Installation Diagram



Picture 8: Reader installation diagram

RFID fixed reader installed at the sides of gate is convenient to identify goods check-in and check-out. RFID fixed reader and display screen installed at the gate of warehouse can detect the specification of the ins-outs goods.

4. System Features

4.1. Realizing first-in first-out management for goods

RFID warehouse management system using the advanced RFID technology, WLAN, data base etc. combine the whole warehouse management with RFID identification technology, which enable efficiently complete various kinds of business operations, improve the warehouse management and enhance the efficiency and value.
For every piece of warehousing goods, the system will automatically record the check-in time, location etc. When goods check out, first-in first-out management will be realized.

4.2. Storage real-time management for warehouse

Storage management of the traditional warehouse depends on hand-report and artificial statistics, so that every department can't timely and exactly know about the storage information. Besides, with business development, the quantity and kinds of cargo are expanded gradually, as well as the demand of clients become complex daily. Real-time warehouse management has become the essential factor which will affect to establish the rapid and efficient operation system. RFID-based warehouse management can real-time and accurately know the storage updates, which can provide the scientific evidence for leaders and the related department can optimize stockage and production management decision.

4.3. Materials tracking and imaging management

This system can realize the function of materials tracking and imaging management on the basis of achieving goods allocation of pallets. This function can make stockage reflected directly and fast by the graphical method, improving the inventory efficiency and accuracy of goods management and enhancing the identification rate of the ins and outs of goods in the process, so that it is no need to open the box for check, at the same time, it will identify multiple items, which boost the efficiency of the ins and outs items.

4.4. Reducing the inventory period and lower the distribution cost

The traditional stock-taking is time-consuming and exhausting things. RFID-based warehouse management system reduces the inventory period, enhances the instantaneity of data and grasps the inventory information dynamically, so as to realize the visual management of storage cargo. Besides RFID warehouse management can improve the efficiency and accuracy of selection and distribution process, and speed up the rate of distribution, so as to liberate the labor force of workers.

5. Other Application Area

- Military goods management for army;
- Logistics warehouse management for tobacco;
- Stock-taking management for medical drugs;
- Distribution inventory management for the retail industry;
- Materials and finished goods warehouse management for large-scale enterprise;
- Baggage sorting and distribution management for airport checking;

- Container cargo management for port and dock ect. and other corresponding RFID application.

6. Equipment Selection

Products picture	Type	Specification	Function
   	Item tag	▪ Operating frequency: 860-960MHz (can be customized） ▪ Data storage: 2048bit （ UID64bit, USER 1728bit）,512bits ▪ Data store period: 10 years(25℃) ▪ Reading distance: 8~10m(work with 1W power reader and 12dBi antenna) ▪ IP rating: IP67 ▪ Working temperature:-40℃-75℃ ▪ Storage temperature:-55℃-105℃ ▪ Humidity: 10%~75% ▪ Installation: Fixed on objects' surface by cassette	Information of cargo and shelves
	NFC-9801A UHF Long-range Reader	▪ Operating frequency: 860-960MHz (can be customized） ▪ RF power range: 20dBm ~30 dBm ▪ Reading distance: 12M ▪ RF protocol : ISO18000-6B, EPC Class 1 GEN 2 ▪ Communication interface: RS-485, RS-232, Wiegand ▪ Power supply: 9VDC	Identify tag information
	NFC-9814A UHF Four-port Reader	▪ Operating frequency: 860-960MHz(can be customized） ▪ RF power range: 20dBm ~30 dBm ▪ Reading distance: 12M(Depend on the antenna, tag) ▪ RF protocol : ISO18000-6B, EPC Class 1 GEN 2 ▪ Communication interface: RS-485, RS-232, Wiegand ▪ Power supply: 5V DC	Identify tag information

	NFC-9801T UHF 12dBi Antenna	❙ Operating frequency: 860MHz~960 MHz (Adjustable for local regulation) ❙ Polarization: Linear ❙ Horizontal 3dB beamwidth : 65° ❙ Vertical 3dB beamwidth : 34° ❙ Gain : 12.0dBi ❙ Connector: N-F ❙ Lightning protection: Direct Ground	With UHF reader for identification
	NFC-9221 UHF Handheld Reader	❙ Operating frequency: 860MHz~960 MHz (Adjustable for local regulation) ❙ Memory: 64M Flash ROM 64M SDRAM ❙ Reading distance: 1.5M ❙ Screen:3.5 inch 240*320 digital color TFT touch-screen and touch pen ❙ Power supply: Rechargeable Li-ion battery (1700mAh); normal use for 10hours, stand-by time up to 100 hours. one backup battery, portable charge	Inventory, checking
	NFC-9211B UHF Desktop Reader	❙ Operating frequency: 860MHz~960 MHz (Adjustable for local regulation) ❙ RF power range: 20dBm ~30 dBm ❙ RF protocol : ISO18000-6B, EPC Class 1 GEN 2 ❙ Communication interface: RS-485, RS-232, Wiegand, USB ❙ Power supply: 5V DC	Register tag information