Studyof RFID application with Zigbee Network in Supply Chain Management

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ABSTRACT

Radio frequency identification (RFID) technology is real time locating system (RTLS) without line of sight. RFID has rapidly grown significantly over the last few years. The RFID network integrated with the ZigBee low cost low power mesh network will increase the efficiency of inventory management effectively resulting to control the product loss or shrinkage in supply chain management (SCM). This paper explain radio frequency identification technique which can be connected to the internet enabling identify, locate, track or monitor supply chain flow. The issues can be resolved by development of smart interface of system and control variables such as coordinates of the readers, the number of the readers and the antenna parameters. The benefit of application of RFID with zigbee network and internet of things in (SCM) increases the traceability of items in real time and update the information exchange. It also increases the quality of care and services, increases the productivity and reduces the cost, power consumption and human error.

Keywords- RFID; Zigbee; GSCM; IOT; RTLS

1.   INTRODUCTION

For the deployment of RFID network with integration of Zigbee communication network and Internet of things (IOT), the various complex processes e.g. services and applications can help to improve the quality of care, accuracy and reduce costs. It also improves the flow of material, equipment, and personnel. Monitoring, real-time logistic analysis, and critical equipment tracking are applications of real-time locating systems (RTLS) in SCM. RTLS can improve service quality and safety, optimize emergency management and time critical processes [1].

RFID is a similar concept to barcode technology, but without requiring a line of contact of the tracking items. Just like bar code systems require a proper optical reader and special tags applied on products, in case of RFID for tracking an items it needs a reader and special tags attached to the products [2]. Besides the benefits of RFID technology the issues like privacy, security, standardization, coverage, load balance, economic efficiency and interference between readers can be resolved by proper system standardization and using optimization algorithms to solve the above issues.

2.   RFID TECHNOLOGY

RFID system consists of three basic components are as follows:

2.1.   Tag (transponder) and Antennas

The tag is a microprocessor chip consists of an integrated circuit with memory and antenna. It can be grouped in to basic categories: Type, Frequency and by capabilities. It may be active (battery powered and proactively emitting a radio frequency signal) or passive (without batteries and reactively emitting a radio frequency signal). It has information about object could be (serial No; Model No. or other characteristics of object) for identification purpose and distinguish from others or to track the movement of object as shown in Fig.1 [3]. Table 1. Shows the characteristics of each tag frequency.
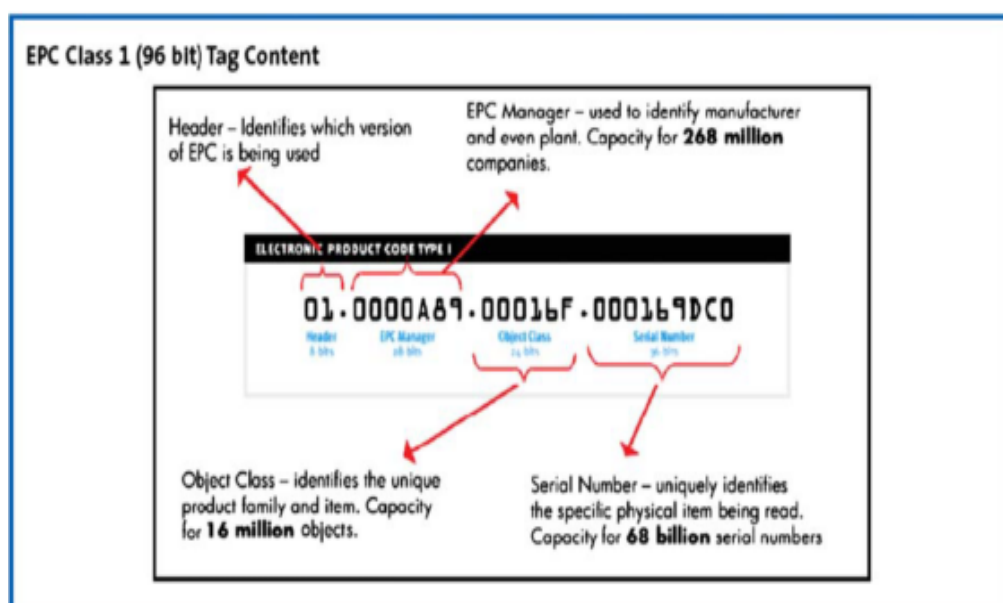

Fig. 1 RFID Tag

2.2. Readers (interrogator)

An RFID reader is equipment that can read data from and write data to compatible RFID tags. Communication between tag and reader enables locating an item to be recorded and transferred to a server through a computer network, thus allowing the movement of the item to be monitor. To ensure the compatibility of the communication, the tag and reader must work at the same speci working frequency and comply with specific regulations and protocols. Readers come in four types: handheld, vehicle-mounted, post-mounted, and hybrid. The first three are used to read either passive or active tags, whereas the hybrid readers can switch between passive and active modes. Fig. 2 shows the reader and tag communication.

Table 1. Applications and characteristics of each tag frequency

Band	Frequency	RF transparent materials	RF opaque materials	Antenna size	Read Rate	Read Distance
LF	125-134kHz	Plastics, fabrics, oils, liquids, wood and some metals	Dense materials (brick and metals)	Largest	Lowest	shortest
HF	13.56MHz 315-433MHz			Large	Low	short
UHF	868-915MHz	Most plastics, fabrics, oils, paper, dry wood	Dense materials, wet wood, mud or snow	Small	High	Long
MW	2.45GHz 5.8GHz	Most plastics, fabrics, oils, paper	Small Dense materials and liquids	Smallest	Very high	Medium

2.3. Communication infrastructure (Middle ware)

The communication infrastructure is a system of wired or wireless network communications that carries out a series of data transfer that are stored in a tag to the reader. This category includes articles on the relevant communication criteria and protocols, safeguards, and network connectivity issues [4].

Radio frequency identification (RFID) is the method of automatically tracking or identifying people, animals or objects through radio waves in real time without line of sight.

Using RFID device (tag) is physically attached to the object that is to be identified at later time. In a remotely application RFID reader transmit signal through antenna can read this tag at a distance to identify the object instantaneously, and then data transmit to communication infrastructure which updates the information of supply chain. Fig.3 shows the typical RFID system.

Monitoring the tagged items periodically helps us to gather critical information such as date of expiry, date of entry, physical location (e.g. rack number), rate of sale, volume, cost, stock requirement of the items [5].
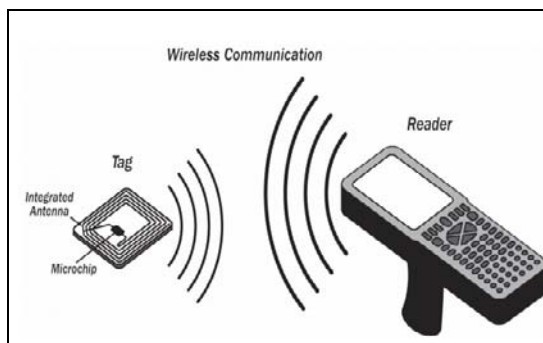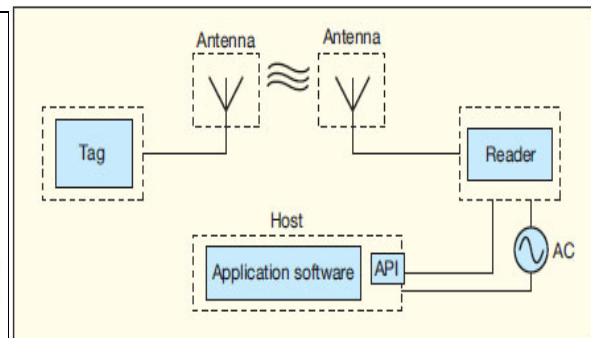

Fig. 2 Reader and tag communication.

Fig.3 Typical RFID System

2.4. RFID applications

RFID is an emerging technology that has been successfully applied in supply chain management, manufacturing, logistics and asset tracking but its range of application extends far beyond these areas. In many cases, the short time lags and failure-free ID entries or even the resistance of RFID tags to adverse conditions (extreme temperatures, dirt, chemicals etc.) contribute substantially to the success of the application. Based on the various industry areas sub-classify this category as follows [6].

- Manufacturing: (Inventory, Tracking, quality control, resource) management
- Transportation: (Distribution, material processing, safety) management
- Ware housing: (Picking, receiving shipping) management
- Retailing: (Inventory, self stock, check out) management

- Traffic, Transportation, ticketing: (Public transport ticket, toll collection, smart car key, automatic vehicle location)
- Monitoring and tracking: (parcels, mail bags, luggage handling, digital signature, library inventory)
- Healthcare: (Pharmaceutics, hospital equipment and personnel, patient medical history, implants and prostheses, elderly care)
- Human identification: (Digital ID, electronic passport, facility access, punishment system), Agriculture :(Animal tracking, animal diagnostics, and crop identification),
- Comestibles: (Recipe control),
- Fuel, Chemicals: (Dispensing control),
- Environment: (Waste haulage, recycling)
- Clothing: (Cleaning control, Laundry ID),
- Sports and Games: (Sport event timing, tracking golf ball, gaming chip),
- Finance: (Smart card, Bank note identification),
- Government and military: (Military logistics)

2.5. RFID benefit

The operations capabilities of the firm are quality, speed, flexibility or cost leadership. To maintain leadership in any of these capabilities, a firm must be in a permanent effort to improve. Most world-class operations exert much effort or energy to deliver high performance in all four of these capabilities. Radio frequency technology is one alternative to enhance the operations capabilities of the service delivery, service quality is improved whenever reliability, conformance to specifications, process features, and customer perception about the delivery are standardized.

This category includes articles on the relevant communication criteria and protocols, safeguards, and network connectivity issues [7]

2.6. RFID Issues on implementation

The implementation issues of RFID technology are as follows.

2.6.1. Privacy

Privacy issues around RFID related to the potential misuse of information by authorized users, leading to the violation and intrusion of individual or business privacy. Consumer advocates are calling for greater regulation and codes of practice, especially for tags that are readable worldwide because of the risk that they confuse to personal location privacy. Although RFID advocators have declared that measures such as ''kill'' functionality and limiting the read range of tags can be put in place to prevent personal information from being used illegally, many people are still concerned about privacy. To consider the studies of RFID privacy and protection issues, and especially those that examine RFID in relation to existing human rights policies, constitutional protection, and data protection law.

2.6.2. Security

Security concerns revolve around susceptible to attack and the protection of confidential information from unauthorized access and manipulation. As with all wireless communication systems, RFID systems are subjected to a number of security problems, one of the most important being the illegal tracking of RFID tags. Other basic and simplest security issues, such as confidentiality, integrity, authentication, authorization, no rejection, and anonymity, can often not be overcome unless special security mechanisms are built into the system.

2.6.3. Standardization

The creation and acceptance of implementation of official standards can powerfully accelerate the adoption of new technology and RFID has no grounds for adverse criticism. However, there is no global public body established to govern the frequencies that are used for RFID, and in principle each country can set its own rules. In a global business environment, the lack of ability to exchange and use information usually in a large heterogeneous network made up of several local area networks between different RFID- based systems will oppose users from making large investments in a

technology that is intended for global use. To extend the widely used ''intranet RFID system'' to a future ''internet of things (IOT),'' an international uniform standard needs to be set up, and to this end several international organizations, such as the ISO and EPCglobal, are cooperating to try to create such a standard. Electronic Product Code (EPC) tags can extremely accurate data sharing within and across enterprises which set to introduce the security of applications [3].

2.7. RFID network planning issues

It includes tags coverage by readers, load balance of reader, economic efficiency and interference between readers [8] [9].

3. ZIGBEE (WIRELESS MESH NETWORK)

ZigBee is a specification for a suite of high level communication protocols using small, low-power digital radios based on an IEEE 802 standard for personal area networks. ZigBee devices are often used in mesh network form to transmit data over longer distances, passing data through intermediate devices to reach more distant ones. This allows ZigBee networks to be formed adhoc, with no centralized control or high-power transmitter/receiver able to reach all of the devices. Any ZigBee device can be tasked with running the network.

ZigBee is targeted at applications that require a low data rate, long battery life, and secure networking. ZigBee has a defined rate of 250 kbit/s; it is simpler and less expensive than other WPANs, such as Bluetooth, the comparison as shown in Table 2.

ZigBee is an IEEE 802.15.4 standard for data communications with business and consumer devices. The ZigBee standard provides network, security, and application support services operating on top of the IEEE 802.15.4 Medium Access Control (MAC) and Physical Layer (PHY) wireless standard. It employs a suite of technologies to enable scalable, self-organizing, self-healing networks that can manage various data traffic patterns. ZigBee is a low-cost, low-power, wireless mesh networking standard. ZigBee has been developed to meet the growing demand for capable wireless networking between numerous low power devices. In industry ZigBee is being used for next generation automated manufacturing, with small transmitters in every device on the floor, allowing for communication between devices to a central computer. This new level of communication permits finely-tuned remote monitoring and manipulation [10] [11].

4. INTERNET OF THINGS (IOT)

Internet of Things is the "material objects connected to the Internet". These elements include radio frequency identification (RFID), global positioning system (GPS), and wireless sensors network (WSN) technology. It means the core of networking and infrastructure and the user-end articles, information exchange and communication. IOT can easily monitor the location of supplies and equipment to achieve identification and transparent management of items, with positive control and anti-theft features [12].

5. GREEN SUPPLY CHAIN MANAGEMENT (GSCM)

The industrial pollution is a critical issue for society. The manufacturing can be monitor with best practices of modern supply chains, such as lean and just-in-time (JIT). Concept of

JIT and SCM focused on increasing the operational efficiency and minimizing waste. The purpose of the minimization of waste was not for environmental only, but economic reasons also. Waste means greater economic loss. To control solid and water pollution waste and warnings of global climate change due to carbon and other greenhouse gas emissions for maintaining natural environment. Within an environmental focus to control the management coverage of GSCM began with the special importance or significance on specific aspects of SCM such as logistics, purchasing, and reverse logistics. Eventually, some early efforts conceptually and systemically integrated purchasing, operations, marketing, logistics, and reverse logistics. Considering the nine organizational theories are as follows.

Complexity 2) Ecological Modernization 3) Information 4) Institutional 5) Resource Based View 6) Resource Dependence 7) Social Network 8) Stakeholder 9) Transaction Cost Economics [13].

Table 2. Wireless technology comparison chart

Standard	Band width	Power Consumption	Protocol Stack Size	Strong hold	Applications
Wi-Fi	Up to 54Mbps	400+mA TX, standby 20mA	100+KB	High data rate	Internet browsing, PC networking, file transfers
Blue Tooth	1Mbps	40mA TX, standby 0.2mA	~100+KB	Interoperability, cable replacement	Wireless USB, handset, headset
ZigBee	250kbps	30mA TX, standby 3#&956;A	4"32KB	Long battery life, low cost	Remote control, battery-operated products, sensors

6. SUGGESTION

Deployment of RFID readers where items to be tracked at various locations in the shop floor associated with the Zigbee standard protocol, using various algorithms such as PSO, ABC and GA to compare their results for optimization to resolve the issues of coverage, load balance, economic efficiency and interference. The security, privacy and standardization issues can be resolved by the help of international organizations, such as ISO and EPCglobal with the application of IOT. The following benefits will get by applying the RFID with zigbee mesh network in the supply chain management (SCM).

1. Increase traceability of items and update the real time information exchange.
2. Increase the productivity.
3. Minimize product loss or shrinkage,
4. Reduce the cost, wastage and time
5. Minimum energy/power usage.
6. Reduce human error.

7. CONCLUSION

It is concluded that RFID network planning with Zigbee and internet of things increase traceability of items in real time locating system in supply chain management. Application of the system will reduce the cost, wastage and time and increase the accuracy, security, care, quantity and quality of product or service at optimum level.

For future work using the IOT system, RFID tag record the personnel identity and movements as well as visiting personnel working in the company through flexible security mechanisms by using Zigbee sensors and RFID application. Zigbee network interface with RFID can monitor the status of each node which displays the information by comparing the various algorithms.

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