

Impact of RFID and Xbee Communication Network on Supply Chain Management

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Abstract. Every industry, organization or individual needs to be minimize their expenditure, time and fatigue and maximize their profit in supply chain. These goals can be achieved through automation by using Radio Frequency Identification (RFID) and Zigbee wireless communication technologies, which is easily available in the market. Basically RFID technology is used for automatically tracking, locating or identifying the entities. It can easily integrate with low cost low power consumption Xbee (Zigbee) device, which is used to increase the communication range by large number of node deployment. RFID-Xbee network integrates with Laboratory Virtual Instrument Engineering Workbench (LabVIEW) Graphical User Interface (GUI), which gives real time information of supply chain at single control panel. The integrated communication model proves the near field inductive coupling and can be used in supermarket for item pricing, office automation, security system, and car parking. This system confirms the concept of real-time locating system (RTLS) in an indoor environment. The impact of RFID and Xbee network communication model enhance the read range of RFID reader, so that out of range items can be tracked easily without additional RFID readers. The benefit of this system is to maximize profit, reduce human intervention and minimize waste.

Introduction

Supply Chain Management (SCM) cycle begins from supplier to storage of raw materials to manufacturing, warehousing, and retailer and in the end used by customer [1]. The goal of supply chain management is value to the customer with minimum wastage by using real time information flow. Eventually it gives a sustainable competitive advantage [2]. The graphical representation of SCM activities depicted in Fig. 1. The efficiency of SCM can be enhanced by using integrated system of wireless technologies including RFID-Xbee with the LabVIEW programming [3]. Radio frequency identification wireless technology is used for identification, tracking or locating the entities wirelessly in an indoor environment. The purpose serve by RFID technology is same doing like barcode technology. The working principle of RFID is different from barcode, and has various advantages over it. RFID reader can easily integrate with Xbee (Zigbee) wireless mesh network device. Xbee is a low-cost, low-power consumption device used for increasing the range of network by large number of node placement is about 65000. It is working on standard protocol IEEE 802.15.4. ZigBee as the leading wireless network, sensing and control standard for use in consumer, commercial and industrial areas. The working frequency of communication occurs at 2.45 GHz. It works on low data rate at 250 Kbps as compared to other wireless technologies like wifi and blue tooth. WiFi transmitters are using the IEEE 802.11. Now it largely disseminated in both office and residential environments. It is a requirement of the system to achieve communication goals for each user of band that these technologies must coexist peacefully [4].

LabVIEW is used for monitoring the SCM operations at a single platform on front panel window. The actual program working behind the front panel at block diagram window. The developed algorithm of integrated system gives real time information of object characteristics and

environmental parameters like temperature and humidity in case of environmental sensor attach with the RFID tag. The benefit of the system can achieve accuracy of data and speed-up the operation of inventory management system. The operating efficiency enhances the productivity; minimizes cost of operation and time with minimum human intervention.

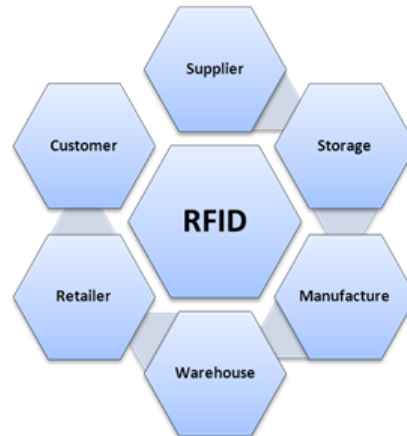


Fig. 1. Supply chain management cycle

Radio frequency identification (RFID)

Radio frequency identification (RFID) technology is used for automatically tracking, locating or identifying people, animals and objects by using electromagnetic waves for the traceability of SCM in order to get real time information. RFID technology has three basic components are tag, reader and middleware. The working principle of RFID system described as, when the reader (interrogator) send an electromagnetic wave through their antenna towards the tagged items, tags in the range transmit back a radio wave signal towards the reader through their embedded antenna along with the information or data stored in the tag. Consequently identify the object instantaneously without human intervention, and then data transmit to communication infrastructure which updates the information of business software as shown in Fig.2. The communication between

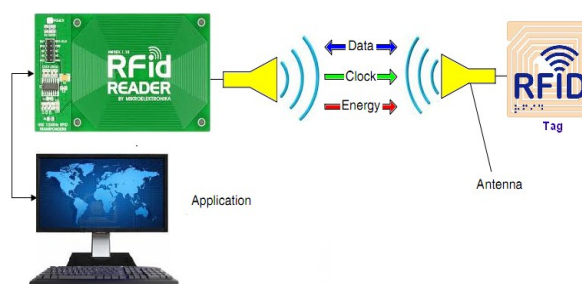


Fig.2. Typical RFID System

tag and reader depends upon the frequency of operation and the distance between them. There are two types of communication system in RFID technology. One is the near-field or inductive coupling working on LF and HF and other one is far-field or backscatter (radioactive) communication. The radioactive communication works on UHF and Microwave. RFID and barcode technologies served for the same purpose, but the principle of operation is different and the various advantages of RFID over it. The advantages of RFID over barcode as it can track through human body and non-metallic materials also can track moving objects. It does not need direct orientation to scan. It can detect large number of items at the same time and able to track in harsh and dirty environment. RFID tags

have longer read range and large storage data and can be writable to update the data at any time. RFID reader can easily integrate with Zigbee wireless mesh network for increasing the node placement and wider the range of detection. RFID system is generally used in the indoor environment for various applications such as asset tracking, manufacturing, logistics and supply chain management [5, 6]. It reduces out-of-stocks items by providing real time visibility of items location.

Xbee (Zigbee) wireless mesh network

Wireless technologies emerge in every field of our life. Wireless communication technologies generally operate at different RF schemes. It can be shared among various users on frequency bands. WiFi, Bluetooth, and ZigBee are used to increase the wireless communication range of the RFID reader. They are working on the 2.4 GHz Industrial, Scientific and Medical (ISM) unlicensed band for communication, using frequency hopping [7, 8]. Table 1. shows the comparison of wireless technologies [9].

Table 1: Wireless technology comparison chart

Characteristics	ZigBee	Wi-Fi (802.11n)	Blue Tooth
Data Rate	20,40 and 250 Kbps	2 to 200Mbps	24Mbps
Range (meters)	1-300	1-100	1-10
Frequency	868MHz, 900-928MHz, 2.4GHz	2.4 & 5 GHz	2.4GHz
Complexity	Low	High	High
Battery life (days)	100-1000+	1-5	1-7
Nodes per network	255/65000+	30	7
Topology	Star, Tree, Mesh	Tree	Tree
Standby Current	3×10^{-6} amps	20×10^{-3} amps	200×10^{-6} amps
Memory	32-60KB	100KB	100KB
Protocol Stack Size	4"32KB	100+KB	~100+KB
Strong hold	Long battery life, low cost, low data rate	High data rate	Interoperability, cable replacement
Applications	Remote control, battery-operated products, sensors	Internet browsing, PC networking, file transfers	Wireless USB, handset, headset

WiFi transmitters are working on IEEE 802.11 and largely spread in both residential and office environments. To fulfill the communication goals it is necessary that both technologies coexist peacefully to allow each user. ZigBee is low-cost, low power consumption, low complexity and low data rate of 250 Kbps. It is working on IEEE 802.15.4 standard protocol and responsible for the physical layer and MAC layer, ZigBee Alliance has developed data link layer, network layer and application programming interface. ZigBee nodes divided into two kinds, one is full function devices (FFD) called coordinator, its function is communicate with various devices and coordinate the network. Another is reduced function devices (RFD) called router or end device. It is used to collect data and transfer to the coordinator [10]. Each network coordinator can accommodate 255 network nodes, providing integrity checks and authentication capabilities, ZigBee constructed the wireless sensor network topology including star, cluster tree and mesh network. ZigBee is best applicable for WSN. It is used for communication of object identification and sensing in an indoor environment by RFID [11]. ZigBee is the leading wireless network, sensing and control standard for use in consumer, commercial and industrial areas. Zigbee network integrate with active RFID system will increase the network range of RFID readers. Data packets travel across multiple nodes in a network to forward data from initial point to the end position in order from zigbee end device to the router and finally zigbee coordinator. In this way no additional RFID readers required to track the far away located items [12].

Proof of wireless integrated system controlled by LabVIEW

The one of the Xbee, configured as coordinator connect to the laptop or PC by USB connector and other one remote Xbee already configured as a router or end device connect to the RFID reader. Open the Virtual Instrument (VI) file which was already developed in database connectivity LabVIEW programming. The integrated system works according to the algorithm shown in Fig.3. Browse at “Address Source File” tab, the UDL file as a path of database connectivity (which was already created) and fill the fields of vehicle table name and item table name as developed prior, at the LabVIEW front panel as shown in Fig.4. Select “Parameter Setting” tab and fill all the fields with required parameters. Now click “Indicators” tab. Begin the tracking process of vehicle and items for identification. The vehicle with RFID tag attached enters from the door of factory. The fixed RFID reader at the door frame identifies it with the unique product code as Reg. No. also shows status as “Available” by green light signal. Its complete data shows in the fields below the green light at the front panel, in case data of vehicle already in the database otherwise indicate red signal with status “Not Available” as shown in Fig 4. The system having facility to filling up the required data in the mentioned fields, shown below the not available status e.g. (Type, Company, Driver Name, Driver IC and License). After putting the vehicle data in the mentioned fields at front panel within required time, keep it identify again to move the tagged vehicle in the range of RFID reader, now it gives status “Available” with green signal and shows complete data at front panel fields. Now keep going for items identification. RFID reader identifies it with unique ID code and shows the status below the “Item code” field as “available” with green light signal. Data shows in the fields below the green light at the front panel. In case of items data not available in the database shows red light signal with status “Not Available”. The operator do input the data of item(s) one by one as mentioned fields according to time constrained until red signal turn “ON”. If red signal turn on before data entry, it means the data not to be updated in the database. Click “OK” button to turn “OFF” red light. Now keep item(s) again for identification by moving the RFID tagged item slowly near, better above the RFID reader within 2cm range, it instantaneously identify the item(s). When all items identifies with green light signal, it shows the database updated for items identification.

In-fact the system proves its proper working and now it can be applicable in security system, car parking, and office automation and for item pricing at hypermarket. The benefit of this system is to identify the entities in real time and updates the process information in the database during tracking process. It shows the complete picture at a single panel and serves efficiently which gives value to the customer with minimum wastage and sustainable competitive business process. However the impact of RFID-Xbee network communication model enhances the read range of RFID reader, so that out of range items can be tracked easily without additional RFID readers in supply chain.

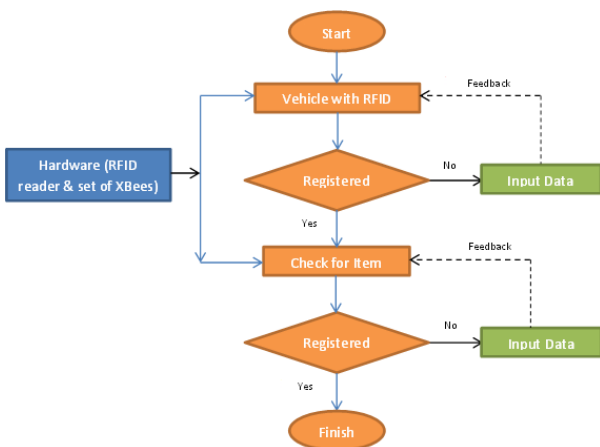


Fig.3. LabVIEW Algorithm



Fig.4. LabVIEW Control panel monitor the RFID

Conclusion and Future work

The impact of RFID-Xbee wireless mesh network system increases the range of communication, which results the far away range of items can be tracked easily without additional RFID reader. The system has great potential to identify the entities at real time locating system (RTLS). The benefit of RTLS reduces human error, optimize inventory management, increases productivity and information accuracy at indoor heterogeneous network of sustainable competitive advantage. Moreover, the power consumption of the system has to be minimized by using low power hardware.

For future work the Wireless Sensor Network (WSN) and Global Positioning System (GPS) can be integrated with the above system, which can monitor indoor as well as outdoor real time tracking or identifying of items characteristics and sensing environmental parameters with greater visibility also reduce the time span.

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