**RuBee : A Visibility Network Identification Protocol**

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**ABSTRACT**

RuBee is a new technology with IEEE1902.1 standard used as automatic identification tool. The RuBee tags used for this technology are competent to RFID tags and routers. RuBee is a protocol using low frequency carrier waves operating in long wave magnetic signals to send and receive the data packets. It is a radiating network trans receiver used for identification and tracking purpose. Low chip cost and low power consumption CMOS technology are the significant properties used in this newly designed visibility network protocol. This Paper provides the detail study about the RuBee device, highlighting the physical layer, tag details, protocol description and market analysis for the new standard network tool.

**Keywords**

RuBee, RFID, security, EEPROM, P1902.1,tags,visibility applications

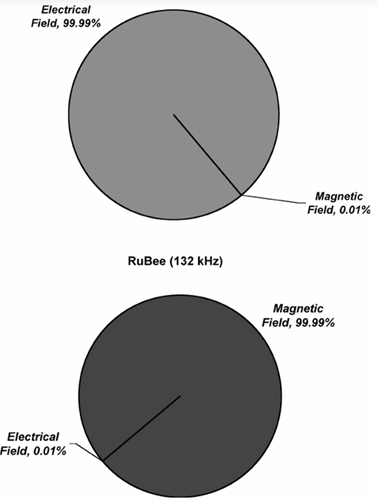
# INTRODUCTION

RuBee is the commercial name given to a two way peer – to- peer wireless protocol that uses long wave magnetic signals to send and receive data packets in a network mainly recognized in automatic identification. It is officially defined by The Institute of Electrical and Electronic Engineers (IEEE) in 2006. According to the IEEE (2006), “RuBee will provide assets for visibility networking that fills the gap between the non-networked, non- programmable, backscattered[1], RFID tags widely used for asset tracking and the high bandwidth radiating protocols”. It is widely used as sensors, controls or even actuators and indicators. RuBee operates below 450kHz and optimally at 132 kHz even below AM in radio band and works in the near field under 50 feet simultaneously without inference from many antennas near by.RuBee acts active radiating transreceiver similar to Wi-fi and Zigbee. But these IEEE 802 protocols operate in electric field in the VHF,UHF SHF band ,unlike RuBee works in LW band within magnetic field. RuBee technology uses tag and reader to communicate in a network between peer devices with minimal power consumption in the established magnetic field[2].

This paper is paper is organized as follows. Section 1 states the differences between RFID and RuBee technology. Section 2 contains the working of Rubee tag module and the trans-receiver modes. Section 3 gives the protocol description with physical layer and data link layer specification in the protocol data unit. Section 4 provides the market analysis for the protocol. Section 5 states the conclusion of the technology.

1. **RuBee Vs RFID TECHNOLOGY**

RuBee is often compared with RFID (Radio frequency identification) technology, but its operation is different as compared to RFID. Studies suggest that RuBee is categorized as a visibility tool providing more object information in real time as well as historical information on the status of object compared to simple tracking tool RFID used only on current object status. RuBee system uses magnetic wave inductance operating as a networked trans-receiver whereas RFID uses RF energy signals works in backscatter transmission mode operating as reflective transponders. RuBee uses volumetric loop antenna where it can read all tags requiring no direct line of sight as compared to RFID that uses dipole antenna which reads in single fixed direction [3].



**Fig 1: RuBee Vs RFID Fields**

RuBee has greater volumetric range of 10,000 square feet read range than passive RFID tags .RuBee technology due to more encryption schemes used is more secure as compared to RFID.Its magnetic signal strength varies as 1/R3 (R is the distance from antenna in meters) as compared to RFID power which drops as 1/R. Thus RF signals can be detected at high frequencies whereas RuBee signals go unnoticeable at the same distance. Thus achieving high level of privacy. The LW low power magnetic waves are not absorbed by the biological tissues of human beings making the device operation more human safe as compared to RFID technology[2]. As the fied strength falls as 1/r3 RuBee systems are less vulnerable to noise in the local visibility network as compared to RFID systems. The RuBee tags use low frequencies and low power consumption on the CMOS chips achieving longer battery life as compared to the RFID chips. RuBee modules are less costly as compared to active RFID tags. HF RFID tags can read at 100 per second and UHF tags can be read at upto 150 to 200 per second, the read rates for RuBee tags are 6-10 per second. Read range is limited and writing to the tag is difficult in RFID which uses EEPROM memory as compared to RuBee tags where read and writing modes have same range.

1. **RuBee MODULE**

RuBee uses magnetic waves producing inductive communication .The Electric field and magnetic field both are tied together with the far field to form electric circuit capable of transferring power RuBee is a packet based protocol in which only one end of the communication at a time generates fields, that is a RuBee tag is a radiating trans-receiver[4]. The complete RuBee module consists of RuBee tags,RuBee router and server system.

* 1. **RuBee Tag**

A RuBee tag is a 4-bit CPU, 1kB SRAM, crystal supported by lithium battery with enhanced lifespan. This tag is about 1 x 1 by 0.07 inches equipped with sensors, displays, SRAM memory and a clock. It can operate at other frequencies (e g 450 kHz) but 131 kHz is optimal. The RuBee protocol uses an IP Address. Data is stored in the tag, there is no need to go to the server for learning about it.



**Fig 2: A typical RuBee Tag**

The tags work well in harsh environment means situation in which one or both ends is near steel or water having range of 1 to 30 m.(3 to 100 ft) depending on antenna configuration[5]. RuBee can read a tag within an ellipsoid volume of about 10 x 10 x15 ft. Moreover encryption techniques used with keys make tags more secure.

* 1. **Transmit and Receive Modes**

The transmitter operates in two modes namely sleep and active mode. In Sleep mode, the transmitter does not transmit data, consuming very less power and switches into it while it enters the receiver section. Whereas in active mode transmitter sends data with 1200 baud rate at 131kHz frequency. On the other side the responder has two states namely sleep and listen. The responder state rests most of the time in sleep state as soon as it detects the carrier, it wakes up and enters into listen state to get the commands [6].

**2.3 RuBee router :**

The Router can manage more than 100 to 1000 tags ,read data from tags and write data to tags through request-response command, which further sends data to the data server for processing the information.

1. **PROTOCOL DESCRIPTION**

IEEE 1902.1 is the standard given to the active wireless protocol. RuBee that uses longWave magnetic signals to send and receive short packets in a local regional network. This standard is used in sensor network applications requiring the physical layer designed as P1902.1[6]. A second standard has been drafted 1902.2 for higher level data functions required in visibility networks. This standard is widely used in real time communication and tracking within a local network. The second standard will address the data link layers based on existing users of the RuBee protocol.

* 1. **Physical Layer**

The Carrier frequency used for communication between the transmitter and the receiver is 131072Hz with the data clock frequency as 1024Hz. Both the controller and responder devices use either ASK or BPSK modulation schemes. The bi-phase mark coding (BMC) is used for the protocol IEE1902.1 in communication. BMC provides better noise immunity, low DC bias and easily derived clock.

* 1. **Data Protocol**

In the RuBee network the communication between controller device and responder device follows a request response model addressing information in the form of protocol data unit (PDU).

* + 1. **Protocol Data Unit(PDU)**

There are two types of PDU formats namely Request PDU format from the controller side and Response PDU format and the responder side. A controller initiates the communication by sending the Request PDU to responder.

**Table 1. Request and Response PDU format**

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **Start** | **Protocol Selector** | **Address** | **Frame body** | **FCS** | **End** |
| 0 x0,0x0,0x 5 | AppProt | ID | Data | FCS | 0 x 00 |
| N nibbles | 1 nibble | 8 nibbles | N nibbles | 2 nibbles | 2 nibbles |

|  |  |  |  |
| --- | --- | --- | --- |
| **Start** | **Frame body** | **FCS** | **End** |
| 0 x05 | Data | FCS2 | 0 x00 |
| 0 x05 | 8 nibbles response code |  | 0x00 |
| 2 nibbles | n nibbles | 0 or 2 nibbles | 2 nibbles |

The responder reply to the request from a controller device when the request is send to an address that the responder has been configured to recognize with different types of responder addresses for broadcast and multicast addresses in network communication[7].

1. **MARKET ANALYSIS**

In 2006, Schurman projected that the market prospects for RuBee technologies are bright and competent to RFID. In the retail and warehouse environment these are effectively used for item tagging, inventory control and metal shelving. These have promising capabilities for smart asset management. For health care applications, equipment monitoring, vehicle registration, access card identification these can be efficiently used with less infrastructure cost. These can be widely used in medical implants as magnetic waves are not absorbed by highly liquid human or animal tissues. Also can be used in animal identification, tracking or breeding operations in animals. The protocol provides the baud rate of 1200 with packet size limited to 100 of bytes. RuBee has the support of leading technology providers namely Epson, Hewitt Packard, Intel, IBM, Motorolla, NCR, Panasonic and Sony [8]. Thus RuBee technology can be competent to RF technology and replace RFID vendors.

1. **CONCLUSION**

RuBee technology is a bi-directional two way active wireless protocol. Communication between the controller and responder devices uses the physical and data link layer of the designed IEEE 1902.1 protocol. RuBee tags using magnetic wave band provides a replacement for RFID technology which uses radio waves. Thus the emerging RuBee technology design and application are increasing and acceptable to be competent with the RFID technology in health, human, animal identification, inventory control and retail marketing. Hence these RuBee modules operate below 450KHz frequency with the help of volumetric antennae, low cost lithium tags widely used in the visibility application in local area network [9].

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