Time-Based CSMA Protocol for Alleviating Collision Problem in RFID System

Poornima.R [1], Bharathi.N [2]
School of Computing SASTRA University, Thanjavur-613401, TamilNadu, India.
[1]poorniajar@gmail.com
[2]bharathi_n@cse.sastra.edu

***Abstract*— Radio Frequency Identification (RFID) System admits rapid identification of entities by itself in the discipline of pervasive computing. RFID system comprises readers and tags. Readers are communicating with the tag by broadcasting RF signals. In existing RFID system channel assignment, tag identification and collision is a vital issue. Henceforth efforts are requisite to minimize these issues. This work evaluating the throughput of the RFID system by incorporating time into Carrier Sense Multiple Access (CSMA) protocol. Time based CSMA (TCSMA) depends on CSMA below low contention and TDMA below high contention in RFID system. The performance can be measured by Mat lab simulator. Time Based CSMA improves the tag read rate and also reduces the collision problem when compared to the conventional algorithm.**

Keyword- Key Words- Time, Collision, CSMA, RFID System, TCSMA.

I. INTRODUCTION

RFID system is one of the new technologies for the pervasive computing paradigm. It is widely used for automatic identification such as service industries, distribution logistics, material flow system, locations and even people based on radio waves. In RFID system, the basic components are transponder (RFID tag) with Electronic Product Code EPC [12],[24], an antenna or coil and a transceiver. Tags are categorized based on the energy of the tags such as passive and active tags. Passive tag will not have its own energy source and active tag is powered by internal battery. A passive tag is charged within its interrogation area using inductive coupling. The reader spreads electromagnetic signal to the tag in which the antenna receive and store the signal in an on-board capacitor then the tags battery get charged[7],[8]. Tag identification is performed by the reader's signal to a tag and then the tag's backscattering its ID as response. In spite of this, if more than one tag send their id‘s simultaneously to the reader means then collision will attain. Hence efforts are required to minimize this collision. By using TCSMA collision avoidance mechanism a reader can improve the tag read rate when compared to the traditional algorithm [16].

TABLE I
TDMA VS CSMA

MAC	Channel Utilization	
	High Contention	Low Contention
CSMA	Low	High
TDMA	High	Low

- In this work TCSMA behave like CSMA below low contention and in TDMA below high contention in RFID system.
- The simulation results show that TCSMA enrich the tag read rate by 70 to 80 percent compare to the traditional algorithm.

This work is systematized as: In section II the related work for Reader collision, tag collision and collision detection protocol. Section III is about detail system design of TCSMA in RFID system is shown. The evaluation of result is illustrated in section IV Finally the work is concluded in section V.

II. RELATED WORKS

A. Collision

Voluminous research work for collision avoidance has been enlightened in the literature. There are mainly two collision occur in RFID System. They are Tag and Reader collision [3]. In the case of tag collision, if more than one tag sends the response signal to more than one reader simultaneously means collision will occur. Reader collision arise when the exposure area of one reader interference with that of another reader [2],[4],[5].

Fig1.RFID Collision: (a) Tag Collision (b)Reader Collision

B. Multiple Access Protocol In RFID

Multiple access protocol are used to avoid the collision problem, different protocols are available such as, space division multiple access (SDMA) is used to allocate individual space to the users , frequency division multiple access (FDMA) divide the frequency into different frequency bands, time division multiple access (TDMA)is allocate individual time slot to the users, code division multiple access (CDMA) is allocate several code space to separate different users and carrier sense multiple access (CSMA) node verifies the absence of other traffic before transmitting in the network[26].

SDMA: Jiexiao Yu [20] proposed to adopt the space division multiple access protocol among the beams and represent the TDBF (twice digital beam forming) technology to avoid the reader collision problem.

FDMA: Reader communicates with the tag by using the same frequency but in the case of FDMA different frequency is used to communicate therefore FDMA is not applicable for RFID System.

TDMA: TDMA protocol can only retrieve one tag's ID at one time slot. In case of significantly increase the system throughput, combining the TDMA protocol with other multiple access technology is necessary [9],[15].

CDMA: Carlo Mutti [1] et al proposed the CDMA-based RFID Systems in Dense Scenarios: Concepts and Challenge it can be used to decode tag signals in different collisions.

CSMA: Lei Kang [19] et al proposed a Receiver-Based CSMA in RFID Systems. To increase the tag read rate by reducing the collision.

III. PROPOSED SYSTEM DESIGN

TCSMA is a combination of TDMA and CSMA by combining their strength while neglecting their weakness [14]. Each tag in TDMA protocol has its own time slot to transmit their signal to the reader. Unlike in TDMA, the tag can send in both its own time slot and if the non-owner's slot is free, and then the tag can send the signal through it. It is not necessary for all the owner of the time slot to send signal at all the time [11]. Therefore, according to CSMA, non-owners can make use of the free time slots available. But the owner has the higher priority than the non-owner. This mechanism has the ability to switch between TDMA and CSMA depending upon the contention ratio. In the case of high contention ratio, TCSMA switches to TDMA which leads to high channel utilization, accuracy and low contention. On the other hand, in the case of low contention ratio, CSMA gets utilized which leads to high channel utilization and low latency [18].

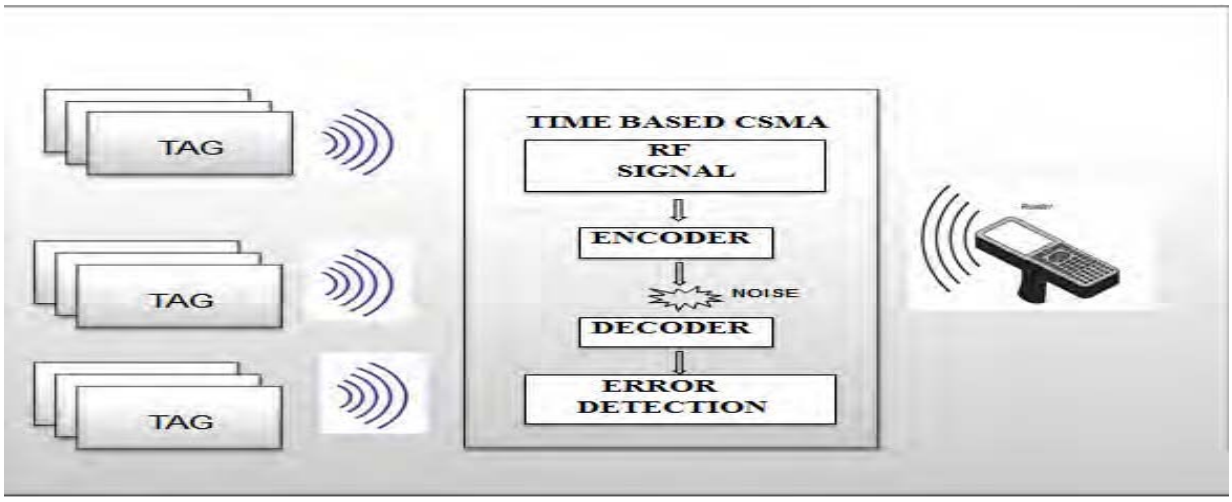

Fig2. System Design of TCSMA

The proposed framework has the following phases,

- RFID Setup phase
- Transmission Control of TCSMA
- Explicit Contention Notification
- Local Time Coordination

A. RFID Setup Phase

RFID setup phase includes Reader placement, Tag discovery, slot assignment, and Local framing

1) *Reader Placement*

A reader or transceivers (transmitter/receiver) consist of an RFI and control unit. Its purpose is to activate the tags, organize the communication sequence with the tag, and sends data between the application and a tag. Readers are of two types: static and dynamic. It can be placed anywhere based on the application.

2) Tag Discovery

RFID tags are attached to the objects to count or identify. Tags mainly consist of a microchip and coiled antenna. Every tag periodically broadcasts a message to the reader. A message contains the ID of the tag. Through this operation, reader gathers the information about the tag.

3) *Slot Assignment*

For slot assignment DRAND is used.it is used to assign time slots for every tag. DRAND is a distributed RAND, used for TDMA protocol or channel assignment for RFID system. Ensuring that no multiple tags are assigned to the same slot. The slot number assigned to a tag should not surpass the size of its local neighborhood (δ). The running time and message difficulty are bounded by O (δ).

4) *Local Framing*

Time Frame uses the time slot for transmitting the signal. The DRAND algorithm, used by TCSMA to allocate time slots to every tag, when used behind the Time Frame that allows for a local neighborhood to vary its Maximum Slot Number (MSN)without any need to send.

B. Transmission Control of TCSMA

Two modes of functions are LCR (low contention ratio) and HCR (high contention ratio).In LCR, non-owners are permitted to strive in any of the slot with low priority. Under HCR, a node does not strive in a slot owned by its two-hop neighbors in order to avoid the hidden terminal problem. Tag is in HCR mode means it gets a ECN (explicit collision notification message) from the reader within the last ECN, otherwise node is in LCR mode. Reader sends ECN messages when they detect high contention.

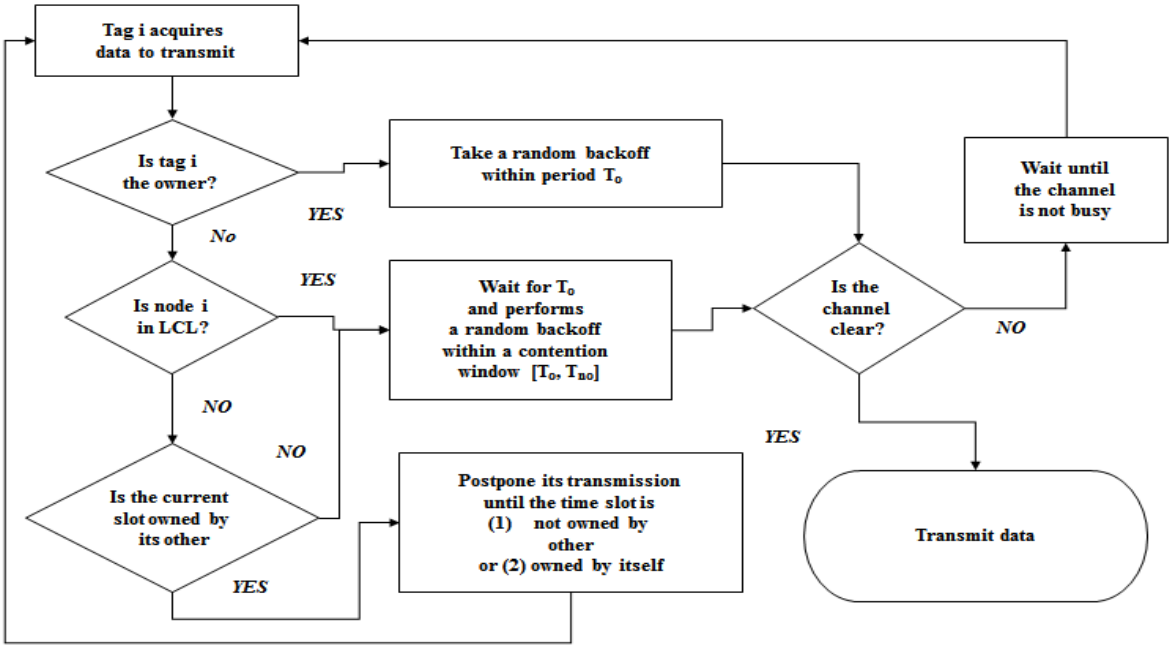

Fig3.Transaction Control

C. Explicit Collision Notification

EXPLICIT COLLISION NOTIFICATION (ECN) messages notify the tag to not turn as hidden terminals to the owner of each time slot when contention is high. High contention is detected passively by each tag.When a tag receives ECN signal, it sets the HCL flag. HCL is detected by lost ACKs or congestion back offs.When the reader identify high contention, it sends a unicast signal, one-hop Explicit collision notification signal, to the tag which is experiencing contention. If there are multiple tags, it broadcasts a message about the multiple tags.

D. Local Time Coordination

Synchronization only required among tags when they are under high contention. Reader can passively synchronize clock to the tags clock without need for extra synchronization messages. Clock values are updated by using a weighted dynamic average of its current clock value and the accepted values. The weight is based on a trust factor which reflects how often the node transmitted and received synchronization messages.Data loss could arise due to low SNR between the tag and reader. The data loss is signified by

$$P_L \Rightarrow SNR_{r \to t} = \left(\frac{P * P_l (d_{r \to t})}{N} > th \right) \quad (1)$$

Where p is power,

r and t be the reader and tag,

$P_l (d_{r \to t})$ is a path loss factor

N is the noise power and

th is the threshold value of SNR.

IV. PERFORMANCE EVALVATION

TCSMA transmission with different FER and SNR was executed. Generally, when the signal is transmitted to the tag or reader, it should have the minimum FER and maximum SNR. So, the analyses have been performed for the values of FER for different type of SNR values of the transmitted signal. Red, blue, green lines denote the signal transmission at the particular FER and SNR rates. The yellow line denotes the TCSMA transmission & reception of single user signal in the channel. This type of transmissions gives the good resolution only when the SNR increases, which reduces the FER. Hence this gives perfect transmission. The black line denotes the TCSMA transmission with multiple users. Here also the FER goes to low range. So, the transmission denotes the quality by using TCSMA. Because the single user or multiple users are having the same output flow.

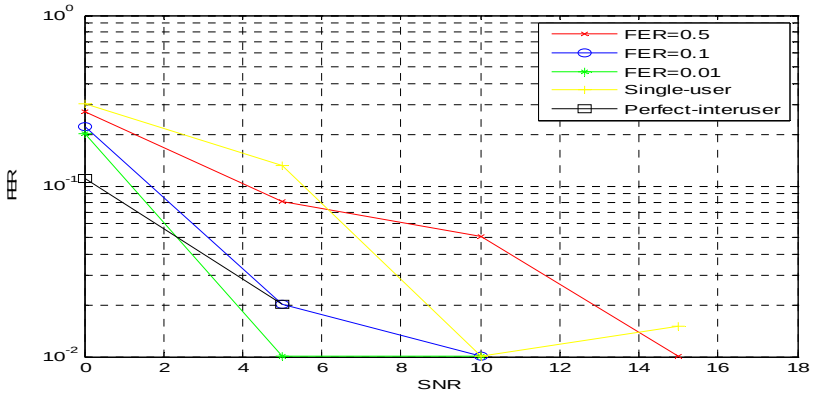

Fig 4. PERFORMANCE EVALUATION OF TCSMA

V. CONCLUSION

Existing techniques doesn't have much capability to avoid collisions in RFID system. This work proposes the performance of a multiple channel time based CSMA protocol (TCSMA) to avoid collision. To analyze the throughput of the RFID system, time is incorporated into CSMA protocol. TCSMA depends on CSMA bellow low contention and TDMA bellow high contention in RFID system. The performance can be measured by Matlab simulator. Time Based CSMA improve the tag read rate and reduce collision when compared to the traditional algorithm.

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