COLLISION AVOIDANCE IN RFID SYSTEMS USING SHADOW SLOTS

Reshma, R1, Tejeswinee.K1, Uva Rani.J1, A.S.Balaji2
1Student, Department of Computer Science and Engineering, Anand Institute of Higher Technology, Kazhipattur, India
2Assistant Professor, Department of Computer Science and Engineering, Anand Institute of Higher Technology, Kazhipattur, India

Abstract—The Radio Frequency Identification (RFID) system consists of a reader and multiple tags [1]. In the RFID environment, consumers can obtain product-related information of tags by using readers which are installed in the required environment. However, the tag collision problem is serious in the environment. This paper proposes a shadow-slot algorithm for handling this problem. In the algorithm, the reader assigns reservation slots, and each tag generates a random sequence in its own reservation slot randomly selected by this tag to reserve a frame slot. The tags are arranged by using the collision tree algorithm. The colliding tags are then placed in a separate new slot called the Shadow slot which is processed in the end. Accordingly, the algorithm significantly reduces collision frame slots, and eliminates empty frame slots. Our performance evaluation shows that the proposed algorithm outperforms other algorithms.

Index Terms—Anti-collision, Collision, Reservation, RFID.

I. INTRODUCTION

The Radio Frequency Identification (RFID), is an automatic identification technique. The process of identifying tags consists of querying to tags and responding to the reader. In case of multiple tags scattering around the reader, there are chances that more than one tag simultaneously responds to the reader and therefore signal is collided. It is widely used in various applications including the traffic control systems and the supply chains. Usually, RFID systems consist of a reader and many tags. Tags are attached to the products and store the product-related information, and transmit IDs in responses to interrogation signals from the reader. The process of detecting the tag IDs from tags by the reader is called tag identification. The RFID system is much preferred to the barcode system.

In recent years, extensive attention has been paid Internet of Things. The benefits of using the RFID reader in Internet of things is that it enables the products to be connected to a single desired network.

Fig.1 describes the application of the mobile RFID reader.

However, there exists a tag collision problem when the tags are being read simultaneously. Tags simultaneously transmit their IDs to a reader and therefore the reader cannot identify them individually. If this tag collision problem occurs in a high probability, the RFID systems will not be appropriate for use in the practical world. A common approach to avoid tag collision is to separate the reception of tags. Various anti-collision algorithms have been proposed for the coordination of tag transmissions.
II. EXISTING SYSTEM

The frame slotted Aloha algorithm is a probabilistic approach where the tags respond to the reader’s query at random time depending on the frame size; hence the estimated number of tags present must be known in prior, which is nontrivial in practice. In general, the Aloha-based schemes are simple and have a low implementation cost. They work well under sparse networks. The existing system uses the Q Algorithm which proposes three cases for reservations of frame slots: (1) Empty frame slot: after waiting for a short time, the reader terminates the current frame if it has not received a random number. (2) Collision frame slot: the reader terminates the current frame slot if there are multiple random numbers in the frame slot. (3) Success frame slot: if only one tag transmits a random number to the reader in the current frame slot, the reader can successfully receive the tag’s ID in the remainder of this frame slot. Reservation Slot with Multi-Bits Aloha (RSMBA) eliminates the drawbacks of Q algorithm. RSMBA uses multiple-bit random sequence rather than one-bit random sequence to reserve a frame slot and results in significantly reducing collision frame slots.

III. TAG COLLISION PROBLEM

In the RFID system, there are many tags within the interrogation zone of the reader. If multiple tags transmit data at the same time, the burst of data traffic will lead to low packet reception rate at the reader because of serious transmission collisions, i.e., the tag collision problem.

In the previous studies, four approaches are presented to avoid the packet collision. These approaches regulate media access based on time, space, frequency, and code. Therefore, these approaches are called Time Division Multiple Access, (TDMA), Space Division Multiple Access (SDMA), Frequency Division Multiple Access (FDMA), and Code Division Multiple Access (CDMA), respectively.

In TDMA-based approaches, aloha-based protocols are used to handle the tag collision problem because of its low complexity. However, due to their random nature, it may cause too many empty frame slots and too many collision frame slots in each inventory round. Therefore, elimination of empty frame slots and collision frame slots is very important.

Deterministic schemes are based on ID tree search protocol which can achieves 100% recognition rate, but these kinds of
protocols have a long time delay. Stochastic schemes are based on frame slot ALOHA (FSA) protocol which can be easily implemented. When the population of the tags gets large, the efficiency of fixed frame length FSA, however, drops dramatically.

IV. PROPOSED SYSTEM

In the proposed system, the security is given by providing the login for the administrator. This login needs details such as the username and the password. The username and the password ensure that no outside user can attack the system without the proper authorization. The username along with the correct password is stored in the database and verified each time access is required.

Once the authorized user has accessed the system, they can have authority over maintaining the number of tags in the RFID environment. The administrator can set the properties of the tags including their nature (active tags or passive tags). The reader specifications are manually set. These settings include the reader version, type, range and the interrogation area of the RFID environment. Once the tags and the reader settings are done, the details can be viewed by the authorized user.

Once the reader starts reception, the tags are in the interrogation area. These tags are generally read in the order they arrive to the reader. The tags which are randomly read are stored in the database in the same order.

When the tag enters the interrogation area, the information from the tag has been transferred to the reader in the form of radio signals. These information include the product name, price, marketing details, and other details. Thus the tag name, tag id, tag description will be recorded in the database along with a random number which is automatically produced by each tag. For creating this random number, the random number algorithm is used, so that no two tags shall have the same random number.

The reader assigns some small-size slots for the tags called the reservation slots. These slots are allocated according to the number of tags being read by the reader in that particular area. Each tag randomly selects a reservation slot and transmits a random number sequence to be placed in the reservation slot. The number of slots allocated depends on the number of tags read by the reader. This step is called the reservation procedure. Fig.4 shows the tags being arranged in the reservation slots.

<table>
<thead>
<tr>
<th>Tags</th>
<th>Slot 0</th>
<th>Slot 1</th>
<th>Slot 2</th>
<th>Slot 3</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tag 2</td>
<td></td>
<td></td>
<td>0101</td>
<td></td>
</tr>
<tr>
<td>Tag 4</td>
<td>1010</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Tag 1</td>
<td></td>
<td>0101</td>
<td></td>
<td>1110</td>
</tr>
<tr>
<td>Tag 3</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Fig.4 Reservation Procedure

While filling the reservation slots, the random number follows the Collision Tree algorithm as shown in fig.5(a) and fig.5(b). A tag set is split into two subsets in a collision cycle. The random number of the tags are read bit by bit and placed in the collision tree. When collision occurs in a reservation slot, the colliding tags are split using the CT algorithm (Collision Tree Algorithm) [2], [3] and the splitting is continued until there is only one tag left in a set. Therefore, there is exactly only one tag in the leaf node and at least two tags in an internal node. On the other hand, tag identification is same as that of a tree search, where the search starts at the root of the tree and ends at the leaf node.

Fig.5(a) Identification process
Once the reservation slots have been filled randomly, they need to be arranged. The tags inside the slots are arranged in order, so that the tags are read in order.

There might be three cases while reading the tags from the slots.

Case 1: If there are no tags in the slot, the slot will be eliminated.

Case 2: If the slot has only one tag, then the reader reads only that tag.

Case 3: If many tags select the same reservation slot, then the tag that is present second will be moved to the shadow slot.

When there are no tags filled in the reservation slot as in case 1, then there is no possibility of collision. When there is a single tag in the slot, as in case 2, again there can be no collision because there are no enough tags to collide. According to case 3, multiple tags in the same slot provides high chances of collision. In such a case, the colliding tags have to be separated from each other while they are being read.

Fig. 6 shows the collision avoided in the reservation slots by using the shadow slot.

<table>
<thead>
<tr>
<th>Tags</th>
<th>Slot 0</th>
<th>Slot 1</th>
<th>Slot 2</th>
<th>Slot 3</th>
<th>Shadow Slot</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tag 2</td>
<td></td>
<td></td>
<td>0101</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Tag 4</td>
<td>1010</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Tag 1</td>
<td></td>
<td></td>
<td>1110</td>
<td></td>
<td>0101</td>
</tr>
</tbody>
</table>

Therefore, by this method, the colliding tags are placed far apart from each other. This process not only reduces the possibility of collision, but identifies and eliminates it.

V. CONCLUSION

In the existing aloha-based anti-collision protocols, the time overheads from many empty frame slots and collision frame slots lead to the low performance problem, and the problem is serious in the mobile RFID environment. We propose a Shadow Slot protocol to handle this problem in this paper. The main idea of this Shadow Slot algorithm is to avoid the empty frame slots and eventually detect and avoid collision when multiple tags are transmitted simultaneously. The collision tree algorithm is used to arrange the tags in each slot and place the colliding tags in the Shadow Slot. Therefore, Shadow Slot algorithm is a proper solution to the RFID environment.

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REFERENCES


Reshma.R, pursuing Bachelor of Computer Science and Engineering at Anand Institute of Higher Technology, Chennai, India 2015. Her interest includes exploring the new technological devices and well versed in coding in C and JAVA.

Tejeswinee.K, pursuing Bachelor of Computer Science and Engineering at Anand Institute of Higher Technology, Chennai, India 2015. She is passionate about learning new technologies and their real time application. She is interested in the Bluetooth technology.

Uva Rani.J, pursuing Bachelor of Engineering at Anand Institute of Higher Technology, Chennai, India 2015. She is currently doing her internship at Infosys. She has wide range of interests in coding in JAVA and also in wireless technologies.

A.S.Balaji M.E., is an Assistant professor of the Department of Computer science and engineering, Anand Institute of Higher technology at Chennai. He has 8.5 years of teaching experience. His area of interest includes wireless sensor networks, Digital image processing and Software architecture. He guided many Bachelor degree level projects and published variety of papers in many conferences and journals.