A Low Complexity Anti-collision Algorithm for RFID Using Query Tree

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***Abstract*— In order to further decrease the probability of the collision and reduce communication complexity, a new low complexity anti-collision algorithm for RFID is proposed using Query Tree. The proposed algorithm can reduce the probability of collision and the traffic of data communication by tag grouping and setting rules, respectively. The simulation results show that the proposed scheme consumes fewer slots and has lower communication complexity.**

Keywords—RFID; Anti-collision algorithm; Query tree; Data Clipping

I. INTRODUCTION

The Radio Frequency Identification (RFID) is an automatic identification system where the reader identifies the tags by radio waves. In light of high-speed, feasible, convenient and contactless, RFID is one of the key technologies of the Internet of things (IoT) and is widely applied in many fields, such as medical treatment, supply-chain management, transportation and item tracking. However, the rapid development of RFID technology gives rise to several problems, including data security, transmission distance, tag collision and so on. The tag collision seriously restricts the development of RFID [1][2]. How to solve this problem effectively is the key point of the research of RFID technology. To resolve this problem, many tag anti-collision algorithms have been proposed, which are divided into two categories: Aloha-based probabilistic algorithms and tree-based deterministic algorithms.

Since Aloha-based algorithms cannot completely prevent collisions, a specific tag may not be identified for a long time, leading to "tag starvation problem" [3]. Tree-based algorithms including deterministic tree-based algorithm such as query tree algorithm (QT) [4], and probabilistic counter-based algorithm such as binary tree algorithm (BT) [5], which separate collided tags into two sets until each set has only one tag or no tag. Although the tree-based algorithms have relatively long identification delay, they solve the tag starvation problem. However, those algorithms are still inevitably cause lots of idle and collision slots.

In this paper, a query tree with low complexity anti-collision algorithm (QTLC) is proposed to further decrease the probability of the collision and reduce communication complexity, which divides the traditional identification into tag-grouping stage and tag identification stage. In the first stage, the reader determines the grouping prefix by sending a prefix query command and the tags with the same grouping prefix are in the same branch, in which a large search tree is divided into several branches to reduce the probability of the collisions. In the second stage, using the set of reply rules, the data replied by tag is clipped to decrease the transmission quantity of invalid data and reduce the communication complexity of the system. Simulation results show that the proposed algorithm takes great advantage of identification delay, system efficient and communication complexity.

II. ALGORITHM DESIGN

A. Tag Grouping

The purpose of grouping is to divide the mass tags into several groups with the same ID prefix sequence, and each tag is identified in the group, resulting in the reduction of the collision probability in the initial stage. The reader gets the grouping prefix sequence of all the tag ID by sending query command to unread tags, and the tags with the same prefix sequence are divided into one group.

The length of grouping prefix sequence is $n=\lfloor \log_2^g \rfloor$, where $\lfloor * \rfloor$ is a rounded down operation and g is the initial groups. In initial stage of grouping, the reader first sends the k bit query sequence (11... 1000... 0), where the length of ID and the length of 1 are k and n, respectively. While obtaining the query sequence, all tags encoded the former n-bit data of ID to the decimal number m, then a 2^n-bit data is generated, in which the $(m)th$-bit of the sequence is 1, and the remaining bits are all 0. After receiving the tag reply, the reader counts the number of the non-repeating sequence and gets the number of the actual grouping.

For example, there are 8 tags with IDs 00110101 (T1), 00111010 (T2), 00100100 (T3), 10101000 (T4), 10101101 (T5), 10110001 (T6), 11001111 (T7) and 11010100 (T8), respectively and $g=8$. While obtaining the query sequence of"11100000", all tags convert the first 3 bit binary number of ID to decimal number, then replying 8 bits of binary sequence to reader, in which the 1th, 5th, 6th bit of the sequence is "1" respectively , and the other are 0. At the same time, the reader determines the 1th, 5th, 6th bit in this sequence to be "1" and converts it into the corresponding binary sequence, namely, "001", "101" and "110". The prefix, such as "000","010","011","100","111", is eliminated. As a result, the prefix sequence of each group of tag is determined.

B. Data Clipping

For NEAA [6] and CTTA [7] algorithm, when there is a collision, the reader still receives the remaining ID data sent by the tag and this invalid data information increases the communication complexity of the system. According to the above problem, QTLC algorithm sets up a data clipping mechanism. When the reader sends a query prefix sequence with h bits, if the former h bits of tag' ID match this sequence and the (h+1)Th-bit is "0", the tag will sent the remaining (k-h) bits to the reader; otherwise, it only replies "1" to reader. Using data clipping technology, QTLC algorithm can reduce the communication complexity of the system, and speeds up the identification.

For example, when the current query prefix is "001", T1, T2 and T3 will assigned to the same group. By detecting the information bits. T3 reply the remaining bits to the reader, that is, it is "00100". T1 and T2, however, reply "1" to the reader.

III. EXPERIMENTAL RESULTS AND DISCUSSION

The identification efficiency with different initial groups is demonstrated in Fig.1, which shows that the system gets a higher efficiency with a larger initial groups. Fig.2 shows the traffic of a reader. The traffic of four algorithms increases with the number of tags, and this pattern of growth is linear. The proposed algorithm has slowest growth because it automatically generates valid query prefixes, which greatly reduces the number of queries sent by a reader. The similar results on the traffic of tag can be obtained from Fig.3.

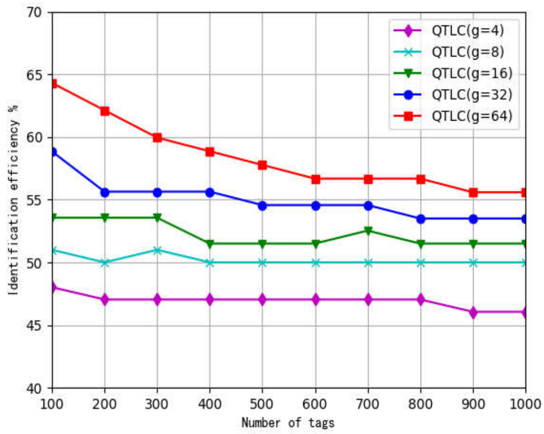

Fig.1. The identification efficiency with different initial groups.

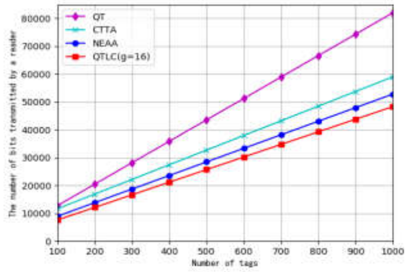

Fig.2. The compare of traffic of a reader.

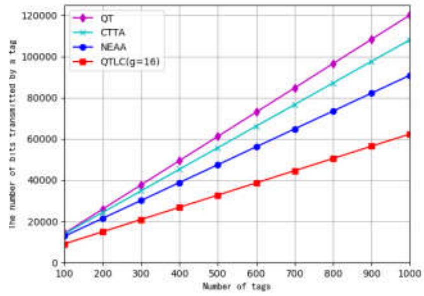

Fig.3. The traffic of tag.

IV. CONCLUSION

In this paper, a new QTLC-based anti-collision algorithm for RFID is proposed. Simulation results show the good performance on identification efficiency and system traffic.

ACKNOWLEDGMENT

This work was supported in part by the National Science Foundation of China under Grant 61771226, 61671223 and 61571031.

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