Comparative Analysis of Anti-Collision Protocols in RFID

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Abstract— *Radio Frequency Identification, abbreviated as RFID which was originally invented as a replacement tool for bar-code scanning and identification has now evolved into a vital technology spanning across fields such as supply chain management, shipping of goods, tracking and identification, etc. However along with the widespread use of RFID, the underlying problem of collision of readers, and tags has been hampering the reliability, and integrity of RFID; thus causing a problem in the further evolution and future deployment of the same in new-born organizations. This papers aims at surveying the various anti-collision protocols which are designed and implemented in order to curb one of the major encumbrances in RFID technology viz. collision.*

Keywords— ***RFID, Anti-collision, ALOHA protocols, Tree protocols, Hybrid variants, Energy- efficient, MAS protocol.***

I. INTRODUCTION

RFID [Radio Frequency Identification] technology, which provides efficient wireless object identification, is envisioned to bridge the physical world and the virtual world. Many large companies have set foot in this area, providing hardware and software solutions as well as contributing to a global standard. The major RFID technology providers include Philips Electronic, Texas Instruments, IBM, Intel, SAP, VeriSign, Sun Microsystems, and Alien. [1] Ubiquitous tagging is a paradigm where every entity has a unique tag associated resources. On the other hand, tags vary significantly in their computational capabilities. They range from dumb & passive tags, which respond only at reader commands, to smart active tags, which have an on-board micro-controller, transceiver, memory, and power supply. [3] Among tag types, passive ones are emerging to be a popular choice for large scale deployments due to their low cost. [4]

II. PROBLEM STATEMENT

Collision due to simultaneous tag responses is one of the key issues in RFID systems [7]. It results in wastage of bandwidth, energy, and increases identification delays. To minimize collisions, RFID readers must use an anti-collision protocol. To this end, this paper reviews state-of-the-art tag reading or anti-collision protocols, and provides a detailed comparison of the different approaches used to minimize collisions, and hence help reduce identification delays. Such review will be of great importance to researchers and designers that are building RFID systems involving interrogation zones with varying tag densities.

with it. Picture a scenario where everything in the world is associated with, and can be identified using an electronic tag. Such ubiquitous applications have become common in multiple fields which are related to access

control, and security systems. The first traditional technology to be replaced by RFID is the barcode system. RFID can do everything that barcodes can, and much more. [2] RFID systems consist of a reading device called a reader, and one or more tags. The reader is typically a powerful device with ample memory and computational

Tag

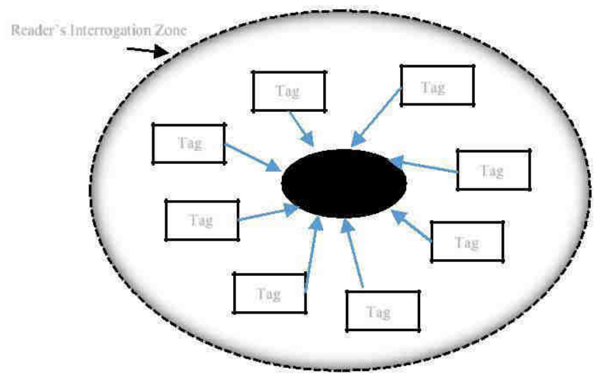

Fig. 1. Tag collision in RFID [3]

III. ANTI-COLLISION PROTOCOLS

Anti-collision protocols are critical to the performance of RFID systems. Broadly, they can be categorized into, space division multiple access (SDMA), frequency division multiple access (FDMA), code division multiple access (CDMA, and time division multiple access (TDMA).

Multiple Access/Anti-Collision Protocols

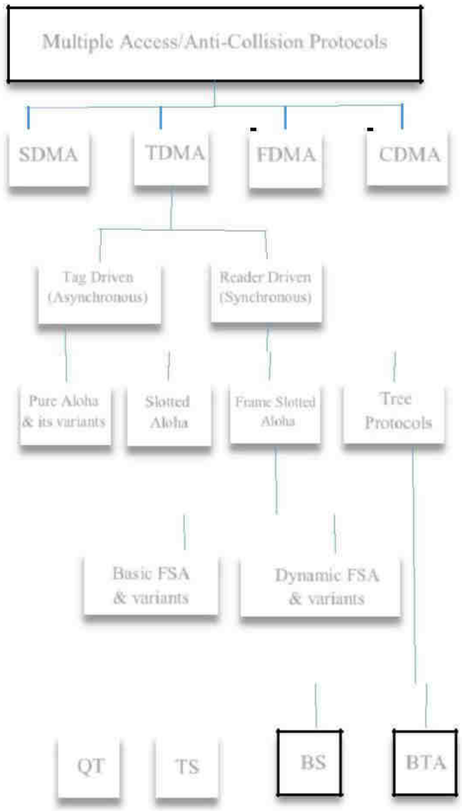

Fig. 2. Classification of Anti-Collision Protocols [3]

The protocols that we have considered for our survey are Pure Aloha, Query tree and Multi slotted scheme with assigned slots which is a hybrid protocol and a combination of Aloha based and Tree based protocols. The description of these protocols and their survey outcome is described in detail as follows.

IV. PURE ALOHA PROTOCOL

In PA based RFID systems, a tag responds with its ID randomly after being energized by a reader. It then waits for the reader to reply with, i) a positive acknowledgment (*ACK*), indicating its ID has been received correctly, or ii) a negative acknowledgment (*NACK*), meaning a collision has occurred. If two or more tags transmit, a complete or partial collision occurs [10], which tags then resolve by backing off randomly before retransmitting their ID. After simulating the process of tag detection in RFID system we obtain the graphs that show the energy conserved in the process.

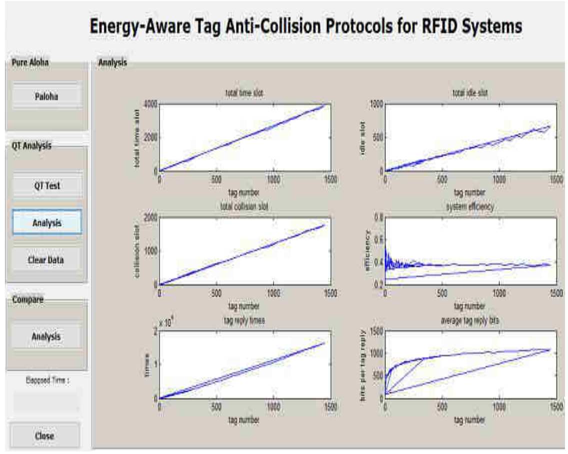

Fig. 3. Through put obtain in Pure Aloha system [3]

V. QUERY TREE PROTOCOL

Tree based protocols were originally developed for multiple access arbitration in wireless systems [16]. These protocols are able to single out and read every tag, provided each tag has a unique ID. All tree based protocols require tags to have muting capability, as tags are silenced after identification. In TS variants, tags require a random number generator and a counter to track their tree position, thus making them costly and computationally complex. Query tree algorithms overcome these problems by storing tree construction information at the reader, and tags only need to have a prefix matching circuit. After simulating the process of tag detection in RFID system we obtain the graphs that show the energy conserved in the process.

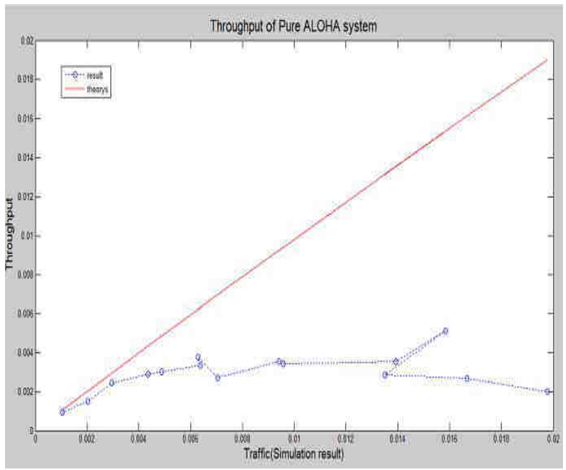

Fig.4. Throughput for Query tree system

VI. MULTI SLOTTED SCHEME PROTOCOL

The Multi-Slotted (MS) scheme works as follows. At each node of the B-ary tree2, F slots are used to read tag responses. Tags randomly choose a slot to respond. If all tags with the prefix of the node are read successfully within the F slots without collisions, the sub-trees of that node are not queried further. If there is at least one collision in the responses, sub-trees from that node are queried as before and so on. Some tag IDs may be read without collision, but since reader does not know to which sub trees the colliding tags belong to, it still has to query all the sub-trees This is because the reader has no way of telling the tags that were read, to stop responding. These tags would thus still respond to further queries until their prefix is ignored by future queries. After simulating the process of tag detection in RFID system we obtain the graphs that show the energy conserved in the process.

VII. COMPARITIVE ANALYSIS

After simulation each of the above mentioned protocol individually we obtained the reading for their performance. Using the reading we obtained from the protocols we will evaluate the performance of the above mentioned anti-collision protocols with respect to the energy conservation that each of the anti-collision protocol advocate. The graphs below show the comparison of the anti-collision protocols with respect to energy conservation.

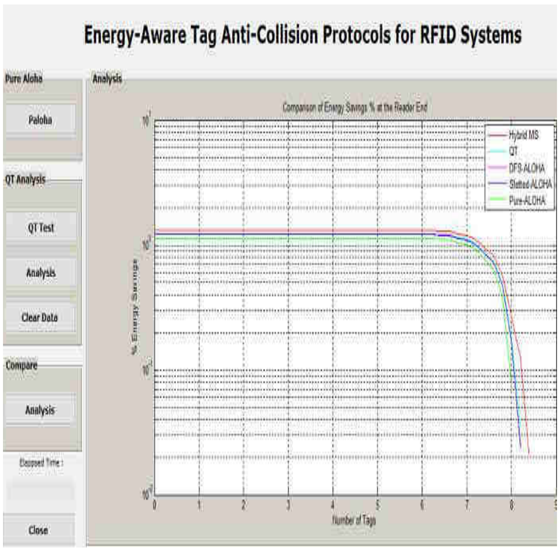

Fig. 5. Comparative analysis of Pure aloha, QT and MS in terms of energy conservation.

VIII. CONCLUSION

The approach of using multiple slots per node of a Binary search tree to reduce collisions among tag responses was presented to provide for energy-aware RFID tag arbitration by the reader. Three different variants i.e. Pure aloha, query tree and Multi slotted scheme were explored with the aim of finding the one which was most efficient in trading off time in exchange for reduced energy consumption. These protocols, like the existing Query Tree protocol, are memory less requiring the tags to store no state of the arbitration process and offer guarantees on the time required to read all tags. An analytical framework was developed to predict the average case performance of these protocols for different input parameters. The numerical evaluation of this framework was further validated with the help of simulation. All three protocols were shown to reduce energy consumption at the reader as well as active tags. In this work we explored the benefits of using a frame with multiple slots per node of the binary tree. The frame size F, however, was kept fixed at all nodes. As we query more levels, the number of tags responding to a prefix keeps decreasing. This creates an opening for designing a scheme that uses a decreasing frame size F as we descend the tree. If done carefully, this should preserve the energy savings at the reader and active tags, while at the same time eliminating the number of wasted time slots resulting in increased tag reading throughput and even more energy savings at the reader. So this analysis present to us an outcome indicating that with increase in the tag number the energy consumption by the pure aloha and query tree increases as compared to that of the multi slotted scheme .

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