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An RFID Best Effort Mechanism for in Motion Tracking Applications

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ABSTRACT

In this article, the authors propose an algorithm that reduces useless responses for RFID systems in a motion environment, for tracking applications. The mechanism achieves its goals by reducing the number of packets exchanged between readers and tags. They analyze the behavior of their proposal by considering the average number of identification rounds. With extensive simulations using an RFID module for the ns-2 simulator, the authors show the benefit of the proposed mechanism. When compared to the Pure Q Algorithm and Binary Tree Slotted Aloha, their mechanism reduces the number of packets up to 43%, which is a good result in terms of performance of motion applications and energy consumption of the devices used in the communications.

KEYWORDS

Binary Tree Slotted Aloha, ns-2 Simulator, Pure Q Algorithm, RFID Systems

1. INTRODUCTION

The “Internet of Things” (IoT) consists in a vision where objects become part of the Internet: every physical object has its unique identification, and is accessible from the network, providing an expanded Future Internet (Coetzee & Eksteen, 2011). In this scenario it is expected, for example, that the users use the Internet to check the location of people and their belongings within a pre-defined area. Thus, it is needed that readers periodically send requests to store the data about people and objects.

RFID (Sheng, Li, & Zeadally, 2008) is a key technology of the IoT, since small passive RFID tags allow to link millions and billions of physical products with the virtual world (Wu, Zeng, Feng, & Gu, 2013). When a large number of tags are used, there is a high probability that there will be more than one tag within a reader zone at some time. When the tags transmit their responses simultaneously to the reader, collisions will happen because the communication is done over a shared wireless channel. Therefore, RFID tag anti-collision mechanisms will play an important role in the IoT (Wu et al., 2013; Chunli & Donghui, 2012; Jia, Feng, Fan, & Lei, 2012).

Many efforts have been made in the literature to improve the performance of anti-collision protocols (Wu et al., 2013; Leonardo & Victor, 2012; Felemban, 2012; Jia, Feng, & Yu, 2012; Guilan & Guochao, 2010; Zhong, Chen, Wu, & Pan, 2012; Jian Su and Guang-Jun Wen, 2012; Chunli & Donghui, 2012; Han, Park, & Lee, 2012). However, little research has been conducted for IoT scenarios (Guilan & Guochao, 2010). According to (Namboodiri, DeSilva, Deegala, & Ramamoorthy, 2012)

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there are several disadvantages of using the Q algorithm, the standard Algorithm for Class 1 Generation 2 RFID systems, because too many packets need to be transmitted, in a single identification process, between the reader and tags. This process generates considerable overhead and increases the power consumption, since the energy consumption is proportional to the number of actions of the readers (Klair, Chin, & Raad, 2009). In an IoT scenario, where readers regularly consult the tags and make them available on the Internet, the problem is compounded, generating even more overhead.

The aim of this paper is to propose a mechanism to increase the chances to meet QoS re-quirements for IoT tracking scenarios, whose nodes are RFID tags. The mechanism reduces the number of delay slots (idle and collision), and consequently the amount of messages exchanged in the network, when compared to the Pure Q Algorithm and to the Binary Tree Slotted Aloha - BTSA algorithm. The proposed mechanism is based on the principle that the tags do not need to reply to all reader queries if they don't change their locations.

The proposed mechanism had its performance evaluated through simulated experiments in the simulator ns-2, and the results confirm its effectiveness. For instance, in a scenario with 500 tags, and using the proposed mechanism, there was a reduction in the number of delay slots of about 24%–43% when compared to the classical mechanisms.

The contributions of this paper are:

- A mechanism to decrease the delay slots in RFID systems used to deploy IoT applications;
- As a consequence of the first contribution, a decrease of energy consumed by readers and an increase to the chances to meet QoS requirements.

Besides the mechanism that reduces the number of delay slots, this paper is different from those found in the literature and advances the state of the art because it performs experiments simulating real IoT scenarios (Welbourne et al., 2009) with an RFID ns-2 module, varying the number of tags, and because the proposed mechanism is compatible with the global standard communication protocol for passive RFID tags.

The rest of this paper is organized as follows: Section 2 provides the background on anti-collision protocols and their development over the years in the literature. In Section 3, we present the proposed mechanism and how our contribution differs from that of prior work. In Section 4 we describe the scenarios simulated to evaluate the performance of the proposed mechanism. In Section 5 we analyze the results of the experiments with the mechanism by comparing it with the Pure Q Algorithm and BTSA algorithm. Conclusions and suggestions of future work are presented in Section 6.

2. BACKGROUND AND RELATED WORK

(Ming & Yan, 2012) summarized the QoS metrics (Response time, Reliability, Availability) of the IoT which still needed research. They also proposed a dynamic management strategy of QoS for the IoT. They concluded that research is needed to improve the analysis and calculation of IoT QoS in a variety of scenarios. The mechanism proposed by us in this paper can improve the response time and the reliability of the IoT by reducing the overhead during the identification of objects. The availability is also improved since the energy consumption is directly related with the number of collisions and our mechanism reduces this number (Klair et al., 2009).

(Nef, Perlepes, Karagiorgou, Stamoulis, & Kikiras, 2012) has shown that it is necessary to define service models that can categorize IoT applications and determine the Quality of Service (QoS) factors necessary to satisfy the requirements of those models. In (Duan, Chen, & Xing, 2011), QoS is one of the key factors for advancing the state of art of the IoT. They analyzed the QoS requirements (Jin, Gubbi, Luo, & Palaniswami, 2012) in every layer of the IoT and proposed a QoS architecture for the IoT which focuses on a control mechanism for transferring and translation of QoS requirements

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