**Abstract**

Radio Frequency Identification (RFID) is a rapidly emerging technology that wirelessly transmits the identity of transponders (tags) attached to an object or a person. The RFID technology took more attention since the adoption of the EPCglobal Class 1 Gen 2 standard in 2005. It has replaced other automatic identification systems like barcodes in some applications, e.g. logistics. In such applications, the identification time is very critical performance parameter. Currently, developments are underway in various areas of RFID to decrease the total identification time for a massive number of tags. The present thesis focuses on passive Ultra High Frequency (UHF) RFID, whose transmission on the Medium Access Control (MAC) layer is scheduled by Framed Slotted Aloha (FSA). Conventional FSA regards only the reply of a single tag as a successful slot. Empty and collided slots are considered as losses. Therefore, the reading efficiency is limited due to empty and collided slots. Modern physical layer systems have the capability of converting part of the collided slots into successful slots. This is called Collision Recovery. Moreover, modern RFID readers can identify the type of slot, e.g., successful, collided, or empty. In addition, the readers are able to terminate a slot earlier upon recognizing that it is empty. The performance of such systems depends strongly on two main parameters: First, the precise estimation of the number of tags in the reading area. Second, the optimizations of the FSA frame length.

In this thesis, a novel tag estimation method is introduced, taking into consideration the collision recovery capability of modern RFID systems. The proposed method provides the advantage of giving a novel closed form solution for the tag population estimator, which considers the collision recovery probability of the used system. Simulation results indicate that the proposed solution is more accurate when compared to state-of-the-art.

Apart from that, closed form solutions for the optimum FSA frame length for different scenarios are calculated. The first scenario is the Time-Aware Framed Slotted ALOHA. It considers the differences in slots durations without collision recovery capability. The second scenario is the Time-Aware with constant collision recovery coefficients system. This proposal provides a novel closed form equation for the frame length considering the different slot durations and the collision recovery capability with equal coefficients. Moreover, a new calculation method of the collision recovery probability per frame is presented. In the third scenario, the multiple collision recovery coefficients system is introduced. There, the differences in the collision recovery probability coefficients are examined with equal slots durations. In this regard, the values of the collision recovery coefficients are extracted from the physical layer parameters. Finally, a Time-aware and multiple collision recovery system is suggested, taking into account the multiple collision recovery probability coefficients in addition to the different slot durations. For each scenario, timing comparisons are presented in the latter simulation results show the reading time reduction using the proposed frame length compared to other the state-of-the-art algorithms.

This thesis focuses on the EPCglobal C1 G2 standard. Therefore, the tags cannot be modified, and all the improvements are done only on the reader side. However, due to the limitation of the EPCglobal C1 G2, there is still a room of improvement between the proposed solutions and the theoretical lower bound of the identification time. Therefore, compatible improvements of the EPCglobal C1 G2 standard are proposed. This proposal includes compatible modifications in the UHF RFID tags/readers, to be capable of acknowledging more than a sole tag per slot. Finally, the obtained results demonstrate that the proposed system optimizations lead to identify tags in significantly shorter time, which is crucial for time-sensitive applications.