Chapter 7

Conclusions and Future Work

Nowadays, there is a great interest in RFID due to the number of applications used in this field. RFID systems provide low cost and low power object identification and tracking mechanisms. It is the key requirement for different ultra dense applications, e.g., logistics, access management and timing sports events. In such applications, dense number of tags are expected and fast identification is required.

The main goal of the thesis is to increase the system throughput and to faster identify tags in the reader range. The transmission of tags is scheduled on the MAC layer with a anti-collision protocol called DFSA. The identification time directly depends on reading efficiency of the DFSA anti-collision protocol. The DFSA reading efficiency is controlled by two main parameters: 1) The accuracy of number of tags estimation algorithm. 2) Frame length optimization. Modern RFID receivers have been developed from the PHY layer. They have a collision recovery capability, which means that some of collided slots can be converted to a successful slots. This capability reduces the losses from the collided slots. Moreover, modern RFID receivers have the capability to identify the type of slot and terminate it as soon as it recognizes that, it is not a successful slot. This capability reduces the losses from the empty slots.

In this thesis, I focus on optimizing the DFSA anti-collision algorithm taking into consideration the physical layer parameters e.g. the collision recovery capability and the differences in slots durations. Thus, the thesis aims to establish and propose of advanced algorithms to increase the performance of the system. Since my work is focused on passive UHF RFID systems that work with simple tags which are only capable of in-complex operations, almost all proposed changes and signal processing is performed on the reader side except in chapter 6, a new compatible changes of EPCglobal C1 G2 standards are proposed.

7.1 Conclusions

The advanced RFID readers, which are proposed in this thesis shorten the mean average reading time. They incorporate different PHY layer parameters in order to efficiently optimize the MAC anti-collision protocols. First, in chapter 4 a novel closed form solution for a collision recovery aware ML estimator that considers the effects of the collision recovery probability of the RFID reader. The theoretical derivations lead to a new analytical estimator that can be easily implemented in RFID readers. Using the proposed formula, we need neither look-up tables nor numerical searching. Furthermore, the estimator gives more precise relative number of tags estimation error compared to the other state-of-art proposals. Moreover, the proposed estimation algorithm reduces the total identification time by almost 10 % compared to the best other state-of-art solution.

In chapter 5, different proposals of frame length optimization is presented. The first proposal is called “Time aware frame length” frame length. In this proposal, the frame length considers only the differences in slots durations is considered and no collision recovery effect is considered. A closed form solution for the optimum frame length is analytically derived. The proposed solution results 10 % average saving in reading time compared to the conventional FSA with frame length $L = n$. The second proposal is “Multiple collision recovery aware” frame length. This proposal considers the differences between the collision recovery coefficients. Thus, it considers that, the collision recovery capability strongly depends on the umber of the collided tags. However, it assumes constant slots durations regardless the slot type. A closed form solution for the optimum frame length is analytically derived. The proposed solution results 12 % average saving in reading time compared to the conventional FSA with frame length $L = n$. The third proposal is “Time and constant collision recovery coefficients aware” frame length. In this proposal, the frame length considers the time differences in slots durations and the collision recovery capability of the receiver. However, it assumes that the receiver has a constant collision recovery capability regardless the number of collided tags. A closed form solution is analyzed for the frame length. The proposed solution results 18 % average saving in reading time compared to the conventional FSA with frame length $L = n$. Finally, the fourth proposal is "Time and multiple collision recovery aware" frame length. This proposal considers the differences in slots durations and the variable collision recovery coefficients. A closed form solution is analyzed for the frame length. The proposed solution results 22 % average saving in reading time compared to the conventional FSA with frame length $L = n$. For the proposed systems, there is still $\simeq$ 10 % room of improvement between the best proposed system and the theoretical limit of the EPCglobal C1 G2 standard [11]. The main reason of this is, the allowed optimization was only in the reader side. To follow the EPCglobal C1 G2 standard [11], the tags could not be modified.

In chapter 6, backwards compatible improvement of the EPCglobal Class 1 Gen 2 standard is proposed. It proposes some modifications on the communication signal of Tag/reader. Using these modifications, a new system is presented approaches the theoretical lower reading time limit of the EPCglobal C1 G2 standard. The proposed system is compatible with the EPCglobal C1 G2 standards, i.e. the proposed tags could be jointly operated with conventional tags and identified by conventional readers without affecting the performance. Additionally, conventional tags can also be operated together with the proposed tags and can be identified by the proposed reader.

7.2 Open Issues and Future Work

Despite the effort invested in this dissertation, there are still some remaining issues left that require further investigations. To mention but some examples, the influence of the initial frame length of the proposed system is neglected. The influence of the initial frame length should be analyzed. In addition, the MAC layer knowledge of the current SNR should send a feedback signal to the PHY layer. In this signal, the MAC layer decide to start resolving the current collided slot either to a successful or unsuccessful slot, depending on the current value of the SNR. Thereby, if the current SNR value is below a certain threshold, it might be better to leave this slot to a normal collided slot. On the other hand, when the current value of the SNR is above this threshold, it would be better to resolve this collided slot to a successful slot. Finally, practical assessment of the proposed work through measurements would be beneficial for a more comprehensive evaluation.xx