Using Interference to Block RFID Tags

Krigslund, Rasmus; Popovski, Petar; Pedersen, Gert Frølund; Bank, Kristian

Publication date:
2011

Document Version
Early version, also known as pre-print

Citation for published version (APA):
Krigslund, R., Popovski, P., Pedersen, G. F., & Bank, K. (2011). *Using Interference to Block RFID Tags*. Poster presented at 5th annual IEEE International Conference on RFID, Orlando, United States.

Using Interference to Block RFID Tags

Rasmus Krigslund, Petar Popovski, Gert F. Pedersen and Kim Olesen
Aalborg University, Department of Electronic Systems, E-mail: {rkr, petarp, gfp, ko}@es.aau.dk

***Abstract*—We propose a novel method to block Radio Frequency IDentification (RFID) tags from responding, using intentional interference. We focus on the experimental evaluation, where we impose interference on the download and uplink, respectively. The results are positive, where modulated Co-Channel Interference (CCI) shows most effective to block a tag.**

I. Introduction

Radio Frequency IDentification (RFID) has received great attention in recent years [1]. RFID is primarily utilized in supply chains, where the trend is moving towards item level tagging. This will create new challenges when deploying RFID systems. As an example consider a store with item level UHF tagging. Readers are placed at the door and should use sufficient transmission power so that unpaid items tucked away in pockets and bags are read. This may cause tags still inside the store to respond as well, which is not desired. In this paper we propose a novel idea to block tags from responding by imposing interference while the reader is operating.

This application is related to the concept of reader collisions, covering over two different types; Reader-tag and reader-reader collisions. The EPC Global Class 1 Gen 2 standard [2] implements a dense-reader-mode, allowing densely deployed readers to operate simultaneously in separate frequency bands. Modern readers are therefore able to filter out the undesired bands, but tags do not have this option, and are thus forced to cope with the interfered signal.

In this paper we investigate the impact of reader collisions at the tag under different types of interference in order to block a tag from responding. Basically the communication between reader and tag can be interfered during 1) the commands from reader to tag, and 2) during the tag response. The reader and tag represents two different levels of complexity, and is therefore expected to have different susceptibility to interference. Hence, in this paper we consider each of the periods above separately.

Immense work have been published in the area of reader collision already, proposing different methods to utilize the dense-reader-mode and optimize for low probability of reader collision. In [3], and references therein, existing methods to cope with this problem are surveyed. Moreover, [4] investigates what level of interference will cause a tag not to be identified by the reader. Though existing works present intelligent methods to avoid reader collision, they are not differing between reader-reader collision and reader-tag collision. This paper focus on interference at the tag, i.e. reader-tag collisions, and presents an experimental investigation of the applicability of blocking tags using interference.

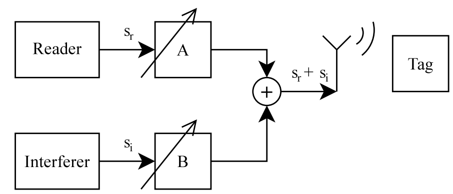


Fig. 1. Signal flow diagram of the setup used in this work.

The remainder of this paper is structured as follows; Section II describes the system model. The experimental setup and results are presented in section III. In section IV the final conclusions are drawn.

II. System Model and Experimental Setup

We consider a sample scenario with two adjacent readers. The probability of reading a tag decreases with the distance to the reader, where we define the interrogation zone as the area around the reader where a tag is read with probability > 99 %. Outside a tag may still be read, but with low probability.

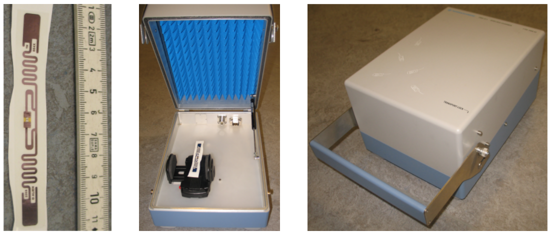
To investigate the impact of interference in this scenario we have constructed a setup, where distances are introduced artificially using signal attenuators, see the flowchart in Fig. 1. The reader and interference signals are denoted s_r and s_i respectively. A and B are attenuators to adjust the signal range, or the theoretical distance, from the interrogating and interfering reader to the tag. The utilized interrogation power is 30 dBm. But due to connectors and cables we have a fixed attenuation of 8.5 dBm, resulting in a maximum power delivered by either the interrogating or the interfering reader of 21.5 dBm. The resulting Signal to Interference Ratio (SIR) is then given by the difference between A and B.

An interfering reader shifts between transmitting commands, using an amplitude modulated carrier wave, and listening for tag responses while transmitting the un-modulated carrier to energize tags. To investigate both situations s_i is modeled with and without amplitude modulation.

The available reader, an Intermec IF5, does not support dense-reader-mode, making Co-Channel Interference (CCI) particularly harmful in this setup. However, imposing Adjacent-Channel Interference (ACI), whether dense or single reader mode is utilized, will have similar effect on both a tag and readers ability to receive.

III. Results

We have constructed an experimental setup based on the flowchart from Fig. 1. The tag in Fig. 2(a) is placed inside a shielded box, see Fig. 2(b), to shield it from multi-path effects in the lab. When investigating collisions at the tag,



(a) The tag. (b) The shielded box. (c) Closed box.

Fig. 2. The utilized tag, an Alien, ALN9640 (Passive, UHF), and the shielded box, with the coupling element (black) and the tag.

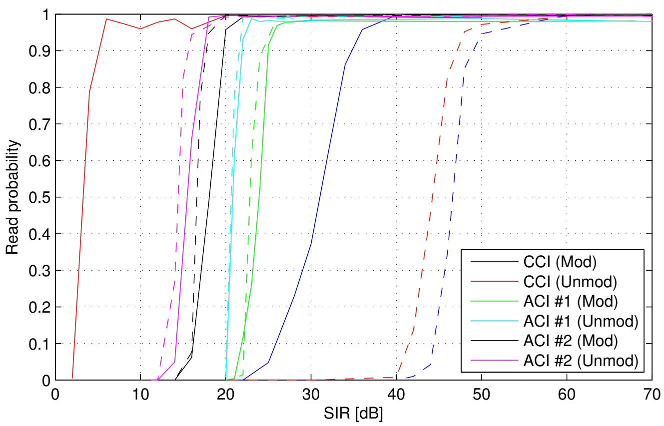


Fig. 3. Read probability for reader-tag collisions (solid lines) and reader-reader collisions (dashed lines) plotted as a function of SIR.

we are interested in the tags ability to receive and interpret the reader commands under interference. Connecting a probe directly on the tag would change the reception parameters of the tag significantly. [5] Instead we utilize that a tag requires the `Preamble + Select + Query` commands [2] to respond. It is therefore only required to switch on the interferer during the initiation of the interrogation round, leaving the tag response undistorted. Assuming the tag is located inside the interrogation zone, with a read rate $> 99\%$, any failed readings can be ascribed to the tags ability to receive the reader commands. To achieve this, an attenuation $A = 4$ dB has been experimentally identified.

The CCI has a center frequency of 866.5 MHz, and we introduce two ACIs; ACI $\#1$ and ACI $\#2$ centered at 867 MHz and 867.5 MHz respectively. The interference power is stepwise increased by decreasing the attenuation B. For each SIR value, the reader initiates n interrogation rounds, and based on the number of successful responses the response probability is calculated. For the response probability to be statistically significant, n is set to 500. In Fig. 3 the results for reader-tag collisions and reader-reader collisions are plotted as a function of SIR. From the plots we see that in general a high SIR is required to maintain a good response rate. Considering first the plots for reader-tag collisions, and a response rate of $99\ \%$, we see modulated interference has the most significant impact on the tags ability to respond. Between modulated CCI and modulated ACI $\#1$ we see a difference of ≈ 10 dB. Since the tag does not come with any internal frequency filtering, this is unexpected. But as the frequency distance between the reader and interferer signals increase, the interference has less impact.

For reader-reader collision, the ACI leaves the system in much better conditions to receive the tag reply, as expected. In all examples there is a very small but constant difference between unmodulated and modulated interference, the latter being most harmful. The plots for CCI and ACI $\#1$ are horizontally shifted approximately 25 dB. For a reader using dense mode we would expect a better performance under CCI, as the tag replies in the side bands.

If we compare the read probabilities for reader-tag and reader-reader collisions, we see that for ACI they require approximately the same SIR conditions to maintain a high read rate. Only for CCI we see a significant difference. The tag is able to reply under an interference level around 15 dB higher than the SIR level a reader is able to receive the reply in. Here we see the effect of the channel filters, because, for CCI, the reader is unable to filter out the interference, hence the tag response disappears in the interference. For unmodulated CCI the tag is able to respond even with very low SIR. This indicates that with unmodulated CCI it is possible to help power up the tag, but investigating this is outside the scope of this paper.

IV. Conclusion

In this paper we consider interference in Radio Frequency IDentification (RFID) systems, where we investigate its impact at the tag, and whether interference can be used constructively to block tags from responding.

The experimental results show that by imposing interference on the communication between tag and reader, we can abstain a tag from responding. This is in line with the general perception, seeing interference as a limitation. To keep the tag from receiving the reader commands the type of interference showed important. Using modulated interference in the same channel as the reader requires the least interference power to block the tag or from being received at the reader. Thus interference towards adjacent readers is kept low. The ability to block a tag enables a sharper separation between adjacent interrogation zones and helps reduce unintended readings of tags.

References

[1] M. Bouet and A. L. dos Santos, "RFID Tags: Positioning Principles and Localization Techniques," *IFIP Wireless Days (WD'08)*, pp. 1–5, November 24-27 2008.

[2] EPCglobal, "EPC Radio-Frequency Identity Protocols Class-1 Generation-2 UHF RFID," no. v1.2.0, 2008.

[3] D.-H. Shih, P.-L. Sun, D. C. Yen, and S.-M. Huang, "Taxonomy and survey of RFID anti-collision protocols," *Computer Communications*, vol. 29, no. 11, pp. 2150–2166, 2006.

[4] D.-Y. Kim, B.-J. Jang, H.-G. Yoon, J.-S. Park, and J.-G. Yook, "Effects of Reader Interference on the RFID Interrogation Range," *Proceedings of European Microwave Conference*, pp. 728–731, October 9-12 2007.

[5] W. A. T. Kottennan, G. F. Pedersen, K. Olesen, and P. Eggers, "Cable-less Measurement Set-up for Wireless Handheld Terminals," *12th IEEE International Symposium on Personal, Indoor and Mobile Radio Communications (PIMRC'01)*, vol. 1, pp. 112–116, September 2001.