# Optimizing the design of a global RFID system in aircrafts

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## 1 Introduction

Integrating RFID (Radio Frequency Identification) technologies on helicopter parts is a major challenge. Our work is concerned with the implantation of RFID tags in an aircraft with a complex system of transceivers (for a more detailed explanation see : [2]). Technologies have to be developed and adapted to the aeronautic requirements that are very constraining for on-board items. The objective is to read and update each tag in the aircraft according to harsh environment (metal parts, temperature, vibration, etc.). Tags will support and improve many processes and industrial operations in the aeronautical industry. It spreads from supply to maintenance through production and logistics (see for instance [1]). This paper intends to present an optimization problem related to implementing a global RFID system into an aircraft. Satisfying major constraints and minimizing costs are important to control the global system weight and price. The model should be general enough to be applicable for any aircraft type or model, but also for similar systems (cars, etc.). This generalization property is important for the repeatability and credibility of the optimization model.

## 2 Short introduction on RFID technologies

RFID (Radio Frequency Identification) technologies allow for automatic identification of data. They are made of three main elements : a **tag**, a **transceiver** and a **middleware**. The tag is composed of a silicon ship, which is monitoring information data (read / write memory properties). This ship can communicate with the external world thanks to an antenna. A packaging is protecting the whole. The transceiver (or reader) emits radio wave signals and receives answers coming from the tags. The middleware links the RFID system to the industry applications. Thanks to radio waves, RFID technologies provide information of several tags in real time, simultaneously and without contact or line of sight.

## 3 Optimization model

Our optimization model aims at designing the global RFID system. Within an industrial context and for a short return on investment, cost optimization is the most important lever. The variables of the model are chosen in such a way that costs are minimized. Costs and potential benefits are major parts of the decision drivers to implement new technologies in an industry.

To perform optimization, parameters related to the aircraft context and the RFID system are required. Moreover, to ensure that the model is realistic enough, we introduce physical equations to properly estimate the covering (or not) of a specific tag by a specific transceiver. The physical model is based on the power received coming from the backscattered signal (Friss Equations). Indeed, the transceiver is emitting radio wave signals in the air. If a tag is in the field of a transceiver and if the power received is satisfactory, the tag can answer the transceiver. Our approach is based on the minimum power received by the transceiver related to the tag answer. Our model gives a good estimation of what really happens with radio waves. Moreover, the model is not frozen, it can evolve according to different customizations. We can see the impacts of parameter modifications (read/write distance : improvements due to R&D developments) on the outputs of the model.

The results of the model have to fit with the constraints specific to our use case. These constraints are set by the RFID global system needs for its functioning and by the aircraft integration context. Our model is a generalization of the facility location problem. An example of such generalization is given in [4]. Customer nodes correspond to tags and facilities are transceivers for our system. The problem is an extension of the location set covering problem with general constraints (as presented for instance in [3]). We have to locate the right number of transceivers for covering all tags in the aircraft.

## 4 Conclusion

Our model proposes optimized solutions to the decision makers for different scenarios. The advantages and disadvantages of each scenario are presented in order to qualify possible systems and to support decisions. The proposed location of transceivers and tags will give the integrator (program manager for instance) decision elements that are much more precise than "empiric" solutions. The model helps to quantify the impacts of various critical decisions.

Finally, the model can be extended to other systems than aircrafts. It spreads from vehicle like cars or trains to aircrafts (rotary wings or fixed wings).

## Références


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