UNIVERSITAT POLITÈCNICA DE CATALUNYA
BARCELONATECH

Sensor Fusion Methods to Improve Localization and Tracking Performances of a Robot within a Building

A Degree Thesis

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by

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Abstract

In this paper, we study the impact of beacon placement on the performance of a fingerprinting localization architecture. The goal is to use this results for another project, which is deployed inside a hospital, where the goal is to have patient's wheelchairs that navigate independently. Almost 30 tags of 433 MHz/868 MHz-UHF-RFID active technology have been deployed both in a corridor and in hall environment to see the different impacts.

First, we focus on the number of tags that should be deployed, regardless their placement, to reach a given location performance. We also give suggestions on beacon placement that leads to an enhanced location performance, for a reduced number of deployed tags. Finally, some hints to maintain a given level of performance as the number of tags is further decreased.

Resum

En aquest document, s’estudia l'impacte que té el posicionament de radiobalises en el funcionament d'una arquitectura de localització, que es basa en l’estratègia de “Fingerprinting”. L’objectiu és utilitzar aquets resultats en un projecte que s’implementarà en un hospital, on es vol que les cadires de rodes dels pacients es moguin de manera independent. Gairebé 30 targetes electròniques de tecnologia 433 MHz/868 MHz-UHF RFID actives s’han desplegat en dos entorns diferents, en un passadís i a una sala gran.

Primer, ens enfoquem en el nombre d'etiquetes/targetes que haurien de ser desplegades, sense importar la seva posició, per exercir una localització donada. Seguidament es donen suggerències sobre quina col·locació de balises condueix a una localització òptima, desplegant un nombre reduït d'etiquetes. Finalment també consells sobre com mantenir un nivell de funcionament, amb el menor nombre d'etiquetes possible.

Resumen

En este documento, se estudia el impacto del posicionamiento de radiobalizas en el funcionamiento de una arquitectura de localización basada en “fingerprinting”. El objetivo es utilizar los resultados en un proyecto a implementar en un hospital, donde se quiere que las sillas de ruedas de los pacientes se muevan de manera independiente. Casi 30 tarjetas electrónicas de tecnología 433 MHz/868 MHz-UHF- RFID activas se han desplegado tanto en un pasillo como en un entorno de sala grande.

Primero, nos enfocamos en el número de etiquetas/tarjetas que deberían ser desplegadas sin importar su posición, para desempeñar una localización dada. Se dan algunas sugerencias sobre cómo colocar las balizas, para que se llegue a una localización óptima para un número reducido de etiquetas. Finalmente algunos consejos sobre cómo mantener un nivel de funcionamiento, con el menor número de etiquetas.

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1. Introduction

A robot can be located through optical and RF beacons positioned in its environment as well as mechanical technics. Several sensors are embedded on the robot. Merging the information coming from those sensors improves localization performances. Spatial filtering algorithms not only improve localization accuracy and precision but also allow tracking.

1.1. Indoor techniques

Indoor and outdoor location techniques are now widely spread not only for context-aware human orientated new services but also for object themselves. Our study focuses on the location of a mobile robot in a hospital. This kind of building has two characteristics. The presence of numerous corridors and large rooms on the one hand, and the need for radio localization solutions to comply with the regulations on the other hand. For obvious stage of production costs, we will consider a location architecture in which the robot embeds a single reader and several low cost UHF-RIFID tags are deployed in the environment. In this study we implement a fingerprinting technique and we use RFID tags active in the ISM band.

The characteristics of the indoor channel are so complex (Rayleigh or Nakagami-Rice models) that a simple (and bijective) One-Slope model is commonly used, so indoor localization techniques such as multi-lateration necessarily induce an estimation bias due to the model itself. The interest of fingerprinting is that it does not require any modelling of the propagation channel. To comply with the requirements of the ISM band, we will compare the location performance by deploying 433 MHz and 868 MHz active RFID tags in both environments: corridors and halls.

The counterpart of this technique is that it requires an important preliminary measurement campaign to store the electromagnetic fingerprint from the installed beacons. The problem is to know where to place these emitting beacons. We propose to study the impact of localization of beacons on localization performance by fingerprinting methods and to propose optimized tags deployment architectures according to the environment.

The paper is organized as follows. In section 2, we detail the specificities of each environment, the impact of the positioning of the beacons in the environment as well as the specificities of the fingerprinting technique. The experimental conditions of the study are described in section 3. Performance criteria are then determined. A special mention is made on the algorithms that we have developed and on the volume of data that have been processed. The main results obtained are presented in section 4. On the basis of these results, we propose configurations for the deployment of UHF active RFID tags in Hall or Hall environments and we present the expected related performances. Section 5 contains the concluding remarks and further studies hints.

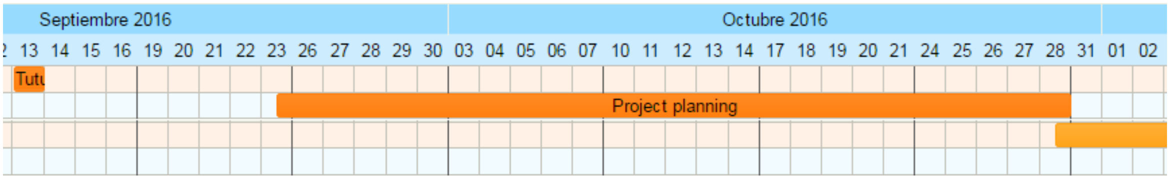
1.2. Work plan

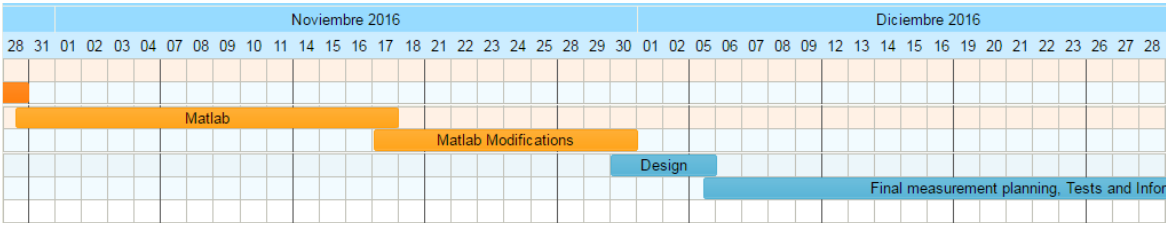
The table below describes the plan followed during the research. Underneath, the equivalent Gantt diagram is plotted.

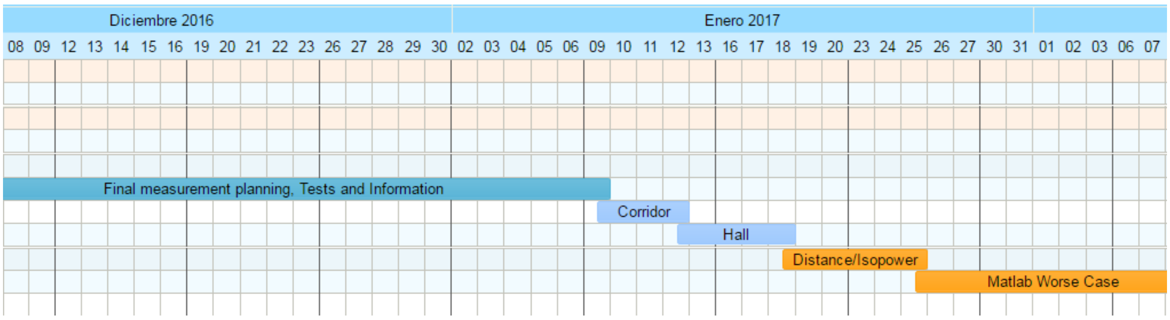
Period	Description
13/09/2016	- Tutor, team and school presentation.
23/09/2016 – 28/10/2016	- Project planning. - Reading and gathering information about Location and Navigation schemes. Write summary.
28/10/2016 – 17/11/2016	- Matlab Installation. - Matlab routine: Verify the existence of unique power vector. In case of non-unique, compute most repeated.
17/11/2016 – 30/11/2016	- Routine corrections: Adding more samples, optimisations to reduce execution times.
30/11/2016 – 05/12/2016	- Measurement campaign planning. - Hall and corridor dimensions. - Testing tags, batteries, reader and tag programmer.
05/12/2016 – 09/01/2017	- Final measurement campaign plan design and getting the material. - Testing tags, batteries, reader and tag programmer. - Reading and gathering information about Propagation Channels and Channel Modelling approaches.
09/01/2017 – 12/01/2017	- Corridor Measurements.
12/01/2017 – 18/01/2017	- Hall Measurements.
18/01/2017 – 25/01/2017	- Matlab Routine: Distance dependence. Isopower vectors, Isopower map.
25/01/2017 – 08/02/2017	- Matlab Routine: Worse case detection for all environments and frequencies. Vector size for achieving certain goal. Number of tags for single positioning.
08/02/2017 – 13/02/2017	- Results evaluation.
13/02/2017 – 22/02/2017	- Paper writing: Introduction and Methodology.
22/02/2017 – 27/02/2017	- Paper writing: Results and Conclusion.

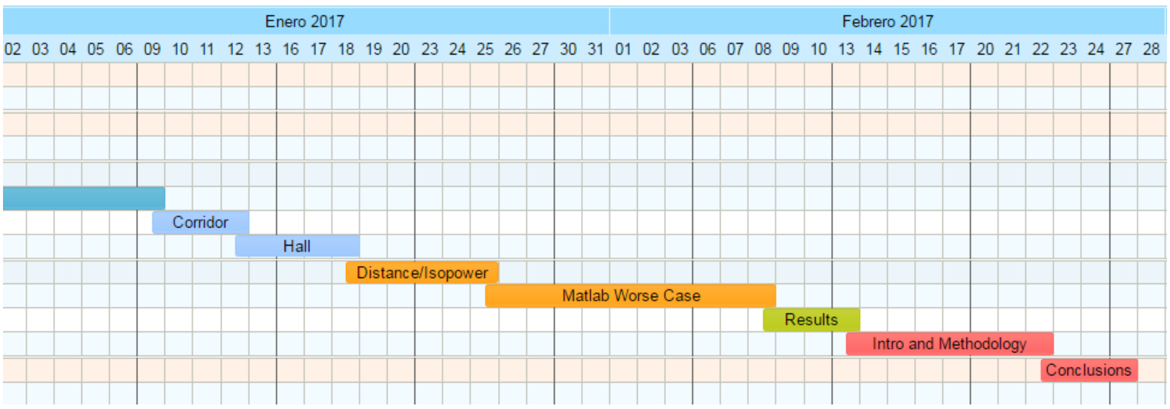
Gantt Diagram

A second research study is still being carried out, where a propagation model designed by Professor Alain Moretto, is being observed under different dielectric materials. The work done so far, was parallel to the research described in this document, but it has not been reflected in the planning diagram, as the work load was mostly testing and information gathering.









1.3. Deviations

The initial step of the project was to carry out a campaign of measures in a hall type room, to study how to use the measures in order to obtain navigation and localisation schemes and observe its propagation model characteristics.

To do so, the materials provided where a RFID reader, a RFID tag and a RFID tag programmer. When all the software to control the hardware was installed, the RFID reader did not respond. It was found that it was broken, a replacement had to be found, delaying the schedule.

Once the new RFID reader arrived, and the measurements could start, the software in charge of collecting the power values from the reader to the computer was not working properly. This software, called “Mesure Lina”, was created by a student in a past research project, therefore it couldn’t be reprogrammed as no specifications or guides on how it had been designed were given.

In order to continue with the research, it was decided to put aside the study of the hall type room, and get back some past measures of a corridor type room. From then, some modifications on what studies would be carried out were done. Unfortunately, the measurement database that was found was not enough, as only the central line of the corridor had been evaluated.

A second version of the “Mesure Lina” software was found, so the measurement campaign was redesigned. New samples were taken from the whole corridor and the whole hall, enough to fulfil the study. There were some problems during the measuring campaign, as sometimes data was received with errors, some tags were not properly programed, or had no battery. The measures were taken twice (for both frequencies and environments), once the tag programming software was replaced, and also some manual filtering had to be done.

The goal of this study is to create a scientific paper for the next IPIN conference 2017. The International Conference on Indoor Positioning and Indoor Navigation aims to bring together researchers and practitioners from academia and industry to discuss innovative positioning technologies, emerging location-based applications and services. Thus, the work plan will be different, as various interesting aspects to study may arise during others. The paper has been already submitted.

As mentioned above the Gantt diagram, a second research was expected to be completed during the stay at EFREI, unfortunately it has not been possible to finish it in the time abroad, but Professor Alain Moretto and me are working together remotely to finish it.

2. State of the art

2.1. Beacon placement problem

When it comes to indoor localization RF techniques, two approaches are often observed. In both approaches, indoor positioning RF (Bluetooth, WIFI, BLE, Zigbee, RFID…) techniques need to deploy beacons in the environment. The first approach consists in locating a mobile beacon using a constellation of networked transceivers [1:4]. This approach is particularly interesting when this network is already deployed. Methods such as ToA, DToA, trilateration, cell-based, multi-lateration, and triangulation can be implemented. In the second approach, one seeks to locate a mobile reader and deployed transmitting beacons with known positioning (anchors). This latter approach is particularly interesting because it reduces the cost of the localization solution and allows the solution to be adapted to the evolutions of the environment (a tag can easily be moved by an authorized team). In both approaches, the problem is to know where to place the transmitters.

Early on, it was demonstrated [5] that the placement of the beacons had a very important impact on the performances of localization of mobile robots in an outdoor environment (GPS techniques). It was demonstrated, by simulation, that he performances were very sensitive to the density and the granularity of the beacon network, much more than to the random noise that can affect the radio connectivity and thereby affect the quality of localization. It was not until the end of this first decade that the community published initial studies on the impact of unconnected emitting beacons placement on indoor tracking performance.

A recent and clever approach makes it possible to use a single transmitter for the simultaneous detection of the distance and the direction of a human body with respect to a beacon [6], but in most cases the localization techniques require two beacons (Goniometry) or more, depending on the number of dimensions that it is desired to handle.

In 2013, Krzysztof Piwowarczyk and al. [7] introduced parameters that can be useful to describe the quality of localization of radio landmarks and presented a software for computer aided reference radio stations placement inside buildings. In order to calculate signal attenuation and to estimate the distance between the antennas a Multi-Wall indoor radio propagation model for distances beyond 1m and used a free space model for distances under 1m.

Simultaneously, clearer indications were given at the IPIN IEEE conference as regards the deployment of 433 MHz RFID beacons in hall environments in the specific case of tri and multi-lateration techniques [8, 9]. It was shown that quadruplets of tags should have a central positioning in a corridor whereas they were expected to be equally distributed.

In [10], Authors not only showed that with prior knowledge of the map and a model of beacon coverage, it was possible to uniquely localize with only two beacons but they also used an enhanced Geometric Dilution of Precision (GDOP) metric to compare various beacon placement algorithms in terms of coverage and expected accuracy. This approach helped reducing to reduce the number of beacons by an average of 33% as compared to standard trilateration.

In the general context of our study, we seek to locate a mobile robot in a hospital environment using radio and visual RFID tags. We will present our work concerning the deployment of radio beacons and the optimization of their positioning. We opted for a fingerprinting localization approach. This approach requires a first step of measuring the received signal strength (RSSI) in order to draw up a radio map of the site. The signal received by the reader embedded on the robot is the sum of all the multipath and shows fast fading characteristics. The received signal is therefore very dependent on the geometrical configuration of the places, on the nature of the materials and on the used frequency band. We will look for the minimum number of tags to be deployed in two distinct environments (the first one is of the corridor type and the second one is of the hall type) for a given performance level and we will indicate where to place these best candidates. This study will be conducted for two standard ISM frequency bands in RFID, 433 MHz and 868 MHz.

3. Methodology

3.1. Environment of the Measurement Campaign

In order to analyse the dependencies in beacon positioning, various measurement campaigns are performed in a corridor-type location of size 14m x 2m x 2.5m and a hall-type location of 7m x 8.8m x 6.8m both at the EFREI engineering school, aiming to compare different environment geometries. Two frequencies will be observed, 433 MHz and 868 MHz which belong to the ISM RFID band. Both areas remain empty and with doors closed, meaning neither furniture nor people walking along, in order to avoid any additional fading or scattering effects.

Figure 1. Images of the environments where the measures were acquired. On the left, an image of the hall and on the right the corridor.

Tags are placed alternately on walls at 1.30m (shown in yellow) and 2.10m (shown in green) high. The distance between two tags is 1m in both surroundings. The heights respectively correspond to a doorknob and a standard door height. Figure 2 illustrates the previously described environments.

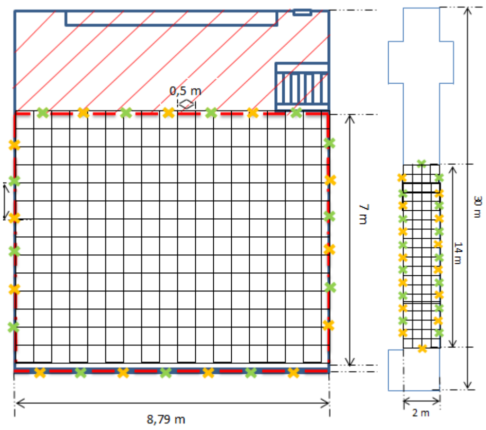


Figure 2. On the left, the layout of the tags in the Hall and on the right, in the Corridor.

The localization architecture should help us know in front of which contiguous doors our robot is, so measurements will be taken every 50cm. 50cm is also the intermediate distance of a person's step when walking. A total of 81 samples are obtained in the corridor and 208 samples in the hall for both of the ISM frequencies.

3.2. Equipment for the fingerprinting

The robot works with an RFID reader from ELA Innovation that includes two embedded dipole antennas, and active RFID tags are deployed in the area to be used as active beacons for location detection. This reader interrogates the ID of each tag by means of a communication protocol where the tag's identification is automatic and periodic. Each tag is identified by the reader at each tag's transmission period.

As soon as a tag's identification frame is received, the reader transmits this information on the RS232 port. This emission is always repeated as long as the tag remains in the reader's detection area, with the RFID's tag emission cycle. Table 1 describes the tag configuration for each frequency.

433 MHz tags	868 MHz tags
Emission Cycle: 200ms *Radio Format: 24 bits HD*	*Emission Cycle: 220ms* *Radio Format: 24 bits HD*

Table 1. Tag configuration

Tags are set with software and tag programmers provided by ELA Innovation. For the 433 MHz frequency we used the COIN ID active RFID badge, and for the 868 MHz THINLINE IR badge. Both have a wireless range up to 80 meters. A total of 28 tags were deployed in the corridor and 26 tags for the hall scenarios.

The RSSI values and the ID from each tag are simultaneously captured by the receiver and stored in the computer connected to it with the help of a software. After this process, the data must be filtered as, for some power values, the tag identification have not been received correctly.

4. Results

4.1. Data Analysis

It is important to mention that the great volume of information generated from the measurement campaigns forces to rule out some data in order to optimize the computation times. For example, to study the location uncertainty in the corridor environment, a vector is created from grouping the power received from different tags, PVtags.

$$Num_{PVtags} = \frac{num\ of\ Tags!}{(num\ of\ Tags - PV_{tags}SIZE)!PV_{tags}SIZE!} \qquad (1)$$

NumPVtags is the number of available PVtags depending on the number of tags we are combining to find a position. For triplets of tags, PVtagssize= 3, for quadruplets PVtagssize= 4, etc.

We aim at finding the minimum number of combined tags leading to an unambiguous position. To reach that goal, each combination is introduced in a loop so as to find coincidences in distinct points of the corridor line, in this case Nmeasures. Finally, this procedure is repeated for every measurement point, resulting k calculations for every size:

$$k = Num_{PVtags} \times N_{measures} \times (N_{measures} - 1) \quad (2)$$

The simulation time dramatically increases as the number tags increases. It jumps from less than one second for only one tag in the environment, on an 8 Go RAM 2.4GHz dual icore7 computer, up to 4 hours for 6 deployed tags (Fig. 3).

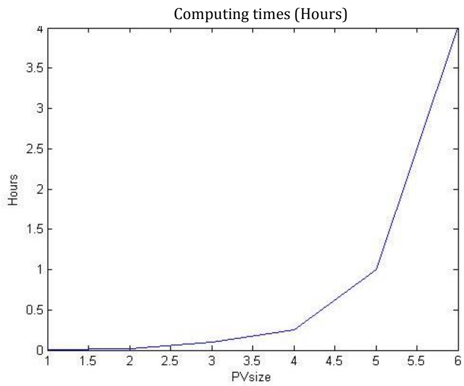


Figure 3. Simulation time as a function of number of tags involved in the localization process

As a consequence, parallel computing is needed as some calculations would take several days, given the volume of the measurements.

4.2. Incertitude reduction

Ideally, a set of received powers should correspond to a given position. In reality, there is no bijective link, so we have localization uncertainties. We want to know how the repeated sets of received powers change depending on the number of tags that are deployed. Therefore, the power received by a certain group of tags is analysed to see if it is repeated or not in the environment under study.

We have to take into account that the environment is “noisy” (fast fading occurs). A margin of ± 0.1dBm around the targeted received powers vector coordinates is considered in the case of low noise level propagation channels. The margin increases up to ± 0.4dBm for noisier channels. Our script calculates the maximum number of times a vector can be repeated along a given path, showing thus the worst case for the given assortment of beacons. A “2 repetitions configuration” means that a given vector of received powers is detected in two other measurement samples. Figure 4 and 5 show the results for the different environments at each frequency.

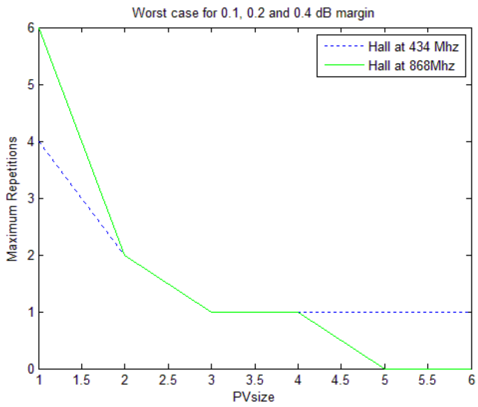


Figure 4. Worst case for hall environment for both frequencies

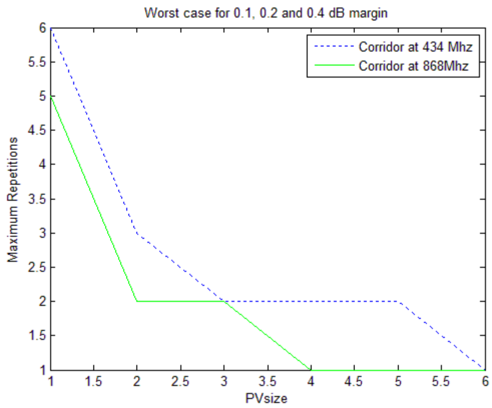


Figure 5. Worst case for corridor environment for both frequencies.

No matter the considered environment and the frequency band, experience clearly shows that, in both cases, the noise margin on RSSI has no meaningful influence on the number of repeated schemes (Fig. 4 and 5). Calculations were repeated with a ± 1dBm margin of power to take a closer look at the noise effect, as shown in Figures 6 and 7.

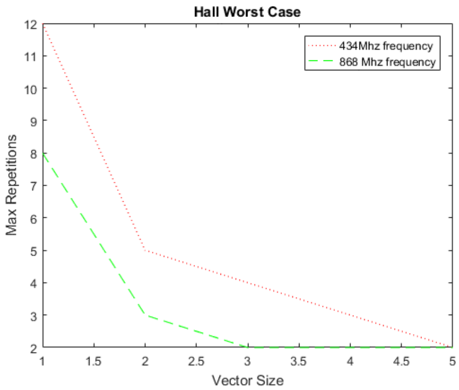


Figure 6. Worst case in the hall environment at 1dBm margin.

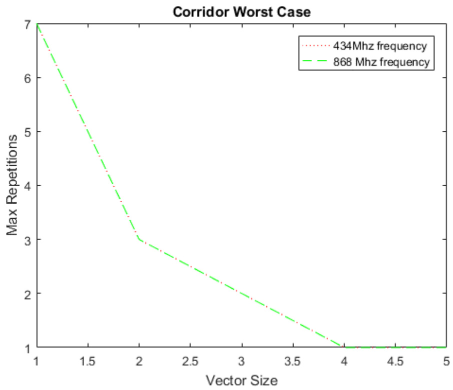


Figure 7. Worst case in the corridor environment at 1dBm margin.

For the hall environment at low level noise, repetitions rapidly converge to a minimum number of repetitions. The only way to go beyond this “plateau effect” and to achieve a better performance is to deploy much more tags into the environment. Moreover, it is observed that for this same geometry, the choice of the working frequency band makes a big difference when working in really noisy channels.

The 868 MHz frequency band always leads to better results, except for the corridor case with high level of noise, in which no distinction is found for both experimental results exploitation.

It is worth mentioning that for a limited noise level, the overall performances are rather similar whatever the geometry of the environment.

Fig. 6 and 7 clearly show that the number of tags that are deployed has a far greater impact on performances than the noise level itself.

4.3. Knowledge on the beacon position

In the last section, we were looking for the maximum number of repetitions for a given set of received powers. In this section we focus on the total number of repetitions for every configuration of N-uplets of tags.

We are aiming to find out, depending on how many repetitions our system is able to rule out, how many tags have to be deployed without placement concerns.

As a first approach, deploying one only tag without studying the impact of its location is not recommended if the future system has poor filtering capacities (Fig. 8 and 9).

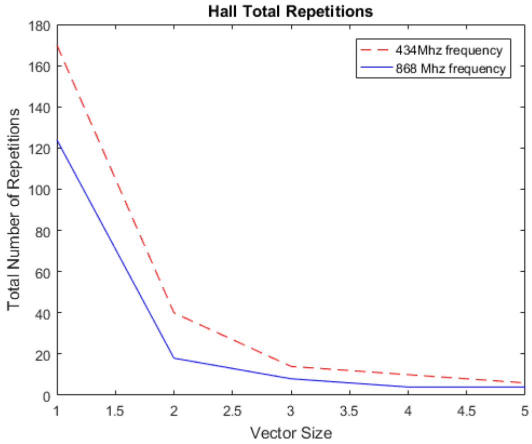


Figure 8. Total repetitions in the hall environment without positioning concerns in a noisy case of ± 1dBm

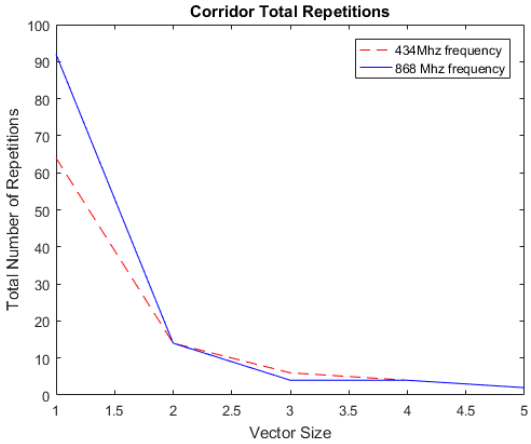


Figure 9. Total repetitions in the corridor environment without positioning concerns in a noisy case of ± 1dBm.

The performance greatly improves adding a second tag, although the total number of repetitions is still quite high.

A third tag will divide the number or repeated schemes by 2 in both environments. Beyond that number, we face the same “plateau effect” at the 868 MHz frequency band. Almost twice as much tags are needed to decrease the number of repetitions beyond the plateau.

Fig. 8 and 9 both confirm that the higher frequency band leads to a lower set of repetitions. This is easy to understand in so far as the attenuation of the received signal is a function of *log (frequency)*. As we increase the frequency, we decrease impact of the multipath effect leading to a lower effect of constructive interferences.

Figures 10 and 11 show where the combination of tags that correspond to the previous worst cases are placed. Yellow marks correspond to the beacons at 433 MHz and in orange the ones at 868 MHz. Due to presentation purposes, Figure 10 (a) includes, in the same hall map, the case for a unique tag (coloured star) and a pair of tags (coloured circles), at both frequencies. It is worth recalling that the hall environment, the bottom and the right walls are made of glass, while the top and left walls are built from cement.

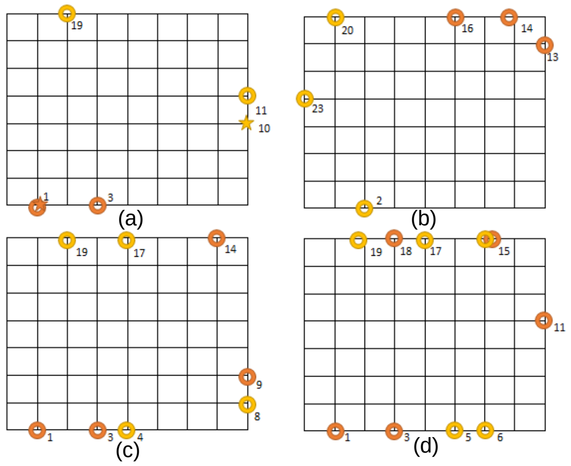


Figure 10. Position of the tags that provide the worst case in the hall at ± 1dBm, depending on the power size and on the working frequency.

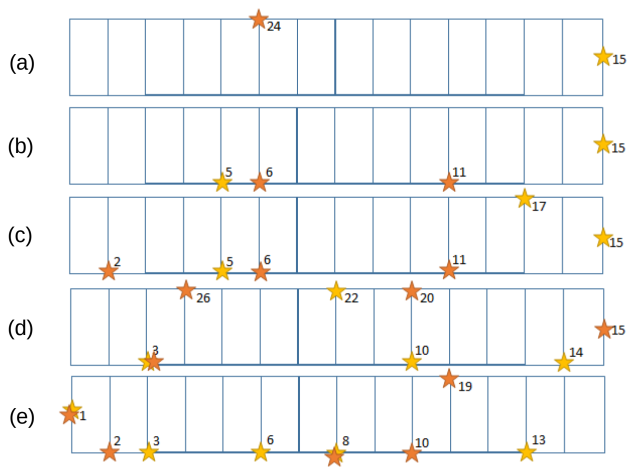


Figure 11. Position of the tags that provide the worst case in the corridor at ± 1dBm, depending on the power size and on the working frequency.

The tags that are placed in the glass walls of the hall are normally members of the worst case configuration. Beacons in this same environment placed 2.10m high (almost half way to ceiling), show the worst performance at 868 MHz. On the contrary, at 433 MHz, the poorest execution is carried out by the tags at 1.3m (almost half way to ceiling once again). Looking at the successive worst cases for this same geometry, the location of the tags is always approximately around the central area.

The aforementioned result is best reflected in the corridor environment, where for any size of the arranged tags, one of them is positioned around the centre.

In both cases, places that generate high interference levels should be avoided. One solution is to avoid symmetries in the placement configuration (central positions, extremities and medium height placements).

To reduce the number of repetitions, we definitely have to avoid similar propagation conditions as we would obtain similar received power patterns. For instance, placing all the beacons at the same height is clearly an error (Fig 11b. for positions 13/14/16). In both environment placing a majority of tags at medium height leads to poor performances.

4.4. Optimization of the deployment performance

Through the inverse analysis, with the minimum number of repetitions of the power vectors, information on best beacon placement can be obtained. As seen in Figure 12, the lowest amount of repetitions that can be obtained is normally zero, except for the corridor environment at 434MHz. For this scenario, the zero result is not obtained until a second tag is included.

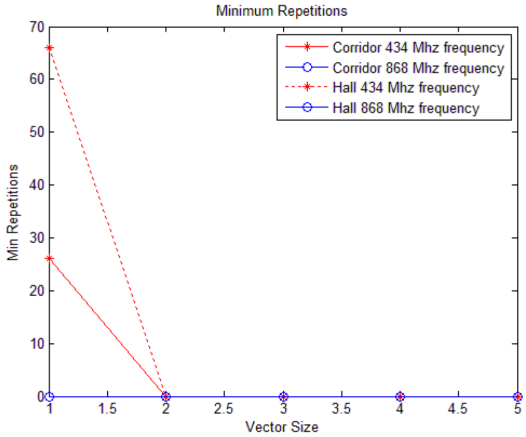


Figure 12. Minimum repetitions in the both environments in a noisy case of ± 1dBm.

If more than one tag is deployed, the minimum repetitions in this noisy environment are zero. This means two things. First, that beacon placement concerns have most impact for single tag configurations. Second, that fingerprinting method only needs two beacons to find the mobile robot in an indoor environment without ambiguity.

Beacon arrangement for one and two deployed tags is shown in Fig. 13. Yellow marks represent the ones at 433 MHz and in orange the ones at 868 MHz. Stars correspond to the single tag case, circles to the paired tags. Configurations with more than two tags are not represented, as the percentage of a zero repetition is always a majority rule, as it can be seen in Figure 14.

For the corridor, the best performance for single tags is reached when they are placed half way in the corridor for both frequencies. Deploying two tags changes the optimal arrangement to an extreme of the corridor, at heights of 1.3m and 2.1m alternatively.

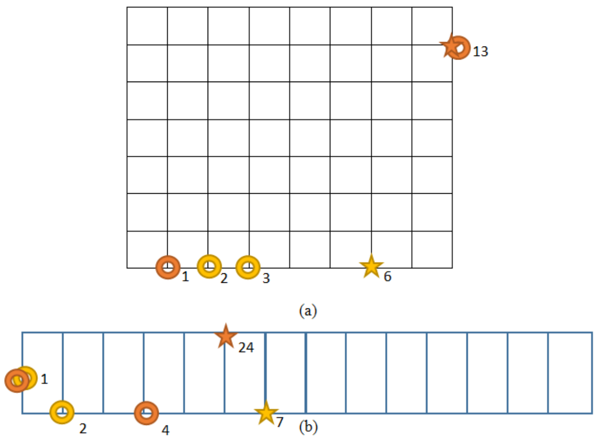


Figure 13. Placement of the tags that give the minimum repetitions in the both environments in a noisy case of ± 1dBm.

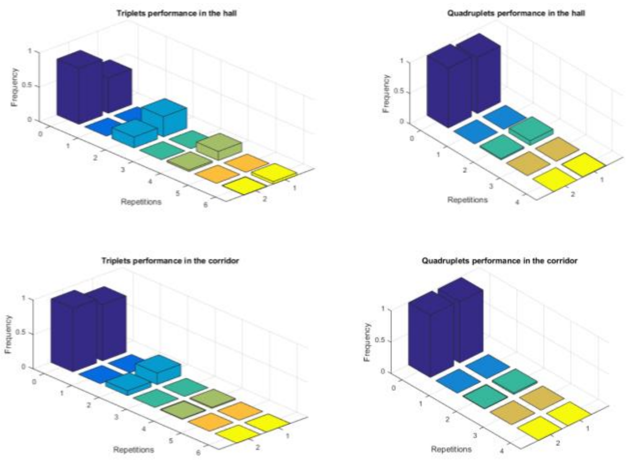


Figure 14. Zero repetitions frequency.

For readability reasons, not all the best tag deployment configurations have been illustrated in Fig. 13. Yet, data analysis clearly shows at asymmetrical placement (opposite walls, different heights…) always lead to high performances.

5. Budget

An approximation of the cost would be the following, as all the material was provided by the EFREI engineering school.

Period	Number	€/Unity	Total €
Reader 433 MHz	1	103,78	103,78
Reader 868 MHz	1	103,78	103,78
Tag Programmer 433 MHz	1	130	130
Tag Programmer 868 MHz	1	130	130
Antenna 433 MHz	2	3	6
Antenna 868 MHz	2	9	18
433 MHz tags	28	35,00	980
868 MHz tags	28	40,00	1120
TOTAL			2.591,56 €

Period	Days	Total Hours	x8€/h
23/09/2016 – 28/10/2016	35	140h	1120€
28/10/2016 – 17/11/2016	21	84h	672€
17/11/2016 – 30/11/2016	13	52h	416€
30/11/2016 – 05/12/2016	5	20h	160€
05/12/2016 – 09/01/2017	16	64h	512€
09/01/2017 – 12/01/2017	3	12h	96€
12/01/2017 – 18/01/2017	6	24h	192€
18/01/2017 – 25/01/2017	7	28h	224€
25/01/2017 – 08/02/2017	14	56h	448€
08/02/2017 – 13/02/2017	5	20h	160€
13/02/2017 – 22/02/2017	9	36h	288€
22/02/2017 – 27/02/2017	5	20h	160€
TOTAL			4.748€

Total components and design:

TOTAL	2.591,56 € + 4.748€ = 7.339,56€

6. Conclusions and future development

	Hall	Corridor
433 MHz	*Avoid central areas.* *Avoid low height tags.*	*Avoid extremities.* *Avoid tags high heights.*
868 MHz	*Avoid central areas.* *Avoid tags at high heights.*	*Avoid extremities.*

Table 2. Beacon placement consideration summary for Hall and corridor environments at two different frequency bands.

In this paper, we focused on beacons placement considerations in a fingerprinting localization architecture. We deployed UHF-RFID tags in two specific indoor environments and sampled space so as to get all powers received from all tags. Experience gave us quantitative and qualitative clues on how to deploy an efficient fingerprinting solution. In addition, bad tag deployment configurations were identified.

Fig. 16 summarizes, in a very simplistic way, beacon placement errors that should be avoided. One should bear in mind that, when it comes to fingerprinting approach, the chosen beacon configuration must not follow the symmetric patterns of the environment (medium height placement in general, use of symmetries in the room…). It appears that higher frequencies also lead to unambiguous location capacities.

If the experimenter does not wish to optimize the number of tags and their positioning then more than two tags are needed, whatever the environment or the frequency band. A larger variety of 3-tags or 4-tags configurations leads to unique positioning solutions. If we want to reduce the number of tags, the experimenter should follow our recommendations to reach the same efficiency.

At last, we demonstrated that beacon placement concern is far more significant on location efficiency than the noise level in the environment due to both, the measurement itself and the fast fading effect.

Bibliography

The different references below are found as: Conference paper [1], journal paper [2], book [3], standard-1 [4], standard-2 [5], online reference [6], patent [7], M.S. thesis [8] and Ph.D. dissertation [9].

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Appendices

This section contains code information and design sketches on the measure campaing.

Matlab routine: Isopower Map

```
obtain_power_readings_full;
   %   CONTOUR(Z) draws a contour plot of matrix Z in the x-y plane, with
   %   the x-coordinates of the vertices corresponding to column indices
   %   of Z and the y-coordinates corresponding to row indices of Z. The
   %   contour levels are chosen automatically.

switch env
   case 2 %corridor
      %line x=1,5
      powers1_15=powers1(:,55:81);
      powers2_15=powers2(:,55:81);

      %line x=1
      powers1_1= powers1(:,28:54);
      powers2_1=powers2(:,28:54);

      %line x=0,5
      powers1_05=  powers1(:,1:27);
      powers2_05= powers2(:,1:27);

      p1=sum(powers1_05);
      p2=sum(powers1_1);
      p3=sum(powers1_15);

      z=[p1; p2; p3];

   case 1 %hall
      ini=1;
      fin=16;
      powers=powers1(:,ini:fin);
      p1=sum(powers);

      z=p1;
      while fin~= 208
         ini=ini+16;
         fin=fin+15;
         powers=powers1(:,ini:fin);
         p=sum(powers);
         z=[z;p];
      end
end

C=contour(z);
clabel(C);
```

Matlab routine: Max_group_size

```
%This function calculates how many times a power vector appears in
%the different measured positions.
function
[max_rep,res,tpvcomb]=max_group_size(numberOfTags,powers1,r,m_start,m_end,th)

%-----------------------------------------------------------------------------------------------------------
        %Initialization

        %pvcomb{m} contains the combination of the powers in measure 'm', in groups of
size 'r'
        for m=m_start:m_end
           pvcomb{m}=nchoosek(powers1(:,m),r);
        end

        %Tag correspondance. Example: tpvcomb(1,:) contains the tag_id of the
pvcomb{1}(1,:)
        tpvcomb=nchoosek(1:numberOfTags,r);

        %Number of combinations given the group size
        ncombs=length(tpvcomb);
%-----------------------------------------------------------------------------------------------------------

%Times each vector is repeated
res=zeros(ncombs,m_end);

for m=m_start:m_end
           parfor k=1:ncombs
              res(k,m)=vector_repetitions(pvcomb,th,m_start,m_end, m, k);
           end
end
%Save and return the maximum value
        res(res==0)=1;
        max_rep= max(max(res));
end
```

Matlab routine: Obtain_powers_line

```
% Initializations
env=input('\n1 for Hall\n2 for Corridor\nEnvironment?: ');
freq=input('\n1 for 434MHz \n2 for 868 MHz\nWorking frequency? : ');


switch env
  case 2
    numberOfTags=28;
    numberOfMesures=27;

    posTag = [%CORRIDOR
      %x      %y      %z
      1.0     0.0     1.30 ; % Tag 1 BEGINNING CORRIDOR
      0.0     1.0     2.10;  % Tag 2
      0.0     2.0     1.30;  % Tag 3
      0.0     3.0     2.10 ; % Tag 4
      0.0     4.0     1.30 ; % Tag 5
      0.0     5.0     2.10 ; % Tag 6
      0.0     6.0     1.30;  % Tag 7
      0.0     7.0     2.10;  % Tag 8
      0.0     8.0     1.30 ; % Tag 9
      0.0     9.0     2.10 ; % Tag 10
      0.0     10.0     1.30 ; % Tag 11
      0.0     11.0     2.10;  % Tag 12
      0.0     12.0     1.30;  % Tag 13
      0.0     13.0     2.10 ; % Tag 14
      1.0     14.0     2.10 ; % Tag 15 END CORRIDOR
      2.0     13.0     1.30 ; % Tag 16
      2.0     12.0     2.10 ; % Tag 17
      2.0     11.0     1.30 ; % Tag 18
      2.0     10.0     2.10 ; % Tag 19
      2.0     9.0     1.30 ; % Tag 20
      2.0     8.0     2.10 ; % Tag 21
      2.0     7.0     1.30 ; % Tag 22
      2.0     6.0     2.10 ; % Tag 23
      2.0     5.0     1.30 ; % Tag 24
      2.0     4.0     2.10 ; % Tag 25
      2.0     3.0     1.30 ; % Tag 26
      2.0     2.0     2.10 ; % Tag 27
      2.0     1.0     1.30 ; % Tag 28

      ];


  case 1
    numberOfTags=26;
    numberOfMesures=16;
```

```
        posTag = [%HALL
           %x       %y      %z
           7.0      0.0     1.30 ; % Tag 1
           6.0      0.0     2.10;  % Tag 2
           5.0      0.0     1.30;  % Tag 3
           4.0      0.0     2.10 ; % Tag 4
           3.0      0.0     1.30 ; % Tag 5
           2.0      0.0     2.10 ; % Tag 6
           1.0      0.0     1.30;  % Tag 7
           0.0      1.0     1.30 ; % Tag 8
           0.0      2.0     2.10 ; % Tag 9
           0.0      3.0     1.30 ; % Tag 10
           0.0      4.0     2.10;  % Tag 11
           0.0      5.0     1.30;  % Tag 12
           0.0      6.0     2.10 ; % Tag 13
           1.0      7.0     2.10 ; % Tag 14
           2.0      7.0     1.30 ; % Tag 15
           3.0      7.0     2.10 ; % Tag 16
           4.0      7.0     1.30 ; % Tag 17
           5.0      7.0     2.10 ; % Tag 18
           6.0      7.0     1.30 ; % Tag 19
           7.0      7.0     2.10 ; % Tag 20
           8.8      6.0     1.30 ; % Tag 21
           8.8      5.0     2.10 ; % Tag 22
           8.8      4.0     1.30 ; % Tag 23
           8.8      3.0     2.10 ; % Tag 24
           8.8      2.0     1.30 ; % Tag 25
           8.8      1.0     2.10 ; % Tag 26
           ];
   otherwise
      fprintf('Wrong environment input \n');
end

numberSignalTags(1:numberOfTags) = 0;
powers1(1:numberOfTags,1:numberOfMesures) = 0;
powers2(1:numberOfTags,1:numberOfMesures) = 0;
distance(1:numberOfTags,1:numberOfMesures) = 0;
posMes = cell(1,numberOfMesures);

% Open file------------------------------------------------------------

switch env
   case 2 %corridor
      imshow('corridor.png')
      switch freq
         case 1 %434
            dir Measurements\Corridor434
            prompt = 'Choose line to study: ';
            str1 = input(prompt,'s');
            str2=strcat('Measurements\Corridor434\',str1);
```

```
        case 2 %868
          dir Measurements\Corridor868
          prompt = 'Choose line to study: ';
          str1 = input(prompt,'s');
          str2=strcat('Measurements\Corridor868\',str1);
      end

  case 1 %hall
      imshow('hall.png')
      switch freq
        case 1 %434
          dir Measurements\Hall434
          prompt = 'Choose line to study: ';
          str1 = input(prompt,'s');
          str2=strcat('Measurements\Hall434\',str1);
        case 2 %868
          dir Measurements\Hall868
          prompt = 'Choose line to study: ';
          str1 = input(prompt,'s');
          str2=strcat('Measurements\Hall868\',str1);
      end
end

fid = fopen(str2);

% Read file, save informations, and close it
line = fgetl(fid);

while ischar(line)
  % Get X and Y of current mesure
  tmp = regexp(line, '<Mesure_Irene numero="([0-9]+)" x="([0-9,.]+)" y="([0-9,.]+)"',
'tokens', 'once');
  if isempty(tmp)
  else
      countMes = str2double(tmp(1)); % Number of the mesure
      xMes = str2double(tmp(2));  % X, in meters
      yMes = str2double(tmp(3)); % Y, in meters
      zMes = 1.0; %height of the reader when taking measures

      posMes{1,countMes} = [xMes,yMes,zMes]; % Store position of the mesure
  end;

  % Get all ID's of tags, count ID's
  tmp = regexp(line, '<id est="([0-9]+)"', 'tokens', 'once');
  if isempty(tmp)
  else
      idTag = str2double(tmp(1));
      numberSignalTags(idTag) = numberSignalTags(idTag) + 1;
  end;
```

```
    % Get power of current tag
    tmp = regexp(line, '<Valeur>([0-9,/]+)<', 'tokens', 'once');
    if isempty(tmp)
    else
        power = regexp(tmp(1), '/', 'split');

        % Determine power
        p1 = 586/19 + (-12/19)*str2double(power{1}{1}); % Power 1 (converted from RSSI)
        p2 = 586/19 + (-12/19)*str2double(power{1}{2}); % Power 2 (converted from RSSI)

        % Determine distance
        d = sqrt((xMes - posTag(idTag,1))^2 + (yMes - posTag(idTag,2))^2 + (zMes -
posTag(idTag,3))^2);

        % Save all values
        powers1(idTag, countMes) = p1;
        powers2(idTag, countMes) = p2;
        distance(idTag, countMes) = d;
    end;

    line = fgetl(fid);
end;
fclose(fid);

% Clear useless variables
clearvars fid line numberSignalTags p1 p2 d tmp countMes xMes yMes zMes idTag
power;
```

Matlab function: Vector repetitions

```
function reps=vector_repetitions(pvcomb,th,m_start,m_end, m_comparing_vector,
k_loop_comparing)
reps=0;

for m2=m_start:m_end

    resta=pvcomb{m2}-pvcomb{m_comparing_vector}(k_loop_comparing,:);
    aux=-th<resta & resta<th;
    aux=double(aux);
    aux(aux==0)=NaN;
    if ~isempty(rmmissing(aux))
        reps=reps+1;
    end
end

end
```

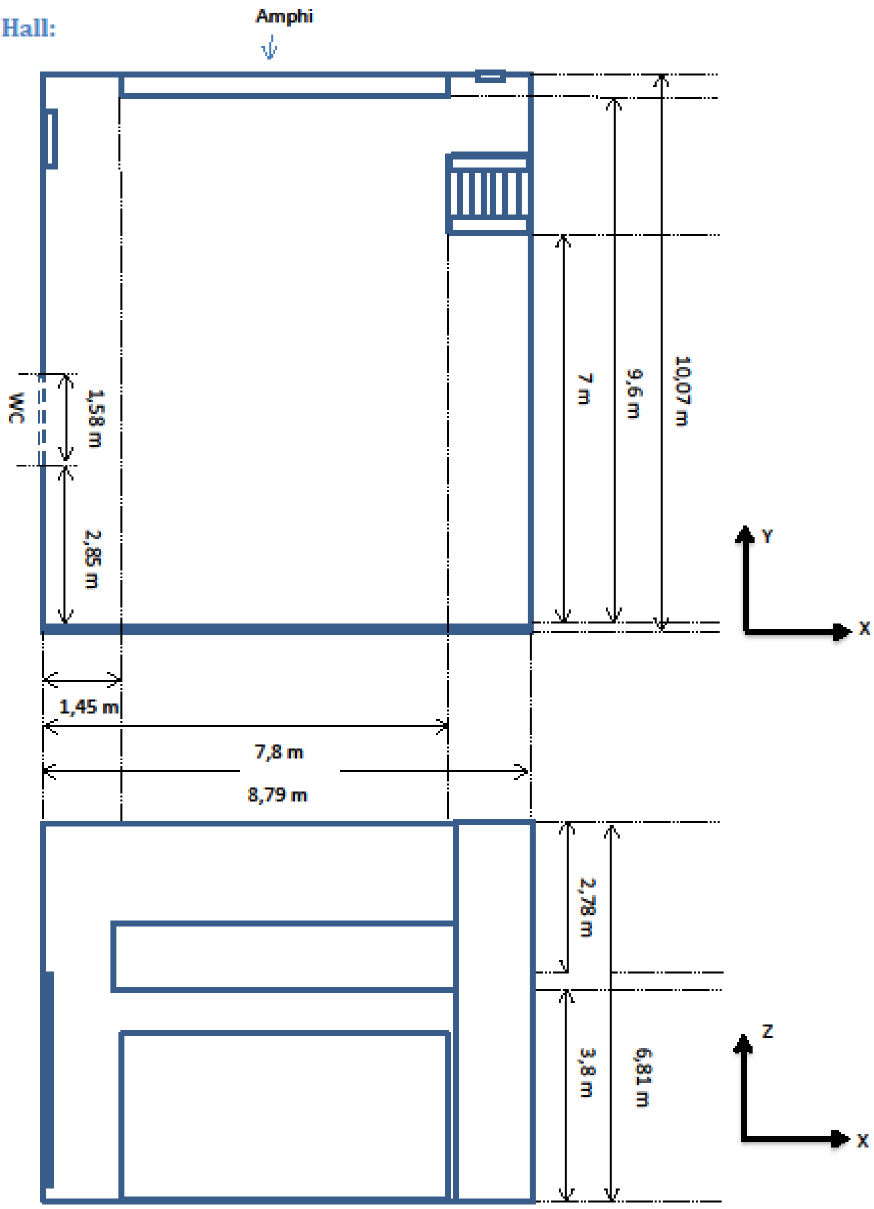
Matlab routine: Repetitions_vs_tags

```
%This script aims to observe how many tags are required to obtain unique
%power measures.
obtain_power_readings_by_line;
e=1;

corridor=[0    0    0;
    0   14    0;
    2   14    0;
    2    0    0];

hall=[0    0    0;
    0    7    0;
    8.8  7    0;
    8.8  0    0];

m_start=1;
m_end=numberOfMesures;

Results=cell(1,4); %evaluating 4 different th=0.1,0.2,0.3,0.4
%Threshold
 for th= 0.1:0.1:0.4

    u=1;
    Table=cell(1,4); %evaluating 4 different sizes r=3,4,5,6

    %Size
    for r=3:6

        %This function calculates how many times a power vector appears in
        %the different measured positions.

[max_rep,res,tpvcomb]=max_group_size(numberOfTags,powers1,r,m_start,m_end,th);

        %Save data into a table
        [Vector_Comb,Measure]=find(res==max_rep);
        Max_Repetitions=max_rep*ones(length(Vector_Comb),1);
        Vector_Size=r*ones(length(Vector_Comb),1);
        Tag_Combination=zeros(length(Vector_Comb),r);
        Meas_Pos=zeros(length(Vector_Comb),r);
        Threshold=th*ones(length(Vector_Comb),1);

        for z=1:length(Vector_Comb)
            Tag_Combination(z,:)=tpvcomb(Vector_Comb(z),:);
            Meas_Pos(z,:)=posMes{Measure(z)};
        end

        %Identical row detection-------------------------------------------------
        figure;
```

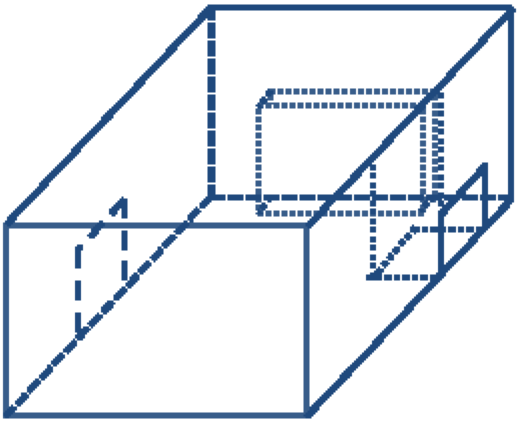
```
        title(strcat('Vector size',string(r)));

        switch env
           case 2
              plot(corridor(:,1),corridor(:,2));
              hold on;
              plot(Meas_Pos(:,1), Meas_Pos(:,2),'*');
           case 1
              plot(hall(:,1),hall(:,2));
              hold on;
              plot(Meas_Pos(:,1), Meas_Pos(:,2),'*');
        end


        %Save results for different vector size
       Table{u}=
table(Tag_Combination,Measure,Max_Repetitions,Vector_Size,Threshold);
       u=u+1;

    end
        %Save results for different thresholds
        Results{e}=Table;
        e=e+1;
        clear Table

 end

%Graph results--------------------------------------------------------------
figure;
for i=1:length(Results)


    for j=1:length(Results{1,1})
     n_tag_ini=[1 2];
     max_rep_ini=[0 0];

     n_tag_ini=[n_tag_ini table2array(Results{1,i}{1,j}(1,4))];
     max_rep_ini=[max_rep_ini table2array(Results{1,i}{1,j}(1,3)) ];

    end

     plot(n_tag_ini,max_rep_ini);
     title('Power Vectors');
     xlabel('N_tags')
     ylabel('Max_Repetitions')
     hold on;

end
 legend('Threshold 0.1' ,'Threshold 0.3','Threshold 0.5', 'Threshold 0.7','Threshold 0.9');
```

Measurement campaign plan

Hall:



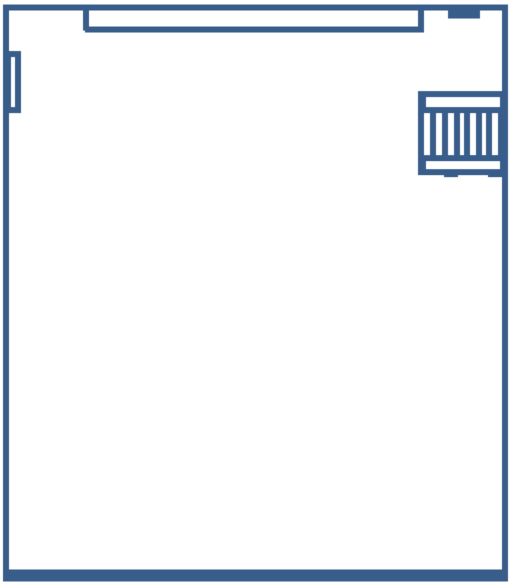
Tag position:



Tags required:

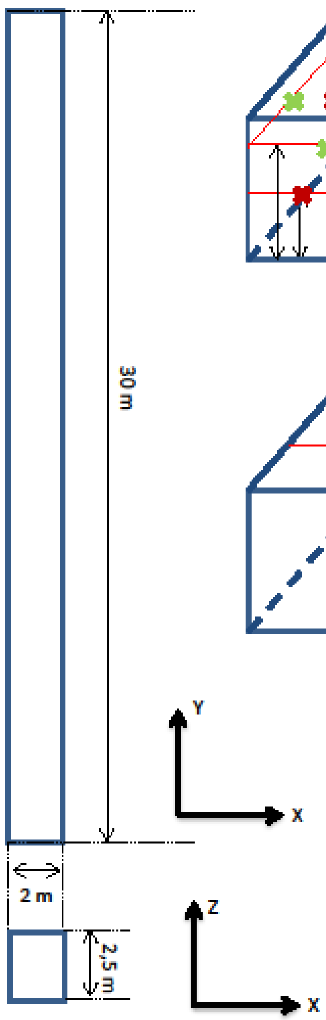
Space between tags:

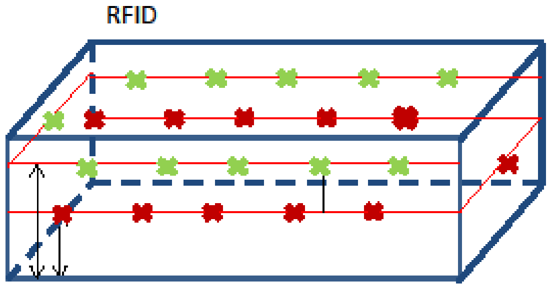
Measurement position:

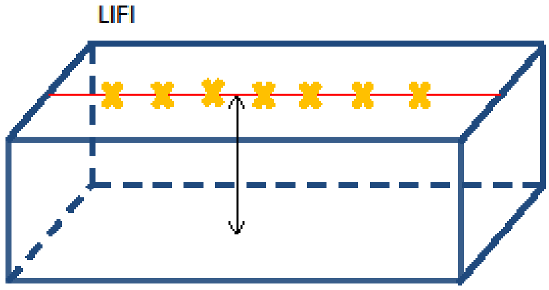


Number of measures:

Corridor:





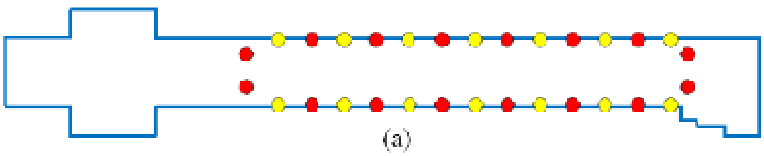


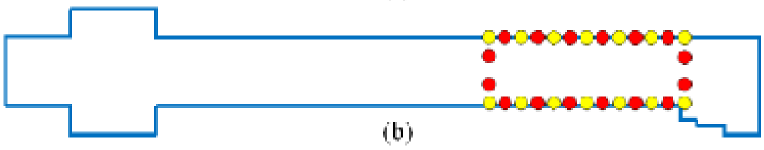
Tags required/ Space between tags

LIFI: RFID:

Number of measures:

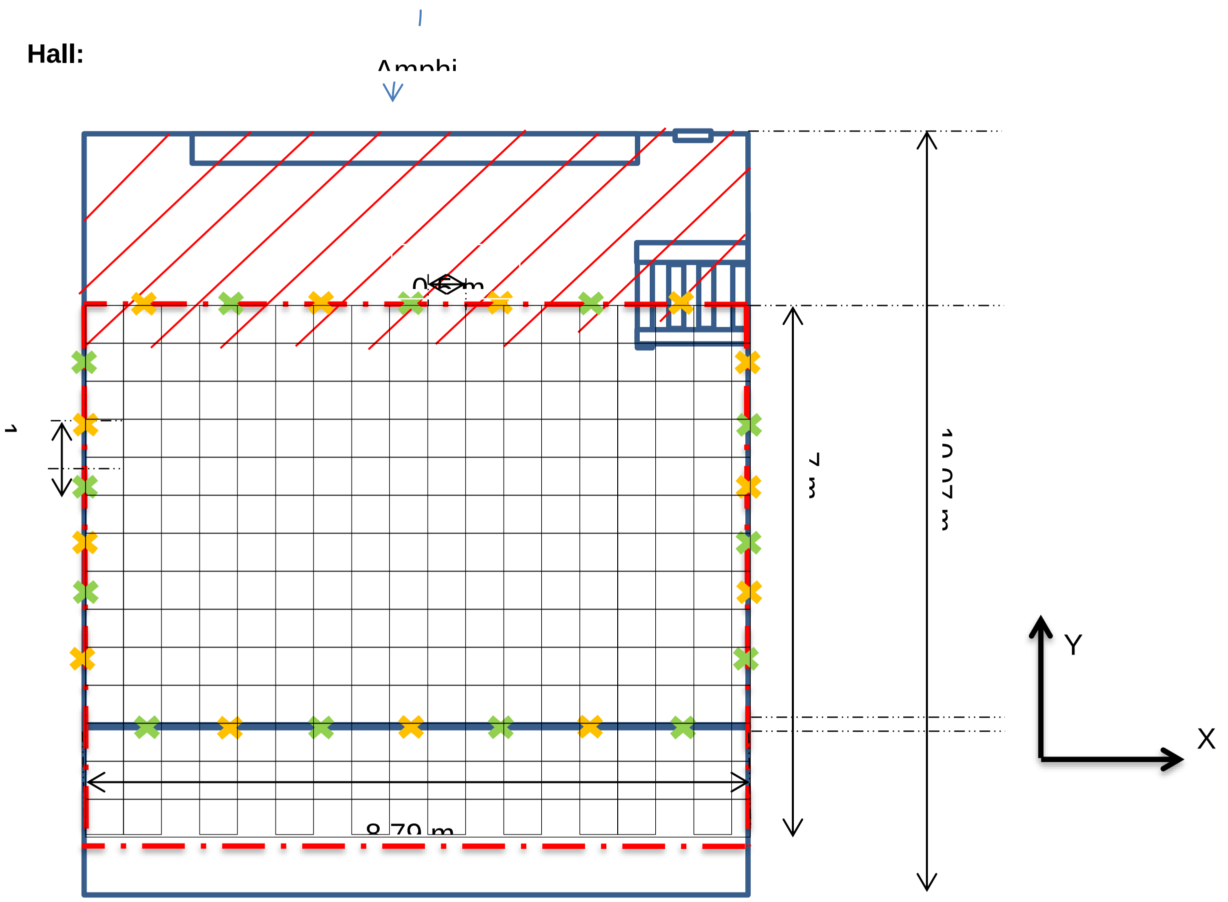
LIFI: RFID:


(a)


(b)

Measurement campaign plan

Hall:



Total number of tags: 6+7+6+7 = 26

Number of measures: 17x13 = 221

Space between tags: 1 m

Space between measures: 0,5 m

Reader height: 1 m

: Tag at 1,3 m

: Tag at 2,1 m

- PROGRAM/NUMBER TAGS – REGISTER POSITION
- REGISTER MEASUREMENT POSITION
- REGISTER POSITION OF METALIC ELEMENTS

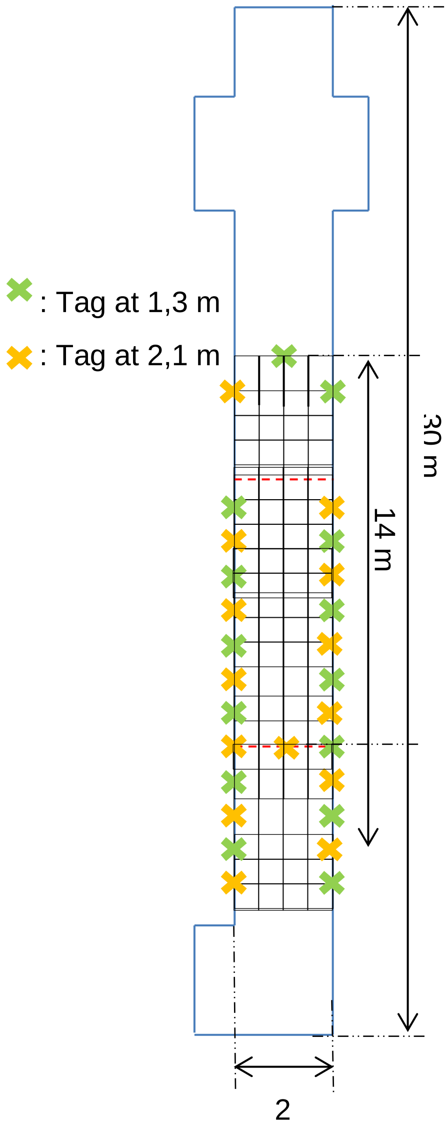
Extension lead for the reader

Pate a fix to stick the tags

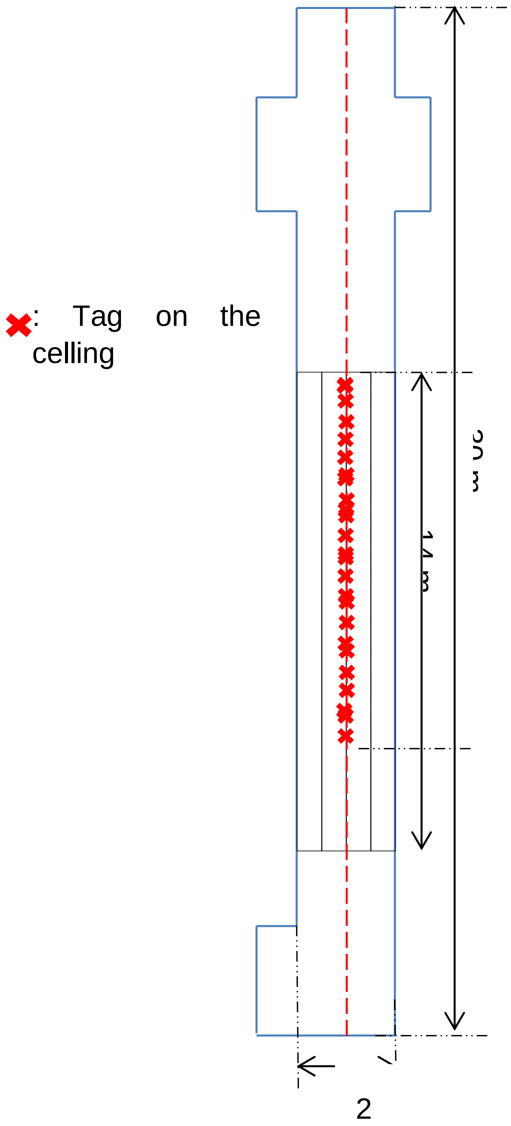
Stickers to mark the measurement position on the floor

Corridor:

Configuration 1



Configuration 2



Total number of tags: 13+13+1+1 = 28

Number of measures: (14x2-1)x3 = 81

Space between tags: 1 m

Space between measures: 0,5 m

Reader height: 1 m

Total number of tags: 28

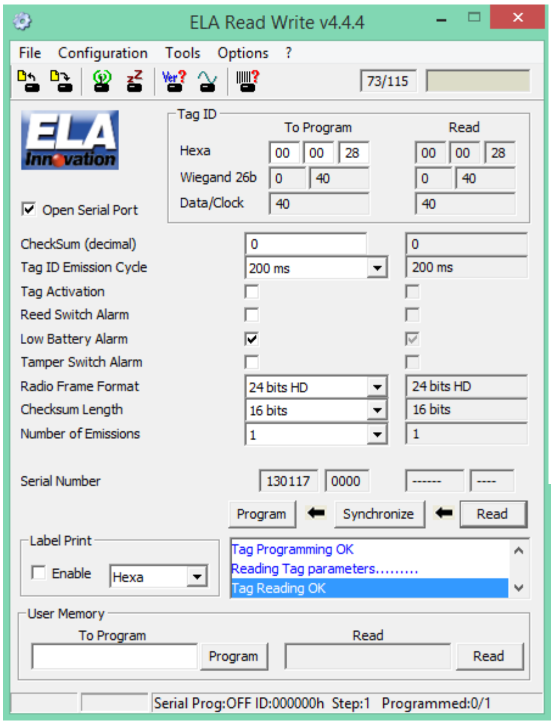
Number of measures: (14x2-1)x3 = 81

Space between tags: 0,5 m

Space between measures: 0,5 m
*Lay down the reader

1) PROGRAM/NUMBER TAGS – REGISTER POSITION
2) REGISTER MEASUREMENT POSITION
3) REGISTER POSITION OF METALIC ELEMENTS
   - Extension lead for the reader
   - Pate a fix to stick the tags
   - Stickers to mark the measurement position on the floor

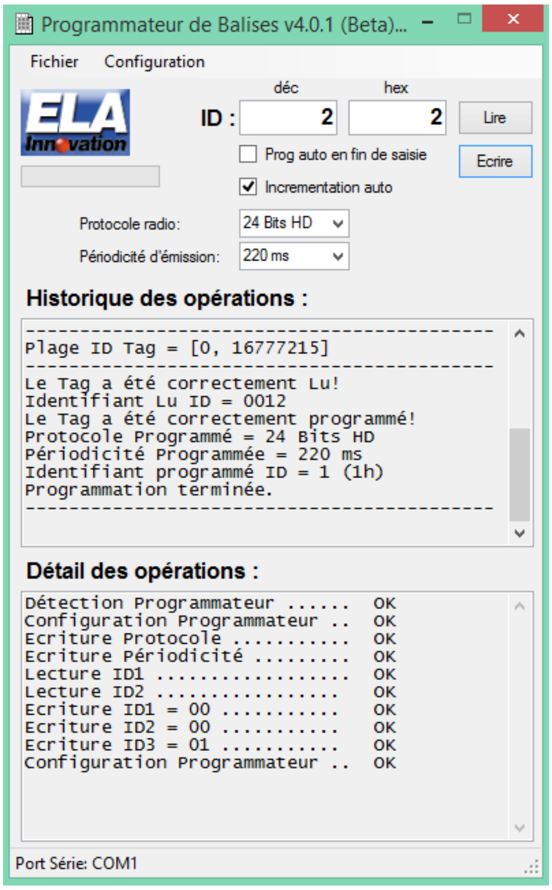
Tag programming:



<u>434Mhz tags</u>

The 28 tags have the following parameters:

- *Emission Cycle: 200 ms*
- *Radio Format: 24 bits HD*
- *Checksum Length: 16 bits*
- *Number of emissions: 1*



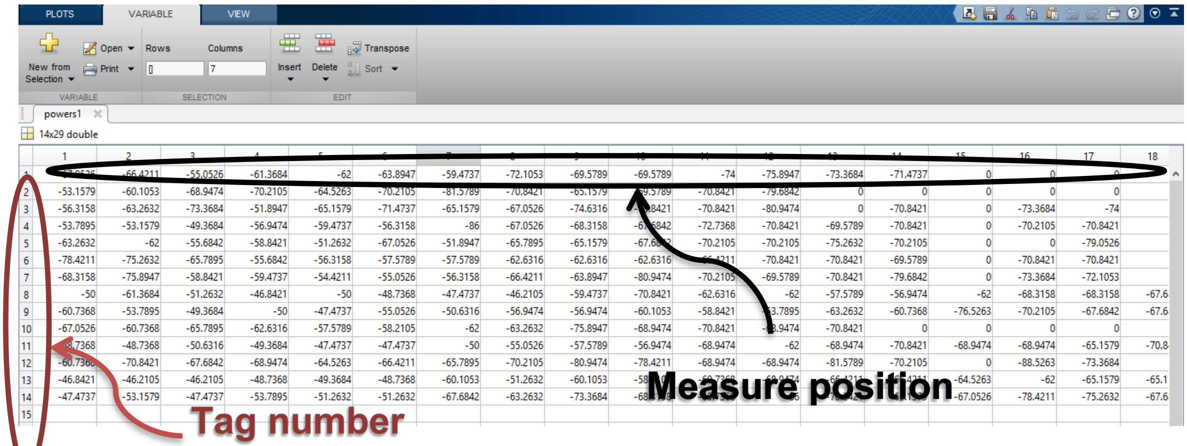
<u>868 Mhz tags</u>

The 28 tags have the following parameters:

- *Emission Cycle: 220 ms*
- *Radio Format: 24 bits HD*

Tag dependency

From a measurement campaign, we have a database with the received powers of different tags at some fixed positions:



It would be interesting to know if by combining the received power values of different tags, for example, grouping 3 tags (n=3):

$$Pv_{position\ 1} = \begin{cases} P_{R,tag\ 1} \\ P_{R,tag\ 2} \\ P_{R,tag\ 3} \end{cases}$$ In this example: $Pv_{position\ 1} = [-67{,}0526, -53{,}1579, -56{,}3158]$

Given a corridor environment, 3 main lines will be studied. For each line, it is interesting to observe:

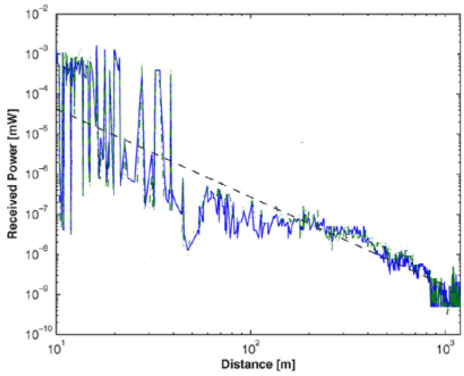
1. Which group of tags is the best? Given a line, we compute how many times each $Pv_{position\ m}$ vector appears. The maximum value will be kept. When all the lines have been analysed, the best group of tags will be the ones that follow:
$$\min[max(line_1), max(line_2), max(line_3)]$$
With the minimum values, we assure less ambiguity when finding a certain position. The group of tags that give this power combination will be considered the best.

2. Is this exact $Pv_{position\ m}$ produced by a different group of tags in a different measurement position? If it is, how many times does it happen? Which power vector is repeated the most?

3. If it doesn't happen, then which other tag group is best?

Power measures

After the measure campaign, a great database will have been created. It will contain information about the received power of every tag in the environment, according to a certain distance. With this data, a figure like the following one can be found (example):



As it can be seen, the graph presents intense climbs and abrupt descents in the received power. This is because of the interferences caused by obstacles and multi-route propagations, which cause this fading.

To get an idea of how the environment affects the received power, a simplification of this relation is created by means of the *One slope model,* providing an estimation using a lineal regression $f(x) = ax + b$ type and a path loss exponent *n*:

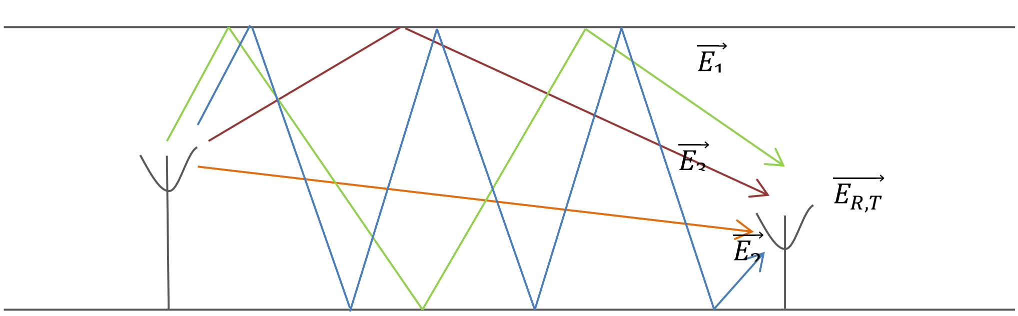
$$P_R = \frac{K}{d^n} \rightarrow P_R(dBm) = 10\log_{10} K - n10\log_{10} d$$

This approximation is represented by the dotted line in the previous figure.

Deterministic loss propagation model

The radio communication scenario normally consists of two antennas, the emitter and the receiver, established at a given height and distance. Due to the reflections caused by objects, people and walls, the total electromagnetic field is the sum of the all the detected powers at the receiver:

$$\overrightarrow{E_{R,T}} = \overrightarrow{E_1} + \overrightarrow{E_2} + \overrightarrow{E_3} + \ \dots$$



Obtaining the power levels by: $P_R = \alpha \left\| \overrightarrow{E_{R,T}} \right\|^2$

Introducing this data into the Matlab software, using the Statistics Toolbox's function "fitdist", we will be able to obtain a Rice probability distribution object by fitting the power values. The Rician distribution is used in communications theory to model scattered signals that reach a receiver using multiple paths.

```
pd = fitdist(x,'Rice')
```

Example of application:

```
Trial>> powers1(1,:)
ans =

  Columns 1 through 11

  -67.0526  -66.4211  -55.0526  -61.3684  -62.0000  -63.8947  -59.4737  -
72.1053  -69.5789  -69.5789  -74.0000

  Columns 12 through 22

  -75.8947  -73.3684  -71.4737         0         0         0         0
0         0         0         0

  Columns 23 through 29

         0         0         0         0         0         0         0

Trial>> Et=sqrt(abs(powers1(1,:))) CONVERT POWER IN dBm TO Mw FIRST!!!!!

Et =

  Columns 1 through 11

    8.1886    8.1499    7.4197    7.8338    7.8740    7.9934    7.7119
8.4915    8.3414    8.3414    8.6023
```

```
Columns 12 through 22

    8.7118    8.5655    8.4542         0         0         0         0
0         0         0         0


Columns 23 through 29

         0         0         0         0         0         0         0

Trial>> Et=Et';

Trial>> Et(Et==0) = []


Et =

    8.1886

    8.1499

    7.4197

    7.8338

    7.8740

    7.9934

    7.7119

    8.4915

    8.3414

    8.3414

    8.6023

    8.7118

    8.5655

    8.4542


Trial>> fitdist(Et,'Rician')

ans =

  RicianDistribution

  Rician distribution

        s = 8.18318   [7.99101, 8.37535]

    sigma =  0.3665   [0.252959, 0.531004]
```

With the power received from a tag measured at different distances, we have obtained a Rician distribution:

Parameters:

Name	Description	Support
s	Noncentrality parameter	$s \geq 0$
sigma	Scale parameter	$\sigma > 0$

The probability density function (pdf) is

$$f(x|s,\sigma) = I_0\left(\frac{xs}{\sigma^2}\right)\left(\frac{x}{\sigma^2}\right)\exp\left\{-\frac{x^2+s^2}{2\sigma^2}\right\} \quad ; \quad x \geq 0\,,$$

where I_0 is the zero-order modified Bessel function of the first kind.

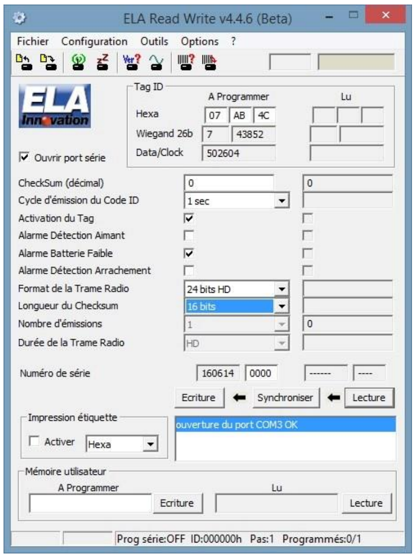
Example of measures received:


```
<?xml version="1.0" encoding="utf-8"?>
<Mesures>
  <Mesure_Irene numero="27" x="0.5" y="13.5" teta="0" repere="0">
    <id est="000003">
      <Date>28/01/2017 12:05:07:716</Date>
      <Valeur>158/157</Valeur>
    </id>
    <id est="000027">
      <Date>28/01/2017 12:05:07:396</Date>
      <Valeur>159/164</Valeur>
    </id>
    <id est="000023">
      <Date>28/01/2017 12:05:13:160</Date>
      <Valeur>150/164</Valeur>
    </id>
    <id est="000022">
      <Date>28/01/2017 12:05:13:432</Date>
      <Valeur>150/142</Valeur>
    </id>
    <id est="000019">
      <Date>28/01/2017 12:05:12:984</Date>
      <Valeur>134/140</Valeur>
    </id>
    <id est="000017">
      <Date>28/01/2017 12:05:09:126</Date>
      <Valeur>128/124</Valeur>
    </id>
    <id est="000007">
      <Date>28/01/2017 12:05:08:820</Date>
      <Valeur>154/148</Valeur>
    </id>
    <id est="000011">
      <Date>28/01/2017 12:05:07:781</Date>
```

<Valeur>136/135</Valeur>
</id>
<id est="000005">
<Date>28/01/2017 12:05:11:208</Date>
<Valeur>152/157</Valeur>
</id>
<id est="000010">
<Date>28/01/2017 12:05:12:519</Date>
<Valeur>143/155</Valeur>
</id>
<id est="000002">
<Date>28/01/2017 12:05:07:940</Date>
<Valeur>152/151</Valeur>
</id>
<id est="000024">
<Date>28/01/2017 12:05:11:895</Date>
<Valeur>147/142</Valeur>
</id>
<id est="000001">
<Date>28/01/2017 12:05:09:333</Date>
<Valeur>143/144</Valeur>
</id>
<id est="000015">
<Date>28/01/2017 12:05:08:4</Date>
<Valeur>131/143</Valeur>
</id>
<id est="000025">
<Date>28/01/2017 12:05:12:551</Date>
<Valeur>154/146</Valeur>
</id>
<id est="000009">
<Date>28/01/2017 12:05:10:998</Date>
<Valeur>156/137</Valeur>
</id>

<id est="000026">
<Date>28/01/2017 12:05:11:350</Date>
<Valeur>154/157</Valeur>
</id>
<id est="000012">
<Date>28/01/2017 12:05:11:383</Date>
<Valeur>135/137</Valeur>
</id>
<id est="000008">
<Date>28/01/2017 12:05:09:269</Date>
<Valeur>136/147</Valeur>
</id>
<id est="000020">
<Date>28/01/2017 12:05:11:911</Date>
<Valeur>150/140</Valeur>
</id>
<id est="000021">
<Date>28/01/2017 12:05:11:751</Date>
<Valeur>140/142</Valeur>
</id>
<id est="000018">
<Date>28/01/2017 12:05:08:500</Date>
<Valeur>153/136</Valeur>
</id>
<id est="000013">
<Date>28/01/2017 12:05:04:66</Date>
<Valeur>121/117</Valeur>
</id>
<id est="000004">
<Date>28/01/2017 12:05:09:109</Date>
<Valeur>156/151</Valeur>
</id>
<id est="000014">
<Date>28/01/2017 12:05:11:799</Date>

<Valeur>141/119</Valeur>
</id>
<id est="000006">
<Date>28/01/2017 12:05:10:165</Date>
<Valeur>155/154</Valeur>
</id>
<id est="000016">
<Date>28/01/2017 12:05:11:142</Date>
<Valeur>126/128</Valeur>
</id>
<id est="000028">
<Date>28/01/2017 12:04:47:639</Date>
<Valeur>156/157</Valeur>
</id>
</Mesure_Irene>



- **Programmateur sans contact infrarouge pour Tags Rfid active ELA INNOVATION**
- **Gestion avec logiciel ERW pour PC**
- **Paramétrages et activation**
- **Auto alimentation par prise USB**

DATA SHEET

SCIEL PROG IR

Programmateur Tag RFID active & Logiciel ERW

Référence: SCP02B

Spécifications	
Connexion	USB 1.1
Fréquence de lecture	433.92 MHz
Fréquence d'écriture	4 KHz
Mode d'écriture	Fenêtre LED Infrarouge
Boîtier	Aluminium : 125x80x30 mm
Température utilisation	-25°C to +60°C

1 PRESENTATION

Le SCIEL PROG IR / SCP02B permet l'Ecriture et la Lecture des données de tous les Tags RFID active de notre gamme, par technologie infrarouge.

L'appareil dispose d'une prise USB 1.1

Le logiciel ERW gère le programmateur SCP02B, Il permet :

- Programmation de TAG à l'unité
- Programmation de TAG en série
- Enregistrement des toutes les opérations de programmation
- Programmation des numéros ID des TAG
- Programmation des paramètres TAG (périodicité, gestion des alarmes)
- Activation / Désactivation directe des TAG
- Programmation et lecture de la plage mémoire utilisateur interne du tag (100 caractères maxi non transmis)

2 INSTALLATION DU LOGICIEL

Avant de connecter le programmateur, il est nécessaire d'installer le Driver usb fourni, sur le PC d'exploitation. Le driver est compatible Windows Xp, Vista, 7 et 8.

Le Driver est disponible sur notre site dans l'espace de Téléchargement : www.ela.fr

Télécharger également le logiciel de configuration ERW

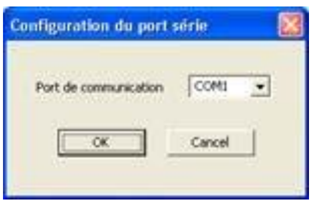
Suivre les étapes indiquées pendant l'installation.

3 OPERATIONS DE PARAMETRAGE

3.1 Configuration et commandes ERW

Vérification préalable : Il est conseillé de vérifier que le port de communication sur lequel est connecté le programmateur est bien paramétré dans le logiciel ERW.

Menu « Configuration » et « Port série » puis choisir le COM de la prise usb utilisée.



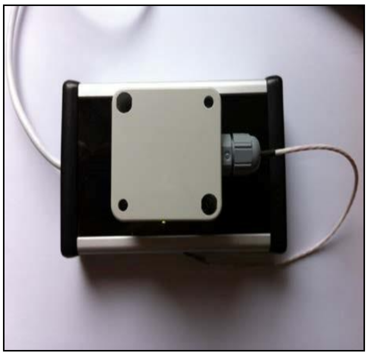
3.2. Positionnement des Tags RFID active sur le SCIEL PROG IR

Le Tag est directement posé sur la fenêtre du programmateur sans orientation particulière.

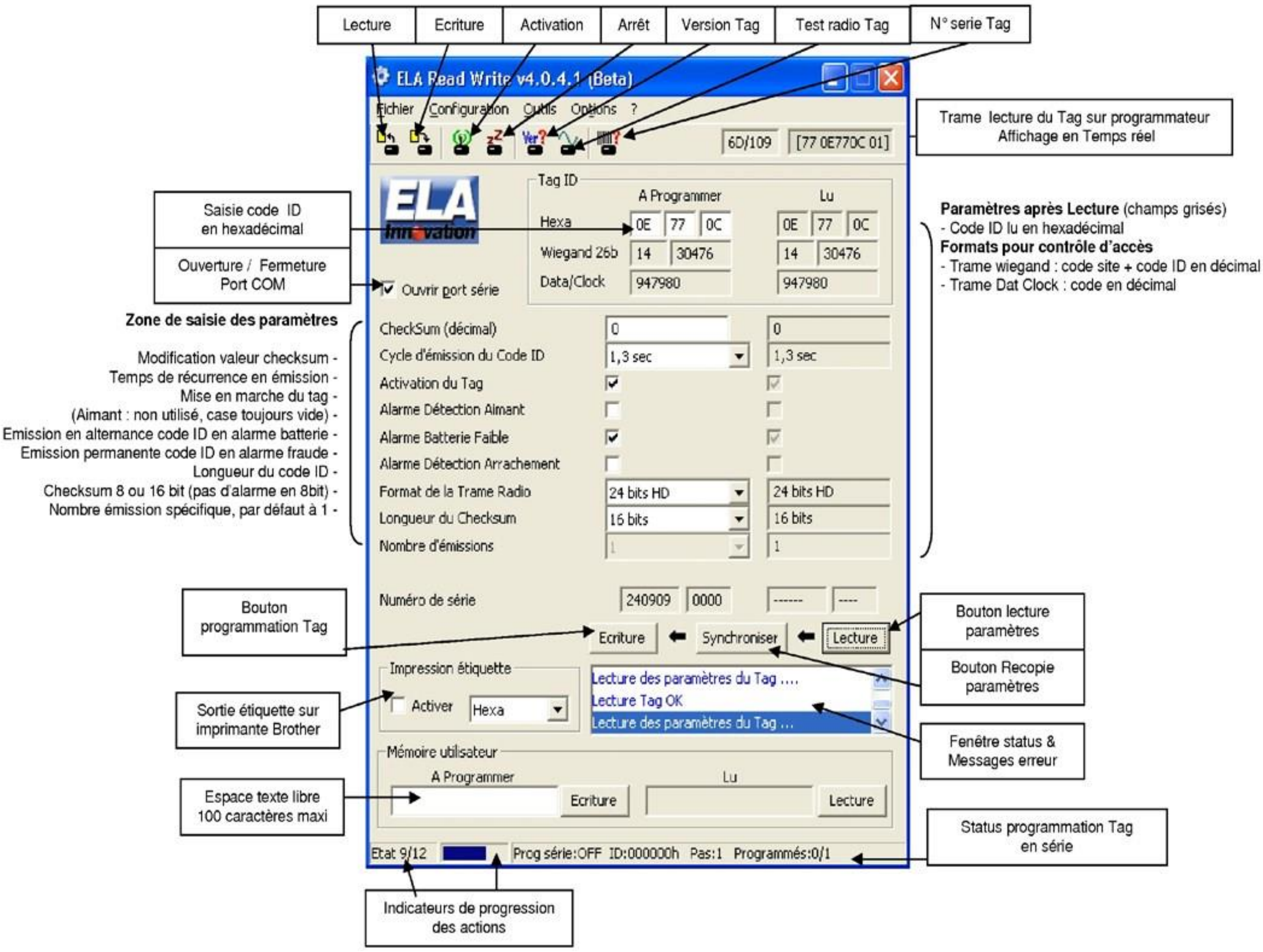
Les figures suivantes indiquent le positionnement des TAG à utiliser lors d'une lecture ou écriture :

Position pour ITEMS_IR **Position pour SLIM_ID**

Position pour THINLINE **Position pour COIN**



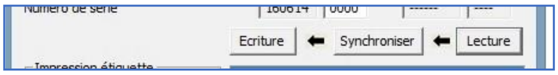
3.2 Principales fonctions ERW



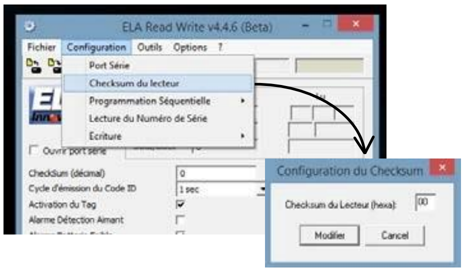
3.3 Principales opérations :

3 étapes à suivre pour paramétrer le Tag

- **Lecture :** permet de lire les paramètres du TAG
- **Synchroniser :** permet de remplir les champs « à programmer » avec les données lues (recopie des paramètres)
- **Ecriture** : Permet d'écrire les données « à programmer » dans le TAG placé sur le programmateur.



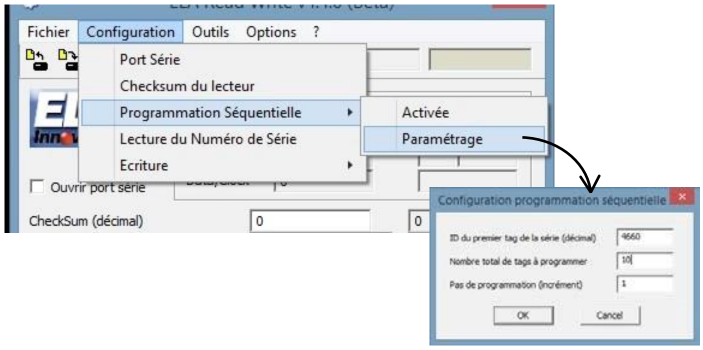
3.5 MENU CONFIGURATION



Valeur du checksum de lecture :

En cas de nécessité de compatibilité avec le CRC du Tag(s)

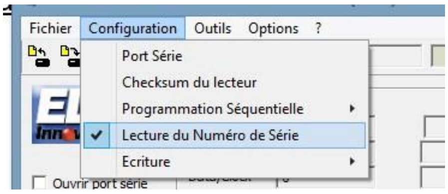
à paramétrer, utiliser l'option ci-contre pour modifier la valeur CRC du SCIEL PROG IR (par défaut à 00)



Programmation d'une série de Tags : L'option ci-contre permet de programmer une série incrémentale d'un lot de Tags avec un numéro ID de début et un pas d'incrémentation <u>en décimal</u>

Lecture du Numéro de série :

L'option ci-contre, cochée, permet le lire le numéro de série du Tag <u>à chaque</u> operation de Lecture.



Décocher l'option pour annuler l'opération.

Le numéro de série du Tag s'affiche dans les champs ci-contre

3.6 MENU RACCOURCIS

Les icônes permettent d'accéder directement à certaines fonctions du Menu principal de la fenêtre du logiciel ERW

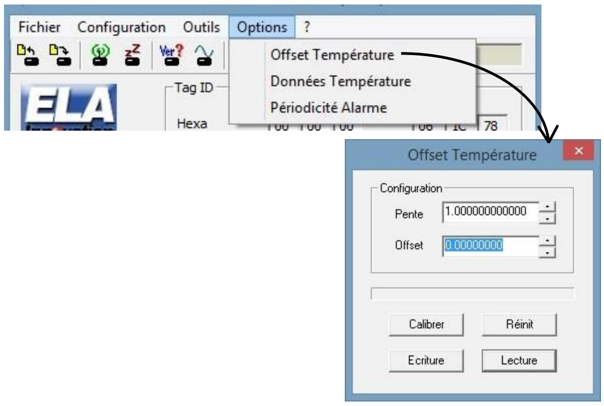
Respectivement les fonctions sont

- Lecture d’un Tag
- Ecriture d’un Tag
- Activation d’un Tag
- Désactivation d’un Tag
- Version soft du Tag
- Activation d’une porteuse radio
- Lecteur du numéro de série d’un Tag

3.7 MENU OPTIONS

Un seule des trois options ci-contre est opérationnelle

- **Offset Température**
- *Données Température (option non valide)*
- *Periodicité Alarme (option non valide)*



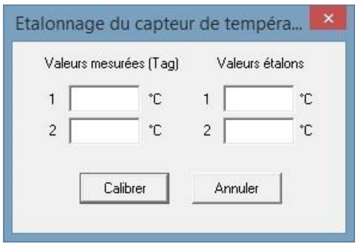
Offset Temperature

A utiliser pour le calibrage des capteurs de Température RFID sans fil.

L’option permet de modifier la valeur de la pente et d’offset du capteur par rapport à un capteur étalon.

Les boutons Réinit, Lecture et Ecriture permettent de modifier les paramètres de temperature du Tag.

Dans le cas où la pente et l'offset du Tag sont inconnus, le bouton Calibrer, de la fenêtre ci-dessus, permet de les calculer automatiquement. La boîte de dialogue ci-contre permet de saisir les valeurs mesurées et celles du Tag étalon. Le bouton Calibrer calculera les valeurs qui seront appliquées au Tag.



Données Temperature

Option non valide

Periodicité Alarme

Option non valide

Tag RFID Active
THINLINE IR
Ref. IDP0231

- Identifiant du tag paramétrable (RW)
- **Longue portée : jusqu'à 80m** (champ libre)
- **Autonomie** : **jusqu'à 10 ans** (en fonction des paramètres)
- **Épaisseur : 5 mm**
-

Spécifications techniques	
Tension d'alimentation batterie	3 VDC –Pile CR2032 remplaçable
Fréquence	433.92 MHz
Paramétrage	Code ID – Temps cycle émission – Activation /Désactivation
Périodicité émission	0.22s à 12heures
Configuration	Outil SCIEL PROG IR et logiciel ERW
Compatibilité du lecteur	Lecteur gamme SCIEL READER
Gestion du niveau de batterie	Code ID spécifique quand la batterie est faible
Boîtier	54 x 33 x 5 mm – ABS blanc – encoche porte clé
Température d'utilisation	-30°C à +70°C
Standards	EN 301 489 – 3 : 2002 V1.4.1 ; EN 300 220 – 2007 : V2.1.2 ; CE; RoHS

Option accessoire : TAG HOLDER / Ref. ACIOM29

Support de tag adhésif pour pare-brise

Dimensions 60 x 38 x 12 mm
Matière ABS blanc

UNIVERSITAT POLITÈCNICA DE CATALUNYA BARCELONATECH

telecom BCN

ELA

Active RFid

Active radio-frequency identification

Automated System for treatment and detection of active RFID tag's s traffic direction. Applications : bidirectional-ways detection and counting, access control

UTP DIFF2 RS : serial interface (RS232, RS485 or RS422)

UTPDIFF2W:Wiegand26bitsorClock&Data(for Access Controller) Options : Ethernet, 6VDC backup battery

Specifications		
On-Board Power Supply	6 to 12 VDC or 230VAC	
Average Current	80 mA @ 6V (2VA @ 230Vac)	
Receiving Range	Adjustable up to 80m (open field)	
On-board connectors	Pluggable Screw connectors	
Serial Interface	1 RS232 or RS485	
Output Protocols (for UTP DIFF2W)	WIEGAND	CLOCK & DATA
Connections	Data 0 Data 1 PRESENCE (OPEN	DATA CLOCK PRESENCE (OPEN collector)
Data Format	26 bits	10 or 13 characters
Access Control Option	2 indepedant ways (badges for the entrance and for the	
Connectivity Option	External IP converter	
Antenna Connectors	2 BNC female connectors for directive RFID antenna	
Casing	ABS, waterproof, W=180 mm / H= 90 mm / L = 182 mm	
Operating Temperature	-20°C to +60°C	
Standards	EN 301 489 – 3 : 2002 V1.4.1 ; EN 300 220 – 2007 : V2.1.2 ;	

Glossary

BLE	Bluetooth low energy
DToA	Differential time of arrival
EFREI	Ecole Française d'Electronique et d'Informatique
ELA	Environmental Lighting for Architecture
GDOP	Geometric Dilution of Precision
GPS	Global Positioning System
ID	Identification
IEE	Institution of Electrical Engineers
IPIN	Indoor Positioning and Indoor Navigation
ISM	Industrial, scientific, and medical radio band
RAM	Random Access Memory
RF	Radio Frequency
RFID	Radio Frequency Identification
RS323	Recommended Standard 232
RSSI	Received signal strength indication
ToA	Time of arrival
UHF	Ultra High Frequency