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XXXIV Cycle

An innovative low cost Real Time Locating System

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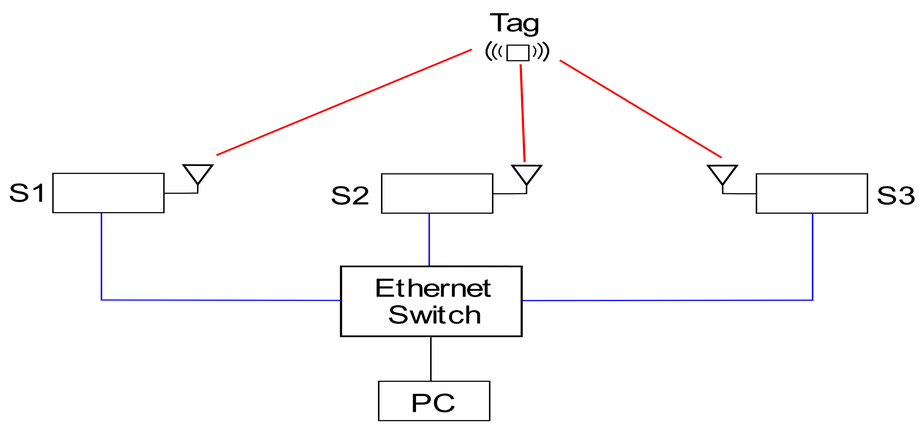
Research context and motivation

- A **Real Time Location System** (RTLS) consists of a fixed infrastructure of sensors and software to enable accurate real-time tracking of small battery powered (active) tags, which can be attached to people or assets, within the area covered by the sensors infrastructure
- Compared to Global Positioning Systems (GPS), RTLS provides greater accuracy (typically of ten centimeters) and the ability to work in situations where GPS does not (such as inside buildings) and with very small devices (active tags)
- The aim is to develop a **low-cost** prototype of both the active tag and the sensors

Addressed research questions/problems

- Design and manufacturing of an **Ultra Wide Band** (UWB) transmitting tag with:
  1. Configurable sequence repetition frequency
  2. Configurable unique ID

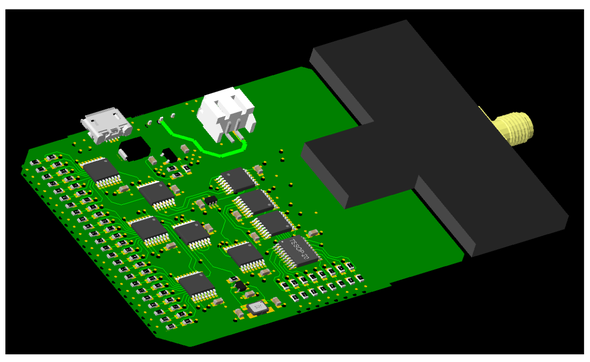
- Design and manufacturing of the sensor architecture: in order to estimate the tag's position, the RTLS need three sensors that:
  1. Receive a continuous stream of data and recognize the presence of a sequence and the ID of the corresponding tag
  2. Evaluate the sequence Time Of Arrival (TOA) with an accuracy related to the sampling period
  3. Send the obtained information to a central PC through Ethernet

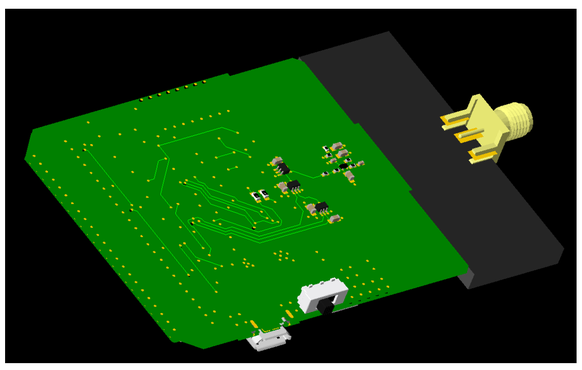


- Development of a dedicated PC application to:
  1. Computation of the tags position by estimating the Time Difference Of Arrival (TDOA) using the timing information's received from the sensors
  2. Synchronization between sensors and calibration

Novel contributions

- **Prototyping** of a tag transmitting an On-Off Keying (OOK) modulated sequence of UWB pulses centered at 7.25 GHz
- **Prototyping** of the sensor architecture using low cost COTS hardware
- **Development** of highly efficient and real time sensor firmware to calculate TOA



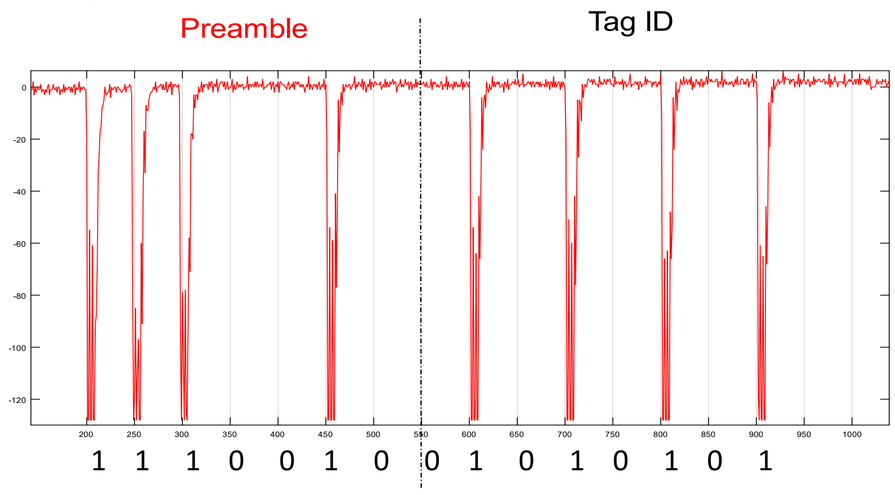


Submitted and published works

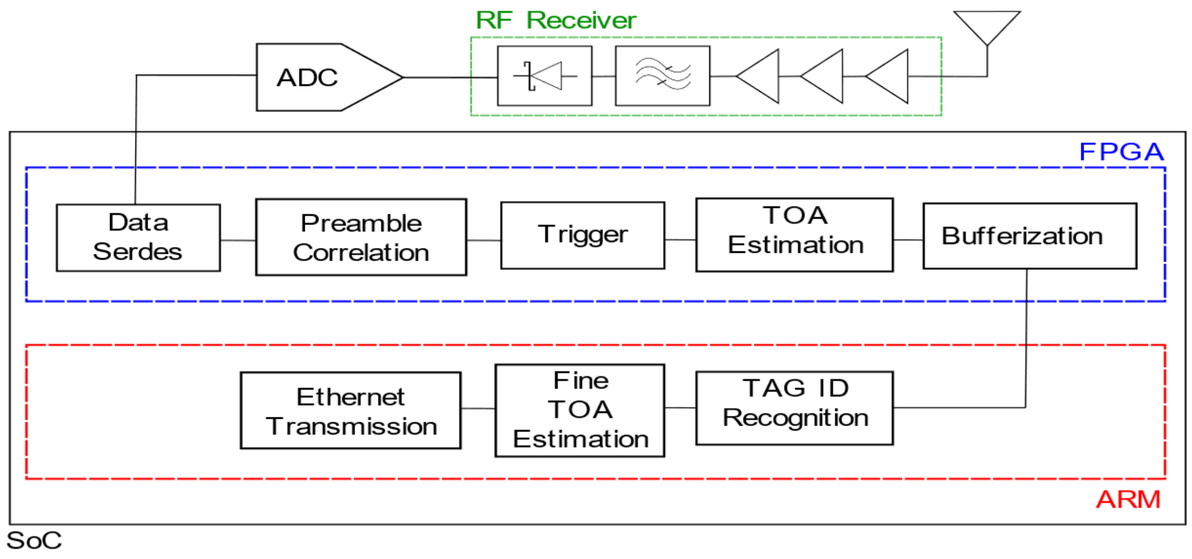
- Bottigliero S., Milanesio D., Saccani M., Maggiora R., Viscardi A., and Gallesi M., "An innovative harmonic radar prototype for miniaturized lightweight passive tags tracking", IEEE Radar Conference, Boston, 2019

Adopted methodologies

- The pulse sequence of each tag is composed of a **Preamble**, common to all, and a **unique ID**
- The extraction of the sequence from the incoming data stream is implemented into the sensor **FPGA** by correlating the Preamble with the received data. If a sequence is found, the corresponding data and TOA are sent to an **ARM** microprocessor.



- The Tag identification is implemented in the ARM microprocessor.
- The calculated results from each sensor are sent to a PC that performs the TDOA and each tag position estimation



Future work

- A first version of the tag has been manufactured in few samples
- The sensor firmware and software have been implemented on development boards (one for the SoC, ZedBoard, and one for the ADC, HMCAD1511)
- A first version of the PC software has been implemented and the system is being validated
- Next steps will be the realization of a new tag version and the design and prototyping of the sensor on a single dedicated board

List of attended classes

- 01NVEOQ – Radiating electromagnetic systems (05/07/2019, 8 CFU)
- 01MMRRV –Tecniche numeriche avanzate per l'analisi ed il progetto di antenne (14/03/2019, 4 CFU)
- 01QFDRV – Photonics: A key enabling technology for engineering applications (24/07/2019, 5 CFU)
- 01QSCIU – Reconfigurable computing (11/02/2019, 4 CFU)
- 01SFURV – Programmazione scientifica avanzata in Matlab (27/03/2019, 4 CFU)
- 01SWPRV – Time management (03/01/2019, 1 CFU)
- 01RISRV – Public speaking (02/01/2019, 1 CFU)
- 01SHMRV – Entrepreneurial Finance (08/01/2019, 1 CFU)
- 02LWHRV – Communication (04/01/2019, 1 CFU)
- 08IXTRV – Project management (29/07/2019, 1 CFU)

EXTERNAL TRAINING ACTIVITIES

- Emerald Core Transferable Skills Week (12/02/2019, 5 CFU)
- IEEE Radar Summer School 2019 (25/04/2019, 4 CFU)

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