ECSA-7
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Implementation of a WSN-based IIoT Monitoring System within the Workshop of a Solar Protection Curtains Company

Aitor Biurrun [1], Imanol Picallo [1], Hicham Klaina [2], Peio Lopez-Iturri [1,3], Ana V. Alejos [2], Leire Azpilicueta [4], Abian B. Socorro [1,3] and Francisco Falcone [1,3]

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OUTLINE

- Introduction
- Workshop Description
- Results
  - Radio Channel Assessment within the Workshop
  - System Performance
- Discussion

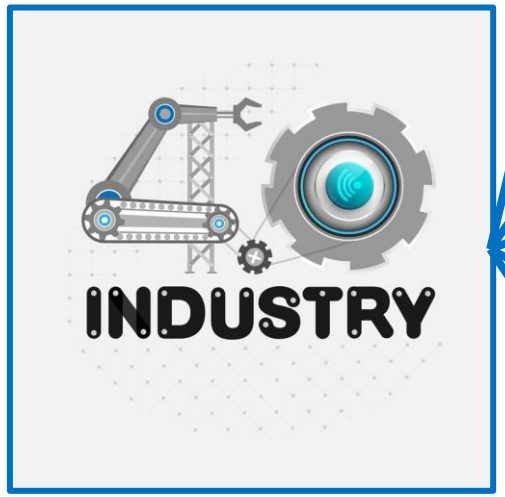
1. Introduction

1. INTRODUCCTION

- Industry 4.0 will allow
  - ✓Innovative manufacturing techniques
  - ✓Real-time data
  - ✓Interconnected smart devices

thanks to

Industrial IoT



- Automation
- Connection
- Integrated System
- Big Data
- Cloud computing

1. INTRODUCCTION

- **Wireless Sensor Network (WSN)** necessary for manufacturing process

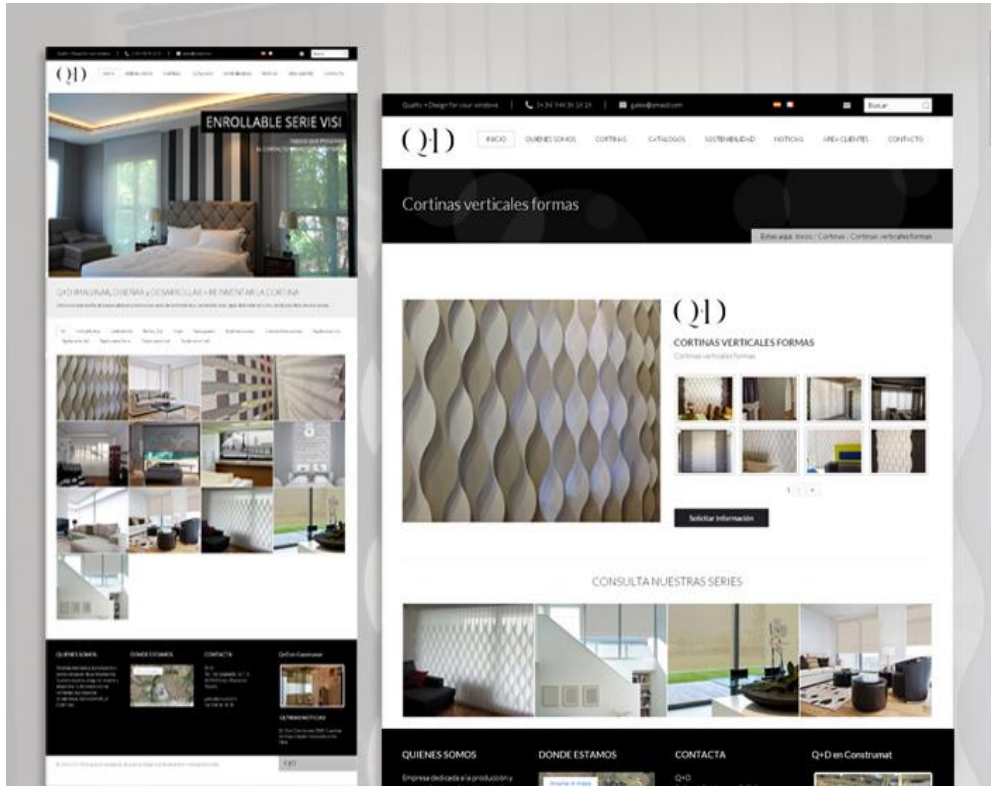
➢Monitoring → Capacity, Flexibility, Scalability → Optimization of Operating Costs

- Necessary to carry out a wireless channel analysis

➢Noised caused by → Harsh industrial environment (metallic objects), Strong multipath components

1. INTRODUCCTION

- **Galeo Enrrollables Company**



✓Designs and manufactures technical and solar protection curtains

✓Company wants to integrate an **Enterprise Resource Planning (ERP) system**

- Effective management of the entire manufacturing plant
- Control and Optimize all resources and processes

Aim of the work

➢**Deployment and optimization of a WSN** in the facilities of Galeo Enrrollables Company

➢**WSN will acquires real-time** data from machinery and workstations, to supply **them to the ERP system**

2. Workshop Description

2. Workshop Description

- **Galeo Enrrollables Company**
  - ➢ Founded in 2008 and **located in Navarre (Spain)**
  - ➢ **Specialized in the manufacturing, design and innovation of technical and solar protection curtains**
    - ✓ **Different types of Windows and glass enclosures** (large facades and indoor solutions)
    - ✓ Wide variety of **products**
      - **Roller blinds**
      - **Vertical curtains**
      - **Japanese pannels**
      - **Pleated curtains**
      - **Night and day blinds**
      - **Nautical curtains**
      - **Outdoor curtains**
      - **…**

2. Workshop Description

- **Galeo Enrrollables Company** contains
  - Different automatic and semi-automatic cutters based on crush cutting, laser, ultrasounds and blades
  - Thermal and ultrasound-based welding machinery
  - Automatic machinery for the manufacture of slats

2. Workshop Description

- **Galeo Enrrollables Company**

wants → to integrate

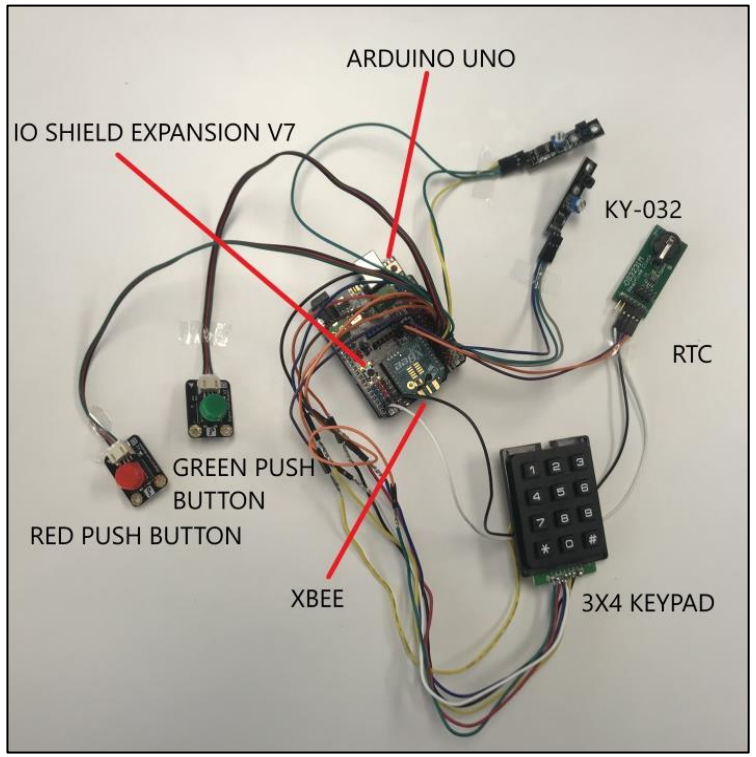
ERP system

Control and monitor:

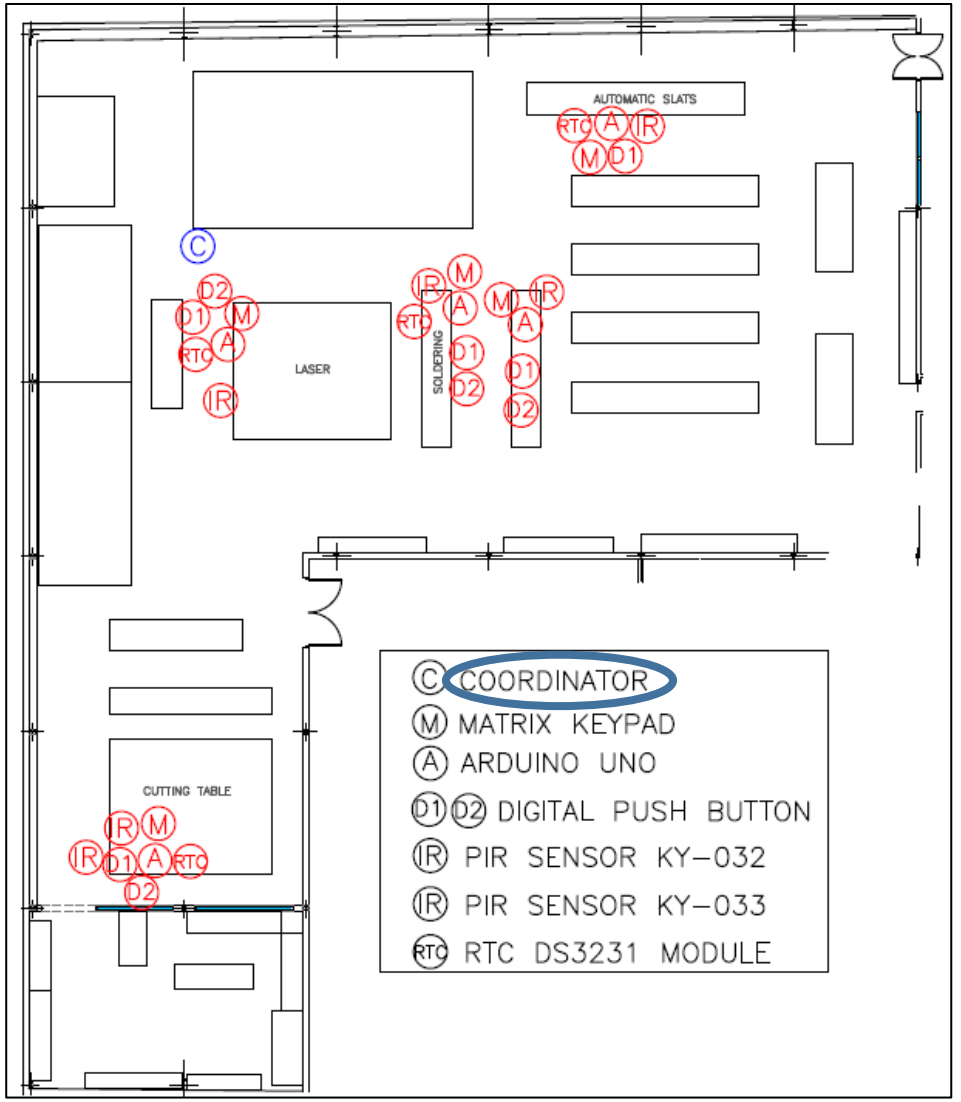
- ✓ Manufacturing times
- ✓ Stock of the warehouse
- ✓ Administrative tasks

→ Calculation of operating costs

Nodes consist on



ZigBee-based WSN deployment



3. Results

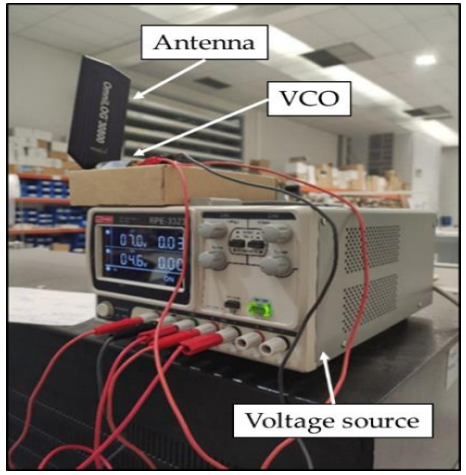
- ✓Radio Channel Assessment within the Workshop
- ✓System Performance

3. Results

- Radio Channel assessment within the Workshop
  - ➢ **Potential interference sources** (laser and soldering machinery) **on the wireless radio channel** measured
    - ✓ **Band** from **2.4 GHz to 2.5 GHz** presents **RF** signals/**noise** due mainly to the **Wi-Fi access points**
    - ✓ Some free bands near 2.5 GHz
    - ✓ **ZigBee protocol choses automatically** the **best operation frequency** band
    - ✓ **ZigBee systems** are very **robust** in terms of **losing packets** when coexisting with Wi-Fi signals
    - ✓ **No potential problems** have been **detected** for the deployment of **our ZigBee-based WSN**

3. Results

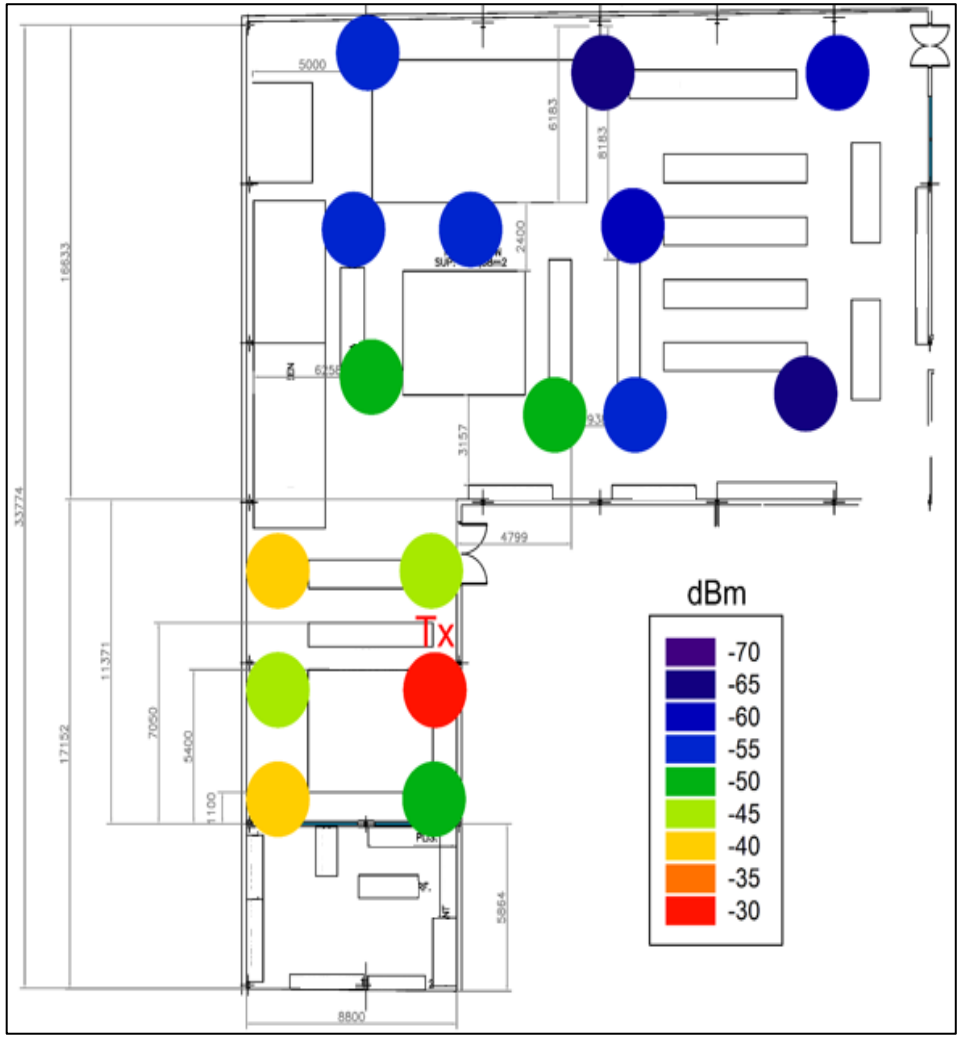
- Radio Channel assessment within the Workshop
  - In **complex industrial scenarios** the radio propagation of the **deployed system** can be **affected due to the obstacles** and metallic objects



- ✓ **Transmitter**: **Voltage Controller Oscillator** with 7.5 dBm of power transmission
- ✓ **Receiver: Portable Spectrum Analyzer**
- ✓ **Omni-directional Broadband Antenna** (300 MHz-8 GHz)

- ✓ **Location of the transmitter (TX)** has been chosen **to study different areas with LoS and NLoS conditions**
- ✓ **Points nearer to the transmitter received higher RF power level,** and the **NLoS zones the lowest**
- ✓ **Received power level** at **every point** is **significantly higher** than the **sensitivity values** of the employed ZigBee nodes (**-100 dBm**)

RF power lever measurements in the 2.4 GHz band



3. Results

- System Performance
  - ➢ **To assess the overall performance**
    - ✓ **Each node programmed to send 10,000 packets** in a time interval of 2 hours
    - ✓ **During a high activity period of the workstations and during the rest period**
    - ✓ **No packet has been lost during the activity period (0.00% PER),** and **only 2 packets in the rest period (0.005% PER)**
    - ✓ Example of part of the **information included in the packets transmitted**

Node	Activity period	Rest period
Cutting table	10,000	9,999
Laser	10,000	10,000
Soldering	10,000	10,000
Automatic slats	10,000	9,999

Time	Date	Module	Worker	Fab. Order	T1 ID	T1 time	T2 ID	T2 time
14:01:27	07/10/2020	1	34	0	1			
14:01:44	07/10/2020	1	34	78055	8	17		
14:03:00	07/10/2020	1	34	78055	9	0	9	19
14:04:55	07/10/2020	1	34	78055	10	39	15	24
14:06:50	07/10/2020	1	34	78055	11	52	9	23

✓ These **data will help to adjust their working fluxes** for a **more efficient performance**

4. Discussion

4. Discussion

- **Galeo Enrollables Company bets on Industry 4.0 paradigm**
  - ✓Installing a ERP system to improve the quality of the products and to optimize the manufacturing processes and reduction of cost
- **Company needs to deploy a WSN within the workshop**
  - ✓**ZigBee wireless communication technology** has been chosen
  - ✓ZigBee **problem**: **High power consumption** of the wireless nodes
  - ✓**But**, **nodes** are **connected to** the corresponding **workstation** and no extra energy supply is needed
  - ✓Prepared **nodes satisfied the company's expectations**
    - Due to its **versatility** (mesh topology, ease of adding new nodes to the network)
    - **Low cost** (Arduino compatible devices operating at free 2.4 GHz ISM band)
- **Future work:**
  - ✓**Integration** of the **data collected by** the **WSN into** the **ERP system**
  - ✓Analysis via Big Data techniques **for** the **predictive optimization** of the manufacture processes

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