MONALISA 2.0 – Sub activity 3.3

Indoor positioning System: PTS Onboard Installation

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The Networked Vessel
Activity 3, Sub activity 3.3
D3.3.4 PTS onboard Installation
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## Release History

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<td>First release</td>
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3 Scope of the document

Scope of the document is to report results of installation and test on People tracking pilot system realized in the EU TNT co-funded project MONALISA 2.0 on board Ruby Princess Cruise Vessel.

4 References


5 Acronyms

CMOS: Complementary MOS technology, semiconductor technology approach utilized to realize Camera chip where pixel are made by Metal-Oxide-Silicon transistors
EM: Electro-Magnetic, referring to Electro-Magnetic waves or fields
HF: High Frequency, it refers to RF frequency in the range of 3 MHz - 30 MHz
LED: Light Emitting Diode, solid state device that emits light when crossed by electrons current
LF: Low Frequency, it refers to RF frequency in the range of 30 kHz - 300 MHz
LIDAR: Laser Imaging Detection and Ranging, metering technique that use a light pulse to measure distances
PTS: People Tracking System, used here as synonym of Indoor Positioning System
RFID: Radio Frequency Identification, identification and tracking systems that use Radio Frequency Electro-Magnetic waves
RSSI: Received Signal Strength Indication, parameter used to deduce the target position from the power of signals received from many RF emitters
RTLS: Real Time Locating System, positioning system that work in real time
SMCS: Safety Monitoring and Control System, Software that manage all safety systems on board of large vessels
TDOA: Time Difference Of Arrival, parameter used to deduce the target position from the time a signal need to reach RF reference receivers
UHF: Ultra High Frequency, it refers to RF frequency in the range of 300 MHz-3 GHz
TDC: Trace Data Collector, which collect information from all satellites and compile a database used from Top system Software;

6 People tracking use on board Ruby Princess

The use of the People Tracking System on board Ruby Princess is connected to the emergency management in “Machinery Space”. The system will help crew
members during emergency in order to reducing timelines that lead to the resolution of emergencies in place. For this reason the Satellites installed on board are placed in all area covered by CO2 fire extinguish system. Besides CO2 areas, satellites have been placed in both “muster station”, which are the areas used to group all crew that can access “machinery space”.

7 Pilot system installation description

7.1 Pilot system Architecture
Martec People tracking System required many technical adaptations of market available technologies in order to be able, at system level, to fulfill all of the requirements that are needed on board of a Vessel [1]. Thus, validation test performed on board Ruby Princess have focused on verify correct functionality of the following items:

- Power Line communication;
- Low Frequency behavior in ship ambient;
- High Frequency communication in ship ambient;
- Data transportation from Tag to Top System;

Before going in detail about the installation and system test, the general system architecture is depicted and its main components are described:
As depicted in Figure 1, the pilot system is composed by:

- 12 branchese;
- 312 Satellites;
- 4 cabinets which include all the electronic needed to powered branchese and collect information for Top System;
- 1 TDC (Trace Data Collector);
- 2 Operator Station, one in ECR and the second in Bridge;
- Around 140 TAGs distributed to person which can access to the Machinery Space;

To clarify better following a description of the key items:

1) **RFID TAG**: this device is carried by tracked people. This is an active device, battery powered, that communicate its position to fixed devices, called satellites.

2) **Satellites**: PTS system is composed by various devices, called satellites, fixed at specific position in the vessel rooms. Satellites perform mainly following activities:
   - Communicate with carried TAGs through RF signal, identifying TAG position;
   - Transmit data to the upper levels of the system (DCU);
   - Execute specific commands from the upper system levels.
   - Many satellites are connected on the same cable (called branch), from which they receive power supply and through which they transmit collected data. PTS might have more than one branch.

3) **Data Collection Units (DCU)**: These devices perform following main activities:
   - Provide power supply to the Satellites through branches cables;
   - Collect data from all of the satellites through branches cables;
   - Through branches cables, forward to satellites commands that are coming from upper levels of the system;
   - Forward data collected to upper levels of the system by Ethernet connection.

Data collection units are connected to Satellites through branches cables. Each branch cable is connected with two DCU, one at each edge. This redundancy is needed to make the system compliant to Safe Return To Port regulation.

4) **Branch**: one cable starting from and ending to a DCU, interconnecting a certain number of Satellites, carrying data from them and providing power supply to them.

5) **TDC (Tracking Data Collector)**: it is a software module installed on a PC or on a server at middleware level of the system. It is used in normal function of the satellite to collect information about satellites status and
about tags localization. Collected data are saved in a specific database, in order to be available to the top system application software.

6) **SMCS** (Safety Monitoring & Control System): this software reports localization data to safety operators;

Following picture show software modules architecture in more detail, highlighting modules interaction and mode of operation.

In the next description we refer with the name **Power Line** to the network that supplies power to satellites ad that carries data from and to satellites. Power line in thus composed by DCUs, one cable and multiple satellites.

Next paragraphs describe more in detail the system installed on board.
7.2 Pilot System Installation on Board

7.2.1 Pilot System Covered Area

In this paragraph will be showed all the placement of the satellites gaps. As is possible to see, coverage is quite dense in order to realize a people tracking with big precision. Satellites have been placed not only in the CO2 area but also outside in order to be able to detect persons who have come out from area.
MONALISA 2.0 - INDOOR POSITIONING SYSTEM: PTS ONBOARD INSTALLATION
Figura 7

Figura 8
MONALISA 2.0 - INDOOR POSITIONING SYSTEM: PTS ONBOARD INSTALLATION
Positioning is the first part of the engineering of the pilot system. This is a very important part in order to define how many satellites are needed for the system. After positioning of the satellites on the gap, it is necessary to verify the correct position and the possibility to install the satellite in the position defined. This requires a visit on board Ruby Princess.
7.2.2 Branch Definition

After Satellites positioning the next step is to define how to connect satellites between them so that it complies with ship safety rules. Each branch starts from one cabinet, connects a number of satellites and then finishes in a different cabinet, as defined in the following figure:

![Figure 17](image)

Then each satellite have been assigned to a branch and in the followings figures it is possible to see these assignment:
LOOP 3

FZ 5

FZ 6

DECK 04

DECK 02

DECK 01

Figura 20

LOOP 4

FZ 6

FZ 5

DECK 04

DECK 03

DECK 02

Figura 21
7.2.3 Cable Laying and Satellites installation

These first two steps are part of the engineering of the system and these steps are very important for the correct functionality of the entire system. With all drawings
depicted in the figures before, it is possible starting with the cable laying and with the installation of the satellites.

This step is the one which require a lot of time, during this period were realized all cabinets needed for the electronics.

7.2.4 Cabinet Composition

In order to be able to power all branches and collect information for the Top System there was realized 4 cabinets which include all the necessary electronics.

In the following figures are depicted dimensions and internal plates of the cabinets:

1) Cabinet 1:

![Diagram of Cabinet 1]
2) Cabinet 2:
3) Cabinet 3:
4) Cabinet 4:
With a total of 12 branches have been installed 24 DCU, two for each branch.

7.3 Pilot system Startup

Concluded the first stage “Pilot System Installation on Board”, the system is ready for the startup. In this second stage will be applicate the procedures described in the document 70-0585-T-R00 chapter 6.1 “Pilot System Architecture” in order to startup all branches:

The two software which will be used are:

1) **PLPData**: it is a software module installed on a PC or on a server at middleware level of the system. It is used during branch configuration to make the startup of the branch assigning unique address to each satellite.
2) **ModbusTcpPts**: it is a software module installed on a PC or on a server at middleware level of the system. It is used during branch configuration once the startup of the branch is terminated. It is used to send the final configuration to the satellite firmware.

### 7.3.1 Cable Verification

Before start with the configuration it is very important to verify the correct connection between all satellites on the branch in order to prevent inversions of power supply polarity.

This test is made as follow:

1. Supply Branch from Main DCU;
2. Measure power supply on the connector of the Backup DCU;

The test is passed if on the Backup DCU connector there is a positive supply.

### 7.3.2 Branch Startup

When cable verification is done, next steps are:

1. Assign DeviceId;
2. Download Firmware;
3. Configure;

In the following figure is depicted a typical branch:

![Figura 39](image)

The following steps are needed:

1. Open software ModbusTcpPts;
2. Insert Main DCU IP Address:
3) When press OK the following window will open:

4) Press the button Monitor in the DCU Set Status;

5) Now is possible to open _PLDataMain.cmd:

6) With this software we are able to set the unique DeviceId for each satellite on the branch. This DeviceId is essential in order to be able to communicate with the satellites for the future operations;
7) After the assignment of the DeviceId the next step is to download the application firmware because satellites at the end of production has only a bootloader loaded. For Firmware download it is necessary the same software _PLDataMain.cmd;

8) At the end of the firmware download satellites are ready for the final configuration;

9) Final configuration with all needed parameters for the people tracking application is done with the ModbusTcpPts software:

10) At the end of the final configuration, both DCU Main and Backup are ready to acquire information from satellites about tags detected;

This procedure is done for all twelve branches. At the end we have all the bottom level of the system running.

This startup procedure permit to test the following items tested in laboratory and described in the document 70-0585-T-R00 chapter 6.2:

1) Electrical performance, power supply on the branch cable;
2) Data transfer on branch cable performance;

The results of the tests are:

- The voltage drop on the line does not affect the proper functioning of the branch;
- Power line communication has not degradation, respectively, than in laboratory tests;

### 7.3.3 Top System Startup

Once all branches are started and all DCU are communicating with satellites and acquire tags detected it is possible to startup the TDC (Trace Data Collecting), and
SMCS (Safety Monitoring & Control System) which reports localization data to safety operators.

7.3.3.1 Trace Data Collector

This software installed on PC has the task to acquire all the information provided from all satellites installed on board. How is possible to see in Figure 1 there is one PC installed in Engine Control Room dedicated to the TDC, this PC is connected from one side to the Fiber Optic Loop which connect together all DCU, from the other side to the Operator Stations where is running the Top System software. The PC where is running TDC has not visualization monitor because data acquired are not visualized but only used to fill a database.

7.3.3.2 SMCS

This is the only software used to report localization data to safety operators on a monitor. This software read data from database which was previously compiled from TDC and visualizes results:
7.4 Conclusion

The activity of installation of the system on board has permission to install all the components that are part of the system in order to make it available for the next phase which is the Validation. During this activity were verified a part of test made in laboratory before regarding:

- Power Line Communication;
- Voltage Drop;

The results are aligned with what was seen in the laboratory before start onboard installation. The installation of the system has also confirmed the ease and speed of installation due to the architecture chosen for the system that has a branch connection, and thanks to the power line communications which allow using cable with only two wires for power and communication. Connection of satellites in branch, and not in star configuration, has big benefits in cables length because it is not necessary to lay one cable for satellite starting from control cabinet, but connections start from control cabinet Main, then connects all satellites one after the other and finish in control cabinet Backup.
7.5 Next Activity

After onboard installation People Tracking System is ready for the next activity which will be very important because next step is:

- Onboard Validation;

During this activity system will be validated in two steps:

- Preliminary Validation Test;
- Validation Test;

These steps will be very important for final validation of the system in real condition of use.
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