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Report on the installation processes and delivery of an updated RV Specification Sheet of the RV Laura Bassi (Activity 5.15; B6; OGS_CGN)

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1. Introduction

This report describes the ongoing progress of acquiring and installing various systems for a digital automation for the RV Laura Bassi, activity expected within the WP5.15.

The automation systems encompass technical and mechanical operations (such as the propulsion plant, the auxiliary engines, auxiliary machinery operation, cargo operation, navigation and administration of maintenance) and the different systems related to the scientific equipment onboard (e.g. piston cores, oceanographic winches, seismic equipment, sonars, environmental sensors, CTDs).

The purpose of this task is to enhance the digital integration of the vessel, with a particular focus on enhancing the connectivity of scientific equipment.

Information generated by the equipment will be comprehensively stored onboard, with a portion transmitted to a ground segment in near-real-time, depending on the available communication capability.

The ultimate goal is to replicate a section of the onboard monitoring system in a remote location, effectively creating a digital twin of the vessel.

To accomplish this purpose, the first step involves implementing enhanced communication capabilities for the vessel.

At the beginning, since the RV Laura Bassi mounted two VSat antennas (in C and Ku band) onboard, the plan was to duplicate them to guarantee a continuous data connection; this issue was addressed by incorporating a StarLink antenna, which bandwidth and coverage make StarLink a game changer in connectivity.

In June 2023 we installed a maritime grade Starlink antenna subscribing to a standard maritime contract; since then the connection speed in download has always operated within the 40-220 Mbps.

If we compare these values with the maximum of 150 kbps that can be reached with VSat it becomes easy to say that StarLink is a game changer in the field of maritime communication.

With such a communication performance our idea to duplicate ashore a remote engine control room and duplicate the control of many scientific instruments is now a reality.

We will therefore dedicate a space that will serve as a hub for collecting and analysing data, offering the potential for research activities and training sessions for both students and crew members.

All data generated will adhere to the FAIR principle, ensuring Findability, Accessibility, Interoperability, and Reusability for comprehensive and effective utilisation.

2. Current status

This report is an overview of the acquisition progress of the goods, services and instrumentation for the RV Laura Bassi, which have been described in the proposal.

The complete purchase procedure has not been completed yet.

Details of the implementations are outlined below.

1.1 Modernisation and digitalisation of the vessel

The modernisation and digitalisation of the vessel comprises two principal aspects: the expansion and upgrade of the integrated automation and I/O lifecycle system and the vessel digitalisation.

The supply entails a comprehensive upgrade to the existing onboard automation system, involving the following key components:

Replacement from CIO to MIO: the transition from CIO to MIO is a fundamental aspect of the upgrade, ensuring enhanced functionality and compatibility.

Creation of a New Ethernet Fieldbus: a new Ethernet fieldbus has been established between the upgraded ACN processors and the newly introduced MIO. The entire system adheres to the regulations of the classification society.

The upgraded architecture features complete redundancy for both power and communication.

This redundancy has been achieved by segregating the IPSP power supply pair and the IBC bus controller pair into two groups, each accommodating 16 existing I/O cards. The new configuration supports a maximum of 32 cards, divided into two groups of 16.

Operator stations, the engineering station, and Valmet DNA Historian (IMS/TEA) remained unchanged. Software modifications have been carried out while preserving the existing layout configuration, logic, and visual interface.
The retrofit encompasses systemic and electromechanical engineering, through the creation of new layouts for I/O cabinets, electrical diagrams, and Excel tables for signal connections.
Work on I/O cabinets involved disconnecting flat cables from terminals, removal of old terminals, arrangement of profiles, channels, and DIN rails according to the new layout, new installation of ACN I/O, connection to new power supplies and I/O channels, spot testing of I/O, and functional system startup test.
Software adjustments have involved signal redirection while ensuring that the existing software's layout configuration, logic, and visual interface remained unaltered.
The retrofit included sea trials and on-site training, with provisions for an unmanned machinery navigation mode through a system like Extension Alarm.
This comprehensive approach covers equipment, engineering, programming, functions, and services, ensuring a seamless and enhanced automation system onboard.

The update to the industrial internet proceeds also through the provision of cloud-based self-service analysis tools equipped with a Process Analysis Tool and Dashboard Creator, facilitating the effortless and swift creation of custom dashboards.

Moreover, the establishment of a remote control room, involves the development of an on-shore mirroring system for the Operator Viewer Station in the Onshore Group Station (in OGS offices the so named ashore digital twin) and shipowners' offices (PB Tankers), the setup of a virtual machine dedicated to machinery automation, operator training for effective utilisation

of the new system and the implementation of an OPC UA Data Interface Gateway to facilitate seamless data exchange.

2.2 AUV

Nowadays the Autonomous Underwater Vehicles are an extension of the data acquisition capability of a research vessel; such systems allow the extend the scientific data acquisition capability of an enormously. OGS has already acquired a Kongsberg Hugin AUV capable of operating up to 1800 metres depth carrying a large variety of scientific instruments.

To be operated from the vessel a specific launch and recovery system is requested; in addition an underwater digital communication system is also necessary to dialog with the AUV. The primary purpose of the launch and recovery system is to facilitate the deployment and retrieval of the AUV, and contemporary transmit to and receive data from the AUV.

The system's design consists in a two-stage ramp system capable of horizontal movement and tilting during launch and recovery. An additional feature involves an extension to position the AUV as close as possible to the sea surface. Operation of the system relies on a hydraulic power unit (HPU), responsible for guiding and tilting the Stinger. The HPU controls have the possibility to be operated remotely.

To ensure the proper navigation of the AUV during launch and recovery, guidance systems are essential. Two orientation systems are provided, one for launch and one for recovery. The equipment complies with relevant EU product directives.

2.3 Digital system for remote operation of the vessel

It has been requested a cutting-edge integrated system to replace the existing navigation support systems, namely Kelvin Hughes - MANTA DIGITAL, and part of the GMDSS station onboard the Laura Bassi ship.

This replacement system is designed to seamlessly integrate with the current Dynamic Positioning (DP) system, encompassing both software updates and selected hardware components within a singular supply.

The overarching goal of this supply is the comprehensive modernization and integration of digital navigation assistance systems. This initiative aims to streamline ship operations, furnish valuable data for scientific activity planning and management, and bolster operational safety for personnel in remote and extreme latitude environments.

Highlighted in the request are the stringent requirements for accessories, particularly radar, GPS, and GMDSS antennas, which must exhibit an operating temperature range compatible with a Polar Service Temperature (PST) of at least -30°C. This aligns with the POLAR CODE standards, essential for operations in areas featuring a Minimum Design Low Temperature (MDLT) of -20°C.

Furthermore the DP system is earmarked for an upgrade, coupled with a provision for remote operation. This enhancement ensures that all navigation and environmental parameters are not only up-to-date but also shareable and compatible with OPC standard protocols. The holistic approach to this system upgrade encompasses both hardware and software, reinforcing the vessel's capabilities in navigating challenging conditions.

3. Timeline forecast

November 2023/August 2024: Modernisation and digitalisation of the vessel (Valmet)

July 2024: Digital system for remote operation of the vessel (Kongsberg)

September 2024: REMOTE and DIGITAL SHIP certification (RINA)

4. Preliminary conclusions

In this phase we are still in the process of finalising the specified deliverables.

Despite this, we maintain an unwavering commitment to closely monitor the project's development, ready to steer it in the right direction as needed.

We hold an optimistic outlook, anticipating that all requirements will be fulfilled as projected within the given timeline.

The achievements we have attained so far are not a final destination but rather a foundation for continuous improvement in the services that the RV Laura Bassi can provide to the scientific community. There's always room to enhance and refine, ensuring that our contributions remain at the forefront of scientific excellence.

As we forge ahead, the progress we make will be diligently reported and updated in future documents, keeping stakeholders informed and involved in the evolving narrative of our endeavours.