STATSBYGG

REQUIREMENTS FOR AUTOMATION CONTROL – AND SAFETY SYSTEMS – USER EQUIPMENT

OSC-30-H004-S-SP-00001

1107305 Ocean Space Centre

Project	Ocean Space Centre
Client	Statsbygg
Issued by	Multiconsult
Date of print	02.09.2022
Last revision	02.09.2022
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Project Ocean Space Centre

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03	02.09.2022	Issued for tender	EO	HØL	OJH
02	18.08.2022	Issued for review Statsbygg/SINTEF	EO	HØL / Sintef	OJH
01	30.06.2022	Issued for review Statsbygg/SINTEF	EO	HØL / Sintef	OJH
Version	Date	Text	Prep by	Checked by	Approved by

Project number:	Issued by:	Project name	Code:	Document type:	Document code:	Version:
1107305	**EO**	**Ocean Space Centre**	**S**	**SP**	**OSC-30-H004-S-SP-00001**	**03**

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1 Table of Content

1 Introduction

1.1 Objectives

The purpose of this document is to specify automation requirements in general that applies for components, equipment and machinery in Ocean Space Centre. To specify the interface between equipment/ machinery in the new Ocean Basin and Seakeeping Basin, to a centralized control system, Hydrodynamic Laboratory Centralized Control (HLCC) and to a Main Interlocking System (MIS).

This document describes all functions for automating the Ocean Space Centre and may not be applicable for all Contractor Systems. Detailed specifications are described in each Contractor System Main Requirement Document.

Final design will be decided during Joint Collaboration Phase (JCP).

1.2 Definitions and abbreviations

Definitions:

Company:	Statsbygg, which is the Norwegian government's key advisor in construction and property affairs, building commissioner, property manager and property developer.
Contractor:	Means the party named as such in the Form of Agreement
Subcontractor:	Means a Third Party who has entered into an agreement with the Contractor for the supply of goods or services in connection with the Work.
End-user:	SINTEF Ocean and NTNU
Work:	Means all work which Contractor shall perform or cause to be performed in accordance with the Contract
Company Materials:	Means equipment, systems, and/or materials supplied by Company, and which are to be incorporated in the Contract Object.
Contractor System:	Means equipment, systems, and/or materials supplied by Contractor, and which are to be incorporated in the Contract Object.
Main Requirement Document	The requirement document describing each Contractor System and from this document was referenced.

Abbreviations:

OSC	-	Ocean Space Centre
OB	-	Ocean Basin
SMB	-	Seakeeping and Manoeuvring Basin
NEK	-	Norsk eletroteknisk komité (NEK is member of International Electrotechnical Commission (IEC) and European Committee for Electrotechnical Standardization (CENELEC)
HLCC	-	Hydrodynamic Laboratory Centralised Control

MIS	-	Main Interlocking System
PLC	-	Programmable Logic Controller
ESD	-	Emergency shut down
GUI	-	Graphical User Interface
API	-	Application programming interface
PTP	-	Precision Time Protocol
JCP	-	Joint Collaboration Phase

1.3 Standards and Regulations

The following standards/requirements and norms applies for the Work:

- EU Machine directive 2006/42/EC
- Regulations on machines FM FOR-2009-05-20-544 (maskinforskriften)

  Contractor shall deliver "Declaration of conformity of the Machinery" according to EU Machine directive 2006/42/EC, Annex IIA
- NEK IEC 60204-1 Safety of machinery - Electrical equipment of machines - Part 1: General requirements
- FSE - Regulations on safety when working in and operating electrical installations (Forskrift om sikkerhet ved arbeid i og drift av elektriske anlegg
- FEL - Regulations on low-voltage electrical systems (Forskrift om elektriske lavspenningsanlegg)
- EMC-requirements: NEK EN 61000-6-2 and NEK EN 61000-6-4.

1.4 General requirements

All systems need to be clear on how they handle external factors like temperature, water/moisture, light, electrical noise or others. If active measures are required for operation in the described environments, it should be stated if this is to be delivered with the system or external measures are needed.

2 System topology

2.1 Hydrodynamic Laboratory Centralised Control (HLCC)

Ocean Space Centre will have a common centralised control system called **H**ydrodynamic **L**aboratory **C**entralised **C**ontrol (**HLCC**). The system will be provided by Company. HLCC shall cover all OSC fixed and mobile laboratories. Laboratory tests and scientific experiments will be planned, managed, and performed from HLCC. HLCC will be interfaced with all main laboratory equipment and systems.

Main functions of HLCC are:

- Preparation of testing program/recipe
- Preparations for start-up before start of testing program
- Uploading of weather conditions and other environmental parameters
- Start and stop of tests and experiments
- Status reporting
- Alarm handling
- Data acquisition

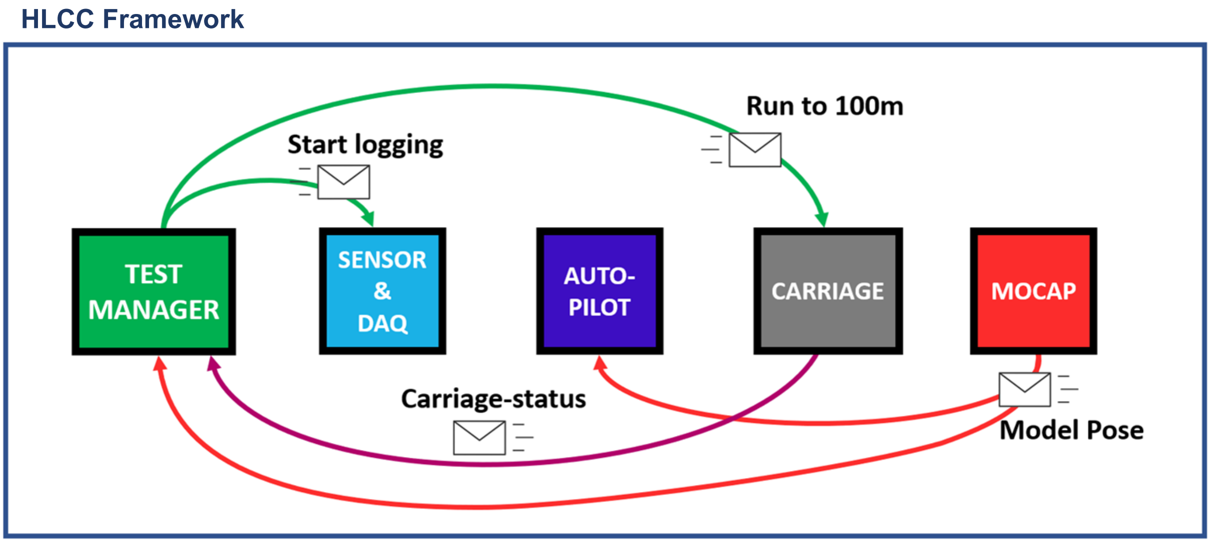

Figure 1: Figure showing part of the control system during a test.

2.1.1 Operating modes

The Contractor Systems must be delivered with a control system and a GUI for user operation of the equipment, called **local mode**. In addition to the local control system provided by Contractor, all systems shall be able to receive remote commands from HLCC, called **remote mode**.

Changing the mode between local and remote should only be done from the provider's GUI/HMI/control panel.

Local Mode:

In this mode the equipment is working as a stand-alone system. The operator controls the equipment by the built-in GUI / local control panel / joystick.

Remote mode:

Setting the Contractor System in remote mode enables the equipment to be run by HLCC, with time series file or real time control signals. All functionality available in local mode must also be available in remote mode to cover all functionality necessary for running a complete set of experiments.

2.1.2 Communication with HLCC

HLCC will control every Contractor System in the laboratory through each systems' built-in API, without accessing the Contractor System GUI. Only exception from this is changes between Local and Remote mode (See section 2.1.1).

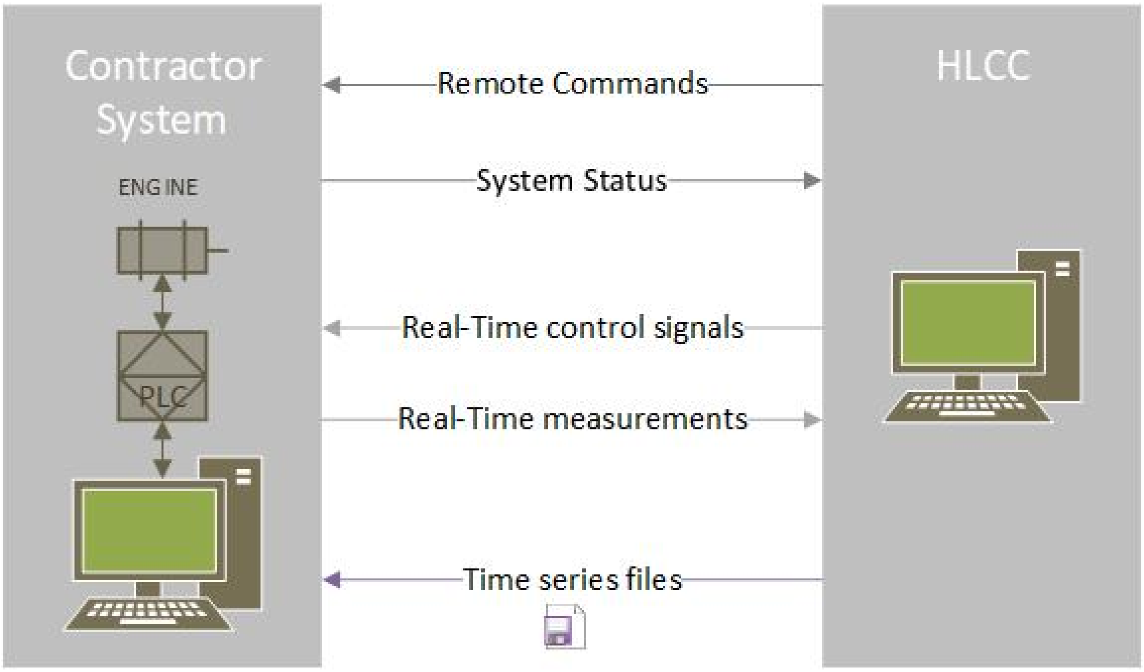

Figure 2: Contractor System communicating with HLCC.

2.1.3 Local mode

In local mode the equipment is controlled by the user interface provided by Contractor. Even though the system is running in local mode, status and measurements must be sent to HLCC.

Data sent to HLCC:

- **System Status**

  For description and examples see Remote Mode
- **Real-Time measurements**

  For description and examples see Remote Mode

2.1.4 Remote mode

In this mode HLCC sends Remote Commands to the systems built-in API. All relevant changes made by HLCC shall be presented in the Constructor systems GUI.

In this mode there are two types of signals that can be used:

- **Remote Commands (API)**
  HLCC sends a non-time-critical message to the equipment. Typical messages are:
  - Setting parameters
  - Enable and disable the equipment
  - Start and stop
  - Setting a position-, velocity- or power setpoints
- **Real-Time Control Signals (Streaming)**
  Streaming time-critical Real-Time control signals from HLCC. Typical signals are:
  - Start and stop
  - Position-, velocity- or power setpoints
- **Real-Time measurements (Streaming)**

  Measurements are time stamped and sent continuously sent to HLCC. Typical measurements are:
  - System state (on/off, temperature etc)
  - Position-, velocity- or power measurements
- **System Status**

  All relevant status is time stamped and continuously sent to HLCC. Typical status signals are:
  - Power state
  - Mode (Local or Remote)
  - States (starting, running, stopping, stopped)
  - Error status and description

For requirements on communication, protocols and communication frequencies for each equipment, see Main Requirement Document (each contractor system).

2.2 Main interlocking system (MIS)

Machinery that are dependent of each other to avoid hazardous situations, needs to be interlocked with each other by the **Main Interlocking System - MIS.**

Automatic unmanned tests require monitoring of critical functions on systems and barriers to avoid people getting in contact with moving mechanical parts. Contractor system must be equipped with input such that external systems (MIS) can shut down the machine if a barrier is broken. Or prevent it from starting.

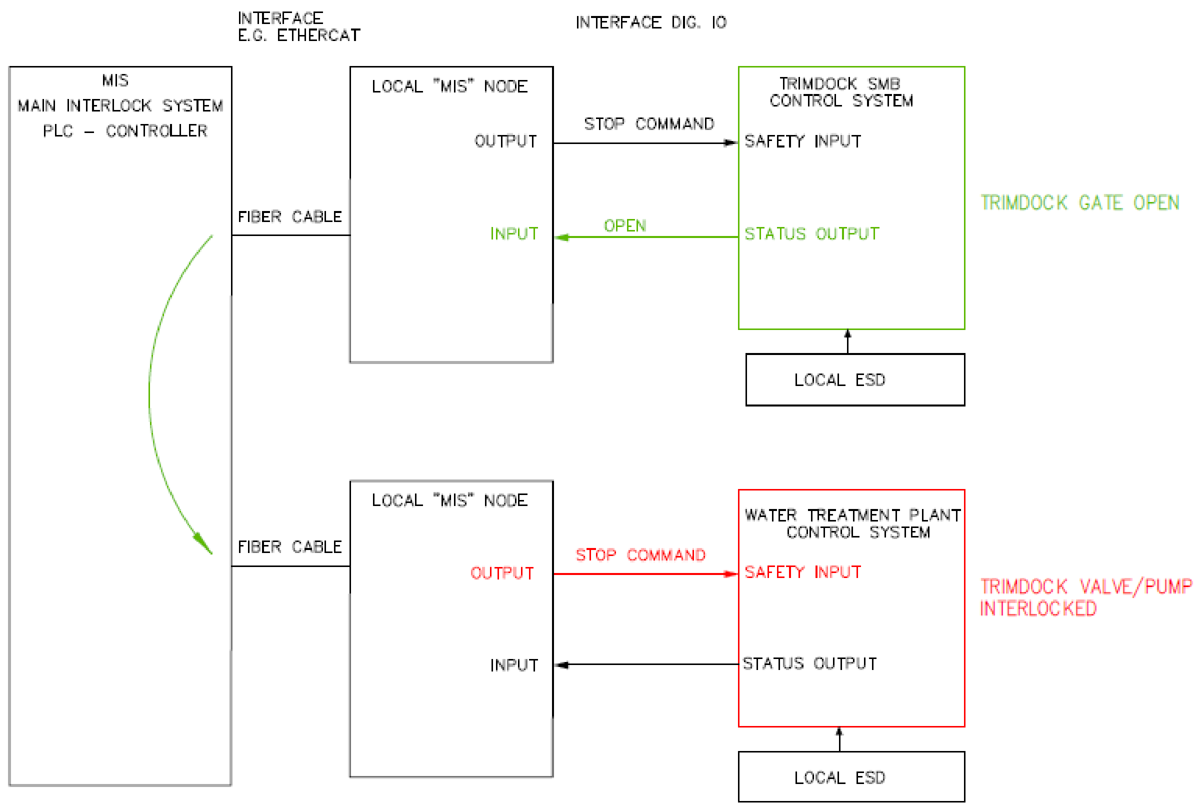

Figure 3: Example of interlock between systems.

A complete set of interlocks will be decided in the Joint Collaboration Phase **(JCP)** between the contractors – detailed engineering.

2.3 System topology - SMB

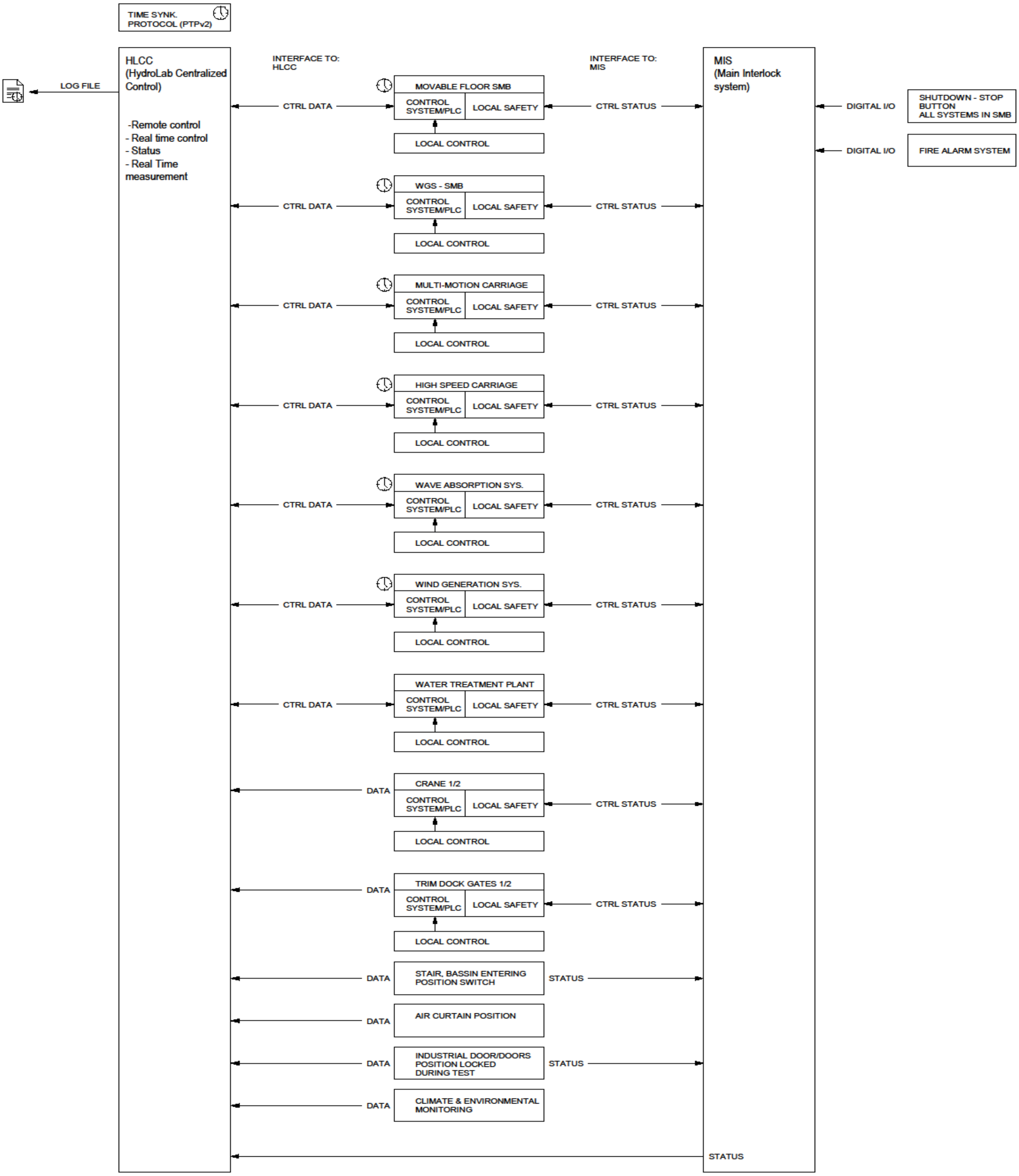

Figure 4: System topology SMB - B-01-S-56-60-002

2.4 System topology – OB

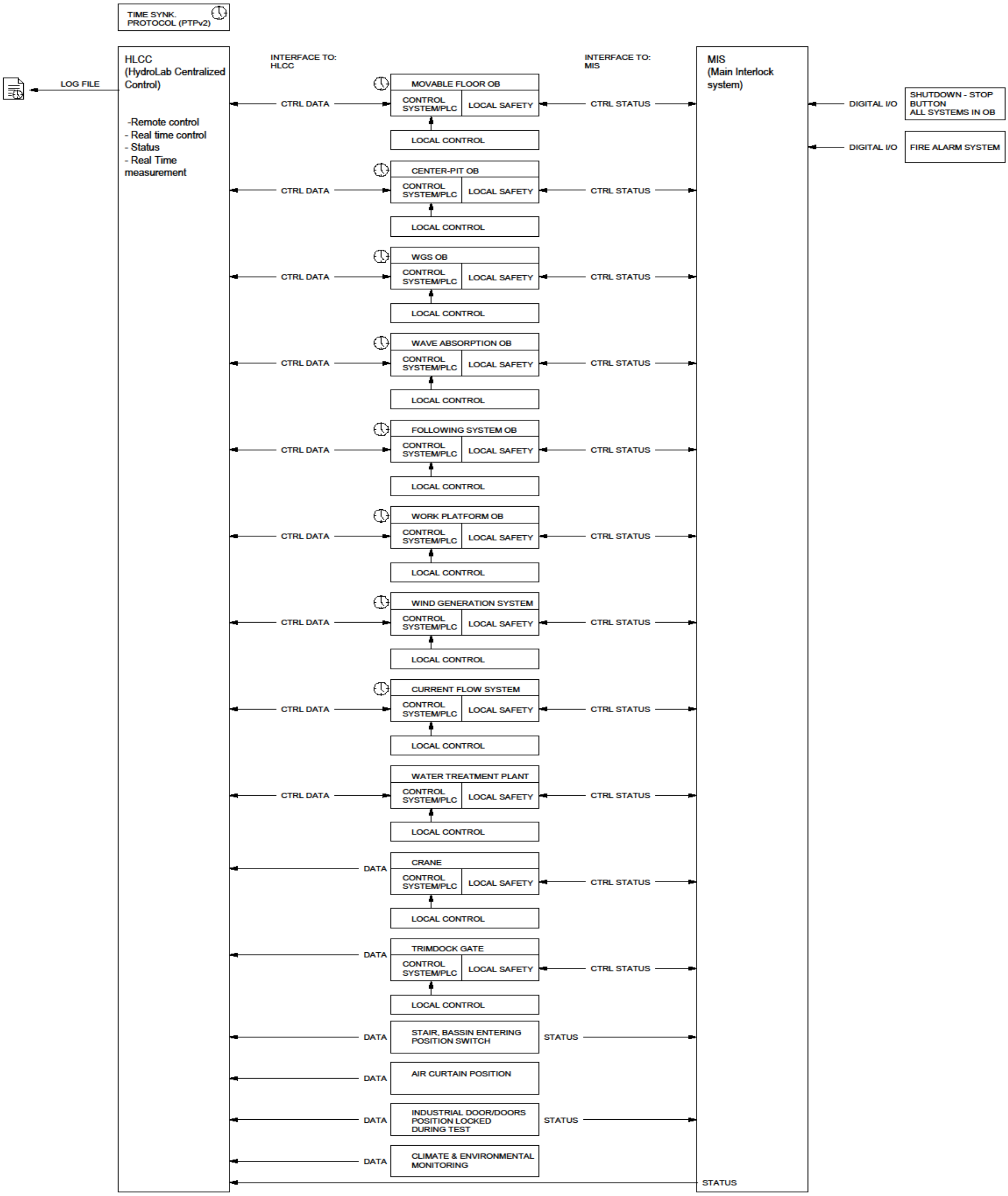

Figure 5: System topology OB - B-01-S-56-60-001

2.5 Time synchronisation

Contractor Systems in Ocean Space Centre laboratories need to be time synchronised.

Recommended time synchronisation protocols are:

- IEEE 1588-2008, also known as PTPv2
- IEEE 1588-2019

The Precision Time Protocol (PTP) is a protocol used to synchronize clocks throughout a computer network. In the Ocean Space Centre local area network, it achieves clock accuracy in the sub-microsecond range, making it suitable for both measurement and control systems.

IEEE 1588-2008 (PTPv2) is not backward compatible with the original 2002 version. IEEE 1588-2019 was published in November 2019 and includes backward-compatible improvements to the 2008 publication (PTPv2).

3 Main requirements

- Contractor Systems shall be delivered with a local control system with an interface to Hydrodynamic Laboratory Centralised Control (HLCC) and Main Interlocking System (MIS).
- The local control system shall include local control panels / SCADA / software package.
- Possibility to set the Contractor System in local / remote mode.

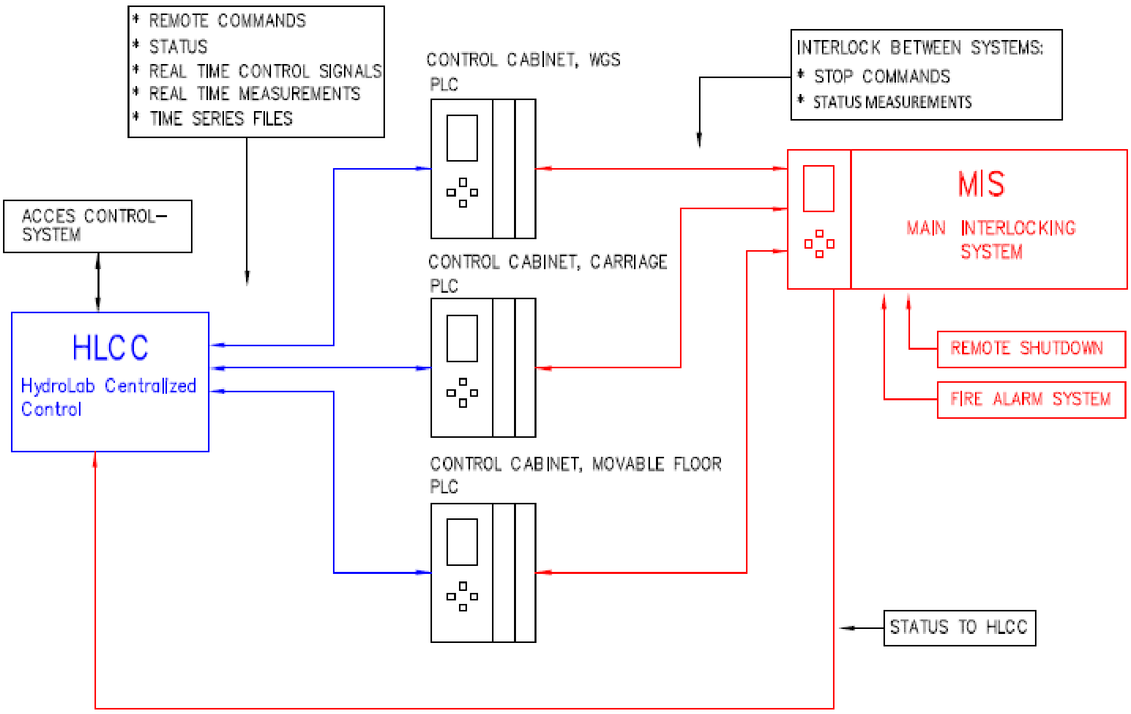

Figure 6: Example of systems that communicate with HLCC and MIS.

3.1 Safety

The safety of each machine must be ensured internally by each local machinery control system. All necessary safety equipment for each machinery must be added to operate in a safe manner, and to be approved in accordance with applicable laws and regulations.

A multilevel ESD shall be implemented.

1. Centrally
2. Locally (Near the equipment)
3. Remote

Digital output signals need to be available, to warn people of the equipment status. Examples:

- A signal defined by the machinery power status.
- A signal defined by the machinery operative status.
- A pulse (for sound) indicating change of operative status.

3.2 HLCC

- Contractor System shall have an open interface to communicate with the centralised control system HLCC. Requirements on communication, protocols and communication frequencies for each system are specified in Main Requirement Document, for each contractor system.
- All functionality available in local mode must also be available in remote mode to cover all functionality necessary for running a complete set of experiments. Only exception from this is the mode changes between Local and Remote (See section 2.1.1).
- Limitations of Contractor System must not be able to be exceeded by remote commands from HLCC.
- Flow of Real-Time measurements and System status must be uninterrupted, regardless of condition, so that data can be used in the control systems, automatic quality assurance, monitoring, and security functions. Both the Real-Time measurements and System status must be time stamped with correct global time.
- Allow for multiple receivers of Real-Time measurements and System status.
- When applicable; HLCC must be able to send Real-time control signals to Contractor System (See section 2.1.4).
- Contractor System must use static IP address for communication over Ethernet. The static IP address must be possible to change if necessary.
- Contractor System must be a slave to Ethernet communication (e.g TCP/IP).
- All test activity must be configurable from the control room without entering the basin area.
- All values must be defined in the SI system.

3.3 MIS

- Contractor Systems shall be delivered with a shutdown input directly connected to the main controller such that external system (MIS) can shut down the machine if a barrier is broken.

  Shutdown inputs are intended to ensure a controlled stop of the system. Emergency stop and other local safety measurements must be incorporated locally at contractor system.

- Contractor System needs outputs signals on status and position of the equipment, connected to MIS, to prevent unintended operation.

The format of the signal exchange is to be decided during JPC / detailed engineering. For some systems digital IO can be adequate.

3.4 Time synchronisation

Contractor Systems in Ocean Space Centre laboratories need to be time synchronised.

Recommended time synchronisation protocols are:

- IEEE 1588-2008, also known as PTPv2
- IEEE 1588-2019

If another protocol than PTPv2 is chosen (such as IRIG etc.), the internal clock of user equipment needs to able to synchronise within less than 60 seconds from powered on and with an internal clock accuracy less than 1 millisecond.

Wireless equipment must support time synchronizing via NTP or more accurate.

All data sent to HLCC and stored locally must be time stamp with correct global time. This is also applicable for System status, Real-Time measurements and Data logging (See section 2.1.4 and 3.5).

3.5 Data logging

All data sent to HLCC with System status and Real-Time measurements and other internal measurements must be able to store locally in the Contractor System. These data must be stored in an open format and must be time stamped (ref. 2.5).

Data logging must be able to turn on and off from the Contractor Systems GUI and from HLCC through the API. The file name should be possible to set from HLCC.

3.6 Digital twin functionality

The digital twin functionality is split in two, a simulator that simulates the interaction between HLCC and the Contractor System with start/stop ramping, running etc. (Machine Interface Simulator) and a simulator that simulates the output generated by the Contractor System (Full Simulator) for instance generated waves in the OB or SMB).

Contractor System shall:

- be delivered with a digital twin which can run on a regular PC.

Proposed functionality around this from Contractor will be important for evaluating the quote.

3.6.1 Machine Interface Simulator

To develop and test control systems the possibility to connect and operate the machine without running the system and generating a physical test is a requirement. The Machine Interface Simulator is essential prior to commissioning and to simulate automated testing and functionality.

Contractor System, or a separate simulator shall:

- be able to run in simulated mode and give realistic feedback signals.
- be delivered with enough simulated sensors to evaluate the status of the equipment.
- parameters of the digital twin must be able to be updated.

3.6.2 Full Simulator

The Full Simulator has all functionality of Machine Interface Simulator and is able to simulate the output generated from the supplied system. The purpose of this is to be able to simulate the experiment in advance. Parameters must be adjustable.

3.7 Registration / Traceability

All relevant equipment used in tests must be traceable in a common database. The equipment shall be able to send:

- All setups and settings
- Calibration data
- Firmware version
- Software version

4 References

5 Attachments

1. B-01-S-56-60-002 System diagram Automation control and safety system SMB
2. B-01-S-56-60-001 System diagram Automation control and safety system OB