

Ventana Control System Upgrade

Software Architecture

Subject: *This document defines the software architecture for the Ventana control system upgrade. It provides a list of applications running on the various computing nodes and describes how the applications communicate with each other to meet system requirements. Taken as a whole, it provides a complete picture of the network communications that are necessary for the software component of the control system to operate.*

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Revision History

Revision 002

<i>Revision</i>	<i>Initials</i>	<i>Date</i>	<i>Comments</i>
001	apo	12/08/14	Document initiated, content defined
002	Jdr	12/09/14	Review and clarifications

Table 1: Revision history

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Software Architecture

1 Introduction

The purpose of this Software Architecture document is to provide an overview of the distinct applications that work together to provide the software component of *Ventana's* control system. Individual applications communicate using a publish-subscribe network messaging mechanism. Applications publish information over a *channel* to which one or more other applications may *subscribe* to receive that information. Individual units of information published on a channel are called *signals*. This document will outline the responsibility of each application, the computer where it executes, the channels it publishes and those to which it subscribes. This will enable the reader to both understand the system as a whole as well as quickly isolate malfunctions to the offending computer and application.

2 Computing Nodes

The applications that comprise the software component of the vehicle control system are distributed over several computing nodes. There are 4 primary computing nodes by function in the *Ventana* control system design: a pilot computer, a copilot computer, the topside computer and the control system computer. As Greensea applications use a network messaging scheme a given application can be run on any of these computing nodes to produce a functionally identical system (especially since serial access is mediated through MOXA serial servers). This document will outline a proposed distribution of applications across the nodes for load balancing and other purposes.

3 Topside Applications

The topside applications are responsible for aiding operator awareness of *Ventana's* state and to forward operator commands to the vehicle control system. The topside applications can be broadly divided into Operator Interface, Alarm Manager and Signal Mapping functional groups. Each group is described below.

3.1 Operator Interface

The operator interface provides graphical representations of *Ventana's* state, configurable as well as predefined controls and a means to view and configure other select applications in the control system. The operator interface is organized around 'views' of the system that combine context-specific system state and controls. The organizing principle behind each view is listed below:

3.1.1 Flight View

The flight view provides the primary operator controls for vehicle flight. The current attitude, position and on-screen flight controls for the vehicle are displayed here. The operator may also import navigational charts as well as define navigational waypoints and markers in addition to many other features.

3.1.2 Alarm View

The alarm view provides operator control of the alarm management system. Using this view the operator may create and edit alarms as well as view the current state of all alarms in addition to past alarm events.

3.1.3 Signal Mapping View

The signal mapping view provides operator control of the signal mapping system. Using this view the operator may create

and edit signal maps.

3.1.4 Device View

The device view provides dedicated displays of the current state of each device in the system as well as configuration and control of selected devices.

3.1.5 Data View

Provides value inspection, searching and plotting of all channels and signals used by the telemetry system.

3.1.6 Control View

Provides a full-screen area for user-defined control and status elements.

3.1.7 Primary interfaces with openSEA core applications

The following diagram illustrates the channels the Operator Interface uses to communicate with other openSEA core applications as well as applications specific to the *Ventana*:

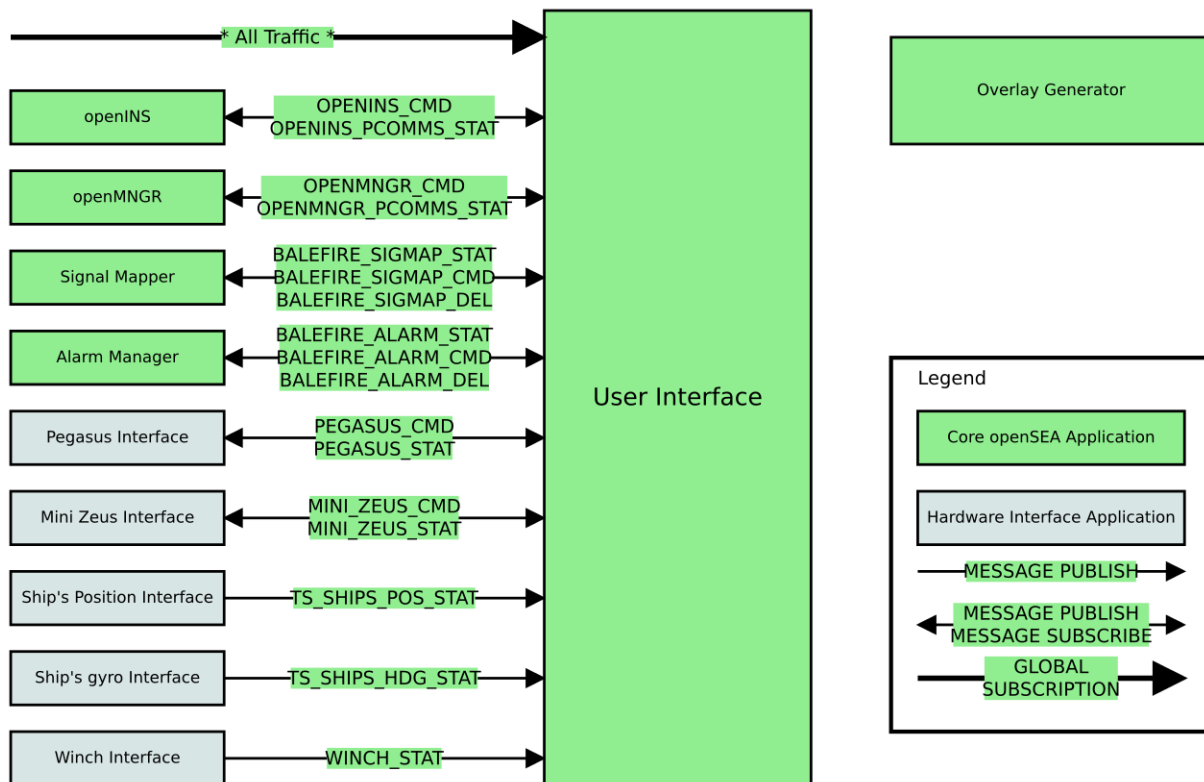


Illustration 1: Operator interface primary communication channels diagram

3.2 Alarm Management

The alarm management system monitors all channels and signals for operator-defined exceptional situations. The complete state of all defined alarms is periodically published over the channel BALEFIRE_ALARM_STAT. The alarm manager monitors the channel BALEFIRE_ALARM_CMD for alarm editing commands and BALEFIRE_ALARM_DEL to delete alarms. The following diagram illustrates the primary network connections that comprise the alarm management system:

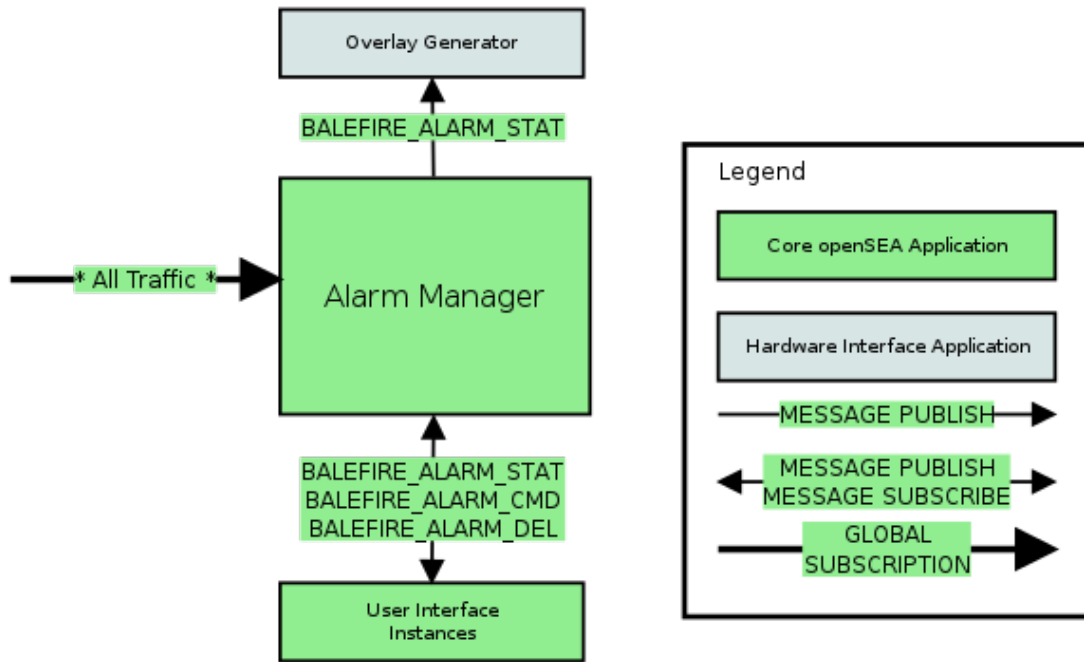


Illustration 2: Alarm management system primary communication channels diagram

3.3 Signal Mapping

The signal mapping system monitors all channels and signals for operator-defined signal transformations. This very flexible system provides the operator configurable assignment of physical controls to logical functions in addition to scaling of analog input/output values to or from more representative units. A range of transformations from simple inversion to scalable two-axis controls with configurable dead-bands are available. Any transformation can be chained with others to provide more complex behavior such as two-axis control with variable bias, stick locking and optional secondary or tertiary functions.

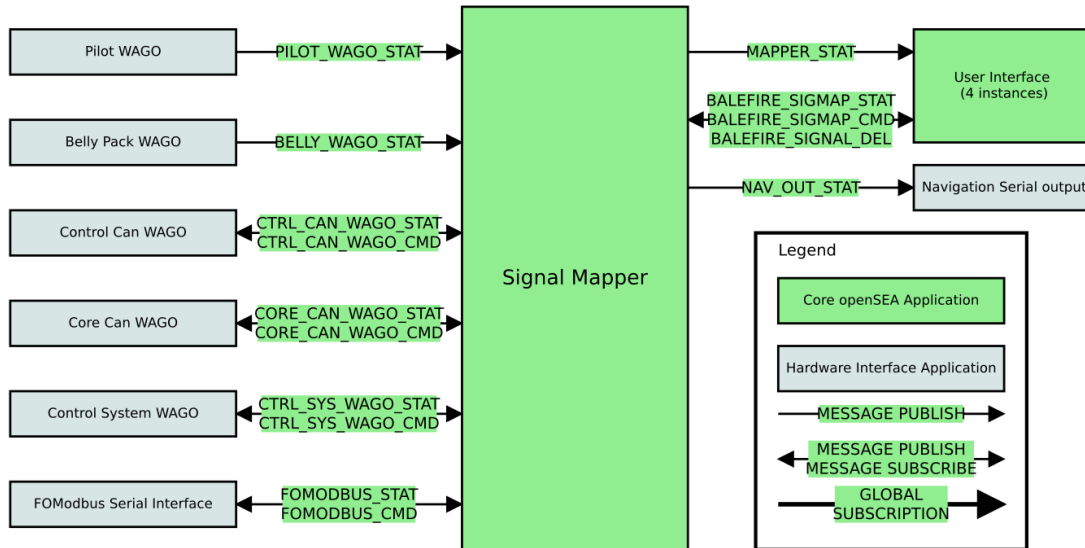


Illustration 3: Signal mapping system primary communication channels diagram

3.4 openDEVICE

openDEVICE, in the *Ventana* control system, provides the operator configurable control over serial device interface applications as well as the navigation serial output. The serial port, baud and other serial parameters may be configured through the Operator Interface. It is expected that openDEVICE will primary be used to configure the serial navigation output.

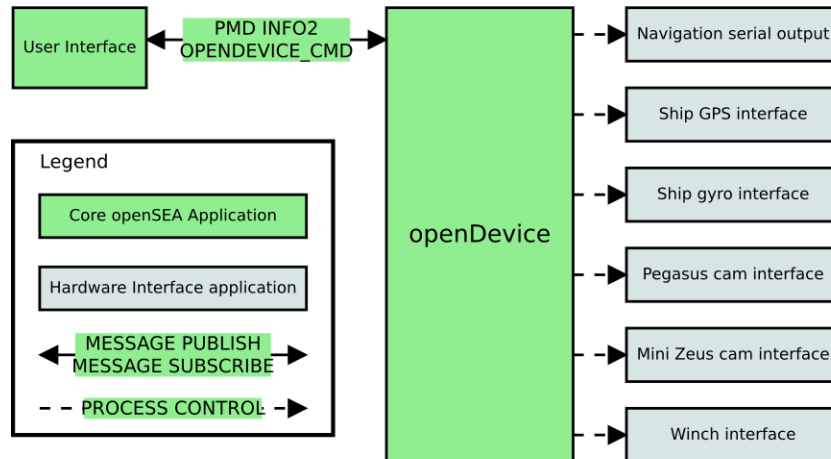


Illustration 4: openDEVICE primary communication channels diagram

4 Vehicle Applications

The vehicle applications encapsulate the vehicle hardware of the *Ventana* control system. The vehicle applications provide low-level device status and control to high-level navigation estimates, single degree-of-freedom auto-pilots as well as station keeping. The vehicle applications are broadly divided into Vehicle Navigation and Vehicle Control. Each group is described below.

4.1 Vehicle Navigation

The vehicle navigation group is responsible for providing vehicle position and attitude estimates to the operator as well as the vehicle control group. Each navigation sensor has a dedicated application that forwards the sensor information to the openINS application; the core of the vehicle navigation group. The individual sensor measurements are then fused by openINS to provide statistically optimal estimates of vehicle position and attitude for the rest of the *Ventana* system.

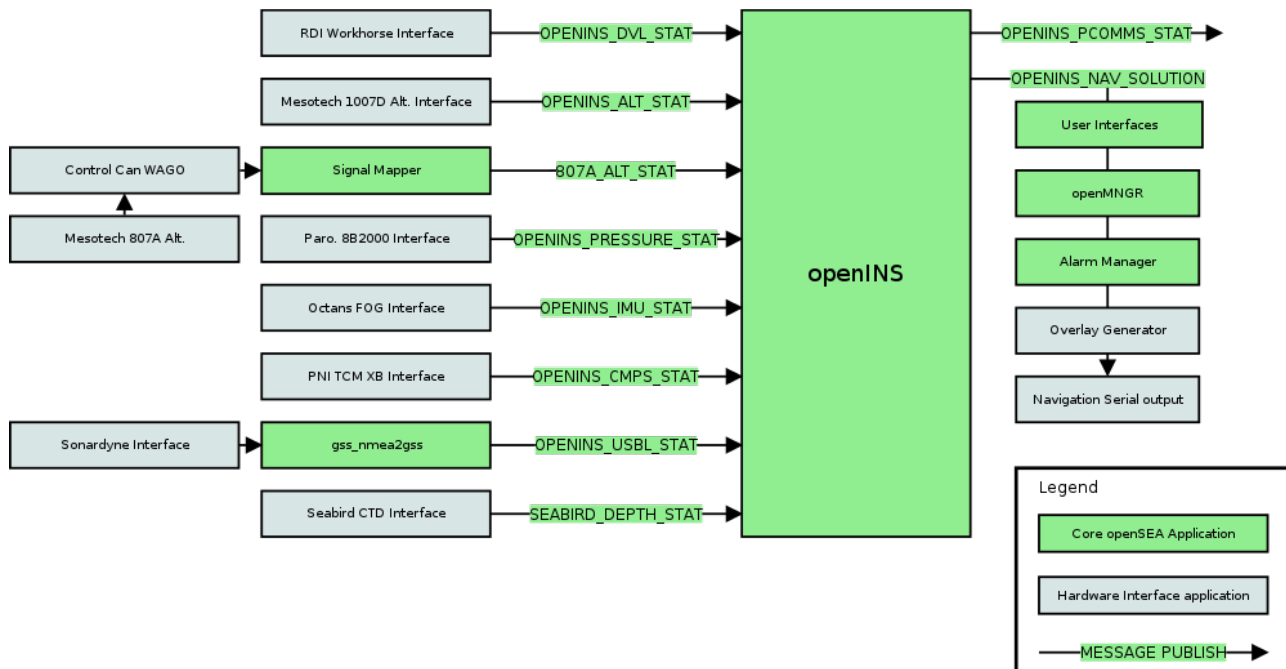


Illustration 5: Navigation Diagram

4.2 Vehicle Control

The vehicle control group is responsible for providing both open and closed-loop control of *Ventana*'s thrusters. Open-loop operator commands are collected from the console, transformed to percent deflection and then forwarded to openMNGR. Closed-loop mode and set-point commands can originate from the Operator Interface, Touchscreen or other control but will be communicated over the OPENMNGR_CMD channel.

openMNGR is responsible for forwarding operator intentions to openCMD where the closed-loop controllers are implemented. In open-loop mode, openCMD will simply forward the joystick deflection percent as percent effort for a given degree of freedom. In closed-loop, openCMD will calculate thruster efforts based on the navigation solution, auto-pilot set-points and other information. In both cases, the ventana_control application will convert percent efforts for all degrees of freedom into appropriate valve commands for each of *Ventana*'s thrusters.

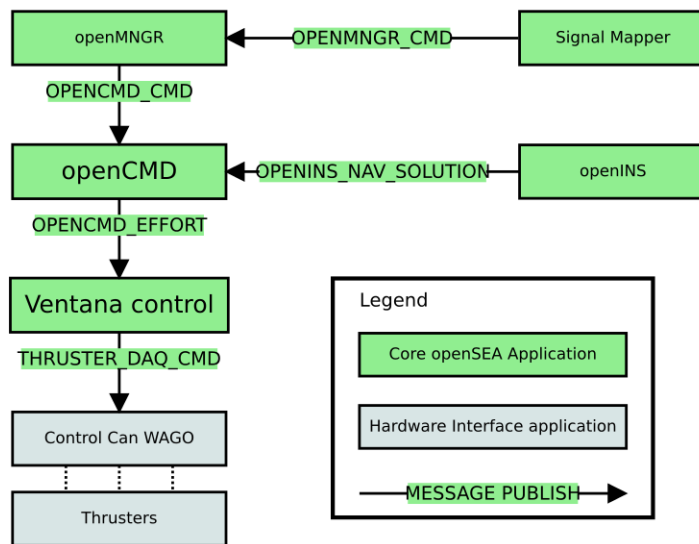


Illustration 6: Ventana Control Diagram

5 Application descriptions by computing node

The following is a complete list of the applications that together comprise the software component of the *Ventana* control system. The responsibility of each application is described in addition to the computing node where it is intended to be executed.

<i>Application</i>	<i>Description</i>	<i>Responsibility</i>
balefire_workspace	Pilot Lower-Left Touchscreen	The primary application for user interaction, displaying current vehicle device and sensor data, navigation solution, and providing a means to control vehicle functions. Alarms and signal mapping are configured from the user interface. The primary means of interacting with the Workspace will be via touchscreen controls. The Pilot Lower-Left Touchscreen and Pilot Lower-Right Touchscreen applications differ only in the configuration file.
balefire_workspace	Pilot Lower-Right Touchscreen	The primary application for user interaction, displaying current vehicle device and sensor data, navigation solution, and providing a means to control vehicle functions. Alarms and signal mapping are configured from the user interface. The primary means of interacting with the Workspace will be via touchscreen controls. The Pilot Lower-Left Touchscreen and Pilot Lower-Right Touchscreen applications differ only in the configuration file.

Table 2: Table of Pilot computer applications

<i>Application</i>	<i>Description</i>	<i>Responsibility</i>
balefire_workspace	Pilot Upper-Left Touchscreen	The primary application for user interaction, displaying current vehicle device and sensor data, navigation solution, and providing a means to control vehicle functions. Alarms and signal mapping are configured from the user interface. The primary means of interacting with the Workspace will be via touchscreen controls. The Pilot Upper-Left Touchscreen and Pilot Upper-Right Touchscreen applications differ only in the configuration file.
balefire_workspace	Pilot Lower-Right Touchscreen	The primary application for user interaction, displaying current vehicle device and sensor data, navigation solution, and providing a means to control vehicle functions. Alarms and signal mapping are configured from the user interface. The primary means of interacting with the Workspace will be via touchscreen controls. The Pilot Upper-Left Touchscreen and Pilot Upper-Right Touchscreen applications differ only in the configuration file.

Table 3: Table of Copilot computer applications

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<i>Application</i>	<i>Description</i>	<i>Responsibility</i>
gss_wago	Pilot WAGO	This applications translates between the serial protocol from the WAGO data acquisition device and the Greensea publish-subscribe messaging format. The primary recipient is the signal mapper application.
gss_wago	Control Can WAGO	This applications translates between the serial protocol from the WAGO data acquisition device and the Greensea publish-subscribe messaging format. The primary recipient is the signal mapper application.
gss_wago	Belly Pack WAGO	This applications translates between the serial protocol from the WAGO data acquisition device and the Greensea publish-subscribe messaging format. The primary recipient is the signal mapper application.
gss_nmea2gss	Ship's Position Interface	This applications translates between the serial NMEA position sentences received from the MOXA and makes the position available to the user interface over the Greensea publish-subscribe messaging format.
gss_nmea2gss	Ship's Gyro Interface	This applications translates between the serial NMEA position sentences received from the MOXA and makes the attitude available to the user interface over the Greensea publish-subscribe messaging format.
gss_pegasus	Pegasus Interface	This applications translates between the Greensea publish-subscribe messaging format and Insite Pacific Pegasus Camera.
gss_mini_zeus	Mini Zeus Interface	This application translates between the Greensea publish-subscribe messaging format and the Mini Zeus Camera, with functionality for zoom, focus and basic initialization.
gss_mtn_lci90	Winch Interface	This application makes the serial stream from the Measurement Technology Northwest's LCI-90i available in the Greensea publish-subscribe messaging format.
gss_pcomms2csv	Navigation Output	This application takes the user-defined navigation data, converts it to CSV format and sends it out a serial interface to the MBARI data logging application.
opendevic	openDEVICE	This application enables the operator interface to start, stop, configure and monitor device interface applications on the Pilot computer.
gss_configurable_panel	Overlay Generator	The output of this specially configured instance of the Balefire Workspace will be used as the input to the Miranda DVI-Ramp to create an overlay on the main video stream.

Table 4: Table of Topside computer applications

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Application	Description	Responsibility
openmngnr	openMNGR	This application takes high level listens on the navigation solution and high level commands such as waypoints and provides a desired destination for openCMD to command the vehicle to.
openins	openINS	This application takes inputs from all ROV navigation sensors and uses sensor fusion techniques to provide a best estimate of current navigation state including position, velocity and attitude.
opencmd	openCMD	This application takes a commanded position from openMNGR and calculates the required effort in 6 degrees of freedom to reach that destination.
gss_wago	Control Can WAGO	This applications translates between the serial protocol from the WAGO data acquisition device and the Greensea publish-subscribe messaging format. The primary recipient is the signal mapper application.
gss_wago	Core Can WAGO	This applications translates between the serial protocol from the WAGO data acquisition device and the Greensea publish-subscribe messaging format. The primary recipient is the signal mapper application.
gss_fomodbus	FOModbus Serial Interface	This applications translates between the FOModbus protocol and the Greensea publish-subscribe messaging format.
gss_dvl	RDI Workhorse Interface	This application receives the PD5 serial data input from the DVL and converts the information to LCM format for openINS and other applications.
gss_octans	Octans FOG Interface	This application makes the Octans serial protocol available in the Greensea publish-subscribe messaging format.
gss_parosci	Paro. 8B2000 Interface	This application makes the Paroscientific pressure sensor serial protocol available in the Greensea publish-subscribe messaging format.
gss_nmea2gss	Mesotech 1007D Altimeter Interface	This application makes the Mesotech 10007D NMEA output available in the Greensea publish-subscribe messaging format.
gss_nmea2gss	Sonardyne Interface	This application makes the Sonardyne NMEA output available in the Greensea publish-subscribe messaging format.
gss_seabird_ctd	Seabird CTD Interface	This application makes the pressure output of the Seabird CTD available in the Greensea publish-subscribe messaging format.
gss_tcmxb	PNI TCM XB Interface	This application makes the PNI TCM XB serial protocol available in the Greensea publish-subscribe messaging format.
gss_signal_mapper	Signal Mapper	This application allows mapping and transforming of an input signal to an output signal. This is used to assign functionality to physical buttons and knobs on a control console and soft buttons on the user interface through to outputs on the vehicle data acquisition and control modules.
gss_alarm_manager	Alarm Manager	This application monitors all signals on the network and allows logical tests to be performed against them to trigger an alarm.
ventana_control	Ventana Control	This application converts percent efforts for each degree of freedom received from openCMD into appropriate valve commands output to the Control Can WAGO to control Ventana's thrusters.

Table 5: Table of Control Computer applications

6 Table of applications by published channel and computing node

The following is a complete list of channels published by each application organized by computing node. These tables, taken together, should enable the operator to associate specific instances of a given application with the data they produce.

<i>Application</i>	<i>Publish Channel</i>	<i>Purpose</i>
balefire_workspace	OPENMNGR_CMD	High-level auto-pilot commands originating from the Operator Interface.
balefire_workspace	BALEFIRE_SIGMAP_DEL	Signals the signal mapper to delete a signal map.
balefire_workspace	BALEFIRE_SIGMAP_CMD	Signals the signal mapper to edit or add an signal map or transform.
balefire_workspace	OPENDVICE_CMD	Commands from the Operator Interface to configure the openDEVICE service.
balefire_workspace	BALEFIRE_ALARM_DEL	Signals the alarm manager to delete an alarm.
balefire_workspace	BALEFIRE_ALARM_CMD	Signals the alarm manager to edit or add an alarm.
balefire_workspace	OPENINS_CMD	The Operator Interface sends commands to openINS such as zero the depth sensor reading, specify current vehicle position (latitude and longitude) and magnetic declination.
balefire_workspace	PEGASUS_CMD	Commands from the Operator Interface to configure the Pegasus Insite Pacific camera.

Table 6: List of channels published by Pilot and Copilot computer applications and their purpose

<i>Application</i>	<i>Publish Channel</i>	<i>Purpose</i>
gss_wago	PILOT_WAGO_STAT	Polled status from the Pilot Station WAGO Stack made available in the Greensea publish-subscribe messaging format.
gss_wago	BELLY_WAGO_STAT	Polled status from the Belly Pack WAGO Stack made available in the Greensea publish-subscribe messaging format.
gss_nmea2gss	TS_SHIPS_POS_STAT	The NMEA ship's position stream made available in the Greensea publish-subscribe messaging format.
gss_nmea2gss	TS_SHIPS_HDG_STAT	The NMEA ship's attitude stream made available in the Greensea publish-subscribe messaging format.
gss_pegasus	PEGASUS_STAT	Polled status from the Insite Pacific Pegasus camera made available in the Greensea publish-subscribe messaging format.
gss_mtn_lci90	WINCH_STAT	Polled status from the LCI-90i line control instrument made available in the Greensea publish-subscribe messaging format.
opendevic	PMD_INFO2	Status of openDEVICE managed processes.
gss_alarm_manager	BALEFIRE_ALARM_STAT	Periodic publication of the complete list of all defined alarms and their status.
gss_alarm_manager	BALEFIRE_ALARM_EVENT_STAT	Immediate publication of a single alarm when it changes state. Used for low-latency notification of an alarm condition.

Table 7: List of channels published by the Topside computer applications and their purpose

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<i>Application</i>	<i>Publish Channel</i>	<i>Purpose</i>
openmngr	OPENMNGR_PCOMMS_STAT	The internal state of the openMNGR application.
openmngr	OPENCMD_CMD	Auto-pilot commands from openMNGR to openCMD.
opencmd	OPENCMD_EFFORT	Desired thruster efforts in percent for each degree of freedom.
opencmd	OPENCMD_PCOMMS_STAT	The internal state of the openCMD application.
openins	OPENINS_PCOMMS_STAT	The internal state of the openINS application.
openins	OPENINS_NAV_SOLUTION	The vehicle navigation solution. This information is widely subscribed throughout the system as the authoritative source of vehicle position and attitude information.
gss_signal_mapper	NAV_OUT_STAT	Signal source for the configurable serial navigation output for use by MBARI.
gss_signal_mapper	MAPPER_STAT	Configurable status output. Primarily intended to aid advanced control and transformation options.
gss_signal_mapper	BALEFIRE_SIGMAP_STAT	A complete listing of all configured signal maps as well a listing of the current transform capabilities of the signal mapper.
gss_signal_mapper	CTRL_CAN_WAGO_CMD	Accumulated output commands to the Control Can WAGO Stack.
gss_signal_mapper	CORE_CAN_WAGO_CMD	Accumulated output commands to the Core Can WAGO Stack.
gss_signal_mapper	CTRL_SYS_WAGO_CMD	Accumulated output commands to the Control System Can WAGO Stack.
gss_signal_mapper	FOMODBUS_CMD	Accumulated output commands to the FOModbus serial interface.
gss_wago	CTRL_SYS_WAGO_STAT	Polled status from the Control System WAGO Stack made available in the Greensea publish-subscribe messaging format.
gss_wago	CORE_CAN_WAGO_STAT	Polled status from the Core Can WAGO Stack made available in the Greensea publish-subscribe messaging format.
gss_wago	CTRL_CAN_WAGO_STAT	Polled status from the Control Can WAGO Stack made available in the Greensea publish-subscribe messaging format.
gss_fomodbus	FOMODBUS_STAT	Polled status from the FOModbus serial interface made available in the Greensea publish-subscribe messaging format.
gss_dvl	OPENINS_DVL_STAT	Polled status from the RDI Workhorse Navigator DVL made available in the Greensea publish-subscribe messaging format.
gss_octans	OPENINS_IMU_STAT	Polled status from the IXSEA Octans Fiber-optic Gyro made available in the Greensea publish-subscribe messaging format.
gss_parosci	OPENINS_PRESSURE_STAT	Polled status from the Paroscientific 8B2000 pressure sensor made available in the Greensea publish-subscribe messaging format.
gss_signal_mapper	807A_ALT_STAT	Polled status from the Mesotech 807A analog output, after transformation to meters by the Signal Mapper, available in the Greensea publish-subscribe messaging format.
gss_nmea2gss	OPENINS_ALT_STAT	Polled status from the Mesotech 10007D NMEA output available in the Greensea publish-subscribe messaging format.
gss_tcmxb	OPENINS_CMPS_STAT	Polled status from the PNI TCM XB output available in the Greensea publish-subscribe messaging format.
gss_nmea2gss	OPENINS_USBL_STAT	Polled status from the Sonardyne USBL output available in the Greensea publish-subscribe messaging format.
gss_seabird_ctd	SEABIRD_DEPTH_STAT	Depth information from the Seabird CTD made available in the Greensea publish-subscribe messaging format.

Table 8: List of channels published by the Control Computer applications and their purpose

7 Open Work

7.1 To Be Determined (TBD)

<i>TBD Number</i>	<i>Description</i>

7.2 To Be Resolved (TBR)

<i>TRD Number</i>	<i>Description</i>

8 Deleted Requirements

The following requirements no longer form part of the requirements set but are retained here for reference.

<i>Number</i>	<i>Requirement</i>	<i>Rationale for Deletion</i>

End Page

