



openMNGR

Interface Control Document

Subject: *This document describes how to interface with openMNGR directly and within the context of the Balefire system.*

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Revision History

Revision 002

<i>Revision</i>	<i>Initials</i>	<i>Date</i>	<i>Comments</i>
001	Clr	06/04/15	Initial.
002	Meb	06/18/15	Edited content.

Table 1: Revision history

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1 Introduction

The openMNGR application provides a command interface between operators and vehicle control applications. In the Balefire system openMNGR listens to all user commands, including those from the Balefire Workspace, joystick controls, and user selection tools. openMNGR arbitrates the user commands and sends commands to the Balefire control system, openCMD.

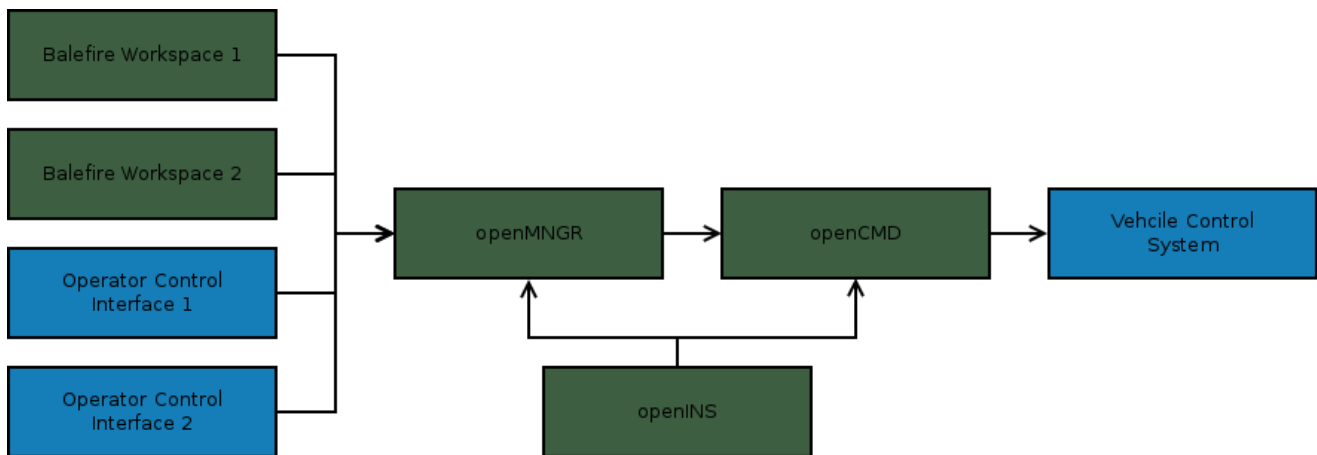


Illustration 1: Balefire control flow.

1.1 Coordinate Frame

openMNGR uses a six single degree of freedom (SDOF) model for command and control. All user commands and control commands are in the NED coordinate frame.

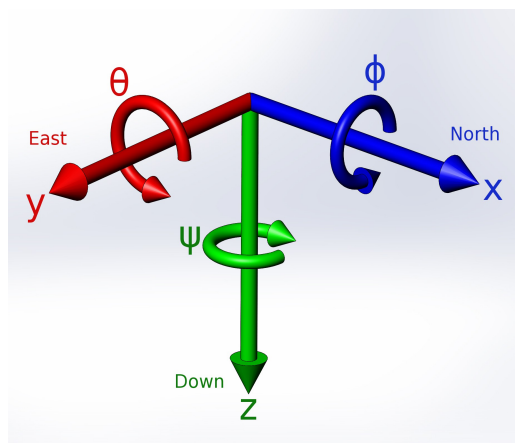


Illustration 2: NED coordinate frame.

2 Modes of Operation

openMNGR uses discrete modes of operation to manage how user commands are interpreted and transformed into SDOF vehicle commands. openMNGR can only be in one mode of operation at a time.

<i>Modes of Operation</i>	<i>Integer Identifier</i>	<i>Description</i>
Fly By Wire (FBW)	1	User command interface for both open and closed-loop operations.
Waypoint	2	A waypoint engine for autonomous operations.
Sonar Control	3	A sonar relative control mode.

2.1 Fly-by-Wire

Fly-by-wire mode is the default mode of operation, allowing the user to directly control a vehicle in both open and closed-loop modes. Within the FBW frame work the user can select from a number of enable states. FBW provides an enable state for each DOF and the user can independently set each DOF enable state. The following enable states are supported by FBW.

<i>Enable State</i>	<i>Integer Identifier</i>	<i>Description</i>
Secure	0	Secure the DOF, set the DOF control output to null.
Manual	1	Manual operation. The user input commands will be output directly to the control output.
Auto	2	SDOF autopilot enable. This will use the DOF navigation solution as the feedback signal for the autopilot.
Reference	3	SDOF reference autopilot enable. This will use the reference state single as the feedback signal for the autopilot.
Velocity Position	4	Velocity position autopilot enable. Enable a nested velocity position controller for the DOF.
Cruise	5	Cruise control enable. Set the DOF to cruise control.

2.2 Waypoint

The waypoint mode of operation uses openSEA's waypoint engine to control the vehicle. The waypoint type is used to configure the active waypoint route stored within openMNGR. openMNGR monitors the systems navigational state to ensure the system is capable of performing the autonomous mission. If the navigational state does not allow for normal waypoint operations, the system will be set to secure.

Waypoint mode allows the user to configure the system for depth following, altitude following, setting the heading toward the waypoint, and completing the depth set point before moving to the next waypoint.

2.3 Sonar Control

The sonar control mode uses sonar feature data as the input for feature relative control. This mode of operation allows the user to lock the controlled vehicle onto a feature for object tracking and identification. As soon as sonar control mode is enabled, the frame of reference of the user commands are transformed into the sonar's frame of reference. The X DOF is changed to point toward the target, the Y DOF commands the vehicle to orbit the target either clockwise or counter-clockwise, and Z commands the depth or altitude of the system. When the vehicle is

commanded into sonar relative mode the heading of the vehicle is commanded toward the referenced target, ensuring the vehicle is always facing the target. At the same time, the vehicle is placed into X control, keeping the X distance from the target constant. The user then has the ability to operate the vehicle in the new reference frame. Any time the user is not commanding the vehicle the heading and X distance will be maintained to stabilize the vehicle.

3 Communications

openMNGR uses LCM as the primary interface for communications. LCM is a set of utilities and libraries that uses UDP multicast to move data through serial or LAN communication from different sources by encoding or decoding the data into a unified, internally readable format. The UDP protocol allows for low latency by allowing messages to be dropped and new messages taken in, out of order.

The LCM messaging protocol is stateless in its design. The structure of the LCM code generating utility allows the system to create types from multiple programming languages by adding LCM bindings that are native to that programming language.

3.1 PCOMMS Commands

openMNGR has a PCOMMS-based command interface for setting navigation parameters and system configurations. The PCOMMS command interface uses the pcomms_t LCM type. openMNGR subscribes to a PCOMMS command channel and listens for incoming PCOMMS commands. The commands are arbitrated by the name field in the three native pcomms_t types; analog_t, digital_t, and message_t. Below is a table outlining the command names:

<i>Command Name</i>	<i>Type</i>	<i>Description</i>
U_DAQ_JOY_X	analog_t	X Joystick Command Range [100 % to -100 %].
U_DAQ_JOY_Y	analog_t	Y Joystick Command Range [100 % to -100 %].
U_DAQ_JOY_Z	analog_t	Z Joystick Command Range [100 % to -100 %].
U_DAQ_JOY_PHI	analog_t	Phi Joystick Command Range [100 % to -100 %].
U_DAQ_JOY_THETA	analog_t	Theta Joystick Command Range [100 % to -100 %].
U_DAQ_JOY_PSI	analog_t	Psi Joystick Command Range [100 % to -100 %].
U_KEEP_STATION	digital_t	Enable Station Keeping.
U_AUTOVERT_EN	digital_t	Enable Auto Vertical Control.
U_AUTOALT_EN	digital_t	Enable Auto Altitude Control.
U_AUTOROLL_EN	digital_t	Enable Auto Roll Control.
U_AUTOPITCH_EN	digital_t	Enable Auto Pitch Control.
U_AUTOHDG_EN	digital_t	Enable Auto Heading Control.
U_AUTOLAT_CMD	analog_t	Set the auto latitude commanded set point.
U_AUTOLON_CMD	analog_t	Set the auto longitude commanded set point value. The commanded set point will not take effect until the use command is set to true.
U_AUTOX_CMD	analog_t	Set the auto X commanded set point value. The commanded set point will not take effect until the use command is set to true.
U_AUTOY_CMD	analog_t	Set the auto Y commanded set point value. The

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<i>Command Name</i>	<i>Type</i>	<i>Description</i>
		commanded set point will not take effect until the use command is set to true.
U_AUTOVERT_CMD	analog_t	Set the auto vertical commanded set point value. The commanded set point will not take effect until the use command is set to true.
U_AUTOROLL_CMD	analog_t	Set the auto roll commanded set point value. The commanded set point will not take effect until the use command is set to true.
U_AUTOPITCH_CMD	analog_t	Set the auto pitch commanded set point value. The commanded set point will not take effect until the use command is set to true.
U_AUTOHDG_CMD	analog_t	Set the auto heading commanded set point value. The commanded set point will not take effect until the use command is set to true.
U_AUTOXY_USE_CMD	digital_t	Set the value stored in the commanded auto set point as the active auto pilot set point.
U_AUTOX_USE_CMD	digital_t	Set the value stored in the commanded auto set point as the active auto pilot set point.
U_AUTOY_USE_CMD	digital_t	Set the value stored in the commanded auto set point as the active auto pilot set point.
U_AUTOVERT_USE_CMD	digital_t	Set the value stored in the commanded auto set point as the active auto pilot set point.
U_AUTOPHI_USE_CMD	digital_t	Set the value stored in the commanded auto set point as the active auto pilot set point.
U_AUTOTHETA_USE_CMD	digital_t	Set the value stored in the commanded auto set point as the active auto pilot set point.
U_AUTOHDG_USE_CMD	digital_t	Set the value stored in the commanded auto set point as the active auto pilot set point.
U_KEEP_STATION_DX	analog_t	Station keeping X step size.
U_KEEP_STATION_DY	analog_t	Station keeping Y step size.
U_KEEP_STATION_DZ	analog_t	Station keeping Z step size.
U_STEP_PHI	analog_t	Station keeping phi step size.
U_STEP_THETA	analog_t	Station keeping theta step size.
U_KEEP_STATION_DPSI	analog_t	Station keeping psi step size.
U_PROFILE_REQUEST	analog_t	Set the mode of operation. Refer to the mode of operation.
U_MIN_SONAR_DISTANCE	analog_t	Set the minimum sonar relative X tracking distance.
U_ORBIT_CW_EN	digital_t	Enable sonar relative clockwise orbit.
U_ORBIT_CCW_EN	digital_t	Enable sonar relative counter clockwise orbit.
U_ORBIT_SPEED	analog_t	Set the sonar relative orbit speed.

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<i>Command Name</i>	<i>Type</i>	<i>Description</i>
U_CRUISE_EN_X	digital_t	Enable X cruise control.
U_CRUISE_EN_Y	digital_t	Enable Y cruise control.
U_CRUISE_STEP_SIZE_X	analog_t	Set the X cruise control step size.
U_CRUISE_STEP_SIZE_Y	analog_t	Set the Y cruise control step size.
U_CRUISE_STEP_POS_X	digital_t	Step the cruise control set point by the U_CRUISE_STEP_SIZE_X step size in the positive direction.
U_CRUISE_STEP_NEG_X	digital_t	Step the cruise control set point by the U_CRUISE_STEP_SIZE_X step size in the negative direction.
U_CRUISE_STEP_POS_Y	digital_t	Step the cruise control set point by the U_CRUISE_STEP_SIZE_Y step size in the positive direction.
U_CRUISE_STEP_NEG_Y	digital_t	Step the cruise control set point by the U_CRUISE_STEP_SIZE_Y step size in the negative direction.

Table 2: PCOMMS commands.

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