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DYNAMIC POSITIONING CONFERENCE
October 14-15, 2014

DESIGN AND CONTROL

Approach for Advance Testing of DP Control System

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Navis Engineering/Beier Radio

NAVIS ENGINEERING

Approach for advanced testing of DP control system

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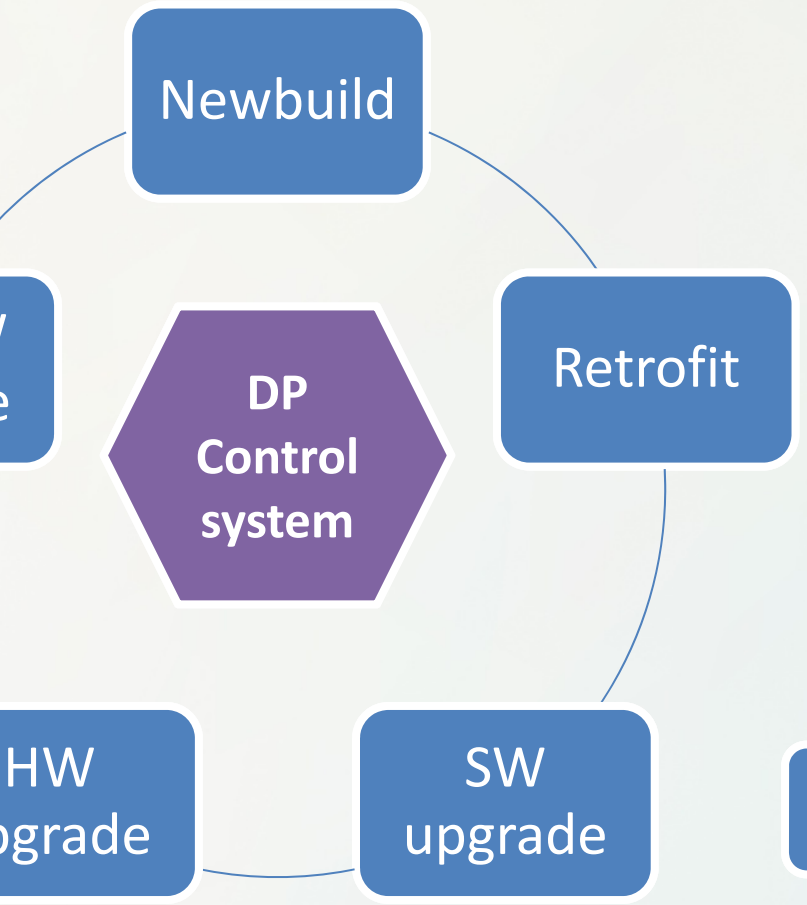
- Petr Opekunov

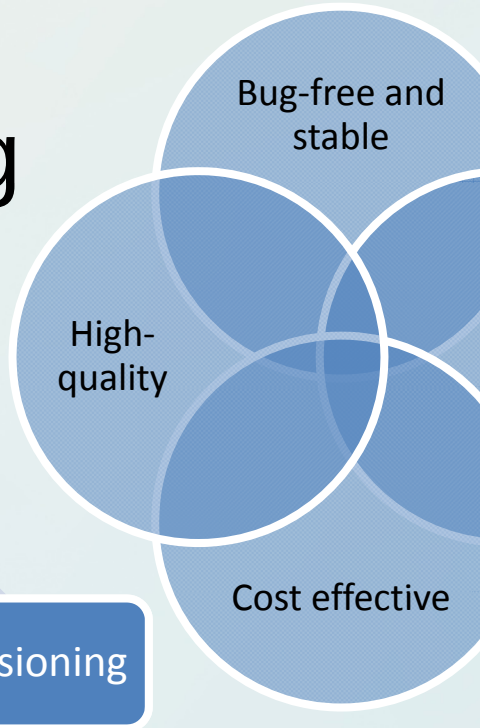
Different requirements and configurations, sub-systems interaction

System	Classification society	DP class	Deliver
ntrol system	ABS	Non class	New syste
wer system	BV	Class 0	HW upgrad
nsor system	CCS	Class 1	SW upgrad
RS system	DNV\GL	Class 2	
	LR	Class 3	
	RS	Advanced sub-class	
	Others..		

e product with fast
very for different
figurations, how



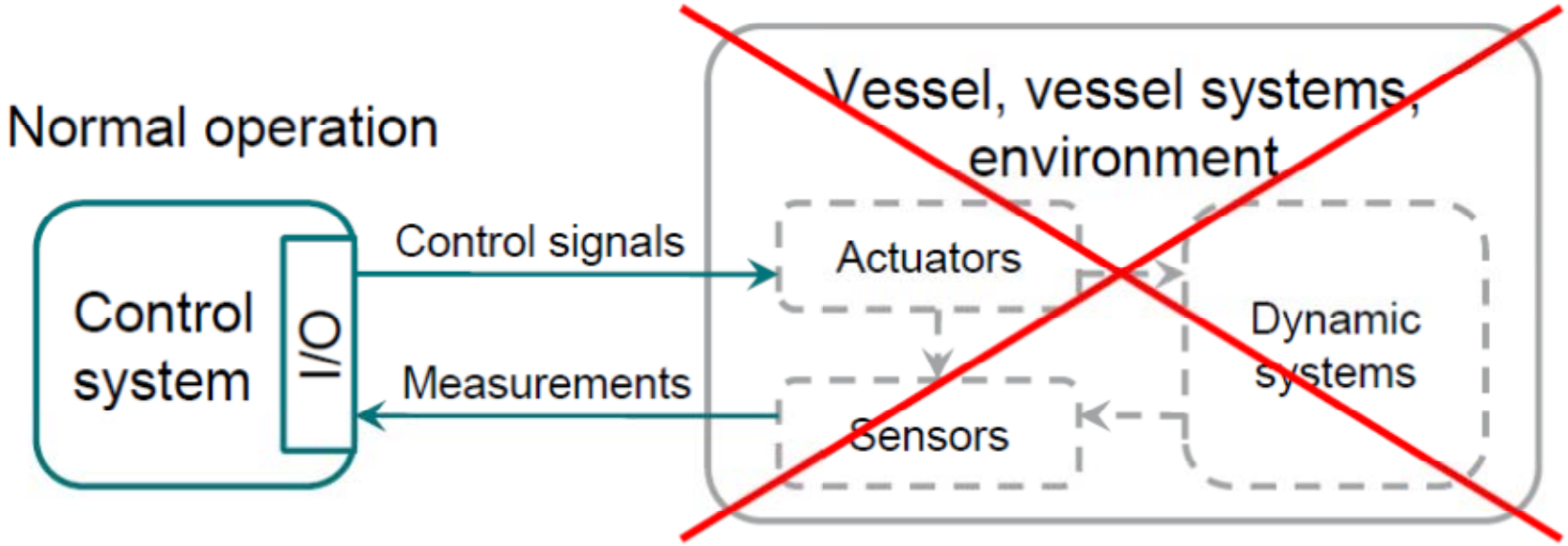
Advanced testing



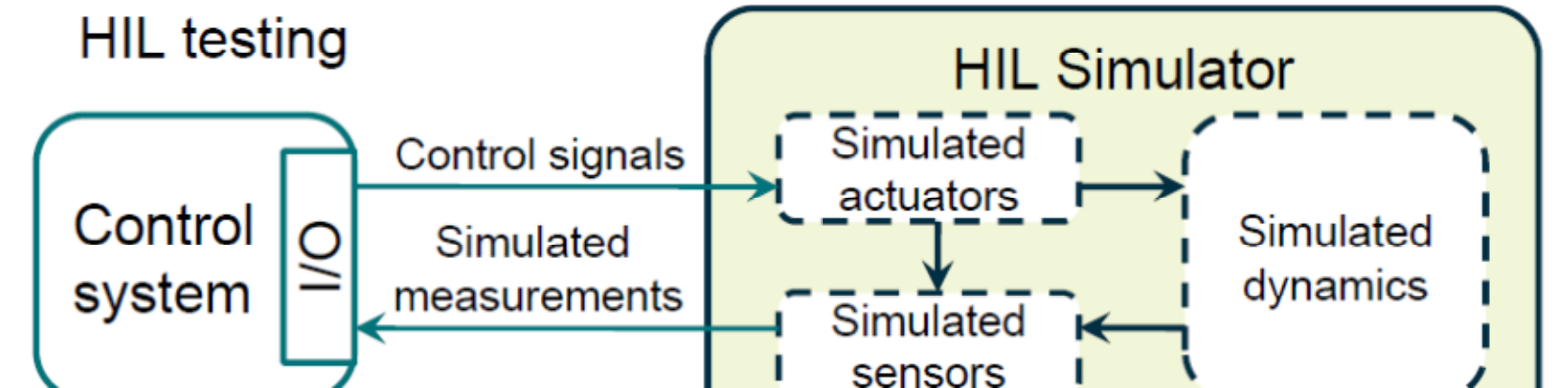
Internal testing → Factory testing → Commissioning

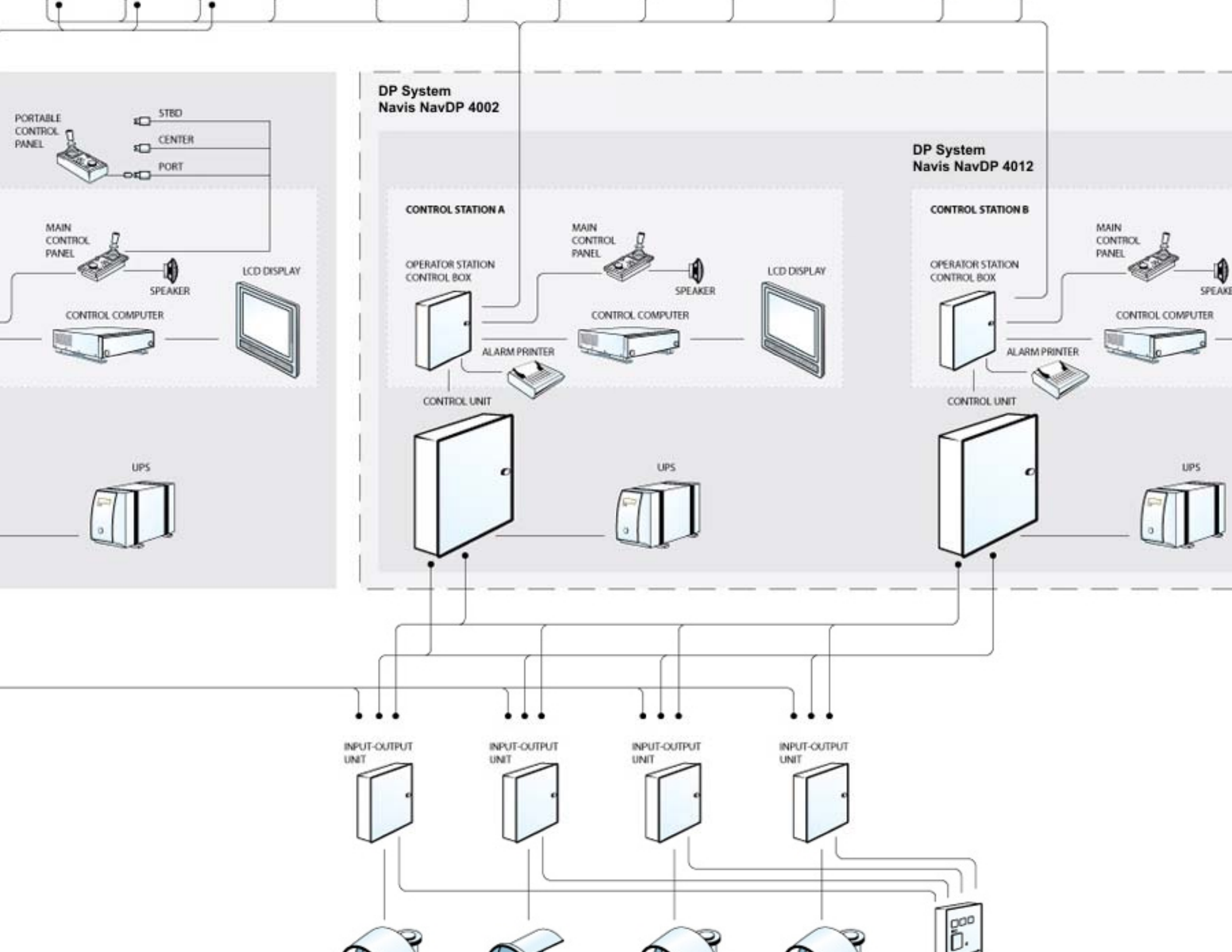
ilable ready to use solution?

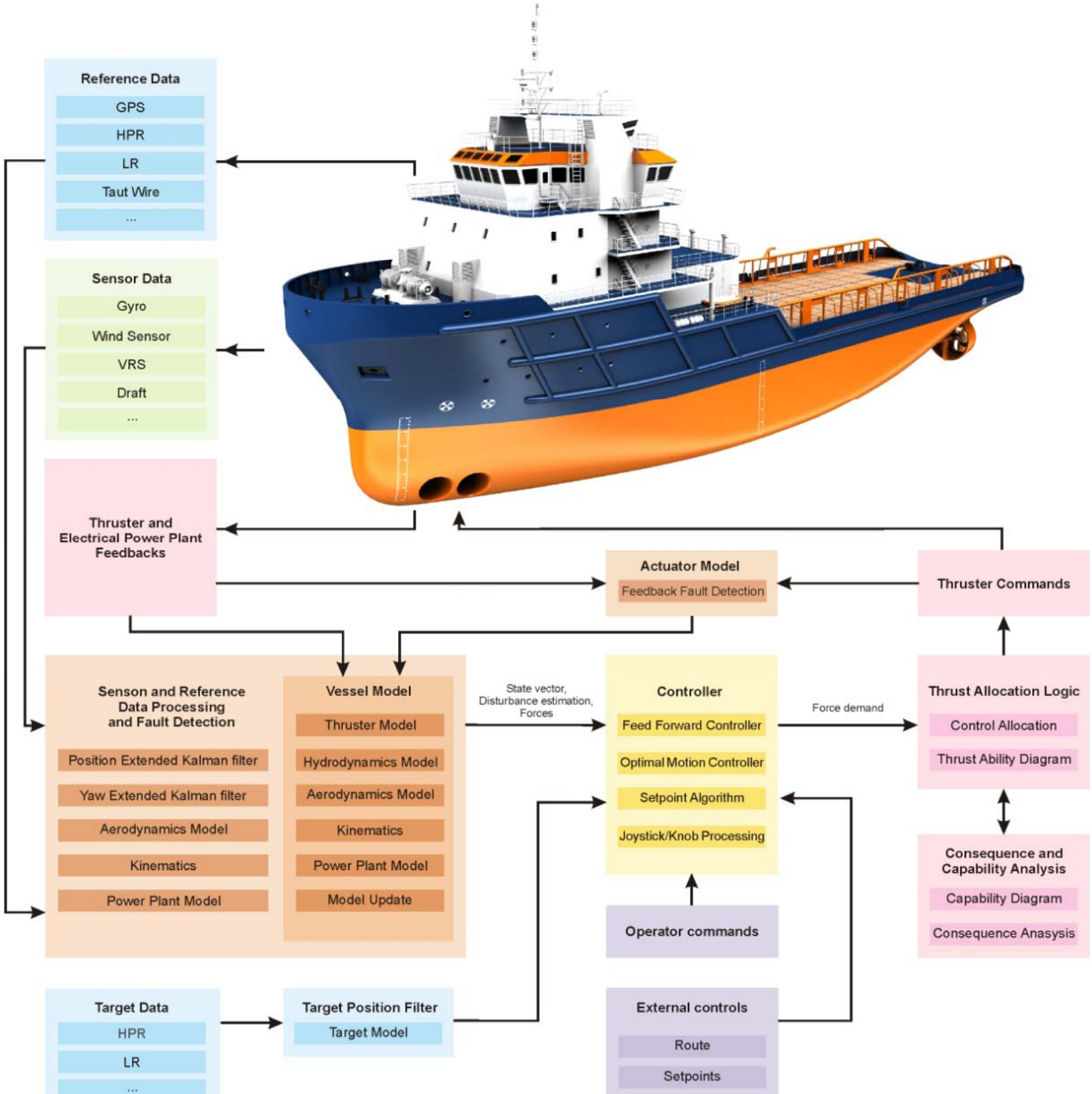
THE CONCEPT OF HIL TESTING

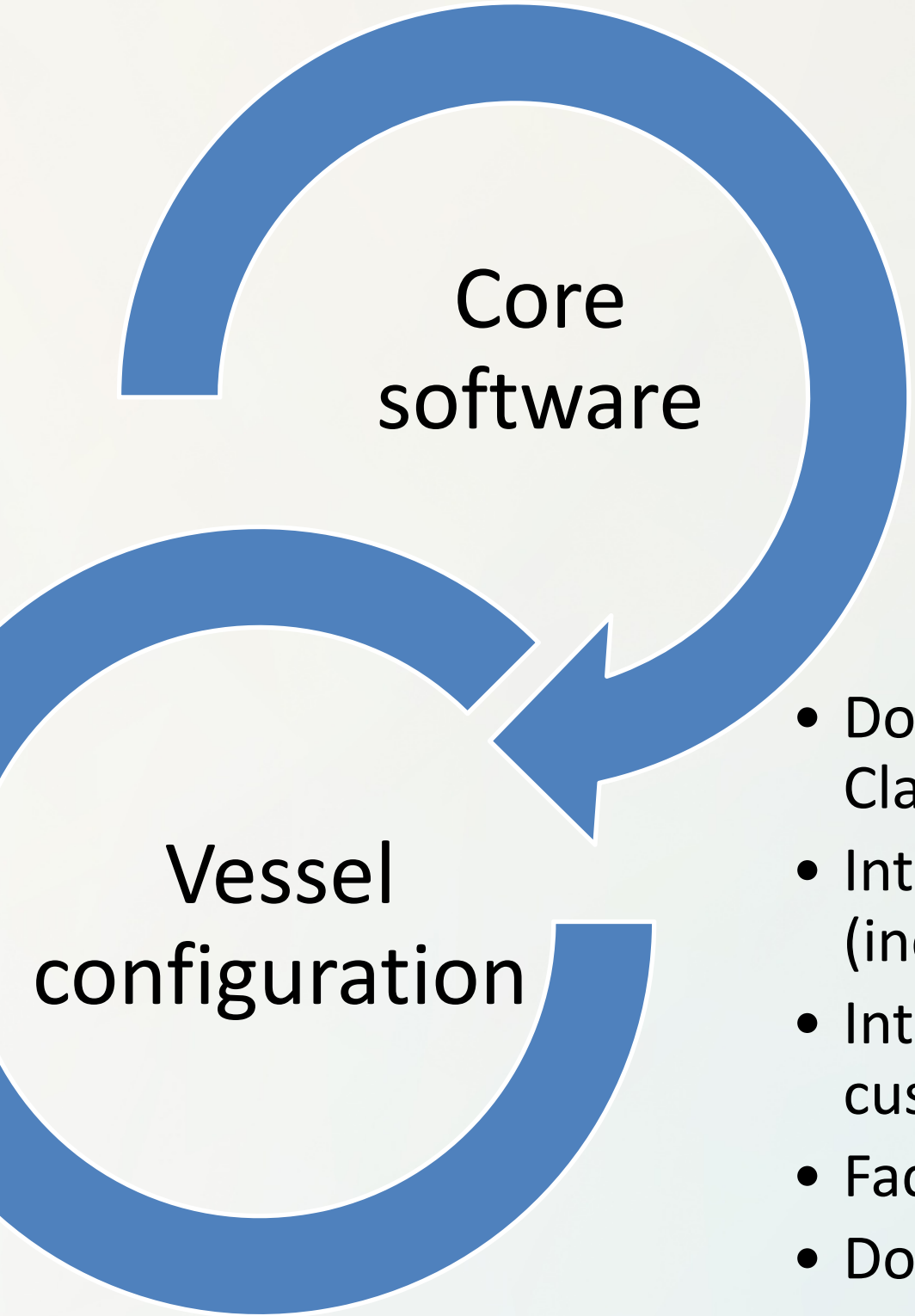


When performing HIL testing, the machine itself (including actuators sensors, VFD's etc) is replaced with our simulator:



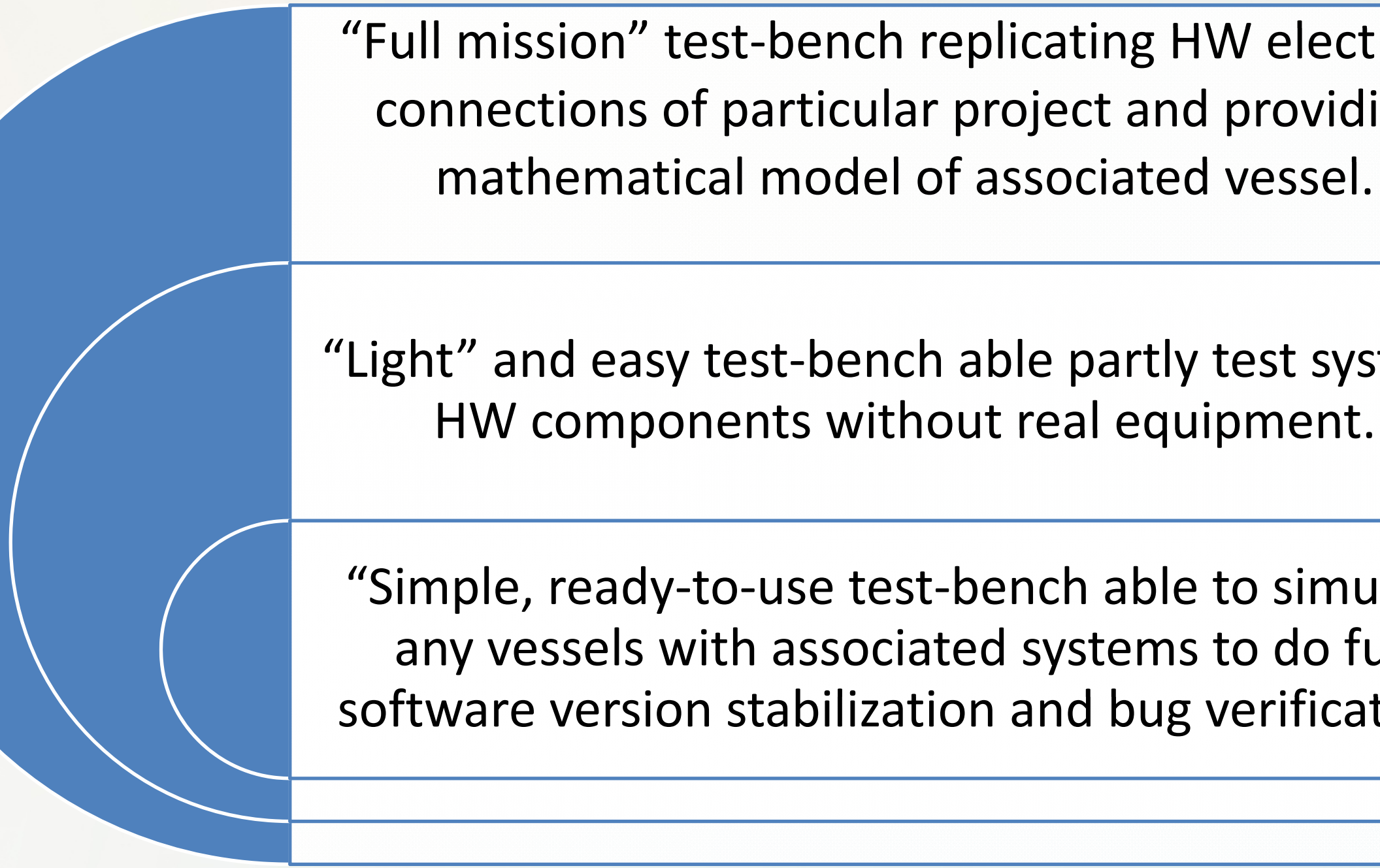

DP System
Navis NavDP 4002
DP System
Navis NavDP 4012
PORTABLE
CONTROL
PANEL
STBD
CENTER
PORT
MAIN
CONTROL
PANEL
SPEAKER
LCD DISPLAY
CONTROL COMPUTER
UPS
CONTROL STATION A
OPERATOR STATION
CONTROL BOX
ALARM PRINTER
CONTROL UNIT
CONTROL STATION B
INPUT-OUTPUT
UNIT


Reference Data
GPS
HPR
LR
Taut Wire
...
Sensor Data
Gyro
Wind Sensor
VRS
Draft
...
Thruster and Electrical Power Plant Feedbacks
Actuator Model
Feedback Fault Detection
Thruster Commands
Senson and Reference Data Processing and Fault Detection
Position Extended Kalman filter
Yaw Extended Kalman filter
Aerodynamics Model
Kinematics
Power Plant Model
Vessel Model
Thruster Model
Hydrodynamics Model
Aerodynamics Model
Kinematics
Power Plant Model
Model Update
State vector, Disturbance estimation, Forces
Controller
Feed Forward Controller
Optimal Motion Controller
Setpoint Algorithm
Joystick/Knob Processing
Force demand
Thrust Allocation Logic
Control Allocation
Thrust Ability Diagram
Consequence and Capability Analysis
Capability Diagram
Consequence Anasysis
Operator commands
Target Data
HPR
LR
...
Target Position Filter
Target Model
External controls
Route
Setpoints



- Internal testing of SW (debuggin verification , custom functions testing);
- Internal testing of Documentatio

- Documentation review and approval b Classification society;
- Internal testing of every HW compone (including internal wiring)
- Internal testing of algorithms and customized vessel configuration data;
- Factory acceptance testing;
- Dock and sea trials;


“Full mission” test-bench replicating HW elect
connections of particular project and providi
mathematical model of associated vessel.
“Light” and easy test-bench able partly test syst
HW components without real equipment.
“Simple, ready-to-use test-bench able to simu
any vessels with associated systems to do fu
software version stabilization and bug verificat

lied test-bench family

- Large ware)

- Test and simulation SW (simulator) run on standalone PC's.
- PLC with embedded SW and analog I/O simulating sub-systems signals handshaking
- HW for simulation custom interfaces (e.g EPP Modbus\Profibus interface)
- RS 232\422 COM-ports for simulation of sensors\PRS data connection

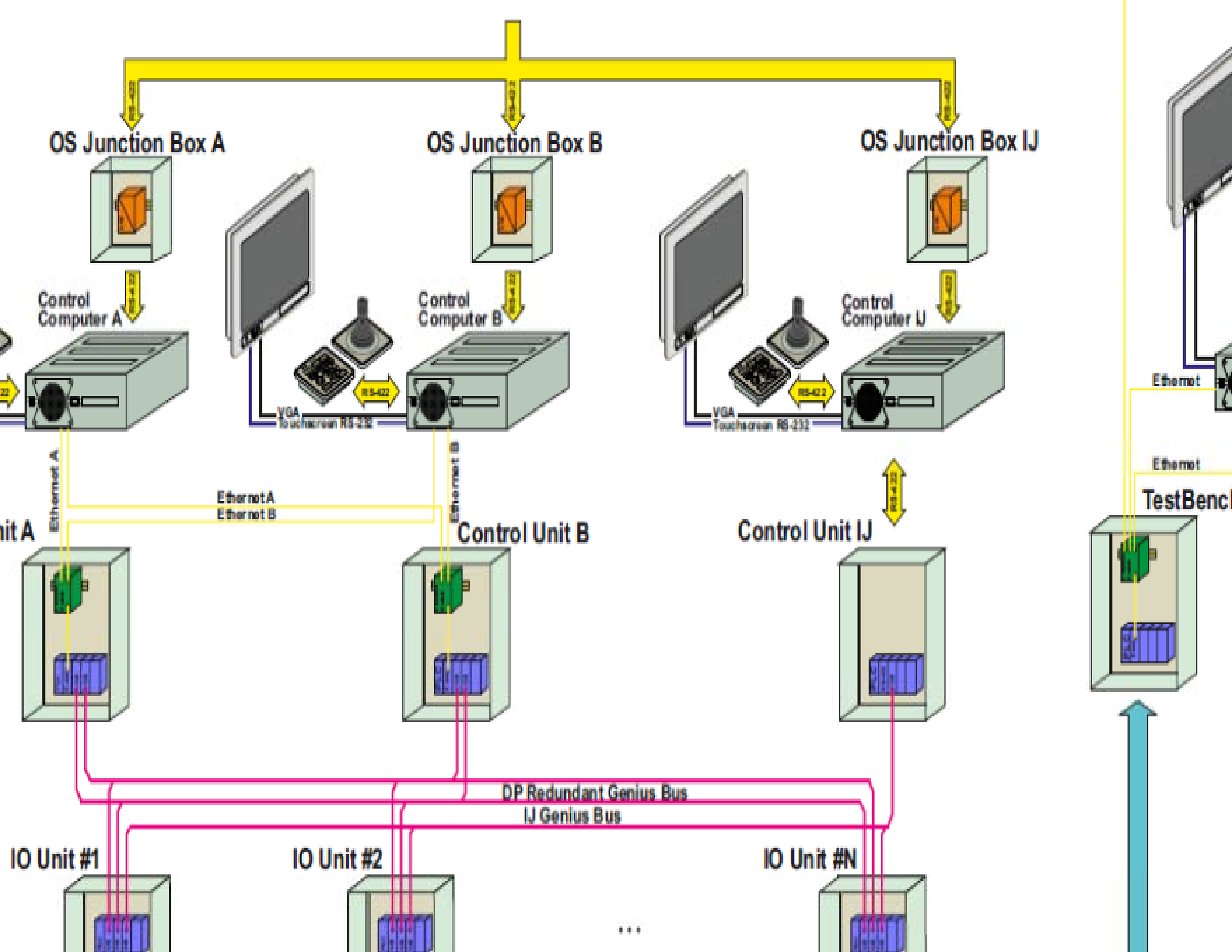
- Medium ardware)

- Test and simulation SW (simulator) run on standalone PC's.
- PLC with embedded SW
- Ethernet virtual ports for data communication between PC's.

– Small ware)

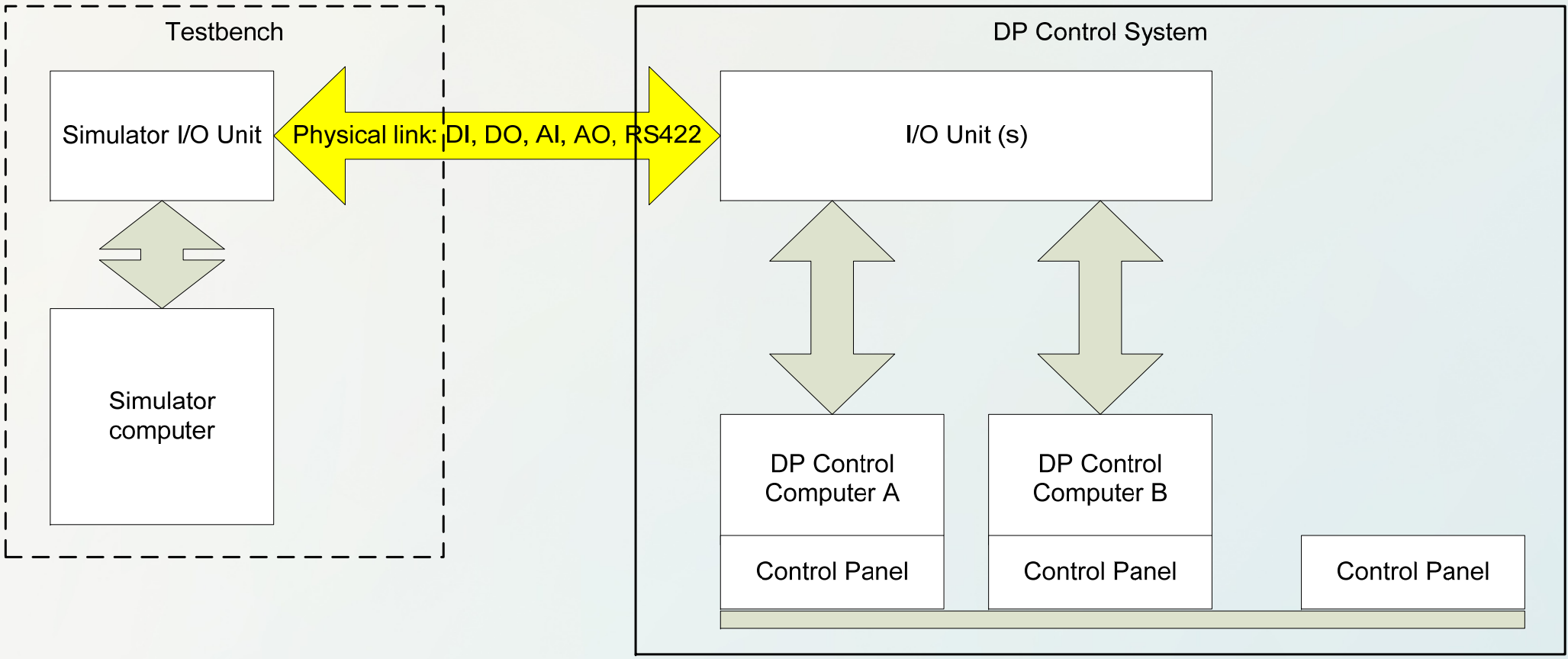
- Test and simulation SW (simulator) run on the same computer.

Task	S	M
SW development	+	+
SW version stabilization\release	+	
Release documentation check	+	
FAT of class\non-class system		
FAT of upgrades	+	+
Debugging	+	+
Troubleshooting	+	+


OS Junction Box A
OS Junction Box B
OS Junction Box IJ
Control Computer A
Control Computer B
Control Computer IJ
RS-422
VGA
Touchscreen RS-232
Ethernet A
Ethernet B
Ethernet
Control Unit B
Control Unit IJ
TestBench
DP Redundant Genius Bus
IJ Genius Bus
IO Unit #1
IO Unit #2
IO Unit #N

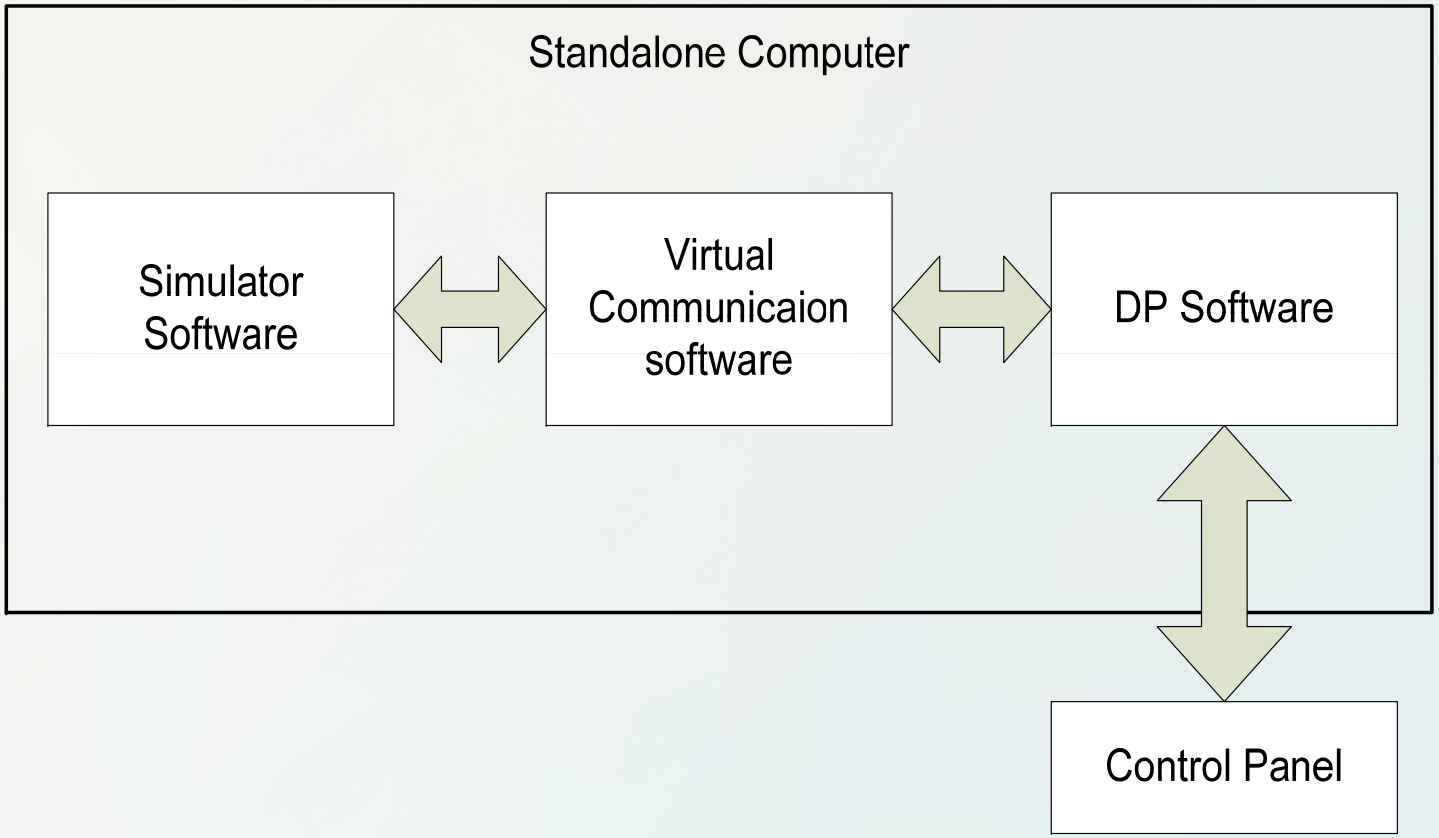
ype M

pose	• Testing of core SW functionality; • Testing of PLC HW\SW component; • Testing of algorithms and configuration data; • Testing of SW upgrades;
ing	Ethernet connection;
	Ample opportunities for configuration;
tra	Not all functions and parts able to be verified.



ype S

pose	• Testing of core SW functionality; • Testing of algorithms and configuration data; • Troubleshooting;
ing	Virtual interfaces(PC memory)
	• Available for any specific vessel and configuration; • Fast ready to use; • Can be installed at any PC;
tra	• Impossible to test PLC SW; • HW faults emulated with the simulator SW;



el model

- Realistic vessels dynamic;
- 6 DOF (including roll and pitch);
- Ship displacement\draft (constant or variable);
- Proper thrusters forces in bollard-pull and free-run (for AP);
- Realistic environmental disturbance – wind, wave, current;

ruster
ystem

- Proper dynamics;
- Faults simulation: control failure, noise in feedback, dead-band, low speed, feedback loss, time-delay, etc

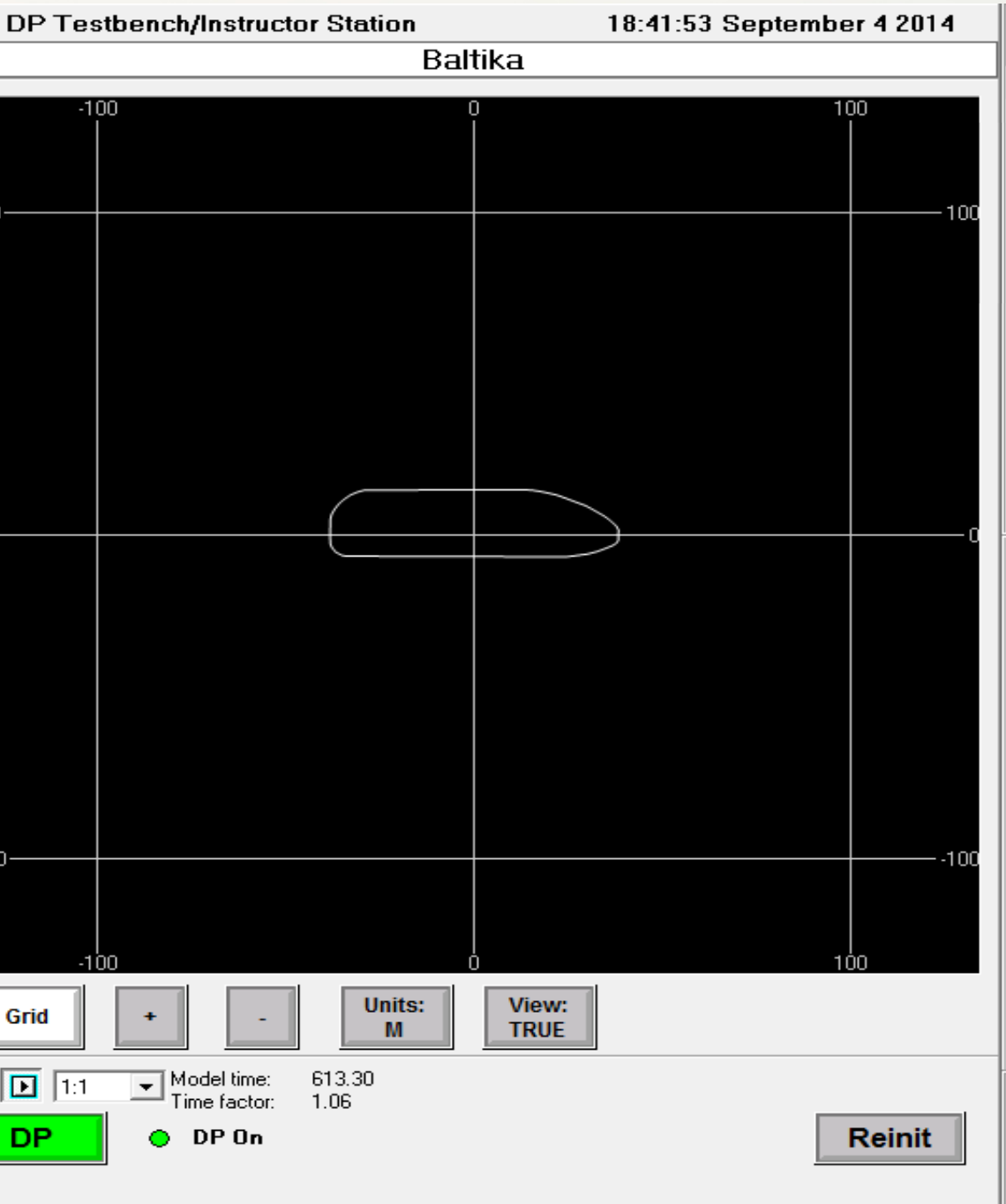
ower
ystem

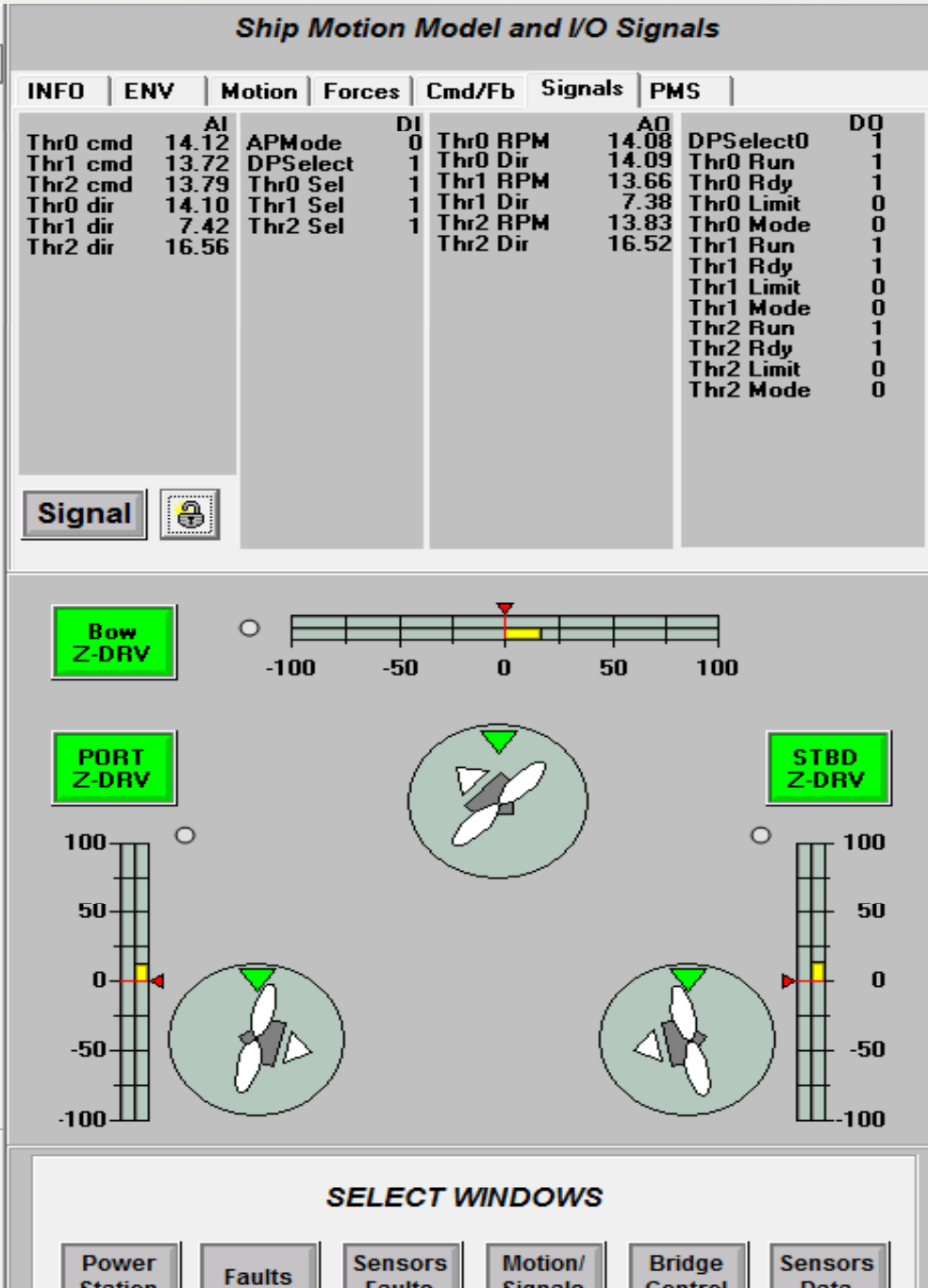
- Circuit breakers control connect/disconnect;
- Load sharing between buses;
- Additional load on buses (external consumers);
- Faults of breakers (signals), generators;
- Specific interface, if necessary;

nsors,
PRS's

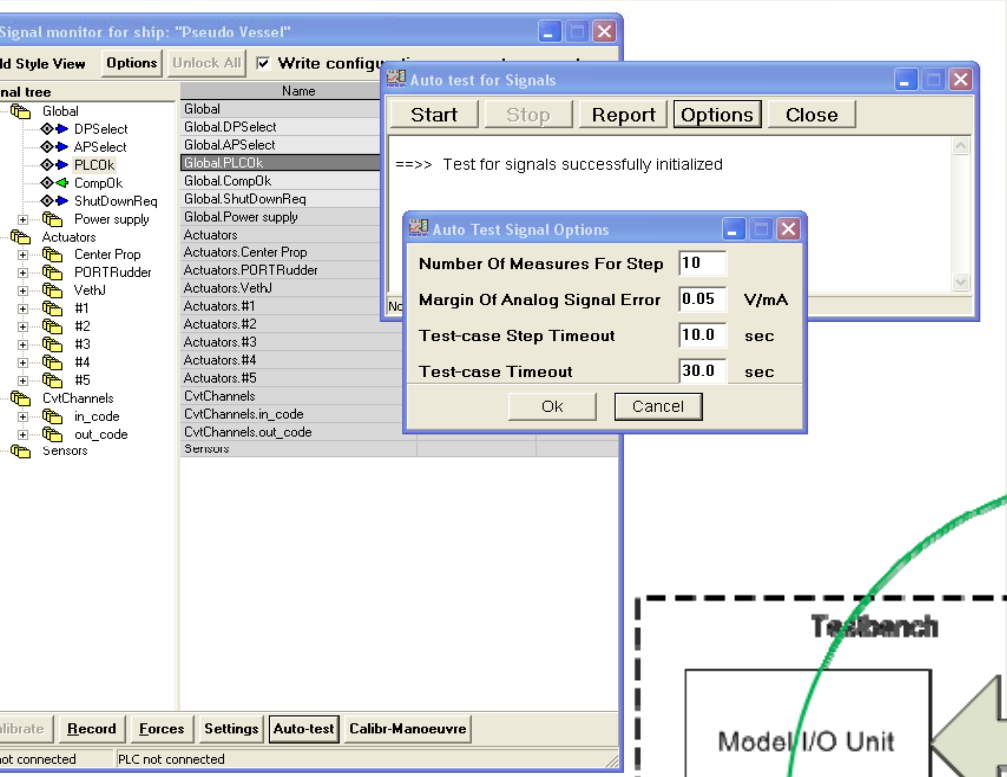
- Real model of measurements;
- PRS antenna position depending on roll, pitch;
- Roll\pitch sensor;
- Gyro\Magnetic compass with deviation model;
- Hydroacoustic system and associated beacons;
- Laser\ microwave radar with associated reflectors;
- Configurable data output – NMEA, or other format
- Faults simulation: data drift, data jump, data noise, data corruption, no data, etc

ware: CotMACS-JDP
Win XP\ Win 7

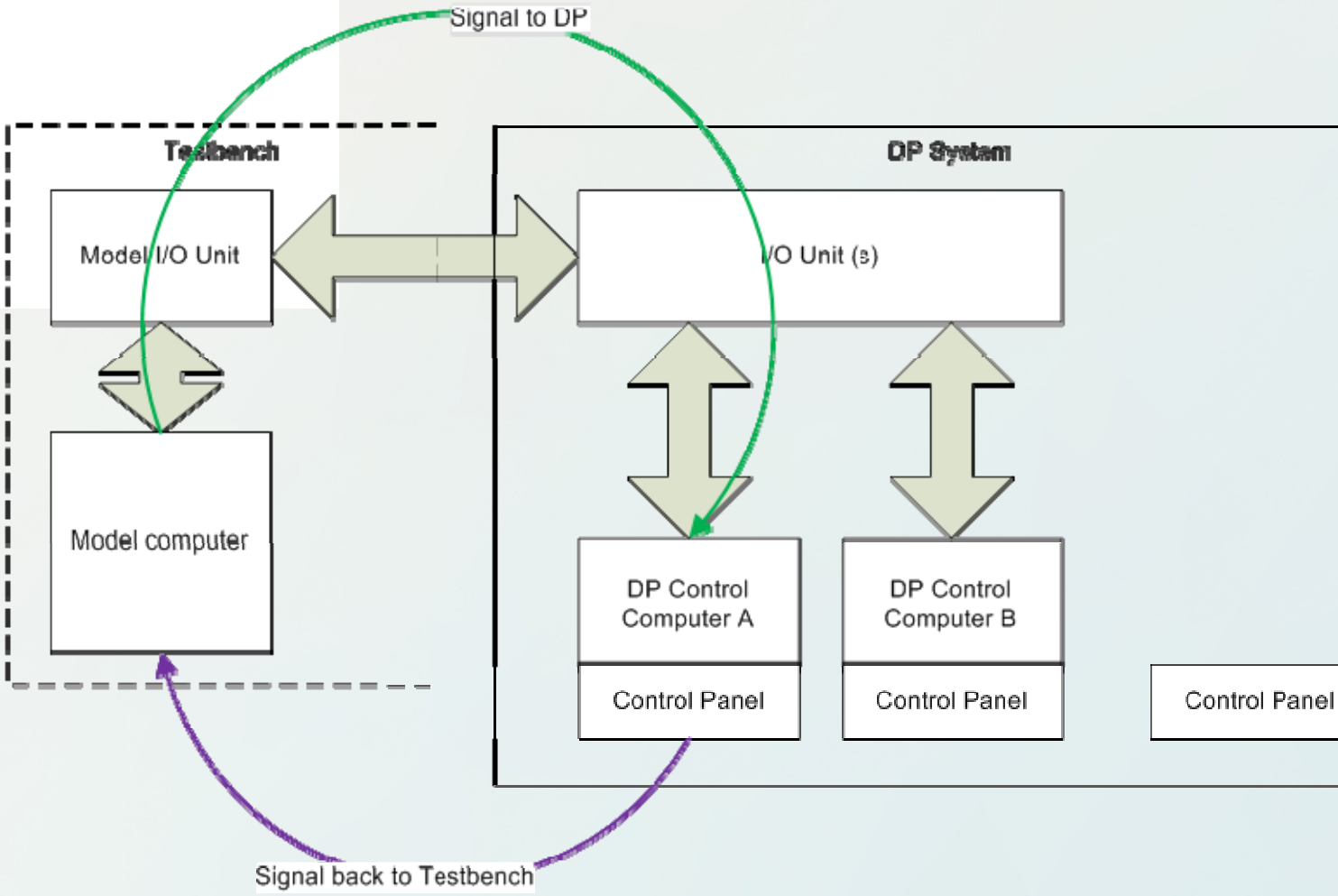




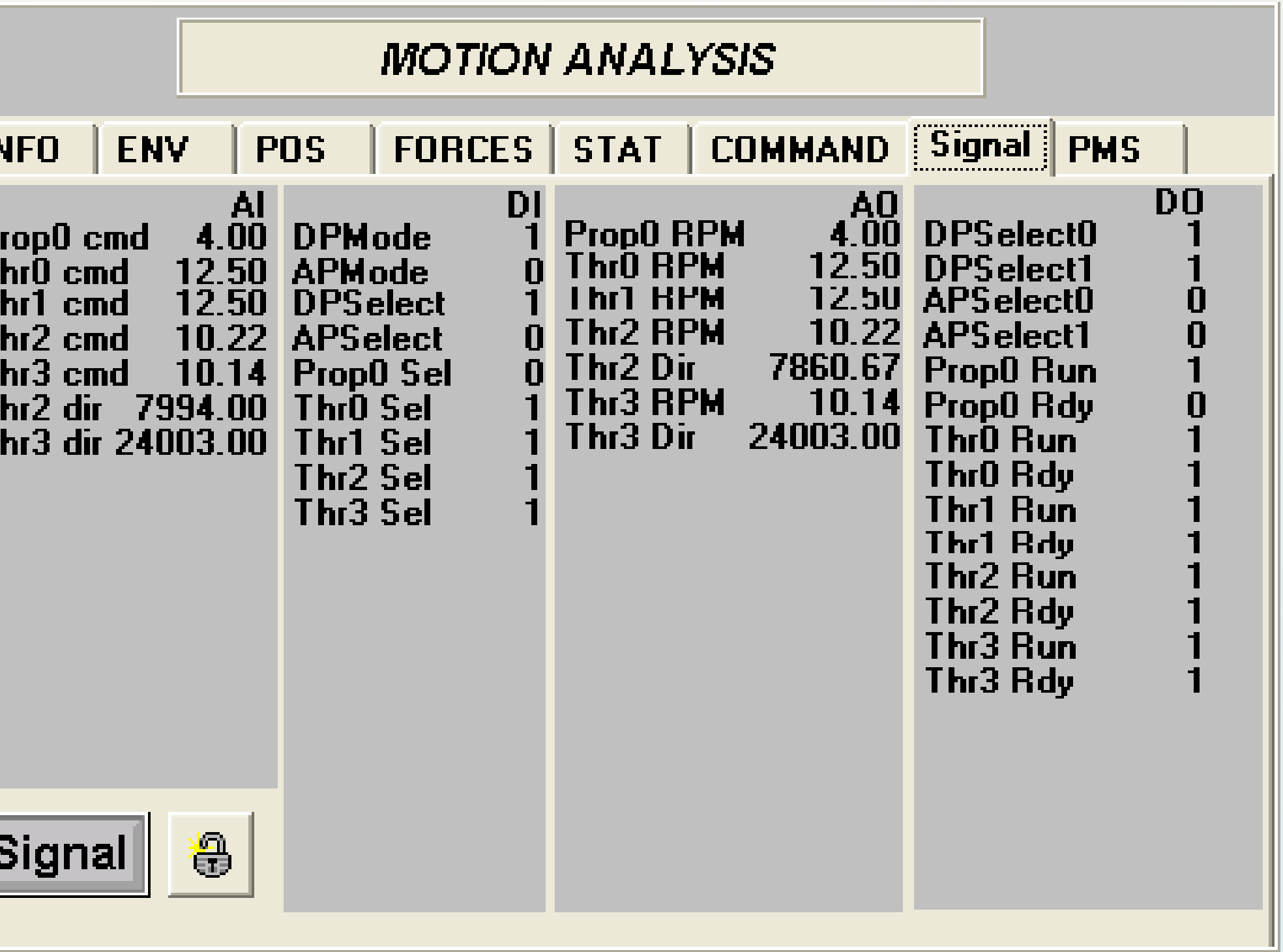
diagnostic



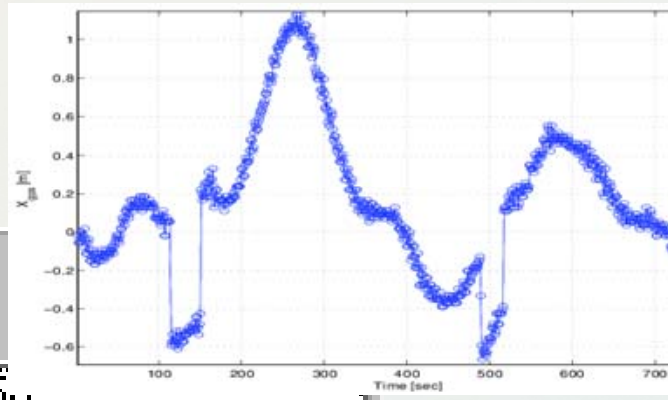
Signal monitor function constantly checking availability and health of data flow establishing auxiliary Ethernet communication between DP and Simulator Computer



Signals data window



Sensor faults window



GPS1 | 1.0 Hz | COM4

GPGGA,135330.26,2955.48202,N,09003.18778,W,2,05,1.2,,,,10.0,0100*5

GPS | GP Mode: 2 = Differential GPS SPS | Route

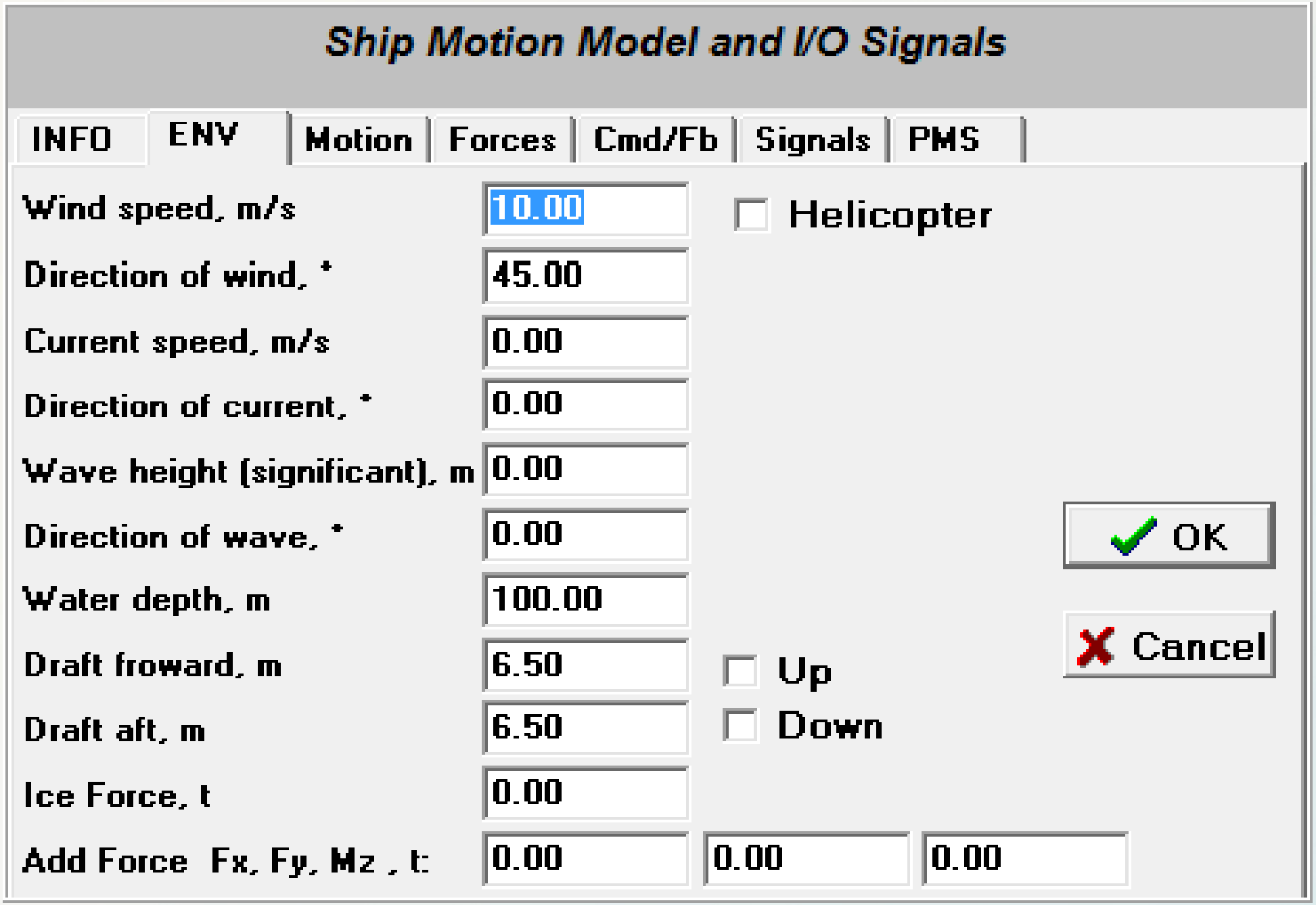
Errors: Perfect

					dXq	dYq
Noise	A,m	0.2			0	0
Single	A,m	0	T,s	0	0	0
Jump	Ax,m	0	Ay,m	0	0	0
Drift	Vx	0	Vy	0	0	0

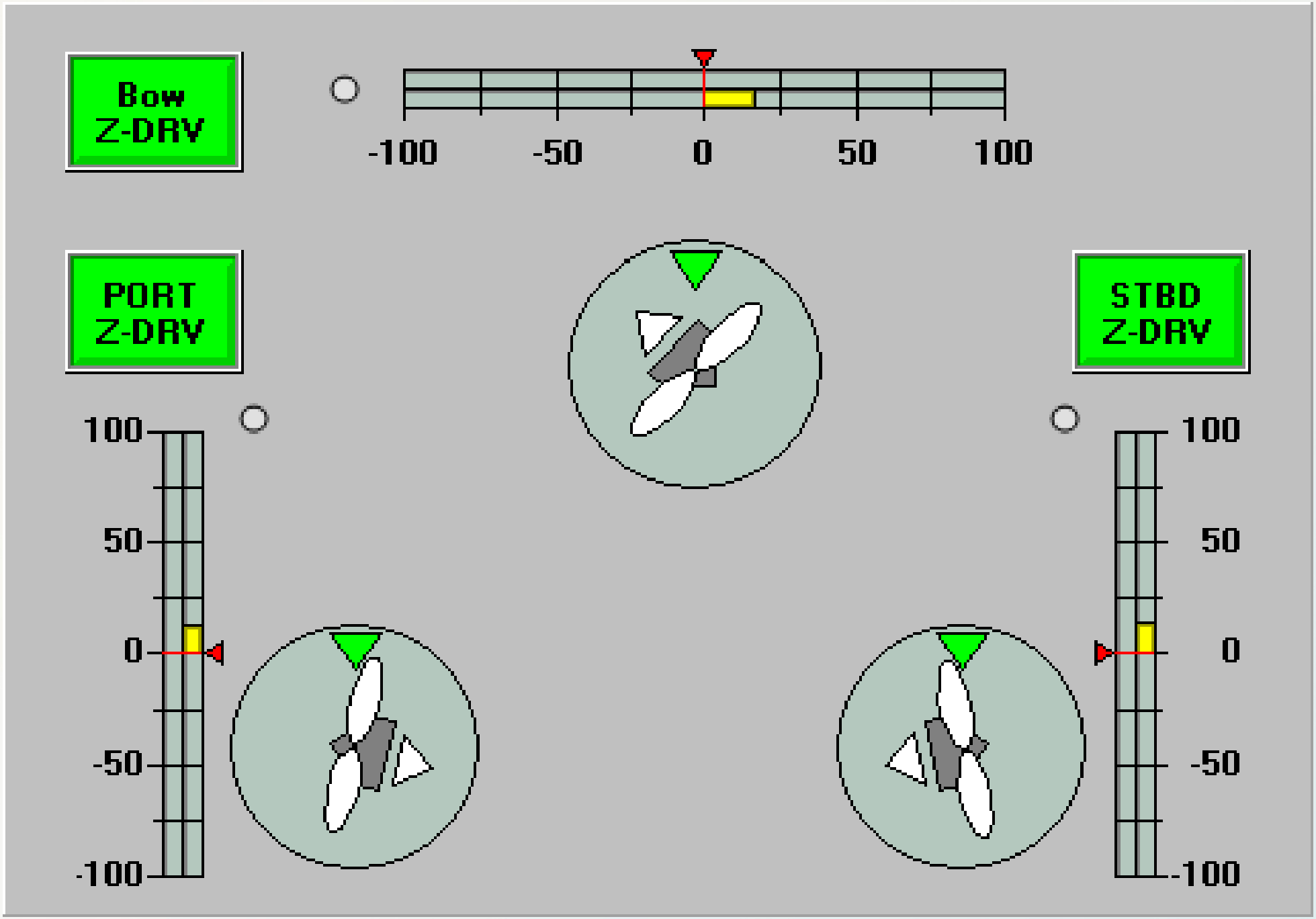
DTM
ZDA
VTG
GBS
GNS
GGA
GLL
RMC
POS

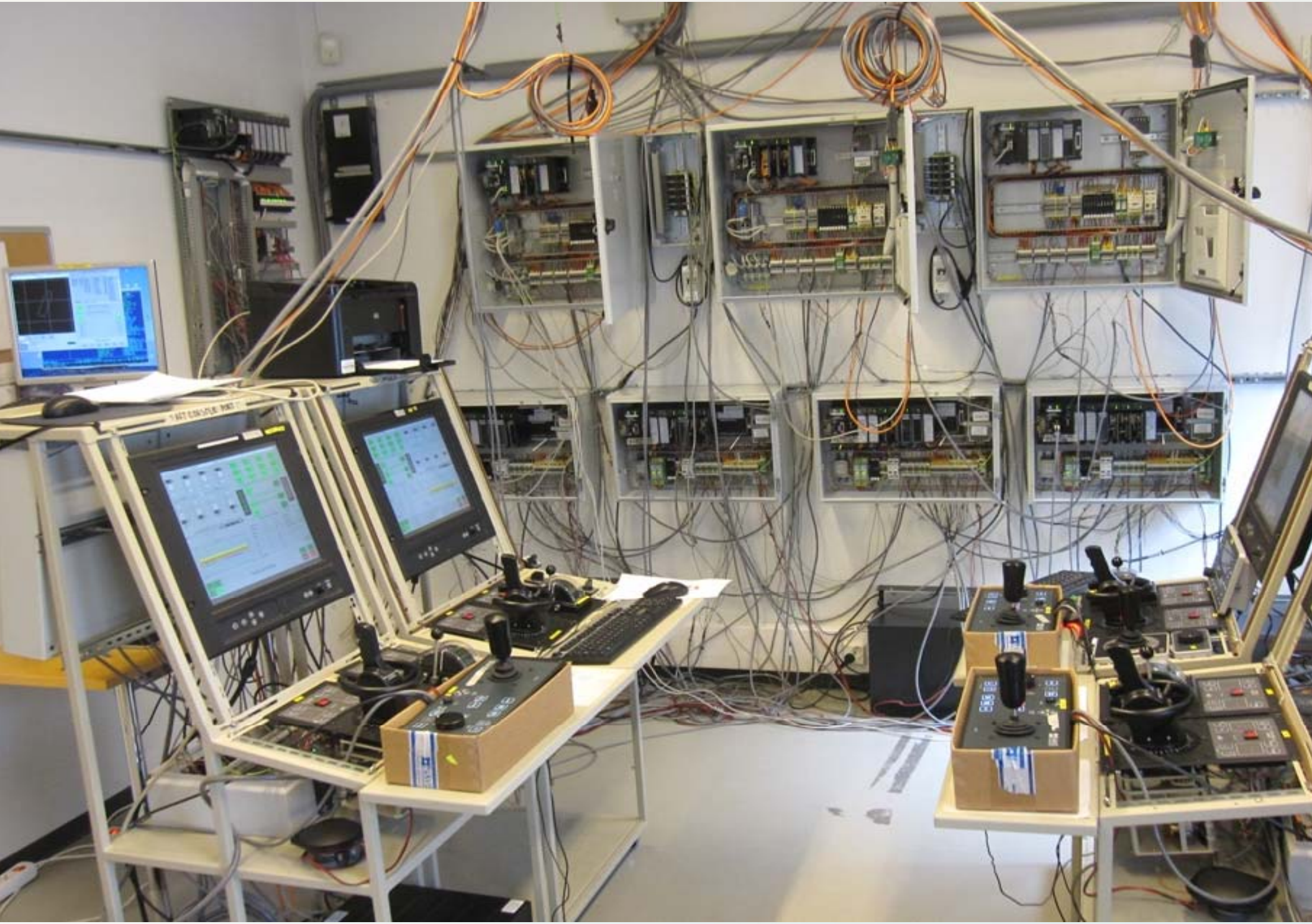
Format Errors: Empty data | Invalid msg | Not WGS84 | Lat/Lon Out of limit | COG/SOG Out of limit

Environments settings

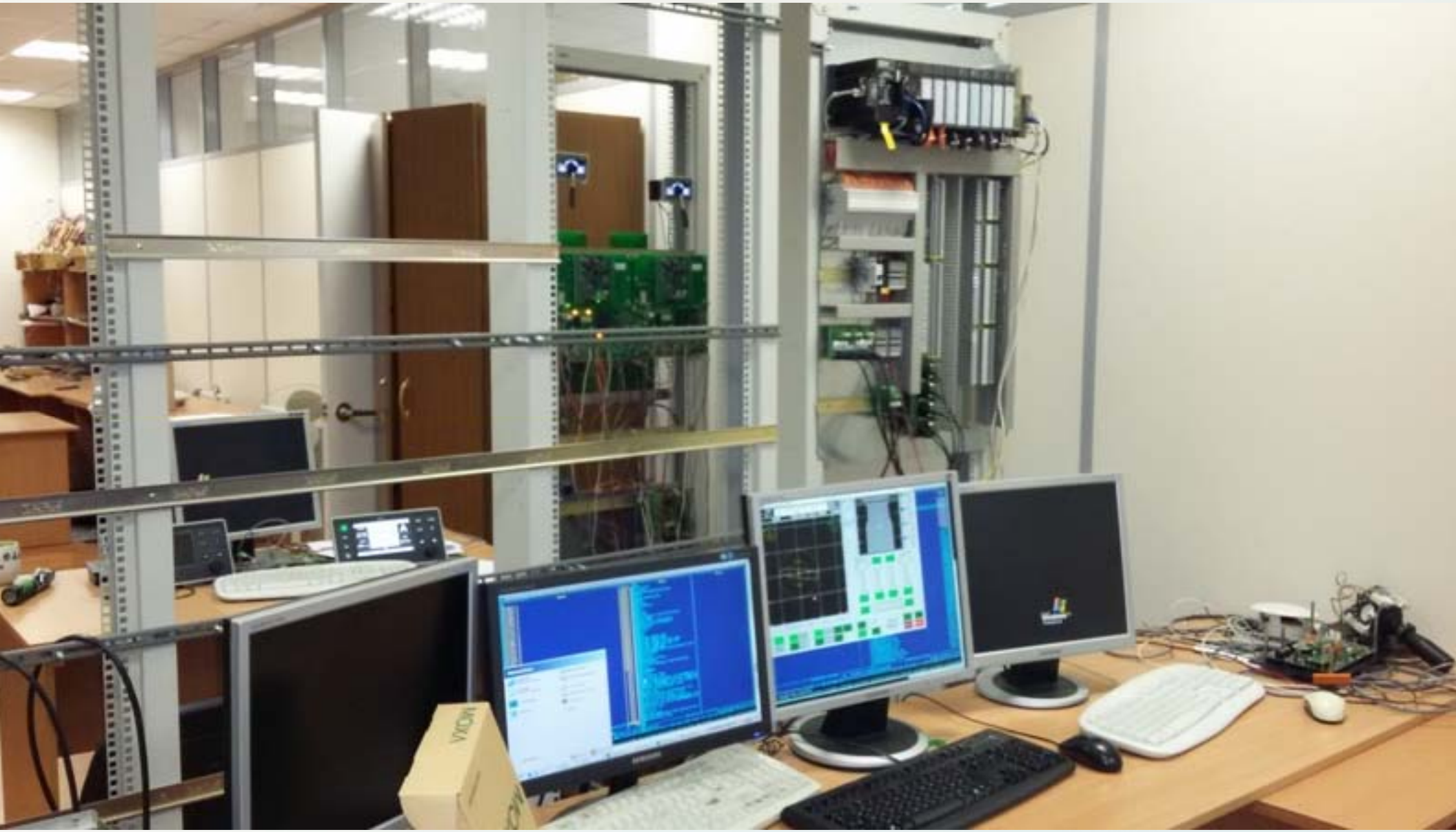


Thrusters control window





NavDP 4012

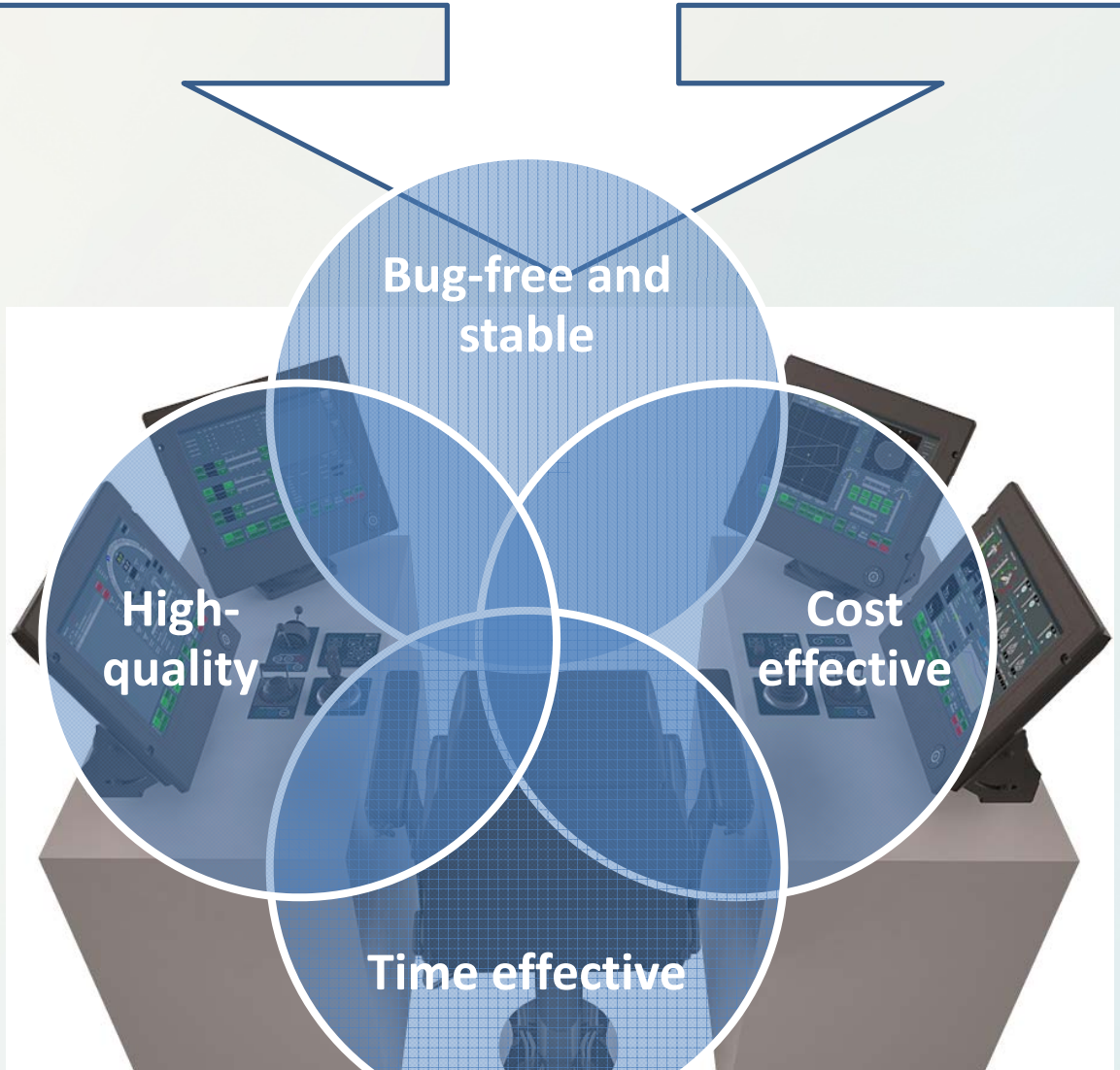


ically, implementation of mentioned test-bench family for QA control,
cation and troubleshooting finally allows to significantly reduce:

me for troubleshooting and fault finding (up to couple of minutes);

n-board time for system commissioning (up to couple of hours);

ervice calls in regard to DP control system;



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Thanks for Your attention!