MARINE CYBERNETICS
a DNV GL company

MARINE CYBERNETICS: FROM 0-100 IN 10 YEARS

ITK 60årsjubileum, 2014-11-07

Øyvind Smogeli, COO

ABOUT ME - «AFFILIATED» WITH ITK SINCE 2000

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- MSc Marine Technology 2002
  - Specialized in Marine Cybernetics (the study)
  - Master thesis at MIT on a force feedback VIV test setup
- PhD Marine Technology 2006
  - Working with modeling, simulation and control of propellers and ship motion
  - Thesis: Control of Marine Propellers: from Normal to Extreme conditions
- With Marine Cybernetics (the company) since 2003
  - Consultant/developer
  - Senior project engineer
  - Product manager
  - CTO
  - COO

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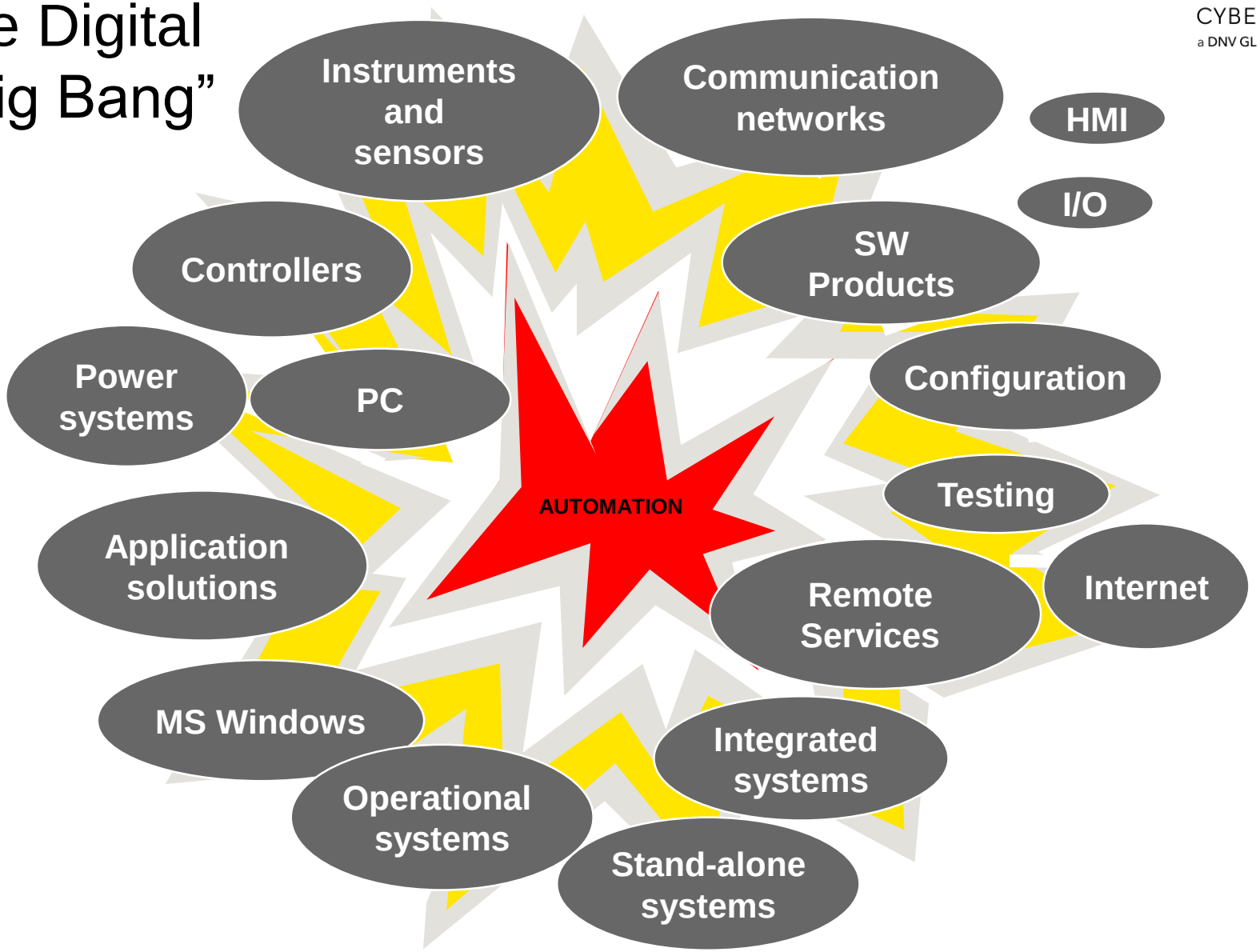
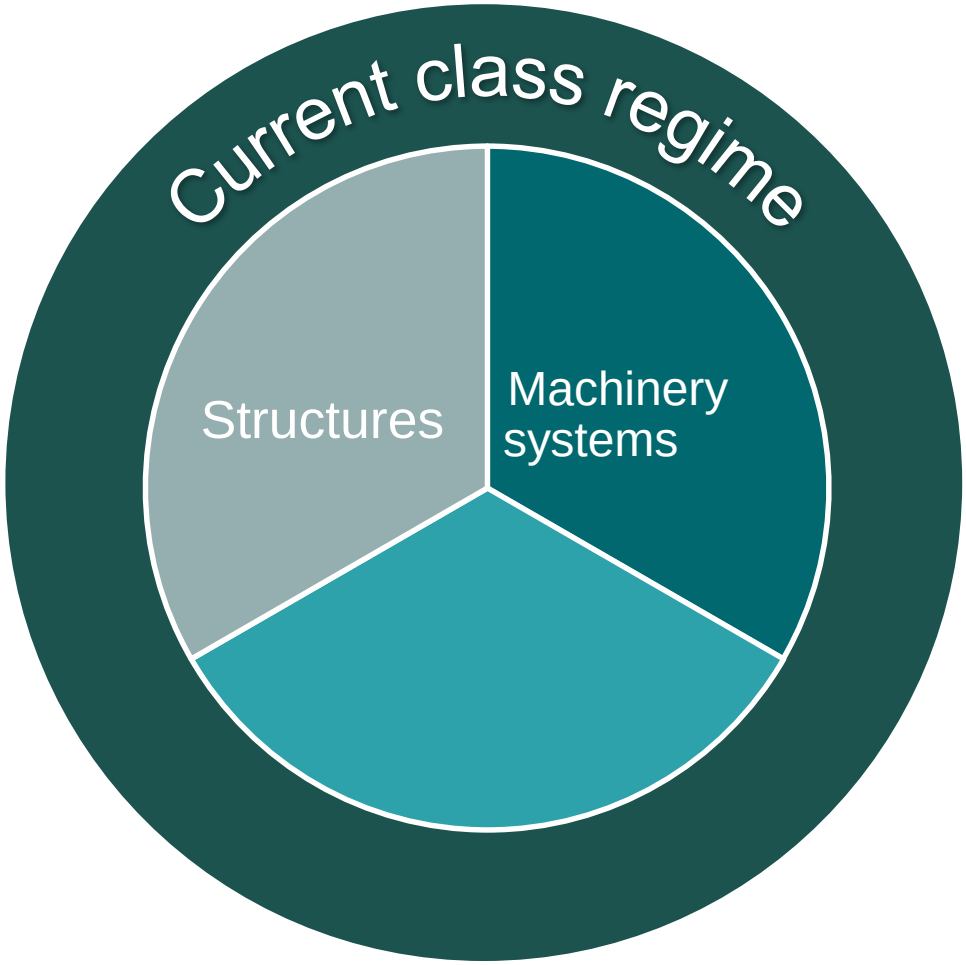
Marine Cybernetics ANS

Publisher and Technical consulting company owned by Thor Inge Fossen

The Digital "Big Bang"



GAP IN THE CURRENT CLASS REGIME



THE FOUNDERS

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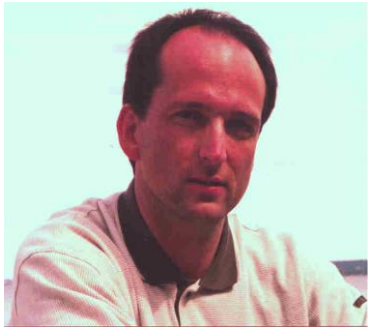


Marine Cybernetics AS

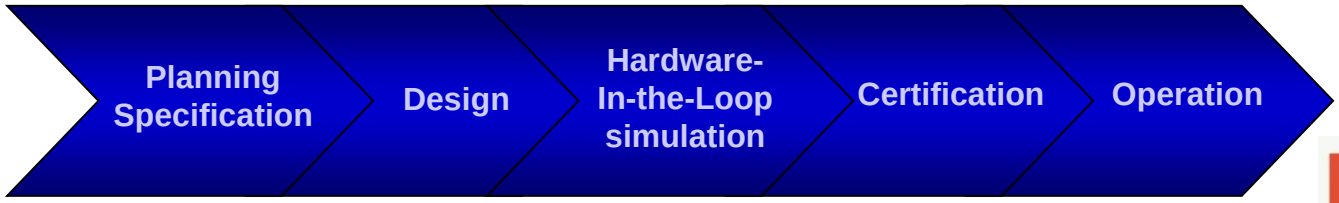
A spin-off from NTNU. Founded in December 2002

Vision

To be established as the leading and most profitable niche company in independent testing and verification of control systems

Business Idea

To improve safety and profitability for our customers by developing and applying *Hardware-In-the-Loop (HIL)* solutions for *independent testing* of software in control systems on ships and offshore installations



WHAT IS HIL TESTING?

CONTROL SYSTEM IN NORMAL OPERATION - CONTROLLING REAL VESSEL

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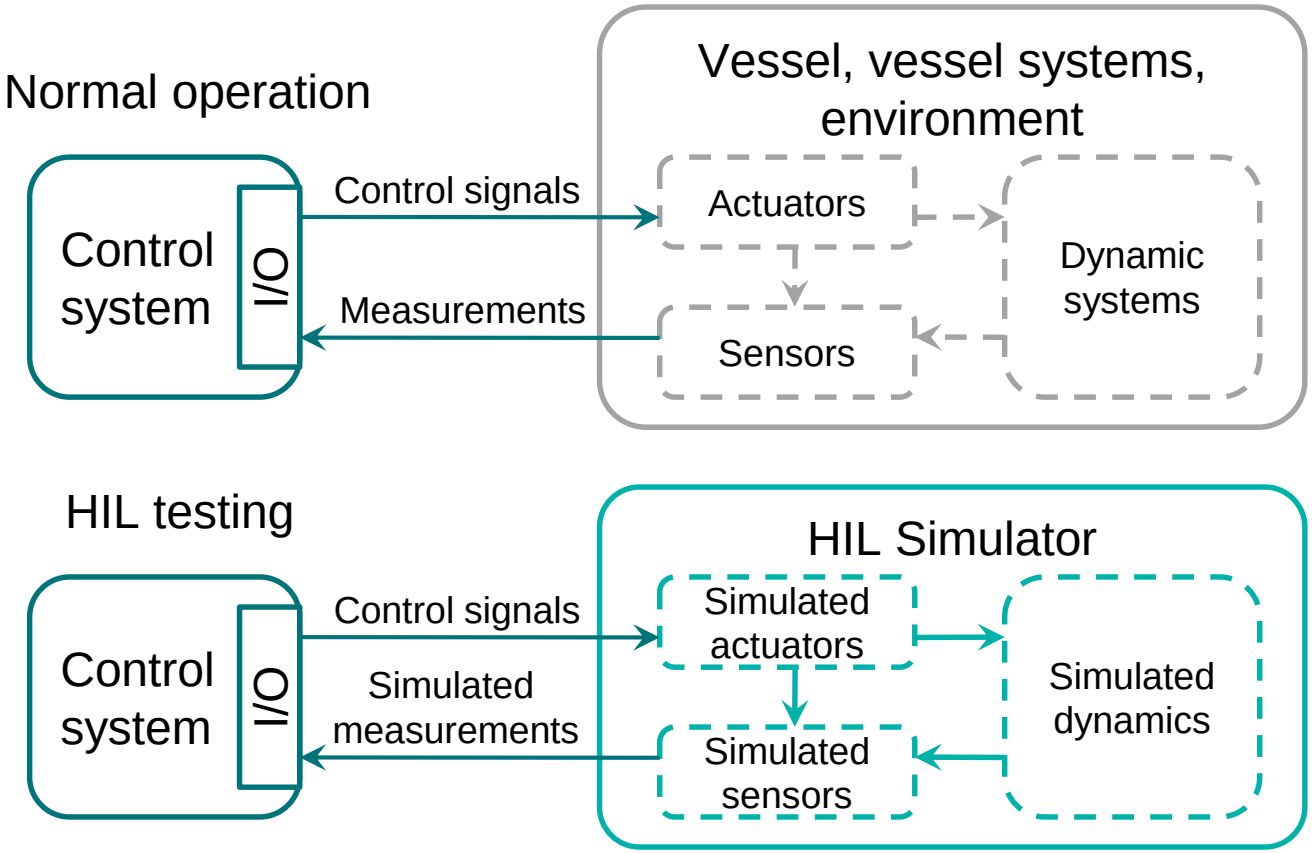
WHAT IS HIL TESTING?

CONTROL SYSTEM IN NORMAL OPERATION – CONTROLLING SIMULATED VESSEL

THE CONCEPT OF HIL TESTING



2004 – THE FIRST EMPLOYEES




2004-2005 – a company of nerds: 6.25 PhD, 1 MSc

First comment from the industry to our HIL test program:

«*What the …. is an orthogonal coordinate system?*»

DP-HIL PILOT PROJECT: VIKING POSEIDON, 2004

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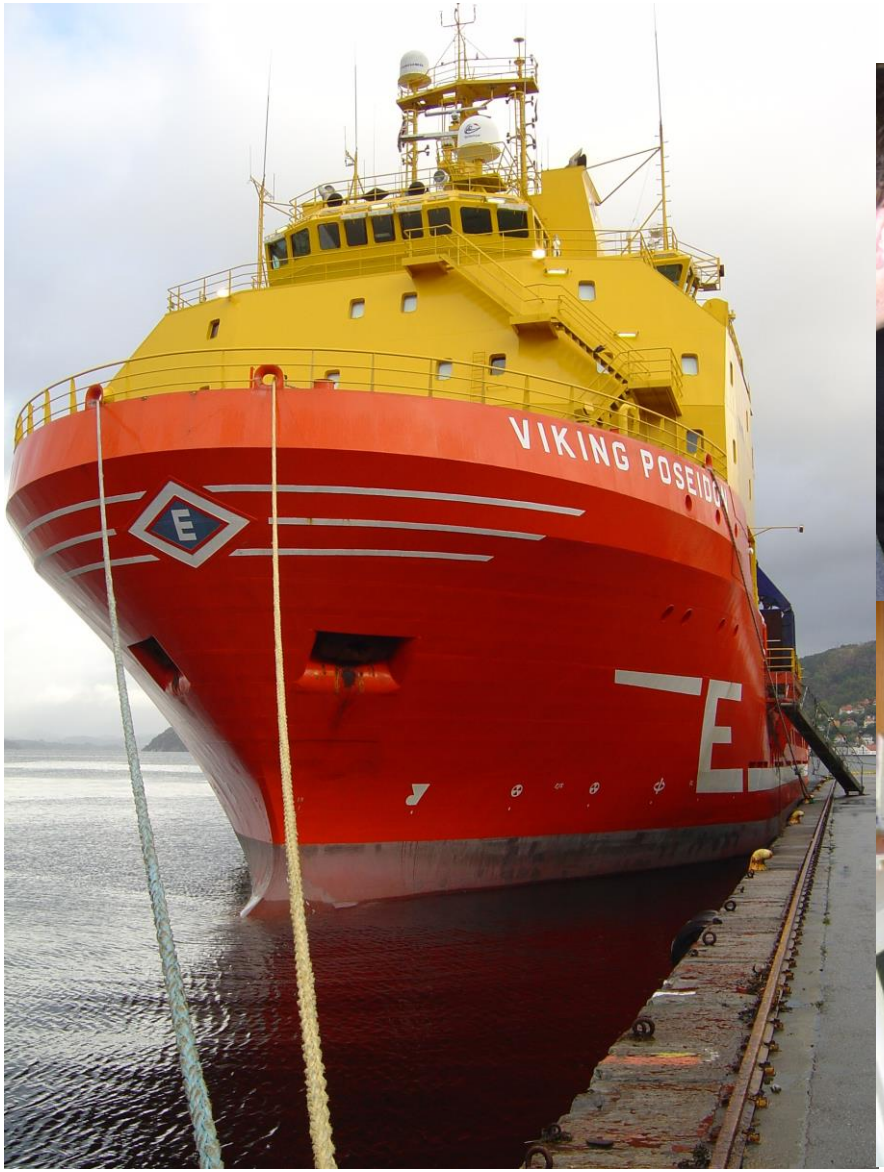

FIRST COMMERCIAL HIL-TEST JANUARY 2006

COMPANY HISTORY

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Identifying software issues:

- Reducing risk for incidents and accidents
- Reducing risk for off-hire and non-productive time
- Securing safe and reliable operations
- Securing flawless startups

Safe software – safe operation


2012 BOP-HIL launched


2010 Integration Testing of Maritime systems – DrillMAX ICE


2009 Drill-HIL of Maersk Discoverer


2008 SPT-HIL pilot with ABB


2006 PMS-HIL of Bourbon Mistral and Bourbon Monsoon

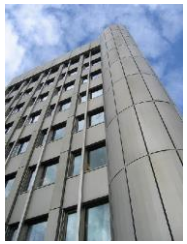

2004 DP-HIL of Viking Poseidon


2002 Marine Cybernetics founded

HEADCOUNT, REVENUE AND EXPANSION

July 2010 / April 2011: Houston office opened / US legal entity established

January 2011 / May 2011: Rio de Janeiro office opened / Brasil legal entity established



MAY 2014: DNV GL ACQUIRES MARINE CYBERNETICS

MARINE CYBERNETICS
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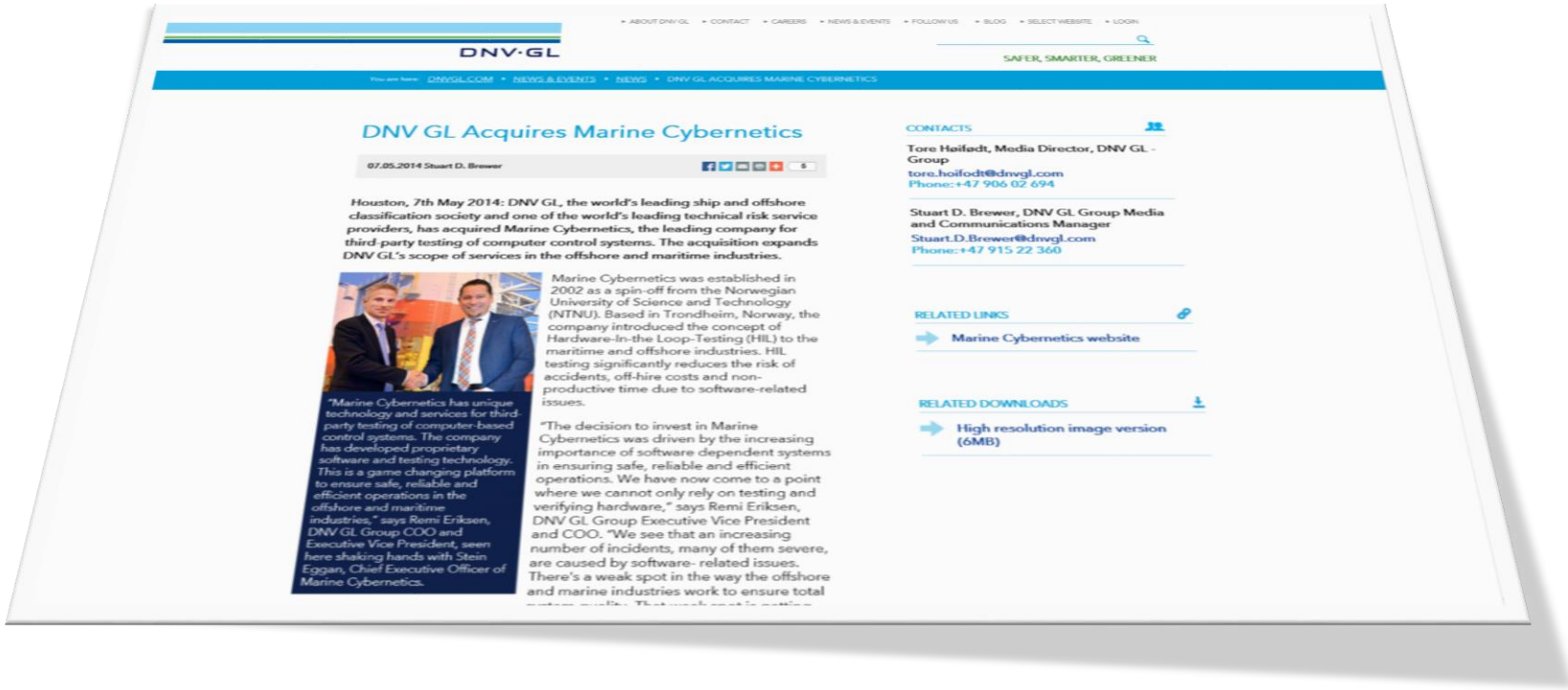

DNV·GL

SAFER, SMARTER, GREENER

DNV GL ACQUIRES MARINE CYBERNETICS

DNV GL Acquires Marine Cybernetics

07.05.2014 Stuart D. Brewer

Houston, 7th May 2014: DNV GL, the world's leading ship and offshore classification society and one of the world's leading technical risk service providers, has acquired Marine Cybernetics, the leading company for third-party testing of computer control systems. The acquisition expands DNV GL's scope of services in the offshore and maritime industries.

"Marine Cybernetics has unique technology and services for third-party testing of computer-based control systems. The company has developed proprietary software and testing technology. This is a game changing platform to ensure safe, reliable and efficient operations in the offshore and maritime industries," says Remi Eriksen, DNV GL Group COO and Executive Vice President, seen here shaking hands with Stein Eggan, Chief Executive Officer of Marine Cybernetics.

Marine Cybernetics was established in 2002 as a spin-off from the Norwegian University of Science and Technology (NTNU). Based in Trondheim, Norway, the company introduced the concept of Hardware-In-the Loop-Testing (HIL) to the maritime and offshore industries. HIL testing significantly reduces the risk of accidents, off-hire costs and non-productive time due to software-related issues.

"The decision to invest in Marine Cybernetics was driven by the increasing importance of software dependent systems in ensuring safe, reliable and efficient operations. We have now come to a point where we cannot only rely on testing and verifying hardware," says Remi Eriksen, DNV GL Group Executive Vice President and COO. "We see that an increasing number of incidents, many of them severe, are caused by software- related issues. There's a weak spot in the way the offshore and marine industries work to ensure total

CONTACTS

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RELATED LINKS

Marine Cybernetics website

RELATED DOWNLOADS

High resolution image version (6MB)

DNV·GL

MARINE CYBERNETICS

MARINE CYBERNETICS' CURRENT HIL TESTING OFFERING

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Testing of different control systems

Marine control systems (including on drilling rigs)

Dynamic Positioning (DP)

Steering, Propulsion, Thruster (SPT)

Power Management (PMS)

Drilling systems

Drill floor

Blowout preventer (BOP)

Intelligent Drilling/ Managed pressure drilling (MP

Other automation systems

Emergency Shutdown (ESD)

Crane

Bow-loading systems

Integrated systems

In most projects Marine Cybernetics tests several different control systems together and how they interact

Testing on different type of vessels and rigs

Mobile offshore drilling units (MODU)

40 drilling rigs tested

Platform Supply Vessels (PSV)

26 vessels tested

Offshore Construction Vessels (OCSV)

22 vessels tested

Anchor Handling Tug Supply (AHTS)

15 vessels tested

Shuttle Tankers

14 vessels tested

Emergency Rescue Recovery Vessels (ERRV)

6 vessels tested

Fixed installations

1 installation tested

Seismic Vessel

1 vessel tested

Marine Cybernetics offers HIL testing on a range of control system software for marine and drilling applications

WHAT IS HIL TESTING?

CONTROL SYSTEM IN NORMAL OPERATION – CONTROLLING SIMULATED VESSEL

CYBERSEA REAL-WORLD MODELS

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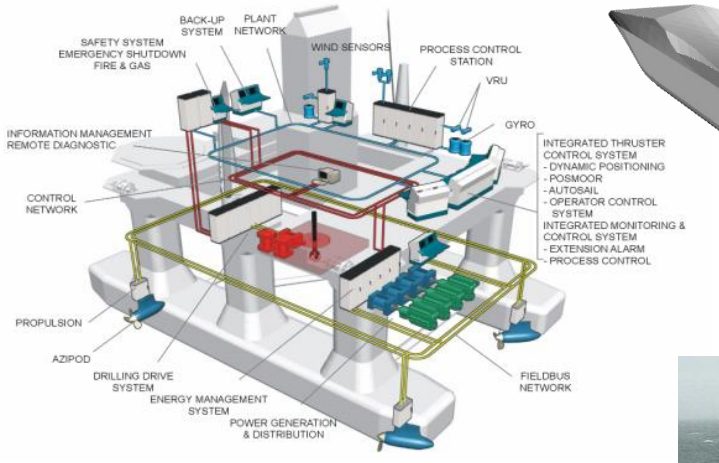
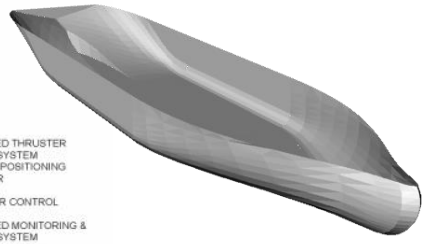
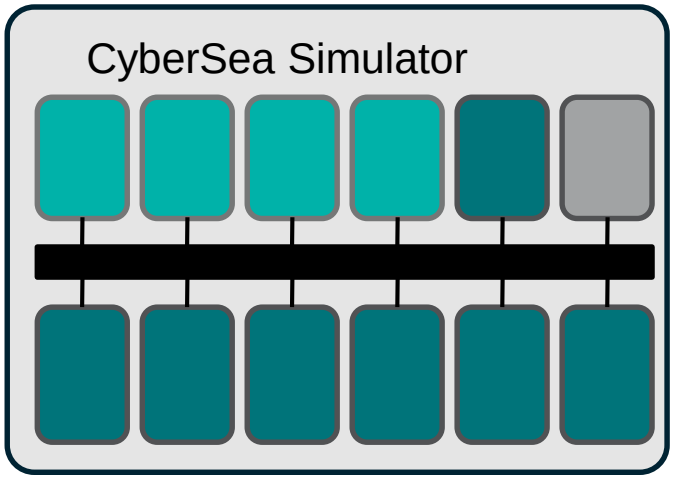






Mathematical models of environment, vessels, equipment and onboard systems are implemented and simulated in the CyberSea Simulator

Marine Cybernetics DP System (demo version)

Marine Cybernetics Dynamic Positioning System

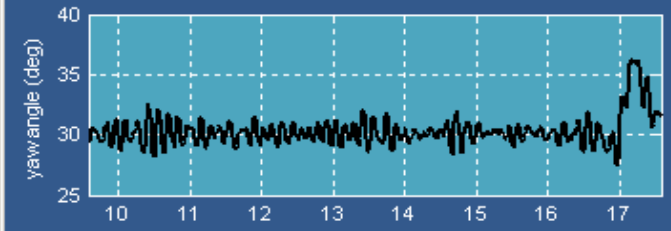
Marine Cybernetics
www.marinecybernetics.com

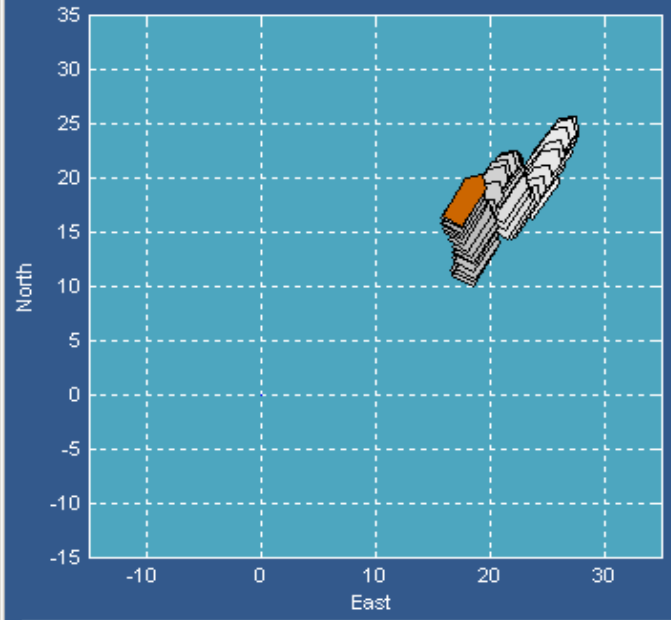
Set-Points

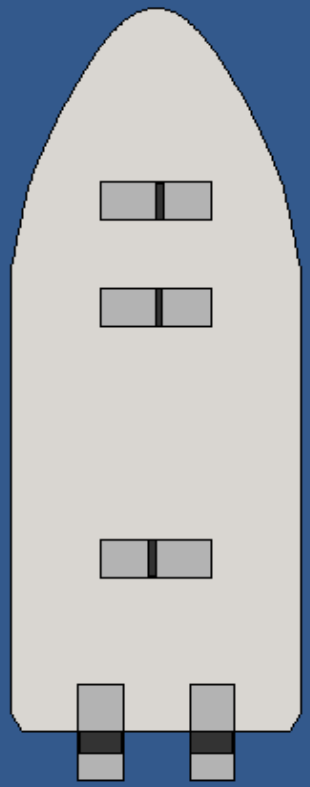
North position (m):	15.0
East position (m):	15.0
Heading (deg):	30.0

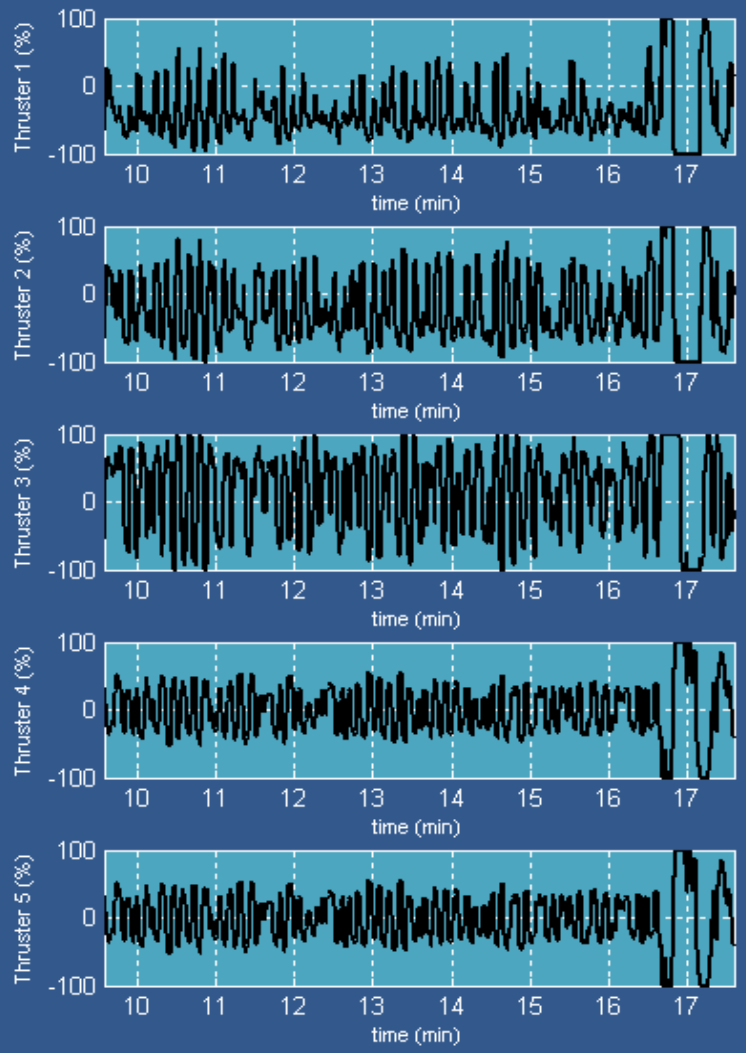
Sensors

	North	East
GPS1	16.8 m	19.1 m
GPS2	19.4 m	17.1 m
HPR	16.8 m	17.1 m
Gyro	31.6 deg	









12-Jun-2003 16:39:05 Warning: GPS2 wild-point detected
12-Jun-2003 16:18:06 Status: Marine Cybernetics DP running

CyberSea Simulator (Viking Poseidon DP) version 1.2066

Reset | Scenario | Settings | Environment | Power | DGPS | HPR | 24-Nov-2004 09:11:34 | ?

Vessel

Simulator time:	642s
Latitude:	60°24.5308'N
Longitude:	005°00.9929'E
North pos [m]:	-117.5
East pos [m]:	-13.8
Heading [deg]:	48.7
Heave pos [m]:	-1.2
Roll angle [deg]:	-0.9
Pitch angle [deg]:	0.0
Speed [m/s]:	0.1
Course [deg]:	58.6

Thrusters

	MTC	Pitch [%] cmd	Pitch [%] act	Pitch [%] fbck	Direction [deg] cmd	Direction [deg] act	Direction [deg] fbck
Thruster 1	☑	-17	-17	-17			
Thruster 2	☑	-17	-17	-17			
Thruster 3	☑	18	18	18	-105	-150	-150
Thruster 4	☑	20	20	20			
Thruster 5	☑	20	20	20			
Thruster 6	☑	-9	-9	-9			
Thruster 7	☑	9	9	9			
Rudder port	☑				0	0	0
Rudder stbd	☑				0	0	0

Posref / Sensors

	North	East
DGPS1	-100.8 m	2.0 m
DGPS2	-102.5 m	4.7 m
HPR1	-117.5 m	-15.1 m
HPR2	----	----
Artemis	----	----
Fanbeam	-106.1 m	4.3 m
Tautwire	----	----

	Roll	Pitch
VRS1	-0.9°	0.0°
VRS2	-0.9°	-0.0°

	Heading
Gyro1	49.2°
Gyro2	49.2°
Gyro3	49.1°

	Speed	Dir
Wind 1	0.0 m/s	10.2°
Wind 2	0.1 m/s	10.3°

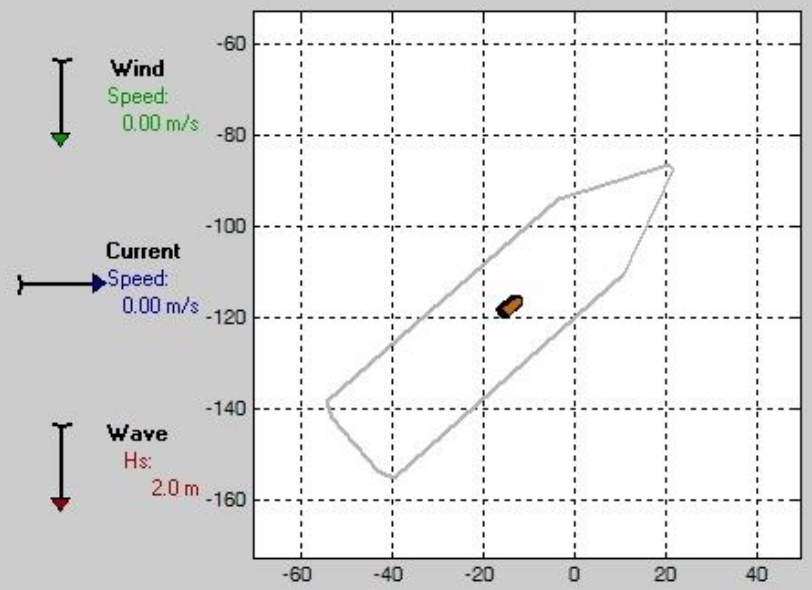
☐ SensorBypass

Network status

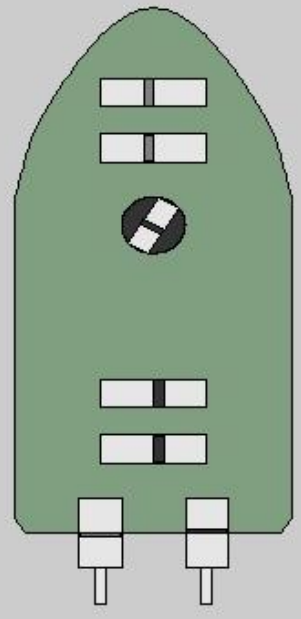
☑ Net A selected

Status Net A

Status Net B

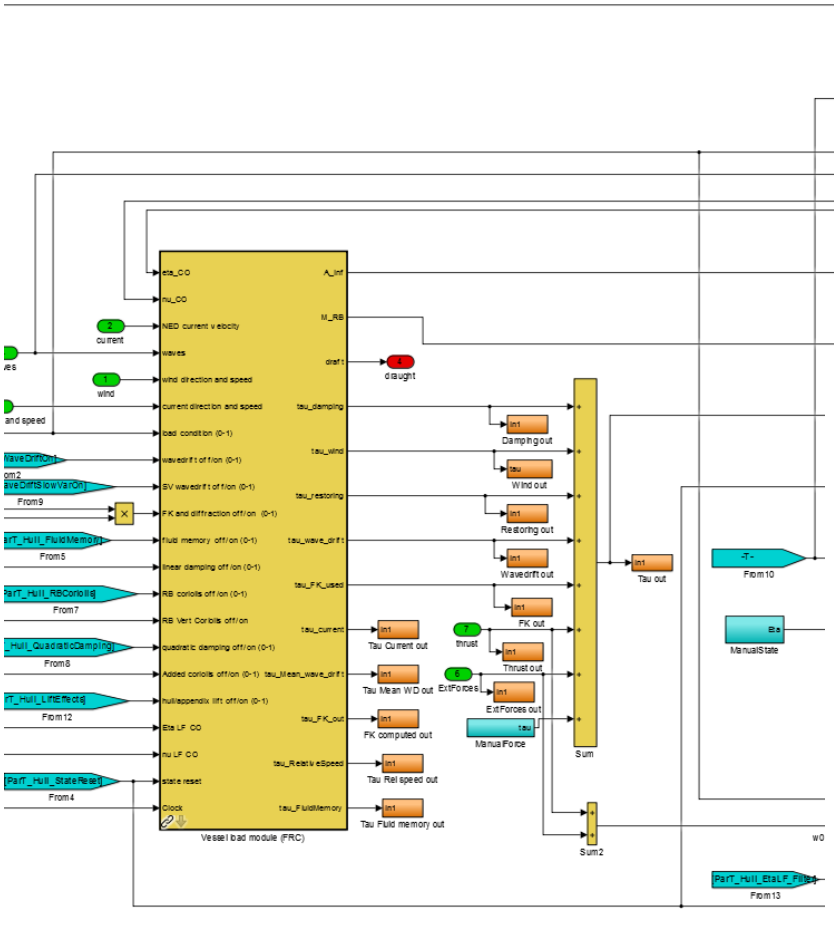


Center



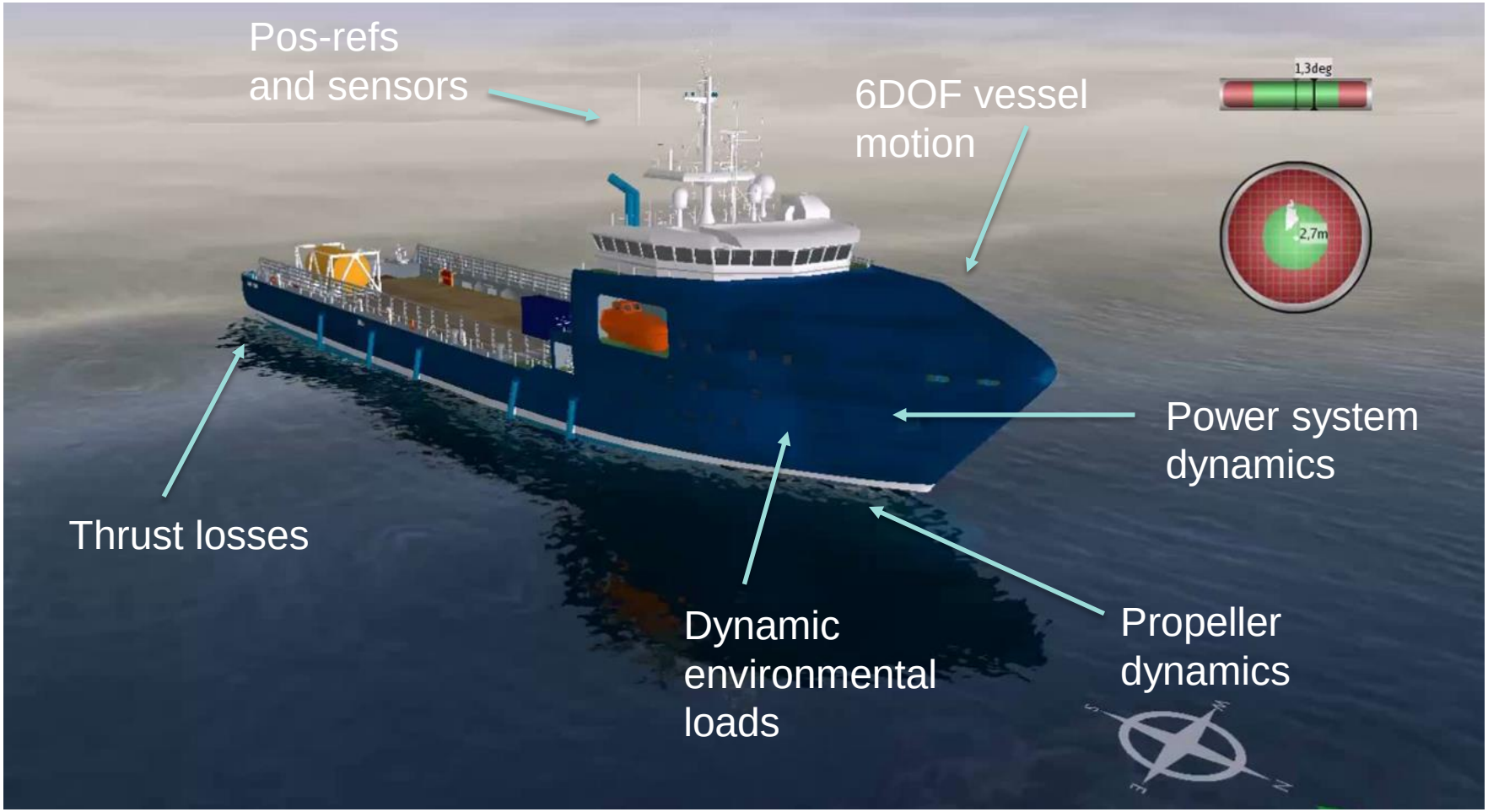
MC

THE FUN STUFF – UNDER THE HOOD

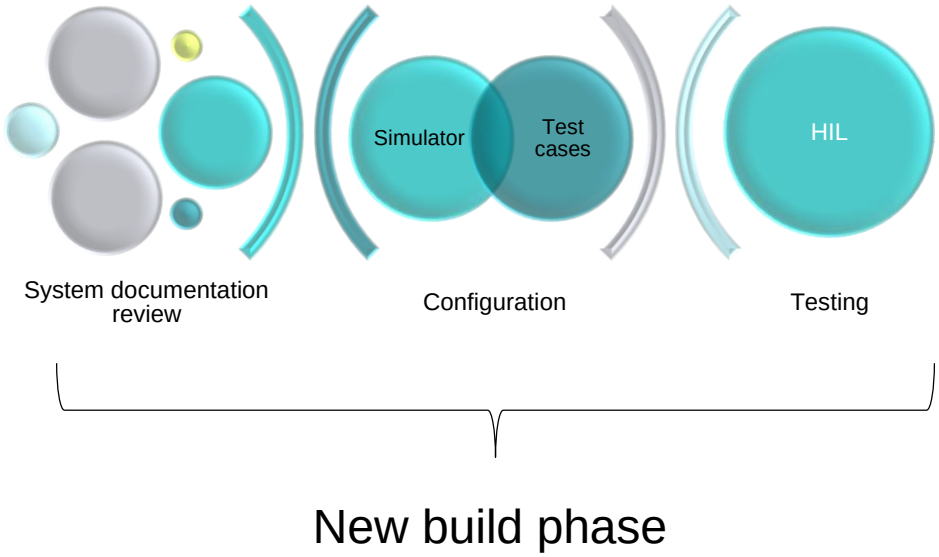



```
Input.Offloading.Mode    = 0;     %  0 = tandem, 1 = SAL, 2 = SPM

% 1. Hawser data for TANDEM operation
Input.Hawser.Weight{1}     = 17.4;              % weight per meter cable length (kg)
Input.Hawser.YoungsMod{1} = 0.12e9;             % Young's modulus (Pa)
Input.Hawser.Length{1}     = 80.0;              % length of cable (m)
Input.Hawser.Area{1}       = pi*0.084^2;        % cross-section area of bow hawser (m2)
Input.Hawser.Break{1}      = 656*9.81*1e3;      % breaking load (N)
Lpp_Target                 = 232;               % Length of FPSO
Input.TurretLocation       = 0.8*Lpp_Target;    % Arm from CG (Turret) to aft point of FPSO.

% 2. Hawser data for submerged turret loading (SAL)
Input.Hawser.Weight{2}     = 3;            % neutrally buoyant (weight/buoyancy) (kg)
Input.Hawser.YoungsMod{2} = 0.12e9;        % Young's modulus (Pa)
Input.Hawser.Length{2}     = 200.0;        % length of cable (m)
Input.Hawser.Area{2}       = pi*0.084^2;   % cross-section area of bow hawser (m2)
Input.Hawser.Break{2}      = 656*9.81*1e3; % breaking load (N)
Input.Hawser.DepthSAL      = 100.0;        % water depth (m)

% 3. Hawser data for single point mooring (SPM)
Input.Hawser.Weight{3}     = 17.4;         % weight per meter cable length (kg)
Input.Hawser.YoungsMod{3} = 0.12e9;        % Young's modulus (Pa)
Input.Hawser.Length{3}     = 80.0;         % length of cable (m)
Input.Hawser.Area{3}       = pi*0.084^2;   % cross-section area of bow hawser (m2)
Input.Hawser.Break{3}      = 656*9.81*1e3; % breaking load (N)

% Target origin w.r.t. hawser atack point (only for tandem operation)

Input.TargetPsi      = 30*pi/180;           % initial heading of target

% Tandem data for FPSO
Input.TandemMinv      = inv(diag([160e6 180e6 9.1e11]));   % inverse mass matrix
Input.TandemZeta      = 1.0*[1 1 1];                       % relative damping ratios
Input.TandemTimeConst = [70 70 70];                        % Time constants
```

THE CYBERSEA VESSEL SIMULATOR



TODAY – MANUAL HIL TESTING



Challenges

WAY FORWARD - MANUAL AND AUTOMATIC HIL TESTING

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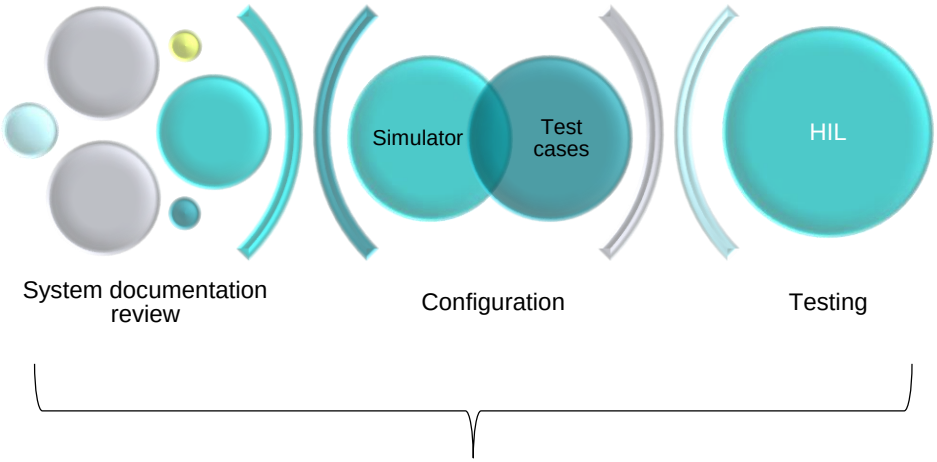
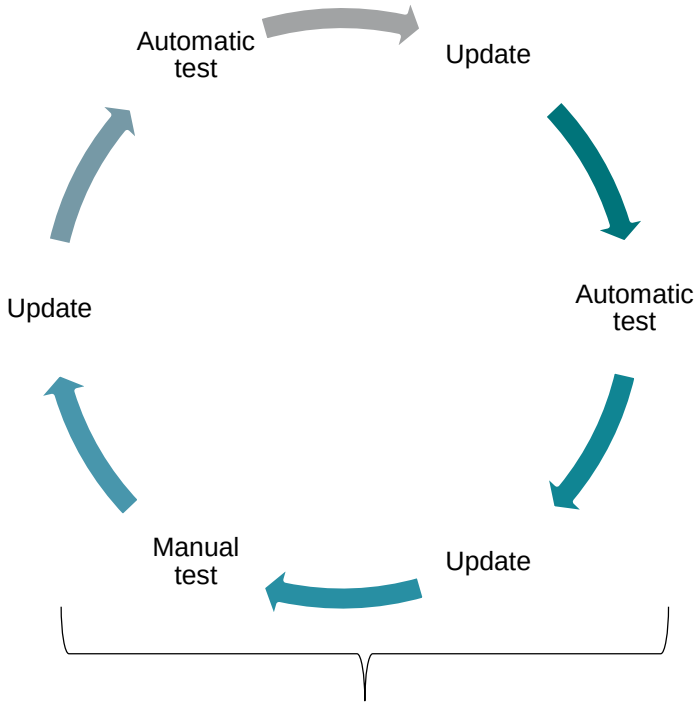
Solution



New build phase



Ship in operation phase

CYBERSEA SIGNATURE

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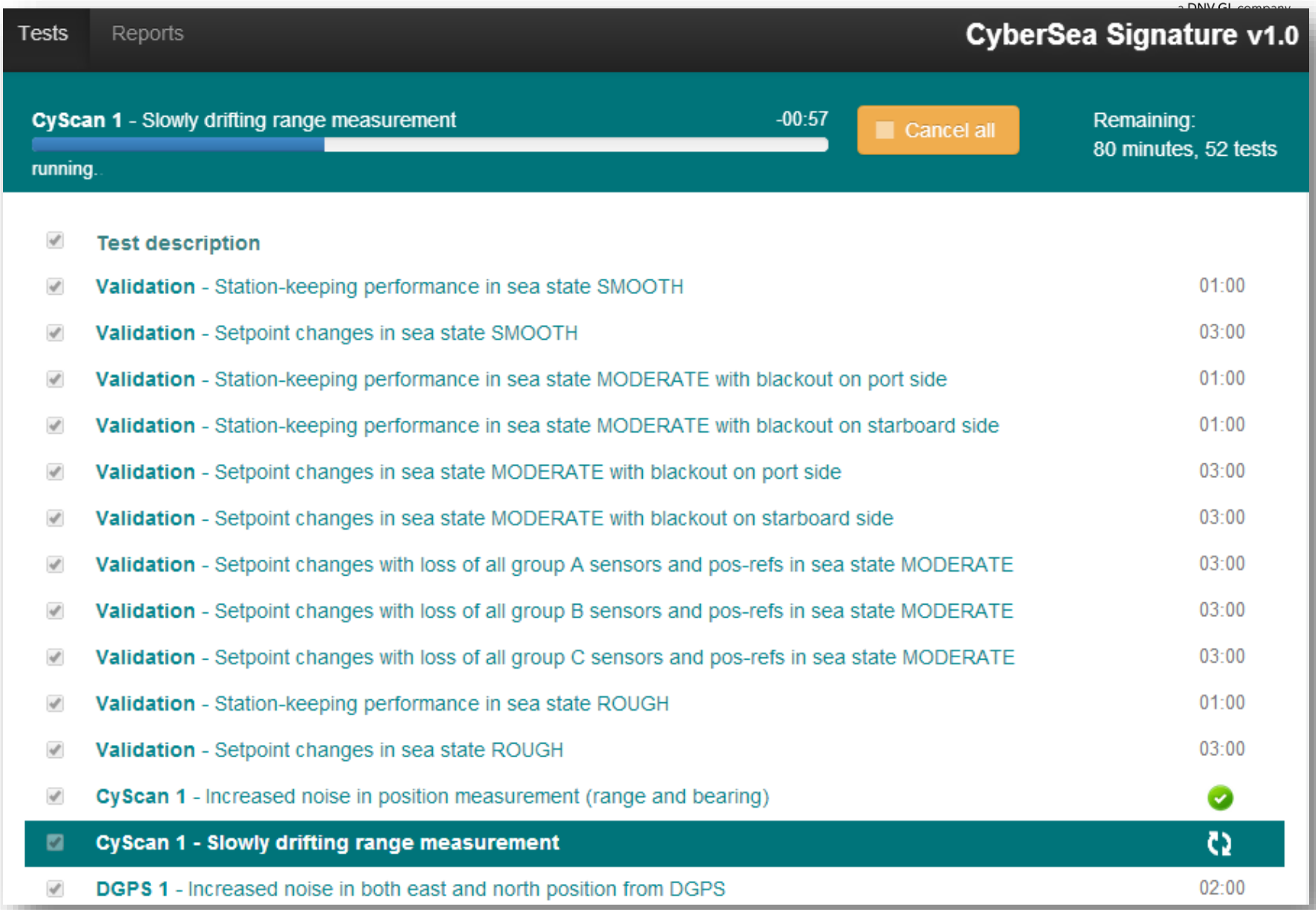

HIL TESTING TODAY – HARDWARE INTENSIVE

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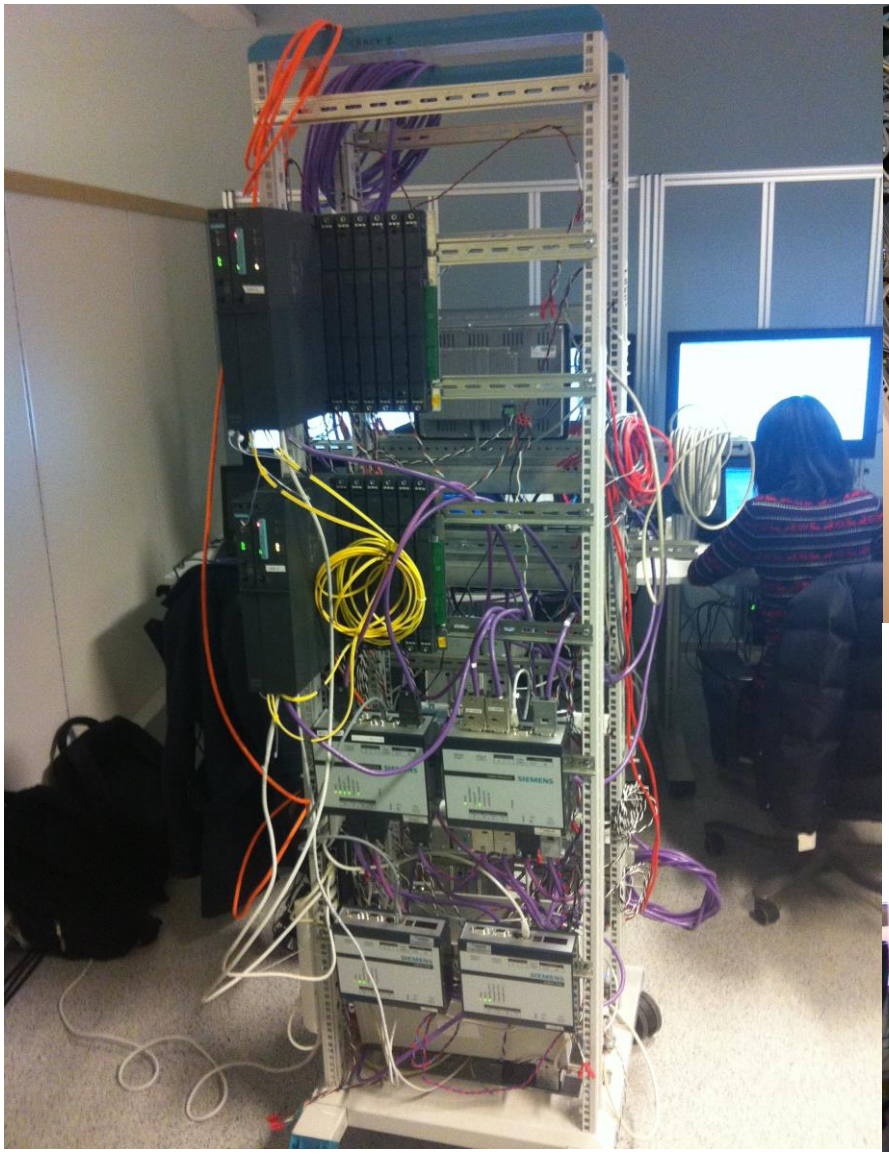
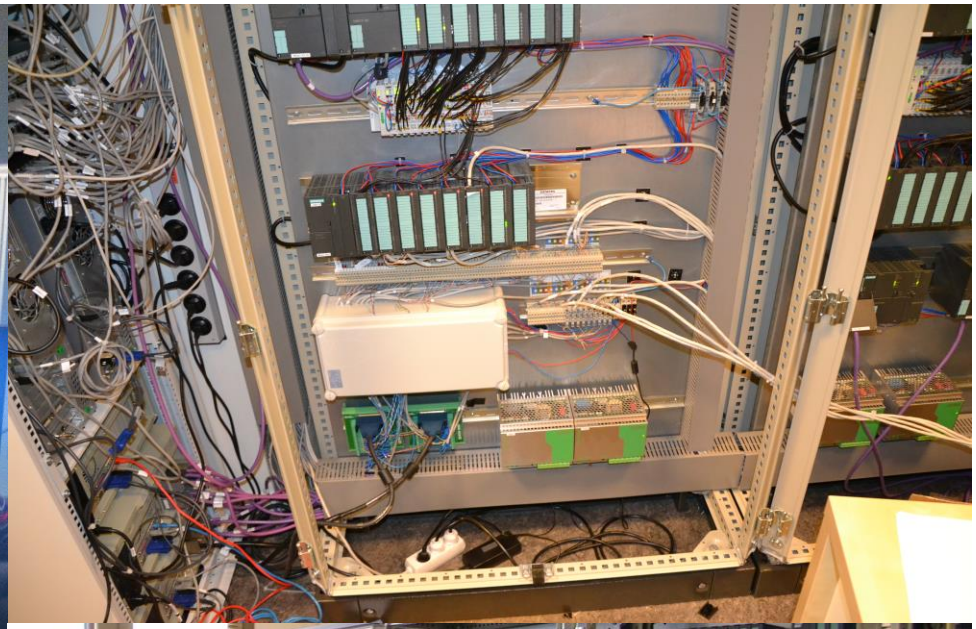
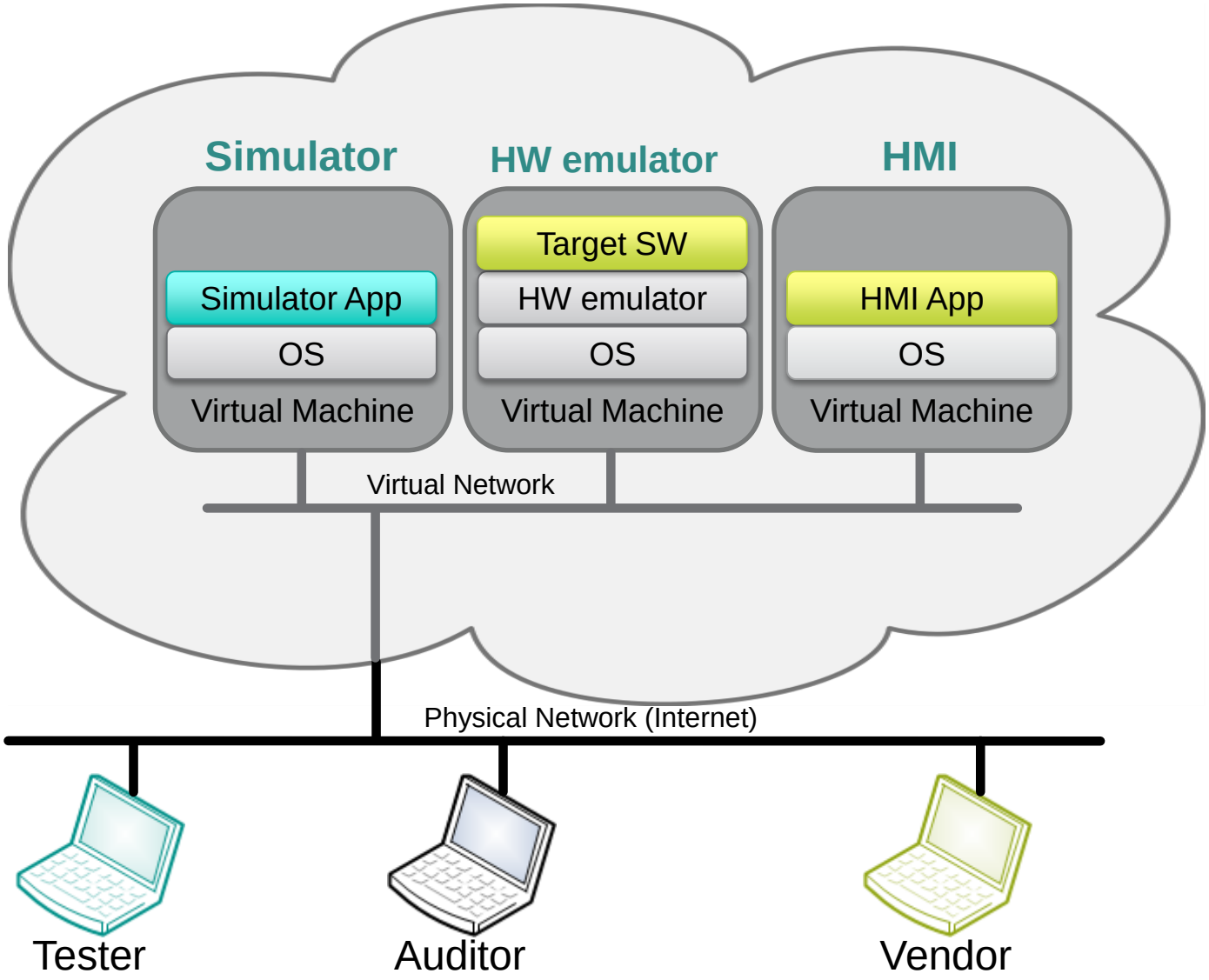




SOFTWARE-IN-THE-LOOP (SIL)



SIL CLOUD SERVICE – VIRTUAL TEST SETUPS

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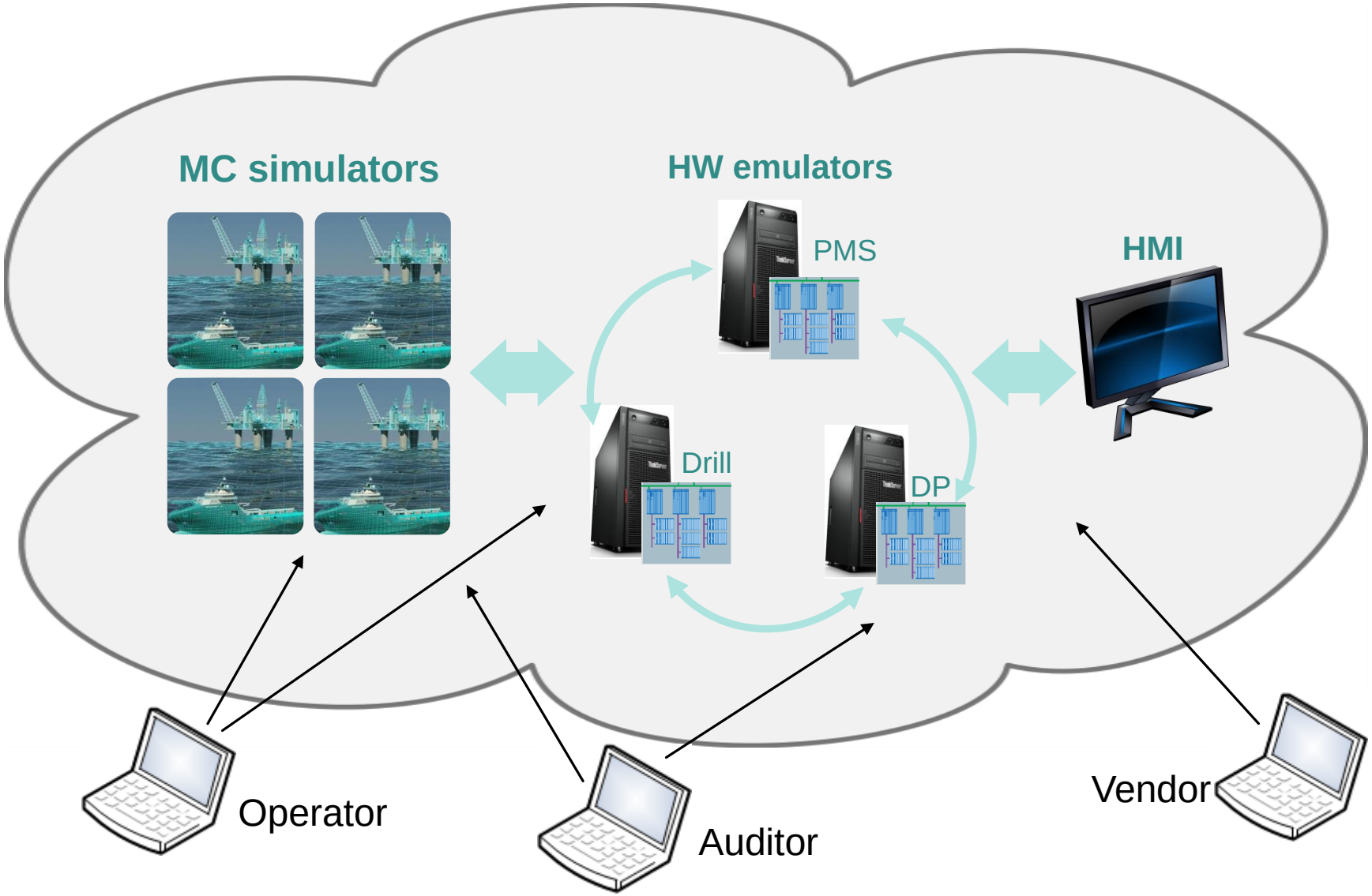

DNV GL LONG-TERM VISION