The future of digital assurance

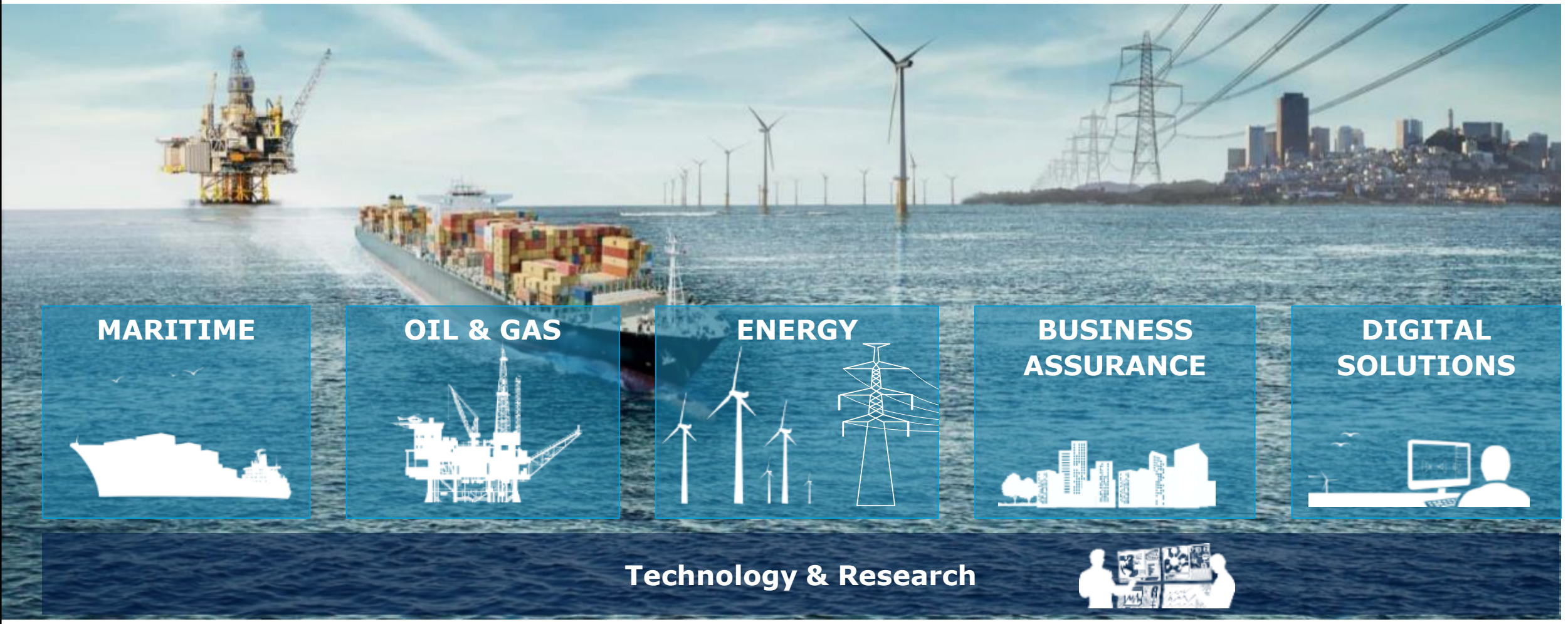
Close your trust gap in a digital world

Michael Chen

10 December 2020

Contents

Group Technology and Research serves all business areas of DNV GL



Group Technology and Research programs in 2020

MARITIME

- Digital class
- Remote-controlled and autonomous ships
- Zero carbon fuels

OIL & GAS

- Safety of unmanned facilities
- Twin-based assurance
- Low carbon value chains

POWER & RENEWABLES

- Renewables
- Assurance of digital assets in power

PRECISION MEDICINE

- Data sharing
- Assurance of technologies & processes

DIGITAL ASSURANCE

- Simulation & testing
- Assurance of digital assets
- Remote inspection

OCEAN SPACE

- Aquaculture
- New ocean value chains

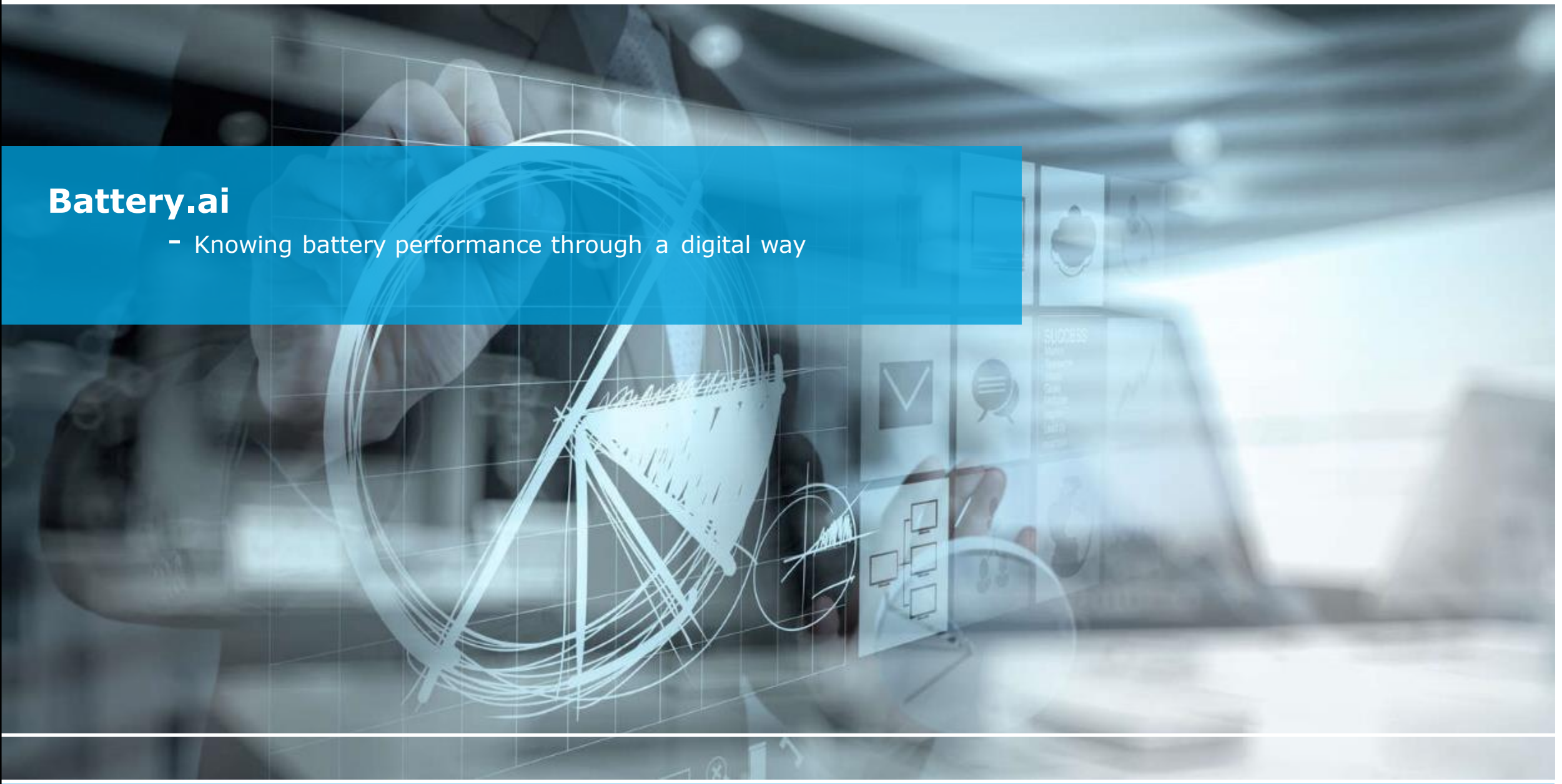
ENERGY TRANSITION

- Energy transition outlook

ARTIFICIAL INTELLIGENCE

- Computer vision
- AIoT assurance

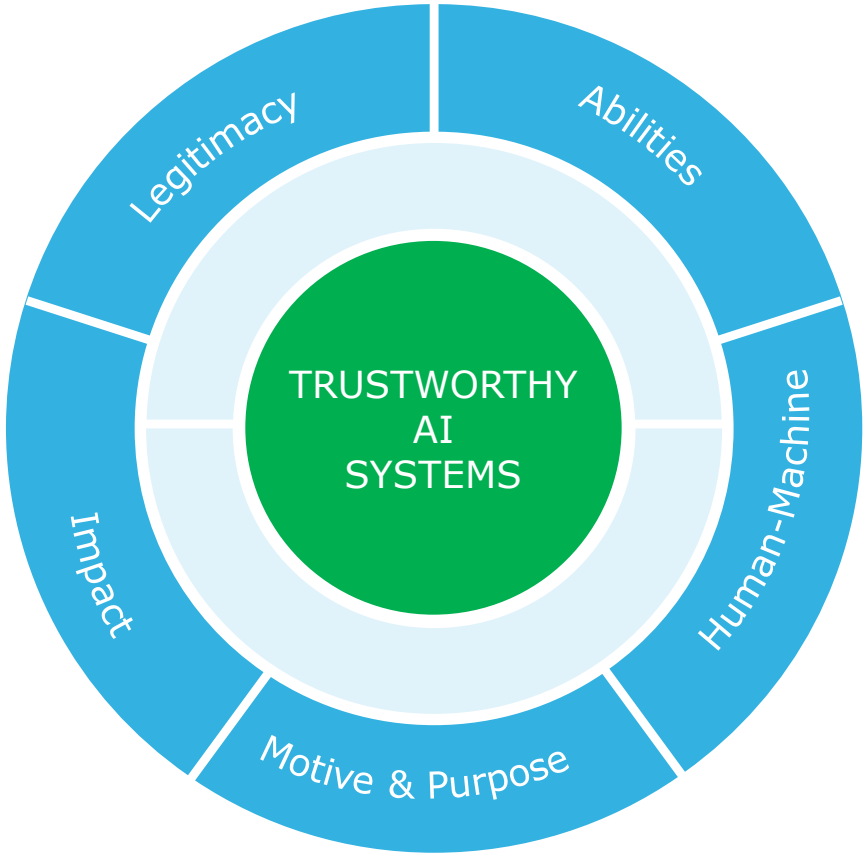
The role of DNV GL in the digital era

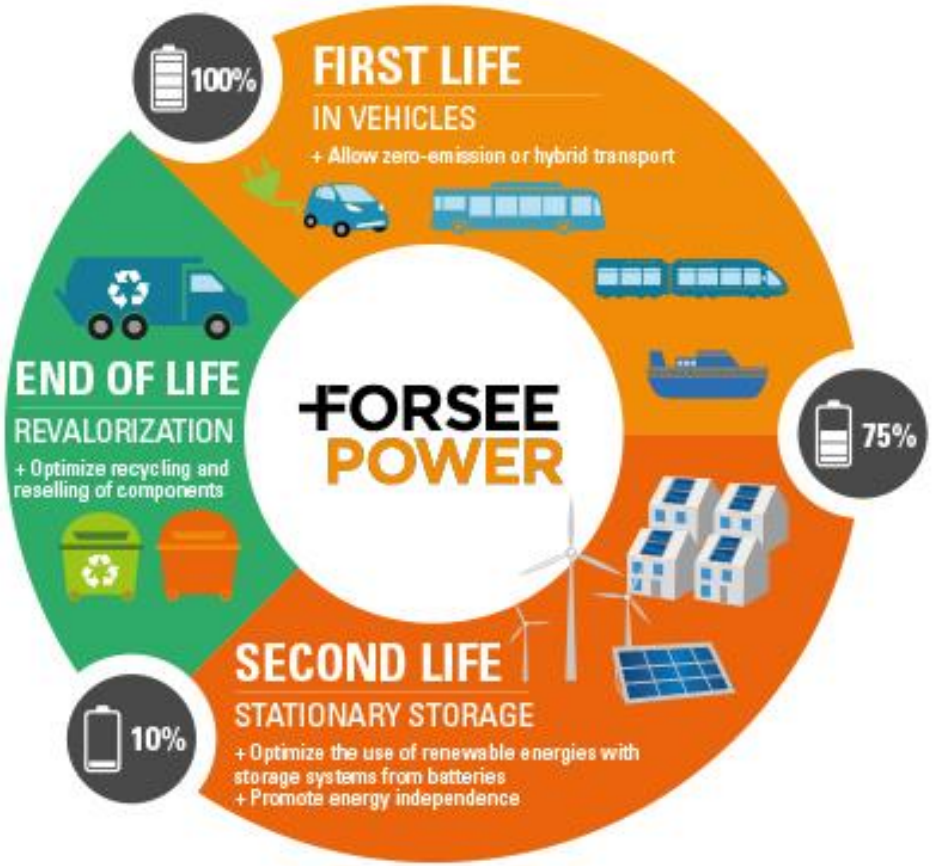


Battery.ai

- Knowing battery performance through a digital way

Trust gap needs to be closed in each phase of battery



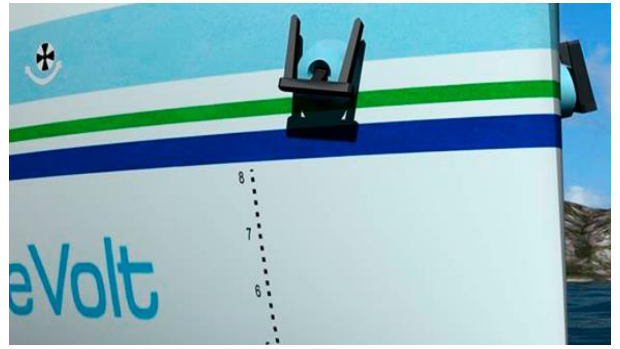


Understanding battery performance independently is important

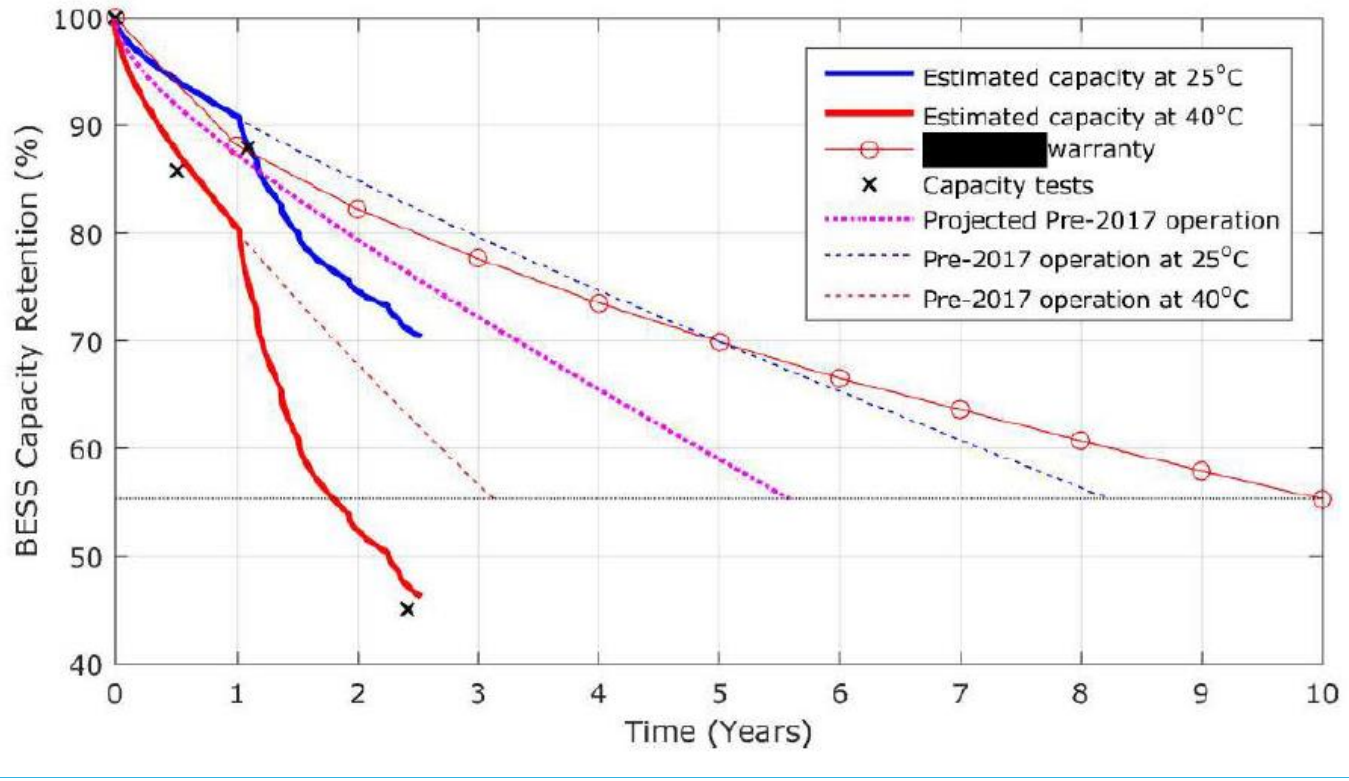
- Business domains:

Solar, wind energy storage

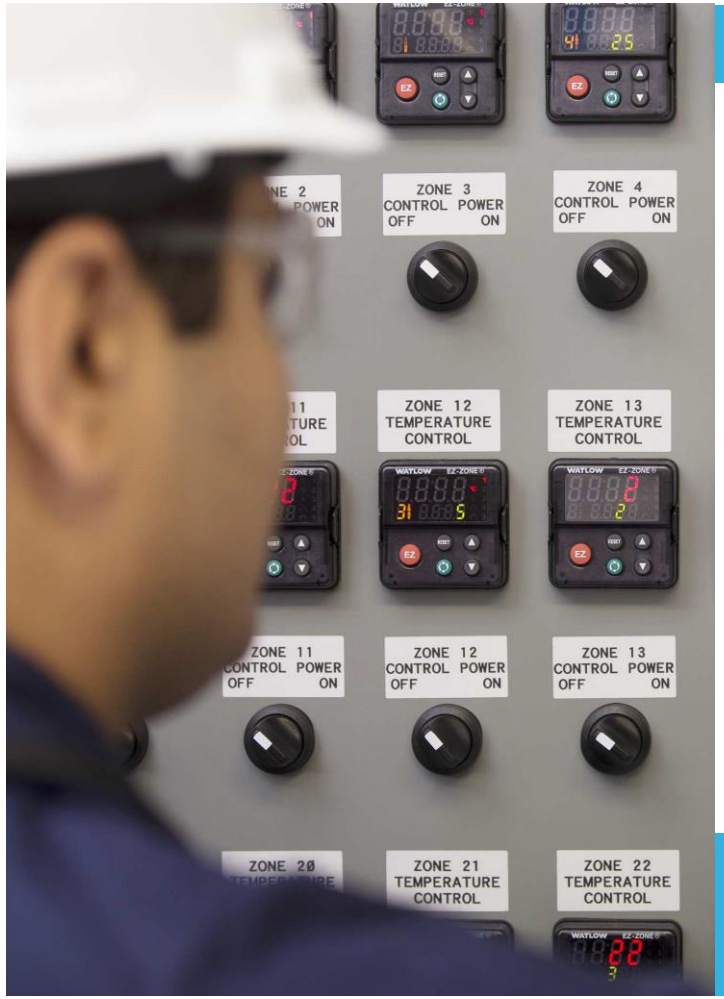
Maritime renewable ships



- Technical needs:
  - Sizing,
  - Battery
  - Storage
  - Battery



Traditional testing



Annual capacity test – uncertainties, errors

- DoD should be at least 50% (even then there is some uncertainty)
  - 100% is not practical on the vessel
- Impractical relaxation of 2 hours
- Effect of temperature
- Effect of current level and current regulation
- Current sensor error
- Temperature sensor error
- Cell voltage sensor accuracy

Our solution- Battery.ai

Big data

Millions of PQP testing hours per year

+

AI

+

DNVGL Expert

Phase I: battery degradation analysis tool

- Predict for preset and dynamic conditions
- Design assistant tool to rightsizing battery systems and architectures
- Analysis tool to understand degradation for operational sites and estimate the RUL
- Speed battery tests

Phase II: online battery health monitoring

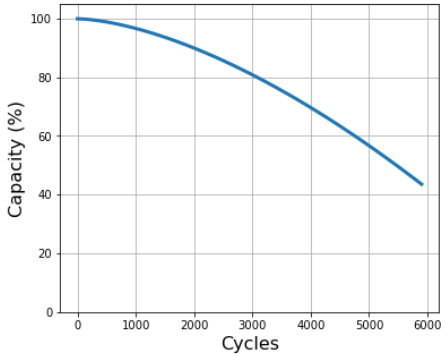
- Online prediction for operating condition
- Checkup of warranty in time
- Reduce/replace the time-consuming and intrusive experimental capacity tests
- Early warning of unusual degradation

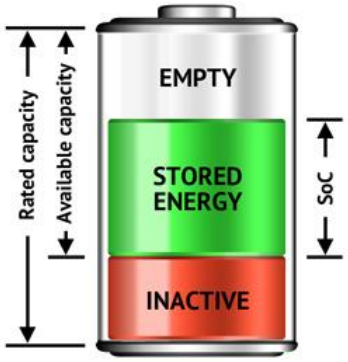
Objectives

State of health(SOH) estimation

SOH reflects the current maximum available capacity of a battery, compared to its nominal capacity.

- ✓ Capacity
- ✓ Resistance





Traditional

Capacity Experiment

Resistance Experiment

Objective

Data

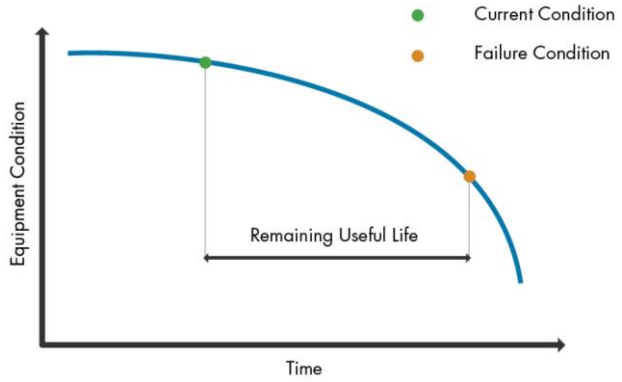
SOH Estimation

- ✓ Less time
- ✓ Low cost
- ✓ Online without intervention

Residual useful life(RUL)

Length of time that a battery is likely to operate before it requires repair or replacement.

- ✓ Failure threshold definition
- ✓ Degradation trend prediction



Condition before $T_{failure}$

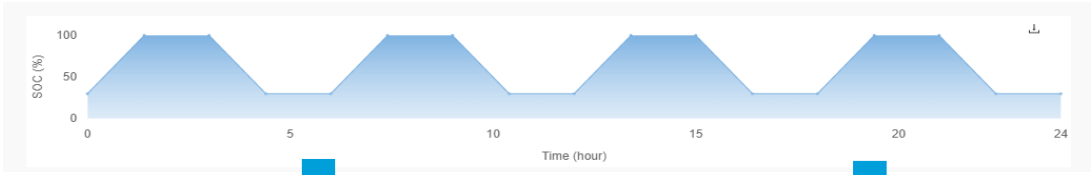
SOH Estimation

RUL

Degradation Modelling

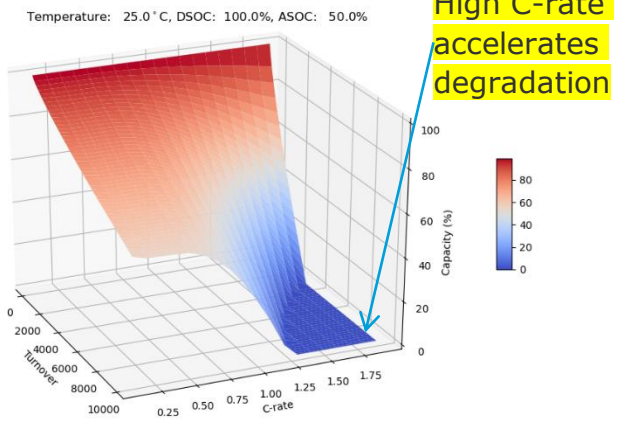
Degrading Factors

Charge/Discharge rate | Average SOC | SOC Window | Temperature



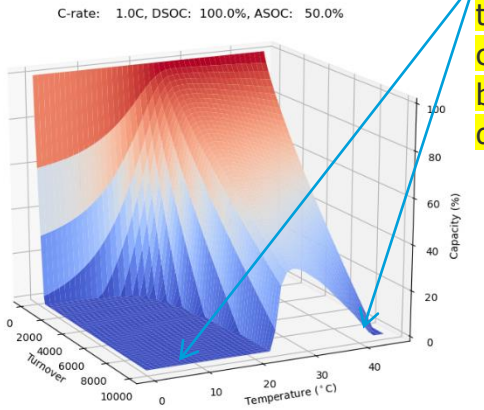
Empirical Model | Deep Learning Model

C-rate Effects



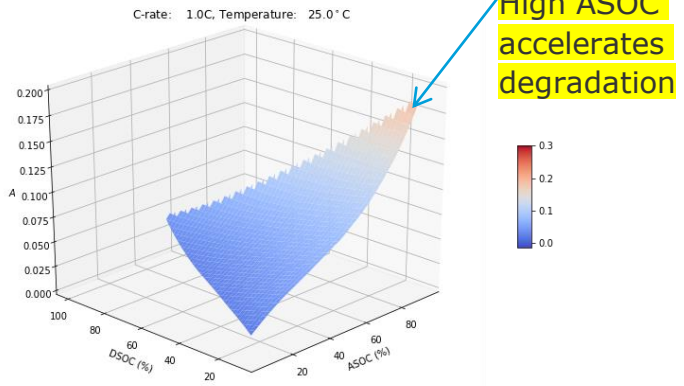
High C-rate accelerates degradation

Temperature Effects



High/low temperature can accelerate battery degradation

ASOC and DSOC Effects

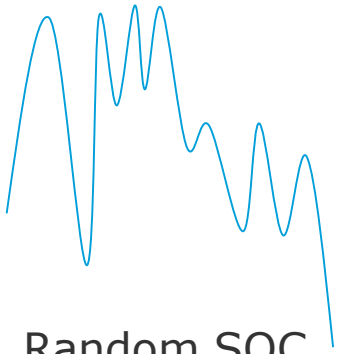


High ASOC accelerates degradation

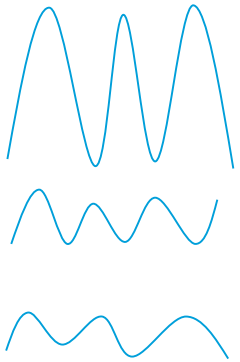
A is degradation coefficient.

Dynamic conditions

- Cycle decomposition

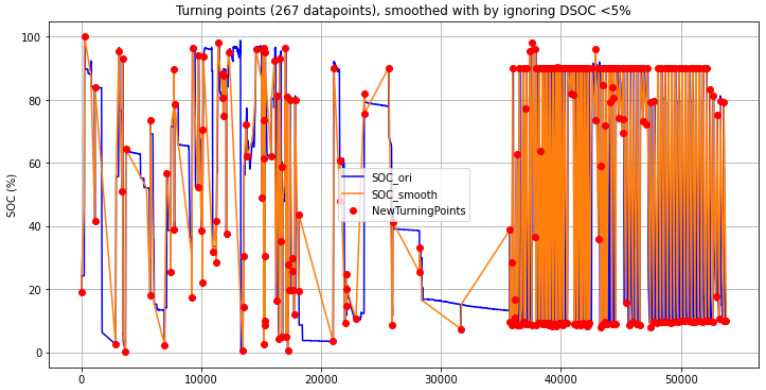


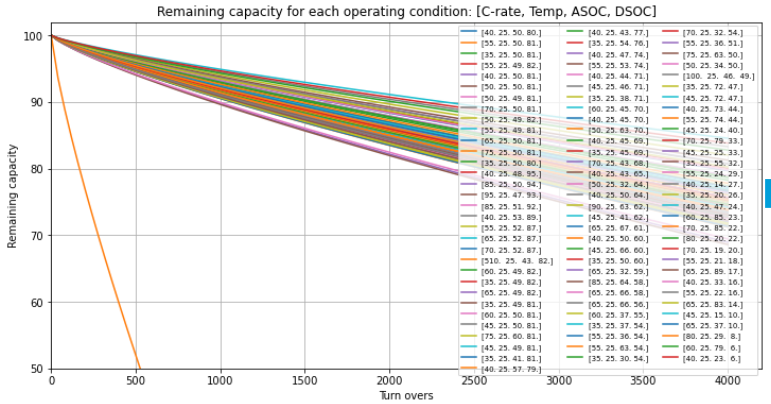
Random SOC

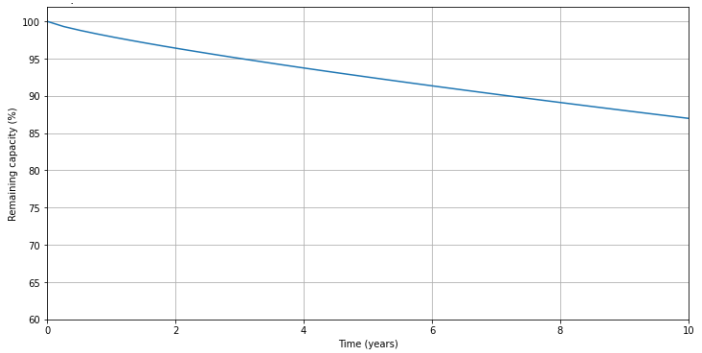


Standard SOC

Combined Prediction

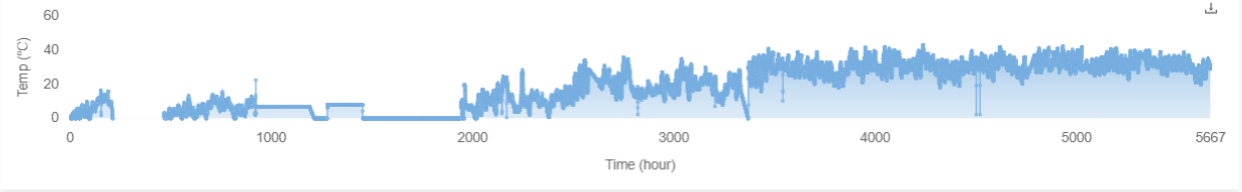


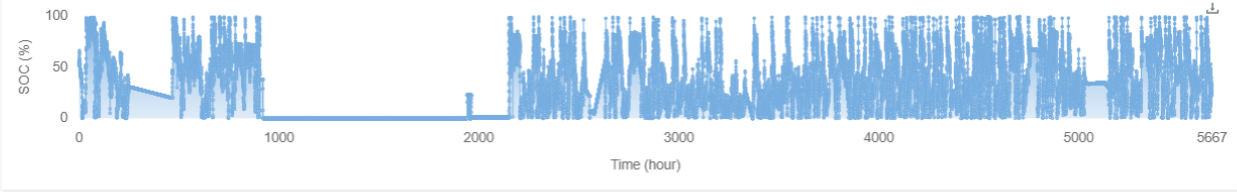




Battery.ai 1.0 live

My conditions: Preset test 1 | Preset test 2 | EDF_PCS001_Stage1

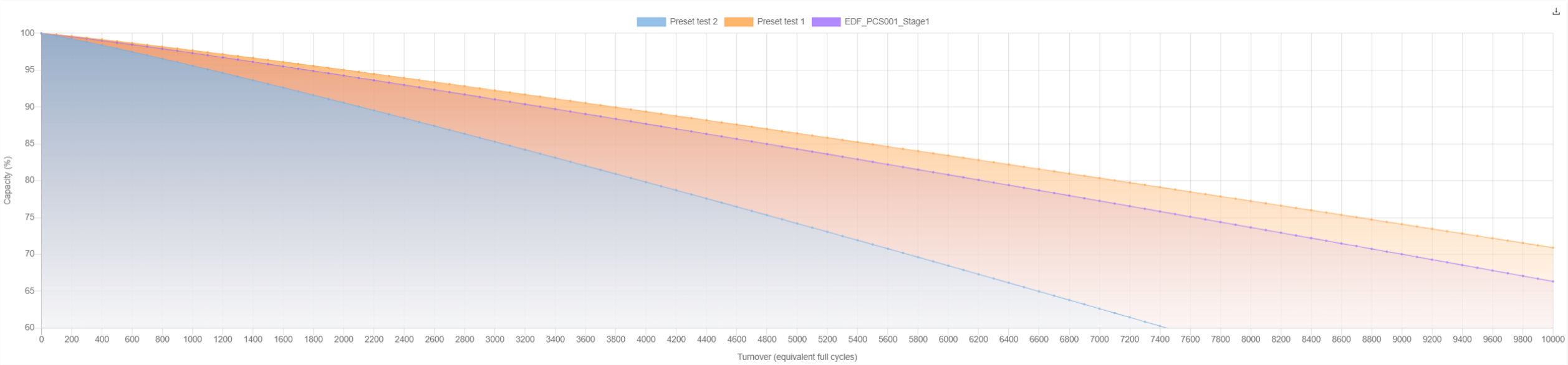




Estimated degradation

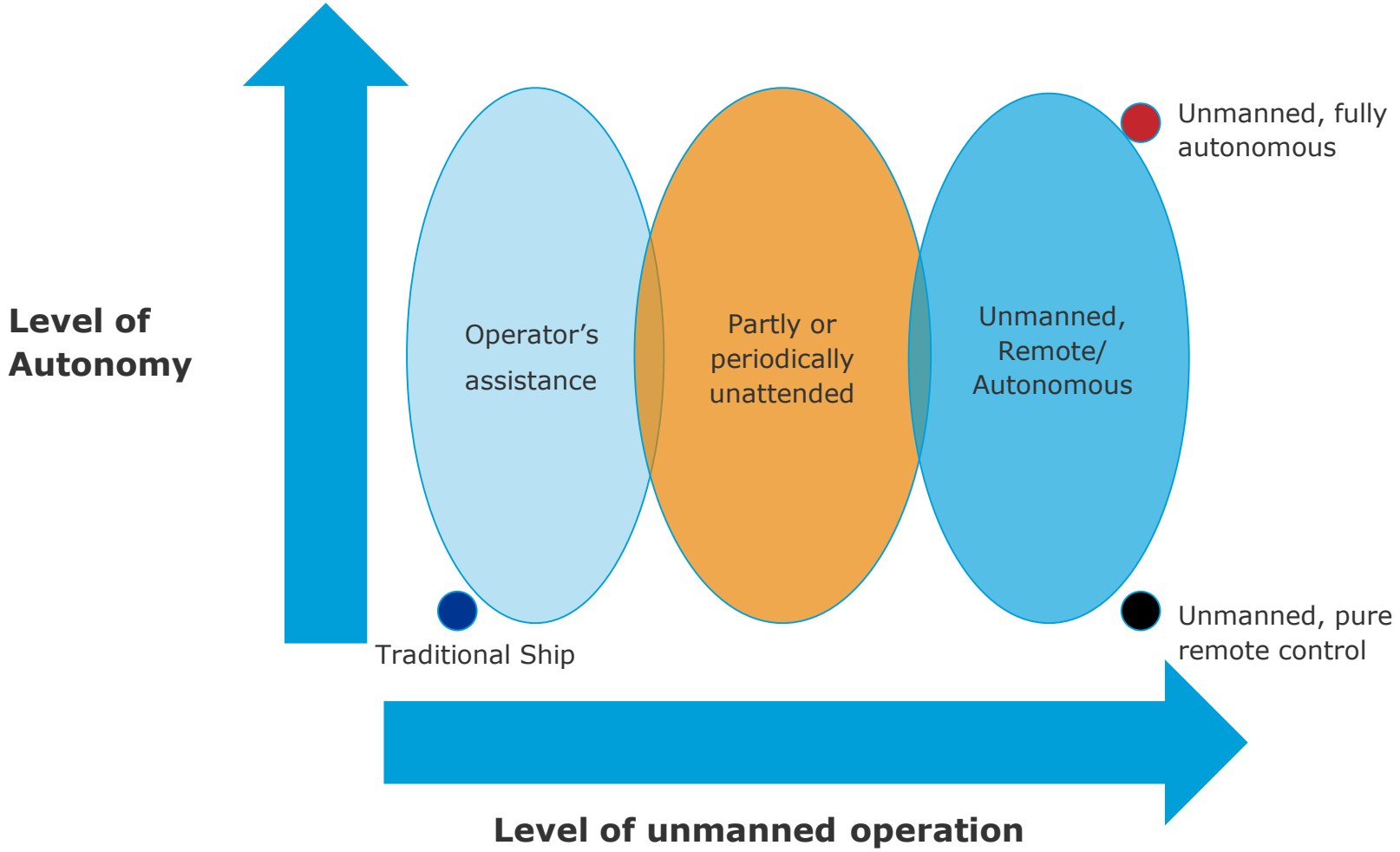
BATTERIES COMPARISON | CONDITIONS COMPARISON

Show batteries: NMC_X(NMC_X_ml_1.0) NMC_X_1(NMC_X_em_1.0) | Turnover (equivalent full cycles)



Autonomous ships in a safety perspective

“Autonomous Ships” – what does it encompass?



Early applications

Remote controlled engine room operation

Tested with Fjord1 ferry in 2019

Fully electric and later autonomous/remote controlled container vessel – short distance

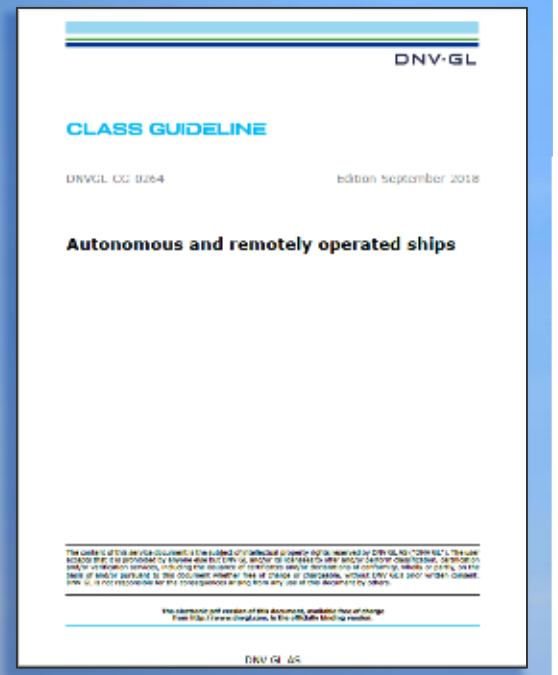
Launched in early 2020, operation to start later

DNV GL guidelines for autonomous and remotely operated ships (DNVGL-CG-0264)

Assuring autonomous and remote controlled ships – first steps

The principles in the class guideline

1. ***Equivalent safety*** *to conventional vessels*
2. ***A risk-based approach*** *for the unknown aspects*
3. ***Operational focus****, what shall be done? what to automate? Who is in charge?*
4. ***Minimum risk conditions****, there shall be a plan B, C, … to keep the vessel safe*
5. ***Functional focus****, 14 different key functions, some may be distributed in the infrastructure*
6. ***Autonomy and remote-control categories per function****, navigation vs engineering*
7. ***System engineering and integration****, verifying the complete functionality and capabilities*
8. ***General design-principles****, for single failures, redundancy, independence and failure-types*
9. ***Software engineering and testing****, processes for software-development, use of simulators*
10. ***Cyber security****, separate cyber security analysis, the 'cyber secure' class notation*


DNV·GL

CLASS GUIDELINE

DNVGL-CG-0264 Edition September 2018

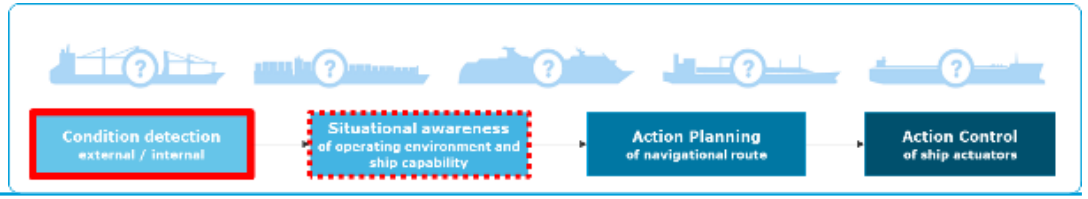
Autonomous and remotely operated ships

DNV GL AS

Available at: http://rules.dnvgl.com/docs/pdf/DNVGL/CG/2018-09/DNVGL-CG-0264.pdf

Testing autonomous ship navigation software

Test set up for condition detection – using augmented images



Class scope

Meta data analysis

Data augmentation

Algorithm evaluation

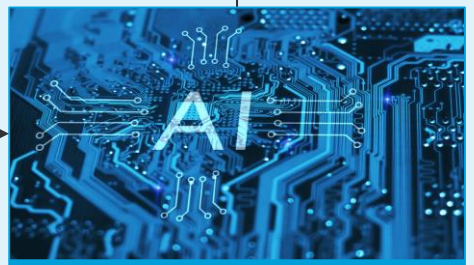
Test report

TEST INTERFACE

Vendor scope

Data for training

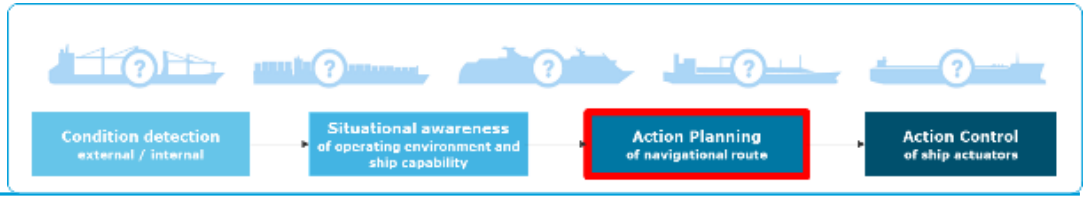
Data for test



Algorithm training / testing

Algorithm deployment

Test set up for collision avoidance – using simulations of ship-to-ship encounters



Class scope

TEST MANAGEMENT SYSTEM

VIRTUAL WORLD

Vendor scope

Metocean conditions

Traffic

Map

Vessel configuration

White box

Scenario Manager

Set scenario inputs

TEST INTERFACE

Grey box

OPERATING ENVIRONMENT

Wind
Waves
Current

Geographic location

Interactive traffic situation

Sensor input

Motion

Set test inputs

Black box

COLREGS

Safety

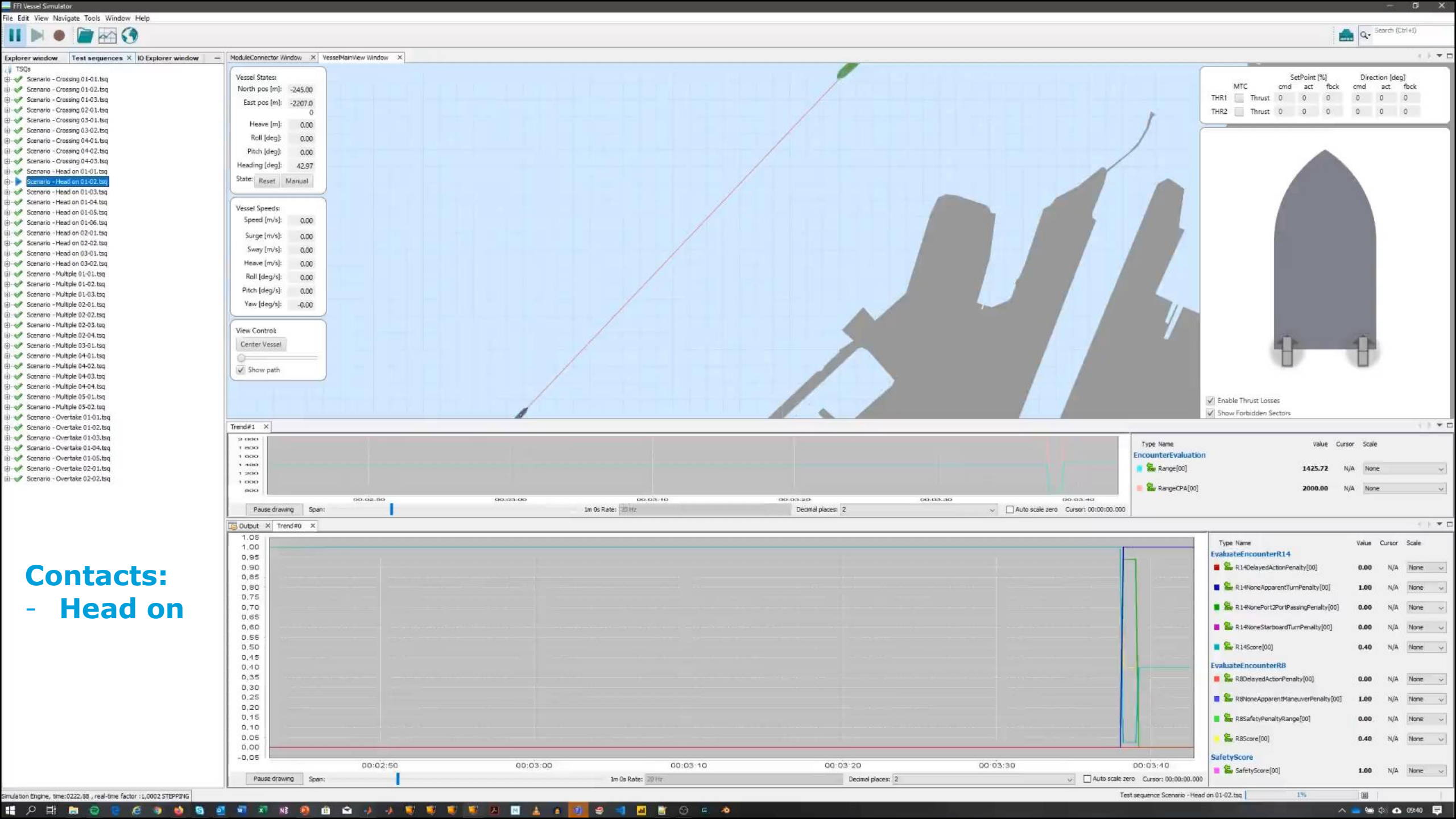
Rules & regulations

White box

Test Evaluation

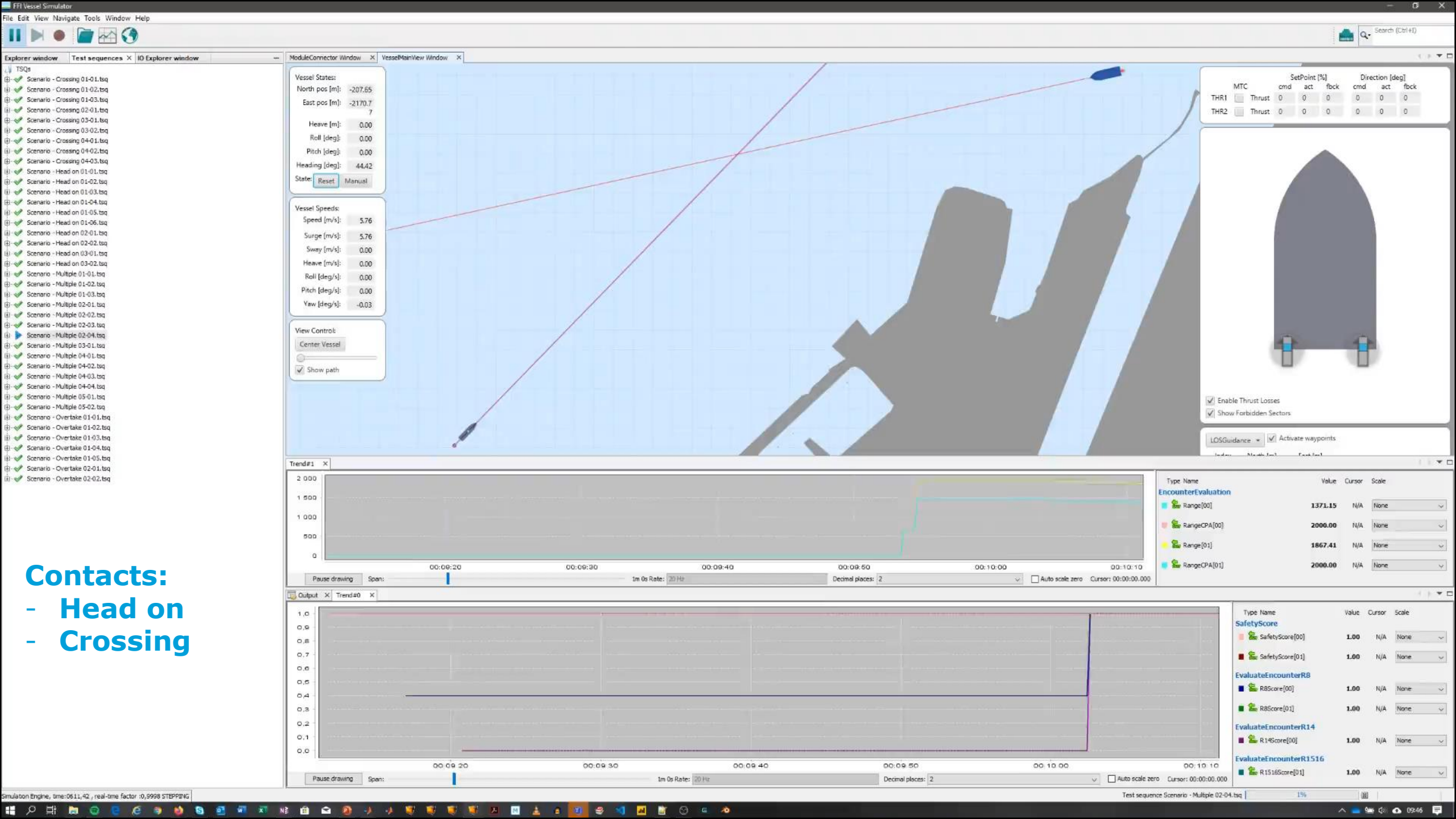
Alarms actions

Scenario log



Contacts:

- **Head on**



Contacts:

- **Head on**
- **Crossing**

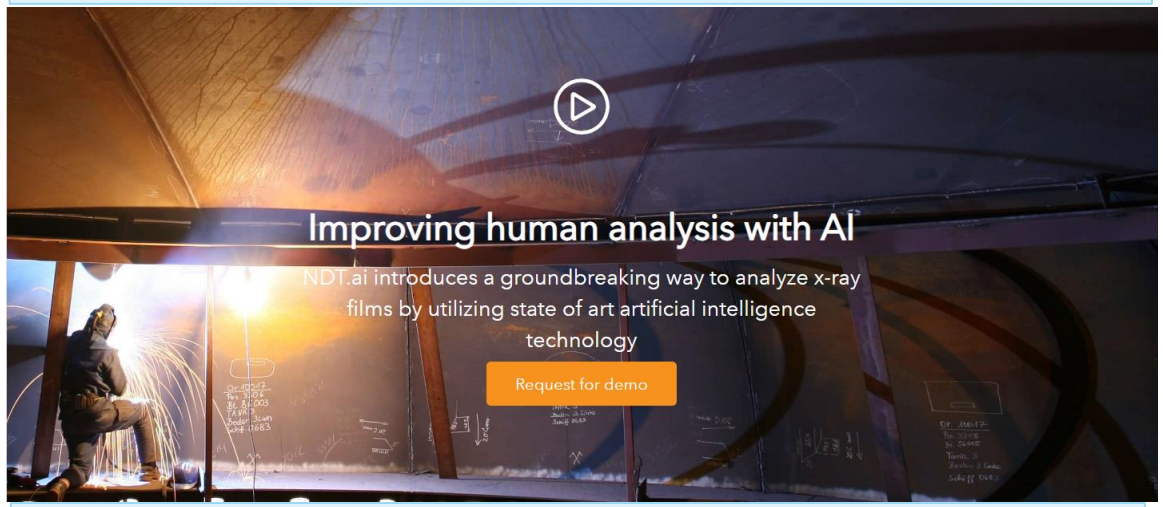
Boarder interests

Explore artificial intelligence technologies and build into prototypes for new/enhanced services

Corrosion.ai

- Full type support
- Condition assessment (IMO)
- Area measurement with depth information
- Online, Offline & video support
- Full coverage (image stitching)

NDT.ai



- Image quality check
- Film processing
- Full type indication assessment
- Digital assistance

Comments and Questions


Thank you!!!