Japan – Norway Workshop
Future Technology and Finance in the Maritime Sector

How to utilize Big data and IoT in the shipping sector ?

12th February 2016

Hideyuki Ando, MTI (NYK group)

Outline

1. Introduction of MTI
2. IoT and Big data
3. SIMS (Ship Information Management System)
4. Data analysis
5. Open platform
6. Concluding remarks

Outline

1. **Introduction of MTI**
2. IoT and Big data
3. SIMS (Ship Information Management System)
4. Data analysis
5. Open platform
6. Concluding remarks

Introduction of MTI (*Monohakobi* Technology Institute)

Monohakobi Technology Institute

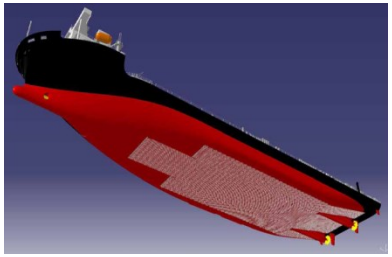
- Established - April 1, 2004
- Locations
  - Head office – 7th floor, NYK building, Tokyo, Japan
  - MTI Singapore branch
  - MTI Yokohama Laboratory
- 100% owned by NYK
- Number of employees – 63 (as of April 1, 2015)
- President – Mr. Makoto Igarashi
- Business areas
  - R&D of Maritime Technology
  - R&D of Logistic Technology

MTI Yokohama Laboratory

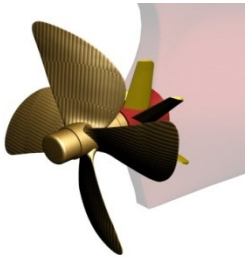
Please visit our web page -> http://www.monohakobi.com/en/

Examples of MTI R&D projects

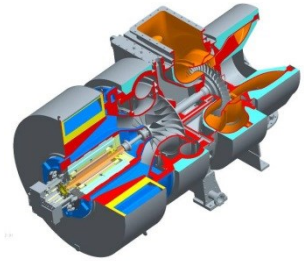
Reduction of resistance
Air lubrication system



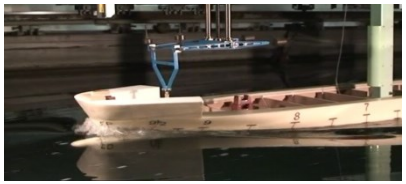
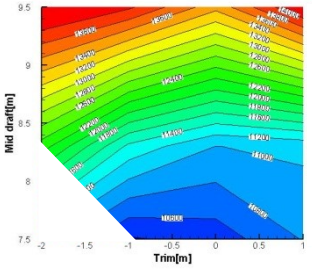

Propulsion efficiency
Energy saving devices




Power plant efficiency
Hybrid turbo charger




Operational efficiency
Performance management system

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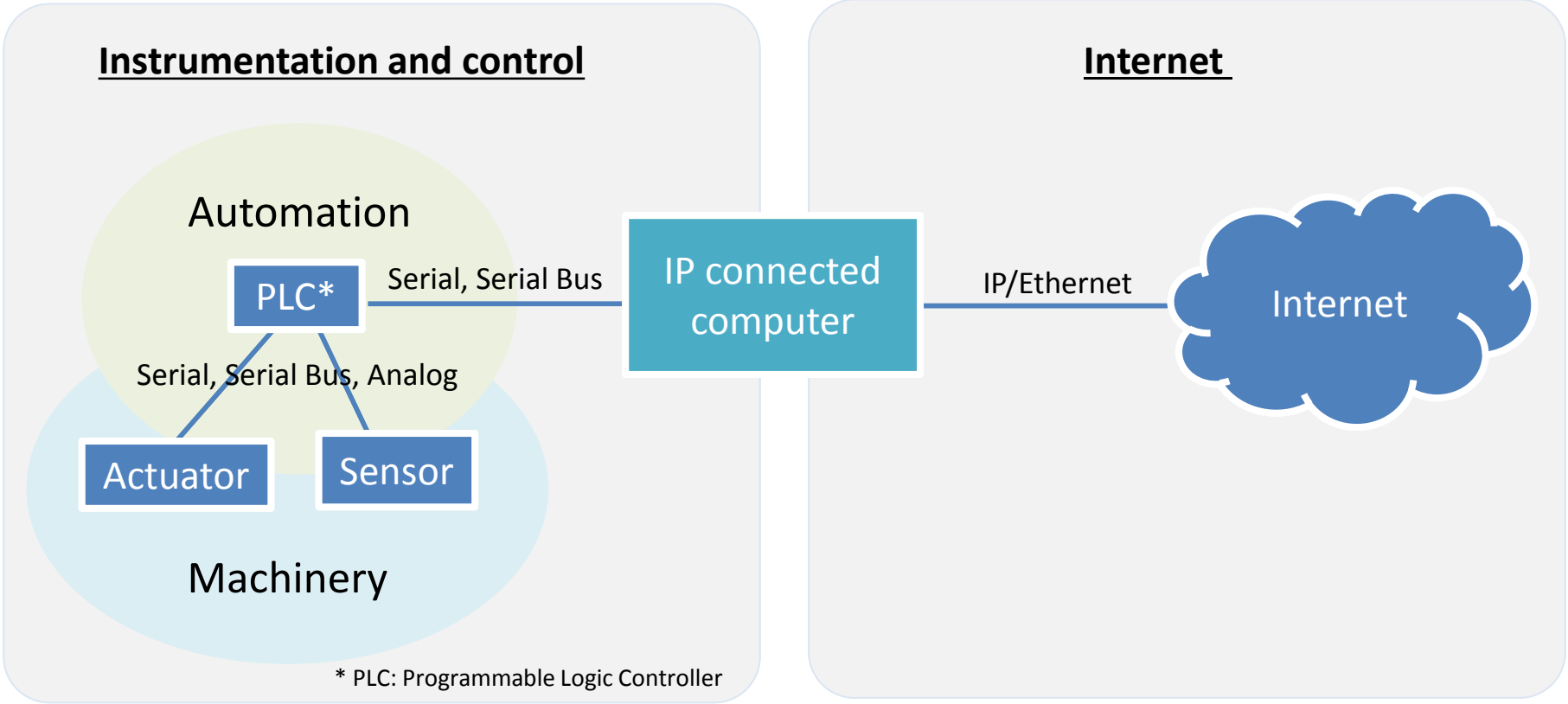
IoT (Internet of Things)



"Instrumentation and control" and "Internet" are to be bridged.
The era of "transparency" where user can access field data.

Big data in shipping

Examples of Big data in shipping

Voyage data
- Automatically collected data (IoT)
- Noon report

Machinery data
- Automatically collected data (IoT)
- Manual report data
- Maintenance data / trouble data

AIS data
- Satellite AIS / shore AIS (IoT)

Weather data
- Forecast / past statistics
- Anemometer / wave measurement (IoT)

Business data
- Cargo transport data

Industrial Internet - example of GE (IoT of industrial machineries)

Target

- Prevent unpredicted downtime
- Energy efficiency in operation
- Reduce maintenance cost

Measure

- Condition monitoring
- Big data analysis
- Support service engineer
- Intelligent machinery
  - Self diagnostics

Change way of working

Reference) https://www.ge.com/sites/default/files/GE_IndustrialInternetatWork_WhitePaper_20131028.pdf

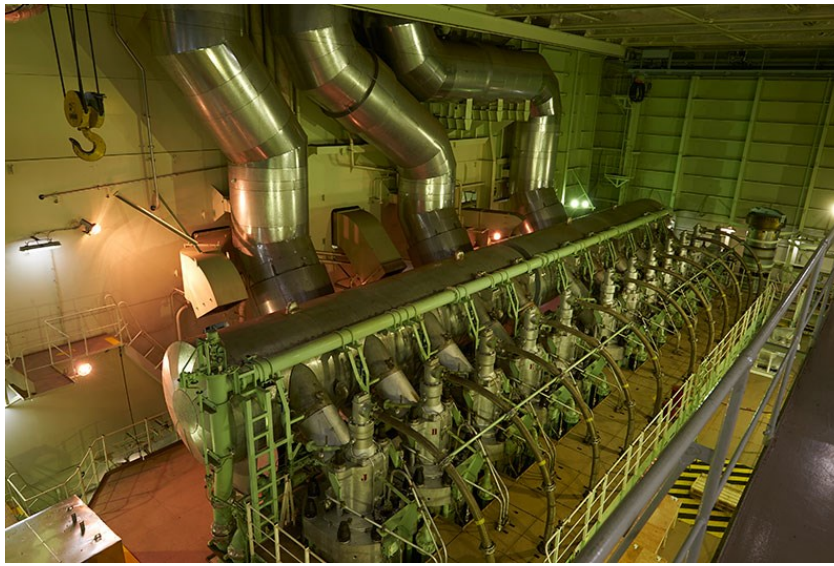
Same concepts are applicable to marine industry

Target

- Prevent unpredicted downtime (**owner**)
- Energy efficiency in operation (**operator**)
- Reduce maintenance cost (**owner**)

Measure

- Condition monitoring
- Big data analysis
- Support service engineer
- Intelligent machinery
  - Self diagnostics



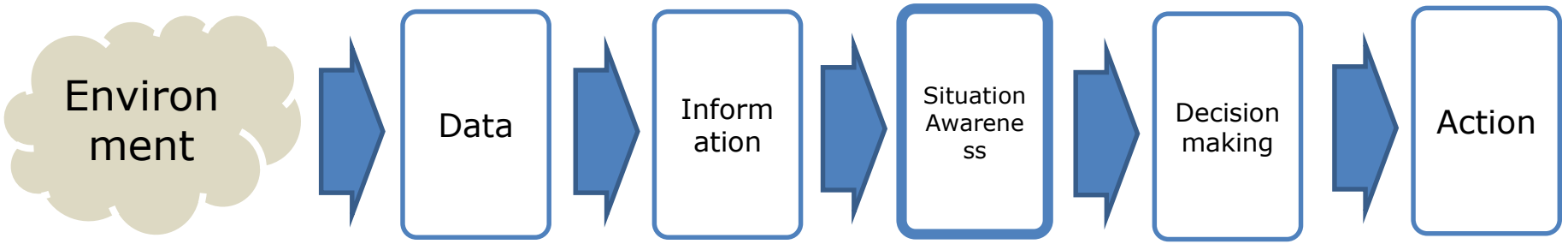
Change way of working

IoT and Big data application areas

Role	Function	Example of Big data application
Ship operator	**Operation**	• Energy saving operation • Safe operation • Schedule management
	Fleet planning	• Fleet allocation • Service planning • Chartering
Ship owner	**Technical management**	• Safety operation • Condition monitoring & maintenance • Environmental regulation compliance • Hull & propeller cleaning • Retrofit & modification
	New building	• Design optimization

Other partners in value chains, such as cargo owners, shipyards, equipment manufacturers, class societies and others, have also interests in ship Big data.

Big data processing flow



Necessary Technology

- Sensor
- Measurement
- Network
- Communication
- IT

- Data analysis
- Statistics
- Engineering
- Visualization
- Web

- Business knowledge
- Workflow
- Collaboration
- Organization

- Management
- Business

- Command
- Assistance
- Training
- Incentive
- PR
- Change Business

"Big data" is an organizational process
The target is to change way of working by utilizing data

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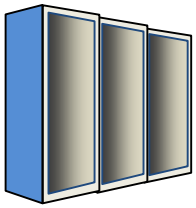
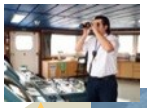
SIMS overview

SIMS auto logging data (per hour)
& NYK's electronic abstract
logbook data (per day)



Data Center



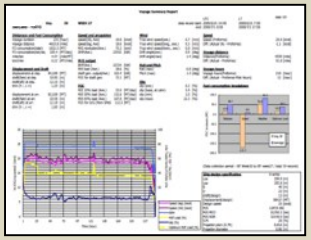
FOP Data Collection System Onboard

VSAT/Inmarsat-F/FB

SIMS Monitoring & Analysis System at Shore

Communications via Technical Management

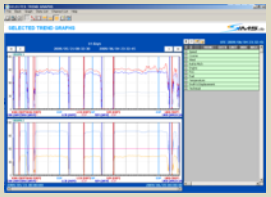
Feedback to captains



Voyage Analysis Report
Break down analysis of fuel consumption for each voyage

Report

Operation Center (London)



SIMS Viewer

-Trend monitoring of speed, M/E RPM, fuel consumption and other conditions per hour

- Engine monitoring

- GPS
- Doppler log
- Anemometer
- Gyro Compass

VDR

SIMS unit

Data Acquisition and Processing

Viewer

Motion sensor

<Navigation Bridge>

<Engine Room>
- Main Engine
- FO flow meter
- Torque meter
- Re-liquefaction Plant

Integrated Automation System

Technical Analysis (MTI)

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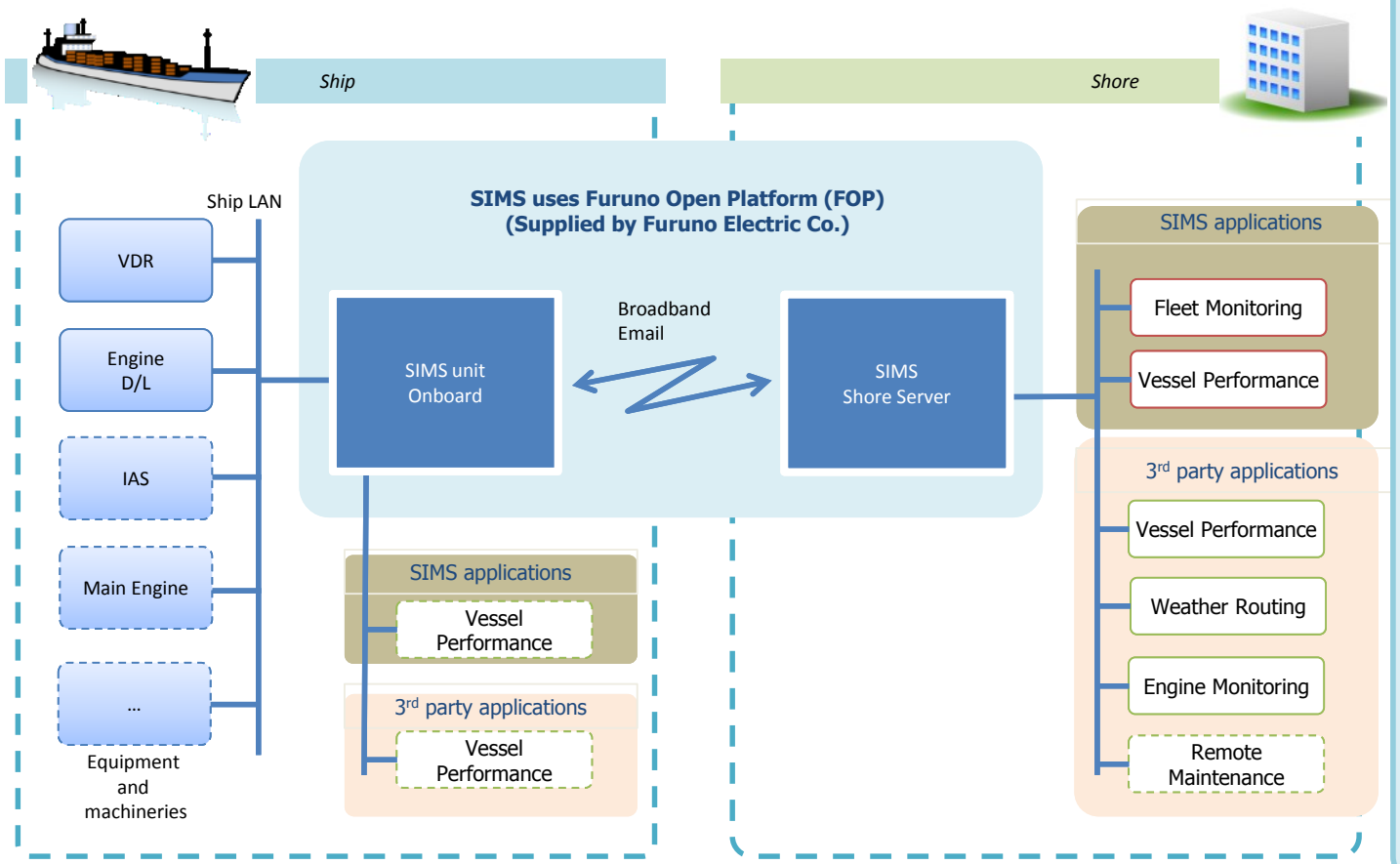
SIMS as open platform

Open platform = interface to 3rd party applications



SIMS also works as a open platform to collect onboard equipment data and share them with 3rd parties' applications.

SIMS uses Furuno Open Platform (FOP) supplied and maintained by Furuno Electric, one of the world-wide marine equipment suppliers.

SIMS provides open API (Application Programming Interface) to 3rd party applications.

Installation records of SIMS onboard

Type of vessel	SIMS1 installed	SIMS2 installed	Total
Bulk	5	48	53
Tanker	0	8	8
Car Carrier	6	32	38
Container	19	27	46
LNG	1	2	3
Total	31	117	**148**

As of December, 2015

- SIMS1 (2008 – 2013)
  - Supplier: NYK Trading
  - Measurement data : Vessel performance data
  - Remote maintenance : No
- SIMS2 (2013 -)
  - Supplier: Furuno Electric
  - Measurement data : Vessel performance data + engine condition data from ICA/IAS
  - Remote maintenance : Yes (if VSAT or Inmarsat FBB full time connection is available onboard)

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Toolbox of using Big data

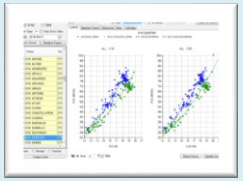
Dashboard

- For operator
- For ship manager

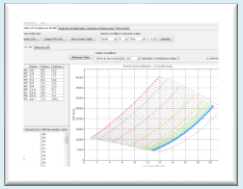
Big data

Data warehouse
(Cloud)
IoT data + Voyage +
Weather

Performance analysis

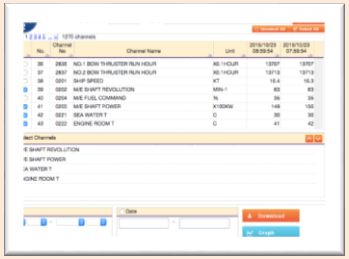


- Long term analysis



- In-service performance model

Business Intelligence (BI)

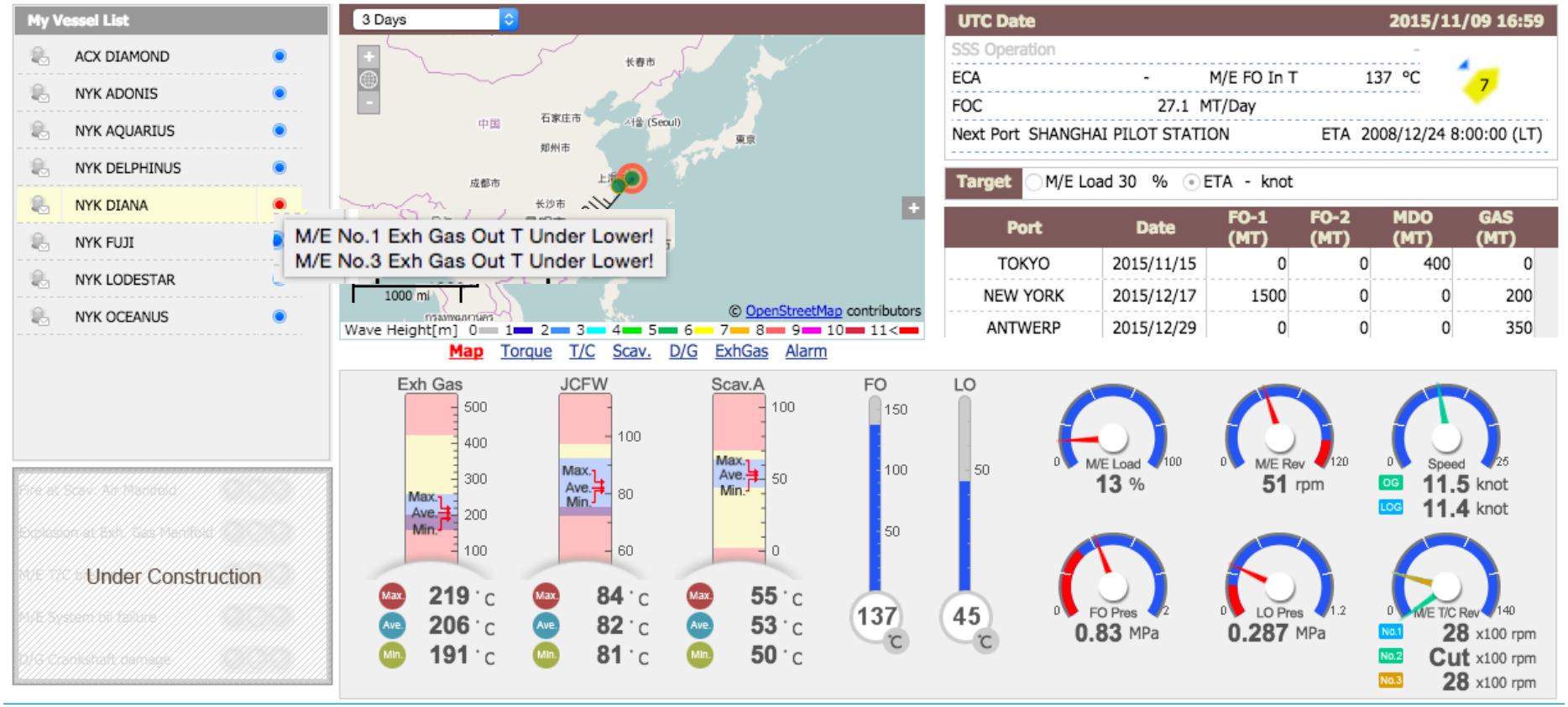


Data download

BI tool

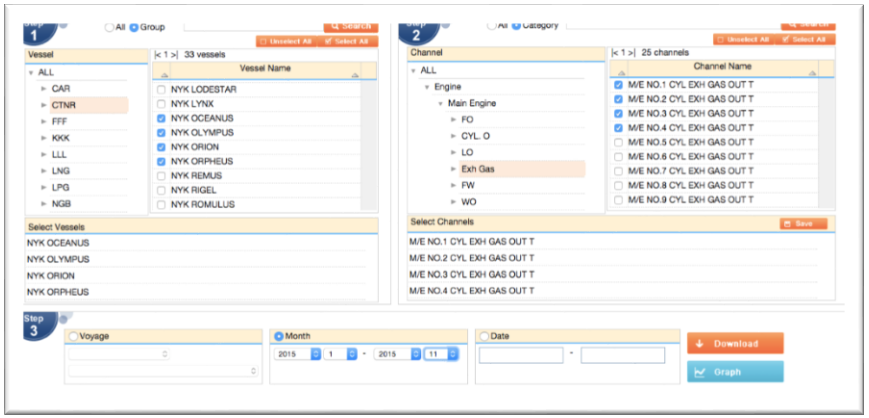
Dashboard

- Example) Dashboard for ship manager
  - Support safety management of fleet

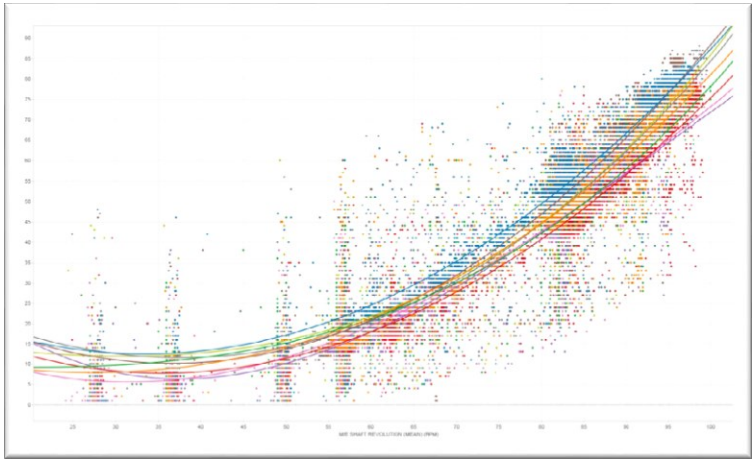


Business intelligence (BI) tool

- Quick visualization of data
- Business experts can be the best data analysts
- Standardization of data naming is very important to accelerate data usage



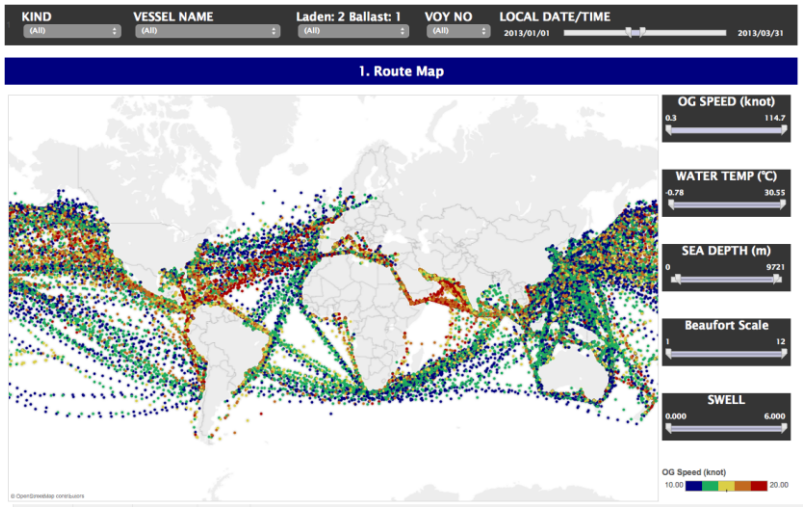
Download data from multiple vessels
(Data Finder)



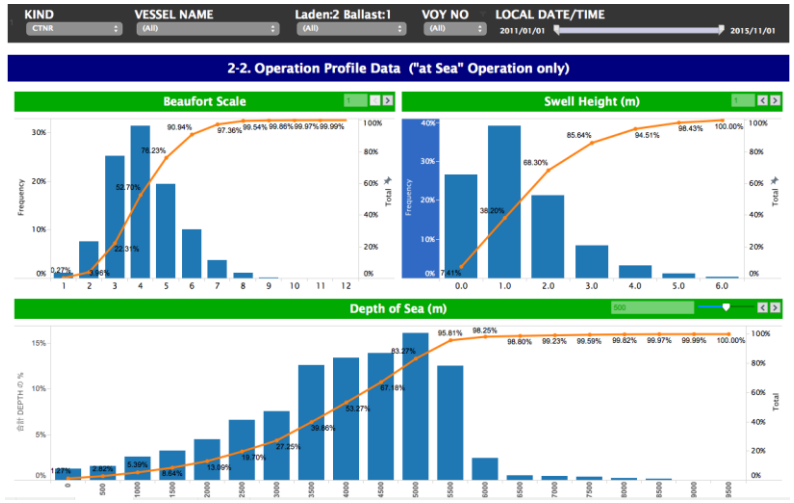
Data analysis with BI tool
(e.g. comparison of engine data of multiple vessels)

Business intelligence (BI) tool

- Dashboard created by using BI
  - Easy to make (rapid prototyping)
  - Easy to customize

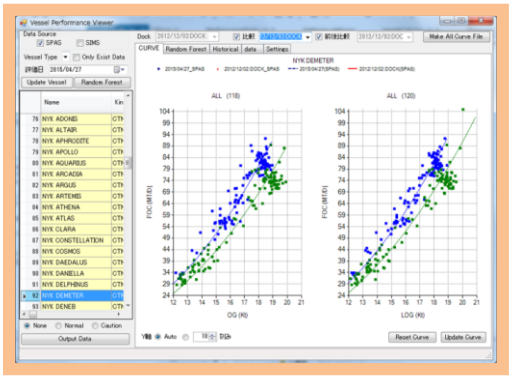


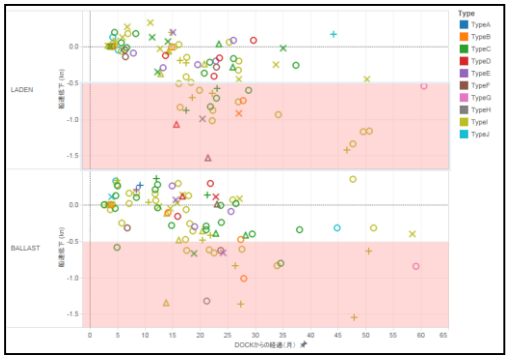
Filtering data

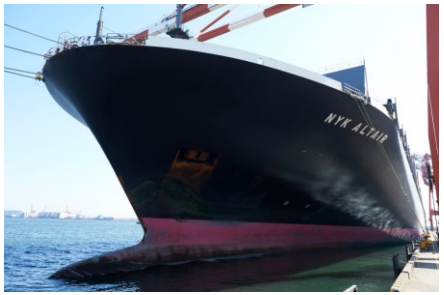


Statistics e.g. operational profiles

Performance analysis - long term analysis -







Performance analysis
Semi-automate the long term analysis process

Pick-up target vessels
Visualize performance drops of fleet vessels after last dry dock

Cleaning hull & propeller
Expand service available ports

Performance Management

Operation Management

Hull & propeller Cleaning Service Provider

Performance analysis - in-service performance

6000TEU Container Ship
Wave height 5.5m, Wind speed 20m/s
BF scale 8, Head sea

@ engine rev. 55rpm

<Calm sea performance>

speed: 14 knot
FOC: 45 ton/day

<Performance in the rough sea(BF8)>

speed: **8 knot**
FOC: **60 ton/day**

Effecting factors

1. Weather (wind, wave and current), 2. Ship design (hull, propeller, engine), 3. Ship condition (draft, trim, cleanness of hull and propeller, aging effect)

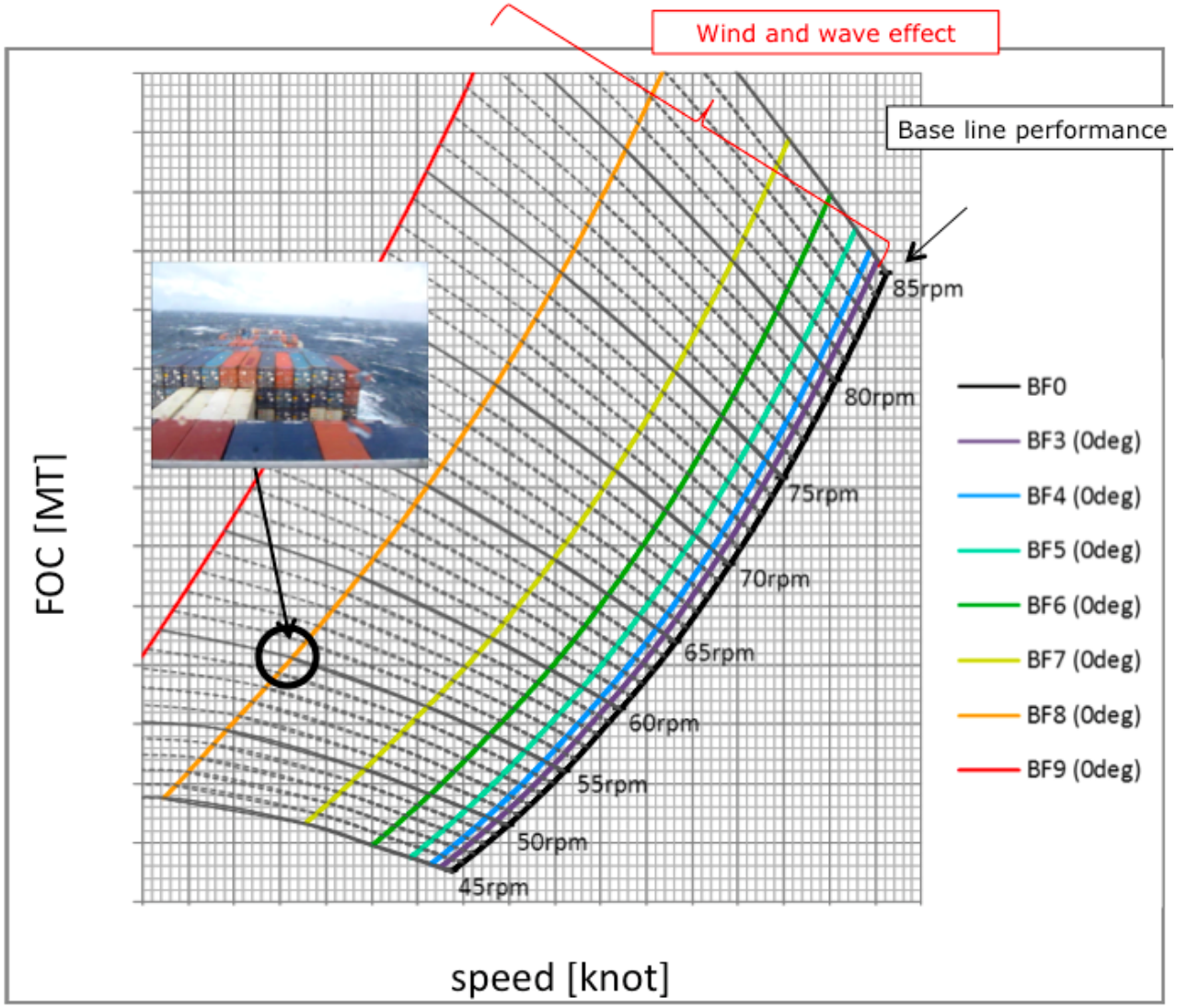
In-service performance model

<Target vessel>
6000TEU Container
Draft 12m even

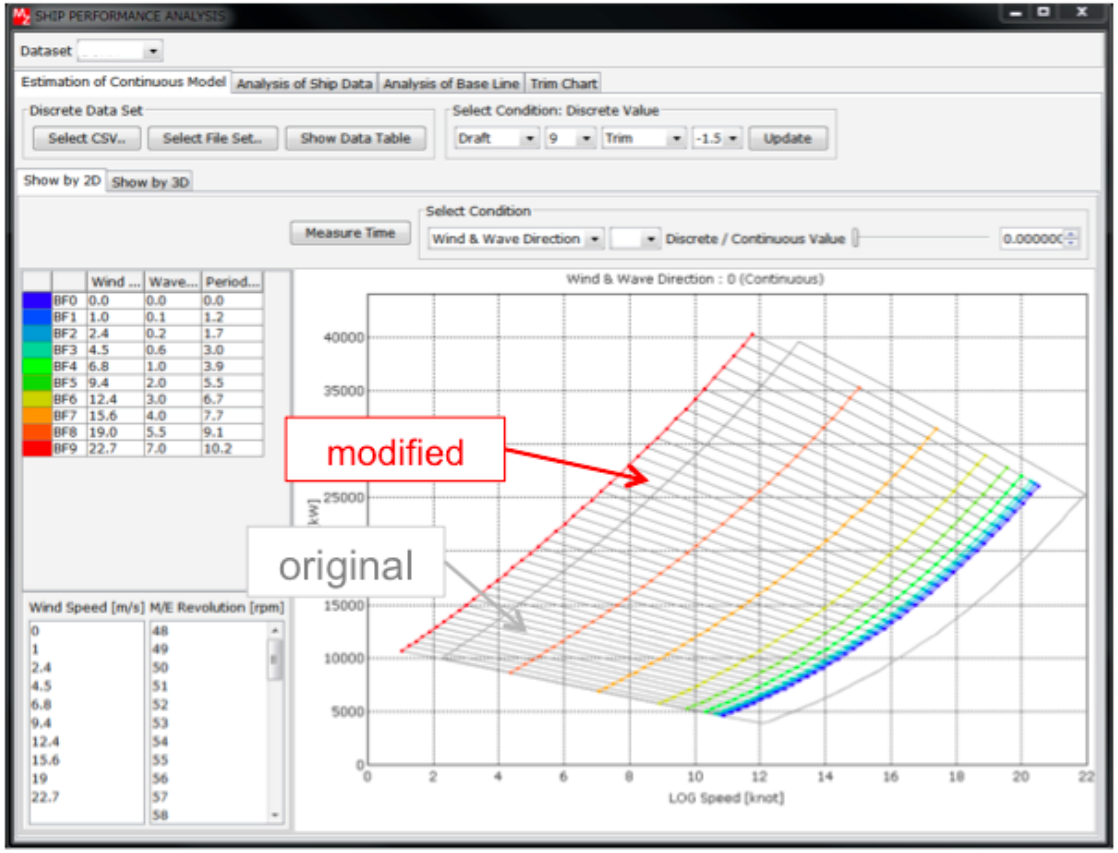
Sea condition
Beaufort scale

	wind speed (m/s)	wave height (m)	wave period (sec)
BF0	0.0	0.0	0.0
BF3	4.5	0.6	3.0
BF4	6.8	1.0	3.9
BF5	9.4	2.0	5.5
BF6	12.4	3.0	6.7
BF7	15.6	4.0	7.7
BF8	19.0	5.5	9.1
BF9	22.7	7.0	10.2

0deg (wind, wave) – head sea

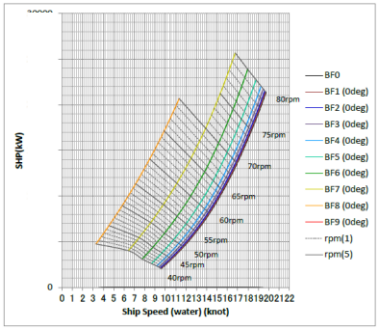


In-service ship performance model



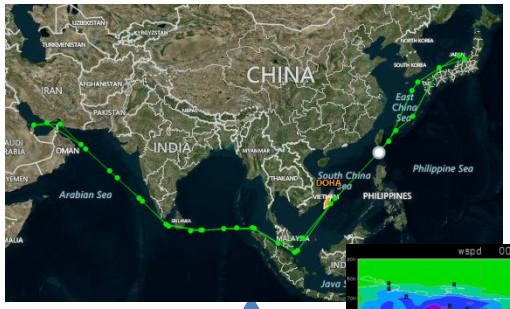
- It is a “Digital Twin” of each ship regarding performance in-service.
- Performances under all possible conditions (draft, trim, wind, wave) are integrated in the model.
- Simulation results are compiled into a multi-dimensional mathematical model.
- IoT data are used for correction of the model.

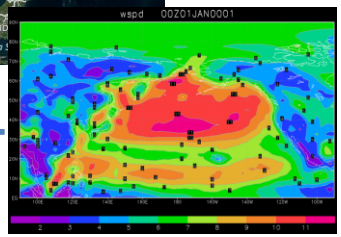
Operation optimization with in-service ship performance model



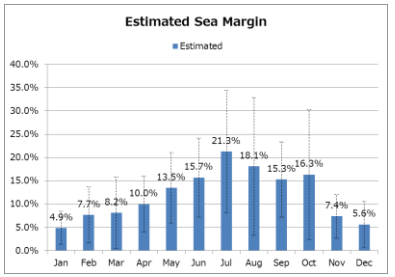
In-service performance model

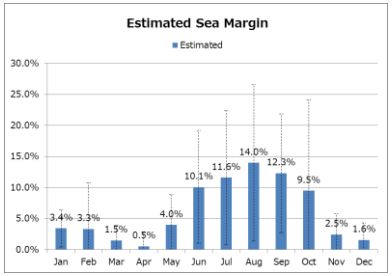
Service route





Hindcast weather data





Estimation of
- Sea Margin
- Sailing time
- Average Speed
- Total FOC

Simulating ship performance in actual weather to optimize ship services

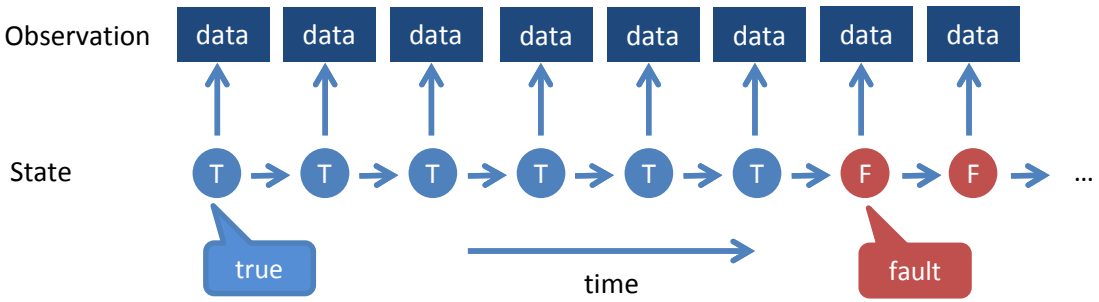
IoT for preventive maintenance

Target

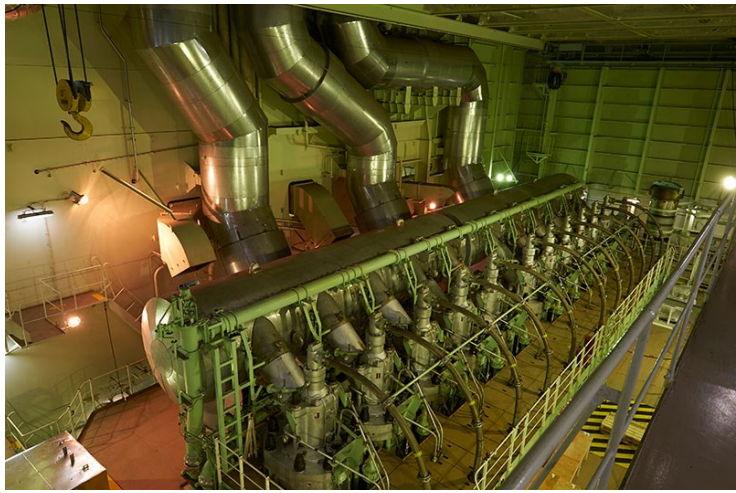
- Prevent unpredicted downtime
- Energy efficiency in operation
- Reduce maintenance cost

Measure

- Condition monitoring
- Big data analysis
- Support service engineer
- Intelligent machinery
  - Self diagnostics



Collaborations with external experts are necessary



Ship main engine

Shore dashboard

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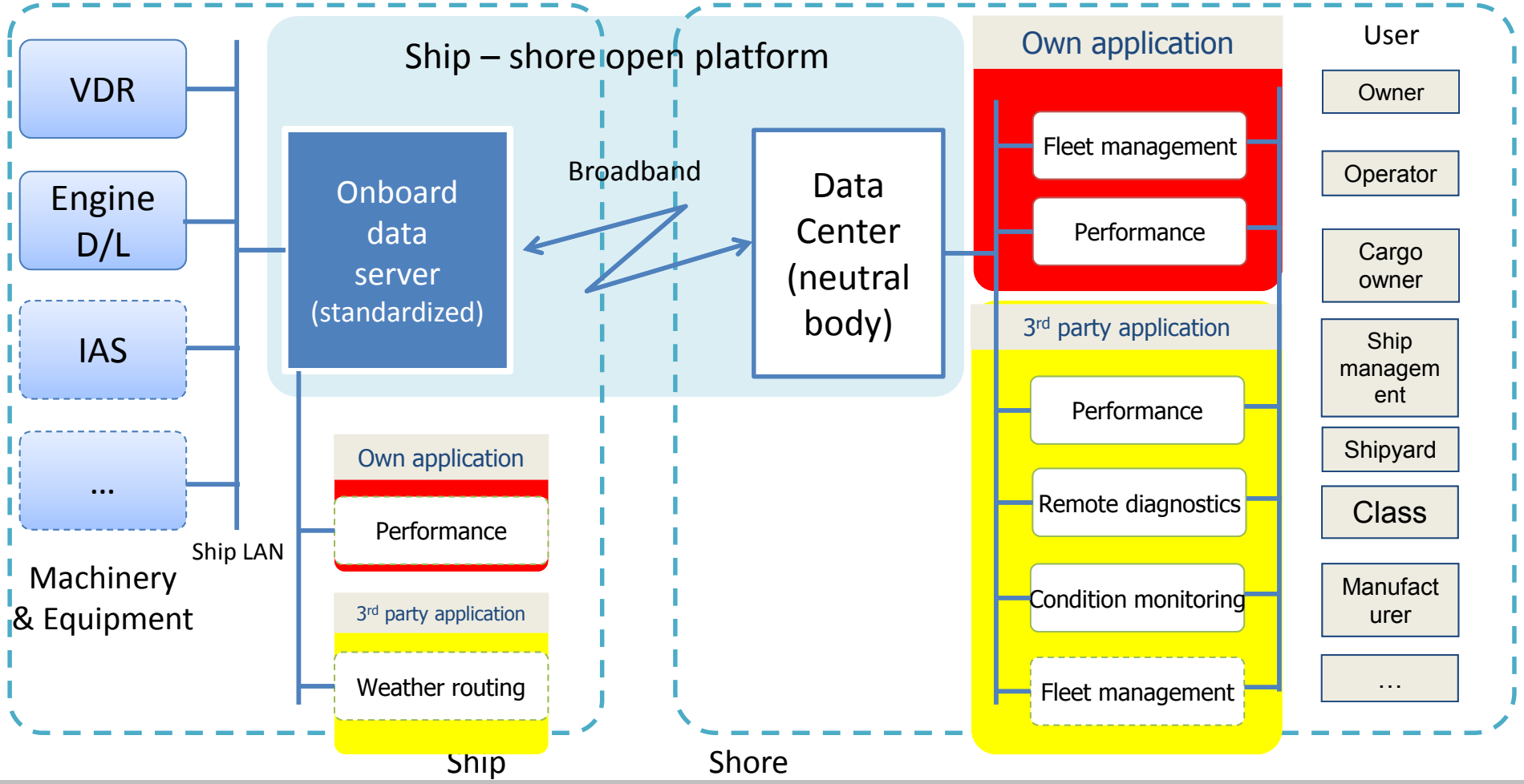
Concept of ship – shore open platform

Ship-shore open platform provides good security and access control to enhance cooperation with industry partners.



Smart Ship Application Platform (SSAP) Project
- A standardization activity regarding ship IoT data -

http://www.e-navigation.net/index.php?page=ssap-smart-ship-application-platform

- Submitting Organization:Japan Ship Machinery and Equipment Association (JSMEA) Smart Ship Application Platform WG
- Point-of-Contact: Dr. Hideyuki Ando (MTI : Research company of NYK group), hideyuki_ando@monohakobi.com
- Functional Capabilities: Provide current and past numerical data on Weather routing, Trim, Performance monitoring, Engine monitoring, Hull and cargo condition monitoring, Power plan
- Intended Purpose: The target is t and international standards of da onboard machinery and equipme
- Portrayal examples:Not specified
- Last edited: April 22, 2014

Description

Smart Ship Application Pla

1. Genaral information

Project name
Name of testbed

Proposals for new ISO

- **ISO/NP19847 - Shipboard data servers to share field data on the sea**
  - Specifications of shipboard data server
- **ISO/NP19848 - Standard data for machinery and equipment part of ship**
  - Specifications of naming rules for shipboard data channel

Expected Applications of Ship IoT and Open Platform

Role	Application of Ship IoT and open platform
Shipping	Ship owner and operator needs applications for energy saving, minimize downtime, safety transport and environmental conservation
Manufacturer	Remote diagnosis, preventive maintenance and self diagnostics
Shipyard	Data analysis services for ship owners, life-cycle support and feedback to new design
Service provider	Fleet management system, big data analysis services, condition monitoring services and IoT platform
Academy	Research on big data analysis, numerical simulation methods and digital twin. Education and trainings.
Class society	Shore data center. Class inspection

Government … utilization for e-navigation and MRV

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R&D by open collaboration

In the coming era of ship intelligence, we think we need open collaborations to pursue wide variety of possibilities to improve our safety and efficiency

Concluding remarks

- From our experiences with SIMS, we consider the concepts of IoT and Big data are applicable and making values to our shipping industry.

- To pursue further utilization of IoT data, we need open collaboration by sharing the data. We are working on standardization of IoT data collection and open platform to share the data.

- We hope to keep good communication and collaboration with the maritime industry in Norway also in the coming ship intelligence era.

Thank you for your attention