24th National Maritime Summit
In Haugesund, Norway

Digitalization in Shipping
- the future as seen by Nippon Yusen Kaisha (NYK) a global shipping company -

8th February 2017

Hideyuki Ando

MTI (*Monohakobi* Technology Institute), NYK Group

Outline

1. Introduction of NYK/MTI
2. Digitalization in Shipping
3. Activities for digitalization in NYK
4. Open platform

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1. **Introduction of NYK/MTI**
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NYK Corporate Profile

- NYK Line (Nippon Yusen Kaisha)
- Head Office: Tokyo, Japan
- Founded: September 29, 1885
- Business Scope:
  - Liner (Container) Service
  - Tramp and Specialized Carrier Services
  - Tankers and Gas Carrier Services
  - Logistics Service
  - Terminal and Harbor Transport Services
  - Air Cargo Transport Service
  - Cruise Ship Service
  - Offshore Service
- Employees: 34,270 (as of the end of March 2016)
- Revenues: $ 22.7 billion (Fiscal 2015)

NYK Head Office in Tokyo

NYK Fleet (as of the end of March 2016)

Containerships
(including semi-containerships and others)
99 vessels / 5,820,781 DWT

Bulk Carriers
(Capesize)
108 vessels / 21,248,606 DWT

Bulk Carriers
(Panamax & Handysize)
269 vessels / 16,411,393 DWT

Wood-chip Carriers
47 vessels / 2,509,047 DWT

Cruise Ships
1 Vessel / 7,548 DWT

Car Carriers
119 vessels / 2,165,138 DWT

Tankers
68 vessels / 11,030,601 DWT

LNG Carriers
29 vessels / 2,176,681 DWT

Others
42 vessels / 695,974 DWT

782 vessels
62,065,769Kt (DWT)

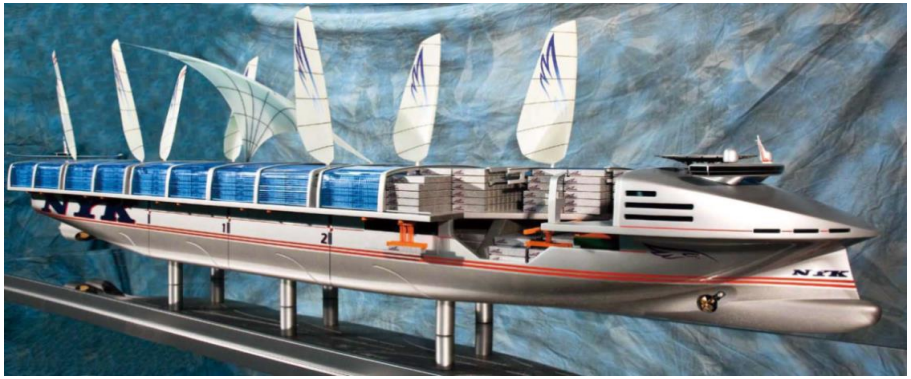
MTI (*Monohakobi* Technology Institute)

- strategic R&D arm of NYK Line -

http://www.monohakobi.com/en/

Monohakobi Technology Institute

- Established : April 1, 2004
- Stockholder : NYK Line (100%)
- Number of employees : 62 (as of 1st April, 2016)
- Location
  - Head Office : 7th Fl., Yusen Building, Tokyo, Japan
  - MTI CO.,LTD. SINGAPORE BRANCH, Singapore
  - MTI YOKOHAMA LAB (Transportation Environment Lab), Yokohama, Japan



NYK SUPER ECO SHIP 2030 (Concept ship for the future 69% less CO2 emissions)

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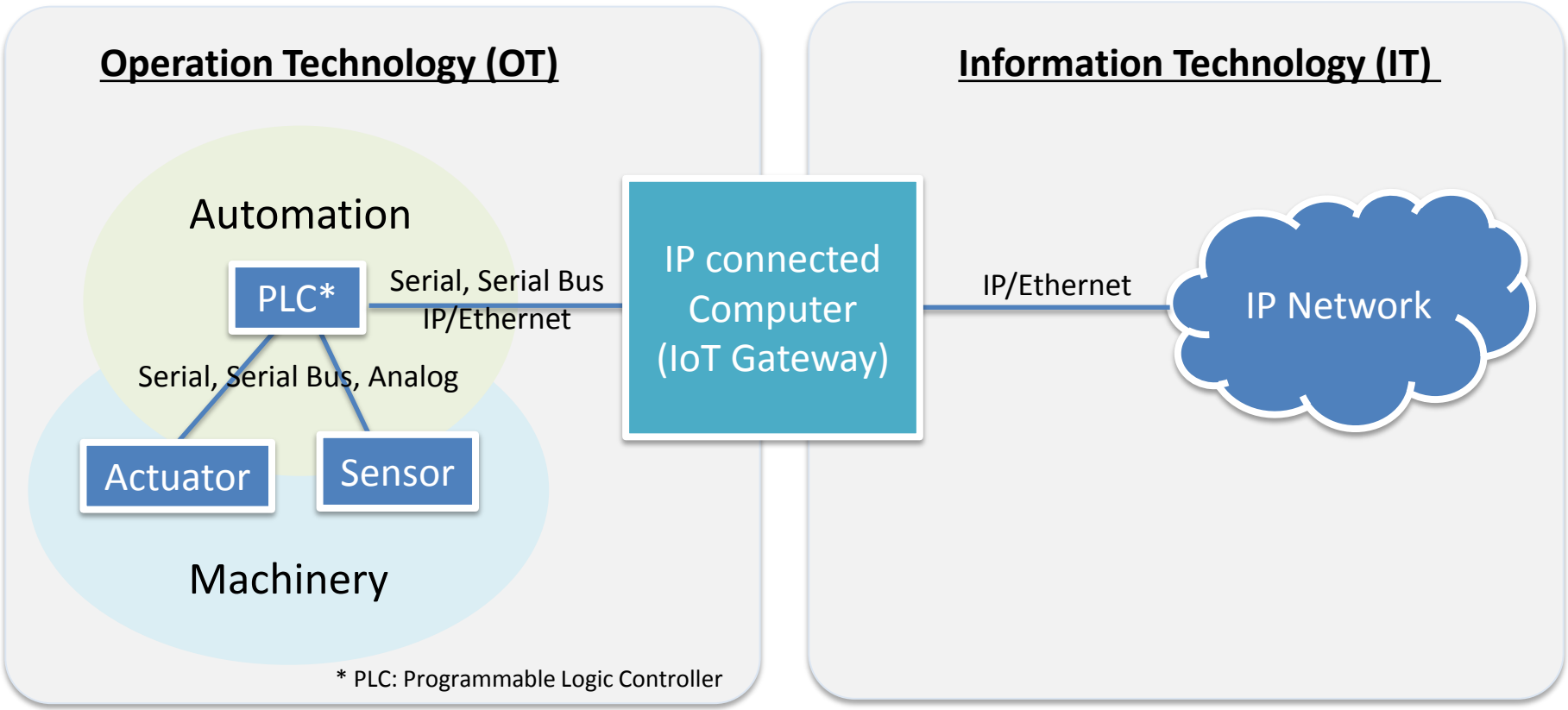
Digitalization - the next techno-economic great wave

1. **Use assets more efficiently**
    1. **Automate ship operations & navigation**
    2. **Manage ship/shore personnel into a single more productive team**
    3. **Integrate fleet systems to improve asset performance**
    4. **Use big data to find ways to improve performance & reduce accidents**
    5. **Inform management on how the business is performing**
2. **Produce regulatory information digitally**
3. **Develop global through transport system**

Reference)

Martin Stopford, Shipping's Next Techno-Economic Great Wave, Tokyo, Dec 2015
(http://www.jpmac.or.jp/forum/pdf/106_1.pdf)

IoT (Internet of Things)



"Operation Technology (OT)" and "Information Technology (IT)" are to be bridged.
The era of "transparency" where user can access the field data.

Digital Twin

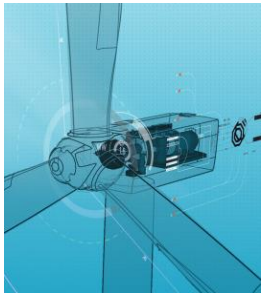
An approach of Product Lifecycle Management(PLM) to extend computer-based engineering capabilities to fleet operations

Real (Product, Plant…)

IoT data →

← Information & Service

Virtual (3D model, simulation)



Reference)
1. http://www.gereports.com/post/119300678660/wind-in-the-cloud-how-the-digital-wind-farm-will/
2. Michael Grieves, Virtually Perfect: Driving Innovative and Lean Products through Product Lifecycle Management (English Edition), 2012

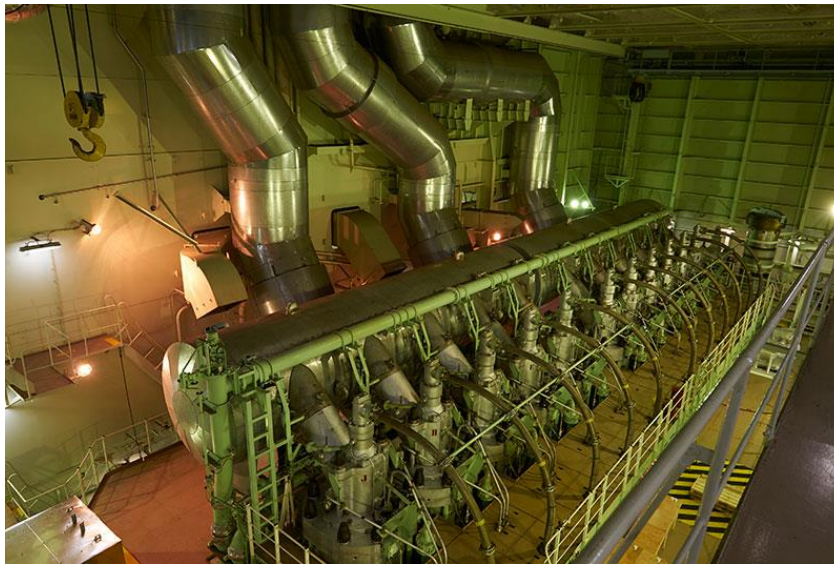
Utilize IoT in shipping

Target

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

Measure

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



Change way of working !

IoT and Big data application in shipping

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

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

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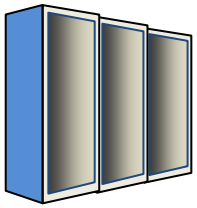
IoT platform of NYK

SIMS (Ship Information Management System)

SIMS IoT data
+ SPAS manual data



Data Center

SIMS Data Collection Onboard

Sat Com
(VSAT, FBB)

- GPS
- Doppler log
- Anemometer
- Gyro Compass

VDR

SIMS unit (IoT gateway)

Data Acquisition and Processing

Onboard dashboard

Motion sensor

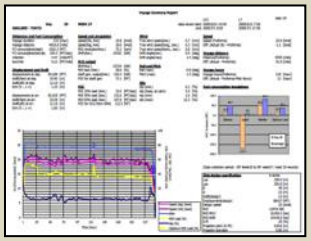
<Navigation Bridge>

<Engine Room & Cargo>

- Main Engine
- Power plant
- Cargo control
- Auxiliary machineries

Integrated Automation System

SIMS Monitoring & Analysis at Shore



Big data analysis

- Operational efficiency
- Performance
- Engine & plant condition

Analysis report

Technical Analysis
(NYK, MTI)

Operation (Tokyo, Singapore ...)

Shore Dashboard

- For operation
- For ship manager

Ship performance in service

6000TEU Container Ship

Wave height 5.5m, Wind speed 20m/s

BF scale 8, Head sea @ Trans-Pacific (Oakland, US – Tokyo, JP)

@ engine rev. 55rpm

<**Calm sea** performance>

speed: 14 knot

FOC*: 45 ton/day

* FOC: Fuel Oil Consumption

<**Rough sea(BF8)** performance>

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)

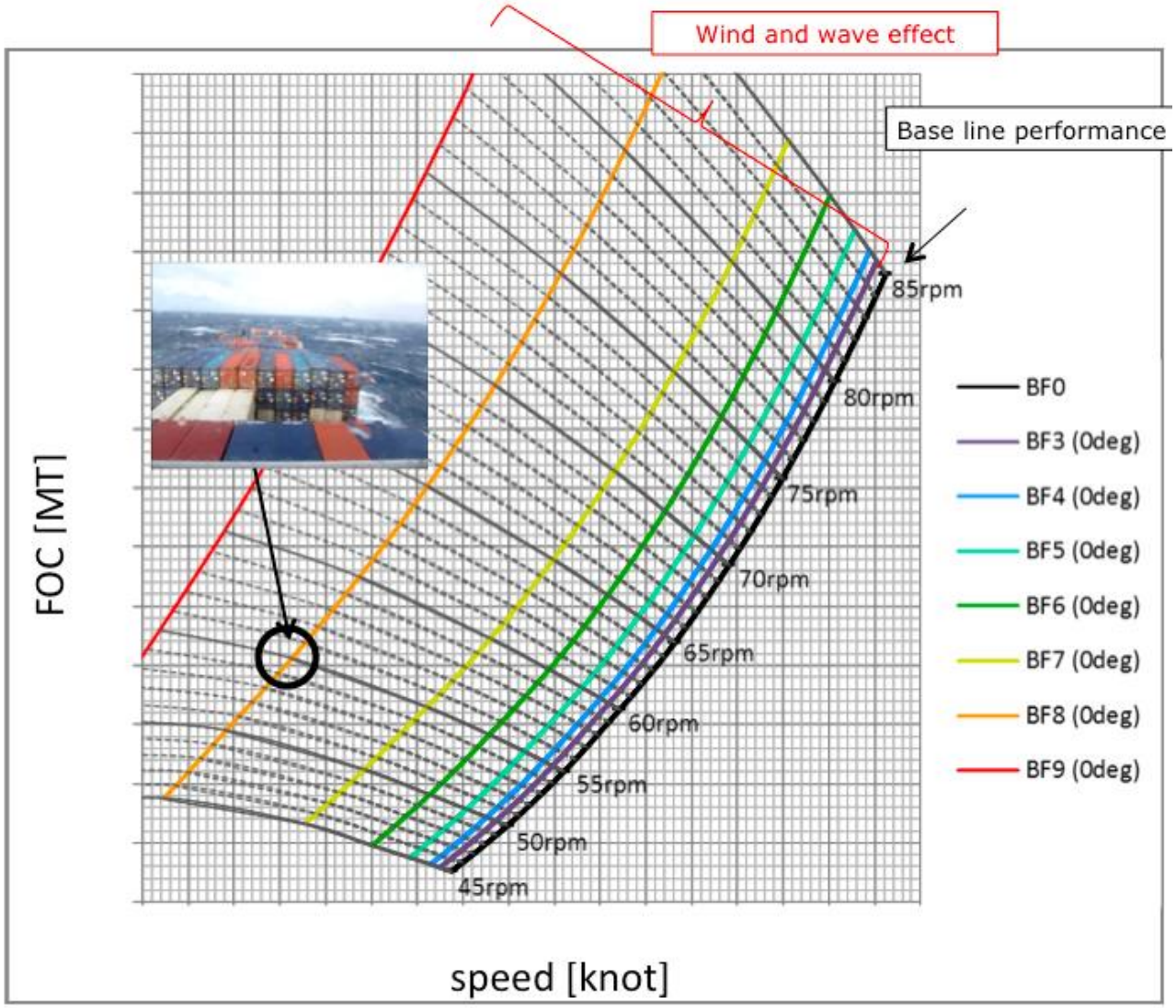
In-service ship performance model

<Target vessel>
6000TEU Container
Draft 12m even

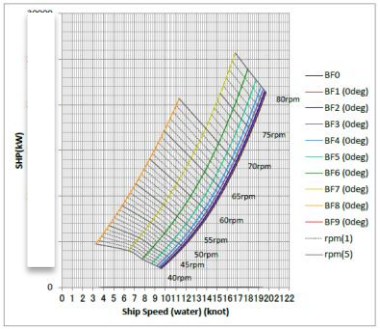
Sea condition
Beaufort scale

	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

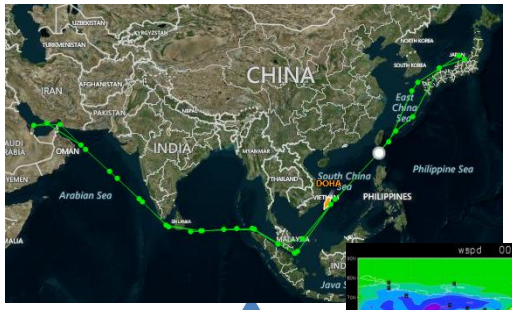


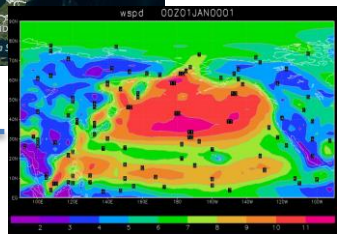
Operation optimization

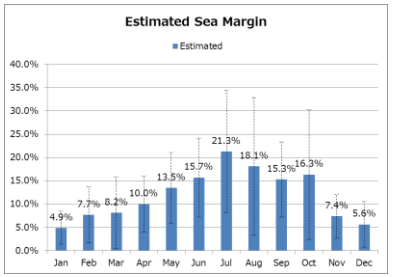


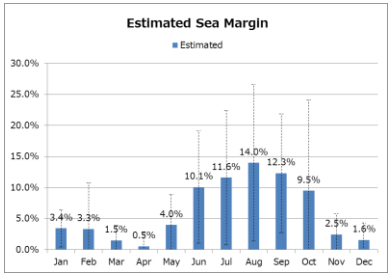
Ship performance model

Service route







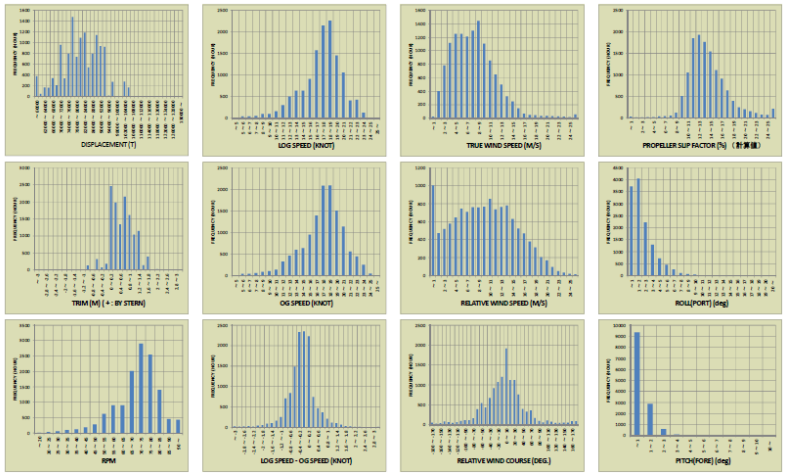


Estimation of
- Sea margin
- FOC and etc.

Voyage simulation with past weather data

Combine ship performance model with weather data to optimize ship services

Energy saving hull modification



23 % CO2 reduction was confirmed

Operation profile

- Speed, RPM, Power
- Draft, trim, displacement
- Weather
- Sea margin
- Etc.

Energy saving modification

- Bulbous bow modification
- Install energy saving device (MT-FAST)
- Etc.

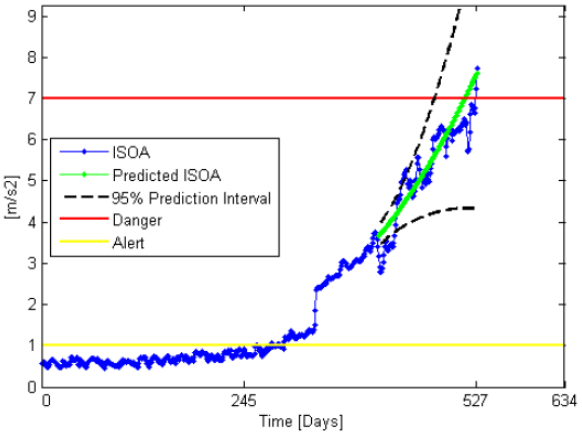
Prognostics and health monitoring in shipping for preventing troubles

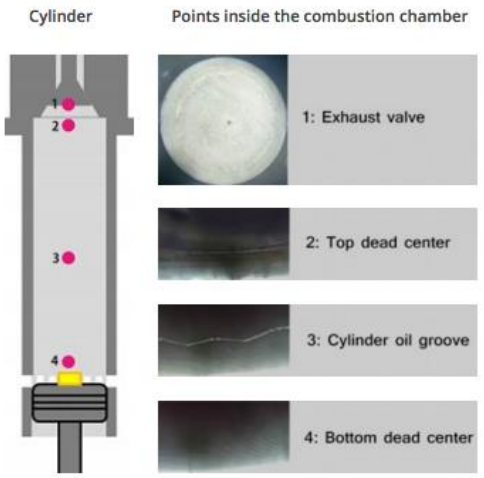
Target

- Prevent unpredicted downtime
- Reduce maintenance cost
- Predict remaining useful life

Measure

- SCADA data analysis
- Condition monitoring (image, vibration, AE and etc.)
- Estimate RUL (Remaining of Useful Life)





KIRARI NINJA
360-degree panoramic camera to take photos inside the dark combustion chamber

Reference)
1. Prognosticating fault development rate in wind turbine generator bearings using local trend models (B&K Vibro, DTU), PHM Europe 2016, pp. 132-141
2. https://theta360.com/s/f41xbUZ4smDJX4wsFh7gNUuZg?view=embed

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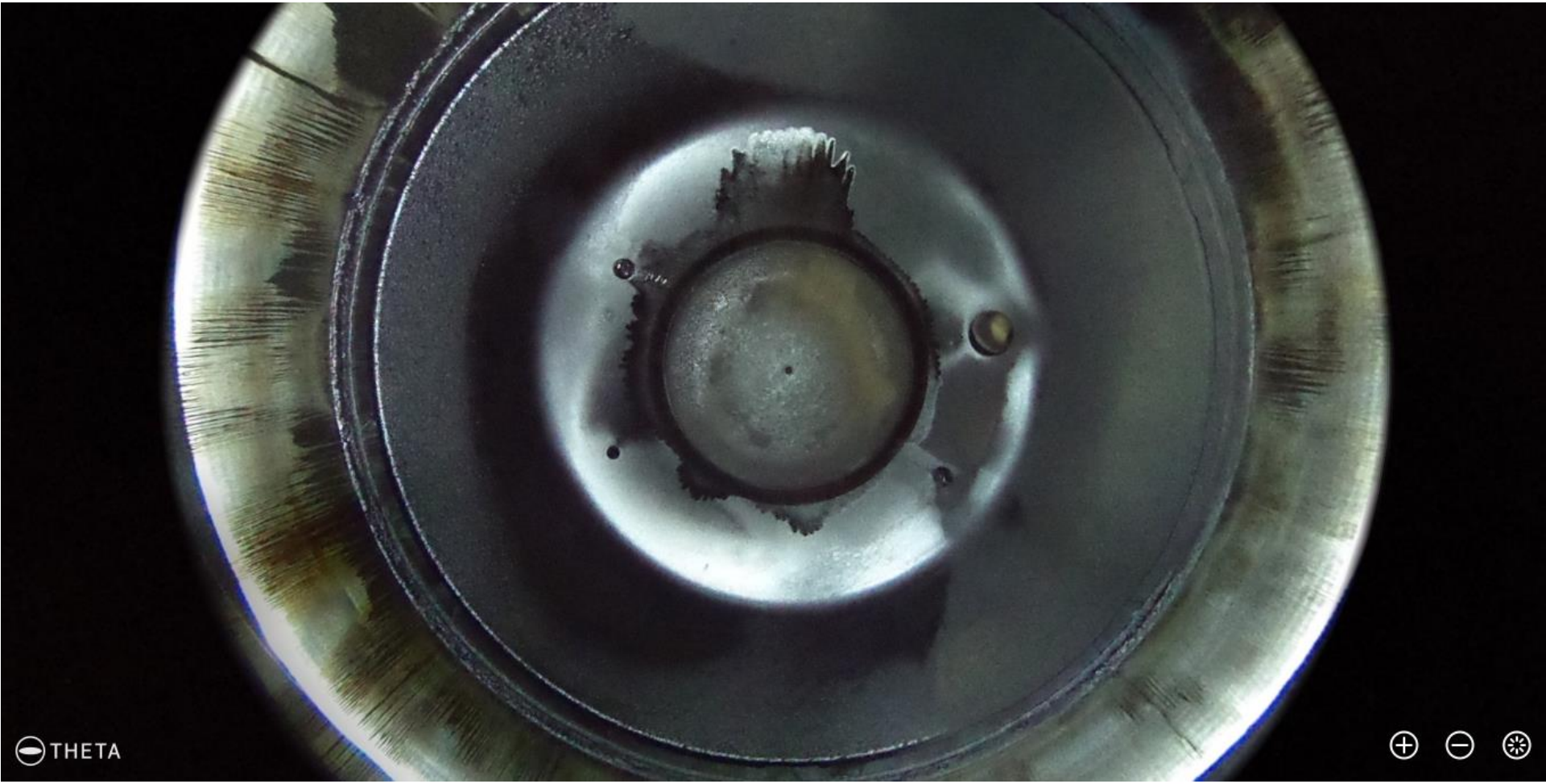

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Monohakobi Technology Institute

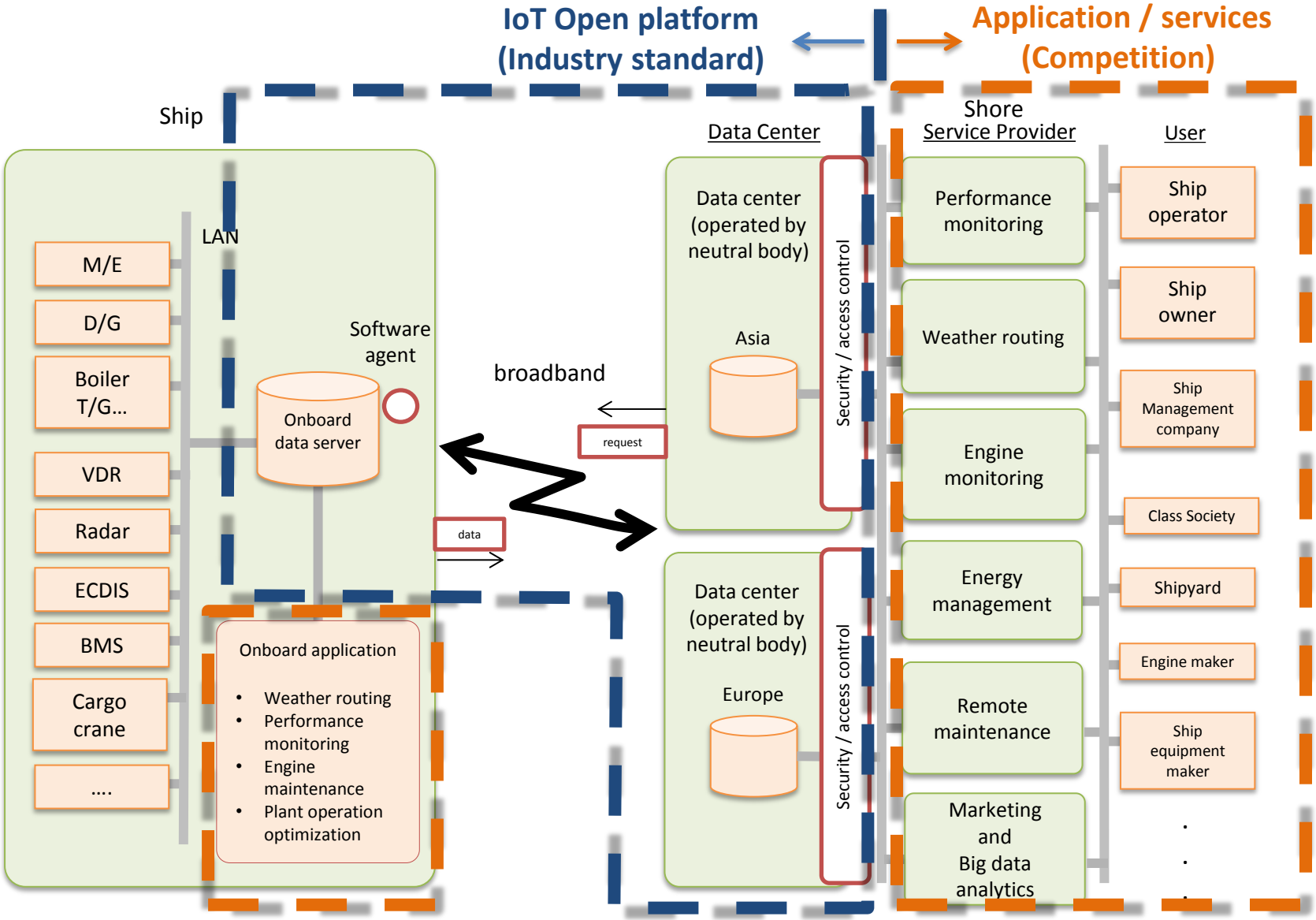
NYK GROUP

NYK/MTI's R&D activities for digitalization

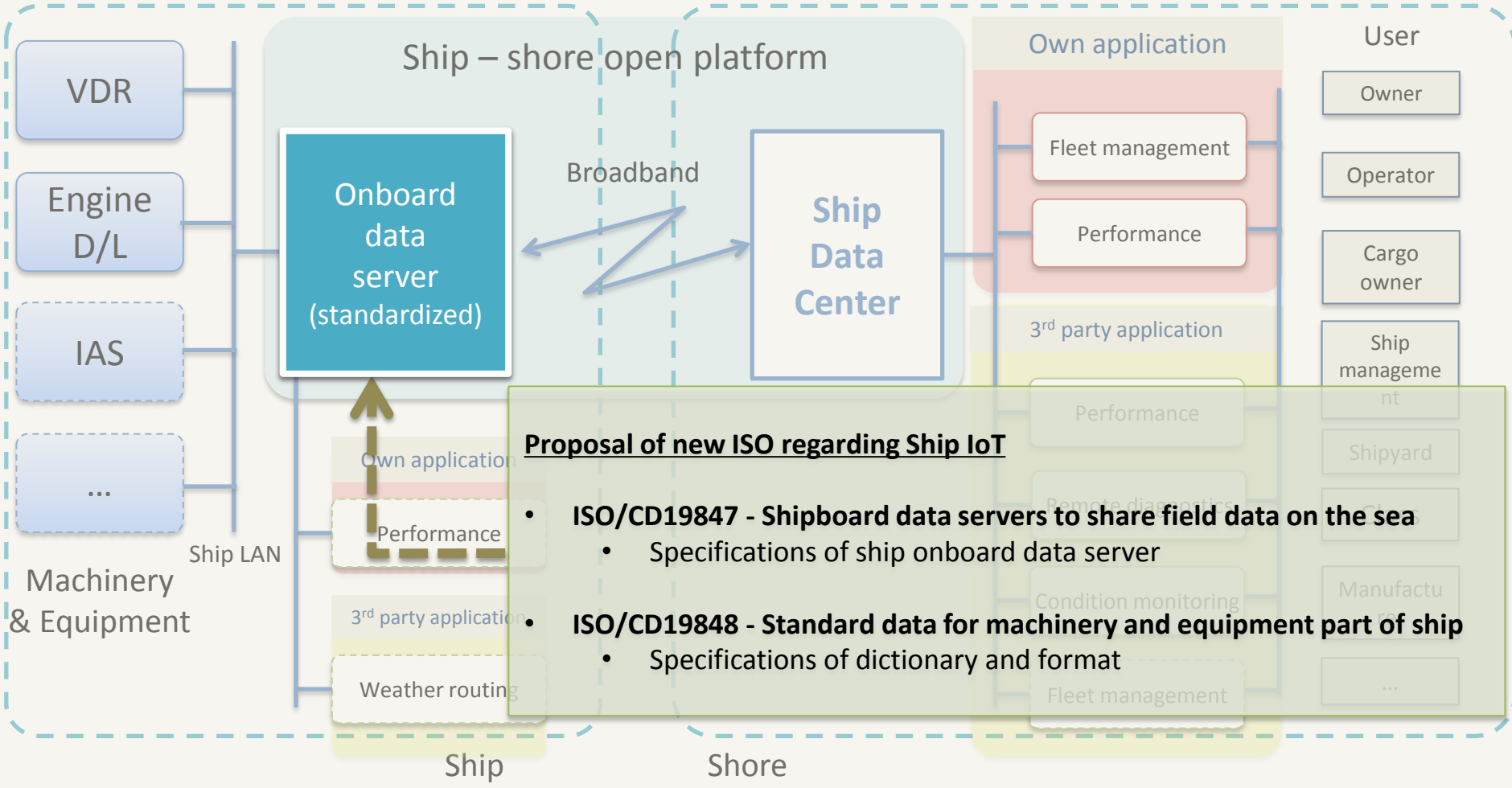
- Open collaboration with industry partners -

i-Shipping: Japanese government funding projects Ship IoT for safety (2016-2020)

Open platform for maritime industry

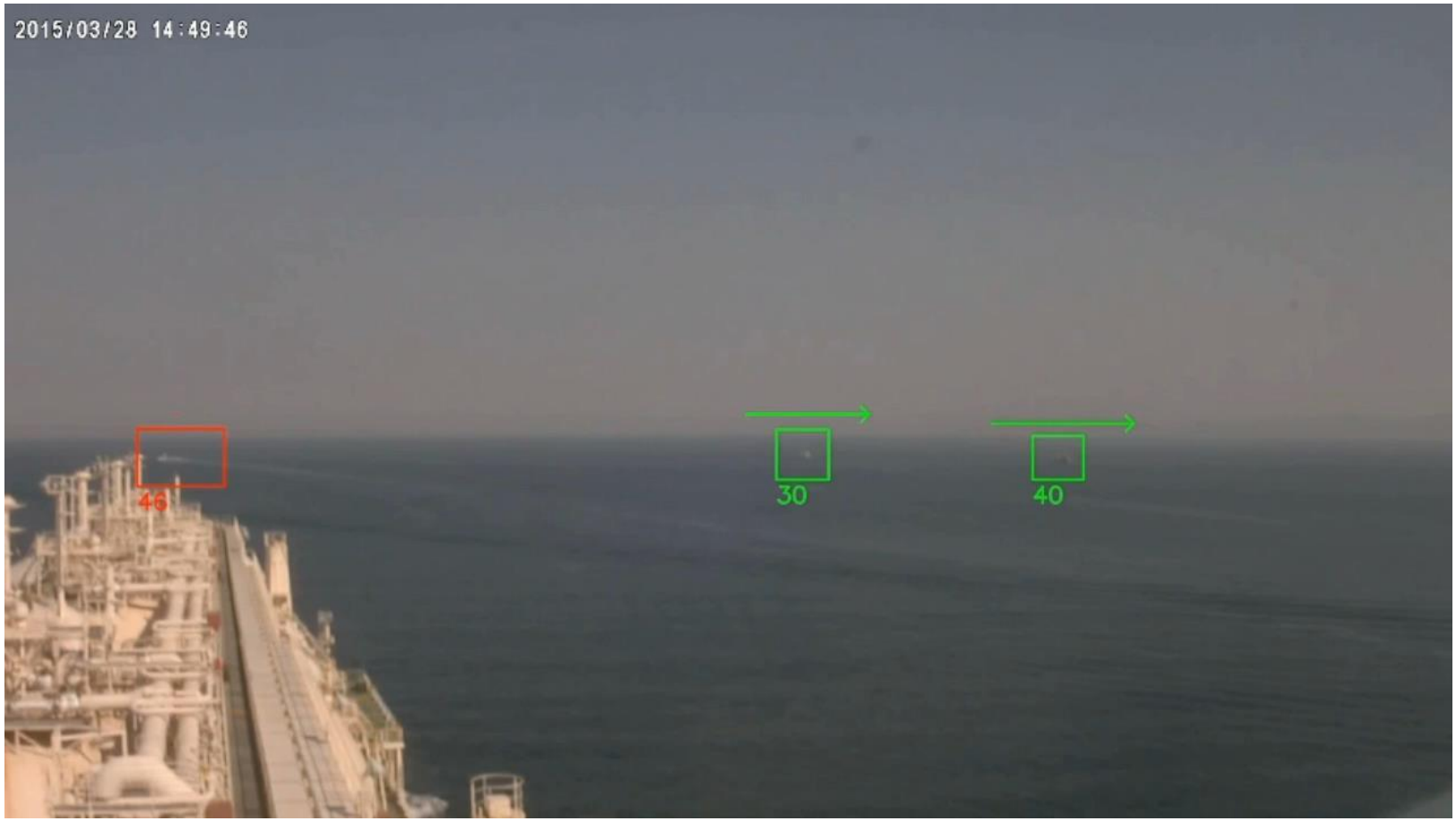


Standardization activities of Ship IoT platform
(SSAP2: Smart Ship Application Platform 2 Project by JSMEA)



JSMEA: Japan Ship Machinery and Equipment Association

Further collaborations for future



In the coming era of ship intelligence, we need open collaborations with wide variety of partners to seek possibilities of improving our safety and efficiency

Thank you very much for your attention