International Workshop on Maritime Autonomous Surface Ships and IMO Regulations
Monday, 14th May 2018 @ Main Hall, IMO Headquarters, London

Digitalization in Shipping
- Approach of NYK -

14th May 2018

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MTI (NYK Group)

Outline

1. Digitalization in shipping
2. Big data, IoT and Digital Twin
3. Open collaboration and open platform
4. Way forward and summary

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1. **Digitalization in shipping**
2. Big data, IoT and Digital Twin
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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)

Value creating digitalization in shipping

- Analogy from mining industry examples -

1. **Deep understanding of operating fleet and market**
2. **Optimized logistics and operations**
3. **Anticipation of failures**

Continuous learning ↑

↓ Continuous Improvement

4. **Incremental automation of ship functions**
5. **Monitoring of fleet performance and improvement**

Better decisions

Pursuing total optimization of operation and ship design

Safer, more consistent operations

Reference) McKinsey Company, How digital innovation can improve mining productivity, 2015
https://www.mckinsey.com/industries/metals-and-mining/our-insights/how-digital-innovation-can-%20improve-mining-productivity

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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 records
- Anemometer / wave measurement (IoT)

Business data
- Commercial data
- Market data

Methods of utilizing Big data

Identifying right issues to solve

Identified issues

Optimum operation
- Fuel saving
- Reasonably minimized margin

Support business decision
- Tactical ship/fleet allocation

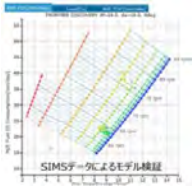
Safe operation

Big data

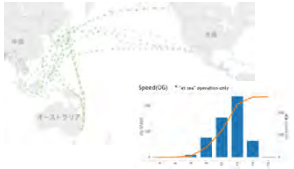
- IoT Data
- Report data
- AIS data
- Weather data

Analysis

Engineering knowledge
e.g. vessel performance



Data analytics & IT



Any useful data

Operation data
- Schedule
- Route
- CB/HB
- AIS

Technical data
- Performance
- Sea trial
- Particular
- Paint

Market data
- Bunker cost
- Hiring cost
- Market

Commercial data
- Contract
- Fleet plan
- Owner info.

Digital Twin

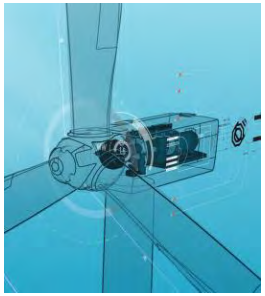
Capture real world by IoT, compute & simulate with vast computing power in digital, and solve & optimize real world problems

Physical (Product, Plant…)

IoT data

Problem solving
Optimization

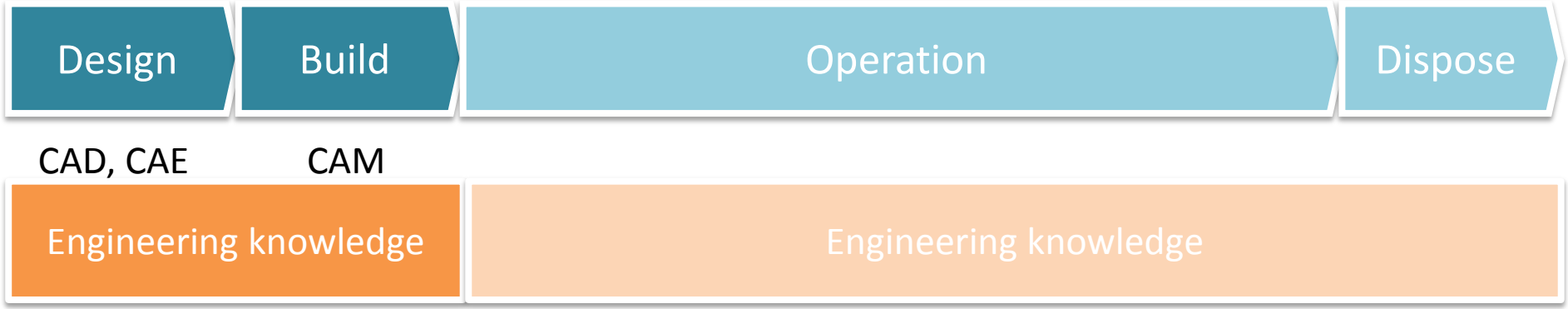
Cyber (Engineering model, simulation)



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

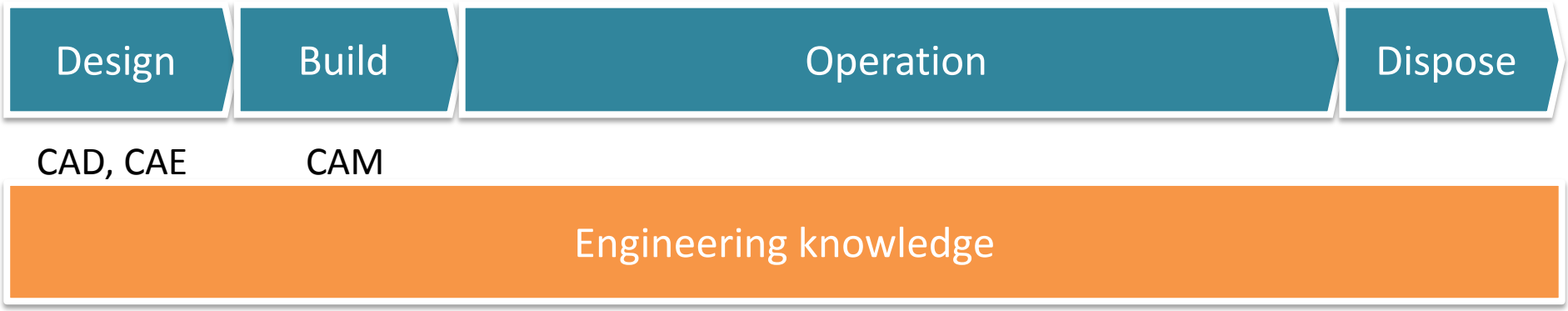
Before IoT:

Engineering knowledge, simulations and tools have been used for design and production



- Designers and engineers consider life cycle values of products only at design stage
  - Manufacturability, usability, maintainability, disposability …

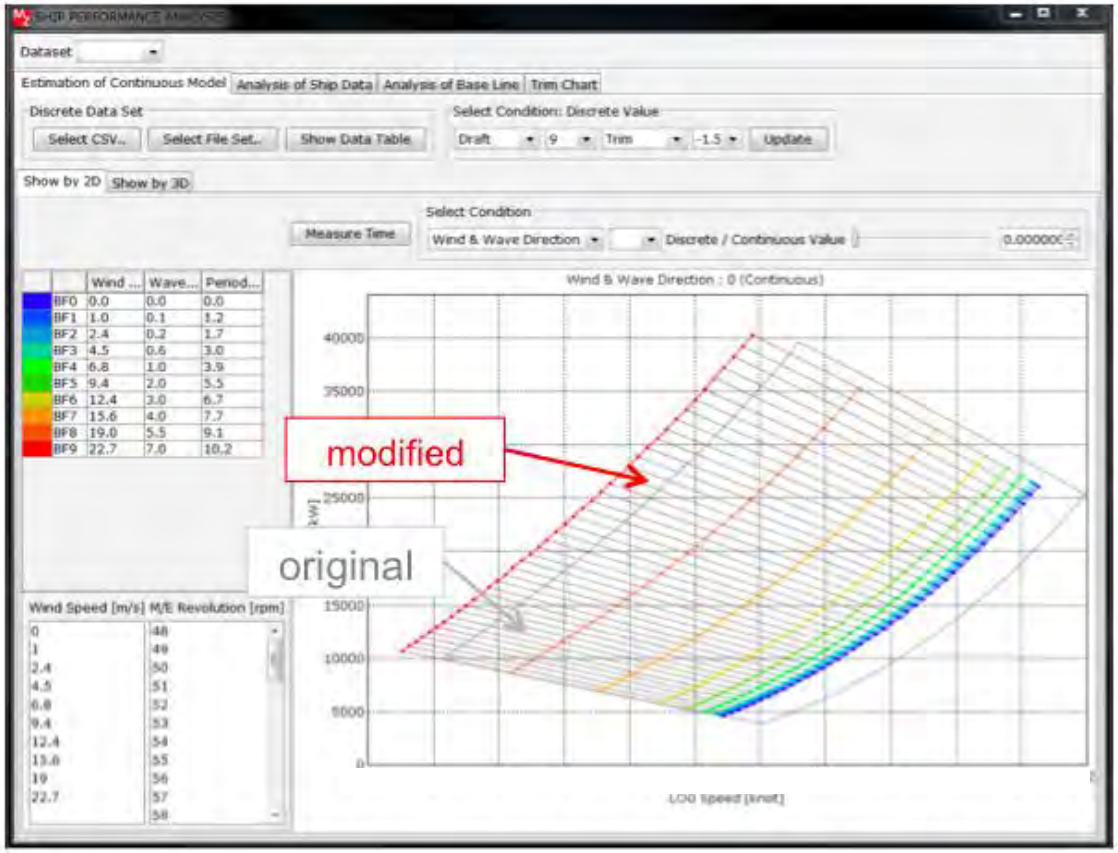
Era of IoT:
Engineering knowledge, simulations and tools are now demanded through life cycle of products



- **Operation optimization** with engineering knowledge
- Feedback of operation data to product design for **design optimization**

Pursuing total optimization of operation and product design

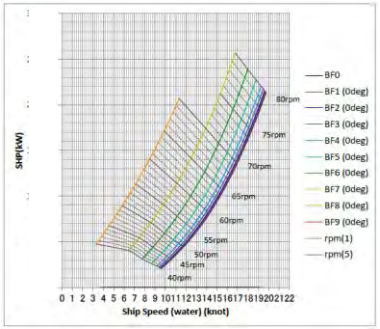
Vessel performance model
as 'Digital Twin' of each vessel's performance in service



- Digitalize actual ship performance by combination of engineering simulation and data
- Simulate voyages under variety of scenarios by using digitalized model and weather data
- Statistical evaluations of the simulation results solve actual operational issues

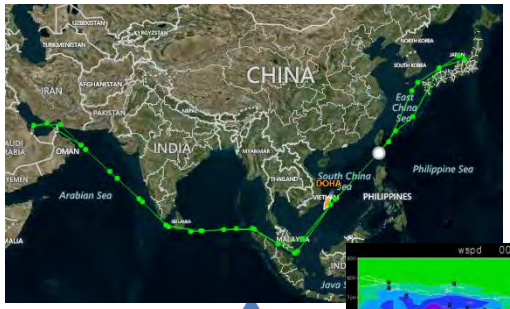
What is the issue?

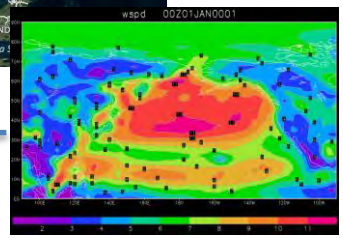
Understand seasonal operation risks



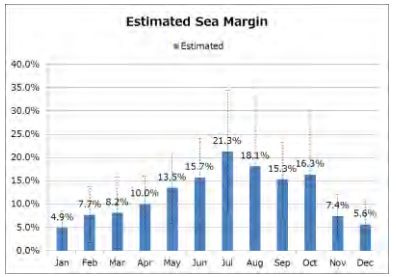
Ship performance model

Service route





Voyage simulation with past weather data

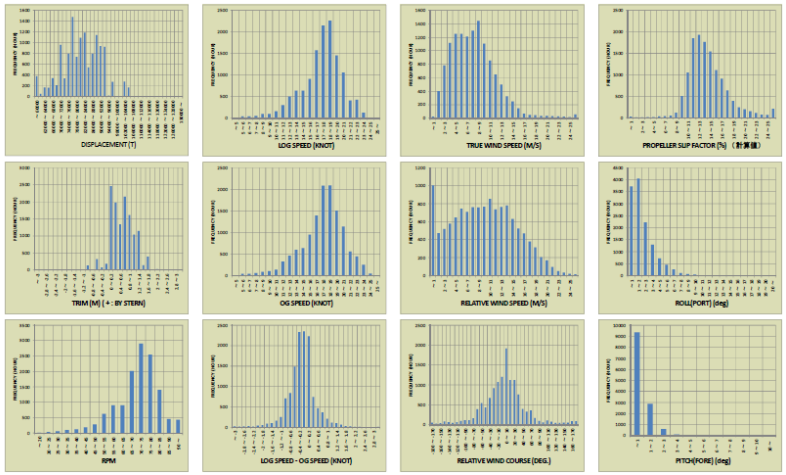


Estimation of
- Sea margin
- FOC and etc.

Combine ship performance model with weather data to optimize ship services

What is the issue?

Improve bad performance ship



23 % CO2 reduction was confirmed

Operational profile

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

Energy saving modification

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

‘Digital Twin’ will be more used not only for energy efficiency but also for improving safety

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Open collaboration with industry partners
- for enhancing safety operation of ships -

MLIT Ministry of Land, Infrastructure, Transport and Tourism
ClassNK

i-Shipping(Operation): Japanese government funding R&D projects – IoT for safety (2016-2020)
Joint research with ClassNK

Utilizing data and computing powers for reducing troubles in engine & plant operations

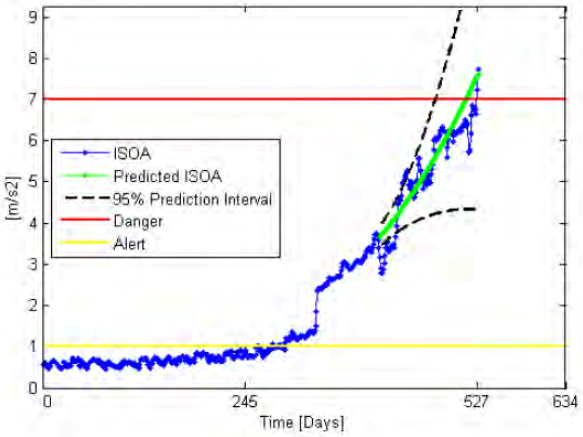
- Marine engineers
- IT specialists
- Manufactures

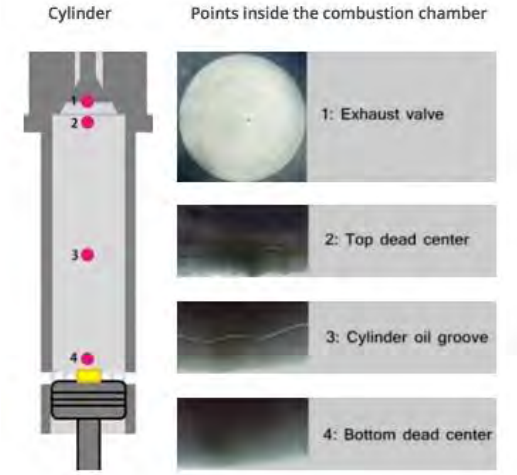
Target

- Prevent unpredicted downtime
- Condition-based maintenance

Measure

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

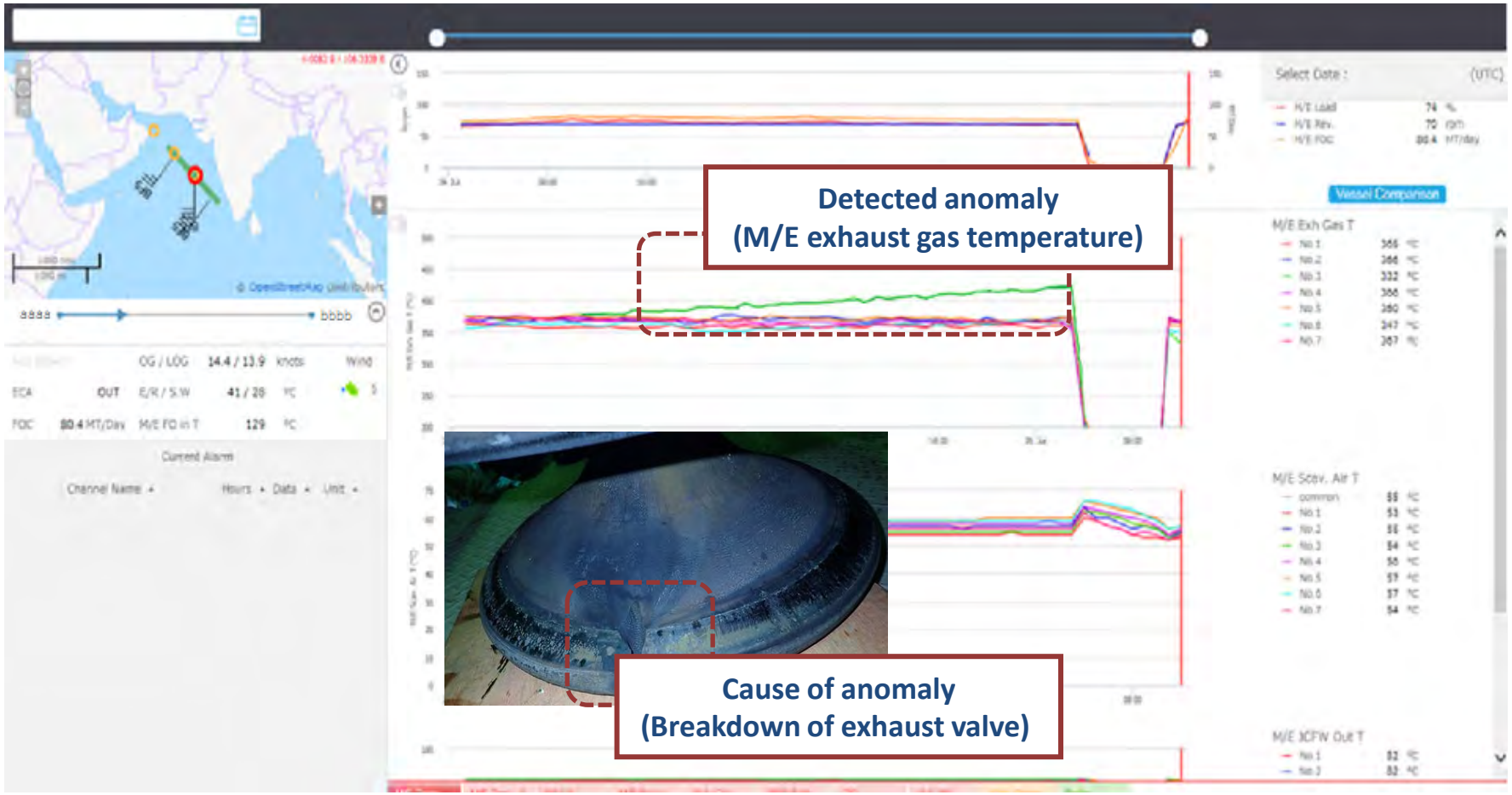




KIRARI NINJA
360-degree panoramic camera to take photos inside the dark combustion chamber

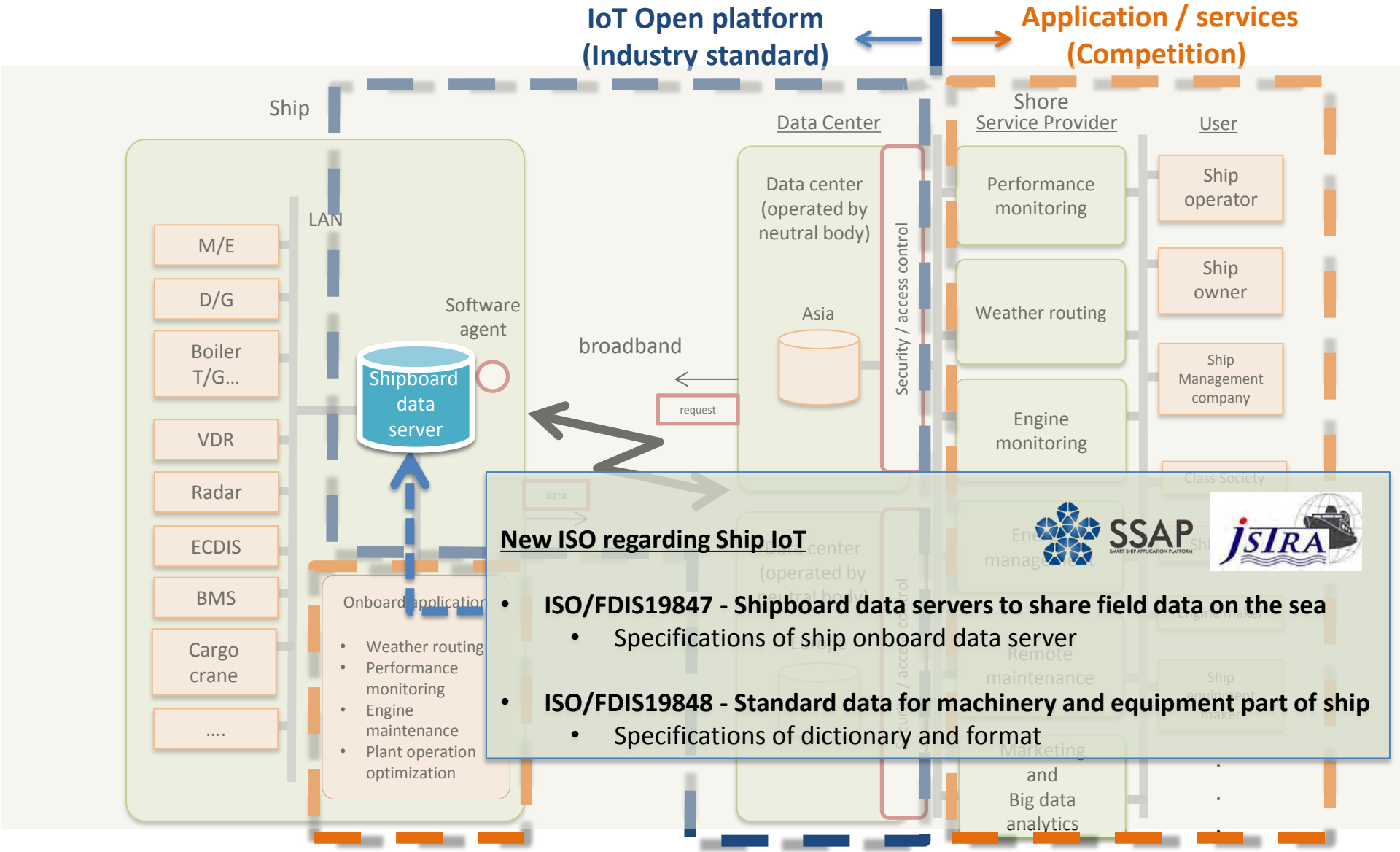
Reference)
1. Prognosticating fault development rate in wind turbine generator bearings using local trend models (B&K Vibro, DTU), PHM Europe 2016, pp. 132-141
2. https://theta360.com/s/f41xbUZ4smDJX4wsFh7gNUuZg?view=embed

Anomaly detection for enhance safe operation

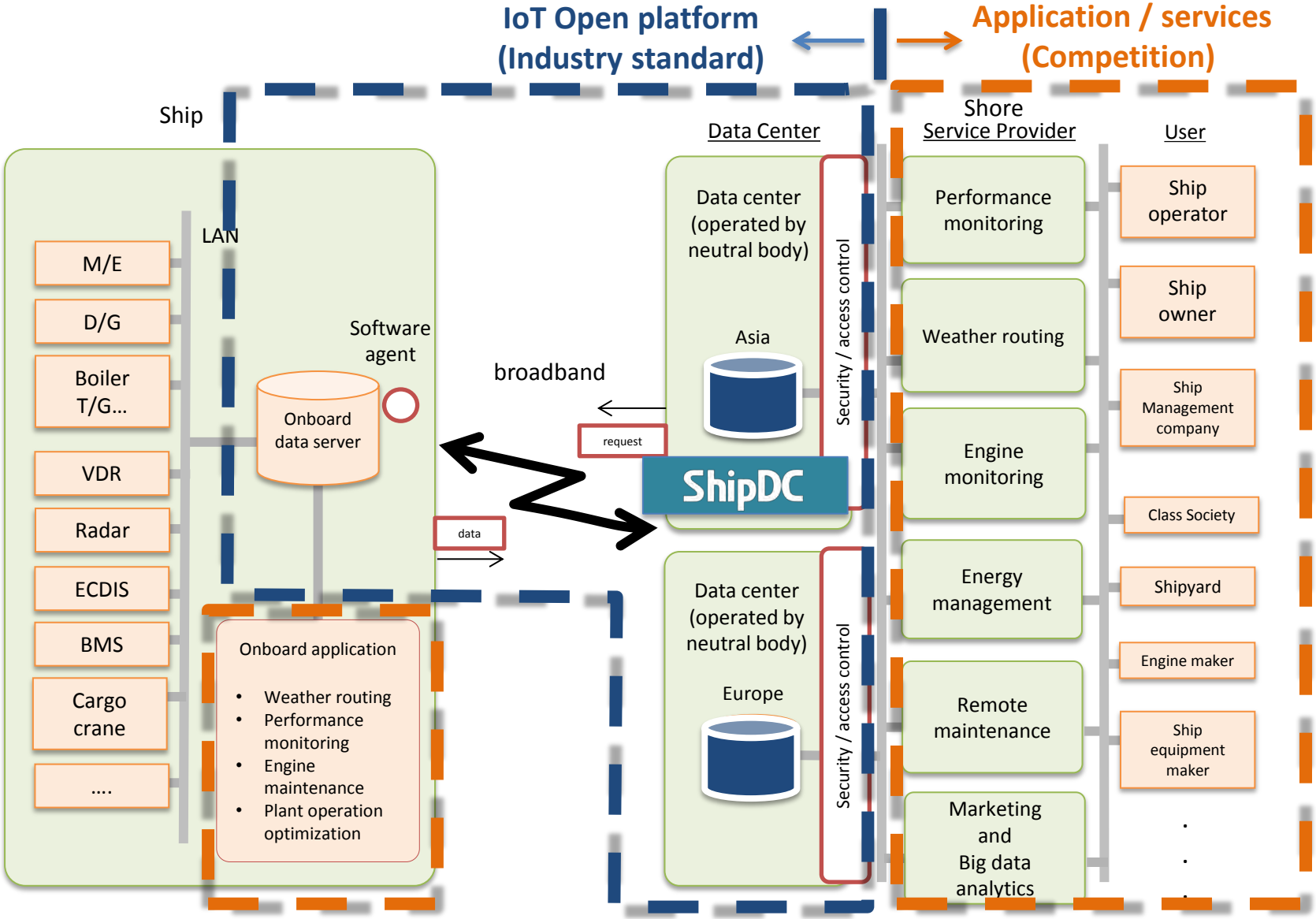


We are enhancing R&D collaborations with manufacturers by sharing ships' data to improve operation and design.

Concept of open platform for marine industry



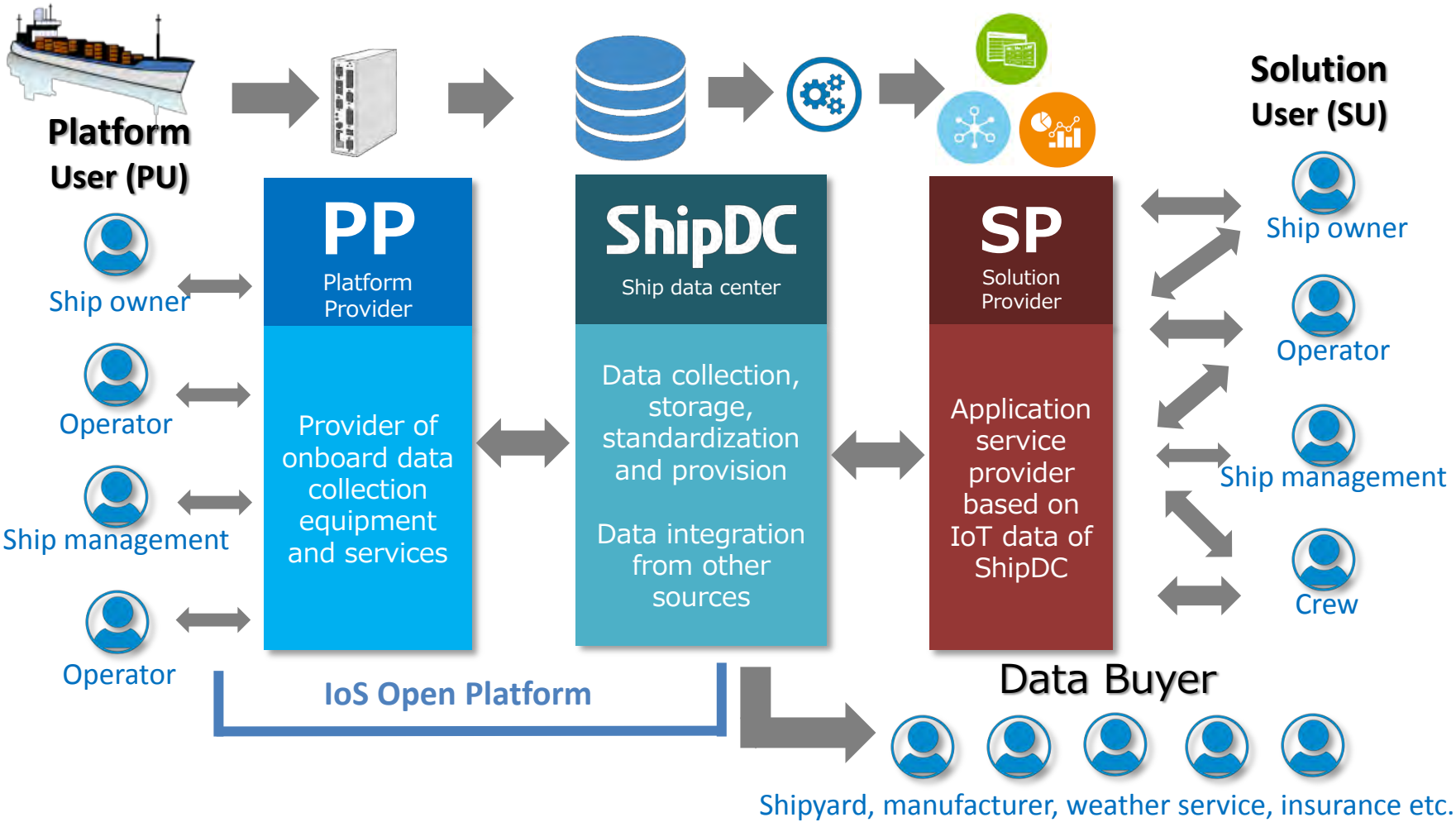
Concept of open platform for marine industry



Internet of Ships (IoS) Open Platform

ShipDC

Roles are defined and each player provides their expertise on the Internet of Ship(IoS) platform. Data governance and business rules have been built by IoS OP Consortium under ShipDC.



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R&D activities for enhancing safety in navigation

Objective

- Collision avoidance
- Reduce crew workload

Measures

- Work support
- Enhanced situation awareness
- Decision making support
- Support from shore
- Remote control
- Autonomous

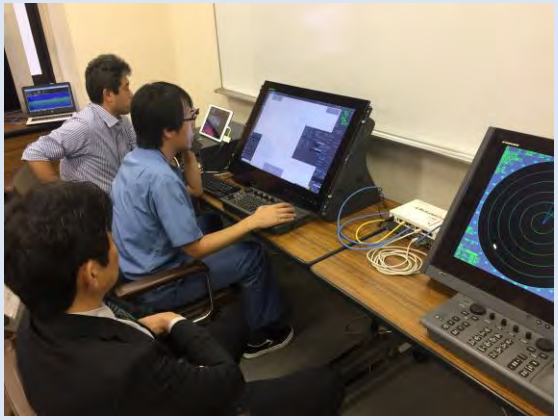
i-shipping(operation)

"Collision avoidance & highly automated ships"

Project partners: NYK, MTI, JMS, Furuno, JRC, Tokyo-keiki, ClassNK

Remotely controlled
Full-mission simulator

Sat
Com



Remote control station

Shore-shore remote control experiment (Oct. 2017)

Q1: Regulatory compatibility -> Scoping exercises in IMO/MSC (e.g. COLREG and STCW)

Q2: Reliability of the total system – e.g. Software, hardware, human-machine system, communication, data, sensor, cyber security management, BRM and education & training.

(e.g. class guidelines & notations for highly automated or autonomous ship)

In the era of digitalization, Pursuing total optimization is the challenge

- Optimization of fleet operation and ship design by utilizing the data
- Pursuing the best combination of **PPTO** (People, Processes, Technology and Organization)
- Continuous improvement, or step-by-step approach, by identifying right issues and solving them with industry partners

Limited integration

- Traditional practice
- Periodic onshore support

Integration across ship and shore

- Integrated onshore and offshore processes and centers
- Continuous onshore support

Integration across companies

- Integrated operator and vendor centers
- Automated processes
- Digital services and 24/7 operations

Example) from O&G offshore

Reference)

- http://www.iocenter.no/system/files/sites/default/files/IO_Conference/IO14/Presentations/P5_Heitmann%20Hansen.pdf
- T. Rosendahl and V. Hepso, Integrated Operations in the Oil and Gas Industry: Sustainability and Capability Development 1st Edition, IGI Global, 2012

Summary

Data and Technology are more available

In the era of digitalization, accessibility of data and technology become more available.

Identify right issues to solve is mostly important

Shipping is a rich semantics domain so it is very difficult for external consultants or data scientists to identify right issues to solve. People internally in shipping themselves have to lead innovations.

Pursuing optimization of fleet operation and ship design

Best combination of PPTO (people, process, technology & organization) and solving issues with right partners are indispensable. Step-by-step implementations of automation should be a part of this improving process.

Thank you very much for your attention