DNV GL National Committee Meeting
in Kawana, Japan

Digitalization in Shipping
- current status and way forward -

23rd February 2017

Hideyuki Ando

MTI, NYK Group

Outline

1. Digitalization in shipping
2. Application examples
3. Open platform and standardization
4. Way forward and summary

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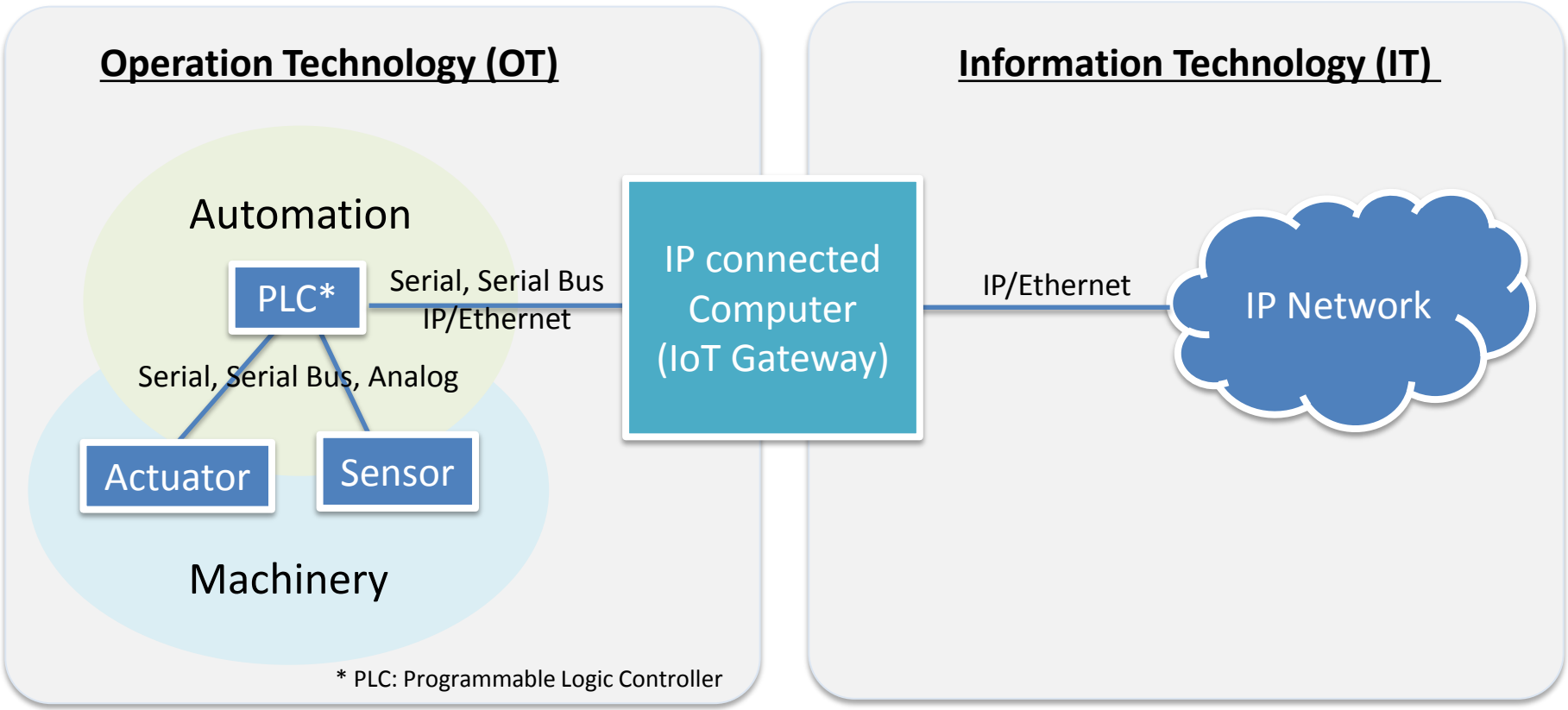
Digitalization - the next techno-economic great wave

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

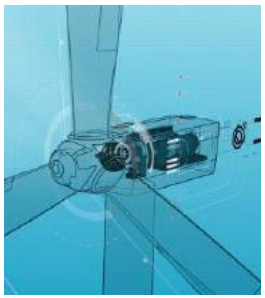
An approach of Product Lifecycle Management(PLM) to extend computer-based engineering capabilities to fleet operations

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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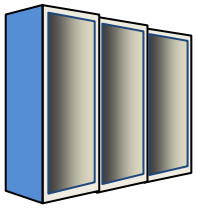
IoT platform of NYK

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

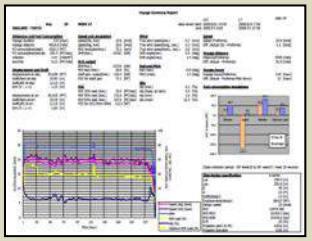
<Navigation Bridge>

<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)

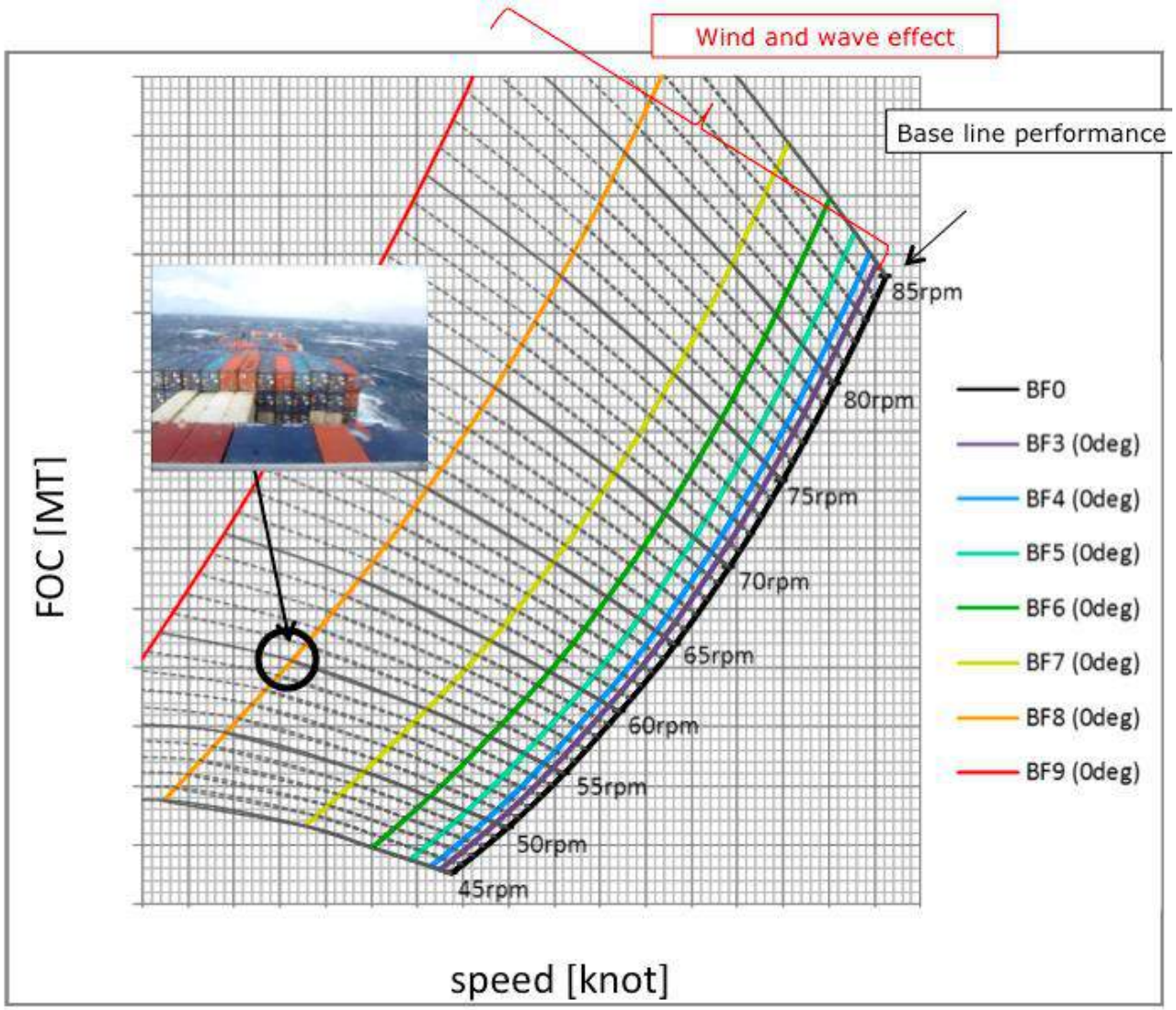
In-service ship performance model

<Target vessel>
6000TEU Container
Draft 12m even

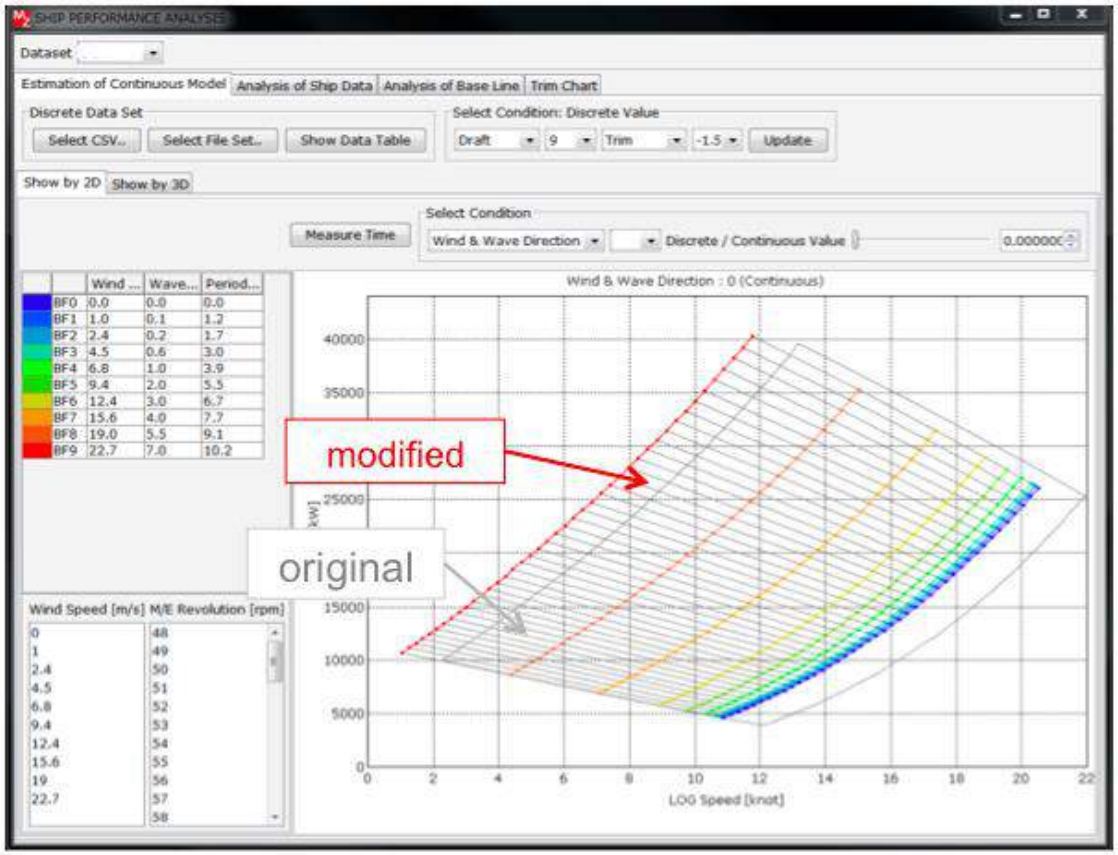
Sea condition
Beaufort scale

	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

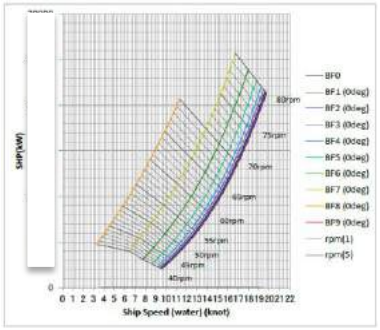


Ship performance model in service



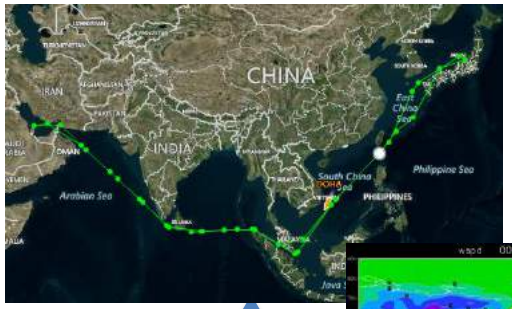
- *Digital Twin* of ship performance in-service
- Performances under all possible conditions (draft, trim, wind and wave)
- IoT data are used for correction of the model.

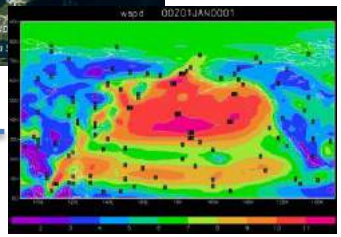
Operation optimization



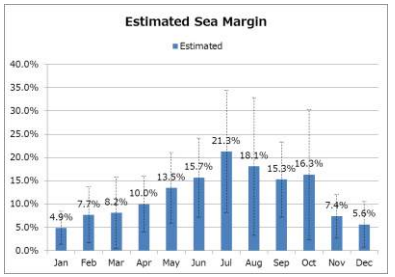
Ship performance model

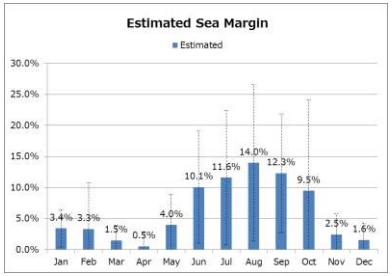
Service route





Voyage simulation with past weather data

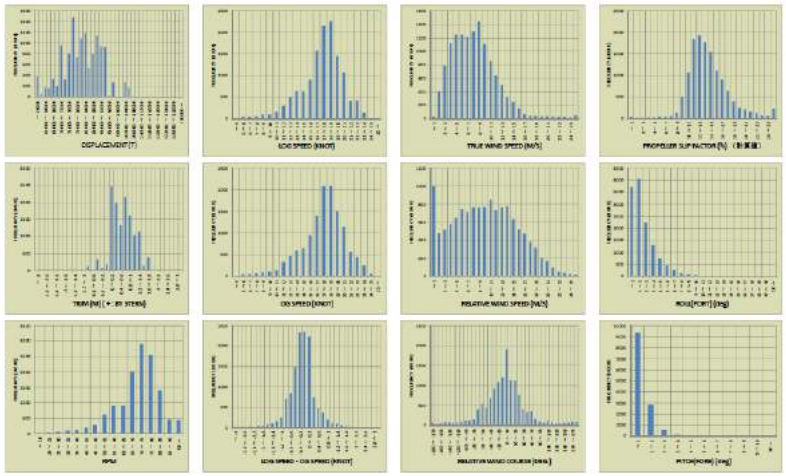




Estimation of
- Sea margin
- FOC and etc.

Combine ship performance model with weather data to optimize ship services

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.

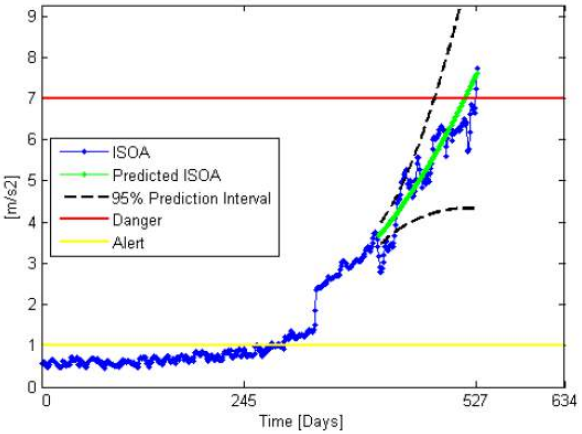
Prognostics and health monitoring in shipping for preventing troubles

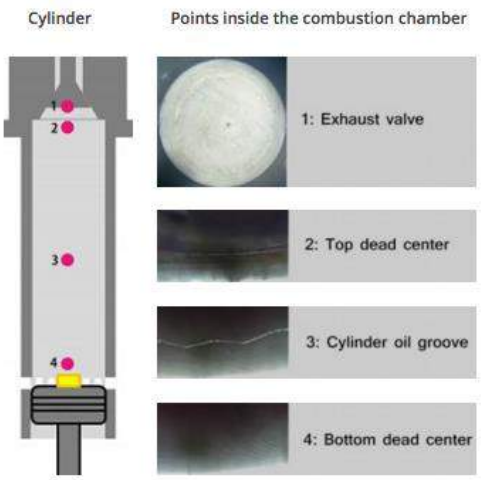
Target

- 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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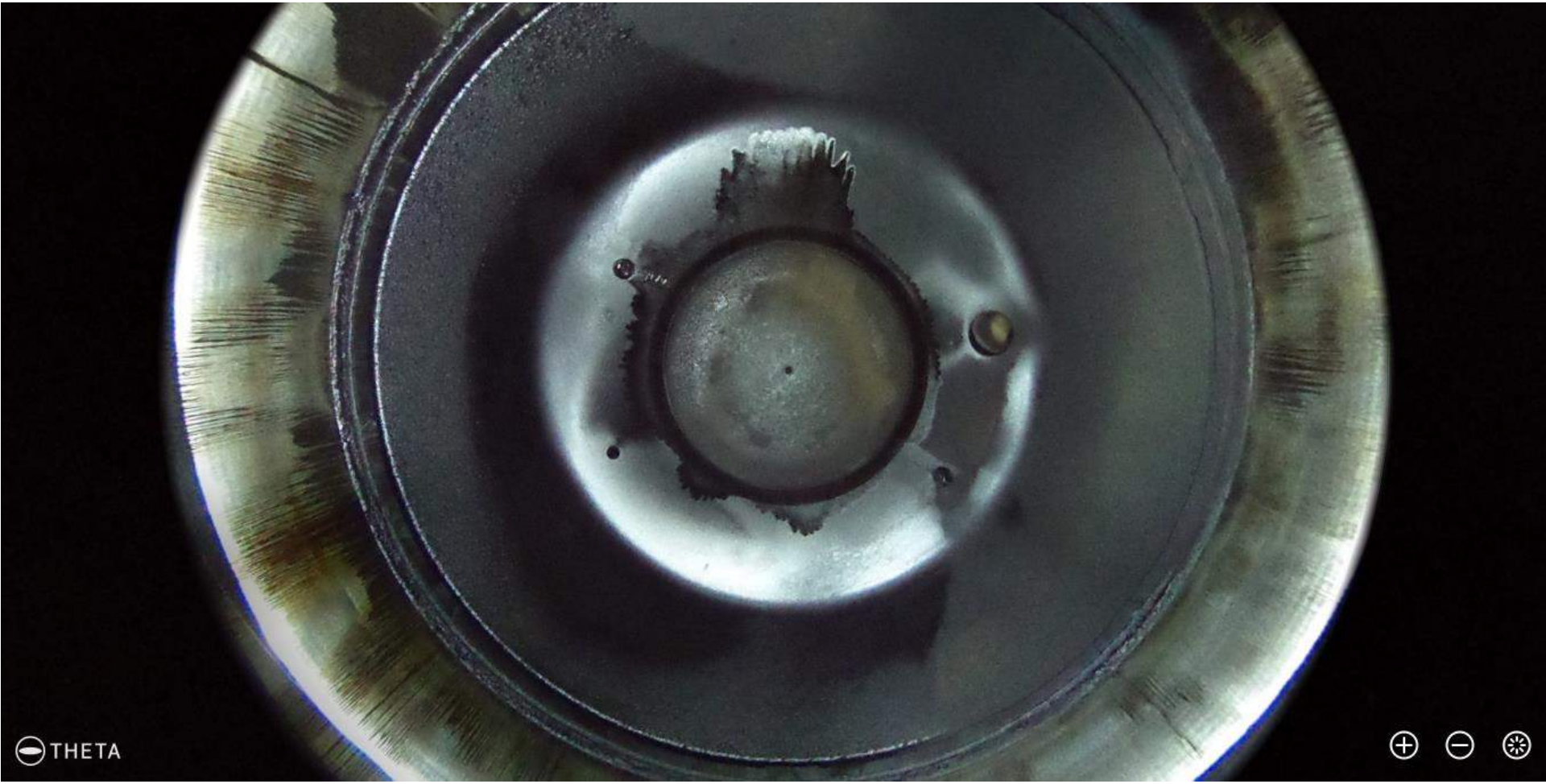

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Monohakobi Technology Institute

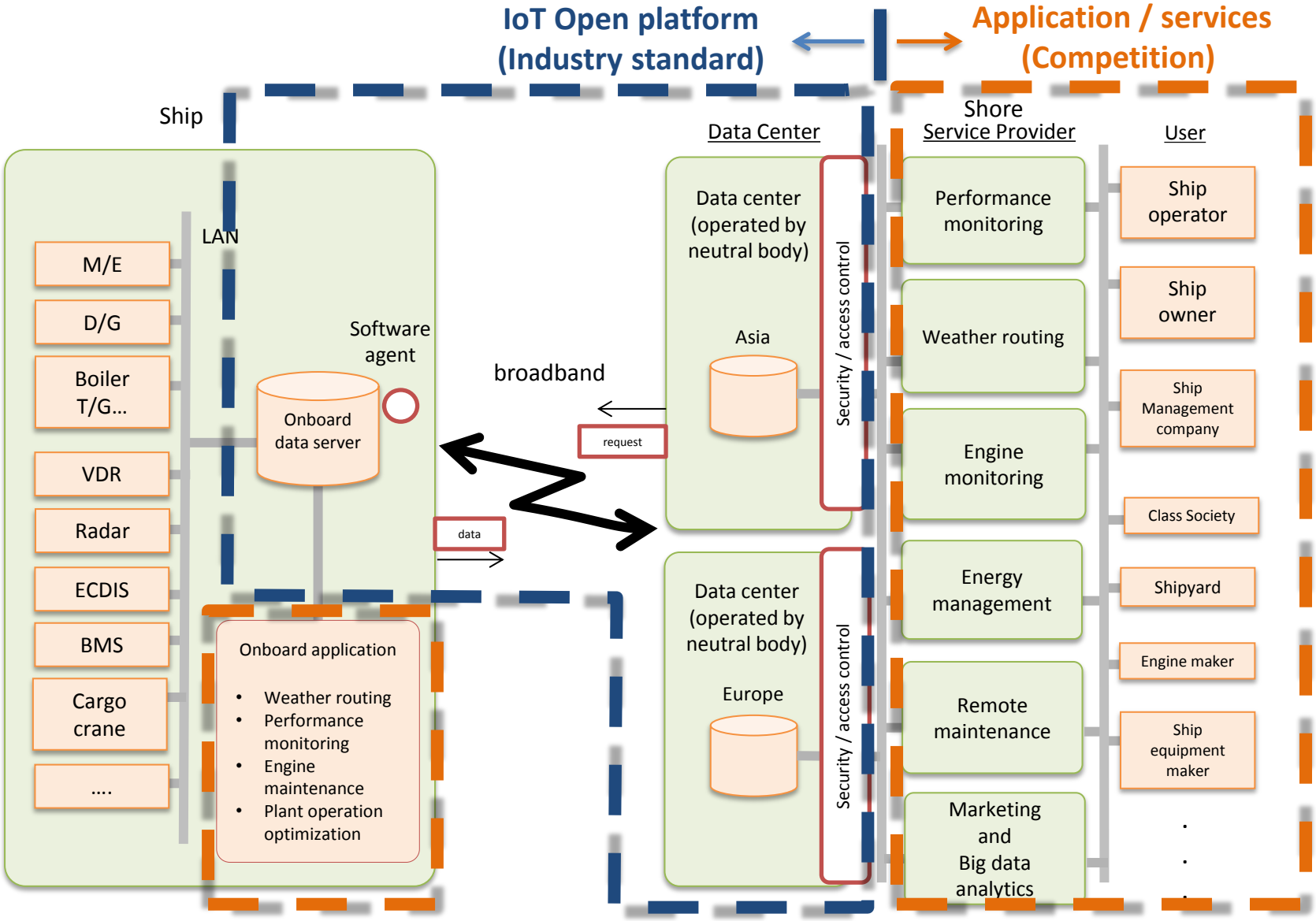
NYK GROUP

NYK/MTI's R&D activities for digitalization

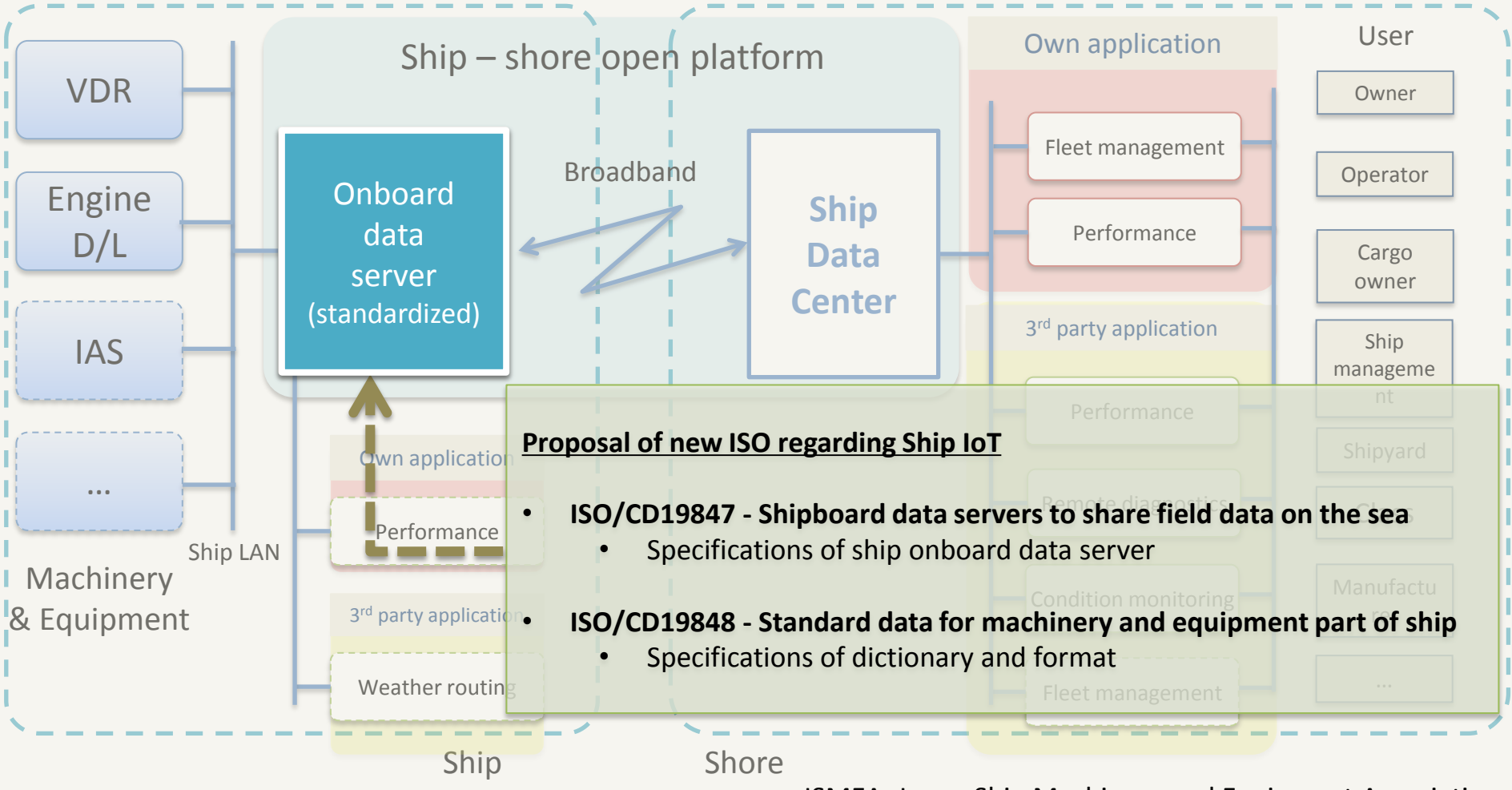
- Open collaboration with industry partners -

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

Open platform for maritime industry



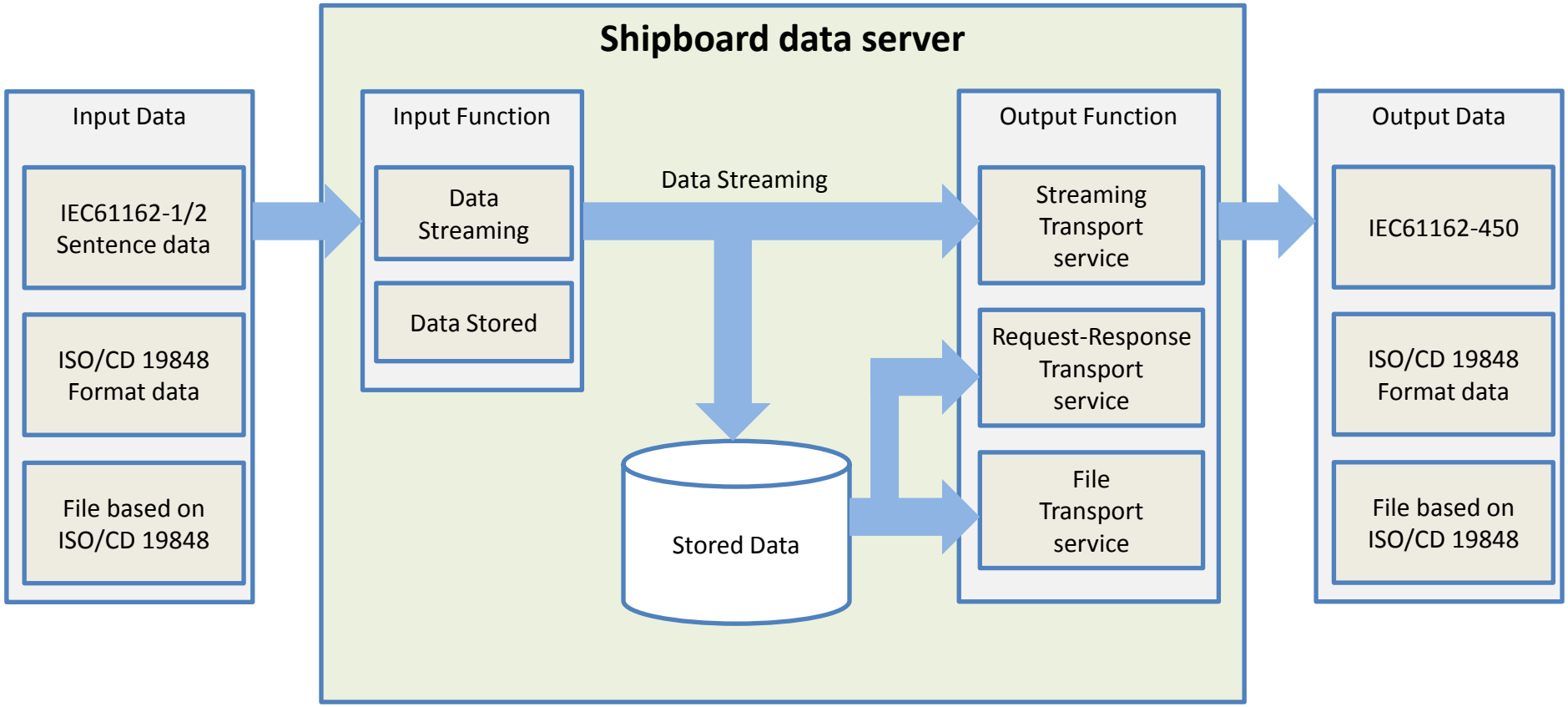
Standardization activities of Ship IoT platform
(SSAP2: Smart Ship Application Platform 2 Project by JSMEA)



JSMEA: Japan Ship Machinery and Equipment Association

ISO CD 19847

- Requirements for shipboard data servers to collect and share field data



Monohakobi Technology Institute

ISO / CD 19848

– Naming rule & data standard –

Standardized ID of sensors, common data model & format

ID of sensors

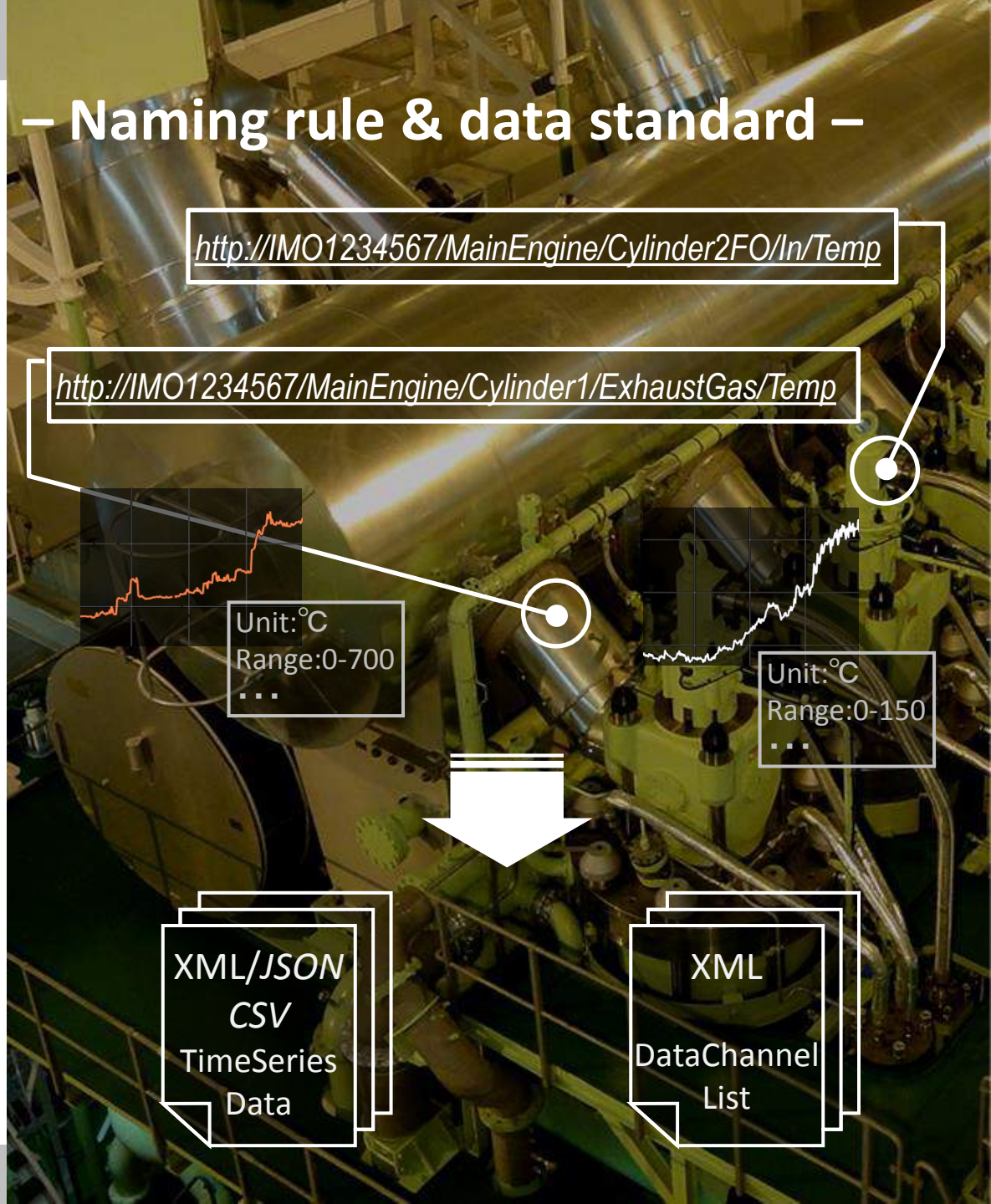
- ***URL*** compliant naming scheme
- Dictionaries (*informative*)
  - JSMEA
  - DNV-GL

Data model

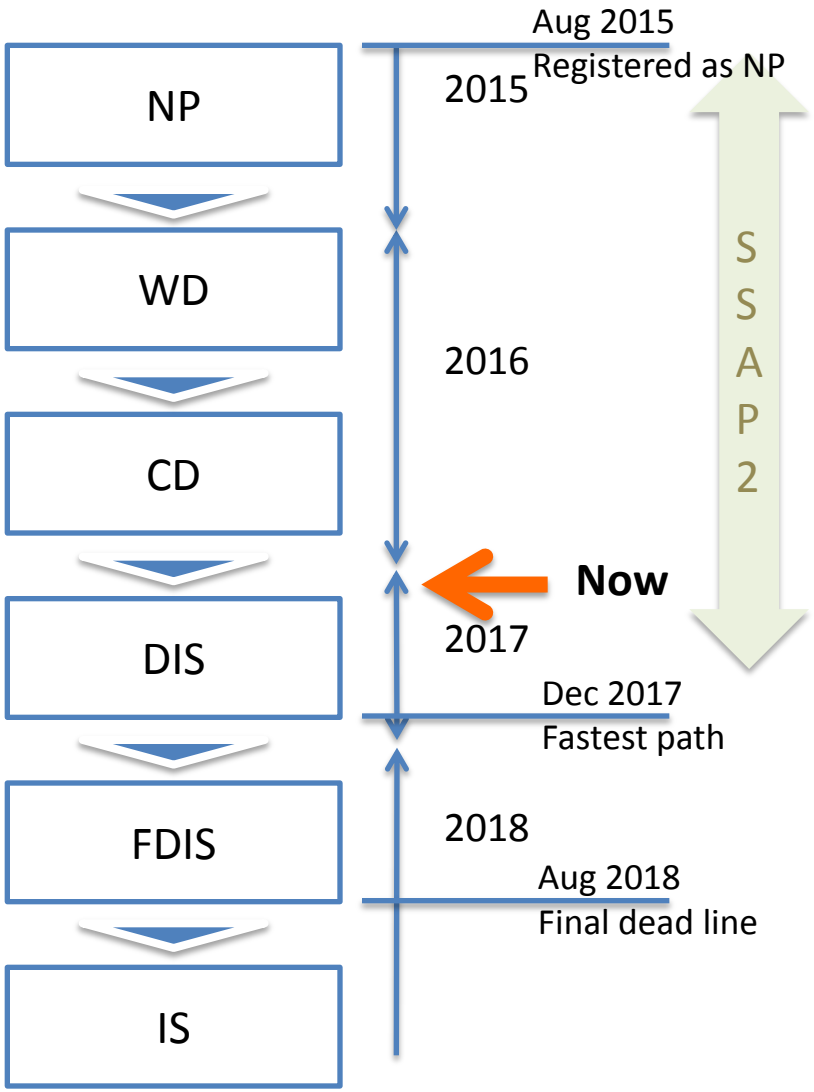
- Data channel list (meta data)
- Time series data (data)

Data format

- ***XML*** with schema definition
- *JSON/CSV (informative)*
- *CSV (informative)*



Process for ISO (ISO CD19847, ISO CD19848) *



- ISO PWI 19847/19848 were accepted as NP in Aug 2015
- The first ISO/TC8/SC6/WG16 meeting was held in June 2016 in Tokyo
- ISO CD 19847/19848 were accepted in Nov 2016
- Drafting of ISO DIS 19847/19848 undergoes.
  - Many contribution from Norway, Finland and Denmark
- 2 DISs will be distributed soon for comment and voting to the P-members of ISO/TC8/SC6

・NP: New work item Proposal, WD: Working Draft
・CD: Committee Draft, DIS: Draft International Standard
・FDIS: Final Draft International Standard, IS: International Standard

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Integrated bridge operation

Objective

- Prevent collisions
- Reduce workloads of crews
- Contingency backup

Measure

- Integrated bridge system
- Enhanced situational awareness
- Remote operation
- Autonomous ship

Infrastructure & regulation are very important

Reference) ULSTEIN BRIDGE CONCEPT

A possible scenario
- integrated operations (IO) for ocean-going vessels ? -

PPTO perspective is crucial

People, Processes, Technology and Organization

Integration across companies

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

Integration across on- and offshore

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

Limited integration

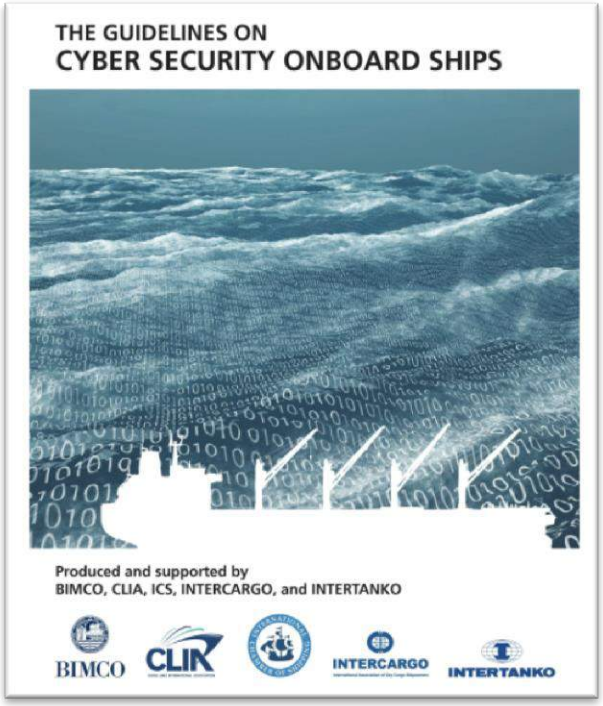
- Traditional practice
- Periodic onshore support

- *It is just an example from O&G offshore*
- *But, we have to think - until which extent and how will we utilize IO ?*

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

Cyber Security onboard ships
- towards cyber resilient ships and operations -



BIMCO, Feb 2016

Cyber security guidelines

- **IMO, MSC** – interim guidelines on cyber risk management (Jun 2016)
- **BIMCO** – the guidelines on cyber security onboard ships (Feb 2016)
- **DNV-GL** – Recommended Practice: Cyber security resilience management for ships and mobile offshore units in operation (Sep 2016)

Risk management on cyber security (BIMCO)

1. Understanding the cyber threat
2. Assessing the risk
3. Reducing the risk
4. Developing contingency plans

In Japan, JSTRA started a study group of cyber security in Aug 2016 and will continue for 3 years

A roadmap regarding digitalization toward 2020

Topic		2016	2017	2018	2019	2020
Application	R&D projects (e.g. i-Shpping in Japan and autonomous ships in Europe)	R&D projects (Navigation, engine, hull, cargo, operation and etc.)				
	PHM*1 services & products (Machinery & equipment)	Condition monitoring and PHM for main engine, machineries and equipment.				
	IT and IoT utilization in fleet operation	Integration of ship with shore operation system. Optimization, automation and simulation technologies.				
Platform	Ship IoT standardization (ISO CD 19847/19848) and other ISOs	ISO 19847/19848		(FDIS)	Smart Ship related ISOs ?	
	Ship data center		Trials & Operation			
Regulatory	Cyber security	BIMCO guideline, IMO MSC guideline, Class guideline ↔ IACS Cyber Security Panel				
	MRV *2				IMO MRV EU MRV	
	e-Navigation and autonomous ship regulations	Model development	Standardization		Implementation	Operation
		Several autonomous ship projects in Norway, Finland and in other nations				

*1 PHM: Prognostics and Health Monitoring, *2 MRV: Monitoring Reporting and Verification

Thank you very much for your attention