NYK’s Approach
To Maritime Digitalization

26th June 2019

Jungo Shibata
MTI (NYK Group)
Outline

1. Introduction
2. IoT and Big data in Shipping
3. NYK’s Activities for digitalization
4. Open Platform and Standardization
5. Way forward
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: 35,711 (as of the end of March 2019)
- Revenues: $ 20.5 billion (Fiscal 2018)
### NYK Fleet (as of the end of March 2019)

<table>
<thead>
<tr>
<th>Type</th>
<th>Number</th>
</tr>
</thead>
<tbody>
<tr>
<td>Container vessels (including semi-container ships and others)</td>
<td>63 vessels</td>
</tr>
<tr>
<td>Bulk Carriers (Capesize)</td>
<td>105 vessels</td>
</tr>
<tr>
<td>Bulk Carriers (Panamax &amp; Handysize)</td>
<td>194 vessels</td>
</tr>
<tr>
<td>Wood-chip Carriers</td>
<td>44 vessels</td>
</tr>
<tr>
<td>Cruise Ship</td>
<td>1 vessel</td>
</tr>
<tr>
<td>Car Carriers</td>
<td>118 vessels</td>
</tr>
<tr>
<td>Tankers</td>
<td>56 vessels</td>
</tr>
<tr>
<td>LNG Carriers</td>
<td>75 vessels</td>
</tr>
<tr>
<td>Others</td>
<td>42 vessels</td>
</tr>
<tr>
<td><strong>Total Vessels</strong></td>
<td>757 vessels</td>
</tr>
<tr>
<td><strong>(Owned 334 vessels)</strong></td>
<td></td>
</tr>
</tbody>
</table>
MTI Company Profile

- MTI is “Monohakobi (= quality transport) Technology Institute”
- Established: April 1, 2004
- Equity capital: JPY 99 million
- Stockholder: NYK Line
- Number of employees: 70 (as of end of March, 2019)
- Head office: 2-3-2 Marunouchi, Chiyoda-ku, Tokyo, 100-0005, Japan
- URL: www.monohakobi.com/en/

SINGAPORE BRANCH
1 Harbourfront Place #13-01
HarbourFront Tower One
Singapore 098633)

YOKOHAMA LAB.
(Transportation Environment Lab.)
5-32-84, Sugita, Isogo-ku, Yokohama,
Kanagawa, Japan
Smarter ship and operation in NYK/MTI

**Ship (Hardware)**
- Alternative Marine Power
- Wind Power Generator *Andromeda Leader*
- Solar Panel *Auriga Leader*
- Electric Controlled Engine *Monohakobi*
- Improved Governor Controller
- Wind Resistance Reduced *MT-COWL*
- MT-FAST
- Air Lubrication System *YAMATO, YAMATAI*
- Innovative Air Lubrication System *SOYO*
- Hybrid Electric Power Supply *Auriga Leader*
- Hybrid T/C *Shin Koho*
- 30% Energy Saving PCTC
- Super Eco Ship2030
- Super Eco Ship 2050

**Operation (Software)**
- Electronic Controlled Engine *MONOHAKOBI*
- Improved Governor Controller
- Electronic Controlled Engine *MONOHAKOBI*
- Fuel Consumption Indicator *FUELNAVI*
- Integrated Operation Management System *NYK e-missions*
- IBIS Project *NYK SATCOM Project*
- IBIS Project *NYK e-missions*
- FUELNAVI
- Onboard Broadband *NYK SATCOM Project*
- LIVE Operation Portal Site
- Detection of Mach. Trouble with monitoring data
- ShipDC & *IoS-OP*

**Now**
- OIL
- LNG
- HYDROGEN

**Future**
- Now
- Future

- LNG-Fueled Tugboat *Sakigake*
- LNG-Fueled PCTC Delivery in 2016
- LNG Bunkering Vessel Delivery in 2016

- NYK’s own safety and Environment standard *NAV9000*
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What is IoT and big data in shipping

Examples of IoT and 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
Utilize IoT data 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!
Methods of utilizing Big data #1

Identifying issues with deep domain knowledge, skill of data analytics and Big data

** 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.
Methods of utilizing Big data #2

The process of issue solving with domain knowledge, skill of data analytics and iterative prototyping. --> It is a collaborative process.

To realize the issue solving process, “Organizational Support” is necessity.
Methods of utilizing Big data #3

Operate and maintain data managing infrastructure

E.g. Data collection, error handling, data quality and data standardization.

Reference] DNV-GL, STANDARDISATION AS AN ENABLER OF DIGITALISATION IN THE MARITIME INDUSTRY, GROUP TECHNOLOGY & RESEARCH, POSITION PAPER 2017
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**IoT Platform of NYK**

- Data Acquisition and Visualization -

- Data Acquisition
- Data Cleansing
- Communication
- Data Integration
- Visualization

**SIMS (Ship Information Management System)**

For Operator
For Ship Manager
Case 1

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)
Case 1
In-service ship performance model

<Target vessel>
6000TEU Container
Draft 12m even

Sea condition
Beaufort scale

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

0deg (wind, wave) – head sea

Wind and wave effect
Base line performance
Case 1

Operation optimization

Ship performance model

Service route with past weather

Estimate data

Combine ship performance model with weather data to optimize ship services
Case2

Improve bad performance ship

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.

‘Ship IoT data’ will be more used not only for energy efficiency but also for improving safety
Case3

Anomaly detection from IoT data
- Find trouble phenomenon in engine & power plants -

Case) M/E (Main Engine) No.3 cylinder abnormal exhaust gas temperature

1. Visualize IoT data
2. Analysis with domain experts knowledge (marine engineer). Accumulate cases.
3. Implement automatic anomaly detection function by using the accumulated data.
Case 4

Utilizing IoT data for safer operation
- Open collaboration with industry partners -

- Collision avoidance and autonomous ship
- Simulation of LNG cargo transport
- Structural Health Monitoring
- Damage prevention of engine-power plant

i-Shipping(Operation): Japanese government funding R&D projects – IoT for safety (2016-2020)
Joint research with ClassNK
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Standardization activities of Ship IoT platform
( SSAP3: Smart Ship Application Platform 3 Project by JSMEA)

Proposal of new ISO regarding Ship IoT

- **ISO 19847** - Shipboard data servers to share field data on the sea
  - Specifications of ship onboard data server

- **ISO 19848** - Standard data for machinery and equipment part of ship
  - Specifications of dictionary and format

JSMEA: Japan Ship Machinery and Equipment Association
ISO19847 - Shipboard data servers to share field data at sea -

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

**Shipboard data server**

**Input Data**
- IEC61162-1/2 Sentence data
- ISO/CD 19848 Format data
- File based on ISO/CD 19848

**Input Function**
- Data Streaming
- Data Stored

**Output Function**
- Streaming Transport service
- Request-Response Transport service
- File Transport service

**Output Data**
- IEC61162-450
- ISO/CD 19848 Format data
- File based on ISO/CD 19848

**Data Streaming**

**Stored Database**
ISO19848 - Standard data for shipboard machinery and equipment -

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)*
Internet of Ships (IoS) Open Platform

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

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**Platform User (PU)**

**PP**
Platform Provider

Provider of onboard data collection equipment and services

**ShipDC**
Ship data center

Data collection, storage, standardization and provision

Data integration from other sources

**SP**
Solution Provider

Application service provider based on IoT data of ShipDC

**Solution User (SU)**

Ship owner

Operator

Ship management

Crew

**IoS Open Platform**

Shipyard, manufacturer, weather service, insurance etc.

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Way Future - Integrated bridge operation -

Objective
- Prevent collisions
- Reduce workloads of crews
- Contingency backup

Measure
- Integrated bridge system
- Enhanced situational awareness
- Advanced support system
- Manned Autonomous ship

Infrastructure & regulation are very important
Manned-Autonomous Ship

- Advanced support system ... additional functions to assist cognitive process of human operator based on existing navigation system
- Autonomous operation under approval of human operator

Integrated Navigation Support System J-Marine NeCST

NYK/MTI and Japan Radio Co. Ltd. jointly developed navigation support tool that enables officers to better manage and share navigational information.

(Press Released at 17th May 2017)

- Gathering all necessary information for navigation by using IoT
- Integrated navigation information management system
- Contribution to safe & efficient navigation

<Features of J-Marine NeCST>

1. Handwritten inputs
2. Compatibility with ECDIS
3. Implementation of meteorological and hydrographical forecasts
4. Information sharing with other ships and land
5. Flexible customization
Cyber Security and Cyber Resilient Ship

Cyber risk management will need to be implemented. Protection of Industry Control System is crucial

Cyber security guidelines in shipping

- **IMO, MSC (98)** – Cyber risk management onboard ships should be included in SMS as of 1 Jan 2021 (Jun 2017)
- **BIMCO** – the guidelines on cyber security onboard ships – version 3 (Nov 2018)
- **ABS, DNV-GL, LR, BV etc.** – Guidelines and notations of cyber security onboard ships (2016)
- **IEC 61162-460** – Safety and security standards for navigation and radio communication equipment
- **IACS Maritime Cyber System Recommendations (MCSR)**

**Cyber security guidelines**

- **NIST Framework and 800-53** – computer security policies, procedures and guidelines
- **ISO 27001/2** – ISMS: Information Security Management System

Source: BIMCO
https://www.bimco.org/products/publications/free/cyber-security
“Ship-Shore data sharing and Cyber Security Platform” in collaboration with Dualog

1. Realization of secure and efficient data-sharing platform between ship and shore.
2. Raise of on-board cyber risk management level through ship and shore cooperation

Source) NYK LINE
Thank you very much for your attention