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

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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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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 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 -


- 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)
"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

Reference:
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

<table>
<thead>
<tr>
<th>Role</th>
<th>Function</th>
<th>Example of IoT and Big data application</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Ship owner</strong></td>
<td>Technical management</td>
<td>• Safety operation&lt;br&gt; • Condition monitoring &amp; maintenance&lt;br&gt; • Environmental regulation compliance&lt;br&gt; • Hull &amp; propeller cleaning&lt;br&gt; • Retrofit &amp; modification</td>
</tr>
<tr>
<td></td>
<td>New building</td>
<td>• Design optimization</td>
</tr>
<tr>
<td><strong>Ship operator</strong></td>
<td>Operation</td>
<td>• Energy saving operation&lt;br&gt; • Safe operation&lt;br&gt; • Schedule management</td>
</tr>
<tr>
<td></td>
<td>Fleet planning</td>
<td>• Fleet planning&lt;br&gt; • Service planning&lt;br&gt; • Chartering</td>
</tr>
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</table>

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)**

**Data Center**
- SIMS IoT data + SPAS manual data

**SIMS Data Collection Onboard**
- Sat Com (VSAT, FBB)
- Data Acquisition and Processing
- Onboard dashboard
- Motion sensor

**SIMS unit (IoT gateway)**
- VDR
- GPS
- Doppler log
- Anemometer
- Gyro Compass

**<Navigation Bridge>**
- Technical Analysis (NYK, MTI)

**<Engine Room & Cargo>**
- Main Engine
- Power plant
- Cargo control
- Auxiliary machineries

**Sat Com (VSAT, FBB)**
- Operation (Tokyo, Singapore ...)

**Onboard dashboard**
- Big data analysis
  - Operational efficiency
  - Performance
  - Engine & plant condition

**Motion sensor**
- Shore Dashboard
  - For operation
  - For ship manager

**Operation Dashboard**
- Analysis report

**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

| 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

Wind and wave effect

Base line performance
Operation optimization

Ship performance model

Voyage simulation with past weather data

Combine ship performance model with weather data to optimize ship services

Estimation of
- Sea margin
- FOC and etc.
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)

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

KIRARI NINJA
360-degree panoramic camera to take photos inside the dark combustion chamber
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NYK/MTI’s R&D activities for digitalization
- Open collaboration with industry partners -

- Collision avoidance and autonomous ship
- Simulation of LNG cargo transport
- Cargo crane condition monitoring
- Multi-layered Doppler log
- Structural Health Monitoring
- Propulsive efficiency monitoring
- Damage prevention of engine-power plant

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

IoT Open platform (Industry standard)

Data Center

Data center (operated by neutral body)

Asia

Europe

Security / access control

Application / services (Competition)

Shore Service Provider

Performance monitoring

Weather routing

Engine monitoring

Energy management

Remote maintenance

Marketing and Big data analytics

User

Ship operator

Ship owner

Ship Management company

Class Society

Shipyard

Engine maker

Ship equipment maker

Onboard application

- Weather routing
- Performance monitoring
- Engine maintenance
- Plant operation optimization

M/E

D/G

Boiler T/G...

VDR

Radar

ECDIS

BMS

Cargo crane

....

Onboard data server

Software agent

LAN

broadband

request

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

Proposal of new ISO regarding Ship IoT

- **ISO/CD19847 - Shipboard data servers to share field data on the sea**
  - Specifications of ship onboard data server

- **ISO/CD19848 - Standard data for machinery and equipment part of ship**
  - Specifications of dictionary and format

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