How to utilize Big data and IoT in the shipping sector?

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Hideyuki Ando, MTI (NYK group)
Outline

1. Introduction of MTI
2. IoT and Big data
3. SIMS (Ship Information Management System)
4. Data analysis
5. Open platform
6. Concluding remarks
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Introduction of MTI
*(Monohakobi Technology Institute)*

• Established - April 1, 2004
• Locations
  – Head office – 7th floor, NYK building, Tokyo, Japan
  – MTI Singapore branch
  – MTI Yokohama Laboratory
• 100% owned by NYK
• Number of employees – 63 (as of April 1, 2015)
• President – Mr. Makoto Igarashi
• Business areas
  – R&D of Maritime Technology
  – R&D of Logistic Technology

Examples of MTI R&D projects

**Reduction of resistance**
Air lubrication system

**Propulsion efficiency**
Energy saving devices

**Power plant efficiency**
Hybrid turbo charger

**Operational efficiency**
Performance management system
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"Instrumentation and control" and "Internet" are to be bridged. The era of "transparency" where user can access field data.
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 statistics
- Anemometer / wave measurement (IoT)

**Business data**
- Cargo transport data
Industrial Internet - example of GE (IoT of industrial machineries)

Target
• Prevent unpredicted downtime
• Energy efficiency in operation
• Reduce maintenance cost

Measure
• Condition monitoring
• Big data analysis
• Support service engineer
• Intelligent machinery
  – Self diagnostics

Change way of working

Same concepts are applicable to marine industry

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

**Measure**
- Condition monitoring
- Big data analysis
- Support service engineer
- Intelligent machinery
  - Self diagnostics

**Change way of working**
## IoT and Big data application areas

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

Other partners in value chains, such as cargo owners, shipyards, equipment manufacturers, class societies and others, have also interests in ship Big data.
“Big data” is an organizational process
The target is to change way of working by utilizing data
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SIMS overview

FOP Data Collection System Onboard

VSAT/Inmarsat-F/BB

SIMS Monitoring & Analysis System at Shore

SIMS auto logging data (per hour) & NYK’s electronic abstract logbook data (per day)

Data Center

Data Acquisition and Processing

VDR

Motion sensor

Navigation Bridge

Engine Room

- Main Engine
- FO flow meter
- Torque meter
- Re-liquefaction Plant

Integrated Automation System

SIMS unit

Viewer

Communications via Technical Management

Operation Center (London)

Report

SIMS Viewer

- Trend monitoring of speed, M/E RPM, fuel consumption and other conditions per hour
- Engine monitoring

Technical Analysis (MTI)

Voyage Analysis Report

Break down analysis of fuel consumption for each voyage

Feedback to captains

- GPS
- Doppler log
- Anemometer
- Gyro Compass

<Navigation Bridge>
SIMS as open platform
Open platform = interface to 3rd party applications

SIMS also works as an open platform to collect onboard equipment data and share them with 3rd parties’ applications.

SIMS uses Furuno Open Platform (FOP) supplied and maintained by Furuno Electric, one of the world-wide marine equipment suppliers.

SIMS provides open API (Application Programming Interface) to 3rd party applications.
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6. Summary
Toolbox of using Big data

Dashboard
- For operator
- For ship manager

Big data
- Data warehouse (Cloud)
- IoT data + Voyage + Weather

Performance analysis
- Long term analysis
- In-service performance model

Business Intelligence (BI)
- Data download
- BI tool
Dashboard

- Example) Dashboard for ship manager
  - Support safety management of fleet
Business intelligence (BI) tool

- Quick visualization of data
- Business experts can be the best data analysts
- Standardization of data naming is very important to accelerate data usage

Download data from multiple vessels (Data Finder)

Data analysis with BI tool (e.g. comparison of engine data of multiple vessels)
Business intelligence (BI) tool

• Dashboard created by using BI
  – Easy to make (rapid prototyping)
  – Easy to customize

Filtering data

Statistics e.g. operational profiles
Performance analysis - long term analysis -

Performance analysis
Semi-automate the long term analysis process

Pick-up target vessels
Visualize performance drops of fleet vessels after last dry dock

Cleaning hull & propeller
Expand service available ports

Performance Management
Operation Management
Hull & propeller Cleaning Service Provider
Performance analysis - in-service performance

6000TEU Container Ship
Wave height 5.5m, Wind speed 20m/s
BF scale 8, Head sea

@ engine rev. 55rpm
<Calm sea performance>
speed: 14 knot
FOC: 45 ton/day

<Performance in the rough sea (BF8)>
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, cleanliness of hull and propeller, aging effect)
In-service performance model

<Target vessel>
6000TEU Container
Draft 12m even

Sea condition
Beaufort scale

<table>
<thead>
<tr>
<th>BF</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

speed [knot]

FOC [MV]
In-service ship performance model

- It is a “Digital Twin” of each ship regarding performance in-service.

- Performances under all possible conditions (draft, trim, wind, wave) are integrated in the model.

- Simulation results are compiled into a multi-dimensional mathematical model.

- IoT data are used for correction of the model.
Operation optimization with in-service ship performance model

Simulating ship performance in actual weather to optimize ship services.
IoT for preventive maintenance

**Target**
- Prevent unpredicted downtime
- Energy efficiency in operation
- Reduce maintenance cost

**Measure**
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Collaborations with external experts are necessary
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Ship–shore open platform provides good security and access control to enhance cooperation with industry partners.

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**Concept of ship – shore open platform**

**Ship–shore open platform**

- **Onboard data server (standardized)**
- **Ship LAN**
- **VDR**
- **Engine D/L**
- **IAS**
- **Machinery & Equipment**

**Broadband**

**Data Center (neutral body)**

**Own application**
- Fleet management
- Performance
- Remote diagnostics
- Condition monitoring
- Fleet management

**3rd party application**
- Performance
- Weather routing

**Ship LAN**

**User**
- Owner
- Operator
- Cargo owner
- Manufacturer
- Shipyard
- Class
- ...
Smart Ship Application Platform (SSAP) Project
- A standardization activity regarding ship IoT data -


Proposals for new ISO

- ISO/NP19847 - Shipboard data servers to share field data on the sea
  - Specifications of shipboard data server

- ISO/NP19848 - Standard data for machinery and equipment part of ship
  - Specifications of naming rules for shipboard data channel
# Expected Applications of Ship IoT and Open Platform

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<thead>
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<th>Application of Ship IoT and open platform</th>
</tr>
</thead>
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<tr>
<td><strong>Shipping</strong></td>
<td>Ship owner and operator needs applications for energy saving, minimize downtime, safety transport and environmental conservation</td>
</tr>
<tr>
<td><strong>Manufacturer</strong></td>
<td>Remote diagnosis, preventive maintenance and self diagnostics</td>
</tr>
<tr>
<td><strong>Shipyard</strong></td>
<td>Data analysis services for ship owners, life-cycle support and feedback to new design</td>
</tr>
<tr>
<td><strong>Service provider</strong></td>
<td>Fleet management system, big data analysis services, condition monitoring services and IoT platform</td>
</tr>
<tr>
<td><strong>Academy</strong></td>
<td>Research on big data analysis, numerical simulation methods and digital twin. Education and trainings.</td>
</tr>
<tr>
<td><strong>Class society</strong></td>
<td>Shore data center. Class inspection</td>
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*Government ... utilization for e-navigation and MRV*
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R&D by open collaboration

In the coming era of ship intelligence, we think we need open collaborations to pursue wide variety of possibilities to improve our safety and efficiency
Concluding remarks

• From our experiences with SIMS, we consider the concepts of IoT and Big data are applicable and making values to our shipping industry.

• To pursue further utilization of IoT data, we need open collaboration by sharing the data. We are working on standardization of IoT data collection and open platform to share the data.

• We hope to keep good communication and collaboration with the maritime industry in Norway also in the coming ship intelligence era.
Thank you for your attention