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

12th February 2016

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
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
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
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
“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>Ship operator</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 allocation&lt;br&gt;• Service planning&lt;br&gt;• Chartering</td>
</tr>
<tr>
<td>Ship owner</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>
</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 processing flow**

“Big data” is an organizational process. The target is to change way of working by utilizing data.
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
SIMS overview

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

Data Center

SIMS Monitoring & Analysis System at Shore

Communications via Technical Management

Operation Center (London)

Report

Voyage Analysis Report
Break down analysis of fuel consumption for each voyage

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

SIMS unit

Viewer

Motion sensor

VSAT/Inmarsat-F/FB

FOP Data Collection System Onboard

VDR

Data Acquisition and Processing

<Navigation Bridge>

GPS
Doppler log
Anemometer
Gyro Compass

<Engine Room>

Main Engine
FO flow meter
Torque meter
Re-liquefaction Plant

Integrating Automation System

Technical Analysis (MTI)

Feedback to captains

FOP Data Collection System Onboard

Monohakobi Technology Institute
SIMS as open platform

Open platform = interface to 3rd party applications

SIMS uses Furuno Open Platform (FOP) (Supplied by Furuno Electric Co.)

SIMS unit Onboard

SIMS Shore Server

Ship LAN

VDR

Engine D/L

IAS

Main Engine

... Equipment and machineries

Broadband Email

SIMS applications

Vessel Performance

3rd party applications

Vessel Performance

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.
## Installation records of SIMS onboard

<table>
<thead>
<tr>
<th>Type of vessel</th>
<th>SIMS1 installed</th>
<th>SIMS2 installed</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bulk</td>
<td>5</td>
<td>48</td>
<td>53</td>
</tr>
<tr>
<td>Tanker</td>
<td>0</td>
<td>8</td>
<td>8</td>
</tr>
<tr>
<td>Car Carrier</td>
<td>6</td>
<td>32</td>
<td>38</td>
</tr>
<tr>
<td>Container</td>
<td>19</td>
<td>27</td>
<td>46</td>
</tr>
<tr>
<td>LNG</td>
<td>1</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>31</strong></td>
<td><strong>117</strong></td>
<td><strong>148</strong></td>
</tr>
</tbody>
</table>

As of December, 2015

- **SIMS1 (2008 – 2013)**
  - Supplier: NYK Trading
  - Measurement data: Vessel performance data
  - Remote maintenance: No

- **SIMS2 (2013 - )**
  - Supplier: Furuno Electric
  - Measurement data: Vessel performance data + engine condition data from ICA/IAS
  - Remote maintenance: Yes (if VSAT or Inmarsat FBB full time connection is available onboard)
Outline

1. Introduction of MTI
2. IoT and Big data
3. SIMS (Ship Information Management System)
4. Data analysis
5. Open platform
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, cleanness 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>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
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

In-service performance model

Service route

Hindcast weather data

Estimation of:
- Sea Margin
- Sailing time
- Average Speed
- Total FOC

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

Collaborations with external experts are necessary
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
Concept of ship – shore open platform

Ship-shore open platform provides good security and access control to enhance cooperation with industry partners.
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

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

Government ... utilization for e-navigation and MRV
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
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