IAMU Student Forum
19 – 24 July 2015 at Sinagawa Prince Hotel, Tokyo, Japan
Keynote Lecture in Opening Ceremony

How to deal with new technologies - IoT and Big data -

21st July 2015

Hideyuki Ando, MTI (NYK group)

Outline

1. Introduction of NYK and MTI
2. Performance management
3. IoT and Big data
4. Examples of IoT and Big data in NYK
5. Next R&D topics
6. Summary

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NYK Corporate Profile

NYK Head office in Tokyo

- NYK LINE (Nippon Yusen Kaisha)
  - Head Office： Tokyo, Japan
  - Founded： September 29, 1885
  - Business Area
    - 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 : 32,342 (as of the end of March 2014)
- Revenues : $ 22 billion (Fiscal 2013)

NYK fleet (as of the end of March 2014)

Containerships (including semi-containerships and others)

101vessels / 5,572,991 DWT

Bulk Carriers (Capesize)
129 vessels / 24,576,302 DWT

Bulk Carriers (Panamax & Handysize)

286vessels / 17,597,420 DWT

Wood-chip Carriers
49 vessels / 2,580,879 DWT

Cruise Ships
3 Vessels / 21,577 DWT

Car Carriers
125 vessels / 2,230,958 DWT

Tankers
77 vessels / 12,056,781DWT

LNG Carriers
29 vessels / 2,172,415 DWT

Others
26 vessels / 318,002 DWT

877 vessels
68,036,568Kt (DWT)

MTI

http://www.monohakobi.com/en/

- Established - April 1, 2004
- Locations
  - Head office – 7th floor, NYK building, Tokyo, Japan
  - Singapore branch office - Singapore
  - Laboratory – Yokohama, Japan
- Stockholder - NYK Line (100%)
- 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

Laboratory, Yokohama

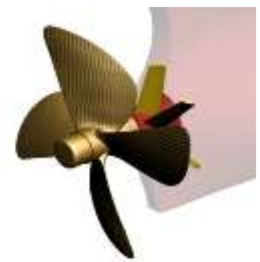
Example areas of MTI R&D in maritime technology

Reduction of resistance

•Air lubrication system

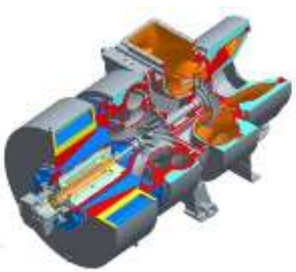
Improve propulsion

•Energy saving devices



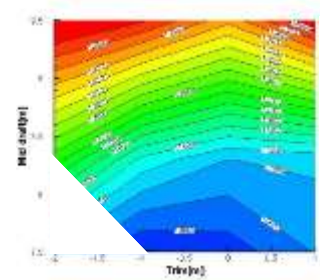
Power plant efficiency

- Hybrid turbo charger



Technology for operational efficiency

- Performance management system



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An operational efficiency project in NYK

NYK IBIS Project (2012-)

IBIS – Innovative Bunker and Idle time Saving

Fuel Efficiency Helped NYK Line Succeed in 2013

Tuesday January 7, 2014

Efficiency improvements, particularly reductions in fuel consumption, helped **Japan**'s **Nippon Yusen Kaisha Line** (NYK Line) succeed in 2013, despite a difficult market and high bunker prices, President **Yasumi Kudo** said in his New Year statement.

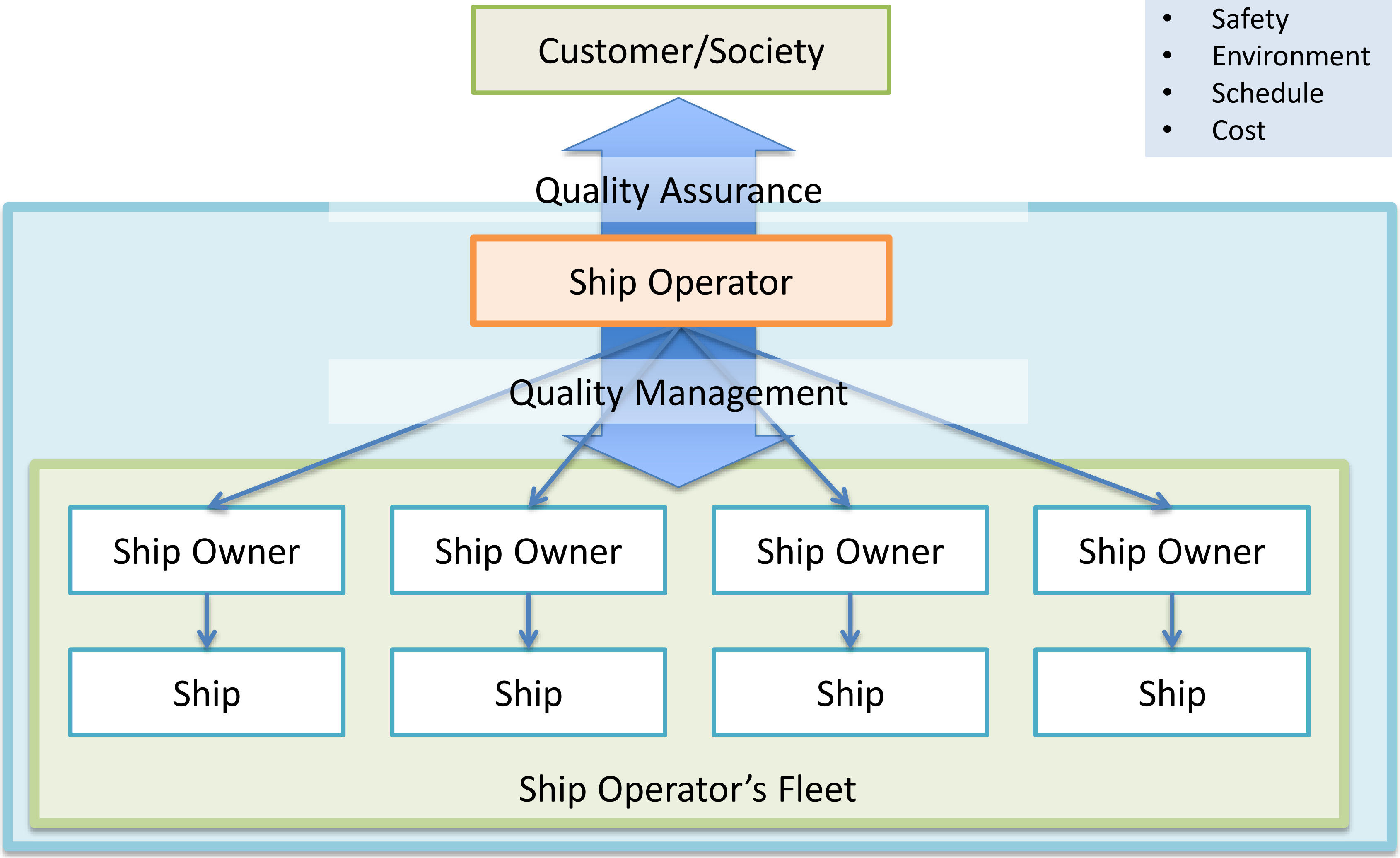
NYK Line President Yasumi Kudo said the company faced difficult conditions in 2013

Kudo said the shipping company reduced "muda," or wasted activity, through initiatives including its "**Innovative Bunker and Idle-time Saving**" (IBIS) project, which shares real-time information between land and ships to economise ship movements, and an air-lubrication system adopted on the vessel *Soyo* to increase fuel efficiency.

Article from Ship and Bunker

Fuel cost saving by IBIS $40 million in 2013

Ship operator’s view of management



Quality Shipping

- Safety
- Environment
- Schedule
- Cost

Performance management

Performance management is organizational improvement process by using performance monitoring

- Share objective among related parties
- Continuous improvement and learning cycle with performance monitoring
- **Pursue target by Information sharing and collaboration**

NYK has implemented onboard broadband communication since 2012

NYK to Introduce Onboard Broadband Communication System on All Containerships to Reduce CO2 Emissions

March 9, 2012

NYK has decided to introduce an onboard broadband communication system on all its containerships with the aim of reducing CO_2 emissions during ship operations.

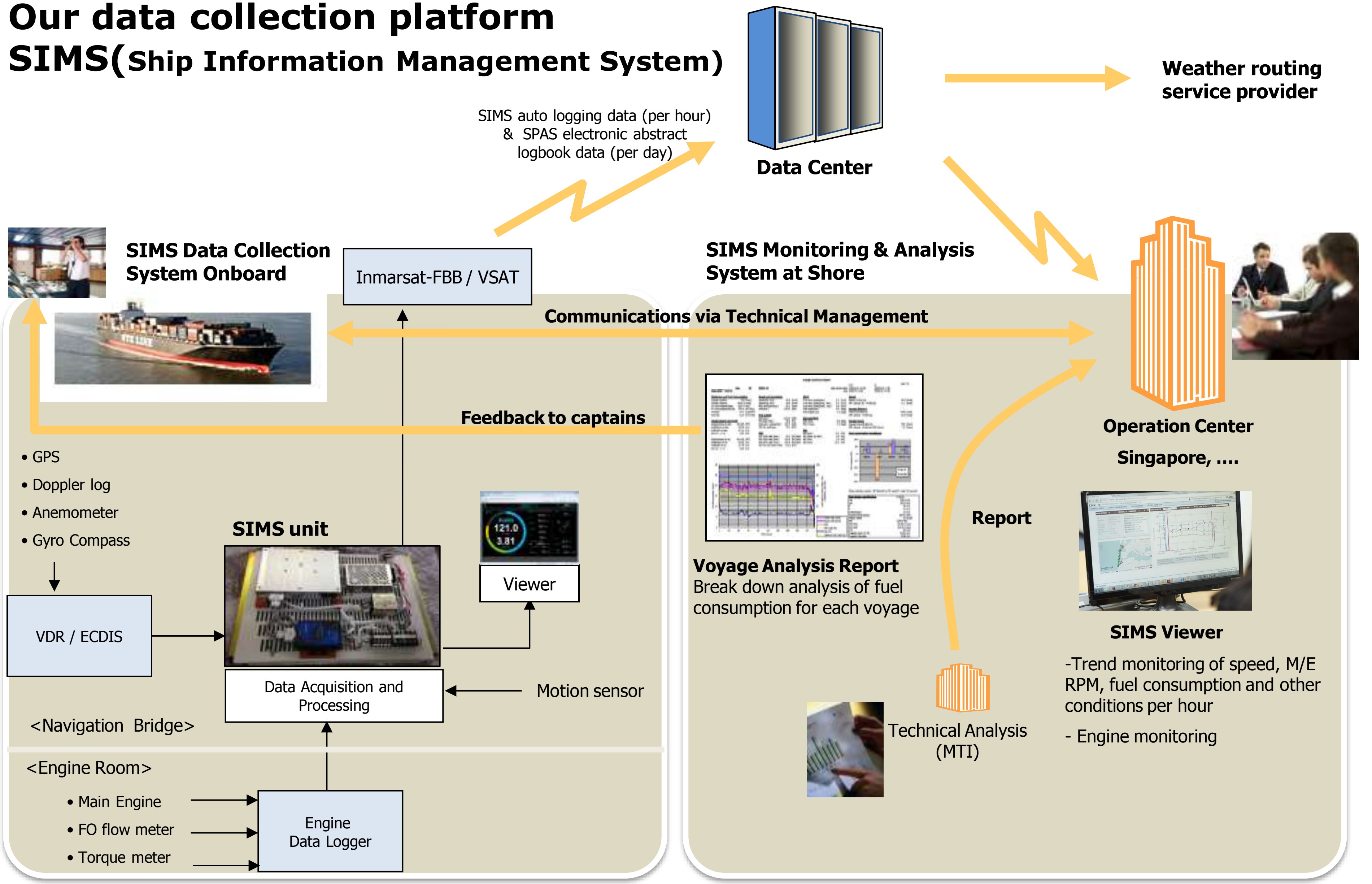
Reducing CO2 emissions by introducing onboard broadband

Onboard tests of the broadband communication system started in October 2010 on various types of vessels, and the results have been studied. When the system is introduced as part of the IBIS (innovative bunker and idle-time saving) project that NYK has implemented on its containerships to achieve optimal economic ship operation, real-time large-volume data communication between land and ships can be achieved. The results of the tests showed that the large volume of assorted data required for reducing CO_2 emissions can be obtained in real time. The new system enables the acquisition of more specific weather and sea-current forecast information on board, improves the automatic transmission of ship operation data and ship operation monitoring on land, and speeds up information-sharing and communication between staff on land and on board vessels. In response to these test results, NYK has decided to move

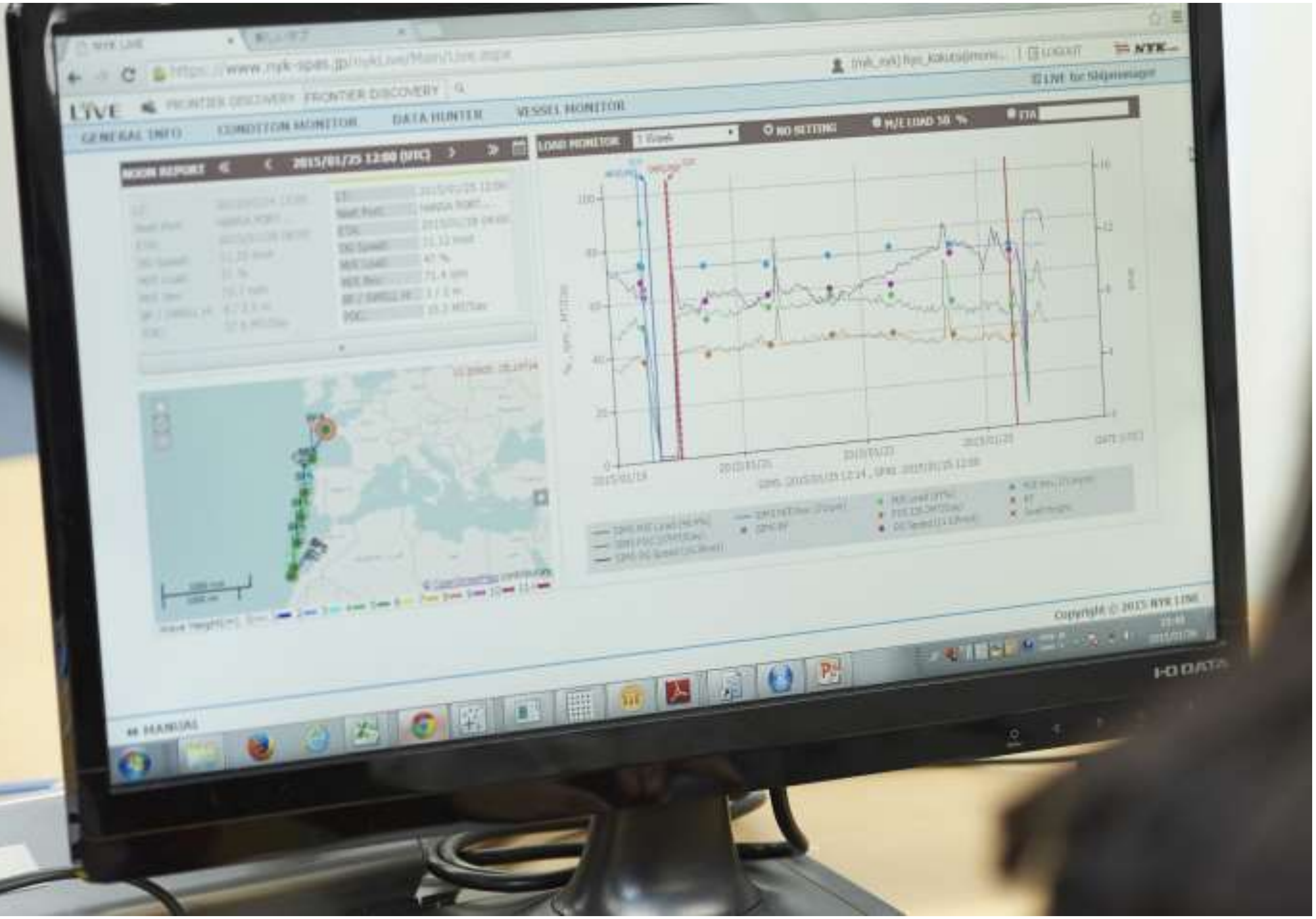
Monohakobi Technology Institute

NYK GROUP

Our data collection platform SIMS(Ship Information Management System)



Shore dashboard for ship operator



Ship operator can easily check current situation of the vessel and voyage records.

Map:
- ship position
- ship speed
- Beaufort scale
- wind direction

Trend graph:
- departure time
- arrival time
- ship speed
- RPM
- fuel consumption

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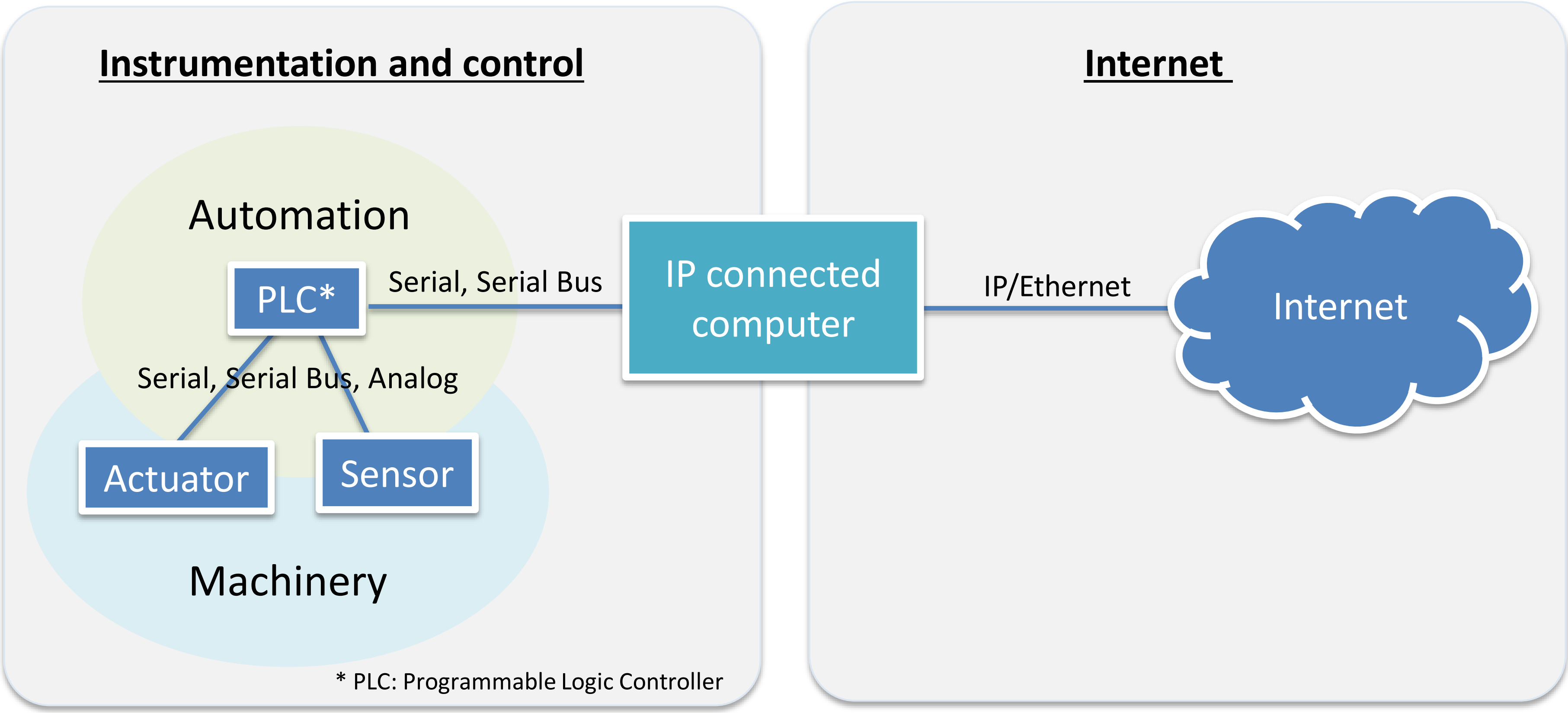
IoT (Internet of Things)



"Instrumentation and control" and "Internet" are to be bridged

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

AIS data

- Satellite AIS / shore AIS

Weather data

- Forecast / past statistics

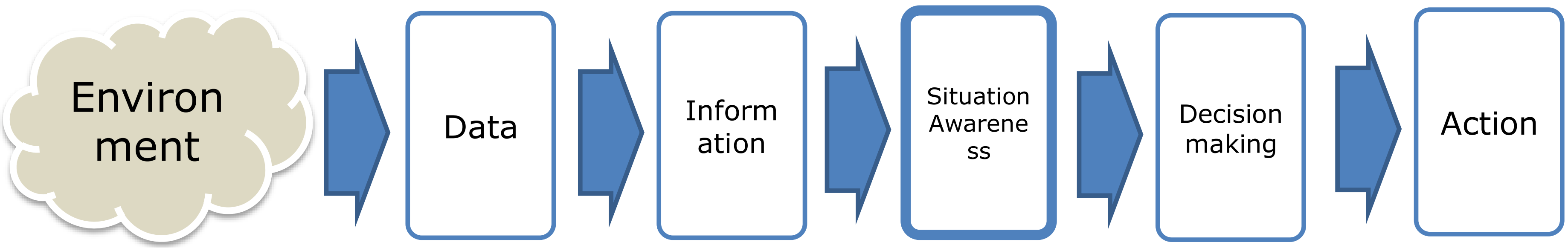
Business data

- Container transport data

IoT and Big data application areas

Role	Function	Example of Big data application
Ship operator	**Operation**	• Energy saving operation • Safe operation • Schedule management
	Fleet planning	• Fleet allocation • Service planning • Chartering
Ship owner	**Technical management**	• Safe operation • Hull & propeller cleaning • Condition monitoring and maintenance • Environmental regulation compliance • Energy saving retrofit
	New building	• Design optimization

Big data processing flow



Necessary Technology

Data
- Sensor
- Measurement
- Network
- Communication
- IT

Information
- Data analysis
- Statistics
- Engineering
- Visualization
- Web

Situation Awareness
- Business knowledge
- Workflow
- Collaboration
- Organization

Decision making
- Management
- Business

Action
- Command
- Assistance
- Training
- Incentive
- PR
- Change Business

Provide information to right people at right time for assisting their situation awareness for right decision and action

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Ship performance – key technology for analysis

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)

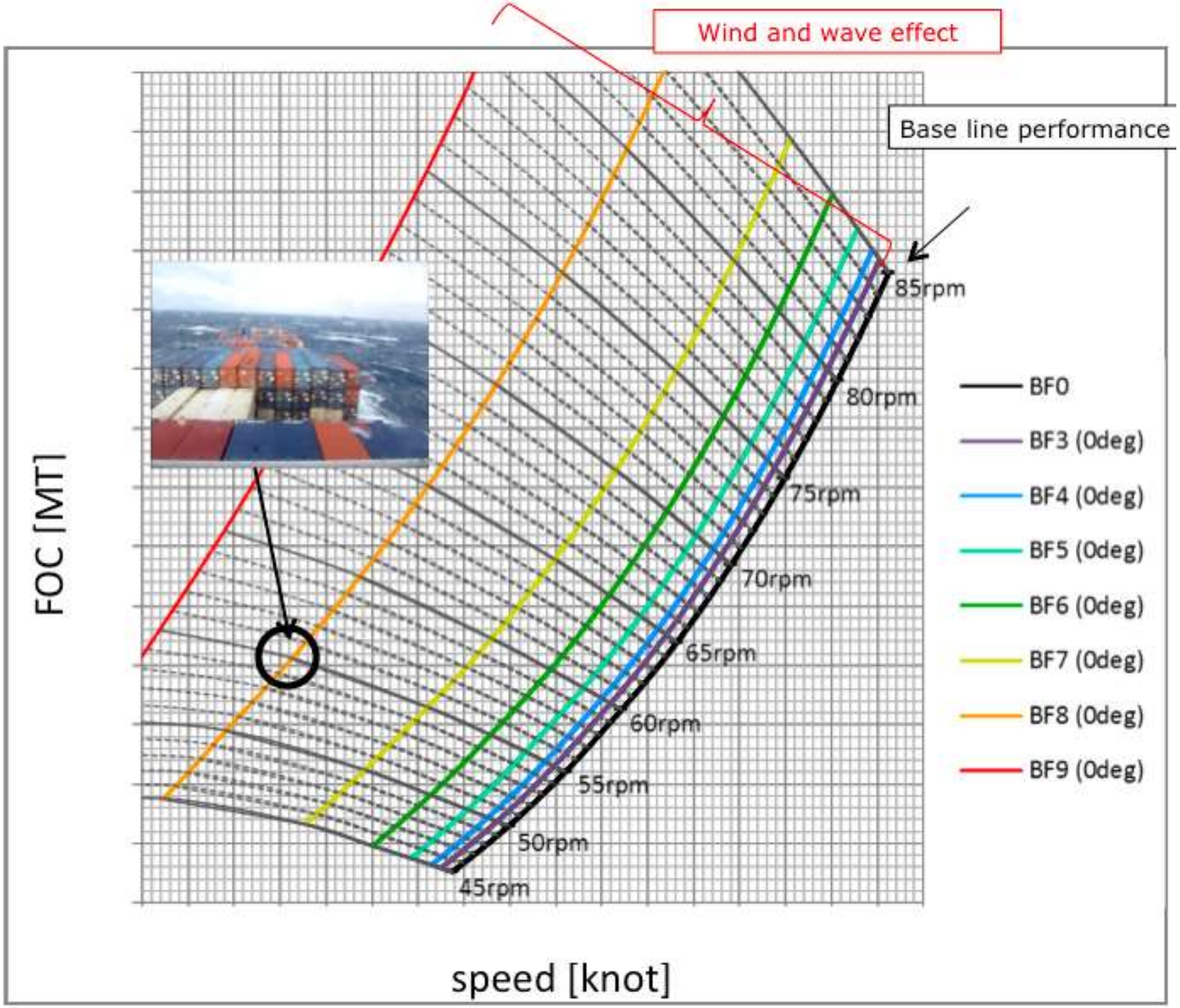
Ship performance in all weather

<Target vessel>
6000TEU Container
Draft 12m even

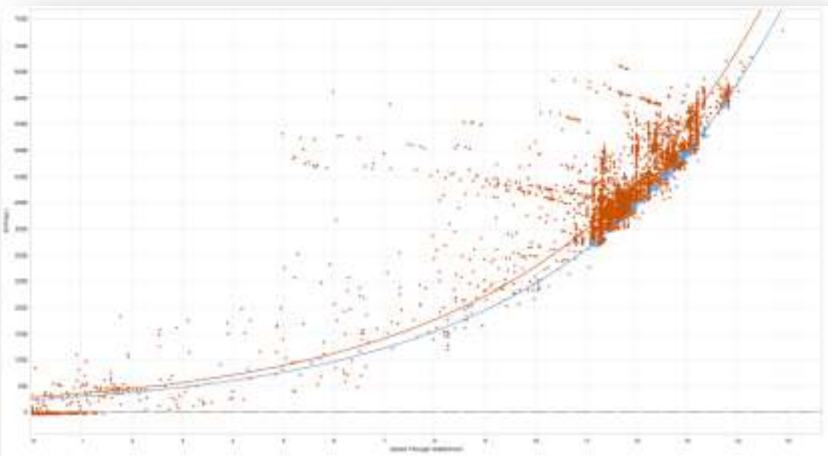
Sea condition
Beaufort scale

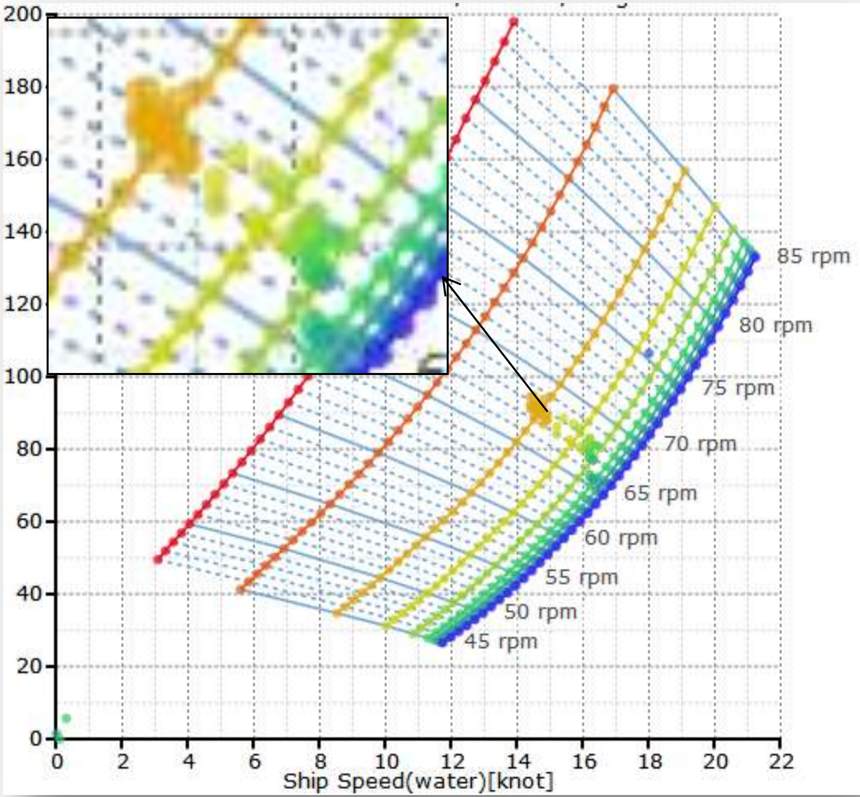
	wind speed (m/s)	wave height (m)	wave period (sec)
BF0	0.0	0.0	0.0
BF3	4.5	0.6	3.0
BF4	6.8	1.0	3.9
BF5	9.4	2.0	5.5
BF6	12.4	3.0	6.7
BF7	15.6	4.0	7.7
BF8	19.0	5.5	9.1
BF9	22.7	7.0	10.2

0deg (wind, wave) – head sea



Performance model correction by measurement data



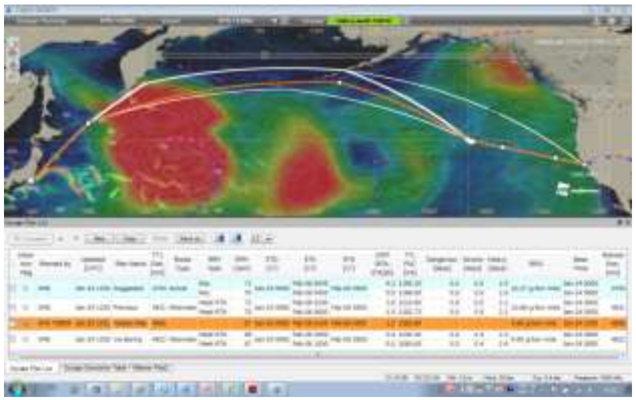


Measurement data

Performance model correction

Optimum weather routing with performance monitoring

weathernews



Weather Routing（PLAN）

Monitoring（CHECK）

- Voyage plan
  - \+ course, speed, RPM, FOC, weather
  - \+ ship performance model

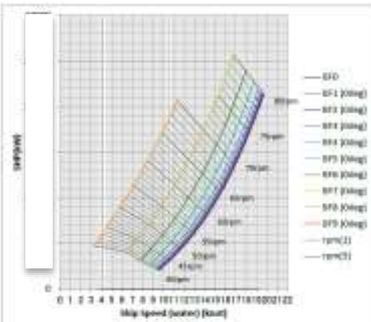
Feedback

- Voyage actual
  - \+ actual speed – RPM, RPM - FOC
  - \+ actual weather

Ship model and weather forecast are inherently include errors.

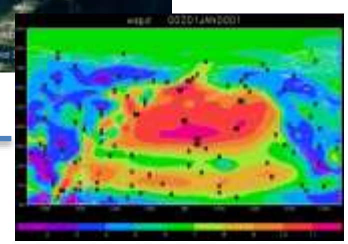
But feedback loop by monitoring can make this system work better.

Operation optimization

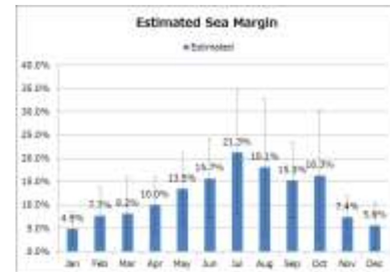


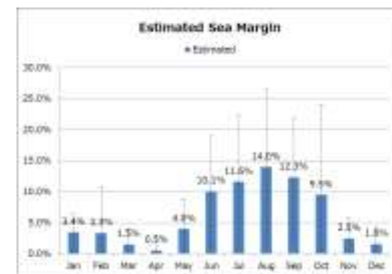
Ship performance model

Service route



Hindcast weather data

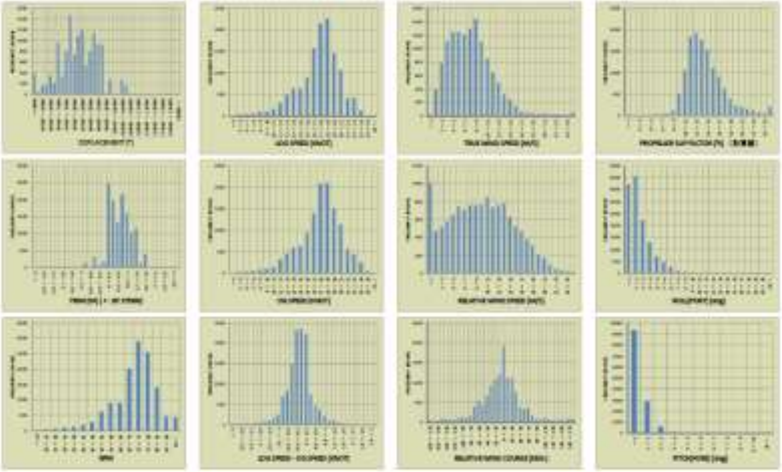




Estimation of
- Sea Margin
- Sailing time
- Average Speed
- Total FOC

Combine ship performance model with weather data to optimize ship services

Energy saving hull modification



Operation profile

- Speed, RPM, Power
- Draft, trim, displacement
- Weather
- Sea margin
- etc

23 % CO2 reduction was confirmed

Energy saving modification

- Bulbous bow modification
- Install energy saving device (MT-FAST)
- etc

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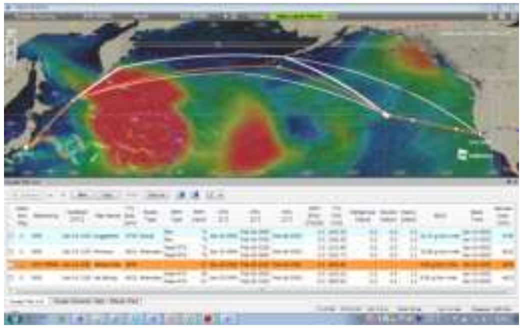
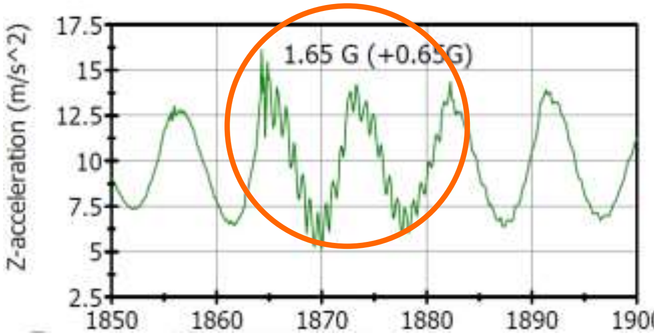
Ship and cargo safety in rough sea
- wave, ship motion and hull stress -



ship motion simulation

criteria



actual ship motion and acceleration

cargo securing & ship structural safety

Wave impact add additional acceleration and load on cargo and ship structure

Plant operational efficiency and safety

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

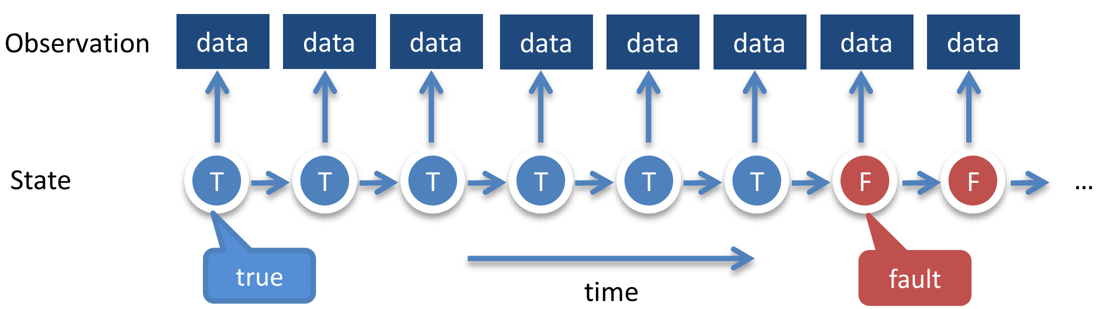
Measure
- Condition monitoring
- Big data analysis
- Support service engineer
- Intelligent machinery
  - Self diagnostics

Working style will change

Condition monitoring for maintenance support

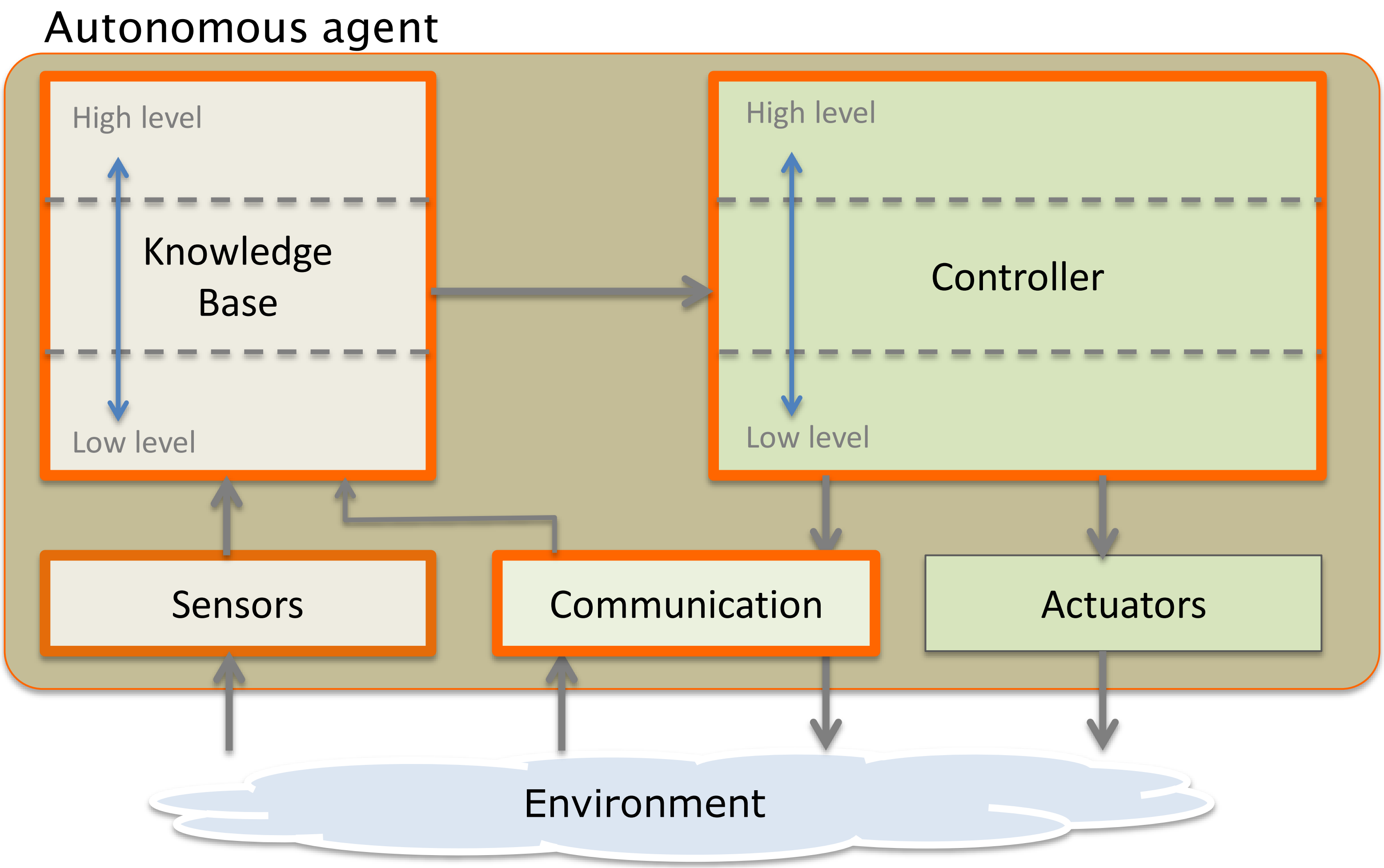
- Estimate condition status from observed data
  - Faulty situation finding
  - Support service engineer

- Data analysis methods
  - Rule-base
  - Machine learning
  - Etc.



Shore dashboard for
Fleet technical manager

Automation and autonomy



If scopes are bounded, implementations of Sensors, Knowledge Base, Controller and Communication are possible. E.g. Self diagnosis system of machinery and equipment

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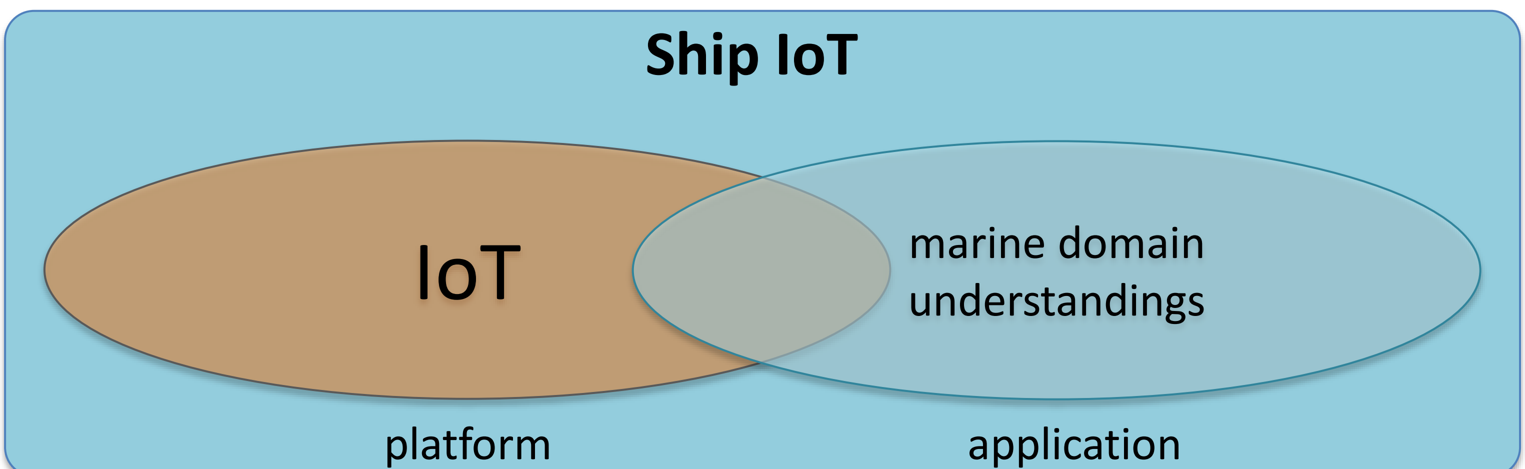
Era of Ship IoT

- Good collaborations of IoT technology and marine domain understandings are necessary
- You should play key roles in design and implementation of Ship IoT



Summary

- Big data and IoT have large potentials in many aspects of our marine industry
- Cargo owners, ship operators, ship owners and onboard crews will share more and more transparent data
- Technology, organization and business will be highly intertwined with the glue of IoT and Big data
- You should play very important roles in the coming era of Ship IoT and Big data

Thank you very much for your attention