International Seminar on Practical Use of Maritime Big Data
~ for creating new business opportunities ~

How we tackle IoT of Ship
- Data Utilization and Standardization -

24th June 2015

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Outline

1. IoT and Big data
2. Data utilization
3. Standardization
4. Summary

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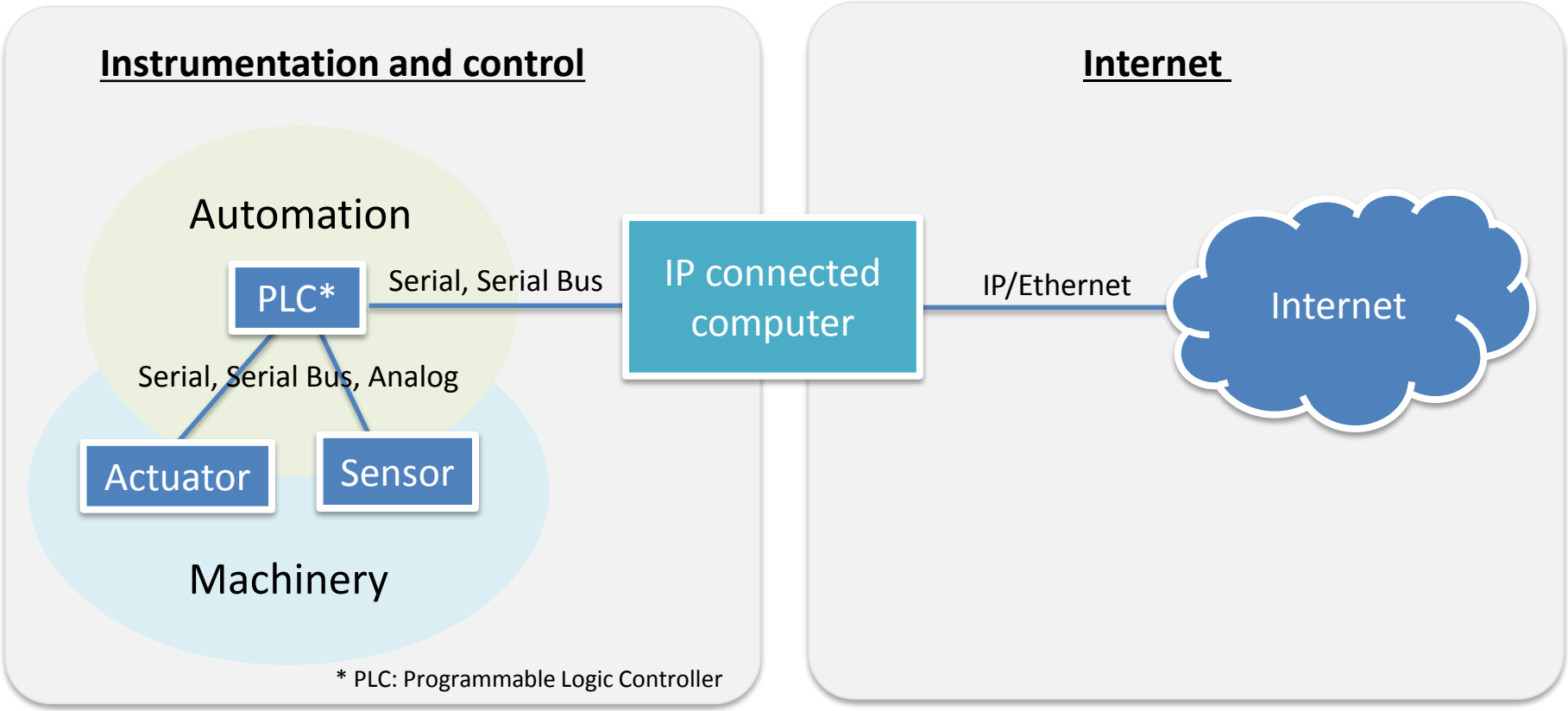
IoT (Internet of Things)



"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

Industrial Internet (IoT of Industry machineries)

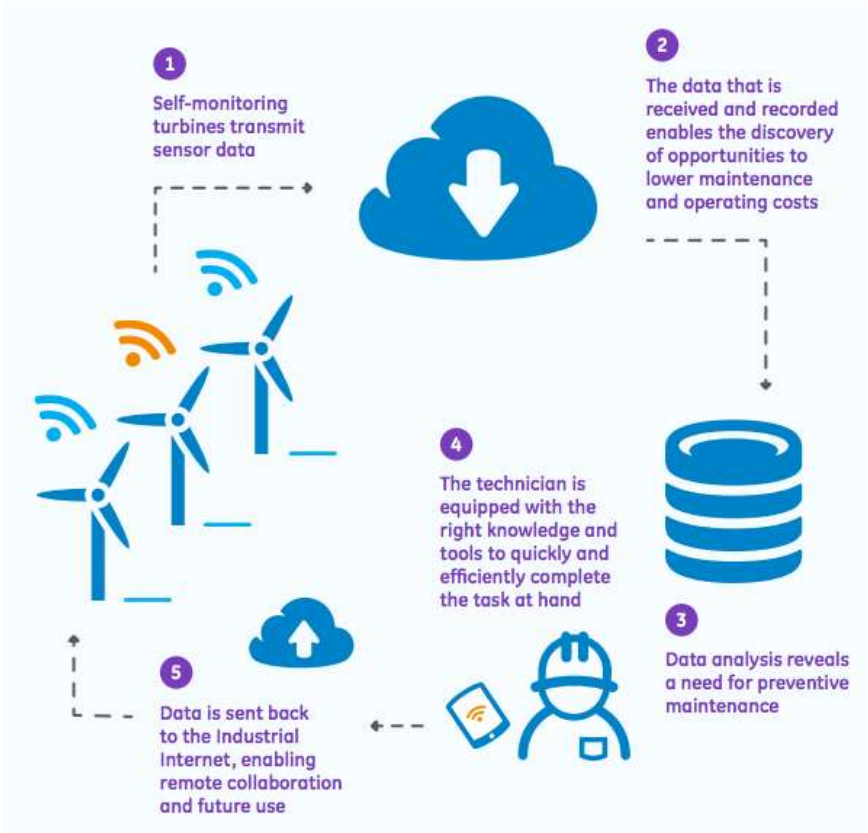
Target

- 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



Reference) https://www.ge.com/sites/default/files/GE_IndustrialInternetatWork_WhitePaper_20131028.pdf

Same concepts are applicable to marine industry

Target

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

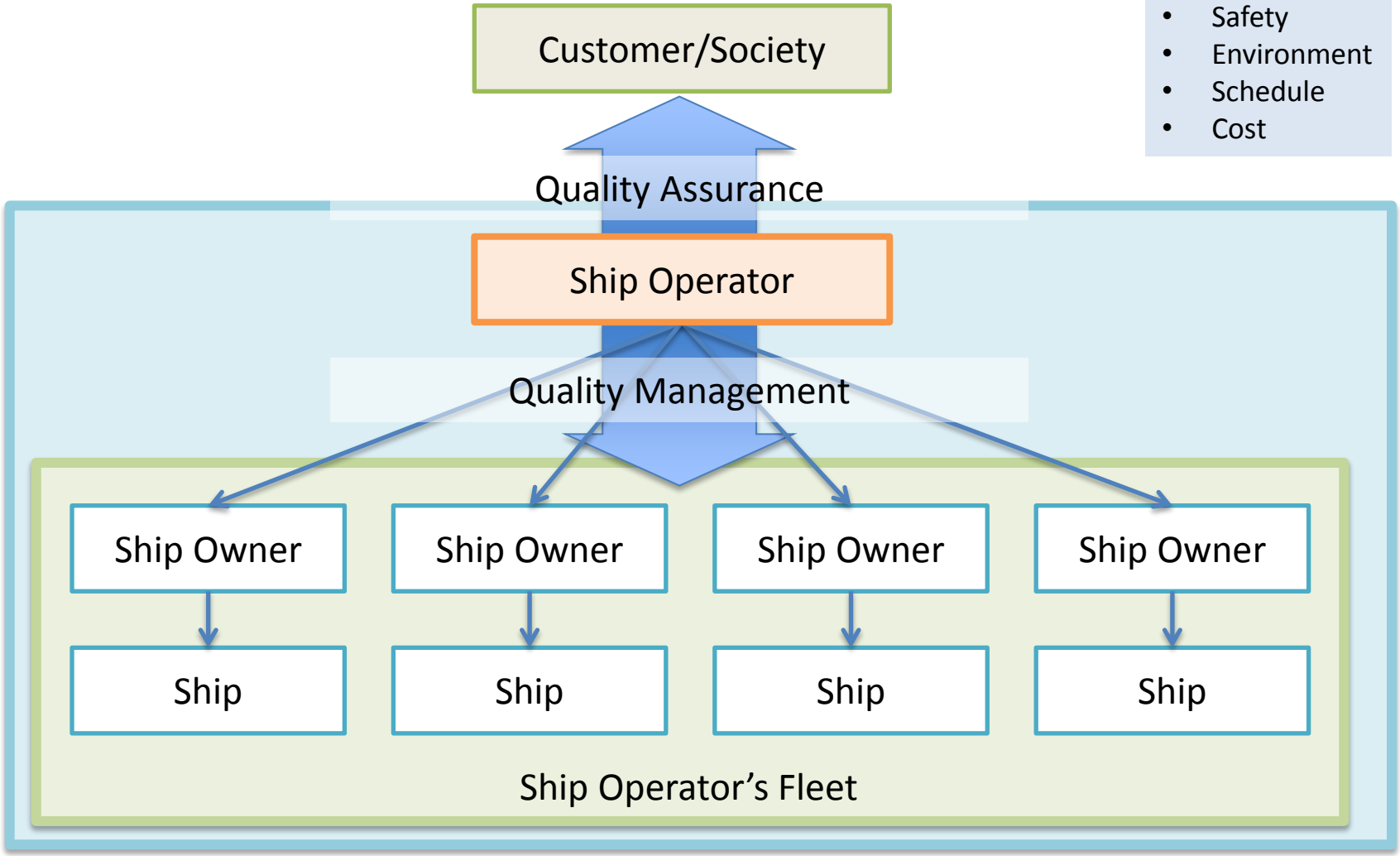
Measure

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

Change way of working

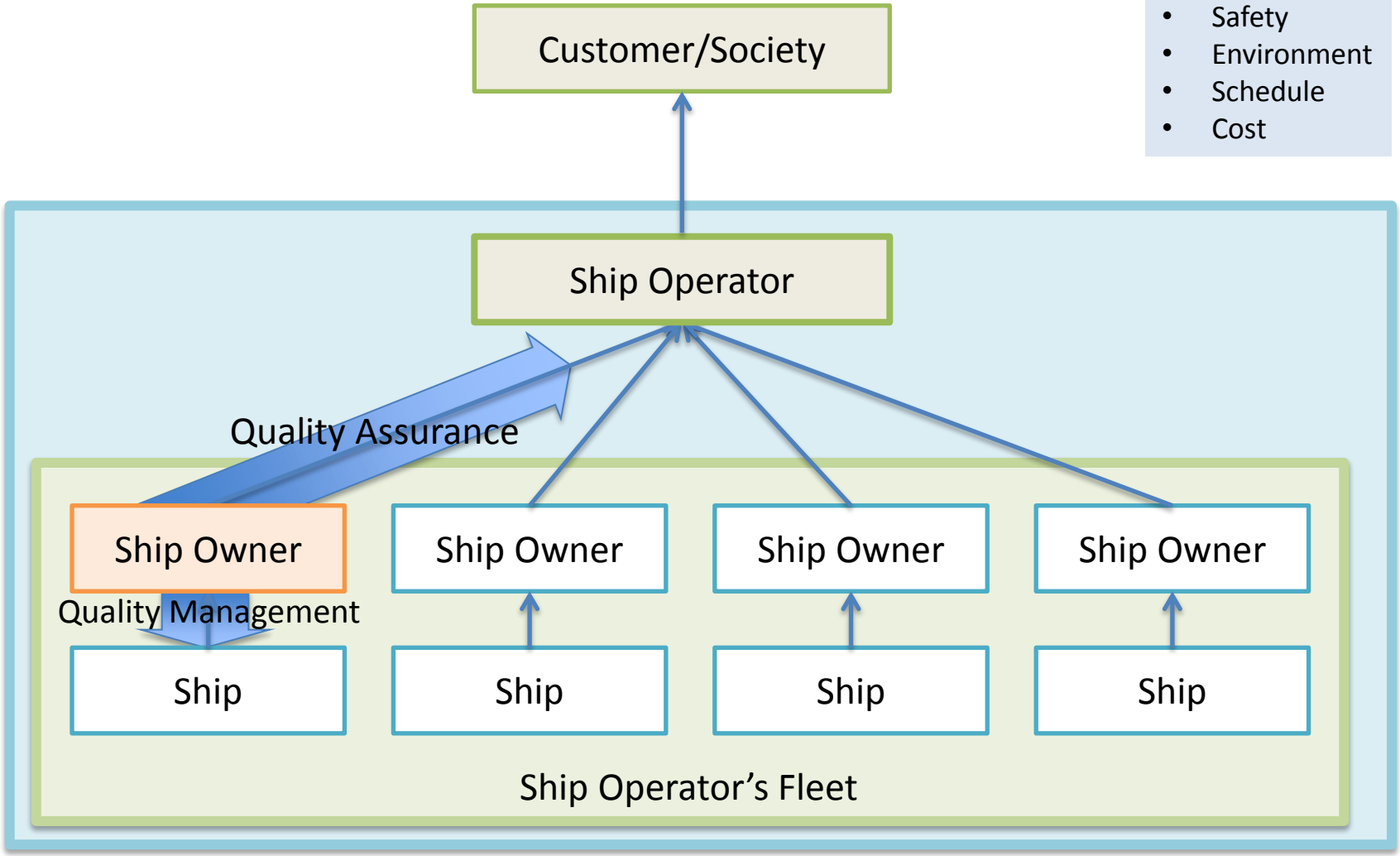
Ship operator's view of management

Quality Shipping
- Safety
- Environment
- Schedule
- Cost



Ship owner's view of management

Quality Shipping
- Safety
- Environment
- Schedule
- Cost



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

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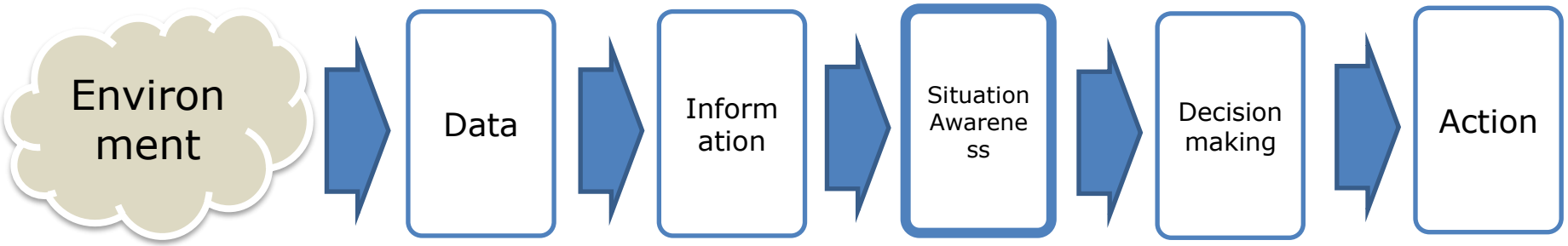
Big data processing flow



Necessary Technology

- Sensor
- Measurement
- Network
- Communication
- IT

- Data analysis
- Statistics
- Engineering
- Visualization
- Web

- Business knowledge
- Workflow
- Collaboration
- Organization

- Management
- Business

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

It is cross functional and organizational process to change action

Ship performance – key technology for analysis

6500TEU 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)

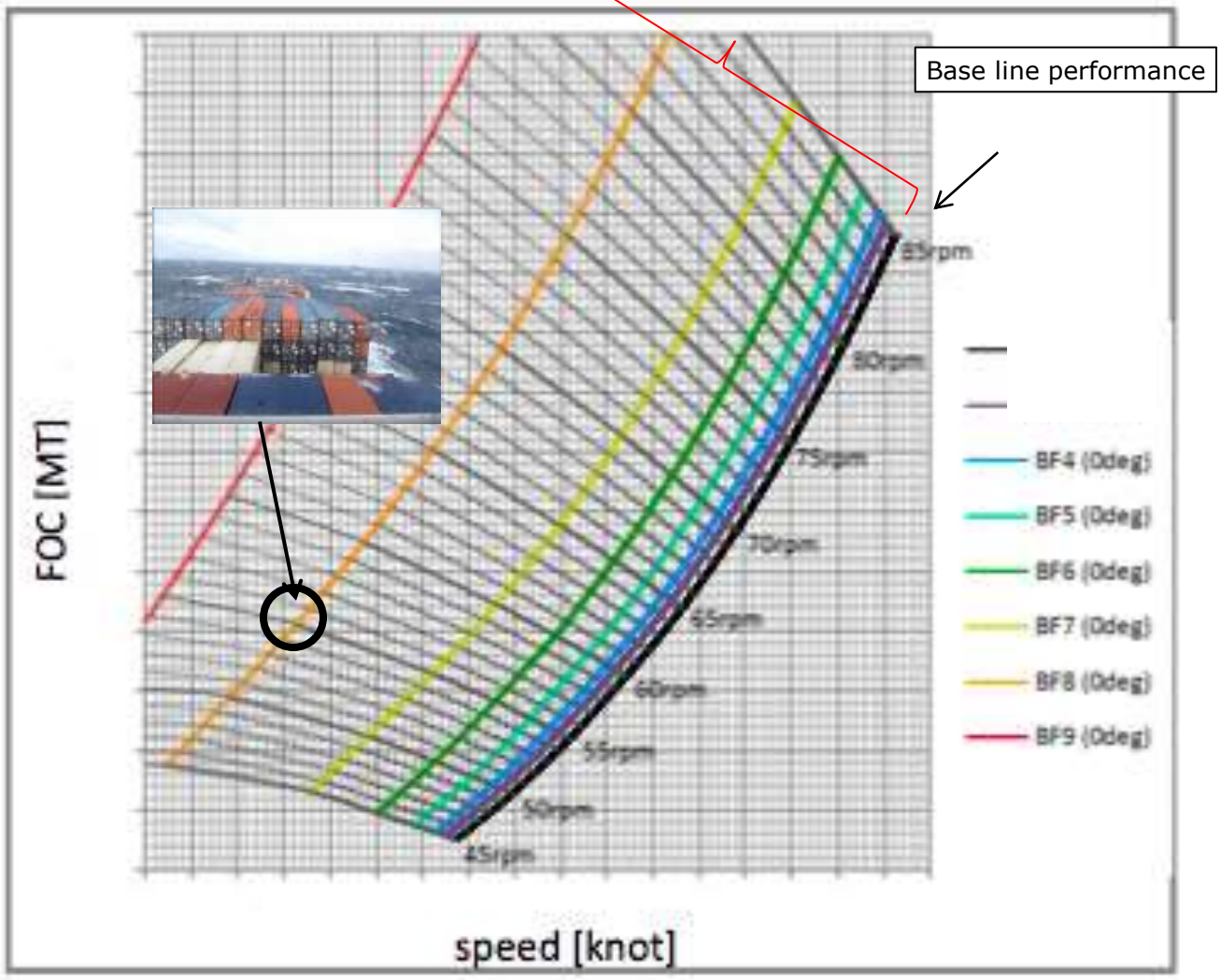
Ship performance in all weather

<Target vessel>
6500TEU Container
Draft 12m even

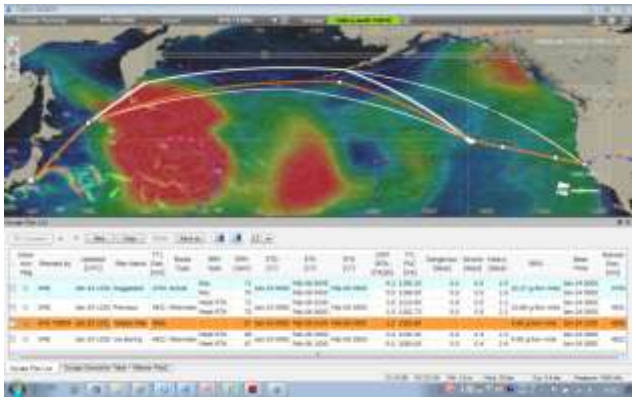
Sea condition
Beaufort scale

	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



Optimum weather routing with performance monitoring



Weather Routing（PLAN）

Monitoring（CHECK）

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

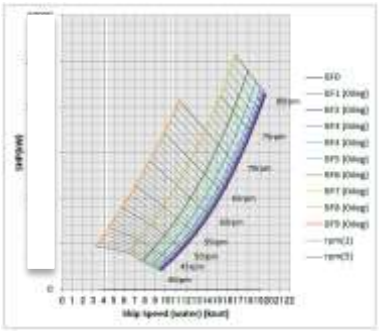
Feedback

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

Ship model and weather forecast are inherently include errors.

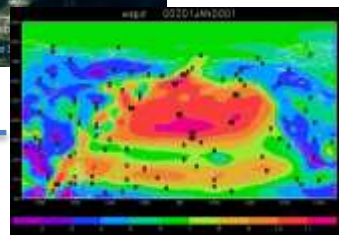
But feedback loop by monitoring can make this system work better.

Operation optimization

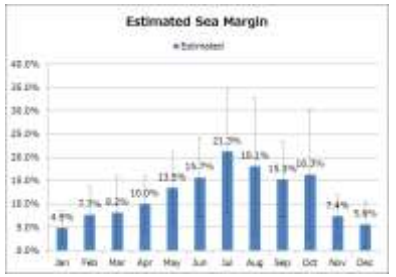


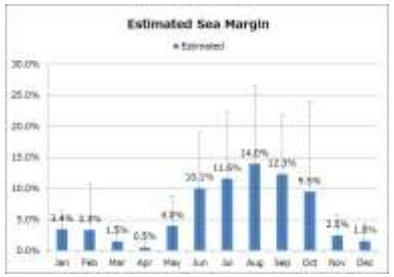
Ship performance model

Service route



Hindcast weather data

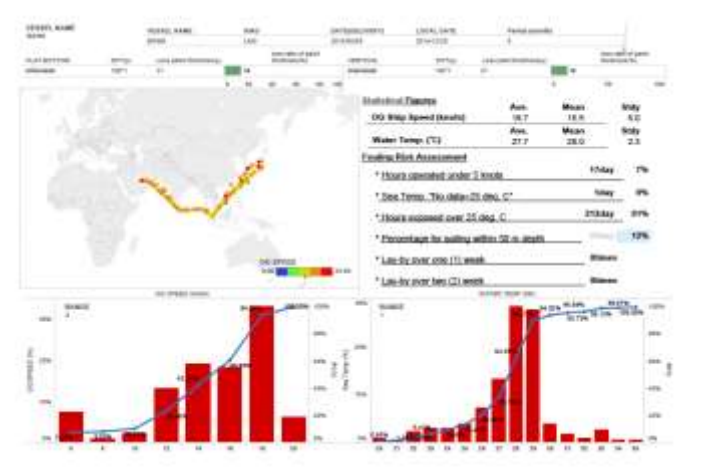




Estimation of
- Sea Margin
- Sailing time
- Average Speed
- Total FOC

Combine ship performance model with weather data to optimize ship services

Fouling risk assessment and maintenance

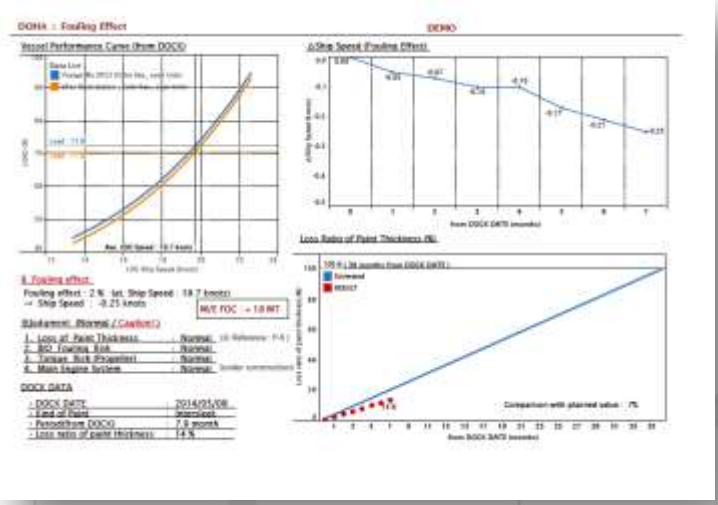


Operation profile

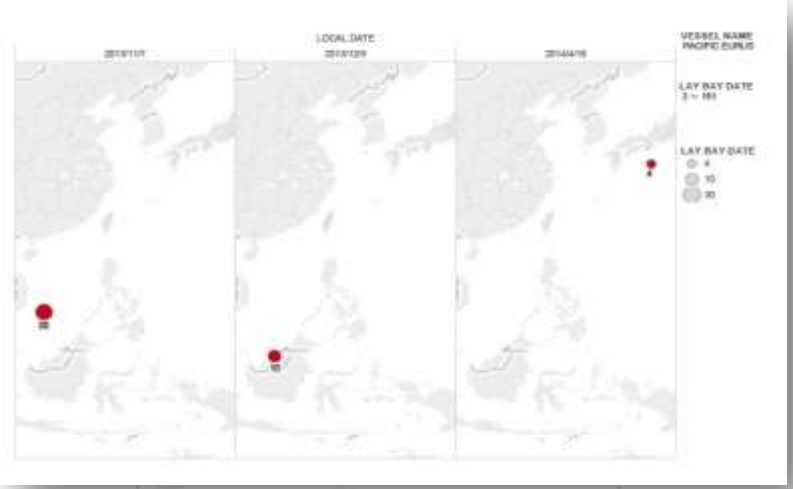
Fouling risk assessment will be conducted by using the following information

- **Operation profile**
- **Long term performance analysis**
- **Lay-by days/area/season**

To recommend under water inspection and hull / propeller cleaning

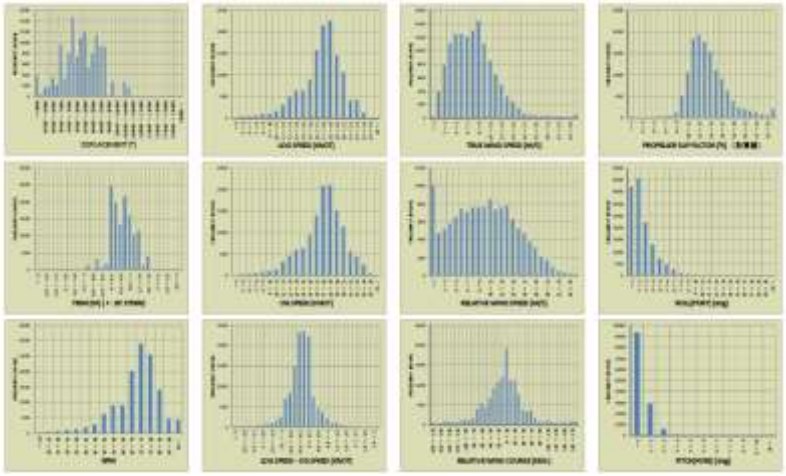


Long-term performance analysis



Lay-by days/area/season

Energy saving hull modification



Operation profile

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

23 % CO2 reduction was confirmed

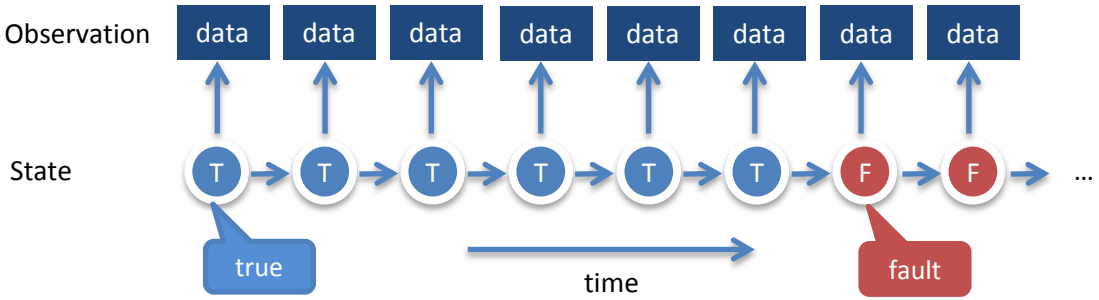
Energy saving modification

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

Condition monitoring for maintenance support

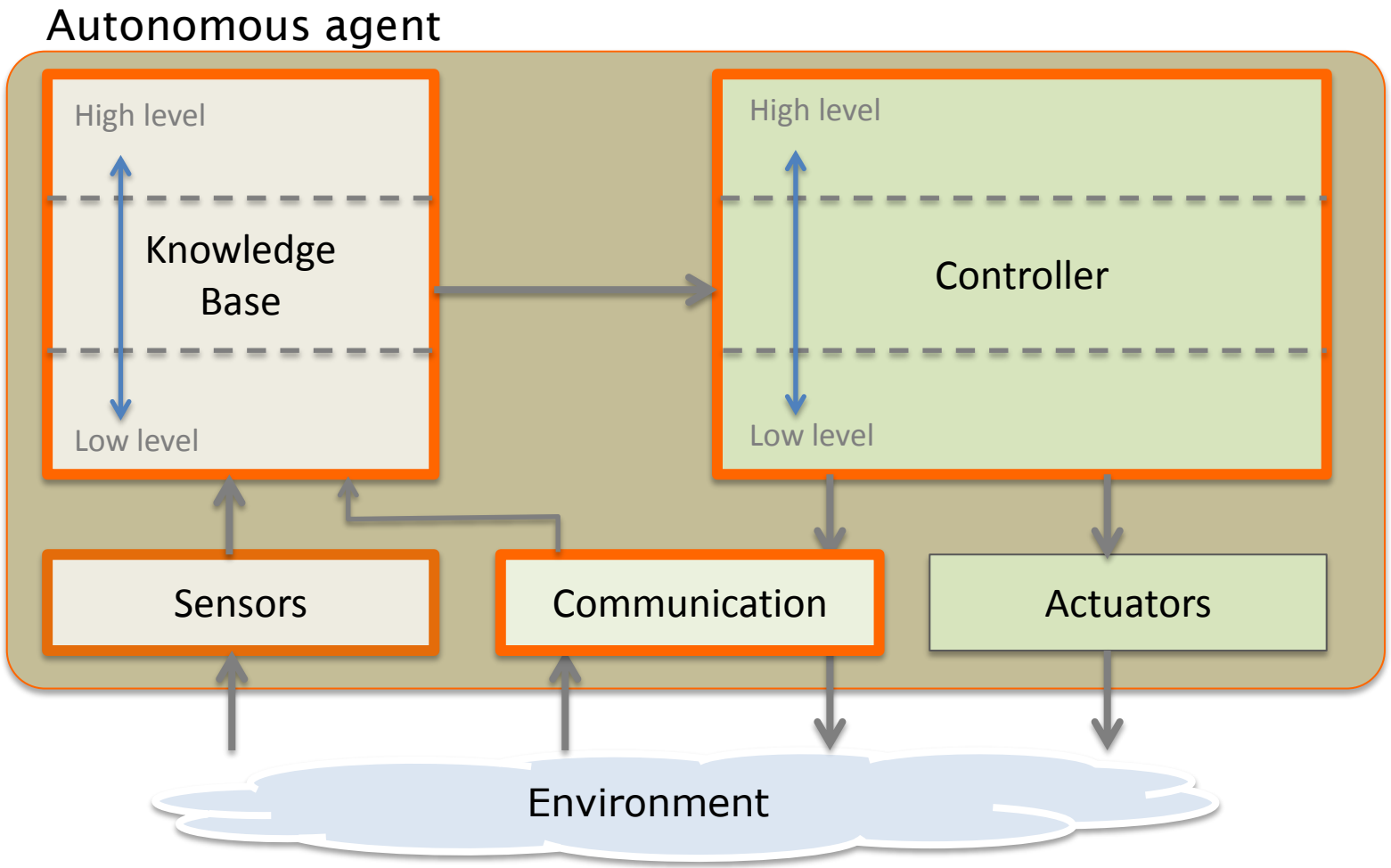
- Estimate condition status from observed data
  - Faulty situation finding
  - Support service engineer

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



Shore dashboard for
Fleet technical manager

Autonomy – e.g. for self diagnostic system



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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Smart Ship Application Platform (SSAP) Project
- Japanese Society of Machinery and Equipment Manufacturer -

http://www.e-navigation.net/index.php?page=ssap-smart-ship-application-platform

- Submitting Organization:Japan Ship Machinery and Equipment Association (JSMEA) Smart Ship Application Platform WG
- Point-of-Contact: Dr. Hideyuki Ando (MTI : Research company of NYK group), hideyuki_ando@monohakobi.com
- Functional Capabilities: Provide current and past numerical data on Weather routing, Trim, Performance monitoring, Engine monitoring, Hull and cargo condition monitoring, Power plant energy management and Remote maintenance.
- Intended Purpose: The target is to design a master database, interface prototypes, specifications of communication system between ships and shore facilities and international standards of data server requirments and structure of ma
onboard machinery and equipment so that as many application services a
- Portrayal examples:Not specified special display devices for this SSAP.
- Last edited: April 22, 2014

Description

Smart Ship Application Platform Project (JAPAN)

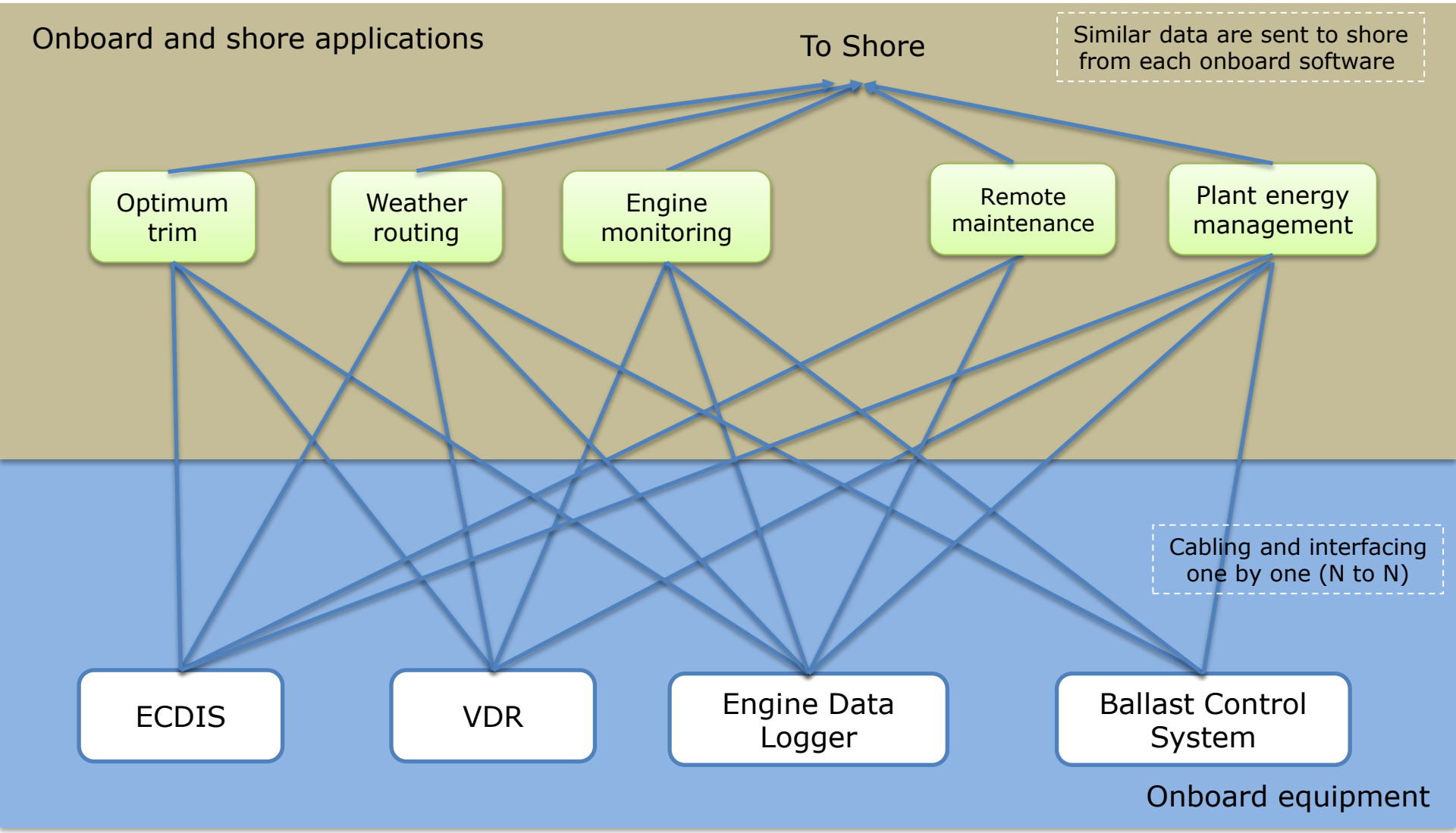
1. Genaral information

Project name	SSAP (Smart Ship Applicati
Name of testbed	Application platform for data sharing at s

Proposal for new ISO in May 2015

- **ISO/PWI19847 - Shipboard data servers to share field data on the sea**
  - Specifications of ship data server
- **ISO/PWI19848 - Standard data for machinery and equipment part of shi**
  - Specifications of dictionary and format

Onboard data collection (now)



Onboard data collection (future)

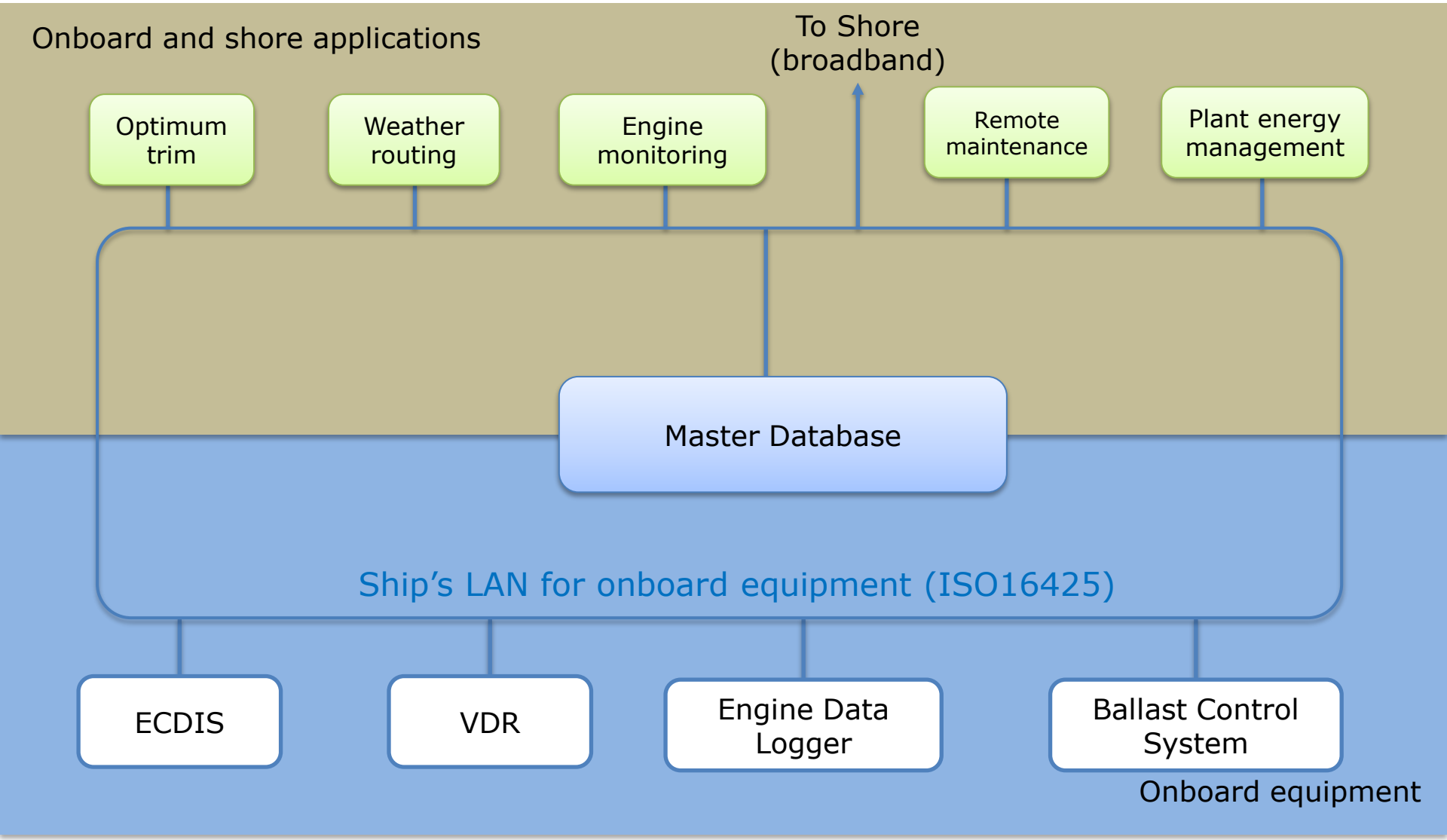
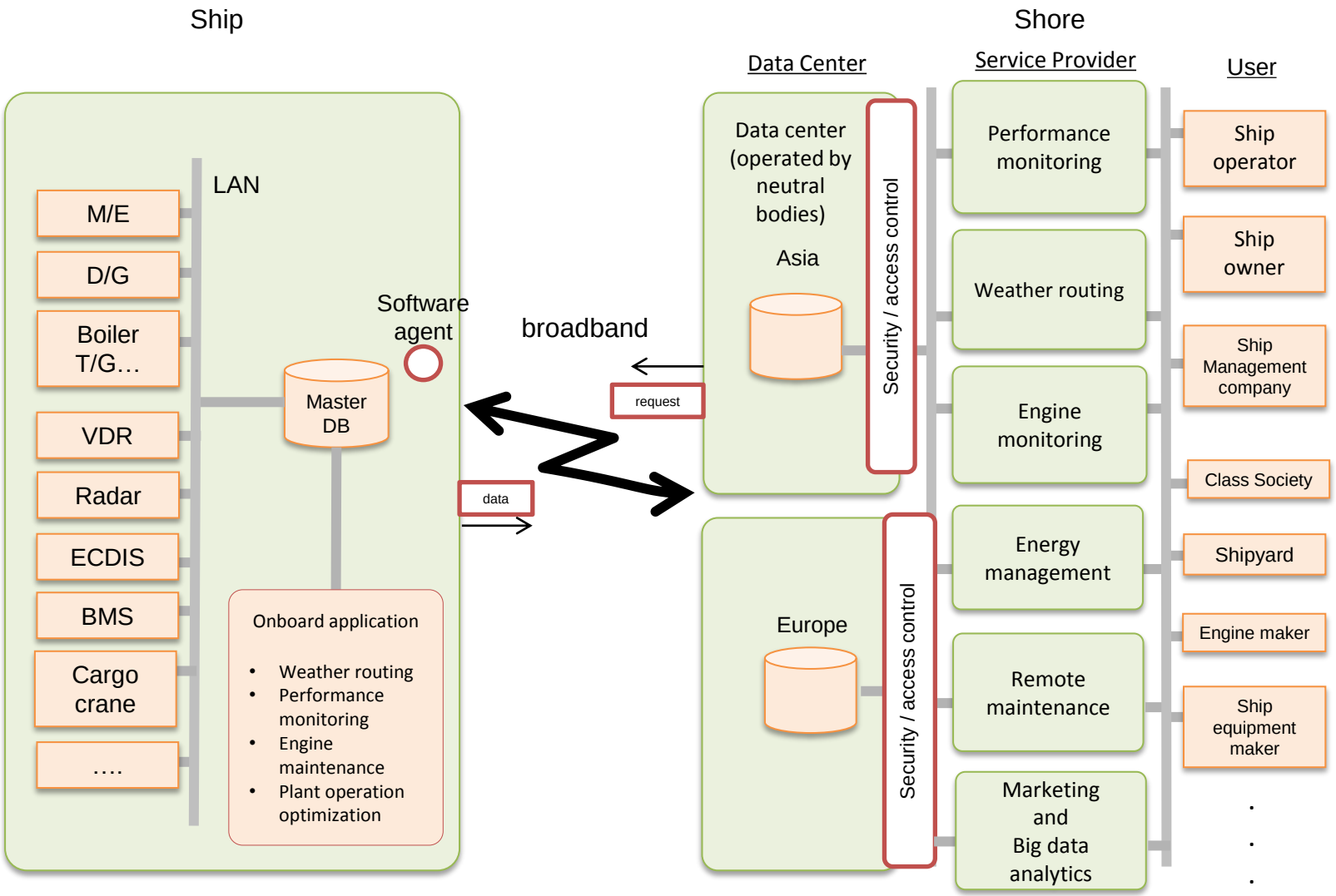


Image of ship – shore open platform



Courtesy of Smart Ship Application Platform (SSAP) Project of JSMEA 2014-15

What are the benefits of such platform ?

- ✓ Safety and energy-efficiency service application providers can concentrate on software function, quality and usability without spending resources for data collection
- ✓ Equipment manufacturers can develop their remote maintenance services by using the standardized platform
- ✓ Ship owners investment cost (CAPEX and OPEX) for onboard applications and shore services will be reduced
- ✓ Ship owners can use robust and reliable data center services to access ship operation data
- ✓ Shipyards and equipment manufactures can collect data from running equipment to improve service levels of their products
- ✓ Ship owners can manage/control ship data transmission to shore

Image of the open platform pilot project

Item	Target
Data server onboard	SSAP proposes the specification of the hardware and protocol/format
Shore data center	Shore independent data center hosted by class society
Ownership of data	Ownership of the data belongs to the ship owner. Under agreement by the owner, 3rd party service providers can utilize the ship IoT data
Security and access control	Data security and data access control shall be implemented
Business model and contract template	Business model and contract templates shall be established

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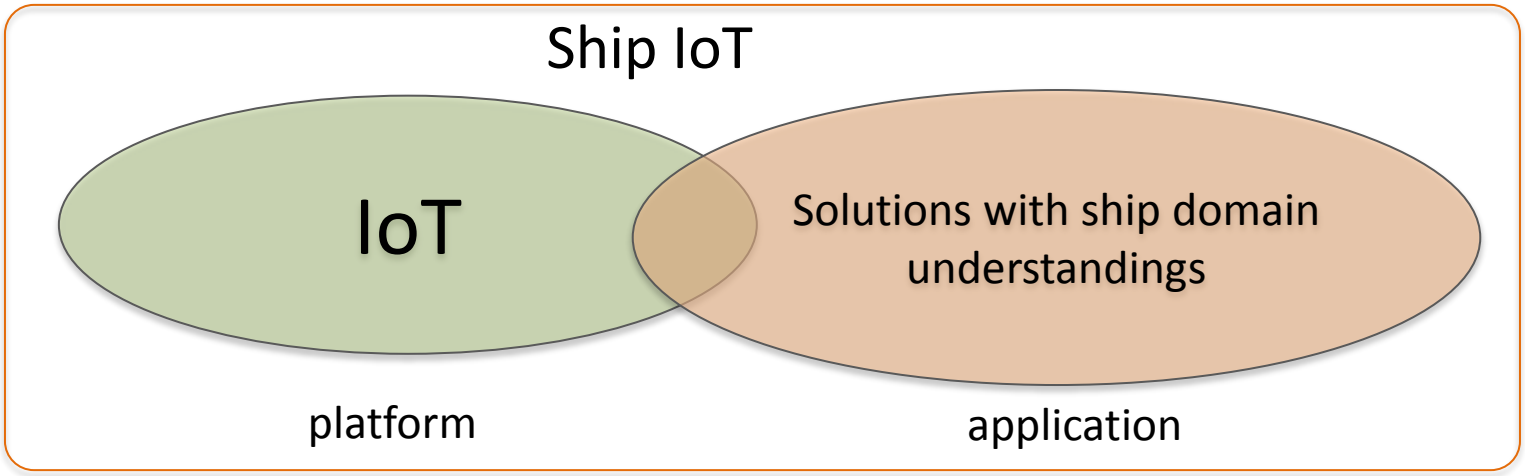
Ship IoT

- Good collaborations of IoT platform and marine domain understandings are necessary for Ship IoT

- SSAP project will provide the foundation of Ship IoT



Expected Applications of Ship IoT and Open Platform

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

Government … utilization for e-navigation and MRV

Summary

- IoT has been prevalent such as Industry Internet. The concept and technology are also applicable to marine industry.
- Several examples of IoT data utilization are introduced. There are two different views of ship owner and operator who utilize the Big data.
- Smart Ship Application Platform (SSAP) project aims at developing standard of onboard data server and data format / protocol for IoT of Ship
- To achieve Ship IoT, combination of good IoT platform and marine domain understandings are important to make good solutions.

Thank you for your attention