The role of MTI as a R&D company which aims to assist ship owners/operators

Tamio Kawashima

M T I

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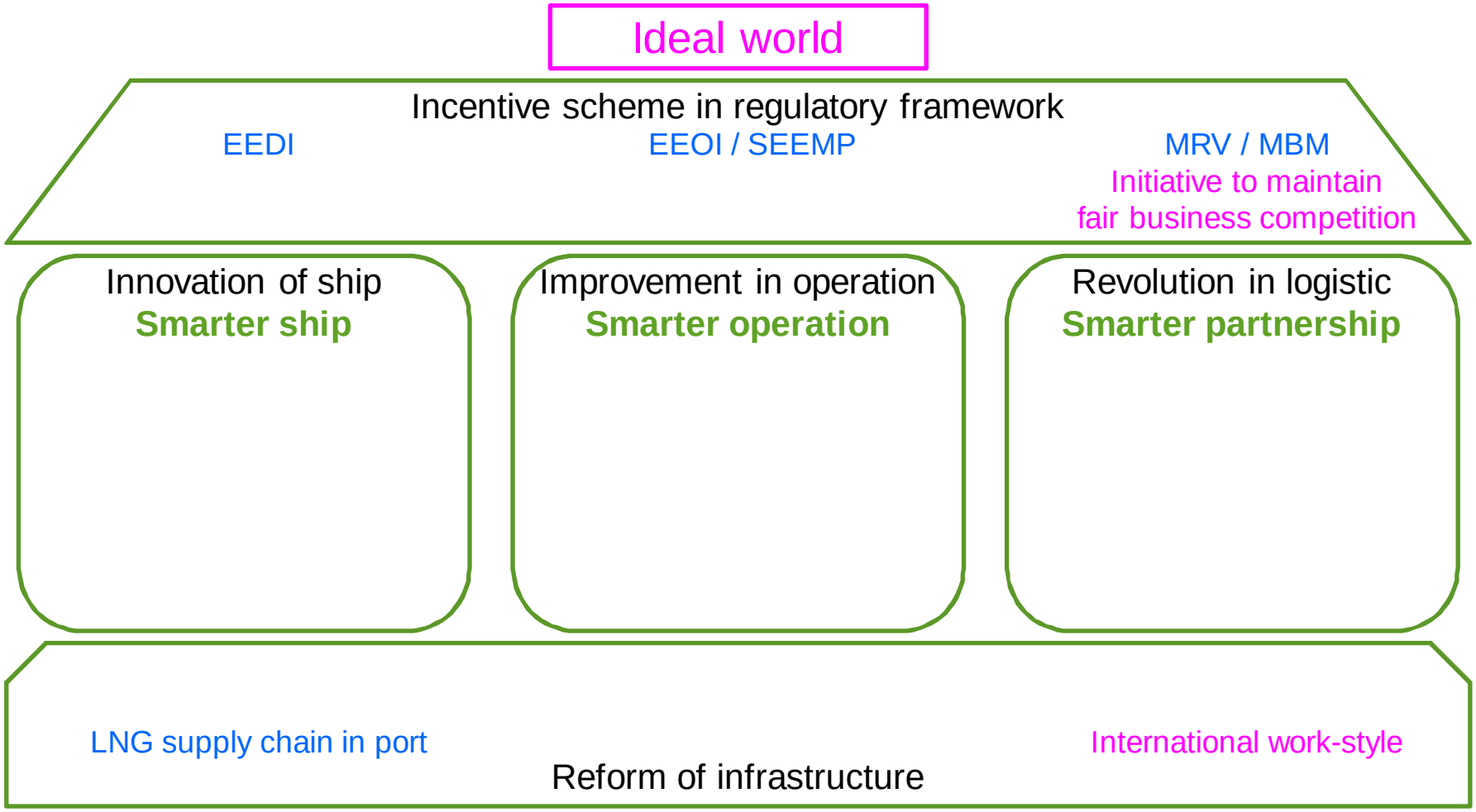
1. Ideal world

International shipping can be more environment-friendly.
We have many possible ways to become smarter.

Areas of R&D may be categorized into five fields.



2. What NYK/MTI is

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: 32,342 (as of the end of March 2014)

Revenues: $ 22 billion (Fiscal 2013)

NYK Head office in Tokyo

2. What NYK/MTI is

NYK Fleet (as of the end of March 2014)

NYK LINE

Containerships (including semi-containerships and others)
101 vessels / 5,572,991 DWT

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

Bulk Carriers (Panamax & Handysize)
286 vessels / 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 / 12,056,781 DWT

LNG Carriers
29 vessels / 2,172,415 DWT

Others
78 vessels / 1,227,245 DWT

877 vessels
68,036,568Kt (DWT)

2. What NYK/MTI is Land & Air Biz.

NYK LINE

Air-Cargo Transport

Aircraft : 12 (as of the end of March 2014)

Distribution center

Distribution centers and facilities: Worldwide in 477 locations, in 39 countries

Total warehouse space: 2,126,000㎡

Terminals

Container terminals: 23 ports

Ro-Ro terminals: 35 ports

Other terminals: 6 ports

2. What NYK/MTI is Offshore Biz.

NYK LINE

FPSO

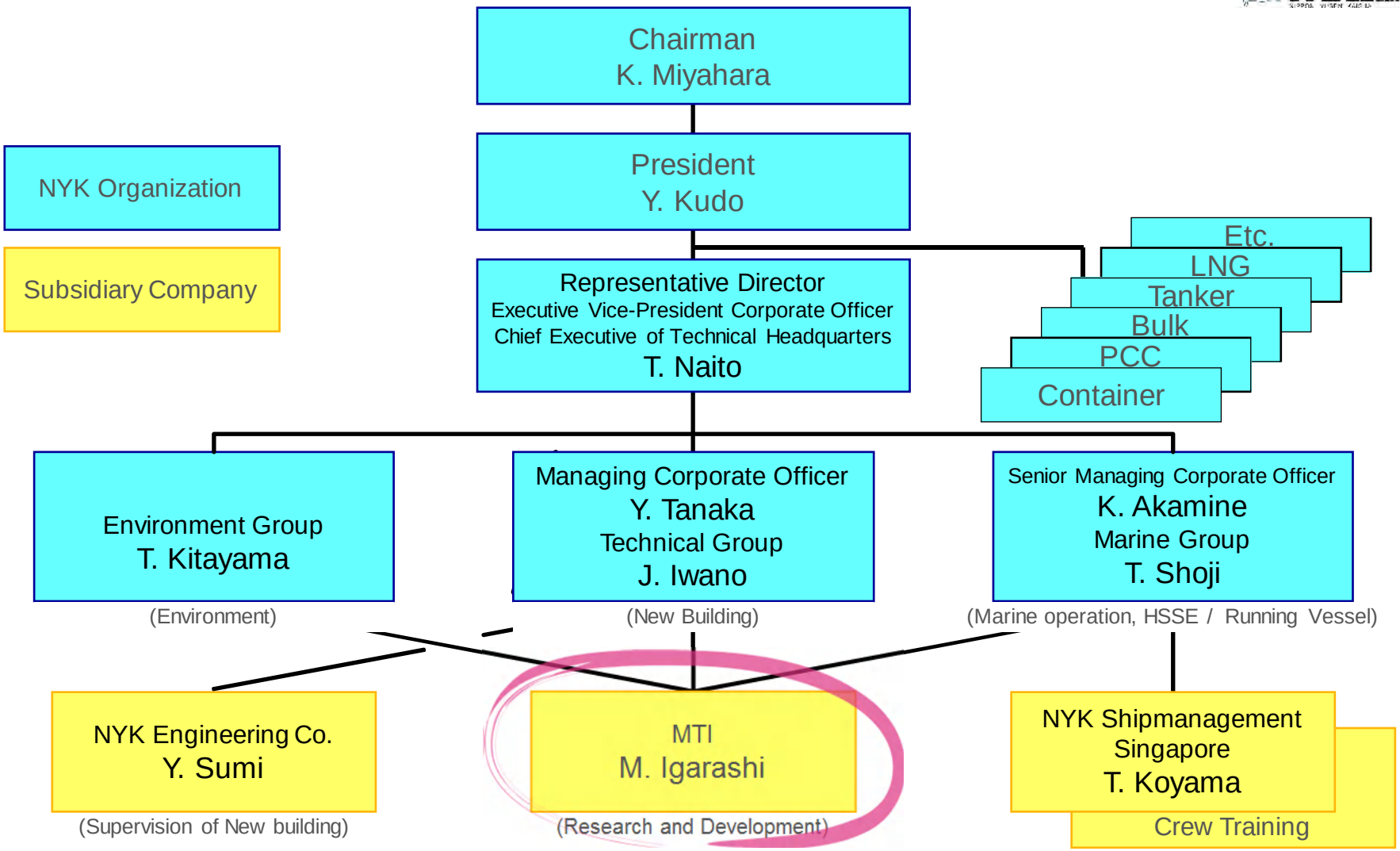
Drill Ship

Shuttle Tanker

2. What NYK/MTI is

NYK Technical Headquarters (from 1st April 2014)

NYK LINE

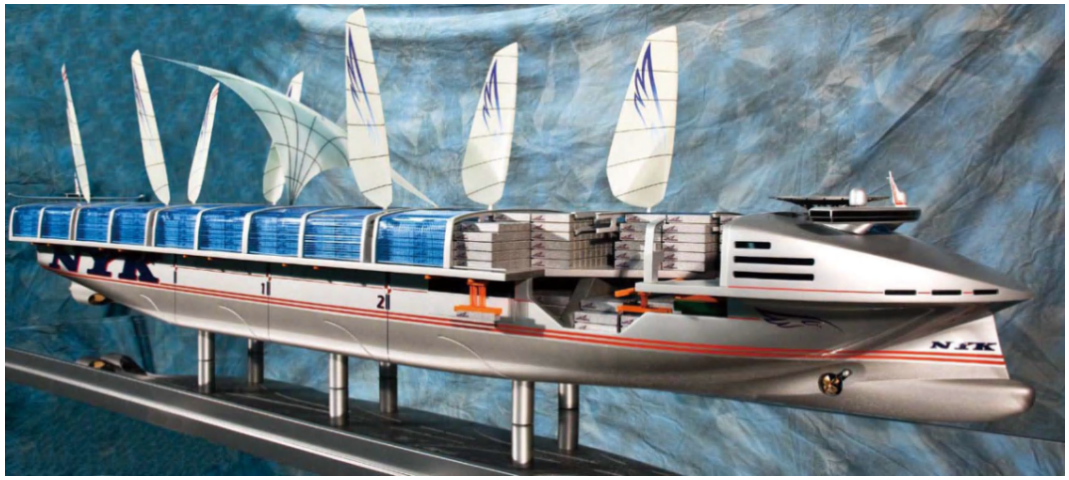


2. What NYK/MTI is

MTI Company Profile

MTI is “Monohakobi (= quality transport) Technology Institute”
Established : April 1, 2004
Equity capital : JPY 99 million
Stockholder : NYK Line
Number of employees : 63 (as of 1st January, 2015)
Head office : 2-3-2 Marunouchi, Chiyoda-ku, Tokyo, 100-0005, Japan
URL : www.monohakobi.com/en/

Monohakobi Technology Institute



NYK SUPER ECO SHIP 2030 (Concept ship for the future 69% less CO2 emissions)

Branch office :

SINGAPORE BRANCH
1 Harbour
Front Place #13-01
HarbourFront Tower One
Singapore (098633)

Laboratories :

YOKOHAMA LAB
(Transportation Environment Lab)
5-32-84, Sugita, Isogo-ku, Yokohama,
Kanagawa, Japan

2. What NYK/MTI is

About MTI

Our mission at MTI, as a member of the NYK Group, is to contribute to people's everyday lives, economic activities, and cultural initiatives the world over by developing and implementing MONOHAKOBI solutions. To that end, we are committed to conducting a wide range of R&D initiatives that translate into new technologies for safer navigation, environmental conservation, energy efficiency, and responsible eco-logistics.

There are three groups and Singapore branch in R&D section.

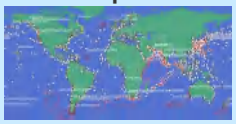
- Maritime Technology Group and Singapore Branch for Smarter ship
- Maritime Information Group and Singapore Branch for Smarter operation
- Logistics Technology Group for Smarter partnership.

Monohakobi Technology Institute

R&D

Sales

Maritime Technology Division	Logistics Technology Division	Maritime technology	Logistics technology
Maritime Technology Group Maritime Information Group Singapore Branch	Logistics Technology Group	Marketing Group	

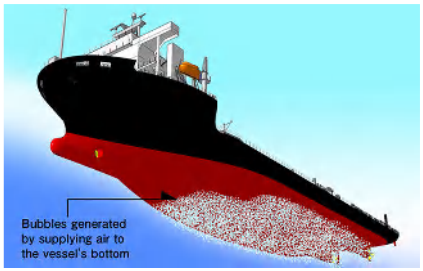


3. What NYK/MTI is acting

3-1. Smarter ship by Maritime Technology Group 1/4

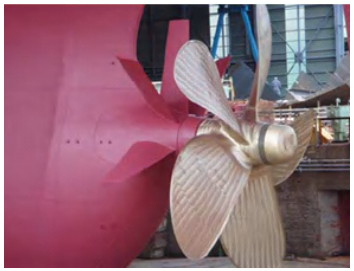
Reduction of resistance

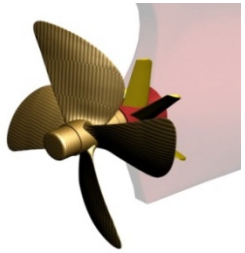
- Air lubrication system
- Low frictional coatings



Improve propulsion

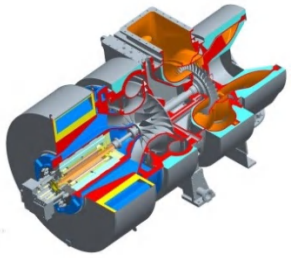
- Pre-swirl and post-swirl appendages
- Energy efficient propellers





Power plant efficiency

- Hybrid turbo charger
- Waste heat recovery system



NOx Reduction

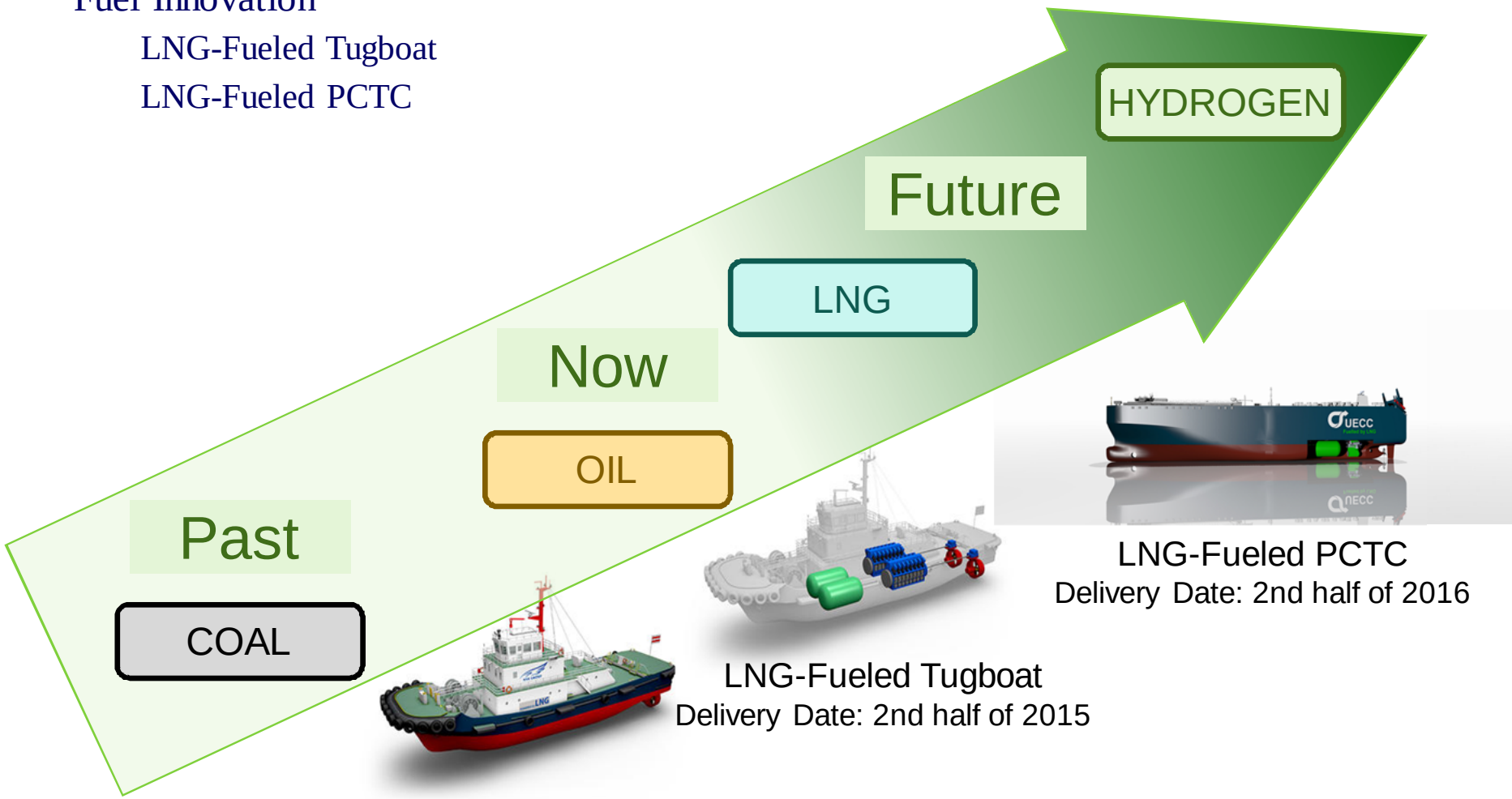
- SCR
- EGR

3. What NYK/MTI is acting

3-1. Smarter ship by Maritime Technology Group 2/4

Fuel Innovation

- LNG-Fueled Tugboat
- LNG-Fueled PCTC



LNG-Fueled PCTC
Delivery Date: 2nd half of 2016

LNG-Fueled Tugboat
Delivery Date: 2nd half of 2015

3. What NYK/MTI is acting

3-1. Smarter ship by Maritime Technology Group 3/4

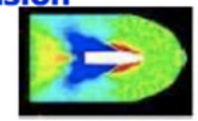
NYK Super Eco Ship 2030

CO2 emission ▲69%

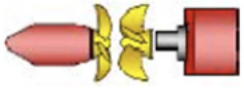
Reduction of Energy for Propulsion


Weight savings 9%


Hull friction 10%


Hull form optimisation 2%


Wind resistance 1%


Propulsion efficiency 5%


Superconductivity 2%


Reduced power for ship use 2%

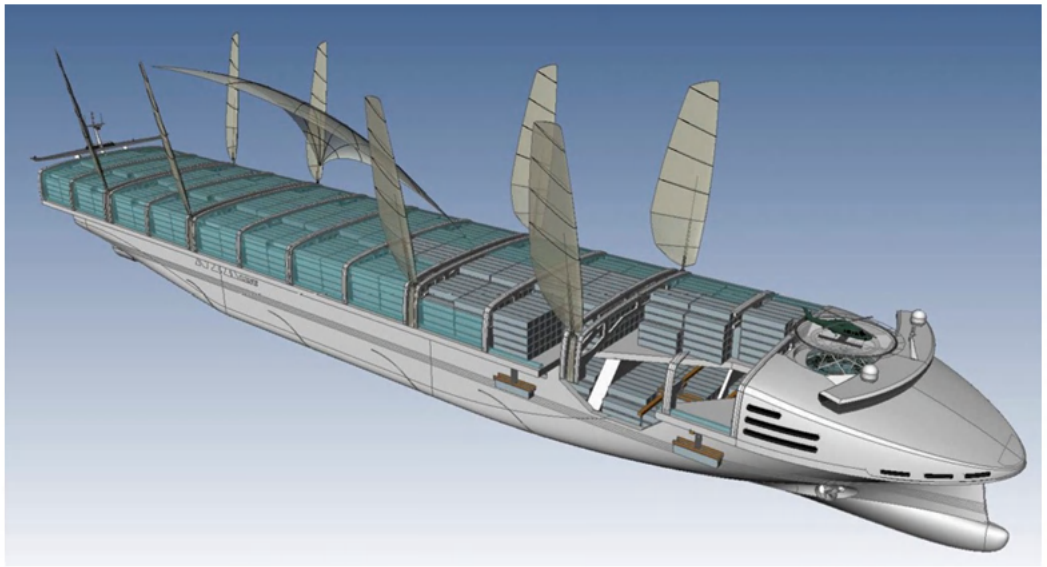
Energy Conversion


Fuel cells / LNG fuel 32%

Use of Natural Energy


Solar power 2%


Wind power 4%



ELOMATIC Garroni Design Monohakobi Technology Institute

3. What NYK/MTI is acting

3-1. Smarter ship by Maritime Technology Group 4/4

Japanese shipyards take a few interest in retrofit works of existing vessel.

NYK/MTI took retrofit works in Singapore under MPA contribution.

- Modifying shape of bulbous bow
- Retrofitting of energy saving device “MT-FAST”

Before Retrofit

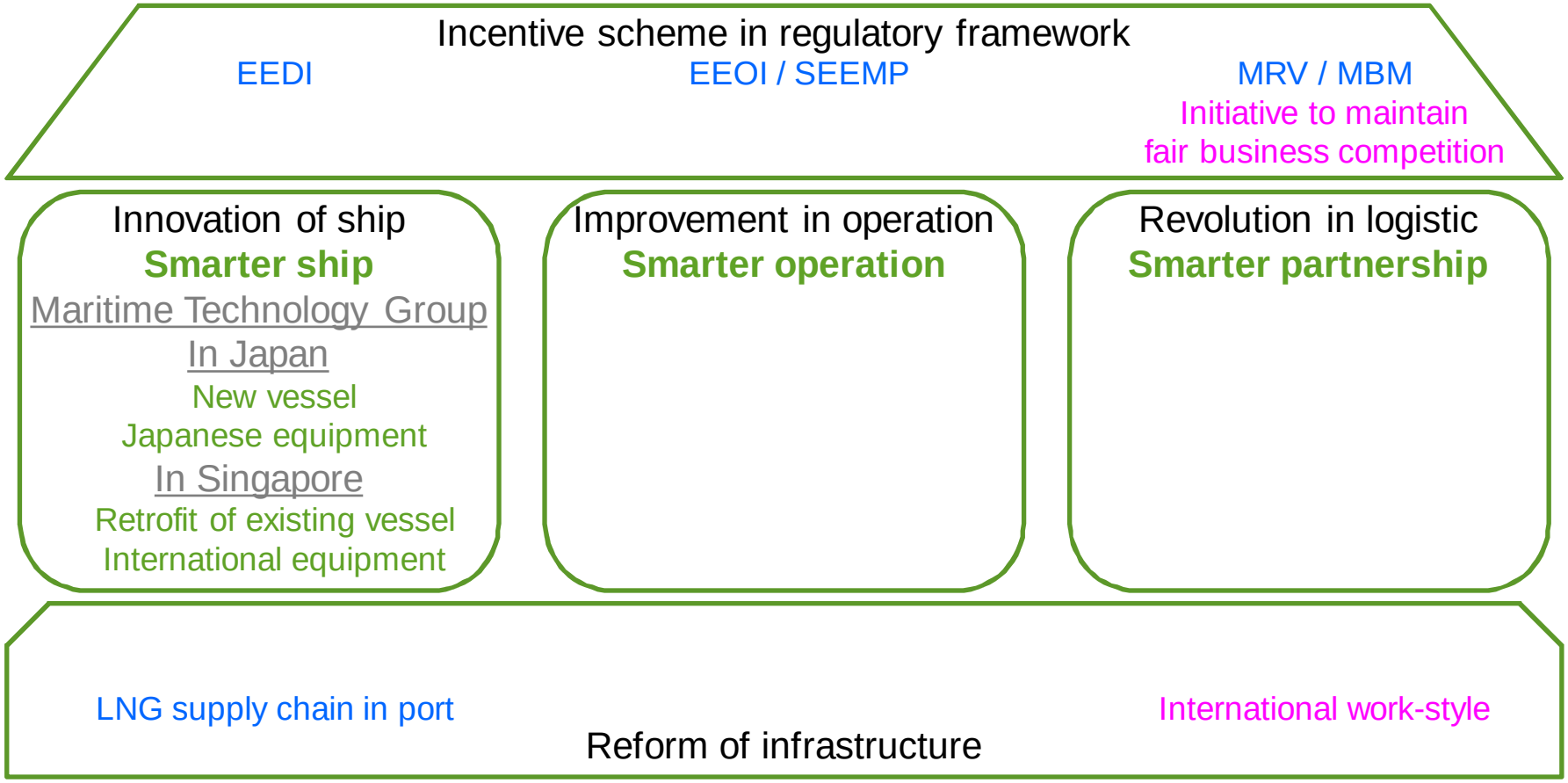
After Retrofit

3. What NYK/MTI is acting

Maritime Technology Group and Singapore Branch for Smarter ship

In Japan, R&D for new vessel with Japanese shipyards and/or Japanese manufactures

In Singapore, Retrofit works of existing vessel with Singapore shipyards, using international equipment including Japanese equipment



3. What NYK/MTI is acting

3-2. Smarter operation by Maritime Information Group 1/8

Slow Steaming as save bunker activities

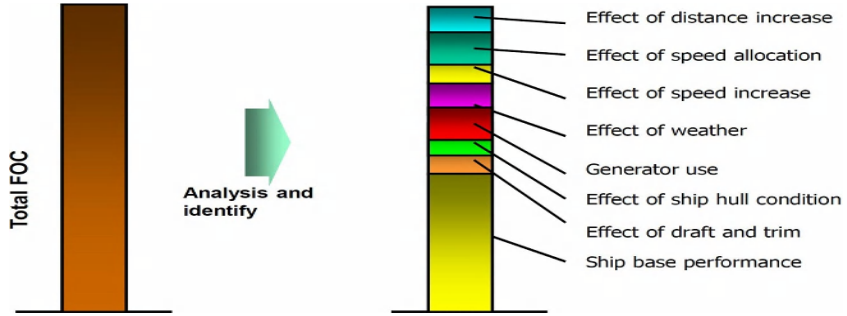
According to increased cost of bunker, ship operators have applied operational and technical measures for fuel saving.

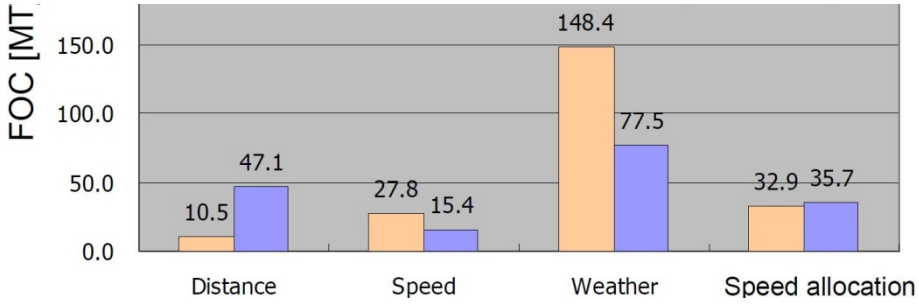
By using detail monitoring data and appropriate analysis methods, total FOC can be breakdown into each cause.

Cost benefit and emission reduction by slow steaming

e.g. 8,000 TEU container

		Slow steaming	
Ship speed	24 knot	20 knot	- 16 %
M/E fuel consumption	225 ton/day	130 ton/day	- 42 %
M/E fuel cost (@ 600 USD/MT)	134,800 USD/day	78,000 USD/day	
CO2 emission	696 ton/day	403 ton/day	





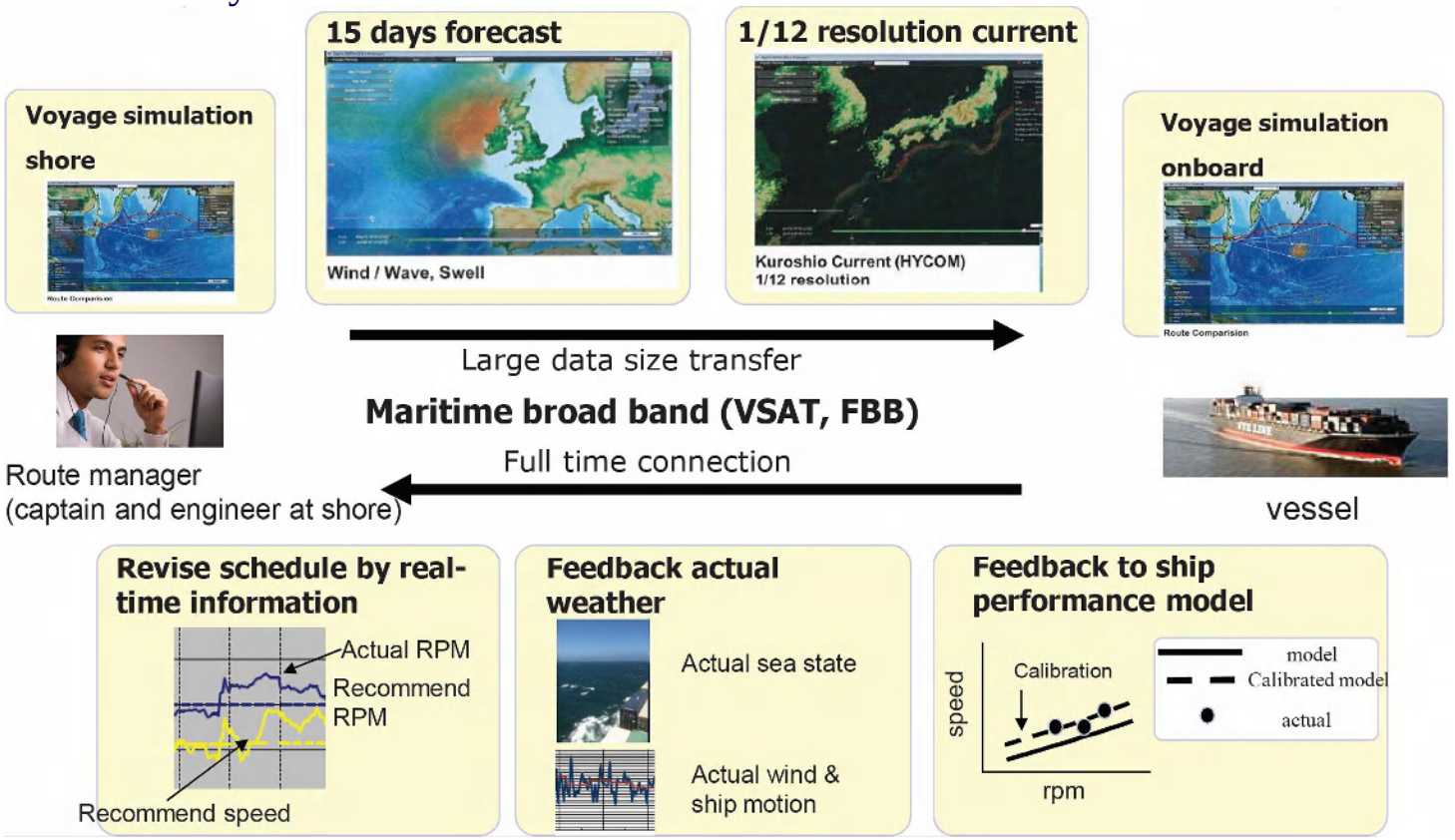
3. What NYK/MTI is acting

3-2. Smarter operation by Maritime Information Group 2/8

Integration of weather routing and monitoring

Voyage plan vs. Voyage actual

Ship model and weather forecast are inherently include errors. But feedback loop by monitoring can make this system work better.



3. What NYK/MTI is acting

3-2. Smarter operation by Maritime Information Group 3/8

Example of voyage summery report

Voyage Summary Report

page 1/8

NYK ATHENA Voy. 57
OAKLAND - TOKYO

WEEK 36

	UTC	LT
data record start:	2009/09/13 12:56:09	2009/9/13 5:56
end:	2009/09/23 08:56:51	2009/9/23 17:56

Distanace and Fuel Consumption

Voyage duration	237	[hour]
Voyage distance	4672.1	[mile]
FO consumption(total)	1090.3	[MT]
FO consumption(ton/day	110.4	[MT/day]
mile/ton	4.29	[mile/MT]
ton/mile	0.23	[MT/mile]

Displacement and Draft

displacement at dep.	75,317	[MT]
draft(fore) at dep.	10.60	[m]
draft(aft) at dep.	10.90	[m]
trim (h -, s +)	0.30	[m]
displacement at arr.	74,880	[MT]
draft(fore) at arr.	10.10	[m]
draft(aft) at arr.	10.80	[m]
trim (h -, s +)	0.70	[m]

Speed and propulsion

speed(OG, Ave)	19.9	[knot]
speed(log, Ave)	20.1	[knot]
M/E revolution(Ave.)	73.5	[rpm]
DHP(Ave.)	23378	[kW]

M/E output

BHP(Ave.)	23370	[kW]
M/E load (Ave.)	38.0	[%]
shaft gen. output(Ave.)	-7.5	[kW]
FOC for shaft gen.	-0.5	[MT]

FOC

M/E 10% load (Ave.)	33.1	[MT/day]
M/E 50% load (Ave.)	137.2	[MT/day]
M/E 65% load (Ave.)	164.5	[MT/day]
FOC for D/G (from SPAS	103.6	[MT]

Wind

True wind speed(ave.)	9.4	[m/s]
True wind speed(long., ave.)	0.1	[m/s]
True wind speed(trans., ave.)	0.3	[m/s]
Drift angle(ave.)	1.2	[deg]
Drift angle(max)	7.2	[deg]

Roll and Pitch

Roll (max)	13.1	[deg]
Pitch (max)	3.6	[deg]

Slip

slip (ave.)	4.3	[%]
slip (base, at calm)	2.3	[%]
slip (min)	0.0	[%]
slip (max)	16.6	[%]

Speed

Speed (Proforma)	20.7	[knot]
Diff. (Actual OG - Proforma)	-0.8	[knot]

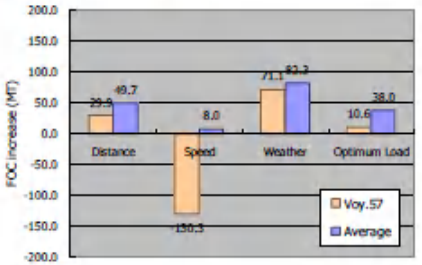
Voyage distance

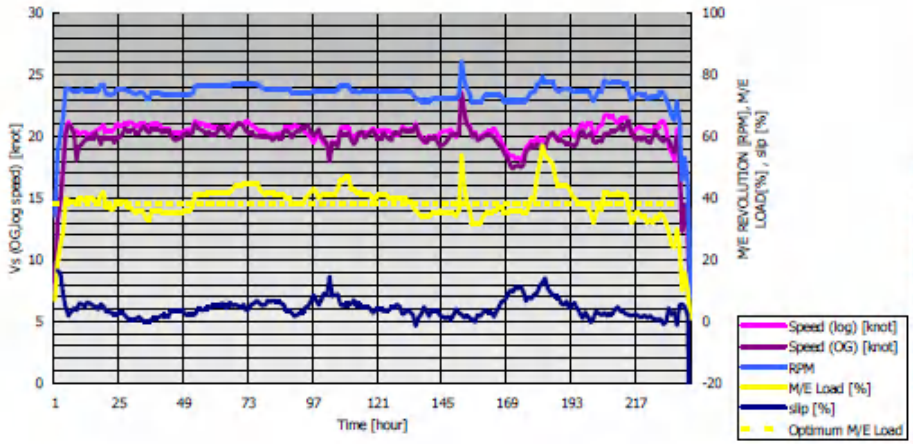
Distance(Proforma)	4559	[mile]
Diff. (Actual - Proforma)	113.1	[mile]

Voyage hours

Voyage hours(Proforma)	218	[hour]
Diff. (Actual - Proforma-Pilot Hours)	14	[hour]

Fuel consumption breakdown





(Data collection period : 08' Week10 to 09' week27 / total 19 records)

Ship design specification	A-series	
Loa	299.9	[m]
Lpp	283.8	[m]
B	40	[m]
D	23	[m]
draft(design)	13	[m]
Displacement(design)	98437	[MT]
Design speed	25	[knot]
M/E	RTA 96C	
M/E MCO	1350.3	[kw]
M/E NOR	2149.9	[kw]
S.M.	20	[%]
Propeller pitch (0.7R)	8.816	[m]
Propeller diameter	8.86	[m]

3. What NYK/MTI is acting

3-2. Smarter operation by Maritime Information Group 4/8

Fleet Operation Optimizing

Ship monitoring ⇒ Fleet monitoring ⇒ Fleet management ⇒ Business management

Best balance of safety, economy and environment

- No cargo and ship damage
- Keep schedule
- Maximize time charter equivalent (minimize cost)
- Minimize emissions

Snapshot from NYK e-Missions'

NYK fleet: about 800 vessels now

3. What NYK/MTI is acting

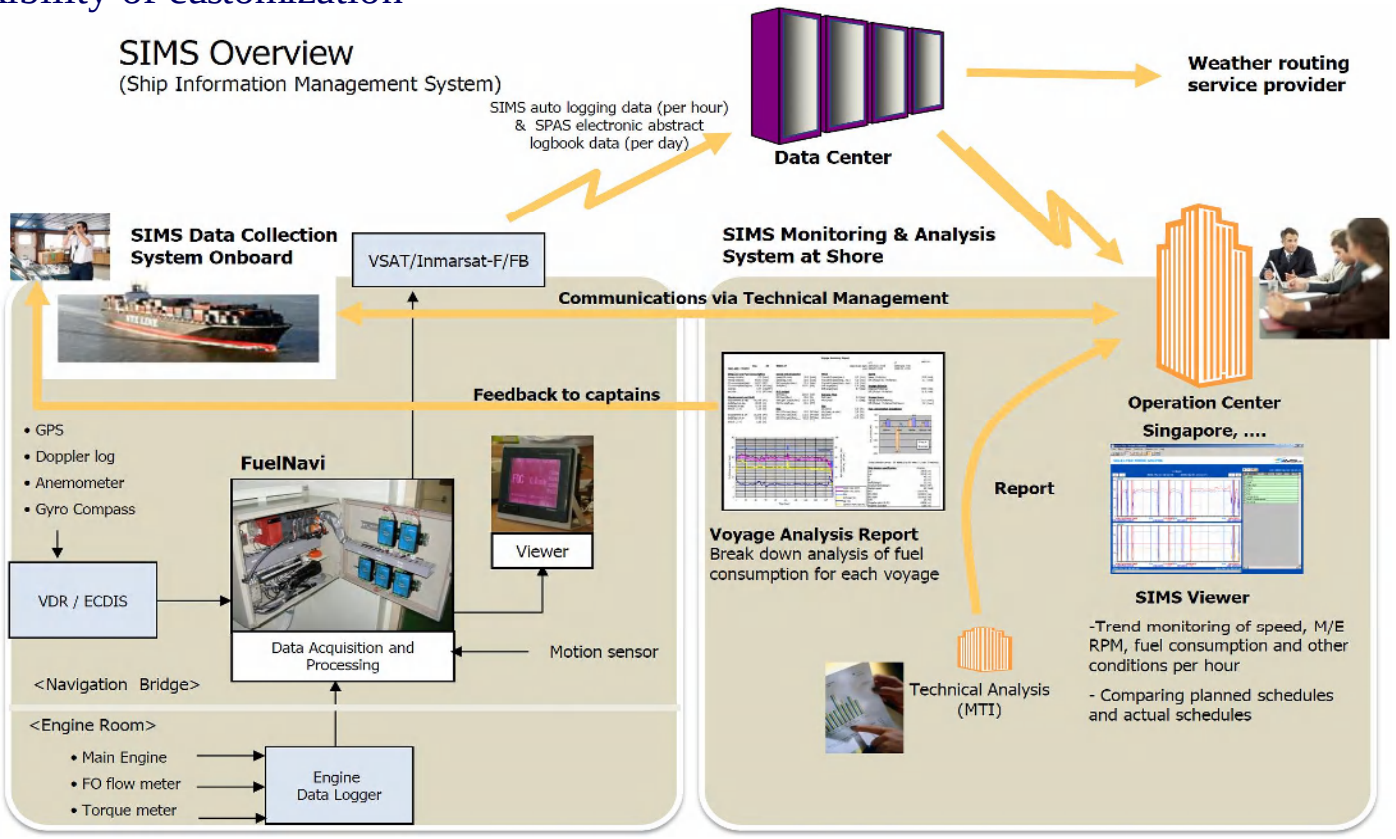
3-2. Smarter operation by Maritime Information Group 5/8

SIMS : NYK/MTI original data collection system

Interface to onboard equipment, such as engine D/L, GPS, anemometer, flow meter and so on

High reliability … 24 hrs, 365 days work without maintenance

Flexibility of customization



3. What NYK/MTI is acting

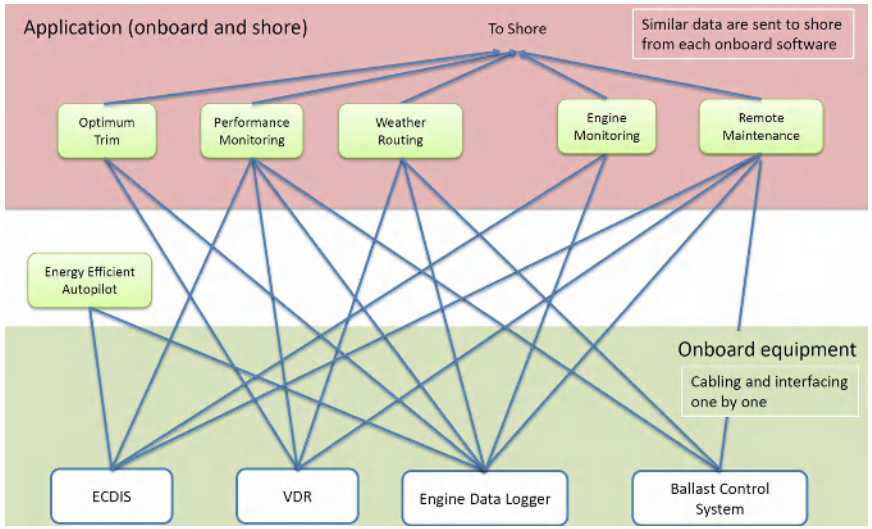
3-2. Smarter operation by Maritime Information Group 6/8

International standard of maritime data format and protocol in ISO/TC8/SC6

Installation of onboard applications require 1 to 1 connections to each onboard equipment. Cabling and customization raise application installation cost.

Standardized format and protocol will enhance application development. Application can take any ship equipment data from standardized master database.

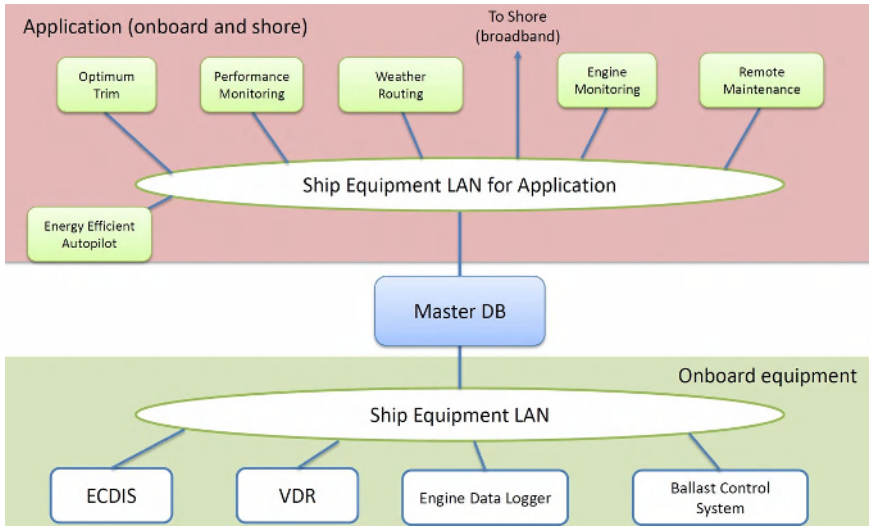
Current situation



ISO/PWI 19847 Shipboard data servers to share field data on the sea

ISO/PWI 19848 Standard data for machinery and equipment part of ship

Expecting future



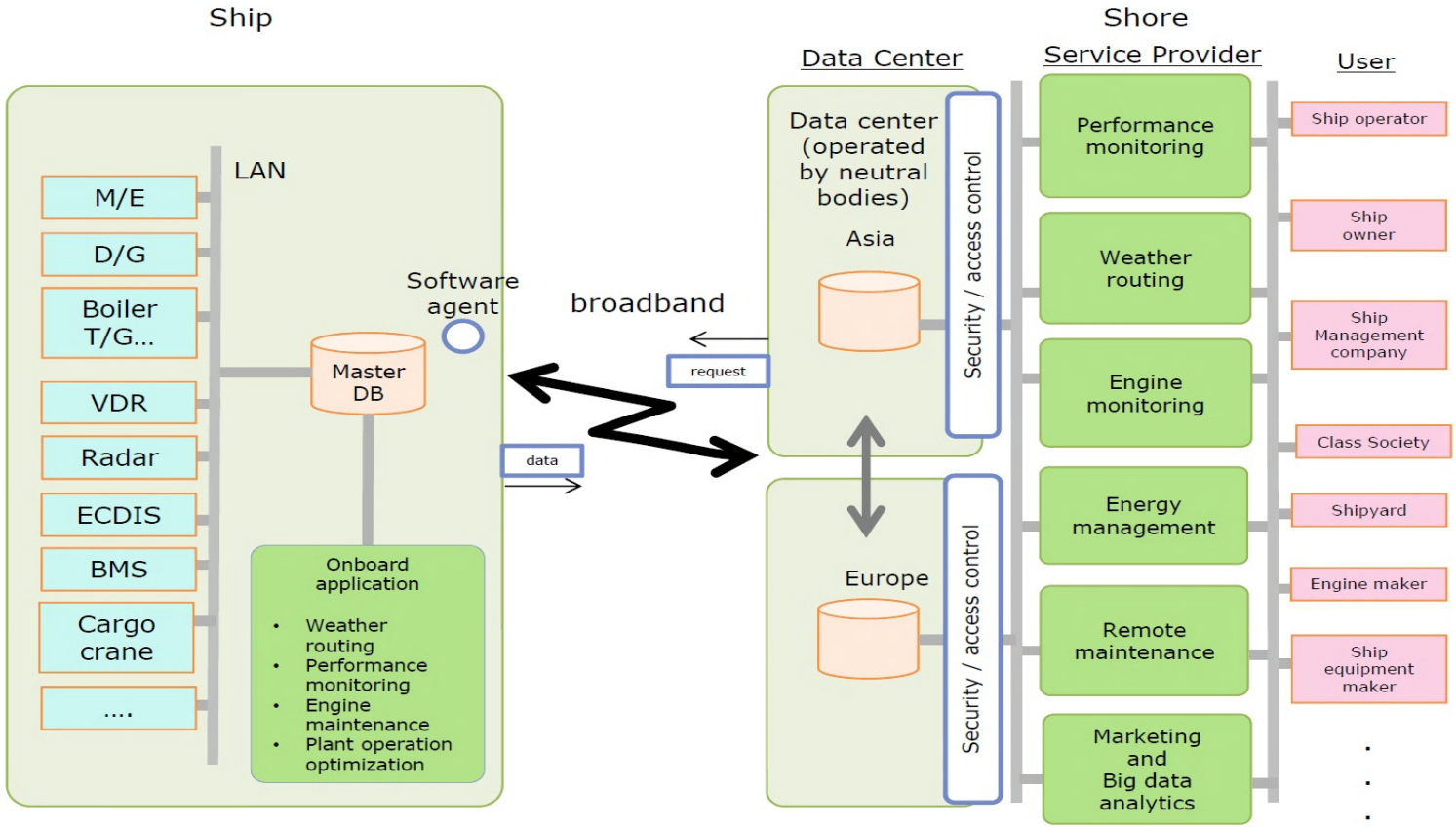
3. What NYK/MTI is acting

3-2. Smarter operation by Maritime Information Group 7/8

Maritime Data Center as ship-shore big data infrastructure

Application providers can easily provide onboard and shore application software/services.

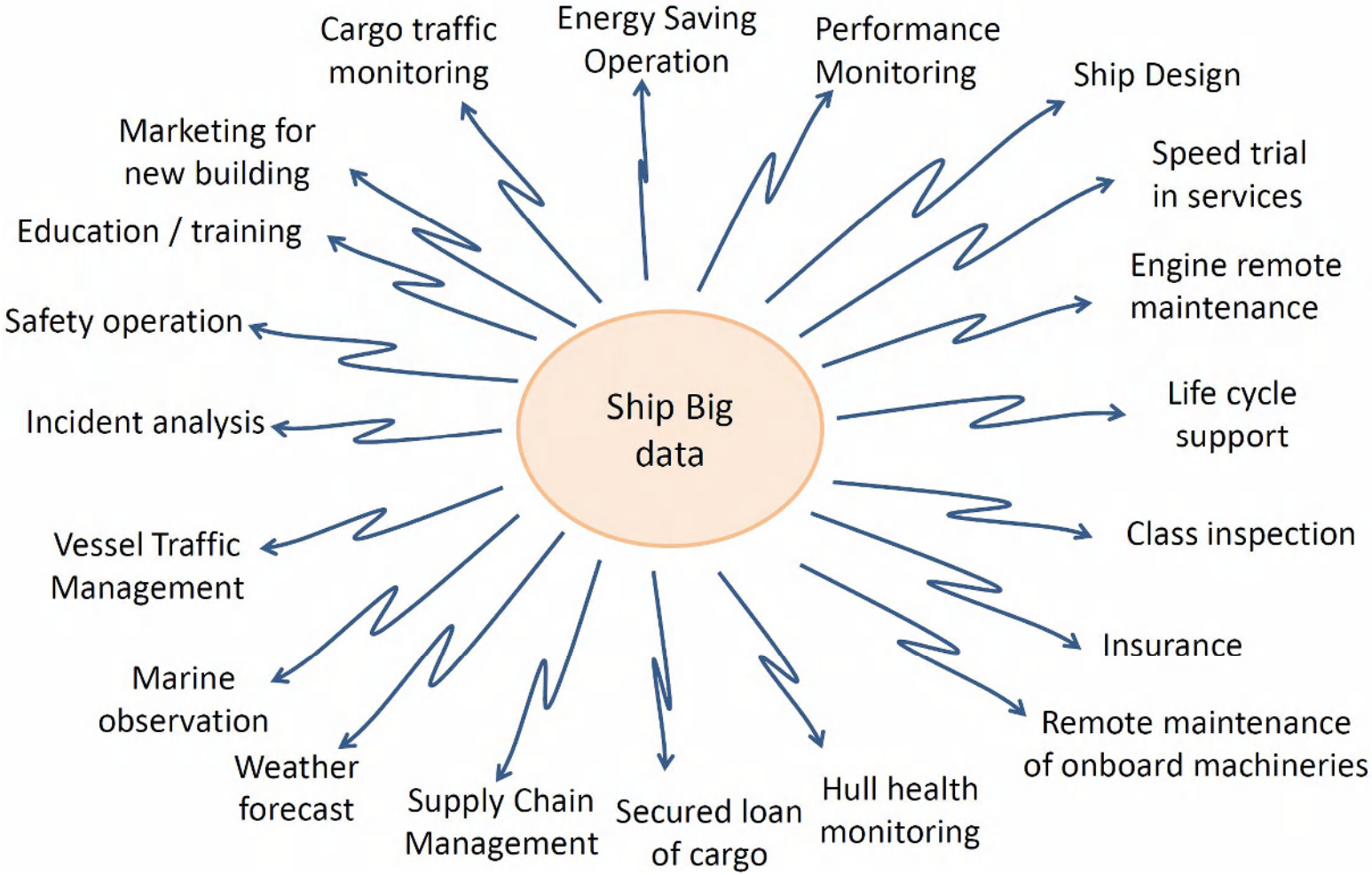
Equipment manufacturers can easily provide their services, such as remote maintenance.



3. What NYK/MTI is acting

3-2. Smarter operation by Maritime Information Group 8/8

Possibilities of Ship Big Data



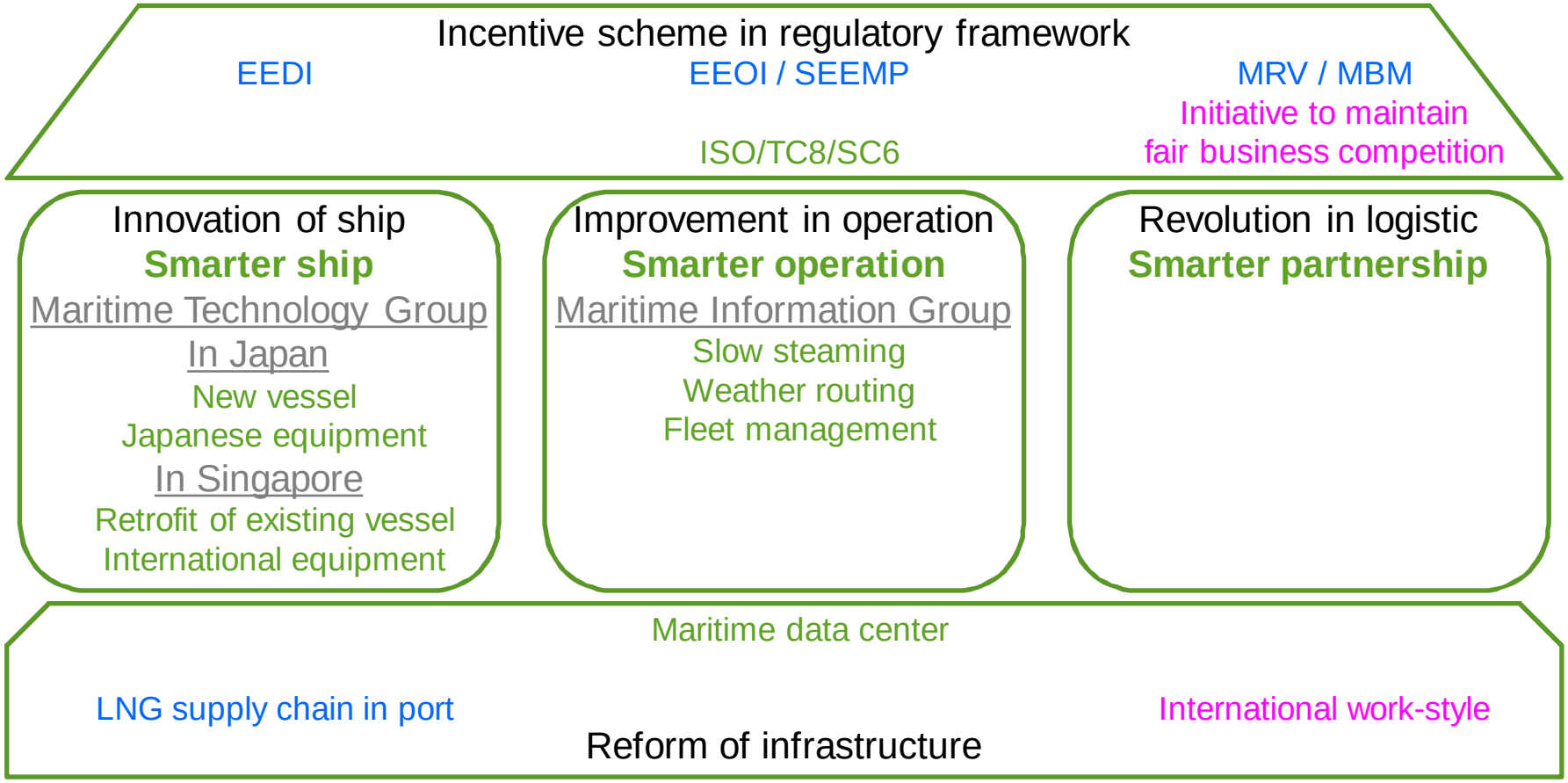
3. What NYK/MTI is acting

Maritime Information Group and Singapore Branch for Smarter operation

Smarter operation is the core of ship owner/operator

International standard of maritime data format and protocol in ISO/TC8/SC6

Maritime data center as ship-shore big data infrastructure

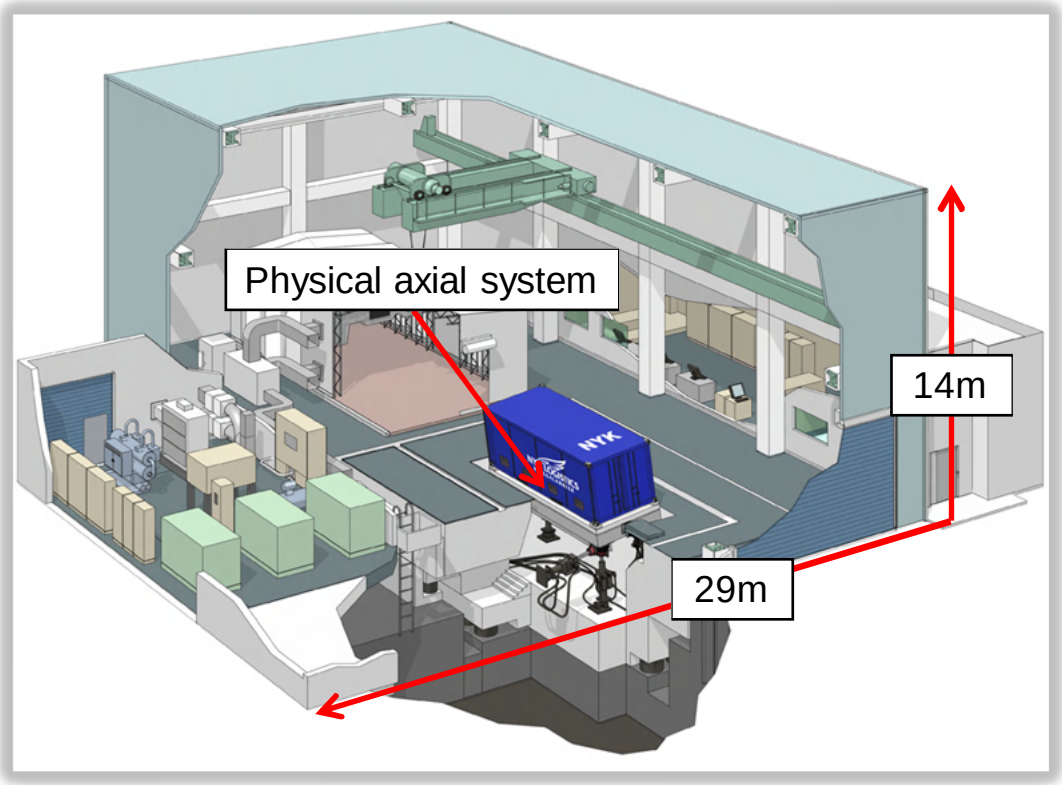


3. What NYK/MTI is acting

3-3. Smarter Partnership by Logistics Technology Group 1/3

Multi Cargo Simulator (MCS) in Yokohama Laboratory

The large scale 3-D Physical Axial Systems perfectly simulates vibrations, shocks, the rolling motions of cargo in transportation, and even seismic vibrations as strong as the earthquakes such as the Great East Japan Earthquake in 2011 and the Great Hanshin Earthquake in 1995.



Physical axial system	
Specification	6 degrees of freedom (3 axes)
Table size	2.6 m x 6.2 m
Maximum loading weight	20 ton
Maximum acceleration (loading weight:5 ton)	Horizontal:2.0G Vertical:3.0G
Maximum rolling angle	20°

3. What NYK/MTI is acting

3-3. Smarter Partnership by Logistics Technology Group 2/3

Products on a commercial bases

Tag of Location Management System
for Finished Vehicles

Reusable Transport Items
Management System

Automatic-recognition System
at Warehouse

Round-trip type One-way type

Shock-Absorbing Pallet
Round-trip type / One-way type

Heat Insulation Sheet
for Ocean Container

3. What NYK/MTI is acting

3-3. Smarter Partnership by Logistics Technology Group 3/3

International Logistic chain

We have many experiences of “Smarter efficiency of each segment”.

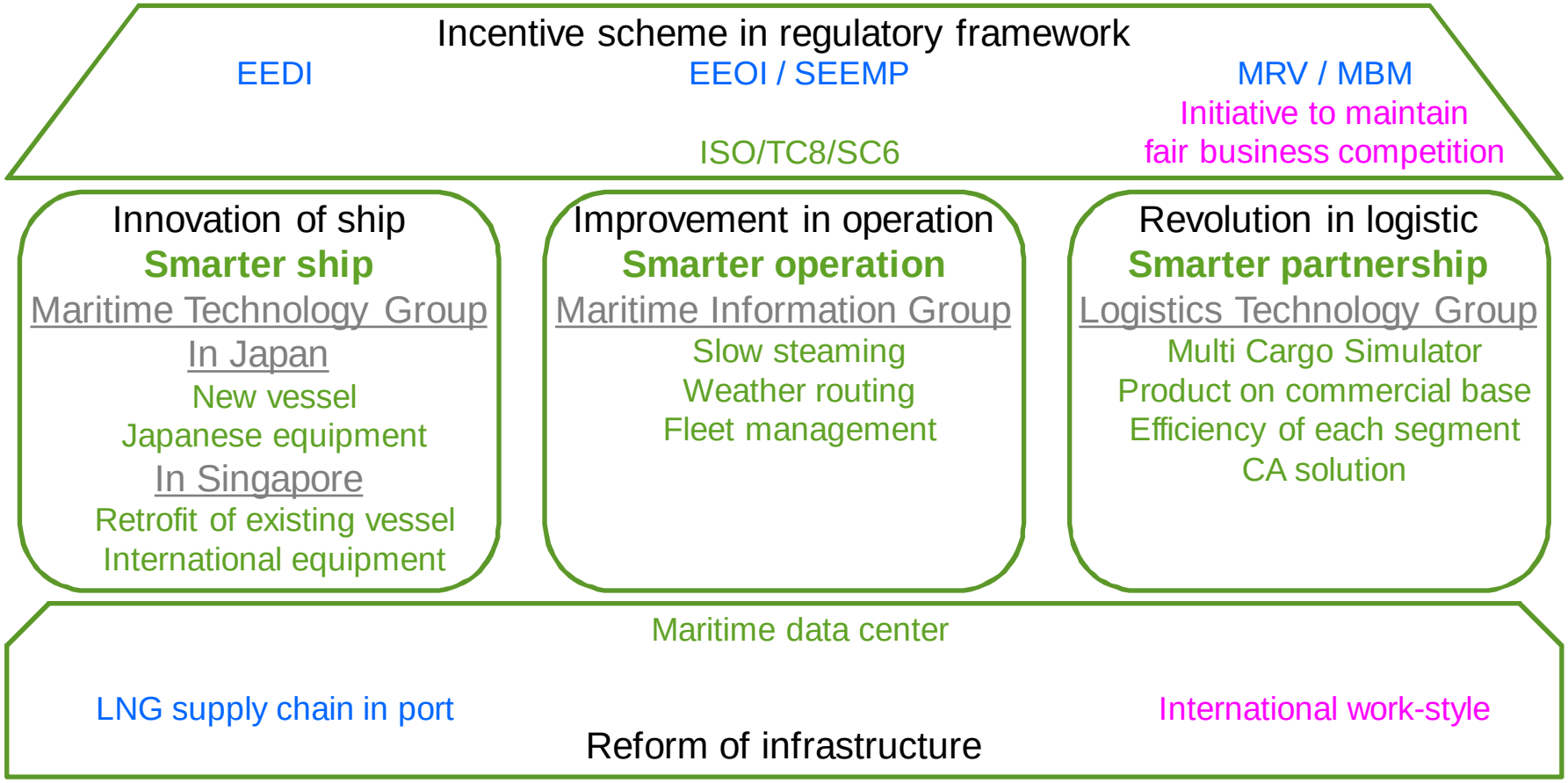
CA (Controlled Atmosphere) solution for Japanese fruit export business

3. What NYK/MTI is acting

Logistics Technology Group for Smarter partnership

Smarter efficiency of each segment, including MCS and commercial products

Smarter logistic chain, including CA solution

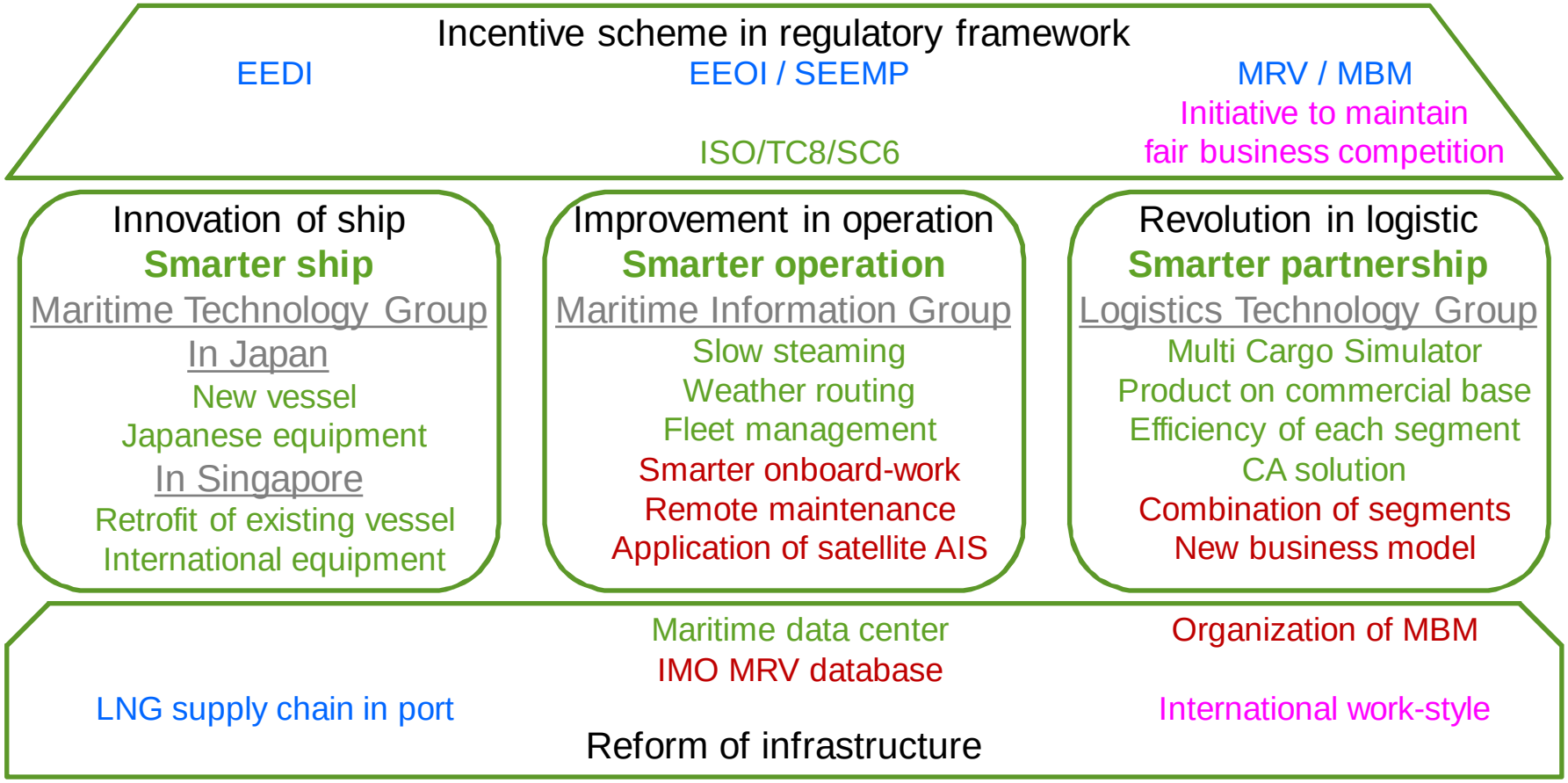


4. What NYK/MTI is NOT acting

As for smarter operation, we have many possibilities of ship big data solution.

As for smarter partnership, there are undeveloped field as of combination of segments, efficiency of combination, new business model and more win-win with customer.

Not close enough to reform of infrastructure and incentive scheme in regulatory framework.

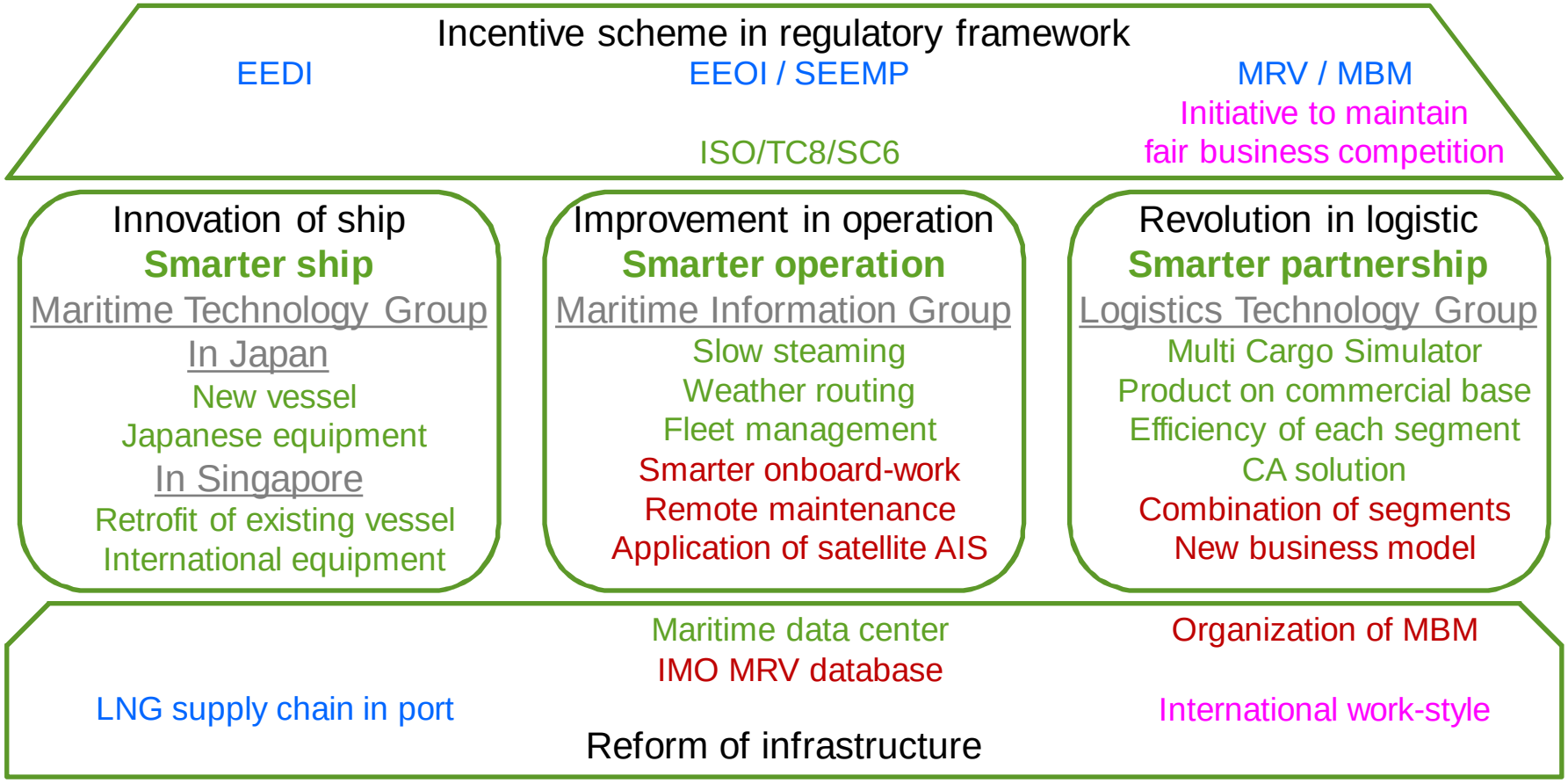


5. Necessity of worldwide partnership

NYK/MTI recognize the necessity of worldwide partnership and international work-style.

One of the final goal is to keep initiatives to maintain fair business competition.

As for an example, 0.5% SOx Global Cap EGCS project, which is decided to proceed at this Global Research and Innovation Centre.

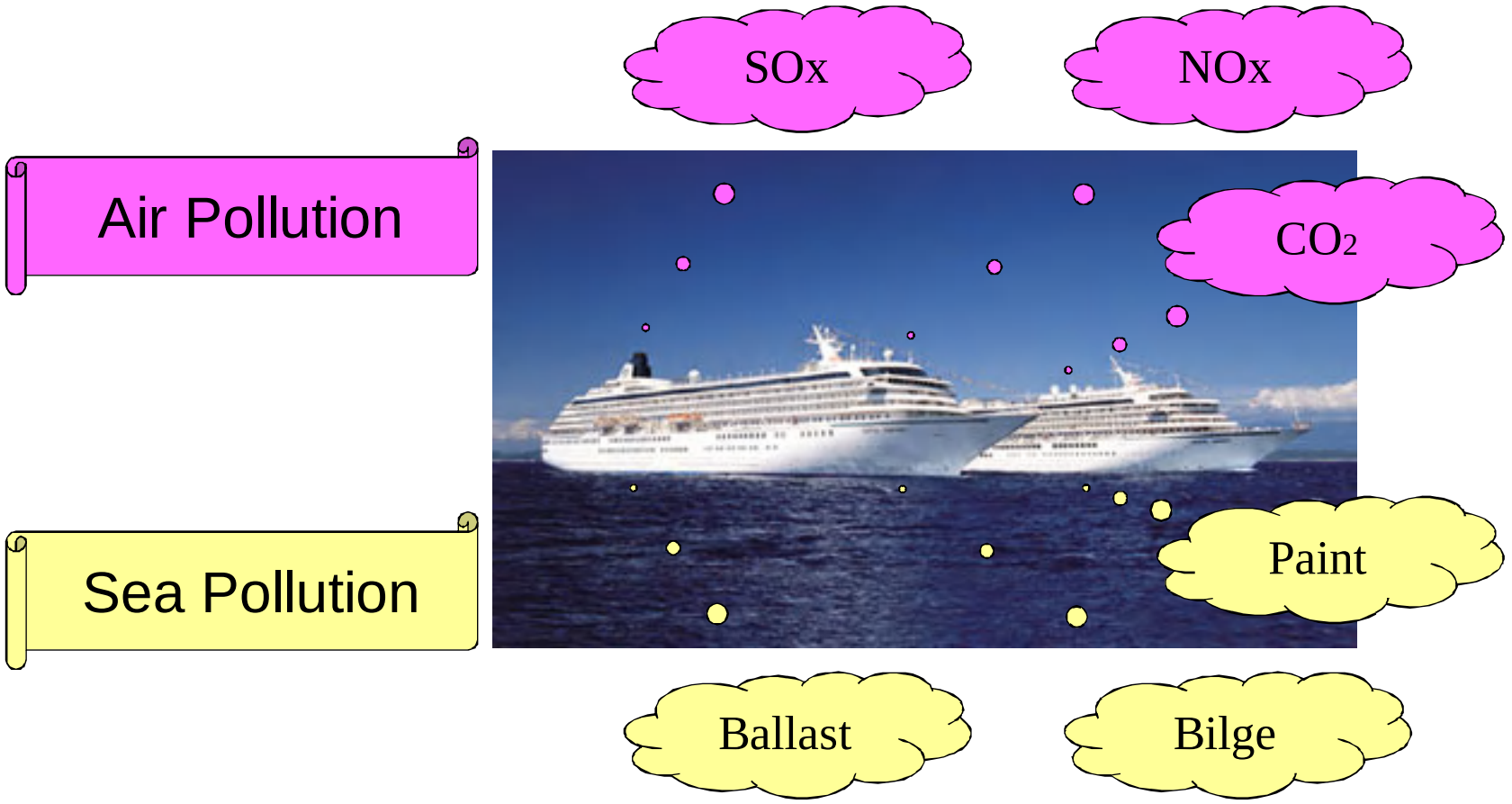


6. 0.5% SOx Global Cap EGCS

6-1. Outlook for the impact by each regulation

There are so many new regulations by IMO.

They may be sorted out by each impact on Ship-owners/operators business.



6-1. Outlook for the impact by each regulation

My logic of calculation

Assumptions of initial cost and running cost

- Running cost of 0.1% SOx ECA; 100$ (0.1%MGO-1.0%LSO/MDO) x 50 ton/day x 200 day/year x 5 year x 20%
- Running cost of NOx Tier Ⅲ; +2%FOC = 600$ (3.5%HFO) x 50 ton/day x 2% x 200 day/year x 5 year
- Running cost of CO2; 30 $/CO2–ton x 3.1 x 50 ton/day x 200 day/year x 5 year
- Running cost of 0.5% SOx Global Cap; 300$ (3.5%HFO-0.5%LSO)) x 50 ton/day x 200 day/year x 5 year

Target vessels (including or excluding existing vessels)

- New vessels during 5 years = 2,000 ships/year x 5 years = 10,000 ships, Existing vessels = 30,000 ships

[Unit: M$]	Cost per vessel			Target Vessels		Cost of our industry		
	Initial	Running (5 years)	Total	New	Existing	New (5years)	Existing	Total
BWMS	2.0	0.0	2.0	○	○	20,000	60,000	80,000
0.1% SOx ECA	0.0	1.0	1.0	○	○	10,000	30,000	40,000
NOx Tier Ⅲ	2.0	0.6	2.6	○	–	26,000	0	26,000
CO_2	0.0	4.7	4.7	○	○	46,500	139,500	186,000
0.5% SOx Global Cap	0.0	15.0	15.0	○	○	150,000	450,000	600,000

You may make your own table in accordance with your logic.

For me, 0.5% SOx Global Cap is the biggest impact regulation.

Impact on existing vessels is much bigger than impact on new vessels.

The most important issue is how to keep initiatives to maintain fair business competition.

6-2. Countermeasures for 0.5% SOx Global Cap

EGCS and LNG as fuel are considered as the alternative to LSFO (Low Sulfur Fuel Oil), in order to reduce the impact of 0.5% SOx Global Cap.

	Target Vessels						Cost per vessel [Unit: M$]	
	New			Existing				
Route of Voyage	ECA only	World with ECA	World w/o ECA	ECA only	World with ECA	World w/o ECA	Initial	Running (5 years)
Number of Vessels	1,700	3,300	5,000	5,000	10,000	15,000		
LNG as fuel	○	○	○	○	△	△	Biggest	△ 5.0
Hybrid EGCS	-	○	-	-	○	-	Bigger	0.0
0.1% EGCS	○	-	-	○	-	-	BIgger	0.0
0.5% EGCS	-	△	○	-	○	○	3.0	0.0～3.0
LSFO	△	△	△	△	△	△	0.0	15.0

If LSFO will be used by many ships in Global Cap Area, the supply of LSFO will be in short. It means price difference between LSFO and HFO will go up substantially.

As it will take a long time to establish LNG infrastructure all over the world, existing vessels have a few chance to be applied retrofit work to LNG fuel.

Hybrid EGCS is one for both 0.1% SOx ECA and 0.5% SOx Global Cap

0.5% EGCS is the best solution for existing vessels whose voyage is worldwide, especially without ECA. (Bulker between Australia and Asia, VLCC between the ME and Asia, so on.)

Market of 0.5% EGCS is much bigger than one of others.

6-3. Difference between 0.1% EGCS and 0.5% EGCS

R&D for 0.1% EGCS used in ECA is being carried out.

R&D for 0.5% EGCS is not recognized as important issue yet. The reason is not due to a man-power problem which no one can deal with such a more remote future regulation but due to **a preconception that we can use 0.1% EGCS as 0.5% EGCS**.

However, if 0.5% EGCS is designed

to miniaturize the reactor due to lower requirement of SOx reduction ratio,
"3.5% => 0.1%" is 97.2% off, "3.5% =>0.5%" is 85.7% off

to simplify water treatment system with omitting closed cycle system, because regulation allow to discharge the treatment water into the sea in Global Cap Area,

to offer easier retrofit work of existing vessels to shipyard,
to establish standardization of retrofit work of existing vessels by shipyard,
(In general, cost of retrofit work by shipyard is twice or more than equipment cost.)

to offer easier operation to crew,

to require smaller budget to ship-owner/ship-operator,

0.5% EGCS will get its position.

At present, MDO/MGO are usually used in ECA. **There is potential to use "MDO/MGO in ECA" and "HFO + 0.5% EGCS in Global Cap Area"**.

6-4. Handling of sulfur and sludge

EGCS removes SOx/sulfur, Particulate matter, Soot/Black carbon, Oil content, Metals, etc. from exhaust gas, **however, they are still onboard**.

Quantity of sulfur and sludge

Sulfur

- From 50 ton of HFO,
- Sulfur = 50 ton x 3.0% (3.5% - 0.5%) = 1.5 ton
- Na2SO4 (sodium sulfate) by neutralization = 1.5 x (23x2+32+16x4)/32 = 6.7 ton
- + Same weight of water for easy handling = 13.3 ton = 7 ~ 8 m^3

Sludge (Particulate matter, Soot/Black carbon, Oil content, Metals, etc.)

- From 50 ton of HFO,
- Sludge = 50 ton x 26.5 litre/ton = 1.3 m^3 (solid 20%, water 80%)

Quantity of sulfur and sludge become 9 m^3.
As it is not small, we have to consider how to handle them carefully.

Handling of sulfur and sludge

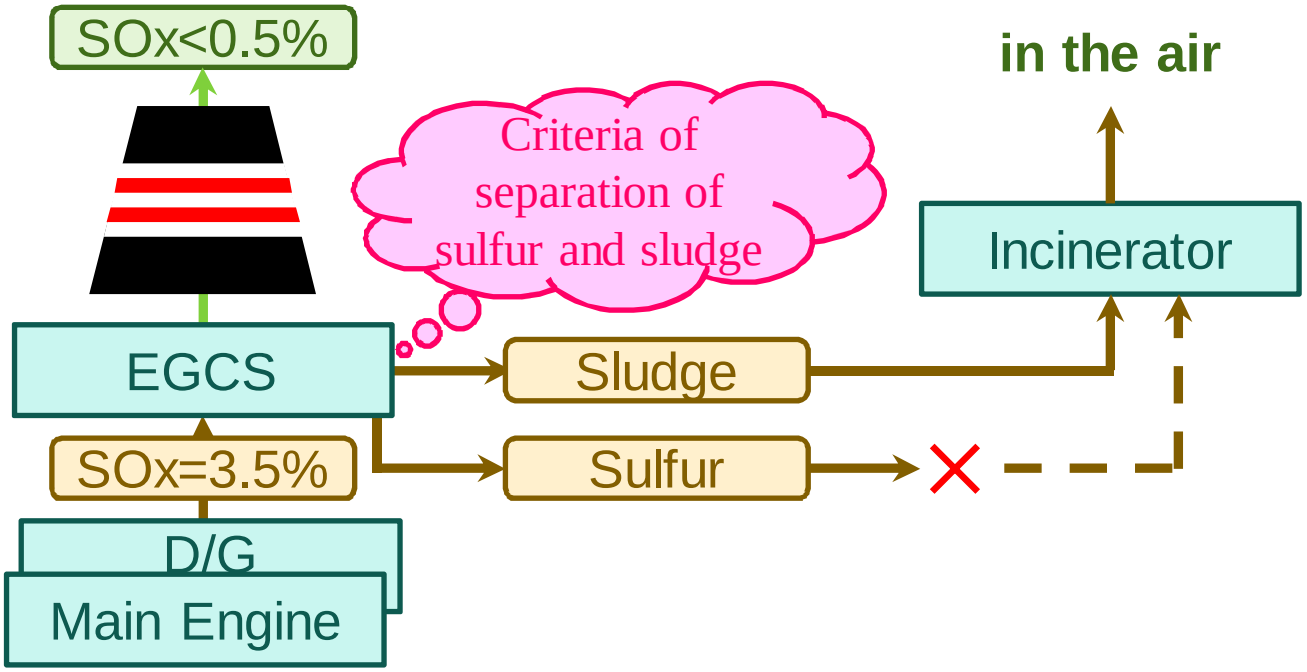
To be burned with Incinerator

To be discharged into the sea

To be unloaded to shore

6-4. Handling of sulfur and sludge

To be burned with Incinerator



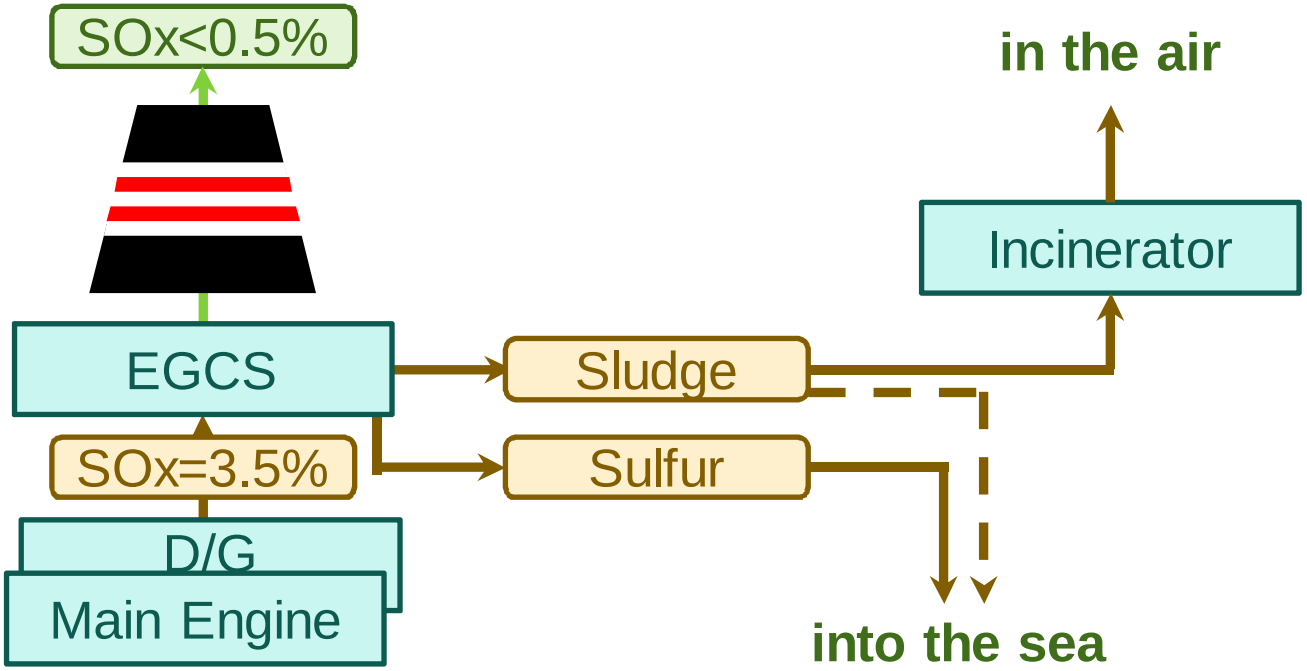
I feel this method is good for sludge, however, something wrong for sulfur because sulfur will go in the air.

For sulfur, this method will be prohibited at the same time when 0.5% SOx Global Cap will be in force.

Criteria of separation of sulfur and sludge should be defined by IMO.

6-4. Handling of sulfur and sludge

To be discharged into the sea



This method is good for sulfur (and some parts of sludge).

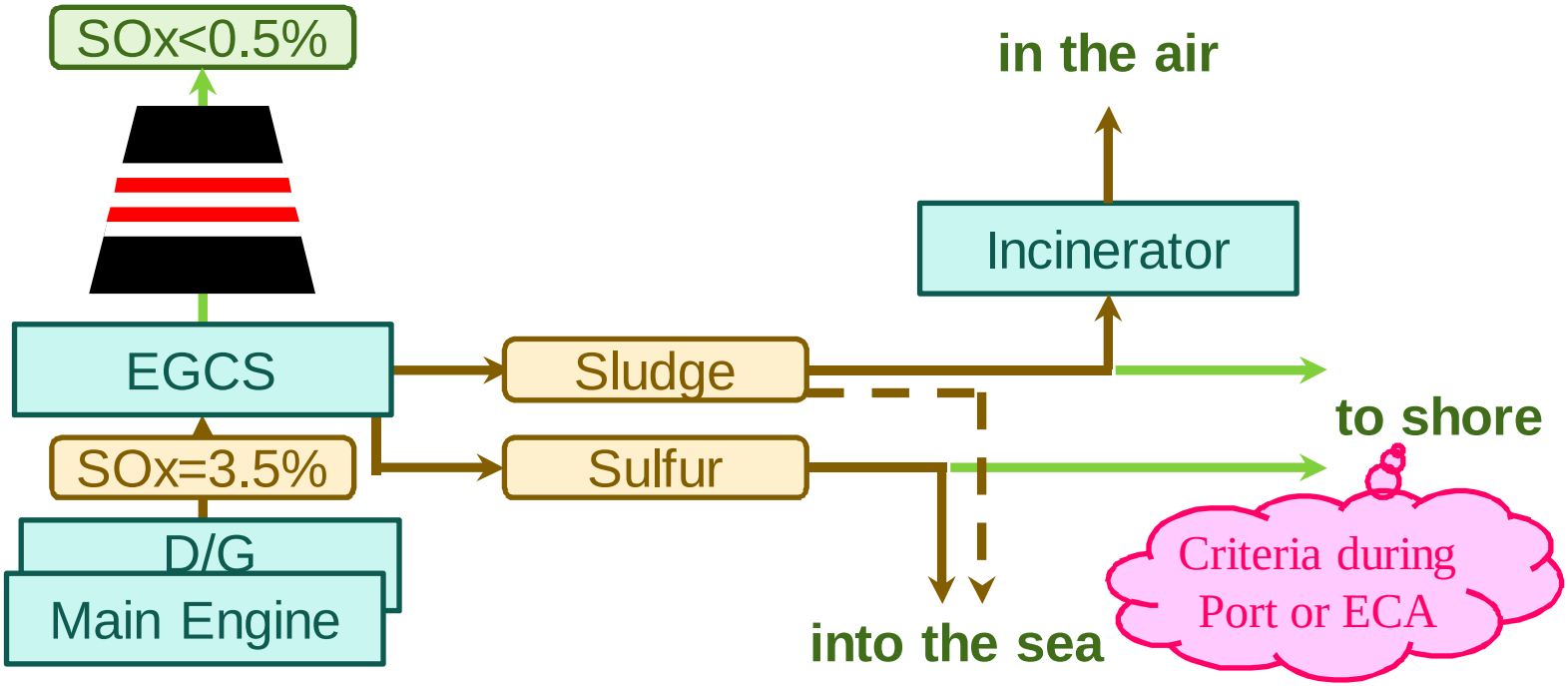
Environment assessment, to check the reasonableness of discharging sulfur into the sea

- Sulfur in sea water = 1,240,000,000,000,000 ton
- Sulfur by EGCS = 50 ton/day x 3% x 200 day/year x 30,000 ships = 9,000,000 ton/year
- Ratio = 0. 000 000 72 %/year

I hope this number is small enough for environmentalist to allow us discharging sulfur into the sea.

6-4. Handling of sulfur and sludge

To be unloaded to shore



If it will be prohibited by IMO's future regulations to discharge sulfur and sludge in the air and/or into the sea during Port and/or ECA, sulfur and sludge will be kept onboard until they will be unloaded to shore.

Procedure of unloading from ship to shore shall be standardized all over the world.

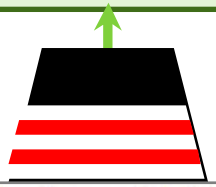
Shore facilities should be prepared by States.

6-4. Handling of sulfur and sludge

how to create the strategy step by step

[1] Product
- ✓ $CaSO_4+2H_2O$: gypsum, raw material for gypsum board/plasterboard
- 146Mton/year/world, 100USD/ton
- ✓ $(NH_4)_2SO_4$: ammonium sulfate, fertilizer
- 22Mton/year/world, 100-300 USD/ton

SOx<0.5%



Comparison between "[5]+[3] unloading to shore" and "[5'] discharging into the sea", making feedback to [4] criteria of discharging water in global cap area.

Net-EGCS

EGCS

Pre-EGCS

Post-EGCS

SOx=3.5%

D/G

Main Engine

[5']Process[5]

Incinerator

in the air

Sludge

Sulfur

Sulfur

to shore

[4] Criteria of discharging water in global cap area

into the sea

[6] acidification of ocean

Product

[1] Valuable

Shore facility

[2] Process

Waste

Valueless

[3] Composition of sulfur compound

- ✓ What composition of sulfur compound from ship to shore is the best for [2] easy shore process to make [1] valuable product. Is it Na_2SO_4 (sodium sulfate) ?
- ✓ Criteria/quality of sulfur compound will be required by shore facility.

6-4. Handling of sulfur and sludge

how to create the strategy step by step

[1] Product

$CaSO_4+2H_2O$: gypsum, raw material for gypsum board/plasterboard

- 146Mton/year/world, 100USD/ton

$(NH_4)_2SO_4$: ammonium sulfate, fertilizer

- 22Mton/year/world, 100-300 USD/ton

[3] Composition of sulfur compound

What composition of sulfur compound from ship to shore is the best for [2] easy shore process to make [1] valuable product. Is it Na_2SO_4 (sodium sulfate) ?

Criteria/quality of sulfur compound will be required by shore facility.

Total cost of [5] cost of Post-EGCS and [3] price of Sulfur compound

Boundary line between roles of ship facility and roles of shore facility.

[5'] Cost of discharging sulfur compound into the sea in accordance with [4] criteria of discharging water in global cap area.

Comparison between "[5]+[3] unloading to shore" and "[5'] discharging into the sea", making feedback to [4] criteria of discharging water in global cap area.

[4] Criteria of discharging water in global cap area will be discussed again in IMO, with considering [6] acidification of ocean related with sulfur amount in ocean.

6-5. Political issues for 0.5% SOx Global Cap

There are several issues which shall be defined by IMO (MEPC/PPR)

Criteria of discharging water

- It will be defined in accordance with three categories, Port, ECA and Global Cap Area.

			Present	2020/2025	2050
Port	Sludge	Oil content	×	×	×
		Soot/Black carbon	△	×	×
		Particulate matter, Metals, so on	△	×	×
	Sulfur	Without treatment	△	×	×
		After treatment	○	○	△
ECA	Sludge	Oil content	×	×	×
		Soot/Black carbon	○	△	△
		Particulate matter, Metals, so on	○	△	△
	Sulfur	Without treatment	○	△	△
		After treatment	○	○	○
Global Cap Area	Sludge	Oil content	×	×	×
		Soot/Black carbon	○	○	△
		Particulate matter, Metals, so on	○	○	△
	Sulfur	Without treatment	○	○	○

Criteria of incinerator exhaust gas

MRV method of discharging water and incinerator exhaust gas

Guideline of PSC (Port State Control) including guideline of MRV

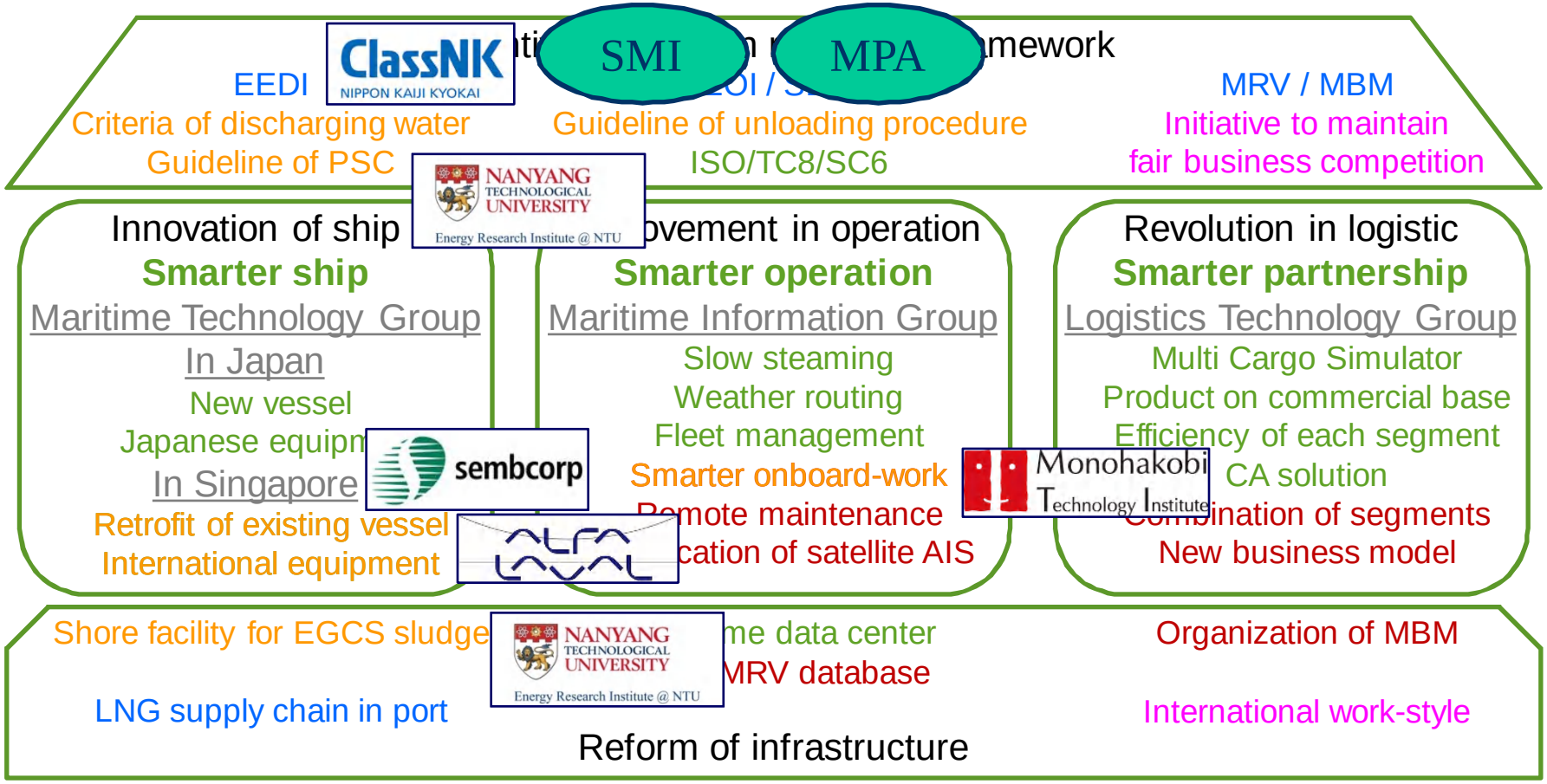
Guideline of unloading procedure of sulfur and sludge from ship to shore

Recommendation for States to build shore facilities as an infrastructure.

6. 0.5% SOx Global Cap EGCS

How to create Project team ?

Project is not only to develop an equipment but also retrofit of existing vessel, smarter onboard-work, shore facility for EGCS sludge, criteria of discharging water, guideline of PSC and guideline of unloading procedure.

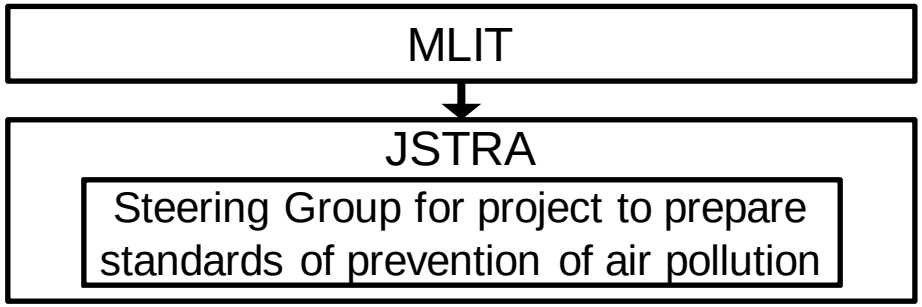


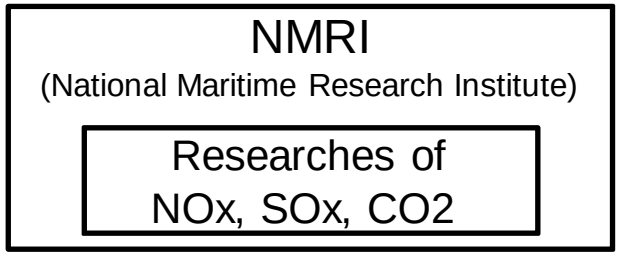
7. International work style

Japanese government organization

Japanese government (MLIT / Ministry of Land, Infrastructure and Transport) has “Steering Group for project to prepare standards of prevention of air pollution” in JSTRA (Japan Ship Technology Research Association).

NMRI (National Maritime Research Institute) is a kind of subsidiary institute of MLIT.





Singapore government organization

MPA provides “MINT Fund” and “Green Technology Program”, and SMI provides some schemes of R&D grant including “Ad-hoc project” and “Green Technology Grant Call”.

NK

NK supports many R&D projects as part of “the ClassNK Joint R&D for Industry Program”.

NK has a plan to establish GRIC (Global Research and Innovation Centre) in Singapore.

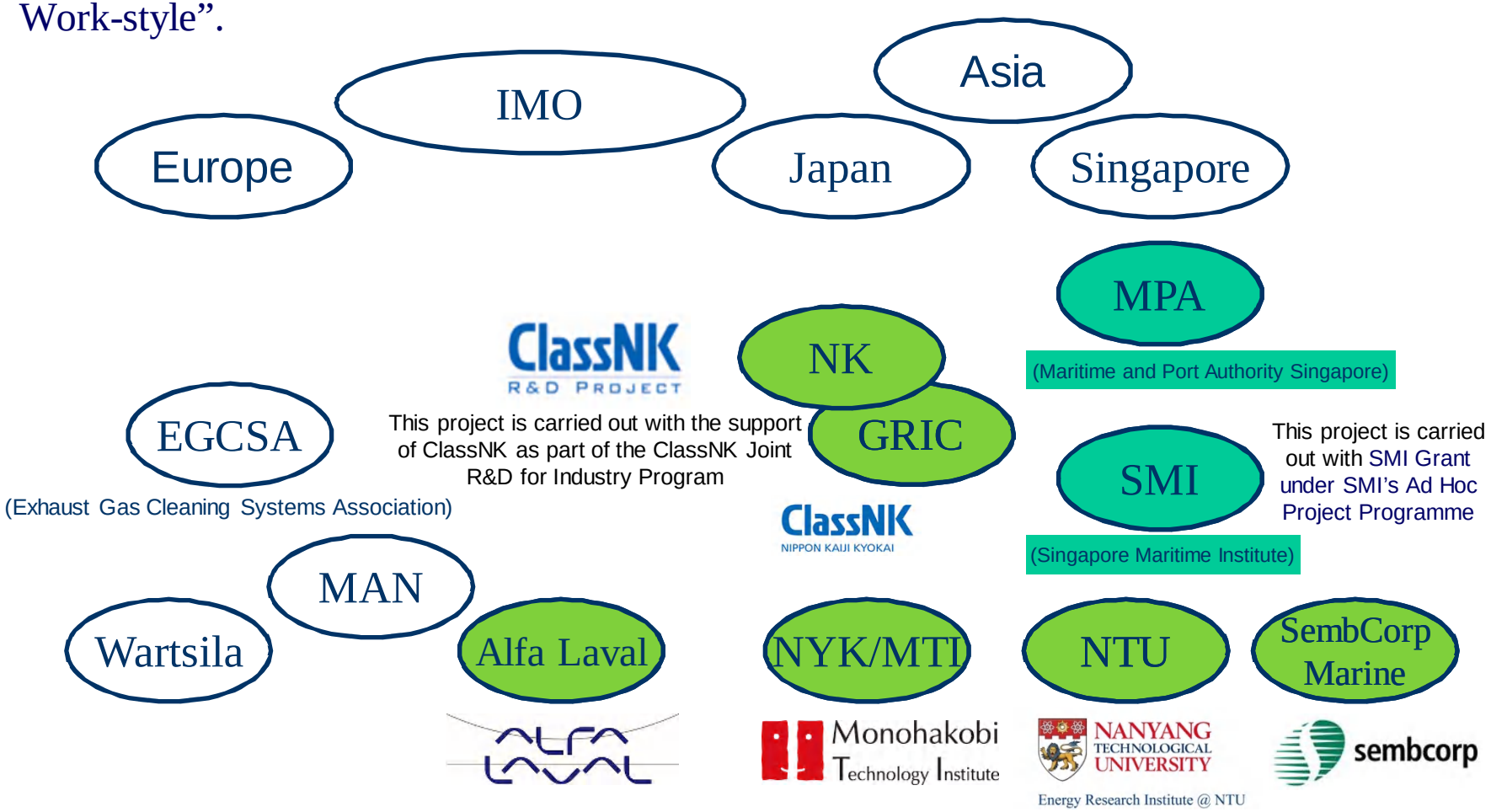
Nanyang Technical University, SembCorp Marine Technology Pte ltd, Alfa Laval Japan, NK and NYK/MTI start JV R&D project, with SMI Grant under SMI’s Ad Hoc Project Programme and with NK Fund as part of the ClassNK Joint R&D for Industry Program.

7. International work style

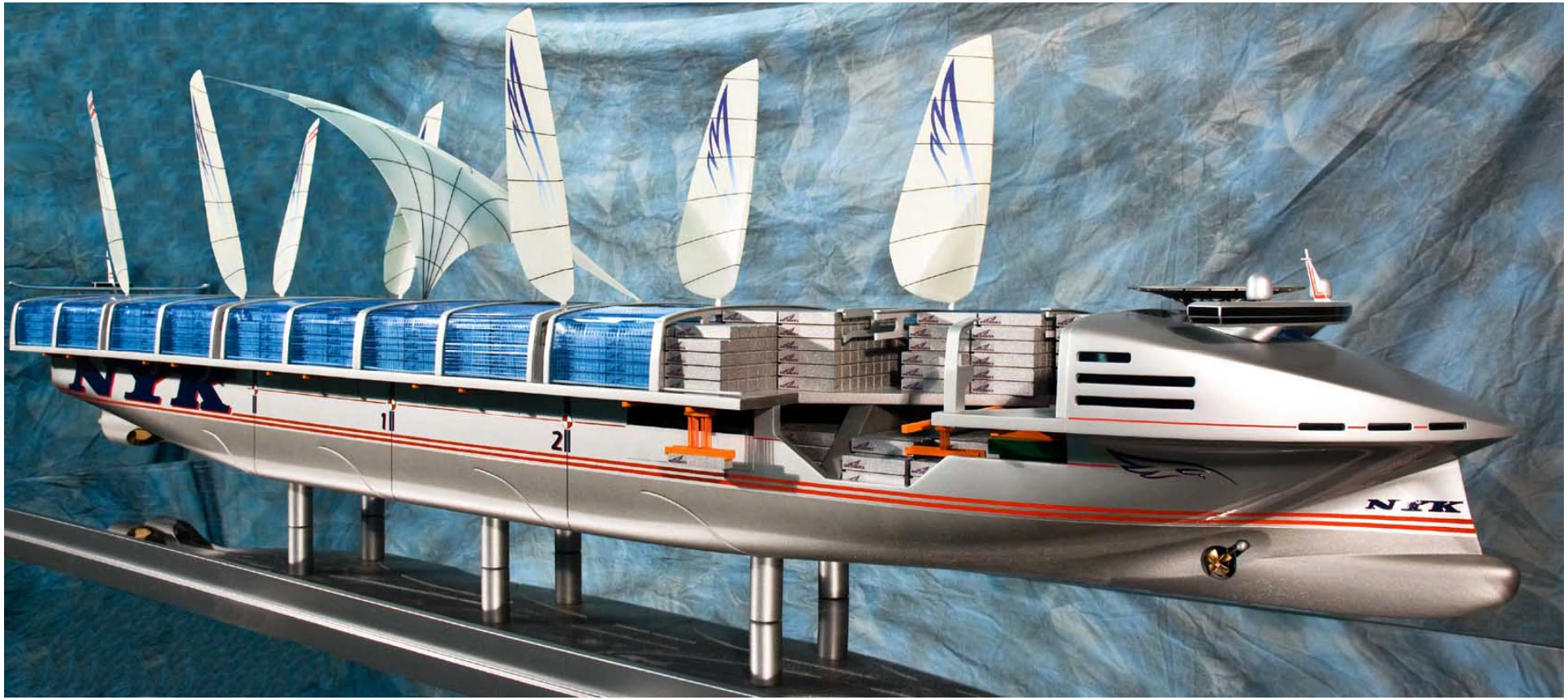
0.5% SOx Global Cap EGCS is a nice experience to create “International Work-style”.

“International Work-style” become more popular in our maritime R&D.

NK GRIC (Global Research and Innovation Centre) become the core of “International Work-style”.



For the Future



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Thank you

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