MASS Development and Demonstration in Japan – DFFAS+ Project in MEGURI2040

MTI Capt. S. Togashi

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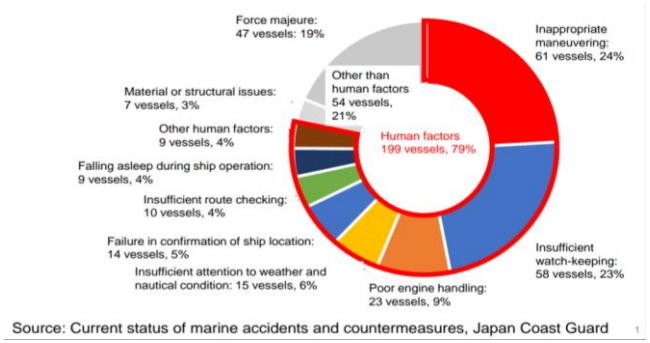
Why do we need Autonomous Vessel

Safe Operation、Shortage of seafarer、Logistics stability



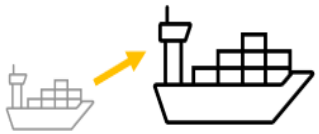
Navigation Accident is **Human error** <u>**about 80%**</u>

Safe Operation

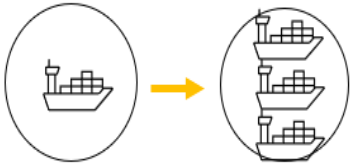
Value of Autonomous Vessel

Shortage of Crew

Logistics stability



Bigger Vessel



More congestion

Reduce Maneuverability
→**Early action** is important

- **Global seafarer shortage 8.8%**, highest ever
- **Eliminate the shortage of seafarers** in Japan
  (by 2040 there will be a 30% shortage of seafarers compared to today)

- **Future increase in maritime transport**
(from Trucks to Shipping and Train)

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Project Outline

DFFAS+ Designing the Future of Fully Autonomous Ships

- **Challenge**
  Solving labour shortages in the domestic shipping industry, which supports Japan's logistics, through social implementation of unmanned vessels (= maintaining the health of domestic logistics).
- **Goal**
  Develop technologies that will lead to the future through Open Innovation, with a view to long-term industrial growth, and draw up a GRAND DESIGN for autonomous vessels in Japan and around the world.

All Japan structure with all consortia participating in MEGURI2040 Stage 1 integrated into the DFFAS consortium (Phase 1: 30 companies → Phase 2: 53 companies).

DFFAS Designing the Future of Full Autonomous Ship

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Result of MEGURI2040 Stage 1

Demonstration voyages in Feb & Mar 2022

FOC
Makuhari

Port of Tokyo
Incl. Uraga Straight traffic route

Port of Tsu-Matsusaka
Incl. Irago Straight traffic route in Ise bay

Round trip
424 NM
(790km)

26-27 Feb 2022

28 Feb – 1 Mar 2022

Demonstration of simulated actual fully autonomous operations on existing congested routes

Containership ”Suzaku”, 749GT with fully autonomous functions

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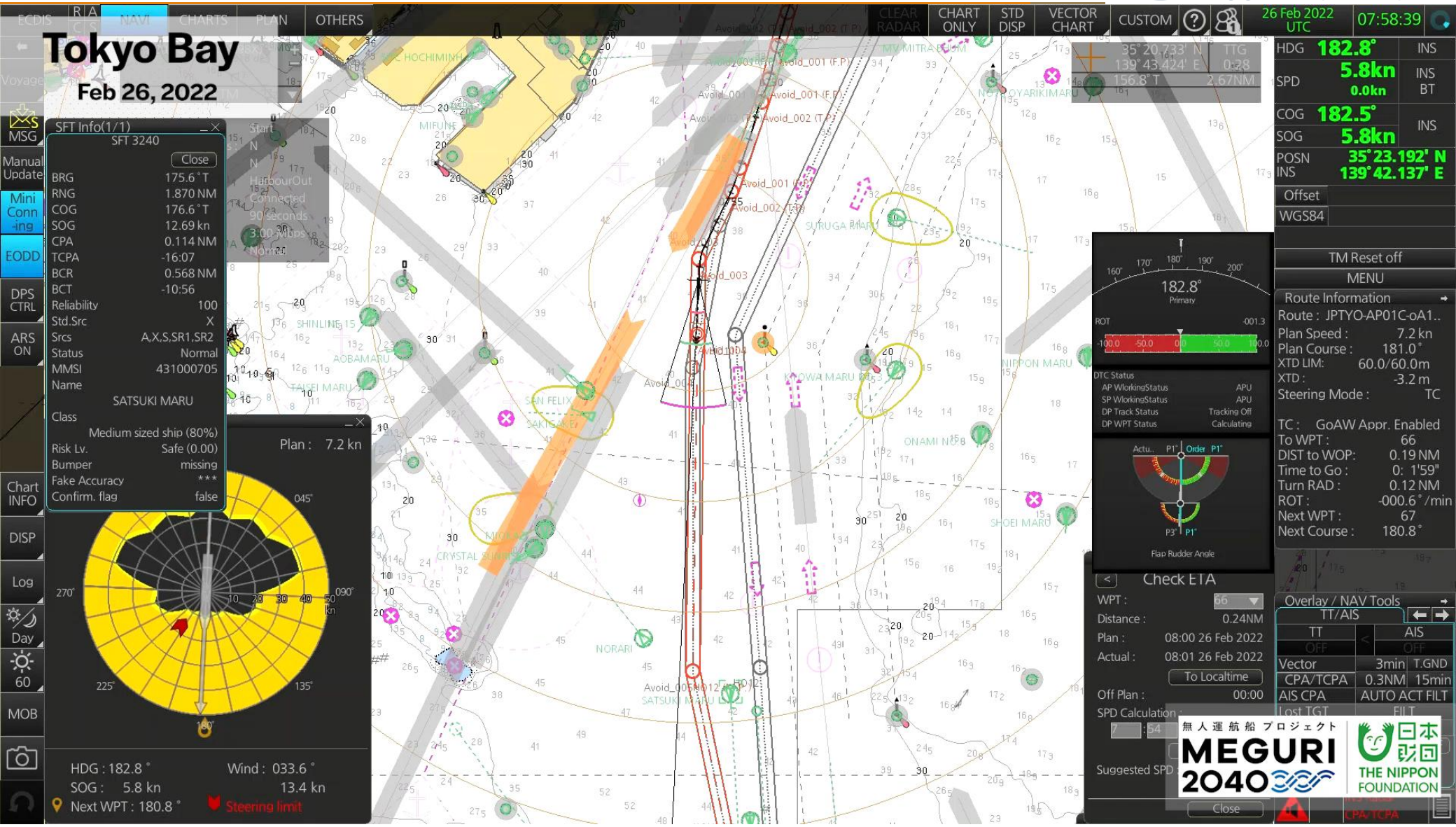
Result of MEGURI2040 Stage 1



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Result of DFFAS Project

➢ Outward

2022/02/26 ～ 27
KEIHIN Port (Inside Tokyo Bay) → TSU Port (Inside Ise Bay)

Voy.Dist: 207.5NM (384.3KM)
Voy.hours: 20h10m
System Operation time: 19h39m
Ave.Speed: 10.3kt
Number of avoid: 107times

Operation Rate

97.4%

➢ Return trip

2022/2/28 ～ 3/1
Tsu Port (Inside Ise Bay) → KEIHIN Port (Inside Tokyo Bay)

Voy.Dist : 216.4NM (400.8KM)
Voy.hours : 19h38m
System Operation time : 19h34m
Ave.Speed: 11.0kt
Number of avoid : 34 times

Operation Rate

99.7%

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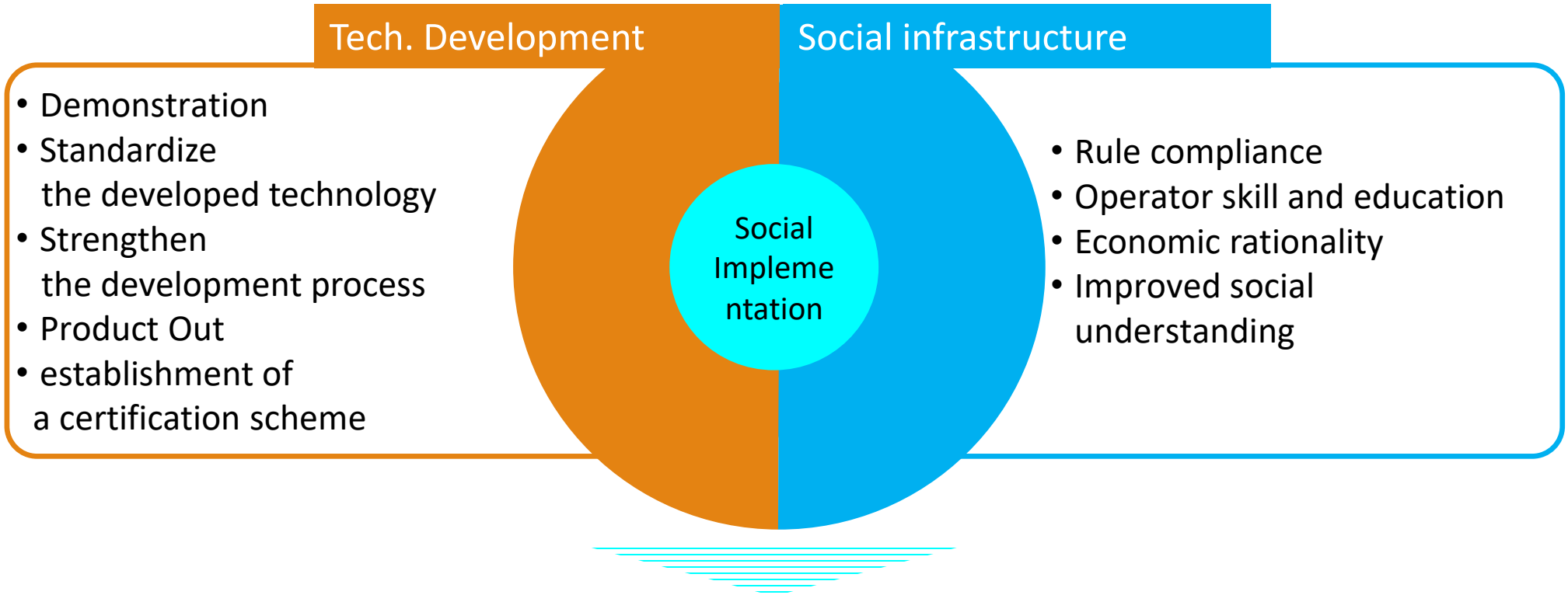
MEGURI2040 Stage2 Project Target



- Aim for ‘practical use (actual operation) = autonomous commercial operation (cargo/passenger loading & crew-only operation)’ through social implementation demonstration tests.
- Development with a view to ‘practical application’ through continued use of the system after the project is completed.

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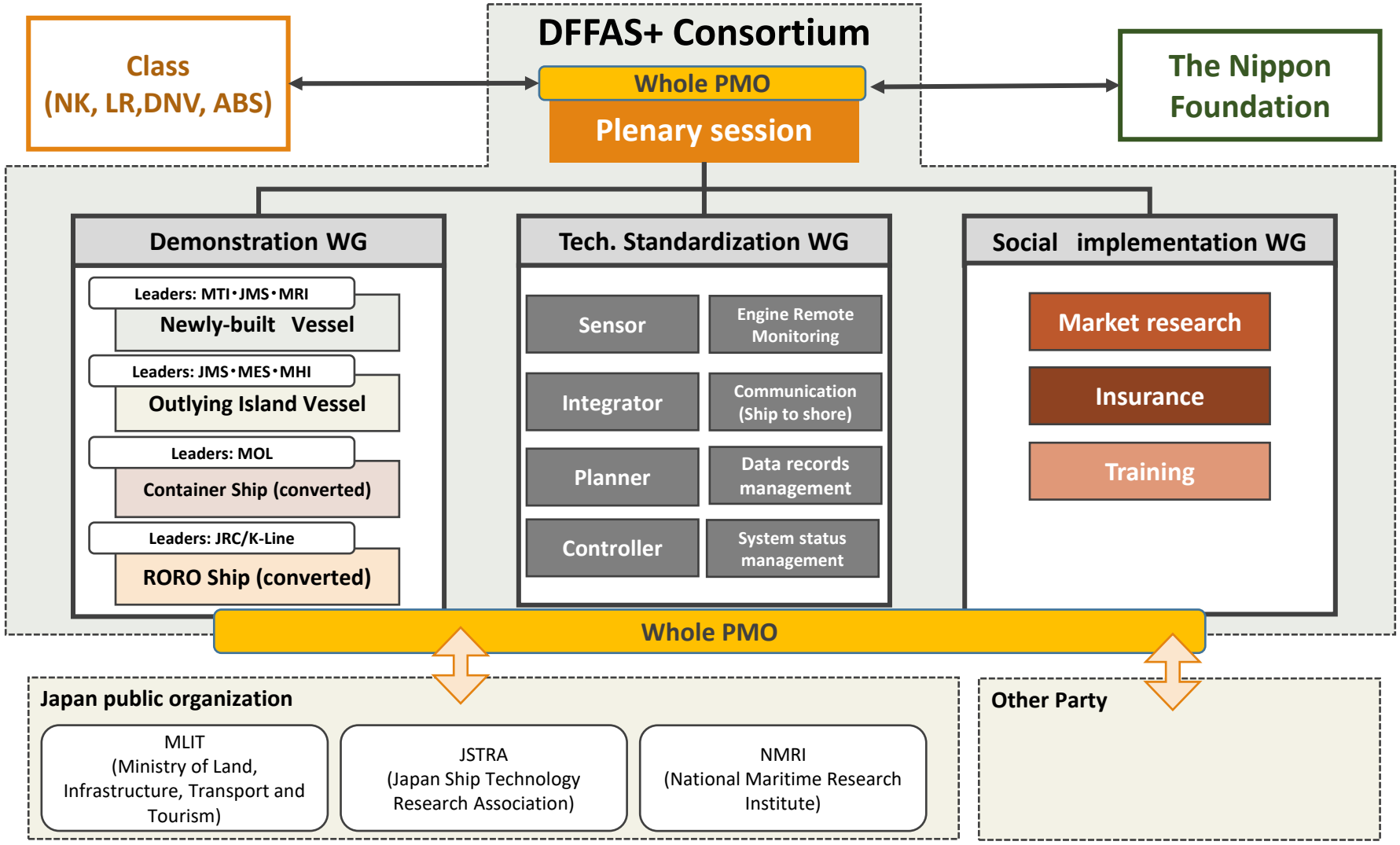
Organization of DFFAS+ Consortium



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DFFAS+ System ～Status～

- Full Autonomous
  Fully autonomous state, moving unmanned (= no human involvement in the Navigation task).
- Monitoring Mind ON
  Autonomous navigation, but with occasional awareness of system operating status (Stand by at conning position)
- Monitoring with APPR
  State in which autonomous functions are performed with occasional human monitoring of the system and approval actions. Track Control
- Track Control / Manual
  Conduct the same manoeuvres as existing vessels

Status	Status Name	LR Lv,	HANDS	EYES	MINDS
Full Autonomous	Full Autonomous	AL4	OFF	OFF	OFF
Monitoring	Monitoring Mind ON	AL4	OFF	OFF	ON
	Monitoring w/approval	AL3	OFF	ON	ON
Fallback	Track Control (Speed Control含む)	AL2	OFF/ON	ON	ON
	Manual	AL1, 0	ON	ON	ON

As an emergency measure, the vessel must immediately have the same functionality as the existing vessel and be able to be safely manoeuvred by the master.

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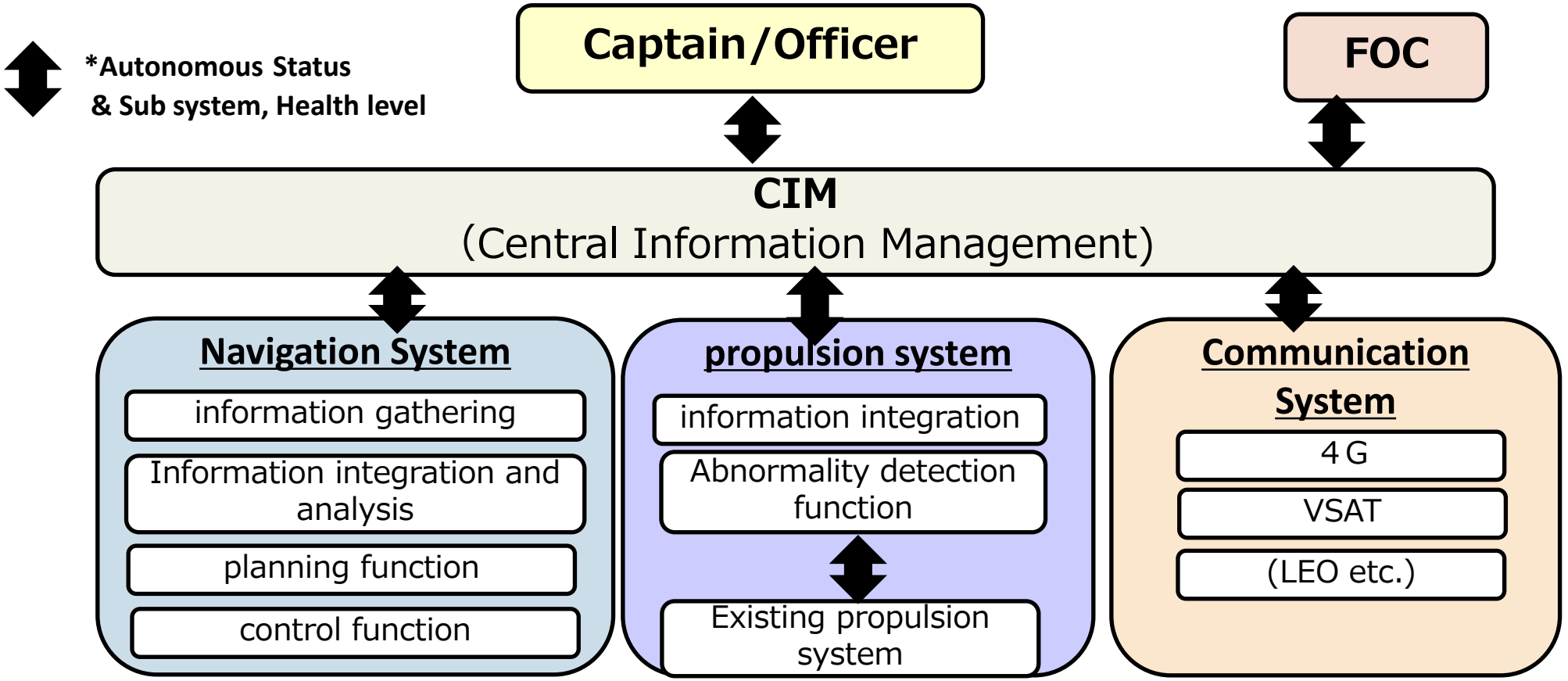
How to monitoring Autonomous Status

This is a system in which the ship's captain is placed in the highest level of responsibility and the status of each subsystem is managed by the Central Information Management (CIM), which determines the autonomous navigation level and navigates the ship.



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MEGURI2040 & DFFAS+ PJ Outline

<Key Point>

- **Unmanned on the bridge/manned on board**
  The system aims to be 'a system that can navigate safely even when the bridge is unmanned', but with the concept of 'a human presence on board', as it is assumed that the ship will return to normal operation in an emergency (*Since the system is a certified device, it is positioned the same as existing AP and INS systems).

- **Future goals (first steps towards social implementation)**
  - **Reduction of Navigation duty personnel :**
    On vessels of 749 GT and above (coastal),
    '2 Personnels x 3 = 6 Personnels' ➡ '1 Personnels x 3 = 3'
  - **Reduction of Engine Crew:**
    On vessels of 749 GT and above (coastal), 'chief engineer + engineer structure' ➡ 'chief engineer is FOC, engineer on board'.
  - **B0(Bridge 0) Operation**:
    Unmanned ship bridges for coastwise navigation in demonstration trials.

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MEGURI2040 & DFFAS+ PJ Outline

- **Aimed system level:**
  ‘Level of automation where fully automated driving is partially possible (Automotive Automation Level 4)’

  (Reference)
  The biggest difference is **the time horizon**
  Vehicles: Level 4 achieved by system alone
  Vessels: Level 4 achieved by system + operation

- **Operating levels of automation according to operational design domain (ODD)**
  Autonomous levels (statuses) are **switched between leaving and arriving at port and navigating based on the sea area and environmental conditions.**

  *‘Level 4 ⇔ Level 3 ⇔ Level 2 ⇔ Level 1’.
  Human guards and manoeuvres as required.

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Our Development Items

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・Status management
・Data records

ROC

Remote Operation
Ex)・Remote Monitoring vessel's plant
・Make Voyage plan

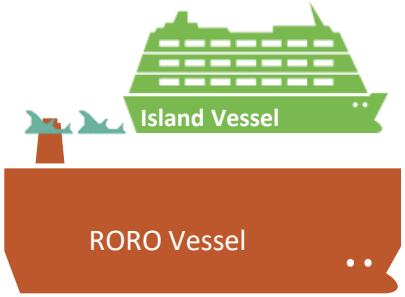
Communication with Cyber Security

Navigation

New Sensor | Integrator | Planner | Controller

Machinery

Abnormalities detection



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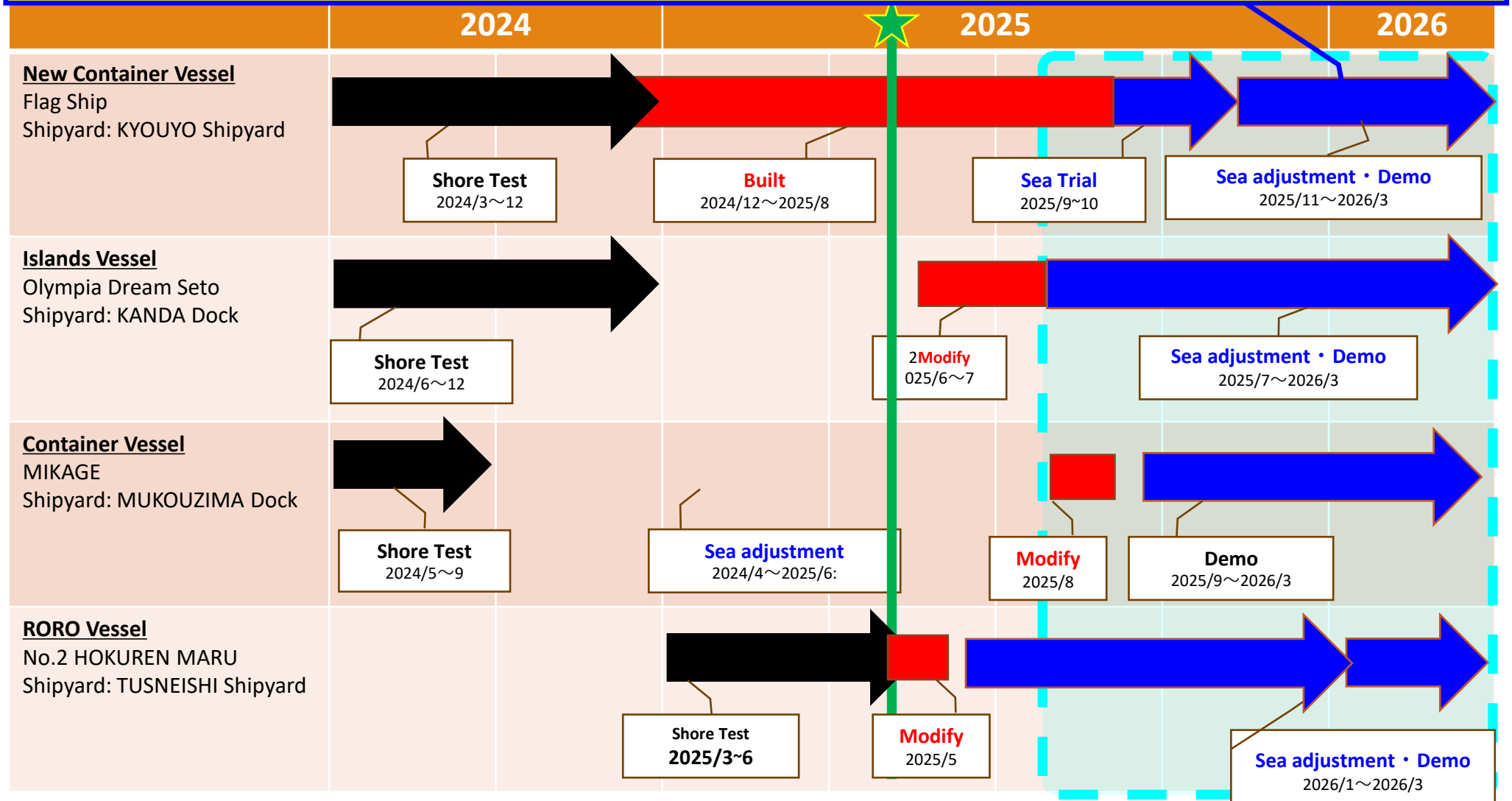
DFFAS+ Schedule

‘We will build on various demonstrations and eventually take a practical (i.e. in-service B0 navigation) step forward’.



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Outline

Demonstration

Four vessels will be used as demonstration vessels, and two onshore support centers (+α) will be used to support the demonstration vessels from the shore.
The demonstration period is scheduled to last up to nine months, starting in July 2025.

Period	Type & Ship name	Feature	Demo. ship
2025/Nov.~ (5 months)	New Container Vessel GENBU (5,689GT / Coasting Area)	• Autonomous ships certified by JG & NK • Remote monitoring capabilities for the engine room • Commercial autonomous operation on container ships • Newly built vessel designed with the concept of autonomous operation • Automation of mooring operations	
2025/Jul.~ (9 months)	Island Vessel OLYMPIA DREAM SETO (942GT / Inland sea Area)	• Autonomous ships certified by JG & NK • Commercial autonomous operation on passenger ships • Contribution to maintaining routes to remote islands	
2025/Sep.~ (7 months)	Container Vessel MIKAGE (749GT / Coasting Area)	• Autonomous ships certified by JG & NK • Development of technology advanced from Stage 1	
2026/Jan.~ (3 months)	RO-RO Vessel No.2 HOKUREN MARU (11,413GT / Coasting Area)	• Commercial autonomous operation on RORO ships • Autonomous ships certified by JG & NK • Contribution to modal shift	

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