Introduction of research activities on MASS at Tokyo University of Marine Science and Technology

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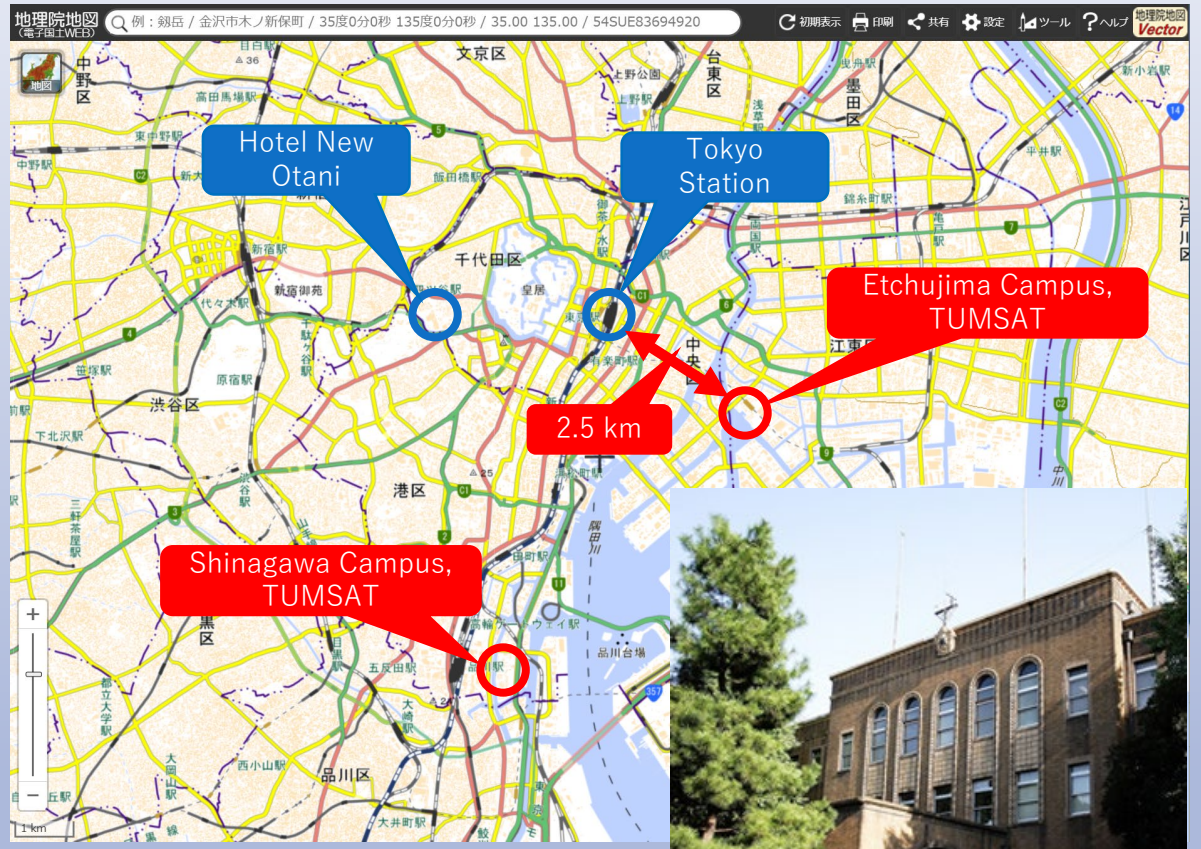
Tokyo University of Marine Science and Technology

- **Tokyo University of Marine Science and Technology (TUMSAT), Tokyo, JAPAN** was established in 2003 by merging **Tokyo University of Mercantile Marine since 1875** and **Tokyo University of Fisheries since 1888**.
- School of Marine Technology, the former Tokyo University of Mercantile Marine, has always been the leading academic institution in Japan in providing higher education for students wishing to become marine/maritime engineering.



Research activities on MASS at TUMSAT

- Research Facilities

Maritime Autonomous Surface Ships / Ship Systems

- Maritime Autonomous Surface Ships (Maritime Autonomous Ship, Systems, MASS) consists of a combination of the following systems.
  - ***Autonomous Ship*** cruises autonomously without human intervention.
  - ***Remote Operation Centre*** monitors and provides navigational command to autonomous ships.
  - ***Support Services*** monitor environmental conditions and provide assistance during the ship's arrival and departure.
  - ***Communication System*** transmits and receives information between ships and land facilities.

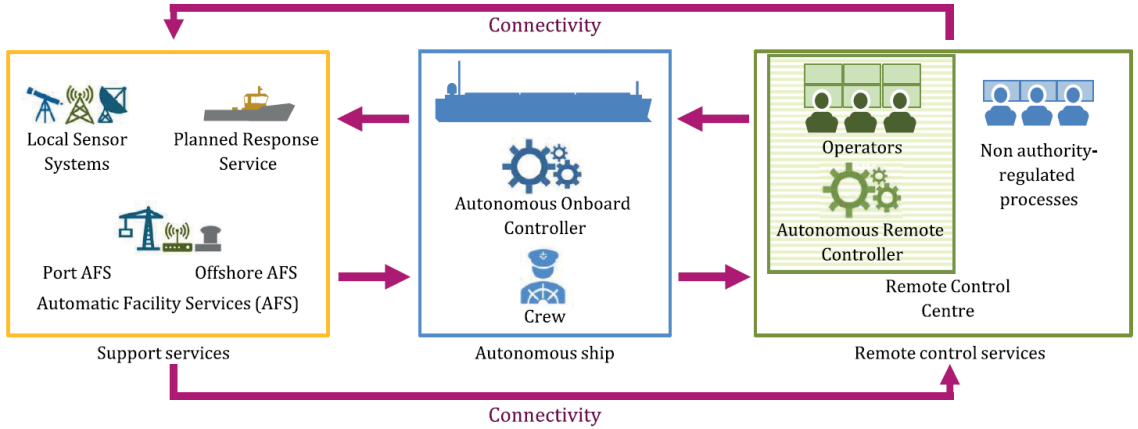


Figure A.1 — Autonomous ship system

Here, the autonomous ship system is illustrated as four main groups of components that for the purpose of this annex are grouped into the following clusters:

a) the autonomous ship itself (middle);

b) the remote-control services(s) where some of the ship system's control functions may reside (right);

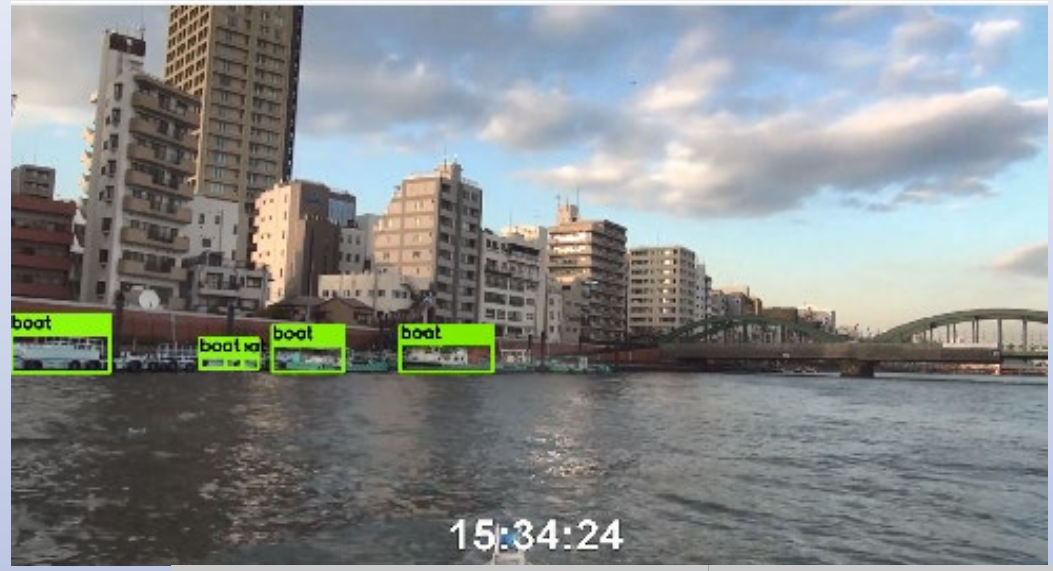
c) support services located in the ship's operational area (left); and

d) the connectivity (arrows) which provides communication between the components.

Ref.) ISO/TS 23860 First edition 2022-05

Technical Challenges for MASS

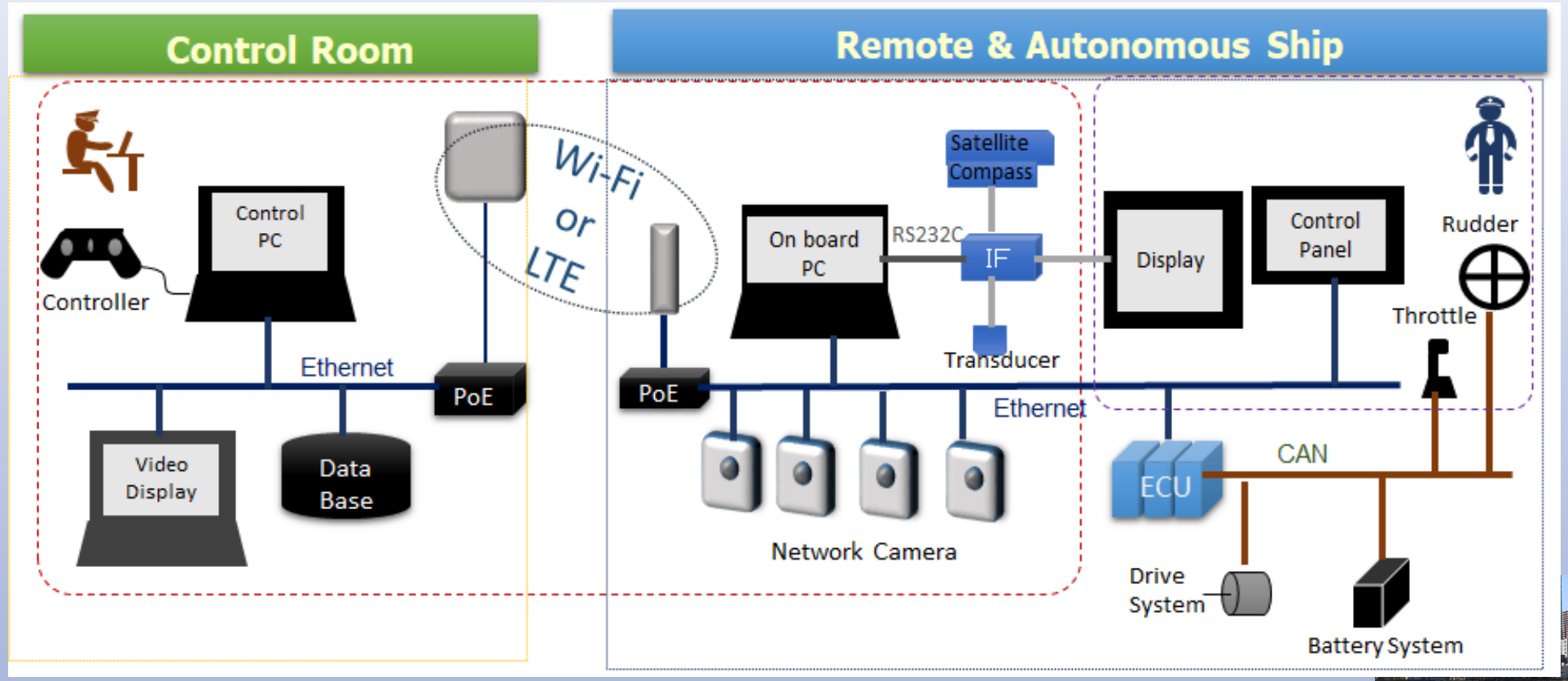
- ***Issues to be considered vary greatly depending on the target vessel and the sea area.***
  - Autonomous Ships
    - Object and Event Detection and Response (OEDR) Technology, Collision Avoidance Manoeuvre, …
  - Remote Operation Centre
    - Selection of Information, Competence of remote operator, …
  - Communication Systems
    - Area, Speed, Capacity, …
  - Support Services
    - Digital Map, Port Facilities, …



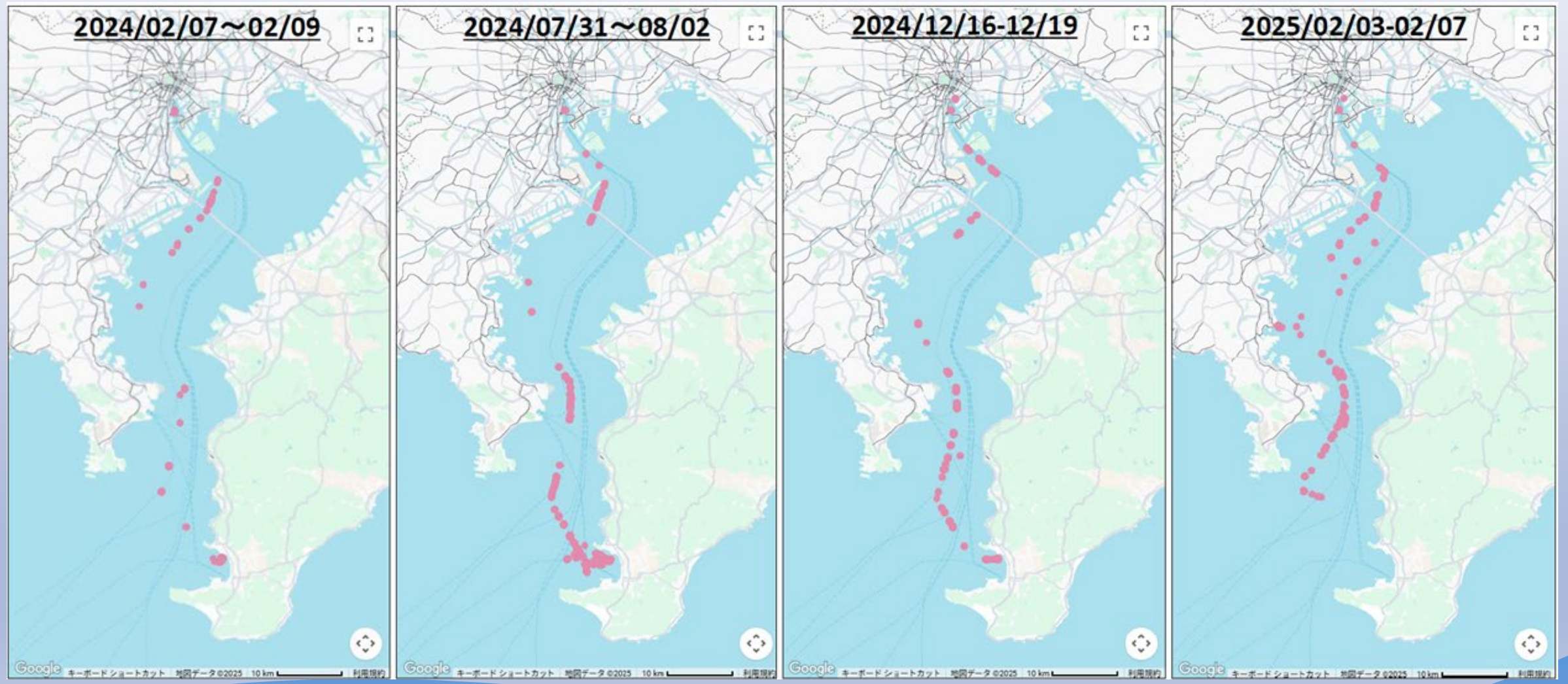
Ex) OEDR

Perception	Judgement			Control
	Object	*Event*	*Response*	
Situational Awareness (SA) sensors Alternative means and data processing	Ignorable objects	Cleared	Keep course and speed	*Lateral vessel motion control (Rudder control)*
	Other vessels	Collision avoidance	Passing side and distance	
	Static objects	Contact avoidance	Approach angle	
Position, Navigation and Timing (PNT) sensors *GNSS* *Sonar*	Instruction objects	Route adjustment		
	Underwater objects	Stranding avoidance	Speed adjustment	*Longitudinal vessel motion control (Output power control)*
	Disturbance	Stabilizing		
	Rescue needed objects	Search and rescue		
Planning	Landmark	Waypoint	Steering	
Passage plan *Electric chart*	Self-position			

Ex) Remote Control System of Our Experimental Boat

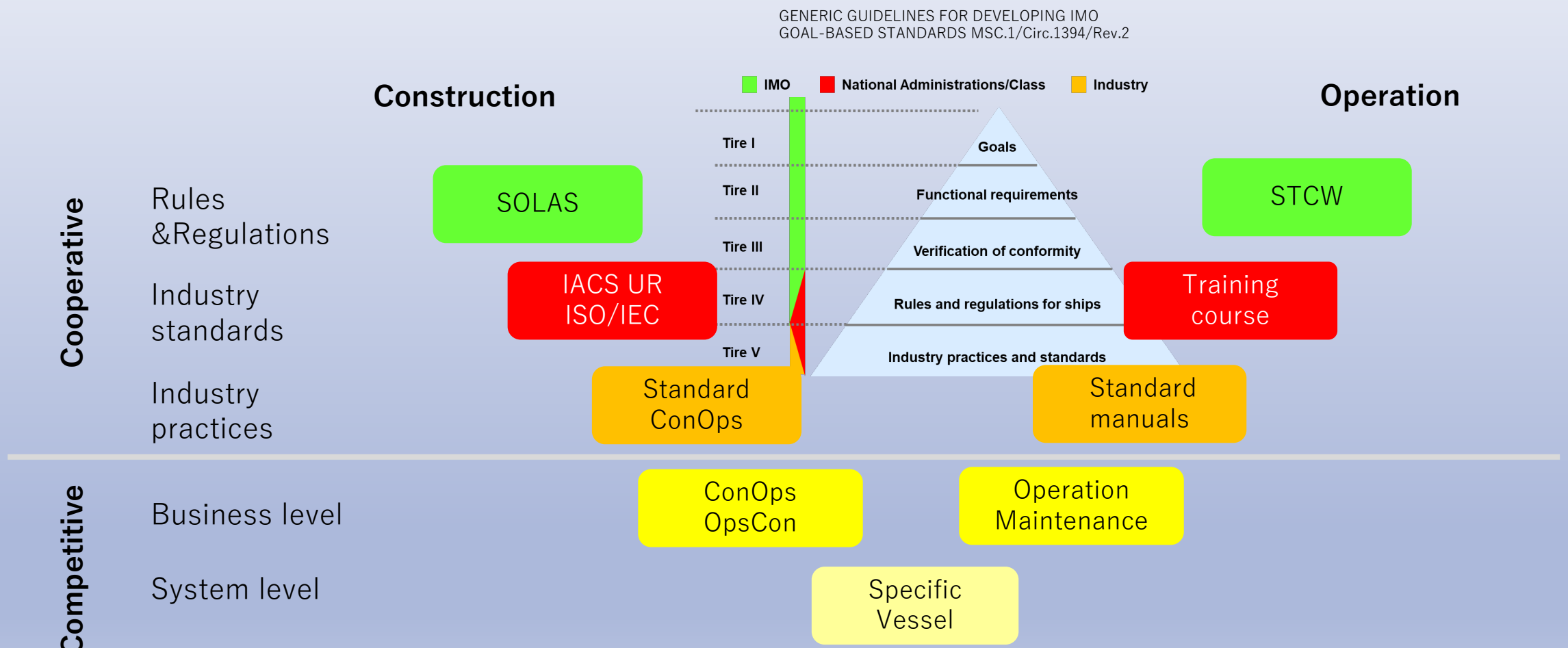


Ex) Communication Characteristics in Tokyo Bay



Red mark means “DISCONNECT”

Ex) Human-Technology Interaction based Development



Conclusions

- Research activities on MASS at Tokyo University of Marine Science and Technology are introduced.
- The autonomous unberthing manoeuvre and the autonomous collision avoidance manoeuvre are demonstrated.
- The technical challenges of achieving MASS and the experimental results of the communication characteristics in Tokyo Bay are also explained.
- At the current state of the art, it is not possible to replace all human tasks with the system.
- On the other hand, technology for MASS is useful for reducing the workload of seafarers and preventing accidents.
- The competence and experience of the MASS masters / the remote operators of MASS are essentials for safe operation of MASS.

Thank you for your kind attention.

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