

Industrial Trends of Electric Propulsion Ships and Autonomous Ships

2021.09.08

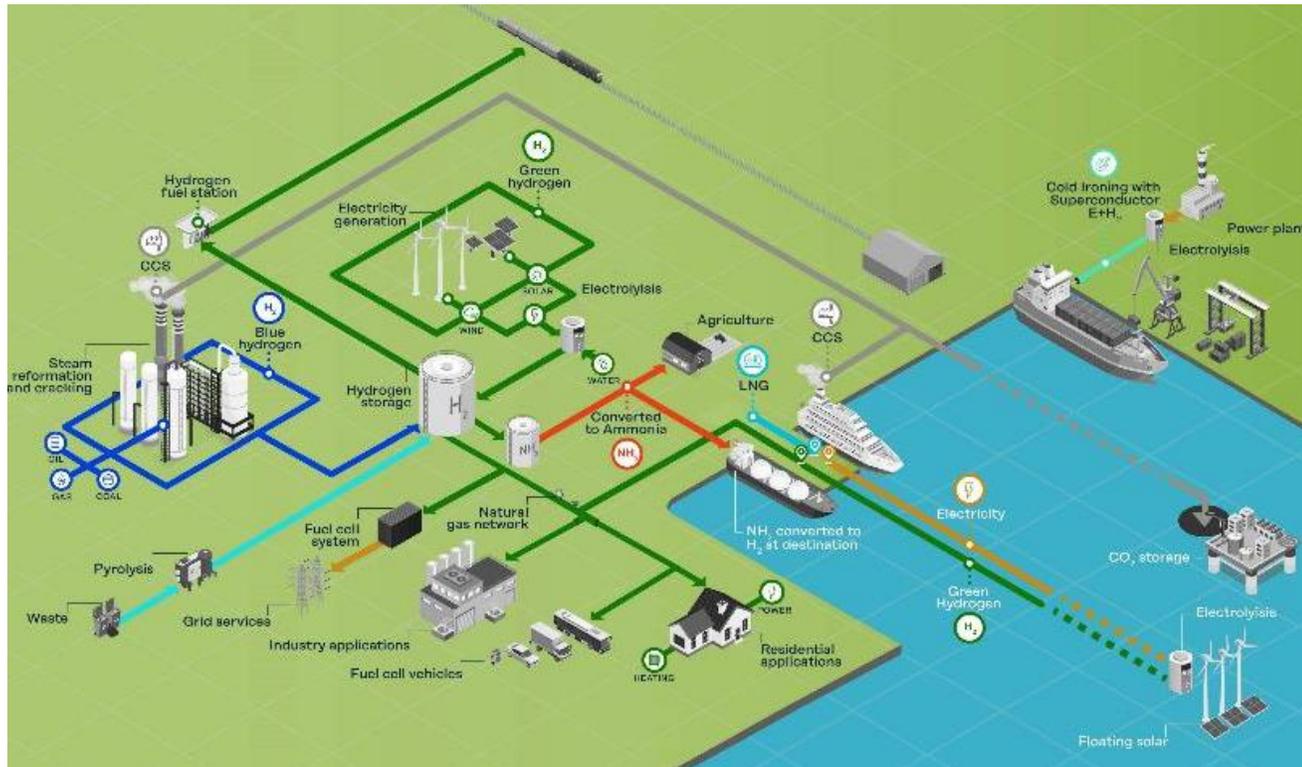
HYUNDAI GLOBAL SERVICE

KYOUNGSOO AHN

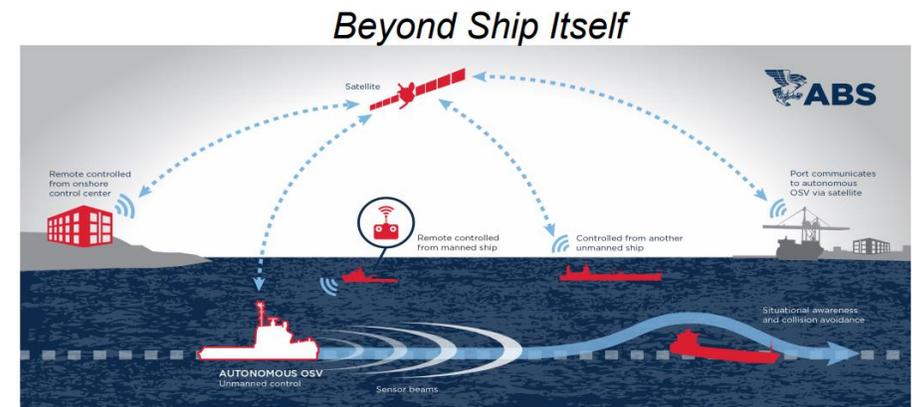
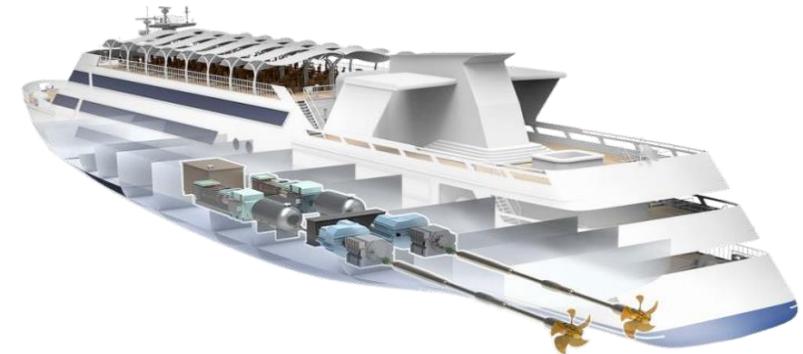


Next-Generation Ship Trends

- ✓ The trend of next-generation ship can be summarized as decarbonized and autonomous vehicles.
- ✓ Electrification will be the key of decarbonization of shipping industry.
- ✓ Autonomous will be the key of safety and efficiency of ship and fleet.



Source: Hydrogen Europe



Source: ABS

“ Essential elements for IMO environmental regulatory response ”



International Maritime Organization (IMO)

- ✓ Reduction the total annual GHG emissions by at least 50% by 2050 compared to 2008



IMO MEPC 76th

- ✓ Shipping GHG emission reduction measures adopted
 - Energy Efficiency Existing Ship Index (EEXI) calculated
 - Annual operational CII (Carbon Intensity Indicator) established



Biden Administration

- ✓ Paris Agreement rejoined
- ✓ Green New Deal to be enforced (\$ 2 Trillion Climate Plan)

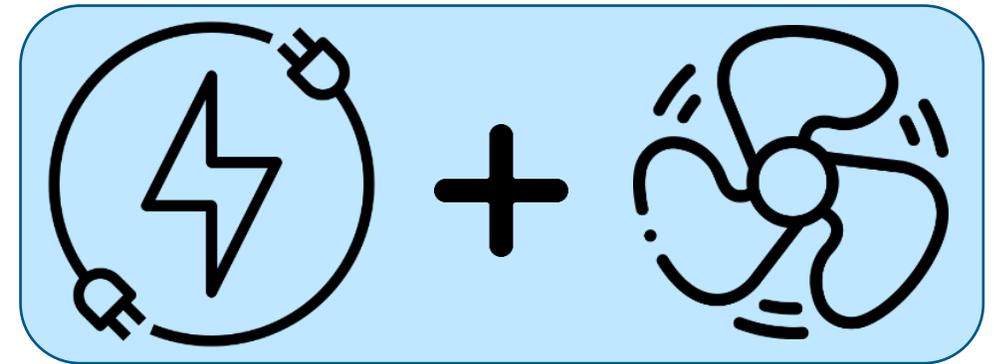


Korean Administration

- ✓ Green Ship-K Initiative (\$870 million investment to 2031)
- ✓ carbon net zero by 2050 to be achieved

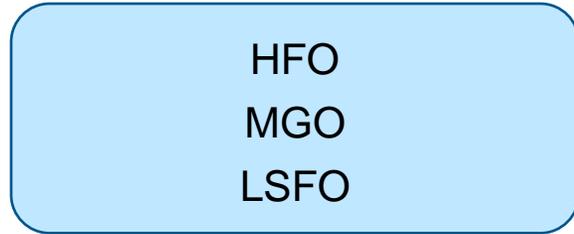


Advantages of Electric Propulsion

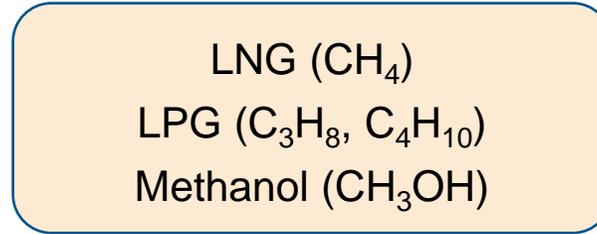


- ✓ Renewable / Carbon-free Energy Usage Option
- ✓ Flexible/Compact Arrangement of Propulsion Equipment
- ✓ Better Comfort due to Reduced Vibration and Noise
- ✓ Reduced Life Cycle Cost by Less Maintenance Cost
- ✓ Better Dynamic Response from zero to Max. Propelling Speed
- ✓ Improved Maneuverability

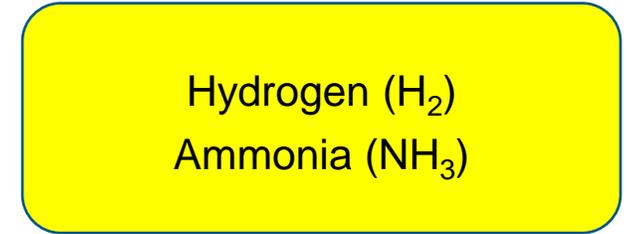
✓ Decarbonization



Internal combustion engine

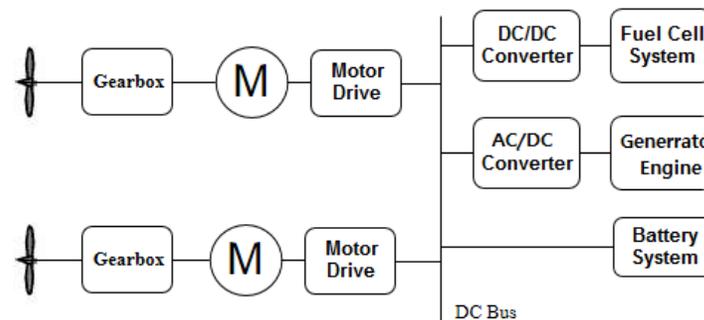
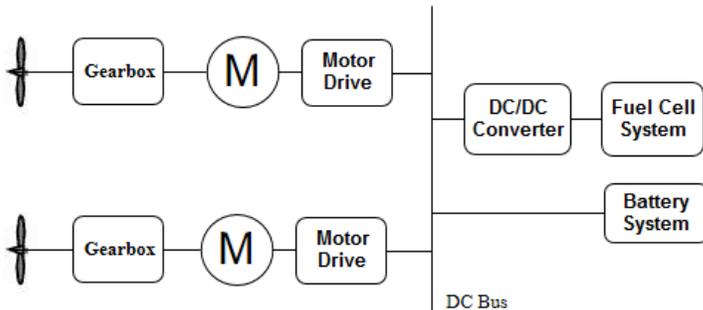
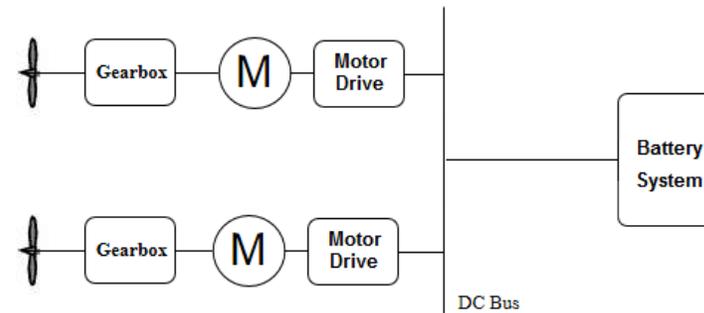
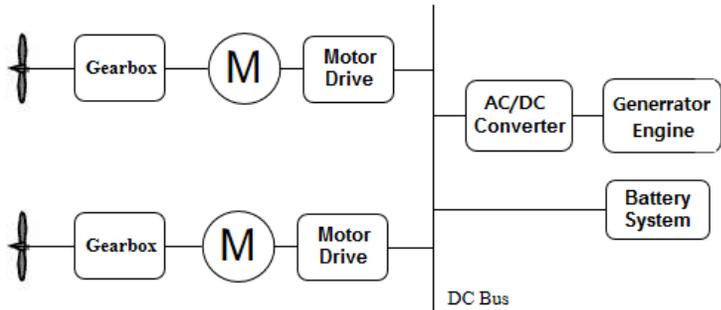


Internal combustion engine



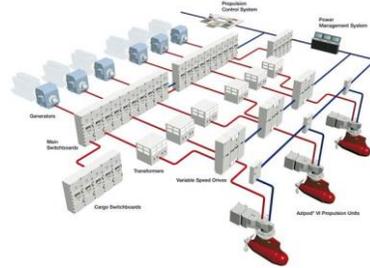
- Internal combustion engine
- Fuel cell engine

✓ Flexible Energy Sources and their Combinations



✓ ABB

- ✓ The world's most efficient electric propulsion system
- ✓ Azipod® propulsion systems of Ice-class LNG
 - Power capacity: 60MW, Propulsion: 15MW Azipod x 3EA



✓ Siemens

- ✓ The world's proof electric propulsion system for the safe, efficient, and reliable operation based on SINAMICS drive system.
- ✓ SISHIP BlueDrive PlusC is representative high efficiency EP system



Image courtesy of Siemens Marine and AIDA Cruises



✓ China

- ✓ Invest into Propulsion Drive Technology
- ✓ Silent Electric System (SES) Technology Co., Ltd. in China Shipbuilding Industry Corporation (CSIC)
 - 2019, Pilot Project (2,200 dwt Research Vessel)
- ✓ Xiong Cheng Tianwei 1
 - 2020, medium voltage DC integrated electric propulsion

The Technical Progress and Pilot Projects on Electrical/Hybrid Powered Vessels



Yunxiang Wu
Wuxi Silent Electric System Technology Co. Ltd.
China



<IEEE –TEC Conference>



<Xiong Cheng Tianwei 1>

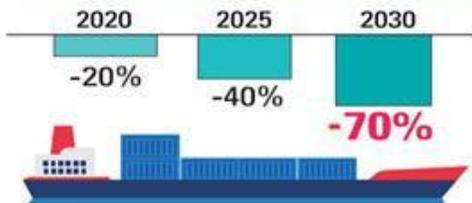
✓ 2030 Green Ship-K Initiative

➤ “2030 GreenShip-K Promotion Strategy” to Dominate the Global Green Ship Market

- Carbon-free technology with hydrogen, ammonia, etc.
- Low-carbon technology with fuel mixture, energy-saving device, etc.
- Localization of the core technology about LNG, electrification, and hybridization.

GreenShip-K Ecosystem for Net Zero 2050

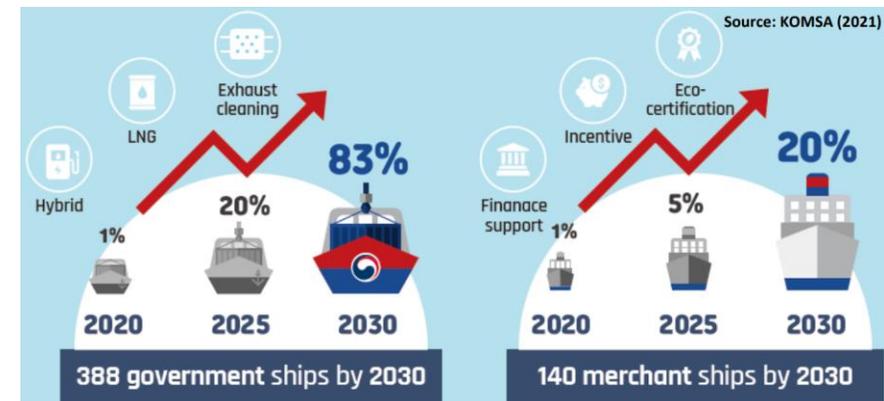
GreenShip-K Goals



Development of technology to reduce GHG by 70 percent (40% by 2025 → 70% by 2030)



Achieve 15% rate of conversion to greenships (convert 528 ships out of 3,542 greenships)



☑ Port Guide Ship of Busan Port Authority

- First MW Class Full-Electric Power and Propulsion Ship based on Battery in Korea (Ordered in 2020, To be Delivered in 2022)
- Ship Construction : Heamin Heavy Industries in South Korea
- EP Package Provider : ABB in Switzerland (CORVUS ESS applied)

ABB to power South Korea's first domestic zero-emissions ferry

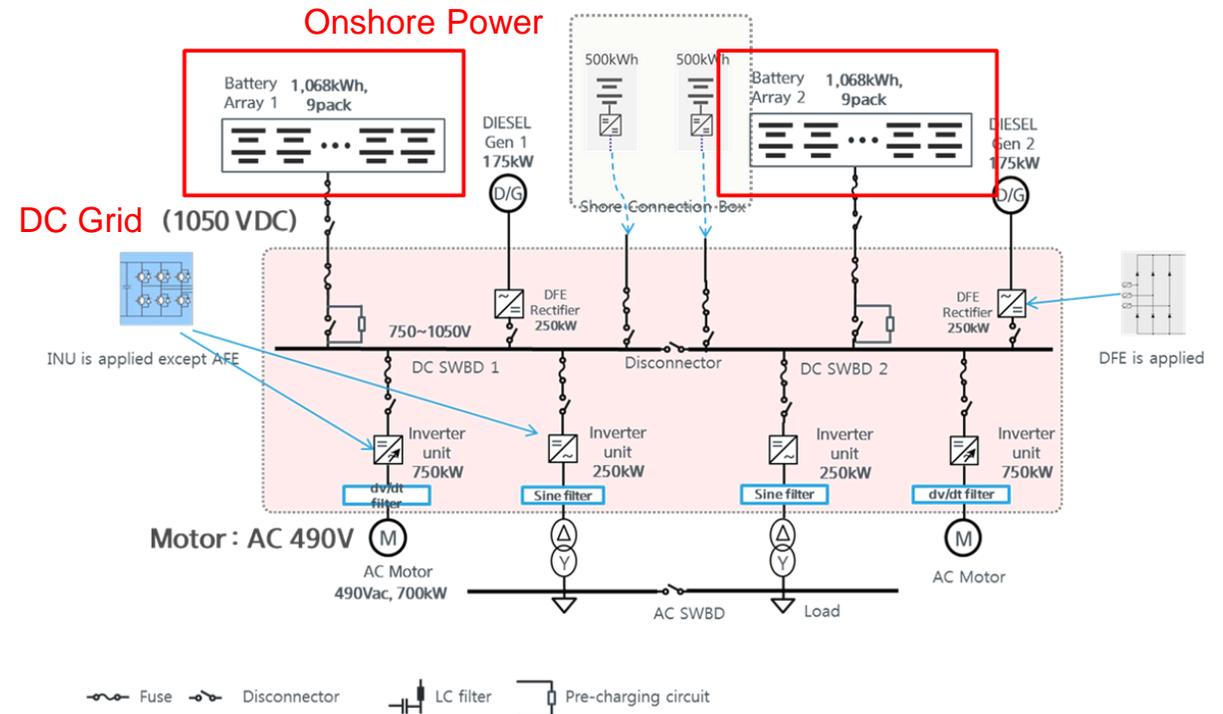
Group press release | Zurich, Switzerland | 2021-01-28

ABB has secured a contract with Haemin Heavy Industries shipyard to provide a complete power and propulsion solution for Busan Port Authority's first all-electric passenger ferry

The new ferry represents the first commitment by South Korean authorities to a plan which will see 140 state-owned conventionally powered vessels replaced with those operating on cleaner alternatives by 2030, in line with environmental legislation. Sustainable transportation, including marine vessels, will play an important role in South Korea's plan to achieve net-zero emissions by 2050, set out in the country's Green New Deal, announced in 2020.

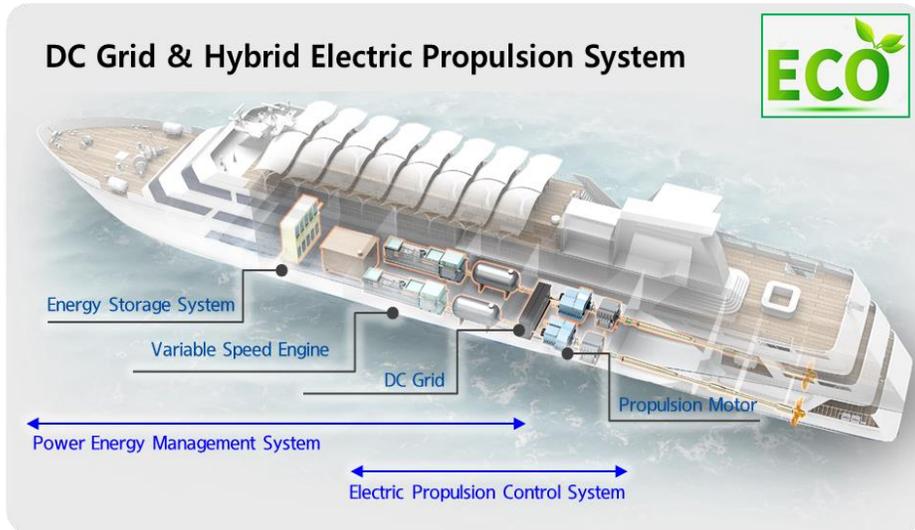


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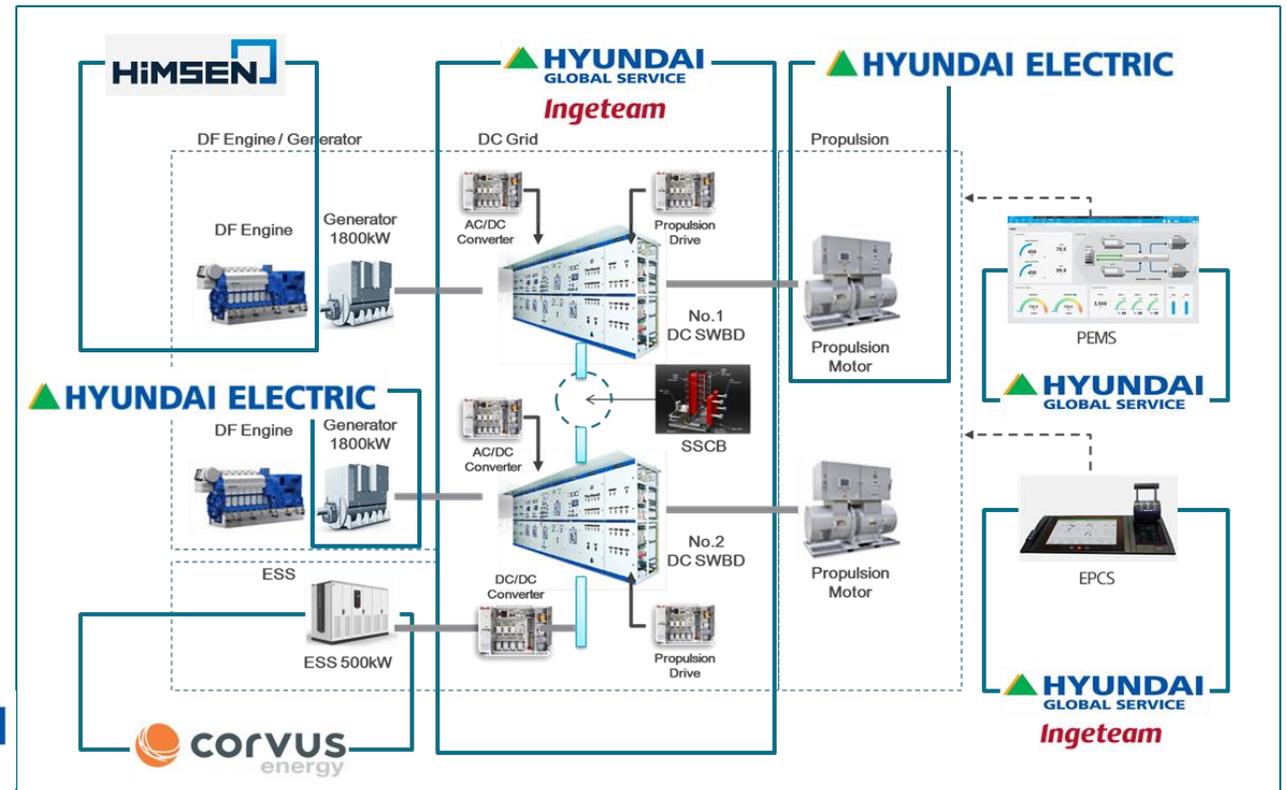
☑ Whale Watching Tour Ship of Ulsan

- Smart Electric Ship based on G/E and Battery hybrid (Total 4.5 MW, LVDC Grid applied) (Ordered in 2020, To be Delivered in 2022)
- Ship Construction : Hyundai MIPO Dockyard in South Korea
- EP Package Provider : Hyundai Global Service in South Korea (CORVUS ESS applied)



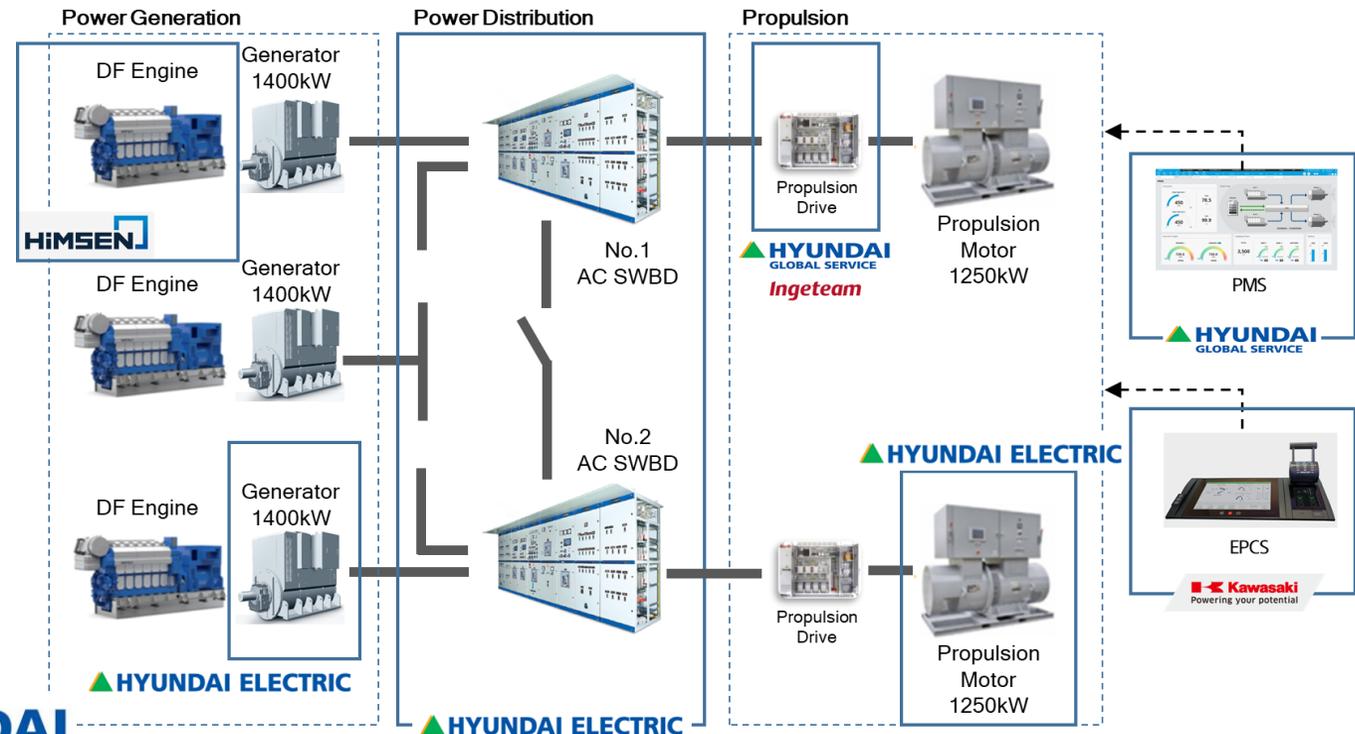
HYUNDAI
MIPO DOCKYARD

HYUNDAI
GLOBAL SERVICE



✓ 7.5k LNG Bunkering Vessel

- 3.6 MW Class DF Engine Based Electric Propulsion Ship (LVAC Grid applied) (Ordered in 2021, To be Delivered in 2023)
- Ship Construction : Hyundai Heavy Industries in South Korea
- EP Package Provider : Hyundai Global Service in South Korea
 - First EP Package System Integration on LNG Bunkering Vessel with Azimuth Thrusters by Domestic Provider

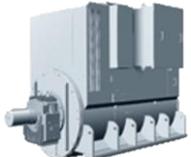


System Configuration for Electric Propulsion System

- ✓ EP Package consists of various equipment combination. Each equipment has to be integrated the System Integrator.
- ✓ So, competitiveness of each equipment and the capabilities of system integrator are important and necessary.

**Energy Management System
(Electric Power Management)**

**EP Control System
(Propulsion Power Control)**

Power Generation		Power Distribution	Propulsion		Propulsor
Engine	Generator		Driver	Motor	
 Diesel, LNG, LPG, Ammonia	 Generator	Converter 	Inverter 	 Synchronous Induction	 Propeller  Thruster
	 ESS  Fuel Cell	 DC SWBD	 AC SWBD		

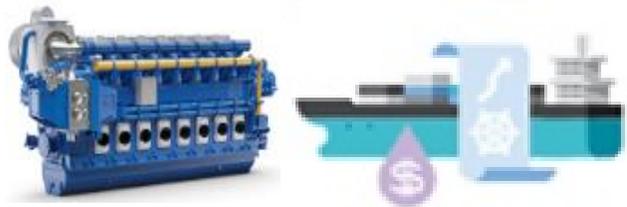
Technical Status of Domestic Suppliers

- ☑ ESS (Energy Storage System), PM (Permanent magnet) Rotating Machine, VFD (Variable Frequency Driver), Propulsor like Azimuth thruster, etc. must be localized and competitive.

	International	Domestic	Technical level
Engine	Wartsila	HHI	Equivalent
ESS	CORVUS, ABB, CATL (CN)	Hanhwa ('25), Kokam	somewhat Inferior
PEMFC	CORVUS (Toyota)	HMC	Superior
Synchronous Generator	ABB, Siemens, CN	HE, Hyosung	Equivalent
PM Generator	ABB, Siemens, The Switch	Production possible	somewhat Inferior
AC SWBD	ABB, Siemens, CN	HE, KTE	Equivalent
DC SWBD	ABB, Siemens, The Switch	C&A	somewhat Inferior
Propulsion Driver	ABB, Siemens, The Switch		Inferior
Inductive Motor	ABB, Siemens	HE, Hyosung	Equivalent
PM Motor	ABB, Siemens, The Switch	Production possible	somewhat Inferior
Propulsor	Wartsila, ABB		Inferior
System Integration	Wartsila, ABB, Siemens,	HGS	somewhat Inferior

SMART to AUTONOMOUS

- ✓ Ship's digital technology trends have started from performance improvement and will shift to autonomous navigation through a transition period of intelligence.



Smart Ship
(~2017)

IoT based
data monitoring
for operational
efficiency



Intelligent Ship
(~2025)

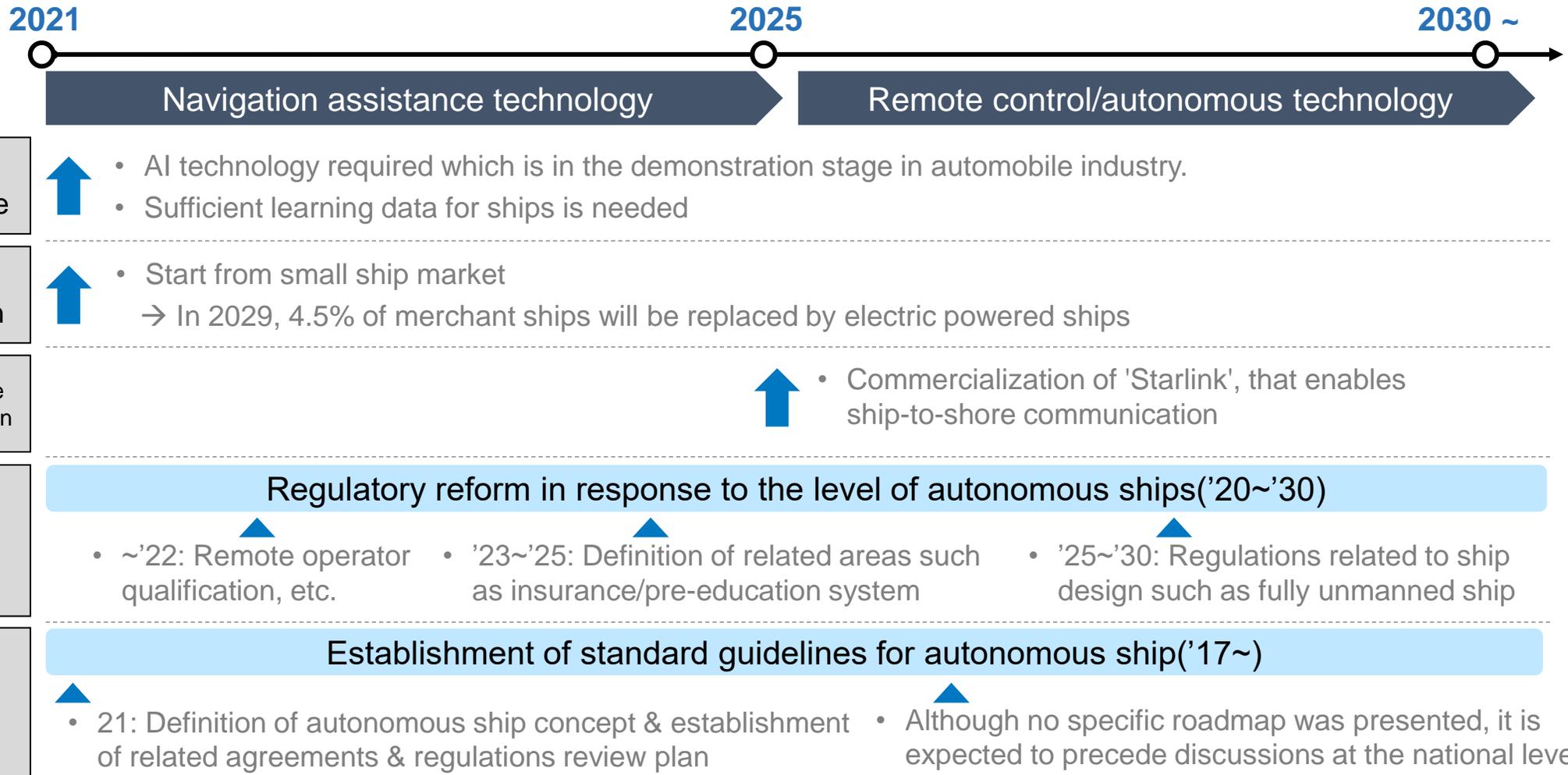
AI & big data
based Intelligent
optimization and
automation solution
Partially autonomous



Autonomous Ship
(~2030)

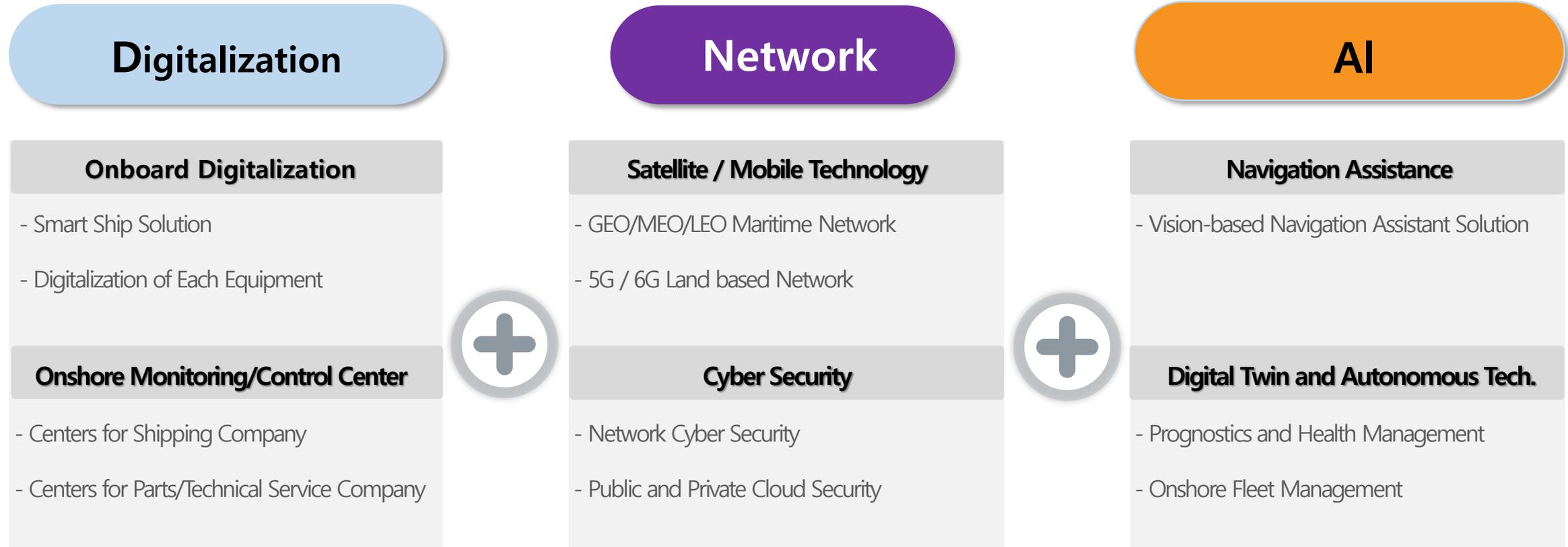
Fully autonomous
ship based on
Robotics technology

☑ Autonomous ship market has begun with 'Navigation assistant system'



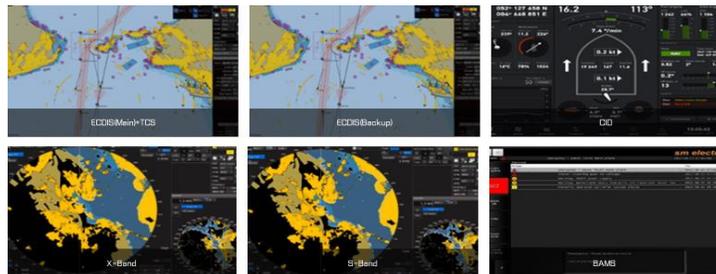
* IMO, Bloomberg, SK Shipping, Clarksons Research

- ✓ Digital has to be combined with Network and AI technologies.

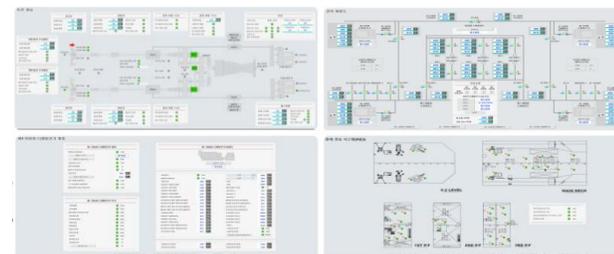


☑ All Onboard Equipment have to be digitalized and interactively communicated.

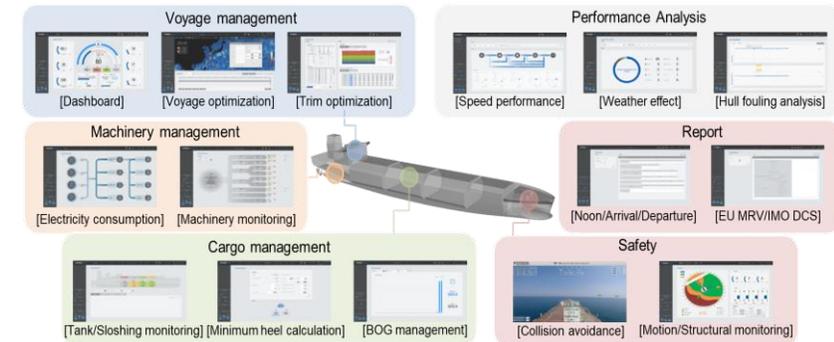
Navigation Equipment



Propulsion Equipment

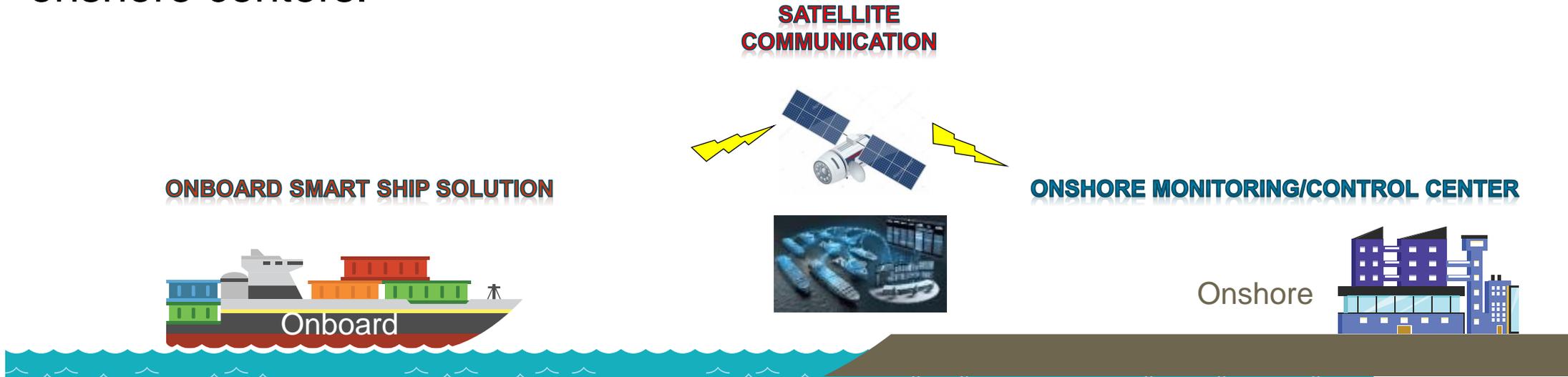


Smart



Onshore Monitoring/Control Center

- ✓ Current trend is to share all information about ships and their equipment with onshore centers.



A collage of software interface screens for ship management, categorized into two main sections:

- MACHINERY MANAGEMENT:**
 - MACHINERY MONITORING
 - ENERGY FLOW
- VOYAGE MANAGEMENT:**
 - DASHBOARD
 - FUEL CONSUMPTION
 - WEATHER INFORMATION
 - TRIM OPTIMIZATION
- ANALYSIS & REPORT:**
 - SPEED PERFORMANCE
 - WEATHER EFFECT
 - NOON / VOYAGE



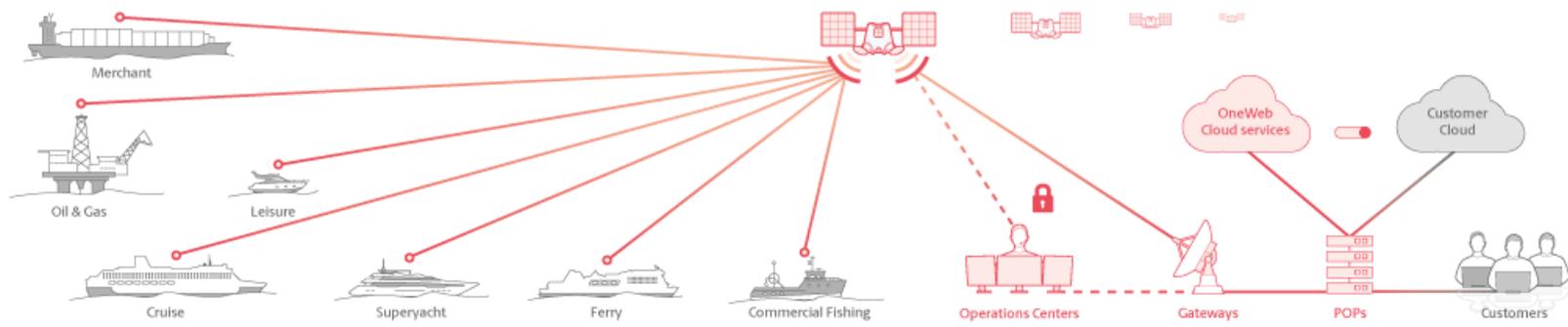
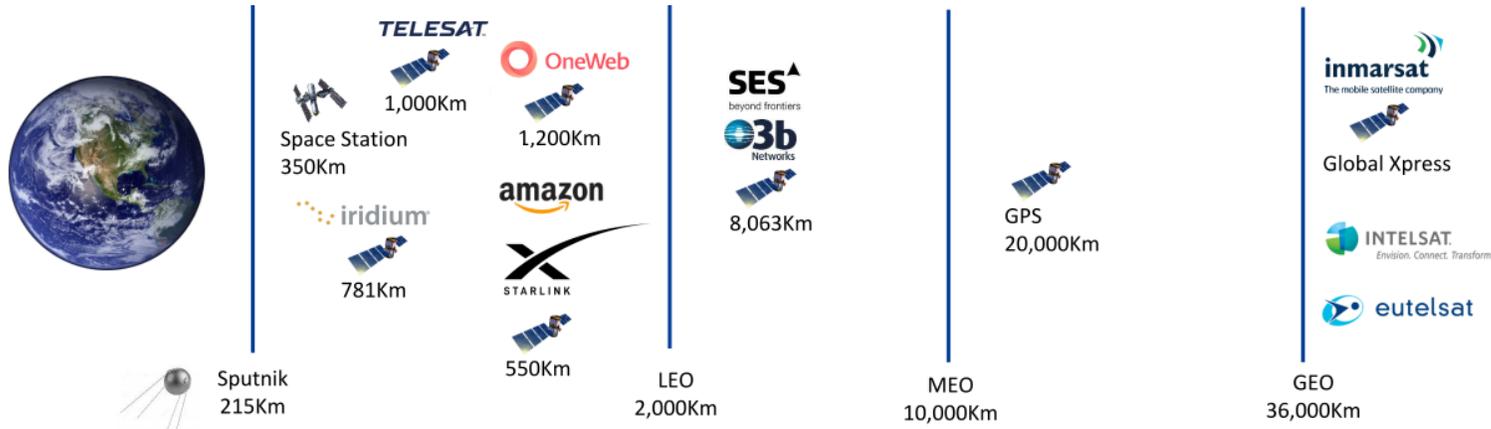
<Hyundai Global Service>



<Hyundai Merchant Marine>

Communication

☑ The telecommunications environment is rapidly changing.



Source: Oneweb

✓ The stronger the connectivity, the greater the security threat.



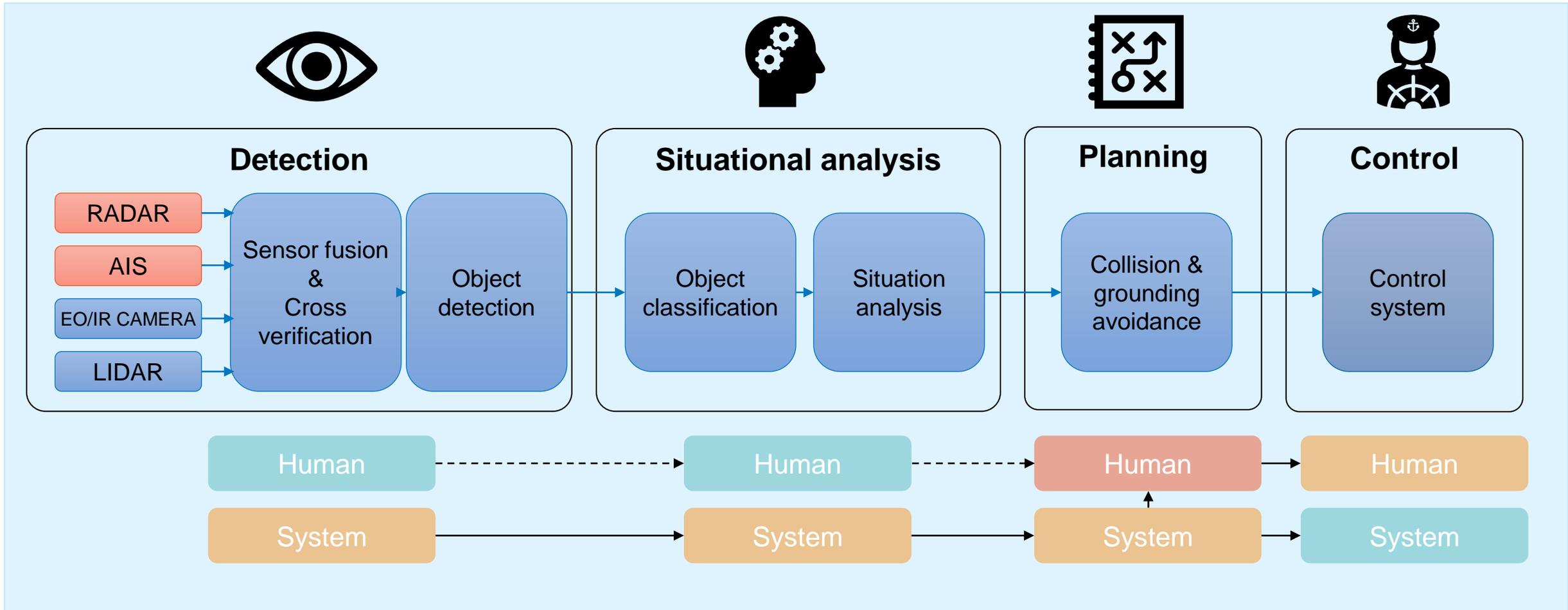
Source: Rolls-Royce marine



Source: Safety4Sea

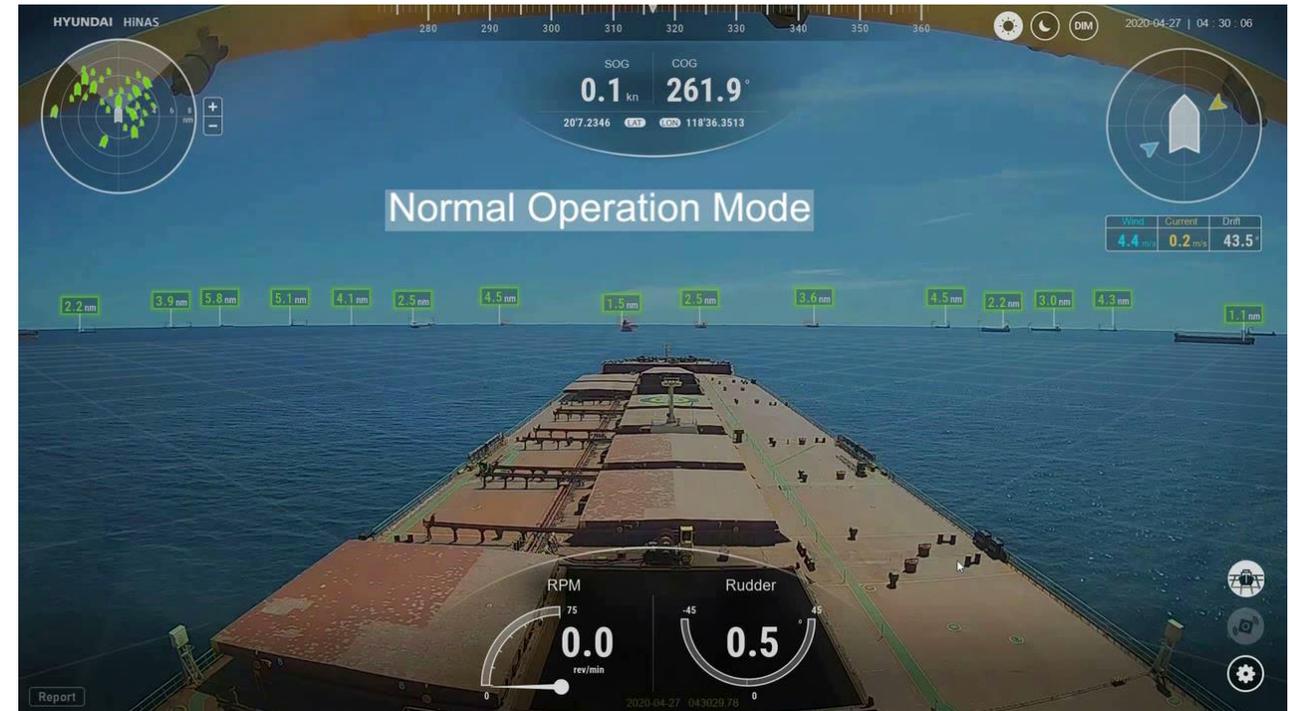
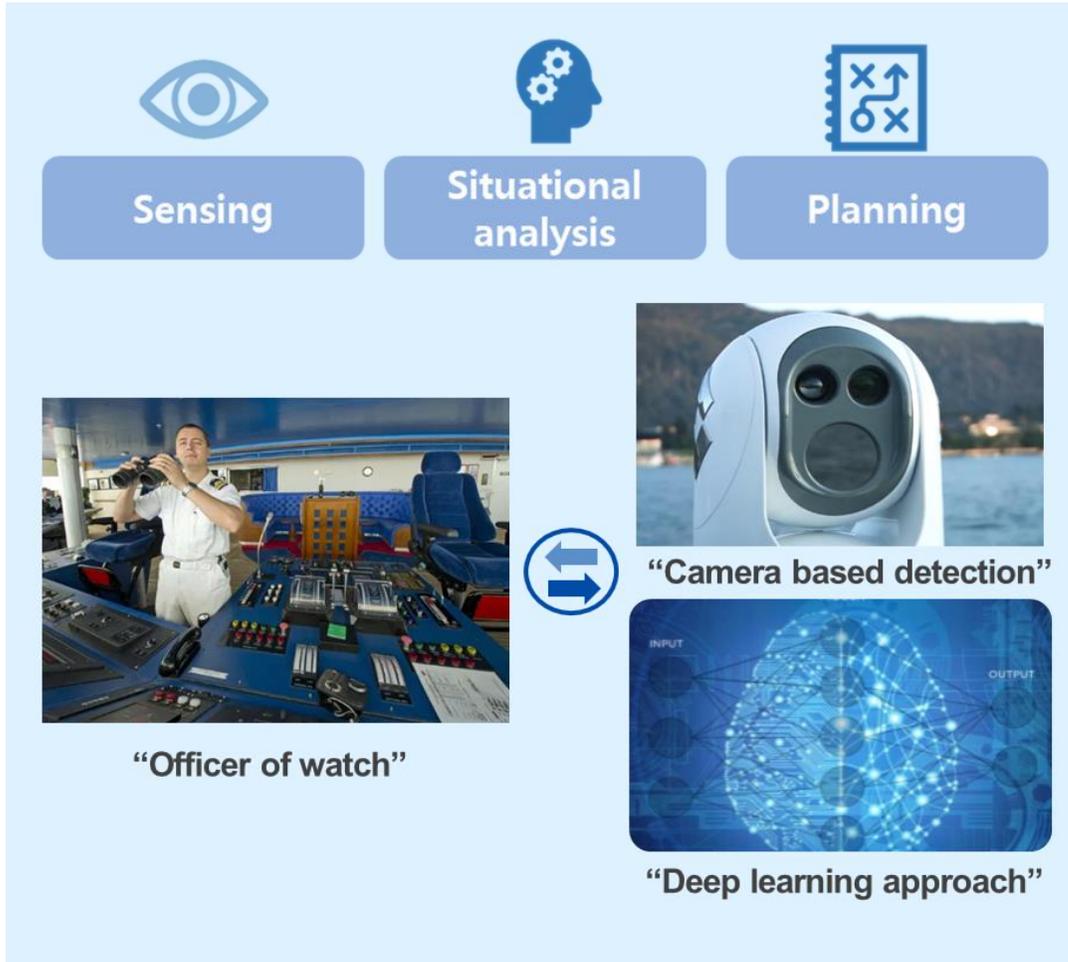


- ✓ Especially, Navigation automation requires the automation of object detection, situational awareness, action planning, and control technology

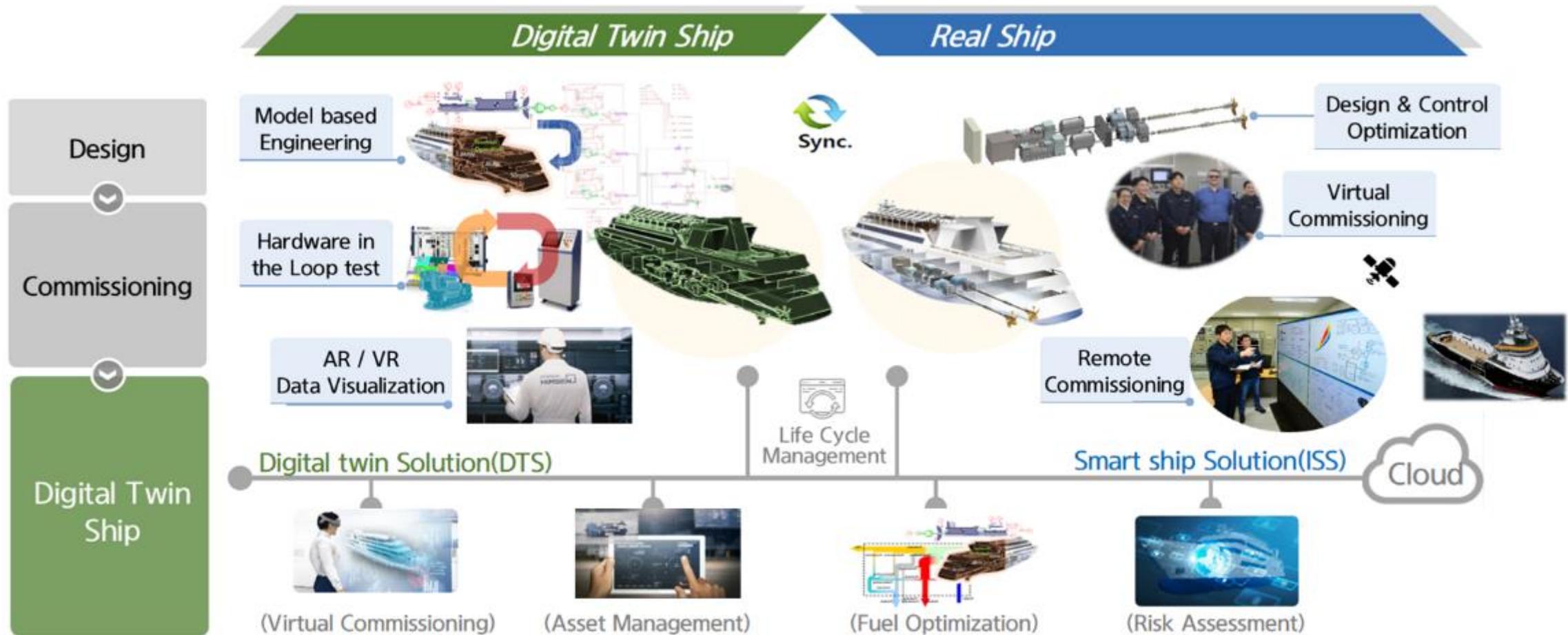


Navigation Assistant Solution – System Introduction

☑ Artificial intelligence (AI) can help reduce human accidents.

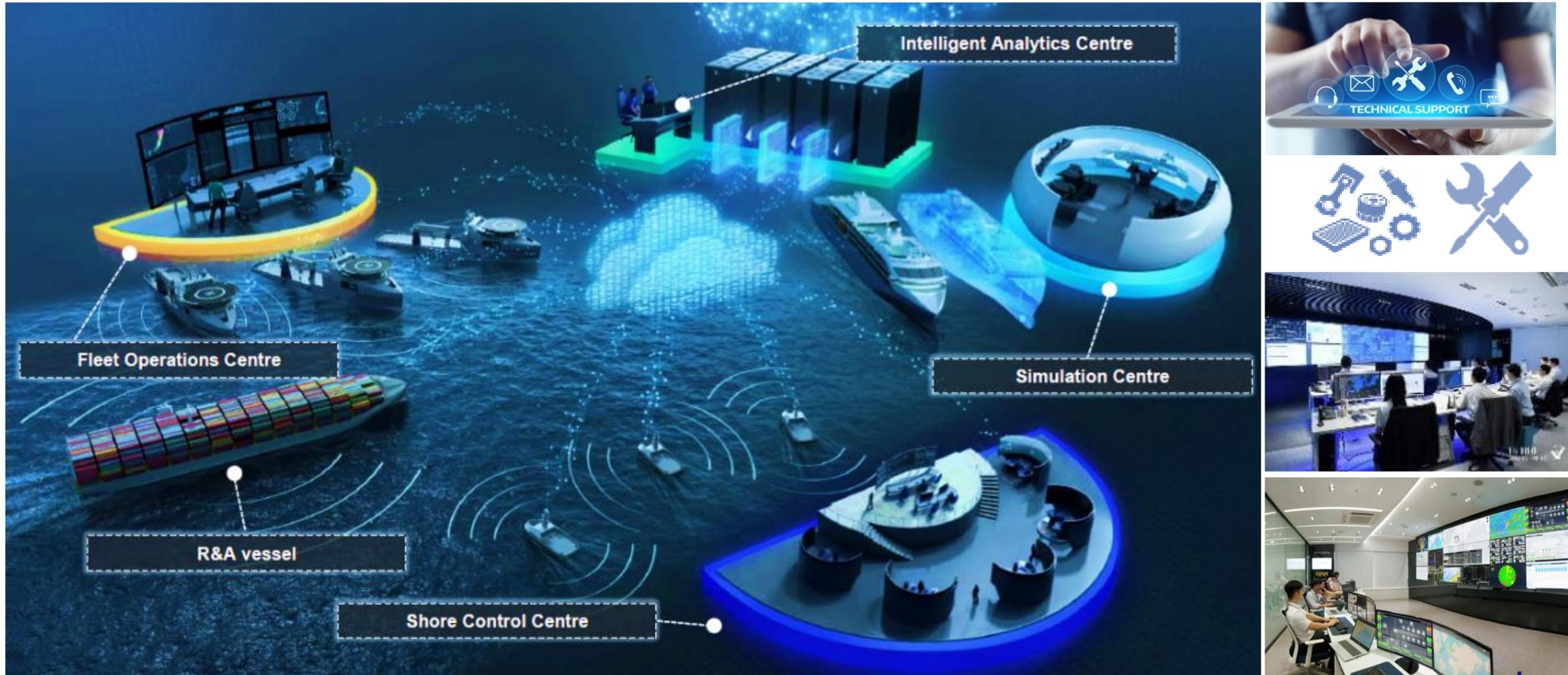


- ✓ Digital twin will help the life cycle management of ships and their equipment.



Digital Twin

- ✓ Ultimately, Digital Twin will be essential for autonomous / unmanned ships.



☑ Electric Propulsion Ship

- Essential elements for IMO environmental regulatory response
- National support such as Green Ship-K initiative and eco-friendly conversion of government ships
- Introduction of several ongoing pilot / business projects (Flexible energy sources)
- Technical evaluation of capabilities of domestic suppliers

☑ Autonomous Ship

- Shift to autonomous ship from smart ship through a transition period of intelligence.
- Market begin from navigation assistant system
- Digital Transformation Keyword : Digitalization, Network, AI
- Introduction of navigation assistant system and its demonstration

☑ More Investment and Support to develop essential equipment and

More Pilot Opportunities to demonstrate their performance are critical to the future.

Thank You!

