Technical Issues and KRISO Research Projects on MASS



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1

Discussion Trend of MASS in IMO MSC



IMO's official recognition of MASS in '18, development of international regulations

"Four key issues in the shipping and shipbuilding industry are 'Safety, reliability, efficiency, eco-friendliness' and MASS that solves the problem"

- Better passengers and cargo safety
- Greater Ships and equipment reliability
- Higher navigation and maintenance efficiency
- Eco-friendly fuel efficiency and energy consumption

* Global market size for MASS: 150 trillion won in 2030 (Allied Market Research in the US))

Background

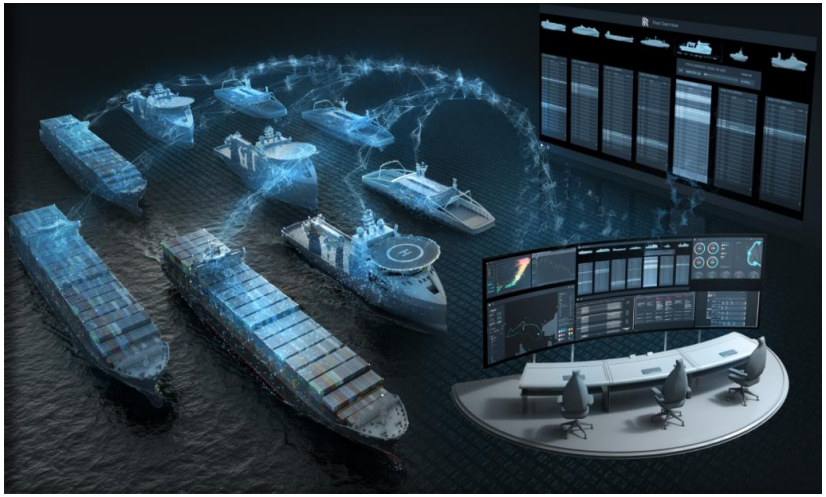
- (Change of paradigm) Efforts to improve maritime safety, and active development of MASS technology through application of digital technology to ships
- (Implementation of international regulations) Urgency of need for unified international regulations applicable to new types of ship technology

Major discussions on MASS

① Adoption of **interim guidelines for MASS trials** ('19.6)

② Completion of **Regulatory Scoping Exercise (RSE)** ('21.5)

③ Roadmap for the development of **MASS Code** (development & approval of non-mandatory code, adoption of mandatory code, etc.)



〈 Conceptual diagram of the autonomous navigation system of the UK (Rolls-Royce) 〉



〈 Norway (Yara Birkeland) MASS〉

Major Discussions on MASS

- Interim guidelines for MASS trials
  - ✓ (MSC 99th, 2018) Development of temporary guidelines to accumulate more research data and experience on MASS
  - ✓ Test operation technology, monitoring, safety considerations, cyber security, etc.
  - ✓ 9 Principles for the development of guidelines on MASS trials (MSC 100/WP.8)
  - ✓ Adoption of Interim Guidelines For MASS Trials in MSC 101 (2019) (MSC.1/Circ. 1604)

[Principles for the Development of Guidelines on MASS trials]

① the Guidelines should be developed as a single document addressing Administrations, the industry and other relevant stakeholders;

② the Guidelines should be generic;

③ the Guidelines should not be too technical or prescriptive;

④ the Guidelines should be goal-based, describing functions and goals to be achieved;

⑤ the Guidelines should encourage information sharing, both with the Organization(feedback) and other stakeholders;

⑥ the Guidelines should include reporting to the relevant coastal State(s) on the trial(s) to be conducted, so as to enable the dissemination of information on the trials to all ships in the specified area;

⑦ the Guidelines should ensure the safe, secure and environmentally sound operation of MASS;

⑧ the Guidelines should provide that MASS trials are to be in line with mandatory instruments; and

⑨ the Guidelines should provide that a scope should be specified for each trial to be conducted (e.g. mooring, navigation, new equipment, etc.).

Source: http://www.monthlymaritimekorea.com/news/articleView.html?idxno=26660, 채종주, 2020

Major Discussions on MASS

- Regulatory Scoping Exercise, RSE
  - ✓ (MSC 98th, 2017) Initiation of the Regulatory Scoping Exercise (RSE) to assess the existing IMO instruments in the context of application of new technologies
  - ✓ At the request of 9 member countries, including Denmark, Japan, UK, USA and Korea, IMO Convention agreed on RSE as a new task for MASS (MSC 98/20/2)
  - ✓ (MSC 103rd, 2021) By completing the RSE, the existing instruments were assessed and the necessity of developing a MASS Code was confirmed.

- Development of the Mass Code
  - ✓ (MSC 104th, 2021) The development of a MASS Code was adopted as a formal agenda, and was envisaged to be completed by '25.
  - ✓ MSC approved a roadmap containing a work plan for necessary instruments for MASS.
  - ✓ (MSC 105th, 2022) Discussion of roadmap for the development of MASS Code at the IMO level
  - ✓ Joint MSC-LEG-FAL Working Group to be established to address common issues identified by the RSE ('22.9)

Roadmap for Development of MASS Code

Recognition of the need for MASS Code development,
Commencement of MASS Code development through the roadmap for goal-based instrument

Development of an instrument that can accommodate technological diversity of MASS and embrace the concept of new technology

Main Goals per Session

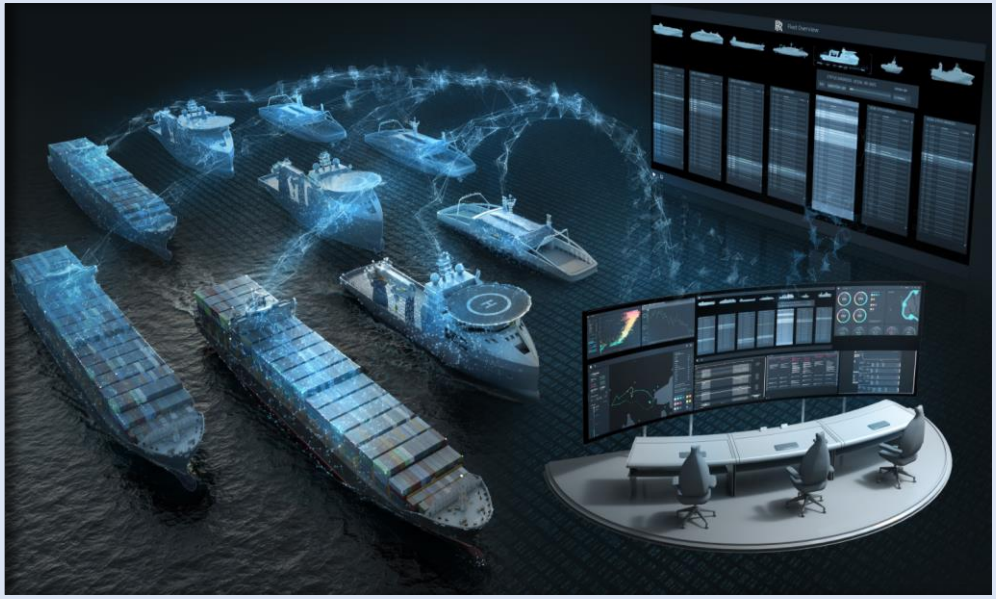
MSC 106	Consideration of common potential gaps, themes identified by RSE from priority items, development of glossary/terminology, development of provisions for a goal-based instrument
MSC 107	If necessary, continue execution of the work plan from the 106th, (consideration of scope and framework, impact and changes to existing IMO instruments, etc.)
MSC 108	Finalization process of non-mandatory MASS Code development
MSC 109	Finalization and Approval of non-mandatory MASS code ('24), finalization of draft mandatory MASS code based on approval of non-mandatory instrument
MSC 110	Approval of mandatory MASS Code ('25) ('28.1.1. entry into force)

- Established a work plan aimed for approval at the 109th MSC (scheduled for '24), leaving possibility of entry into force by '28. 1. 1., agreement to review and update the roadmap at each session

Technology Trends for MASS

Recent Technology Trend

- Fully automated MASS development project* for commercial vessels is promoted mainly in Northern Europe (UK, Norway, etc.)
  * Promotion of commercialization of MASS with the goal of developing unmanned commercial ships by '35
- The IMO has adopted the development of the MASS Code to ensure the safety of MASS operation as an official MSC agenda and is in discussion (from 2022)



〈 Conceptual Diagram of the Autonomous Navigation System of the UK (Rolls-Royce) 〉



〈 Norway (Yara Birkeland) MASS〉

2

Korea Autonomous Surface Ship (KASS) Project

Project Overview

Project Name

Development of Key Technology for Autonomous Ships

Funding

Ministry of Trade, Industry and Energy, Ministry of Oceans and Fisheries

Period

2020~2025 (6 years, 1~4y development, 5~6y operation & verification)

Budget

Total 160.3 billion KRW (about 120 million €)

Goals

MASS Key Tech.[1] Development and Verification for Commercialization[2]

1) Key Technologies:
   ① Intelligent Navigation System
   ② Autonomous Engine System
   ③ Sea Test-bed & Validation Technology
   ④ Operation Techniques and Standardization
2) Commercialization: Medium sized MASS for International Voyage (Ocean IMO Level3, Coastal IMO Level2)

* 2 Main(Management) Projects and 4 Main Tech., 13 Sub-projects (51 participating organizations)

Source: Korea Autonomous Surface Ship Project Office

Goals for Project

▪ Vision of KASS Project

Vision Taking the lead on future market share and international standards by developing technologies for the autonomous ships

Autonomous navigation systems Level 2(coastal) & 3(Ocean)	Global level reliability(99.9%) & standardizations(36cases) (IACS cert. / cyber security CS2 level)	Autonomous ship Leading on market share

National R&D project
(2020~2025)

Operation techniques
& Standardization
(3 Sub-project)



Intelligent navigation system
(3 Sub-project)



Autonomous engine system
(2 Sub-project)



Sea Test-bed & Validation
(5 Sub-project)

Source: Korea Autonomous Surface Ship Project Office

▪ Core Technologies and Development Plan

1. Autonomous Navigation System
2. Autonomous Engine System
3. Test-bed and Verification Techniques
4. Operation Techniques and Standardizations

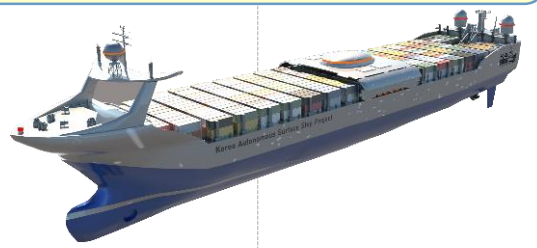
- Development of Integrated Platform & Digital Bridge for Autonomous Navigation, Control of Engine Room
- Development of a Situational Awareness System for Preventing Collisions and Accidents of Autonomous Ships
- Development of Autonomous Navigation System with Intelligent Route Planning Function
- Development of Performance Monitoring and Failure Prediction and Diagnosis Technology for Engine System of Autonomous Ships
- Development of Integrated Energy Control System for Autonomous Ships
- Development of Evaluation and Validation Testbed for Autonomous Ship Performance
- Development of Validation and Verification Technique for Intelligent System of Autonomous Ships
- Development of Shore Remote Control System of MASS
- Development of Cyber Security Technology for Maritime Autonomous Surface Ship
- Development of the Next Digital Communication Technologies for Ship2Ship2Shore
- Incident Response System and Reliability Assessment for Autonomous ship
- Development of Remote Management and Safe Operating Technology of Autonomous Navigation System
- Development of International Standardization Technology for Autonomous Ship

KASS Test Ship Platform('22.6)





KASS Shore Test-bed & Center('22.9)



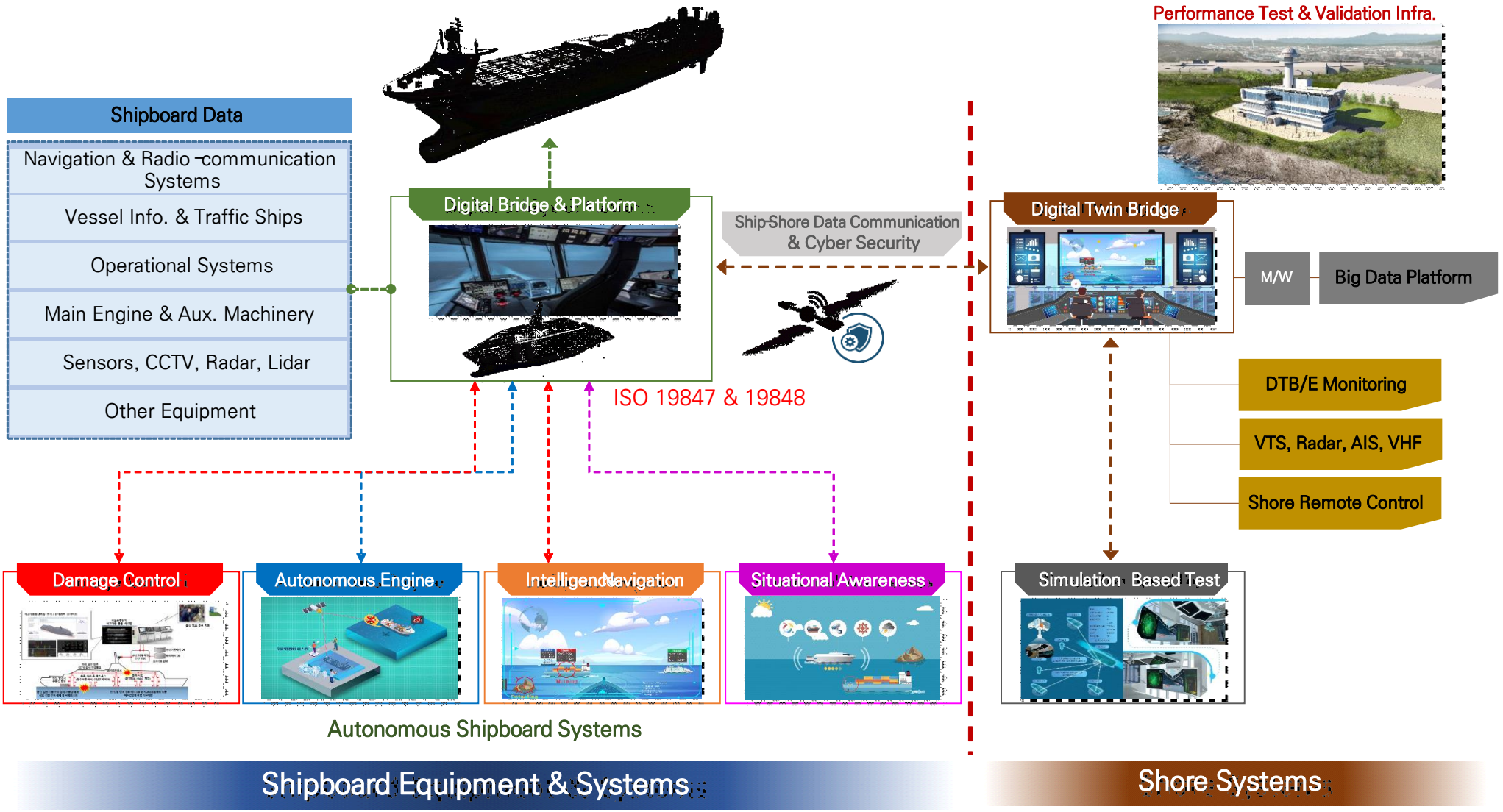
Demo Ship to be built('24~25)

2020 2021 2022 2023 2024 2025 2026

Source: Korea Autonomous Surface Ship Project Office

Research Contents and Plan

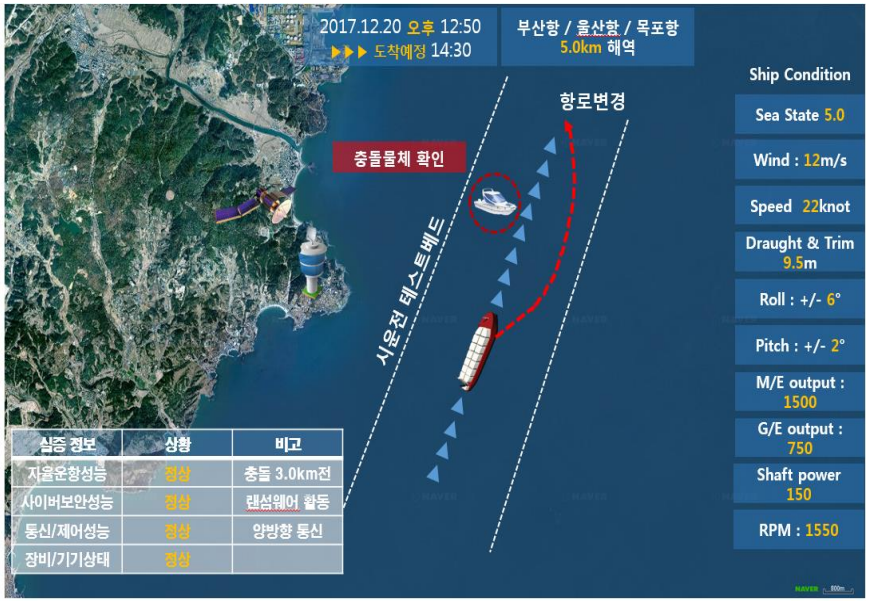
- Logical Configuration for the System Integration
  - System Interface Diagram



Source: Korea Autonomous Surface Ship Project Office

Research Contents and Plan

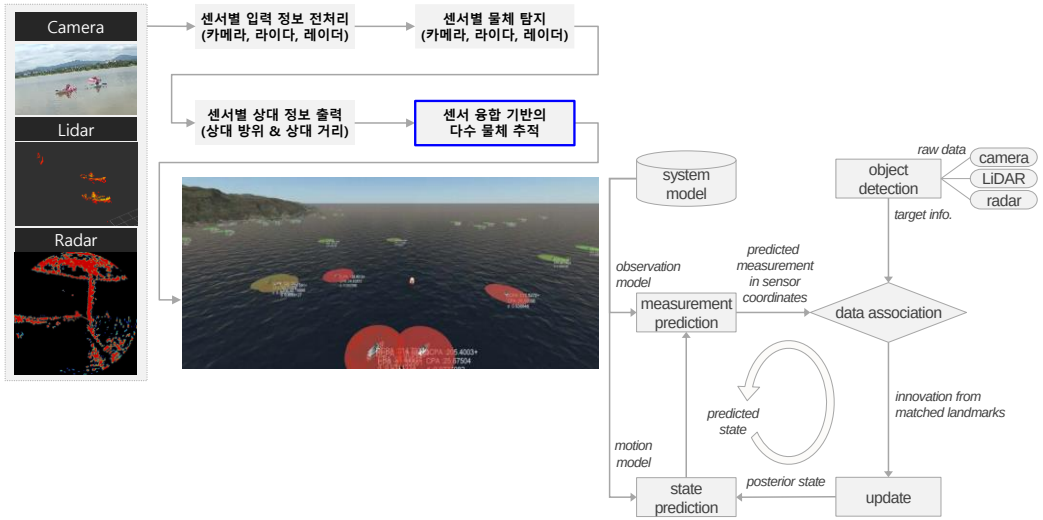
▪ Intelligent Navigation System

Item	Contents
Project name	(1-1) Development of Autonomous Navigation System with Intelligent Route Planning Function
Total period	2020.04 ~ 2025.12 (5years 9months)
Technical overview for development	 ▶ Precision of Operational Model for the Development of Autonomous Navigation Algorithms ▶ Development of Path Planning Algorithms for Safe Navigation – Development of Path Planning Algorithms for Economic Navigation ▶ Development of High-Reliability Route Tracking Control Algorithm ▶ Development of a common service platform for autonomous/economic navigation [(H/W)+(S/W)] ▶ Development of Algorithms for Automatic Berthing ▶ Application and Development and of Algorithm Verification Environment
Participants	Ministry of Oceans and Fisheries

Source: Korea Autonomous Surface Ship Project Office

Research Contents and Plan

▪ Intelligent Navigation System

Item	Contents
Project name	(1-2) Development of a Situational Awareness System for Preventing Collisions and Accidents
Total period	2020.04 ~ 2024.12 (4years 9months)
Technical overview for development	
Participants	Ministry of Trade, Industry and Energy

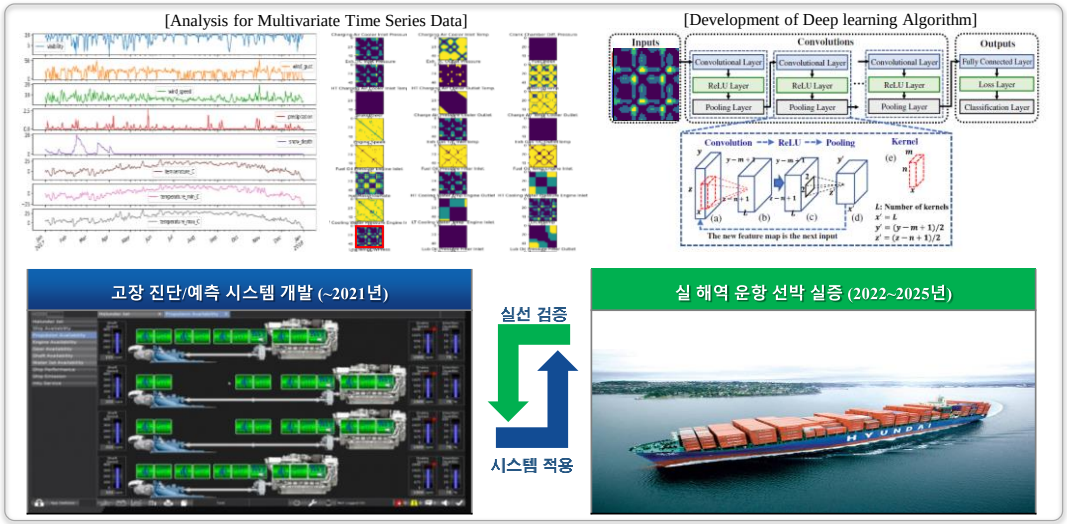
❖ **Situational Awareness System**

- A system for real-time recognition and analysis of sea conditions around ships in order to ensure navigation safety of autonomous ships
- Key components of the situational awareness system
  - ✓ Collection and integration processing of heterogeneous sensor data and output system for information coordination
  - ✓ Verification support systems of virtual and real environment data sets for artificial intelligence learning
  - ✓ Technology for automatic detection, identification and tracking of floating objects by heterogeneous sensor data
  - ✓ AI-based technology for estimating motion information of floating objects and collision risk assessment

Source: Korea Autonomous Surface Ship Project Office

Research Contents and Plan

▪ Autonomous Engine System

Item	Contents
Project name	(2-1) Development of Performance Monitoring, Failure Prediction and Diagnosis Technology for Engine System of Autonomous Ships
Total period	2020.04 ~ 2025.12 (5years 9months)
Technical overview for development	 Ministry of Trade, Industry and Energy ** CBM(Condition Based Maintenance), MWP(Maintenance Work Package)*	❖ **CBM* & Remote Maintenance Technology for Propulsion and Power Generation of Autonomous Ships** • [Target Technique Ⅰ] State-based fault diagnosis/predicting techniques(Condition based Maintenance) ✓ Decision-making support to prevent/respond to accidents in advance by diagnosing ✓ Predicting faults through real-time status monitoring of the vessel engine system • [Target Technique Ⅱ] Augmented Reality-Based Intelligent Ship Remote Maintenance Support System (Fail-safety) ✓ Augmented Reality-based engineering information using MWP* for maintenance and remote support from experts at shore
Participants	

Source: Korea Autonomous Surface Ship Project Office

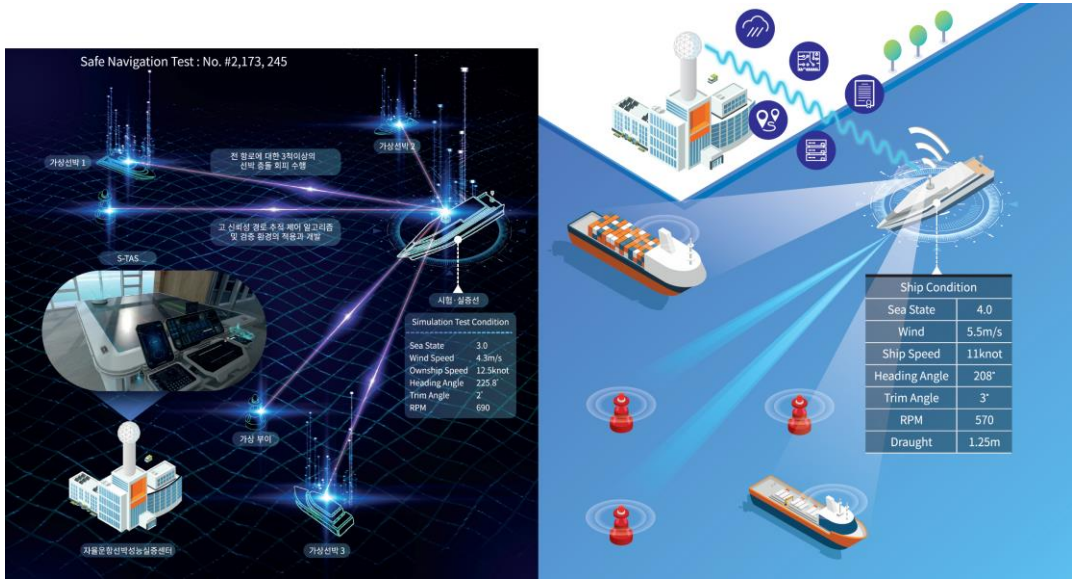
Research Contents and Plan

▪ Sea Test-bed and Validation Technology

Item	Contents
Project name	(3-1) Development of Evaluation and Validation Test-bed for Autonomous Ship Performance
Total period	2020.04 ~ 2024.12 (4years 9months)
Technical overview for development Ministry of Trade, Industry and Energy	 ▶ Verification of safety and performance for autonomous ships, navigational equipment/devices, and cybersecurity ▶ Development and establishment of testing environment and infrastructure for testing/evaluation/verification of autonomous ships ▶ Certification of autonomous ships and systems (equipment and algorithms) ▶ Sea trials testbeds including test ships (25 meters), and infrastructure for collecting and analyzing big data to improve systems of autonomous ships, as well as equipment and human resources
Participants	

Source: Korea Autonomous Surface Ship Project Office

▪ Sea Test-bed and Validation Technology

Item	Contents
Project name	(3-2) Development of Validation and Verification Technique for Intelligent System for Autonomous Ships
Total period	2020.04 ~ 2024.12 (4years 9months)
Technical overview for development	 ▶ Development of a system for Simulation-based Test-bed for Autonomous Ship; S-TAS* ▶ Development of a real-time monitoring system for testing in real sea conditions ▶ Development of test-bed for performance verification in real sea ▶ Development of procedures for test/performance evaluation of MASS ▶ Performance evaluation of MASS system Ministry of Trade, Industry and Energy ** S-TAS(Simulation-based Test-bed for Autonomous Ship)*
Participants	

Source: Korea Autonomous Surface Ship Project Office

▪ Operational Technology and Standardization

Item	Contents
Project name	(4-3) Development of International Standardization Technology for Autonomous Ships
Total period	2020.04 ~ 2025.12 (5years 9months)
Technical overview for development	 ▶ Development of enactment, revision for laws and systems for the introduction and commercialization of autonomous ships ▶ Development of standard ship insurance terms and conditions for the compensation of marine accidents related to MASS ▶ Development of testing standards for key equipment and materials of certification procedures for type approval ▶ Submission and adoption of standard documents for the establishment of international standards
Participants	

Ministry of Oceans and Fisheries

Source: Korea Autonomous Surface Ship Project Office

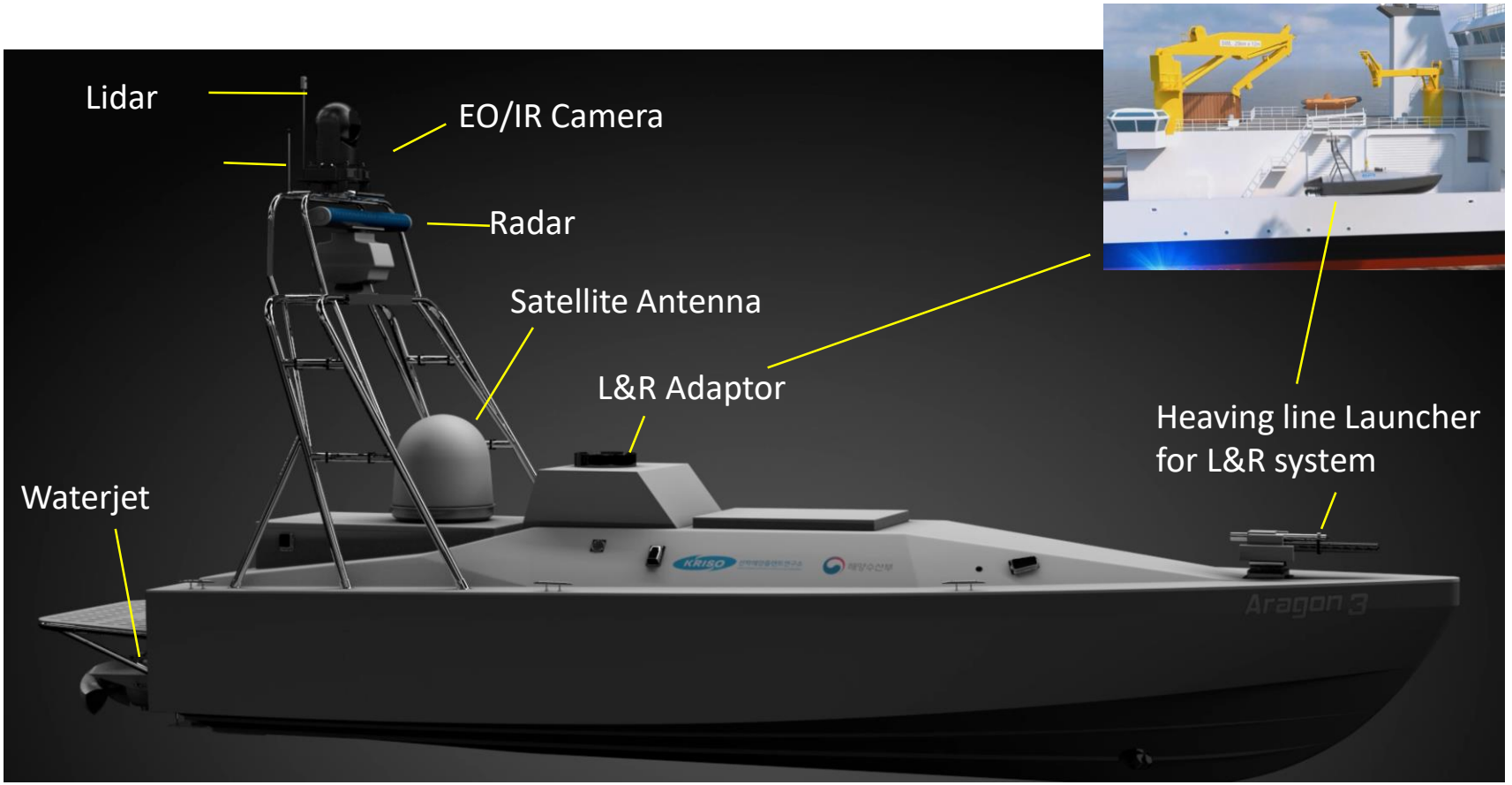
3

KRISO Unmanned Surface Vehicle (USV) Project

Korean USV Project

Development of Autonomous USV for Maritime Survey and Surveillance

- Project Period : 2011 ~ 2019
- Budget : 20.0 billion Won sponsored by Korean Ministry of Oceans and Fisheries
- Leading Organization : Korea Research Institute of Ship & Ocean Engineering (KRISO)

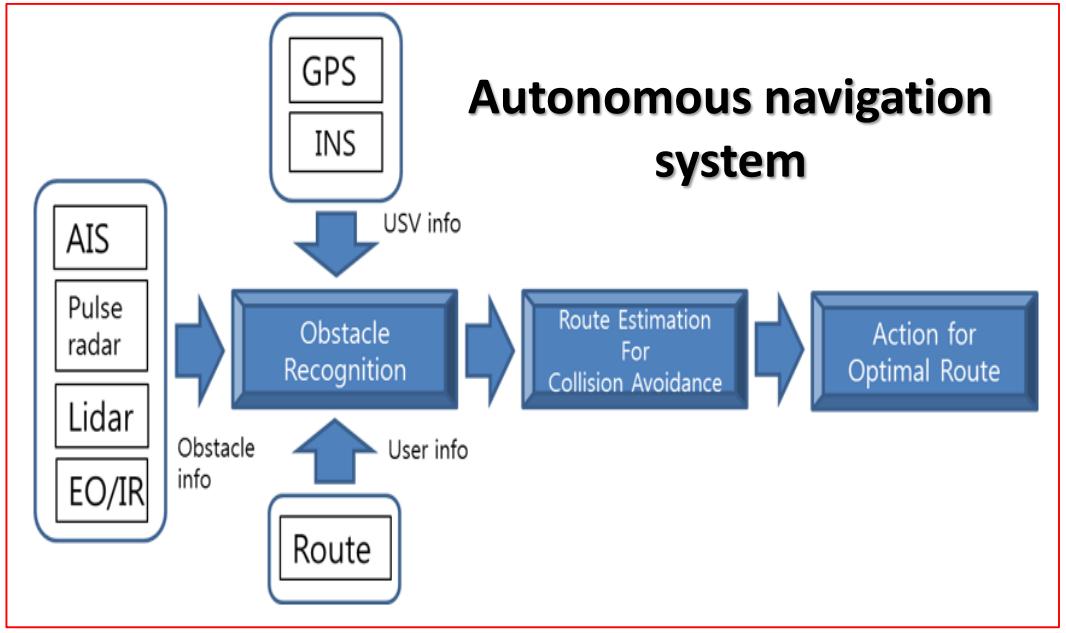


USV ARAGON I, II, III







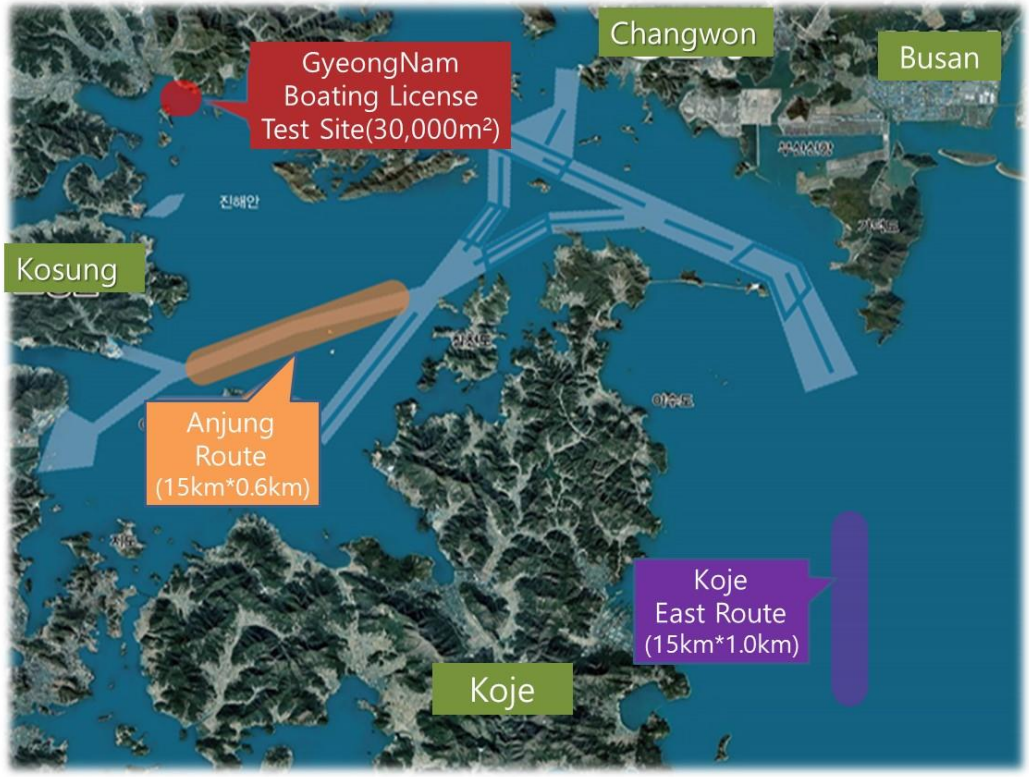


Main Features of ARAGON III

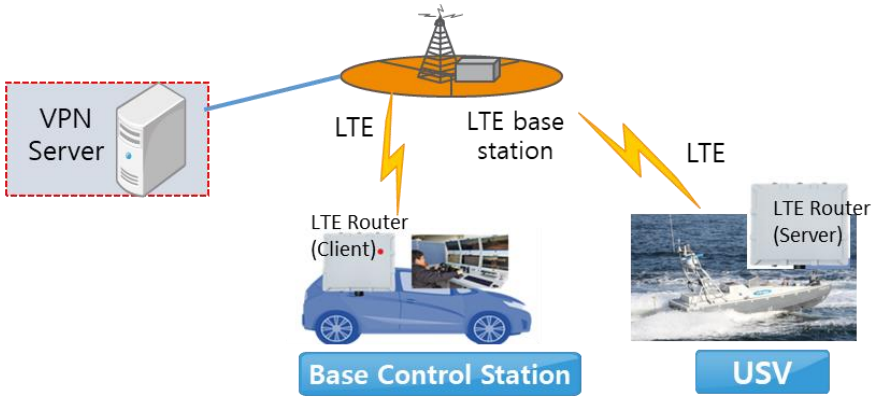
- Platform
  - Planning Hull with waterjet
  - Max. Speed 45kts, Operable up to Sea state 4
  - Attitude Control System with Interceptor
- Triple Communication System
  - S-band modem (Main, 20km, 16Mbps), UHF modem (backup, 30km, 300Kbps)
  - Satellite Communication (Emergency, 150Kbps)
- Autonomous Navigation System
  - Automatic Path Planning and Following with GIS Information
  - Automatic Obstacle Detection & Tracking by Sensors fusion (Radar, Lidar, Camera, AIS)
  - Automatic Collision Avoidance
- Mission Equipment for Maritime Surveillance and Ocean Survey
  - EO/IR Camera for Target Identification and Tracking
  - Water Canon & LRAD (Long Range Acoustic Device) for control illegal fishing
  - Multi-beam Sonar, ACDP, CTD for Ocean Survey
- Launch & Recovery System
  - Using Heaving line Launcher of USV & Crane on Board

GyeongNam Unmanned Ship Regulation Free Special Zone

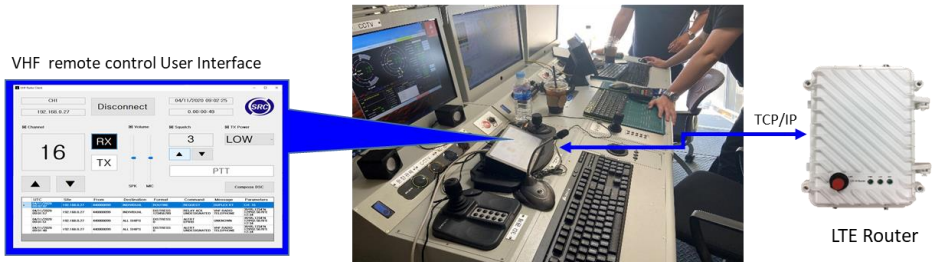
- Project Outline
  - Period : 2020. 1. ~ 2023. 12.
  - Designated area : Anjung Route, Koje East Route, Gyeongnam Boating License Test Site
  - Scope
    - Support R&D and Tests for Participants
    - Establish Infrastructure for USV Tests
    - Establish Law & Regulation for USV



〈 Test Site 〉







Field demonstration of ARAGON USV III

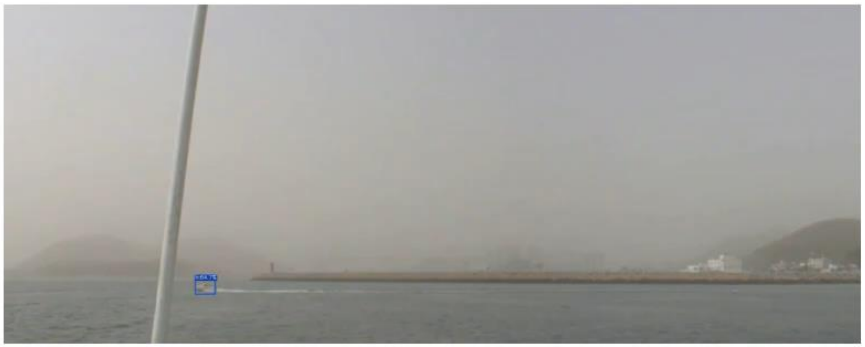
- Fully-unmanned operation in complex coastal traffic areas





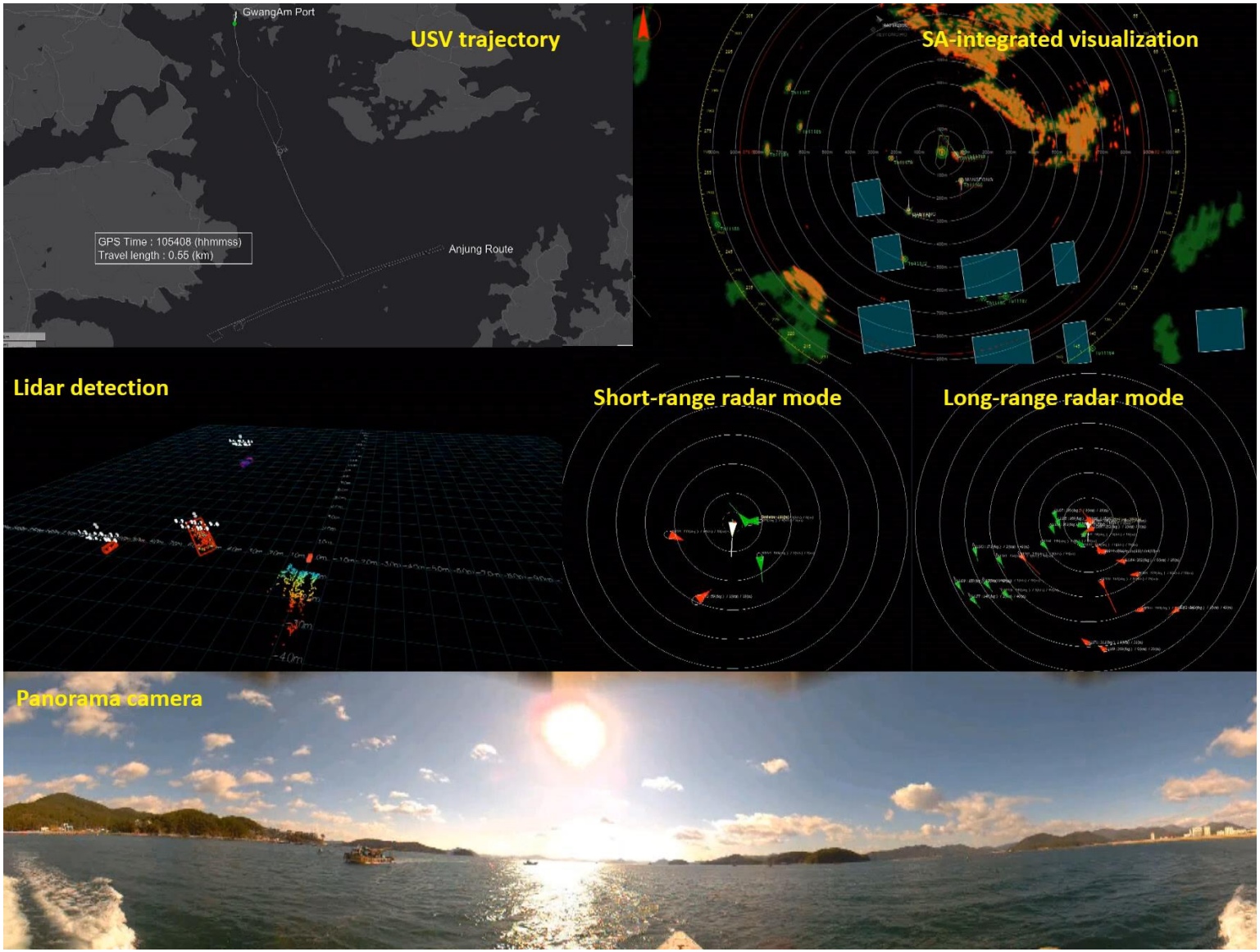






Field demonstration of ARAGON USV III

- Situational awareness based on multi-sensor fusion technique



Field demonstration of ARAGON USV III

- Feasibility tests for the USV's capabilities to perform real-world tasks of Korea Coast Guard









4

Summary

Summary

Major Discussions on MASS in IMO MSC

- Regulatory Scoping Exercise, RSE (MSC 103rd, ’21)
- Commencement of MASS Code development (MSC 104th, ’22~)

+

MASS Projects KRISO is working on

- Korea Autonomous Surface Ship (KASS) Project
- Unmanned Surface Vehicle (USV) Project

+

IMO Documents for MSC 106

- Methodology for accident response in fire and flooding accident of MASS
- Introduction of Autonomous Ship Verification & Evaluation Research Center in KRISO


Thank you for your attention!
INTERNATIONAL
MARITIME
ORGANIZATION