

---

# Samsung Autonomous Ship Technology

---

Advance toward productization of  
autonomous navigation system, SAS

Eunhyu, Lee

Autonomous Ship Research Center

[eunhyu87.lee@samsung.com](mailto:eunhyu87.lee@samsung.com)

'24. 05. 14

# CONTENTS

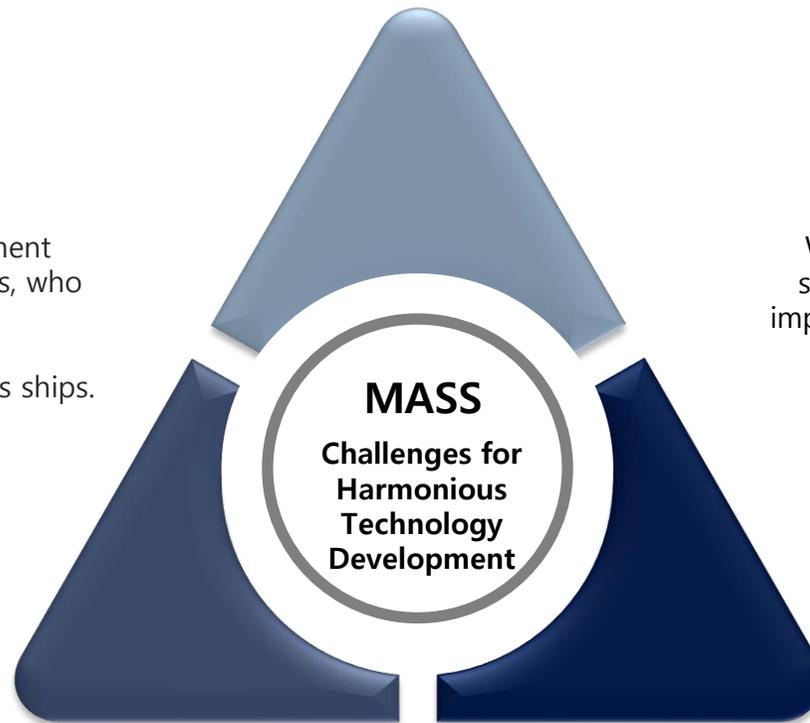
---

## Collaborative Development

Collaborative Technical Development with a wide range of stakeholders, who possess extensive expertise and experience, is essential for the commercialization of autonomous ships.

## Harmonized Technology

We believe that the combination of sea-trial, simulation, and continuous improvement is an important factor in developing and advancing autonomous ship technology.



## Various type of MASS

While the application of autonomous navigation technology may appear distinct between large and small ships, there are certain areas in common and several areas that complement each other.

# Samsung Autonomous Ship, SAS

## ■ The History and Development of Samsung Autonomous Ship



**2016 Jan**

Research started on the research background of autonomous ships



**2019 Aug**

First test with 3.3m model in lab



**2019 Dec**

Test with 3.3m model in real environment



**2020 Oct**

Test with 38m Tug Boat(T8) in real environment

**2021 ~**

SAS Applied to Segero-ho (L>130m, 9200MT)



**2024**

SAS Applied to Hanbando/Hannarae (L>109m, 6280MT)



**2023 ~**

SAS Applied to Container (L>360m, 15000TEU)



**2022 ~ 2023**

SAS Applied to Block Carrier (L>160m, 16100MT)



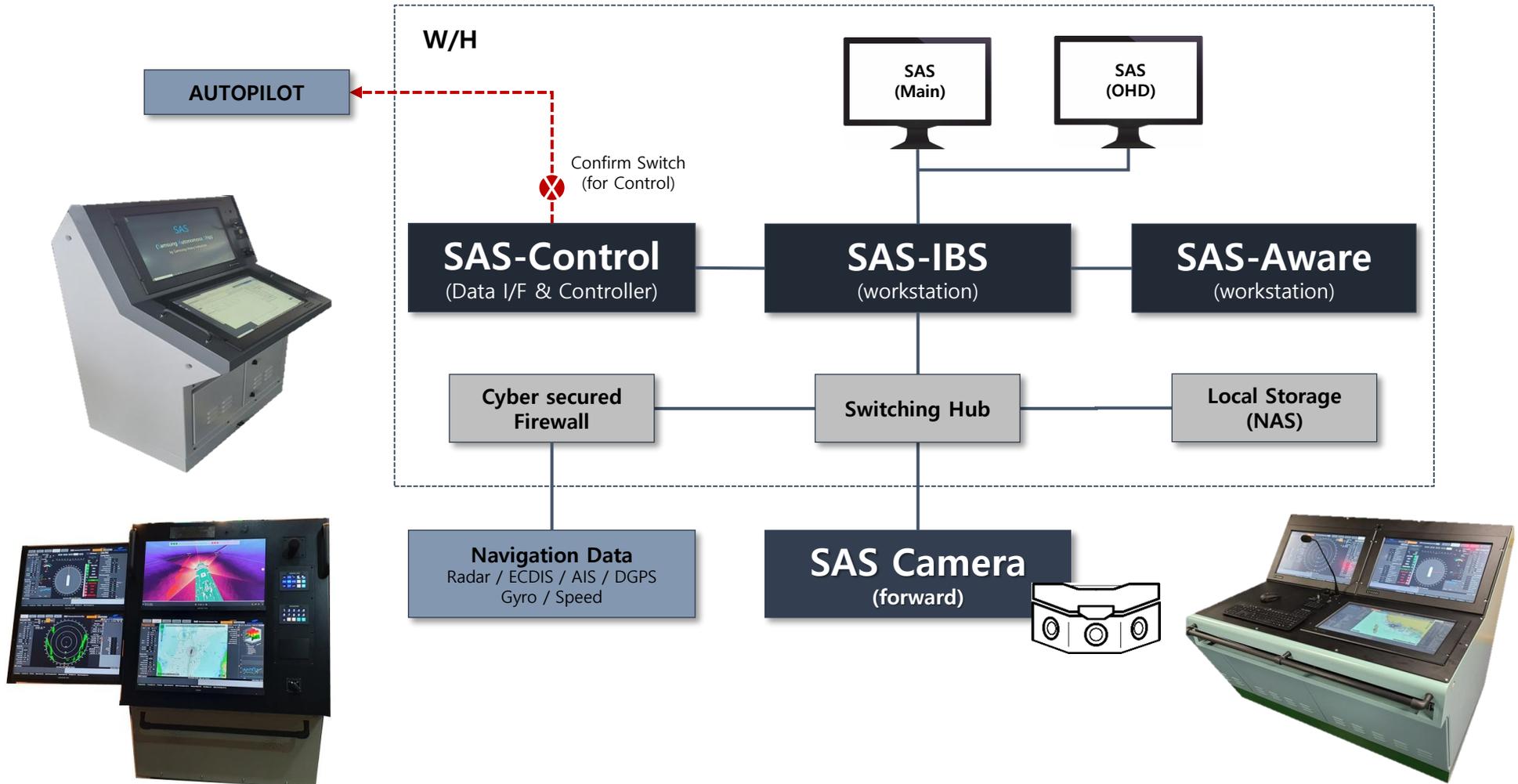
**2022 ~ 2023**

SAS Applied to LNGs (L>95m, 5700MT)

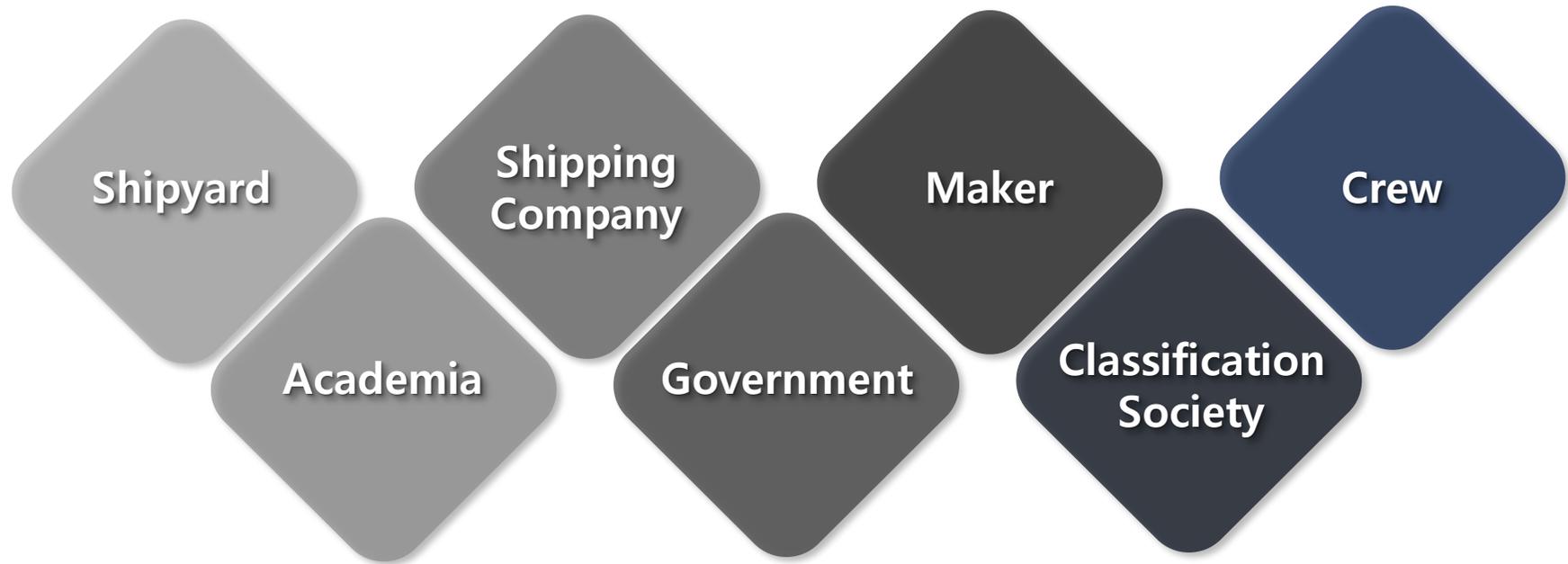


# Samsung Autonomous Ship, SAS

## ■ Configuration of SAS

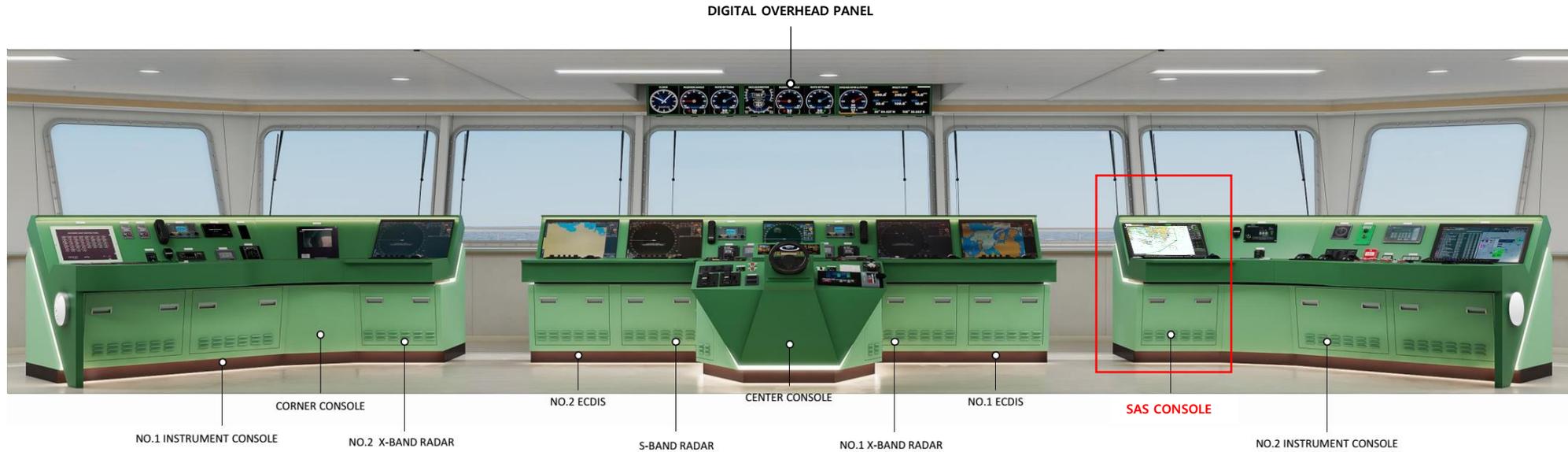


# Collaborative development



# Collaborative development

## ■ Shipyard - SHI BCC Design including SAS



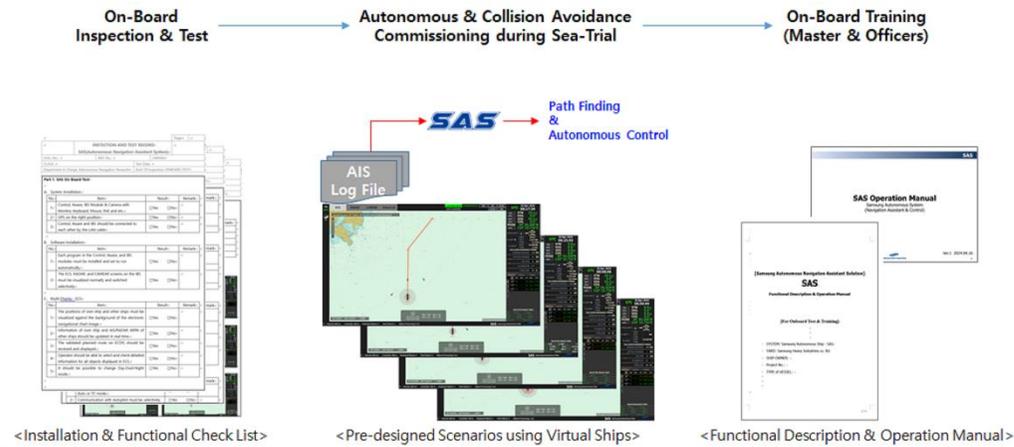
# Collaborative development

## ■ Shipping Company

Ships (shipping company)	SM JEJU No.2 (KOREALINE)	MegaCaravan (MEGALINE)	EVERMAX (EVERGREEN)
<b>Demonstration history and plans</b>	<ul style="list-style-type: none"> <li>• Initiated through joint research between Samsung Heavy Industries-KLCSM-KR('22)</li> <li>• Planned to secure and demonstrate coastal data for the South Sea route between Tongyeong and Jeju after installing the autonomous navigation system in June('23)</li> </ul> 	<ul style="list-style-type: none"> <li>• Launched through joint research between Samsung Heavy Industries and Megaline ('22)</li> <li>• Demonstration of South Sea route between Geoje and Yeongsung (China) after installation of autonomous navigation system in June ('23)</li> </ul> 	<ul style="list-style-type: none"> <li>• Launched through Samsung Heavy Industries-Evergreen joint research ('22)</li> <li>• Installed as a navigational assistance kit on a 15K Container Ship</li> <li>• Validation of Obstacle-Free Route suggestion and obtaining international route data as of delivery date ('23)</li> </ul> 

# Collaborative development

## ■ Crew - OnBoardTest & Commissioning Procedure



# Collaborative development

## ■ Maker (Ship Technology & Service Providers)

- BMS Interface



**Nabtesco**  
Precision Equipment Company

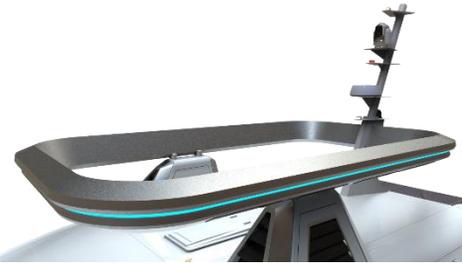
- Route Interface(RTZ) with ECDIS



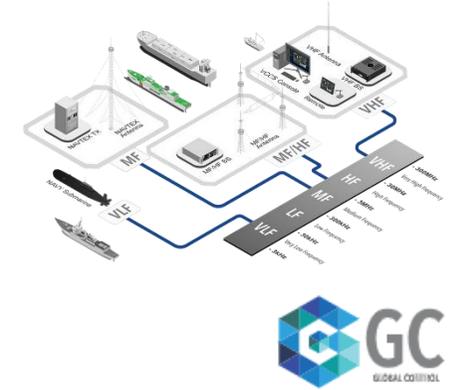
  
**marinenetworks**

**ROME**  
Electronics Technology

- Auto Navigational Light System



- Auto Communication System based on VHF



  
**GC**  
GLOBAL CONTROL

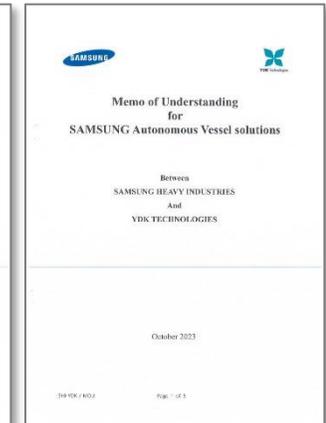
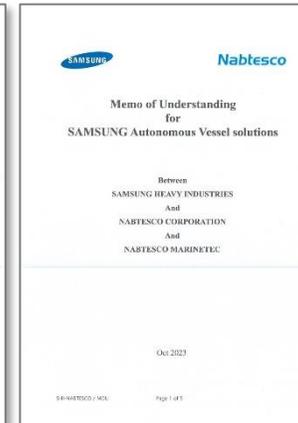
- MOU for SAMSUNG Autonomous Vessel Solutions

 *Japan Radio Co., Ltd.*

**FURUNO**  
**TOKYO KEIKI**

**Nabtesco**  
Precision Equipment Company

  
**YDK Technologies**



# Collaborative development

## Academia

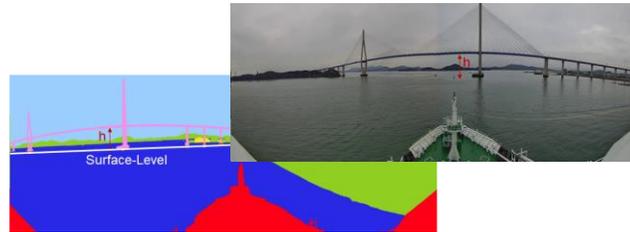


- Launched through joint research between Samsung Heavy Industries and Mokpo National Maritime University

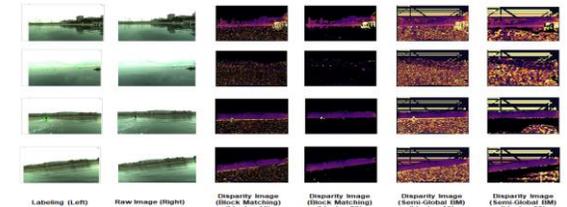
- Successful demonstration of autonomous vessels



- Development of object-specific segmentation technology for vessel image-based obstacle detection



- Stereo-based object location recognition method for USV autonomous driving in a maritime environment



- Launched through joint research between Samsung Heavy Industries and Korea Institute Of Marine and Fisheries Technology

- (Hannarae) Remote Operation Verification / (Hanbando) ECDIS Package Verification



- Real-time Navigational Risk Assessment

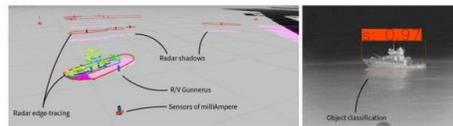


Figure 17 Sensor fusion of radar and lidar (left) and infrared camera (right)

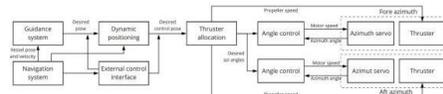
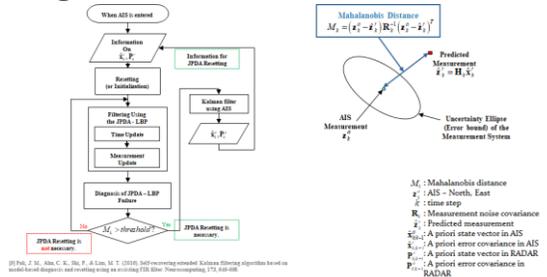


Figure 18 Motion control system



- Development of object recognition and tracking technology using radar signals



IP, Park, J. H., Ahn, C. K., Ba, P., & Lim, M. T. (2016). Self-organizing ensemble Kalman filtering algorithm based on model-based diagnosis and tracking using an extended IS filter. *Measurement*, 75, 408-416.

# Collaborative development

## Government

### Development of a standard model for waterway information for smart ships



**표준개발 · 국제활동**  
S-XXX ED. 1.0.0 Approval

**정책 및 법제화**  
수로정보 표준 도입 정책 세미나 개최

**수로정보 시뮬레이션 & 실증**  
자율운항선박 실선 실험역 검증

**시뮬레이션**

**실선 실험역 실증**

### Demonstration of unmanned/remote maritime logistics transportation service using autonomous ships



- ROUTE PLANNING
  - 자율 항해 출발 승인, VTS 출항 통보
  - 원격 or 승선 OPERATOR : 이만 후 WP1 이동
- WP 0 (자율항해 Starting Point)
  - 자율항해 시스템 재점검
  - 컨트롤 연동 이상 유무 확인
  - 자율항해 컨트롤 연동 START
- WP 1 → WP 2
  - 타선 조우상황 연동, 자율항해 시스템 승도리피 시연
- WP 4 → WP 5
  - ROC 통신 두절 상황 연동
  - 자동 알람, 승선자 상황 전파
  - 비상 대응 프로세스에 따라 시스템 자동 대응
  - 통신 시스템 복구 및 ROC 연결
  - 상태 확인 및 자율항해 재시작
- WP 7
  - 최종 WP 도착
  - 시스템 상태 확인
  - 자율항해 컨트롤 연동 종료
  - 원격 or 승선 OPERATOR : 작업실시 이동 및 집안

**VTS 원격 제어**

**항해상황 대응 안정성**

**비상 대응 HMI 원격 제어**

**원격 제어**

\*ROC(Remote Operation Center) : 원격제어센터  
\*WP(Way Point) : 경유지  
\*OTA(Over-the-Air) : 무선 소프트웨어 업데이트  
\*VTS(Vessel Traffic Service) : 해상교통관제시스템  
\*HMI(Human Machine Interface) : 인간-기계 상호작용

### Demonstration of autonomous navigation-based eco-friendly mobility service



**실증장소 : 감천(대전시 유성구/서구 일원), 대청호(대전시 동구/대덕구 일원) 등**

• 대전 주요 도심, 주요관광지(엑스포공원, 한밭수목원 등)를 관통하는 국가하천

• 갑천 중심권이 정부의 국제경수형 여간관광 특화도시로 지정(23.3.)

• 둔산대로 중심으로 도용가동보 등이 설치되어, 수위 확보 가능

• 현재 수상레저용으로 활용 중

### Establishment of autonomous ship-based maritime transportation system infrastructure



# Collaborative development

## Classification Society



- Risk assessment(HAZID) by CLASS
- Inspection for System I/F and Autonomous Function by CLASS

**RISK ANALYSIS FOR SAMSUNG AUTONOMOUS NAVIGATION SYSTEM FOR SEGERO**  
HAZID Report

**SURVEY REPORT**  
Class No.: 1800106  
**SEGERO**

Name of Ship: SEGERO      IMO No.: 987207  
Official No.: 18P-180219      Gross Tonnage(TTC): 6,196.00 (6,196)  
Flag/Port of Registry: KOREA / MOKPO      Other Class: -  
Class Notation: «RSE1 SPECIAL PURPOSE SHIP  
TRAINING CLEANLY IWS HW PSPC DPS US U

«RSM1 UMS BYE EYOM DPS(1)

Owner: Republic of Korea(Min. of Education)  
Manager: Republic of Korea(Min. of Education)  
Tech. Manager: MOPVO NATIONAL MARITIME UNIVERSITY

Place of Survey: MOPVO      Review: 2022-10-31  
First Visit: (Dry-Dock: -) (Voyage Survey: ) (Remote-Survey: )  
Last Visit: (Dry-Dock: -) (Voyage Survey: ) (Remote-Survey: )

The undersigned surveyor(s) has/have carried out the below survey(s) satisfactorily

Surveyor (H): BAEK Youngchul      Surveyor (M): BAEK Youngchul  
Surveyor (L): JUNG Heju      Verified



- ClassNK P&S certification related to smart ship in progress
- Rule amendment for Computer-based system based on IACS UR E22 Rev.3

**ClassNK Innovation Endorsement**  
Third-party certification of innovations and initiatives (concepts and real services)  
Convincing stakeholders of feasibility and value of the innovations  
Developing adequate and accountable standards for emerging tech

	Digital	Green	Safety	Labor
<b>Ships</b> Notations on Class Cert.	Digital Smart Ship (DSS)	Advanced Environmental Awareness (A-EA)	Advanced Safety (A-SAFE)	Excellent Accommodation (E-ACC)
<b>Products &amp; Solutions</b>	ESM, E-Log Book, Data Quality	Hydro for Energy Efficiency	Navigation Monitoring, Alerting	Low Cable Vibration
<b>Providers</b>	System Integrator	Revolving Yard, EEO Phase II	Traffic Control Support	Remote Hospital

**& YOURS**

**Proposal of "Digital Smart Ship" Notation**      ClassNK Innovation Endorsement

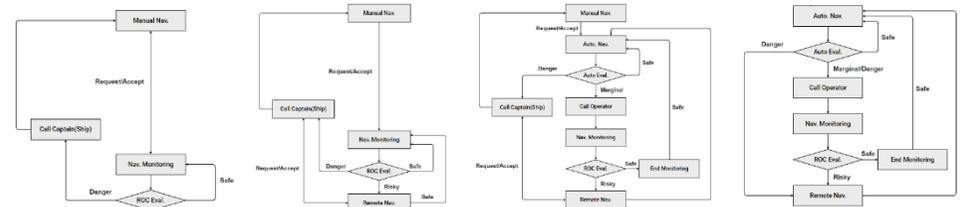
**Characters** ✓ There is a high possibility that the following items is affixed to your good ship!

✓ 1. Energy Efficiency	DSS(EE)	Fuel consumption optimization
✓ 2. Hull Monitoring	DSS(HM)	Class NK Rules for Hull Monitoring System
✓ 3. Machinery Monitoring	DSS(MM)	CEM including ClassNK CMAXS
✓ 4. Connected Ship	DSS(CNS)	ISO 19847, Satellite data communication
5. Slushing	DSS(SLOSH)	Slushing detection system
✓ 6. Shore Monitoring	DSS(SM)	Shore monitoring system
7. On Board Local Area Network	DSS(LAN)	Local Area Network for Ship
8. Refrigerated Cargo Shore Monitoring	DSS(RCSM)	Refrigerated Cargo Area / Container data shore monitoring
9. Emission Shore Monitoring	DSS(ESM)	Engine emission data shore monitoring

**Example**  
To be expanded flexibly by clients' needs and industry situation



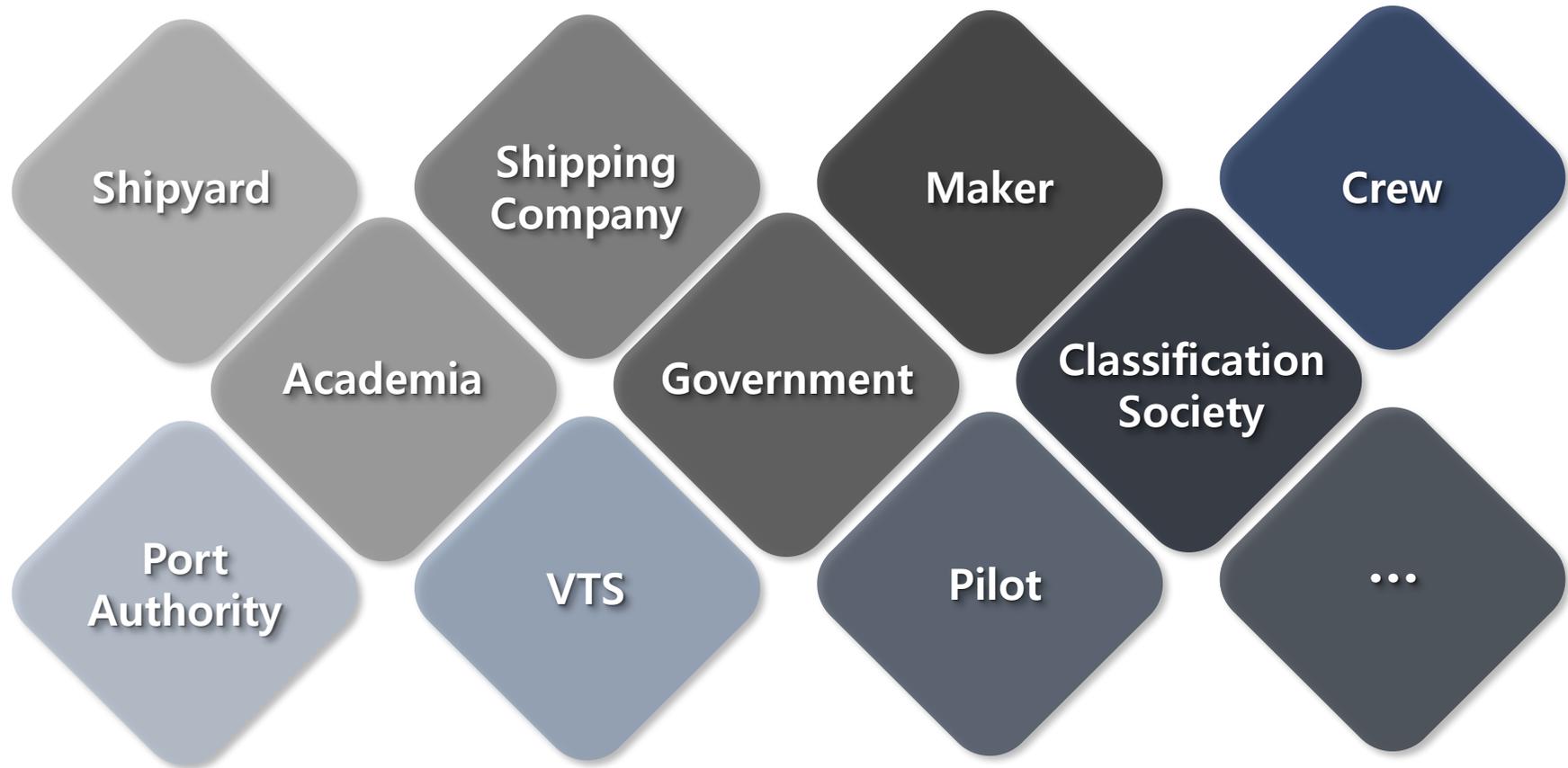
- JDP for Samsung Remote Operation Center AiP



ROC ConOps Based on MASS Level

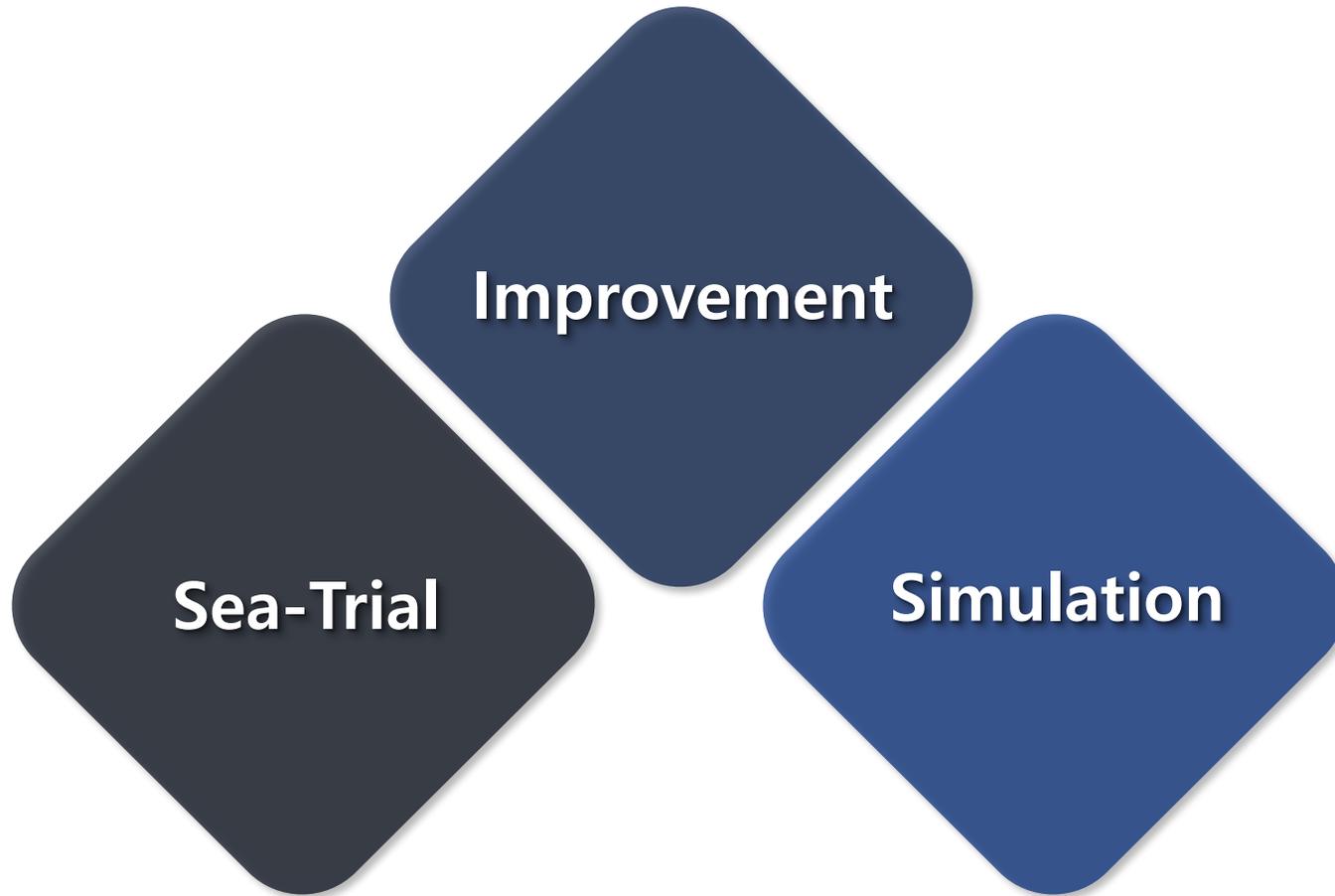
# Collaborative development

## ■ Plan for the other parties



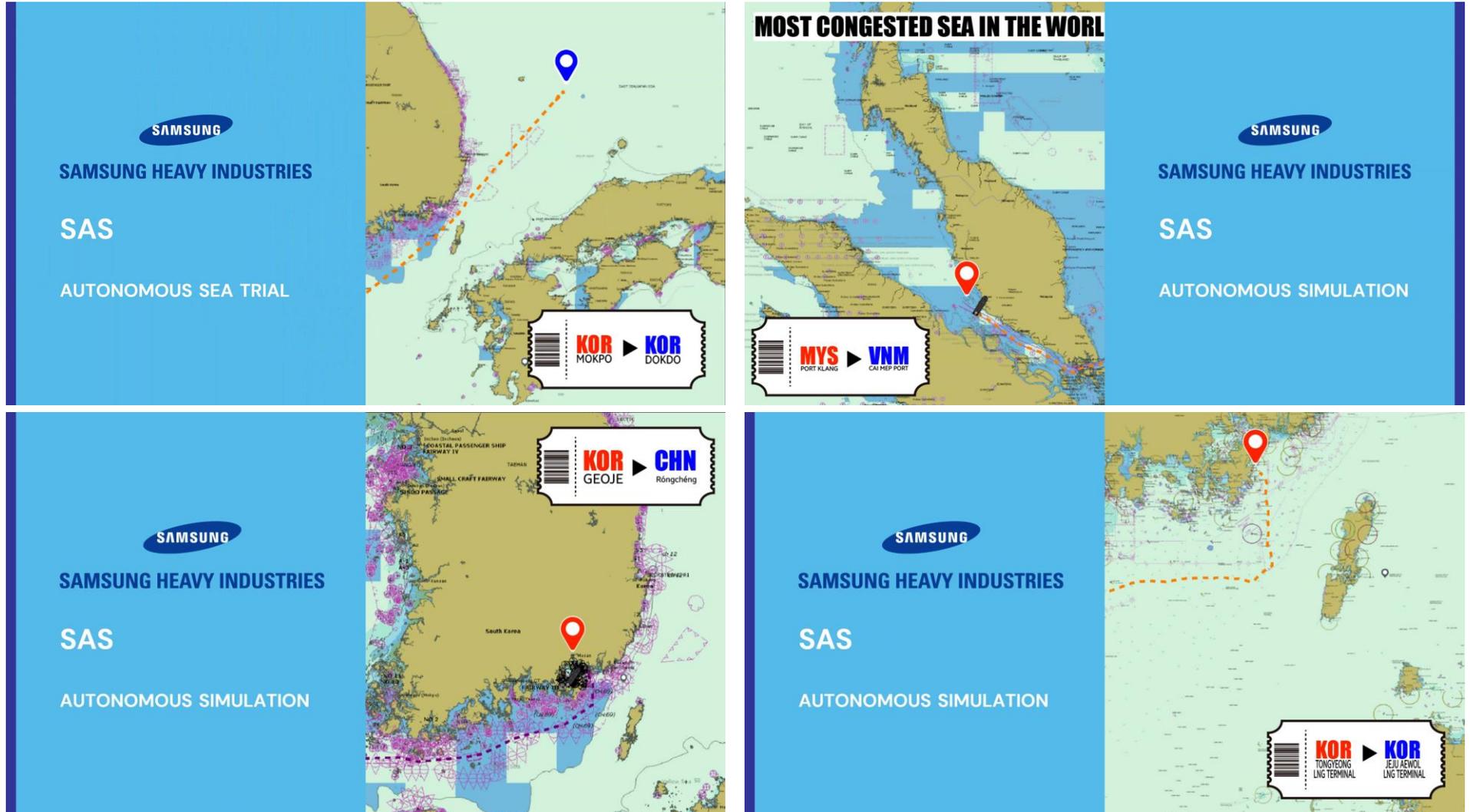
# Harmonized technology

---



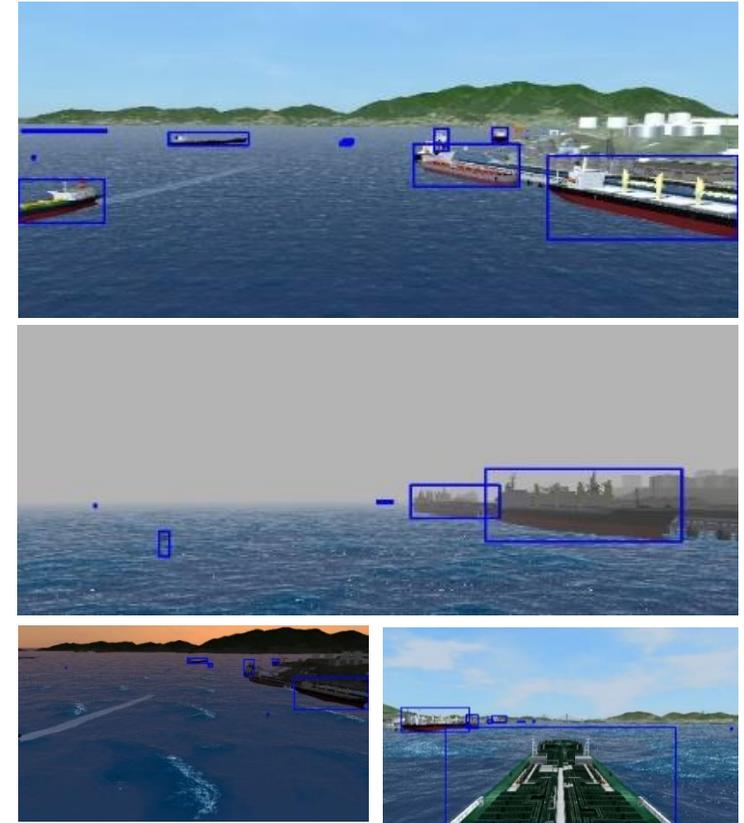
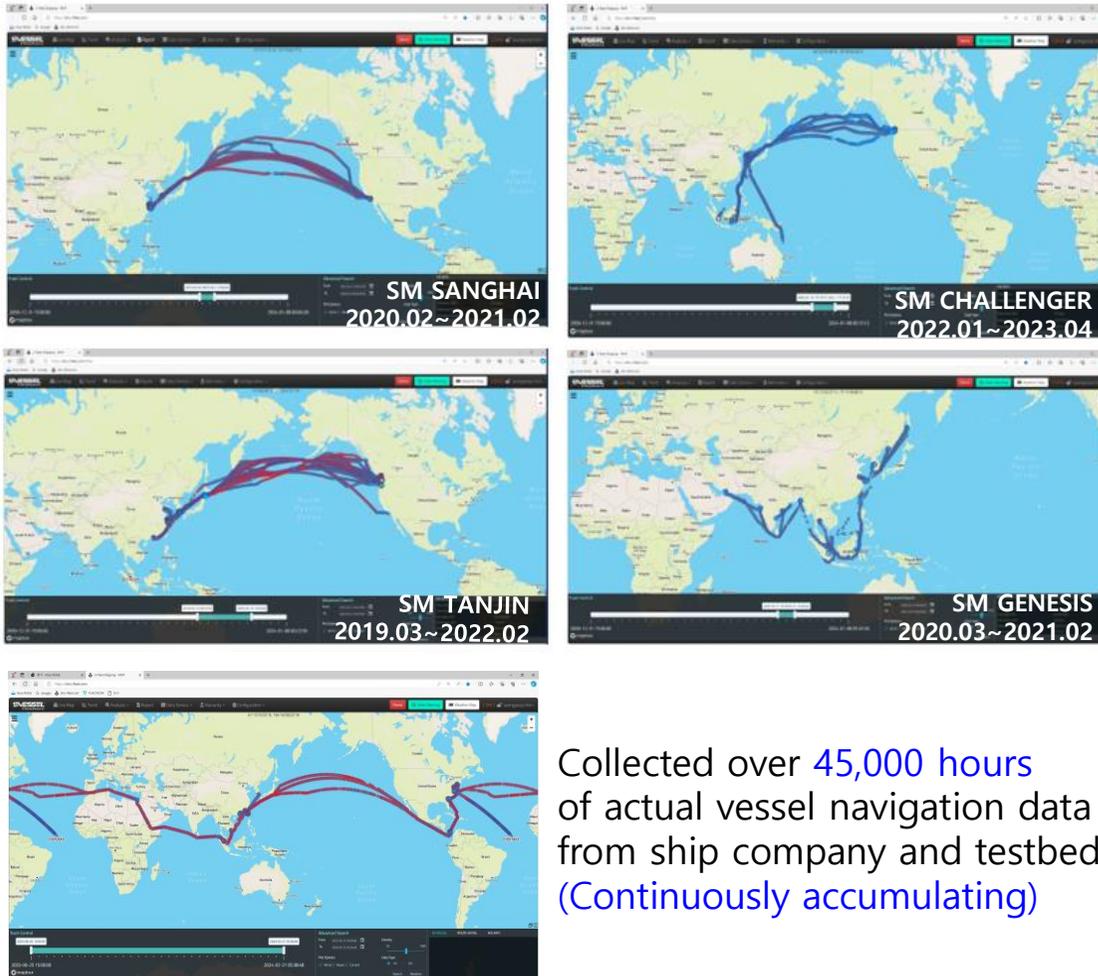
# Harmonized technology

## ■ Sea-Trial



# Harmonized technology

## ■ Simulation



**3D VIRTUAL ENVIRONMENT DATA**

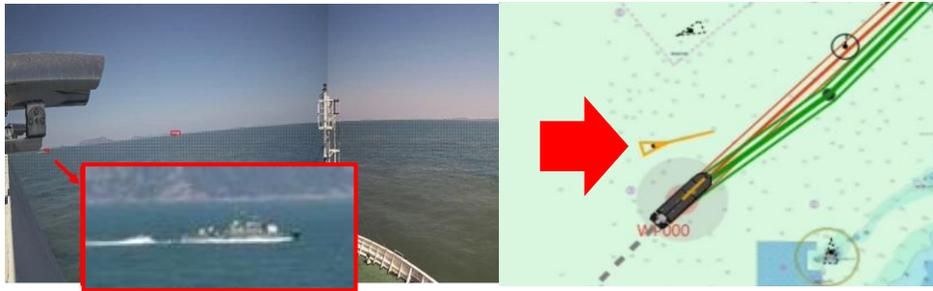
Autonomous navigation simulation is performed by creating a virtual vessel in 3D space reflected ship dynamics model, waves, and weather environment factors.

# Harmonized technology

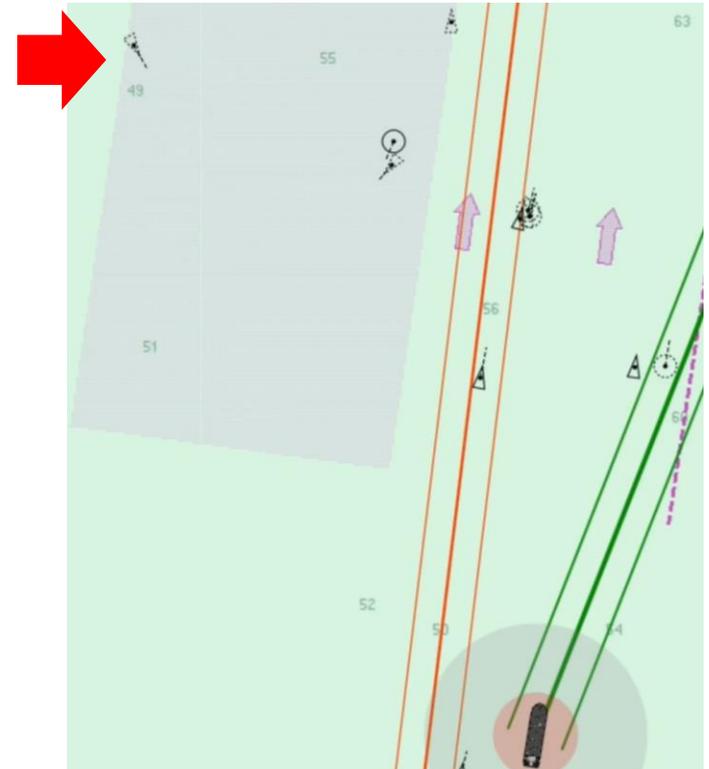
## ■ Improvement – Situation Awareness

- **SAS-Aware system can generate recommended route to avoid non-AIS obstacles.**
  - For generating accurate recommended route, **we focus the computation about stable obstacle movement.**  
COG and SOG

Case 1: Military vessel



- Case 3: non-AIS vessel (video)



Case 2: Towed barge

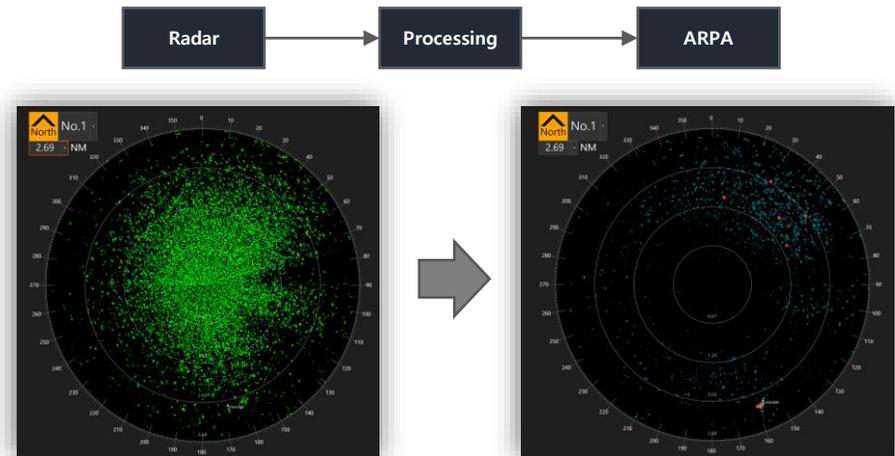
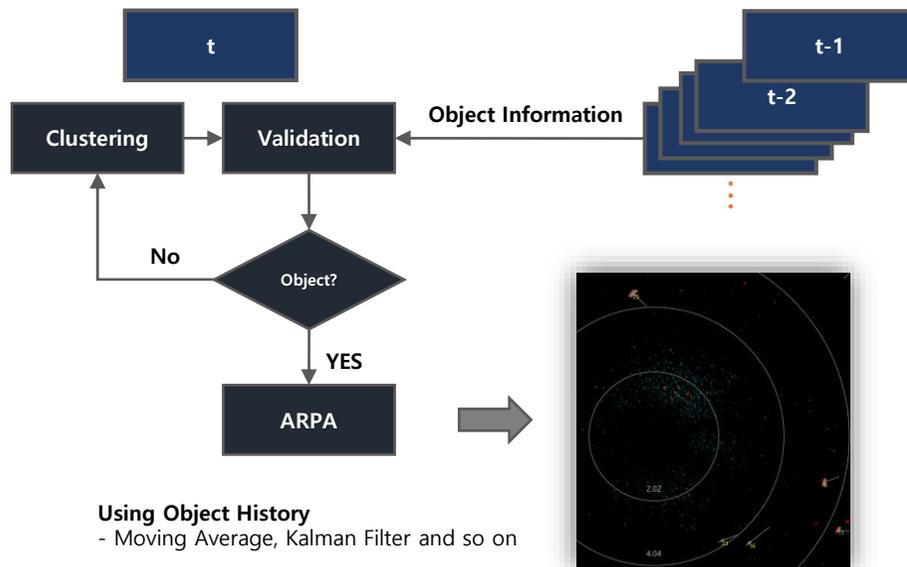


# Harmonized technology

## ■ Improvement – Situation Awareness

### - SAS-Aware system using self-generated ARPA(Automatic Radar Plotting Aid).

- To produce an ARPA using Moving Average, Kalman filter and so on.
- Using self-generated ARPA has an advantage due to using like a navigator instead of using simple RADAR echo(or image).



# Harmonized technology

## ■ Improvement – Grounding Avoidance

### Situational Awareness Info.

- AIS
- RADAR ARPA
- Vision Fusion

### ENC Data

- Bridge
- Coastline
- Restricted Area
- Sounding

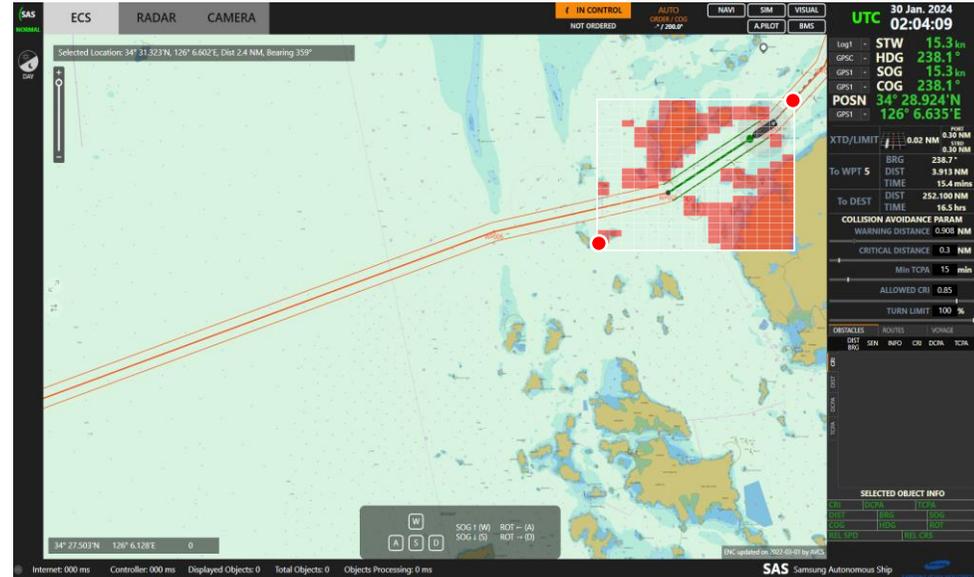
processing by category →

S-57

### Geo Objects Classes

- Land
- Depth contours
- Depth area
- 
- 
- Buoy locations
- Offshore platforms
- Bridge pylons

Min.Depth  (m)



- Ship Position/Route/COG/...
- Local Path-finding Area(with Grid size)
- ENC Data Extraction & Update
- Data Area → Grid Creation
- ENC Data – Grid Mapping
- **Object Grid → Navigable vs. Unnavigable**

# Harmonized technology

## Improvement – Grounding Avoidance

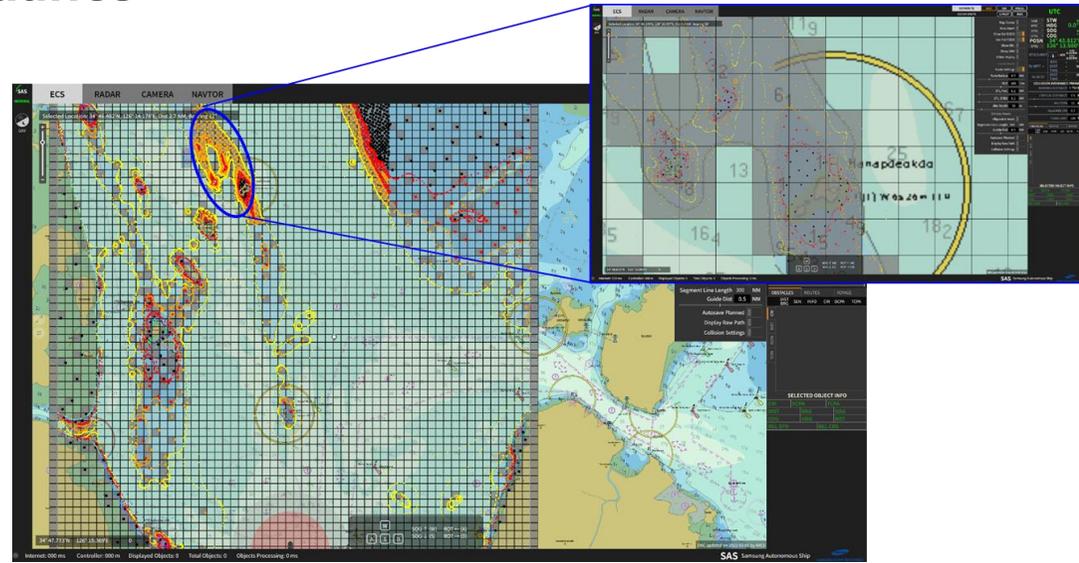
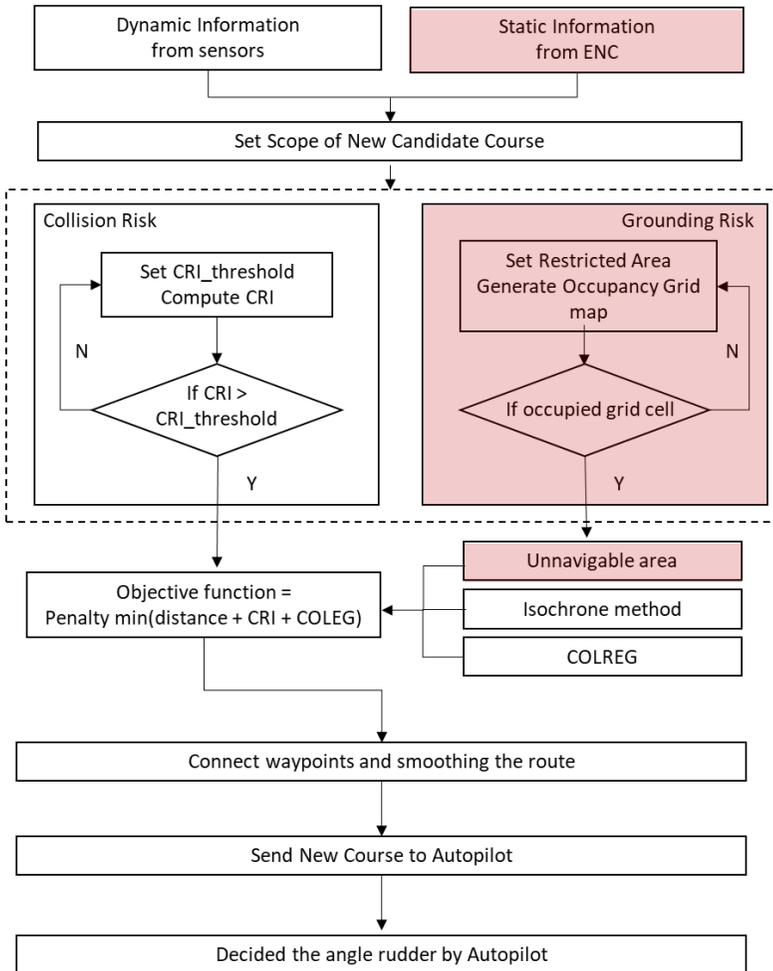
Situational Awareness

Risk Assessment

Path Finding

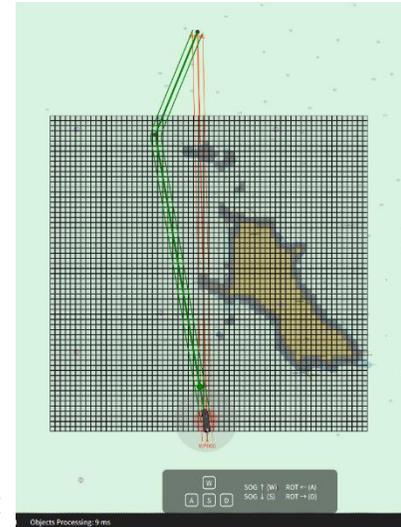
Decision Making

Control



ENC Data Extraction

- Sounding
- Depth Contour
- Grid for (Un)navigable Area



Island Grounding Avoidance Test

# Harmonized technology

## Improvement – ODD/OE

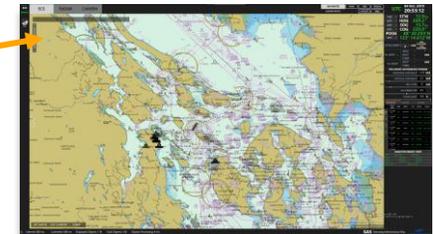
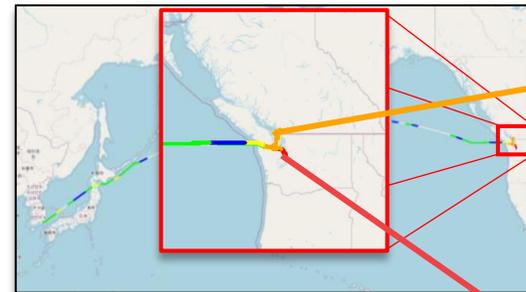
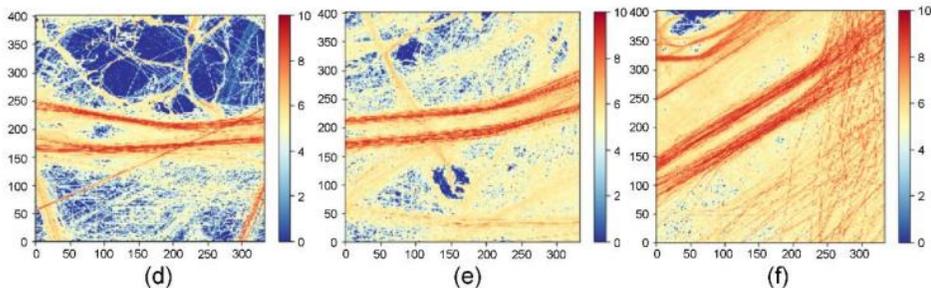
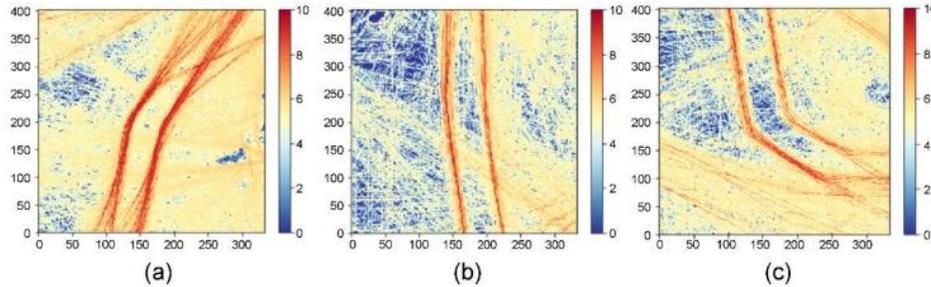
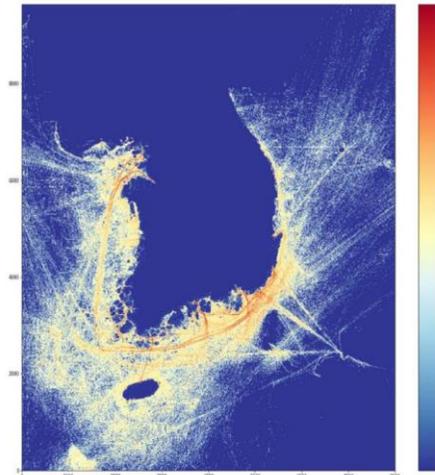
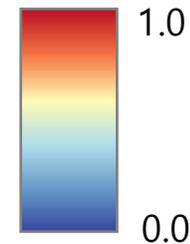
### - Design the index to determine ODD/OE of SAS system

- The index takes into account Number of Objects, Distance, DCPA, CRI etc.
- Define the area of operations, including coverage/connectivity and traffic condition along the Korean coast.

$$P_{RRA} = f(Dist_{risk}, DCPA_{mean}, TCPA_{risk}, CRI_{risk}, CRI_{mean})$$

$$0.0 \leq P_{RRA} \leq 1.0$$

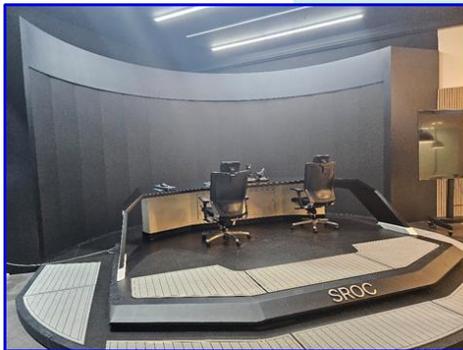
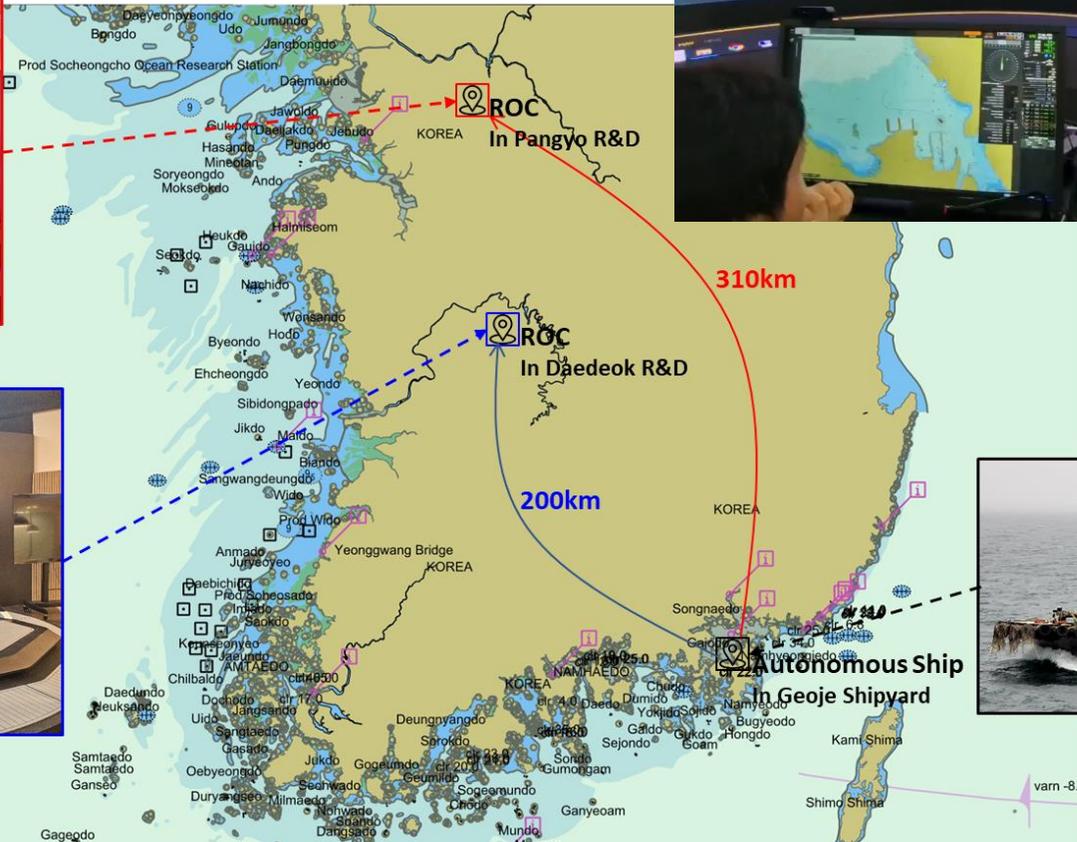
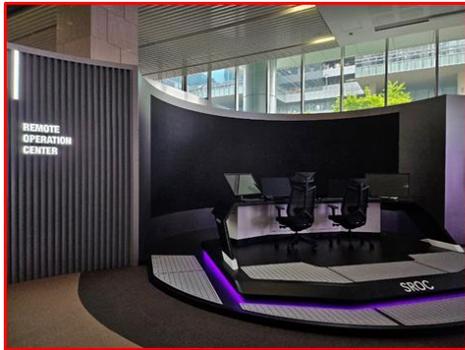
(※Consider Number of Objects, Actual Distance, DCPA, CRI)



# Harmonized technology

## Improvement – Remote Operation

- LTE / 5G / Starlink Network : Nav. Signals, Vision Image
- CBM Monitoring
- Around View
- Remote Navigation



# Various type of MASS

## High Technical Requirements:

The complexity and sophisticated design demand in the MASS technology present significant challenges.

## Diverse Customer Needs:

Customer requirements vary widely from small vessels to large ships, necessitating a flexible approach to MASS solutions.



# Various type of MASS

## ■ Small ship Test-bed

Ships (shipping company)	T-Ship (Electrine)	Marine Nuri (KRISO)	SAMSUNG T8 (Samsung Heavy Industry)	SeaDrone (Samsung Heavy Industry)	Lefishing Boat (HLB)
<b>Demonstration history and plans</b>	<ul style="list-style-type: none"> <li>• <b>Samsung Heavy Industry</b> Initiated through Electrine collaboration ('22)</li> <li>• 4.5 meter vessel for testing small ship/boat autonomous navigation systems</li> <li>• Developing a system suitable for the marine operating environment of boats/fishing vessels</li> </ul> 	<ul style="list-style-type: none"> <li>• KASS National Project Autonomous System Demonstration Vessel(built by KRISO in '23)</li> <li>• Utilized as an infrastructure for national R&amp;D and industry technology demonstration and verification along with the Autonomous Ship Demonstration Research Center</li> <li>• Conducted demonstration of virtual other ship collision avoidance in conjunction with SHI autonomous Navigation system ('23)</li> </ul> 	<ul style="list-style-type: none"> <li>• Tugboat (38m) for the Movement of Samsung Heavy Industries Construction Ships</li> <li>• Installed autonomous navigation system and demonstrated first collision avoidance ('20)</li> <li>• '23 Continued demonstration of situational awareness systems (radar-only obstacle recognition, radar-vision fusion recognition, etc)</li> </ul> 	<ul style="list-style-type: none"> <li>• Autonomous TEST Small Vessels</li> <li>• Small craft situational awareness and autonomous navigation testing continues</li> <li>• Research and Application of Outboard Speed Control Interface</li> <li>• Research and Application of Autonomous Berthing Technology</li> </ul> 	<ul style="list-style-type: none"> <li>• Leisure Boat developed by HLB (coming soon with SAS-BOAT)</li> <li>• Conducted real-obstacle collision avoidance autonomous navigation tests ('23)</li> </ul> 

# Development technology for various ship sizes

## ■ Small Ship : SHIFT-Auto (Samsung Heavy Industry Future Shuttle - Auto)

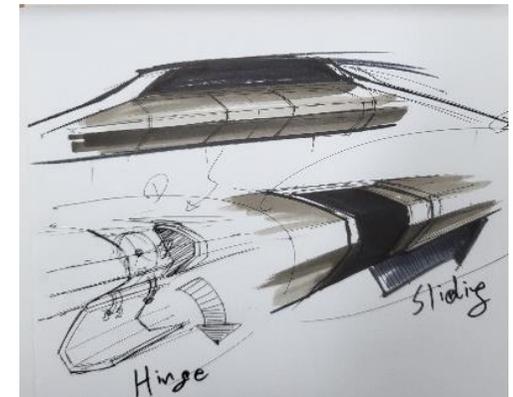
- Present model of future mobility appearance
- Comfortable accessibility and familiar transport
- Highest safety standards, ensuring a smooth and trouble-free board



# Development technology for various ship sizes

## ■ SHIFT-Auto (Samsung Heavy Industry Future Shuttle - Auto)

- Digital + Autonomous(Unmanned) + Laboratory
- HMI(Human Machine Interface)







# Thank you



SAMSUNG

SAMSUNG HEAVY INDUSTRIES