MASS Technology Development & Commercialization Status

Status report on MASS technology and outlook for future MASS operations

5-6th September 2022

Avikus
MARITIME AUTONOMOUS PIONEER

Research Engineer **Hyogyeong Joo**

Pioneer in Autonomous Ship Technology

Maritime Autonomous Pioneer

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Maritime Autonomous Pioneer

Smart to Autonomous

Journey to Autonomous Ship of HHI Group

The autonomous ship is inevitable in terms of safety and economy

Smart System (2014~)

Assistant System (2019~)

Autonomous System (2024~)

'14

Collision Avoidance Support System(HiCASS)

'17

Integrated Smart Ship Solution(ISS)

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Equipment Management Solution(HiEMS)

Digital Innovation(DI) Center

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Navigation Assistant System(HiNAS)

Berthing Assistant System(HiBAS)

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Found of Avikus

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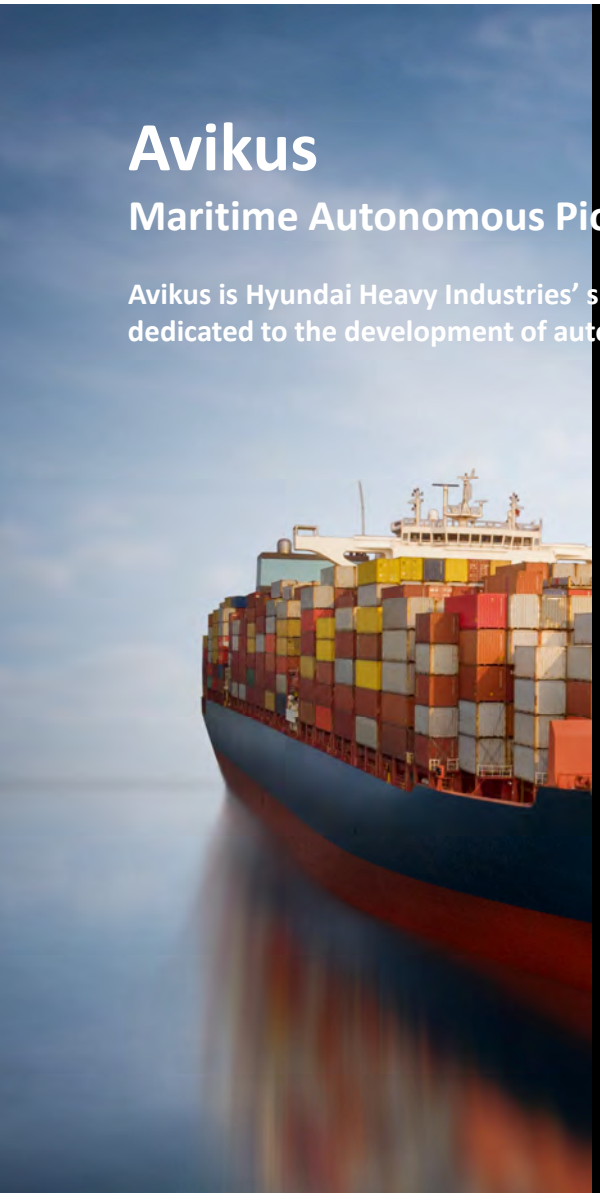
Pohang Canal Autonomous Navigation

CES 2022

'23

ICT Integrated Electric Propulsion Smart Ship

Trans Ocean Autonomous Ship Test (HiNAS2.0)



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Maritime Autonomous Pioneer

Avikus is Hyundai Heavy Industries' spin-off start-up dedicated to the development of autonomous navigation solutions.

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"Our mission is to achieve accident-free navigation through 'revolutionizing marine mobility' with autonomous technology"

Safe

AI(Artificial Intelligent) and ML(Machine Learning) reduce marine accidents caused by human error

Convenient

Modern UI/UX for optimal usability and ergonomics and intuitive GUI help inexperienced crew

Profitable

Crew optimization, route planning, and risk reduction bring improved economics

Solutions

Status Report on MASS Technology

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Key Technology

for autonomous system from detection to control

Detection

- Vision Sensing
- Sensor Fusion

Situation Analysis

- AR Visualization
- Surround View

Planning

- Route Planning
- Route Optimization

Control

- Autonomous Control
- Auto Docking

HiNAS for ships (NAS/ BAS)

Hyundai intelligent Navigation Assistant System

AiBOAT for boats

Avikus intelligent Boat Autonomous Solution

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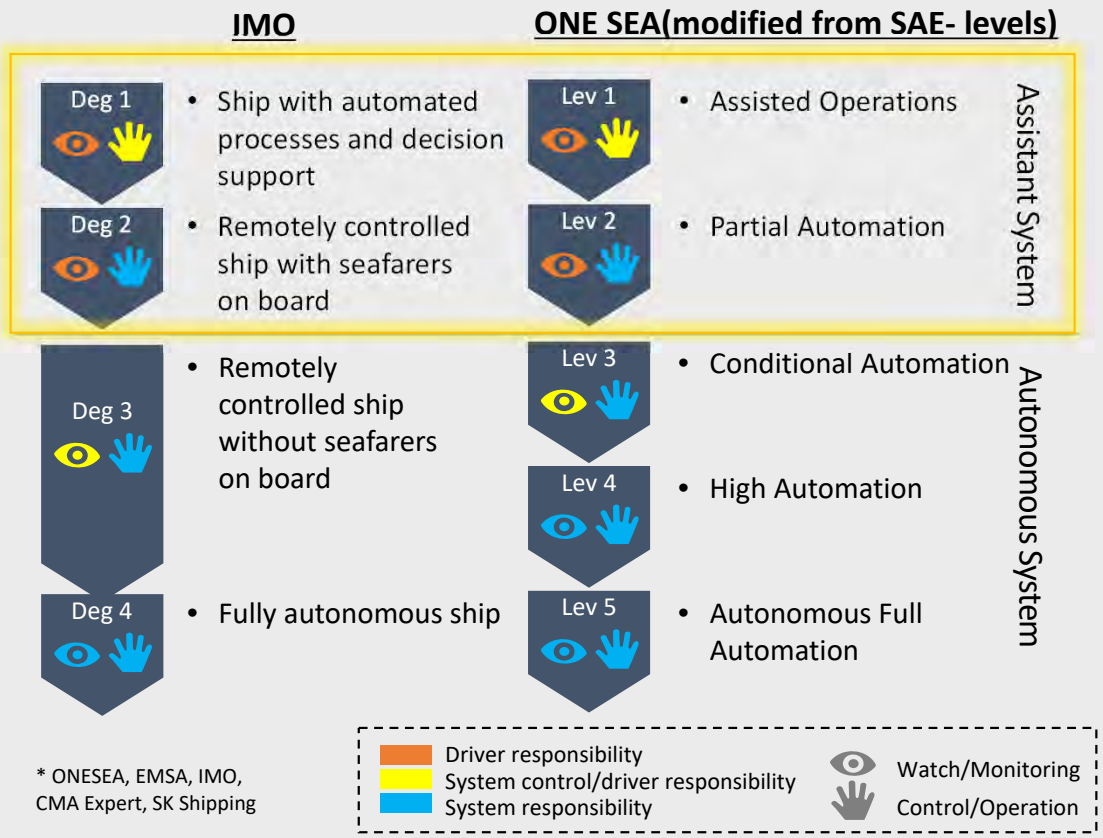
Degree of Autonomy

focusing on commercialization of degree 1&2 solutions



* ONESEA, EMSA, IMO,
CMA Expert, SK Shipping

"As long as the watch duty of the crew is maintained, **degree/level 1 and 2** autonomous assistant systems are **in compliance with current regulations**"

		HiNAS/BAS
Navigation **A**ssistant **S**ystem	**1.0** - Situational Awareness	Retrofit/Standard at HHI
	2.0 - Control	Retrofit/Standard at HHI in '23
Berthing **A**ssistant **S**ystem	**1.0** - Situational Awareness	Retrofit/Standard at HHI in '23
	2.0 - Control	Available in 2023

Record breaking orders
Global coverage

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Autonomous Systems for Ships

Detection — Situation Analysis — Planning — Control

Degree 1/Level 1 — **HiNAS / HiBAS**

Degree 1/Level 2 — **HiNAS 2.0**

HiNAS(Navigation)

HiBAS(Berthing)

HiNAS 2.0(Control)

Vision Sensing | **Sensor Fusion** | **AR Visualization**

*OTA software update

AR Visualization Top-view Image | **Distance Estimation** | **3D BAS**

Autonomous Nav. with Collision Avoidance

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HiNAS Navigation Assistant System

Computer vision & deep learning-based objects detections
→ **Algorithm was developed based on more than 5M data points**

Algorithm test for infrared camera data
→ **to detect obstacles at night or restricted visibility**

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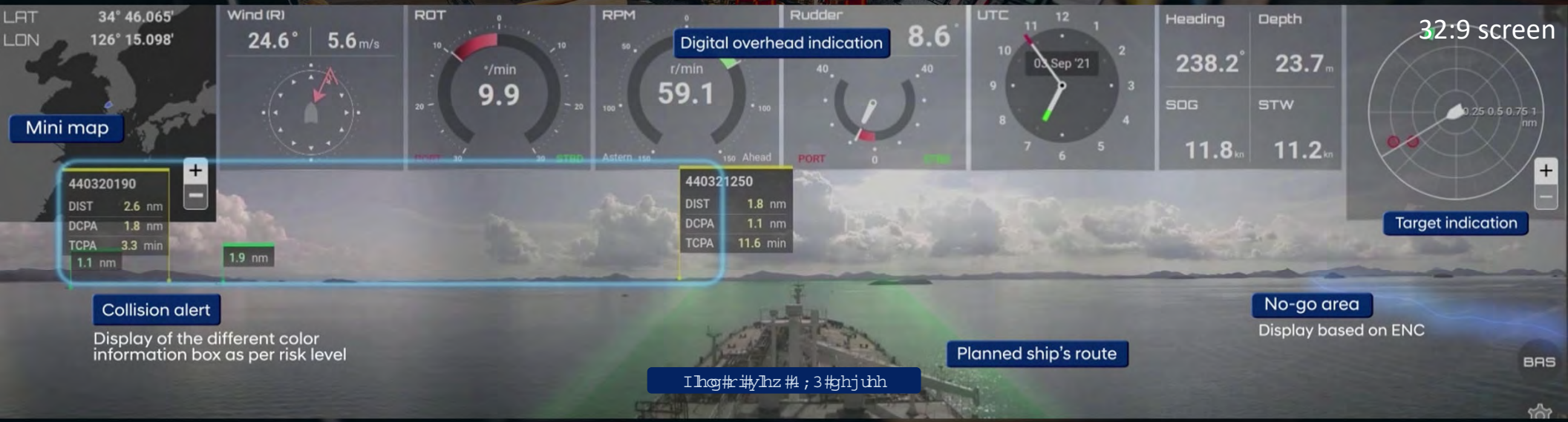
HiNAS Navigation Assistant System

S-band Radar / X-band Radar / AIS / EO & IR Camera

→ Through sensor fusion algorithm, it is possible to recognize the situation comprehensively, accurately and with high stability



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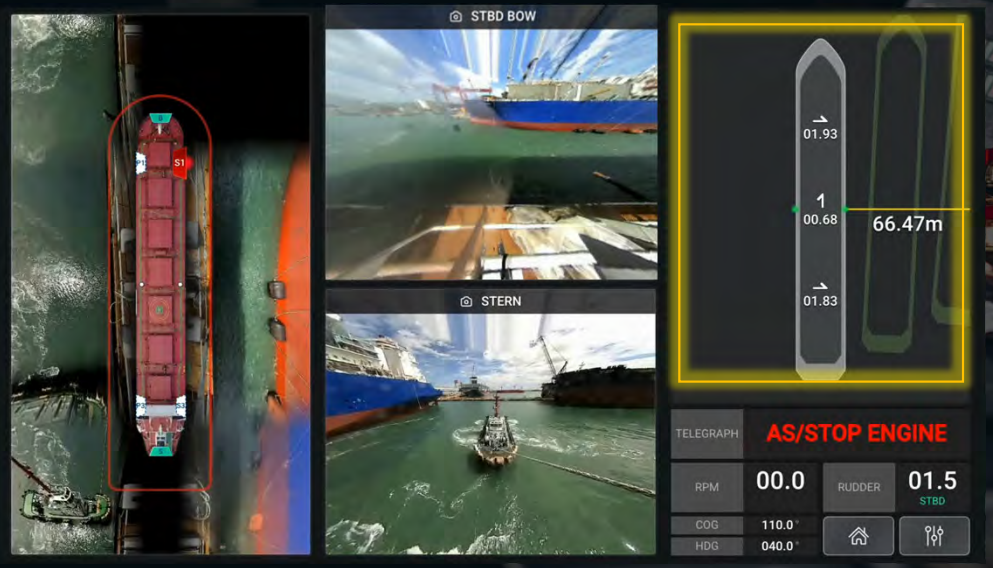
HiBAS Berthing Assistant System



- 360-degree top view AR image
- 32-channel LiDAR installed as standard
- Distance alarm with predictive ship dynamics

- 3D BAS using the surrounding camera
- Available to various vessel types

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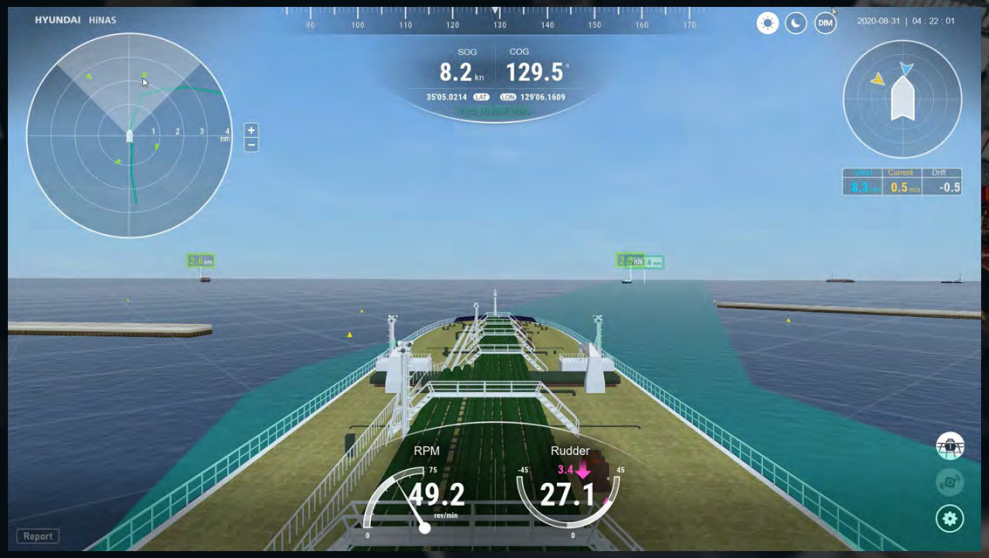
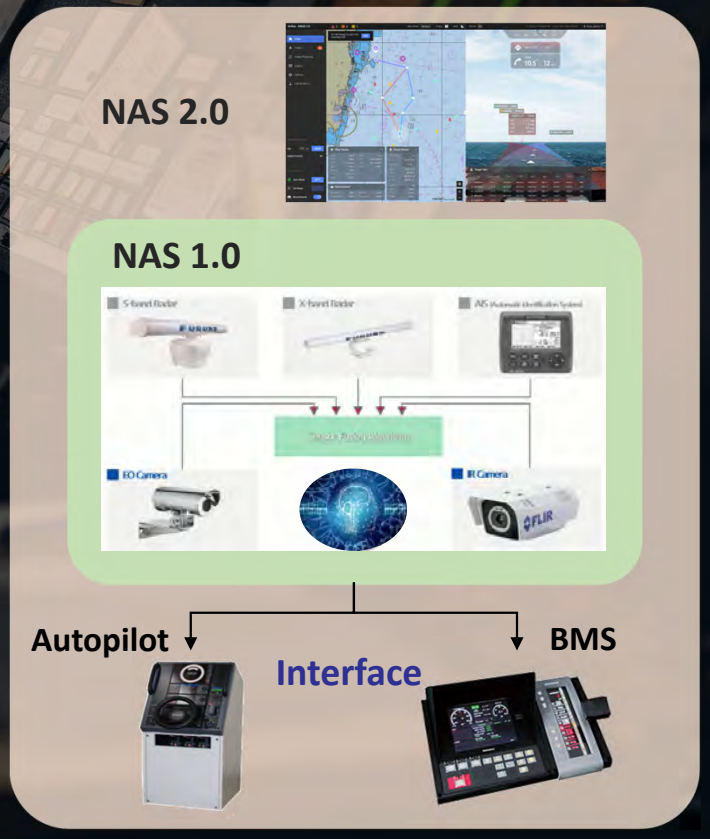
HiNAS 2.0 Navigation Assistant System with Control



- Route optimization
- Following and altering course autonomously
- Autonomous collision avoidance
- Incorporating experienced captain’s know-how into algorithms



Technology Demonstration

From the World's First to the World's Best

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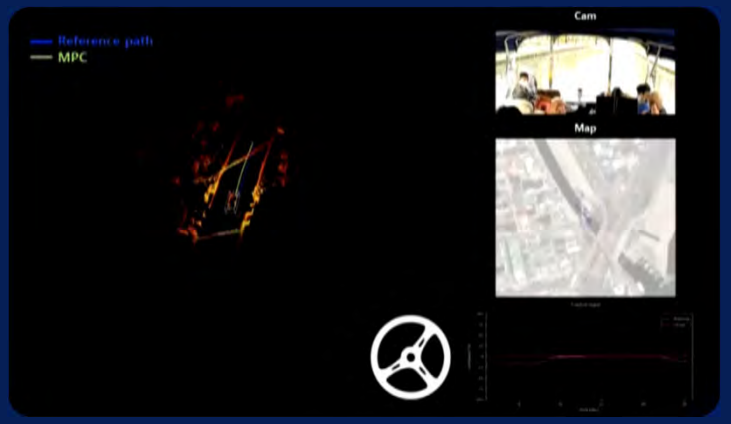
World's 1st Canal Cruise Autonomous Navigation Test

Pohang Canal Cruise Autonomous Navigation Test

10 Pohang Canal **km**

0 without human intervention **take over**

10 with the help of **sensors**



16th Jun. 2021 (Avikus-KAIST)

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World's 1st Transoceanic Voyage with HiNAS 2.0

SK Shipping 180K LNGC
'PRISM COURAGE'
built by HHI

Autonomous route control

10,000km, 350hour navigation
without any human intervention

Autonomous collision avoidance

100 encounters, after collision risk assessment
70 course keeping, **30** avoidance

Route optimization

increased fuel efficiency 7%

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HiNAS 2.0 Continuous Voyage to Higher Autonomous Nav.

HiCASS (2012~2018)

- Collision Avoidance Support System
- Verification of its usability in real-round voyages(2014)

HiNAS2.0 & HILS (2019~2022)

- HiNAS/HiCASS integration with control H/W interface
- Extensive verification & validation using hardware in the loop simulation(HILS) with ABS and SK shipping

Transoceanic Voyage (2021~2022)

- HHI yard sea trial test for system verification
- Transoceanic autonomous navigation (10,000 km, medium congested area)
- Statement of facts(SOF) from ABS classification

Commercialization (2022~2023)

- Class certification
  - ABS AIP('22/6)
  - PDA('22/12)
  - DNV TA('23/5)
  - KR TA('23/5) with Liberia flag and HHI shipyard
- HHI new building spec-in in '23

Commercialization Status

World-Leading in Commercialization

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Commercialization Status

HiNAS / HiBAS

Degree 1/Level 1

- Currently the highest level of commercialized solution through **HHI new building spec-in**
- Receiving orders of about 230 ships

HiNAS 2.0

Degree 1/Level 2

- Receiving orders of 23 ships
- Planned to receive class certifications
  ABS AIP('22/6), PDA('22/12), DNV TA('23/6)
- **HHI new building spec-in in '23**

In parallel to our current products, we do research and development for degree 3 & 4 solutions

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Value Proposition for Autonomous Assistant System

The sea is constantly **challenging** us

More than 80% of maritime accidents are due to human error

Increasing lack of experienced seafarer

New environmental regulations and increased competition drives down margins

Improve safety

- **Reducing human error**
- **Possibility of insurance discount**

Assist seafarer

- **Assisting with algorithms that incorporate experienced captain's know-how**

Reduce OPEX

- **Increasing fuel efficiency**
- **Reducing GHG emission**

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Summary

In spite of competition, cooperation is also necessary

Degree 1 & 2

- No big problem right now as the responsibility is on the seafarer because it's just an assistant system
- Possibility of unrecognized potential risk in the system and equipment integration
- Need to identify potential risks and considerations while applying and operating relevant regulations

Degree 3 & 4

- Many problems that are not covered by existing regulations because the seafarers are not on board
- Need for legislation/amendment and international consensus for early commercialization of high-level autonomous navigation technologies that can meet market needs

Degree 1 — Degree 2 — Degree 3 — Degree 4

"We will lead the degree 3 & 4 solutions with the leadership achieved from an unparalleled amount of data and world-leading order-intake accumulated in the degree 1& 2"

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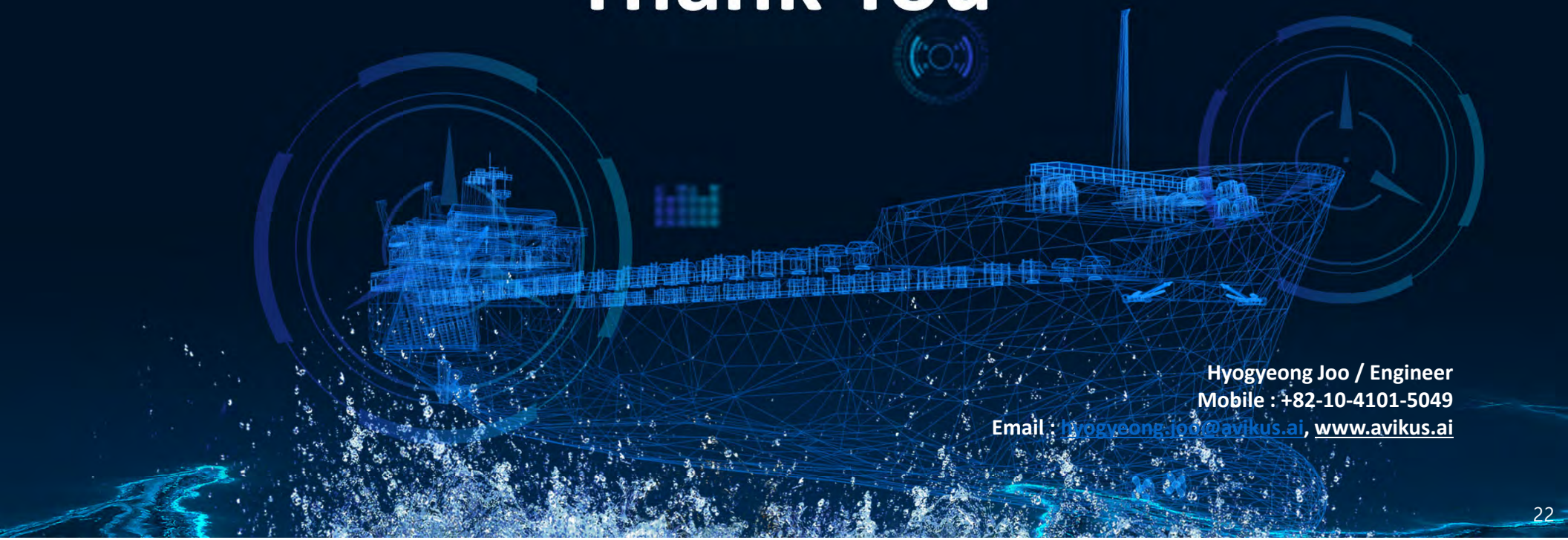
Revolutionizing Future of Marine Mobility

Thank You



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