ENHANCING e-NAVIGATION CAPABILITY
DIGITAL@SEA WORKSHOP

INTERNATIONAL MARITIME ORGANIZATION

KOMSA
KOREA MARITIME TRANSPORTATION SAFETY AUTHORITY

Ministry of Oceans and Fisheries

VIRTUAL WORKSHOP REPORT
9 - 10 November 2021

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Rapporteur

10 November 2021

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Executive Summary

The workshop on Enhancing e-navigation Capability - Digital@Sea was held on 9 and 10 November 2021 as a virtual event organized jointly by IMO, IALA and the Republic of Korea.

The workshop was very well attended by 82 participants from 28 countries and territories.

Several promising e-Navigation and digitalization initiatives with global relevance are being conducted in Asia. Connectivity, service discoverability, identity management, and trust, are core elements of future digital service provision and implementation. While global solutions are preferred, these can be based on results obtained through local or regional initiatives serving as initial testbeds for important concepts. It is important to establish testbeds with a wider geographical scope to gain experience in providing and consuming digital services from several providers, from different countries. One such example is the Safety@Sea Cluster project.

The Republic of Korea has clearly demonstrated that coastal waters and beyond can be covered with mobile phone technology (LTE-Maritime) providing sufficient connectivity for safety critical digital services and more. Mobile phone technology and internet protocols are being used widely to create smartphone applications for promulgating useful information to mariners. The IHO Geospatial Registry (S-100) and the Maritime Resource Name (MRN) concepts are being embraced and implemented throughout the region.

It is evident that Asia is very capable in this domain and is even moving into the space segment since China's recent launch of three VDES satellites in October 2021. Asia appears to be becoming an epicentre for the development of innovative e-Navigation and digital services and solutions. Many governments have established funding schemes which enable this work to continue for the foreseeable future.

CONTENTS

1. INTRODUCTION

The workshop on Enhancing e-navigation Capability - Digital@Sea was held on 9 and 10 November 2021 as a virtual event organized jointly by IMO, IALA and the Republic of Korea.

A total of 82 participants from 28 countries and territories registered for the workshop. The list of participants is attached in annex A.

Figure 1 Photograph of selection of Workshop attendees

The dedicated website for the workshop is https://events.iala-aism.org/iala-events/digitalatsea-cb-workshop-2021/

2. DAY 1, SESSION 1 – OPENING OF THE WORKSHOP

Mr Kevin Gregory chaired the opening session and welcomed familiar and new attendees to the Workshop.

2.1. WELCOME FROM IMO, MR B. SITKI USTAOGLU

Mr Ustaoglu declared it a privilege and a pleasure to open the Workshop. He described how e-Navigation had been on the agenda of IMO, IALA and IHO since 2005 and how the pandemic demonstrated the importance of interconnectivity to ensure efficient and safe travel of vessels. He stated e-Navigation is also the crucial backbone of MASS and current developments in cyber security. He said S-Mode will improve interface standards and a single maritime window will result in more efficient connectivity, which in turn reduces the carbon footprint of vessel movements. Mr Ustaoglu said he hoped that the workshop would help to refocus on developing issues and help align progress between developing countries and more advanced States in encouraging harmonization of maritime services.

2.2. WELCOME FROM IALA, MR OMAR FRITS ERIKSSON

Mr Eriksson welcomed familiar and new faces and reminded the workshop of IALA's goals - to achieve global harmonization through the publication of standards and associated documentation, and to enlighten, educate and engage with coastal States to help them conform to the standards. IALA works to raise the awareness of high level decision makers of their obligations, to help them overcome barriers to harmonization, and to facilitate and assist implementation of standards by running workshops such as this. Mr Eriksson reminded the attendees that the Workshop is a part of a wider international cooperation concept called Digital@Sea. He stated how fundamental global maritime digitalization is to harmonization. There is a need to agree on data models and to package information using internationally agreed standards to facilitate data exchange. Mr Eriksson gave a brief overview of the current progress to transition to an intergovernmental organization. With 77 days remaining of the signature period, he encouraged States to persuade their governments to become signatories.

2.3. WELCOME FROM REPUBLIC OF KOREA, MR SUNBAE HONG

Mr Hong welcomed everyone and thanked Mr Ustaoglu and Mr Eriksson for their welcomes and the Workshop introductions from IALA and IMO. He stated that there had been many changes in the e-Navigation sector since the IMO resolution on harmonization in the context of e-Navigation, published in 2019. Several new services have been introduced since then and Mr Hong stated it is a very timely point to discuss IMO policies on MASS and data exchange and the associated issues arising from decarbonization and the quest for economic growth. Mr Hong said there is challenge in taking the first step and then that coastal States should proceed step-by step and in the spirit of cooperation. Progressing together towards global digitalization would then realize safer and more efficient voyages and the oceans would be reborn as "one sea". Mr Hong remarked he was looking forward to the Workshop presentations and to future face to face meetings when the pandemic recedes.

2.4. WORKSHOP OBJECTIVES AND WORKING ARRANGEMENTS, MR KEVIN GREGORY

Mr Gregory gave a summary of the workshop agenda, which included presentation of examples of digital services delivery and to hear from countries on the challenges and systems presented by the delivery of those services.

3. DAY 1, SESSION 2 – THE BASICS

Chaired by Mr Kevin Gregory who described the purpose of the session as setting the scene on the basic concepts of e-navigation.

3.1. BASIC CONCEPTS WITHIN E-NAVIGATION, MR MINSU JEON

Mr Jeon presented a high level focus on the concepts of e-Navigation with background information for those less familiar, to help understanding of principles and future challenges. He described the background of Digital@Sea as being the inception for the concept of e-Navigation, in 2006. Maritime trends have changed dramatically over the last twenty years and in response, in 2019 IALA published "Current drivers and trends" Ed 2.0. e-Navigation is intended to meet present and future needs including MASS through optimization of systems and supporting shore services. Mr Jeon described the IMO's seven principles of e-Navigation and the IMO's maritime Strategy Implementation Plan (SIP) with five prioritised solutions for e-Navigation. Mr Jeon described the flow of data from shore to ship as data collection, integration, exchange, presentation, and analysis and concluded using the analogy of ordering pizza for the development of a maritime information system, including specification of maritime services, technical services, and data model specifications.

3.2. CONNECTIVITY, IDENTITY AND TRUST (MCP), MR THOMAS CHRISTENSEN

Mr Christensen described the concepts of the maritime connectivity platform (MCP) as a means of exchange of information in a modern way, using contemporary technology between different stakeholders. He explained the various services referred to when developing an MCP, and the additional IALA guidance available in the specification of technical services and web based S-100 data exchange. Mr Christensen described how in addition to secure and reliable date exchange, MCPs require an identity registry providing trusted verification of identity, and a service registry so that services can be discovered and accessed. He described how MCPs would be decentralized but overseen by a governing body. He concluded by describing the current testbeds running since 2015. There are 26 members and operational instances in Korea and Sweden, and soon to be, in Finland.

3.3. DIGITAL@SEA CLUSTER, MR. MICHAEL BERGMANN

Mr Bergmann described the development of the Digital@Sea from its inception at e-Navigation Underway meetings. The Digital@Sea cluster has its own website and Mr Bergmann described how the cluster aims to demonstrate the benefits of e-Navigation services to the world and how its participants include maritime administrations, shipping companies and satellite communications providers. Digital@Sea is focused on three main aspects, increased safety, increased efficiency, and environmental protection. He described where regional areas were coming together to validate e-Navigation concepts and services including the Baltic, Korea, and the wider Asian Pacific area. He highlighted however, that harmonized and established concepts required support from digital infrastructure with a global reach. The GMDRT concept provides global verification, validation, and a harmonization route for seamless digital maritime services. e-Navigation can support global voyage data exchange through any area and validate requirements for MCP. Mr Bergmann concluded by describing the GMDRT phases, with phase 1 currently hosted by the Korean Ministry of Oceans and Fishery (KRISO) and Bergmann Marine, and execution of the project expected in 2023.

3.4. QUESTIONS AND ANSWERS

There was a query asking if another country wanted to establish an instance of an MCP would they need large information technology support? The speakers confirmed that setting up an MCP is not a difficult task. There is a need to define procedures and specifications, but anyone can implement an MCP free of charge. It would require one technical person who could restart a server or issue technical updates. All the existing instances are accessible world-wide so to provide services, there is not a need initially to build an individual instance. Navelink can be joined at no cost for example. Three ways to access an MCP are third party, own servers or cloud based servers.

Another query asked was how can problems of communication with smaller vessels be mitigated with e-Navigation? It was agreed that there will always be this problem because small vessels can't be excluded from certain areas. Korea has undertaken a project to provide communication services for small vessels and further information may be provided in the next presentation.

Mr Gregory commented that the three speakers provided a good introduction of e-Navigation concepts with practical examples, and had covered a lot of information, setting the scene for rest of conference.

4. DAY 1, SESSION 3 – EXAMPLES

The session was chaired by Mr Omar Frits Eriksson who commented that the first presentation would be directly related to the question regarding smaller vessel connectivity, recorded above.

4.1. COASTAL CONNECTIVITY USING MOBILE PHONE TECHNOLOGY, DR WOO-SEONG SHIM

Dr Shim from the Korean Research Institute of Ship and Ocean engineering (KRISO) described a project to establish coastal connectivity using mobile communications rather than VHF, AIS, MF, HF, or satellite systems, which have small capacity for data communication, or are relatively expensive. However, the density of antenna on land is not as available when on the oceans and when in the city, the maximum coverage distance of 107km is not an issue. Dr Shim described the Korean e-Navigation project, LTE Maritime which has been developed to provide a line of site coverage to a maximum of 100km offshore. Research identified that vessels only require 11% of data transmission in real time and 60% of the time vessels are within 4G or LTE coverage. If a ship has an LTE router within 100km they can access the navigation service, including updates of ENC etc., with acceptable data speeds to facilitate the data exchange required. Dr Shim's final comment was "smart" doesn't have to mean almighty, but appropriate.

4.2. WEB BASED PROMULGATION OF MARITIME SAFETY INFORMATION (APP WEB), MS HAWAJIN NA

Ms Na described the background and progress of the development of the APPWeb application. Since 2006 digitalization, standardization and connection have been particular priorities for the IMO and global maritime consortia. In 2019, the Australian Maritime Safety Authority (AMSA), the Korean Ministry of Fisheries and Oceans (MOF), the United States Coastguard and IALA decided on the application of the S-124 data standard, to gather requirements from other Asia Pacific areas and to define non-functional requirements. It is intended in 2022 to develop and implement the application in two countries for testbed projects and it is intended that APPWeb will be used in earnest in 2025. The application will gather and provide maritime information including Navtex, weather, AtoN and incident history information. It will link to a maritime connectivity platform and be accessible by government agencies, international organizations, and civilian users. Ms Na showed a brief video demonstration of APPWeb and described how the benefits of the APPWeb will lead to timesaving, cost reduction and a decrease in consumption, waste, and pollution. Ms Na asked for any State who is interested in being one of the testbed locations, to get in touch with her.

4.3. UTILIZATION OF MARITIME RESOURCE NAME (MRN), MR MINSU JEON

Mr Jeon explained that MRN is a naming scheme that can uniquely identify any maritime resources name on a global scale. This could be an organization, a person, a physical or virtual document, a buoy, or an electronic service. Unique identifiers are key for the internet of things and will be essential to ensure machine readable resources for e-Navigation. A uniform resource identifier (URI) is the combination of what – the uniform resource name (URN) and the where – the uniform resources locator (URL). A publication ISBN number is an example of a URN. The application of MRNs in the AtoN sector is covered by IALA Guideline G1143. MRN must be unique, decentralized, future compatible and flexible. Most existing identifiers can be accommodated by prefixing them with urn:mrn. Mr Jeon provided examples of MRN syntax for buoys and publications respectively and informed the workshop that IALA are working on the maritime resource registry, with more information to be provided in due course.

4.4. QUESTIONS AND ANSWERS

The sessions generated interesting discussion and one question asked was, is it possible to exchange the maritime mobile communication information through a relay network. Is that part of the project concept? Dr Shim commented that although the LTE-Maritime project currently only has direct communication, a mesh network could be implemented, so there is the potential for relay.

Mr Eriksson commented that it was very interesting to understand that only 11% of data information was required in real time by vessels and that connectivity can be achieved beyond territorial waters and implemented globally. He commented that the APPWeb presentation was an example of information being properly packaged and shared by an authority. It is a product of years of collaboration, and he encouraged all countries to sign up and participate. He concluded the session by commenting on the interesting concept of the MRN naming convention as a flexible identity scheme, currently being used in IALA, and offered to members.

5. DAY 1, SESSION 4 – COUNTRY REPORTS

The session was chaired by Mr Omar Frits Eriksson and the countries proceeded to provide updates in turn.

5.1. DELEGATION FROM CAMBODIA, MR SUTHY HENG

Mr Heng described the Cambodia Port EDI project which will go live in August 2022 and is funded by the Japanese government. Aims of the project include modernization of port administration, streamlining of procedures and operational efficiencies. The project will benefit government agencies and the private sector leading to improved ease in doing business, together with regulatory compliance. Mr Heng described the Port EDI application which would allow shipping agents and operators to submit information through the system, which can then be checked by the authorizing agencies. The system will also link with the Cambodian government finance department portal, the CNSW. Mr Heng concluded by describing how digital signatures and QR codes are key features of the new system.

5.2. DELEGATION FROM CHINA, MR YONG QIANG LU

Mr Lu described the development of VDES systems and how three VDES satellites had been launched for two-way communications of sky-ground-sea integrations. These are currently being verified. He described the development of MASS with “Zhifei”, the first MASS container ship to meet the needs of unmanned autonomous navigation testing. The vessel was built in June 2021 and is currently undergoing intelligent navigational function testing. Mr Lu described the development of the Green Routes System e-Navigation project which has developed technical services for eight maritime services. The system has provided public services since September 2019, with 21,000 active users and more than 3,300 daily active users. Finally, Mr Lu described how 40 technical personnel attended IALA L1.2 AtoN training for technical personnel and he thanked IALA for the support of the WWA in the training activities. He said China MSA hope to arrange L1.1 training in 2022.

6. DAY 2, SESSION 5 – COUNTRY REPORTS

The session was chaired by Mr Kevin Gregory and the workshop continued with country reports.

6.1. DELEGATION FROM CHINA HONG KONG, MR JIANG GUIFU

Mr Jiang described the mobile application, “iSailing” for Hong Kong, developed to provide communication between the vessel traffic centre and river vessels coming to Hong Kong port. He described how Hong Kong is a major port, complicated and congested. VTS started in 1989 and most vessels are required to report to the vessel traffic centre, but that VHF communication service is busy and the VTSO has less time to provide services to individual vessels. The “iSailing” application provides additional means to submit reports, provide reminders and transmit Maritime Safety Information. The application will enable pre-population of forms, keep all records, and facilitate robust records management. Mr Jiang commented on how this will result in better communication and provide the VTS officer with the opportunity to focus on vessel movements.

6.2. DELEGATION FROM CHINA TAIWAN, MS SHWU-JING CHANG

Ms Chang described the development of several e-Navigation and Digital@Sea related systems and services. She described the administrations and research organizations that have input into the developments including the Ministry of the Interior and the Ministry of Transportation and Communications. Ms Chang described the coastal AIS network and the structure and connectivity of the weather application specific AIS network which includes information such as weather observation location reports, air pressure and temperature, every 10 minutes via an application. Ms Chang described the S-100 digitalization plan that runs to 2026 and the AtoN database, where a digital list of lights can be generated in PDF and GML formats. Challenges in Taiwan include the development of offshore wind farms and adverse weather conditions makes navigation tricky for vessels waiting to access Taichung port. Ms Chang concluded by describing future developments including integration of 19 systems and information sources to establish Changhua VTS and a Maritime Information Centre.

6.3. DELEGATION FROM INDIA, MR KANAN KUMAR SINGH

Mr Singh requested postponement of information sharing as he requires permission to release certain information.

6.4. DELEGATION FROM INDONESIA, MR NANDITYA WARDHANA

Mr Wardhana described maritime transport facts and figures including Indonesia's extensive coastline numerous shipping activities, over 1 million seafarers, 284 lighthouses and 23 VTS centres. This maritime complexity has led to the development of an e-Navigation Indonesia baseline study between 2020 and 2024, with subsequent studies and test bed developments over the next ten years. Mr Wardhana described the intention to strengthen maritime infrastructure to monitor non-SOLAS convention vessels, and to strengthen VTS operations and e-pilotage. He also described how an international online symposium on e-Navigation was held in 2020 and attended by neighbouring coastal States, Japan, and Australia. Mr Wardhana concluded describing the development of national regulations to strengthen maritime communications, VTS, AIS and promulgation of Maritime Safety Information.

Mr Gregory noted the international cooperation and encouragement of vessels to carry AIS were both excellent ways of promoting harmonization.

6.5. DELEGATION FROM JAPAN

The delegation from Japan requested permission to provide the country report after the meeting due to insufficient time to prepare.

6.6. DELEGATION FROM MALAYSIA, MR IZUAN BIS ISNAN

Mr Isnan described the national approach to e-Navigation, consolidated in 2017 with a ten year Local Vendor Development programme, to commence national e-Navigation in line with IMO direction. The programme goals are to support technological research and development and to upgrade and improve infrastructure and supporting systems. Mr Isnan described how it is the intention to develop e-Navigation web based software, electronic AtoN products, the "Marine Electronic Highway" and the Maritime Data Support Centre (MDSC). These developments will be in accordance with international standards and have the aims of increasing maritime safety and security, improving the environment, creating employment, and developing new markets.

Mr Gregory again noted the excellent developments building on sound VTS and infrastructure and the ability of Malaysia to influence adherence to international standards, due to the location of the excellent training facility, the Asean Regional VTS training centre.

6.7. DELEGATION FROM PHILIPPINES, CDR ORLY A WONG

Cdr Wong described the responsibilities for safety of navigation in the Philippines and described how the Philippine coast guard is responsible for the management of Marine Aids to Navigation including VTS. He described how the Philippines have 36,289 km of coastline and the country is located within a busy maritime transportation network. Cdr Wong described how during the Covid 19 pandemic there was a drop of 36% domestic ship calls in 2019-2020 but a corresponding minor increase in foreign ships during the same period. He therefore anticipates an increase over the next years as, hopefully the pandemic recedes. Cdr Wong described how this high volume of traffic and shallow areas causing grounding, leads to navigational risk. He described how to mitigate the risk the Philippines has 600 lighthouses and 489 navigational buoys and there are VTS centres in Batangas, Cebu and Manilla. Finally, Cdr Wong described how he and colleagues have attended the IALA Risk Management Toolbox training and concluded how e-Navigation should be a priority and how they would implement ideas identified at the Workshop.

Mr Gregory was pleased with the reference to the IALA Risk Management training and to see the Philippines undertaking both VTS and Risk Management training.

7. DAY 2, SESSION 6 – OPPORTUNITIES IN 2022

The final session was chaired by Mr Omar Frits Eriksson.

7.1. IALA WWA EDUCATION, TRAINING AND CB ACTIVITIES IN ASIA IN 2022, MR KEVIN GREGORY

Mr Gregory described the objectives of IALA to enlighten, educate and engage coastal States and to undertake training to bring standards to life. IALA provide advice and guidance on overcoming challenges, importantly, at the State's invitation. The IALA corporate Goal of contributing to harmonization through expertise sharing is partly fulfilled by the undertaking of technical missions worldwide where help is required with either strategic, operational and VTS activities. In 2021, the Academy has recommenced technical missions, and has visited Lebanon and El Salvador. It has also worked with the Port of Mogadishu in Somalia virtually over Microsoft Teams. Mr Gregory described how technical webinars can be found on the IALA YouTube Channel and the importance of the Asean VTS training centre in Malaysia as a location for connecting international professionals. He described how there have been recent developments in IALA training courses; the content has been refreshed and the training is highly interactive. There are three levels of training including L1.3, the IALA Risk Management Toolbox. Mr Gregory concluded by describing how accredited training organizations can be found on the IALA website.

7.2. IMO TECHNICAL COOPERATION IN ASIA, MR B. SITKI USTAOGLU

Mr Ustaoglu confirmed that there were 175 member states, Botswana joined this year and there are three associate members. He briefly covered the makeup of the IMO Council and committees. The main subcommittee covering the safety of navigation and e-Navigation is the Navigation, Communications and Search and Rescue Committee (NCSR). Mr Ustaoglu emphasized the importance of collaboration, consultation, and coordination at both national and international levels and one of the best ways to encourage capacity building is to participate in the regular meetings of the IMO, IHO and IALA. He commented that although geographical location can make collaboration difficult at times, virtual workshops

such as these had shown remote monitoring and participation of events was possible, virtually. Mr Ustaoglu gave a brief introduction around the IMO information websites, namely imo.org, docs.imo.org, and gisis.imo.org/public/. He encouraged States to use these websites to keep up with developments and audio from meetings could also be found on the websites. He concluded saying he was impressed by the example of collaboration he had observed at the workshop, and he reiterated his message for collaboration and building relationships through peer meetings, such as this workshop. Mr Ustaoglu thanked the workshop organizers for a successful event.

7.3. DISCUSSION AND SUMMARY OF DAY 2, MR OMAR FRITS ERIKSSON

Mr Eriksson gave a brief introduction to the IALA website and demonstrated how to access certain pages including the Lighthouse of the Year, Events, the World-Wide academy and how to search for publications.

There was a question on if there is any guidance to formulate the course content for the VTS V103.1-5 courses? Mr Gregory confirmed each of the courses has a model course document that explains the course content in general terms. Guidance on the accreditation of training organizations is just about to be updated, but further guidance on ensuring harmonization of model course provision can be obtained by contacting the World-Wide Academy.

Mr Ustaoglu added his comments on the requirements for VTS training and that harmonization firstly requires coastal States to have an appropriate legislative structure and that a competent authority has been defined. Mr Ustaoglu commented that previously, he had used the IALA model courses as a very helpful starting point, but ensured the courses were adapted for specific local areas and complexities.

Mr Ustaoglu commented on the use of mobile communication systems for maritime systems. This technology has enabled rapid adaptation and the same could apply to e-Navigation. It could help developing States align its progress with more developed States in the field of e-Navigation and other sectors that could benefit from mobile communication technology.

Mr Eriksson reiterated the requirement for coastal States to request their governments, who have not already done so, to sign the Convention for IALA's transition to an intergovernmental organization.

7.4. CLOSING REMARKS, MR OMAR FRITS ERIKSSON

Mr Eriksson reflected how in Asia, several promising e-Navigation and digitalization initiatives with global relevance are being conducted. Connectivity, service discoverability, identity management, and trust are core elements of future digital service provision and implementations. While global solutions are preferred, these can be based on results obtained through local or regional initiatives serving as initial testbeds for important concepts. He also stated that it is important to establish testbeds with a wider geographical scope to gain experience with providing and consuming digital services from several providers from different countries. One such example is the Safety@Sea Cluster project.

Mr Eriksson stated that the Republic of Korea has clearly demonstrated that coastal waters and beyond can be covered with mobile phone technology (LTE-Maritime) providing sufficient connectivity for safety critical digital services and more. Mobile phone technology and internet protocols are being used widely to create smartphone applications for promulgating useful information to mariners. The IHO Geospatial Registry (S-100) and the Maritime Resource Name (MRN) concepts are being embraced and used throughout the region.

Mr Eriksson said that throughout this workshop we have seen that Asia is very capable in this domain and is even moving into the space segment since China recently launched three VDES satellites in October 2021. He concluded that, Asia seems to be becoming an epicentre for the development of innovative e-Navigation and digital services and solutions. Many governments have established funding schemes which enable this

work to continue for the foreseeable future. Finally, Mr Eriksson thanked the IMO, the Korean Ministry of Fisheries and Oceans, all presenters, participants and the IALA Secretariat.

Mr Ustaoglu echoed the comments made by Mr Eriksson, noting the commendable approach to the safety of navigation and developments in e-Navigation made by the Asian coastal States. He also offered his thanks to the Republic of Korea for their facilitation and offer of funding if required and to IALA for their efforts to facilitate this fruitful workshop on e-Navigation.

ANNEX A LIST OF PARTICIPANTS

Surname	Name	Country	Affiliation
PEREIRA	Guilherme Black	Brazil	Marinha do Brasil - Diretoria de Hidrografía e Navegação
BO	Acrun	Cambodia	Merchant Marine Department, Cambodia
HENG	Suthy	Cambodia	Ministry of Public Work and Transport
LU	Yongqiang	China	China MSA
XUE	Feng	China	China MSA
JIANG	Guifu	China, Hong Kong	Marine Department HKSAR
TANG	Hung Fai	China, Hong Kong	Marine Department HKSAR
CHI	Luh-Hsiang	China, Taiwan	Central Weather Bureau
TERNG	Chuen Teyr	China, Taiwan	Central Weather Bureau
CHEN	Yen-Ti	China, Taiwan	Ministry of the Interior, Taiwan ENC Center
CHIANG	Chi-Yuan	China, Taiwan	Ministry of the Interior, Taiwan ENC Center
CHIANG	Te-Shu	China, Taiwan	Ministry of the Interior, Taiwan ENC Center
HUCH	Ellen	China, Taiwan	Ministry of the Interior, Taiwan ENC Center
TIEN	Kate	China, Taiwan	Ministry of the Interior, Taiwan ENC Center
HUANG	Yi-Kai	China, Taiwan	MOTCMPB
CHANG	Shwu-Jing	China, Taiwan	National Taiwan Ocean University
LAN	Wenhau	China, Taiwan	National Taiwan Ocean University
CHRISTENSEN	Thomas	Denmark	OFFIS EV
BRACQ	Isabelle	France	IALA
ERIKSSON	Omar Frits	France	IALA
GREGORY	Kevin	France	IALA
JEON	Minsu	France	IALA
ROBINSON	Sarah	France	IALA
TSITSKISHVILI	Givi	Georgia	Batumi State Maritime Academy
BERGMANN	Michael	Germany	BM Bergmann Marine
LOH	Yee	Germany	SevenCs GmbH
JOSEPH	Prasanth	India	Alpha Polymers
SINGH	Kanan Kumar	India	DGLL
KUMAR	Praveen	India	KDU MARINE
CAHYADI	Rizky	Indonesia	Directorate of Navigation Directorate General of Sea Transportation

Surname	Name	Country	Affiliation
MUTAALI	Fathan	Indonesia	Directorate of Navigation Directorate General of Sea Transportation
WARDHANA	Nanditya Darma	Indonesia	Directorate of Navigation Directorate General of Sea Transportation
FARHANGI	Amirsaba	Iran	Ports and Maritime Organisation - Iran
MOUSAVI MAHVELATI	Mehdi	Iran	Ports and Maritime Organisation - Iran
ANTOKU	Hiroyuki	Japan	Japan Coast Guard
KAGATANI	Kenta	Japan	Japan Coast Guard
ISNAN	Mohd Izuan	Malaysia	Light Dues Board Peninsular Malaysia Marine Department
RASHEED	Adhil	Maldives	Maldives Transport Authority
BERREVOETS	Maarten	Netherlands	Ministry of Infrastructure and Water Management
SCHUETT	Todd	Norway	Kongsberg Norcontrol
OBAID MUSTAFA	Muhammad	Pakistan	Directorate General Port & Shipping - Ministry of Maritime Affairs Pakistan
DAGUIO	Maria Aurora	Philippines	Maritime Industry Authority
TORIO	Ralph	Philippines	Maritime Industry Authority
WONG	Orly	Philippines	Maritime Safety Services Command, Philippine Coast Guard
BASCO	Rex Randolph	Philippines	Philippine Coast Guard Headquarters
MORANTE	Joyce Anne	Philippines	Philippine Coast Guard Headquarters
LEE	Elly Seomgyeol	Republic of Korea	GMT Cybernetics Co Ltd
NA	Hwajin	Republic of Korea	GMT Cybernetics Co Ltd
KIM	Jae-Hyeon	Republic of Korea	IT Convergence headquarters Consulting Team
LEE	Joo-Hyung	Republic of Korea	IT Convergence headquarters Consulting Team
CHAE	Jongmi	Republic of Korea	Korea Coast Guard – Republic of Korea
CHO	Ayoung	Republic of Korea	Korea Coast Guard – Republic of Korea
CHOI	Jayun	Republic of Korea	Korea Coast Guard – Republic of Korea
HONG	Sunbae	Republic of Korea	Korea Coast Guard – Republic of Korea
KIM	Hyemi	Republic of Korea	Korea Coast Guard – Republic of Korea
RYU	Jungsun	Republic of Korea	Korea Coast Guard – Republic of Korea
AHN	Changsu	Republic of Korea	Korea Maritime Transportation Safety Authority

Surname	Name	Country	Affiliation
CHOI	Choongjung	Republic of Korea	Korea Maritime Transportation Safety Authority
CHIN	SunYoung	Republic of Korea	Korean Register of Shipping
WONG	Jaybee	Republic of Korea	Korean Register of Shipping
KANG	Dongwoo	Republic of Korea	KRISO Korea Research Institute of Ships and Ocean Engineering
LIM	Kwanghyun	Republic of Korea	KRISO Korea Research Institute of Ships and Ocean Engineering
SHIM	Woo-seong	Republic of Korea	KRISO Korea Research Institute of Ships and Ocean Engineering
JUNG	Sowhi	Republic of Korea	MEC&WIP
LIM	Myung-bin	Republic of Korea	MEC&WIP
KIM	HyunSook	Republic of Korea	PopUp Tech
RYU	Kyung-Jin	Republic of Korea	PUKYONG NATIONAL UNIVERSITY
YANG	Benjamin	Republic of Korea	Republic of Korea
LEE	Eunkyu	Republic of Korea	SafeTechResearch, Inc.
MEHLMAUER	Migel	Slovenia	Slovenian Maritime Administration
PANCORBO	Javier	Spain	ESSP-SAS
PEIRIS	Upul	Sri Lanka	Merchant Shipping Secretariat
RAMBARRAN	Terry	Trinidad & Tobago	Aatash Norcontrol Ltd
ALKABIR	Mutaz	Turkey	HAVELSAN AS
TURHANGIL	Huseyin Cenk	Turkey	HAVELSAN AS
ERLEVENT	Burcin	Turkey	Istanbul Technical University
USTAOGLU	Bekir Sitki	United Kingdom	IMO
TRENT	Michael	United States	MARITECH USA
NGUYEN	Cuong	Vietnam	Maritime Administration of Quangninh
MINH THUAN	Tran	Vietnam	Vietnam Maritime Safety South
TIEU	Long	Vietnam	Vietnam Maritime Safety South
NGUYEN	Ha Hai	Vietnam	Vinamarine

ANNEX B ABBREVIATIONS

ADS-B	Automatic Dependent Surveillance Broadcast
AI	Artificial Intelligence
AIS	Automatic Identification System
ANN	Artificial Neural Network
AtoN	Aids to Navigation
ATC	Air Traffic Control
ATTOL	Autonomous Taxiing, Take-Off, and Landing
CPDLC	Controller Pilot Datalink
COLREG	Convention on the International Regulations for Preventing Collisions at Sea
DME	Distance Measuring Equipment
DP	Dynamic positioning
EGNOS	European Geostationary Navigation Overlay Service
EICAS	Engine Instrument and Crew Alerting
GNSS	Global Navigation Satellite System
IACS	International Association of Classification Societies
IALA	International Association of Marine Aids to Navigation and Lighthouse Authorities
IEC	International Electrotechnical Commission
IFP	Instrument Flight Procedures
IGO	Intergovernmental Organization
IHO	International Hydrographic Organization
ILS	Instrument Landing System
IMO	International Maritime Organization
INAS	International Network for Autonomous Ships
IoT	Internet of Things
ITS	Intelligent Transport Systems
ITU	International Telecommunication Union
ISO	International Organization for Standardisation
LTE	Long Term Evolution
MASS	Maritime Autonomous Surface Ship
ML	Machine Learning
MSC	Maritime Safety Committee
ODD	Operational Design Domain
OEM	Original Equipment Manufacturers
OEP	Original Equipment Parts
PAP	Policy Advisory Panel
PBN	Performance Based Navigation
PNT	Positioning, Navigation and Timing
NFAS	Norwegian Forum for Autonomous Ships

NGO	Non-governmental organisation
RCC	Remote Control Centre (in MASS context) / Rescue Control Centre (in maritime context)
RSE	Regulatory Scoping Exercise
SESAR	Single European Sky ATM Research
VDES	VHF Data Exchange System
VDL	VHF Data/Digital Link
VTS	Vessel traffic services
VTSO	Vessel traffic services operator