
IMPLEMENTING E-NAVIGATION IN THE ASIA-PACIFIC REGION

**18 to 20 June, 2017**

**Lotte Hotel, Jeju Island, Republic of Korea**

# Conference Report

# E-NAVIGATION UNDERWAY ASIA-PACIFIC 2017

## IMPLEMENTING E-NAVIGATION IN THE ASIA-PACIFIC REGION

SUPPORTED BY

Australian Government
Australian Maritime Safety Authority

BIMCO

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ORGANIZED BY

IALA

Ministry of Oceans and Fisheries

Danish Maritime Authority

### 1 INTRODUCTION

The first e-navigation Underway Asia-Pacific conference was held from 18th to 20th June, 2017 at Lotte Hotel, Jeju Island, Republic of Korea. It was organised by the IALA (International Association of Marine Aids to Navigation and Lighthouse Authorities), DMA (Danish Maritime Authority) and MOF (Ministry of Oceans and Fisheries). The conference was attended by 245 delegates, representing 25 countries and 11 APHoMSA (Asia-Pacific Heads of Maritime Safety Agencies) members. The associated exhibition attracted 6 exhibitors, displaying the latest developments in e-navigation and the IALA conference 2018.

The Conference focused on technical aspects of providing e-navigation services, not only for SOLAS but also for non-SOLAS ships, on further developing global test bed cooperation for field testing of newly developed e-navigation technologies, and on seeking capacity-building and regional cooperation for the implementation of e-navigation in the Asia-Pacific Region.

The conference agreed the following five highlights:

1. It is desirable to strengthen global e-navigation testbed initiatives to facilitate implementing the IMO Strategy Implementation Plan (SIP). This work should be based on harmonised standards, a common communication framework and human centered design to ensure interoperability and usability.
2. Web based solutions such as ArcticWeb, BalticWeb and a future Asia-PacificWeb could be a means of accessing e-navigation services at an early stage.

3. MSPs should be scalable to include non-SOLAS ships. This might include developing connectivity between Non-SOLAS and SOLAS ships, customised e-navigation services and on-board e-navigation capable platforms for Non-SOLAS ships.
4. It is important for all relevant stake-holders to contribute to the activities of the IMO-IHO Harmonisation Group on Data Modeling (HGDM), which will work on the development of guidance on definition and harmonisation of the format and structure of e-navigation Maritime Service Portfolios (MSP).
5. It is essential to develop an e-navigation technical cooperation program for developing countries which includes training and capacity building.

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# Implementing e-navigation in the Asia-Pacific Region

## 1 INTRODUCTION

e-navigation is a paradigm that involves the pursuit of both safety and efficiency, based on user-driven needs, digitalized information services and communication networks. This is why e-navigation is beneficial to all stakeholders ranging from practical users to policy makers.

The International Maritime Organisation (IMO) has adopted an e-navigation Strategic Implementation Plan (SIP) at its 94th session of the Maritime Safety Committee (MSC) to ensure the utilization of new technologies to achieve its main objectives set out in the IMO slogan "safe, secure and efficient shipping on clean oceans." The SIP aims to meet all the necessary technical requirements by the end of 2019 to allow the maritime sector to utilize e-navigation services starting from 2020.

In order to achieve the ultimate goals of e-navigation and to effectively implement it globally, it is necessary for the relevant stakeholders to take a harmonized approach to e-navigation. This will include the development of e-navigation services and technologies progressed at a national and a regional level, as well as the mutual understanding between relevant stakeholders from user, industries to governments of Member States.

The first e-navigation Underway Asia-Pacific conference was held from 18 – 20 June, 2017 at Lotte hotel, Jeju Island, Republic of Korea. It was organized by the IALA (International Association of Marine Aids to Navigation and Lighthouse Authorities), DMA (Danish Maritime Authority) and MOF (Ministry of Oceans and Fisheries). The conference was attended by 245 delegates, representing 25 countries and 11 APHoMSA (Asia-Pacific Heads of Maritime Safety Agencies) members. The associated exhibition attracted 6 exhibitors, displaying the latest developments in e-navigation and the IALA conference 2018.

A list of participants is at ANNEX A.

## 2 OPENING OF THE CONFERENCE

### 2.1 Opening Speech: Kwang Youl Park, *Ministry of Oceans and Fisheries, Korea, Director General*

Mr. Kwang Youl Park, Director General of the Ministry of Oceans and Fisheries welcomed the participants to the first e-navigation Underway Asia-Pacific conference and hoped that e-navigation Underway Conference series including the Asia-Pacific conference would play a pivotal role in the development of technology in this area and be an active forum for future industry promotion. He suggested a review of e-navigation services for the Non-SOLAS vessels and training cooperation, strengthening the capacity-building of developing countries in order to achieve e-navigation's ultimate goals.

### 2.2 Welcome Speech: Francis Zachariae, *IALA, Secretary-General*

Conference participants were welcomed by Mr Francis Zachariae, Secretary-General of IALA. He mentioned that the conference was a timely initiative in view of the growing maritime significance of the region and the important role it played in global shipping. Also, the e-navigation Underway Asia-Pacific conference made a special contribution from an Asia-Pacific perspective and helped promote understanding between equipment manufacturers and users to stimulate cooperation in testbeds and in the verification of emerging e-navigation concepts and technologies.

### 2.3 Congratulatory Speech: Andreas Nordseth, *DMA, Director General*

Mr Adreas Nordseth, Director General of DMA congratulated the conference organisers. He announced that the conference was important because e-navigation Underway made it possible for stakeholders to meet and discuss important agendas while sharing experiences and trends. In addition, he pointed out the possibility of discussing and paving the way for harmonizing new technologies and digitalization process.

# THEMED SESSIONS

## 3 (Session 1) - The role of IMO/CIRM/IHO/IALA in the harmonized approach to e-navigation

## Chair: Jorge Arroyo, *USCG, Program & Management Analyst*

### 3.1 Taking the lead: IMO Radio Technical Committee for Maritime Services (RTCM); and, past Vice-Chair

#### 3.1.1 Presenter and Author

Sascha Pristrom, *IMO, Technical Officer – Operational Safety*

#### 3.1.2 Abstract

In May 2006 IMO's Maritime Safety Committee (MSC) agreed to include in the work programme of the Navigation and Communication/Search and Rescue Sub- Committee (NCSR) a high priority item on "Development of an e-navigation Strategy". The complexity as well as the novelty of this subject delayed the finalization of the IMO e-navigation Strategy Implementation Plan (SIP) until MSC 94, in November 2014, approved the SIP developed initially by the NAV and later the NCSR Sub-Committee.

The presentation highlighted the key issues surrounding the discussion at IMO, the difficulties encountered, as well as the latest update on the approach taken to make progress on the e-navigation Strategy Implementation Plan for which IMO has the lead. He highlighted the overarching concept of e-navigation and the many overlaps this subject has with many of the other work items under consideration at IMO, including the modernization of the GMDSS or the work of the Facilitation Committee in respect to the Single Window concept.

He informed participants of the common work practice of the IMO so as to highlight the possibilities and constraints faced in developing internationally binding instruments such as the various e-navigation outputs agreed by IMO Member States. Further, the importance of close cooperation between IMO and other international organisations providing some of the technical input for the work on e-navigation were highlighted, including the importance of IHO, IALA and non-governmental organisations.

### 3.2 Harmonisation and Innovation: Getting the balance right

#### 3.2.1 Presenter and Author

Richard Doherty, *CIRM, Deputy Secretary-General*

#### 3.2.2 Abstract

CIRM is the principal international association for marine electronics companies. For manufacturers of bridge equipment, harmonisation involves the development of common standards supporting compatibility between different systems, and is a key concept associated with e-navigation. The scope of the e-navigation initiative and ongoing international e-navigation work present both opportunities and challenges to manufacturers, as they suggest the development of new and innovative products and services but also introduce the possibility that incompatible regional implementations will emerge.

In order to justify the research and development costs associated with innovation, manufacturers must be able to identify a viable business case, and the larger the prospective market for their solutions, the stronger this business case will be. Therefore, because a globally harmonized e-navigation infrastructure ensures that manufacturers' solutions can be deployed across the global fleet, harmonisation is a key element enabling manufacturer innovation.

At the same time harmonisation must not be overly prescriptive which would limit manufacturers in their design choices, because in order to truly innovate their solutions the equipment makers need flexibility. It is therefore important that the right balance is found between developing common standards in support of harmonisation and leaving flexibility in support of innovation. CIRM is directly involved in ongoing e-navigation-related harmonisation efforts, participating in testbeds and projects like EfficienSea2, SESAME Straits and Sea Traffic Management and contributing to the work of organisations like IMO, IALA and IHO. Specific ongoing work includes development of a VDES prototype and an “intelligent roaming” communications system (EfficienSea2). Through the coordinated efforts of CIRM members, CIRM can help the international stakeholder community achieve the right balance between introducing harmonisation and retaining flexibility.

## 3.3 S-100 and e-navigation

### 3.3.1 Presenter and Author

Yong Baek, *IHO, Vice Chair of IHO S-100 Working Group*

### 3.3.2 Abstract

The International Hydrographic Organisation (IHO) is an intergovernmental consultative and technical organisation established in 1921 to support the safety of navigation, and to contribute to the protection of the marine environment.

One of the IHO’s primary roles is to establish and maintain appropriate standards to assist in the proper and efficient collection and use of hydrographic data and information. Digital hydrographic information underpins all aspects of the sustainable use and protection of the maritime domain. Consequently, IHO’s objective to ensure greater uniformity and interoperability through standardising hydrographic data and information addresses a variety of stakeholders beyond the community of national hydrographic offices.

The first edition of IHO Publication S-100 – Universal Hydrographic Data Model – was published on 1 January 2010 as an international standard of the marine geospatial information era. The objective of S-100 is to address user’s requirements to facilitate access to and use of digital hydrographic data through modern IT technology. The IHO and other organisations are now developing S-100 based product specifications such as S-101, the product specification for the next generation of electronic navigational charts (ENCs). Furthermore, IMO has been developed a Common Maritime Data Structure (CMDS) based on the S-100 data model.

S-100 provides a contemporary hydrographic geospatial data standard that can support a wide variety of hydrographic-related digital data sources, products, and customers. This includes the use of imagery and gridded data, enhanced metadata specification, unlimited encoding formats and a more flexible maintenance regime. This enables the development of new applications that go beyond the classification, marine GIS, etc. S-100 is designed to be extensible and future requirements such as 3-D, time-varying data (x, y, x and time) and Web-based services for acquiring, processing, analyzing, accessing, and presenting hydrographic data can be easily added when required.

This paper is to explain “What is S100?” and outline the expected implications for e-navigation community preparing for the future. It also contains the basic concept of S-100, the associated infrastructure and the new types of digital hydrographic products and services developed by the IHO and other domain.

### 3.4 e-Navigation in Developing Countries

#### 3.4.1 Presenter and Author

Omar Frits Eriksson *IALA, Dean of the IALA World-Wide Academy*

#### 3.4.2 Abstract

e-Navigation is all about exploiting contemporary technology to enhance information exchange between all stakeholders, including ship-ship and ship-shore, for the benefit of afety of navigation, efficiency of shipping and ultimately the protection of the environment.

While e-navigation is often regarded as something primarily relevant for the developed regions of the world, e-navigation provides several opportunities for developing countries with limited resources and capacity.

Mr Eriksson provided an overview of some of these opportunities and how the IALA World-Wide Academy can assist developing countries in implementing simple e-navigation solutions and harvest some of the benefits of e-navigation as early as possible.

### 3.5 e-navigation connects oceans and tomorrow

#### 3.5.1 Presenter and Author

Sunbae Hong, *Ministry of Oceans and Fisheries, Head of e-navigation*

#### 3.5.2 Abstract

Aiming to start e-navigation service from 2020, the IMO plays a leading role is undertaking various necessary works together with the IHO, IALA, IEC and so on. For example, the IHO and IALA develop data exchange standards for the e-navigation services, and the IEC develops standards for ship equipment and data links.

At this point, in order to achieve the ultimate goals of e-navigation and to effectively implement it globally, it is necessary for the relevant stakeholders to take a harmonious approach to e-navigation. This might include the development of e-navigation services and technologies progressed at a national and a regional level, as well as a mutual understanding between stakeholders, from users to industry to governments of Member States. For this, it is important to facilitate the IMO-IHO HGDM by getting as many stakeholders as possible involved.

Secondly, it is desirable to utilise and strengthen the testbeds cooperation globally in order to validate the effects and share the results of such development. At the same time, the efforts on training and educating stakeholders of member states is necessary.

The IALA and the series of e-navigation Underway Conferences are required to play a pivotal role for supporting and concentrating efforts regarding the harmonised approach to e-navigation.

## 4 (Session 2) - e-navigation for Non-SOLAS Ships

## Chair: Axel Hahn, *OFFIS - Institute for Information Technology, Member of the Board*

### 4.1 Survey on the Korean VMSs for Fishing Vessels and Challenges for Monitoring the High-risk Ships

#### 4.1.1 Presenter and Author

Geonung Kim, Jochun Choi Dept. of Computer Engineering *Mokpo National Maritime University, Republic of Korea*
Gyeikark Park, Taeho Hong *Division of International Maritime Transportation Science / Division of Navigation Information System*, *Mokpo National Maritime University, Republic of Korea*
Doyeon Kim, Gijeong Jo *GMT Co. Ltd, Republic of Korea*

### 4.1.2 Abstract

According to the last five-year report of the KMST (Korea Maritime Safety Tribunal), fishing vessels had been involved in 68.5% of maritime accidents in Korea. There are three VMSs (Vessel Monitoring System) related to the fishing vessels; the Fishing VMS managed by the Suhyup (the National Federation of Fisheries Cooperatives), the V-Pass system managed by the Korea Coast Guard and the GICOMS (General Information Center on Maritime Safety & Security) managed by the Ministry of Oceans and Fisheries. The presenter examined the background and role of each VMS.

The Fishing VMS uses HF (High Frequency) and VHF (Very High Frequency) technologies achieving a coverage range of the fisheries communication of over 1,300 km. Because every fishing vessel should report its position once per day, the icon location on the map can be different from the real-position of the vessel. Since 2013, the Suhyup deployed the VHF-DSC Automatic Position Reporting System. It uses digital data communication and gathers the location of vessels hourly.

The V-Pass system was originally developed to support the function of Korea Coast Guard (Automatic Departure/ Arrival Report and SAR (Search and Rescue) – SOS button). It can gather the location of fishing boats every 30 seconds (up to 2 minutes). It works in the coastal area (~ 30km range) and the area around the warship of Korea Coast Guard. However, it is a closed-system (it is not based on the global standard and the Korea Coast Guard does not provide the information to other authorities or vessels).

The first WP (Work Package) of the SMART-Navigation project is “monitoring assistance for high risk ships(SV1)” There are 3 activities in WP1; vulnerable situation detection; evaluation and warning on collision/grounding; assistance for accident correspondence. Data from 3 VMSs can be used in vulnerable situation detection.

## 4.2 e-navigation Solutions for High-end Non-SOLAS Vessels

### 4.2.1 Presenter and Author

Bjorn Age HJOLLO, *NAVTOR AS, Project Manager e-navigation*

### 4.2.2 Abstract

The presenter looked into e-navigation services and how they apply to Non-SOLAS vessels both today and in the future related to the concept of a Shore Based Bridge. In addition, he answered a question raised from time to time - how can we make business out of e-navigation to have the “e-navigation wheel” rolling by itself? The NAVTOR concept of e-navigation service was considered, focusing on the similarity of SOLAS vessels and high-end Non SOLAS vessels when it comes to e-navigation.

NAVTOR AS was established by a former ship owner in mid-2011 to build an automatic and market leading service for distributing and updating of e-navigation services including electronic charts, publications, weather, routing etc, as well as SW solutions for e.g. ECDIS systems. NAVTOR has a very specialised team of personnel with extensive experience in the development and support of official electronic charts and navigation information services. In addition, NAVTOR has a subsidiary manned by highly experienced technical SW engineers doing SDK development for the ECDIS manufactures, at the same time utilising this leading technology in NAVTOR SW (e.g. NavStation back of bridge planner).

NaVTOR’s main market is commercial shipping, and as the IMO ECDIS carriage requirement moves forward to 2018/19, NAVTOR’s vision is to supply the growing market, both SOLAS and non-SOLAS, with an innovative and integrated service for e-navigation, focusing on simplifying the use and utilisation of these services, as well as the secure exchange of information ship-shore.

Within e-navigation, IMO and IALA have agreed five prioritised solutions, one being the Maritime Service Portfolios (MSP). Several of the MSPs are already well established and operational on thousands of vessels, so in one way the definition of e-navigation is already behind the benchmark of the industry. From an industry perspective, the presenter saw the lack of digital information as the main obstacle. This is partly due to some

actors looking at digital safety information as an easy earning, making a global coverage of e.g. ENCs on board very costly. Luckily, the industry has come up with solutions overcoming this challenge; e.g. the Pay-As-You-Sail principle for ENCs (Electronic Navigational Chart), gives the vessel all needed charts in their ECDIS (Electronic Chart Display and Information System) for only a small premium fee, still only paying for the charts for waters that the vessel actually sails through.

NAVTOR is recognised in the industry to be a main driver for e-navigation solutions, and their market, starting in Norway, is now mainly international with sales offices in e.g. Singapore, Japan UK, USA, Norway, Sweden and several partners globally.

NAVTOR started out by establishing a new way of distributing ENC-charts by utilising the PAYS-principle; ENC permits and updating of the chart portfolio is automatic, and today many ECDIS manufactures may seamlessly import the ENC directly into their respective ECDIS system. The new approach save times for the navigator, is safer and more secure, and in most cases, saves costs as less charts are ordered.

To be able to meet the requirement of e-navigation, NAVTOR extended their e-Nav Concept capabilities to include an on-board black-box, “NavBox”, to automatically download and distribute all e-navigation information.

With the business idea to make e-navigation easy, NAVTOR continued to add digital publications (as Admiralty ATT, ADLL, ADRS, etc) and other related navigation information (e.g. weather, Navarea Warning, etc) into their e-Nav Concept; in the presentation a demo of NavStation was be given, focusing on a real Passage Planning utilising the integrated and harmonised e-Nav information.

In the early days, NAVTOR targeted SOLAS vessels as they are all within the ECDIS mandate and required ENC service as a starting point. However, as the PAYS ENC services became known, NAVTOR was approached by high end non-SOLAS vessels as Offshore vessel, larger Fishing vessel and national short sea vessels outside the ECDIS mandate. They wished to move from paper based navigation to digital navigation for the same reason as the SOLAS vessels; less hassle in installation and updating of ENCs and publications, reduced time for Passage Planning and increased insight for ship owner using the web-based fleet and contingency service. Meaning the ECDIS mandate is NOT the only driver for the shift from paper to digital charts.

Some have asked for the business ideas for e-navigation; for NAVTOR “e-navigation made easy” is the only business.

## 4.3 Comparison between STM for SOLAS ships and SMART-Navigation for Non-SOLAS ships

### 4.3.1 Presenter and Author

Dongsik Woo, *RISE Viktoria, Sweden / Ministry of Oceans and Fisheries, Republic of Korea*
Mikael Lind, *RISE Viktoria, Sweden*
Kwanghyun Lim, *KRISO, Republic of Korea*
Mikael Hägg, *RISE Viktoria, Sweden*
Robert Rylander, *RISE Viktoria, Sweden*
Jinhyoung Park, *KRISO, Republic of Korea*

### 4.3.2 Abstract

One of the main causes of maritime accidents has been attributed to human errors.

Though more electronic equipment and digitised information are used onboard ships, they are utilised to some limited extent and in an unharmonised manner. IMO has seen great potential for reducing maritime accidents caused by human errors by introducing and harmoniously utilising electronic equipment and information.

Since IMO has decided in 2006to introduce e-navigation by 2019, many countries have tried to develop and apply various e-navigation services. For example, the EU has carried out various projects such as MarNIS, SafePort, BLAST, EfficienSea, MonaLisa, ACCSEAS, MUNIN and STM which have been focusing on ships

regulated by the International Convention for the Safety of Life at Sea (SOLAS). SOLAS rules apply to merchant ships on international voyages that meet certain criteria (so called SOLAS ships) and the rest of ships such as fishing vessels, merchant ships operating in domestic waters and leisure boats (so called Non-SOLAS ships) are under the discretion of each country.

SOLAS and Non-SOLAS ships have different characteristics in various aspects. In terms of navigational equipment, SOLAS ships are required to have magnetic compass, nautical chart and publications, GNSS receiver (ex. GPS), radar reflector, echo sounder, AIS etc., whereas many Non-SOLAS ships in Korea, especially small ones, are not required to have such basic navigational equipment. SOLAS ships are required to have many means of communication such as MF, HF, VHF, EPIRB, NAVTEX etc., whereas more than 1/3 of Non-SOLAS ships in Korea are not even required to have any means of communication.

SOLAS ships inevitably encounter Non-SOLAS ships at some points of their voyages. In order to avoid any dangerous situations, ships have to be well aware of and communicate each other. However, many Non-SOLAS ships don't have any navigational or communication means as mentioned above, which may increase the possibility of maritime accidents. Further, even when they have same communication means, many crews in Non-SOLAS ships can't speak international languages to communicate. In case of Korea, fishing vessels alone are involved in more than 70% of maritime accidents.

Surprisingly, the number of SOLAS ships is estimated at less than 1% of all ships in some countries and in the world as well, and thus more than 99% of the ships are to be left out of IMO's e-navigation services. Also, many of the e-navigation services developed so far, such as route cross check and enhanced monitoring may have limited effect unless Non-SOLAS ships are taken into account.

There is an impending necessity not only to introduce e-navigation services for Non-SOLAS ships but also to address the issues occurring when SOLAS ships and Non-SOLAS ships encounter each other in order e-navigation to be more effective.

This research compared Sea Traffic Management (STM) developed for SOLAS ships and SMART-Navigation being mainly developed for Non-SOLAS ships to address the issues. Both projects have the same concept of improving safety and efficiency through coordinated, harmonised information with the help of information and communication technology. They have similar services and tools; MSI, route exchange, route cross-check, enhanced monitoring, pilot route service, search and rescue service, single window, maritime cloud, maritime simulator and so on. There are also different services such as port-call optimisation and winter navigation in the STM project whereas electronic chart streaming and update services using LTE-M, and enhanced monitoring service with intra ship information is unique to the SMART-Navigation project.

There are possible ways of linking STM and SMART-Navigation services and thus provide both SOLAS and Non-SOLAS ships with services to address the issues raised. One good example would be to develop technologies and equipment which enable SOLAS and Non-SOLAS ships to communicate and share the information, which are to be further developed and verified from the testbeds in both projects.

## 4.4 ECS Standards for Non-SOLAS Vessels

### 4.4.1 Presenter and Author

Sewoong Oh, *KRISO (Korea Research Institute of Ships and Ocean Engineering)*
Eivind Mong, *BM Bergmann-Marine*
Juhyoung Lee, *SAN Engineering Co. Ltd*
Jaewook Lee, *GMT Co. Ltd*

### 4.4.2 Abstract

According to the statistical report of the Korean Maritime Safety Tribunal, 73% of the marine accidents occur in small vessels of less than 100 GT. Korea considers it necessary to make every effort to reduce the incidents of small vessel accidents, as well as large vessel accidents. In order to prevent marine accidents in the future, the

five-year SMART Navigation project was started. In order to address potential issues with GPS plotters in small vessels, where it is not always clear whether the charts used are official ones or if the charts are up to date with the latest navigational critical information, an ECS standard is being developed within the SMART Navigation project. This ECS standard also aims to address issues with standardised critical symbols for safe navigation and a minimum required set of important functions like safety alarms.

This standard will be developed using a subset of relevant material from international standards like, IEC 60945, IEC 62288, IEC 61174, IEC 61996- 2, IEC 62376, IEC 6238 and RTCM standard 10900.6 for ECS. Moreover, it is expected that the ECS will be a user system that will receive the SMART Navigation services based on the Common Maritime Data Structure (CMDS), S-100 and S-10X product specifications will be considered as optional means of transmitting marine information within the ECS standard. This presentation introduced major characteristics and the development plan for the ECS standard that is being developed in the SMART Navigation project.

### 4.5 Two Acquisition Methods for Sensing non-AIS ship's Location for Location Sharing Systems

#### 4.5.1 Presenter and Author

Yasuyuki Niwa, *Junji Fukuto National Maritime Research Institute*
Hisaya Motogi, *Tomohiro Sunada National Institute of Technology, Oshima College*

#### 4.5.2 Abstract

Location sharing systems will be a powerful tool for navigation safety and need location acquisition methods for sensing ship's locations, especially for non-AIS ships. In this presentation two acquisition methods for sensing non- AIS ship's location were introduced.

One uses onboard RADAR TT (Target Tracking) information acquired by RADARs on ships and shore facilities. Most of the AIS ships use RADAR for sensing non-AIS ship's location as TT information. Some probe ships send AIS and TT information to a cloud server by 4G mobile communication, the cloud server then organises a dynamic map of ships and distributes the information via internet.

The other acquisition method uses GPS location information of smartphones on small craft. A navigation support client application for smartphones was developed, which sends its GPS location to a cloud server. The cloud server also organises dynamic information for ships by smartphone GPS information and AIS information and then distributes the information to the clients.

Two prototypes of each method have been made and tested in actual sea conditions. As a result, both location sharing systems worked as expected.

## 5 (Session 3) - Implementation of the Maritime Service Portfolio and Supporting Infrastructure

## Chair: Jinhyoung Park, *KRISO, Principal researcher*

### 5.1 LTE-Maritime Sea Test Result

#### 5.1.1 Presenter and Author

Boksub Song, *SMART-Navigation Project Office*
Kwanghyun Lim, *SMART-Navigation Project Office*
Hanjin Lee, *SMART-Navigation Project Office*
Deukjae Cho, *SMART-Navigation Project Office*

### 5.1.2 Abstract

The SMART-Navigation project aims to develop 'The next-generation maritime safety integrated management system' through SMART-Navigation based on the IMO (International Maritime Organisation) e-navigation concept. In order to establish the SMART-Navigation project successfully, the LTE (Long Term Evolution)-Maritime will be built as a communication infrastructure to solve communication barriers at sea.

The purpose of the pilot LTE-Maritime is to provide effective high-speed maritime wireless communication network testbeds in preparation for the full-scale LTE-Maritime construction using the test results on the pilot network. The pilot LTE-Maritime is constructed in three areas in Korea; Gangneung Port, Busan Port, and Mokpo Port. Tests are conducted to check coverage, measures to eliminate radio interference with the public network, reduce radio interference with neighboring countries, tidal effects and shaded areas caused by islands, and utilise it as a communication testbed for SMART-Navigation's service and infrastructure. This paper discussed the results of the pilot LTE-Maritime.

This research is a part of the project titled "SMART-Navigation project," funded by the Ministry of Oceans and Fisheries, Korea(PMS3550)

## 5.2 A Message Relaying Architecture based on the Maritime Resource

### 5.2.1 Presenter and Author

Kaemyoung Park, *ICT Center, Korean Register*
Seongsang Yu, *ICT Center, Korean Register*
Jaehee Ha, *School of Computing, KAIST*

### 5.2.2 Abstract

The Maritime Cloud is defined as a communication framework that enables reliable, stable and seamless electronic information exchange using all a variety of communication systems between maritime parties.

The SMART-Navigation project, a Korean e-navigation project, supports both LTE-Maritime and VHF Data Exchange System (VDES) which are heterogeneous communication means by introducing a maritime cloud as a communication framework. Vessels can change communication means based on quality of communication among heterogeneous communication paths at any time.

Even if the ship's communication is unstable and unexpectedly disconnected, the message to the ship must be transmitted seamlessly.

The presenter proposed a message-relaying architecture based on Maritime Resource Name (MRN) which is a unique identifier of ship and maritime actor to support that functionality.

## 5.3 MTCAS: An e-navigation Assistance System for Cooperative Collision Avoidance at Sea

### 5.3.1 Presenter and Author

Christian Denker, *OFFIS - Institute for Information Technology*
Leon Siegel, *OFFIS - Institute for Information Technology*

### 5.3.2 Abstract

History has shown a continuous increase in year on year accidents at sea. In the near future, higher traffic density is estimated, which contributes to this increase. Within the 3-year Project MTCAS, 5 German partners from industry and academia contribute to accident reduction by developing an e-navigation Assistance System for pro-active, predictive and cooperative collision avoidance. MTCAS is the abbreviation for Maritime Traffic Alert and Collision Avoidance System, which implies the basic idea of adopting the Airborne Collision Avoidance System (ACAS) implementation TCAS. However, MTCAS broadens its bounds by assisting the ships' crew in conflict detection and conflict resolution under consideration of a ship's holistic environment. Concrete examples include regularities, bathometry, non-equipped vessels and VTS, which are elaborated on in this talk. Dissident

from TCAS, MTCAS does not automatically intervene in terms of issuing steering commands, but supports seafarers in cooperatively finding safe and efficient trajectories, whose on-board implementation avoids collisions.

An essential contribution of MTCAS is enhancing safety and efficiency, by increasing seafarers' situational awareness about critical traffic situations. A starting point for MTCAS is the route exchange technology, which has been developed in the COSINUS project, enhancing harmonized situational awareness aboard and ashore. MTCAS integrates this technology for conflict detection and evasion. To gain required operational precision the technology will be extended with improved integrity monitoring and exchange of ship dynamics. Additionally, MTCAS is collecting information about the environment from heterogeneous data sources. The more information is available, the better is the situational assessment. When the situation is evaluated, MTCAS will provide the result to the captain and ask for a confirmation. That happens on all related ships. MTCAS will submit the confirmation of the captain to all off the other ships. Therefore, all captains are aware of the situation and know that the others are as well. MTCAS ensures all captains have the same information about the situation and prevents misunderstandings.

Depending on the current traffic situation and under consideration of ship dynamics as well as information on the route and past motions of the own ship MTCAS predicts ship movements and short term traffic progression. This incorporates for instance intention prediction, topology of water ways, bathymetry, ships' destination, rules and regulations and VTS information. This prediction leads to an enhanced alarm management. Due to the prediction false alarms are suppressed or corrected. This decentralized calculation of traffic and maneuver predictions (on each ship) is exchanged (Ship2Ship2Shore) and commonly coordinated/adjusted.

Thus a local overview of the situation is enriched to a complete traffic situation overview over time. MTCAS aims at on-board and ashore working decentralized conflict detection and at safe and efficient conflict resolution in critical situations. Ships' masters agree jointly on a set of evasive trajectories. A set of evasive trajectories is therefore always suggested to all ships' masters, which has to be accepted or declined. MTCAS will guarantee that evasive trajectories are found within real-time and that the crew can always be aware of and integrated in the conflict resolution process.

Within the project MTCAS, safety will be proven with qualitative and quantitative means to secure a gain towards maritime safety. The presenter informed about the activities to enhance the collision detection with prediction and misunderstanding free and consistent negotiation of evasive maneuvers. He invited constructive thought and feedback to foster synergies amongst the project domain.

## 5.4 Human Centered Design for Maritime Technology

### 5.4.1 Presenter and Author

Margareta Lutzhoft, *Australian Maritime College, Professor*

### 5.4.2 Abstract

Systems such as Automatic Identification System (AIS), Integrated Navigation System (INS) and Electronic Chart Display and Information System (ECDIS) are complex and have changed the way in which crew acquire and process information. Electronic navigational aids have reached a level of sophistication that may challenge the knowledge of the average user. These navigation systems have been designed with a multitude of modes and in the majority of cases there has been little or no regard paid to the user of these systems. Lacking in usability they can trap the crew into design-induced errors.

A number of studies have shown that advances in technology and new automation in most safety critical systems are increasing rather than lowering cognitive demands on humans. This is no different in a maritime context. Poor design in shipboard systems has also resulted in the need for increased training and familiarization, which comes at a cost, and does not address the underlying issue. Add to this is that around 33 per cent of accident investigations cite a lack of training or familiarization amongst the causes, and it is clear there is room for improvement. The apparent lack of human centred design and consequential issues associated with these systems needs to be addressed. Maritime regulators have expressed concern through such

statements as 'if we are to avoid the trap of technology overload, and if the industry is to benefit fully from e-navigation, then the technology needs to be standardized and integrated...'. With this in mind, and considering the industry's recent experience with highly complex systems being introduced on ships a focus on user needs was mandated by the International Maritime Organisation to ensure that a human centered design approach is developed for consideration in future navigation systems.

## 5.5 STM Validation project – ecosystem of concrete services in test-beds

### 5.5.1 Presenter and Author

Per Setterberg, *Swedish Maritime Administration, Project Manager*

### 5.5.2 Abstract

STM Validation, a €42m EU-sponsored project gathering over 40 partners from 10 European countries, started in 2015 and will run until the end of 2018. The project introduces large-scale testbeds targeting 300 ships and 13 ports to roll-out interoperable IT systems and services while gathering data to validate the effects of Sea Traffic Management on efficiency, safety and environment for the maritime domain.

The architecture used for the STM test-beds is based on the Maritime Cloud and implementations of its Identity and Service Registries to enable Identity and Access Management for actors and their information exchanged in the eco-system of services. Standardized information services for exchange of voyage plans and port call synchronization are introduced and adopted by market-leading industry partners. Furthermore, a standardised technical interface – connector – has been defined for the secure exchange of peer-to-peer information between service providers and consumers. Through the procurement of 300 ships' systems for STM capability from four leading ECDIS suppliers, a substantial step has been taken towards implementing de-facto standards and a service ecosystem which is envisaged to be in demand beyond the STM Validation Project.

A key success factor for the STM Validation testbeds is services that add concrete value to participating shipping companies and ports. Therefore, several project partners are launching services to be provisioned and consumed over the Maritime Cloud-based infrastructure. Some of these services and their relation to e-navigation service portfolios and solutions were described in this presentation. A few examples are;

- A Pilot Route Service set up by the Swedish Maritime Administration which supplies ships at planning stage with actual pilot voyage plan from berth to pilot station and vice versa. The pilot routes are fused directly in ECDIS with the ships sea passage voyage plan. Refers to MSP 6.

- A Route Planning Service which is suggesting a route to the ship at planning stage, based on current draft and ports of departure and destination. Possibly and partly referable to MSP 1.

- The Finnish and Swedish icebreakers management system is being amended with functionality for route exchange which allows direction of assisted ships through STM. This alleviates administrative procedures and replaces some of the current communication over VHF, phone and emails, which in turn reduces the risk for misunderstanding or mistakes in manual processing of information. Ref. MSP 13.

- The Swedish Search and Rescue management system is being supplied with STM functionality allowing JRCC and rescue units to exchange search areas, text messages and search patterns machine-to-machine. This makes the information permanently available on rescue units where radio- or phone communication under stress is sometimes lost and needs to be repeated. Rev. MSP 16.

- Route optimisation services are set up, both for ocean passages and for squat/speed optimization in coastal areas. Some of these services are existing commercial products, which are now possible to deliver machine-to-machine between service provider and bridge system. This replaces a series of administrative steps in the process compared to the present situation based on emails or web portals. This could be referred to MSP 4 and/or MSP 9, at least in a wider context.

- Ships and ports will be able to exchange requested and estimated times of arrival/departure automatically and frequently, replacing some of the present voice communication over VHF and phone to agree between ship and shore on arrival, pilotage and berthing times. Ref MSP 4.

The STM Validation project, its large scale test-beds and operational digital infrastructure will demonstrate practical and operational e-navigation solutions corresponding to several Maritime Service Portfolios. Thereby, the STM Validation project hopes to take part in the transformation of e-navigation from principles to practice.

## 5.6 The Generic Testbed eMIR: The eMaritime Integrated Reference Platform

### 5.6.1 Presenter and Author

Axel Hahn, *OFFIS - Institute for Information Technology, Member of the Board*

### 5.6.2 Abstract

A number of testbeds for new e-navigation and surveillance technologies are under design and implementation around the globe. These testbeds have numerous objectives: Understanding challenges and requirements for e-navigation, development and test (validation and verification) platforms or to demonstration of the maturity of new technologies.

The international organisations fostering e-navigation like IALA and IMO as well as national bodies regard testbeds as an important method to invent and develop new e-navigation concepts and technologies as well as their dissemination and exploitation. Testbeds could also provide fruitful information about the maturity and usefulness of new standards and specifications (like S-100ff).

Driven by German industry in the context of the NMMT, eMIR provides an open modular research and test environment used for scientific analysis of maritime systems, for R&D by providing testbeds for validation and verification and for demonstration and evaluation of new maritime technologies for navigation, organisation and surveillance or maritime (transportation) systems. Actually is includes virtual and physical testbeds provided by OFFIS and DLR.

Following a joint interoperability architecture eMIR provides the basis to implement and integrate testbeds and project outcomes and to provide a sustainable opportunity to present project outcomes, products and services. The communication infrastructure currently is a modified high-level architecture implementation for the simulation environment combined with a message passing middleware for the physical test bed. This infrastructure allows the communication between different simulation components in a co-simulation environment but also the communication with developed software and physical test bed systems.

eMIR allows the early testing of new maritime technologies in a complex simulation environment and the seamless transfer of these technologies into a physical test bed. The basis of the architecture is a communication infrastructure, a common semantically defined world data model and polymorphic integration interface.

eMIR provides virtual as well as physical testbed elements such as:

· Reference Waterway with communication and surveillance technology along the Elbe between Cuxhaven and Brunsbüttel;

· Research Port Rostock Warnemünde: Testbed for safety and security technology with special focus on GNSS;

· Mobile Bridge and experimental Vessel Traffic Services System: For experiments in situ or in a simulation environment;

· Traffic Database for data analyses and scenario;

· Research Boats Otzum and Zuse: Experimental platforms located in Wilhelmshaven;

· Maritime Traffic Simulation: provides testing scenarios;

· Environmental Simulation: to generate wind, current, wave, tidal influenced simulation environment;

· Sensor Data Simulation: To generate test data for technical systems under test.

### 5.7 VHF Data Exchange System: A maritime communications technology for information sharing

#### 5.7.1 Presenter and Author
Ernest Batty, *IMIS Global Limited, Technical Director*

#### 5.7.2 Abstract

The first specification that covers the VHF Data Exchange System (VDES) was published as ITU-R M. 2092-0. VDES is promoted as an e-navigation enabler and allows the transfer of larger volumes of data between the ship and shore and ship and ship than is currently possible with the existing AIS technology.

To achieve the benefits that result from the use of VDES, there needs to be VDES infrastructure (VDES shore stations and a suitable system to connect the VDES stations together) in place, there needs to be vessels that carry the mobile VDES units and a range of suitable applications that satisfy one of or of the safety, security, economic or environmental needs and demands of the maritime industry.

VDES shore stations combine AIS, ASM and VDE technologies in one box. This is not the only way to deploy VDES but may be the most effective.

In common with AIS, VDES shore side technology is required to take account of ports, coastal, off shore and international maritime VHF communication systems with which it has to coexist in a safe manner.

The VDES shore station is controlled by a network that schedules the transmission of messages and deals with the delivery of the entire message and the priority of these messages and at the same time ensures that the VDES system safety and security is not compromised.

## 6 (Session 4) - Regional Cooperation & Collaboration towards e-navigation
## Chair: Mahesh Alimchandani *AMSA, Head of Maritime Safety*

### 6.1 e-navigation Collaboration Across Borders

#### 6.1.1 Presenter and Author
Lene Vesterlund, *Kongsberg Norcontrol AS, Vice President Marketing & Sales*

#### 6.1.2 Abstract

Lene Vesterlund presented information on a three-year research project termed SESAME Straits (Secure, Efficient and Safe maritime traffic Management in the Straits of Malacca and Singapore), funded by the Norwegian Research Council. The project is an example of international collaboration with Norwegian and Singaporean stakeholders, which resulted in a successful demonstration of e-navigation services both in Europe and in Asia. The project's objective was to improve the safety of vessel traffic and enable "Just-in-time" arrival technology, improving the efficiency of existing port infrastructure, and reducing the environmental footprint by making it possible to predict possible vessel traffic hot-spots in congested waterways, as well as providing new strategies to avoid such congestions. The project partners utilised their unique expertise and experience in ship systems, shore-based systems, and AIS and VDES communications technology to develop and validate shared situational awareness and cooperative decision making between the bridge team and shore side operators.

The SESAME Straits project with Norwegian partners collaborated closely with Singaporean partners to develop technologies that jointly made the just-in-time concept operational. The presentation touched on the opportunities that have arisen and the experiences and the winning themes for making a cross-border and long-distance collaboration fruitful. The presentation concluded with lessons learned from the SESAME Straits project, especially in regards to success criteria and pushing the development of e-navigation services further across global borders.

## 6.2 S-mode - How can Guidance Deliver More Standardization without Compromising Innovation

### 6.2.1 Presenter and Author

Nick Lemon, *AMSA, Manager System Safety*
Margareta Lutzhoft, *Australian Maritime College, Professor*

### 6.2.2 Abstract

Nick and Margareta presented jointly on this topic. They pointed out that many navigation incidents highlight the consequences of lack of standardisation and human centered design in navigation systems. The time has come to suggest that the problem cannot be trained away, but should apply a more effective countermeasure – design the problem out. The standardisation of navigation systems is one effective countermeasure to reduce variability and system complexity, with the development of the S-mode guidelines now included in IMO's agenda, with an output expected in 2018/19. In order to bring a mature draft S-mode guideline to the IMO, informal, collaborative efforts are being made by several IMO member states along with interested international organisations.

Recent workshops have refined the scope of S-mode with concerns raised over the rationale of a single button activation of S-mode. The consensus was that "less emphasis should be placed on the activation of 'a single button' - instead focus should be on guidance that will better achieve standardisation of the 'look and feel' of navigation systems". Although the need for an S-mode guideline is undisputed, complete consensus on S-mode is under active discussion.

Some insist that for S-mode to succeed the 'look and feel' aspects need to be well defined, with some level of prescribed standards necessary. It is also recognised by many that there should not be a single optimal solution for navigation systems user interfaces. Even by following good design guides that optimize usability, quite varied solutions could emerge. However, it has been agreed that a major role of S-Mode is to achieve more commonality in user interfaces to ease the negative aspects of ever-growing complexity of navigation systems and the consequences for bridge familiarization.

## 6.3 Regional cooperation in the north and Europe

### 6.3.1 Presenter and Author

John Morten Klingsheim, *Norwegian Coastal Administration, Senior Engineer*

### 6.3.2 Abstract

John noted that one of the reasons that the IMO developed e-navigation was the lack of coordination and harmonisation of digital maritime solutions. The presenter gave examples of practical implementation of e-navigation in Norway. He outlined how regional cooperation in the North and Europe had led to more harmonisation and standardisation.

The presentation focused on the need for more cooperation between regions and countries, if global solutions are to be implemented. Furthermore, international organisations must play a key role in achieving the goal of global standards and harmonisation.

## 6.4 Asia-Pacific Web – a fast track means for the provision of e-navigation services, based on the Maritime Cloud concept

### 6.4.1 Presenter and Author

Thomas Christensen, *Digital Maritime Consultancy, CEO*

### 6.4.2 Abstract

This forward-looking presentation focused on the plans to establish a regional, web-based portal for maritime stakeholders to access e-navigation services in the Asia-Pacific region. Thomas made the point that Asia-Pacific

web will provide a fast track rollout of e-navigation services before these are fully integrated in equipment on board vessels and at shore installations.

The Asia-Pacific web will draw on the lessons learnt from the Baltic web and the Arctic web.

The Asia-Pacific Web platform will be based on open-source software that is already in use in the arctic area, and that potentially will be used in other regions of the world. The presentation will also introduce the concept of the Maritime Cloud and outline e-navigation how the platform will use the Maritime Cloud communication framework.

# 7 (Session 5) - Wrap Up session, Present Conference Conclusions

## Chair: Sunbae Hong, *Ministry of Oceans and Fisheries, Head of e-navigation, Head of Navigation*

### 7.1 Summary of Session by Session Chairs

### Session 1

Session 1 chair, Mr. Jorge Arroyo briefly summarised the contents of the session 1 presenters as follows.

Four main leading organisations need to work together to provide harmonisation to move forward to ensure the success of e-navigation. The first speaker, Mr. Sascha Pristrom from the IMO, gave a brief update on advances for the whole strategic implementation plan which assisted the member states and other non-governmental organisations. Also IMO has decided to implement the harmonisation group between IMO and IHO (HGDM) for the success of e-navigation.

Speaking of IHO, Mr. Yong Baek announced the S-100 working as the framework for data management and for data portrayal. He highlighted that there were interoperability issues as the community moves forward under the framework of S-100.

An interesting, different viewpoint from IALA was work of the IALA World Wide Academy and network building. It was very encouraging to see how the World Wide Academy is already moving forward with web series and associated type of services that support e-navigation to progress the connectivity of protocols and navigational services.

And then, on the local front Mr. Sunbae Hong within the whole SMART Navigation dealt with leading the whole e-navigation effort for the world right now. The SMART Navigation project is showing good progress using diverse technologies, particularly, the use of LTE mobile and other means of communication for navigational services.

Richard Doherty of CIRM gave a great presentation on the importance of harmonisation, explaining that it has to be tied with innovation but also recognising the risks. There is a need to innovate and do things differently than the way it is been doing under the umbrella and under the guidance of being more harmonised, working in a more integrated manner.

### Session 2

Session 2 chair, Prof. Axel Hahn briefly summarized the contents of the session 2 presenters as follows.

As reported by Director Oh, the non-SOLAS vessels have to be addressed within the scope of e-navigation. Especially, the MSPs should be scalable to include non-SOLAS vessels and might include developing connectively between non-SOLAS and SOLAS vessels.

For high-end non-SOLAS vessels, it was identified by Mr. Bjorn Hjollo and Mr. Geonuung Kim that they have the same needs as SOLAS vessels for monitoring and supply of additional information.

He mentioned that the same standard for SOLAS and non-SOLAS vessels is applied in terms of work done on network solutions.

### Session 3

Session 3 chair, Dr. Jinhyoung Park briefly summarised the contents of the session 3 presenters as follows.

The first one was the LTE-M and the second one was the VDES. From the LTE-M, one could find the feasibility of LTE-M for the application of maritime safety communication link and from the VDES presentation by Ernie Batty, one could find what is going on in VDES in IALA and what it would be like in reality.

Mr. Kaemyoung Park presented what is the inside of the Maritime Messaging Service and what it the technical process, and what is required for heterogeneous simulations roaming.

There were two presentations on the testbeds for e-Mir, cyber physical testbed and the STM algorithm testbed which is the largest testbed with 300 vessel sites.

Also, the technical solution was the collision avoidance algorithm which was one of the Critical Technical Elements for e-navigation services. Although MTCAS is at its early stage, it could be found that it has a very unique approach by using a status approach.

Regarding the last presentation, Mr. Park explained that human centered design is all about how to can give easier access to newly developed technologies.

### Session 4

Session 4 chair, Mr. Mahesh Alimchandani briefly summarised the contents of the session 4 presenters as follows.

The SESAME Straits presentation showed the importance of novel standards on e-navigation solutions that are being developed, and the need to collaborate across the regions.

The S-Mode presentation revealed the standardisation of navigation systems such as the ECDIS. This was an important user need that was identified very early in the place Nick mentioned, the balance in an IMO guideline on S-mode is going to be challenging. There has been a lot of interest in this work, which has been harnessed and the manifestations was this close collaboration that's taken the work to where we are now.

The presentation form Mr. John Klingsheim of NCA emphasised the point that is wiser to include user needs from the outset. The inclusion of user needs gives projects a much better chance of success.

Thomas' Asia-Pacific Web presentation made the point that the Asia-Pacific Web gives early access to e-navigation services, and that this has many benefits for the users.

### 7.2 Panel discussion: Summary by IALA Secretary General, Dean IALA World Wide Academy and session chairs

A panel comprising Jorge Arroyo (USCG), Axel Hahn (OFFIS), Jinhyoung Park (KRISO), Mahesh Alimchandani (AMSA), Francis Zachariae (IALA), Omar Frits Eriksson (IALA) discussed a number of questions with the audience.

The individual session chairs made a brief summary of each of their sessions. Some of the most important elements have been captured in the conference highlights.

After this, the IALA Secretary General, Mr Zachariae, and the Dean of the IALA World Wide Academy, Mr Eriksson, each answered a central question put forward by Mr. Hong.

Mr. Zachariae was asked how the series of e-navigation Underway conferences can best support the e-navigation process, locally and globally.

Mr. Zachariae answered by initially pointing out, that we now have three conferences; two regional ones in North America and Asia-Pacific and a global one based in Europe. Furthermore, he pointed out that the approach to e-navigation in the different regions is quite different, stressing the strong focus on non-SOLAS vessels in Korea. He argued that the conference series could turn this diversity into a benefit, by ensuring efficient dissemination of result from the different regions. Furthermore, he informed that an overall coordination group for the conference series has been established, to ensure both coordination and dissemination of information.

In addition to this, Mr. Zachariae stressed the importance of the fact that the IMO Maritime Safety Committee recently had established the IMO/IHO Harmonisation Group on Data Modelling, with Mr. Hong himself as chair. He said that at this stage, this group and its work was the most important initiative within the framework of e-navigation.

Mr. Hong asked Mr. Eriksson how can we best support training and capacity building in developing countries in the Asia-Pacific region.

Mr. Eriksson started out by talking about the importance of e-navigation awareness in the regions on all levels, from future practical users to politicians whom must be convinced to invest in e-navigation. The e-navigation Underway series of conferences has an important role to play in this.

Mr. Eriksson continued to speak about the concept of ‘embryonic e-navigation’, which is of particular relevance to developing countries. This is the idea of making e-navigation services available on web-based platforms at an early stage, before they are actually integrated into relevant equipment. He referred to the examples of ArcticWeb, BalticWeb and Asia-PacificWeb, which he had mentioned in his presentation.

Finally, he assured that the WWA in their work had a big focus on e-navigation, when they engage with nations that are in need of improving their maritime safety.

# 8 CONFERENCE HIGHLIGHTS

## 8.1 Conference highlights

Mr. Sunbae Hong session 5 chair, presented the conference highlights derived from the conference proceedings.

It was made clear that IALA will consider the following conference highlights and identify any appropriate actions required, thus there are no associated Recommendations.

The conference highlights were:

1. It is desirable to strengthen global e-navigation testbed initiatives to facilitate implementing the IMO Strategy Implementation Plan (SIP). This work should be based on harmonised standards, a common communication framework and human centered design to ensure interoperability and usability.
2. Web based solutions such as ArcticWeb, BalticWeb and a future Asia-PacificWeb could be a means of accessing e-navigation services at an early stage.
3. MSPs should be scalable to include non-SOLAS ships. This might include developing connectivity between Non-SOLAS and SOLAS ships, customised e-navigation services and on-board e-navigation capable platforms for Non-SOLAS ships.
4. It is important for all relevant stake-holders to contribute to the activities of the IMO-IHO Harmonisation Group on Data Modeling (HGDM), which will work on the development of guidance on definition and harmonisation of the format and structure of e-navigation Maritime Service Portfolios (MSP).

5. It is essential to develop an e-navigation technical cooperation program for developing countries which includes training and capacity building.

## 9 Closing of the conference

Mr. Francis Zachariae, Secretary-General of the International Association of Marine Aids to Navigation and Lighthouse Authorities (IALA) thanked all participants for their attendance. He congratulated the speakers, session chairs, supporting organisations and the steering committee for the excellent arrangements as well as the conference partners. In particular, on behalf of all attendees, he thanked host, the Ministry of Maritime Affairs and Fisheries led by Mr Sunbae Hong, for his outstanding effort and execution. Mr Zachariae was sure this conference will a memorable one and a part of the history of the e-navigation Underway series of conferences.

In closing, Mr Zachariae wished all delegates a safe voyage home and looked forward to attending the 2017 e-navigation Underway North-America Conference.

## 10 Exhibition

### 10.1 Exhibitors

The names of the exhibitors and their products are given below:

| Name of exhibitor | Products |
|---|---|
| **XIAMEN NAVI-GUIDER**<br>Qi Shao | Ship dynamic monitoring system,<br>Big data of navigation mark, etc. |
| **SAFEBRIDGE**<br>Michael Bergmann | ECDIS systems,<br>Vessel Training Kit |
| **KT**<br>Seung-min Kim | LTE-Maritime network, OTHAD,<br>Maritime satellite network, etc. |
| **The 19th IALA Conference 2018**<br>Yong-Chan Bae | The 19th IALA Conference 2018 |
| **SMART-Navigation Project**<br>Sumi Han | SMART-Navigation |
| **Danish Maritime Authority**<br>Rasmus Jensen | EfficienSea2 Project |

# 11. Social Events

## 11.1 Pre-conference/Gala/Network Building dinner

On day 1, following a pre-conference dinner in the Crystal Bloom on Jeju Lottel hotel, a buffet style dinner was held. It was served with Korean traditional alcoholic beverages with welcome drinks.

On day 2, personal photographs and a welcome event were followed by a 3 course dinner in the Crystal Bloom with Korean traditional music performance.

On day 3, a network building dinner was consisted of a buffet style dinner in the Crystal Bloom.

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