Report on the

Digital@Sea International Seminar

SEMINAR REPORT

16 to 17 March 2026

IALA Headquarters

Saint Germain en Laye, France

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International Organization for Marine Aids to Navigation

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Executive Summary

The Seminar on Digital@Sea International was held between 16 and 17 March 2026 in Saint Germain en Laye, France.

The workshop was well attended with 52 participants from 17 countries.

Maritime navigation is becoming increasingly digital and data-driven, which introduces new vulnerabilities. Disruptions to positioning systems, cyber risks, and failures in digital delivery can directly impact the safety of navigation.

This seminar brings together maritime authorities, international organizations, and industry stakeholders to build a common understanding of resilient navigation. It explores how S-100/S-200-based services, secure IP-based data exchange, and connectivity frameworks such as VDES and MCP can enhance operational robustness. The programme also considers the responsible integration of artificial intelligence, ensuring that innovation is balanced with human oversight and safety.

Through expert presentations, panel discussions, and targeted group work, participants aim to identify practical implementation approaches and to promote greater harmonization among IALA, IHO, IMO, and national authorities, thereby supporting reliable, interoperable, and future-ready maritime digital services.

Table of Contents

Report of the Digital@Sea International Seminar

1. INTRODUCTION

International Organization for Marine Aids to Navigation (IALA) hosted a seminar in Saint Germain en Laye from 16 to 17 March 2026, as the need to address emerging risks associated with the digital transformation of maritime navigation. As services become increasingly dependent on data, connectivity, and positioning systems, there is a clear requirement for coordinated approaches to ensure resilience, continuity, and safety. It also responds to the need for stronger alignment between international frameworks and practical implementation, bringing together stakeholders to share experience, identify gaps, and support harmonized development of S-100/S-200 services, secure data exchange, and robust maritime connectivity solutions.

The workshop attracted strong participation, bringing together 52 attendees representing 17 countries.

2. SESSION 1 – OPENING AND SETTING THE SCENE

This session was chaired by Omar Frits Eriksson, IALA Deputy Secretary-General. The Secretary was Alisa Nechyporuk, and the IALA organized the logistics for the event.

2.1 Welcome and opening remarks, Omar Frits Eriksson – International Organization for Marine Aids to Navigation (IALA)

Mr. Omar Eriksson opened the seminar by warmly welcoming participants to the Digital@Sea International Seminar at IALA Headquarters, highlighting the strong presence of international experts, innovators, and stakeholders. He conveyed greetings from the Secretary-General and emphasized the importance of the event as a collaborative platform to address key developments in maritime digitalization. In his introductory remarks, he provided an overview of IALA's transformation from a non-governmental association into an intergovernmental organization (IGO), a process that took over a decade and culminated in the entry into force of the IALA Convention in August 2024. He noted that this transition has strengthened IALA's global role and influence, placing it alongside organizations such as IMO and IHO, while maintaining its core mission of developing and harmonizing marine aids to navigation through international cooperation.

Mr. Eriksson outlined IALA's strategic priorities, including digitalization, resilient PNT, maritime connectivity (VDES, MCP), cybersecurity, sustainability, and the integration of emerging technologies such as AI and autonomous shipping. He reflected on the evolution of e-navigation over the past two decades, stressing that progress requires coordinated efforts among international organizations, industry, and national authorities. He emphasized that no single entity could address current challenges alone and that forums such as this seminar are essential for fostering cooperation and practical solutions. Concluding his remarks, he encouraged active participation, open discussion, and networking among attendees to support the development of harmonized, resilient, and future-ready maritime services.

2.2 Opening remarks, Dr. Mathias Jonas – International Hydrographic Organization (IHO)

Dr. Jonas highlighted the growing complexity of the maritime digital environment and introduced the concept of "resilient navigation" as an essential evolution beyond traditional safety and efficiency frameworks. He stressed that modern navigation systems must be capable of withstanding disruptions, including cyber threats and GNSS vulnerabilities, while continuing to provide reliable services to mariners.

He also underlined the importance of strong governance and international cooperation in achieving this resilience. Drawing parallels with developments in other sectors, he pointed to the need for structured frameworks that ensure interoperability and consistency across systems. His remarks reinforced the necessity of aligning technical innovation with practical operational requirements.

2.3 Seminar introduction, format, and objectives, Omar Frits Eriksson – International Organization for Marine Aids to Navigation (IALA)

In introducing the seminar, Mr. Eriksson outlined its structure, objectives, and key thematic areas, including trust, cybersecurity, IP-based data distribution, PNT resilience, S-100/S-200 frameworks, and the role of AI. He emphasized that the seminar is part of a broader, ongoing journey in e-navigation and maritime digitalization, encouraging participants to actively engage, exchange ideas, and challenge assumptions. The objective is to identify practical, implementable pathways and strengthen cooperation across organizations and industry, ultimately contributing to safe, interoperable, and future-ready maritime services.

Presentations from the Seminar can be found on the IALA fileshare.

A list of participants can be found in Annex A.

The full programme of the seminar can be found in Annex B.

3. SESSION 2 – TRUST, SECURITY & IP-BASED DATA DISTRIBUTION

Jeppe Skovbakke Juhl, Chief Naval Architect in the Regulatory Department (BIMCO), chaired this session.

Session 2 was opened by Jeppe Skovbakke Juhl, who introduced the theme of data exchange and satellite connectivity in the maritime domain. He noted that while maritime digitalization is not new, it is becoming increasingly critical for improving efficiency, safety, and sustainability across global shipping.

He emphasized that the sector still faces significant challenges, particularly due to fragmented systems, inconsistent standards, and limited interoperability between ships, shore-based services, and ports. Highlighting the importance of international coordination, he underlined the need for closer collaboration among organizations such as the International Maritime Organization, the International Association of Marine Aids to Navigation and Lighthouse Authorities, and the International Hydrographic Organization.

In closing, Jeppe encouraged participants to actively engage in the session, which aims to explore current challenges and practical solutions for achieving a more harmonized and interoperable maritime digital ecosystem.

3.1 Data distribution and global IP-based connectivity – Jeppe Skovbakke Juhl, Baltic and International Maritime Council (BIMCO)

Mr. Juhl set the scene for the session by addressing the challenges and opportunities of maritime digitalization from a shipowner perspective. He emphasized that while digitalization offers significant benefits in efficiency and coordination, the sector remains fragmented, with numerous systems and data models lacking interoperability. He highlighted the importance of global collaboration to achieve harmonized solutions.

He presented the IMO Compendium as a key enabler for standardized data exchange and stressed the need for common frameworks for IP-based connectivity. At the same time, he noted concerns related to reliance on commercial communication infrastructure and the necessity of ensuring reliable, secure, and globally accessible connectivity for maritime operations.

3.2 MCP as a trust & identity framework – Juho Pitkanen (Fintraffic)

Mr. Pitkänen presented the Maritime Connectivity Platform (MCP) as a decentralized solution for enabling trusted and secure digital communication across the maritime domain. He explained how MCP supports identity management, service discovery, and secure data exchange, building on established internet technologies while addressing maritime-specific constraints such as limited connectivity.

He further elaborated on the concept of trust in digital systems, introducing the development of a maritime trust framework to enable fine-grained control over data sharing and access. He emphasized that interoperability and trust must be built across technical, semantic, and organizational layers, and that MCP can serve as a foundational element in achieving this within a fragmented global environment.

3.3 S-100 ECDIS Sea Trials: Initial Results and Lessons Learned – Richard Doherty (CIRM)

Mr. Doherty provided an overview of the transition to S-100 capable of ECDIS, focusing on the technical and operational implications for equipment manufacturers and the wider industry. He highlighted the complexity of achieving type approval, stressing the need for stable and finalized standards to ensure timely compliance with IMO implementation timelines.

He also shared initial findings from ongoing sea trials, noting improvements in data visualization and navigational awareness through enhanced datasets. At the same time, he emphasized challenges related to system complexity, training requirements, and cost considerations. He underlined the importance of a pragmatic, phased approach supported by industry collaboration and user feedback.

3.4 System Boundaries in Digital Maritime Services: Who and What Are We Designing For? - Capt. Naomi Vanderstockt (Caerulea) – virtual

Capt. Vanderstockt focused on the gap between technical system development and operational reality, questioning whether current digital maritime frameworks fully account for the needs of end users. She highlighted that while significant progress has been made in standards and infrastructure, less attention has been given to human factors, governance, and system integration at the operational level.

She stressed the importance of addressing semantic interoperability, clearly defining system interfaces, and ensuring that mariners and VTS operators are actively involved in system design and validation. Drawing comparisons with aviation, she advocated for stronger governance frameworks and a more holistic approach to implementation, ensuring that digital systems are not only technically sound but also operationally effective.

3.5 Panel Discussion

The panel discussion brought together the session's speakers to reflect on the key themes of trust, cybersecurity, and data integrity in maritime systems. A central point of agreement was that increasing digitalization has outpaced the implementation of adequate security measures, leaving critical systems exposed to risks such as spoofing, data manipulation, and unauthorized access. Panelists emphasized that trust in data cannot be assumed and must be actively verified through layered approaches, including authentication, redundancy, and cross-validation of information sources.

Another recurring theme was the need for stronger international coordination and standardization. While multiple initiatives exist across organizations, the discussion highlighted fragmentation in approaches to cybersecurity and data governance. Panelists agreed that improving information sharing, developing common definitions, and aligning regulatory frameworks would be essential steps forward. The conversation concluded with a recognition that technology alone cannot solve these challenges—human awareness, training, and operational procedures remain equally critical in ensuring secure and resilient maritime navigation systems.

4. SESSION 3 – RESILIENT NAVIGATION

This session was chaired by Stefan Gewies, German Aerospace Center (DLR).

Stefan Gewies opened the session by framing resilient navigation as a critical and timely issue, driven by the increasing reliance on digital systems in maritime operations. He highlighted how modern navigation and communication services have significantly improved efficiency and safety, but also introduced vulnerabilities due to their exposure to disruption, particularly in regions affected by geopolitical tensions, economic pressures, and criminal activity.

He outlined the structure of the session, noting that it would provide a comprehensive overview of current challenges affecting navigation systems, especially GNSS and AIS. He emphasized the importance of understanding both the technical and operational dimensions of resilience and encouraged participants to engage actively by raising questions for the concluding panel discussion.

4.1 Overview – PNT Threats and Risks – Dana Goward (RNTF) – virtual

Mr. Goward focused on the distinction between threats and risks in the context of Positioning, Navigation, and Timing (PNT), stressing that risk—not just threat—should guide decision-making. He introduced a structured risk framework based on probability, vulnerability, and consequence, illustrating how maritime stakeholders can better evaluate and prioritize mitigation strategies.

Drawing on real-world examples, he demonstrated the growing prevalence of GNSS interference and spoofing incidents, highlighting their operational and economic consequences. He emphasized that maritime systems remain highly vulnerable, with increasing evidence of both intentional and incidental disruptions, and urged the community to adopt quantitative risk assessment approaches to support more informed resilience planning.

4.2 What is resilience? – Andy Proctor (RIN)

Andry Proctor challenged conventional, technology-centric interpretations of resilience, arguing that resilience should instead be understood as a behavioral characteristic of systems. He emphasized that adding more sensors or technologies does not inherently create resilience; rather, resilience depends on how systems detect, respond, recover, and adapt under stress.

He introduced a behavior-based framework for designing resilient PNT systems, focusing on performance under disruption and the importance of operational decision-making. By shifting from “buying technology” to “designing behaviors,” he demonstrated how organizations can better define requirements, measure resilience, and ultimately build systems that maintain functionality in both expected and unforeseen conditions.

4.3 AIS spoofing and cybersecurity considerations – Ed Wendlandt (RTCM) – virtual

Ed Wendlandt examined AIS spoofing from both a cybersecurity and operational perspective, highlighting the inherent vulnerability of AIS due to its lack of authentication and encryption. He explained how spoofing has evolved from simple manipulation tactics to sophisticated, coordinated activities used for sanctions evasion, deception, and disruption.

He outlined practical detection and mitigation strategies, including cross-validation with multiple sensors, machine learning techniques, and signal-level analysis. He also introduced the concept of zero-trust architecture as a framework for strengthening maritime cybersecurity, stressing the need for continuous verification, segmentation of systems, and improved crew awareness to enhance resilience across ships, ports, and infrastructure.

4.4 Spoofing and jamming in VTS – Thomas Southall (IALA)

Thomas Southall explored the operational impact of GNSS interference on Vessel Traffic Services (VTS), an area often overlooked in resilience discussions. He demonstrated how both jamming and spoofing can degrade situational awareness, disrupt traffic management, and significantly increase workload for both VTS operators and bridge teams.

He highlighted the cascading effects of unreliable AIS data, including confusion, loss of trust, and increased risk of human error. To address these challenges, he proposed a combination of technical, procedural, and training measures, emphasizing multi-sensor integration, robust operational procedures, and enhanced training to ensure VTS personnel can effectively respond to a degraded navigation environment.

4.5 Cybersecurity initiatives in the EU – Chronis Kapalidis (EMSA)

Chronis Kapalidis presented an overview of cybersecurity initiatives within the European Union, emphasizing EMSA's role in awareness, guidance, and training. He highlighted the growing importance of cybersecurity in maritime operations, particularly as digitalization increases system interconnectivity and exposure to cyber risks.

He described ongoing efforts to develop practical guidance for inspections, promote cyber hygiene, and align EU initiatives with international frameworks such as IMO guidelines. He also stressed the importance of information sharing and identified GNSS and AIS interference as a significant portion of reported incidents, underscoring the need for improved reporting, coordination, and sector-wide awareness.

4.6 Using AIS data in detection and mitigation of GNSS spoofing – Dmitry Rostopshin (DINAV)

Dmitry Rostopshin presented a data-driven approach to detecting GNSS spoofing using AIS data, demonstrating how anomalies such as position jumps, unrealistic speeds, and unusual movement patterns can indicate interference. His analysis of real-world data revealed distinct spoofing patterns, including geographic shifts and clustering effects in affected regions.

He introduced a prototype system that applies machine learning and statistical methods to detect and partially correct spoofed vessel positions. While acknowledging limitations in accuracy, he showed how such tools can provide valuable situational awareness, identify affected zones, and support VTS and maritime authorities in mitigating the impact of GNSS disruptions.

4.7 Panel Discussion

The panel discussion highlighted the lack of a unified international definition and data repository for spoofing and GNSS interference, with speakers acknowledging fragmentation across organizations and regions. While some data and standards exist, there is no single authoritative framework, and improved coordination remains a key challenge.

Speakers also noted that the perceived lack of complaints from industry may reflect insufficient awareness rather than absence of impact. The discussion emphasized the need for better data collection, clearer definitions, enhanced information sharing, and alternative navigation solutions, reinforcing that resilience requires both technological and organizational evolution across the maritime sector.

Guttorm Tomren from the Norwegian Coastal Agency (NCA) led this session.

The session opened with reflections on the evolving priorities of the maritime sector, where resilience is emerging as the next defining theme after decades focused on safety, efficiency, and decarbonization. The IALA Secretary-General emphasized that geopolitical tensions and vulnerabilities in GNSS have renewed attention on resilient positioning, navigation, and timing solutions, including the return of systems such as eLoran. This shift underscores the need for robust, redundant infrastructures capable of supporting safe navigation under degraded or contested conditions.

5. SESSION 4 – S-100/200 AS THE BACKBONE OF RESILIENCE

Guttorm Tomren highlighted that despite rapid technological progress, the mariner remains central to resilience. He stressed that S-100-based systems must be designed with usability in mind, ensuring that navigators can effectively interpret information and maintain situational awareness. The importance of maintaining traditional navigation skills alongside advanced digital tools was emphasized as a critical factor in ensuring safe and resilient maritime operations.

5.1 S-100 ecosystem update & roadmap – Thomas Richardson (UKHO)

Thomas Richardson provided a comprehensive overview of the current status and future trajectory of the S-100 framework, emphasizing its role as a foundational data exchange standard for modern maritime navigation. He highlighted that while initial datasets are now becoming available, many remain in a research or trial phase, with key interoperability standards still under development. The importance of coordinated sea trials, validation processes, and collaboration with equipment manufacturers was stressed as critical steps toward operational readiness by the 2029 milestone.

Looking ahead, Richardson noted that S-100 is expected to evolve gradually rather than through immediate large-scale adoption. Beyond ECDIS, he emphasized broader ecosystem benefits, such as improved shore-to-shore data exchange and faster, more secure information flows. The presentation underlined that real value will emerge through practical use cases, user feedback, and integration with wider digitalization initiatives, positioning S-100 as both an evolutionary improvement and a potential enabler of more transformative maritime technologies.

5.2 S-200 series PS and sea trial – Minsu Jeon (IALA)

Minsu Jeon outlined IALA's S-200 series as a key contribution to the wider S-100 framework, supporting the digital transformation of Aids to Navigation, VTS, and positioning services. It emphasized the 2029 transition to S-100 ECDIS, the importance of interoperability through the IHO GI Registry, and the role of product specifications such as S-201, S-125, S-210, S-211, S-212, and the S-240 series. It also highlighted capacity-building efforts and recent sea trials in R.O.Korea, which demonstrated that real-time, end-to-end maritime data exchange is already feasible and moving toward operational implementation.

The presentation also highlighted practical progress through sea trials, demonstrating successful end-to-end data exchange between ship and shore systems. Jeon emphasized that while the technical framework is advancing, significant challenges remain, including cybersecurity, interoperability, and readiness among member states. He concluded that capacity building, harmonization of terminology, and strong collaboration across organizations are essential to ensure the successful global adoption of S-200 standards.

5.3 Lessons from early S-100 development and implementations – Juho Pitkanen (Fintraffic)

Juho Pitkänen shared practical insights from Finland's early implementation of S-100 and S-200-based digital services, particularly in the VTS domain. He described how these services are built on operational needs and structured service specifications, enabling interactive, bidirectional communication between ships and

shore. The Finnish trials demonstrated the feasibility of integrating multiple data layers and services into a unified system, supported by modern communication frameworks.

From an operational perspective, the trials revealed both benefits and challenges. While digital services improved clarity, traceability, and efficiency of communication, they also introduced complexity in workflows and required careful consideration of user experience and training. Pitkänen stressed that extensive testing, stakeholder collaboration, and alignment with existing procedures are crucial to ensure that digital services deliver real value without compromising safety or usability.

5.4 Lessons from early S-200 development and implementations – Sewoong OH (KRISO) – virtual

Sewoong Oh presented Korea's national approach to S-100 implementation, focusing on the development of a coordinated ecosystem across multiple maritime domains. He highlighted the establishment of a national S-100 committee to align stakeholders, including hydrographic offices, AtoN authorities, and VTS providers. A key achievement was the development of a new AtoN information system based on S-201, replacing outdated manual processes with structured, automated data exchange.

The implementation demonstrated significant improvements in data quality, efficiency, and interoperability, particularly through the integration of standardized identifiers and automated workflows. Oh emphasized that systematic data management and validation are essential for successful digital transformation. The Korean experience illustrates how national-level coordination and investment in infrastructure can accelerate the transition to S-100-based services and deliver tangible operational benefits.

5.5 Panel discussion

The discussion focused on the practical implementation of S-100 and S-200 standards and the challenges associated with their adoption. Participants highlighted the importance of closer collaboration between hydrographic offices, AtoN authorities, and system manufacturers to ensure consistent data exchange and interoperability. The need to accelerate the adoption of standards such as S-201 was emphasized, alongside the importance of aligning data models and definitions across organizations.

Another key theme was the role of testing and trials in demonstrating value and building user confidence. Participants noted that skepticism still exists within parts of the maritime community, and that real-world applications—particularly in areas such as MASS—will be essential to showcase the benefits of S-100. The discussion concluded that while the technical framework is progressing, coordinated implementation and clear communication of benefits are crucial for successful uptake.

6. SESSION 5 – ARTIFICIAL INTELLIGENCE: OPPORTUNITY & RISK

The session was chaired by Omar Frits Eriksson, IALA Deputy Secretary-General.

The session on artificial intelligence was introduced as a forward-looking discussion on both the transformative potential and inherent risks of AI in maritime operations. The chair noted that AI is expected to play a significant role in shaping future vessel traffic services, port operations, and decision-making processes. However, he also emphasized that AI must be approached carefully, with strong consideration given to safety, reliability, and accountability.

The introduction set the tone by framing AI not as a standalone solution, but as an enabling technology that must be integrated responsibly within existing operational frameworks. The importance of maintaining human oversight, ensuring transparency in decision-making, and developing robust assurance mechanisms was highlighted as essential to building trust in AI-driven systems.

6.1 AI use cases in the aviation industry – Thierrry Vanhaverbeke (Air France)

Thierry Vanhaverbeke presented a range of AI applications in aviation, emphasizing a transversal approach to knowledge management and scalability. He explained that AI is used to optimize operations across multiple domains, including route optimization based on weather and operational data. These applications are designed to integrate across systems, enabling consistent and scalable deployment throughout the organization.

He also addressed the sensitive area of safety-related AI applications. While AI is being explored for safety use cases, such as classification of safety reports and behavioral analysis, many of these initiatives remain under development. Limitations arise from data governance constraints and agreements with pilots regarding data usage. This reflects a broader challenge: balancing innovation with trust, regulatory compliance, and stakeholder acceptance.

6.2 AI in Carbon-Neutral Port Operations – Hyerim Bae, Ph.D – virtual

Hyerim Bae focused on the role of AI and digitalization in achieving carbon neutrality in port operations. Using Busan Port as a case study, he demonstrated how integrated strategies combining infrastructure upgrades, operational changes, and digital platforms can significantly reduce emissions. Initiatives such as shore power, automated terminals, and energy-efficient equipment have already delivered measurable environmental benefits.

The presentation highlighted the role of AI in supporting carbon-neutral port operations, particularly through optimization of energy use, logistics, and port efficiency. AI-driven systems can analyze large datasets to improve vessel turnaround times, reduce emissions, and optimize resource allocation, contributing to sustainability goals.

At the same time, the discussion implied that such systems depend heavily on data integration and cross-stakeholder collaboration. The effectiveness of AI in this domain is closely tied to the availability of high-quality data and the ability to align environmental objectives with operational efficiency.

6.3 AI use cases in VTS: National Authority view – Dennis Khoo (MPA) – virtual

Dennis Khoo presented how AI is being explored to enhance vessel traffic services, particularly in complex and high-density maritime environments like Singapore. He outlined several use cases where AI, especially large language models, can support operators by integrating data from multiple sources, identifying collision risks, and automating routine tasks such as communication logging and reporting.

Dennis Khoo described a national-level approach to AI development, emphasizing alignment with broader governmental research programs rather than isolated maritime initiatives. He explained that AI investments are often embedded within cross-sector frameworks, allowing maritime applications to benefit from developments in areas such as space technology, transport, and environmental systems.

He also stressed the importance of open system architectures and interoperability, enabling AI models to be integrated across different platforms. Key cross-cutting challenges include cybersecurity, explainability, and avoiding duplication of effort. The approach reflects a matrix structure where both horizontal (multi-sector) and vertical (sector-specific) innovations coexist.

6.4 AI assurance – Andre Burgess (NPL)

Andre Burgess focused on the critical issue of AI assurance, particularly in the context of measurement standards and quality infrastructure. He highlighted that AI systems can disrupt traditional concepts of traceability and uncertainty, which are fundamental in regulated environments. As a result, there is a strong need to ensure that AI models are explainable and their outputs verifiable.

He also emphasized strict data governance practices, including maintaining control over input data and preventing external use or unintended data exposure. While AI offers significant benefits, its deployment must be accompanied by rigorous validation and assurance processes to maintain trust and reliability in critical applications.

6.5 Panel Discussion

The panel discussion explored the balance between innovation and risk in the deployment of AI across maritime domains. Participants highlighted the wide range of use cases presented, from predictive maintenance and port optimization to AI-assisted VTS operations, demonstrating the technology's potential to improve efficiency and safety. At the same time, concerns were raised regarding data quality, cybersecurity, and the reliability of AI outputs, particularly in safety-critical environments.

A recurring theme was the need for governance and assurance frameworks to support AI adoption. Speakers emphasized that trust in AI systems depends on transparency, explainability, and rigorous validation processes. The discussion also touched on the growing role of AI in autonomous operations, where the shift from human decision-making to machine-supported or machine-driven processes introduces new challenges. Overall, the panel concluded that while AI offers significant opportunities, its successful integration will depend on careful regulation, continuous testing, and strong collaboration across the maritime ecosystem.

7. SESSION 5 – MARITIME CONNECTIVITY FOR RESILIENT SERVICES

This session was chaired by Lukas Kim (AllforLand).

Lukas Kim opened the session by emphasizing the growing importance of connectivity as a foundation for resilient maritime services. Drawing on his background in maritime operations and international cooperation, he highlighted the need to bridge technological development with practical implementation and user expectations.

He also introduced the session as a platform to examine how different communication technologies—terrestrial, satellite, and hybrid—can support digital maritime services. The focus was placed on aligning innovation with operational realities, ensuring that emerging systems deliver tangible value to end users.

7.1 Outcomes of future MARCOM/MARNAV work – Stefan Gewies (DLR)

Stefan Gewies presented the outcomes of a major workshop on future maritime communication and navigation systems, highlighting the increasing risks of GNSS interference and spoofing. He stressed that these threats are no longer hypothetical and require urgent mitigation strategies, including the development of resilient PNT (Positioning, Navigation, and Timing) systems and greater reliance on terrestrial alternatives.

He also outlined the need to update existing IALA recommendations and develop new guidelines to address emerging technologies. The workshop emphasized integrating satellite systems, terrestrial navigation, and standardized reporting mechanisms, particularly using S-100/S-200 frameworks. Coordination, authentication, and standardized data exchange were identified as critical priorities.

7.2 Non-IP vs IP-based connectivity – Mads Sølver Svendsen (Sternula)

Mads Svendsen provided a comparative analysis of IP and non-IP connectivity in maritime environments. He explained that while IP-based systems (such as satellite and LTE) are suitable for non-critical applications, safety-critical systems often require non-IP communication due to security constraints and isolation requirements on the bridge.

He demonstrated practical implementations using VDES and S-100 services, showing how navigational warnings and other critical data can be transmitted reliably via non-IP channels. His key message was that

connectivity solutions must be aligned with safety requirements, and that a hybrid approach is necessary to support different types of maritime services.

7.3 Open digital incubator – Thomas Christensen (DMC)

Thomas Christensen presented the concept of the digital incubator as a collaborative platform to support the implementation of S-100-based services. He highlighted that while standards are now largely in place, the challenge lies in consistent implementation and interoperability across organizations.

The incubator addresses this by facilitating collaboration, developing shared tools and libraries, and providing feedback to improve specifications. It also lowers barriers for implementation and ensures that different stakeholders interpret standards consistently. This approach is essential to achieving the interoperability envisioned in e-navigation.

7.4 VDES, satellite, terrestrial, hybrid models – Lukas Kim (AllforLand)

In his technical presentation, Lukas Kim provided a realistic assessment of VDES capabilities and limitations. He emphasized that while VDES is often perceived as a “next-generation” communication system, it should be understood as a shared, narrowband data link designed for reliable message exchange rather than high-bandwidth communication.

He highlighted key challenges including limited spectrum, shared access, satellite constraints, and the need for coordination and governance. Importantly, he stressed that success depends on aligning VDES capabilities with user needs, ensuring cost-effectiveness, and integrating it within a broader communication ecosystem alongside satellite and IP-based systems.

7.5 Panel discussion

The panel discussion focused on the gap between technological potential and real-world adoption. A key issue raised was the reluctance of shipowners to adopt new systems like VDES unless clear operational benefits and cost advantages are demonstrated. Regulatory requirements alone were seen as insufficient to drive adoption.

Participants also discussed the importance of standardization, interoperability, and user-centric design. The need to integrate multiple communication technologies into a coherent framework was emphasized, along with the importance of delivering reliable, timely, and relevant information. The discussion concluded that practical value, rather than technological ambition, will determine the success of future maritime connectivity solutions.

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DAY 1 – Monday, 16 March 2026

Time	Activity	Chair / Speaker
09:00 – 10:00	**Registration**	
10:00 – 10:35	**Session 1 – Opening and setting the scene**	
15 min	Welcome and opening remarks	**Omar Frits Eriksson (IALA)**
15 min	Opening remarks	**Dr Mathias Jonas (IHO)**
5 min	Seminar introduction, format, and objectives	**Omar Frits Eriksson (IALA)**
10:35 – 11:05	Coffee break	
11:05 – 12:55	**Session 2 – Trust, Security & IP-based Data Distribution**	**Chair: Jeppe Skovbakke Juhl (BIMCO)**
20 min	Data distribution and global IP-based connectivity	**Jeppe Skovbakke Juhl (BIMCO)**
20 min	MCP as a trust & identity framework	**Juho Pitkanen (Fintraffic)**
20 min	S-100 ECDIS Sea Trials: Initial Results and Lessons Learned	**Richard Doherty (CIRM)**
20 min	System Boundaries in Digital Maritime Services: Who and What Are We Designing For?	**Capt. Naomi Vanderstockt (Caerulea) – virtual**
30 min	*Panel discussion*	
12:55 – 14:00	Lunch	
14:00 – 16:30	**Session 3 – Resilient Navigation**	**Chair: Stefan Gewies (DLR)**
20 min	Overview – PNT Threats and Risks	**Dana Goward (RNTF) – virtual**
20 min	What is resilience?	**Andy Proctor (RIN)**
20 min	AIS spoofing and cybersecurity considerations	**Ed Wendlandt (RTCM) – virtual**
15:00 – 16:30	Coffee break	
20 min	Spoofing and jamming in VTS	**Tom Southall (IALA)**
20 min	Cybersecurity initiatives in EU	**Chronis Kapalidis (EMSA)**
20 min	Using AIS data in detection and mitigation of GNSS spoofing	**Dmitry Rostopshin (DINAV)**
30 min	*Panel discussion*	
16:30 – 18:30	**Welcome reception**	

DAY 2 – Tuesday, 17 March 2026

Time	Activity	Chair / Speaker
09:00 – 10:50	**Session 4 – S-100/200 as the backbone of Resilience**	**Chair: Guttorm Tomren (NA)**
20 min	S-100 ecosystem update & roadmap	**Thomas Richardson (UKHO)**
20 min	S-200 series PS and sea trial	**Minsu Jeon (IALA)**
20 min	Lessons from early S-100 development and implementations	**Juho Pitkanen (Fintraffic)**
20 min	Lessons from early S-200 development and implementations	**Sewoong OH (KRISO) – virtual**

30 min	*Panel discussion*	
10:50 – 11:20	Coffee break	
11:20 – 13:10	**Session 5 – Artificial Intelligence: Opportunity & Risk**	**Chair: Omar Frits Eriksson (IALA)**
20 min	AI use cases in the aviation industry	**Thierrry Vanhaverbeke (Air France)**
20 min	AI in Carbon-Neutral Port Operations	**Hyerim Bae, Ph.D – virtual**
20 min	AI use cases in VTS: National Authority view	**Dennis Khoo (MPA) – virtual**
20 min	AI assurance	**Andre Burgess (NPL)**
30 min	*Panel discussion*	
13:10 – 14:10	Lunch	
14:10 – 16:00	**Session 6 – Maritime Connectivity for Resilient Services**	**Chair: Lukas Kim (AllforLand)**
20 min	Outcomes of future MARCOM/MARNAV work	**Stefan Gewies (DLR)**
20 min	Non-IP vs IP-based connectivity	**Mads Sølver Svendsen (Sternula)**
20 min	Open digital incubator	**Thomas Christensen (DMC)**
20 min	VDES, satellite, terrestrial, hybrid models	**Lukas Kim (AllforLand)**
30 min	*Panel discussion*	

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