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Prioritized Main Potential Solutions for the e-Navigation Concept

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ABSTRACT: In the paper the Author, a member of the International Maritime Organization's Correspondence Group on e-Navigation, outlines the prioritized solutions for e-Navigation concept formulated at the beginning of 2013. He presents the details of internal CG's discussions, different national positions after the announcement by the chairman of the group, Mr John Erik Hagen, the working material in this case. The hidden purpose of this study is to show the style and pace of the IMO working group, details regarding the exchange of posts and the formation of a final common position. Author presents just three weeks working with the CG on e-Nav in the lens, doing it with the consent of all participants in this discussion.

1 INTRODUCTION

1.1 *IMO e-Navigation Concept*

The IMO Maritime Safety Committee (MSC) at its 81st session decided to include, in the work programmes of the NAV and Radiocommunications and Search and Rescue (COMSAR) Sub-Committees, a high priority item on "Development of an e-Navigation strategy" with the NAV Sub-Committee acting as coordinator. NAV 52, which met in July 2006, was instructed to give preliminary consideration to this important topic.

The aim was to develop a strategic vision for e-Navigation, to integrate existing and new navigational tools, in particular electronic tools, in an all-embracing system that will contribute to enhanced navigational safety (with all the positive repercussions this will have on maritime safety overall and environmental protection) while simultaneously reducing the burden on the navigator. As the basic technology for such an innovative step is already available, the challenge lies in ensuring the availability of all the other components of the system, including electronic navigational charts, and in using it effectively in order to simplify, to the benefit of the mariner, the display of the occasional local navigational environment. e-Navigation would thus incorporate new technologies in a structured way and ensure that their use is compliant with the various navigational communication technologies and services that are already available, providing an overarching, accurate, secure and cost-effective system with the potential to provide global coverage for ships of all sizes.

The IMO entrusted Norway to coordinate the work of developing a proposal for an IMO strategic implementation plan for the global e-Navigation concept. As Coordinator of the IMO Correspondence Group on e-Navigation and a Chairman of IMO Working Groups (NAV, COMSAR and STW) on e-Nav was nominated Mr John Erik Hagen.

Implementation of e-Navigation should be a phased iterative process of continuous development

including, but not necessarily limited to, the steps shown in the figure 1.

1.2 *IMO Correspondence Group on e-Navigation*

During the work on practical e-Navigation a relatively large number of solutions have been developed. Based on the main goal in the decided strategy for development and implementation of e-Navigation (MSC 85/26/Add.1, Annex 20) and the terms of reference given by NAV 58, the focus will now be on the FSA and to develop a prioritized list of RCOs.

This work will be based on the list of solutions given in NAV 58/WP6 rev.1 Annex 2 (Preliminary List of Potential e-Navigation Solutions), please see table 1.

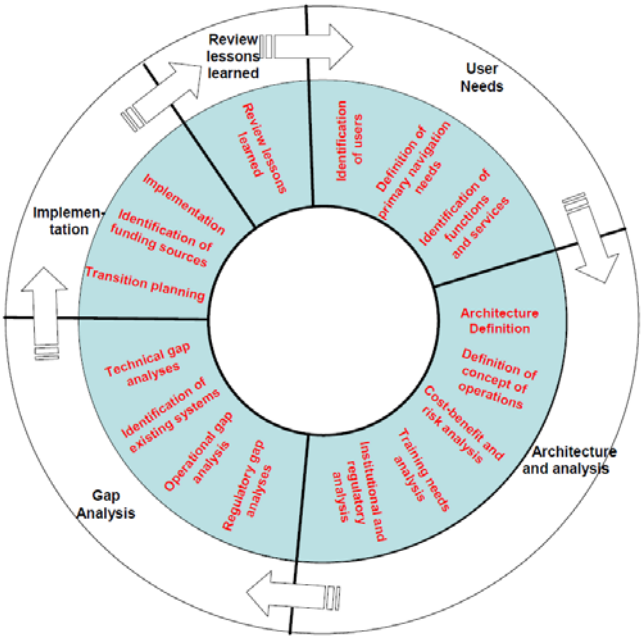

Figure 1. Potential components of an e-Navigation implemen-tation process (MSC 85/26/Add.1, Annex 20)

In the definition and scope of the strategy plan (MSC 85/26/Add.1, Annex 20, paragraph 1) it is stated that e-Navigation is about harmonized collection, integration, exchange, presentation and analysis of marine information on board and ashore by electronic means.

Based on previous inputs on the draft regarding identification of hazard and risk assessment, Chairman of the Group proposed a way forward prior to the feasibility evaluation which might be to carry out updates including revision and simplification of the description of IMO FSA methodology.

The e-Navigation objective is to enhance berth to berth navigation and related services for safety and security at sea and protection of the marine environment.

Hence, it would be necessary to integrate and prioritize the list of solutions given in NAV/58/WP6 rev.1 Annex 2 (Preliminary List of Potential e-Navigation Solutions, which has nine main solutions) to a maximum of five main practical solutions, covering shipboard and shore-based users, that would demonstrate a workable and efficient transfer of marine information/data between ship and shore and vice-versa.

Accordingly, it was suggested that the CG should focus its attention on the following criteria:

1 Seamless transfer of data between various equipment on board;

2 Seamless transfer of electronic exchange of information/data between ship and shore and vice-versa;

3 The work should be based on systems that are already in place (according to the already adopted IMO's e-Navigation strategy (MSC 85/26/Add.1, Annex 20) and development of potential futuristic carriage requirements should therefore be strictly limited;

4 CG should not concentrate on determining cause of marine casualties; and

5 List of potential e-Navigation solutions should be limited solely to achieve 1 and 2 above.

2 PRELIMINARY LIST OF POTENTIAL E-NAVIGATION SOLUTIONS

10 January 2013 Chairman of the IMO Correspondence Group on e-Navigation John Erik Hagen invited the members of the Group to provide input for finalizing a maximum of five main practical solutions, based on the attached list of solutions given in NAV/58/WP6 rev.1 Annex 2 (Hagen, 2013). Preliminary List of Potential e-Navigation Solutions is presented in table 1.

Table 1. Preliminary list of potential e-Navigation solutions (NAV 58/WP6 rev.1 Annex 2)

No.	Short description	Primary user need	User type	Other user needs	Hazard description
S1	**Improved, harmonized and user-friendly bridge design**				
S1.1	Ergonomically improved and harmonized bridge and workstation layout	Improved ergonomics	Shipboard user	Familiariza-tion re-quirements	Suboptimal performance or accident due to lack of familiarity with bridge equipment/ slow response due to not finding the correct infor-mation/control/alarm
S1.2	Extended use of standardized and unified sym-bology for relevant bridge equipment	Standard in-terface	Shipboard user	Improved ergonomics	Suboptimal performance or accident due to misinterpretation of infor-mation or problem locating correct information

S1.3	Standardized digital familiarization material for relevant equipment	Familiarization requirements	Shipboard user	Standard interface	Suboptimal performance or accident due to lack of familiarity with bridge equipment
S1.4	Standard default settings, save/recall settings, and S-mode functionalities on relevant equipment	Standard interface	Shipboard user	Familiarization requirements, Improved ergonomics	Suboptimal performance or collision and grounding due to lack of familiarity with bridge equipment or using settings not appropriate to task
S1.5	All bridge equipment to follow IMO BAM (Bridge Alert Management) performance standard	Alert management	Shipboard user		Suboptimal performance or accident due to not responding to relevant alert
S1.6	Information accuracy/reliability indication functionality for relevant equipment	Indication of reliability	Shipboard user		Suboptimal performance or accident due to actions taken based on inaccurate information
S1.6.1	Graphical or numerical presentation of levels of reliability together with the provided information				
S1.7	Integrated central bridge display system (INS) for improved access to shipboard information	Effective and robust communications	Shipboard user	Improved ergonomics	Suboptimal performance or accident due to not applying available information/ overburdening
S1.8	GMDSS equipment integration – one common interface	Effective and robust communications	Shipboard user		Suboptimal performance or failure to mitigate accident due to poor communication
S2	**Means for standardized and automated reporting**				
S2.1	Single-entry of reportable information in single-window solution	Standardized and automated reporting	Shipboard user		Suboptimal performance or accident due to distraction/ high workload
S2.2	Automated collection of internal ship data for reporting	Standardized and automated reporting	Shipboard user		Suboptimal performance or accident due to distraction/ high workload
S2.3	Automated or semi-automated digital distribution/ communication of required reportable information, including both "static" documentation and dynamic information	Standardized and automated reporting	Shipboard user		Suboptimal performance or accident due to distraction/ high workload
S2.4	All national reporting requirements to apply standardized digital reporting formats based on IMO FAL Forms and SN.1/Circ.289	Standardized and automated reporting	Shipboard user		Suboptimal performance or accident due to distraction/ high workload
S3	**Improved reliability, resilience and integrity of bridge equipment and navigation information**				
S3.1	Standardized self-check/built-in integrity test (BIIT) with interface for relevant equipment (ex.: bridge equipment)	Improved reliability	Shipboard user		Suboptimal performance or accident caused by bridge equipment failure
S3.2	Standard endurance, quality and integrity verification testing for relevant bridge equipment, including software	Improved reliability	Shipboard user		Suboptimal performance or accident caused by bridge equipment failure
S3.3	Perform information integrity tests based on integration of navigational equipment – application of INS integrity monitoring concept	Improved reliability	Shipboard user		Suboptimal performance or accident due to actions taken based on inaccurate information
S3.4	Improved reliability and resilience of onboard PNT systems by integration with external systems	Improved reliability	Shipboard user		Suboptimal performance or accident due to poor information from PNT systems
S4	**Integration and presentation of available information in graphical displays received via communication equipment**				
S4.1	Integration and presentation of available information in graphical displays (including MSI, AIS, charts, radar, etc.) received via communication equipment	User-selectable information received via communication equipment	Shipboard user	Maritime Safety Information (MSI), Improved target detection, Guard zones	Suboptimal performance or accident due to misinterpretation of information or problem locating correct information, information overload and poor situational awareness
S4.1.1	Implement a Common Maritime Data Structure and include parameters for priority, source, and ownership of information				
S4.1.2	Standardized interfaces for data exchange should be developed to support transfer of information from communication equipment to navigational systems (INS)				
S4.1.3	Provide mapping of specific services (information available) to specific regions (e.g. maritime service portfolios) with status and access requirements				
S4.1.4	Provision of system for automatic source and channel management on board for the selection of most appropriate communication means (equipment) according to criteria as, band width, content, integrity, costs				
S4.1.5	Routeing and filtering of information on board (weather, intended route, etc.):				

	i. Develop of SW/HW (module (S)) for processing, filtering and transfer/routeing of information exchanged via communication equipment to the appropriate applications on board, e.g. navigation, other bridge applications (safety, security) and other onboard applications ii. Provide functionality as part of INS to process and filter exchanged information received via communication equipment for relevance to vessel, route, and conditions, ensuring delivery (routeing) and presentation of safety relevant information on INS tasks (displays) iii. Provide an administrative HMI interface in INS task concept for identifying updates and setting of presentation rules based on route plan, vessel characteristics, INS tasks supported and other user-selected priorities				
S4.1.6	Provide quality assurance process to ensure that all data is reliable and is based on a consistent common reference system (CCRS) or converted to such before integration and display				
S4.1.7	Implement harmonized presentation concept of information exchanged via communication equipment including standard symbology and text support taking into account human factors and ergonomics design principles to ensure useful presentation and prevent overload				
S4.1.8	Develop a holistic presentation library as required to support accurate presentation across displays				
S4.1.9	Provide alert functionality of INS concepts to information received via communication equipment and integrated into INS				
S4.1.10	Harmonization of conventions and regulations for navigation and communication equipment				
S5	**Information management**				
S5.1	Improved display of status of available data and indication of available updates	Automated updating of baseline data and documents	Shipboard user		Suboptimal performance or accident due to overburdening/out of date navigational documentation
S5.2	Automated and timely updating of Electronic navigational charts (ENCs), nautical publications and other documentation	Automated updating of baseline data and documents	Shipboard user	Provision of information to vessels	Suboptimal performance or accident due to overburdening/out of date navigational documentation
S5.3	Electronic information to be searchable to the appropriate shipboard user	Effective and robust communications	Shipboard user	Improved ergonomics	Suboptimal performance or accident due to not applying available information/ overburdening
S5.4	Task-based information management	Effective and robust communications	Shipboard user	Improved ergonomics	Suboptimal performance or accident due to not applying available information
S6	**Improved access to relevant information for Search and Rescue**				
S6.1	Automated network for communication and data coordination/distribution among SAR stakeholders	Effective communication and information sharing	SAR user		Failure to mitigate accident due to poor SAR operation coordination
S6.2	Automated SAR information collection	Effective communication and information sharing	SAR user	Access to relevant information within the e-Nav domain	Failure to mitigate accident due to poor situation awareness/lack of information
S7	**Improved reliability, resilience and integrity of bridge equipment and navigation information for shore-based users**				
S7.1	Shore monitoring of quality/integrity of navigation systems, quality of onboard information and effectiveness of communications	Quality assurance	Shore-based user	Improved reliability	Suboptimal performance or accident due to navigation or communication equipment failure/poor onboard navigation documentation
S8	**Improved and harmonized shore-based systems and services**				
S8.1	Integrated system for improved and harmonized presentation of domain awareness	Management of information	Shore-based user	Improved target detection	Suboptimal performance or accident caused by poor situation awareness
S8.2	Standardized and unified symbology for relevant shore equipment	Management of information	Shore-based user		Suboptimal performance or accident due to equipment symbol misinterpretation
S9	**Improved communication of VTS service portfolio**				
S9.1	Improved communication of VTS service portfolio	Provision of information to vessels	Shore-based user		Suboptimal performance or accident due to not applying available information

3 ANSWERS OF THE CORRESPONDENCE GROUP MEMBERS

3.1 *The position of Norway (dated 18 January, 2013)*

With reference to e-mail of January 10, 2013, concerning prioritization of solutions, John Leon Ervik, Head of pilotage and VTS Department in Norwegian Coastal Administration, proposed the following 5 prioritized solutions (Ervik, 2013):

S1: Improved, harmonized and user-friendly bridge design;
S2: Means for standardized and automated reporting;
S4: Integration and presentation of available information in graphical displays received via communication equipment. Solution 4 can be merged with Solution 8: Improved and harmonized shore-based systems and services;
S5: Information Management. Solution 5 can be merged with Solution 9: Improved Communication of VTS Service Portfolio;
S7: Improved reliability, resilience and integrity of bridge equipment and navigation information for shore-based users;

3.2 *The position of Germany (dated 22 January, 2013)*

With reference to e-mail of January 10, 2013, Florian Motz, Project Manager from Fraunhofer – Institute for Communication, Information Processing and Ergonomics FKIE, in conveying the position of an experts working group in Germany, proposed the following 5 prioritized solutions "to demonstrate a workable and efficient transfer of marine information/data between ship and shore and vice-versa covering shipboard and shore-based users" (Motz, 2013):

S2: Means for standardized and automated reporting;
S3: Improved reliability, resilience, and integrity of bridge equipment and navigation information;
S4: Integration and presentation of available information in graphical displays received via communication;
S6: Improved access to relevant information for Search and Rescue;
S9: Improved Communication of VTS Service Portfolio.

The solutions were selected to fulfil best the goal given by Chairman. Germany was as well in preference for e.g., solution:

S1: Improved, harmonized and user friendly bridge design, which is very important and should be addressed in the future e-Navigation process, but they restricted ourselves to the suggestion of only 5 solutions.

Germany did not support the proposal made by Norway (section 3.1 – e-mail dated 18 January 2013) were Norway suggest that e.g. Solution 4 can be merged with solution 8. These solutions are focusing on complete different objectives.

The solutions are related, but if it will be decided to merge solutions, than Germany would suggest to keep all distinct 9 solutions.

3.3 *The answer of Norway (dated 22 January, 2013)*

Jon Leon Ervik from Norwegian Coastal Administration supported, in general, the comments and the suggestions from Germany. He suggested however to change solution S6: (Improved access to relevant information for Search and Rescue) with S8 (improved and harmonized shore-based system services). This is because the MRCC is included in solution 8 .

S2: Means for standardized and automated reporting;
S3: Improved reliability, resilience, and integrity of bridge equipment and navigation information;
S4: Integration and presentation of available information in graphical displays received via communication;
S8: Improved and harmonized shore-based system services;
S9: Improved Communication of VTS Service Portfolio.

3.4 *The answer of Germany (dated 22 January, 2013)*

Germany, represented by Florian Motz, agreed in general with the proposal made by Norway, but he suggested to use Solution 1, which was originally suggested by Norway, instead of solution 8.

"S1: Improved, harmonized and user friendly bridge design" seems to be more crucial than to harmonize the shore base systems in regard to improved and harmonized presentation (S8.1) and standardize and unified symbology for relevant shore equipment (S8.2).

So, Germany suggested now the following 5 solutions (Motz, 2013):

S1: Improved, harmonized and user friendly bridge design;
S2: Means for standardized and automated reporting;
S3: Improved reliability, resilience, and integrity of bridge equipment and navigation information;
S4: Integration and presentation of available information in graphical displays received via communication;
S9: Improved Communication of VTS Service Portfolio.

3.5 *The position of the IHO (dated 22 January, 2013)*

The IHO Secretariat, represented by Giles Bessero, Director of the International Hydrographic Organization, offered for consideration the following comments (Bessero, 2013):

1 NAV58/WP6/Rev.1 Annex 2 provides a "preliminary" list of 38 potential e-Navigation solutions grouped under 9 main headings S1 to S9. NAV 58 endorsed the list as "work in progress" (ref. NAV58/14, paragraph 6.39). Five headings (S1 to S5) refer to "Shipboard users"; S6 refers to "SAR users"; S7 to S9 refer to "Shore-based users".
2 The "preliminary" list attached in Annex 2 to the draft report dated 5 Sept. 2012 contains an enriched list with 57 solutions under 13 main headings S1 to S13. The additional headings S10 to S13 introduces solutions for shore-based users

with the same description as solutions for ship-based users described under headings S1, S2, S4 and S5. Additional solutions are proposed under headings S5, S6 and S7.

3 There is no clear definition of the domains associated with each heading and there is some potential overlap between headings, i.e. S1 and S3, S2, S4 and S5, as far as solutions relevant to shipboard users are concerned.

4 Therefore, it seems necessary to clarify which list should be used as the reference and it is suggested that the selection of practical solutions should be based on individual solutions Sx.y/Sx.y.z rather than on Sx headings.

5 Mr Hagen further suggests in his e-mail that "the CG should focus its attention on the following criteria", as a basis for integrating and prioritizing the list of potential solutions:
   1 Seamless transfer of data between various equipment on board;
   2 Seamless transfer of electronic exchange of information/data between ship and shore and vice-versa;
   3 The work should be based on systems that are already in place (according to the already adopted IMO's e-Navigation strategy (MSC 85/26/Add.1, Annex 20)) and development of potential futuristic carriage requirements should therefore be strictly limited;
   4 CG should not concentrate on determining cause of marine casualties; and
   5 List of potential e-Navigation solutions should be limited solely to achieve 1 and 2 above.

6 The IHO expresses concern that criteria focusing only on seamless transfer of information might not encompass the core objectives of e-Navigation which require also, among others, to improve decision support and to put human factors and ergonomics at the core of system design.

7 The IHO does not wish to influence the selection of the main practical solutions at this stage, considering that the selection should be driven by explicit users' requirements first.

8 As the competent authority for the provision of hydrographic services, the IHO stands ready to assess related solutions, such as S4.1.x, S5.1, S5.2 for shipboard users and their equivalent for shore-based users, if they are retained in the preliminary selection.

3.6 *The position of the Nautical Institute (dated 24 January, 2013)*

David Patraiko, FNI, Director of Projects in the Nautical Institute, informed about position of the Nautical Institute (Patraiko, 2013).

The Nautical Institute (NI) has been participating in the e-Navigation debate since its inception in 2006, has consulted its membership as to their user needs, and has worked closely with all sectors of the industry to try to understand the impact and role of e-Navigation. In 2009, the NI and IFSMA submitted a comprehensive list of Seagoing User Needs (NAV55 INF.8), which was largely accepted and adopted into the existing e-Navigation documentation.

Further to this list, the NI offers the following consideration of priorities. It should be noted that many of them are interdependent and they accept that there may be several other priorities for work or systems that may be needed before these objectives can be achieved.

3.6.1 *Usability*

e-Navigation must be, and continue to be, usable. This stems from the very 'compelling need' (MSC 81/23/10) agreed in the original work package. Ensuring usability also lies at the core of essential issues such as ergonomics, training and competency. There can be no one-off test for usability; it has to be the subject of continual assessment, taking into account the need for systems to remain usable through the whole process of updates, repair, and renewal. Usability criteria will also have to address the reduction of single person error, the response to system failure, and any change in the role of the navigator due to evolving use of technology.

Practical solutions for usability may include but not be limited to:
- existing ISO usability standards;
- adherence to the process of User Centred Design;
- the use of standard symbology
- long term contracts for the maintenance and repair of hardware and software both ashore and at sea.

This will need to apply to the potential solutions S1, S2, S3, S4, S5, S6, S7, S8, S9.

3.6.2 *Data Quality*

It is clear that life in an e-Navigation world will extensively use, and therefore increasingly rely upon, data in digital format. As this data will be used to inform decisions that will result in safety, security, environmental protections and commercial efficiency, it is essential that it is accurate, or that the user is aware of the likelihood of inaccuracies. Data quality will also have to address Positioning, Navigation and Timing (PNT).

Failure to ensure an acceptable quality and security of data will undermine the very concept of e-Navigation.

This will need to apply to the potential solutions S1, S2, S3, S4, S5, S6, S7, S8 and S9.

3.6.3 *Onboard INS with S-Mode*

It seems that the existing IMO INS standard already addresses many of the User Needs identified, such as improved ergonomics, alarm management, improved reliability, standardized interface and the improved use of guard zones.

Practical solutions might include the implementation of INS in compliance with usability standards and enhanced with S-Mode, display of MSI, an e-Pelorus and communication links. Information management features within the INS might address automated reporting, automated updating, and decision support features.

This will need to apply to the potential solutions S1, S2, S3, S4, and S5.

3.6.4 *Communication transparency*

Robust and effective communication will be essential to e-Navigation, although the NI understand that the speed and bandwidth may be variable based upon the essential nature of the data (including voice data) that needs to be communicated. At present there is a plethora of communication options, and it can be assumed that in the future there will be many more, offering different speed, capacity and cost options. Beyond the priority for communication to be robust and reliable, they recommend that technology transparency should also be made a priority. The goal should be for a communication (HMI) interface to be usable. Users should not be focused on technology (i.e. VHF, Sat-C, etc...) but rather on 'how' to communicate (i.e. point to point, broadcast) and how such communications should support operations and decision making both at sea and ashore.

Practical solutions might include the greater use of standardized communication interfaces (HMI), the greater use of automated messaging, and a greater focus on the role of communication during navigation training.

This will need to apply to the potential solutions S1, S2, S3, S4, S5, S6, S7, S8 and S9.

3.6.5 *Evolutionary implementation*

It is generally accepted that e-Navigation is an evolutionary concept, and therefore continuous improvement should be a priority. Many individual 'solutions' will be able to be demonstrated and tested on a limited basis in order to assess their effectiveness and usability and to obtain essential user feedback prior to full scale implementation.

There are a number of existing 'testbeds' and regional projects that are running. There should be a concerted effort to ensure that they are user needs led, and that lessons learned based on user feedback are co-ordinated, harmonized and applied to e-Navigation on a global basis.

This will need to apply to the potential solutions S1, S2, S3, S4, S5, S6, S7, S8 and S9.

3.6.6 *Conclusion*

The Nautical Institute recognizes that e-Navigation has a wide scope. It is a concept that will, and should, evolve over time in support of improved safety, security and environmental protection, and where appropriate should enhance commercial efficiency. However, we need to start somewhere.

The current INS could address many of the issues plaguing shipboard users, such as alarm management and reliability. However such systems (or any systems) must have an effective plan for updates and maintenance.

There are a number of commercial products, and many more to come, that may enhance the exchange of data for the purpose of improved safety and efficiency both at sea and ashore. The extent to which these systems and services integrate with an e-Navigation environment or alongside it must be addressed as a priority.

The value of robust and reliable PNT will have to be assessed, probably on a regional basis. Multi-receiver systems on board offer some improvement. However, the provision of more robust systems such as e-Loran, automatic radar plotting, inertial navigation, or even the e-Pelorus will need to be taken into account when assessing risks to safety and the management of commercial traffic. Although the provision of PNT may differ on a global basis, it will be essential that position fixing and assessment of the reliability is standard for mariners internationally.

The effectiveness and success of e-Navigation will ultimately rely on the industry's ability to ensure usability, data quality, system reliability, and the provision of information to support decision making. These areas will all be essential within an e-Navigation Implementation Plan.

3.7 *The position of Denmark (dated 25 January, 2013)*

Thomas Christensen, Project Manager, Danish Maritime Authority, noted that the previously announced schedule for the CG has been altered and a new way forward for the CG appears to have been set.

Denmark acknowledges the huge effort that has been delivered by Norway, and the fact that such a large number of solutions have been developed, that the broadening of the scope has reached a point, where the process needs to be focused into a spearhead of prioritized solutions. The first iteration of the e-Navigation strategy must be reduced to a realistic scope, to ensure a timely completion.

Through prioritization, remaining solutions may thus be assigned to a roadmap for future iterations of the e-Navigation strategy. The prioritization process was originally intended to be entirely based on Formal Safety Assessment, however the way ahead now suggested, is to prioritize solutions prior to completion of the FSA.

Denmark would like to stress, that this should by no means be seen as a reduction in the ambition level for e-Navigation. The purpose should merely be to describe a well defined and manageable starting point for the strategic implementation plan of e-Navigation however the work already conducted should not be disregarded.

Initially limiting scope to the list of solutions given in NAV/58/WP6 rev1 Annex 2, which was endorsed by NAV as a *preliminary* list of solutions *as work in progress,* may be restricting our selves form including 'low hanging fruits' in relevant solutions already discussed by the CG but not contained in Annex 2. As far as these solutions have been derived from the GAP analysis in NAV/58/WP6 rev1 Annex 1, which was approved by NAV, and discussed by the CG, they should still form part of the candidate set of solutions to be prioritized.

Denmark concurs that work as far as practicable must be based on systems that are already in place. Denmark does however find it necessary to allow the first iteration of the e-Navigation strategy to address current limitations to efficient information transfer, and where deemed necessary suggest to amend or

develop new performance standards. These would apply to future generations of navigation or communication equipment, in order to lay a solid foundation for future evolution of harmonized information services. Denmark agrees that undue or untimely introduction of new carriage requirements should be avoided. Instead options for replacement, allowing modernized but backwards compatible equipment to replace current carriage requirements, could be considered.

First and foremost, the first iteration of the e-Navigation strategy should address *the foundation* for efficient data exchange and operational use of information – and demonstrate the ability to introduce improved information services, where they provide value.

Denmark notes that the timing of the development of the e-Navigation implementation plan, concurrent with the ongoing process for the review of the GMDSS as well as the alignment at ITU of World Radio Conference agenda items related to adjustment of frequency allocations for AIS, e-Navigation and GMDSS in 2015 and 2018, is a historic window of opportunity, which should be kept in mind, when aiming to address needs for maritime information exchange.

Based on this, they encourage liaison with the GMDSS review process, paying attention to the SAR user needs. The promulgation of machine readable MSI should be addressed as an example, to utilize this window of opportunity to develop criteria for how maritime information services in Danish Maritime Authority general can be mapped as either GMDSS related, to be served by prioritized and protected (modernized) GMDSS communication links and infrastructure, or routine / optional / information services to be served by optional communication links.

The chairman suggests that focus should be on the following criteria:

1 Seamless transfer of data between various equipment on board;
Denmark concurs with this, but would like to add that this must include the development of extendible harmonized data models and protocols for the information to be transferred.
2 Seamless transfer of electronic exchange of information/data between ship and shore and viceversa;
Denmark concurs with the same amendments as above, and with the inclusion of transfer of data between ships and between shore stakeholders.
3 The work should be based on systems that are already in place (according to the already adopted IMO's e-Navigation strategy (MSC 85/26/Add.1, Annex 20)) and development of potential futuristic carriage requirements should therefore be strictly limited;
Denmark agrees that unnecessary introduction of new equipment must be avoided, but as stated earlier, amended or new performance standards for some novel elements may be necessary in order to achieve the goals through optional introduction.
4 CG should not concentrate on determining cause of marine casualties; and
5 List of potential e-Navigation solutions should be limited solely to achieve 1 and 2 above.

Denmark does not agree that the list of potential solutions should be limited to achieve 1 and 2 above. We should focus on a select few value adding solutions which address transfer of operational information, spanning the directions of communication (onboard, ship-ship, ship-shore and shore-ship), that demonstrate the value and document ways to fill identified gaps for efficient transfer of information between users in the e-Navigation domain.

Denmark proposed the following solutions to be included in the initial step of the e-Navigation process (Christensen, 2013):

S1 Improved, harmonized and user-friendly bridge design

This solution should in the first iteration address:
- Extended use of standardized and unified symbology for relevant bridge equipment;
- Standard default settings, save / recall settings, and S-mode functionalities on relevant equipment;
- All bridge equipment to follow IMO BAM (Bridge Alert Management) performance standard;
- Information accuracy / reliability indication (Initial focus on presentation of rich position data including accuracy/reliability);
- Integrated central bridge display system (INS) for improved access to shipboard information;
- GMDSS equipment integration - one common interface.

S2 Means for standardized and automated reporting for shipboard users (Ship-shore)

This solution should in the first iteration address:
- On board equipment to exchange data;
- Automated collection of internal data for reporting;
- Single-entry of reportable information in single-window solution;
- Harmonized data format for the information to be exchanged (All national reporting requirements to apply standardized digital reporting formats - FAL forms);
- A communication infrastructure that facilitates the data to be transferred from ship to shore;
- A shore side communication infrastructure that facilities sharing of the data among shore side stakeholders.

This solution could be integrated with elements from S6:
- Automated SAR information collection;
- Automated network for communication and data coordination / distribution among SAR stakeholders.

S4 Integration and presentation of available information in graphical displays received via communication equipment (Shore–ship)

This solution should in the first iteration address:
- Promulgation and display of (machine readable) MSI in navigational display;
- Communication infrastructure to transfer data from shore to ship;
- Harmonised data format for the information to be exchanged;

– Navigational equipment capable of displaying the information.

S7 Improved reliability, resilience and integrity of navigation information

This solution should in the first iteration *facilitate* transition towards modernized communication and PNT systems by:
– Harmonised datamodel for rich positioning data (multiple sources, accuracy, reliability);
– Navigational equipment capable of displaying rich position data;
– Shore monitoring of quality / integrity / effectiveness of communication systems.

S14 Exchange of vessels intentions (ship-ship, ship-shore, shore-ship)

This solution would require:
– Harmonised data model for route;
– Navigational system capable of planning, broadcasting and displaying the information;
– Shore based systems capable of displaying the information (and optionally provide graphical oriented route suggestions);
– (existing AIS could be used, i.e. no need for other communication equipment).

To summarize, Denmarks propose to define a first iteration of the e-Navigation strategy which comprises:
– The development of a communication infrastructure that would facilitate data exchange between relevant stakeholders both shipside and shoreside;
– Develop a few specific services (mentioned above) that would utilize this infrastructure;
– Develop harmonised data models (based on IHO S-100) for the information needed in these services.

3.8 *The position of the Marshall Islands (dated 25 January, 2013)*

Alan L. Blume, Deputy Commissioner of Maritime Affairs presented the position of the Republic of Marshall Islands

The Marshall Islands thanked the Nautical Institute for their input to the request of Mr Haden because it does help ensure this enterprise remains focused on some of the basics. Alan Blume particularly appreciated their comments on usability, data quality, communication transparency and evolutionary implementation.

The Marshall Islands suggested the following (Blume, 2013):
S2: Means of standardized and automated reporting;
S3: Improved reliability, resilience and integrity of bridge equipment and navigation information;
S4: Integration and presentation of available information in graphical displays;
S5: Information management;
S9: Improved communication of VTS service portfolio.

The Marshall Islands did note that there are several solutions under S1, e.g., S1.2 through S1.8, that could be included in solutions S2, S3, S4 or S5. This would leave the ergonomic design of bridges and equipment to sort out.

3.9 *The position of the United States (dated 25 January, 2013)*

Bill Cairns, Senior Technical Advisor, Commandant (CG-NAV) USCG informed about position of the US (Cairns, 2013).

Due to the large number of possible combinationns, tt seems that the correspondence group could parse the discussion of various combinations of prioritized potential e-Nav solutions for years to come. However, the US supports in principle Germany's list (S1, 2, 3, 4, and 9). It seems that the view expressed by Germany is best in line with IMO's focus and centered on ship operations, e.g., bridge design.

Improved and more user-friendly bridge designs seem a more valuable focus than harmonizing shore-based systems. Since shore-based systems don't move from country to country, port states should be free to use whatever systems that best fit their needs, even if it's a "one-off." S8 is not about communications and exchanges between ship and shore. In that instance, standardization would be useful so that ships moving from one country to another would be able use the same process to access and communicate with shore services in each country. Rather, S8 is about the presentation of domain awareness information and symbology for internal systems. It does not seem necessary that the target detection presentation and symbology used in one country should be the same as it is in others. If an Administration wants to use a system designed to meet its own unique needs, it should be free to do that. Furthermore, IMO need not be involved in standardizing the symbology used on shore equipment and the way ship traffic is presented on shore.

The US informed that they do not support the notion that the reduction from 9 to 5 solutions should be merely regrouping or re-categorizing (with more general headings) without any loss or deletion of specific solutions. Their understanding of this latest effort is to reduce the scope of the project.

The US did not have any concern with focusing on seamless transfer of information. Quite the contrary, the US supports that notion. Focusing on seamless transfer of information is likely to produce some real benefits that will form the basic building blocks of the future, i.e., more extensive improvements in ship navigation. IHO's version of the "core objectives" of e-Navigation doesn't seem to be supported by the IMO definition of e-Navigation. Whilst the US believes the IHO objectives are worthwhile, at this point it seems best to stick to the definition e-Navigation, which is focused on the exchange of information.

3.10 *The position of the IMPA (dated 26 January, 2013)*

Simon Pelletier, Vice-President of the International Maritime Pilots' Association presented the position of IMPA.

IMPA has followed with interest the recent exchanges between members and has the following comments (Pelletier, 2013):

1 They greatly appreciate the true leadership shown by Mr Hagen in re-focusing the CG's work to 5 key, pragmatic, priorities. They also understand the urgency there is to wrap-up the overall initiative in a timely way, and to make sure it remains closely aligned with the initial scope the IMO envisaged for it.
2 They believe that Mr. Hagen's suggestion that the five priorities focus on ensuring "seamless transfer of data between various equipment on board" and on "seamless transfer of electronic exchange of information between ship and shore and vice-versa" is not only closely aligned with the initial scope of initiative but is, in fact, most likely to provide real, achievable, benefits.
3 Given the above and what they know of the IMO's focus and of the initiative's raison d'être, they think that the set of solutions to prioritize is: 1,2,3,4 and 9. They also think that the suggestion of merely regrouping all or most of the existing solutions (priorities together) under more general headings defeats the purpose of establishing a narrower and better-defined scope of work for the CG and, as such, they do not support this approach.
4 They think that focusing at this point on improving the means of seamless information transfer is not a retreat from the concept of e-Navigation. Rather, it is concentrating efforts so as to secure an important component of e-Navigation infrastructure that could serve as the foundation for future growth. e-Navigation will continue to develop after this IMO work item is completed, and the CG will have made a valuable contribution to that process.

3.11 *The position of Australia (dated 27 January, 2013)*

Nick Lemon, Manager Nautical & Regulation, Navigation Safety & International Division presented the position of Australia.

First, he thanked Mr Hagen for his excellent work in coordinating this very complex, detailed and demanding task – the establishing recognition of what is essentially a new paradigm in the way ships 'get around' - e-Navigation. He thanked also for this invitation to comment on the way ahead and in particular the simplification and prioritisation of a maximum of five main practical solutions covering ship and shore based users. The debate that has ensued amongst the correspondence group has been extensive, thoughtful, considered and perhaps one of the most valuable discussions the correspondence group has had (Lemon, 2013).

3.11.1 *Some general comments*

Australia has been involved in the development of e-Navigation since work on this important matter commenced at the IMO. As previously noted, Australia believes that at this stage of the process identified solutions should be outcomes based, and not technology specific. This is particularly important due to the now rapid rate of change in the options and possibilities available for particular solutions; new communications product offerings and modern high resolution large area touch screens being some good examples. In the future it will not be possible or sensible to have prescriptive performance standards for e-Navigation equipment and systems.

The human element within e-Navigation will be key to its success, and solutions need to take into account the most effective approach for the user – both afloat and ashore. The solutions should focus on the outcome, the 'what is required', and not attempt to specify any more than is necessary 'how the objectives should be achieved'. To do this a balance will need to be struck so that the result will provide consistency in the way all e-Navigation human / machine interfaces work. Primary benefits of this will be to minimise the amount of any detailed equipment/system specific training, and to enable users, working within systems, to optimally perform their roles and acquit their responsibilities.

Whilst there have been many comments made by others that Australia can fully support, Denmark has provided some helpful advice, which is paraphrased here:

– the broadening of the scope has reached a point where the process needs to be focused into a spearhead of prioritized solutions;
– the first iteration of the e-Navigation strategy should be realistic to ensure a timely completion.
– prioritization of the remaining solutions to provide a roadmap for future work;
– this current prioritisation excise should describe a well-defined and manageable starting point;
– limiting the scope to the list of solutions given in NAV/58/WP6 rev1 Annex 2, which was endorsed by NAV as a preliminary list of solutions as work in progress, may be restricting ourselves form including 'low hanging fruits' in relevant solutions already discussed by the CG but not contained in Annex 2. As far as these solutions have been derived from the GAP analysis in NAV/58/WP6 rev1Annex 1, which was approved by NAV, and discussed by the CG, they should still form part of the candidate set of solutions to be prioritized;
– there remains an important role for the Formal Safety Assessment to process in refining the prioritisation of solutions.

3.11.2 *Some more detailed comments*

Whilst Australia is not particularly wedded to a particular list of five high level solutions, or groups of solutions, they do have some low level comments to offer on three categories of solutions:

1. Information exchange. Any approach to e-Navigation – both ship and shore side – requires effective, efficient and seamless information exchange. This information can be exchanged in many ways: automated, digital communications to address specific information and reporting requirements; voice communications over different carrier types; digital data transmissions over different carrier types.

The approach taken for information exchange should, from the user perspective, be seamless – with an approach taken that does not require the user to identify the appropriate carrier methodology (eg. HF,

VHF, satellite). Noting the increasing capability for digital data transfer over VHF (VHF data exchange) along with the current capabilities, the most efficient means of communication for information exchange should be automatically identified.

At a slightly more detailed level, while many technologies for the information exchange using radio frequencies will not incur a cost for the transmission, there are instances where a cost could be incurred (such as satellite communications for non-emergency transmissions). In the case where a cost could be incurred, this should be highlighted to the user with an option to continue or delay the transmission until such time as another transfer carrier option is available.

With many reporting requirements following set formats, aspects of information exchange can be automated – with the ability to 'pre-populate' reports based on existing information.

The approach taken for information exchange must be focused on practical outcomes, and not specific technology.

2. Integrity, resilience and reliability. In a data rich environment there is a need to ensure the integrity and reliability of the information exchanged. This is linked not only to the quality assurance of equipment and software in use, ensuring the most up-to-date versions are implemented; but also data quality, including for positioning, navigation and timing information.

Software and hardware must be reflective of the requirements of the user, with a scalable approach to ensure information required is available, without overloading systems or users with information that is not required. The latest version of the software should be automatically updated through the information exchange capabilities, with consistent notification of the version in use. Where the latest version is not in use, indication of this must be provided so that the user can take any limitations of data integrity and reliability into account. Within a technical environment that is constantly changing, technical and presentation standards must be updated regularly, to ensure consistency and effectiveness of data transfer and presentation across multiple platforms.

The human element in reviewing and understanding the data is critical. While some aspects could be automated, the watchkeepers (afloat and ashore) will be the ones who will need to interpret the information. Within the concept of integrity and reliability are inherent training requirements. Training can be integrated into system design, with 'help' files, on-line tutorials supplementing more formal training.

3. Usability, ergonomics (human / system interfaces). Noting the work already done on ergonomics, including the current IMO Integrated Navigation System standard, the practical solution needs to ensure consistent implementation of standards and symbology.

The consistency of the implementation of standards related to ergonomics and visualisation / symbology must address both ship and shore users. With the increasing linking of ship and shore, there is a need to consider the use of similar symbology sets for use in both environments.

In addition to a kind of standardised, or harmonised presentation of information there should be opportunities identified to ensure a user requirements focused presentation.

4 CONCLUSIONS

As you can see the work of the IMO correspondence groups are sometimes very intense. For example, in the paper was shown a little more than two weeks (from 10 to 27 January, 2013) action works of the Correspondence Group on e-Navigation under chairmanship of Mr John Erik Hagen.

10 January 2013 Chairman of the IMO Correspondence Group on e-Navigation John Erik Hagen invited the members of the Group to provide input for finalizing a maximum of five main practical solutions. Two weeks later the common position was almost formed. It was exactly before IMO COMSAR session.

The internal debate that has ensued amongst the correspondence group has been extensive, thoughtful, considered and perhaps one of the most valuable discussions the correspondence group has had.

The majority of the CG has prioritized the following main potential solutions:

S1: Improved, harmonized and user-friendly bridge design;
S2: Means for standardized and automated reporting
S3: Improved reliability, resilience and integrity of bridge equipment and navigation information;
S4: Integration and presentation of available information in graphical displays received via communication equipment;
S9: Improved Communication of VTS Service Portfolio.

By the way it appeared a suggestion for consideration concerning the next session of IMO STW. It would be helpful if an e-Navigation presentation could be provided to STW on the first day of the session. Such a presentation will help update those that attend STW about the status of e-Navigation and also share the vision of what e-Navigation should deliver. This would assist STW's deliberations.

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