**DEVELOPMENT OF AN E-NAVIGATION STRATEGY IMPLEMENTATION PLAN**

**Final draft report from the Correspondence Group on e-navigation to NAV 58**

**07-03-2012**

**Background**

1 The work program on e-Navigation, (MSC 86/23/4), outlines a joint plan of work for the COMSAR, NAV and STW Sub-Committees for the period 2009-2012. The Correspondence Group (CG) was re-established by NAV 57 to continue work on its task, and asked to invite its members to submit relevant views, proposals and comments to COMSAR 16, STW 43 and NAV 58 as appropriate. IALA and IHO should also be invited to finalize their gap analyses on the shore side aspects and to report as appropriate.

**Terms of reference**

2 NAV 57re-established the correspondence group on e-navigation under the coordination of Norway and instructed it to take into account the joint plan of work for the COMSAR, NAV and STW Sub-Committees for the period 2012-2014, the comments and general views expressed at NAV 57 and, decisions taken by NAV 52 including the guidance in MSC/Circ.1091 on Issues to be considered when introducing new technology on board ship and MSC/Circ.878-MEPC/Circ.346 on Human Element Analyzing Process (HEAP).

3 The Correspondence Group on e-navigation should undertake the following tasks:

.1 using the overarching e-navigation architecture as a framework, further develop the detailed architecture of both the ship and shore sides, as appropriate, taking into account the outcomes of the gap analysis;

.2 consider the development of Maritime Service Portfolios to achieve harmonization, modernization, integration and simplification on board and ashore, taking into account the use of the IHO's S-100 standard, and recommend the approach to be taken;

.3 further develop and complete the gap analysis with a view to finalization at

NAV 58, taking into account the relevant documents submitted in this respect;

.4 further develop the draft Strategy Implementation Plan;

.5 consider the development of guidelines for usability evaluation of navigational equipment during the preparation of the Strategy Implementation Plan, taking into account the information provided in documents NAV 57/6/5,

NAV 57/INF.7 and NAV 57/INF.8 (Japan) and NAV 57/WP.6, and recommend the approach to be taken;

.6 further progress the preparation of cost benefit and risk analysis processes;

.7 submit interim reports to COMSAR 16 and STW 43 raising specific questions, if required, that should be addressed by the STW and COMSAR

Sub-Committees; and

.8 submit a consolidated progress report to NAV 58

**An operational description of e-navigation**

4 e-navigation is about getting ships safely, securely and efficiently from berth to berth in an environmentally friendly way, using globally enhanced systems for navigation, communication and related services – with the human element in focus. The expectations for e-navigation are given in MSC 85/26/Add.1. Based on this description, these expectations are:

.1 Onboard - harmonization of navigation systems, thereby actively engaging the mariner in the process of navigation to carry out his duties in a most efficient manner, while preventing distraction and overburdening.

.2 Communications - providing an infrastructure which allows seamless information transfer on board ship, between ship and shore authorities and other parties with many related benefits.

.3 Ashore - management of vessel traffic service and related services, such as search and rescue-, port-, and MSI-services, through better provision, coordination, and exchange of comprehensive data in formats that will be more easily understood and utilized in support of vessel safety and efficiency.

**Development of a detailed architecture**

5 Using the overarching e-navigation architecture as a framework, the Correspondence Group has been instructed to further develop the detailed architecture of both the ship and shore sides, as appropriate. The overarching e-navigation architecture is presented in the report of the Correspondence Group to NAV 57 (NAV57/WP6).

6 Further detailing the architecture one should take into account the use of the IHO's S-100 Standard and Registry.

7 NAV 57 (NAV 57/15, Paragraph 15.1.4) approved the proposed way forward for developing a Common Maritime Data Structure (CMDS) (NAV 57/ WP6, Paragraphs 3.12, 3.13 and 3.14.).

8 Using the overarching e-navigation architecture as a framework, the further development of the detailed architecture of both the ship and shore sides, as appropriate, will have to take into account the final gap analysis. Depending on the outcome of NAV 58, the CG will further detail the architecture.

9 The Sub-Committee is invited to endorse the further procedure on the development of the detailed architecture.

**The final gap analysis**

10 According to NAV 57 the reason for performing the gap analysis is to identify e-navigation solutions. The gap analysis identifies practical e-navigation solutions, as listed in Annex 1. The gap analysis, in its present form, may be sufficiently progressed and the next step is to focus on identifying the Risk Control Options (RCOs) that will be subjected to Formal Safety Assessment (FSA) for risk and cost-benefit analyses. The outcome of the analyses will be reflected in the e-navigation Strategy Implementation Plan.

11 Annex 2 demonstrates examples of how e-navigation solutions intended for RCOs may be elaborated.

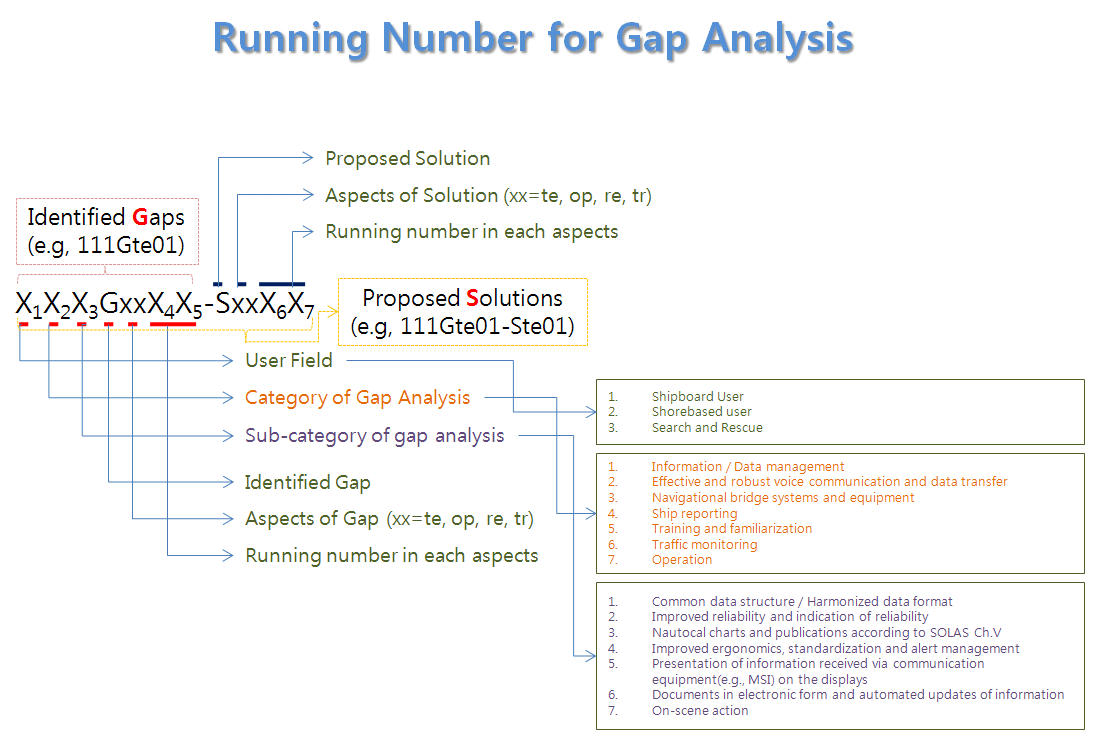
12 Starting with the operational aspect, solutions regarding infrastructure, regulation and training will have to be addressed consequently. Examples of solutions regarding training have been presented to STW 43. NAV 58 is invited to discuss the issue of usability, which may be relevant to the need for training.

13 NAV 56 advised the use of The Human Element Analyzing Process (HEAP) as a checklist in the gap analysis. HEAP is described in SC/Circ.878/MEPC/Circ.346. It is essentially a checklist for issues to consider, in particular relating to the human element, organizational and training issues. The document can be used in a gap analysis as well as in a risk analysis. The CG has reviewed a document concerning HEAP in general, shown in Annex 3, and it is integrated in the gap analysis. The HEAP references in Annex 1 are explained in Annex 3.

14 Gaps derived from the user needs are reviewed and indentified as ‘operational’, ‘technical’, ‘regulatory’ and ‘training’. In the consolidated version of the gap analysis, (Annex 1) the identified gaps are discriminated by these four different aspects. Each piece of information on a gap is linked to its formal origin:

* Category and sub-category (COMSAR 15/11, Section 36)
* User Needs (NAV 56/WP.5/Rev.1 Annex 2,3,4)
* Key strategic elements (MSC 85/26/Add.1, Annex 20 Sec.9)
* Core strategic objectives (MSC 85/26/Add.1, Annex 20, Sec.5)
* Related functions (NAV 56/WP.5/Rev.1, Annex 1)
* Existing equipment
* Operational area (COMSAR 15, NAV 57/6)

15 For the reference and traceability, each gap has been given a unique identifier. The detailed structure of the identifier may be illustrated as follows:



**Figure 1**

16 The Sub-Committee is invited to endorse the finalized gap analysis (Annex 1) taking into account the methodology of the Human Element Analyzing Process (Annex 3).

**Further progress of the preparation of cost benefit and risk analyses processes**

17 In order to prepare further for the cost benefit and risk analyses it is important to focus on identifying Risk Control Options (RCOs). The relevance of RCO identification as a preparation for the FSA was explained in the report of the CG to NAV 56 (NAV 56/8). Planned work on cost-benefit analyses depends on well considered and defined RCOs.

18 Clear and traceable connections between user needs and e-navigation solutions are important. The following 6 steps are relevant to identify e-navigation RCOs.

.1 Identify user needs that are relevant to the e-navigation objectives

.2 Propose relevant e-navigation solutions that have clear origins in user needs, and that contributes to either safety or pollution prevention

.3 Combine or redefine solutions that coincide or are similar – uphold traceability to solution origin.

.4 Develop solutions further to include infrastructural, usability and regulatory requirements.

.5 Evaluate the feasibility of the suggested solutions with regards to regulatory and infrastructural requirements.

.6 Evaluate suggested solutions or RCOs regarding their risk reduction effectiveness – disqualify solutions with low effectiveness.

19 There might be need for additional steps involving categorization of RCOs with regards to required regulatory and infrastructural changes, scalability and Maritime Service Portfolios (Paragraphs 23-28 of this document).

20 Annex 2 presents 28 examples on how e-navigation solutions intended for RCOs may be elaborated. This illustrates how one may address the preparation of transferring the gap analysis into the process of identifying e-navigation RCOs, systematically applying the reference to the gap analysis, which in turn is structured out of the User Needs. This is a goal based approach regarding the definition and structuring of e-navigation solutions that would form the basis for the cost benefit and the risk analyses.

21 A goal based approach regarding the definition and structuring of e-navigation solutions could form the basis for the cost benefit and the risk analysis.

22 The Sub-Committee is invited to endorse the proposed procedure for identifying RCOs taking into consideration the examples of e-navigation solution identification as illustrated in Annex 2, as a basis for performing the risk and cost benefit analyses, noting that there might eventually be additional solutions included by COMSAR 16 and STW 43.

**Maritime Service Portfolios (MSP)**

23 Maritime Service Portfolios (MSP) are introduced in the report of the Correspondence Group to NAV 57 (NAV57/6, paragraph 23-26). A MSP defines and describes the set of operational and technical services and their level of service provided by a stakeholder in a given sea area, waterway, or port, as appropriate. MSPs should be developed to achieve harmonization, modernization, integration and simplification on board and ashore, taking into account the use of the IHO's S-100 standard.

24 It has been noted that the user needs with regard to the e-navigation concept identified and adopted different MSPs corresponding to needs for services and communication in different areas and for different operations and it has been agreed that the MSP areas are divided into:

.1 Harbor operations

.2 Operations in coastal and confined or restricted waters

.3 Transocean voyages

.4 Offshore operations

.5 Operations in Arctic, Antarctic and remote areas

25 The objective of a MSP is to correspond to a need for information and communication services in a defined operational area. A MSP requires a set of service suppliers, and the infrastructure to deliver the services where they are requested. In order to define MSPs a set of services will have to be defined for each area.

26 Example of services may be deducted from NAV 56/WP.5/Rev.1, paragraph 3.8 and Annex 1: Architecture to the “Development of an e-navigation strategy implementation plan” (Paragraph 3: Functions), and SN.1/Circ.289: Guidance on the use of AIS application-specific messages. This implies that further detailing of services is needed. A set of services will require a certain communication infrastructure capacity.

27 MSP services should be distributed among the defined operational areas. Adding the novel services to the already regulated services, the total demand for communication capacity can be identified. Further development of the MSP concept will help provide a clear overview of the distributed need for maritime services, and consequently produce an overview of the need for communication capacity and infrastructure.

28 The MSPs may have an impact on the prioritization of deliverables, and should be further elaborated as part of the Strategy Implementation Plan.

29 The Sub-Committee is invited to comment on the further process of developing the Maritime Service Portfolios as presented in paragraphs 23-28.

**Guidelines for usability evaluation of navigational equipment**

30 The CG has considered the development of guidelines for usability evaluation of navigational equipment during the preparation of the Strategy Implementation Plan, noting the information provided in documents NAV 57/6/5, NAV 57/INF.7 and NAV 57/INF.8 (Japan) and NAV 57/WP.6. Taking into account commonly used methods for usability evaluation, one may identify characteristics of the maritime sector and elements necessary to be considered in developing a tool for usability evaluation of navigation equipment.

31 At NAV 57 it was agreed that the efforts should focus on the development of the Strategy Implementation Plan, and that the development of the guidelines should be incorporated in the implementation plan so that the Sub-Committee could revisit the issue of the usability evaluation in the future.

32 The CG has identified some key issues which should be taken into account when developing guidelines on usability as follows:

.1 The scope of usability should include that the goal is acceptable user experience; the process is human centered design, the measure is quality in use and the outcome is improved safety of navigation.

.2 The context of use must be defined, and consist of: user’s characteristics, their goals, tasks, physical environment, social and management environment and other associated equipment.

.3 Tests for usability should also address the ability to solve operational problems in realistic but demanding and complex conditions.

.4 One should address usability at several levels, including both equipment and systems.

.5 An eventual overarching e-navigation performance standard should address issues of design and usability.

.6 One should be aware of aspects of current performance standards that limit the ability of technology to continually improve to meet evolving needs.

.7 The use of existing ISO general industry usability standards applicable to e-navigation should be encouraged.

.8 The use of ISO standards for the development of systems and software should be encouraged.

.9 There needs to be set an agreed level for the time it takes to achieve user “familiarization”.

.10 The achievement of usability within the development of e-navigation will be an evolutionary process.

.11 The responsibility for ensuring usability should be shared between the ship and shore operating organizations, the manufacturers and any service providers.

.12 Type approval processes should take into account usability and continual improvement.

33 The principles of IMO INS performance standard and the Modular Concept should also be taken into consideration.

34 The Sub-Committee is invited to give comments as appropriated on the further development on guidelines for usability evaluation of navigational equipment.

**Further development of the draft Strategy Implementation Plan (SIP)**

35 The mandate for the final Strategy Implementation Plan (SIP) is presented as part of the e-navigation Work Programme in MSC 86/23/4:

1. Identification of responsibilities to appropriate organizations/parties,
2. Transition arrangements,
3. A phased implementation schedule along with possible roadmaps,
4. Priorities for deliverables, resource management and a schedule for implementation and the continual assessment of user needs,
5. Proposals for a systematic assessment of how new technology can best meet defined and evolving user needs,
6. A plan for the development of any technology and institutional arrangements necessary to fulfill the requirements of e-navigation in the longer term,
7. Proposals on public relations and promotion of the e-navigation concept to key stakeholder groups,
8. Identification of potential sources of funding for development and implementation, particularly for developing regions and countries and of actions to secure that funding.

36 In the context of the implementation of e-navigation solutions, it will be necessary to define the signification and consequences of “responsibility”. There is a spectrum between task sharing and liability. Important issues in this context are the quality and legal aspects, protection, storage, consistency, maintenance and enrichment of data.

37 NAV 54/25, Annex 12, Annex 1 has defined the responsibilities for ownership and control of the e-navigation concept by IMO: “The responsibilities that come with IMO ownership and control of the concept include:

.1 development and maintenance of the vision;

.2 definition of the services including their scope in terms of users and geography, and the concept of operations;

.3 identification of responsibilities for the design, implementation, operation and enforcement of e-navigation, acknowledging the rights, obligations and limitations of flag States, coastal States, port States and the various authorities within those States;

.4 defining the transition to e-navigation in a phased approach, enabling the realization of early benefits and the re-use of existing and emerging equipment, systems and services;

.5 taking the lead in setting the performance standards appropriate for e-navigation covering all the dimensions of the system: ship borne, ashore and communications. These standards should be based on user needs and should encourage technology neutrality and interoperability of system components;

.6 ensuring that the concept accommodates and builds on existing maritime systems and funding programs;

.7 facilitating access to funding from international agencies, such as the World Bank, the regional Development Banks as well as international development funding;

.8 assessing and defining the training requirements associated with e-navigation and assisting the relevant bodies in developing and delivering the necessary training programs;

.9 monitor the implementation of the concept to ensure that contracting States are fulfilling their obligations and ensuring that e-navigation users within their jurisdiction are also complying with requirements; and

.10 leading and coordinating the external communications effort necessary to support the case for e-navigation. “

38 The identification of responsibility might also imply specialized organizations like IALA, IHO and other relevant organizations. There might also be a need for identifying the responsibilities of

.1 National, eventual local and regional authorities

.2 Ship owners, the navigator, etc

.3 The industry

39 Transition arrangements could be divided into the respective sectors of each Sub-Committee.

40 There may be a relation between transition arrangements and the first phases of a phased SIP. This is to some extent elaborated on in NAV 54/25, Annex 12:

“transition planning,” (should be one of the component activities of SIP) “taking into account the phasing needed to deliver early benefits and to make the optimum use of existing systems and services in the short term. The implementation plan should be phased such that the first phase can be achieved by fully integrating and standardizing existing technology and systems and using a reduced concept of operations. Subsequent phases should develop and implement any new technology that is required to deliver the preferred architecture and implement the overall concept of operations”.

41 There may be different implementation plans according to the differences in the start status of the various stakeholders. This may eventually be covered by the different levels of the phases of the SIP. This dilemma could be solved by introducing the notion of roadmaps. In NAV 54/13/4 it was proposed that “in order to develop a detailed implementation plan, common understandings on various issues, in particular, the prospect of technological development are necessary”. It was considered:”that development of a road map might be helpful to clarify common understandings which are necessary for the implementation of e-navigation strategy”. “The-state-of-art and the prospect of technological development which should be reviewed by the Sub-Committee as necessary are clarified by the road map.”

42 The priorities for deliverables and the schedule for their implementation should be closely related to the phased implementation plan and the road maps.

43 A blueprint for describing the methodology for continual assessment of user needs is presented in NAV 55/11/4, UK: “ Development of an e-navigation strategy implementation plan: methodology for developing e-navigation user needs using a task-based approach”, and has been considered by the CG. It may seem appropriate to further develop the methodology for continual assessment of User Needs in light of the development of guidelines for usability and guidelines for test beds.

44 A plan for the development of any technology and institutional arrangements necessary to fulfill the requirements of e-navigation in the longer termwill be a direct consequence of the conclusions of the technology and legal categories of the gap analysis, but also largely influenced by the phased implementation schedule, priorities for deliverables and how it may be decided to systematically assess how the new technology best can meet defined and evolving user needs.

45 The future use of e-navigation INS and communication systems may be seen in relation to the risk of being attacked by computer viruses, and other cyber threats. This should be further considered. Cyber-attacks may have a significant impact on critical infrastructures. Cyber security aspects in the maritime sector may be relevant within an implemented e-navigation platform.

46 A successful implementation of e-navigation solutions needs to take into account software quality. Software quality assurance guidelines should be considered. A possible concept of software quality is presented in Annex 4.

47 NAV 53/13 underlined the importance of active endorsement from the shipping industry as crucial to the success of e-navigation, and recommended that further work should include a formal study by an appropriate organization to provide credible and rigorous information about the likely cost implications to the industry of developing and implementing e-navigation.

48 One important aspect and challenge of the introduction of e-navigation solutions will be the integration of test-bed outcomes. Results from test beds are important to the overall e-navigation process. They assist in keeping the focus on user needs.

49 Experience in gathering user requirements shows that it often is difficult for an active navigator to identify clearly needs, differentiate needs from desires and predict new, unknown system features. Test-beds will provide early implementation and user experience while the system itself is still under development. They also allow early detection of areas of improvements or defects in intended system functionality.

50 Guidelines and harmonization in this area would increase the value of the test beds as input to the e-navigation process. These guidelines should stretch from planning of test-beds, through developing of test systems, to conducting actual sea-test up to the development of systematic reporting structures to increase comparability of test-bed results and allowing to detect the best candidates for implementation.

51 Noting the synergy between e-navigation and the Maritime Electronic Highway (MEH) project and the global significance of the Malacca and Singapore Straits it is relevant to conduct an e-navigation test bed.

52 In order to develop a good public relation and promotion of the e-navigation concept, it is vitalthat all stakeholders are identified, and have sufficient knowledge, obligation and enthusiasm about e-navigation. Some crucial communication objectives could be:

.1 Create necessary enthusiasm

.2 Establish a ground for sufficient participation, and that the concept is known by organizations, states, industries and stakeholders

.3 Create a common understanding of the current situation and challenges today

.4 Create a common obligation to participate for the sake of something bigger than the stakeholder itself

.5 Create a convergence of initiatives, reduce sub-optimization and parallel initiatives

.6 Attract stakeholders

.7 Let communication create momentum in the process, not obstacles

53 When using different communication channels, it will be important to focus on the effects that will be achieved and the vision of the concept. It will be important to have an iterative process in communication and development of a communications strategy.

54 The CG has considered the identification of potential sources of funding for development and implementation, particularly for developing regions and countries and of actions to secure that funding.

55 Funding is briefly commented on in NAV 57/6, Annex 3:

“World Bank and Regional Development Banks could be relevant institutions, provided member countries within the relevant regions are actively cooperating in the process. As an initial step it may be useful to get an overview of existing investments in the sector. There will be a need to separate funding of project development and funding of project implementation such as investments and operating cost. The cost may be related to maritime states; flag States, coastal States or port States. Further, the cost could relate to original equipment manufacturers or to ship owners/operators as detailed in NAV 53/13, and may include needs as well on board as ashore.”

56 The issue of funding is essential in order to secure the global implementation necessary to fully achieve the potential benefits from the e-navigation project. A clear understanding of the benefits and a credible explanation of the potential positive outcome will be a central motivating factor in order to secure funding commitment.

57 Potential sources for funding of development and implementation must be identified and related to final e-navigation solutions.

Some examples might be:

.1 Bilateral and multilateral partnership arrangements for the funding of specific programs involving States, private and public institutions, industry organizations and other private parties

.2 IMO’s Technical Co-operation Fund

.3 Multi-donor Trust Funds

.4 Cash donations

.5 Public-Private Partnerships

58 The Sub-Committee is invited to give its comments as appropriate on thefurther development of the draft Strategy Implementation Plan.

**Intersession working group meeting**

59 According to the revised e-navigation work program (pending approval by MSC 90) it should be considered whether there is a need for a (joint NAV-COMSAR-STW) Intersession working group meeting in 2012. It is expected that the Sub-Committee accordingly will consider and possibly propose a meeting.

60 Examples of important issues that might be relevant to discuss at an intersession meeting could be:

.1 The role and responsibilities of cooperating international organizations

.2 The FSA process in preparation for COMSAR 17, STW 44 and NAV 59

61 The Sub-Committee is invited to consider a possible intersession working group meeting.

**Actions requested of the Sub-Committee**

62 The Sub-Committee is invited to consider the following issues and decide as appropriate:

.1 Endorse the further procedure on the development of the detailed architecture (Paragraph 9).

.2 Endorse the finalized gap analysis (Annex 1) taking into account the methodology of the Human Element Analyzing Process (Annex 3) (Paragraph 16).

.3 Endorse the proposed procedure for identifying RCOs taking into consideration the examples of e-navigation solution identification as illustrated in Annex 2, as a basis for performing the risk and cost benefit analyses, taking into consideration that there might eventually be additional solutions included by COMSAR 16 and STW 43 (Paragraph 22).

.4 Comment on the further process of developing the Maritime Service Portfolios as presented in paragraphs 23-28 (Paragraph 29).

.5 Comment as appropriated on the further development on guidelines for usability evaluation of navigational equipment (Paragraph 34).

.6 Comment as appropriate on thefurther development of the draft Strategy Implementation Plan (Paragraph 58).

.7 Consider a possible intersession working group meeting (Paragraph 61).