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| Draft IALA Guideline |

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Requirements Traceability

Edition 1.0

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1 WHAT IS REQUIREMENT TRACEABILITY? 4

2 WHY REQUIREMENT TRECEABILITY IS IMPORTANT AND WHY A PRACTICAL APPLICATION OF REQUIREMENT TRACEABILITY IS DESIRABLE 4

3 GUIDELINES TO IALA MEMBERSHIP 9

4 DEFINITIONS 9

5 ACRONYMS 9

6 REFERENCES 9

List of Tables

***Non è stata trovata alcuna voce dell'indice delle figure.***

List of Figures

**Non è stata trovata alcuna voce dell'indice delle figure.**

# WHAT IS REQUIREMENT TRACEABILITY?

Requirement traceability is the capacity to retrieve the originator or the originators of requirements for any given technical feature implemented in a technical system (either performances, schedule, costs and others (e.g. lifecycle management)). Specifically, requirements traceability refers to the ability to describe and follow the life of a requirement (the word ‘life’ is appropriate because requirements could change), in both forwards and backwards direction: from user needs or expectations to final acceptance tests.

The requirement traceability analysis is an important task of a systems engineering process and is usually performed by means of a requirements traceability matrix or system. These systems assure that all stated and derived requirements are associated with corresponding design elements, system components, modules and project deliverables (forward trace). It is also possible to use the traceability to point out the original source of a requirement to justify to the final user why certain features were included (backward trace).

Requirements that describe the necessary functions and features of the system, are often organized hierarchically (the high-level requirements state what should be achieved, not how to achieve it) and are specified at every level, from overall system to single hardware and software component.

This notion of requirement traceability carries connotations as follows:

* There are requirements, which are both individual, distinct and discrete, or which could be decomposed into this format.
* There is at least one originator of any requirement – any requirement without an originator firmly committed to that requirement should be deleted.
* There should be clear-cut rationales for any and all individual requirements answering the question why the requirements were established originally. Should a rationale for establishing a requirement disappear or become unclear over time, the rationale should be updated or the associated requirement should be deleted.
* If an individual requirement has more than one originator, then there should be a harmonization process between all the originators when establishing that requirement.
* If this harmonization process fails, then individual requirements should be developed for each originator and rationale.
* The resulting requirements are likely to be similar, yet unique. Since all kinds of variants are likely to eventually lead to excessive implementation expense, if this can not be avoided, the originator(s) for the variants need to be identified and connected to ‘their’ specific requirement; i.e. traceability established.
* To handle the complexity incurred, a requirement management system should be established, the scope of which should at least cover the envisioned system.
* The existence of (or the absence of) an adequate requirement management system has a bearing on the system engineering process as soon as the design, build and eventual operation of the envisioned system is started.
* To ensure the user gets what is needed, and/or required, the use of an appropriate requirements management system is paramount – and requirement traceability is achieved.

# WHY REQUIREMENT TRECEABILITY IS IMPORTANT AND WHY A PRACTICAL APPLICATION OF REQUIREMENT TRACEABILITY IS DESIRABLE

In both the International and domestic context, it is important to have requirement traceability. This is important when considering driving international developments, as well as deployment aspects by an individual maritime service provider.

There are several developments in the international domain which suggest that both requirement traceability and requirement management system(s) on the international level are required or at least implied. The following are some of those developments:

* The very identification by the International Maritime Organization (IMO) of a plurality of explicitly identified, different ship-board, shore-based and specifically Search & Rescue stakeholders as such (compare [1]) suggests the recognition of the importance of requirement traceability in the most abstract sense: They are all participating in the same maritime domain, hence they all need to use at least to some extent the same resources in the maritime domain because otherwise these resources would likely not viable or not cost efficiently deployable. But the following questions are yet to be answered: Which stakeholder has what requirements? And what are their relative bearings on the overall requirement setup? And who, i.e. which stakeholder, should be approached for any further clarifications or requirement refinement, if needed in the course of system development and implementation? These questions lead to the desire to establish requirement traceability throughout.
* The need to share the same resources on an at least similar-requirements basis is particularly true for technical services and systems to interact with shipping, such as technical voice and data communication services. With the advent of the digital age, this fact has led to the recognition that something like a Maritime Connectivity Platform [2] is required.
* The advent of the notions of an ‘Overarching e-navigation architecture’ in general and of the ‘Maritime Service Portfolios (MSPs)’ in particular highlight specifically the importance of requirement traceability (compare [3] and Image 1 next page):

Image 1 - Relationship between user requirements, Maritime Service Portfolios and technical/operational services



(Source: originally [3], Figure 1 ; here reproduced for convenience with above entities highlighted from [4], Figure3-4)

* Implicit to that architecture is the notion of a hierarchy between operational services and technical services; and amongst them ([3], paragraphs 27.1/.2; compare for elaboration of this aspect [5], [6]). This hierarchy between services leads inevitably to a hierarchical ‘requirement chain,’ further suggesting the need for requirement traceability.
* There is an international trend towards further integration of shipboard systems and functions for the benefit of the mariner: Integration of previously separate functionalities and systems lead to the need for harmonization of the respective requirement bases; thus conversely leading to a need for requirement traceability from the integrated system or integrated functionality back to the respective originator or originators. IMO’s recent rule making has produced at least the following two examples for this principle, namely the creation of several task items related to the ‘harmonization of bridge design and display of information received,’ amongst others, ‘via communications equipment’ [7] and the creation of the ‘Guidelines for Shipborne Position, Navigation and Timing (PNT) Data Processing’ [8] together with revised IMO Performance Standards for multi-system shipborne radio navigation receivers’ [9].

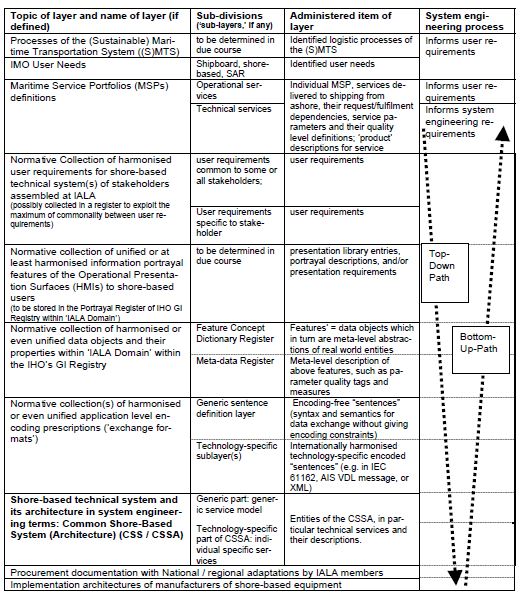
Fortunately, the international community already has developed and documented an initial recognition and acceptance of the necessity for requirement traceability and requirement management system(s). Some international organizations have already developed some mature contributions to future international requirement traceability, as follows:

* The International Hydrographic Organization (IHO) incorporated the concept of requirement traceability already rigidly into their S-100 Geospatial Information (GI) Registry [10, 11]: There, the objects entered into their Registry are tagged with a ‘owner‘ designation. There are also topical ‘Domains,’ which have so-called ‘Domain Owners‘. The concept of the ‘ownership’ means that the tagged entity can only be amended, should there be a need in the due course of maintenance of the Registry, after the respective ‘owner’ has been consulted.

The sophisticated process for this is described in the IHO S-99 standard [11]. The point here is, that to assign an ‘ownership’ and to procedurally run the associated mechanisms for any amendment is already an implementation of requirement traceability: ‘Somebody,’ i.e. at least the ‘owner’ of a specific entity, must have presented and continuously needs to present a valid rationale for requiring the entry of that entity into the IHO GI Registry.

* IALA, when creating a strand of documents on shore-based system architecture, treated the notion of requirement derivation and requirement traceability as a matter of high importance, as illustrated by the following examples:
* ‘Only clearly and consistently stated user requirement result in the technical service provided’ (IALA Recommendation e-NAV 140 [12], Recommends No. 2).
* IALA Guideline 1113 [13], which directly support the above IALA Recommendation e-NAV 140, even provides a dedicated chapter on ‘Seamless and traceable derivation of system engineering requirements from user requirements’ (compare Image 2 below).

Image 2 - Requirement traceability supported by layer hierarchy and system engineering process



(Source: [13], Table 2; reproduced here for convenience) The IALA Guideline on a technical specification for the Common Shore-based System Architecture (CSSA) [14] describes in the section ‘The CSSA’s support of Maritime Service Portfolios (MSPs) definition’ how that technical specification specifically supports requirement traceability (compare [14], in particular section 4.3).

# GUIDELINES TO IALA MEMBERSHIP

The above flow of thought, which stems out of a development process over the past decade in parallel to the development of the e-Navigation strategy at IMO, leads to the following suggestions to IALA Membership:

* IALA Members should consider to establish requirements tracebility as part of their requirement management taking into account the above descriptions, benefits and justification.
* To maximise the benefit of requirement management IALA Members should consider to partecipate in a global harmonised requirement management and traceability schema for application in IALA remit.

# DEFINITIONS

*Requirement traceability:* is the capacity to retrieve the originator or the originators of requirements for any given technical feature implemented in a technical system (either performances, schedule, costs and others (e.g. lifecycle management))

# ACRONYMS

TBD

# REFERENCES

1. IMO. ‘Strategy for the Development and Implementation of e-Navigation’; Attachments ‘Shipborne users’, ‘Shore-based users’, ‘Search & Rescue Users’. In: IMO Maritime Safety Committee. Report of the Maritime Safety Committee on its 85th Session. MSC 85/26/Add.1, Annex 20, 6 January 2009.
2. EfficienSea2 Project. 2017. How to run MCP (Maritime Connectivity Platform) – formerly known as the Maritime Cloud. Workshop at IALA Headquarters, 21-22 November 2017.
3. IMO. ‘Draft IMO e-Navigation Strategy Implementation Plan (SIP).’ In: IMO Sub-Committee on Navigation, Communication and Search and Rescue. Report to the Maritime Safety Committee. NCSR 1/28, Annex 7. 16 July 2014. London. Adopted by IMO MSC 94, 17-21 November 2014.
4. ACCSEAS Project. ACCSEAS e-Navigation Architecture Report. Implementing e-Navigation in the North Sea Region. 15 May 2015. Also available at IALA as document ENAV17-10.4.2.
5. Oltmann, Jan-Hendrik and Jarle Hauge. 2012. The Notion of ‘Maritime Service Portfolio(s) (MSP)’ – a strategic key for international/global harmonization of shore-based services offered to shipping. Presentation at the IALA VTS Symposium 2012 (10-14 September 2012), Istanbul.
6. Oltmann, Jan-Hendrik. 2013. The Structure of Maritime Service Portfolio(s) (MSP). Presentation at the e-Navigation Underway Conference 2013 (29-31 January 2013). Compare particularly slides on ‚Service Spectra‘ and ‘Service Spectra and Management of Requirements.’
7. Australia, Denmark, Finland, Germany, the Netherlands, Norway, the Republic of Korea, ICS, IALA, BIMCO, CLIA, InterManager and the Nautical Institute. Implementing e-navigation to enhance the safety of navigation and protection of the marine environment. IMO MSC95/19/8. 03 March 2015. Compare in particular the Annexes 2 (revised Performance Standards for Integrated Navigation Systems (INS)) and 5 (guidelines on Harmonized display of navigation information received via communications equipment).
8. IMO MSC.1/Circ.1575. Guidelines for Shipborne Position, Navigation and Timing (PNT) Data Processing. 16 June 2017. Compare in particular paragraph 4 for ‘requirement consolidation’ and ‘identification of dependencies.’
9. IMO MSC.401(95). IMO Performance standards for multi-system shipborne radio navigation receivers. June 2015, as amended.
10. IHO/International Hydrographic Bureau. S-100 – Universal Hydrographic Data Model. Edition 3.0.0. April 2017.
11. IHO/International Hydrographic Bureau. Operational Procedures for the Organization and Management of the S100 Geospatial Information Registry (S-99). Edition 1.1.0 – November 2012.
12. IALA Recommendation e-Nav 140 on The Architecture for Shore-based Infrastructure ‘fit for e-Navigation,’ Edtion 2, May 2015.
13. IALA Guideline 1113 on Design and Implementation Principles for Harmonised System Archi-tectures of Shore-based Infrastructure, Edition 1, May 2015.
14. IALA Guideline 1114 on A Technical Specification for the Common Shore-based System Archi-tecture (CSSA), Edition 1.0, May 2015.