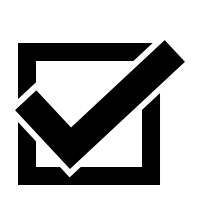
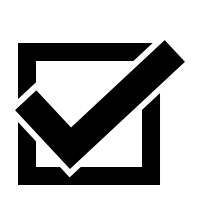
Input paper: [[1]](#footnote-1) ENAV20-9.14

Input paper for the following Committee(s): check as appropriate Purpose of paper:

**□** ARM **□** ENG **□** PAP **□** Input

 ENAV **□** VTS  Information

Agenda item[[2]](#footnote-2) 9

Technical Domain / Task Number 2 …………………………………

Working Group ENAV Committee WG1

Author(s) / Submitter(s) Axel Hahn

A common architecture framework for the maritime domain

# Summary

This input paper is the basis for the discussion about the adaption of the Maritime Architecture Framework (MAF), which is currently under development, as a IALA guideline for a structured engineering method to discuss, align and design existing or upcoming system architectures. The aim of the MAF is to provide a suitable framework for the usage to ease and harmonize the specification of maritime system architectures. This includes the provision of a methodology and methods for definition of architecture descriptions and integration into the existing maritime environment.

## Purpose of the document

This document is intended to be used as informative input to WG1 for discussion about the MAF and its benefit for the integration of e-Navigation systems in the maritime environment. It is envisioned, that the discussion about this document is progressed during ENAV20 to the point of a decision about to use the MAF as IALA Guideline for system architecture engineering.

The underlying intention of the envisioned IALA Guideline is to support maritime stakeholder with a common basis for defining and discussing system architectures within its field of application in order to ensure a common understanding for discussion, alignment and specification of maritime systems from different viewpoints (given by IMO: conceptual, functional, technical[[3]](#footnote-3)). Furthermore, the MAF is designed to consider optional existing influences from the maritime domain as well as from the field of system engineering.

## Related documents

* [DRAFT E-NAVIGATION STRATEGY IMPLEMENTATION PLAN](http://www.imo.org/en/OurWork/Safety/Navigation/Documents/enavigation/SIP.pdf)
* [MSC 85/26, Report Of The Maritime Safety Committee On Its Eighty-Fifth Session, Add. 1, Annex 20](https://www.navcen.uscg.gov/pdf/marcomms/imo/msc_resolutions/MSC267.pdf)
* [ISO/IEC/IEEE 42010:2011(E)](http://www.iso-architecture.org/ieee-1471/cm/)
* IALA Guideine 1114 [A Technical Specification for the Common Shore-based System Architecture (CSSA)](http://www.iala-aism.org/product/a-technical-specification-for-the-common-shore-based-system-architecture-cssa/?download=true)

# Background

The maritime domain is existing of manifold heterogeneous technical systems, divergent social- and organizational structures and has a high dependency from various regulations or guidelines depending on the geographical field of application. A success of the introduction of e-Navigation as well as the inherent integration of any kind of a particular system (technical system, social system or socio-technical system) into the maritime domain depends on its intersections to existing structures and systems on several levels, in which it shall be embedded. Corresponding to this, any kind of system must be designed from a holistic point of view, considering relevant regulations and social structures as well as technical components and cooperating systems in order to have a common basis to establish a harmonized information exchange between systems. Upcoming systems may consider those **interoperability aspects** during the realization of its system design and before the implementation and integration of the system in its maritime environment. However, already existing systems in the maritime domain are mainly loosely coupled.

In order to establish cooperation, alignment and harmonization between systems within the maritime system of systems environment as intended for instance within e-Navigation and its implementation process[[4]](#footnote-4), the benefit of a domain-width approach to harmonize the common engineering process among (new) maritime systems and their field of activities seems to be obvious.

Technical systems as well as social- or organizational structures are usually expressed in an architecture to gather the complexity of (maritime) systems. Such architectures are divergent regarding the intended objectives and viewpoints: data-modelling is for instance described in an entity-relationship model, organizational structures are depicted in an organizational chart and technical component and their interfaces and relations are usually described in UML component diagrams.

The approach of architecture frameworks is intended to establish a “*common practice for creating, interpreting analyzing and using architecture descriptions within a particular domain of application or stakeholder community”*[[5]](#footnote-5)*.* They usually support divergent architecture models from multiple viewpoints with the goal to ensure a comprehensive architecture description of a system. As seen in figure 1, the two viewpoints of an architecture description could be firstly an organizational structure, describing operational processes of a system and secondly a technical architecture, representing the infrastructure of a technical system for supporting the defined operational processes in the organizational structure.

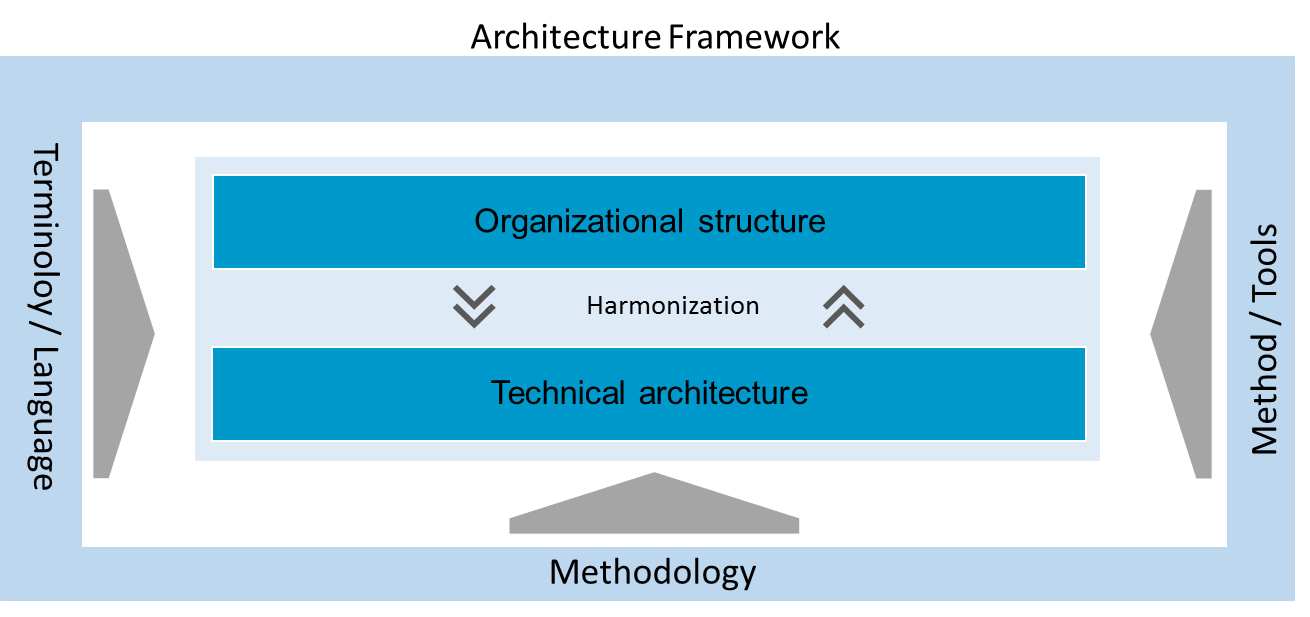


Figure . The approach of architecture frameworks (simplified)

For this, an architecture framework provides a specific methodology to guide a) the definition of the architectures and b) harmonize them. This includes the identification of stakeholders of the envisioned system as well as their concerns and the specific system environment. In addition to that, they usually provide methods and tools as well as a common terminology to ensure a clear understanding between all involved stakeholders (see figure 1).

IMO already defined for e-Navigation architectures at least a technical, functional and conceptual viewpoint.[[6]](#footnote-6) Following this and going beyond, the benefit of an architecture framework for the maritime domain lie firstly on the assistance to establish an holistic architecture description of an maritime system, facilitating and harmonizing different viewpoints and secondly to provide a common basis for the integration of maritime systems into the existing maritime domain, considering interoperability aspects with already integrated systems as well as domain-specific characteristics such as the maritime physical environment and management and control hierarchies.

# Discussion

The intention behind the Maritime Architecture Framework for maritime system design is the support of the architecture description in context of maritime-specific purposes. The Maritime Architecture Framework contributes to the physical and organizational characteristics of the maritime domain and provides a consistent methodology to structure the engineering process of socio-technical system architectures. It captures interoperable information exchange between different systems or system elements and enables for this a) a use-case driven specification of architecture descriptions for maritime systems with regards to IMO’s viewpoints and b) the contextualization of the viewed system inside the maritime environment. This means firstly the allocation in the maritime environment regarding its physical environment (division into ship-side and shore-side as stated by IMOs e-Navigation architecture) and secondly the mapping with other systems in order to identify possible overlaps or gaps on conceptual, technical or functional level for further refinement of a systems design to establish interoperable information exchange between multiple systems.

The envisioned alignment inside the MAF includes in the moment:

* existing (business) objectives and operational processes, that define the benefits and the need of the systems,
* regulation and governance aspects, which regulates the maritime domain,
* technical functions, that are required to realize the initial objectives,
* information exchange between those technical functions including the related information types and / or data models,
* communication protocols to allow the aspired information exchange and
* components, which are required to implement the technical hardware in the system.

The basic concept of the MAF is visualized in the figure below (see figure 2). The intended architecture framework contributes to external domain-specific elements.

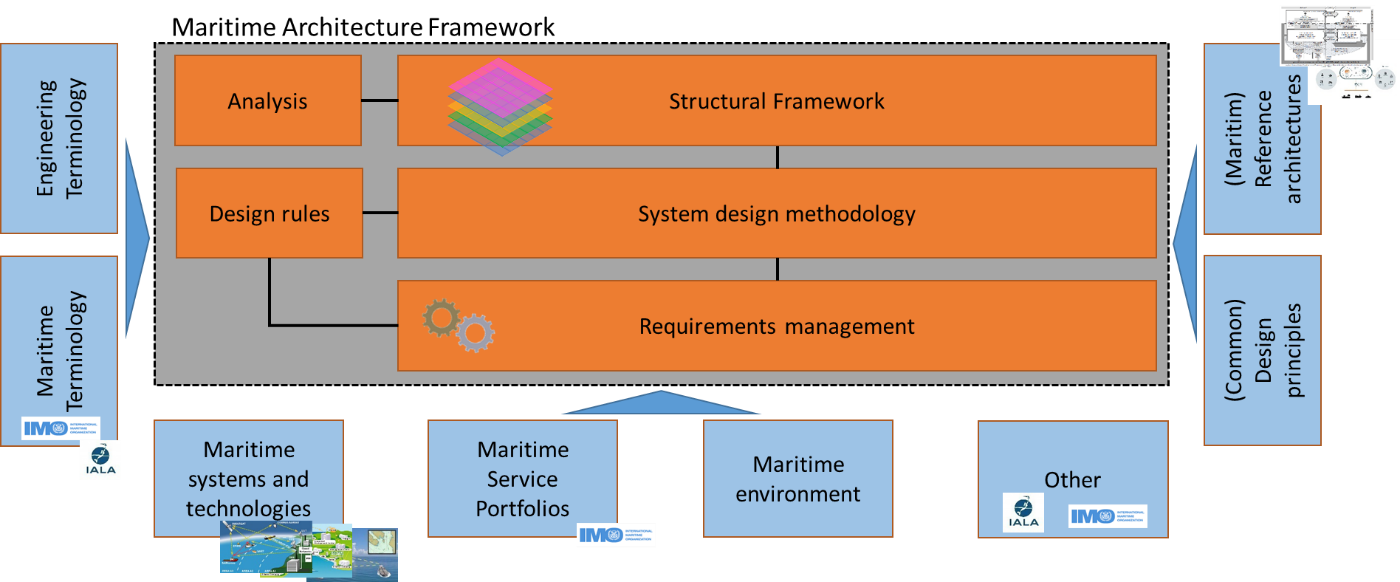


Figure . The Maritime Architecture Framework and its external influences

As seen in figure 2, the MAF refers to divergent terminologies in order to provide a common speech within the specification of a system. Furthermore, the MAF enables due to its orientation towards system of systems, the integration of existing maritime systems and technologies in a system specification. The framework contributes to the already identified MSPs and adapt them as possible use cases and intended objectives for the engineering of maritime systems. It considers also the physical maritime environment as well as the management and control hierarchy of maritime systems in use. Furthermore, the MAF enables the specification of system architectures in context of reference architectures such as the CSSA or design principles such as service-oriented architectures as well.

As seen in figure 2, the Maritime Architecture Framework exists of three core elements:

1. A *Requirements Management* to facilitate and manage requirements for the objectives and functions to be supported by the envisioned system. It provides a description of the requirements in different abstraction levels contributing to the user groups of MAF.
2. A *System Design Methodology* to bring the design process for maritime systems in an order and for documentation purpose. The methodology based upon IMO’s e-Navigation process and follows an iterative refinement approach. It considers the technical design of a system but also enables the description of technology-agnostic and social aspects such as operational processes and organizational structures including influencing standards & regulations.
3. A *Structural Framework*, which represents subsections of the maritime domain in a multidimensional way using the three dimensions Interoperability axis, Topological axis and Hierarchical axis. It is highly integrated in the system design methodology and supports the iterative system design process. The Structural Framework enables the user to map system designs and its elements to dedicated locations within its conceptual space.

Furthermore, the MAF is enriched by additional elements *Analysis* and *Design rules* in order to support the application of the MAF: *Analysis* is reserved for analysis of the (envisioned) system design itself as well as in context to its field of application considering existing maritime structures and systems in order to identify gaps, overlaps or interoperability between different maritime concepts and technologies. The *Design rules* can be interpreted as rules for the structure of the system design. They need to be defined individual for every system specification and bases upon input of relevant reference architectures or design principles.

# Action requested of the Committee

The ENAV Committee is requested to:

Comment on the idea of the Maritime Architecture Framework. Comments should be sent to Benjamin Weinert ([weinert@offis.de](mailto:weinert@offis.de)) for preparing an guideline document.

1. Input document number, to be assigned by the Committee Secretary [↑](#footnote-ref-1)
2. Input papers should be assigned to a work task as listed in the Committee work plan which is available in input papers. Leave open if uncertain but consider how the paper is to be processed if not relevant to a work task [↑](#footnote-ref-2)
3. MSC 85/26, Report Of The Maritime Safety Committee On Its Eighty-Fifth Session, Add. 1, Annex 20, para 9. [↑](#footnote-ref-3)
4. “MSC 85/26, Report Of The Maritime Safety Committee On Its Eighty-Fifth Session, Add. 1, Annex 20, para 9.6” January 2009, https://docs.imo.org/Shared/Download.aspx?did=52734. [↑](#footnote-ref-4)
5. “ISO/IEC/IEEE 42010:2011(E)” [↑](#footnote-ref-5)
6. “MSC 85/26, Report Of The Maritime Safety Committee On Its Eighty-Fifth Session, Add. 1, Annex 20, para 9” January 2009, https://docs.imo.org/Shared/Download.aspx?did=52734. [↑](#footnote-ref-6)