IALA

IALA GUIDELINE

1114

A TECHNICAL SPECIFICATION FOR THE COMMON SHORE-BASED SYSTEM ARCHITECTURE (CSSA)

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DOCUMENT REVISION

Revisions to this IALA Document are to be noted in the table prior to the issue of a revised document.

Date	Page / Section Revised	Requirement for Revision

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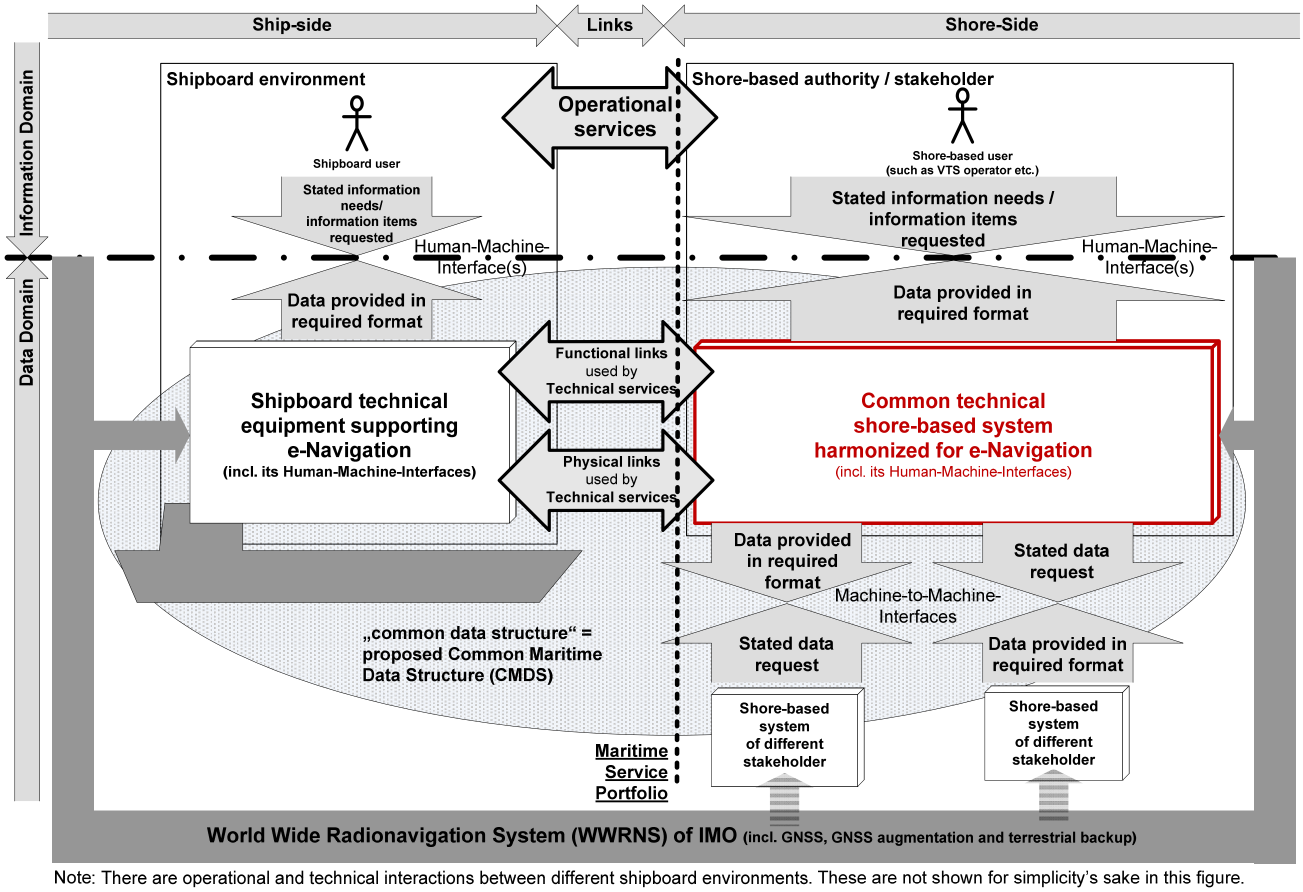
1. INTRODUCTION

This “IALA Guideline on a Technical Specification for the Common Shore-based System Architecture (CSSA)” is a best practice representation of a system layout which was designed, amongst other reasons, as an system engineering response to the prompt for a common technical shore-based system harmonised for e-Navigation (incl. its Human-Machine-Interfaces) as implied by IMO’s overarching architecture for e-Navigation (compare Figure 1; emphasis added) and in accordance with the principles set out in the corresponding IALA Recommendation e-NAV-140 on The Architecture for the Shore-based Infrastructure ‘fit for e-Navigation’, Edition 2, 2015.



(IMO e-Navigation Strategy Implementation Plan (SIP) (NCSR1/28, Annex 7, Fig. 1; as adopted by MSC94))

Figure 1 The overarching architecture as adopted by IMO for e-Navigation

The terms *Common Shore-Based System (CSS)* and *Common Shore-based System Architecture (CSSA)* for the shore-based technical system and its architecture can be directly derived from the above IMO-adopted overarching architecture for e-Navigation:

- ‘Common’: already defined by IMO in their overarching architecture for e-Navigation; ‘common’ here is used in the meaning of several shore authorities employing a similar system architecture when designing and implementing their shore-based infrastructure; ‘common’ is not meant to mean that they are sharing the very same shore-based infrastructure;
- ‘Shore-based’: the place of the technical system is ashore (within the shore-based infrastructure relevant for the scope of e-Navigation);
- ‘System’: self-evident by the topic at hand;

- 'Architecture': each technical system has an architecture (whether expressively stated, which is the topic of this Annex, or implicitly used).

CSS and CSSA are thus generic names. This Guideline provides a generic best practice for such a CSSA regarding system layout.

The following sections focus on the design and implementation principles of the CSS deployed by an IALA National Member[1]. Each IALA National member needs to tailor the following description to their domestic requirements. It is also required to find a name for their own system because CSS and CSSA are generic names.

The CSSA is a system engineering model. The following topics are discussed as follows:

- general layout;
- more detailed layout;
- consequences and options;
- migration and life-cycle management issues.

The CSSA, due to its modular and scalable design, is capable of supporting progressive concepts, e.g. the 'Maritime Cloud (MC).' To that end, appropriate technical services are included in the detailed layout. Their interaction with external entities to function together for such concepts could be the object of dedicated Application Notes.

2. COMMON SHORE-BASED SYSTEM ARCHITECTURE GENERAL LAYOUT

The CSSA describes the technical set-up of the shore-based system of an IALA National Member. The main building block of the CSSA is the technical service. Its qualities are as follows: a technical service encapsulates all primary functions dealing with a specific technology or with a specific user, depending on the kind of technical service. To reap the maximum benefit, all technical services of the CSSA should adhere to the same object-oriented engineering model. Its description can be found in the service engineering model guideline introduced above. All technical services are self-contained and provide all capabilities needed for their tasks, including their own service management.

Figure 2 provides a structural overview representation of the CSSA.

It should be noted that the CSSA is modelled in a client-server-fashion; the individual technical services can regularly assume either role, i.e. be 'clients' or 'servers,' depending on their present role in a given interaction chain to support a given application-to-application data exchange within the overarching architecture.

1 According to the IALA Constitution a National Member is an authority of any country, or any part of that country, which is legally responsible for the provision, maintenance or operation of marine aids to navigation within that country, or any part of that country (hereinafter referred to as National Member).

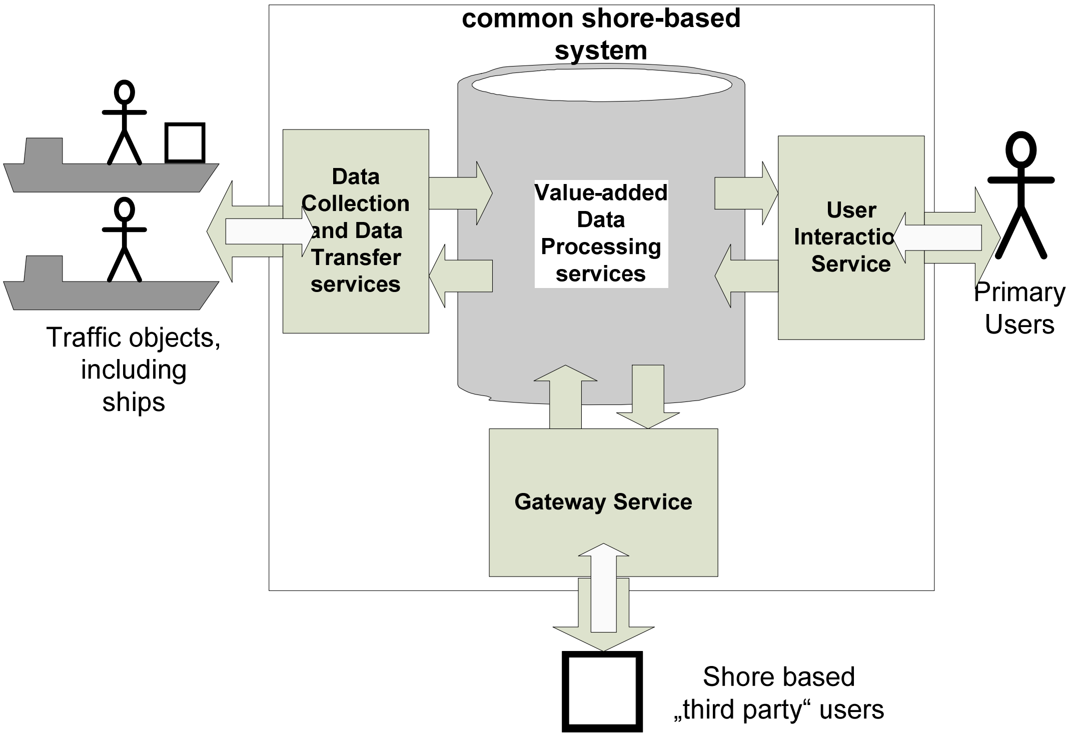


Figure 2   Structural overview on Common Shore-based System Architecture (CSSA)

Figure 2 shows some individual technical services (i.e. the User Interaction Service and the Gateway Service) and some groups of individual technical services (i.e. Data Collection and Data Transfer Services, Value Added Data Processing Services).

All technical services shown in Figure 2 do what is implied by their name:

- the *Data Collection and Data Transfer Services (DCT)* are a group of technical services interfacing the shore-based system via the physical links to traffic objects' electronic systems, to the waterways and to the natural environment;

  For example, the *AIS Service*, the *Radar Service*, the *Visual Aids-to-Navigation Services (fixed, floating)* as well as the *Environmental Sensor Service* belong to this group. Some operate bi-directionally (e.g. the *AIS Service*), while others operate unilaterally on their appropriate physical links.[2]

- the *Value Added Data Processing Services (VAD)* also are a group of individual technical services;

  Their main task is to add value to (raw) data by processing, combination, comparison etc., store data and information and provide it upon request to other technical services.

- the *User Interaction Service (UIA)* – an individual technical service – is specialised to provide the Human-Machine-Interface (HMI) to the primary users of the CSS, i.e. such users as are supported directly by the system via dedicated displays, keyboards and other human interaction devices;

- the *Gateway Service* (GWY) – another individual technical service – specialises in data exchange shore-to-shore. It interfaces mainly to external systems of third parties;

2 Note that by convention the *individual* technical services (i.e. the instances in the object-oriented terminology) are capitalised ('Service') as opposed to technical services (using small letters) in a *generic* sense (i.e. the class descriptions in object-oriented terminology). The proper names of the services are given in italics.

External systems provide data upon request by own system and/or receive access to relevant data from own system, upon legitimate request. The *Gateway Service* can also interface different shore-based systems locally, regionally, and globally.

One further important conclusion can be derived from Figure 2. The combination of the technical services in their system-wide *interaction*, which provides the required functionality of the whole of the system to its users.[3]

Erreur ! Source du renvoi introuvable. provides a structural overview and adds a bit more detail, as will be explained below.

It should be noted, that data exchange between different technical services is exclusively done by *Service Couplers* and only in *Node sites*, e.g. using local area network (LAN) technologies at the Nodes. The topology options in regard to the Node architecture are explained in the corresponding service engineering model guideline.

3 Note, that there is no such thing as a 'super-service,' which would manage or control all services. Such a 'super-service' is unnecessary when adhering properly to the object-oriented paradigm and would also constitute a single point of failure of the CSS. (However, this does not contradict a centralised control of the technical operation of the CSS or its centralised maintenance.)

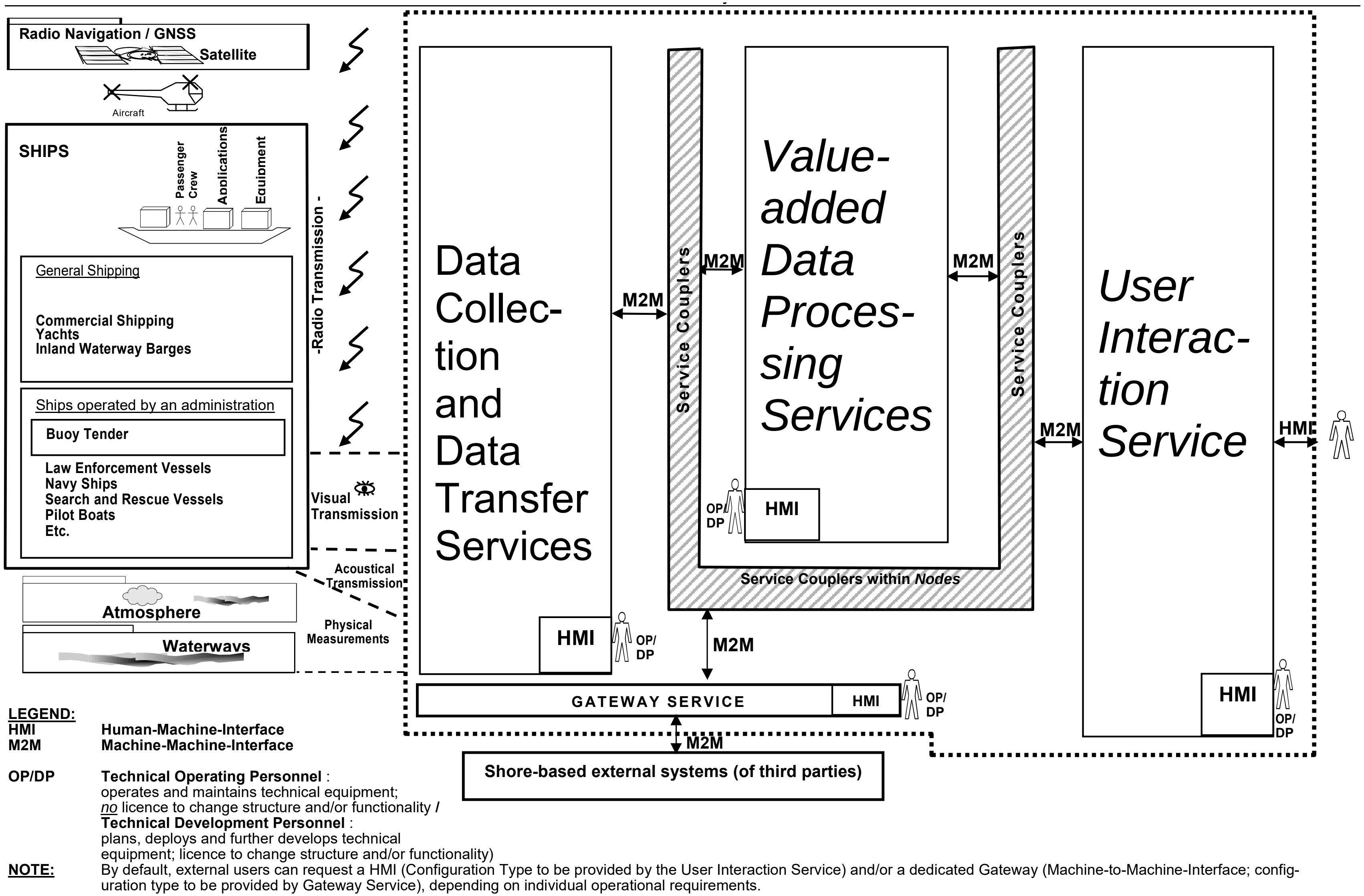


Figure 3 Generic Functional Setup of the Common Shore Based System (CSS) (almost complete)

3. CSSA DETAIL LAYOUT

Figure 4 shows the CSSA in almost full detail. It particularly indicates the variety and plurality of different individual technical services and interactions with the traffic objects and the environment (left hand side), with shore-based primary users (right hand side), and to other shore authorities, shore-based users and shore-based stakeholders (lower side of Figure 4).

The names of the technical services given in Figure 4 are descriptions of what they provide to the CSS. Each of the individual technical service has been assigned a three-letter mnemonic, which is uniquely assigned within the CSSA, and which will be used for various purposes when detailing the architecture and when encoding data items in shore-based data exchange.

Additional technical services and/or additional functions of existing technical services may be defined in the future as prompted by new technologies and/or new features.

Figure 4 is a recommendation for the operational services supported and technical services implemented for an IALA national member. An IALA national member can provide the services as needed and can provide other services that not included. The following list gives a short explanation of each of the technical services illustrated in Figure 4.[4]

- Data Collection and Data Transfer Services (DCT):
  - the *AIS Service (AIS)* is the shore-based infrastructure of a shore-based authority, which allows reception of messages of the Automatic Identification System (AIS) from traffic objects and transmission of messages to them;

    In addition, certain features of the AIS Service allow the CSS of a competent authority to perform certain management functions for the Automatic Identification System intended only for competent authorities.
  - the *Radar Service (RAD)* delivers to the CSS all radar-derived data, i.e. radar images, radar plots, and radar tracks, each of which are provided with radar-specific relevant quality parameters;
  - the *Direction Finding Service (DFS)* determines the current position of a mobile VHF voice/data transmission device operating on one of the several frequency channels monitored;

    Thus, a DF track together with relevant quality parameters (e.g. accuracy estimation) is provided to the CSS.
  - the *DGNSS Augmentation Service (DGN)* delivers to the CSS all relevant measurements regarding the current 'on-air' status of selected components of World Wide Radio Navigation System (WWRNS), such as particular GNSS, terrestrial augmentation and terrestrial backup-systems of other authorities;

    Such measurements could be forwarded to e. g. the *User Interaction Service* for appropriate display to users e.g. in VTS Centres, thus fulfilling user requirements, and/or to the surveying community and/or the general public via the *Gateway Service* for their added value. Also, based on these run-time measurements, the *DGNSS Augmentation Service* provides own DGNSS augmentation data to the own CSS for transmission to traffic objects e.g. via the *AIS Service* or via the *Medium Frequency Broadcast Service*. Hence, the *DGNSS Augmentation Service* does not transmit DGNSS augmentation data to traffic objects on its own but relies on some other technical service to fulfil that specific task.
  - the *Medium Frequency Broadcast Service (MFB)* transmits RTCM 104 standard encoded data using medium frequency bands around 300 kHz (radiobeacon band);

4 The ultimate functionality description for any of those technical services can be found in the appropriate service documentation, in particular considering the Basic Services of each of the technical services as introduced by the service engineering model guideline. (See below)

The RTCM 104 standard encoded data may be DGNSS augmentation data that has been provided by e.g. the *DGNSS Augmentation Service* ('D-Mode'). As the RTCM 104 standard also provides for the transparent transmission of other relevant data ('T-Mode'), the MFB may be used for the transparent transmission of e.g. data related to maritime safety from other sources within the CSS as e.g. received from the *User Interaction Service* and/or from the *Maritime Messaging Service* and external to the CSS (via the *Gateway Service*). Finally, the MFB's transmissions may include a precise timing signal that would allow appropriately equipped shipboard receivers to determine the range to the MFB transmission sites for ranging ('R-Mode') which in turn would be a contribution to create a position fix based on the terrestrial Signals-of-Opportunities (SoOP) approach.

- the *VHF Communication Service (VHF)* allows for shore-based bi-directional voice communication with any mobile radio station operating in the VHF maritime mobile service band;[5]
- the *GMDSS VHF DSC Service (DSC)* allows the CSS to participate in the digital GMDSS DSC-Channel 70 in the VHF maritime mobile service band;
- the *HF Communication Service (HFC)* provides the shore-based bi-directional voice and data communication with any mobile station operating on the HF frequencies (short wave bands) assigned to maritime use;
- the *HF GMDSS Service (HFG)* allows for the bi-directional communication in the HF channels dedicated to the GMDSS;[6]
- the *Navtex Service (NTX)* is a component of the IMO/IHO Worldwide Navigation Warning Service and of the GMDSS;

  The service provides navigation and meteorological warnings and forecasts as well as urgent safety information over MF radio to automated Navtex receivers/printers on-board ships;[7]
- the *Aviation Communication Service (AVC)* allows for shore-based bi-directional voice and/or possibly data communication with any aircraft or helicopter, thus supporting operational applications such as Search and Rescue (SAR) and pollution response;
- the *Fixed Visual Aids Service (FXA)* provides fixed visual Aids-to-Navigation to the mariner. It should be noted, that 'visual' may be a misnomer to the extent that a fixed Aid-to-Navigation (AtoN) could also include on site racons and / or on site AtoN AIS stations, which conceptually would be a part of the FXA;
- the *Floating Visual Aids Service (FLA)* provides floating visual Aids-to-Navigation to the mariner;

  The same cautionary note regarding non-visual technologies as with the FXA applies.
- the *CCTV Video Service (VID)* provides the CSS with the capability to visually observe the areas of waterways covered by video camera observation;

  The output of the *CCTV Video Service* would be a stream of images of the waterway, potentially including some video content analysis data, to be further processed in some other appropriate service of the CSS.
- the *Local Public Address Service (LPA)* allows for acoustically addressing areas of a waterway, for acoustic voice communications and for the dissemination of other acoustic signals to mariners;

  Hence, the acoustic fog signals would belong to that service.

5 Today, this communication is done mainly using analogue voice communication technology, but there is an opportunity for innovation to eventually replace the present analogue technology by high-capacity digital voice/data communication means in the VHF maritime mobile service band.

6 This service has started its legacy period, as administrations, e.g. the US; have relinquished their watch on these frequencies.

7 Presently, there are plans for a future NAVDAT service intended to extend the service provided by Navtex.

- the *Environmental Sensor Service (ENS)* provides the CSS with measurements of relevant parameters of the maritime environment;

  Such relevant sensor data could be hydrological, meteorological or of other physical nature.

- Value Added Data Processing Services:
  - the *Position Determination Service (POS)* processes all real-time data regarding traffic objects (vessels, aircraft, floating objects etc.) from all available relevant sensory sources (e.g. AIS, radar, direction finding);

    Also, fusion algorithms dealing with the different sensory information may be processed here, thus providing the CSS with a multi-sensor-validated track of every traffic object under surveillance by the CSS, together with relevant quality parameters such as accuracy estimations, tracking status and reliability etc. For every traffic object not only is its 'last known' position stored, but also its past tracks which are derived from the validated position reports.

  - the *Ship Data Consistency Analysis Service (SDA)* collects, evaluates, stores and provides on demand non-real-time data regarding traffic objects, in particular their static and voyage related data;

    To that end this technical service draws on a variety of available sources of information for that kind of data, such as AIS reports, historical data from past voyages of the same traffic object, manually acquired data (e.g. from *User Interaction Service*), and third party data bases (accessed via *Gateway Service*). This service also provides pseudo tracking identifiers for the *Position Determination Service (POS)*, for correlation of real-time tracking data with static and voyage related data of the same traffic objects. Amongst other things, this service may handle data as defined by IMO FAL (Convention).

  - the *Environmental Data Evaluation Service (ENE)* collects, evaluates, stores and provides on demand all data of the physical environment of the waterways relevant to safety and efficiency of shipping and to the protection of the environment;
  - to that end this technical service draws on a variety of available sources of information for that kind of data, such as the CSS's own *Environmental Sensor Service*, own historical data, manually acquired data, and in particular from third party data bases (accessed via *Gateway Service*). The *Environmental Data Evaluation Service* also creates added-value information on the physical environment by evaluating the available raw data from the various sources by appropriate algorithms. For instance, tidal windows and under-keel clearances (UKC) may be calculated here.
  - the *Vector Chart Service (VEC)* collects, stores, and provides on demand all data pertaining to vectorised ENCs, both drawing on official sources for ENCs but also drawing on the system's own sources, i.e. on manual input via the *User Interaction Service*;

    The *Vector Chart Service* maintains the ENCs from external sources as they are, but provides overlay layers which contain the additional information from the system's own sources, such as coverage areas of operational and technical services or route topology modelling data.

  - the *Shipping Industry Database Service (SID)* collects, stores, and provides on demand all data pertaining to the shipping industry, i.e. data provided by or learned about relevant stakeholders (compare IMO list of ship-board and shore-based stakeholders in the IMO e-Navigation Strategy (Annex 2 to MSC85/26, Add. 1, Annex 20));
  - the *Maritime Portfolio Registry Service (MPR)* collects, stores and provides on demand all meta-level data pertaining to service portfolios in and for the maritime domain, in particular the *Maritime Service Portfolios (MSPs), as defined by IMO/IALA.* In the future, in the context of the 'Maritime Cloud,' a local copy of the *Maritime Identity Registry (MIR)*, as appropriate for the CSS, and parts of the *MSP Almanac* could be located here too;

The *Maritime Portfolio Registry Service* would thus support the interaction of the CSS of an IALA national member with the 'Maritime Cloud.'

- the *Maritime Messaging Service (MMS)* is the technical service of the CSS specialized in composing messages encoded in technology- or link-specific formats for telecommunication services such as AIS Application Specific Messages (ASM), for Navtex, short message (for GSM), and 'T-Mode' in general, from high-level abstractly encoded data sentences received from requesting services;

  Also, the MMS could enable the CSS to interact with the Maritime Cloud.

- the *Data Mining Service (DMS)* allows for complex queries on present and historical data available from all other technical services of the system.

  It creates stores and provides reports to the requesting service, e.g. the *User Interaction Service* or the *Gateway Service*.

For the *Gateway Service (GWY)* and the *User Interaction Service (UIA)* see above.

Each of the above technical services except for the *User Interaction Service* provides a functional (M2M) interface to any other of the technical services of their own CSS, i.e. on their 'domestic' side. This interface provides the respective functions of a technical service as a set of *Basic Services* specific to that technical service.

For example, the *AIS Service* delivers the so-called Basic AIS Services, which is a set of well defined, AIS specific functions to access the complex AIS VHF data link in an abstract representation. This encapsulates the subtleties of the AIS and its complexity and thereby avoids proliferation of AIS VHF data link specifics throughout the CSS.

The *User Interaction Service* provides its functional interface as a HMI to its users. This functional interface, which may be called *Operational Presentation Surface (OPS)* generally is subdivided into individual functional windows, each with their own specified user interaction.

It should be noted, that data exchange between different technical services is exclusively done by *Service Couplers* and only in *Node sites*, e.g. using LAN technologies at the Nodes. This has at least two important benefits. The wide-area networking topologies of the different technical services, which may be different from each other, are encapsulated within the service. Also, LANs allow for maximum and highly cost-efficient performance of data exchange at the Node sites.

It should also be noted, that the *Value Added Data Processing Services (VAD)* are only represented at Node sites.

The *Shore-Based Wide Area Network Service (SBN)* is a utility service, which support any other requesting service of the CSS. It provides the feeder link and the backbone connectivity for the individual services of the CSS. Because of its supporting position in regard to its requesting services, it is encapsulated by its requesting service.

The *On-Site Infrastructure (INF)* provides resource building blocks needed to support the service components on their sites of installation, hence *On-Site Infrastructure*. Main topics include housing and other structures, traditional utility provision such as power, water, sewer and roads, precise timing, LAN, independent fault detection and alert management, HMIs for *Technical Operation Personnel* and *Technical Development Personnel.* It is important to note that this is where there is usually the largest part of the cost for the National member to support and maintain its CSS.

For further details on the above and additional features of the technical services refer to the corresponding generic service engineering model guideline and/or the individual technical services' descriptions (in IALA appropriate documents, e.g. IALA Recommendation A-124 on the shore-based *AIS Service*).

The following chapters explain in more detail the options for partial implementation and/or configuration by different IALA national members.

The *Operational Presentation Surface*, the 'User Front End,' was introduced above. The architecture can exploit commonalities in functions. For instance, 'traffic image display' will be required by several operational users, although the configuration settings for each of the operational users may be different (e.g. tactical traffic display vs. strategic traffic display).

The concept of *Configuration Type* encapsulates the ability to customise presentation to different users. This concept is shown in Figure 4 within the *User Interaction Service*.

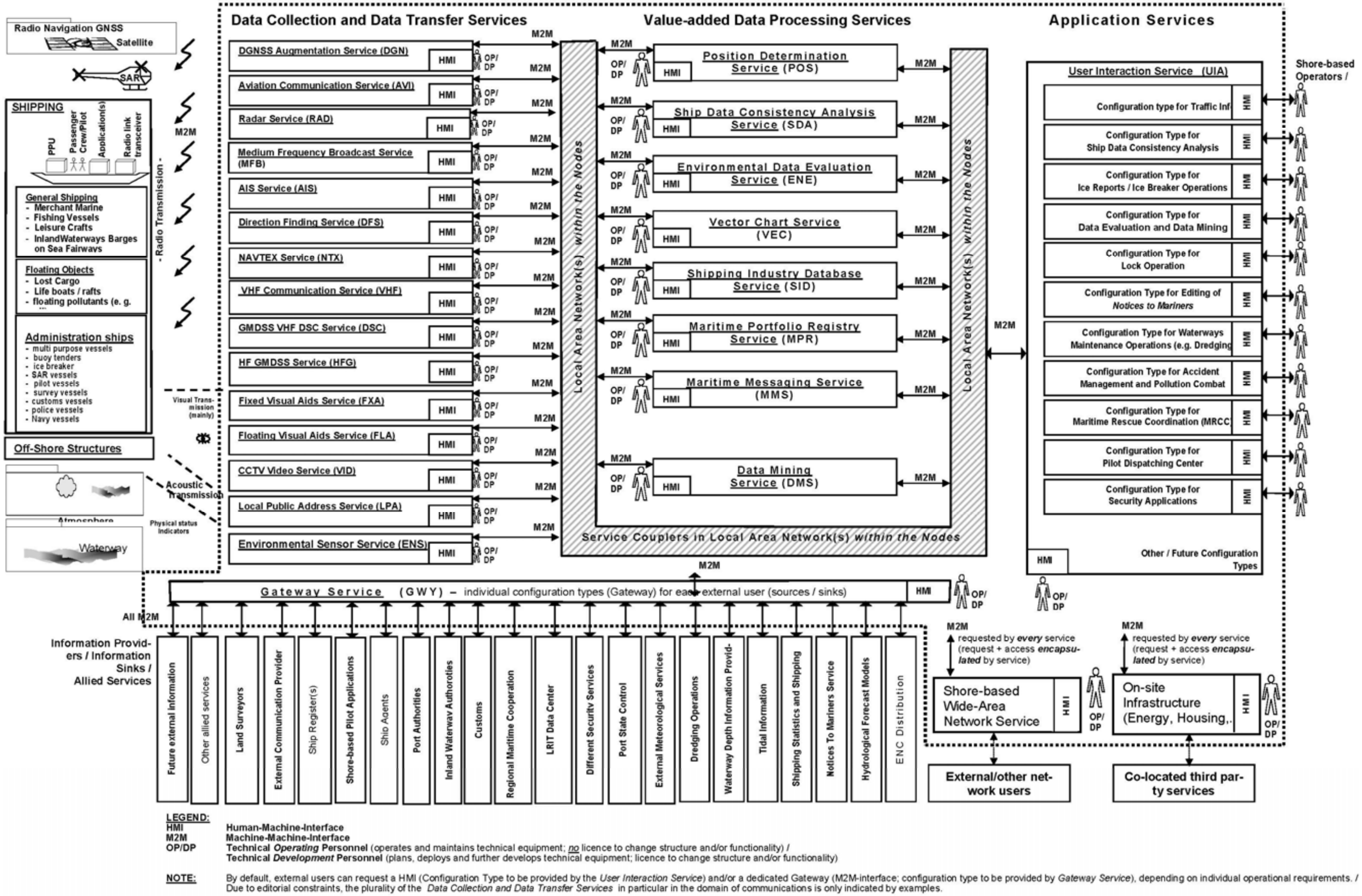


Figure 4 Generic Functional Setup of the Common Shore Based System (CSS) (almost complete)

4. CONSEQUENCES AND OPTIONS

The above configuration is typical for an IALA national member which exhibits a broad scope of activities in the fields of AtoN and VTS. This chapter introduces in more detail the configuration options for different IALA national members when setting up their CSS using the above reference framework.

4.1. THE USEFULNESS OF THE CSSA AS A REFERENCE FRAMEWORK

The CSSA has been presented as a *reference framework* for the design of shore-based systems. The concept of deriving the essential system requirements from user requirements is the starting point for system design.

With defined system requirements, the concept of technical services can be applied. Technical services are used as building blocks to describe a CSS.

All of the necessary services for information and data flow, application interactions and user interfaces can be derived from the essential system requirements.

Services can be described using a generic service model. The technical services introduced in each need to have their own dedicated instance documentation, e.g. in the format of an IALA guideline.

The reference framework created by the CSSA would help in creating an 'innovation friendly eco-system' for technical services and their vendors:

- it would expand the market for individual technical services;

  This would greatly increase the number of solutions that would be offered to IALA National Members for each technical service, reduce their cost and simultaneously improve their quality.

- technical service developers would be able to rely on well-proven, reliable and already available other technical services (i.e. *Data Collection Services*, *Data Transfer Services*, *Value Added Data Processing Services* and *Application Services*) and thus avoid having to developing their own proprietary ones.

  This could significantly reduce the cost of developing technical services and improve their quality.

4.2. GENERAL REQUIREMENTS FOR THE CSS AND ITS COMPONENTS

There are requirements which are almost always used and are described here as a reference. Some of these may not be applicable to all systems. However, all of these must be considered and either applied or rejected with reason as a part of the design process.

These terms are in common use and they are not defined here:

- scalability;
- interoperability;
- flexibility;
- modularity
- reliability / continuity / availability;
- latency;
- maintainability / Life-cycle-friendliness / future-proofing;
- security;
- integrity / plausibility;
- survivability / robustness / graceful degradation;

- safety;
- seamlessness;
- verifiability / validability;
- usability;
- extensibility;
- inclusivity;
- consistency.

4.3. The CSSA's support of Maritime Service Portfolios (MSPs) definitions

As the CSSA is a service-oriented architecture, it directly supports the IMO-developed concept of the Maritime Service Portfolios (MSPs) as well as other maritime service portfolios.

A Maritime Service Portfolio (MSP) is defined as a set of operational and/or technical services which are provided to traffic objects (in most cases from ashore) and which are bundled together for a specific purpose.[8] It is the intention of IMO to describe the MSPs concept in a dedicated Resolution on the Maritime Service Portfolios (Task 17 in the SIP refers (NCSR1/28, Annex 7, Table 7; as adopted by MSC94)).

The CSSA includes many of the shore-based technical services which support operational services delivered by shore-based operators in for example VTS centres maintained and operated by many IALA national members. For example, the radar-derived data flow through the *Radar Service* via the *Position Determination Service* and via the *User Interaction Service* to the VTS operator is supporting his/her task to provide the *operational* services, which the VTS-MSP comprises, namely Information Service (INS), Navigational Assistance Service (NAS), and Traffic Organisation Service (TOS). In addition, these operational services would require the support of communication-oriented services of the CSSA, and most prominently the *VHF Communication Service.*

Hence, the CSSA provides a means for a requirements derivation chain from operational services to technical services as all relevant technical services in such a data flow chain are identified. Thus, the CSSA directly supports not only the traceability of system requirements within the CSS itself, but also the traceability of requirements within the MSPs, i.e. a means to identify operational services calling technical services which in turn call other technical services.

Although each and every service *which interacts with traffic objects* (left hand side of Figures above) is – by definition – part of an MSP, if called, it should be noted that not every service of the CSSA is part of an MSP. Examples for services which are providing technical services within an MSP are the *Visual Aids services (fixed, floating),* the *DGNSS Augmentation Service,* the *VHF Communication Service,* but also the *AIS Service* in its transmitting mode. Those services which provide CSS-domestic functionality are not part of the MSPs, for example the *Value-Added Services* in total, the *Gateway Service*, and the *User Interaction Service.*

To achieve the above function, a copy of any relevant transnational (digital) maritime service portfolio meta-level data definitions will need to be maintained. This is the role for *the Maritime Portfolio Registry Service (MPR)* within the CSSA.

4.4. OPTIONS FOR DIFFERENT NATIONAL IALA MEMBERS

All components identified in the CSSA need not be provided and/or deployed by every single CSS. Hence, the CSSA is scalable. Also, there may be additional individual technical services not mentioned in the above system layout that an administration may wish to provide. Hence, the CSSA is extensible, as additional technical services may be added (while services which no longer exist may be removed). It should be noted, that scalability and extensibility need to comply with the principles of the CSSA. This scalability and extensibility can be applied both

8 While this definition may appear simplistic, it introduces far reaching consequences considering the many existing and envisaged operational and technical services in the maritime domain and the aspiration of the e-Navigation strategy of IMO to harmonize those services internationally.

for the range of individual technical services provided as well as the functionality level of an individual technical service.

More than one IALA national member might share responsibility for providing a service, or there might be overlapping service. The IALA national member participating should describe the shared or overlapped service in their CSS. The shared and overlapped services are bundled into MSPs that can also be used as tools for mutual understanding.

An IALA national member may wish to contract some CSS services. Contracted services should be included in the CSS. Contracted services should be fully described by the CSS, and all requirements defined. IALA national members should apply quality management requirements on the contractor that are at least as strong as their own requirements. Contracted services might need to meet a higher level of requirements such as abiding by Non Disclosure Agreements for added security.

Some IALA national members may be responsible for the provision of operational services delivered from centres they maintain and operate themselves (e.g. VTS). In this case these IALA national members need to set up the *User Interaction Service* in the required configuration to present data on appropriate HMIs to their operators in their centres. However, other IALA national members may only be responsible for providing data flow capabilities through technical services and not operate any centre for any operator in their area of responsibility. In this case the *Gateway Service* would provide the appropriate M2M interfaces, and no *User Interaction Service* would be required for such an administration. Generalising, these examples illustrate that the CSSA provides the option to 'swap', on the planning level, between CSS configurations which exhibit a *User Interaction Service* with one, several, or many configuration types shown above and CSS configurations which have no such capabilities but a much more elaborate 'landscape' of configuration types at the *Gateway Service*.

Finally, it should be noted that the CSSA would also be helpful in the extreme case for an IALA national member to condense the whole of its CSS on one spot only (i.e. in a *One-Spot-Node-Configuration*) or even within the fewest number of machines on that one spot possible. While there are pros and cons of such a configuration, the services of the CSSA would be transformed to software modules running on one or few computers at that one spot, and the CSSA could still support software development in those cases.

5. MIGRATION AND LIFE-CYCLE MANAGEMENT ISSUES

This Chapter discusses aspects of development of shore-based systems over a longer period of time and how change is accommodated.

5.1. MIGRATION AND INTEGRATION OF LEGACY SYSTEMS TO THE CSSA

Legacy systems were not developed with apriori knowledge of the overarching architecture for e-Navigation. During a transition period both services and systems developed in accordance with the CSSA as described in this Guideline will co-exist with legacy services and systems.

The ultimate goal of IALA national members should be to arrive at the CSSA by deploying their own specific configuration. Therefore, some migration of those legacy systems towards the CSSA may be required. Also, legacy components and/or systems may be integrated into an IALA national member's emerging CSS by appropriate interfacing (Service Couplers).

The migration from the legacy systems to the CSS must not threaten the established levels of safety, efficiency and the protection of the environment.

5.2. LIFE-CYCLE MANAGEMENT CONSIDERATIONS

The CSS will comprise many technical services and components contributing to the overall objectives. It is a best practice from the management domain to apply a life-cycle management process to all of those technical services and components to reduce the total cost of ownership and ensure appropriate compatibility with the CSSA.

Life-cycle management for an IALA national member's CSS should be based on (an) appropriate, internationally recognised, service-oriented standard(s) for life-cycle management.

One internationally recognized, service-oriented, life-cycle management best practice collection is contained in the ISO standard 20000, as further refined by the ITIL V3[9] documentation. The ITIL V3 (ISO 20000 based) should be considered a fundamental system architecture design guidance for the CSSA. Figure 5 shows pictorially the concepts presented in the ITIL V3 documentation. Figure 5 hints at the wealth of guidance for implementing life cycle management that is available in ITIL V3.

There could be other internationally recognised standard ways to introduce life-cycle management which could be further investigated.

Figure 5 Example of life-cycle management modules for CSSA as informed by ITIL V3 (ISO 20000 based) [Source: Wikipedia]

9 ITIL = IT Infrastructure Library. The Version 3 (V3) has incorporated the *service-oriented* system layout paradigm.

6. ACRONYMS

The following abbreviations are used throughout this guideline. The mnemonics used to designate technical services of the CSS are in italics.

AIS	Automatic Identification System
AIS	*AIS Service* of the CSS
ASM	Application Specific Messages
AtoN	Aid(s)-to-Navigation
AVC	*Aviation Communication Service* of the CSS
CMDS	Common Maritime Data Structure
CSS	Common Shore-based System
CSSA	Common Shore-based System Architecture
DCT	*Data Collection and Data Transfer Services* group of the CSS
DFS	*Direction Finding Service* of the CSS
DGN	*DGNSS Augmentation Service* of the CSS
DGNSS	Differential Global Navigation Satellite Service
DMS	*Data Mining Service* of the CSS
DP	*Technical Development Personnel* of the CSSA
DSC	Digital Selective Calling
DSC	*GMDSS VHF DSC Service* of the CSS
ENE	*Environmental Data Evaluation Service* of the CSS
ENS	*Environmental Sensor Service* of the CSS
FAL	Facilitation Committee or Facilitation Convention of IMO
FLA	*Floating Visual Aids Service* of the CSS
FXA	*Fixed Visual Aids Service* of the CSS
GMDSS	Global Maritime Distress and Safety System
GNSS	Global Navigation Satellite System
GWY	*Gateway Service* of the CSS
HF	High Frequency (short wave)
HFC	*HF Communication Service* of the CSS
HFG	*HF GMDSS Service* of the CSS
HMI	Human-Machine-Interface
IHO	International Hydrographic Organization
IMO	International Maritime Organisation
IMSAS	IMO Member States Audit Scheme
INF	*On-Site Infrastructure* of the CSS
INS	Information Service, as part of Vessel Traffic Services

INS	Integrated Navigation System, as defined by IMO Performance Standards
ISO	International Organisation for Standardization
IT	Information Technology
ITIL V3	IT Infrastructure Library (V3 = Version 3, service-oriented)
LAN	Local Area Network or Local Area Networking, as appropriate
LPA	*Local Public Address Service* of the CSS
MC	Maritime Cloud
MFB	*Medium Frequency Broadcast Service* of the CSS
MIR	Maritime Identity Registry
MMS	*Maritime Messaging Service* of the CSS
MPR	*Maritime Portfolio Registry Service* of the CSS
MRCC	Maritime Rescue Co-ordination Centre
MSI	Maritime Safety Information
MSP	Maritime Service Portfolio(s)
M2M	Machine-to-Machine Interface
NAS	Navigational Assistance Service, as part of Vessel Traffic Services
NDT	*NAVDAT Service* of the CSS
NTX	*Navtex Service* of the CSS
OEP	Object-oriented Engineering Process
OP	*Technical Operating Personnel* of the CSS
OPS	*Operational Presentation Surface* of the CSS
PKI	Public Key Infrastructure
PNT	Positioning, Navigation and Timing
POS	*Position Determination Service* of the CSS
RAD	*Radar Service* of the CSS
RTCM	Radio Technical Commission for Maritime Services
SAR	Search and Rescue
SBN	*Shore-Based Wide Area Network Service* of the CSS
SDA	*Ship Data Consistency Analysis Service* of the CSS
SID	*Shipping Industry Database Service* of the CSS
SIP	IMO e-Navigation Strategy Implementation Plan (NCSR1/28, Annex 7; as adopted by MSC94, Nov. 2014)
SOA	Service Oriented Architecture
SoOP	Signals of Opportunity
TOS	Traffic Organisation Service, as part of Vessel Traffic Services
UIA	*User Interaction Service* of the CSS

UKC	Under Keel Clearance
VAD	*Value Added Data Processing Services* group of CSS
VEC	*Vector Chart Service* of the CSS
VHF	Very High Frequency (30 MHz to 300 MHz)
VHF	*VHF Communication Service* of the CSS
VID	*CCTV Video Service* (Closed Circuit Television) of the CSS
VTS	Vessel Traffic Services
WWRNS	World Wide Radio Navigation System