

An overview of the ‘Maritime Cloud’ – proposed information exchange infrastructure for e-navigation

Executive Summary

The Maritime Cloud is defined as: ***A communication framework enabling efficient, secure, reliable and seamless electronic information exchange between all authorized maritime stakeholders across available communication systems***

The ‘Maritime Cloud’ is an enabler of seamless information exchange between various systems and across different communication links in the Maritime Domain.

The Maritime Cloud *is not* a ‘storage cloud’ containing all information about every ship or cargo. Nor is it referring to ‘cloud computing’. The Maritime Cloud is the realization of the defined communication strategy for e-navigation as described in the strategy for e-navigation in the report of IMO MSC85 (MSC 85-26-Add.1): *A communication infrastructure providing authorized seamless information transfer on board ships, between ships, between ship and shore and between shore authorities and other parties with many related benefits.*

The Maritime Cloud consists of standards, infrastructure and service reference implementations, that together with governance enable the efficient exchange of information between qualified maritime parties via interoperable information services, utilizing highly automated interfaces to different communication options, enhancing general communications related to berth to berth navigation and related services for safety and security at sea and protection of the marine environment.

The implementation of the Maritime Cloud is not envisaged as a big-bang replacement of the existing infrastructure, procedures and systems, but rather an evolutionary process based on a gradual transition towards a service-oriented information exchange infrastructure. The adoption of the Maritime Cloud will be flexible, fostering increased levels of collaboration within business domains and enabling supporting systems to interact in an interoperable and standardized way.

This document provides a description of the Maritime Cloud and a view of how the Maritime Cloud can be applied to the future of e-navigation in terms of its core components, its applicability to the prioritized e-navigation solutions, relationship with GMDSS and LRIT.

Further considerations on governance, cost distribution and options for implementation will be provided by Denmark for NCSR1.

Description of the Maritime Cloud

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Background

At the very core of the definition of e-navigation

The harmonized collection, integration, exchange, presentation and analysis of marine information onboard and ashore by electronic means to enhance berth to berth navigation and related services for safety and security at sea and protection of the marine environment,

as well as the prioritized solutions, lies the fundamental ability to ensure seamless transfer of information. The strategy for e-navigation in the report of IMO MSC85 (MSC 85-26-Add.1) describes the need for: *A communication infrastructure providing authorized seamless information transfer on board ships, between ships, between ship and shore and between shore authorities and other parties with many related benefits.*

The Maritime Cloud is:

- The realization of the defined communication strategy for e-navigation (MSC 85-26-Add.1)
- An encapsulation of the complexities of seamlessly choosing the best available communication link
- A framework enabling the introduction of enhanced or automated *information services enhancing berth to berth navigation and related services for safety and security at sea and protection of the marine environment*

The Maritime Cloud is NOT:

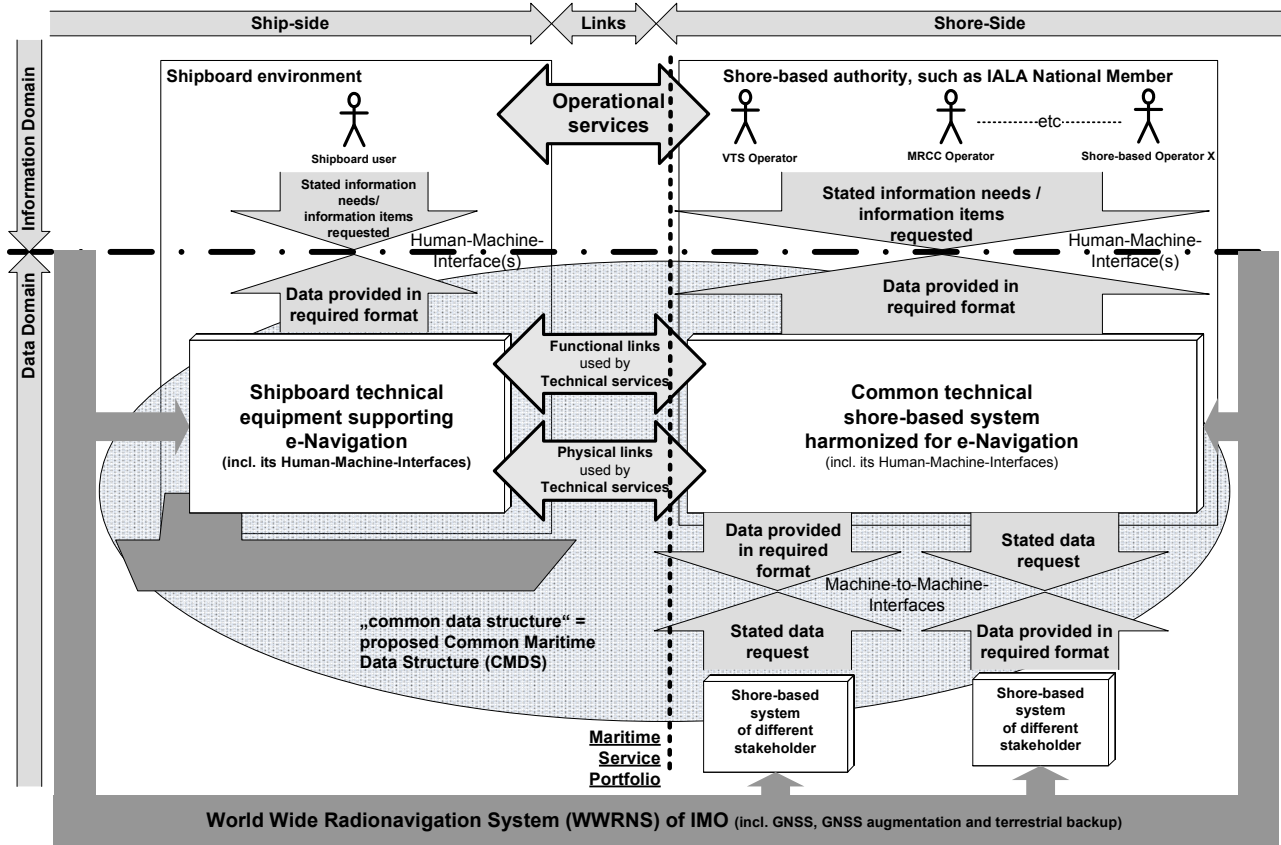
- A 'storage cloud' containing all information about every ship or cargo
- 'cloud computing'
- A specific communication link

The Maritime Cloud is defined as: ***A communication framework enabling efficient, secure, reliable and seamless electronic information exchange between all authorized maritime stakeholders across available communication systems***

The term 'Maritime Cloud' is chosen to illustrate how maritime stakeholders can exchange information, through a gateway to a hazy communication infrastructure, without paying undue attention to the complexities of choosing a specific communication system or channel.

Based on the IMO e-navigation correspondence groups elaborations of user needs, current situation and subsequent gap analysis, the IMO correspondence group has elaborated a large number of proposed e-navigation solutions, five of which have been included in a prioritized list, now under consideration for further maturation as part of the e-navigation Strategy Implementation Plan.

One of the specific prioritized solutions focuses on integrating navigation and presentation systems with communication equipment.



The overarching architecture of e-navigation

The Maritime Cloud is a major facilitating contributor to the realization of the ‘Common technical shore-based system harmonized for e-navigation’, and the shipside component encapsulating the complexities of the physical links, providing the functional links to relevant human-machine interface systems.

Most existing maritime communication solutions are however based on technology specific shore-to-ship broadcast or point-to-point communication systems, and transfer of information typically requires both actors to use the same communication system. Ultimately, a ship or a shore operator should be able to transfer a message to another ship or shore operator and request acknowledge of reception where appropriate. This should function automatically, regardless of actors being within range of specific communication systems and without spending navigators attention on manually monitoring or using a series of different communication systems, and looking up contact information in various publications.

The Maritime Cloud is proposed to be the communication framework, facilitating such roaming capabilities based on availability and least cost routing of communication services, providing a seamless transfer of information.

The Maritime Cloud intends to address both shipside and shoreside prerequisites for the e-navigation solution S4: *Integration and presentation of available information in graphical displays received via communication equipment.*

Trust is highly important, when sharing information over communication links. Some information is purposefully broadcast or multicast as publicly available, while the sharing of more or less sensitive information requires the ability to safely identify the actor with whom sensitive information is shared. The

e-navigation solution S2 *'Means for standardized and automated reporting'* may require a high level of authentication, integrity checking and even encryption of sensitive information. Existing procedures may require written reports including the use of ships stamp and the captains signature. Automating such a reporting process in the digital domain, will require authentication of the issuing ship and signing captain.

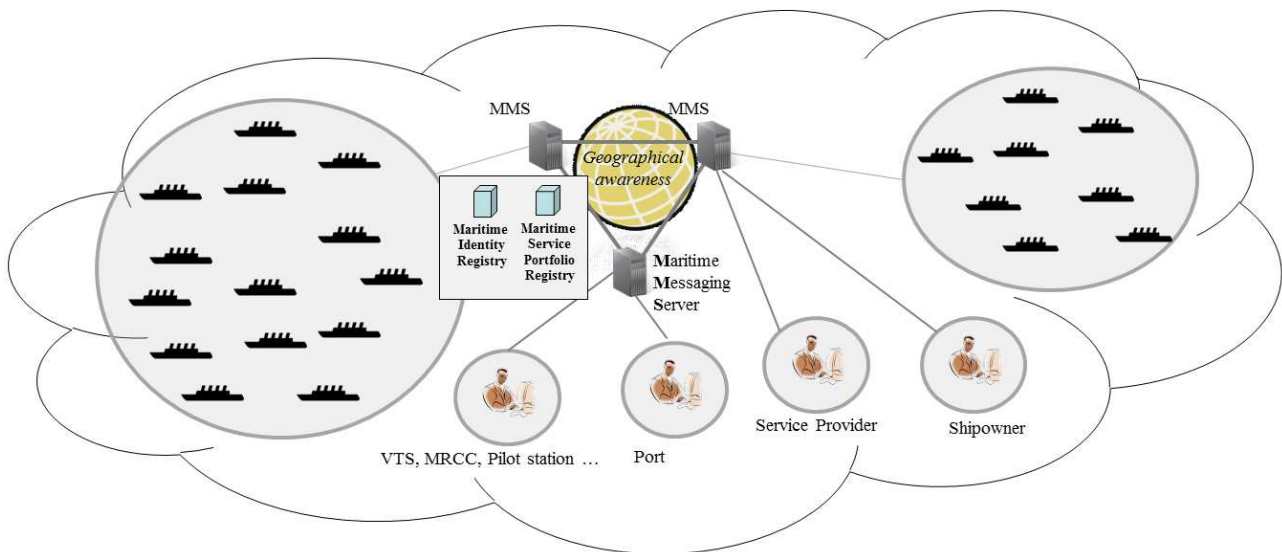
Other situations well known from other domains require higher level authentication processes, for instance billing a specific customer for services provided under a commercial contract, and the transfer of commercially confidential information requiring encryption. Technologies for this are well known from the Internet domain (e.g. financial services) and can be reused by the maritime community.

The Maritime Cloud proposed is based on reuse of such well known technologies from other domains. It is based on experience and concrete implementation efforts in several past and ongoing testbed projects in Northern Europe (EfficienSea, MonaLisa, ACCSEAS). Efforts are underway to establish a global e-navigation testbed based on the Maritime Cloud.

An overview of the Maritime Cloud

Based on proven technologies from the internet domain, the Maritime Cloud aim to provide a community of authorized maritime actors with a basic layer of services for automatically

- Identifying other authorized maritime actors such as Ships, VTS or MRCC, Pilotstations, Ports, Shipowners Office, various Service Providers, etc.
 - Enabling automatic lookup of contact details for direct communication using all existing and / or new technologies
- Authentication of actors
 - Enabling policy based access control to sensitive information
- Secure data connections
 - Enabling authentication of actors when appropriate
 - Enabling integrity verification of data
 - Enabling full confidentiality by encryption when appropriate
- Locating relevant information services
 - Enabling automatic determination of authorized services available in a given area
- Seamless Roaming – by providing a commonly accessible component for Maritime Information Messaging, regardless of choice of currently active communication link:
 - Listening
 - Broadcasting
 - Multicasting
 - Addressing



The Maritime Cloud shall provide a set of Core Services and Facilitation Services, which will facilitate additional information services anywhere, as a layer of services based on internet connectivity. However specific information services do not need to be part of the same Data Center(s), which hosts the Core Services of the Maritime Cloud (the Maritime Identity Registry, Maritime Service Portfolio Registry and Maritime Messaging Servers).

The development of the Maritime Cloud shall take into account

- Providing services should be de-centralized and operate in a peer-to-peer architecture, to ensure high availability, and prevent that any Core Service should constitute any single point of failure – daily maritime operations shall be able to continue without immediate access to the Maritime Cloud Data Center(s), i.e. Plan B shall be possible.
- GMDSS approved communication services and universally available maritime communication shall be the primary means of delivering prioritized maritime safety communication, however (present and future) such as the AIS (or VDES) as well as commercially available communication services shall be utilized as a scalable option for general communication and seamless fallback solution for safety communication.
- Access restrictions to services outside the Maritime Cloud Data Center(s) will be handled by the information service provider. I.e. if a service provider delivers a commercial service, it's up to that service provider to determine which actors are authorized to access the service. The Maritime Identity Registry may however provide methods for authenticating a Maritime Identity and a Public Key Infrastructure for enabling secure data transfer.

Core Services

The core of the Maritime Cloud will be a cluster of servers, providing the three core services:

- A Maritime Identity Registry
- A Maritime Service Portfolio Registry
- A Maritime Messaging Service

The *Maritime Identity Registry* and the *Maritime Service Portfolio Registry* will enable the publication of a dynamic digital publication called *the Almanac*, which will function as a ‘white pages/yellow pages phonebook’ of registered maritime actors and information services, and their public contact details.

The Maritime Identity Registry

Identity of a ship is in ships registers often addressed in terms of a ships name and IMO number. On maritime communication systems, the identity of a ship may be a callsign, MMSI number or system specific terminal number, relevant to a specific technology. These identifiers are however just numbers – and there is no guarantee that a signal identified by a specific callsign or MMSI number corresponds correctly to a unique ship.

Furthermore, none of these identity systems or registers take well into account the need for dealing with actors who are not ships and don’t necessarily have their own radio station, such as ship owners or information service providers.

Building on the integration with existing national ships registers, the ITU MARS database, etc., the intention is to combine these into a Maritime Identity Registry that enables unique reference to a maritime actor, independent of role or specific technology, providing access to an option for digital certificates that enable authentication of an actor requesting access to privileged information.

Obtaining a Maritime Identity in the Maritime Identity Registry, should be integrated with existing registration procedures, enabling for instance ships, who already have an IMO number, callsign and MMSI number, to register with the Maritime Identity Registry and gain access to

- A certificate and public key infrastructure that enable secure data communication with other maritime stakeholders
- The Almanac
- The Maritime Messaging Service

All registered maritime actors should have access to maintain their own contact information (such as VHF working channel, e-mail address, Phone or FAX nr., etc.) other than attributes contained in the Authoritative Registers (such as IMO / MMSI number). This way the Identity registry will provide updated ‘white pages’ contact information readily available to SAR and VTS authorities, or to other maritime professionals if marked as ‘public’, as part of the downloadable and dynamically upgradable publication *‘The Almanac’*.

Adding options for advanced features such as a public-key infrastructure providing digital certificates and authentication capabilities for certain situations, well known from for instance the financial sector, will enable trusted information and facilitate encrypted data transfer between maritime actors, and even digital signing of documents. This may facilitate e-navigation solution S2 *‘Means for standardized and automated reporting’*. Ultimately this should enable automatic information exchange with existing shore systems such as SafeSeaNet or eNOAD, as well as trusted information exchange between shore based stakeholders.

The Maritime Service Portfolio Registry

The Maritime Service Portfolio Registry will provide a digital version of the ‘yellow pages’ directory of where instances of information services are available, in a machine readable format.

S-100 Service specifications are intended to be stored in the IHO GI Registry. For each *instance* of a standardized information service, the service specification is linked with the identity of the service provider, the service address, version and other metadata, such as variants depending on the capabilities of different communication channels available. All Maritime Actors registered in the Maritime Identity Registry shall be able to register the availability of their information services.

As examples, a Port may simply register the address of their webpage where local port information is available, or register an advanced, S-100 standardized service for planning of mooring or automatic registration of needs related bunkering or waste handling.

Service providers specialized in weather optimization of voyage plans may register their service based on S-100 standardized Voyage Plans.

A VTS center may register a service delivering automatic information related to weather, traffic and current restrictions without requiring voice communication troubled by language barriers.

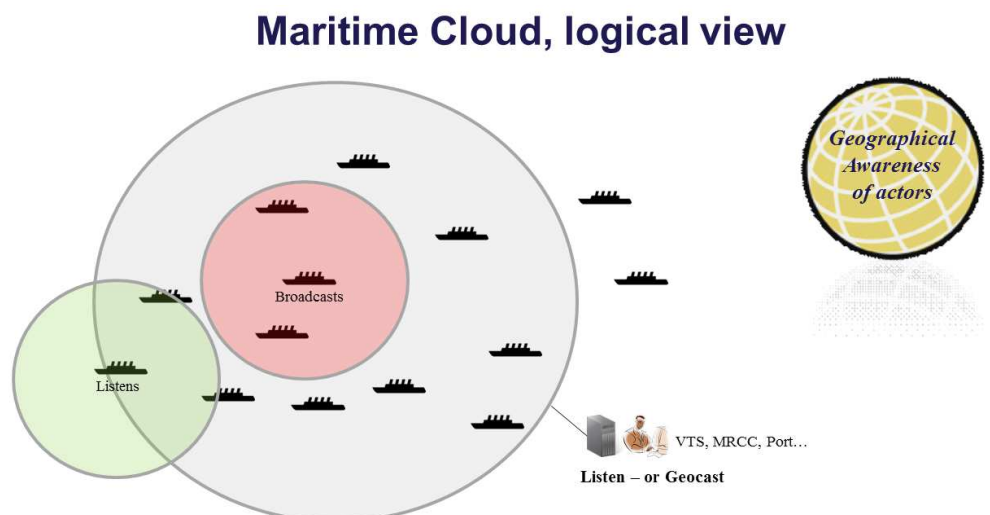
A ship could register the availability of a standardized service allowing actors registered as VTS centres to automatically access certain reportable information such as number of persons onboard, pilot on board, current draught / air draught, etc., or allowing SAR authorities to request information on availability of onboard SAR or medical capabilities.

The Maritime Messaging Service

The Maritime Messaging Service (MMS) within the Maritime Cloud are intended to ensure seamless information transfer *across different communication links*.

The MMS within the Maritime Cloud will be based on internet connectivity, yet any number of alternative communication services may be connected to and utilized by the Maritime Messaging Service via dedicated gateways. This way, a message sent by one specific ship using INMARSAT access to the MMS, may be received via a VSAT terminal on another ship, a HF data connection on yet another ship, or a VTS operator on a DSL landline internet connection.

Each communication service will impose technology and situation specific limitations in terms of restrictions to capabilities, bandwidth availability, size of transferrable data packages, latencies, etc. – but basic transfer of text or structured data (e.g. XML) will be possible.



Thus, when a maritime actor wishes to transfer information to another maritime actor not within range of a compatible communication link, or in need of multicasting information to a group of actors not within range of one single communication link, the MMS can ensure delivery across which ever communication link is currently active at each relevant actor. In case a ship temporarily has no active communication link, the MMS will function as a prioritized store-and-forward queue of messages where the validity period can be defined on messages.

Through mechanisms of protocol level acknowledgements, the delivery of information via the MMS can be quality assured.

The MMS mechanism requires each actor in the Maritime Cloud to maintain a persistent connection or regularly establish a connection to the MMS, maintaining knowledge of which data links are open towards each mobile actors. At each connect, or regularly, mobile actors provide a position update at protocol level to the MMS, enabling a geographical awareness of the position of each actor at the MMS. The geographical awareness may be strengthened through the supplement of (satellite) AIS, providing high resolution but requiring no additional communication. The geographic awareness enables 'Geocasting' – i.e. actors may logically 'broadcast to' or 'listen to' an area around their own position, regardless of which communication link is used for broadcasting or listening in to the broadcast.

Priority information such as MSI may be queued for quality assured delivery (requiring an automatic acknowledge of reception). Shore entities (or military or law enforcement units) may 'listen' to an area of interest without specifying their updated position.

Facilitation services

The Maritime Cloud is anticipated to provide a number of basic facilitation services, acting as enablers of providing more specialized e-navigation services in the future, or facilitating a transition towards achieving the benefits of e-navigation.

The ALMANAC

Identifying other maritime actors and the information services provided in an area will be facilitated by the digital publication '*The Almanac*'. This publication is an offline version of the public part of the Maritime Identity Registry and the Maritime Service Portfolio Registry, acting as a 'white pages/yellow pages phone book'. The Almanac can be updated, whenever a suitably low cost or flat rate data connection is available.

Using The Almanac, you can automatically lookup the MMSI number for a DSC call, VHF working channel or e-mail address, phone numbers or other contact information of a VTS center, Port, the nearest MRCC or another ship you may wish to contact. Or you may lookup which providers of any specific information service are available along a planned voyage.

For instance, the list of MRCC's are supposed to be listed in the IMO SAR plan, however experience documents that securing that this vital document is updated, is difficult. Enabling each MRCC to maintain their own contact information in the Maritime Identity Registry will facilitate more up-to-date information to be readily available.

Global Identification and Tracking

The way mobile actors reconnect regularly to the Maritime Messaging Service inside the Maritime Cloud, providing an updated indication of own position and data link availability, is quite similar to the function of the LRIT (Long Range Identification and Tracking).

In fact, if we assume that mobile actors are required to report its position automatically at least every 6 hours, using any available means of communication – and that we through the MMS can request a mobile actor to increase the update rate to every 15 minutes upon request, then registering with the Maritime Cloud and migrating the shipside solution to connect with the Maritime Cloud, could be considered an LRIT implementation, which can make use of a multitude of communication links.

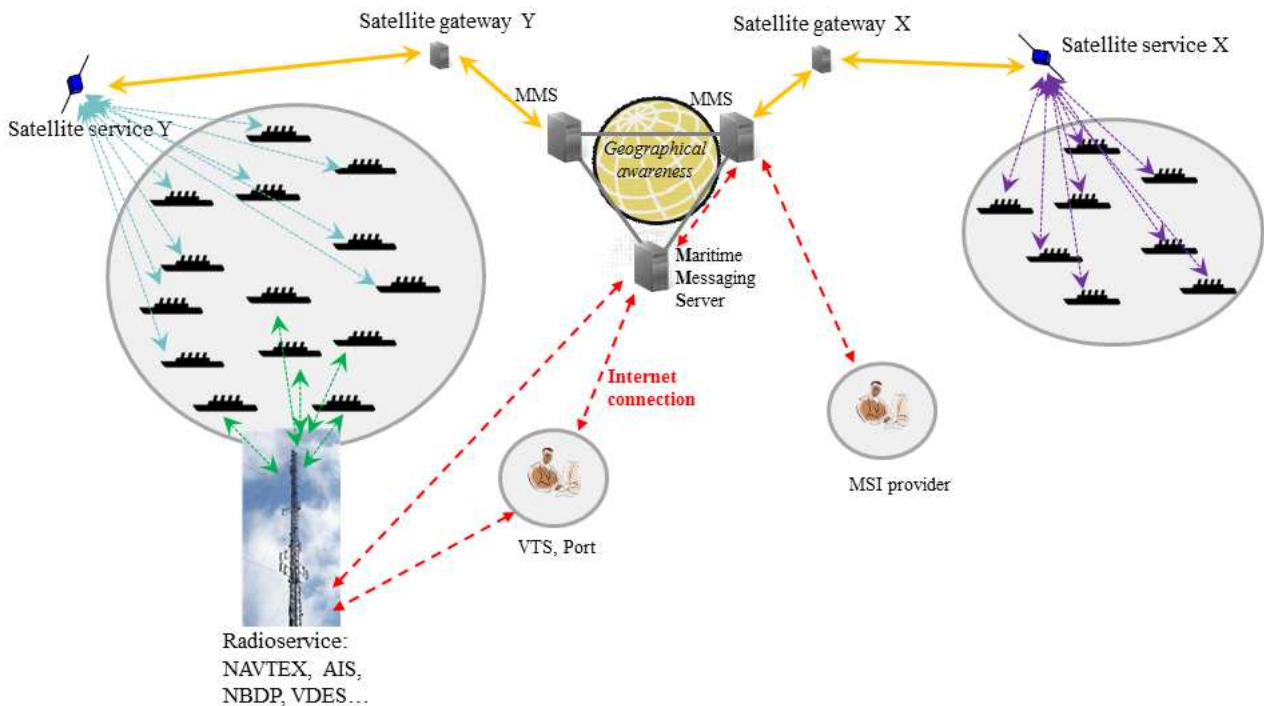
Furthermore foreseeing that the update rate of each mobile actors position may be increased by the simple addition of (satellite) AIS information without requiring additional communication over commercial data links, it is envisaged to include a 'Global Identification and Tracking' service as part of the Maritime Cloud. Registering with and utilizing the Maritime Cloud, could thus be considered an LRIT implementation. No new requirements would be needed to provide MRCC's with access to a more complete picture, including those ships that only provide AIS information. An Access Rule Policy would be based on the existing LRIT Data Distribution Plan, supplemented with the ability for each ship to decide which additional roles or specific maritime identities, that should be given access to it's position data, such as it's the ship owners office, agent, etc.

The Maritime Cloud can be connected to the International Data Exchange for LRIT, and participation in the Maritime Cloud could thus fulfill the LRIT requirement. This will facilitate a gradual transition towards an e-navigation LRIT solution with a greater benefit.

How the Maritime Cloud supports e-navigation

Physical communication links

Existing as well as new communication links may serve to provide information exchange using the Maritime Cloud.



Provision of mandatory information services, such as the MSI service under the GMDSS is currently provided using the NAVTEX and SafetyNet communication services. The TELEX based NAVTEX and SafetyNet technologies do however not allow the distribution of S-100 structured data which can be presented on geographically oriented display systems. Mandatory reporting line interaction with VTS, may utilize VHF voice communication and the AIS. Application Specific Messages via the AIS could support such functions, and these communication services are cost free for the ships.

Business related communication such as FAL reporting is currently conducted using commercially available systems such as internet satellite connections, allowing the distribution of e-mail. These communication links are non mandatory, and many options exist. Their bandwidth, availability and cost can be selected based on the business need of the ship owner.

The Maritime Cloud is capable of delivering a Geocast MSI Service, using Application Specific Messages via AIS, backed up by already available commercial datalinks. Such a system will be capable of achieving a quick introduction of a MSI service providing machine readable and geographically representable MSI, while providing automatic quality assurance of information delivery, where two way datalinks are available.

The existing AIS system has a limited capacity, which already in some areas do not allow the introduction of additional data services. In order to protect the original purpose and function of the AIS, efforts are underway in IALA and ITU to enable the introduction of VDES (VHF Data Exchange System). The VDES will be an option that allows the same Application Specific Messages that can be used on AIS, to be transferred

on different channels, thus protecting the capacity and original purpose of the existing AIS, while also allowing a VHF Data Exchange with 10-30 times higher data capacity than the AIS, for ship-ship and ship-shore two way communications. The VDES system is foreseen to possibly also contain a satellite two way communication link, and thus this service may have global applicability. This service will be suitable for delivering free of charge mandatory information services based on machine readable dataformats near VTS centers, ports, possibly in coastal regions if infrastructure is established - and potentially globally including the polar areas, provided that a business case for establishing a satellite service can be agreed.

A new technology called NAVDAT has already been approved at ITU, which is being tested in the coming years, to demonstrate the ability to introduce a modernized version broadcast system in the same frequency band as NAVTEX, reusing the same physical infrastructure, which may deliver higher bandwidth broadcast of an MSI Information Service using S-100 structured data.

The Maritime Cloud Geocasting service will allow gradually introducing future systems such as NAVDAT or VDES, for mandatory services which are intended to be cost free for the users, while utilizing commercially available internet services as a backup and thus providing additional resilience.

S1: Improved, harmonized and user-friendly bridge design

The Maritime Cloud is as such not related to the design of bridges, but through *'the Almanac'* methods for easily looking up contact details of near by ships, ports, pilot contact points, VTS, MRCC's etc., it will enable user-friendly communication and automated data transfers.

S2: Means for standardized and automated reporting - FAL reporting

Today information flows are at a point midway between signed and authorized paper documents still often painfully filled in by hand, and the computerized handling of information. Most documents produced by computers are still sent manually to the other involved party (and often re-entered manually into another computer). Excessive manual procedures are at risk of taking the attention of navigators, but the world of Internet, e-mail or electronic exchange of information where data is sent from computer to computer with minimal human intervention is rapidly developing.

The timely arrival of information is a vital component in international transport, and as described in IMO FAL.5/Circ.40, Electronic transfer of structured data through EDI, and in general electronic business, has none of the disadvantages of paper documents and brings substantial benefits and savings to companies, which implement it. Accuracy (data are received directly from computer files and are not re-entered manually), speed and savings (it saves on the cost of copying, filing, distributing and capturing data) are some of the advantages.

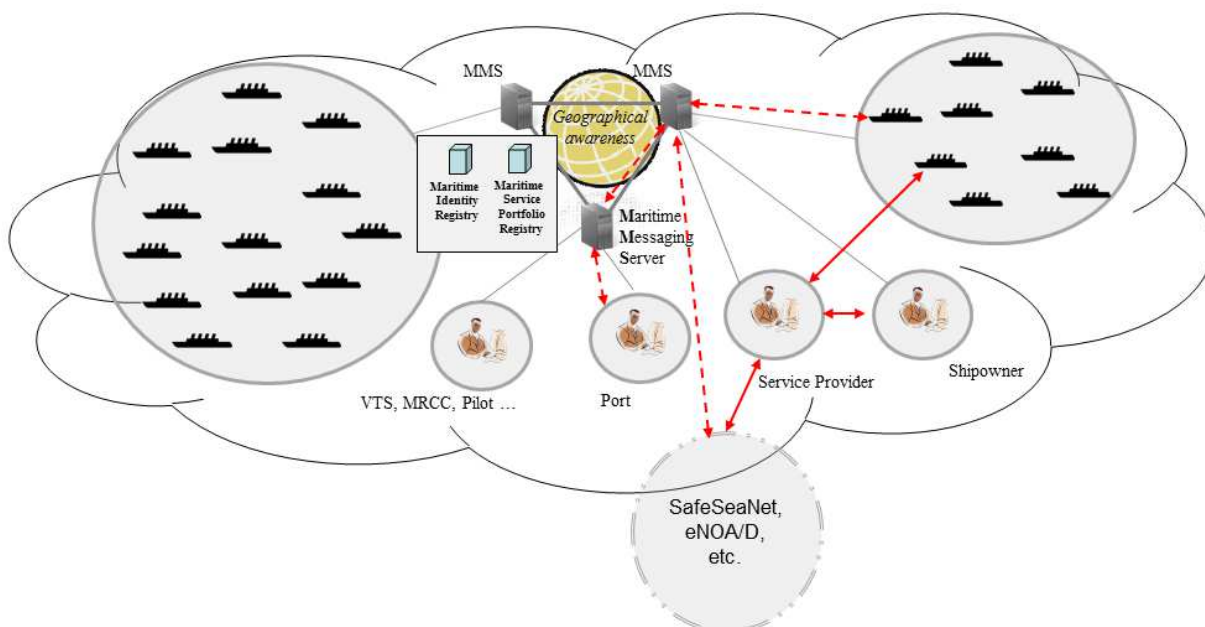
The e-navigation solution S2 is specifically targeted towards enabling automated electronic exchange of such information, based on the recommendations of the IMO FAL as well as local and regional harmonization of electronic reporting systems.

IMO FAL.5/Circ.40 describes in detail, how formats for facilitation of electronic business are available, and provides recommendations on standards and recommended practices for their implementation.

The Maritime Cloud aims to provide mechanisms that will enable the automated and secure seamless integration of business systems. Via the Maritime Identity Registry, methods will be provided that support authentication, integrity and confidentiality of reportable information in the communication process. The Maritime Service Portfolio Registry will facilitate the determination of whether a particular port or national system for FAL reporting supports automated transfer of FAL standardized EDI dataformats, other formats, or whether information must be entered in an existing single window system, sent via e-mail in a specific local data format, or ultimately printed, signed and delivered via alternate means.

In the case of FAL reporting, the most likely physical communication links between ship and shore will be commercially available internet connections. The choice of communication link will be a business decision based on the business needs of the ship.

Existing single window systems for reporting do not have to be abandoned. Instead, an evolving process of automating integration gateways as alternatives to the manually entering of data in a web forms will be facilitated.



Where and how the reportable information is stored and maintained will be a business decision of the individual operators. A captain may maintain all reportable information onboard his ship and push it to the relevant authority or national single window system at the required time – or the shipping company may choose to trust a service provider / agent with the task of maintaining and storing most of the information, only requiring limited synchronization of information from the ship at regular intervals, in order to facilitate the relevant reporting on time.

S3: Improved reliability, resilience and integrity of bridge equipment and navigation information

The Maritime Messaging Service will allow introducing future information services, based on the utilization of several different communication links backing up each other seamlessly. This will provide reliability and resilience in communication.

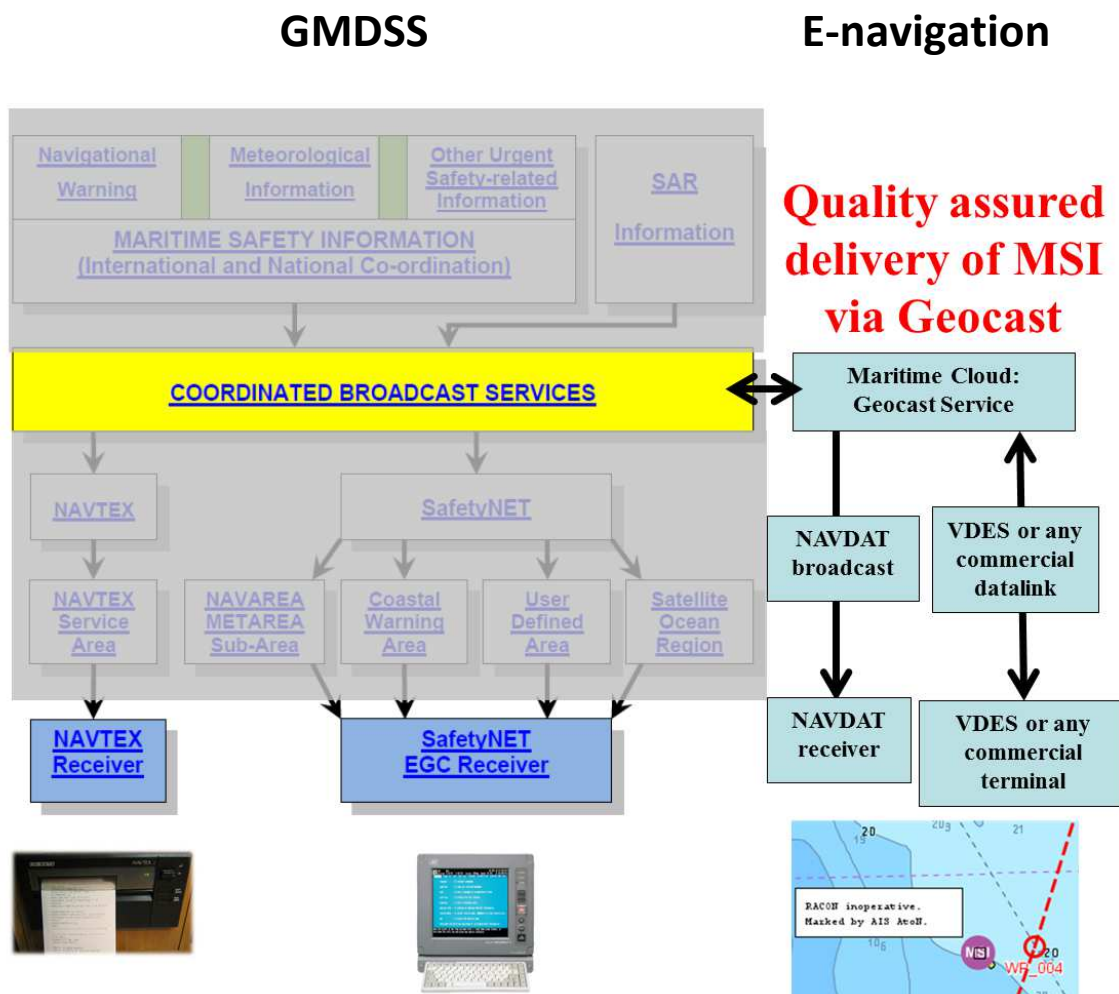
Based on the request for acknowledgements when providing messaging via the Maritime Messaging Service, a basis is provided for automated quality assurance of information delivery. Through the regularly updating the position of mobile, Quality Assurance measures may provide quality reports related to the coverage areas or availability of specific communication services, or the quantitative quality performance of individual radio installations.

S4: Integration and presentation of available information in graphical displays received via communication equipment

One example of an information service, which may be improved through definition of S-100 datastructures (or application specific messages), integration of communication equipment and graphical displays is the promulgation of MSI. Such development of Datastructures could soon be extended to include Temporary and Preliminary Notices to Mariners, able to be provided through the same communication infrastructure.

A MSI or Weather Information Service based on Geocasting, enabling transition of communication technologies (MSP 5, MSP 15)

The ‘Geocast’ capability of the Maritime Cloud will be particularly useful for providing a quality assured, standardized MSI or Weather service, based on S-100 standardized information services. This service can extend the existing coordinated broadcast service, providing quality assured deliver of MSI to all ships inside a given area, or make available to a ship MSI or Weather data relevant to an intended voyage.



A Geocast MSI service complementary to the current technology specific coordinated broadcast of MSI provided through the GMDSS or various local provisions can be readily implemented.

Such a Geocast MSI service will enable a complementary service based on existing commercially available datalinks as well as Application Specific Messages that can carry S-100 standardized data messages displayable on e-navigation enabled display systems such as an upgraded ECDIS. This will facilitate a transition from the existing NAVTEX and SafetyNet systems under the current GMDSS, towards any commercially available datalinks or any new communication systems such as NAVDAT or VDES, that may become available as part of the e-navigation implementation or ultimately the GMDSS modernization.

NAVDAT is already defined by the ITU as a possible alternative to NAVTEX, utilizing the same basic broadcast infrastructure. VDES (VHF Data Exchange System) is currently being discussed by IALA and ITU potentially with a satellite component including two-way communication. Demonstrations of both technologies in the next few years will document whether they are relevant options for universally available technologies for maritime broad-, multicast and point-to-point minimum capabilities that enable participation by all mobile actors in the maritime domain.

Denmark and France are already in the process of implementing solutions for registering Navigational Warnings and T- & P- Notices to Mariners in a 'single window' coordinated broadcast system. Once information is registered in the national 'single Window' MSI system, coordinated broadcast of MSI is automated through a multitude of broadcast systems (NAVTEX, SafetyNet, NBDP, voice VHF – or local warnings on teletext or webpages, etc.) as relevant. Promulgation via the Maritime Cloud geocasting is currently being tested using the Maritime Messaging Service, in the e-navigation testbed and demonstration project ACCSEAS.

Global services such as the WWNWS as well as local services can be accommodated by such a geocast service. By retaining one or more broadcast components in this regime, participation in the basic MSI service by the GMDSS compliant as well as the non-SOLAS segment remains simple, while the participants in the Maritime Cloud will become part of a regime of quality assured MSI delivery, based on structured data that can be presented on graphical navigation displays.

S9: Improved Communication of VTS Service Portfolio

The Maritime Service Portfolio covers a number of VTS related – and other – services. Focusing the VTS related services, these services are supported by the Maritime Cloud in the following manner:

VTS Information Service (MSP 1)

Existing VTS information services available in a particular VTS area, such as weather or oceanographic data, traffic, special restrictions, etc., may be made automatically available. Advanced standardized services based on the development of S-100 datastructures may be implemented and their availability announced via the Maritime Service Portfolio Registry of the Maritime Cloud, enabling automatic recognition of the accesspoint for such services.

The chosen communication system may however impose restrictions to the level of detail that can be contained in the VTS information service. Different versions (with different levels of detail) of the same information service, may thus be implemented.

Information services may initially be delivered via AIS using Application Specific Messages. These may initially be designed to simply provide a link to a web address for an existing VTS information web portal with more detailed information, accessible through other means of communication such as commercially available internet connectivity. Advanced S-100 based information services can at a later stage be detected automatically using the Almanac, and automatic interaction with such services implemented in relevant display systems.

Navigational Assistance Service and Traffic Organisation Service (MSP 2 & MSP 3)

Navigational Assistance Service and Traffic Organisation Services will require a higher degree of interaction between ship and shore, in some cases a higher degree of quality assurance of information delivery and in some cases assurance of authenticity of the communicating parties. The Identify mechanisms of the Maritime Cloud will support authenticated and potentially secure communication.

Vessel Shore Reporting (MSP 8)

It is expected that most of the mandatory reporting information related to VTS reporting lines can be derived from information already available in onboard systems. Creating a local ship borne collection of such information and automation of the mandatory reporting process will reduce the need for extensive use of voice communication for manual and repeated reporting the same information. The geographical location of reporting lines and the information required at the passage of this line, is envisaged to be described as part of the information contained in the Almanac, based on S-100 data structures.

In the short term, mandatory reporting information might be encapsulated into ASM (Application Specific Messages), which can be transported via preferably cost-free digital communication systems such as the AIS – or other available communication systems, if confidentiality is not an issue.

Future services

Future information services may evolve regionally and ultimately become part of the globally harmonized Maritime Service Portfolio. The basic infrastructure will facilitate the future evolution of services.

Shipside requirements

The Maritime Cloud assumes a shipside compatible component that will address the e-navigation solution S4: *Integration and presentation of available information in graphical displays received via communication equipment.*

This component will provide an abstraction layer to communication, encapsulating the complexities of communication roaming and the services provided by the Maritime Cloud. The component (or components) are envisaged to be part of the INS, and will need to function as a local information hub, connected with relevant sensors, navigation displays and communication equipment. It is assumed that this component will address the following tasks:

- Interface different communication systems
- Provide a resilient connection to external information services for relevant user interfaces and display systems related to navigation
- Perform 'least cost route' selection of communication links, based on a user defined rulebase

- Assume responsibility for regular reconnect or position update to the Maritime Cloud MMS (implementing the LRIT functionality as a side effect)
- Hold a store-and-forward prioritized queue of outbound messages from ship to other actors, in case of temporary outage in communication
- Perform system acknowledge of received maritime messages that requests system acknowledge and hold them in a store and forward inbound queue until delivered to relevant user systems
- Hold and regularly update the local copy of 'The Almanac', and make it available to relevant user systems
- Handle public-key infrastructure and certificates of the ship
- Hold a list of updated information relevant for automated reporting

These functions refer to the Tasks '1T2', '1T5', '1T9' and '1T10' in the current draft SIP report.

Introducing the utilization of internet based communication options to support the transport of structured navigational data, will also require the introduction of a security component (firewall), protecting the navigation network from the potential dangers of the internet, and isolating the navigation network from other onboard systems such as business oriented or administrative workstations and crew entertainment. Transporting navigation related information such as position updates or voyage plans between the navigation network and administrative systems used for voyage planning and FAL reporting should be possible, without using unsecure, manual processes such as file transfer via USB stick.

Benefits of the Maritime Cloud

The benefits of the Maritime Cloud include:

- Ability to reuse existing communication systems, while communicating seamlessly across different systems, also facilitating transition to future technologies and systems
- Availability of a prioritized messaging queue for addressing mobile actors
- Automatic Quality Assurance of communication links and information delivery through request for automatic acknowledgements, when using the Maritime Messaging Service
- Verification of Authenticity of origin and content of information as additional service (not generally required)
- Enable the development of a unified communication terminal able to automatically switch between a multitude of different channels to identify and address a specific actor
- Facilitation of the future definition of new and improved information services, based on an open architecture allowing alternatives for distribution of information storage or service points
- A framework enabling secure shoreside data exchange between MRCC, VTS, etc.

Stakeholders

Stakeholders to the Maritime Cloud are Ships, Ships Owners, Charterers, Agents, Ports, VTS, MSI providers, HO's, MRCC, Flag States, Coast States, Port States, AtoN providers and other relevant Maritime Authorities, and potentially many others, that require authorized interaction with maritime stakeholders.

Relation to GMDSS

GMDSS describes the fundamental minimum requirements that ensure global interoperability of equipment and procedures related to ensuring that distress and safety communication is possible between all relevant parties. The GMDSS is currently under review, in a process that is designated to finalize by 2017.

The nine functional requirements of the GMDSS described under regulation IV/4 of SOLAS currently requires that every ship¹, while at sea, shall be capable:

- .1 except as provided in regulations 8.1.1 and 10.1.4.3, of transmitting ship-to-shore distress alerts by at least two separate and independent means, each using a different radiocommunication service;
- .2 of receiving shore-to-ship distress alerts;
- .3 of transmitting and receiving ship-to-ship distress alerts;
- .4 of transmitting and receiving search and rescue co-ordinating communications;
- .5 of transmitting and receiving on-scene communications;
- .6 of transmitting and, as required by regulation V/19.2.3.2, receiving signals for locating;
- .7 of transmitting and receiving maritime safety information;
- .8 of transmitting and receiving general radio communications to and from shore-based radio systems or networks subject to regulation 15.8; and
- .9 of transmitting and receiving bridge-to-bridge communications.

The GMDSS provides through the SOLAS chapter IV the minimum requirements in support of distress and safety and ensure a clear picture of the correct and authorized channels for distress communication including the protection of distress frequencies via the Radio Regulations. Point 31.1 of the Radio Regulations 2012 details: “The frequencies to be used for the transmission of distress and safety information under the GMDSS are contained in Appendix 15. In addition to the frequencies listed in Appendix 15, *ship stations and coast stations should use other appropriate frequencies for the transmission of safety messages and general radio-communications to and from shore-based radio systems or networks*”.

Functional requirement number 8 related to other communication than distress, urgency and safety should thus be handled using ‘other appropriate frequencies and systems’, and would as such be well supported by the Maritime Cloud. Other functions of the GMDSS should be handled primarily through GMDSS specified systems and procedures, but could be complemented by supporting functions of the Maritime Cloud for provision of resilience.

E-navigation may thus provide general communication, plus enhancing and complementary options in support of safety messaging, ensuring seamless transfer, presentation and usability of operational digital information, in support of safety of navigation in general. E-navigation primarily addresses an efficient

¹ Under the general applicability requirements of the SOLAS Convention as well as Regulation IV/1.1, “every ship” means cargo ships over 300 gross tonnage and passenger ships, on international voyages.

implementation of data services related to the general communication between ship and shore (relating to the GMDSS functional requirement no. 8.), and efficient bridge-to-bridge digital information exchange and presentation (related to functional requirement no. 9).

The intention of the Maritime Cloud as an infrastructure for e-navigation, is to enable the utilization of a two-legged communication strategy:

- a) Utilizing GMDSS specified datalinks where appropriate, respecting the need for operational priority of distress, urgency and safety communication over routine communication, while ensuring the familiarization with the use of GMDSS datalinks through everyday operations
- b) Utilizing other communication links on a least cost basis (including no-cost solutions such as AIS (or VDES) where appropriate, also respecting the need for protecting the original purpose of AIS), including any commercially available and scalable solution that may complement the GMDSS data links

The Maritime Messaging Service will provide interoperability across different communication options, and enable a higher level of resilience in providing information services.

The need for modernized communication services for MSI

Current communication services for MSI (NAVTEX and SafetyNet) are based on outdated Telex technologies. The user needs derived by the e-navigation process point towards a need for replacement of the TELEX technologies, to enable machine readable data formats based on the S-100 standard, that will be displayable on ECDIS or other graphically oriented display systems, however these data formats cannot be supported by NAVTEX and SafetyNet.

Alternative broadcast technologies that such as NAVDAT or VDES as well as many commercially available communication services could support the gradual introduction of S-100 or other digitally formatted data structures, in support of ships subject to the SOLAS convention as well as the non-SOLAS segment.

The introduction of the Maritime Cloud may thus facilitate the transition between these technologies, introducing new dataformats and broadcast technologies as options for voluntary enhancement. In this respect liaison between the two correspondence groups (e-navigation & GMDSS modernization) is highly necessary in order to avoid delay in both processes and misunderstanding of the base of maritime radio communication as defined in the GMDSS.

Using the Geocasting service associated with Maritime Cloud, an MSI service complementing the GMDSS broadcast regime may be established as part of e-navigation solution '*S4: Integration and presentation of available information in graphical displays received via communication equipment*', which could have a strong relationship with the GMDSS functional requirement no. 7. This service could also provide MSI related to a ships intended voyage at planning time, before it enters the coverage of regional GMDSS MSI broadcasting networks.

In principle, the GMDSS functional requirement no. 4 regarding *SAR coordinating communication* could be efficiently supplemented by the Maritime Messaging Service, enabling the utilization of GMDSS related or commercial data links in support of on-scene sharing of information. A MRCC could set up a 'SAR incident room' with a common situational picture of units in the area participating in the SAR incident and their SAR capabilities, enabling the distribution of coordinated search areas etc. through S-100 standardized data

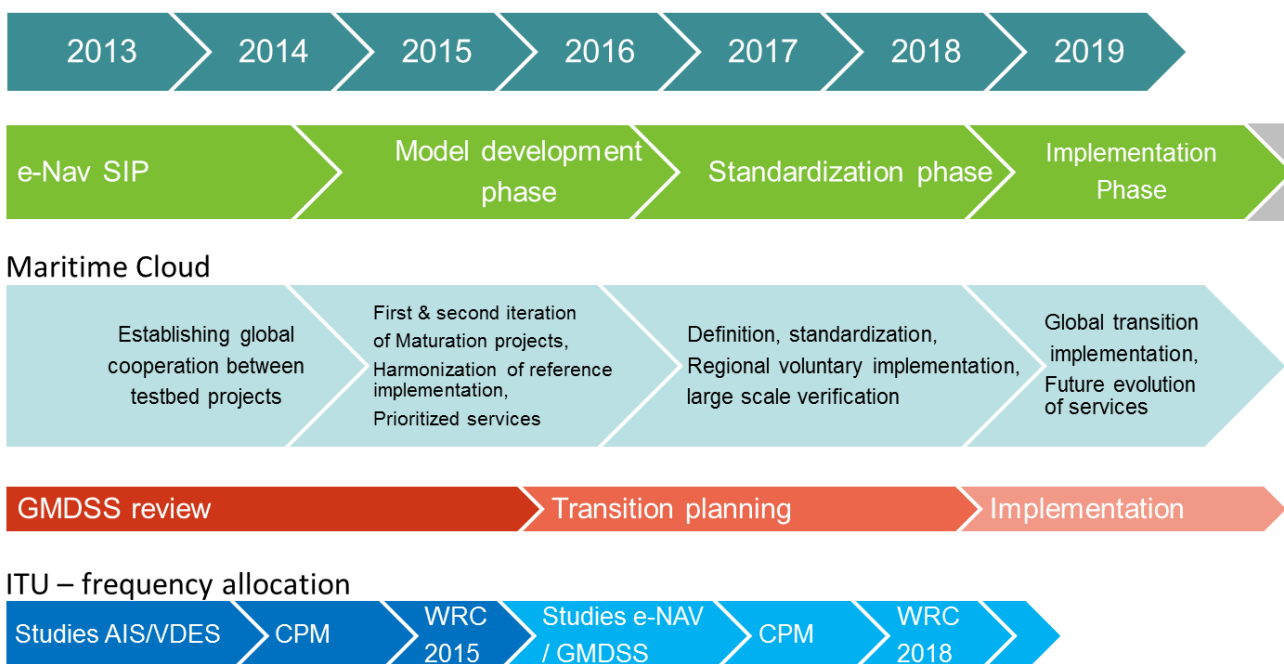
formats and sharing a common logbook ‘chat room’ established on demand by the coordinating MRCC. This could in the future be developed as a global SAR solution based of the minimum capabilities required by GMDSS supplemented by the Maritime Cloud Maritime Messaging Service.

A roadmap for realization

Developing the Maritime Cloud is highly associated with the Task ‘1T9’ focusing on available communication infrastructures, as well as Task ‘1T2’ focusing on INS as the shipside integration of different communication ports, Task ‘1T5’ focusing on firewalling and Task ‘1T10’ on automating the collection of internal ship data, in the current draft of the SIP report.

The Maritime Cloud is proposed to be matured through currently ongoing regional testbed projects, followed by a series of global testbeds, maturation and reference implementation projects in 2015-2016. Establishing cooperation between regional projects forming a global e-navigation testbed, using the Maritime Cloud as a common infrastructure, could facilitate Task ‘1T12’ and provide a path for maturing the reference implementation of the core functions.

By 2017 the definition of the Maritime Cloud concept should be mature enough for regional voluntary implementation, and large scale evaluation of the infrastructure, while the definition phase finalizes the standards, legislative and organizational framework needed for global implementation and transition by 2019. Any needed amendments to the Radio Regulations needed to support e-navigation or the review of GMDSS will be possible by the currently scheduled Agenda items for WRC 2015 and WRC 2018.



For the sake of simplicity, timeliness and cost efficiency, it is proposed to introduce the first iteration of the Maritime Cloud for e-navigation with a reference to the functional requirement 8 (General communication) of the GMDSS, based on voluntary uptake. The safety related information services provided via GMDSS approved broadcast systems will remain and complementary services provided on a voluntary basis via the Maritime Cloud will be separate systems. A progressive convergence process may be considered, after the

relevant capabilities of the Maritime Messaging Service in the Maritime Cloud has been demonstrated, standardized and verified.

Further considerations

Denmark intends to provide an input paper to NCSR1, providing further considerations on:

- Governance of the Maritime Cloud
 - Building trust
 - Experience from LRIT
 - Experience from other existing global information sharing systems
- Drafting a Maritime Cloud regime
 - Reusing experience from LRIT
 - Datacenters, Logical versus Physical datacenters
 - International Open Architecture / Open Source Software Consortium to support the reference implementation development and maintenance of the core functions
 - Auditing
- Options for Implementation, advantages / disadvantages
 - A: One international data center
 - B: One International organization – three Physical data centers
 - C: National Datacenters, International Data Exchange
- Cost estimation, considerations on cost distribution
 - Data Centers
 - Communication
 - Opportunities