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Author(s) / Submitter(s)	The Maritime Cloud Development Forum: RISE Viktoria (Sweden) KRISO (Republic of Korea) ETRI (Republic of Korea) Frequentis (Austria) OFFIS (Germany) Danish Maritime Authority(Denmark) Korean Register (Republic of Korea)

Maritime Cloud conceptual model

1 SUMMARY

The Maritime Cloud is a framework to bring service oriented architectures into the maritime domain. It anticipates the advent of IP based communication availability in the future. Therefore, the main elements of a service oriented architecture are provided: An Identity Management to ensure identification and authorisation and a Service Registry to find services and information to address and to use them. A Messaging Service provides extra services for multi- and broadcasting of messages and offers support to existing and future non IP based communication channels.

These elements are currently in development and tested within the projects EfficienSea2, STM and SMART navigation. Following the service oriented architecture of the Maritime Cloud, the alignment and integration of those elements between the different projects are established using common web service technologies. Usable demonstrations of the Maritime Service Registry(MSR) and Maritime Identity Registry(MIR) as well as the Maritime Cloud portal can be accessed by interested stakeholders on https//management.maritimecloud.net.

Summarized, the Maritime Cloud concept tries to provide a minimalistic infrastructure with appropriate business models to reduce the threshold to use the concept and to provide technical services. The authors perspective sees the Maritime Cloud as an organic system that can grow in the maritime transport sector and provides advantages for every user, ship- or shore wise.

1 Input document number, to be assigned by the Committee Secretary

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

2 BACKGROUND

2.1 Introduction

Until now, vessels and shore-based facilities are equipped with a variety of heterogeneous technical maritime systems to improve a safe voyage from berth-to-berth. Having regard to the global evolution of (communication) technologies and to optimize the maritime transportation process, the International Maritime Organization (IMO) introduces in 2007 the e-Navigation strategy as a holistic approach to harmonize the (civil) maritime infrastructure. This leads to a high need of interoperability among existing and upcoming maritime systems (International Maritime Organization, 2009).

The Maritime Cloud concept faces this demand and is established to provide “a communication framework enabling efficient, secure, reliable and seamless electronic information exchange between all authorized maritime stakeholders across available communication systems” (Maritime Cloud Development Forum, 2016).

This concept takes into account the need of a global communication infrastructure for the maritime sector, as defined within the IMO e-Navigation strategy and beyond, matching the goals of South Korean and EU e-Navigation and e-maritime initiatives.

The mission of the Maritime Cloud is to enable an open vendor-neutral platform for the maritime sector that facilitates information exchange boundary-free and secured across various communication channels such as internet, satellite, cellular phone network and digital radio links. Considering the divergent structures of the maritime sector in international, regional and national matter, this concept shall enable the use of heterogeneous software systems onboard various ship types as well as on offshore structures and ashore. This includes dedicated type approved systems, smartphones, tablets and personal computers to interact according to standardized interfaces, protocols and access control rights (EfficienSea2, D3.2).

This paper gives an update of the recent development and status of the Maritime Cloud. It presents the main conceptual ideas and its core elements for the implementation and usage of the Maritime Cloud, evolved in the context of the projects EfficienSea2, Sea Traffic Management (STM) as well as in CPSE-labs experiments and in the South Korean SMART-Navigation project.

In the following sections, we firstly discuss the concept and the conceptual ideas of the Maritime Cloud. Secondly, we introduce the key elements Maritime Service Registry (MSR), Maritime Identity Registry (MIR) and Maritime Messaging Services (MMS) including its relationships to each other and their allocation within the Maritime Cloud concept.

2.2 The Concept of the Maritime Cloud

The objective of the Maritime Cloud is to provide a secure platform to enable maritime stakeholders to securely access technical services to gain further information for decision-making onboard and ashore during a voyage from berth-to-berth. The Maritime Cloud shall not be considered as a product but as a common communication framework for maritime users to register, discover, and use technical services such as route optimization or weather forecast. Clients and Services communicate by standardized web service technologies supported by standard services to set up and facilitate the communication.

2.2.1 Objectives

The concept of the Maritime Cloud is to provide standardized protocol and functional support for identity management, authentication, encryption, authenticity validation, service discovery and bandwidth/coverage efficient messaging in a geographic context. This enables easy development of innovative solutions targeted at maritime end users in a context of global interoperability by defining service oriented communication system.

Based on a joint coordination among the projects EfficienSea2, STM and SMART-Navigation, the objectives of the Maritime Cloud concept are (EfficienSea2, D3.2):

- Enhance the safety and efficiency of the maritime sector, through information technology innovations that bridge gaps between information islands;

- Follow established and robust international standards wherever feasible;
- Facilitate the development of, and transition towards, globally standardized information services for the maritime sector;
- Provide tools and guidelines facilitating the development of software that may safeguard the confidentiality and verify the authenticity of data exchanged between individuals and organizations;
- Minimize operating costs by efficient usage of available bandwidth in the maritime sector;
- Lower development costs and improve software quality, usability and time to market for commercial and non-commercial software products;
- Ultimately be recognized, governed and supported by a sustainable community, including important international, regional and commercial organizations of the maritime domain (such as IMO, IALA, IHO, IEC, CIRM, BIMCO and EU);

The figure below shows how the Maritime Cloud is allocated within the relation between maritime stakeholders and (technical) services (see figure 1).

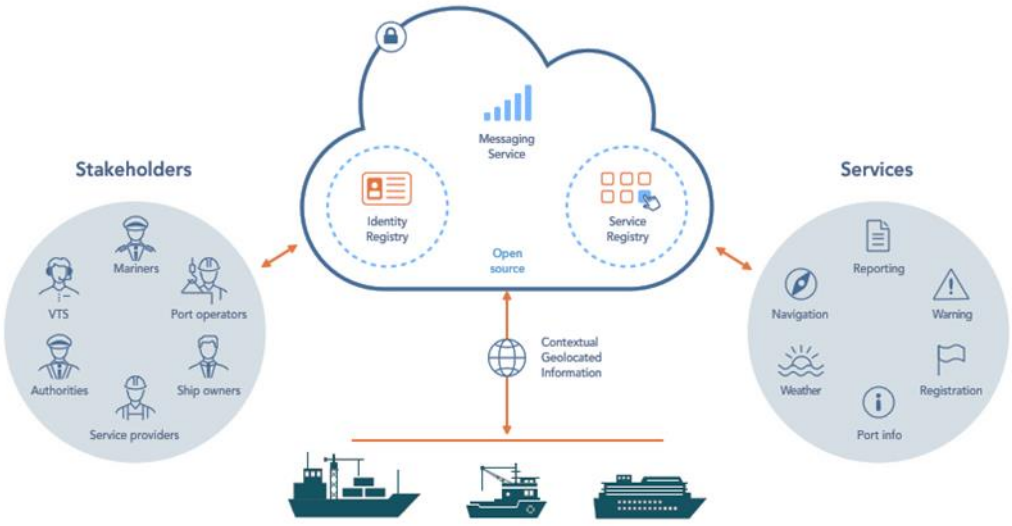

Figure 1 ***The concept of the Maritime Cloud***

The foundation for the technical concept of the Maritime Cloud is based upon three main contributions as depicted in the figure above (EfficienSea2, D3.2) to enable and support service oriented communication:

1 The Maritime Identity Registry deals with managing users, vessels and organizations as well as provide information to be used for controlling their access to resources within the Maritime Cloud.

2 The Maritime Service Registry enables service providers to register their services in the Maritime Cloud and allows the end-user to discover those services.

3 The Maritime Messaging Service enables transparent and seamless transfer of information across different communication links in a carrier agnostic and geolocation context sensitive manner.

The three key elements together form the basis of the frameworks infrastructure. Whereas a generic overview about the technical concept of the Maritime Cloud is given in the sub-section below, the three key elements are described in the sections 2.3-2.5 in more detail.

2.2.2 The technical concept

In order to enable the maritime stakeholder to access the Maritime Cloud with its three key elements, this communication framework needs to be integrated into the existing maritime infrastructure. The challenge is to establish a seamless information exchange across the various existing heterogeneous communication channels to access the Maritime Cloud. System components interact by using the maritime cloud by client server interactions as defined by web services. Therefore, it offers service oriented communication and the setup of service oriented system architectures.

Taking this into account, a cloud component represents a technical client or service which shall be integrated into or connect to existing maritime systems (e.g. an ECDIS or VTS) as the entry point to access any kind of technical service, registered in the Maritime Cloud.

The communication between cloud component with the key elements Maritime Service Registry and Maritime Identity Registry as well as with other services, accessible in the Maritime Cloud is granted either via the roaming device, specified within EfficienSea2 (EfficienSea2, D2.8), or the Maritime Messaging Service (MMS). The roaming among different communication links can be achieved in three ways.

Firstly, the client/service itself identifies the availability of communication links and switches them. This requires the client/service to know all about the communication channel status and to take responsibility of the roaming among communication links.

Secondly, it is established by delegating the roaming from client/service to the roaming device. In this case, the client/server itself does not know about the detailed conditions of the communication links. The roaming device checks the availability of communication links and makes the roaming decision using a suitable IP or non-IP connection.

Thirdly, it is established by providing a roaming through the MMS. The client/server does not need to know about available communication links and their status. This method does not require additional devices nor aware of how the message is delivered. The MMS regulates the access request and connects to available communication channels and either benefits from the roaming devices or direct Non-/IP communication devices. In addition to that, the MMS queues incoming and outgoing messages if no stable connection could be established with any of available communication links.

The figure below (see figure 2), introduces the interactions among elements of the Maritime Cloud and services discussed before. The Maritime Cloud Demonstrator Component (MCDC), specified within the EfficienSea2 project, is a reference implementation for a client or service component (see ref [4] technical specification of the Maritime Cloud).

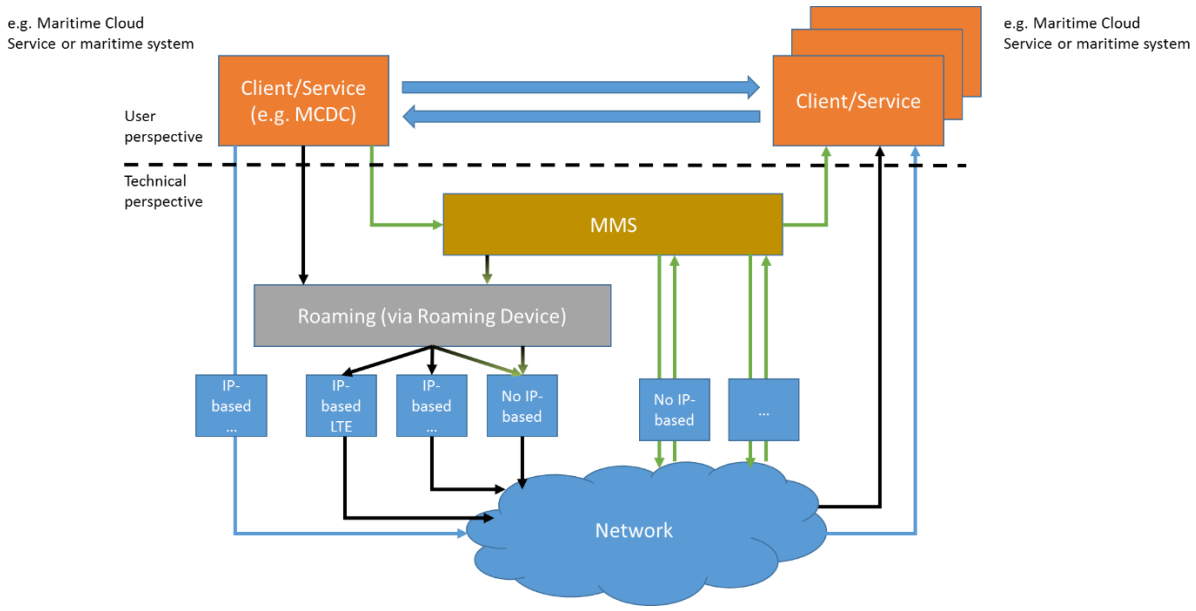

Figure 2 The conceptual interaction between user and service using MMS of the Maritime Cloud

As seen in the figure above, the technical infrastructure of the Maritime Cloud is not visible for the end-user. It does not matter which kind of information exchange is chosen by the different elements.

Furthermore, as an extension of the described Maritime Cloud infrastructure, the Maritime Cloud Portal is a demonstration of a web-based administration platform for service- and identity management. It uses the interfaces to the Maritime Identity Registry and Maritime Service Registry described in the Technical Specification of the Maritime Cloud (EfficienSea2, D3.7). The portal meets the demand to enable shore-based user in the first place in order to manage users, vessels and organizations as well as specify and register services in the Maritime Cloud (CPSE-labs 2016).

While the Maritime Cloud follows a service-oriented approach and furthermore supports common web-service technologies (SOAP, REST) to ensure an easy usage, stakeholders are enabled to build their own solutions to access the MSR and MIR. Following this, partners in STM are currently developing the so called SeaSWIM Connector which answers the demand within the project and also includes necessary functionalities to integrate the Maritime Cloud (STM Validation).

2.3 Technical services and the Maritime Service Registry

(Technical) services and the related service-based economy are a central part of the vision of the Maritime Cloud. In the context of service-oriented architecture, a service usually refers to a set of related software functionalities that can be reused for different purposes together with policies that govern and control its usage. The Maritime Cloud comprises a much broader scope that also includes services, which do not solely rely on machine-to-machine communication such as services delivered over telephone calls (voice or fax), email, websites, NAVTEX and other “primitive” solutions.

The MSR is a central part of that vision. It does not provide actual maritime information but a specification of various services, the information they carry, and the technical means to obtain it. An MSR instance contains service specifications according to an envisioned Service Specification Standard and provisioned service instances implemented according to these service specifications.

A registered service always includes the following specifications:

1 A service specification, which describes one dedicated service (e.g. a weather service) at logical level.

2 A technical design, which follows the technology-agnostic service specification of a dedicated service and provides information about the actual realization of the service

3 A service instance description, which follows the specifications of (1) and (2) and contains the description of one specific implementation (or instance) of a service. Besides this, the service instance description contains the endpoint of the service instance.

The MSR aims at improving the visibility and accessibility of available maritime services and information provided by them. This enables service providers, consumers, and regulatory authorities to share a common understanding of service standards and provisioned services. The MSR also provides the mechanisms to manage the life cycle of service specifications and service instances. The usage concepts are sketched in the figure below (see figure 3).

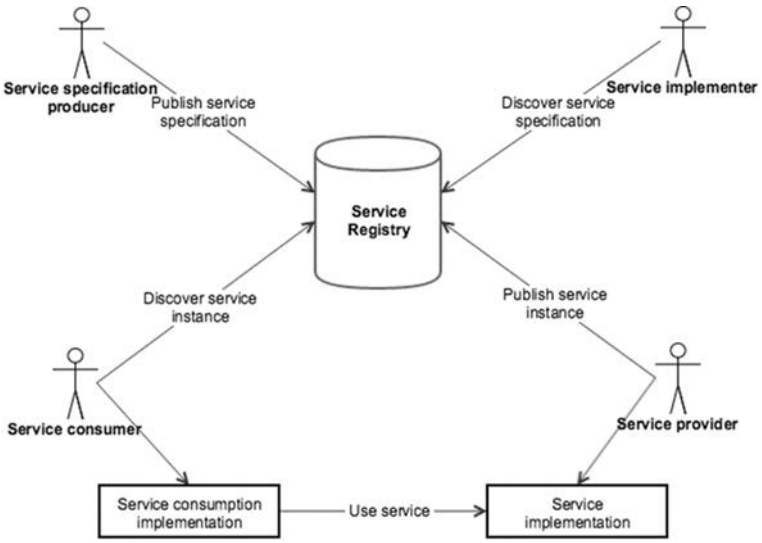

Figure 3 The service management concept of the Maritime Cloud

The functionality of the MSR, as it is defined so far, can be separated into the two areas: service discovery and service management.

The first objective of the MSR is to enable the discovery of a specific service. A service shall be discovered either via a human actor using the Maritime Cloud Portal or via an artificial device such as an ECDIS. Both variants are called service consumer. Services and service instances shall be searched via different criteria such as keywords, (publishing) organizations or combinations, locations and more.

The second objective of the MSR is the service management. As seen in the figure above (see figure 3), the management of a service encapsulates the functions to publish a service specification and register / publish a service instance. While publishing a service specification is handled by the service specification producer, following the envisioned service specification standard, the service implementer uses a service specification discovered in the MSR to implement a service instance. The service provider is consequently responsible for hosting a service instance and publishes the related service instance specification to the MSR.

2.4 Identity Management and the Maritime Identity Registry

The lack of a global digital identity of users/vessels/systems is a serious bottleneck in starting a digital maritime revolution across different companies and individuals. Just as human-to-human communication on a global scale would be impossible without global unique telephone numbers/email addresses, so is trying to integrate a maritime system on a global scale without some concept of a digital maritime identity for the various participating actors.

Identity management refers to the process of employing technologies to manage information about the identity of users and provides means to control access to company resources. The objective of identity management is to improve productivity and security while lowering costs associated with managing users and their identities, attributes, and credentials.

The goal of the MIR is to create a solution that satisfies the most common identification needs for the entire maritime industry on a global scale (EfficienSea2, D3.7).

This is not a simple task as any solution must support every possible user scenario from small leisure sailors to multinational companies. The complexity of this task is the reason why the functionality will be delivered over multiple milestones in the coming years with the most important things such as support for authentication being implemented first. Additional functionality will be added based on user needs in the projects supported by the Maritime Cloud.

Authentication is any process by which a system verifies the identity of a user (human or machine) who wishes to access it. Since access control is normally based on the identity of the user who requests access to a resource, authentication is essential to effective security. In contrast to identification, which refers to the act of stating a person or thing's identity, authentication is the process of actually confirming that stated

identity. It might involve verifying the authenticity of a website by a digital certificate that it provides or validating a person's identity documents.

The way in which a human user or machine may be authenticated, typically falls into three different categories based on what is commonly known as the factors of authentication: something the user knows, something the user has, and something the user is. Each authentication factor covers a range of elements used to authenticate or verify a person's identity prior to being granted access, approving a transaction request, signing a document or other work product, granting authority to others, and establishing a chain of authority.

- Knowledge factors: Passwords, passphrases, pins, challenge response, etc.;
- Ownership factors: ID card, Cell phone, certificates, etc.;
- Inheritance factors: Fingerprint, retinal patterns, face, voice, etc.

Currently, the implementation effort in the Maritime Cloud is concentrating on knowledge factors (typically username/password) for human users and ownership factors (certificates) for machine users. The actual authentication of human users will be the responsibility of the organizations that the users belong to using a brokered identity federation approach (EfficienSea2, D3.7).

2.5 The Maritime Messaging Service

The MMS is a proposed messaging service intended to offer transparent seamless information transfer across different communication links in a carrier agnostic and geolocation context sensitive manner.

The MMS primarily addresses ship-shore connectivity and will be based on internet connectivity, yet any number of alternative communication services may be connected to and utilized by the MMS 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, an 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. using XML) will be possible.

Thus, if a maritime actor wishes to transfer information to another maritime actor or is in need of multicast information to a group of actors, the MMS can ensure delivery across whichever communication links is currently active at each relevant actor. Actors in a multicast group thus do not need to be within range of a single communication link, and actors inside a geographic multicast may be addressable by an information provider, although the identity and exact position of the actors are unknown to the provider of information. 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 for the messages sent.

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

Since heterogeneous communication links are available at sea, a ship may change its communication link at any time by other communication link with better quality. If the communication link is changed, the network locator of the ship can be changed. If the locator of the destination ship changes unexpectedly, the message to the ship's previous locator cannot reach the ship. Thus, it is difficult to transmit a message using only the locater based address in a situation where the ship's locator can be changed.

To implement MMS, we are considering to apply a method in order to correctly transmit the message, even when the ship's locator changes dynamically. Within SMART-Navigation, each ship has a unique identifier and the MMS maps the ship's identifier to the currently accessible locator. The locator of ships can be changed at any time and the MMS has the locator which are currently available to communicate with. When a message sender sends a message to MMS with destination identifier of a destination ship, the MMS forwards the message to the current up-to-date locator of the ship.

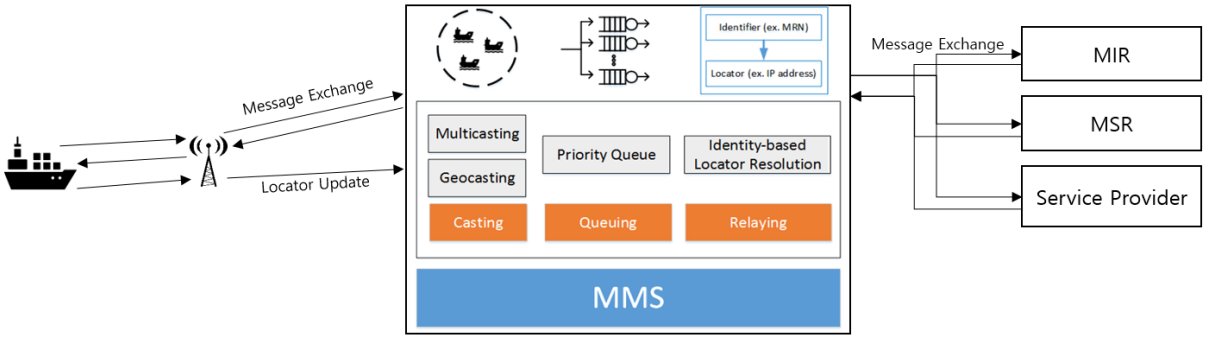

Figure 4 Casting models of Maritime Messaging Service within the Maritime Cloud

As depicted in the figure above (see figure 4), the MMS is a communication brokerage service that provides additional communication patterns (multicasting and geocasting) and uses existing seamless roaming systems or even non-IP based communication systems.

3 REFERENCES

[1] CPSE-Labs (2016): MC PORTAL - A Maritime Cloud Portal in the Maritime Architecture Framework, internal document, unpublished.

[2] EfficienSea2 website: D2.8. Recommended onboard network architecture, project deliverable, published on, project deliverable, published on http://efficiensea2.org/publications, last accessed in November 2016.

[3] EfficienSea2 website: D3.2 Conceptual Model of the Maritime Cloud, project deliverable, published on http://efficiensea2.org/publications, last accessed in November 2016.

[4] EfficienSea2 website: D3.7 Technical Specification of the Maritime Cloud, project deliverable, published on http://efficiensea2.org/publications, last accessed in November 2016.

[5] International Maritime Organization (2009): STRATEGY FOR THE DEVELOPMENT AND IMPLEMENTATION OF E-NAVIGATION, MSC 85/26/Add.1, Annex 20, pp. 1.

[6] Maritime Cloud Development Forum website: www.maritimecloud.net, last accessed in November 2016.

[7] STM Validation website: http://stmvalidation.eu/seaswim-overview, last accessed in November 2016.

4 ACTION REQUESTED OF THE COMMITTEE

The Committee is requested to:

4 Take note of the information provided.