SEA TRAFFIC MANAGEMENT

Draft SeaSWIM Requirement Specification based on needs from PortCDM and Voyage Management

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Summary

This document captures the needs of SeaSWIM from the realization of the Sea Traffic Management concepts' PortCDM and Voyage Management. It is introduced by some foundations and then further specified in the following requirements:

- *Req. #1: SeaSWIM must manage authentication and identity management processes*
  - *Req. #1.1: Identity Management*
    - SeaSWIM shall provide global management of identities for key domain concepts. Key domain concepts include *master identities* with a social core (actors such as information provider and consumers) and identities with a physical core (e.g., vessel and other physical entities). Furthermore, *transactional identities* such as a voyage or a port call need to be managed and interrelated with master identities.
  - *Req. #1.2: Actor authentication*
    - SeaSWIM shall provide trusted mechanisms for authenticating identities, i.e. to ensure an actor is who they claim to be. The actor authentication uses the structure and registry of identities managed in req #1.1.

- *Req. #2: Access Management*
  - SeaSWIM shall provide mechanisms for defining who shall be allowed to provide, access and change information
  - *Req. #2.1: SeaSWIM enable that the owner of the information can determine accessibility of the information*
    - SeaSWIM shall provide mechanisms for information owners to manage who get access to that information.
    - SeaSWIM shall provide mechanisms for nominating collaborators, who shall be allowed to provide / access information or delegate the nomination to other service providers that may do intermediate processing of the information.
    - The right to delegate a nomination is likely to be established in a Service Agreement between the information owner and the service provider. It needs to be evaluated, if it is suitable and technically achievable to control the delegation of access rights, or if this needs to build on trust based on the agreement.

- Req. #3: Versatile and secure point-to-point information transfer
  - *Req. #3.1 Versatile point-to-point information transfer*
    - SeaSwim shall support reliable point-to-point information transfer where different qualities of communication channels is to be considered, regardless of end-point link quality
  - *Req. #3.2 Secure point-to-point information transfer (cyber security)*
    - SeaSWIM shall ensure that the information being communicated is adequately protected from unauthorized access in all communication links from end-point to end-point (see also req. #2)

- *Req. #4: Discoverability of services and identities*
  - SeaSWIM shall provide mechanisms for the discovery of identities and services based on various criteria, such as role, geographical area (which in turn require that identities' location is available), used application, time as well as mandatory/compulsory information exchanges.

- *Req. #5: Different types of services interactions*
  - SeaSWIM shall support different types of services. Such types include:
    - Push type services based on a publisher-subscription interaction
    - Request-response type services based on responding to a client's request.
    - Broadcast type services based on making information available to everyone in (for instance) a selected geographical area.

- *Requirement #6: Structures and updates of data/information objects*
  - *Req. #6.1: Integrated data model capturing object relationships*
    - SeaSWIM shall ensure that access to and provision of single information objects which exists in a larger information structure (data model) is done in relation to the larger information structure
  - *Req. #6.2: Allow multiple services to use the same information*
    - SeaSWIM shall facilitate on-going real-time updates of information and be free of redundancies, i.e. all services have access to consistent information.

- *Req. #7: Enabling communication about states*
  - SeaSWIM shall enable sharing information about intentions and actual performance related to state changes associated with different process steps of the sea voyage, including the port call, enabling distributed coordination of different forthcoming actions.

- *Req. #8: Access to historic information*
  - SeaSWIM shall allow service providers to record/log different performances given that the information owners allow that in their agreement with the service provider, i.e. SeaSWIM needs to facilitate the recording of traceable log files.

- *Req. #9: Monitor and evaluate service provision and consumption*
  - SeaSWIM shall provide mechanisms for capturing the provision and quality of services for the purpose of governing, monitoring and continuously assessing services.

- *Req. #10: Allow third-party development and service portfolio management*
  - SeaSWIM shall provide mechanisms allowing third-party developers to provide STM and SeaSWIM compliant services as part of service portfolio management (including the use of a shared service specification language).

- *Req. #11: Provide information about the status of the communication*
  - The SeaSWIM infrastructure shall allow distribution of information about the status of the communication.

- *Req. #12: Services for non-standardised message interaction*
  - SeaSWIM shall support text messages with non-standardised content. The text-chat function could be used to clarify other standardised information exchange, e.g. explain reason for changed time of arrival. Thus, where possible such exchange of text needs to be linked to other identities or services.

These SeaSWIM requirements have been elicited from STM-specific service needs from PortCDM and voyage management. A core group of people from activity 1 and 2 (in the STM Validation Project) has generated the requirements and the level of detail necessary for the realization of activity 4 has been checked. These processes have brought us to an agreement about both the content and the structure of the requirements.

For each requirement a general description is made and exemplified with the needs from PortCDM and Voyage Management. The document is concluded by some identified further considerations.

Foundations

Conceptual model: Description of the SeaSWIM concept (MONALISA 2.0_D2.3.1-6)

Assumption: PortCDM and Voyage Management sub-concepts of Sea Traffic Management (STM) are instances of SeaSWIM. This has the implication that the SeaSWIM data model must be in compliance with the business logic that these concepts builds upon (e.g. the PortCDM data model). For instance, since PortCDM needs an identifier for Port Call and both concepts need an identifier for a voyage, SeaSWIM must have functionality to manage identifiers as described in the requirements of this document.

Scope: To primarily enable Sea Traffic Management (STM) as a concept encompassing all actors, actions, and services assisting maritime traffic from port to port. STM is a part of the multimodal logistics chain, encompassing sea as well as shore-based operations. The STM concept includes concepts for strategic and dynamic voyage management, flow management, port collaborative decision-making (PortCDM), and the service based communication infrastructure concept SeaSWIM. Sea Traffic Management (STM) is a service-oriented approach to secure sharing and enhanced use of data from the maritime space in real time, in order to improve safety, environmental performance and efficiency in the maritime transport chain

Limitation: This document covers requirements on SeaSWIM functions and infrastructure. Functions and systems in actors own systems, connecting to SeaSWIM by SWIM-connectors e.g on-board navigation systems and Port Community Systems (PCS), are not included.

Three critical roles: Information Owner (and potentially Information Provider acting on behalf of the Information Owner), Service Provider (including the Service Developer and Service Owner), and Service Consumer.

Foundational Logic: SeaSWIM will support current and future systems used by the maritime industry by providing a distributed, flexible, and secure information management architecture for sharing information. SeaSWIM will also help reduce infrastructure costs by decreasing the number of unique interfaces between systems by providing a common interface framework. Furthermore, human interaction is a scarce resource and shall be used effectively by allowing interactions to be automated where appropriate. It is desirable that service interaction can be established without the need to make changes to the underlying systems, i.e. the services are

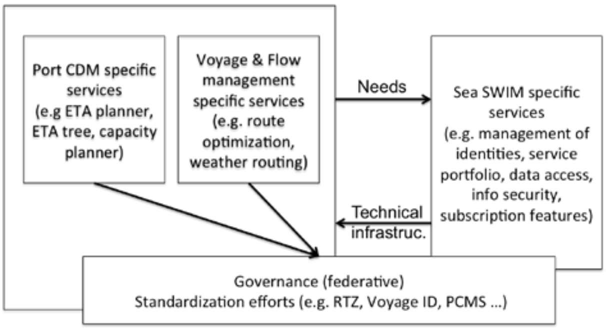

Figure 1: STM versus SeaSWIM specific services

encapsulated and self-contained, may be composed of other services and appear as "black boxes" to consumers. This foundational logic is mimicked from SWIM for aviation and from the definition of Service Oriented Architecture.

Basic service taxonomy: SeaSWIM specific services enabling STM specific services (see figure 1) rely on the attached service taxonomy (see attachment 2).

Requirements on SeaSWIM

In this section the different requirements put upon SeaSWIM are presented and related to the needs of PortCDM and voyage management.

Requirement #1: SeaSWIM must manage authentication and identity management processes

Requirement #1.1: Identity Management

The notion of identities should be conceptualized in a broad sense since there could be actors, physical objects and informational entities (e.g., services, processes) that need to be identified. States, i.e. events, do need to be associated with an identity. A distinction is made between different key domain concepts. Key domain concepts include *master identities* with a social core (actors such as information provider and consumers) and identities with a physical core (e.g., vessel and other physical entities). Furthermore, *transactional identities* such as a voyage or a port call need to be managed and interrelated with master identities. It also needs to be distinguished when the information comes from, or is distributed to, a “public” source.

In PortCDM it must be possible to nominate different actors as collaborators by their identities. PortCDM does also require that data could be streamed from connected physical objects (‘smart things’) via defined communication channels as well as deriving information resulting from different processes such as e.g. voyage plans and port calls. An example of the need for identifiers for processes is the port call as such as well as multiple instances of processes encapsulating that port call, such as several berth shifts within the same port call. The port call identifier encapsulates information associated to the port call.

Requirement #1.2: Actor Authentication

Each provider and user of information and services must be authenticated, i.e. assured that they are who they claim to be. As SeaSWIM can also function as an arena for service providers and service consumers to conduct their business agreements on, the importance of secure authentication and connectivity is emphasized.

In PortCDM this is important since it needs to be assured that the one that is to access information services and/or provide information via information services is a trusted actor.

For Voyage Management, authentication is part of the information security structure together with cyber security and access management, as described below. To reach an implementation of STM, it is a key success factor that all stakeholders are confident that their information is secure, only reaches the authorised actors/collaborators (Access Management) and that there is a trust in the identities to which information is shared.

Requirement #2: Access Management

Access management concerns two aspects; 1) to ensure that each actor provides and/or accesses information they are allowed to do, and 2) an information owner needs to be able to delegate access rights by nominating collaborators.

Requirement #2.1: SeaSWIM enables that the owner of the information can determine accessibility of the information

A collaborator is an actor that accesses information given access to by the nominator. Accessibility is determined by the information owner's nomination of a collaborator allowed to provide/access information or nominate others. This also concerns the possibility to dynamically perform nomination, i.e. to be flexible for providing access to information during the realization of the process. Delegation of access is also essential since one actor might not have the sufficient information in terms of which actors will be involved in later stages of the process. The rights for collaborators to delegate access are set by the information owner/provider through a service agreement. Functionality for auto-nominate is desired.

For PortCDM and Voyage Management it is expected that e.g. shipping companies will be restricted as to who gets access to their voyage plans, which are generally, regarded part of their trade secrets. There are, however, examples where shipping companies are willing to exchange voyage plans with a VTS, provided there is a non-disclosure agreement (NDA) between the parties. The corresponding technical function of an NDA should be effective as part of fulfilling the requirement for Access Management.

For PortCDM and voyage management, empowered by SeaSWIM, it needs to be assured that only allowed actors access information. Further, the dynamic nomination is essential to allow for flexibility during realization of, for example, a port call as a shipping company can nominate an agent that in turn nominates other actors associated with the particular port call.

Requirement #3: Versatile and secure point-to-point information transfer

Note: Sender and recipient can both be human and/or machine as long they fulfil the security related requirements.

Req. #3.1 Versatile point-to-point information transfer

SeaSwim shall support reliable point-to-point information transfer despite different types and qualities of communication channels. While the connection quality for land-based organizations is typically fast and reliable, the connection quality on-board vessels is typically not as reliable - Internet via satellite is often sporadically available, slow and very expensive. Therefore, SeaSwim shall provide mechanisms that mitigate poor connection quality, thus relieving deployed services from that responsibility. This can, for instance, include store-and-forward mechanisms in the SeaSwim communication protocols.

In addition, the SeaSwim communication protocols shall support scalable payloads. At one extreme, due to slow and expensive connection on-board vessels, the overhead for communication must be kept at a minimum. At the other extreme, communication between land-based clients needs to be fast, and may entail transfer of large amounts of data.

Req. #3.2 Secure point-to-point information transfer (cyber security)

It is crucial that information is adequately protected from unauthorized access in all communication links from end-point to end-point, thus employing encryption or other relevant security measures corresponding to stakeholder needs. By end-point, thus the delimitation for SeaSWIM, is meant the access point to a service and does not include for instance the security arrangements inside a system such as a bridge system on a ship.

Requirement #4: Discoverability of services and identities

Discoverability concerns two aspects; 1) Discoverability of identities, and 2) Discoverability of services. This means that SeaSWIM shall enable that both identities and services could be found based on different criteria, such as role, geographical area, used application (e.g. that particular bridge equipment is used), time (e.g. during particular times of the year) as well as mandatory/compulsory information exchanges (e.g. mandatory reporting vs. deep sea assistance). It is also desired that identities and services are clustered in different ways, such as platform specific and add-on services, as well as on the level of granularity. The service definition should contain a geographic scope of any particular service offered. It should also be possible to geographically restrict / enable access to services from mobile actors requiring global location services.

In PortCDM, identities shall be discoverable since the nomination process requires the insights of which actors that are possible to nominate as collaborators.

In PortCDM, services shall be discoverable for the purpose of allowing the vessel / shipping company to understand which services that are provided in the ports included in the voyage plan. The same applies to allowing actors within the port to discover services offered, especially when new services are brought in to the service portfolio (see req. #10). Consequently there are two entrances for discovering appropriate services; discover services in the service repertoire or discovering identities which provide services.

In Voyage Management, there is also a need to discover and present services based on e.g. a geographical service area.

Requirement #5: Different types of services interactions

SeaSWIM should allow for different types of services such as:

- Push type services based on a publish-subscribe interaction. This type allows for distinguished (authenticated) clients
- Request-response type services based on responding to a client's request. This type allows for distinguished (authenticated) clients
- Broadcast type services based on making information available to everyone in (for instance) a selected geographical area. This type does NOT allow for distinguished (authenticated) clients

In PortCDM all these services are necessary, as e.g. continually subscribe on ETA/PTA information from the approaching vessels. In the port, each actor needs to be informed, if there is a state change that affects the planning and performance of the individual actor's planned actions. Push-type services are necessary to inform particular actors that actions are required and request-response type services is to be used for becoming informed of the status of a certain port call (when not subscribing to that information).

In Voyage Management, there is a need for subscription services such as picking up in-port passage plans from a pilotage service as a basis for the ships berth-to-berth voyage planning. In parallel, other services need to support for service calls and responses with input arguments and response formats. An example is weather routing where a ship during a voyage may call a weather service with its voyage plan expecting a weather-optimized voyage plan back.

Requirement #6: Structures and updates of data/information objects

Requirement #6.1: Integrated data model capturing object relationships

Data/information objects do not exist in isolation. A voyage can be associated with one single port call or with multiple port calls and a port call references different actors and physical artefacts. Therefore, an essential requirement of SeaSWIM is to ensure that the access to and provision of single information objects exists in a larger information structure and is conducted in relation to the larger information structure, as e.g. deriving ETA from a vessel should be done related to the voyage plan. This is to avoid that the larger information structure is not updated and that that the derivation of the single information object is seen in a larger context. Consequently the access to, and provision of, a singular information object should always be associated with a reference to the information structure (data model) that it is part of. Single sources of information are thus required, i.e. each part of the information (e.g. a sub-set of a Voyage Information object channelled via the voyage information service) is to be stored at a single place – possible on behalf of someone else. Each part of an object can only have one owner. There needs to be a mechanism in place that ensures that a service consumer is aware of the entire information object.

In PortCDM this means that the port call identifier must be related to the Unique Voyage Identifier (UVID) and that the information about different states, covering the port call process, is related to a particular PortCall_Id. SeaSWIM should manage (and possibly generate) unique PortCall_IDs, based on a specification generated from PortCDM. The UVID provided by SeaSwim should encapculate several PortCall_IDs. The European PortCDM Council takes the role of managing the PortCall_ID specification and PortCallMessage standard.

UVID is a central part of STM. To manage voyage objects in an orderly manner, making sure to keep a high consistency of information for all services, it must be known to an information consumer which subsets of the object exist and where they are. For example, a Voyage Plan may originally reside at a shipping company's service provider, while subsequent revisions (e.g. optimization proposals) may be residing within weather services, VTS's etc. Furthermore, the UVID when used in Voyage Management is envisaged to be tied to other consignments, such as cargo (e.g. containers) carrying own IDs which in turn are used in other parts of the transport chain. The UVID therefore needs to be possible to relate to other identification items. Other examples of voyage related information that could be needed by service providers and is not included in the voyage plan are more detailed ship particulars and characteristics (for optimization), certificates and reporting information like persons onboard and FAL-documents.

Requirement #6.2: Allow multiple services to use the same information

Multiple services will need to access the same information object. This is why it is important that SeaSWIM facilitates that information content contains the latest updates (real-time data management) and that the services use the same information. This further means that terms of use must be possible to regulate in contracts between the information owner and the service provider and in the reclamation of the information by other service providers. Different versions of the information do need to be managed.

In Port CDM this is important due to that the situational awareness constituted by the port call information needs to be the same for all actors.

In Voyage Management this is important due to that voyage information, constituted as voyage plans, would be used by multiple services, at sea and on shore. This requires consistent management of Voyage Objects, where Voyage Objects may be constituted of subsets stored at different locations, with different owners. Information owners may only want to give access to subsets of an information object and not the entire object. For example, a ship may want to give a VTS centre access to a particular range of waypoints in their voyage plan.

Requirement #7: Enable communication about states

STM builds upon enhanced communication about intentions and actual performance related to state changes associated with different aspects that enable distributed coordination of different forthcoming actions. At the core of STM, actors communicate when different states are about to occur and have occurred.

Port CDM as well as route exchange for Voyage and Flow Management builds upon that process states are identified and communicated about. The Route Exchange Format (RTZ[1]) and the Port Call Message Standard (PCMS[2]) captures different possible states. A process state is identified with a unique identifier and different states are related to each other within a larger information structure, on a generic level a state chart for port calls in the world or for a particular port, and on instance level for the particular port. This has the implication that Port CDM require that SeaSWIM both can comply with generic data structures and instantiations of data structures. Consequently SeaSWIM needs to be in compliance with the data model of Port CDM, Voyage Management and Flow Management where it needs to adopt the flexibility with allowing e.g. that one voyage could include one single or multiple port calls, that one port call could include multiple berth shifts, and that one berth shift could include multiple quays and terminals.

Requirement #8: Access to historic information

SeaSWIM must allow service providers to record/log different information exchanges related to different actions given that the information owners allow that in their contract with the service provider. This is to be used for the purpose of making evaluations and data analytics. Essential is that the open service oriented architecture, on which SeaSWIM builds upon, affords distributed implementations, i.e. that centralized storage of data is avoided, in order to enable that the information owner can be in control of how the recorded / stored information would be used.

For STM-specific services, within PortCDM, Voyage Management, and Flow Management, this means that it must be allowed for a service provider to be contracted to record related state updates provided by different information sources. This will allow the service provider to provide performance information being used as a basis to realize continuous improvements of services, such as, for example, the port call improvement service taking information from the of several port calls as the basis for the refinement of port call process and information sharing processes.

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[1] Route Exchange Format (RTZ) is a part of IEC 61174 Edition 4.0

[2] Lind M., Haraldson S., Karlsson, M., Watson R.T., Holmberg P-E. (2015b) Enabling Port Efficiency by increased Collaboration and Information Sharing – Towards a Standardized Port Call Message Format, Accepted to WCTRS-SIG2, The Port and Maritime Sector: Key Developments and Changes, University of Antwerp, 11-12 May, 2015
Lind M., Haraldson S., Karlsson, M., Watson R.T., Holmberg P-E. (2015a) Port Collaborative Decision Making - Closing the Loop in Sea Traffic Management, Accepted to COMPIT 2015 - Conference on Computer Applications and Information Technology in the Maritime Industries, 11-13 May 2015, Ulrichshusen/Germany

Requirement #9: Monitor and evaluate service provision and consumption

For the purpose of system performance and service optimization it is essential that service requests can be monitored and that it is allowed for service consumers to distribute their quantitative and qualitative evaluations (including rankings) from the use of a particular service to inform the community of service providers/consumers. It is thus a need to for mechanisms for capturing the provision and quality of services for the purpose of governing, monitoring, and continuously assessing services. To the extent that it is possible, service interaction patterns should be captured even though that service realization is promoted to be performed peer-to-peer. Access to the monitoring data is reserved to the service provider, who decide how, and if to use the results of the monitoring to improve the service. The service provider should also be allowed to determine which actors are allowed to access such performance information of the services. Different aspects of the service could be monitored, such as e.g. accuracy of provided information, latency of response, reliability and availability of the service etc.

For PortCDM this means that the source and occurrences of (information) service requests that are made by different service consumers, such as e.g. *state_update* (manual and/or automatic), or *Portcall_Overview*, are captured. For PortCDM the evaluation of services is used for informing both other consumers about the value of the services as well as the service providers of refinement needs.

Requirement #10: Allow third-party development and service portfolio management

In order to innovate Sea Traffic Management, the above SeaSWIM requirements must allow for third-party development. This also means that service portfolio management should be included as a governance feature in SeaSWIM. Service portfolio management captures the life cycle of the service; initiation, development, approval, use, evaluation, and liquidation. It is expected that PortCDM services captured in the service repertoire is PortCDM and SeaSWIM compliant, i.e. meeting the requirements of a PortCDM service functioning in the SeaSWIM environment. Further this means that a standardized service specification language should be used in the specification of a service. It thus needs to be a service description methodology in place, which transforms standards agreed on the federative governance level into technical specifications for implementation of those standards into services. It needs to be evaluated if the Maritime Cloud Maritime Service Description Language (MSDL) can and will also be the service description language for SeaSWIM. Such a requirement means that MSDL, as part of MC or extended MC, can function for the wider scope that SeaSWIM has. It is also expected that there would be an available development environment that could be used during the development and testing of the service.

PortCDM will continually be developed where it needs to be allowed for new Service Providers to develop and offer services based on existing information services. During the development of a new service, exemplary test data should be available to use for development and realistic testing allowing the service developers to act as non-certified users of data (non-nominated collaborators) during the development.

The efforts in the PortCDM council should also be synchronized with the efforts in the SeaSWIM federation in order to ensure that the services being approved are both PortCDM and SeaSWIM compliant. This means that criteria being set for putting requirements on what needs to be met, if the service is to be included in the STM service catalogue must be in compliance with the SeaSWIM architecture.

For actors involved in Voyage Management, standardization of data formats will be an essential ingredient for lowering transaction costs for use of available data streams. An example of this is the Route Exchange Format (RTZ) developed in the MONALISA 2.0 project. This standardization process will become part of STM Governance, but also needs a corresponding technical implementation platform as described above.

Requirement #11: Provide information about the status of the communication

Maritime operations such as Vessel Traffic Services (VTS), Search and Rescue (SAR), pilotage and icebreaker coordination often build on “closed loop communications”, i.e. an operator expects that a message when received by another operator is confirmed and read back. Typically this applies to radio communications. When STM services such as route exchange are applied in maritime operations one of the benefits is that radio communications can be reduced, which in turn reduces the load on radio channels and decreases the risk of misunderstanding. However, when moving from radio communication to non-verbal information transfer, it is important that closed loop procedures are still supported. The SeaSWIM infrastructure must allow distribution of information concerning the status of the communication, as e.g. whether certain information content has been communicated, received, responded to, agreed etc. associated with e.g. date and time. An example of this is a confirmation of that a broadcasted message, in the sense of it is to be distributed in a one-to-many communication strategy, has been received by the recipient (such as Maritime Safety Information) in a particular region.

Within the Port Call Message Standard (PCMS) and the Route Exchange Protocol (RTZ) multiple characteristics of communicative states has been identified.

It is recognized that ships are not always online (connected to the Internet) and that they for long periods of time have limited band with and/or high data transmission costs. Therefore, in many cases a ship will need a shore-based SeaSWIM representation which responds to online service requests and – as long as information remains unchanged – acts on the ship’s behalf in repeatedly make data available for nominated collaborators. This representation realizes the ship’s SeaSWIM connector. A base requirement in SeaSWIM is Internet access, i.e. a SeaSWIM connector must be online with a specified reliability. The communication link from the SeaSWIM connector to the ship must, in turn, be able to propagate new or amended information, events and state changes between ship and SeaSWIM connector, making sure that nominated collaborators are provided with valid information at all times. The ship-SeaSWIM connector link is not part of SeaSWIM, but SeaSWIM needs to be able to handle the connectivity status of the ship and the level of validity of the information provided. The Maritime Cloud Messaging Service with its store-and-forward functionality could play a role here, but some users may choose to rely on existing services for fleet monitoring. These options and their implications need to be further investigated.

Requirement #12: Services for non-standardised message interaction

Although much of the information exchange in SeaSWIM will be standardised, regulated by rtz, PCMS, and the voyage object, there will still be a need to have the possibility to send text messages with non-standardised content. The text-chat function could be used to clarify other standardised information exchange e.g. explaining the reason for changed time of arrival, reason for proposing a new route or explanation of the reasons for a route optimisation. Text-chat functions used could in future development be added in standardised information exchange and does thereby serve as an important source to which information sharing standards that is to be developed.

The text chat function should be bi-directional and support a “thread”-function so that new messages are related to earlier communication between the actors. Thereby the interaction pattern could be captured as well as the identifiers of who exchanges messages with whom and for what purpose. These functions and solutions are already used in several popular software and apps like Skype, Whats-app and Messenger used both privately and in business.

A text-message function has been proven to increase the flexibility and trust in communication and reduces the risk for misunderstandings, especially between actors with different mother-tongues according to the findings of previous e-navigation projects where it has been tested together with route exchange (rtz[1]).

Further considerations

It is expected that PortCDM will be realized through a common service integration platform (PortCDM SIP). The PortCDM SIP will inherit SeaSWIM functionality according to the depicted requirements allowing SeaSWIM based information sharing to occur. PortCDM SIP becomes in this way also the integrator towards the different information systems existing in a port.

To stimulate the development of third-party development and provide incentives for this engagement different types of billing mechanisms must be included and promoted by SeaSWIM, such as e.g. billing from the amount of transactions being generated from a specific use of service.

The Maritime Cloud's Maritime Messaging Service (MMS) is envisaged to provide an efficient communication abstraction layer for ships with limited communication capabilities. However, SeaSWIM also needs to cater for shore-based services with stable broadband communication that may not prefer to run their services over the MMS, but rather on other widespread protocols such as SOAP or REST.

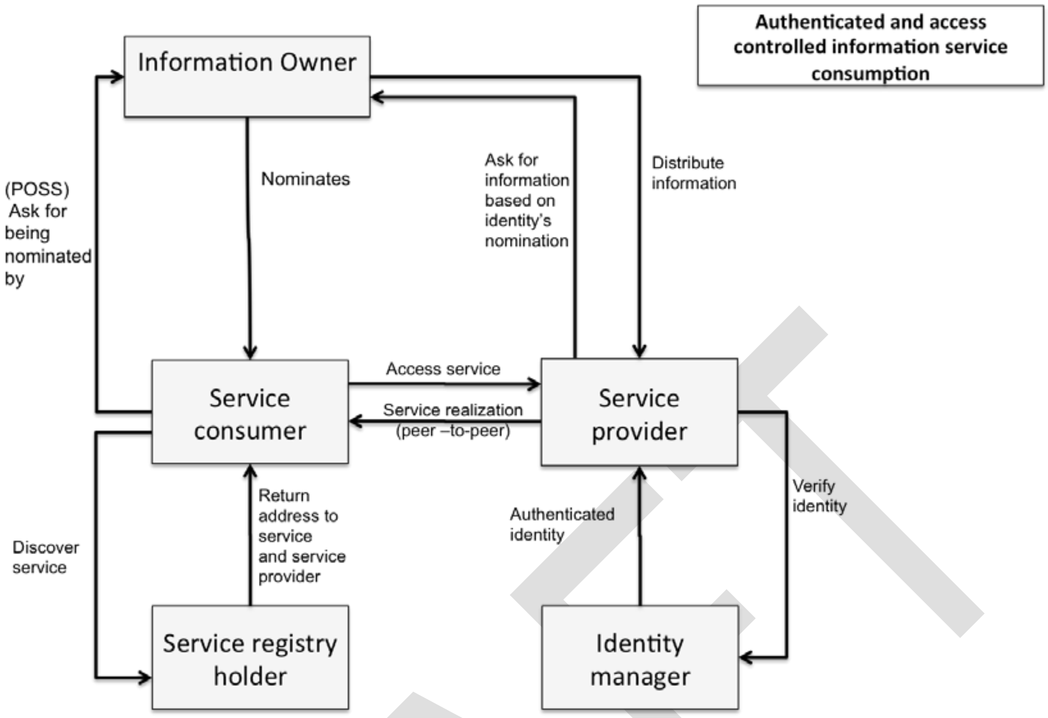
The consequences of supporting a diversity of communication protocols in SeaSWIM need to be analysed, given that common needs described in the other sections of this document must apply on services regardless of communication protocol.

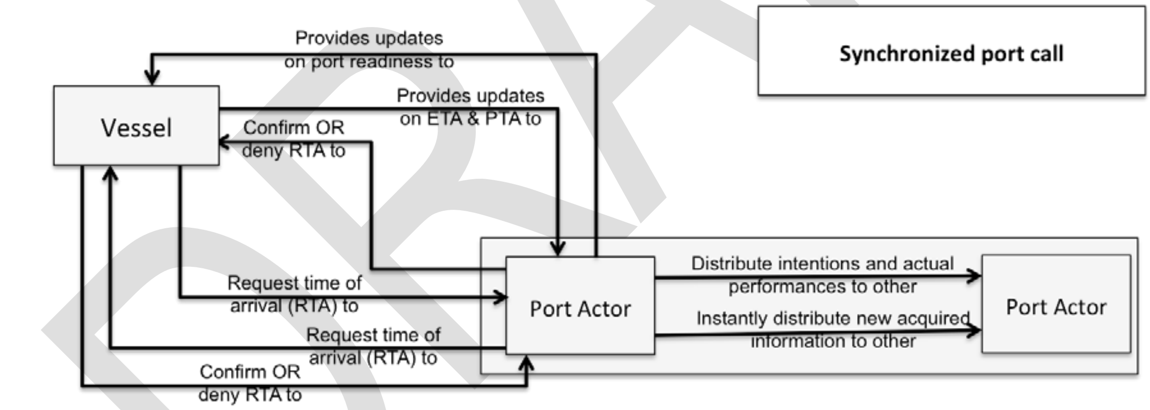
The Maritime Cloud Client Component (MCCC) is providing ship and shore side applications access to maritime information services, via the Maritime Cloud. The component keeps the Maritime Cloud services abstracted from the physical components and encapsulates the complexities of roaming between different physical communication links. The component will function as a local information hub, connected to relevant sensors, navigation displays and communication equipment. It needs to be analysed which role the MCCC should have for services provided through SeaSWIM, both Maritime Cloud services and non-ditto.

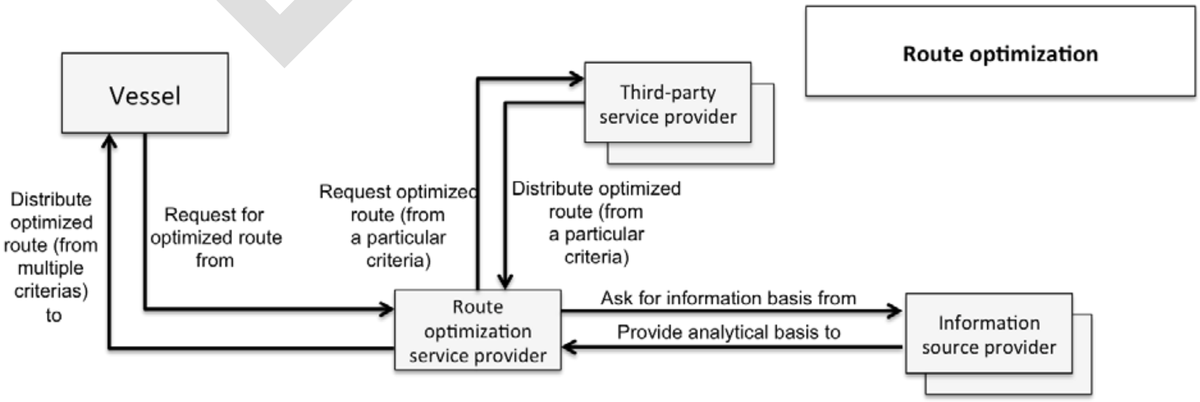
<u>Project-specific technical implementation of the architechture</u>

There must be a technical implementation of the SeaSWIM infrastructure latest 31 March 2017. It is envisaged that Maritime Cloud components such as the Id Registry and the Service Registry will be used for STM. If such components would not be ready for technical implementation in time, the project must 1) find alternatives for project implementation and 2) describe the consequences of a future migration from a project-specific implementation to the Maritime Cloud components.

Appendix 1: Simplified use-cases used to identify requirements







Appendix 2: Service Taxonomy *(Version 0.9 / 28th of October 2015)*

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One essential layer in the architecture of STM is a service ecosystem consisting of and interrelating mandated and optional, internal and external services in various interactions. In order to ensure a consistent specification of each service in this ecosystem, a taxonomy is required facilitating the specification, classification, description and contextualisation of each service.

A proposal for such a service taxonomy is provided in the following. Once finalised and endorsed, this service taxonomy will be used to describe and interrelate all services ensuring consistent and high levels of shared understanding. Such a service taxonomy covers not only the technical attributes of a service, but a diverse set of attribute clusters including its interfaces, relationships (e.g., with requirements or other services), its quality specification, its internal composition or related governance, risk and pricing arrangements. This service taxonomy is to cover both STM-specific and SeaSWIM-specific services (c.f. figure 1).

The following table summarises the six proposed clusters of service attributes.

Service Identification - Service ID - Service Name (max 50 characters) - Service Description (max 300 characters) - Service Context (under which circumstances this service is consumed (when, where etc.)?) - Nature of the service (informational (data), application) - Service type (transactional, analytical, transformational) - Mandated or optional - Service Status o proposed / under review / release / retired	**Service Composition and Interfaces** - Service Composition (documented as a service tree) o Atomic service (what composed services are using it) o Composed service (what atomic services are part of it) - Service Interfaces o input o output o ID requirements (details of authentication/authorization of service consumer)
Service Channel and Engagement Management - ID requirements to access service - Open access or selected users - Channels provided to access service - Access level	**Service Relationships** - Requirements (what requirement(s) are addressed by this service?) - Standards (what standards are related to this service?) - Other services (predecessor, successor, previous version)
Service Interaction Patterns - Details on the interaction pattern, e.g. o service is called by consumer o service is offered to consumer o service request needs to be confirmed o number of parties involved o etc	**Service Governance, Risk and Quality Management** - Service Owner (incl. contractual arrangements) - Exclusivity arrangements (i.e., one single provider?) - Service Level Agreements (e.g., availability, responsiveness, quality) - Service Contracts (i.e. ad-hoc or contract

	required?) - Service charging model (e.g, per consumption, per time period, etc.) - Service risk profile and mitigation - Service Review (frequency, type of review) - Service assessment (channels for service feedback)

Further descriptions of each cluster are provided in the following

1) Service Identification

This group of attributes captures attributes needed to clearly identify each service via a unique Service ID. This ID is needed to address services. Further attributes allow characterising the service and in particular to specify the context in which this service is required. Examples for such contexts could be time-based (e.g., hours to arrival), location-based or message-based (e.g., pilot has been allocated). If a service is mandated, defined events could call and execute the service automatically. Optional services will require different communication services making sure possible consumers are aware of these services. Each service is classified as being either transactional (e.g., conduct route planning), analytical (e.g., consolidate and visualise routes) or transformational (e.g., innovation services dedicated to exploring new services).

The service status, and its change, is an essential attribute for the overall goverance for the service.

2) Service Channel and Engagement

This group of attributes captures a 'black-box' view on the service, i.e. how to interact with the service including requirements for identification (open or identification required), Each service will be related to certain communication channels describing how the service can be accessed and how the service is delivered. A service might have different access levels depending on the access rights and requirements of the service consumer.

3) Service Interaction Patterns

Depending on the sequence of interactions between the provider and the consumer, different patterns can be differentiated. Each service is linked to one or more of these patterns defining the sequence of interactions. Examples might be if a service requested, if a service is offered based on states of an identified actor, if a confirmation is needed after a request or if the interaction is bi-directional or multi-directional, i.e. involving more than one stakeholder. A detailed list of relevant interaction patterns will be made available.

4) **Service Composition and Interfaces**

Services can be differentiated into atomic services (e.g., weather forecast) and composed services (e.g., weather-based route optimisation). For each atomic service, relationships to composed services need to be maintained while each composed service needs to be broken down into atomic services in the form of a service tree. This information allows hierarchical navigation within the service ecosystem and tracing implication in case of a service failure.

Service interfaces describe the (mandated or optional) information and their format needed to interact with the service and are differentiated along the service lifecycle (e.g., request vs confirmation). They also capture identification requirements for each interface. For example, simple enquiries (e.g., availability check) might not require any identification whereas reservations will require it.

5 Service Relationships

In addition to the hierarchical relationships between services as captured in (4), services have further relationships with other entities. They have various relationships with other services capturing service value chains in the form of predecessor-successor relationship. A service could also replace another service (version management or complete new service) or be an alternative for another service. Services can be linked to defined requirements to justify the existence of the service and to facilitate requirements monitoring. Finally, services could be linked to standards. This is relevant for external assessments and to identify services in need for updates in case new standards emerge.

6 Service Governance, Risk and Quality Management

Finally, an entire cluster of service attributes captures most of the compliance, governance and risk attributes. This includes ownership and related exclusivity arrangements. Service contracts and service level agreements provide formalised engagement and quality evaluation models. A dedicated service charging model captures the economic engagement and pricing model. The risk profile of the service (e.g., likelihood of failure, impact, frequency of risk assessment) is captured here as well. Finally, formal service reviews and assessment link to the overall monitoring and quality assessment of the service.