Technical Specification for the Provision of Navigational Warnings to End-users

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1 Introduction

The bulk of work on this document, has been made as a deliverable in the workgroup supporting S-124 –correspondence group.

Navigational Warnings (NW) are part of the Maritime Safety Information (MSI) system. Currently, NW's are promulgated in text via SafetyNET, NAVTEX, and are in some countries accessible on the WWW or as voice broadcasts via coastal radio stations.

As part of S-124 workgroup as subgroup of S-124 Correspondence group, a NW model, and promulgation thereof, is being developed and tested. This involves the specification of a S-124 (NW) service and implementation of a S-124 (NW) service instance that can be integrated with the Maritime Connectivity Platform eco system. This document is structured according to the IALA Guideline G1128: THE SPECIFICATION OF e-NAVIGATION TECHNICAL SERVICES. The design of the service interfaces was adapted from IEC 63173-2:2022.

1.1 Purpose of the Document

The purpose of this service specification document is to provide a holistic overview of the Navigational Warning service and its building blocks in a technology-independent way, according to the guidelines given in G1128. It describes a well-defined baseline of the service by clearly identifying the service version.

The aim is to document the key aspects of the Navigational Warning service at the logical level:

- the operational and business context of the service
    - requirements for the service (e.g., information exchange requirements)
    - involved nodes: which operational components provide/consume the service
    - operational activities supported by the service
    - relation of the service to other services
- the service description
    - service interface definitions
    - service interface operations
    - service payload definition
    - service dynamic behaviour description
- service provision and validation aspects

1.2 Intended Readership

This service specification is intended to be read by service architects, system engineers and developers in charge of designing and developing an instance of the Navigational Warning service.

Furthermore, this service specification is intended to be read by enterprise architects, service architects, information architects, system engineers and developers in pursuing architecting, design and development activities of other related services.

1.3 Inputs from Other Projects

An approach to NW-handling and promulgation via AIS was tested during the initial EfficienSea project. The EPD (e-Navigation Prototype Display) was used to test and evaluate portrayal of NW's on an ECDIS-like device. This was further developed in the ACCSEAS project, which also developed a combined MSI-NM model and interchange format, see [7], plus an authoring system and promulgation via the Maritime Connectivity Platform Messaging Service (please refer to www.maritimeconnectivity.net). The MSI-NM interchange format devised in the ACCSEAS project was furthermore used as input for IHO, targeting the S-124 NW product specification - see [8].

2 Service Identification

The purpose of this chapter is to provide a unique identification of the service and describe where the service is in terms of the engineering lifecycle.

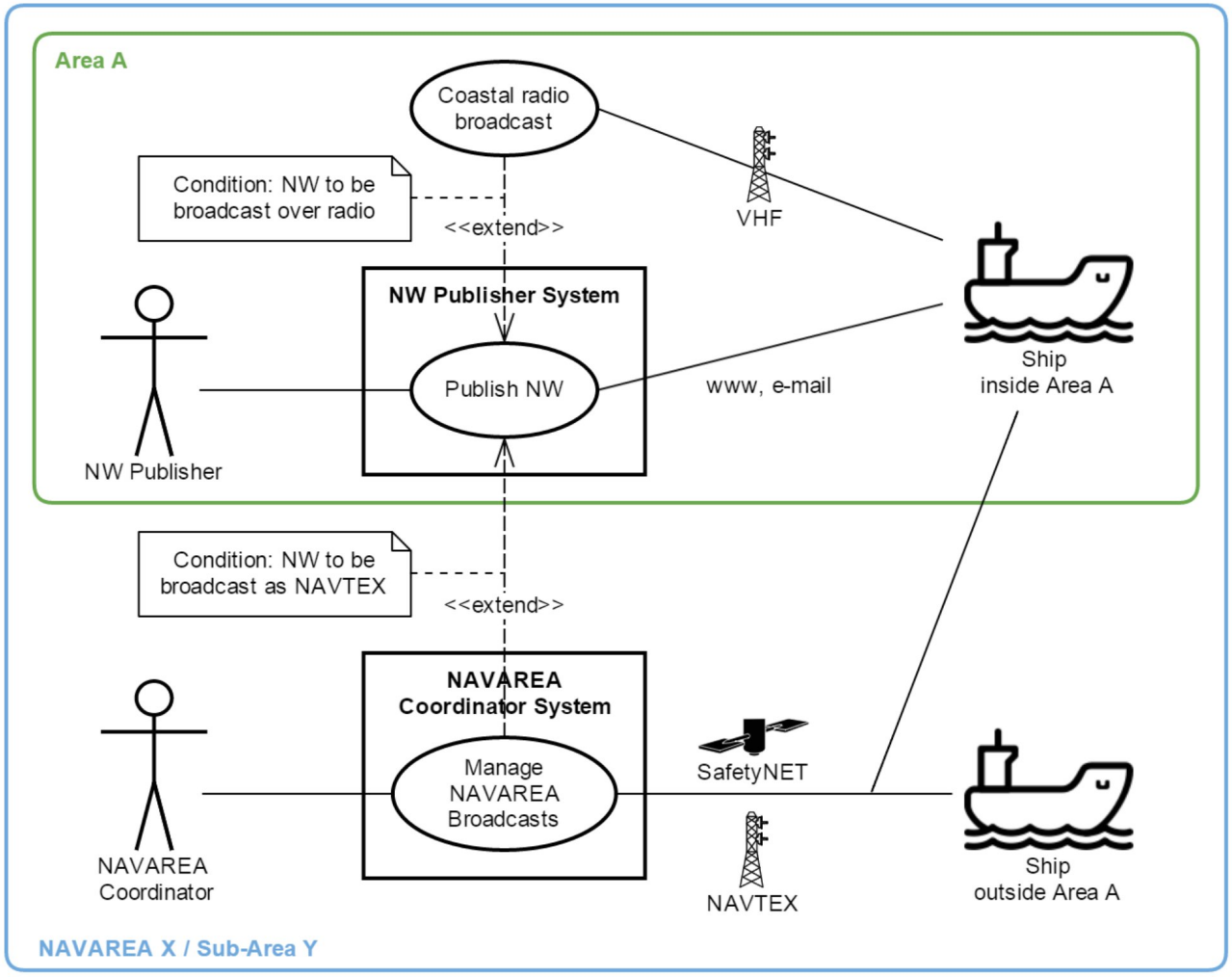
Name	*Technical Specification for the Provision of Navigational Warnings to End-users*
ID	*urn:mrn:iho:techsvc:spec:navwarn*
Version	*0.98*
Description	*This service specification describes a standardized service implementing the corresponding IHO geospatial standard for navigational warnings. S-124 Navigational Warnings are intended to be used in an overlay to ENC within a navigation system.*
Keywords	*S-124, Navigational Warnings, NW, MSI*
Architect(s)	*Navigational Warnings Service Specification WG*
Status	*Provisional*

3 Operational Context

This section describes the context of the service from an operational perspective.

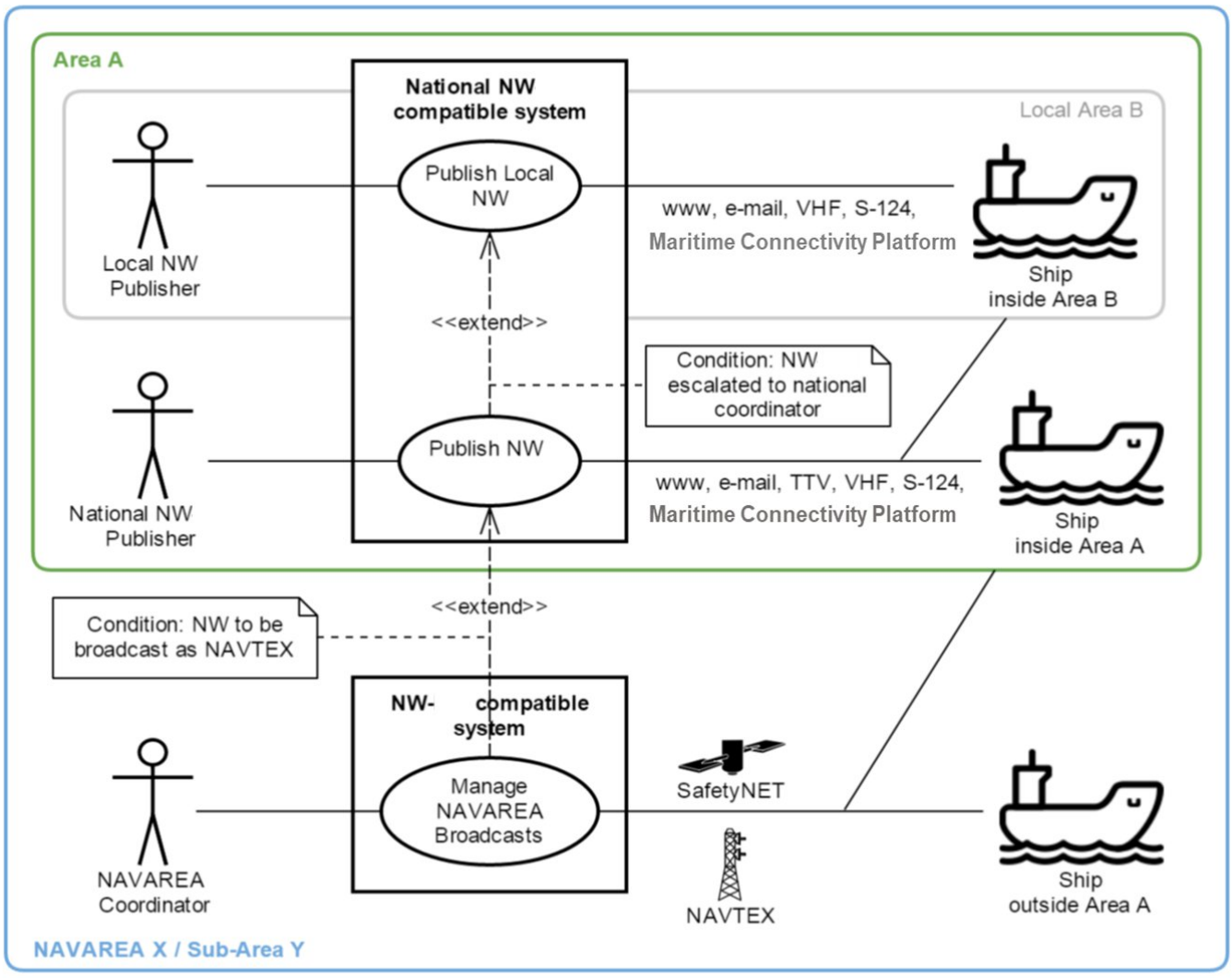
3.1 Present Day Operational Context

Today's NW broadcast regime, i.e. the operational context of NW promulgation at the component level, is depicted below:



System interfaces between NW publishers, NAVAREA (or Sub-Area) coordinator and broadcast service are not standardized, and may rely on manual processes involving e-mail, telephone, voice radio transmissions, fax, telex and manual re-entering of information from one system to another, or much more advanced solutions. Provision of NW via web is not standardized. NAVTEX and SafetyNET cannot transport structured data formats for NW solution.

3.2 Envisioned Operational Context



This Scenario depicts an envisaged future NW promulgation regime, as explored in EfficienSea 2 and furthermore in STM validation. Based on a standardized structured NW format, compatible NW systems will be able to exchange NW seamlessly. As depicted, each country may have a national NW system, used by local authorities (e.g., harbour and port authorities) as well as the national authorities and agencies (e.g. national maritime safety agencies or hydrographic offices).

Local authorities will administer and publish local NW for their area of responsibility, whereas the national authorities will cater for NW on the national level. Local authorities should have the ability to escalate NW to the national coordinator.

The NW received by ships will thus depend on the promulgation method of choice. If, say, a ship targets the website of a specific port authority; it may see the local NW published by this authority. If, however, the ship queries for NW via the Maritime Connectivity Platform, it will receive NW from national and local authorities relevant to its current position and planned routes.

The Navigational Warnings Service detailed in this specification only caters for a small part of this promulgation regime. It exposes multiple service operations for machine-to-machine consumptions of all currently published NW messages from the targeted authority. It may be used by any client, such as a ship, a website or an app.

3.3 Functional and Non-functional Requirements

The table below lists applicable functional requirements for the Navigational Warnings service.

Table 1: Requirements Tracing

Requirement Id	**Requirement Name**	**Requirement Text**	**References**
S-124R001	Subscription to Navigational Warnings	Service consumers must be able to subscribe to Navigational Warnings according to search parameters.	
S-124R002	Broadcast of Navigational Warnings	Service providers should have a possibility to broadcast Navigation Warnings (to subscribers of Navigational Warnings).	
S124R003	Retrieval of Navigational Warnings	Service consumers must be able to request a list of Navigational Warnings and the query the data sets manually.	

The table below defines above described functional requirements for the Navigational Warnings service.

Table 2: Requirements Definition

Requirement Id	**S-124R001**
Requirement Name	Subscription to Navigational Warnings
Requirement Text	Service consumers must be able to subscribe to Navigational Warnings according to search parameters.
Rationale	This is to facilitate the possibility to receive relevant warnings in accordance with for instance a ship's voyage plan.
Author	-

Requirement Id	**S-124R002**
Requirement Name	Broadcast of Navigational Warnings (within a subscription)
Requirement Text	Service providers should have a possibility to broadcast Navigation Warnings (to subscribing) consumers of Navigational Warnings.
Rationale	As is the case in the current Navigational Warning promulgation regime, warnings should be able to broadcast to (subscribing) consumers. This is to ensure consumers always receive the latest changes.

Author	-

Requirement Id	**S-124R003**
Requirement Name	Retrieval of Navigational Warnings
Requirement Text	Service consumers should have the possibility to retrieve Navigation Warnings from providers of Navigational Warnings.
Rationale	Consumers of the service should always have the possibility to download Navigational Warnings in order to assure up to date Navigational warning information for navigational or other purposes.
Author	-

The table below defines dataset related functional requirements for the NW service.

Table 3 Dataset related requirements definition

Requirement Id	**S-124R004**
Requirement Name	Transmission of new Navigational Warning
Requirement Text	It should be possible to publish a new Navigational Warning. The NW is valid until a cancellation NW is issued.
Rationale	Authorities are required to publish Navigational Warnings to increase maritime safety for maritime stakeholders, in the area of resp. authority responsibility.
Author	-

Requirement Id	**S-124R005**
Requirement Name	Transmission of new Navigational Warning – self-cancelling
Requirement Text	It should be possible to publish a new Navigational Warning including a cancellation date.
Rationale	Navigation Warning including a cancellation date reduces the need for separate transmission of cancellation messages related a published Navigation Warning.
Author	-

Requirement Id	**S-124R006**
Requirement Name	Transmission of new Navigational Warning with cancellation
Requirement Text	It should be possible to publish a new Navigational Warning for cancelling a previous warning. Which may include updated information related to the warning cancelled.
Rationale	In case a warning was issued without a cancellation date it should be possible to cancel the previous warning.
Author	-

Requirement Id	**S-124R007**
Requirement Name	Transmission of new self-cancelling Navigational Warning with cancellation.
Requirement Text	It should be possible to publish a new self-cancelling Navigational Warning used to cancel previous warning. Which may include updated information related to the warning that is being cancelled. The new warning includes a cancellation date.
Rationale	In case a warning was issued without a cancellation date it should be possible to cancel the previous warning. The cancellation warning should be self-cancelling.
Author	-

Requirement Id	**S-124R008**
Requirement Name	Transmission of In force-bulletin
Requirement Text	It should be possible to publish a list of references to active Navigational Warnings.
Rationale	The In force-bulletin is required to publish a list of active warnings for reconciliation purposes in case of transmission failure due to communication issues.
Author	-

The table below defines non-functional requirements for the NW service.

Table 4: Requirements Definition

Requirement Id	**S-124NF001**
Requirement Name	Authenticity of Service Provider (optional)
Requirement Text	The recipient of navigational warning data should be able to verify the authenticity of the provider of the received datasets.

Rationale	This is to mitigate possible unauthenticated promulgation of Navigational warnings.
Author	

Requirement Id	**S-124NF002**
Requirement Name	Integrity (required)
Requirement Text	It must be clear to both service provider and consumer whether changes have been made to the navigational warning data after the dataset was created. This is required for the payload although signing the message itself is optional.
Rationale	This is to prevent replay attacks and secure that the message payload is untampered with.
Author	

3.4 Other Constraints

3.4.1 Relevant Industrial Standards

- ISO 25010 software product quality
- IEC 63173-2:2022 Maritime navigation and radiocommunication equipment and systems - Data interfaces - Part 2: Secure communication between ship and shore (SECOM)
- S-124 Navigational Warnings (product specification)
- S-100 Universal Hydrographic Data Model

3.4.2 Operational Nodes

The following tables describe the operational nodes of the service.

Table 5: Operational Nodes providing the ***NW*** service

Operational Node	**Remarks**
Navigational Warning Coordination Centre	The Warning Coordination Centre collects all Navigational warnings from countries and other organizations and distributes them to the consumers in the specific coverage area.

Table 6: Operational Nodes consuming the ***NW*** service

Operational Node	**Remarks**

Ships	Ships sailing in a service coverage area.
Vessel Traffic Service (VTS) centres	VTS centres in responsibility for the service coverage area.
Regional ENC Coordinating Center (RENC)	RENCs are organizational entities where IHO members have established co-operation amongst each other to guarantee a world-wide consistent level of high quality data, and for bringing about coordinated services with official ENCs and updates to them.

3.4.3 Operational Activities

Subscription of Navigational Warnings

A typical use-case of the navigational warning service is to provide a service consumer, i.e. ship, with only the warnings that are relevant for a specific area that intersects with the route under navigation and at the time of scheduled route. Moreover, the warnings could be displayed directly in ECDIS and automatically deleted when they expire and no longer valid.

The navigational warnings do not have to be limited to specific transmission times but will be sent as soon as warnings are registered in national/regional management systems in a subscription pattern.

1) The ship searches a service registry according to geography preferences and discovers a published navigational warning service.
2) The ship requests subscription by consuming the Subscription interface providing a route waypoint list as a geometry parameter and the subscription period, corresponding to the estimated duration of the voyage (cf. ETA).
3) The service responds to the ship with a message and subscriptionIdentifier by calling the SubscriptionNotification interface.
4) New NAVWARN datasets are ready for distribution.
5) The Navigational Warning Service sends new NAVWARN datasets to the ship by consuming the ship's Upload interface, supplying parameter fromSubscription = "true".
6) The ship receives the datasets (via the Upload interface) and receives consecutive NAVWARN throughout the duration of the voyage.
7) Ending the subscription alternatives.
    a) If the ship wants to terminate the subscription of NAVWARN service, for example due to another route plan, it consumes the NAVWARN "Remove Subscription" interface and the NAVWARN service responds by sending a "Subscription Notification" of the approved removal.

When the subscription period ends or when leaving the NAVWARN coverage area, the navigational warning service consumes the ships Subscription Notification interface with eventEnum = "Subscription removed" for the subscriptionIdentifier in step 3)

4 Service Overview

4.1 Service Interfaces

In below description the service interfaces for the NW service are shown.

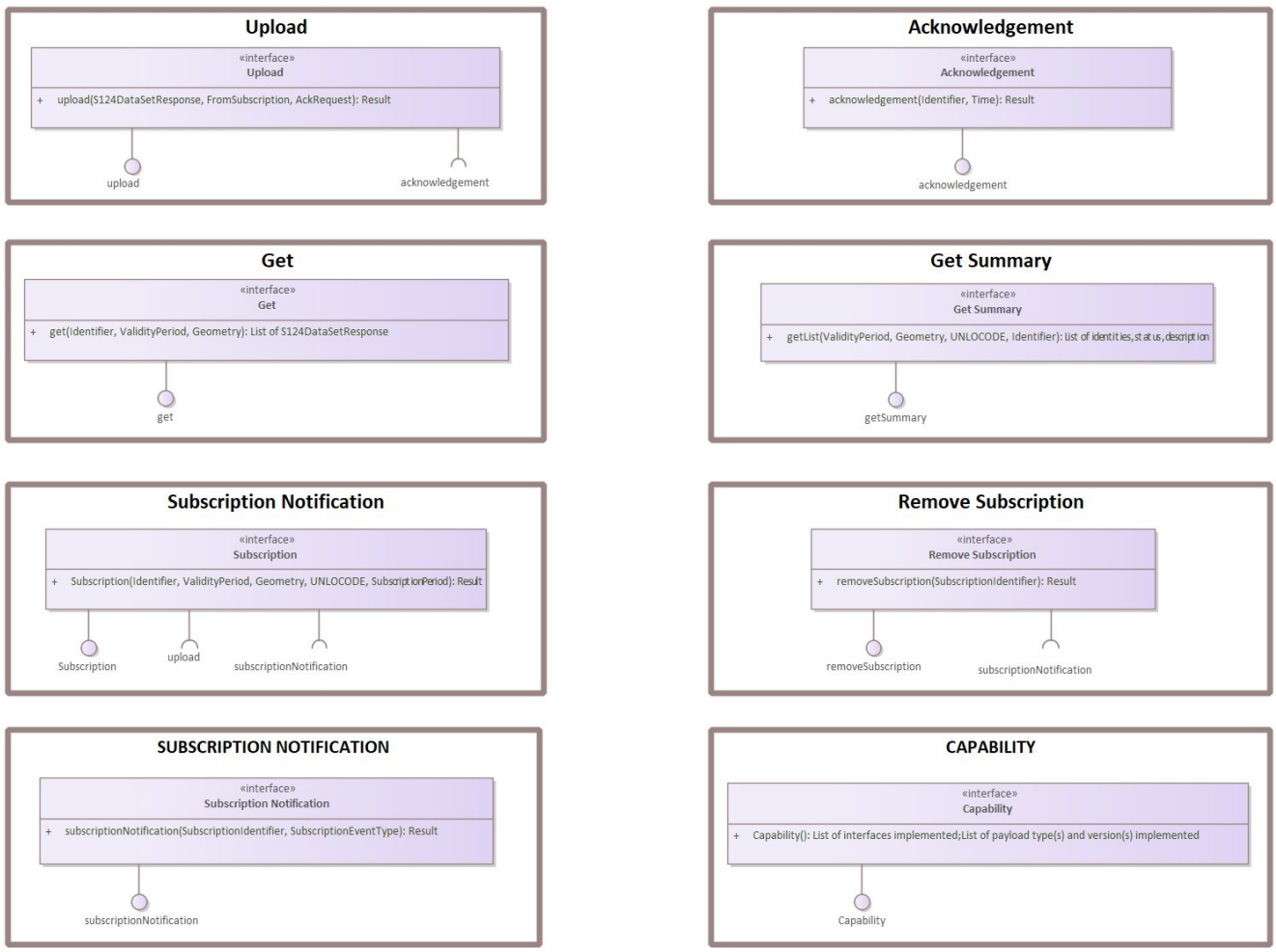


Figure 1: NW service Interface Definition diagram

Table 8: Service Interface overview

Service Interface	Exchange Pattern	Definition
Upload	ONE_WAY	An interface provided by a service consumer, to receive data that is being pushed from the service provider. This is required for receiving data in a subscription.
Acknowledgement	ONE_WAY	An interface provided by the service provider, which can be utilized by the service consumer to notify the service provider, that a NW was received successfully.
Get	REQUEST_RESPONSE	An interface provided by the service provider that can be manually queried by the service consumer to retrieve NWs
Get Summary	REQUEST_RESPONSE	An interface provided by the service provider that can be used by the service consumer to get a list of available NW-datasets.
Subscription	PUBLISH_SUBSCRIBE	An interface provided by the service provider that can be used by the service consumer to start a subscription of NW data.
Remove Subscription	ONE_WAY	An interface provided by the service provider that can be used by the service consumer to remove a subscription.
Subscription Notification	ONE_WAY	An interface provided by the service consumer to receive notifications from the service provider, regarding the creation or cancellation of a subscription of this user.
Capability	REQUEST_RESPONSE	An interface provided by the service provider that can be used to retrieve a machine-readable self-description of the service.

5 Service Data Model

This section describes the logical data structures to be exchanged between providers and consumers of the service.

This service uses an externally defined data model. Included in the service data model is a full description followed by specific extracts for;

- Navigational Warning Features and Information types
- Enumerations
- Complex Attributes

For complete and updated documentation refer to the latest S-124 Product Specification (chapter 6) which can be found on the IHO website under section IRCC/ WWNWS/ S-124NW.

5.1 Service Internal Data Model

As the S-124 data model used to represent the transmitted data is developed independently from this service specification, a way to store additional service metadata that is not directly related to the data model (internal service identifies, signatures, etc.) is required. For further information, refer to IALA Guideline 1157. This metadata is mostly implementation specific and therefore not discussed in this service specification. An example of how to implement this can also be found in the SECOM standard [5]. To indicate S-124 datasets that are coupled with additional service metadata, we refer to the type *S124DataSetResponse*.

6 Service Interface Specifications

This chapter describes the details of each service interface. The following sections describe the interfaces that must be provided by the service provider. According to IEEE, an interface is “a shared boundary across which information is passed” [6]. To establish a service for the exchange of NW information, information is mainly provided by the service provider and is requested from the service consumer via the interfaces of the service provider. However, requirement S-124R001 states that a consumer must be able to subscribe to updates of the service. On the technical level, this may be realized in different ways. For example, the SECOM standard [5] requires the consumer to expose interfaces, to which new information can be pushed directly. Other technical designs may use a message broker as a middleware between consumer and provider, such that the consumer must not expose any public interfaces. For this reason, consumer interfaces are modelled separately and may be implemented by other technical means as the service provider’s interfaces.

To ensure the integrity of the transmitted information, responses or requests from the service provider can be signed digitally by the service provider independently from the signature that is applied to the S-124 dataset itself. The transmitted data may be encrypted for transport. Authentication of service consumer is left as an implementation decision to the service provider.

Furthermore, interfaces that are used internally by an information service provider to transfer datasets from an internal information management system to the specified service are not discussed, as they are specific to those systems and not relevant for consumers of the service.

The Service Interface specification covers only the static design description while the dynamic design (behaviour) is described in chapter 7. The interfaces are designed to be compliant to the SECOM standard on a basic level. However, the SECOM standard explicitly prescribes the usage of certain technologies (such as REST). Therefore, this service specification provides an abstraction layer above SECOM, that makes it possible to also realize the interfaces with different technology stacks than SECOM.

6.1 Upload interface (consumer interface)

The purpose of this interface is to upload (push) Navigational warning datasets to a consumer. Hence, a consumer of the message format needs to implement this interface in order to receive Navigational Warnings from subscription or broadcast.

6.1.1 Operation

This operation is used both in single uploads (broadcast) and uploads during subscription. The parameter <FromSubscription> indicates true/false whether upload within or outside any subscription by the consumer.

When uploading the message, an acknowledgement can be requested which is expected to be received when the uploaded message has been delivered to end system.

6.1.2 Operation Functionality

The operation shall be used for uploading (push) S-124 datasets to a consumer. The operation expects one single signed S-124 Dataset in specified format as payload.

6.1.3 Operation Parameters

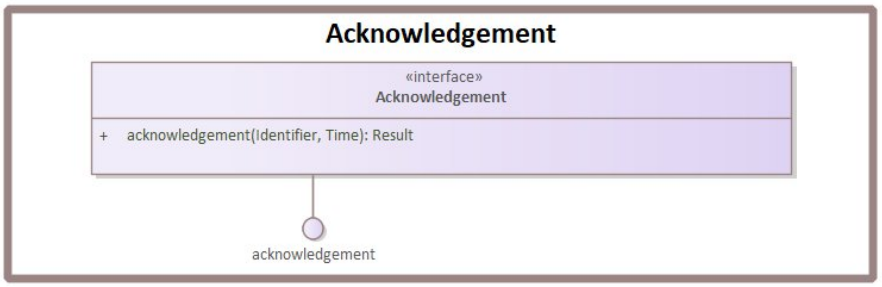
Parameters (in)	Type	Mult.	Definition
Data	S124DataSetResponse	1	Encapsulated S-124 Dataset which conforms to data product specification according to “S-124 Product Specification”
FromSubscription	Boolean	0..1	Flag to indicate whether the payload has been uploaded within an active subscription or not. True if within subscription
AckRequest	Boolean	0..1	True if acknowledgement is requested

ReturnType (out)	Encoding	Mult.	Definition
result from operation	see technical design	1	Any result from the operation, e.g. a Response Code that indicates Success or Failure

6.2 Acknowledgement interface

Optional interface provided to cater for acknowledgement of received navigational warnings.

6.2.1 Operation



During upload of information (see 6.1), an acknowledgement can be requested if the information has been delivered to the service consumer. The acknowledgement contains reference to the information product delivered.

6.2.2 Operation Functionality

The operation shall be used for uploading an acknowledgement when a navigational warning dataset has been successfully received.

6.2.3 Operation Parameters

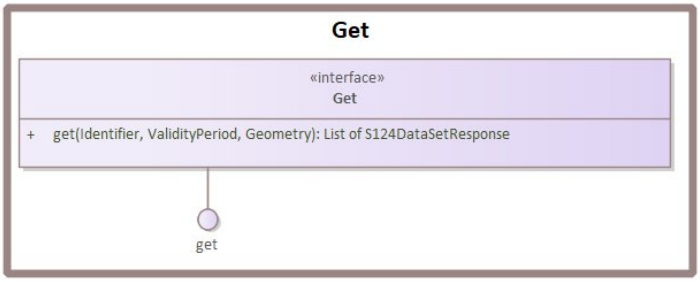
Parameters (in)	Encoding	Mult.	Description
Identifier	see technical design	1	ID of the acknowledged object
Time	see technical design	1	Time when received

ReturnType (out)	Encoding	Mult.	Description
result from operation	see technical design	1	

6.3 Get Interface

The Get interface is used for pulling Navigation warnings from a service producer, e.g. NAVAREA Coordinator. The consumer can filter for Navigational Warnings by its identifier, validity period and geometry.

6.3.1 Operation



6.3.2 Operation Functionality

The operation shall be used for retrieving Navigational Warnings from producer. If no parameters are given, the return all navigational warning datasets the consumer has been given access to by the Service Provider, filtered according to chosen parameters.

6.3.3 Operation Parameters

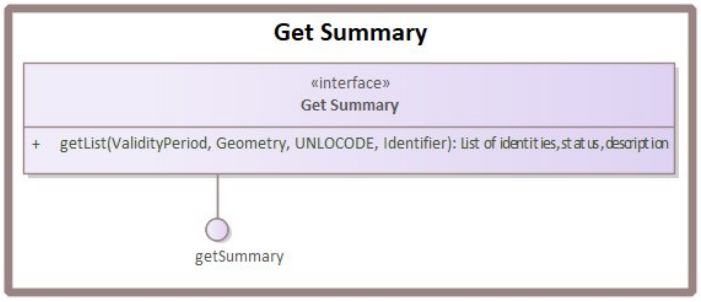
Parameters (in)	Type	Mult.	Description
Identifier	see technical design	0..1	Reference to information object e.g. from Get Summary result. The identifier can be provided as search criteria. A list of identifiers can be retrieved via Get List interface. If no identifier provided, it's up to the service to decide what to return.
ValidityPeriod	TimePeriod	0..1	Time Period (valid from, valid to) in which the data is valid.
Geometry	See technical design	0..1	Geographical Area to filter data sets. According to geometry element of the NavigationalWarningFeaturePart. Should be implemented in WKT CRS 2 (see ISO 19162) with EPSG projection 4326 – WGS 84.

ReturnType (out)	Type	Mult.	Definition
Response	List of S124DataSetResponse	0..*	List of navigational warning data sets.

6.4 Get Summary Interface

A list of accessible S-124 data sets is returned from this interface. The list contains reference to the identifier, a status and a short description. The identifier can be used to retrieve the full dataset via the Get interface.

6.4.1 Operation



6.4.2 Operation Functionality

The Get Summary interface should be used to get a list of available Navigational Warning datasets. These warnings are identified by their identifier, name, status and description. This is not equivalent to the in-force bulletin (as it is a stand-alone data set retrievable, e.g., via the Get interface).

6.4.3 Operation Parameters

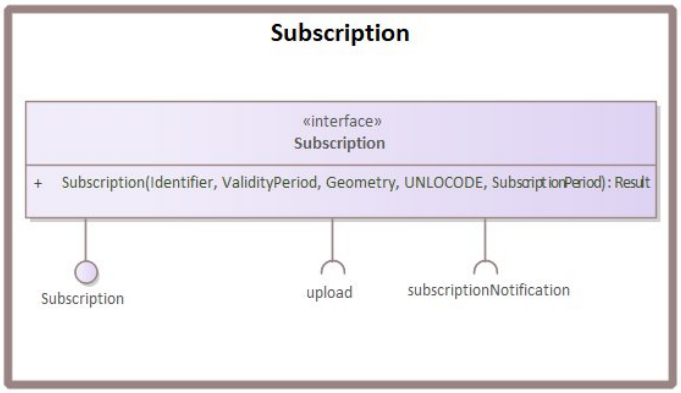
Parameters (in)	Type	Mult.	Description
Identifier	see technical design	0..1	Reference to information object e.g. from Get Summary result. The identifier can be provided as search criteria. A list of identifiers can be retrieved via Get List interface. If no identifier provided, it's up to the service to decide what to return.
ValidityPeriod	TimePeriod	0..1	Time Period (valid from, valid to) in which the data is valid.
Geometry	See technical design	0..1	Geographical Area to filter data sets.
UNLOCODE	UNLOCODE	0..1	UN/LOCODE to filter data sets.

ReturnType (out)	Type	Mult.	Definition
For each object: Identifier Name Status Description of information object	SummaryObject	0..*	List of information objects available.

6.5 Subscription Interface

The purpose of the interface is to request subscription on Navigational Warning datasets, either on specific parameters, or the information decided upon by information provider.

6.5.1 Operation



6.5.2 Operation Functionality

The Subscribe interface should be used to subscribe to Navigational Warnings. The specific NW-data is identified by the parameters. The ids of Navigational Warnings can be retrieved by the Get Summary interface. If no parameters are specified, the consumer subscribes to updates on all NW-datasets. The subscription can be cancelled with the Remove Subscription Interface or can be limited by specifying a subscription period. In a subscription, only updates are submitted to the service consumer. So therefore, it is recommended that a user subscribes to updates and initially requests all active NWs via the Get interface.

This interface consumes the following consumer interfaces

- Upload
- Subscription Notification Interface

6.5.3 Operation Parameters

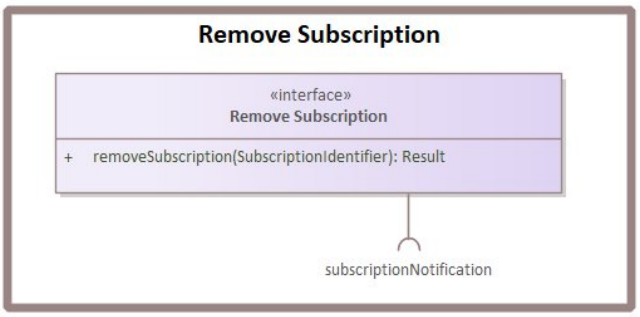
Parameters (in)	Type	Mult.	Description
Identifier	see technical design	0..1	Reference to information object e.g. from Get Summary result. The identifier can be provided as search criteria. A list of identifiers can be retrieved via Get Summary interface. If no identifier provided, it's up to the service to decide what to return.
ValidityPeriod	TimePeriod	0..1	Time Period (valid from, valid to) in which the dataset is valid.
Geometry	See technical design	0..1	Geographical Area to filter data sets.
UNLOCODE	UNLOCODE	0..1	UN/LOCODE to filter data sets.
SubscriptionPeriod	TimePeriod	0..1	The period for which the subscription is active (start and end time).

Return	Direction	Type	Description
Response	Output	Result	Confirmation or error message. Includes a Subscription Identifier on confirmation.

6.6 Remove Subscription Interface

Subscriptions are removed either internally by service provider, or externally by the consumer with this interface. This interface can be used by the consumer to remove a subscription.

6.6.1 Operation



6.6.2 Operation Functionality

The Remove Subscription interface should be used to remove Subscriptions, that were created earlier with the Subscription Interface.

This interface consumes the following interfaces

- Subscription Notification

6.6.3 Operation Parameters

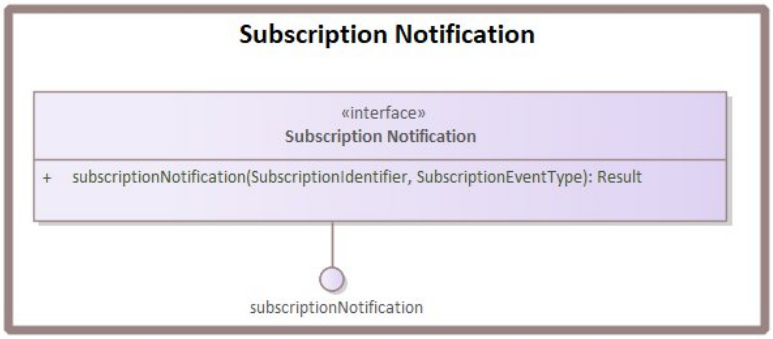
Parameter	Type	Direction	Description
SubscriptionIdentifier	see technical design	Input	Optional Specific identifier of the information object to remove subscription for. If no id entity provided, all subscriptions for the caller are removed.

Return	Direction	Type	Description
	Output	Result	Confirmation or error message

6.7 Subscription Notification Interface (Consumer Interface)

The interface receives notifications when a subscription is created or removed. This interface can be used to track subscription status at the consumer side.

6.7.1 Operation



6.7.2 Operation Functionality

This interface notifies a consumer of the service, when a Subscription was created or deleted.

6.7.3 Operation Parameters

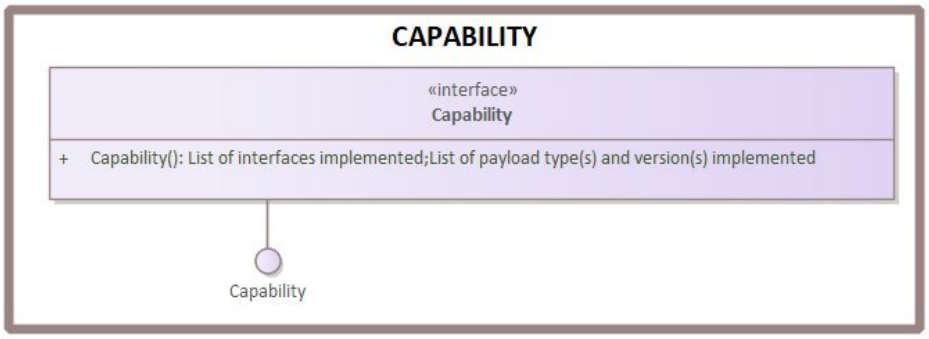
Parameter	Type	Direction	Description
SubscriptionIdentifier	see technical design	Input	Mandatory Specific identifier of the information object to remove subscription for. If no id entity provided, all subscriptions for the caller are removed.
SubscriptionEventType	Enumeration	Input	Mandatory Indicates whether the subscription with the provided identifier was created or deleted. 1- Subscription created 2 - Subscription removed

Return	Direction	Type	Description
	Output	Result	Confirmation or error message

6.8 Capability Interface

The purpose of the interface is to provide a dynamic method to ask a service instance what interfaces are accessible and what payload formats and version are valid.

6.8.1 Operation



6.8.2 Operation Functionality

This interface should be used to get a List of available capabilities of this service. This can also include any kind of Service Metadata. It is recommended to refer to the Capability data model from the SECOM standard (see SECOM section 5.7.13). It is especially recommended to utilize the dataProductType Enumeration (see SECOM section 5.6.7, in this case: dataProductType = “S124”) to harmonize information on the referenced data model.

6.8.3 Operation Parameters

Return	Direction	Type	Description
Response	Output	List of interfaces implemented;List of payload type(s) and version(s) implemented	Description of service capabilities (recommended to use the SECOM data model)

7 Service Dynamic Behaviour

This section describes the interactive behaviour between service interfaces and service consumers. The Navigational Warning Service supports three different types of dynamic behaviours, which are discussed in the following sections.

7.1 Client-initiated Retrieval of Navigational Warnings

The client-initiated retrieval is triggered by the client by querying the GetSummary Interface first, and then using the provided identifiers to retrieve a Navigational Warning Data Set by ID. Another possibility is a consumer-initiated call to the Get interface, providing search criteria for retrieving NWs in a specific spatial or temporal range. Finally, the consumer could provide no search parameters when calling the Get interface. This would return all or none of the available data to the consumer. Details will have to be defined in the service technical design.

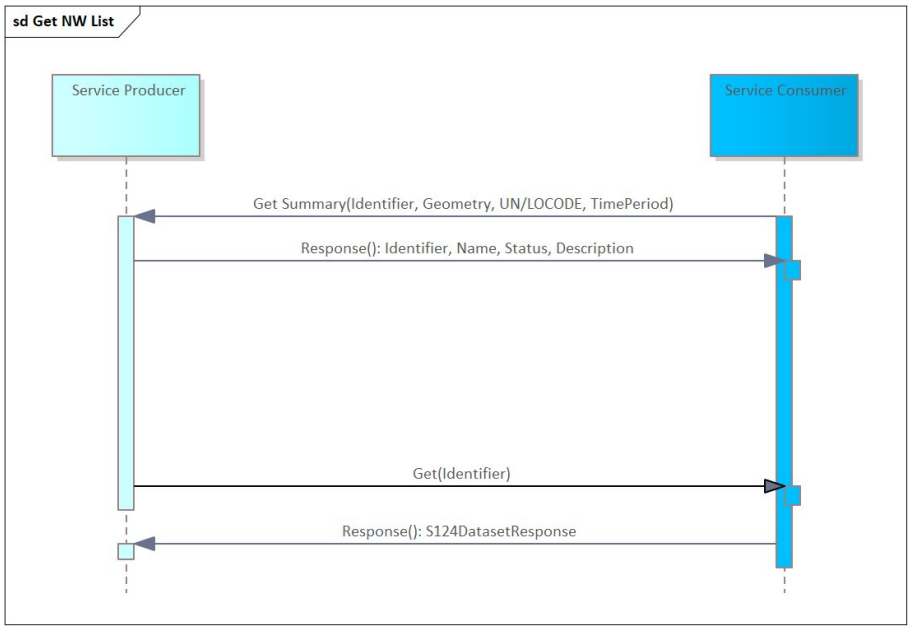


Figure 2 Manual retrieval of Navigational Warnings (needs update).

Service interface	Ship	NAVWARN distributor
Get	-	YES
Get Summary	-	YES
Capability	-	optional

Table 9: Interfaces for the Client-initiated Retrieval of Navigational Warnings.

7.2 Subscription of Navigational Warnings

The Subscription of Navigational Warnings is a consumer-initiated communication flow, in which the consumer actively registers for updates on navigational warnings.

The service consumer asks for a subscription of a specific set of NWs. Whenever an update of this set is available to the service provider, the UPLOAD interface is used to deliver this object to the service consumer. A subscription can also be removed with the REMOVE SUBSCRIPTION interface. In this case, updates are no longer delivered to the client. Directly after a SUBSCRIPTION is created or deleted a notification will be sent to the service consumer for confirmation.

Figure 4 illustrates the typical behaviour of subscriptions. First, a subscription is created by the service consumer with the SUBSCRIBE interface, this is confirmed by the SUBSCRIPTION CREATED NOTIFICATION. Then, whenever an update for the subscribed data is available to the service provider, the UPLOAD interface is used to push this information to the consumer. Depending on the implementation of the service, the consumer may answer to this information by sending an Acknowledgement to the ACKNOWLEDGEMENT interface (see Figure 3).

Figure 3 Upload message initiated by service provider with acknowledgement.

The subscription can be ended by the REMOVE SUBSCRIPTION interface and is confirmed by the SUBSCRIPTION REMOVED NOTIFICATION.

Note that the initial set of Navigational Warnings that are in-force is not automatically transmitted at the initiation of a subscription. Therefore, the service consumer needs to call the GetSummary / Get interface.

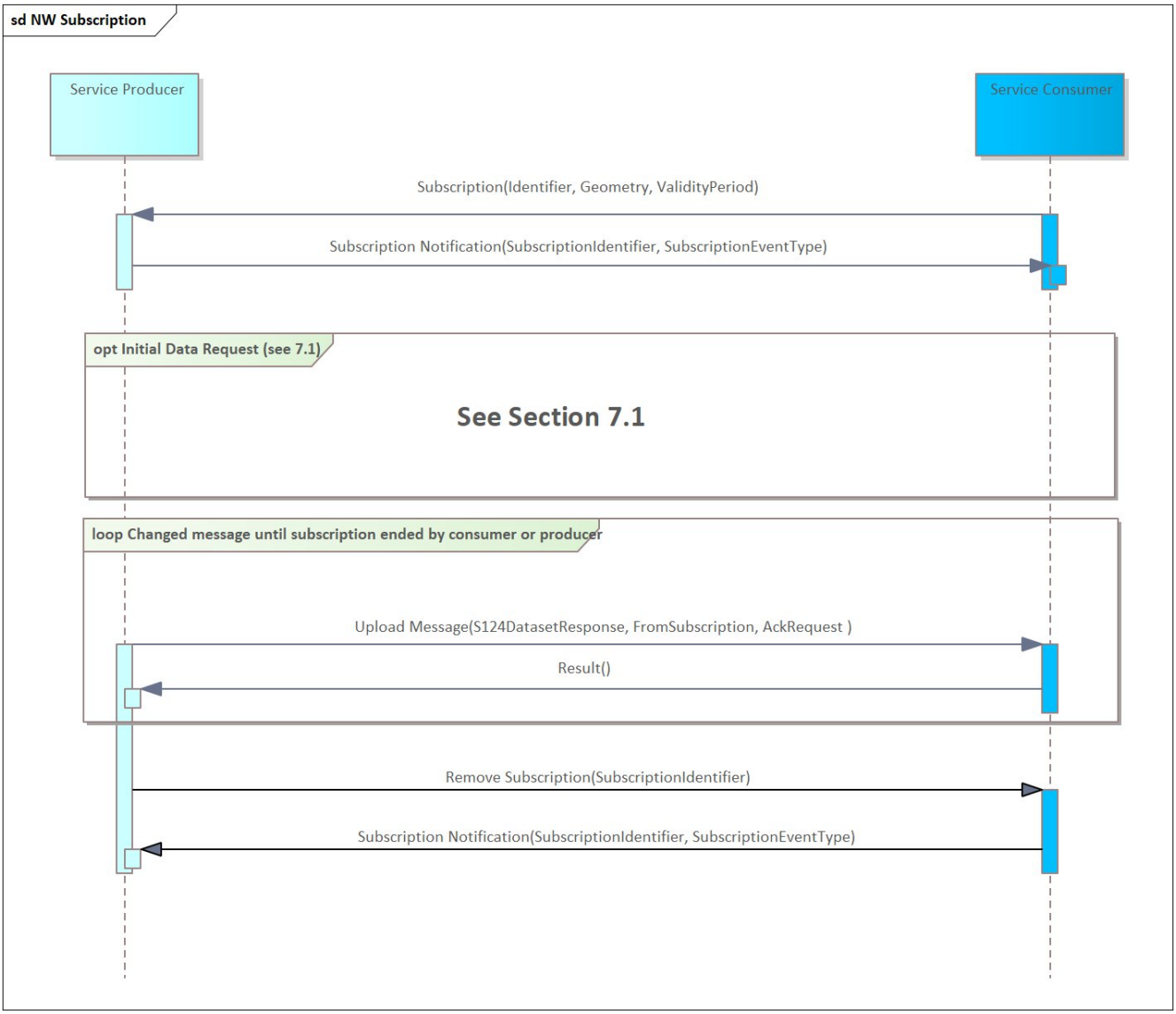


Figure 4 Subscription requested by external service

Service interface	Ship	NAVWARN distributor
Upload	YES	-
Acknowledgement	-	optional
Subscription	-	YES
Remove Subscription	-	YES
Subscription Notification	YES	-
Capability	-	optional

Table 10: Interfaces for the subscription of Navigational Warnings.

7.3 Broadcast of Navigational Warnings

Navigational Warnings may also be broadcasted to a larger amount of service consumers, similar to the procedure in NAVTEX. There are two possibilities to implement broadcast of NW:

b) The first procedure works similar to the subscription flow. However, if a NW is “broadcasted”, it is sent to all active subscribers of the NW service, regardless of what dataset they subscribed to (subscription parameters are ignored and the dynamic behaviour is identical to that defined in section 7.2).

Service interface	**Ship**	**NAVWARN distributor**
Upload	YES	-
Acknowledgement	-	optional
Subscription	-	YES
Remove Subscription	-	YES
Subscription Notification	YES	-
Capability	-	optional

Table 12: Interfaces for the Broadcast (Subscription-based) of Navigational Warnings.

Table 11: Interfaces for the Broadcast of Navigational Warnings.

c) For being able to receive broadcasted NWs in the second possible broadcasting procedure, a client must register its Upload interface in a service registry. If a new NW is being issued for broadcasting, the service provide will query the service registry for all available consumers and utilize their Upload interfaces to transmit the data. This happens independently from the subscription functionality. For the dynamic behaviour of registering a service in a service registry, please refer to the SECOM standard or the specification of the MCP’s Maritime Service Registry.

Service interface	**Ship**	**NAVWARN distributor**	**Service Registry**
Upload	YES	-	
Acknowledgement	-	optional	
Capability	-	optional	
Service Registration	-	-	YES
Service Instance Query	-	-	YES

Table 11: Interfaces for the Broadcast of Navigational Warnings.

Table 12: Interfaces for the Broadcast (Subscription-based) of Navigational Warnings.

References

Nr.	Version	Reference
[1] Service Documentation Guidelines	01.00	SG_Annex_A_Service_Documentation_Guidelines
xx.yy	Deliverable abc	
[2] Maritime Resource Name		Maritime Resource Name, ENAV17-n.n.n
[3] S-100 Universal Hydrographic Data Model	4.0.0	S-100 – UNIVERSAL HYDROGRAPHIC DATA MODEL https://iho.int/uploads/user/pubs/standards/s-100/S-100_Ed%204.0.0_Clean_17122018.pdf
[4] IALA Guideline G1128		THE SPECIFICATION OF e-NAVIGATION TECHNICAL SERVICES
[5] SECOM	ED1	IEC CD 63173-2 ED1: MARITIME NAVIGATION AND RADIOCOMMUNICATION EQUIPMENT AND SYSTEMS – DATA INTERFACE – Part 2: Secure communication between ship and shore (SECOM)
[6] IEEE Standard Computer Dictionary		IEEE. „IEEE Standard Computer Dictionary: A Compilation of IEEE Standard Computer Glossaries“. *IEEE Std 610*, 1990, 1–217. https://doi.org/10.1109/IEEESTD.1991.106963.
[7] ACCSEAS MSI-NM Model		https://academy.iala-aism.org/content/uploads/2016/08/accseas_s_100_product_description_msi_nm_maritime_safety_information_notice_to_mariners_v1.pdf
[8] S-124 Product Specification	Draft-v2.0	IHO GEOSPATIAL STANDARD FOR NAVIGATIONAL WARNINGS, 2019. https://iho.int/uploads/user/Inter-Regional%20Coordination/WWNWS/S-

Nr.	Version	Reference
		124PT/Working%20Documents/S124NW-CG_2019_EN_Product_Specification_Draft_v2.0.0_2019.06.30.pdf

8 Acronyms and Terminology

8.1 Acronyms

Term	Definition
API	Application Programming Interface
MC	Maritime Cloud
MEP	Message Exchange Pattern
MRN	Maritime Resource Name
NAF	NATO Architectural Framework
REST	Representational State Transfer
SOA	Service Oriented Architecture
SOAP	Simple Object Access Protocol
SSD	Service Specification Document
UML	Unified Modelling Language
URL	Uniform Resource Locator
VTS	Vessel Traffic Service
WSDL	Web Service Definition Language
XML	Extendible Mark-up Language
XSD	XML Schema Definition

8.2 Terminology

Term	Definition
External Data Model	Describes the semantics of the “maritime world” (or a significant part thereof) by defining data structures and their relations. This could be at logical level (e.g., in UML) or at physical level (e.g., in XSD schema definitions), as for example standard data models, or S-100 based data produce specifications.
Message Exchange Pattern	Describes the principles how two different parts of a message passing system (in our case: the service provider and the service consumer) interact and communicate with each other. Examples: In the Request/Response MEP, the service consumer sends a request to the service provider in order to obtain certain information; the service provider provides the requested information in a dedicated response. In the Publish/Subscribe MEP, the service consumer establishes a subscription with the service provider in order to obtain certain information; the service provider publishes information (either in regular intervals or upon change) to all subscribed service consumers.
Operational Activity	An activity performed by an operational node. Examples of operational activities in the maritime context are: Route Planning, Route Optimization, Logistics, Safety, Weather Forecast Provision, …
Operational Model	A structure of operational nodes and associated operational activities and their inter-relations in a process model.
Operational Node	A logical entity that performs activities. Note: nodes are specified independently of any physical realisation.

	Examples of operational nodes in the maritime context are: Maritime Control Center, Maritime Authority, Ship, Port, Weather Information Provider, …
Service	The provision of something (a non-physical object), by one, for the use of one or more others, regulated by formal definitions and mutual agreements. Services involve interactions between providers and consumers, which may be performed in a digital form (data exchanges) or through voice communication or written processes and procedures.
Service Consumer	A service consumer uses service instances provided by service providers. All users within the maritime domain can be service customers, e.g., ships and their crew, authorities, VTS stations, organizations (e.g., meteorological), commercial service providers, etc.
Service Data Model	Formal description of one dedicated service at logical level. The service data model is part of the service specification. Is typically defined in UML and/or XSD. If an external data model exists (e.g., a standard data model), then the service data model shall refer to it: each data item of the service data model shall be mapped to a data item defined in the external data model.
Service Design Description	Documents the details of a service technical design (most likely documented by the service implementer). The service design description includes (but is not limited to) a service physical data model and describes the used technology, transport mechanism, quality of service, etc.
Service Implementation	The provider side implementation of a dedicated service technical design (i.e., implementation of a dedicated service in a dedicated technology).
Service Implementer	Implementers of services from the service provider side and/or the service consumer side. Anybody can be a service implementer but mainly this will be commercial companies implementing solutions for shore and ship.
Service Instance	One service implementation may be deployed at several places by same or different service providers; each such deployment represents a different service instance, being accessible via different URLs.
Service Instance Description	Documents the details of a service implementation (most likely documented by the service implementer) and deployment (most likely documented by the service provider). The service instance description includes (but is not limited to) service technical design reference, service provider reference, service access information, service coverage information, etc.
Service Interface	The communication mechanism of the service, i.e., interaction mechanism between service provider and service consumer. A service interface is characterised by a message exchange pattern and consists of service operations that are either allocated to the provider or the consumer of the service.
Service Operation	Functions or procedure which enables programmatic communication with a service via a service interface.
Service Physical Data Model	Describes the realisation of a dedicated service data model in a dedicated technology. This includes a detailed description of the data S-124 to be exchanged using the chosen technology. The actual format of the service physical data model depends on the

	chosen technology. Examples may be WSDL and XSD files (e.g., for SOAP services) or swagger (Open API) specifications (e.g., for REST services). If an external data model exists (e.g., a standard data model), then the service physical data model shall refer to it: each data item of the service physical data model shall be mapped to a data item defined in the external data model. In order to prove correct implementation of the service specification, there shall exist a mapping between the service physical data model and the service data model. This means, each data item used in the service physical data model shall be mapped to a corresponding data item of the service data model. (In case of existing mappings to a common external (standard) data model from both the service data model and the service physical data model, such a mapping is implicitly given.)
Service Provider	A service provider provides instances of services according to a service specification and service instance description. All users within the maritime domain can be service providers, e.g., authorities, VTS stations, organizations (e.g., meteorological), commercial service providers, etc.
Service Specification	Describes one dedicated service at logical level. The Service Specification is technology-agnostic. The Service Specification includes (but is not limited to) a description of the Service Interfaces and Service Operations with their data S-124. The data S-124 description may be formally defined by a Service Data Model.
Service Specification Producer	Producers of service specifications in accordance with the service documentation guidelines.
Service Technical Design	The technical design of a dedicated service in a dedicated technology. One service specification may result in several technical service designs, realising the service with different or same technologies.
Service Technology Catalogue	List and specifications of allowed technologies for service implementations. Currently, SOAP and REST are envisaged to be allowed service technologies. The service technology catalogue shall describe in detail the allowed service profiles, e.g., by listing communication standards, security standards, stacks, bindings, etc.
Spatial Exclusiveness	A service specification is characterised as “spatially exclusive”, if in any geographical region just one service instance of that specification is allowed to be registered per technology. The decision, which service instance (out of a number of available spatially exclusive services) shall be registered for a certain geographical region, is a governance issue.

Appendix A Service Specification XML

This appendix contains the formal definition of the service specification.

To be done.