Outcome from Demonstrations

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MARITIME ITS

Intelligent Ship Transport System

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0.1	MH	02.09.2024	First draft
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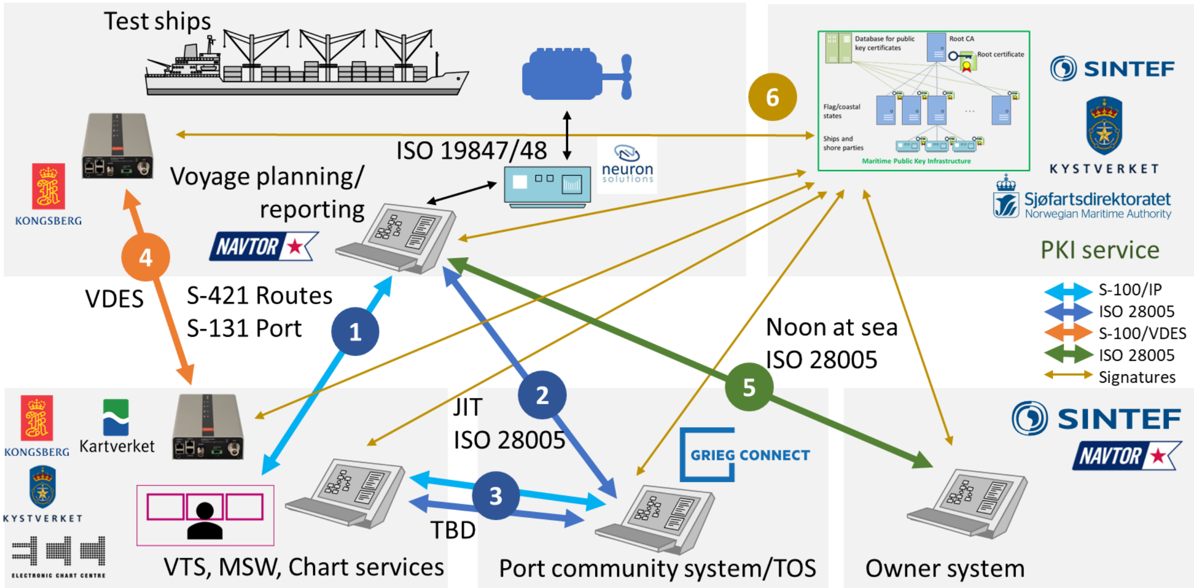
Executive Summary

This report gives an overview of the most important outcomes from the work done with the demonstrations in the ISTS project. This report builds on the demonstration plan as described in Report R5.1. This report focuses on the *Port Call demonstrations over IP protocols* (blue circles with number 1, 2 and 3 in the figure below).



The blue circle numbered 1 covers Pilot A3.1 which is about doing route planning based on available reference route with action point data and to combine this with port asset data. As part of this, an online tool was development to do the mapping from routes in RTZ format to routes in S-421 format. Further, Norwegian port data, *Havnedata*, has been converted to S-131 format by using the IHO Singapore Lab tool. Also, a desk top study on the coding of unique IDs has been done, and feedback to both IHO and the Norwegian Mapping Authority has been provided.

Pilot A5.1 is covered by the blue circles numbered 2 and 3, and this is about port call planning done on the ship together with coordination at the port side to ensure just in time arrival at the port and port optimization. This pilot focused on describing the collaboration process between port and terminals to agree on arrival times to the port and terminals. This process is based on the work done by ITPCO, but this is refined to be used for small, Norwegian ports. The message implementation guide for this is described according the Just in Time data set in the IMO compendium and the technical standard ISO 28005 for Electronic Port Clearance.

Terminology and abbreviations

AIS Automatic Identification System

API Application Program Interface

CG Correspondence Group

CCG Canadian Coast Guard

CHS Canadian Hydrographic Service

CMDS Common Maritime Data Structure

EGDH Expert Group on Data Harmonization (sub-group of IMO FAL Committee)

EMSWe European Maritime Single Window Environment

FAL Facilitation Committee in IMO

GIS Geografiske Informasjons Systemer

GML Geography Markup Language

GNSS Global Navigation Satellite System

GT Gross Tonnage (for ships)

HF High Frequency (Short wave radio)

HTTP Internet hypertext transfer protocol, secure version as HTTPS

IALA International Association for Aids to Navigation and Lighthouse Authorities

ICT Information and Communication Technology

IEC Standards organization International Electrotechnical Commission

IEC TC80 International Electrotechnical Committee Technical Committee 80

IHO International Hydrographic Office

IMO International Maritime Organization

IP Internet Protocol

IRDM IMO Reference Data Model

ISO International Organization for Standardization

ITPCO International Taskforce Port Call Optimization

ITS Intelligent Transport System

JSON JavaScript Object Notation

kbps Kilo-bits per second

MF Medium frequency (medium wave radio)

MIRA Maritime ICT Reference Architecture

MRN Marine Resource Name

MSC Maritime Safety Committee in IMO

MSW Maritime Single Window

NIPWG IHO Nautical Information Provision Working Group

NTOU National Taiwan Ocean University

PCS Port Community System

PKI Public Key Infrastructure

RTZ Route Plan Exchange Format (Traditional)

S-100 The new hydrographic system for description of electronic chart s and overlays

S-131 Marine Harbour Infrastructure

S-131PT S-131 Project Team

S-421 Route Plan Exchange Format (New)

SIP Strategic Implementation Plan of e-navigation

SOLAS IMO Convention on Safety of Life at Sea

SOSI Samordnet Opplegg for Stedfestet Informasjon

REST Representational State Transfer (architectural style for HTTP and similar systems)

UNECE UN Economic Commission for Europe (Responsible for UN/EDIFACT maintenance)

UN/EDIFACT Messaging standard developed and maintained by UNECE.

VDE VHF Data Exchange (2-300 kbps sub-channel of VDES)

VDES VHF Data Exchange System (Not yet fully standardized). Will include the existing AIS.

VHF Very High Frequency – for ships this is approximately 156 MHz to 174 MHz. Mostly voice communication, but AIS and VDES uses digital channels in this band.

VTS Vessel Traffic Services

WCO World Customs Organization

XML Extensible Markup Language

1 Introduction

This report gives an overview of some outcomes from the demonstrations performed during the ISTS project. The demonstrations are further described in Report R5.1 [1], see Figure 1 taken from this report. The numbers in the circles represent six main use cases as briefly described as follows:

1. Sending nautical information about the port from, e.g. the VTS, PCS or from other source to the planning station, containing e.g. routes and port data. Relevant formats are S-421 (Reference routes/Initial routes) and S-131 (Port infrastructure information).

2. Agreeing on arrival time through the ISO 28005 JIT protocol. Estimated, requested, planned times + required ship data. This is identical to the first phase of the digital corridor demonstration defined by Rotterdam and Singapore [2]. The simplest form of this would be one notification of arrival time and one confirmation from the port as a response on this.

3. Transfer between PCS/MSW and VTS to exchange information about planned and actual arrival. This may also cover nautical information to ships. The idea here is that the MSW can assist in certain business to business data exchanges between ship and port.

4. Real-time route suggestions or nautical data from VTS or update of arrival time over VDES during port approach.

5. Noon-at-sea reporting via Neuron data collection (fuel consumption, RPMs etc). A new data model for noon reports are added to the IMO Compendium and also be supported by ISO 28005. Data collection on ship can use ISO 19847 or other protocols as appropriate.

6. It is also desirable to include a PKI infrastructure to save and distribute public signature certificates. This is mostly relevant for the ISO 28005 messages related to port call arrangement, but this may also be used by S-100 type data exchanges.

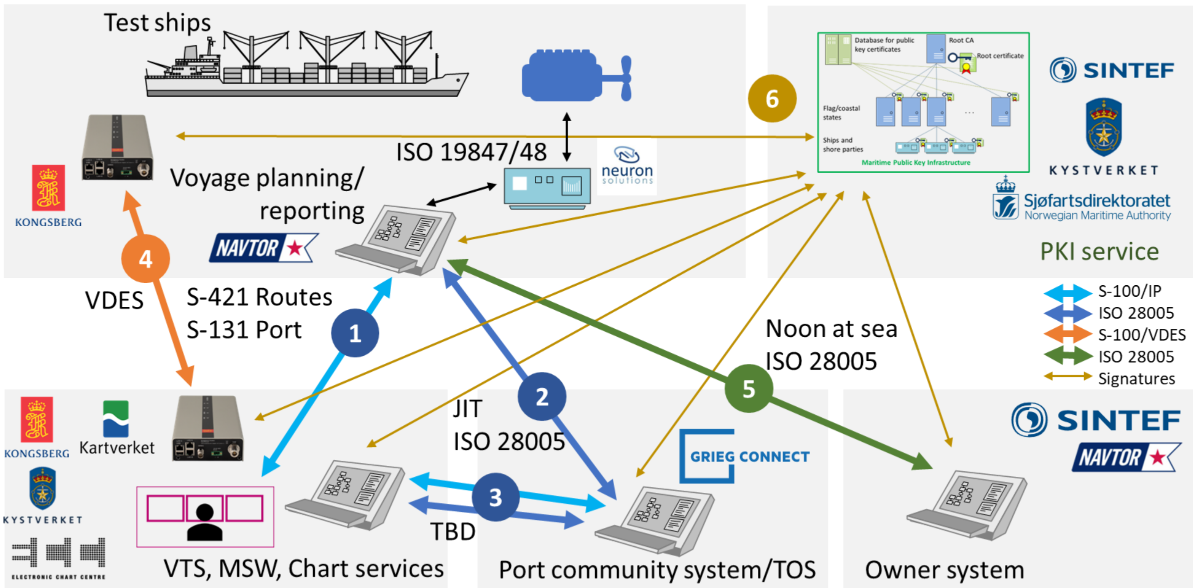


Figure 1 – Baseline demonstration concept

This report focuses on the *Port Call demonstrations over IP protocols* (blue circles with number 1, 2 and 3 from Figure 1). Pilot A3.1 as described in Report R5.1 relates to the blue circle numbered 1, while Pilot A5.1 as described in Report R5.1 relates to the blue circles numbered 2 and 3.

2 Scenario A3.1 Route Planning from Reference Routes and Actions and Harbour Data

2.1 Underlying Process: Voyage Planning at Departure

This scenario relates to the **Departure passage planning** process as described by ITPCO ([3] and [4]), which is the voyage planning from departure port to arrival port done by the ship master about **3 weeks before** port arrival. In principle, this will have to be repeated before departure from each port on the route. Necessary input is nautical publications, reference routes and more specific port and terminal related information. This should also include establishing as accurate as possible arrival and departure time to allow speed optimization. The demonstration related to this scenario has focused on the planning of voyage through usage of reference routes as described by the S-421 format and information about port assets as described by the S-131 format, see Figure 2.

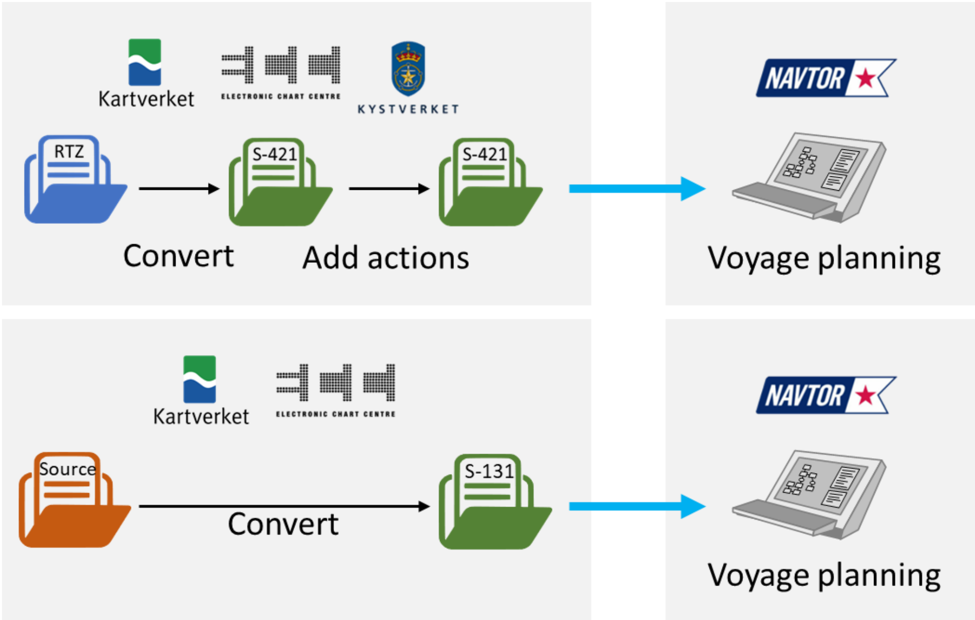


Figure 2 – Schematic concept of route planning from S-421 and S-131

The focus in this work has been to convert existing RTZ messages to the S-421 format (see Section **Error! Reference source not found.**) and to convert the Norwegian *Havnedatasystem* to S-131 format for Marine Harbour Infrastructure by using an internationally facilitated production system for this data provided by IHO (IHO Singapore Lab) (see Section 2.3).

Figure 3 shows the sequence diagram for this scenario, where only two parties are involved, namely the ship doing the voyage planning and the NDP (Nautical data Provider) providing route information on S-421-format and information about port infrastructure on S-131 format.

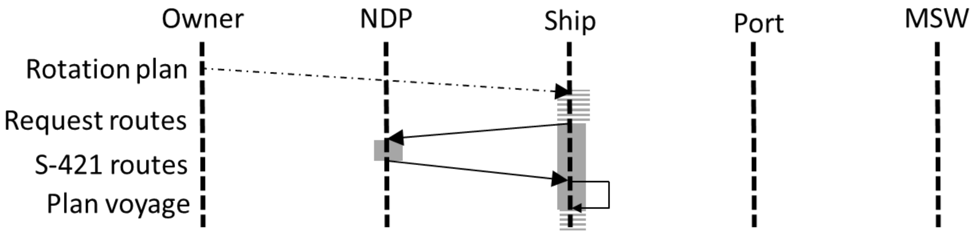


Figure 3 – Sequence diagram case A3.1

2.2 Development of RTZ to S-421 Online Converter Tool

The project has developed an online route converter application that can convert digital routes used for navigation from the RTZ data format to the new S-100 derived format S-421 (Route Plan Exchange Format, available from [5]), Figure 4. The route converter is freely available globally for anyone who wishes to use it for suitable purposes at https://s421creator.ecc.no/index.html . For players in the global maritime sector who develop and facilitate solutions related to S-421 routes, the converter will be a useful tool.

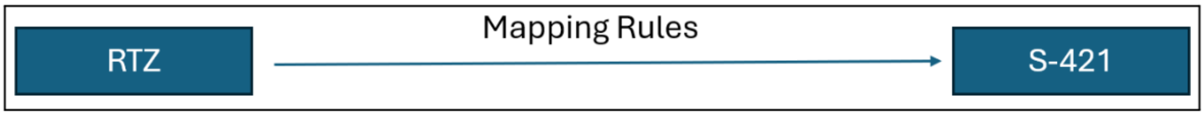


Figure 4 RTZ to S-421 conversion

The S-421 Converter works by loading an RTZ route file into a developed online interface, Figure 5:

Figure 5 S-421 Converter interface (1)

Then, fill in relevant route information, such as versioning, identifiers, name, status, length, permitted draft (max draft allowed on vessel), available sailing height (for example under bridges, air spans, etc.) and general descriptions, Figure 6:

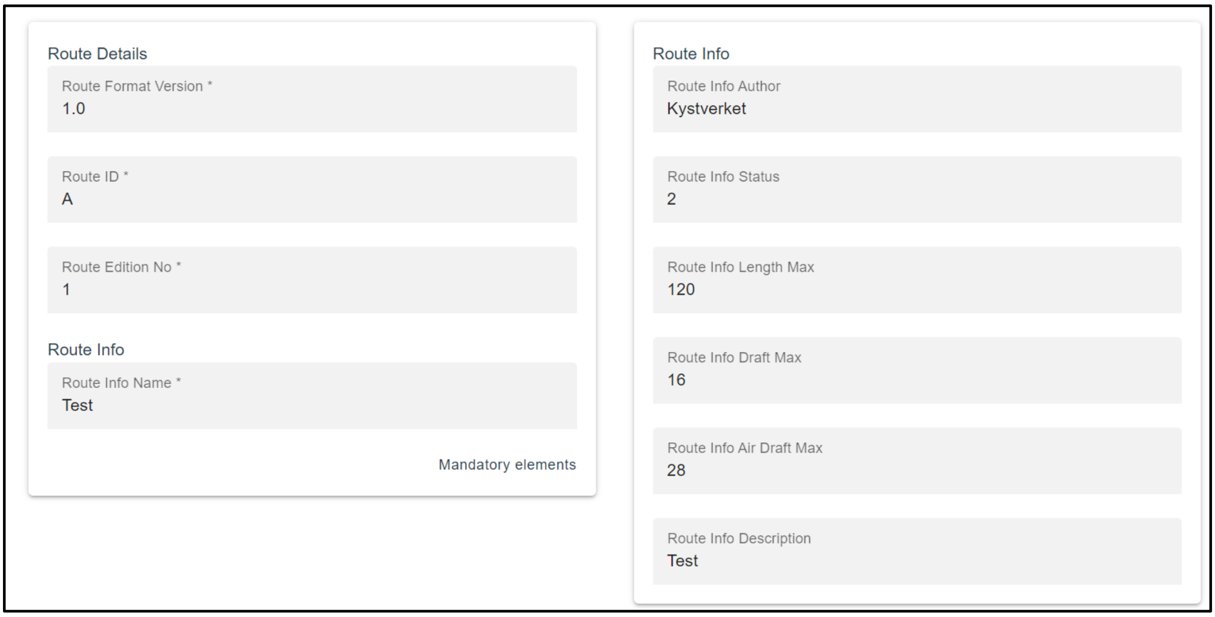


Figure 6 S-421 Converter interface (2)

It is also possible to enter Action Points manually, even if this is not part of the RTZ format, and only can be encoded in the S-421 format. Information is then encoded along the route. This will instruct the user of the route to take action when he is made aware of the information encoded in the Action Point. An example is to instruct the user to contact the port of call to get further instructions about port calls, Figure 7:

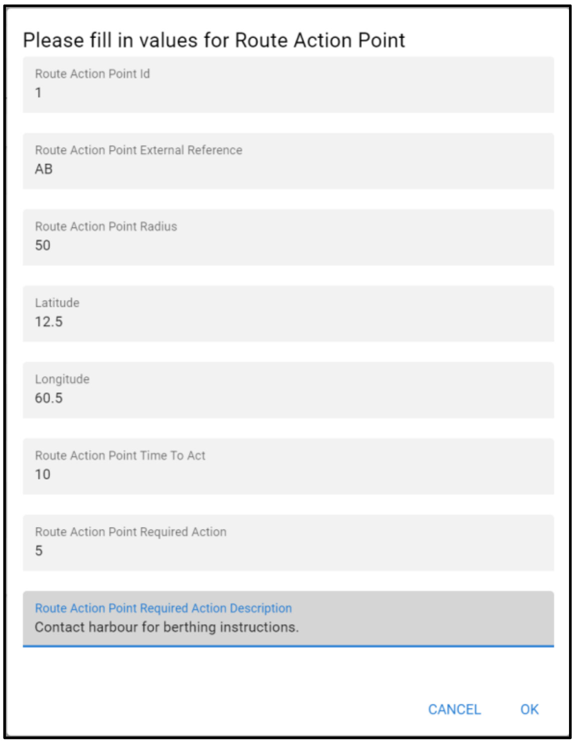


Figure 7 S-421 Converter interface (3)

When all the information has been entered, press submit. The converted route is generated and made available at the destination where you retrieved the original route, Figure 8:

Figure 8 S-421 Converter interface (4)

S-421 routes are encoded in GML format, and this can be easily retrieved in XML compatible software to examine the content and see the structure of the generated dataset. Here is an example of the Action Point information encoded in the S-421 dataset, Figure 9:

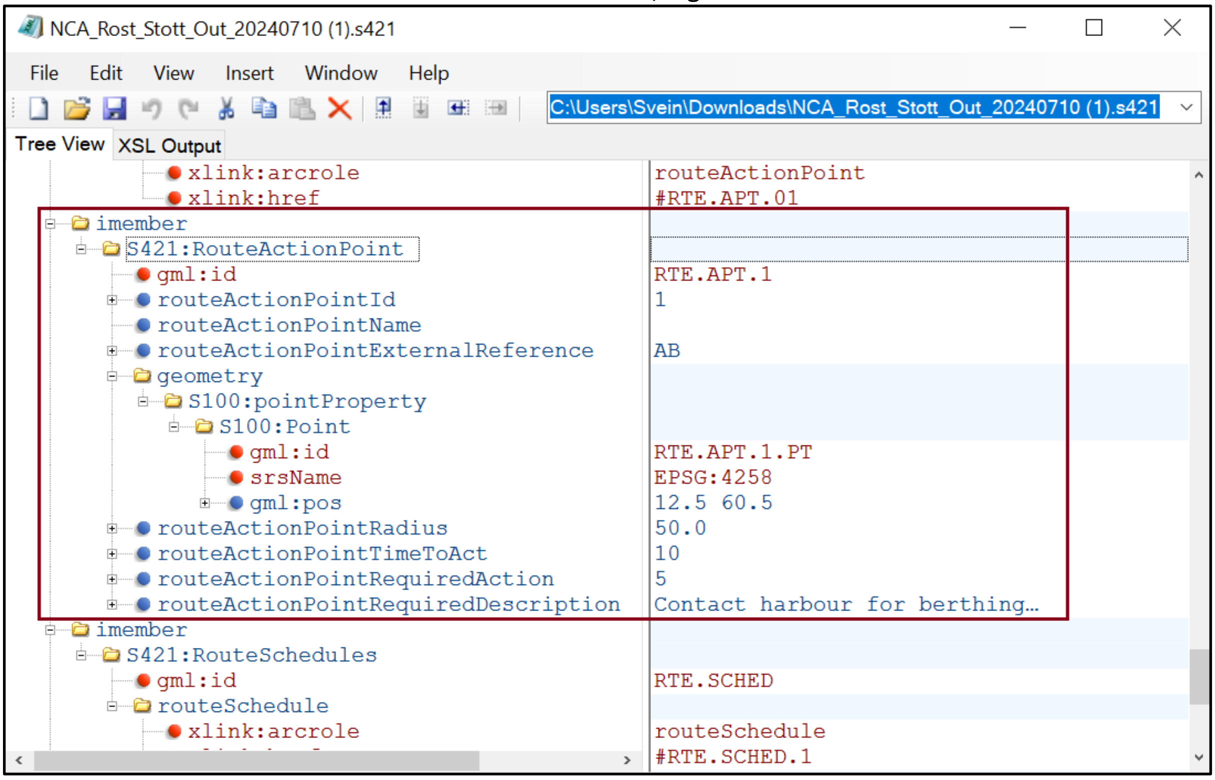


Figure 9 Action Point encoded in a S-421 data set

S-421 Converter har blitt utviklet i samhandling med Kystverket. Kystverkets representant i prosjektet har definert krav til funksjonalitet og innehatt rollen som tester av løsningen underveis i utviklingen. Kystverkets representant er den i prosjektet med førstehånds kunnskap om S-421. Representanten representerer Norge og Kystverket i IEC som utvikler S-421 produktspesifikasjonen.

Løsningen ble "stresstestet" på et møte i IHO Nautical Information Provision Working Group (NIPWG) i september 2024. Da ble det verifisert at tjenesten fungerte optimalt med 29 samtidige oppkoblinger, :

The S-421 Converter was developed by ECC in collaboration with the Norwegian Coastal Administration (NCA). The Norwegian Coastal Administration's representative in the project has defined requirements for functionality and has tested the solution during the development. The Norwegian Coastal Administration's representative is the one in the project with first-hand knowledge of S-421. NCA has participated in IEC/TC80 that develops the S-421 product specification.

The solution was "stress tested" at a meeting of the IHO Nautical Information Provision Working Group (NIPWG) in September 2024. At that time, it was verified that the service functioned optimally with 29 simultaneous users, Figure 10:

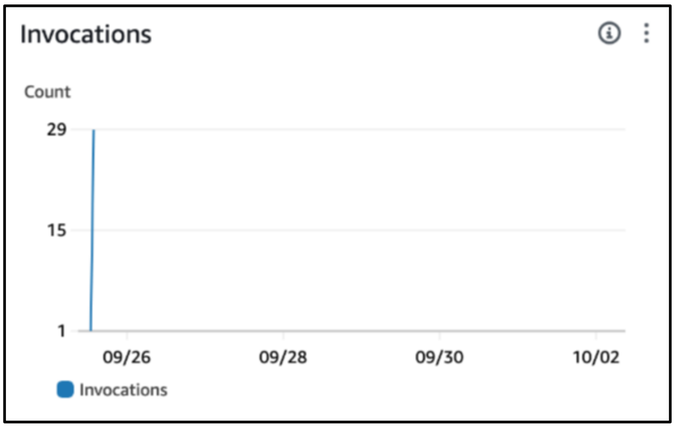


Figure 10 29 registered users

The S-421 Converter is also available via IHO, through their resource portal where, among other things, S-100 compatible software is listed. Reference to the S-421 Converter is now available there, Figure 11:

Software Provider	Application	S-101	S-102	S-104	S-111	S-124	S-129
KHOA	KHOA S-100 viewer Free	Ed.1.0.0	Ed.1.0.0		Ed.1.0.0		
NIWC	NIWC S-100 viewer Free	Ed.1.2.0	Ed.2.2.0	Ed.1.1.0	Ed.1.2.0	Ed.1.0.0	Ed.1.1.0
I4Insight	dKart S-101 Converter Free	Ed.1.0.0					
Teledyne Geospatial	CARIS Easy view Free	Ed.1.2.0	Ed.2.2.0				
	HPD and Composer	Ed.1.4.1					
	BASE Editor		Ed.2.2.0				
	CARIS Cloud		Support		Support		
Esri Inc	ArcGIS Pro 3.3	Ed.1.2.0	Ed.2.1.0				
IIC	Feature Builder[2]	Ed.1.1.0					
	Exchange Set Builder	Yes	Yes	Yes	Yes	Yes	Yes
7Cs	Analyzer for Validation	Ed.1.1.0					
	FME based S-57 to S-101 conversion	Ed.1.1.0					
ECC/PRIMAR	IHO S-100 Ed4 and Ed5 SA protection application	Support	Support	Support	Support	Support	Support
ECC	GDS(Geodata Distribution Server)	Support	Support	To be supported	Support		

- Other applications available: S-421 Converter Free (ECC Provide)

Figure 11 S-421 Converter available at IHO Resources

The inclusion of the S-421 Converter in the IHO Resource Portal has increased the accessibility of this tool for the maritime standardization and development community. NCA and ECC have also promoted the S-421 Convertor at several national and international standardization meetings and conferences. In the final phase of the project, we have identified potential improvements that can be taken forward:

● Further development according to the new version of the S-421 product specification that is being prepared by the IEC.
● Create drop-down menus for attributes with code list values.
● Consider setting up an API to automate the upload of RTZ / return of S-421.
● Development of a graphical display of the routes that are uploaded[1].
● Interaction with the graphical display for defining positions, for example Action Point positions.

2.3 Converting *Havnedata* to S-131 by using IHO Singapore Lab

ECC has through this project tested the IHO Singapore Lab tool to covert the Norwegian *Havnedata* to the S-131 format (Marine Harbour Infrastructure). In earlier projects, ECC has prepared a theoretical mapping from the Norwegian port data model *Havnedata* to the international S-131 model. There are some challenges in doing the mapping between the two models due to differences in scope and packaging format. Basically, S-131 has a scope that goes beyond the physical elements of a port, in contrast to *Havnedata* which only focuses on land-based physical infrastructure. In addition, *Havnedata* is encoded in the SOSI (Coordinated Arrangement for Location Information) format while S-131 is encoded in the GML format.

During 2024,ECC hired a student trying to develop a tool to convert *Havnedata* to S-131, similar to the S-421 Converter. Such a tool could potentially provide good value for the Norwegian Mapping Authority's Maritime Division and Norwegian ports in order to produce *Havnedata* in S-131 format.

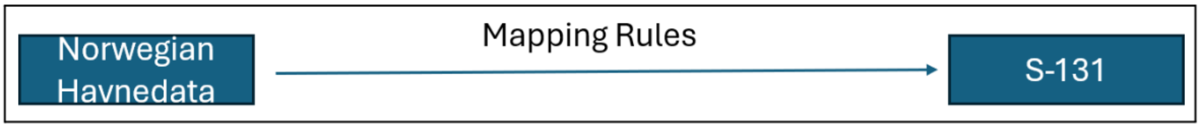
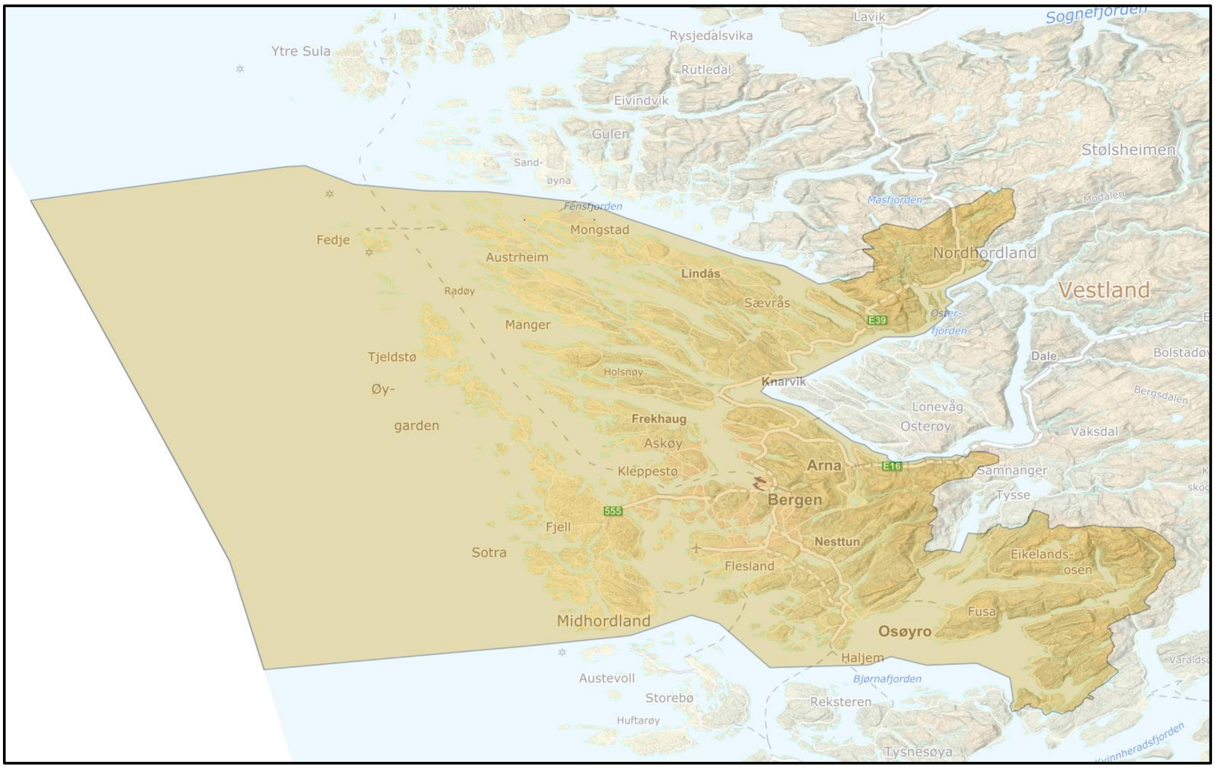


Figure 12 S-421 Converting Norwegian *Havnedata* to S-131 by using Mapping Rules

Due to the size of the S-131 model, which is one of the larger data models derived from the S-100 format, there was a need to be able to automate the setup of mapping rules in the developer's Java code approach, Figure 12. Unfortunately, this effort was not successful. Instead, data for *Havnedata* was produced by using the tool IHO Singapore Lab, which is a web-based tool developed by IIC Technologies and National Taiwan Ocean University (NTOU). Port data for Port of Bergen, Norway, was produced by using the IHO Singapore Lab online S-131 production tool, see Figure 13 for a visualization of the administrative port area and how information is encoded in the file format itself (GML):

[1] Work on the graphical display of routes was started by a summer student, but has not yet been implemented in the application.



Feature	Value
131N100_NOBGO — HarbourAreaAdministrative	
displayName	true
(Derived)	
(Actions)	
gml_id	HarbourAreaAdministrative.2
displayName	true
language	nor
name	Bergen Havn
uNLocationCode	NOBGO
locationMRN	urn:mrn:iho:test:s100:no:no01:test:nobgo:harbourareaadministrative:000001

Figure 13 Administrative Port Area in Port of Bergen

In the work with the IHO Singapore Lab online tool, data from *Havnedata* was extracted from the Norwegian Mapping Authority's Maritime Division databases with the help of the Norwegian Mapping Authority's Maritime Division representative. The extracted dataset was further fragmented into a selection of files in GeoJson format which were then imported into the Singapore Lab tool, before the information was further processed. Object and attribute information in the source data was linked to the correct object and attribute classes in the S-131 model, Figure 14.

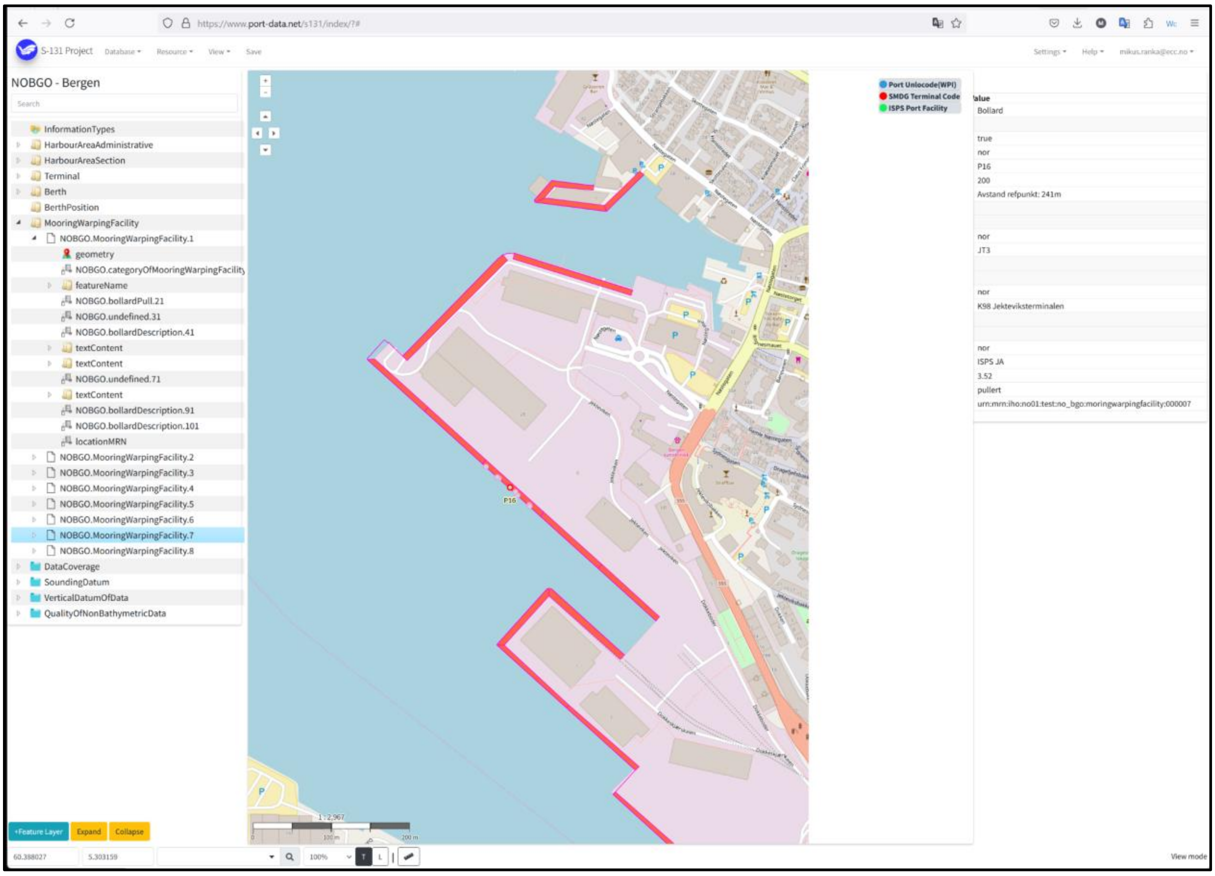


Figure 14 Quay front codes as a Berth in the IHO Singapore Lab Tool

When producing data in S-131 format for test purposes, a number of challenges and faults in the IHO Singapore Lab tool were discovered and further communicated back to the developers of the tool:

- The tool does not save the added objects.
- GML data files are unresponsive and hence do not load in.
- Although only S-131 GML files can be loaded, this is not made clear in user documentation.
- Once the mapping rules are established, it should be possible to save them in a rule file for reuse on different ports using the same schema geojson file.
- It is only possible to choose one feature to import.
- It is not possible to see the adding from the loaded source at individual features level
- When choosing to add the locationMRN attribute, there is no way to add a text string of the MRN - there is no input field provided.
- The Export to S-131 function does not work , the screen just briefly moves up and down and then the same window of export stays on screen. No other feedback is shown on the screen, so it is not possible to know if the export is successful, and where it is saved.
- With regards to geometry and too dense vertices: It should be possible to reuse the existing data that the ports have added in the *Havnedata* database, being their official geometries. If too dense number of vertices is a problem for the tool, perhaps a solution should be sought to cater for the native geometries coming from the port data.
- When importing the GeoJson data to S-131 with the chosen Harbour Facility object, it is not possible to choose the attributes and their mapping. (It only allows to map the last attribute mapped for the last import, and it is not shown when it chooses this attribute).
- The attribute choice is only a very thin empty line on the screen. Preferably it should be possible to map the locationMRN , the name and the textContent attributes.

Feedback was also provided to the Norwegian Maritime Authority with input on the Norwegian port data model, and to the NIPWG and S-131 Project Team (S-131PT) with input on the S-131 data model related to Berth bearing. Berth bearing may be information that should be considered for inclusion in the model – at least for portrayal purposes. As the Berth can now be encoded as geometry of type line, the geometry could probably be used by an end user system to identify the bearing of the line. We propose that S-131PT report a need for portrayal of this information in end user systems, Figure 15.

IHO Definition: Place in which a ship is moored at wharf.				
S-10x Geo Feature: Berth (BERTHS)				
Super Type: Layout (5.6)				
Primitives: point, curve, surface				
Real World	Paper Chart Symbol		ECDIS Symbol	
S-10x Attribute	**S-57 Acronym**	**Allowable Encoding Value**	**Type**	**Multiplicity**
Available Berthing Length			RE	0, 1
Bollard Description			TE	0, 1
Bollard Pull			RE	0, 1
Minimum Berth Depth			RE	0, 1
Elevation	(ELEVAT)		RE	0, 1
Cathodic Protection System			BO	0, 1
Category of Berth Location		1 : Wharf Reference Metre Mark 2 : Wharf Reference Position 3 : Pier (Jetty) 4 : Conventional Mooring	EN	0, 1
Port Facility Number			TE	0, 1
Bollard Number			TE	0, 2 (ordered)
GLN Extension			TE	0, 1
Metre Mark Number			TE	0, 2 (ordered)
Manifold Number			TE	0, 2 (ordered)
Ramp Number			TE	0, 1
Location by Text			TE	0, 1
Method of Securing		1 : Bow to Seaward	EN	0, 1

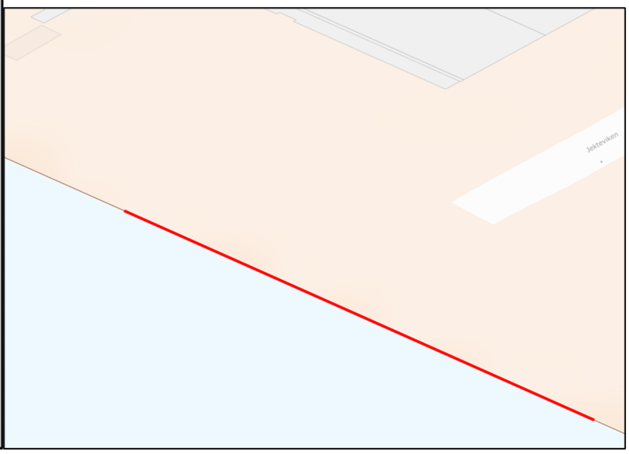


Figure 15 S-421 Berth Bearing

A suggested improvement regarding *Havnedata* provided to the Norwegian Maritime Authority's Maritime Division are that *havneanleggId* and *havneanleggNavn* are not encoded in accordance with the "registration instructions". The *havneanleggNavn* seems to be encoded for the *havneanleggId*, Figure 16.

Egenskaper	Beskrivelse	Datatype	Multiplisitet
Fellesegenskaper	Se kapittel 3.1 (tabell 6 og 7)		[1..1]
HavnId	Se kapittel 3.2 HavnId		[0..1]
havneanleggId	Unik identifisering av det enkelte havneanlegg.	Tekst	[0..1]
havneanleggNavn	Navn på havneanlegg. Navn bør stemme overens med SafeSeaNet.	Tekst	[0..1]
ISPS	Boolsk verdi som angir om havneanlegget er et ISPS Havneanlegg.	Boolsk(ja/nei)	[0..1]

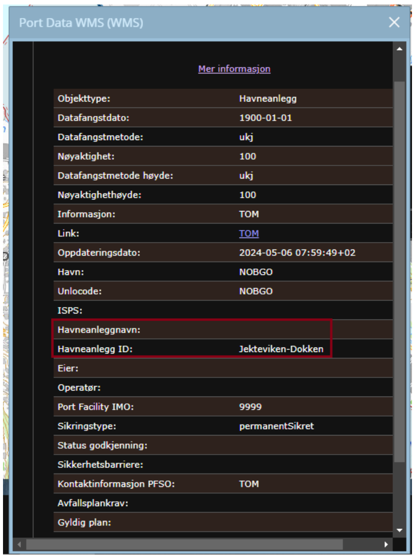


Figure 16 Error in coding of havneanleggID and havneanleggNavn

2.4 Desktop Study on Coding of Unique Ids

Furthermore, through coding unique identifiers (unique ID) on objects, the project demonstrated the benefits of using unique IDs across digital geo-located products. The work on port data has resulted in input to the international standardization work under the auspices of IHO as well as input to the Norwegian national port data model. This demonstration was performed as a desktop study, since S-131 is a phase 2 product according to IHO's S-100 Implementation strategy, Figure 17. IHO is in the process of producing operational versions of a number of product specifications built on the S-100 framework. The amount of product specifications compared to available development resources has made it necessary to prioritize. Therefore, IHO has defined 2 phases for the development of the product specifications in its S-100 Implementation strategy, with a focus in the first phase on those products that will be used for route monitoring. Since S-131 is in Phase 2, this means that the maturity is still some way off from being operational. Therefore, incorporating support for receiving, displaying and using the product in end-user tools such as planning stations and back-of-bridge systems is not currently at the top of the priority list.

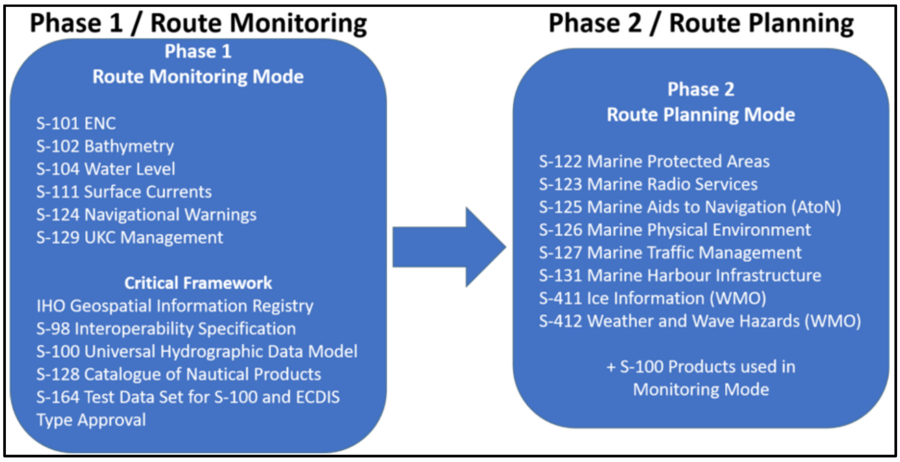


Figure 17 IHO S-100 Implementation plan

The main purpose of this test was to demonstrate how S-131 and S-421 can be used to provide clarity in port-to-ship communication. This test contributes to the availability of S-131 and S-421 test data according to the graphical representation defined in the ISTS demonstration plan, Figure 1. It will serve as an example of digital communication between shore and ship using products built within the S-100 framework. The example demonstrates the use of a common, unique MRN identifier across products, and show the benefits of unique identification of information found or referenced in different products.

The goal of this desktop study was to:

- Produce an S-131 port data dataset for the Dokken Port Facility in the Port of Bergen.
- Demonstrate the usability of port data encoded in the S-131 format.
- Produce an S-421 route dataset leading to the Dokken Port Facility in the Port of Bergen.
- Demonstrate the usability of route data encoded in the S-421 format.
- Demonstrate the use of digital information exchange in communication between shore and ship.
- Provide feedback and input to the development team behind the national specification for port data.
- Provide feedback and input to the IHO S-131 development team.
- Demonstrate the use of unique identifiers (MRN) across the two products.

The use case is described as follows:

- The ship has access to the S-131 data set for the Port of Bergen.
- The captain on board contacts the port to request guidance to the berth.
- After the request, an S-421 route is sent containing the planned route from the current position to the port basin in the Port of Bergen.
- The port authority handles the request:
    - Based on the size of the ship and weather forecasts of strong winds from the east, a decision is made to berth the ship at Jektevikskaien, berth JT3 in the Dokken Port Facility, with specific instructions to use the bollards with a pulling force >= 150 tons.
- The port creates an S-421 route containing Action Point information.
- The route data set contains relevant references in Action Point (using MRN) to different types of port information (Port Area Administrative, Port Area Section, Terminal, Berth, Mooring Facilities (bollards)).
- Also, the specific bollards with a pulling force >= 150 tons are referenced using the MRN in the Action Point information.
- The port sends the updated route to the ship.
- The ship receives the updated route.
- The updated route is loaded into the chart system/planning system, and becomes available there together with the S-131 port data.
- The captain and the bridge crew can now visually see the route and the port-specific information (berth and bollards) visually on the chart screen, and can start planning the docking/mooring operation.

As described above, port data for Bergen Port was produced in the S-131 format. This data was encoded with unique identifiers that could be referenced in the route dataset. Theoretically, it should then be possible to display both port data and route data in a planning system/end-user system on board a vessel. As objects have the same identifiers in the different products (S-131 and S-421), displaying in the end-user system can utilize the fact that objects with same identifiers are actually the same objects, and this can be used to support planning operations to arrive at the berth and do mooring at the berth. Here are examples of unique IDs used in both products (highlighted in blue in Figure 18):

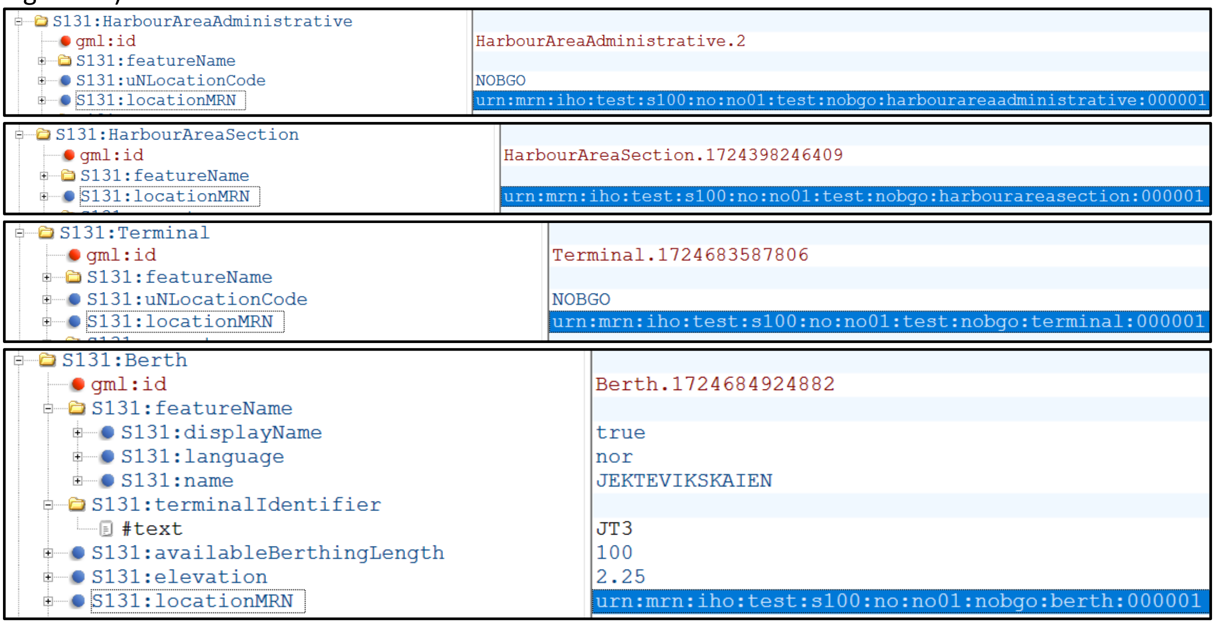


Figure 18 MRN encoded in S-131 *Havnedata* format

Figure 19 MRN Coded in S-421 Route Data set:

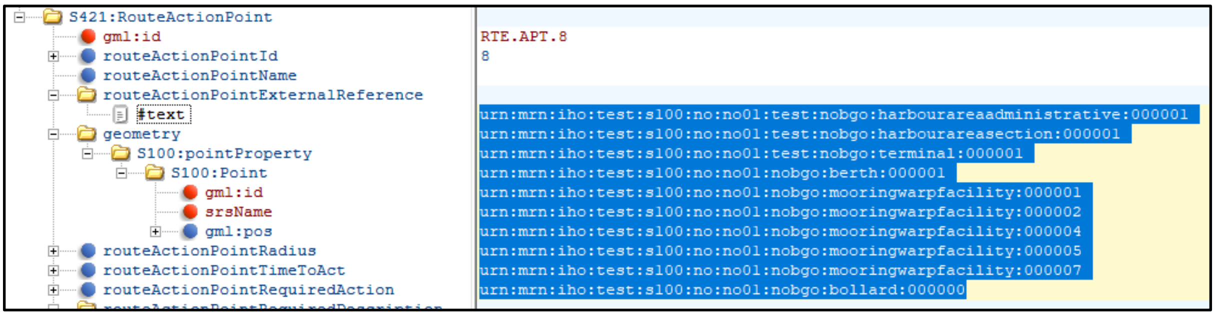


Figure 19 MRN Coded in S-421 Route Data set

An important part of this test was the actual preparation of the MRN codes. In the S-100 framework, MRN is identified as an approved mechanism for providing unique IDs to information encoded in S-100 compatible datasets. MRN consists of human-readable text strings. Currently, there are no official guidelines for how to structure these text strings. In this test, we developed our own logic for building the MRN identifiers. As a result of this work, we described our logic to the IHO NIPWG for developing IHO guidelines for the use of MRN. Figure 20 contains an overview of our defined MRN structure with justification for each element of the text string.

MRN considerations:
Currently a specific guidance on the encoding of MRN information is not yet developed in the S-100 framework. The reasoning for the MRN encoding logic is therefore explained here in more detail, for use in future MRN discussions in the IHO standardisation bodies:

String component	Explanation
urn:	set by the MRN schema
mrn:	set by the MRN schema
iho:	set by the MRN schema
test:	to indicate that the following schema is only for testing purposes. Will not be present in the approved schema.
s100:	main theme identifier. Identifies that the digital twin object is from the S-100 standard's series exchange data (as per the general IALA recommendations for MRN application).
no:	identifies country (as per the general IALA recommendations for MRN application)
no01:	identifies the data responsible authority generating the mrn for the mentioned theme and country.
nobgo:	Localises the port location. Most likely the majority countries, especially the ones using the Singapore S-131 web tool, will use the S-131 for one UNLOcode port.
featurename:	feature name as registered in the IHO GI registry in the context of S-131 product specification.
numeric code:	as agreed within the project, the six number numeric ID code. Random, but unique for the same S-131 object type (featureName).

Figure 20 MRN Setup and Explanations

Results from the desktop exercise are described in the following:

Task	Result
Produce an S-131 port dataset for Dokken Port Facility in Bergen Port.	We succeeded in producing a port dataset in the S-131 format for Dokken Port Facility in Bergen Port. The dataset contained information about Port Area Administration, Port Area Section, Terminal, Quay and Mooring Facilities.
Demonstrate the usability of port data encoded in the S-131 format.	The dataset was loaded into GIS software (QGIS) to verify visual display and access to object/attribute information. Thus, the usability of the data was verified. Furthermore, information encoded in the dataset (MRN) was reused in the production of route datasets.

Produce an S-421 route dataset leading to Dokken Port Facility in Bergen Port.	The S-421 route dataset leading to Dokken Port Facility in Bergen Port was produced.
Demonstrate the usability of route data encoded in the S-421 format.	The desktop exercise showed the potential for encoding Action Point information with instructions to the route user included. Potential functionality in end-user tools for how the user is notified of the desired action was not demonstrated.
Demonstrate the use of digital information exchange in communication between shore and ship.	This was described as a theoretical exercise only.
Provide feedback and input to the development team behind the national port data specification.	An inconsistency in the encoding of port data was discovered and reported back to the development team behind the national port data specification, see Annex A, page 32.
Provide feedback and input to the IHO S-131 development team.	A potential improvement for S-131 was identified and reported back to the S-131 development team. In addition, many improvements were made to the IHO Singapore Lab tool based on our input, see Annex A, page 32.
Demonstrate the use of unique identifiers (MRN) across the two products.	Encoding of unique MRN information across products was demonstrated. Furthermore, the intended use of the information in end-user systems was theoretically described.

A complete overview of the test scenario and specific feedback produced and provided to the Norwegian Mapping Authority's Marine Division, IHO NIPWG, IHO S-131PT and IHO Singapore Lab is available in Annex A, page 32.

3 Scenario A5.1 Port Planning and Service Arrangements

3.1 Underlying Process: Port Arrival Planning

This scenario relates to the **Port planning arrival planning** process as described by ITPCO ([3] and [4]), which is the port planning done immediately before arrival in port, e.g. **less than three hours before**. This consists of agreeing on ETA and location for any pilot boarding, as well as ordering other services directly related to arrival, such as the use of tugs, VTS, linesmen etc. This scenario demonstrates the preparation for a port call, including ordering of services, Figure 21. Each service has to be ordered in a separate message sequence, so the scenario only includes one service request, e.g. instructions for cargo handling in the form of discharge and loading plans.

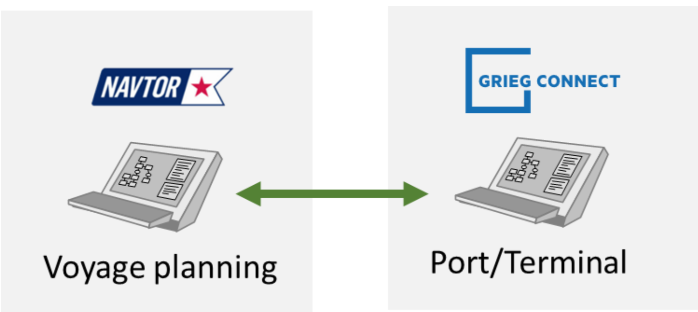


Figure 21 – Service ordering scenario

It is assumed that this can be done via the planning station, possibly as a pre-programmed action from the passage plan. Figure 22 shows the sequence diagram. This is a simple exchange of a request and acknowledgment with the inclusion of an estimated, requested and planned service start time.

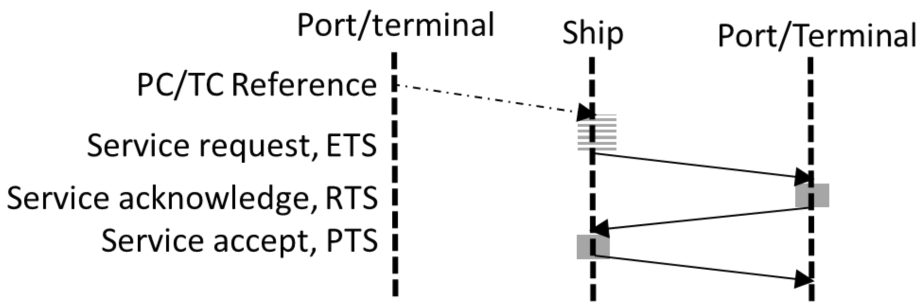


Figure 22 – Service ordering sequence diagram

3.2 Implementation in Norwegian Ports

The ITPCO initiative described in [3] and [4] has large ports as Rotterdam as their starting point when describing the port as the coordinator between all port actors to ensure just in time arrival of ships and port optimization. For Norwegian ports, the implementation may look like indicated in Figure 23.

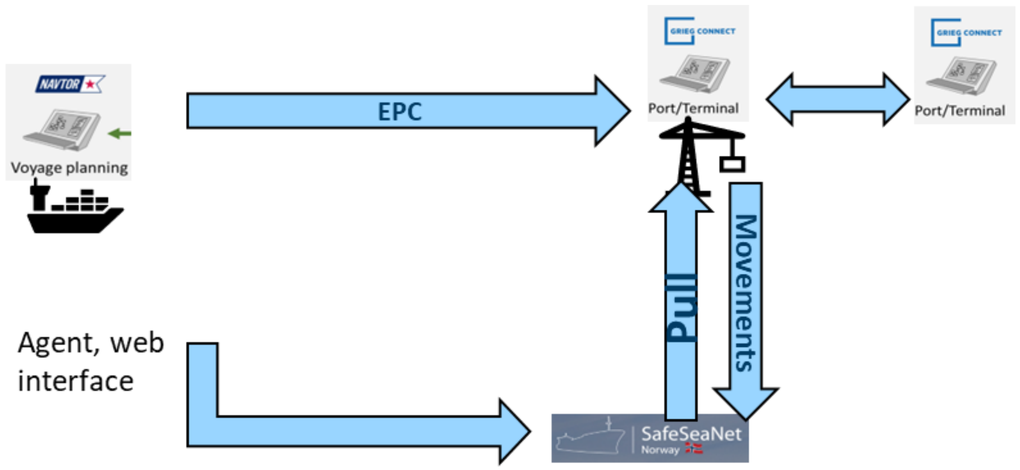


Figure 23 Implementation of JIT Coordination for Norwegian Ports

Typically, agents enter information about port calls in the **SeafeSeaNet (SSNN)** system. Every 15th minute, port calls from SSNN are imported to the Port Community System (PCS) (for several Norwegian ports this is the Port Community System from Grieg Connect called Port) and matched against already existing port calls. Port calls can also be entered directly to the Port system (PCS), and then, later, be entered to SSNN. This is the case for instance for cruise ships where the booking to the port is done for instance one year in advance.

In this demonstration, we have investigated how to implement JIT arrival for Norwegian ports, by sending EPC (Electronic Port Clearance) messages to a PCS. One possibility for coordination for Norwegian ports is to use the PCS as the coordination centre which receives port clearance requests, timestamps and service requests from the ship side, and coordinates the port call with all the port actors.

Also, when EMSWe is introduced in 2025, more details of ship movements during a port call need to be reported. As this information is already available in the Port system, this can be sent to SSNN directly, and further to EMSWe.

Also, the project has demonstrated the benefits of using unique IDs across digital geo-located products, as this is as critical pre-requisite for a ship being able to order a berth from a digital planning station, and to have positional information about this berth in the ECDIS. It is also important to decide on how to maintain these IDs.

3.3 Message Implementation Guide for Just in Time (JIT) Arrival Data Set

This section describes a Message Implementation Guide as it relates to the IMO Compendium and the ISO28005 standard on Electronic Port Clearance.

3.3.1 Overview of the JIT Arrival Coordination

The main data elements related to JIT negotiation are shown in Figure 24:

- Location: The location where the time is related to, for instance the general identification of the arrival port described by the UNLOCODE, the LAT/LON coordinates of the pilot boarding place (PBP) or the identification of the berth to call at.
- Time type: A tag describing the time as *Estimated*, *Requested*, *Planned*, or *Actual*, dependent on where in the process the time is used.
- Timestamp: This is the date and time, including the time zone.
- Maritime Service: Maritime services may be part of the JIT Arrival information for critical services, for instance pilotage and tugboats. In those cases where these services are needed, their availability must be checked and confirmed as part of the negotiation process in the port.

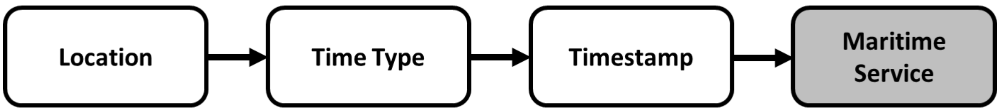


Figure 24 Main JIT data elements

Figure 26 shows the sequence diagram of a just-in-time port call planning process that is initiated by the ship. A prerequisite for tFigure 26 JIT Arrival Message Sequence: Port-Terminal Coordination message exchange to start is that the ship and terminal already have completed their contractual work to decide which berths in which terminals are available for a certain ship, see the square *Ship-Terminal contractual phase* at the top of Figure 26.

The role of the port in this description is to give clearance to the ship to enter the port and also to coordinate the calls at the different terminal berths during the port call (port planner role). The role of the terminal is that of a berth planner and to respond to the coordination done by the port.

The message exchange regarding JIT Arrivals should not start too early. Typically starting time is at the departure from the previous port or alternatively, about 48 hours before the arrival to the port. When the arrival is getting closer, for instance about 20 hours before the arrival, new ETAs will be known by the ship, and new ETAs and ETDs can be sent to the port. This can start a more detailed planning process as the timestamps now are more reliable. When updated ETAs are received, the same process as described in Figure 26 is repeated with new and more accurate values of the time stamps. This process can be repeated several times. The final round of negotiations of the time stamps typically starts 2-12 hours before arrival to the port, dependent on the contract that the ship is sailing under and the size of the port area, among other factors.

The message exchange is initiated when the ship sends the ETAs and ETDs for the port call and for the list of berths to visit, to the *Port Coordination ICT,* which is the ICT system that holds the role of *Port Planner*. The *Port Coordination ICT* receives the arrival requests from the ship. Based on this, the *Port Coordination ICT* coordinates the arrivals of the ship to all terminals during this port call.

The *Port Coordination ICT* does the coordination with the *Terminal ICT* systems. In Figure 26, two different terminal ICT systems are shown. Each of the terminals may coordinate the arrival to one or more berths during a port call. Also, the same berth can be visited more than once during a port call. The sequence diagram in Figure 26 shows an example with two terminals represented by *Terminal ICT-1* and *Terminal ICT-2*, where the ship requests a call to one berth in the first terminal and to two berths in the second terminal.

The coordination between the port and the terminals is performed differently in different locations, dependent for instance on the ICT systems, the level of digitalization and the size of the port. The coordinated process is indicated in Figure 26 by the square named *int Port and Terminal Coordination*. The result of the coordination between the port and the terminals are a set of RTAs and RTDs to the port and to the list of berths requested by the ship. These RTAs and RTDs are sent by the *Port Coordination ICT* to the ship.

The ship confirms the arrival and departure times to the port and to the berths by sending the PTAs and PTDs to the port and to the terminals.

3.3.2 Background

This section contains a simple message implementation guide for the just in time arrival subset. It specifies how the just in time arrival subset in the IMO Compendium can be used when implementing APIs (Application Programming Interfaces) to support the Just in Time (JIT) concept for the negotiation of arrival and departure times to and from a port and terminals. It is based on the possibility to have direct communication between the actors at the seaside and the actors at the shore side. The seaside is represented by the ship and some ship representative, and the shore side is represented by the berth planner in a terminal representing the terminal operator, the port authority responsible for the clearance of ships to the port, and the port coordinator responsible for coordinating the negotiation of ship arrivals and departures to the port and the berths between the different port actors.
This description is based on the business processes for the JIT concept found in IMO GIA Just in Time Arrival Guide[2], ITPCO Port Information Manual[3], and the Just-In-Time arrival sub-model from IMO FAL[4].

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[2] IMO GIA Just In Time Arrival Guide:
https://greenvoyage2050.imo.org/wp-content/uploads/2021/01/GIA-just-in-time-hires.pdf

[3] ITPCO Port Information Manual:
https://portcalloptimization.org/images/Port%20Information%20Manual%203.02.pdf

[4] FAL47/7/5 REVIEW AND REVISION OF THE IMO COMPENDIUM ON FACILITATION AND ELECTRONIC BUSINESS, INCLUDING ADDITIONAL E-BUSINESS SOLUTIONS Just-In-Time arrival sub-model, Submitted by Norway, Singapore, UNECE, WCO, ISO, BIMCO and IPCSA

This guideline describes a service where the ship side actors and the shore side actors exchange information about arrival times and departure times to specific locations related to a port call. The purpose of this service is to ensure close collaboration and well-defined data exchange between ships, ship agents and ship operators representing the ship, and all actors on the shore side, including port authorities, terminal operators, and maritime service providers (eg. tug boats, pilots, linesmen, bunkers, electricity, waste disposal).

This guideline describes the usage of four different time types for the arrival time, and the same for the departure time, namely *Estimated, Requested, Planned*, and *Actual*.

3.3.3 Communication

The JIT negotiation involves asynchronous communication between sender and receiver, since the handling of a request at the receiver's side may involve several other ICT systems where some of them also may involve human interactions. An example of this is when a request for several movements in a port are sent to different terminal operators for approval.

3.3.4 Roles

The following roles are used in the description of the JIT arrival message exchange:

The Ship side:

The ship operational software system (SHIP, Figure 26) onboard the ship will be the main source used for requesting arrival to and departure from the various locations in the port and terminal since the captain onboard will know the latest updates on the times to be used. Other software systems representing the ship is also relevant, for instance software systems used by the ship agent, the ship manager, the ship operator and the charterer of the ship.

The ship side system will both be the sender and receiver of messages as it will both send time and location information to the Port Coordination Centre, and possibly also directly to the terminals, and also receive updates on times and location from the Port Coordination Centre.

The Shore Side:

The port coordination software system (PORT COORDINATION CENTRE, Figure 26) on the port side will receive requests for arrival to and departure from locations in ports at specific times and will also coordinate requests to different local software systems for the terminals and other service providers in the port. The ship will send requests for berth arrivals to the Port Coordination Centre. A prerequisite for this is that the ship representatives and the terminals already have a general agreement for the usage of the terminal.

The shore side system is both the sender and receiver of messages as it will both send updated time and location information to the ship, and also receive times and location requests and updates from the ship side and also from the terminal side.

Each of the terminals may have their own software (TERMINAL 1, TERMINAL 2, etc) to receive and send requests, either machine to machine or through a user interface to the berth planner or the service provider organizer.

The Port Coordination Centre also represents the port authority, and the clearance messages are sent to this system. This system will coordinate the requests to terminals and terminal services.

3.3.5 Physical Architecture

Figure 25 shows an example outline of the physical ICT architecture for the JIT implementation.

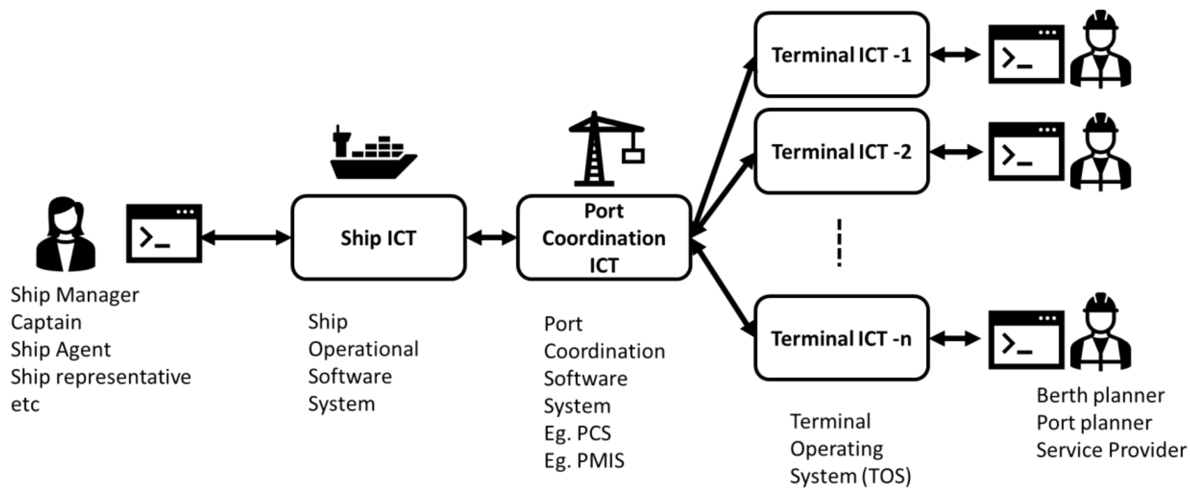


Figure 25 JIT Negotiation Physical Architecture

3.3.6 Data

From the ship's side, the ETA specifies the first point in time where arrival to a specific location is estimated. Similarly, the ETD specifies the last point in time where the departure from a specific location is estimated.

3.3.7 Implementational Issues

If at least one of the Terminal 1, Terminal 2, … Terminal n, Figure 26, does not respond with a RTA and/or RTD within a certain time interval after the request is received, the ship representative or the Port Coordination Centre must decide whether the negotiation process can continue with only the terminals that have answered the request, or whether the whole negotiation process is cancelled and then restarted.

There are several variants of the sequence diagram in Figure 26 that can be considered:

- What is the role of the pre-arrival message (FAL1) in the context of JIT arrival negotiation?
- What is the role of the Notice of Readiness (NOR) message in the context of JIT arrival negotiation? One example is that NOR can be sent from the ship when the RTA and RTD for the port call are sent by the Port Coordination Centre, or at some other event.

3.3.8 Description of the Sequence Diagram

The sequence diagram of a just-in-time port call planning process in Figure 26 is initiated by the ship. A prerequisite for this message exchange to start, is that the ship and terminal already have completed their contractual work to decide which berths in which terminals are available for a certain ship, see the square *Ship-Terminal contractual phase* at the top of Figure 26.

The role of the Port Coordination Centre in this description is to give clearance to the ship to enter the port and also to coordinate the calls at the different terminal berths during the port call (port planner role). The role of the terminal is that of a berth planner and to respond to the coordination done by the Port Coordination Centre.

The message exchange regarding JIT Arrivals should not start too early. Typically starting time is at the departure from the previous port or alternatively, about 48 hours before the arrival to the port. When the arrival is getting closer, for instance about 20 hours before the arrival, new ETAs will be known by the ship, and new ETAs and ETDs can be sent to the port. This can start a more detailed planning process as the timestamps now are more reliable. When updated ETAs are received, the same process as described in Figure 26 is repeated with new and more accurate values of the time stamps. This process can be repeated several times. The final round of negotiations of the time stamps typically starts 2-12 hours before arrival to the port, dependent on the contract that the ship is sailing under and the size of the port area, among other factors.

Note that in this description, the **IMO0153 Ship Stay Reference number** is not exchanged among the actors. However, the Port Coordination Centre must still be able to identify a port call internally to be able to identify which port call a negotiation process belongs to.

3.3.9 Description of the Messages

This section describes more details about the messages needed to implement a JIT arrival negotiation. A mapping between the JIT Data set in the IMO Compendium and ISO28005 is found in Annex B.

3.3.9.1 Message 1a. PortArrivalRequest

This message is the initial port arrival request sent from the ship to the port to start a JIT arrival negotiation session.

Each berth that will be visited, must be identified by a BerthId **(IMO0548)**. One visit at a terminal may include several berth visits.

The **alt** frame **alt Port Arrival Request** in Figure 26 shows that either 1a. or 1.b is selected as the start of the JIT arrival process. 1a. is used the first time a request is sent to the Port Coordination Centre. 1.b. is used when a previous request has been sent, meaning that the ship has already got a berth call id (BerthCallId) from the Port Coordination Centre.

The role of the Port Coordination Centre in this description is to give clearance to the ship to enter the port and also to coordinate the calls at the different berths during the port call (port planner role). The role of the terminal is that of a berth planner.

The following information is provided by the ship to the port in message 1a. PortArrivalRequest:

- ETA-port: ETA to the arrival port (**IMO0064)**
- ETD-port: ETD from the arrival port (**IMO0066)**

- ArrivalPort: UNLOCODE for the arrival port (**IMO0108)**
- ETA-BerthId: ETA to a berth identified by the BerthId **(IMO0541)**
- ETD-BerthId: ETD to a berth identified by the BerthId (currently not in the IMO Compendium as of FAL48)
- BerthId: Identification of a berth to call at during the port call **(IMO0548)**
- ShipInfo: Ship name **(IMO0142)**, MMSI **(IMO0326)**, IMO number **(IMO0140)**, ship type **(IMO0160)**, length **(IMO0377)**, beam **(IMO0378)**
- CargoInfo: Brief description of cargo **(IMO0119)**
- PilotInfo: Information if a pilotage is needed or not
- TugInfo: Information if a tug is needed or not

3.3.9.2 Message 1c. Response

This message is sent from the port to the ship as the response to a port arrival request. However, the port cannot give a response immediately, since it will need to coordinate with the terminals regarding the proposed times. This means that the port will notify the ship that the message has been received OK, and that the coordination with the terminals will start. In some cases, the initial request from the ship may be received so early that the coordination with the terminals has to wait. This will be communicated to the ship in this message.

3.3.9.3 Message 1b. PortArrivalRequestUpdate

This message is sent when an updated ETA is sent from the ship to the port. This means that the JIT arrival negotiation is restarted, with a new ETA, and with the BerthCallIds that have already been received from the terminal during previous negotiations. The difference between 1a. and 1b. when it comes to the information provided, is that in 1b., the terminals have already been contacted, and that the terminals have already replied with BerthCallIds. A data element for BerthCallId is currently not included in the IMO Compendium as of FAL48.

3.3.9.4 Sequence int Port and Terminal Coordination

The Port Coordination Centre is responsible for coordinating the arrival to the port with the arrival to the different terminals in the port based on the request from the ship. When the port receives a request from a ship for a port call, the port must check the requirements regarding pilotage and tugs for this ship and port call. According to the availability of pilots and tugs, the port can proceed with the requests to the terminals. A request for one berth stay is sent as a separate message to the terminal handling this berth. The Port Coordination Centre must receive the responses from each terminal and must also handle the case where one or more of the terminals does not respond. Also, the Port Coordination Centre must handle the case where the changes in the arrival and/or departure times done by one terminal affects berth stays in other terminals.

3.3.9.5 Message 2a.PortArrivalConfirmRTA

When the coordination between the port and the terminal is finalized, and the port has received all RTAs and RTDs for all berth calls, the confirmation (RTAs and RTDs) is sent to the ship. The RTA and RTD of the port describe the time slot for the ship stay at the port, while the RTA and RTD for each berth describe the time planned for the ship to stay at that berth. Each berth call is identified by a BerthCallId.

3.3.9.6 Message 3a. PortArrivalConfirmPTA and 3b. TerminalArrivalConfirmPTA

When the ship has received the confirmation of the arrival and departure times (RTAs and RTDs), the ship, often represented by the ship agent in the arrival port, confirms the arrival and departure times by sending the PTA and PTD to the port (for the arrival at the port) and directly to all the terminals involved.

Each visit at a berth must be identified by a **BerthCallId**. All *BerthCallId*s related to one port call must be unique. A ship may have several berth visits to the same terminal during one port call. If large changes to the RTAs and RTDs to the berths have been done, for instance, the sequence of berth calls has changed, one possibility is that the terminal changes the *BerthCallId*s and send these updated *BerthCallId*s to the ship.

3.3.9.7 Message 3a. PortArrivalConfirmPTA and 3b. TerminalArrivalConfirmPTA

When the ship has received the confirmation of the arrival and departure times (RTAs and RTDs) from the port, the ship, often represented by the ship agent in the arrival port, confirms the arrival and departure times by sending the PTAs and PTDs to the Port Coordination Centre and/or possibly also the PTAs and PTDs directly to the terminals involved. The confirmation of the RTAs and RTDs may be sent directly to the terminal, not through the Port Coordination Centre, dependent on the contractual agreement already set up between the ship and the terminal.

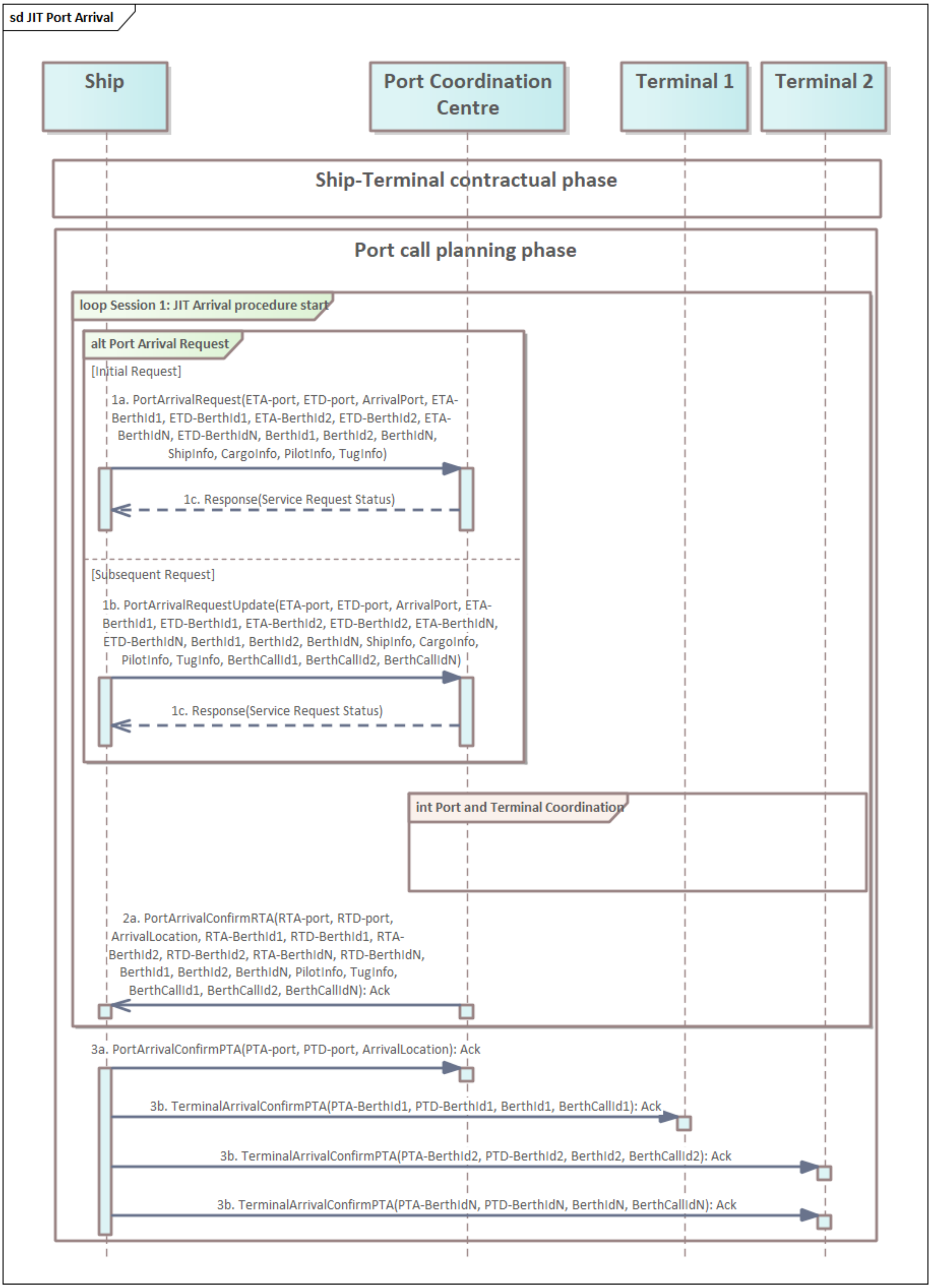


Figure 26 JIT Arrival Message Sequence: Port-Terminal Coordination

3.4 Pilot Implementation by Grieg Connect

During the project, Grieg Connect has implemented support for external actors such as agents and operators to enter the platform and work towards a port. The portal covers new port call requests, port call updates, service requests, service updates, vessel updates, preliminary cargo as well as invoice approval flows, Figure 27.

The external portal is then complemented with an inbox for internal port users where all requests can be managed, either approved, rejected or sent back for further information. Responses on requests from the port will notify the external user with email and in-app notification to ensure efficient communication between the parties.

This means that the port call and quay visit entity structures are mirrored to keep port call request, port call updates and quay visit requests separated from the approved data. Now it is implemented so that all messages from the portal ends up in this inbox stage – and same will be used for external communication machine-to-machine. The flow is therefore very similar to the described workflow in Figure 26. All development has been with ISO28005 in mind to be prepared for future usage.

One advantage of using the portal in Port is that all entities are using the internal structure, such as vessels, quays, services and cargo types. This ensures that all data is properly registered in all scenarios.

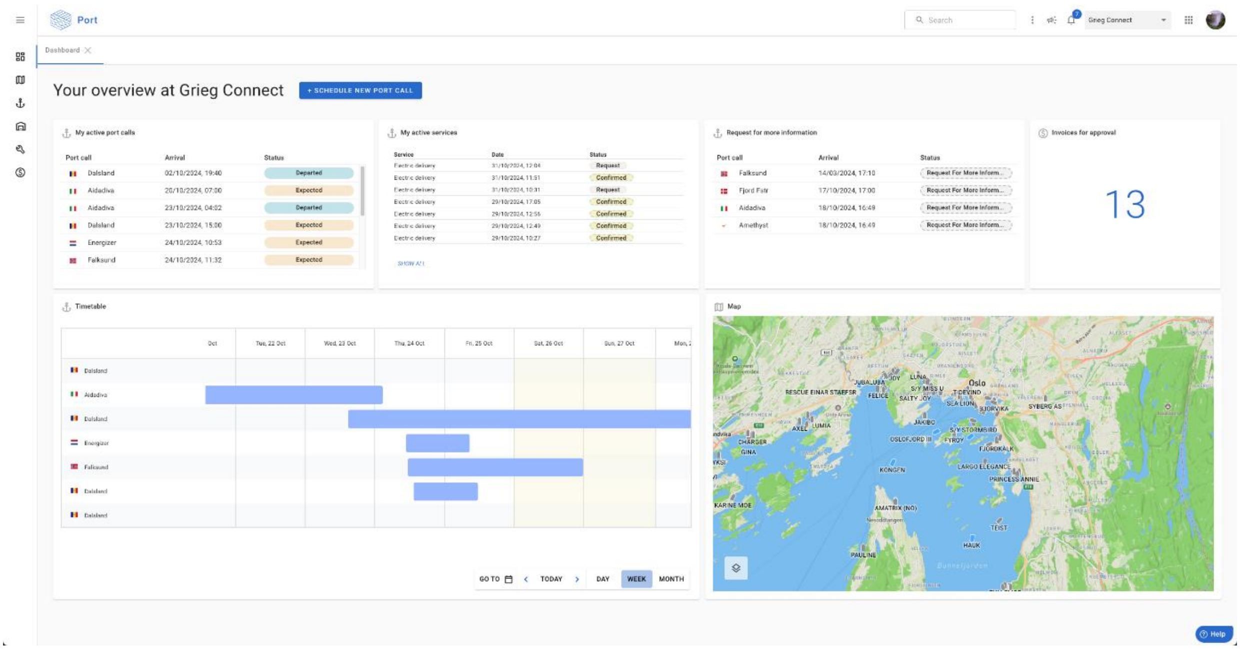


Figure 27 Port calls in the Grieg Connect Port system

Port call requests

The main flow usually starts with an agent creating a new port call request and entering key information such as ETA, ETD, vessel etc., Figure 28. After that, available quays and services are suggested based on the vessel attributes. The services are configured by the port which enables dynamic suggestions based on location, customer and vessel. When finished, a port call request will be sent to the port for response.

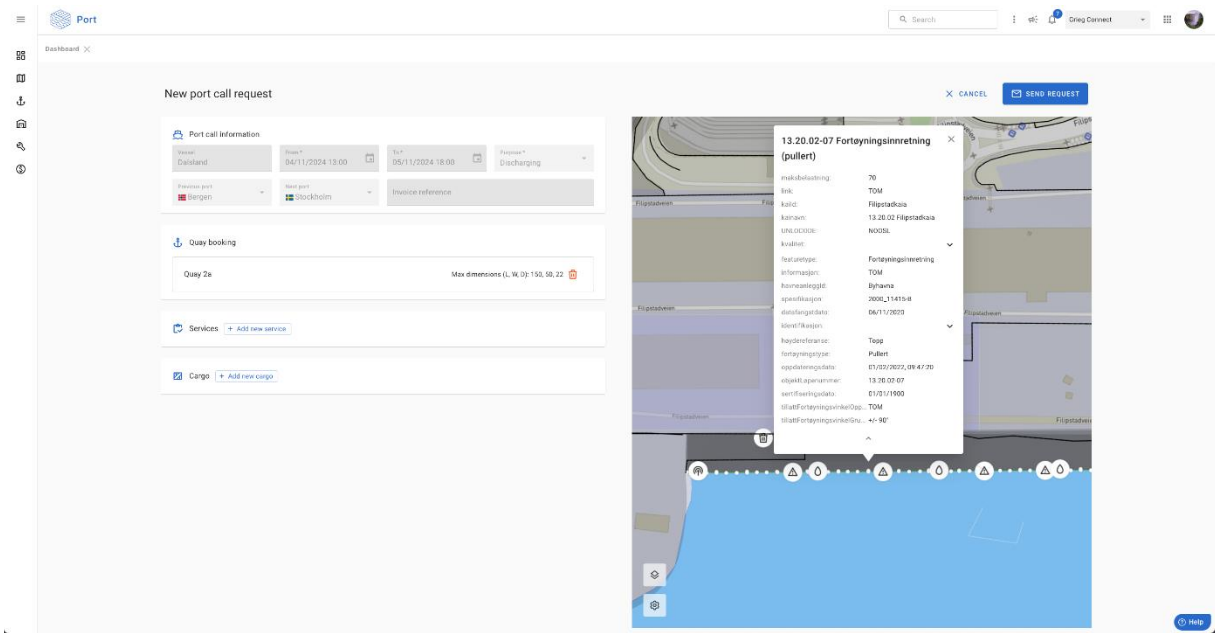


Figure 28 Registering New Port call in the Grieg Connect Port system

In the pilot project, the response from the port will be sent by email and in-app notification to the reporter of the port call request. However, the flow is prepared to send the response machine-to-machine via ISO2008 as well according to Figure 26.

Port call updates

When the agent registers the port call in SafeSeaNet (SSN), it will be matched and connected as a port call update to the original port call request sent from the external portal, for the port to manage, Figure 29. Similar the other way around: If the port call was initially registered in SSN, it can be found in the portal for the users to create port call updates instead of a new request. This ensures all sources are synchronized and avoids duplicates when several sources communicate around and update one single port call. External IDs like SSN, AIS and possible other sources are stored on the port call to simplify the update process when finding the right port call for external messages.

Port call updates can be created until arrival and will always end up in the Port inbox before it updates the actual port call. Depending on the response, a notification message including link to the port call in the portal will be sent to the reporter. Same goes if the port does updates on the port call.

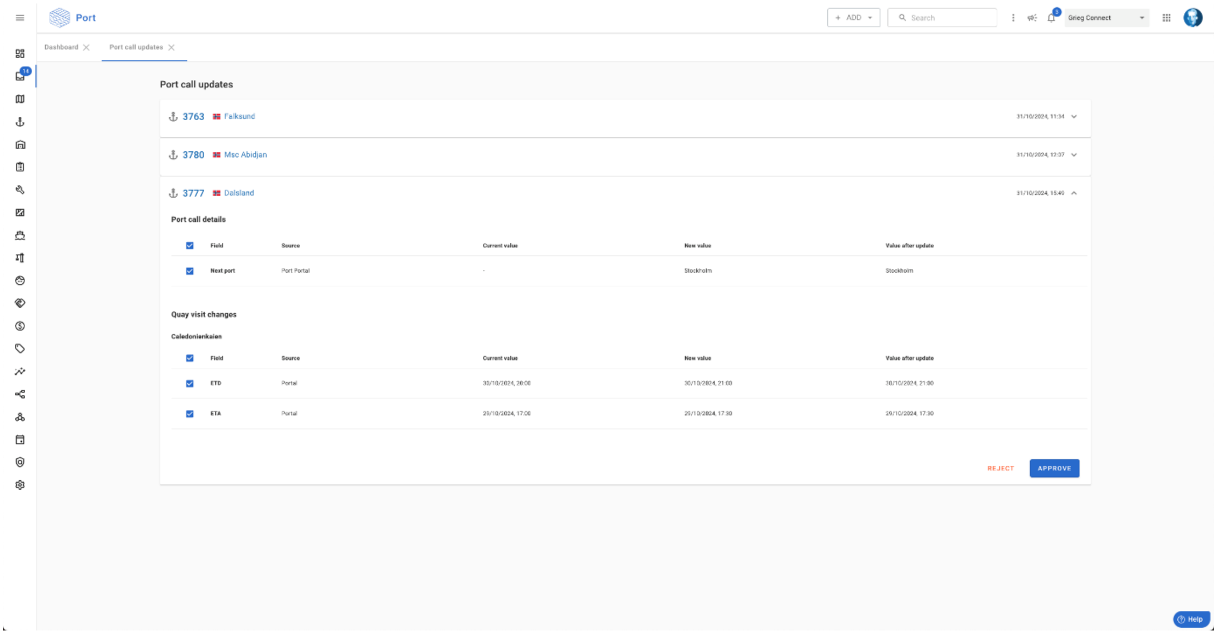
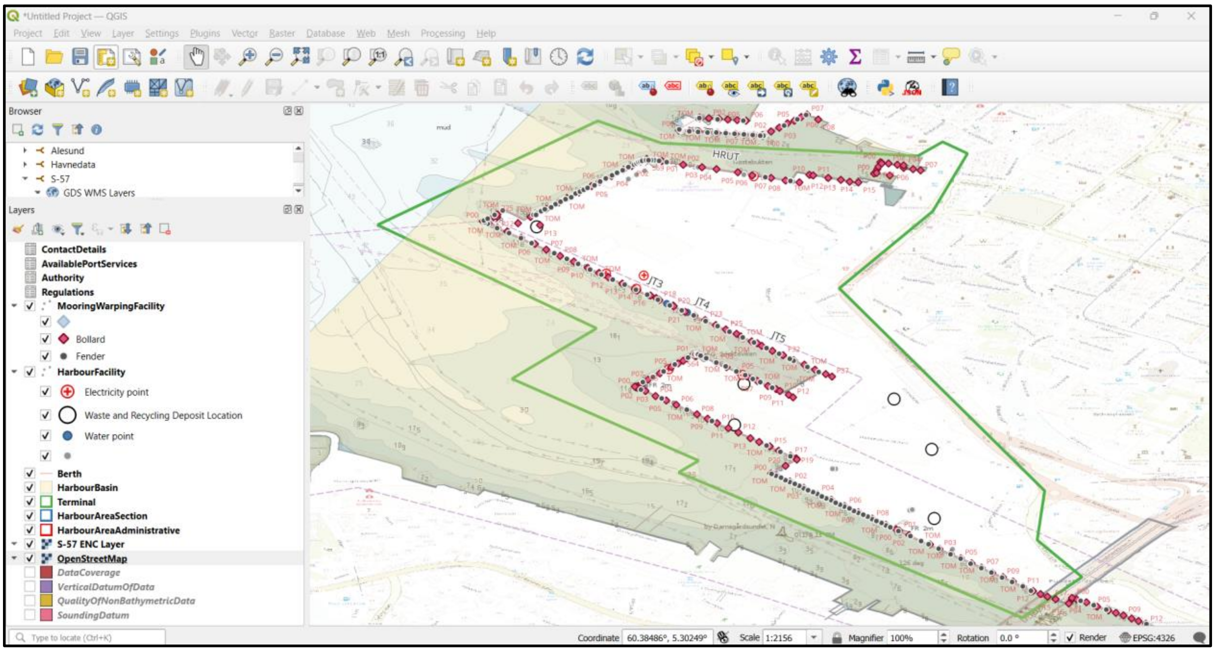


Figure 29 Updating Port calls in the Grieg Connect Port system

Service requests

Service requests can be made in the port call request process or separately for the port call. Available services are configured by the port and can be ordered by authorized users. The service requests are managed by the port in a similar way to the port call requests, they can either be approved, rejected or sent back for further information. Services can also be distributed for execution to third party suppliers. Notifications are then sent to the person who ordered the service and to the suppliers.

4 Annex A: Desktop Exercise S-131 and S-421 MRN Unique Identifiers



Purpose:

The main purpose of this test is to demonstrate how S-131 and S-421 can be used for clarification purposes in the ship-shore communication between a harbour and a vessel.

It will serve as an example of effective digital communication in ship-shore communication using products created on the S-100 framework structure.

The example will demonstrate the use of common (unique MRN) identifiers across products - showcasing the benefit of unique identification of features found or referenced in different products.

Scope:

- Produce an S-131 harbour data dataset for Dokken Havneanlegg in the Port of Bergen.
  - Demonstrate usability of harbour data encoded in S-131 format.
- Produce an S-421 route dataset leading to Dokken Havneanlegg in the Port of Bergen.
  - Demonstrate usability of route data encoded in S-421 format.
- Demonstrate the use of digital information exchange in shore-ship communication.
- Provide feedback and input to the National Harbour Data Product Specification development team.
- Provide feedback and input to the IHO S-131 development team.
- Demonstrate the use of unique identifiers (MRN) across the two products.

Scenario/User Story:

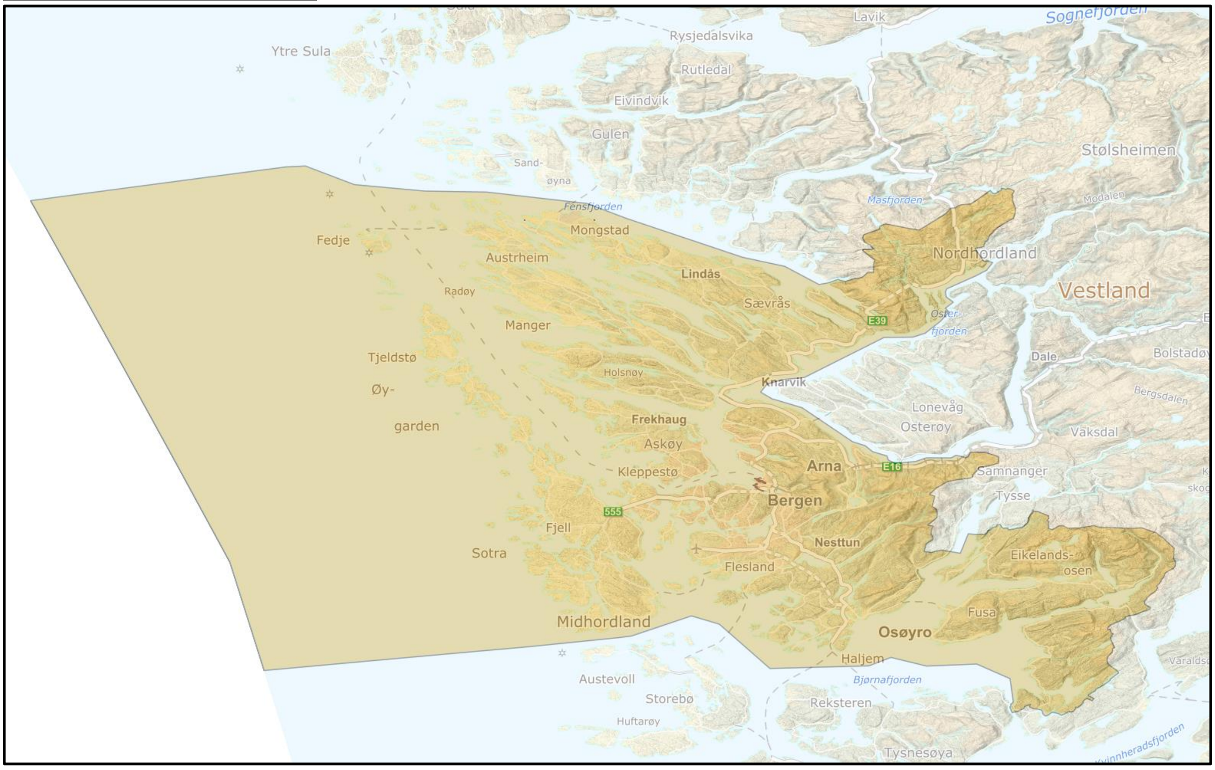
- Vessel has access to the S-131 dataset of Bergen Harbour.
- Captain onboard the vessel is contacting the harbour to ask for directions to berth.
  - Following the request is an S-421 route containing the planned route from the current position to the Bergen Havn harbour basin.
- Harbour processes the request:
  - Considering the size of the vessel and forecasted weather warnings of heavy wind from E, a decision is made to moor the vessel alongside Jektevikskaien Bert JT3 in Dokken Havneanlegg - with specific instructions to use the bollards with bollardPull>=150 tons.
- Harbour creates an S-421 route containing action point information:
  - The route dataset containing relevant references using MRN to harbour features (HarbourAreaAdministrative, HarbourAreaSection, Terminal, Berth, MooringWarpingFacility (bollards)) encoded in the route action points, is created.
  - The specific bollards having bollardPull>=150 tons are referenced using MRN in the action point information.
- Harbour provides the updated route to the vessel.
- Vessel receives the updated route
  - Updated route is loaded in the chart system, together with the S-131 harbour data.
  - Captain and bridge crew are now able to visually see in the chart display the route and harbour specific information (berth and bollards), and can start planning the docking/mooring operation.

Scenario outplay:

The Harbor receives requests from the vessel.

Harbour encodes the S-131 dataset containing the following information:

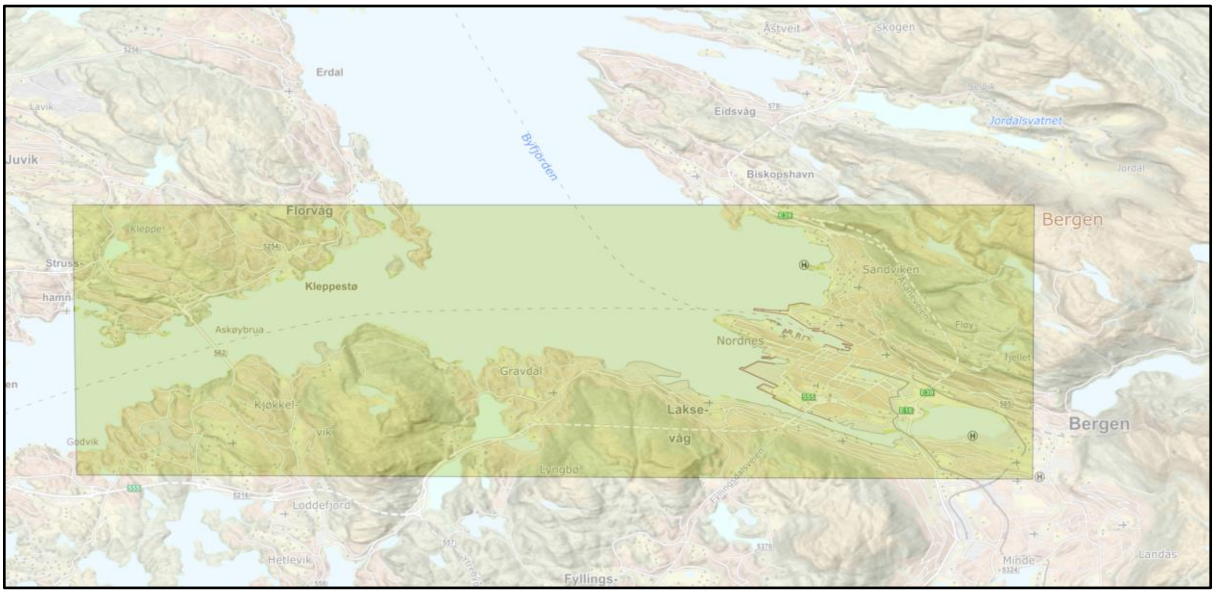
HarbourAreaAdministrative



Attributed information and MRN:

Feature	Value
131N100_NOBGO — HarbourAreaAdministrative	
displayName	true
(Derived)	
(Actions)	
gml_id	HarbourAreaAdministrative.2
displayName	true
language	nor
name	Bergen Havn
uNLocationCode	NOBGO
locationMRN	urn:mrn:iho:test:s100:no:no01:test:nobgo:harbourareaadministrative:000001

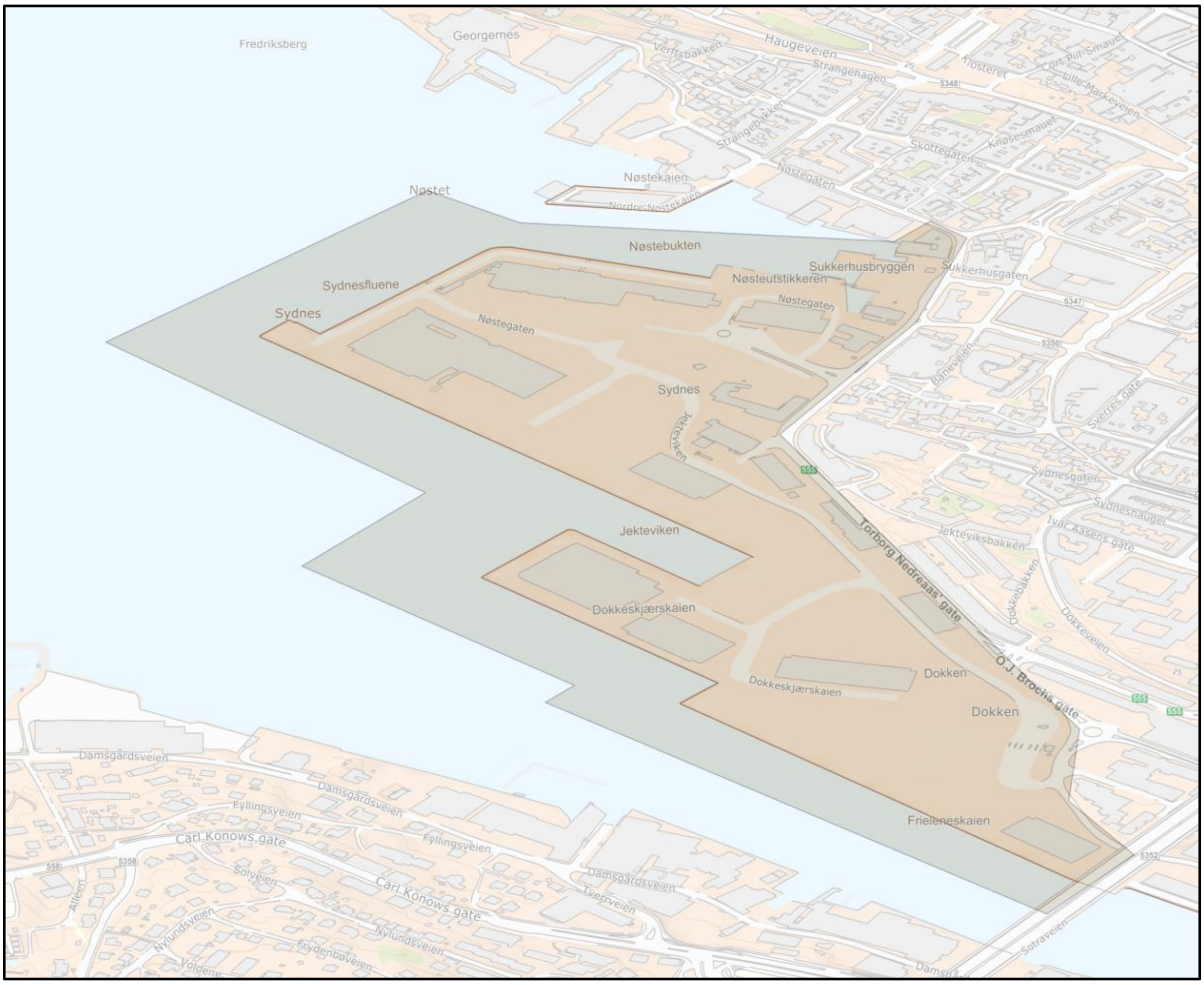
HarbourAreaSection



Attributed information and MRN:

Feature	Value
131N100_NOBGO — HarbourAreaSection	
displayName	true
(Derived)	
(Actions)	
gml_id	HarbourAreaSection.1724398246409
displayName	true
language	nor
name	Bergen Central Havn
locationMRN	urn:mrn:iho:test:s100:no:no01:test:nobgo:harbourareasection:000001

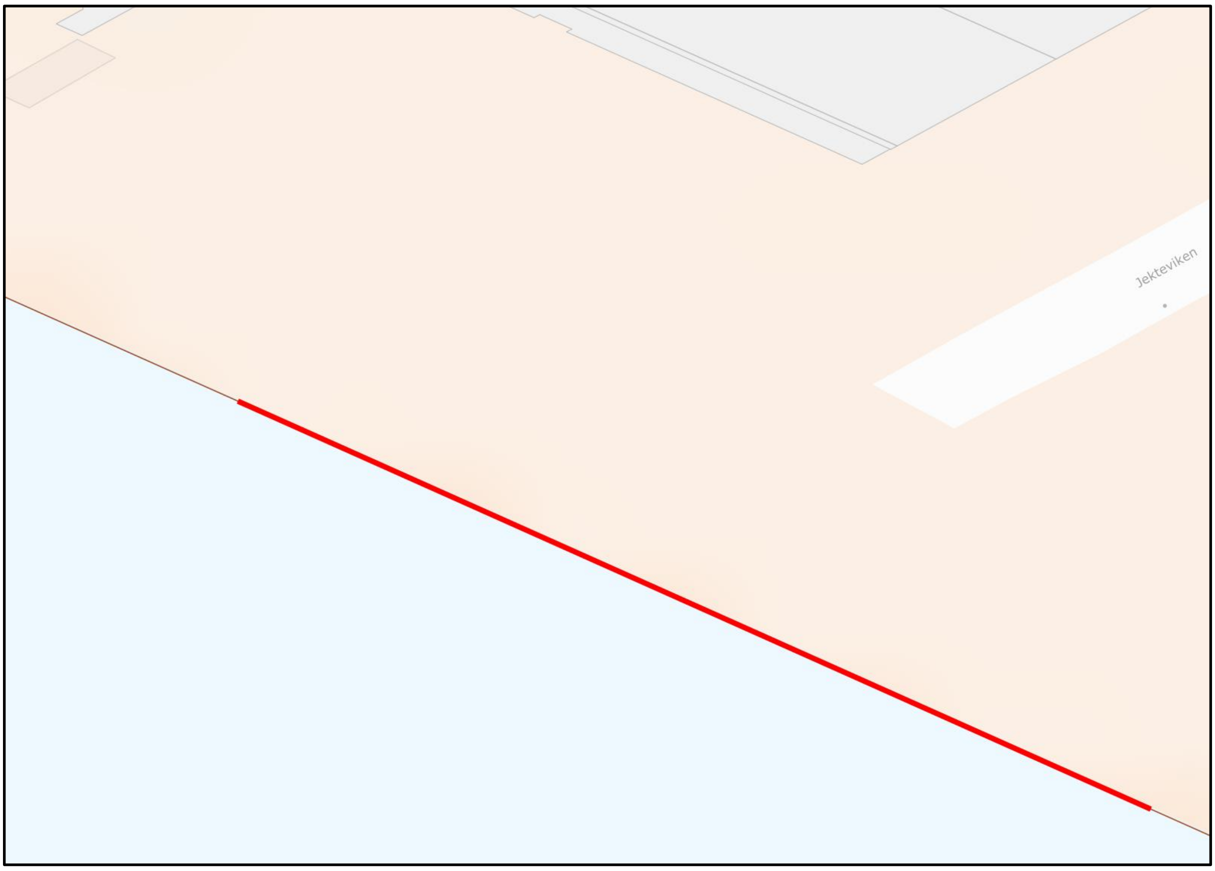
Terminal



Attributed information and MRN:

Feature	Value
131N100_NOBGO — Terminal	
displayName	true
(Derived)	
(Actions)	
gml_id	Terminal.1724683587806
displayName	true
language	nor
name	Dokken Havneanlegg
uNLocationCode	NOBGO
locationMRN	urn:mrn:iho:test:s100:no:no01:test:nobgo:terminal:000001

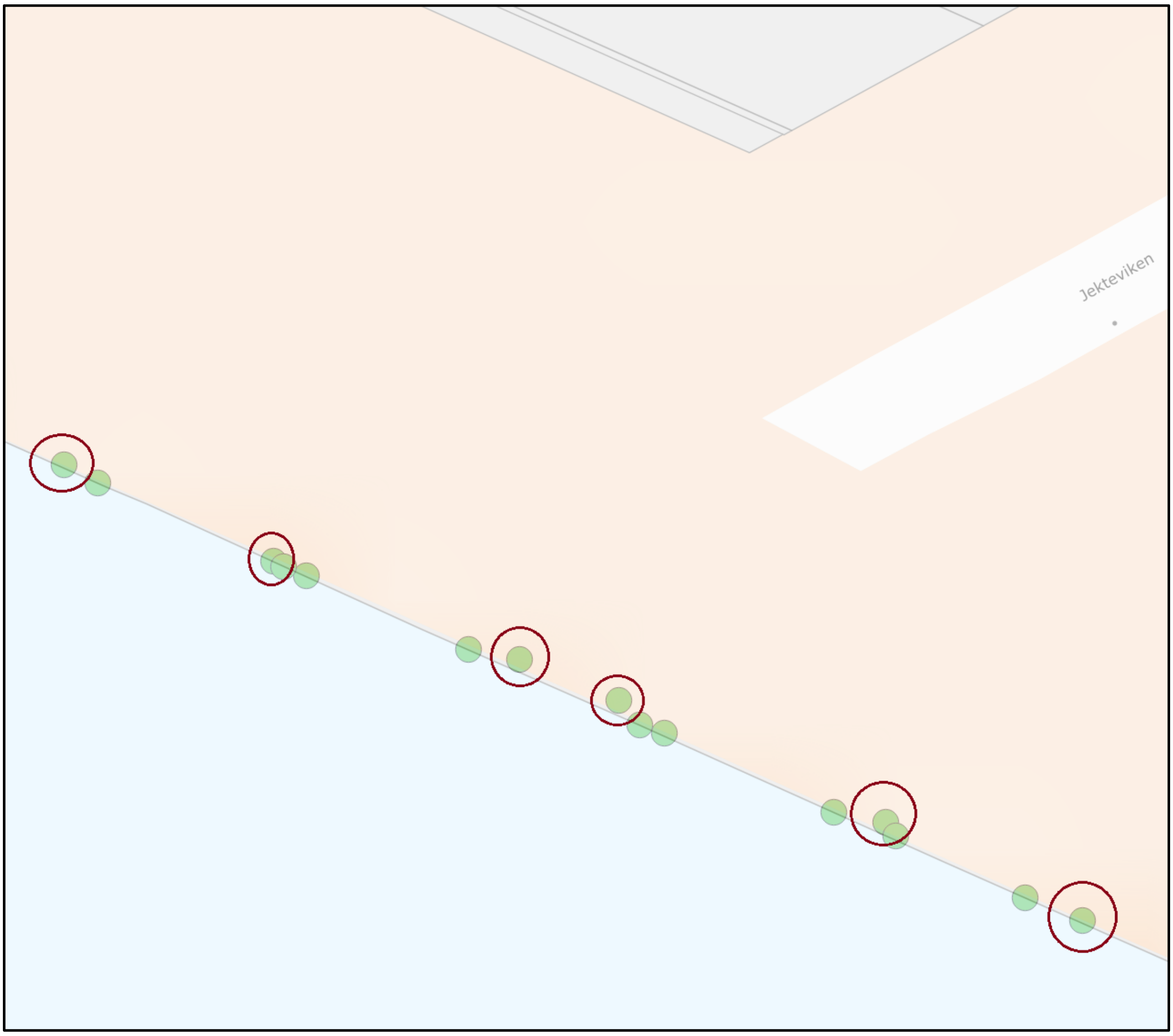
Berth



Attributed information and MRN:

Feature	Value
131N100_NOBGO — Berth	
displayName	true
(Derived)	
(Actions)	
gml_id	Berth.1724684924882
displayName	true
language	nor
name	JEKTEVIKSKAIEN
terminalIdentifier	JT3
availableBerthingLength	100
elevation	2.25
locationMRN	urn:mrn:iho:test:s100:no:no01:nobgo:berth:000001
uNLocationCode	NOBGO
reportedDate	19000101
source	http://data.geonorge.no/Havnedata/so
headline	Individual Horizontal Position Uncertainty
textContent|information|language	nor
text	50

MooringWarpingFacility (bollards)



Attributed information and MRN:

Feature	Value
131N100_NOBGO — MooringWarpingFacility	
displayName	true
(Derived)	
(Actions)	
gml_id	MooringWarpingFacility.1724684928995
categoryOfMooringWarpingFacility	Bollard
displayName	true
name	P13
bollardPull	100
bollardDescription	Avstand refpunkt: 205m
headline	Bollard Type, Elevation, Berth ID, Berth Name, Individual Horizontal Position Ur
language	nor, nor
text	pullert, 3.49, JT3, K98 Jektevikstermінalen, 5
reportedDate	20231123114227
source	http://data.geonorge.no/Havnedata/so
locationMRN	urn:mrn:iho:test:s100:no:no01:nobgo:mooringwarpingfacility:000001

Feature	Value
131N100_NOBGO — MooringWarpingFacility	
displayName	true
(Derived)	
(Actions)	
gml_id	MooringWarpingFacility.1724684934875
categoryOfMooringWarpingFacility	Bollard
displayName	true
name	P14
bollardPull	100
bollardDescription	Avstand refpunkt: 224m
headline	Bollard Type, Elevation, Berth ID, Berth Name, Individual Horizontal Position
language	nor, nor
text	pullert, 3.36, JT3, K98 Jekteviksterminalen, 5
reportedDate	20231123114227
source	http://data.geonorge.no/Havnedata/so
locationMRN	urn:mrn:iho:test:s100:no:no01:nobgo:mooringwarpingfacility:000002

Feature	Value
131N100_NOBGO — MooringWarpingFacility	
displayName	true
(Derived)	
(Actions)	
gml_id	MooringWarpingFacility.1724684934854
categoryOfMooringWarpingFacility	Bollard
displayName	true
name	P16
bollardPull	200
bollardDescription	Avstand refpunkt: 241m
headline	Bollard Type, Elevation, Berth ID, Berth Name, Individual Horizontal Position
language	nor, nor
text	pullert, 3.52, JT3, K98 Jekteviksterminalen, 5
reportedDate	20231123114227
source	http://data.geonorge.no/Havnedata/so
locationMRN	urn:mrn:iho:test:s100:no:no01:nobgo:mooringwarpingfacility:000004

Feature	Value
131N100_NOBGO — MooringWarpingFacility	
displayName	true
(Derived)	
(Actions)	
gml_id	MooringWarpingFacility.1724684934098
categoryOfMooringWarpingFacility	Bollard
displayName	true
name	P17
bollardPull	150
bollardDescription	Avstand refpunkt: 254m
headline	Bollard Type, Elevation, Berth ID, Berth Name, Individual Horizontal Position
language	nor, nor
text	annen, 3.96, JT3, K98 Jekteviksterminalen, 5
reportedDate	20231123114227
source	http://data.geonorge.no/Havnedata/so
locationMRN	urn:mrn:iho:test:s100:no:no01:nobgo:mooringwarpingfacility:000005

Feature	Value
131N100_NOBGO — MooringWarpingFacility	
displayName	true
(Derived)	
(Actions)	
gml_id	MooringWarpingFacility.1724684934119
categoryOfMooringWarpingFacility	Bollard
displayName	true
name	P19
bollardPull	150
bollardDescription	Avstand refpunkt: 279m
headline	Bollard Type, Elevation, Berth ID, Berth Name, Individual Horizontal Position
language	nor, nor
text	annen, 3.97, JT3, K98 Jekteviksterminalen, 5
reportedDate	20231123114227
source	http://data.geonorge.no/Havnedata/so
locationMRN	urn:mrn:iho:test:s100:no:no01:nobgo:mooringwarpingfacility:000007

Feature	Value
131N100_NOBGO — MooringWarpingFacility	
displayName	true
(Derived)	
(Actions)	
gml_id	MooringWarpingFacility.1724684931704
categoryOfMooringWarpingFacility	Bollard
displayName	true
name	P21
bollardPull	100
bollardDescription	Avstand refpunkt: 300m
headline	Bollard Type, Elevation, Berth ID, Berth Name, Individual Horizontal Position
language	nor, nor
text	pullert, 3.42, JT4, K98 Jekteviksterminalen, 5
reportedDate	20231123114227
source	http://data.geonorge.no/Havnedata/so
locationMRN	urn:mrn:iho:test:s100:no:no01:nobgo:bollard:000000

Encoded in the S-131 GML dataset:

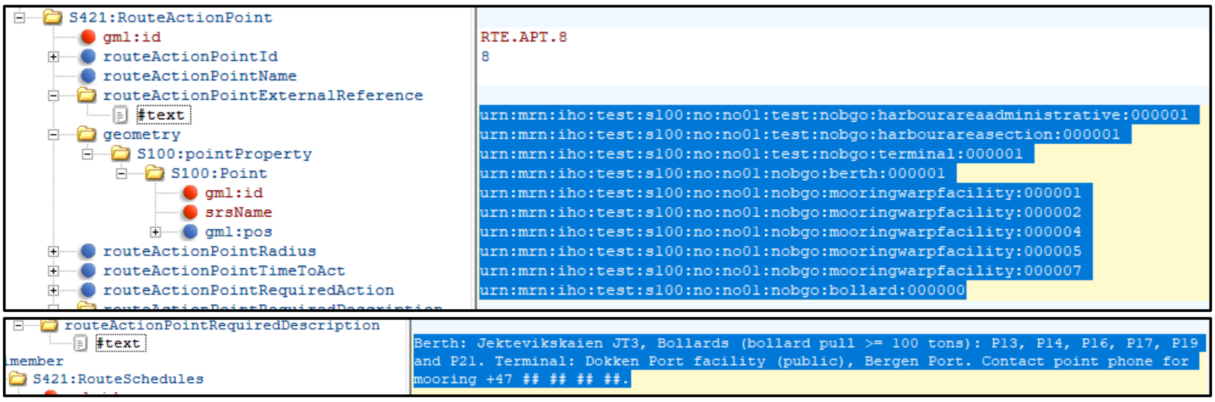
S131:HarbourAreaAdministrative	
gml:id	HarbourAreaAdministrative.2
S131:featureName	
S131:uNLocationCode	NOBGO
S131:locationMRN	urn:mrn:iho:test:s100:no:no01:test:nobgo:harbourareaadministrative:000001

S131:HarbourAreaSection	
gml:id	HarbourAreaSection.1724398246409
S131:featureName	
S131:locationMRN	urn:mrn:iho:test:s100:no:no01:test:nobgo:harbourareasection:000001

S131:Terminal	
gml:id	Terminal.1724683587806
S131:featureName	
S131:uNLocationCode	NOBGO
S131:locationMRN	urn:mrn:iho:test:s100:no:no01:test:nobgo:terminal:000001

S131:Berth	
gml:id	Berth.1724684924882
S131:featureName	
S131:displayName	true
S131:language	nor
S131:name	JEKTEVIKSKAIEN
S131:terminalIdentifier	
#text	JT3
S131:availableBerthingLength	100
S131:elevation	2.25
S131:locationMRN	urn:mrn:iho:test:s100:no:no01:nobgo:berth:000001

Encoded in the S-421 dataset:
The following information is then encoded in the S-421 dataset created by the harbour and sent to the vessel:



In S421: RouteActionPoint nr. 8 the following information is encoded:

- routeActionPointExternalReference: mrn references to XXX are encoded.
- routeActionPointRequiredDescription: Also there is descriptive text about the referenced features.

It is now expected (although not demonstrated in this exercise) that onboard systems like for example S-100 ECDIS will be able to portray the provided information in combination - and as such demonstrate the benefit of unique identifiers across different products.

MRN considerations:
Currently a specific guidance on the encoding of MRN information is not yet developed in the S-100 framework. The reasoning for the MRN encoding logic is therefore explained here in more detail, for use in future MRN discussions in the IHO standardisation bodies:

String component	Explanation
urn:	set by the MRN schema
mrn:	set by the MRN schema
iho:	set by the MRN schema
test:	to indicate that the following schema is only for testing purposes. Will not be present in the approved schema.
s100:	main theme identifier. Identifies that the digital twin object is from the S-100 standard’s series exchange data (as per the general IALA recommendations for MRN application).
no:	identifies country (as per the general IALA recommendations for MRN application)

no01:	identifies the data responsible authority generating the mrn for the mentioned theme and country.
nobgo:	Localises the port location. Most likely the majority countries, especially the ones using the Singapore S-131 web tool, will use the S-131 for one UNLOcode port.
featurename:	feature name as registered in the IHO GI registry in the context of S-131 product specification.
numeric code:	as agreed within the project, the six number numeric ID code. Random, but unique for the same S-131 object type (featureName).

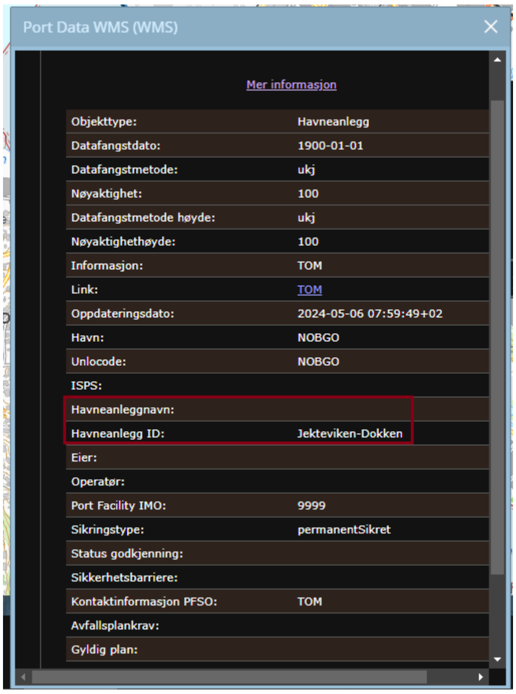
Feedback provided:
Placeholder for feedback provided to S131PT and national harbour data development team.

Feedback to IHO Singapore Lab Web based S-131 tool:

- The tool does not save the added objects.
- GML data files are unresponsive and hence do not load in.
    - Although only S-131 GML files can be loaded, this is not made clear in user documentation.
- Once the mapping rules are established, it should be possible to save them in a rule file for reuse on different ports using the same schema geojson file.
- It is only possible to choose one feature to import.
- It is not possible to see the adding from the loaded source at individual features level
- When choosing to add the locationMRN attribute, there is no way to add a text string of the MRN - there is no input field provided.
- The Export to S-131 function does not work , the screen just briefly moves up and down and then the same window of export stays on screen. No other feedback is shown on the screen, so it is not possible to know if the export is successful, and where it is saved.
- With regards to geometry and too dense vertices: It should be possible to reuse the existing data that the ports have added in the havnedata database, being their official geometries. If too dense an amount of vertices is a problem for the tool, perhaps a solution should be sought to cater for taking care of the native geometries coming from the port data.
- When importing the geojson data to S-131 with the chosen Harbour Facility object it is not possible to choose the attributes and their mapping. (It only allows to map the last attribute mapped for the last import, and it is not shown when it chooses this attribute).
- The attribute choice is only a very thin empty line on the screen. Preferably it should be possible to map the locationMRN , the name and the textContent attributes.

Feedback to the Norwegian harbour database development team:

- Looks like the encoding of havneanleggId and havneanleggNavn is a bit wrong, in this example the havneanleggNavn seems to be encoded for the havneanleggId.



The data seems to not be encoded in accordance with the “registreringsinnstruks”.

Egenskaper	Beskrivelse	Datatype	Multiplisitet
Fellesegenskaper	Se kapittel 3.1 (tabell 6 og 7)		[1..1]
HavnId	Se kapittel 3.2 HavnId		[0..1]
havneanleggId	Unik identifisering av det enkelte havneanlegg.	Tekst	[0..1]
havneanleggNavn	Navn på havneanlegg. Navn bør stemme overens med SafeSeaNet.	Tekst	[0..1]
ISPS	Boolsk verdi som angir om havneanlegget er et ISPS Havneanlegg.	Boolsk(ja/nei)	[0..1]

Feedback to 131PT:

- Berth can be using geometry of type line - which is good.
- Berth bearing may be information that should be considered for inclusion in the model.
    - Used by mariners during berth Planning and berthing operation.

5 Annex B: JIT Data Set

Data Number	Data Element	ISO 28005 Mapping
IMO0001	Agent city	/Agent/Address/CityName
IMO0002	Agent contact family name	/Agent/Person/FamilyName
IMO0003	Agent country code	/Agent/Address/CountryCode
IMO0004	Agent country sub-division name	/Agent/Address/CountrySubdivisionName
IMO0006	Agent email	/Agent/ContactNumbers/Email
IMO0007	Agent identification number	/Agent/CompanyId
IMO0008	Agent landline number	/Agent/ContactNumbers/BusinessTelephone
IMO0009	Agent mobile number	/Agent/ContactNumbers/MobileTelephone
IMO0010	Agent name	/Agent/Company
IMO0011	Agent postcode	/Agent/Address/PostCode
IMO0012	Agent street and number	/Agent/Address/StreetName /Agent/Address/StreetNumber
IMO0014	Authentication date time	/Authenticator/AuthenticationDate
IMO0016	Authenticator family name	/Authenticator/Person/FamilyName
IMO0017	Authenticator party identification number	/Authenticator/CompanyId
IMO0063	Date and time of arrival - actual	/PortOfArrival/Arrival[TimeType="Actual"] or /PortOfDeparture/Arrival[TimeType="Actual"] Or actual arrival to other locations.
IMO0064	Date and time of arrival - estimated	/PortOfArrival/Arrival[TimeType="Estimated"] /PortOfDeparture/Arrival[TimeType="Estimated"] Or estimated arrival to other locations.
IMO0065	Date and time of departure - actual	/PortOfArrival/Departure[TimeType="Actual"] /PortOfDeparture/Departure[TimeType="Actual"] Or actual departure from other locations.
IMO0066	Date and time of departure - estimated	/PortOfArrival/Departure[TimeType="Estimated"] /PortOfDeparture/Departure[TimeType="Estimated"] Or estimated departure from other locations.
IMO0078	Message date time	/EPCMessageHeader/SentTime
IMO0082	Message sender identifier	/EPCMessageHeader/SenderId/Company
IMO0108	Port of arrival, coded	/PortOfArrival/Location/CountryCode /PortOfArrival/Location/UNLoCode
IMO0109	Port of arrival name	Use the country code to find the country name: /PortOfArrival/Location/CountryCode /PortOfArrival/Location/Name

Data Number	Data Element	ISO 28005 Mapping
IMO0110	Port of call sequence number	/PortCallList/PortCall/SequenceNumber
IMO0111	Port of departure, coded	/PortOfDeparture/Location/CountryCode /PortOfDeparture/Location/UNLoCode
IMO0112	Port of departure name	Use the country code to find the country name: /PortOfDeparture/Location/CountryCode /PortOfDeparture/Location/Name
IMO0128	Authenticator role, coded	/Authenticator/ContactType
IMO0136	Ship call sign	/EPCMessageHeader/ShipID/CallSign
IMO0140	Ship IMO number	/ShipID/IMONumber
IMO0142	Ship name	/EPCMessageHeader/ShipID/ShipName
IMO0153	Ship stay reference number	/EPCMessageHeader/ShipStayReference
IMO0172	Primary purpose of call, coded	/CallPurpose/CallPurposeCode
IMO0184	Port facility, coded	/PortOfArrival/Location/CountryCode /PortOfArrival/Location/UNLoCode /PortOfArrival/Location/FacilityCode
IMO0185	Port facility name	Facility name: /PortOfArrival/Location/FacilityName Port name: /PortOfArrival/Location/Name Use the code for country to find the name of the country: /PortOfArriva/Location/CountryCode
IMO0191	Voyage number	/VoyageNumber
IMO0229	Anchorage name	/AnchorageArrival/Location/Name or /AnchorageDeparture/Location/Name
IMO0230	Terminal name	/TerminalArrival/Location/SMDGterminalCode /TerminalDeparture/Location/SMDGterminalCode (select the actual ID type)
IMO0231	Pilot Boarding Place name	/PilotBoardingPlaceArrival/Location /PilotBoardingPlaceDeparture/Location (select the actual ID type)
IMO0232	Berth name	/BerthArrival/Location/Name /BerthDeparture/Location/Name
IMO0233	Berth position	/BerthPositionArrival/Location/Name /BerthPositionDeparture/Location/Name (select the actual ID type)
IMO0234	Date and time of arrival - requested	/BerthArrival/Arrival[TimeType="Requested"] /BerthPositionfArrival/Arrival[TimeType="Requested"] /PortOfArrival/Arrival[TimeType="Requested"] /TerminalArrival/Arrival[TimeType="Requested"] /AnchorageArrival/Arrival[TimeType="Requested"] /FacilityArrival/Arrival[TimeType="Requested"] /PilotBoardingPlaceArrival/Arrival[TimeType="Requested"]

Data Number	Data Element	ISO 28005 Mapping
IMO0235	Date and time of arrival - planned	/PortOfArrival/Arrival[TimeType="Planned"] /BerthArrival/Arrival[TimeType=" Planned"] /BerthPositionfArrival/Arrival[TimeType="Planned"] /PortOfArrival/Arrival[TimeType="Planned"] /TerminalArrival/Arrival[TimeType="Planned"] /AnchorageArrival/Arrival[TimeType="Planned"] /FacilityArrival/Arrival[TimeType="Planned"] /PilotBoardingPlaceArrival/Arrival[TimeType="Planned"]
IMO0236	Date and time of departure - requested	/PortOf Departure/ Departure[TimeType=" Requested"] /Berth Departure/ Departure[TimeType=" Requested"] /BerthPositionf Departure/ Departure[TimeType=" Requested"] /PortOf Departure/ Departure[TimeType=" Requested"] /Terminal Departure/ Departure[TimeType=" Requested"] /Anchorage Departure/ Departure[TimeType=" Requested"] /Facility Departure/ Departure[TimeType=" Requested"] /PilotBoardingPlace Departure/ Departure[TimeType=" Requested"]
IMO0237	Date and time of departure - planned	/PortOf Departure/ Departure[TimeType=" Planned"] /Berth Departure/ Departure[TimeType=" Planned"] /BerthPositionf Departure/ Departure[TimeType=" Planned"] /PortOf Departure/ Departure[TimeType=" Planned"] /Terminal Departure/ Departure[TimeType=" Planned"] /Anchorage Departure/ Departure[TimeType=" Planned"] /Facility Departure/ Departure[TimeType=" Planned"] /PilotBoardingPlace Departure/ Departure[TimeType=" Planned"]
IMO0305	Message function code	/EPCMessageHeader/MessageFunctionCode
IMO0326	Ship MMSI number	/ShipID/MMSINumber
IMO0536	Trade service identifier	/TradeService/Identifier

Data Number	Data Element	ISO 28005 Mapping
IMO0537	Distance to destination	/PortOfArrival Location/NauticalMilesToDestination[TimeType=" Estimated", "Requested", "Planned"] /BerthArrival/Location/NauticalMilesToDestination[TimeType=" Estimated", "Requested", "Planned"] /BerthPositionfArrival/Location/NauticalMilesToDestination[TimeType=" Estimated", "Requested", "Planned"] /PortOfArrival/Location/NauticalMilesToDestination[TimeType=" Estimated", "Requested", "Planned"] /TerminalArrival/Location/NauticalMilesToDestination[TimeType=" Estimated", "Requested", "Planned"] /AnchorageArrival/Location/NauticalMilesToDestination[TimeType=" Estimated", "Requested", "Planned"] /FacilityArrival/Location/NauticalMilesToDestination[TimeType=" Estimated", "Requested", "Planned"] /PilotBoardingPlaceArrival/Location/NauticalMilesToDestination[TimeType=" Estimated", "Requested", "Planned"]
IMO0540	Date and time to location in port - actual	/PortOfArrival/Arrival/dateTime[TimeType="Actual"] Also mappings to BerthArrival, BerthPositionArrival, TerminalArrival, AnchorageArrival, FacilityArrival and PilotBoardingPlaceArrival.
IMO0541	Date and time to location in port - estimated	/PortOfArrival/Arrival/dateTime[TimeType="Estimated"] Also mappings to BerthArrival, BerthPositionArrival, TerminalArrival, AnchorageArrival, FacilityArrival and PilotBoardingPlaceArrival.
IMO0542	Date and time to location in port - requested	/PortOfArrival/Arrival/dateTime[TimeType="Requested"] Also mappings to BerthArrival, BerthPositionArrival, TerminalArrival, AnchorageArrival, FacilityArrival and PilotBoardingPlaceArrival.
IMO0543	Date and time to location in port - planned	/PortOfArrival/Arrival/dateTime[TimeType="Planned"] Also mappings to BerthArrival, BerthPositionArrival, TerminalArrival, AnchorageArrival, FacilityArrival and PilotBoardingPlaceArrival.
IMO0544	Location in port, latitude	/PortOfArrival/Location/Position/Latitude Also mappings to BerthArrival, BerthPositionArrival, TerminalArrival, AnchorageArrival, FacilityArrival and PilotBoardingPlaceArrival
IMO0545	Location in port, longitude	/PortOfArrival/Location/Position/Longitude Also mappings to BerthArrival, BerthPositionArrival, TerminalArrival, AnchorageArrival, FacilityArrival and PilotBoardingPlaceArrival

Data Number	Data Element	ISO 28005 Mapping
IMO0546	Anchorage, coded	Select the required values from the following data elements: /AnchorageArrival/Location/Name /AnchorageArrival/Location/GLN /AnchorageArrival/Location/Position/Latitude plus /AnchorageArrival/Location/Position/Longitude
IMO0547	Terminal, coded	Select the required values from the following data elements: /TerminalArrival/Location/Name /TerminalArrival/Location/FacilityCode /TerminalArrival/Location/GLN
IMO0548	Berth, coded	Select the required values from the following data elements: /BerthArrival/Location/Name /BerthArrival/Location/FacilityCode /BerthArrival/Location/GLN
IMO0574	Agent P.O. Box	/Agent/Address/PostOfficeBox
IMO0581	Agent contact given name	/Agent/Person/GivenName
IMO0582	Authenticator given name	/Authenticator/Person/GivenName
IMO0584	Service provider contact given name	/MaritimeService/ServiceProvider/Person/GivenName

References

[1] ISTS Report R5.1: ISTS Demonstration Plan

[2] https://www.mpa.gov.sg/media-centre/details/singapore-rotterdam-green---digital-shipping-corridor-accelerates-digitalisation-and-decarbonisation-with-new-global-value-chain-partners

[3] ITCPO Port Call Business Processes diagram https://portcalloptimization.org/images/Business%20process%20220222.pdf

[4] ITPCO - International Taskforce on Port Call Optimisation https://portcalloptimisation.org/

[5] https://webstore.iec.ch/en/publication/32931

[6] IMO Compendium: https://www.imo.org/en/OurWork/Facilitation/Pages/IMOCompendium.aspx