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**Author(s)/Submitter(s)** Kongsberg Discovery - Seatex

Recent Satellite VDES Service Demonstrations in Norway[[3]](#footnote-3)

# Introduction

Satellite VDES provides a low-cost alternative to existing communication solutions, outside VHF base station coverage and in the Arctic, where the availability of infrastructure for communications is limited.

A Norwegian consortium and the European Maritime Safety Agency (EMSA) have under a European Space Agency contract demonstrated three important services using a VDES satellite:

* Search and Rescue coordination service
* Ice chart distribution service
* Mandatory Reporting System (MRS) service

The system configuration is shown in Figure 1.

A diagram of a satellite

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Figure : Chart distribution, SAR and MRS test system.

The consortium consisted of Space Norway, as prime contractor, Kongsberg Discovery – Seatex, the Norwegian Coastal Administration (NCA) and the European Maritime Safety Agency (EMSA).

# Services description

## Coverage Area

The NorSat-2 VDES satellite was used. This satellite has a moving coverage area which can be approximated with a circle with 2500 km radius. The centre of the circle is 1250 km from the subsatellite point and in the boresight direction of the satellite antenna as shown in Figure 2.

A map of the earth

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Figure : Instantaneous NorSat-2 coverage area.

The satellite would cover both Navarea XIX and can also cover Lisbon. A typical pass would last 10 minutes and 10 passes/day would cover Navarea XIX. The Lisbon installation would see the satellite 6 times per day.

## Search and Rescue coordination service

Current search and rescue (SAR) coordination procedures is to a large extent based on voice communication. Use of voice communication is inefficient and opens for interpretation. To increase efficiency, it is highly beneficial to provide ships involved in SAR operations individual search patterns overlayed on a visual display, i.e. ECDIS, ECS, or similar. The current availability of communication solutions suited for such information exchange is limited. Such a service requires a communication solution available to all ships.

In the test activity, individual search pattern waypoints, were sent via satellite VDES to vessels which would log the search positions and transmit these back to shore when the VDES satellite was in view. Such a service would enable the RCC operator to know where the searches had taken place, unlike AIS where positions are reported only when a satellite is in view. VDES provides more reliable data delivery than AIS to the Rescue Coordination Centre because channel loading is controlled, and selective repeat protocols are used to prevent data loss.

## Ice chart distribution service

For safety of life at sea, distribution of Maritime Safety Information (MSI) is important. MSI information include weather forecasts, low-pressure front maps, ice charts and navigational hazard warnings. MSI information distribution requires a low-cost communications solution available to all ships. VDES can support such services, and the equipment can be fitted on-board vessels at a low cost.

The Ice Service of the Norwegian Meteorological Institute (NMI) is responsible for ice monitoring within the Atlantic sector of the Arctic and provides daily (working day, Monday-Friday) ice charts with an emphasis on Svalbard and the Barents Sea. In addition, the Ice Service of the Norwegian Coastal Administration is responsible for informing vessels about the ice situation in southern Norwegian waters. NMI also provides a weekly (on Mondays) ice chart for the Weddell and Bellingshausen Seas of the Antarctic during the summer (October to April).

These ice charts are analysed and drawn manually by a Sea Ice Analyst. New updated ice charts for European waters become available to the public on weekdays (Monday-Friday) and for the Antarctic on Mondays, both after 1500 (GMT +1), at the Norwegian Ice Service website (https://cryo.met.no/en/latest-ice-charts). The ice charts are provided as graphics files or alternatively as shapefiles for GIS. There is currently no distribution system for these ice charts. The mariners need to access the internet and download the charts through the website.

A vectorized format intended for display on chart plotters have been defined and developed, named S-411 (IHO). The Ice Service of the Norwegian Meteorological Institute (NMI) have had a long-term plan to be able to provide their ice charts in S-411 format in the future. Upon request by NCA for the Ice Service to prepare S-411 ice charts and make them available to the VASP project, they raised the priority. In November 2020 the Ice Service started to provide their daily ice charts in S-411 format on an ftp-server for test purposes. The Ice Service has reduced the file size of the ice charts by removing redundant and unnecessary information. However, the file size is dependent on the ice extent and the geographical complexity of the ice type variation. Thus, in the current test format the S-411 ice charts often exceed the practical workable file size of the distribution solution implemented in the VASP project. A file transfer protocol is on the list of items to develop to work around the issue with excessive file size. It can be investigated if it is possible to subdivide the ice charts into smaller geographical areas before conversion into the S-411 format to ensure the ice chart files to be transferred have a suitable size. AIS position reports can be used to give priority to transmission of ice chart files for areas with ships.

The Arctic ice extent is receding, so the service is primarily relevant for vessels operating in the area around Svalbard. Ice charts are generated daily and in the afternoon. Hence, it should therefore be sufficient to begin transmitting updated ice charts during the first available satellite pass after they are released. Transmission of an ice chart will be repeated regularly until a new updated ice chart becomes available and replaces it.

## Mandatory Reporting System (MRS) service

There is an untapped potential to simplify the work of both ships reporting to coastal stations and the coastal stations operators receiving the reported data. The benefit lies in exploring the synergies between the Vessel Traffic Service (VTS), Mandatory Reporting System (MRS) and SafeSeaNet (SSN) data and, where necessary, making the technical, administrative, and legal arrangements. Satellite VDES can be instrumental in providing the means for exchanging such data on a global level.

In the last two decades we have seen huge developments in technology within navigation and communication systems, and advanced technology is developing rapidly. Automation of ship reporting functions has taken a big step forward and has featured in several International Maritime Organization (IMO) decisions aiming at simplifying the communication of safety related information.

This trend is also reflected in the proposal for the revision of IMO Resolution A.857(20) on Guidelines for Vessel Traffic Services providing a framework for implementation of VTS globally in a harmonized manner and foreseeing accommodation of new trends, such as e-navigation and others aiming at more safe, secure and efficient maritime traffic and trade.

To meet this need, a concept for a MRS service where the mariners on board ships can reuse information already available in the SafeSeaNet (SSN) has been developed. Relevant information available in SSN can be requested by the ship before reports are due. Alternatively, SSN information can also be pushed to ships after SSN updates. This information is provided to the ship as an integrated ship report (ISR) and can form the basis for MRS reports where the mariner on board only validates or update as needed the information before submitting the report. An EMSA developed On-Board Application is used for this purpose. The information collected by the MRS service will be made available by EMSA to relevant authorities of the Member States. EMSA will then await and collect responses from these authorities and push them to the relevant ships to be made available via the OBA.

# Test facilities

## Ship installation

The Covid pandemic affected the scope of the tests, but five Kongsberg VDES 300 ship terminals were installed on two Arctic vessels (Polarsyssel and Advent supplier) and at fixed sites in Trondheim, Oslo and at EMSA in Lisbon.

The terminals had a LapTop with display SW (Kongsberg) and the OBA (EMSA) to display and operate the information in connection with the three use cases.

## VDES satellite

The Norwegian Space Agency NorSat-2 satellite with a VDES payload was used. 50 kHz robust channel formats were used both uplink and downlink. This reduced the capacity, but it was used because automatic retransmission functionality was not yet implemented on the satellite.

## Ground segment

### Satellite earth stations

Existing S-band earth stations in Vardø and at Svalbard were used for VDES data transfers, monitoring and control.

### Satellite control

The satellite was controlled by Statsat, located at Space Norway’s facility in Oslo. Space Norway has developed a VDES router to provide a simple VDES data interface and specific applications were developed for the three services as shown in Figure 1.

### Services application platform

Space Norway has developed VDES router software with a simple API that allows for easy transfer of data to and from the satellite payload. For each of the services demonstrated special application software was developed to extract Ice charts from the Norwegian Meteorological Institute (NMI) server, a simple SAR application and a REST API to EMSAs and NCA MRS systems.

# Test results

Figure 3 shows the total number of data transmission each way for every month during the tests. Full testing was done in November and December 2022. The MRS service was creating most traffic.



Figure : Uplink and downlink VDES traffic during the tests.

The Ice chart distribution was the first service to be tested and we see that typically 500 ice charts were transmitted during a month. Figure 4 shows an example of the Ice chart and AIS vessels position on the display system (LapTop).

A map of the ocean

Description automatically generated with low confidence

Figure : Ice chart and AIS positions on the display system.

The SAR service was the second service to be tested. Figure 5 shows a spiral search pattern and ice situation on the display system.

A screenshot of a computer game

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Figure : Spiral search pattern and ice situation shown on the display system.

The MRS service was tested towards EMSA servers. Successful message transfers with the test equipment were logged. Figure 6 shows the number of records updated per day for the five test MMSI’s.

A screenshot of a graph

Description automatically generated with low confidence

Figure : MRS daily traffic per MMSI.

# Conclusions

Three important end-to-end services have been tested successfully using the wide area NorSat-2 VDES satellite system. To our knowledge this is the first time such demonstration has been performed.

A major task was to develop all the software that interfaced VDES to EMSA, NCA and Norwegian Met Office existing systems.

It is unlikely that real time VDES satellite coverage will be available soon, and the tests have shown that the store and forward nature of satellite VDES with delays can support services that are not very time critical.

Normal satellite VDES waveforms and equipment were used for the testing, but not all satellite VDES features. Selective repeats and resource allocation were not used. These features will improve system capacity and performance when implemented.

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