MARLINK
ABOVE AND BEYOND

The Future of Polar Connectivity

An investigation into current and emerging satellite network capabilities and trends in the Polar regions

September 2022

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1.0 Introduction

In this report, Marlink examines the current landscape for Polar shipping, assesses the future outlook for vessel traffic growth, and explores how changes in connectivity and communications will drive a new era at the frontier of maritime operations.

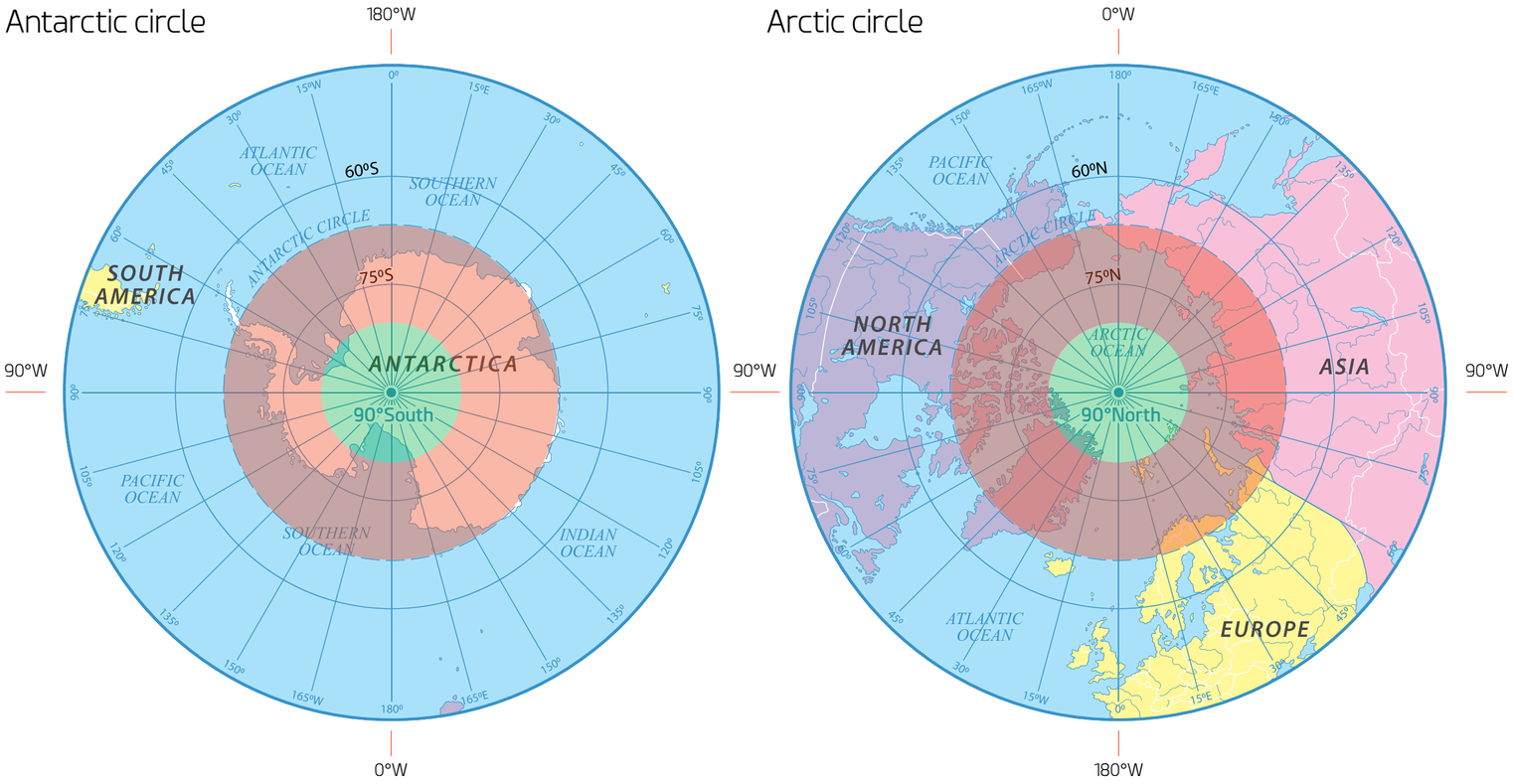
With higher numbers of cruise ships expected to visit Polar regions in the coming years, passenger and operational demand will be met through a combination of new and existing satellite capacity at ever more extreme latitudes.

2.0 Defining Polar Connectivity

For ships and other operators in Polar regions, connectivity has always been a valuable resource. While conventional satellite networks can be used in Polar regions, each will face challenges when used on a standalone basis.

Polar connectivity currently available is heavily impacted by the latitudes at which users operate. Both Arctic and Antarctic regions extend from their respective Polar circles at 66.5 degrees north and south to the geographic north and south poles.

Between 65.5 degrees and 80 degrees, network choice and throughput are close to normal, but both become more limited above 80 degrees.



3.0 Connectivity Trends in the Polar Regions

The need for high quality data connectivity in Polar regions is set to increase as specialist and mainstream cruise operators expand sailings to meet a growing demand.

A post-COVID bounceback in cruise passengers is predicted in Arctic cruising, with forecast data for Norwegian domestic cruise traffic set to increase in 2022.

This is in contrast to merchant shipping – often cited as having large scale Polar potential, but which is being constrained by geopolitics impacting Russian waters and the surrounding areas in particular – while government activity is also showing growth.

The increase will spur steady growth in satellite bandwidth demand between 65 and 80 degrees latitude where large conventional cruise ships are likely to operate and **a potential boom in bandwidth between 80 and 90 degrees,** with a new generation of satellite constellations providing high throughput bandwidth to expedition and specialist vessels for the first time.

For vessel operators, the ability to meet this demand will rely on a Polar connectivity strategy designed around a hybrid network model, optimised for connectivity at extreme latitudes but signal-agnostic, combining all networks into one independent network of networks.

The rising demand for bandwidth has become more apparent as additional users join the Marlink network. Even during the pandemic, existing mobile and fixed customers increased their bandwidth allowances to reflect higher usage and upgraded legacy systems – including in Polar regions.

The trend towards higher cruise traffic will see additional growth in bandwidth demand, with large 'floating village' cruise ships consuming more **Ka-, Ku- and C- band** satellite capacity with some also adopting **Non-Geostationary Orbit (NGSO).** Expedition cruise operators with itineraries above 80 degrees latitude north and south will likely pursue a strategy focused on NGSO services with back-up services.

Even with demand predicted to increase and new services coming online over the next five years, users will continue to rely on the experience of service providers that can **harness multiple constellations, orbits and bands into a tailored, secure package.**

Click here for a detailed explanation of frequency bands (Ka, Ku-, C- and L-band)

Click here for a detailed explanation of Non-Geostationary Orbit Satellites (NGSOs) (e.g. OneWeb & Starlink)

4.0 What Satellite Connectivity is Available Today?

Ku, Ka and C-band GEO VSAT together with GEO/LEO L-band and 4G/5G services (in port and close to land infrastructure) are the primary channels between 66.5 degrees and 80 degrees latitude north and south.

Beyond 80 degrees, commercial service availability currently comprises two LEO services from Marlink and more networks exists in the same area, one real-time, one store-and-forward, as well as other government and military networks. In northern latitudes, users can also access an additional regional Ka-band service which provides coverage to just above Svalbard.

Thanks to a recent regulatory change by the IMO, maritime users can also access the Global Maritime Distress and Safety Service (GMDSS), reporting safety incidents using L-band LEO services at both poles, marking the first time the service has been extended to truly global coverage.

Table 1: Commercial Maritime Networks with Polar Coverage

Orbit	Available Connectivity	Frequency	Speed	Typical Round-Trip Latency	Markets	Polar Coverage Latitude North / South
GEO	Marlink Sealink VSAT	C-band	Up to 100 Mbps*	6-800 msec	B2B	65-80°
	Marlink Sealink VSAT	Ku-band	Up to 100 Mbps*	6-800 msec	B2B	65-80°
	Inmarsat Fleet Xpress	Ka-band	Up to 10 Mbps*	6-800 msec	B2B	65-80°
	Telenor Anker	Ka-band	Up to 35 Mbps	6-800 msec	B2B	65-75 (N)°
	Inmarsat FleetBroadband	L-band	Up to 432 Kbps	6-800 msec	B2B	65-80°
LEO	Iridium Certus	L-band	Up to 704 Kbps	400 msec	B2B/B2C	65-90°
	Kepler	Ku-band	Up to 700Mbps	N/A – Store & Forward	B2B	65-90°
NGSO						
LEO	OneWeb	Ku-band	TBA – Future	70-150 msec	B2B	65-90°
	StarLink	Ku-band	TBA – Future	TBA	B2B/B2C	65-90°
HEO	Future Inmarsat Fleet Xpress expansion -Arctic region only	Ka-band	TBA – Future	800-1300 msec	B2B	65-90°
	Telesat Lightspeed	Ka-band	TBA – Future	TBA	B2B	TBA°
GMDSS						
GEO	Inmarsat C	L-band	N/A	6-800 msec	B2B	65-80°
	Inmarsat FleetBroadband	L-band	N/A	6-800 msec	B2B	65-80°
LEO	Iridium GMDSS & Future Iridium Certus expansion	L-band	N/A	400 msec	B2B	65-90°

Source: Marlink.

*Higher bandwidth provided on request.

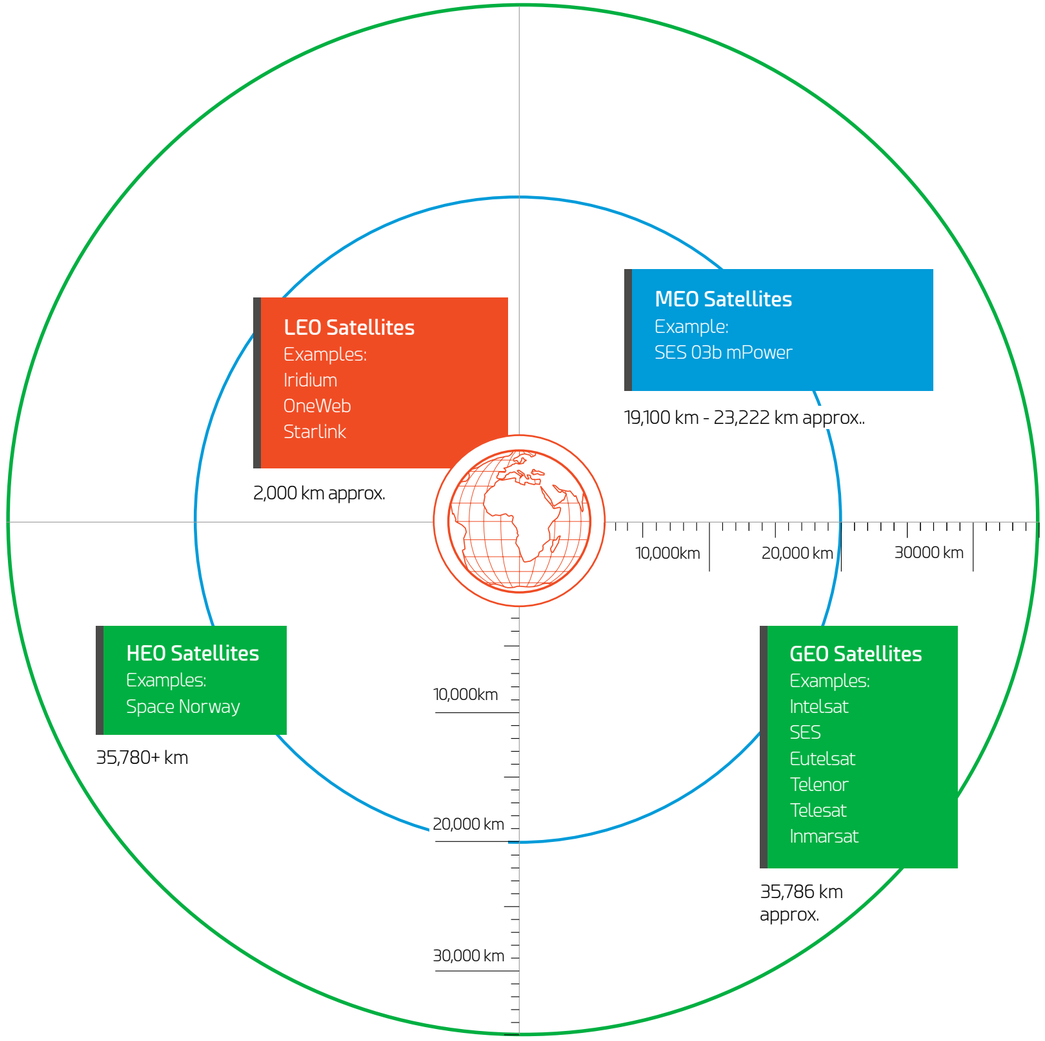
4.1 What Satellite Connectivity is Available Today?

The quality of coverage these services provide will depend to a large extent on the vessel's sailing patterns, data requirements and antenna performance and size; encouraging users to mix and match the most suitable network for their requirements.

In a Polar hybrid network, Ku-, Ka- and C- band VSAT provides the main conduit for data in addition to smaller vessels and late broadband adopters who still use low throughput satcom services.

Despite the lower level of human activity in Polar regions, the bandwidth scarcity is set to change when the new Non-Geostationary (NGSO) constellations begin to offer commercial services.

The increase in demand from merchant and cruise shipping, military and government users will be addressed by the emergence of these new satellite services which will provide close to seamless coverage in the areas north and south of 80 degrees where VSAT is not available.



5.0 Polar Shipping Activity

The total Ice Class/Polar Class fleet is estimated by IHS Markit at 16,296 vessels, with an orderbook of a further 210 vessels. Of the largest categories, general cargo ships, fishing vessels and container ships dominate. The fully cellular container ship fleet numbers 1,587 ships with 14 on order while the general cargo fleet numbers 3,861 units with 30 on order.

The ice-capable cruise ship fleet totals 102 vessels with an orderbook for a further 15 vessels.

While the last few years have broadly seen a maintenance of the status quo in Polar shipping operations, prospects for future growth are considered positive. This reflects not just the presence of merchant, energy, mining, fishing and cruise shipping activity but considerable expansion of military/defence activity in both marine and land mobile communications.

Data collected using maritime AIS signals sourced from IHS Markit indicates that **3,400 ships - just under 3% of the SOLAS fleet of 83,000 vessels - spent more than 24 hours in Polar regions in the last 12 months.**

A total of 264 Polar capable ships were delivered in 2021 and another 149 are due for delivery by the end of 2022. A further 115 ships are contracted for delivery between 2023 and 2032 including 14 fully cellular containerships and 18 general cargo vessels.

Marlink has been monitoring activity in Polar shipping for several years as part of its long term strategy to meet needs for future connectivity. The company collated publicly-available AIS data for ships that had spent over 24 hours at latitudes between 65 and 80 degrees north or south over 12 months.

The above figure does not represent all satellite end users in these regions and maritime AIS data is not 100% accurate since vessels can switch off their own transponders, which is sometimes done for commercial reasons.

Source: IHSMarkit.com

5.1 Polar Shipping Activity

Table 2: IMO registered vessels sailing beyond 60 degrees N/S – 2021/2022

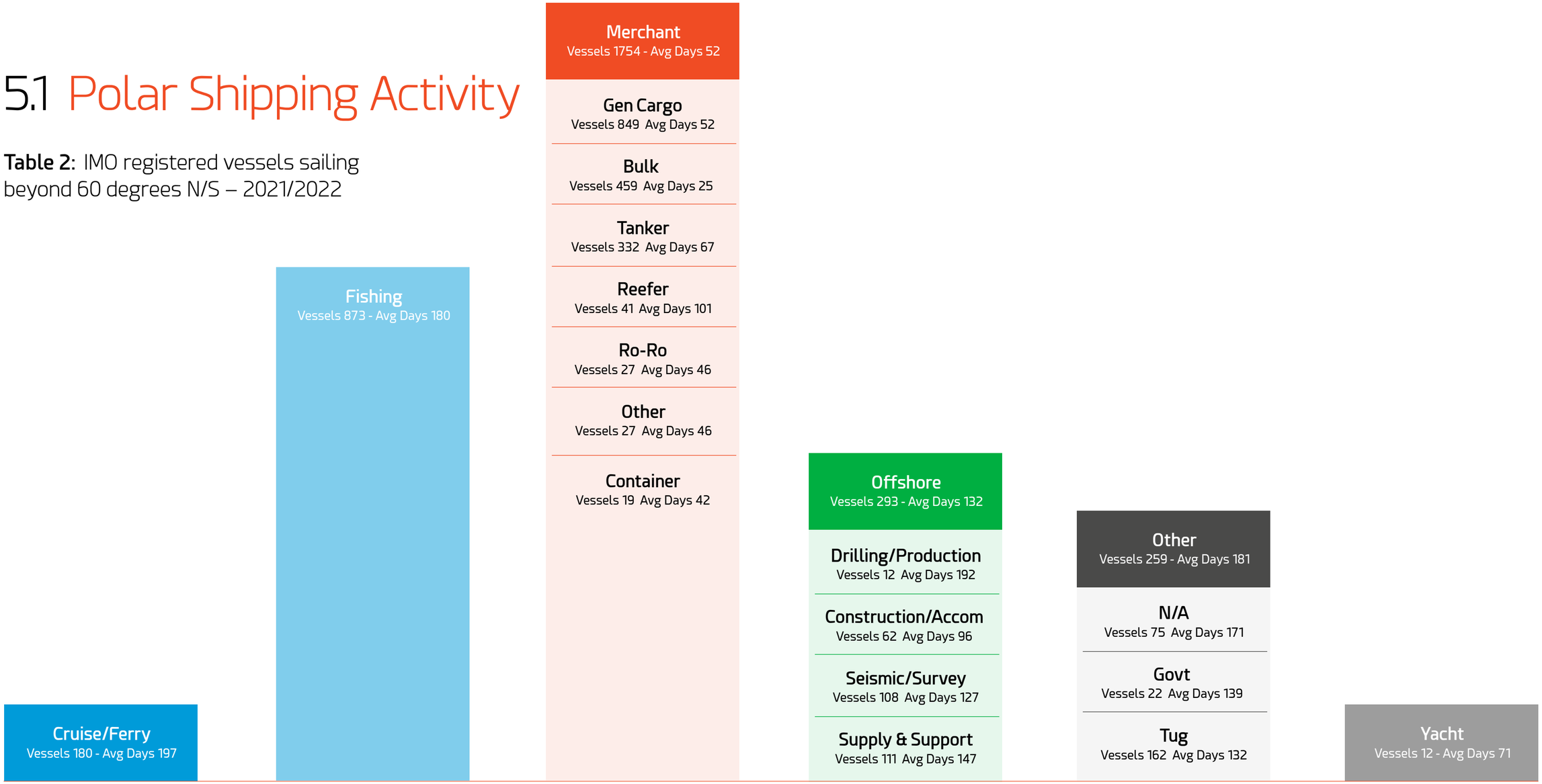


Chart not fully to scale. For illustrative purposes only.
Data Source: IHS Markit.

Total = Vessels 3371 - Avg Days 104

5.2 Polar Shipping Activity

Table 3: IMO registered vessels sailing beyond 80 degrees N/S – 2021/2022

The data collected between April 2021 and April 2022 reflects the negative impact of the Pandemic on cruising and other maritime operations with cruise itineraries slowly re-starting and oil and gas exploration also reduced as COVID impacted operations.

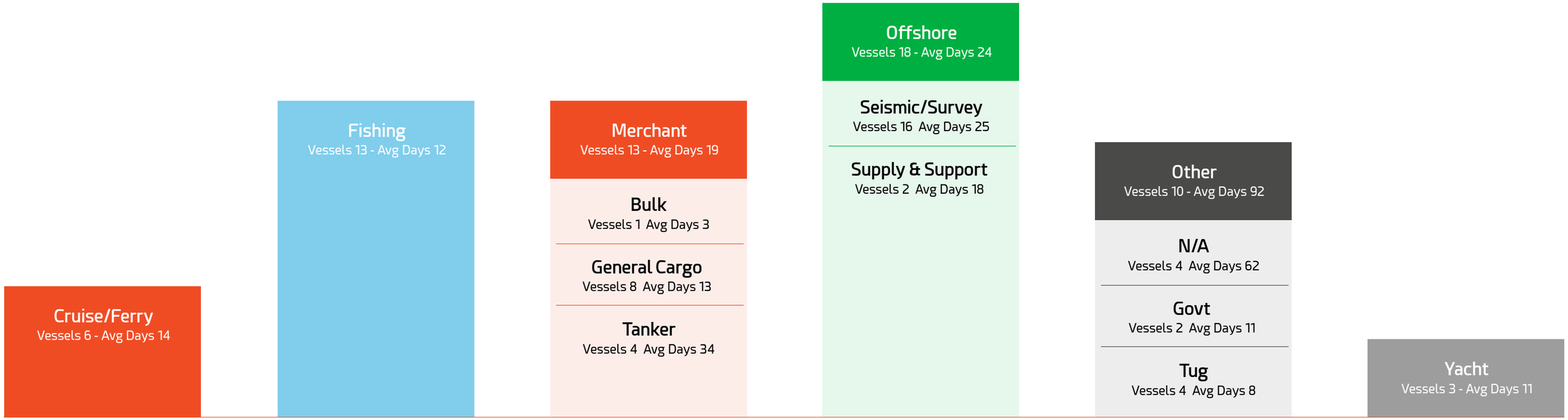


Chart not fully to scale. For illustrative purposes only.
Data Source: IHS Markit.

Total = Vessels 63 - Avg Days 23

6.0 Future Networks

The NGSO constellations in the process of design or development promise to improve connectivity in Polar regions by using a larger number of satellites to increase coverage, improve throughput and reduce latency.

Current and planned commercial NGSO constellations promising Polar coverage include OneWeb, Telesat Lightspeed, and Starlink, with service start dates to be confirmed. Further additional capacity will come onstream from the end of 2022 when Space Norway HEOSAT begins to operate two satellites in Highly Elliptical Orbit, with coverage from 65 degrees North provided via a commercial operator.

Another private-public Norwegian initiative will see the launch of Norway's first Polar satellite constellation, comprising three nano-satellites that will improve surveillance, tracking and reporting of civilian ships, defence and government assets.

There is also a Canadian program called Enhanced Satellite Communication project to provide further reliable and secure communications for the Arctic.

Together services like these will offer a degree of future proofing to business strategies designed around both shipping and other applications, including aviation in Polar areas. While some remain purely commercial ventures there is a growing focus on collaboration between government agencies and commercial service providers to improve Polar communications.

These new services promise to change the accessibility of high quality Polar coverage. While it is currently possible to provide VSAT services between 66.5 and 80 degrees latitude, the bandwidth availability is significantly reduced when going above 80 degrees. NGSO networks will for the first time make higher bandwidth available at both poles.

Once NGSO services begin to become available, we foresee theoretical services of up to 100 Mbps. The costs and extent of these services are yet to be fully defined by the providers and they have yet to complete proof of concept testing and acceptance under Marlink's quality standards for equipment and service testing.

To take advantage of these developments and be able to support established end users and new ventures, Marlink works with Polar connectivity providers and has struck a partnership with OneWeb to provide LEO services, while HEOSAT services will be offered to Marlink clients using the Global Xpress Ka-band service.

Shipping remains among the most important markets for new bandwidth capability and Marlink customers are already enquiring in growing numbers about investment in equipment upgrades and new integrations that will be necessary to take advantage of these new high throughput services.

6.1 Future Networks

For conventional Polar connectivity, it has traditionally been the case that bigger equipment provides a better signal and 'more means more'. Physics determines that a larger dish will deliver a more efficient service, utilise bandwidth better and increase the user's chances of staying connected at high altitudes compared to a smaller antenna.

A larger, higher powered 2.4m VSAT antenna will have the ability to provide higher throughput and better service quality at the edge of coverage areas. A 1m antenna might provide slightly lower speeds but still deliver acceptable service quality for most vessels sailing in the region.

Once again this equation will be altered by the availability of new NGSO constellations. New constellations in Low Earth Orbit will need less power and can use smaller antennas but still promise high throughput.

Selecting the majority of the NGSO constellations will require investment in new antenna hardware and other equipment and in most cases, users will still employ a hybrid network approach that combines either GEO VSAT and NGSO, or NGSO and LEO/GEO to provide primary and secondary channels. In some cases, we expect NGSO satellites to form the primary communication channel, with VSAT used as back-up.

Obtaining seamless and reliable Polar connectivity requires the use of a hybrid network agnostic of frequency or orbit, with guaranteed throughputs.

The applications and tools needed can then be optimised for best possible performance in terms of sensitivity to latency and bandwidth requirements. This approach, employing software defined routing (SD-WAN) can deliver best user performance on an application level designed around each clients' requirements, enabling the highest possible user experience.

7.0 Customer Requirements and Sustainability

Where ships sail will of course depend on the markets they serve and in the case of cruise operators and research there is some demand in the southern Antarctic peninsula. Northern regions are expected to be a much larger consumption market, with voyages to Svalbard and Greenland and more extreme journeys to the geographic North Pole.

The increasing number of low and ice-free days on the Northern Sea route have led some shipping analysts to predict that regular liner trades could operate seasonally, potentially shaving several days off the length and cost of a typical Asia-Europe passage.

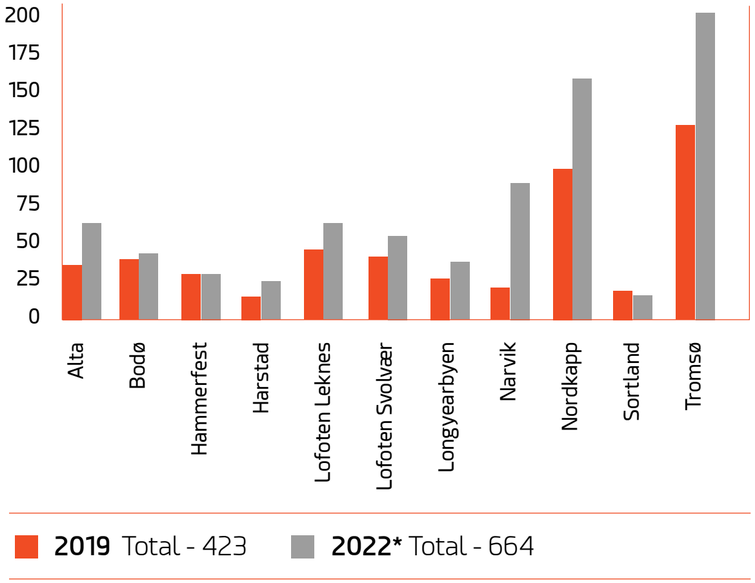
At the moment, traffic on the Northern Sea Route has come to a standstill but this is likely to be a temporary effect. In the longer term, the export of LNG is predicted to start in earnest but when and what the destinations will be is unclear at the moment, according to Morten Mejlaender-Larsen, Director Arctic Operation and Technology, DNV.

"We don't believe there will be a huge increase in traffic on the Northern Sea Route in coming years and the same is likely for the Northwest Passage which is open in the summer only and has no ice breaking capacity," he says.

"We know that many shipowners have studied transit of the Northern Sea Route and in some cases gained some experience but then largely shelved the project until they see a clearer business opportunity."

Larsen says DNV does expect to see more cruise ship traffic in both Polar regions, Arctic and Antarctic, in future. "This will be in the form of expedition cruise operators who are in these regions regularly and also regular cruise operators who may send some vessels to these regions during the summer seasons."

Table 4: Port calls in Norway inside the Arctic circle



* Forecast. Data Source: Cruise Norway

7.1 Customer Requirements and Sustainability

Data from industry body Cruise Norway also support a positive outlook for cruise vessel traffic operating to and from Norwegian ports inside the Arctic circle.

As the summer season nears its end, forecast data predicts a potential increase in full year totals for 2022. Passenger volumes are expected to recover as COVID travel restrictions are removed, prompting higher forward bookings, while operators have switched itineraries to northern destinations away from geopolitical risk.

The number of cruise vessels set to call at the top 11 ports in the Norwegian Arctic had been predicted to rise by nearly 57% to 664 calls according to forecast data from Cruise Norway, compared to 423 actual cruise port calls in 2019. Tromsø, Nordkapp and Lofoten are the top destinations.

As of August 2022, the actual number of cruise calls to destinations within the Arctic circle indicate the forecast for 2022 is most likely quite moderate compared to actual numbers by end of year.

For ships in Polar waters there is no additional position reporting requirement under the Polar Code but ships are required to show that they have updated ice information in databases onboard and can receive telemedical assistance. He adds that the demand for data from Polar shipping is internet access on cruise vessels, as passengers expect to be able to use their connected devices in Polar regions just as they would anywhere else.

Both northern and southern regions are the location for increasing fisheries activity and operators must remain in compliance with regulations regarding catch reporting as well as environmental protection.

Polar research continues in both regions but bandwidth demand is less predictable. However, whether studying the effects of climate change on temperature, sea ice, tides and currents or the broader marine ecosystem, bandwidth demand can be considerable.

> At a time when attention is increasingly focussed on climate change, Polar shipping operations can be controversial, since the potential for pollution or other impact can be magnified in a delicate environment. Because of the challenges of Polar shipping, it remains the preserve of dedicated and highly professional operators with the resources necessary to navigate in extreme environments while minimising environmental impact.

For shipping operators subject to the IMO Polar Code – such as cruise and merchant operators of all sizes – the aim is to minimise harmful pollution emissions, reduce fuel consumption and production of carbon dioxide, eliminate discharges of ballast water and waste – and even to reduce the noise impact of the vessel on the marine environment.

With environmental activism increasing at regional and local level, sometimes beyond the scope of global regulations, it seems clear that operators who wish to maintain the 'social contract' to operate in Polar waters will need to provide data on demand that demonstrates compliance.

This calls for an approach to communications that combines the best available networks integrated to provide seamless coverage and priority for safety services and reporting. As demand for Polar connectivity increases, operators will need to consider adding NGSO services to existing available networks, increasing the options available to improve coverage and reduce latency.

> Creating a network of networks is about more than just new satellites, it's the provision of guaranteed bandwidth, brought together in a package that reflects the importance of the data to the user taking coverage, throughput, latency and applications into account.

Meeting that demand will require more than just 'best effort', it means bringing the elements together in the most efficient way – and continuing to respond as demand grows in future.

8.0 Future Outlook

What is the outlook for Polar connectivity? Undoubtedly the largest share of new connectivity demand will be taken by cruise vessel operators, whose passenger-heavy sailings combine demand from customers, crew and enterprise applications. This sector is likely to represent the majority of fresh and incremental demand, with both conventional and specialist ships increasing numbers of sailings.

Bandwidth serving merchant shipping, energy, fishing, mining and government marine customers will continue to be a feature of Polar operations – as will demand from the aero sector. Connectivity will be boosted by the gradual availability of NGSO networks over Polar regions, providing a high throughput supplement at lower latitudes and a new level of high performance, low latency services for itineraries to the geographic north and south poles. For Polar connectivity beyond 80 degrees the change from today's bandwidth scarcity to the bandwidth in the pipeline could happen quite quickly and the positive impact will be felt more strongly for those operating in Polar areas.

As President, Maritime, Marlink, Tore Morten Olsen points out, **the best possible Polar connectivity is always going to be agnostic about constellation, orbit or frequency.**

"The scale of the Polar connectivity challenge is considerable but so is the opportunity and we think that the situation could change quickly from scarce bandwidth to fresh capacity that will support safer operations and higher frequency of reporting. A single connectivity system is never going to be a complete solution for our customers requirements; all available networks are needed to optimise opportunities and meet these fast-changing needs."

As the largest independent provider of communications to maritime, energy and land mobile markets, Marlink is present in all segments of Polar operations.

Our experience in these regions – and the agreements we have struck to bring next generation services to users – mean we can provide services that can provide the best possible coverage today and evolve as operational profiles change.

The Polar environment remains the world's most challenging –for shipping companies in particular. Marlink's best of breed approach to hybrid connectivity and advanced network tools can provide customers with the tools they need to stay safe and connected wherever they operate.

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Marlink would like to express its thanks to the Norwegian Coastal Administration for data on the Norwegian cruise market, DNV Maritime for comments on shipping trends and IHS Markit for data on trends in Polar vessel traffic.

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