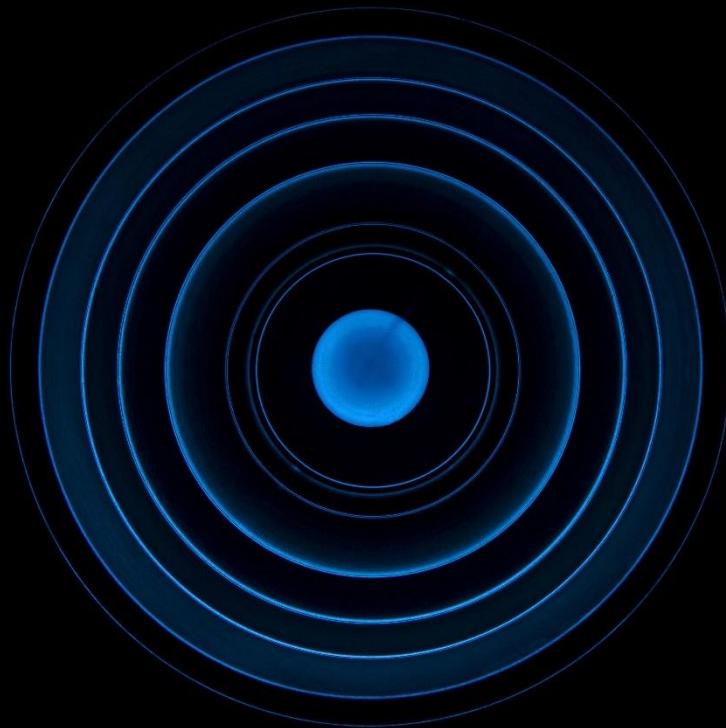


# Revolutionizing Maritime Connectivity:

Leveraging the LEO Satellite Networks for  
Enhanced Connectivity



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# Introduction

The maritime industry has long been an essential driver of global trade and commerce, facilitating the movement of goods and people across vast distances. However, despite the advances in ship technology and navigation, the industry has faced persistent challenges in communication and connectivity. In recent years, the introduction of Low Earth Orbit (LEO) satellite networks has presented an opportunity to revolutionize the way maritime stakeholders communicate, enhancing operational efficiency, safety, and crew welfare.

In late 2022, Japanese shipping company, Mitsui O.S.K. Lines (MOL), agreed with smart hybrid digital solutions provider Marlink to integrate the LEO satellite network service, Starlink powered by SpaceX, alongside its Sealink (GEO) VSAT service and its digital platform on selected vessels in the MOL fleet.

After trials on actual ships, MOL verified how Marlink's unique network can enhance operating safety and improve high-speed communications for seafarers. Starlink high speed, low latency connectivity will form an integral part of this hybrid solution.

The onboard network is completed with an L-band backup solution for further redundancy and is seamlessly and securely orchestrated with Marlink's network management platform, Xchange, and advanced Cyber threat detection, including the Security Operation Centre (SOC) monitoring as a service.

This hybrid and optimized blend of communications networks combining LEO and guaranteed bandwidth services simultaneously will enable MOL's digitalization journey to continue moving forward. It must also be remembered that unleashing internet connectivity transforms a ship from an asset with regular, but limited internet access, to the interactive world of constantly updated internet and social content. Cyber security and network management protocols are essential for a future-proof strategy.

This whitepaper delves into the transformative impact of LEO satellite networks on the maritime industry, providing an overview of the current connectivity landscape, the capabilities of LEO networks, and their potential applications in the sector. We will discuss various use cases of LEO networks that can directly benefit maritime operations and improve crew welfare, while also addressing the challenges that need to be overcome in order to fully leverage this technology. Our goal is to provide a comprehensive understanding of how LEO satellite networks can shape the future of maritime communication, ultimately enabling more efficient, secure, and sustainable operations across the globe.

# The Communication Conundrum: Maritime Connectivity Limitations

## 1. Traditional GEO Satellites: Hitting the Ceiling

The maritime industry has long relied on traditional satellite systems, such as Geostationary Earth Orbit (GEO) satellites, for communication and connectivity. However, these systems are not without their limitations. The distance between GEO satellites and Earth (approximately 36,000 kilometers) leads to significant latency, which can adversely affect real-time communication and data transfer. Furthermore, bandwidth constraints limit the amount of data that can be transmitted, resulting in reduced communication capabilities and higher costs for users. These limitations become even more pronounced in remote and high-latitude regions where coverage can be sparse or unreliable.

## 2. Current Connectivity Problem: The Seafarers' Perspective

In the Seafarers Happiness Index (SHI) 2023 Q1 report<sup>1</sup>, seafarers shared their experiences and thoughts on the current state of connectivity at sea. While there were positive sentiments regarding the affordability of contacting family and the stress relief provided by online access, several issues remained. Respondents noted concerns about the quality of internet connections, data allowances, and speed, as well as disparities in connectivity experiences across different companies and even within the same fleet.

The SHI report highlighted the importance of reliable and affordable internet connectivity for seafarers to maintain communication with their families, manage their work-life balance, and access information and entertainment. Challenges with data allowance, speed, and availability, as well as variations in connectivity across company fleets, suggest the need for improvements in the provision of internet services to seafarers to enhance their well-being and job satisfaction.

Moreover, seafarers expressed optimism about the potential of Starlink services to provide the access they crave at costs they can afford. This underlines the growing interest in and demand for LEO satellite networks in the maritime industry.

## 3. LEO Satellites: Soaring to New Heights

LEO satellite networks offer a groundbreaking solution to the connectivity challenges faced by the maritime industry. Orbiting at an altitude of 1,200 kilometers or less, LEO satellites are significantly closer to Earth than their GEO counterparts. This proximity allows for lower latency, higher data transfer speeds, and more consistent global coverage, including hard-to-reach polar regions.

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<sup>1</sup> [Seafarer Happiness Index Quarter 1 2023, The Mission to Seafarer \(2023\)](#)

LEO networks are comprised of hundreds or even thousands of small satellites, working together in a constellation to provide continuous, seamless coverage. This approach ensures that even if one satellite fails or becomes obstructed, others in the constellation can compensate and maintain connectivity. The launch of mega-constellations, such as SpaceX's Starlink, OneWeb, and in the future Amazon's Kuiper has accelerated the development and implementation of LEO technology, making it a more viable option for industries like the maritime industry that require reliable, high-speed communication.

The introduction of LEO satellite networks holds the promise of greatly improving connectivity in the maritime sector, offering more efficient communication, enhanced safety measures, and better overall crew welfare. In the next section, we will delve into the wide array of LEO satellite network applications that stand to benefit the maritime sector, as well as explore the direct impact on crew welfare. We will also discuss the challenges that must be addressed to fully harness the potential of this groundbreaking technology.

	<b>GEO Satellites</b>	<b>LEO Satellites</b>
<b>Altitude</b>	Approx. 36,000 km	1,200 km or less
<b>Latency</b>	High (due to greater distance from Earth)	Low (due to closer proximity to Earth)
<b>Data Transfer Speed</b>	Limited (due to bandwidth constraints)	Higher (Less constrained by bandwidth limitations)
<b>Global Coverage</b>	Inconsistent (sparse in remote regions)	More consistent (including polar regions)
<b>Network Resilience</b>	Single satellites (higher vulnerability)	Constellations (multiple satellites for redundancy)
<b>Cost</b>	Higher (due to fewer satellites)	Lower (large constellations reduce costs)

Table 1. Comparison GEO vs LEO Satellites

## LEO in the Maritime Sector, Possible Use Cases:

MOL's analysis – which would be recognized by many of today's shipowners – defines the impact on efficient vessel operations and crew welfare services in terms of three major gaps: time, information, and quality of life if sufficient bandwidth is not available.

First, low bandwidth allows vessel crew to receive information only at irregular intervals instead of on a real-time basis. Communication can take time to establish, causing issues in case of emergencies because the Master and crew must create a text-based report for shoreside teams, rather than being able to convey the situation via video.

Real-time data can be hard to access because network stability depends on the circumstances at the vessel's location. For example, when a vessel encounters heavy weather, it is most in need of real-time weather data and forecasts, but access may not always be possible.

Next, low bandwidth availability allows crews to receive only limited information from shore which can make it harder for them to understand what's going on in their company or at home, which makes them feel isolated.

Lastly, because of bandwidth scarcity, crews onboard ships must be highly self-sufficient. Even when crew members are injured or sick, they must manage the situation by themselves. In terms of entertainment onboard, the options are highly limited. Crews are mainly restricted to outdated movies or entertainment using physical media. They can enjoy their local food only if a versatile cook is onboard or if it is possible to translate recipes.

# Unleashing LEO Satellite Networks in the Maritime Sector

## 1. Empowering Real-Time Communication and Decision-Making

With low-latency, high-speed data transfer capabilities, LEO satellite networks enable seamless real-time communication between vessels and shore-based offices, improving operational efficiency and decision-making. Maritime professionals can access vital data, such as weather updates, navigational charts, and route optimization information, allowing them to make well-informed decisions and respond more effectively to changing conditions.

## 2. Enhancing Safety and Emergency Response

LEO networks can improve safety and emergency response by providing reliable, high-speed communication, even in the middle of the ocean. This ensures that vessels can maintain contact with rescue services, monitor distress signals, and access vital information during emergencies. Additionally, the ability to share real-time data and analytics can help in identifying potential risks, preventing accidents, and reducing response times. Vessels will be able to share real-time navigational data with shore and carry out remote inspection and troubleshooting with shore-based teams. Maintenance procedures can be upgraded to include streaming services for tutorials and Augmented and Mixed Reality devices with experts assisting crew onboard.

## 3. Enabling Advanced IoT and Automation Technologies

The adoption of LEO satellite networks can accelerate the integration of advanced Internet of Things (IoT) and automation technologies in the maritime industry. Enhanced connectivity facilitates the collection and analysis of large volumes of data from sensors and devices installed on vessels. This data can be used to optimize ship performance, predict maintenance needs, and enhance the overall efficiency of maritime operations.

Additionally, vessels can be equipped with sensors to collect and share real-time information about weather conditions, piracy activities, and other incidents in their vicinity. This shared network of data enables better situational awareness and decision-making for the entire maritime community, leading to improved safety and operational efficiency.

## 4. Streamlining Supply Chain and Logistics

LEO satellite networks can play a critical role in streamlining the supply chain and logistics operations by providing continuous, real-time tracking of vessels and cargo. This enables stakeholders to optimize their

operations and minimize delays, improving the overall efficiency and profitability of the maritime sector.

In the longer term, vessel operations will become more automated, not in terms of crew presence, but potentially in making their own operational decisions without the assistance of shore staff.



# Crew Welfare: Fostering a Connected and Engaged Workforce

## 1. Bridging the Connectivity Gap

LEO networks can significantly improve the quality of life for seafarers by providing reliable, high-speed connectivity even in remote regions. This enables crew members to stay in touch with their families and friends, access news and entertainment, and maintain a sense of connection with the world beyond their vessel, reducing feelings of isolation and loneliness.

## 2. Access to Online Training and Professional Development

With the support of LEO satellite networks, maritime professionals can access online training and professional development resources while at sea, allowing them to enhance their skills and stay up-to-date with industry advancements. This not only contributes to the personal growth of individual seafarers, but also benefits the maritime industry as a whole by fostering a highly skilled and competent workforce.

## 3. Enhancing Medical Support and Expanding Entertainment Options

The limited bandwidth currently available on ships often restricts crew members from accessing essential resources in times of need, such as medical assistance, as well as limiting their entertainment options. The adoption of LEO satellite networks can provide the following benefits:

### a) Remote Medical Assistance:

High-speed, low-latency LEO connectivity can facilitate remote medical consultations and support for crew members who fall ill or suffer injuries while onboard. Access to telemedicine services ensures that seafarers receive timely, professional advice and guidance, improving their physical and mental health and safety outcomes.

### b) Diverse Entertainment and Cultural Experiences:

LEO networks can significantly expand the range of entertainment options available to crew members. With improved connectivity, seafarers can stream movies, TV shows, and music from various online platforms, providing a wider selection and up-to-date content. Furthermore, they can access digital resources, such as recipe translations and cooking tutorials, enabling them to enjoy a taste of home and improve their culinary skills even when a versatile cook is not on board.

The next section will discuss the challenges that must be overcome to fully leverage the potential of LEO satellite networks and unlock their transformative impact on the maritime industry.

## Testimonials from MOL Crews

MOL and Marlink have carried out a Starlink trial on a MOL managed vessel. The trial onboard provided an unprecedented opportunity for the crew to experience first-hand the transformative potential of this technology. Their testimonials offer invaluable insights into how enhanced connectivity can profoundly impact both professional operations and personal lives onboard a ship.

### **"High-Speed Internet: A Catalyst for a Happy Ship" - Captain**

"High expectations accompany high-speed internet onboard. Not only does it promise smoother business operations and enhanced safety, but it also significantly impacts the welfare of the crew. A happy crew makes for a happy ship. Poor internet affects our work, especially when sending important emails and correspondences related to port requirements. It also impacts our personal lives when our data is consumed waiting for connectivity to talk with our families. With high-speed internet, our life onboard becomes easier and happier. As a Master onboard, I want to see my crew happy - just like a father wants to see his children happy. A satisfied and motivated crew leads to safer operations and overall improved ship safety. High-speed internet is not just a luxury - it's a necessity for our well-being and effective operations onboard."

### **"Navigating the High Seas while Staying Connected" – Crew Member**

"Internet connection onboard is vital to us. Our work takes us miles away from home, from our families, from our communities. With a reliable internet connection, we're able to reach out to them in real time. We can witness our kids growing up and understand what is happening outside the ship. It is equally important for ship operations to have smoother transactions and reporting. Seeing our families, our loved ones and their smiling faces during a video call makes us comfortable. It bolsters our spirits and encourages us to work harder onboard."

For a more immersive experience, we have filmed the installation process of the Starlink antenna and captured real-time reactions and interviews with our crew. This behind-the-scenes look provides an in-depth understanding of the technology integration and the genuine impact it has on those onboard.



[Dive into the Experience: Watch the Video Here](#)

# Navigating the Obstacles to LEO Satellite Network Adoption

## 1. Regulatory Hurdles and Licensing

One of the primary challenges in implementing LEO satellite networks in the maritime industry is navigating the complex regulatory landscape. While some countries have granted licenses to LEO network operators, many others are still in the process of developing appropriate regulations or remain hesitant to approve their use. This lack of uniform licensing and regulation across jurisdictions presents a significant barrier to the widespread adoption of LEO satellite networks.

## 2. International Waters: A Grey Area for LEO Networks

In international waters, there is currently no clear guidance on the use of LEO satellite networks, creating uncertainty for maritime operators. The absence of established regulatory frameworks and the potential for conflicting regulations among different countries may deter ship owners and operators from investing in LEO network technology. To fully leverage the benefits of LEO networks, international cooperation, and a harmonized regulatory approach are crucial.

## 3. Cost and Infrastructure Challenges

While LEO satellite networks promise to lower connectivity costs in the long run, the initial investment required for the infrastructure, such as terminals and antennas, may be substantial. For smaller shipowners, the upfront costs may present a barrier to adopting LEO network technology. Additionally, the need for regular maintenance, software updates, and potential hardware replacements must be considered when evaluating the total cost of ownership.

## 4. Cybersecurity Risk Exposure

The adoption of LEO satellite networks also introduces new cybersecurity risks to maritime operations. As digital connectivity and data transmission increase, so does the potential for cyber threats. These threats range from unauthorized access, data breaches, and hacking of navigation systems to more complex attacks targeting the ship's control systems. Ensuring robust and resilient cybersecurity measures are critical to protect sensitive data, maintain privacy, and ensure the safe and reliable operation of maritime communication systems.

In the next section, we will draw conclusions about the transformative potential of LEO satellite networks for the maritime industry and outline the steps required to overcome the challenges and unlock their full potential.

# Sailing Towards a Connected and Efficient Maritime Future

The introduction of LEO satellite networks promises to revolutionize the maritime industry, addressing long-standing connectivity challenges and opening new possibilities for enhanced communication, safety, operational efficiency, and crew welfare. By enabling real-time decision-making, advanced IoT and automation technologies, streamlined supply chain and logistics, remote medical assistance, and diverse entertainment options, LEO networks have the potential to significantly improve the lives of seafarers and bolster the overall performance of the maritime sector.

However, to fully harness the benefits of LEO satellite networks, it is crucial to overcome the challenges related to regulatory hurdles, international waters regulations, cost and infrastructure. Collaborative efforts among LEO satellite operators, regulatory bodies, and the maritime industry are essential to develop harmonized regulations, and affordable infrastructure solutions.

We believe that regulators with responsibility for national waters can make a genuine contribution to improving the quality of life onboard ships for seafarers – and support the safety of shipping - by granting approvals for the use of LEO satellite networks within their territories. Co-ordinating this approach in international forums will also encourage more maritime nations to make LEO constellations available to ships in their waters, so supporting safer and more efficient operations.

As the maritime industry continues to evolve and adapt to new technologies, the widespread adoption of LEO satellite networks can pave the way for a more connected, efficient, and resilient global maritime ecosystem. By investing in LEO network technology and addressing the associated challenges, stakeholders in the maritime sector can unlock new opportunities for growth and innovation, while significantly enhancing the well-being and job satisfaction of seafarers who are at the heart of this vital industry.

In light of the potential benefits and growing interest in LEO satellite networks, we, Mitsui O.S.K. Lines, have decided to roll out Starlink to over 200 of our managed vessels. This strategic decision reflects our commitment to embracing cutting-edge technology and fostering a more connected and efficient maritime future for our existing & potential crew members and the wider industry.

