

DIGITALIZING SHIP PERFORMANCE:

**WHY MARITIME LEADERS NEED TO
TRANSITION TO HFD**



Abstract

The maritime industry is at a critical juncture where traditional performance monitoring systems—anchored in low-frequency noon reporting—are no longer sufficient for operational excellence, regulatory compliance, or competitive advantage. This white paper examines the limitations of noon reports and underscores the urgency of adopting High-Frequency Data (or HFD) as a transformative approach to vessel performance monitoring.

HFD provides real-time, granular insights into vessel operations, enabling dynamic

decision-making, accurate emissions reporting, predictive maintenance, and more efficient voyage planning. Drawing on industry expertise, case studies, and technological benchmarks, this paper outlines the compelling benefits of HFD, addresses challenges to its implementation, including technical, operational, and cultural barriers, and presents a roadmap for maritime stakeholders to transition from manual logs to intelligent, automated data systems.

For maritime leaders aiming to stay competitive in a fast-evolving landscape of digitalization and environmental accountability, the adoption of HFD is not just an option; it's a strategic imperative.

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Forward

Charting a New Course for Maritime Performance

According to a report, ships handle 80% of the world's [trade](#). And today, the maritime industry is at the brink of a profound shift in how it uses data for its revenue-generating processes. Before we delve deeper into the new phase of data management, let us quickly look into some events that progressively led to a transformation.

For decades, ship management teams have relied on noon reports that provide a daily synopsis of vessel performance – its position, speed, fuel level, and the weather conditions faced – for the past 24 hours. Meanwhile, the industry also saw revision of some strategic regulations by International Marine Organization (IMO). One of these was the International Safety Management (ISM) code in 1993 that was mandated by SOLAS amendments in 1998 to establish a gold standard for safety management systems aboard ships. It requires shipping companies to maintain documented procedures, conduct regular audits and ensure accountability across operations. Another important change was the adoption of ISPS Code in December 2002 – it imposed security requirements for ships and port facilities in response to escalating global terrorism threats.

The regulation mandated risk assessments, designated security officers, access control, and coordinated threat-monitoring protocols. More recently, in January 2020, IMO tightened fuel sulfur

limits from 3.5% to 0.5% globally, delivering around a 70% reduction in sulfur oxide emissions to improve air quality near ports. The rule forced a major industry shift toward low-sulfur fuels or scrubber installations and elevated expectations around accurate emissions monitoring and compliance reporting.

With the need to stay flexible for such changes, the shipping industry had to make its reporting and adaptability more dynamic. And today, in line with standards across other verticals, it does have the potential to get granular insights for greater cost efficiency, compliance, and sustainability. Because High-Frequency Data (HFD) systems make that attainable – they continuously monitor and stream real-time data collected from an array of sensors to give a more dependable and detailed overview of vessel operations. Fleet managers can use these insights to make timely, informed decisions on voyage planning and predictive maintenance.

As shipping companies face rising cost pressures and tightened environmental regulations, choosing HFD is not optional or a mere upgrade over noon reports – it is a strategic imperative. With support for energy efficiency, reduced emissions, and proactive maintenance to reduce downtime, an HFD platform aligns with the International Maritime Organization's decarbonization goals while boosting operational reliability.

This paper by Smart Ship® Hub Digital highlights how HFD generates measurable value for the maritime ecosystem and provides the precision to unlock the full potential of fleets through data-driven transformation.

Executive Summary

Why Noon Reports Fall Short – And What HFD Brings to the Table

Even as the industry operates in a world of instant connectivity, several decisions around maritime operations are based on once-a-day, manually recorded data.



Traditional methods based on noon reports and other low-frequency data (LFD) sources offer periodic information but cannot keep up with demands for up-to-the-minute, data-rich insights. Indeed, studies indicate that nearly 9 out of 10 spreadsheets have mistakes due to manual entries and these could be avoided simply with the use of a more focused system.

With low temporal resolution and its vulnerability to human error, an LFD record lacks the ability to capture short-term operational fluctuations. This causes blind spots for critical areas like fuel consumption, emission reporting, and the parameters to be assessed for predictive maintenance.

HFD, powered by automated sensors, captures data every few seconds. It equips vessel operators with detailed, real-time inputs that shape better decisions for voyage optimization, equipment health monitoring, compliance adherence, and overall operational efficiency. Yet, HFD adoption across the maritime sector remains thin. The challenges faced by companies range from inadequate sensor coverage and system interoperability to high integration costs and internal resistance to change.

This whitepaper explains the limitations of noon reporting and demonstrates the value of HFD through successful use cases. It also provides a roadmap to overcome adoption barriers for HFD. In addition, it describes a phased strategy for deploying LFD and HFD systems together, helping maritime enterprises design an intelligent, more responsive data network for their fleets.

Introduction

The Case for Data-Driven Maritime Operations

In our data-driven world, the significance of high-fidelity information cannot be overstated. But the truth is that companies lose millions of dollars due to poor data quality that leads to bad decisions, reduced business efficiency, missed opportunities, lost revenue, increased costs, and compliance risks. Inaccuracies in data collection and analysis stem from legacy systems that are error-prone and do not integrate well with Industry 4.0 applications. The global shipping sector too is caught in this whirlpool of issues inadvertently caused by noon reports and other outdated methods of leveraging data. Meanwhile, it operates in a complex environment marked by volatile fuel prices, evolving emission norms, and the geopolitical tensions that affect route planning.

Companies must meet the expectations of customers, regulators, and stakeholders while ensuring more transparency and accountability in their performance. In this light, let us consider the regulations under the EU Emissions Trading System (EU ETS) for shipping that came into effect on January 1, 2024. They set a cap on total greenhouse gas (GHG) emissions and allow companies to buy or trade carbon credits (known as EU Allowances or EUAs) to offset emissions they cannot reduce [directly](#). As per the regulations:

- Ship operators must monitor, report, and verify their CO₂ emissions from voyages to/from/within the EU.
- For every ton of CO₂ emitted, a ship operator must submit one EUA.
- If a company's emissions exceed its allowance, it must purchase additional EUAs from the market—or face penalties.

With carbon credits trading at around €70 per ton, even a minor misreporting of 3 tons of fuel oil would translate to an additional €210 in EUA obligations per voyage segment. For a single ship operating multiple voyages daily, that becomes €653 per day. And across a fleet of 100 ships, this adds up to approximately €65,300 per day—nearly €23.8 million annually in unplanned compliance costs. This explains why accurate, high-frequency emissions data isn't just good practice but essential for managing exposure especially in the EU ETS market.

As in other sectors, digitalization paves a smoother path forward. Maritime players can leverage advances in sensors , Internet of Things (IoT) connectivity, and analytics to monitor their vessels at a more nuanced level, uncovering the flaws that were once imperceptible. By turning raw data into actionable insights with HFD, companies can reduce fuel consumption, refine maintenance plans, and fortify compliance with environmental standards.

While HFD empowers maritime enterprises to make high-quality, real-time data to compete in their evolving seascape, they can also retain their legacy LFD systems through their journey. Those easy-to-deploy and universally understood setups are still valid to monitor and benchmark sister ships over time.

By combining LFD's historical context with HFD's deeper, dynamic details, companies can foster a robust data strategy that balances immediate insight with big-picture analysis.

The Limitations of Noon Reporting

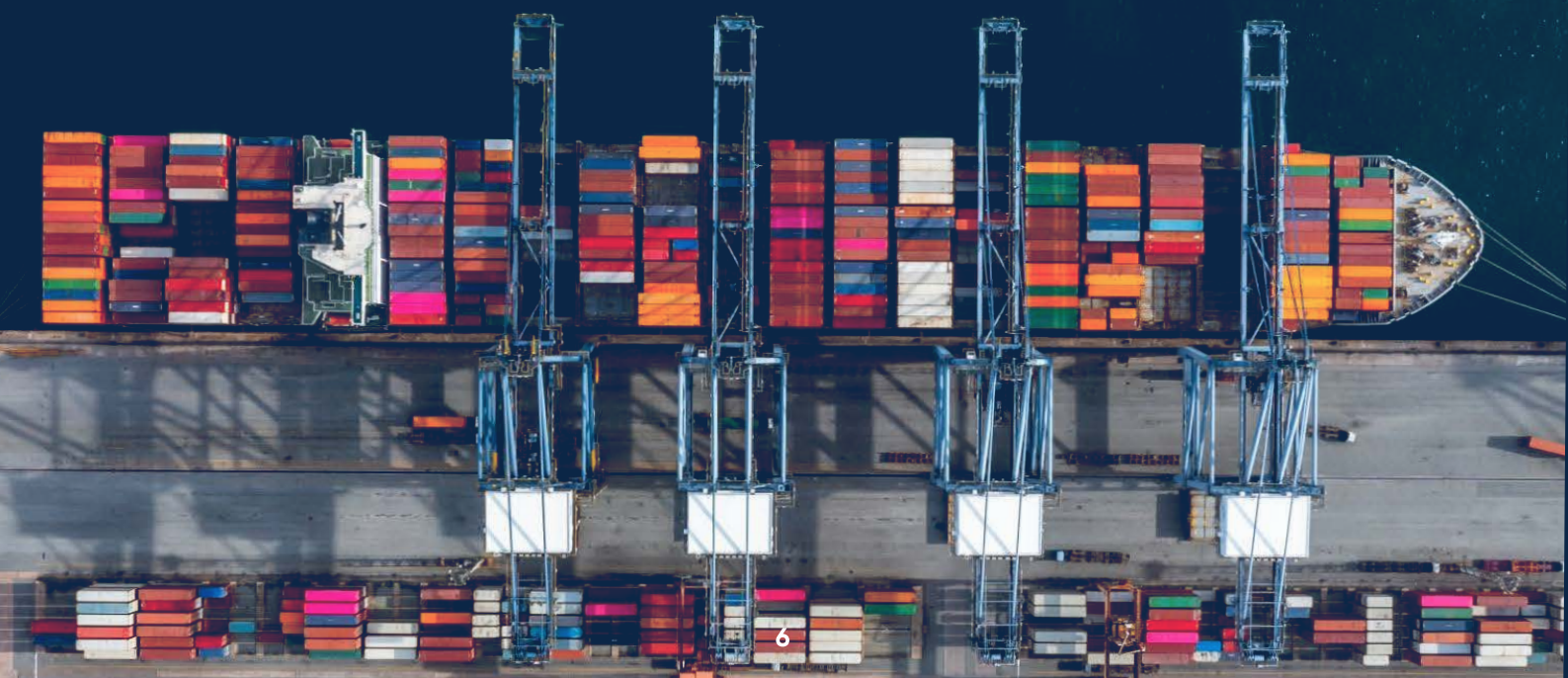
While sea vessels have seen a dramatic progress in their propulsion and navigation technologies, the performance monitoring operations have remained traditional for decades.

The once-a-day, noon report has been the industry's go-to-tool. It is the snapshot that everyone understands. However, as shipping becomes more complex and machines more modern, data-driven, simply collecting a set of figures every 24 hours is no longer enough. It's time to look at where this traditional practice falls short. By understanding the gaps in their age-old reporting methods, companies can see why smarter, more dynamic data collection is essential to keep fleets efficient, compliant, and future-ready in a competitive market.

Problems with Noon Reports and Other LFD Mechanisms

↓ Low Temporal Resolution and Operational Blind Spots

- Data captured only once per day
- Missed short-term fluctuations in speed, load, and weather
- Failure to detect sudden changes in system performance
- Limited visibility during critical port operations
- Restricted ability to optimize voyage in real-time
- Gaps in fuel consumption analysis



Manual Data Entry Errors



Typos in manual entries



Inconsistent data from different crews and ships



Delayed reporting



No real-time verification



Extra burden on crew



Data reliability issues



Confusing subjective entries like Beaufort Force 4 or Beaufort Force 6 for wind conditions

Challenges in Emission Tracking and Decision-Making

- Inaccurate emissions estimates
- Compliance risks with regulations
- Missed fuel-saving opportunities
- Poor-quality data for reporting
- Hard-to-benchmark performance
- Cost & Penalty due to misrepresentation

The High-Frequency Data Advantage

HFD systems help shipping companies redefine performance measurement in their digitally transforming industry. Unlike noon reports and other LFD systems that extract inputs once every day, an HFD platform works day and night, collecting up to 5000 data points from a vessel's critical components every few seconds. It monitors sensors and connected systems to sketch a clear picture of what's really happening on board, minute by minute.

With seamless monitoring, crews and shore-based teams can detect anomalies as they arise to make informed decisions for safer navigation and vessel health. The insights also make tracking of fuel consumption and emissions more precise, reducing waste and helping companies demonstrate environmental accountability. As per research by Faculty of Mechanical Engineering and Naval [Architecture](#), slow steaming, guided by real-time data, can reduce fuel consumption and CO2 emissions by 30-40% while also maintaining optimal engine health.

HFD's comprehensive, time-stamped records lay the foundation for maintenance powered by AI-driven advanced analytics. By catching patterns in equipment behavior, engineers can address potential failures before they disrupt schedules or inflate costs.

The rich, standardized data stream offered by HFD makes it easier to meet regulatory demands. Automated, true-to-life reports reduce administrative burden, keeping data consistent and audit-ready. With a mix of features for sustainability and safety, HFD helps maritime companies make their operations more efficient, transparent, and resilient.

An HFD system can also power digital twin models by providing operators with dynamic simulations to reflect the actual vessel performance. Based on these inputs, operators can test scenarios, predict outcomes, and fine-tune processes without downtime.

Use Cases and Impact Scenarios

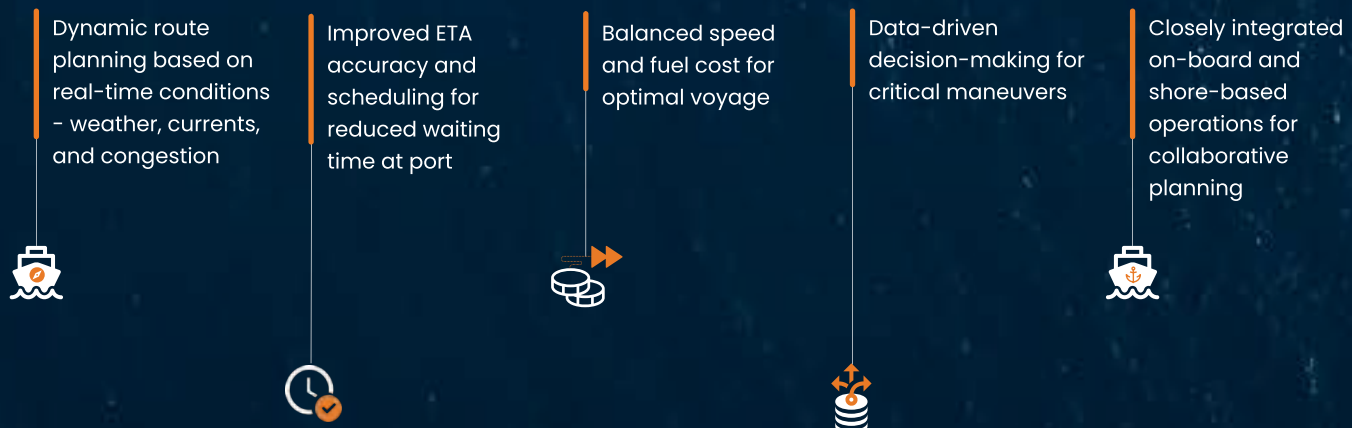
HFD's ability to continuously monitor vessel operations allow crews to organize their revenue-generating activities more effectively. Leveraging HFD they can base their voyage decisions on dynamic route optimization as per existing sea and weather conditions.

Thanks to more accurate estimated time of arrival (ETA) predictions and Voyage Speed based on HFD, just-in-time (JIT) arrivals become achievable, avoiding long waits at port. At the fleet level, an HFD platform's continuous data collection helps to benchmark performance across vessels, know where improvements are necessary, and share best practices. HFD also brings greater transparency in charter party agreements by offering tamper-proof data and verifiable records of speed, fuel use, and compliance.

Here's how these applications demonstrate the high-impact value of HFD across operational, financial, and contractual dimensions in shipping:

Use Cases for High Frequency Data

Navigate Smarter With:



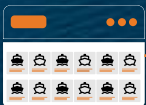
Plan Arrivals, the JIT Way



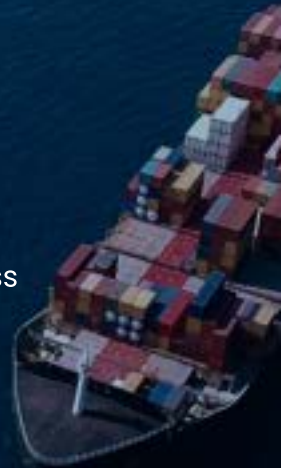
- Minimized port idle time
- Speed matched to berth slots
- Reduced congestion and waiting time in queues
- Smoother port operations and logistics planning
- Enhanced ETA accuracy
- Better fuel efficiency with avoidance of unnecessary speed changes



Measure and Boost Fleet Operations



- Compare vessel performance across routes
- Identify underperforming ships for targeted action
- Track fuel consumption patterns fleet-wide
- Set and monitor operational benchmarks
- Deploy continuous improvements with data insights
- Build the data foundation for autonomous vessel readiness



Build Stronger Trust in Charter Agreements

- ✓ Provide tamper-proof operational data
- ✓ Reduce disputes with clear performance records
- ✓ Verify speed and fuel compliance easily
- ✓ Ensure fair settlement of claims
- ✓ Support transparent billing and invoicing
- ✓ Strengthen relationships with data-backed trust



The Roadblocks to HFD Adoption (And How to Eliminate Them)

Adopting HFD systems offers clear operational advantages, but for most companies, deploying them is not a simple task. This is also about moving up the digital maturity ladder—from Level 0, where everything is manual and scattered, to Level 4, where data drives fully integrated, predictive decisions. Let's look at the barriers in three broad categories and the practical strategies to overcome them and unlock the full potential of HFD for the industry.

1. Technical Hurdles

A robust technical foundation is critical to orchestrate HFD systems, but a huge number of ships have aging and weakly maintained sensor network. Misaligned sensors can cause transmission of incomplete or poor-quality data. Another issue is interoperability because legacy systems often don't communicate with modern platforms, creating silos. Then there is a lack of industry-wide data standards implying inconsistent formats that make it difficult to consolidate insights across fleets.

It's also important to remember that HFD is not always error-free. Outliers—the extreme data points that fall outside expected ranges—may arise due to sudden sensor malfunctions, external impacts, or rare environmental conditions.

If unaddressed, these anomalies skew analytics, deliver misleading insights, and affect operational decisions.

The Solution

Shipping companies should start with a sensor audit to understand critical points of failure and standardize calibration protocols. Investing in modular, open-architecture setups helps to enhance flexibility and future integration potential. Equally important is selecting platforms with strong Data Quality Management (DQM) systems that can automatically flag anomalies, control outliers effectively, and maintain high-integrity data flows for sound analytics. Smart Ship Hub's HFD platform supports globally recognized maritime clean data standards that simplify harmonization. Its automated data validation and outlier-detection algorithms ensure that only reliable, clean data fuels decision-making.

2. Operational Concerns

Ahead of buying new equipment, rolling out HFD systems requires ongoing operational commitment. The costs of retrofitting older vessels and maintaining new hardware and software can be significant. Processing delays occur when existing systems cannot handle large datasets, which dilutes the value of "real-time" insights.

Cybersecurity is another major concern. With increased connectivity between ships there are greater risks of attacks to steal data, disrupt operations, and threaten safety. In the first half of 2024, more than 23000 malware cases were reported in the [sector](#). For many marine enterprises, these factors slow down adoption or limit the scope of HFD implementation.

The Solution

Companies can control their HFD deployment costs by using a phased approach to prioritize high-value use cases and ships in the beginning. Systems with local edge computing solutions used by Smart Ship Hub enable onboard processing and filtering of data to send only essential insights over limited bandwidth – this reduces delays and transmission costs while maintaining real-time capabilities for prioritized use cases. Our HFD platforms also have built-in cybersecurity measures with data encryption and regular updates. What's more, they help shipping companies prepare for compliance with the new UR E26/E27 standards issued by classification societies, which mandate robust cybersecurity requirements for vessels built after 1 July 2024. Network segmentation, access control, training of crew in cyber hygiene, and establishing a strong incident response plan are other technical strategies we recommend to maximize ROI and minimize risk.

1. Cultural Resistance

Even with proven benefits of a digital transformation technology, human factors often eventually determine its success or failure.

Many seafarers and shore teams have a natural skepticism about new systems, especially if they feel complex, intrusive or designed to “track” performance. Low trust in data itself leads to it being disregarded or misused. Resistance to change is common in an industry rooted in tradition, where prevailing workflows seem familiar and safer.

Furthermore, there is typically a skills gap – crews may not be trained to infer high-frequency information or act on insights supplied by it. Without the ability to transform data into decisions, even the finest of systems fall short of their potential.

The Solution

Change management to address cultural resistance starts with clear communication on how data enriches efficiency, safety, and workload planning. Intuitive dashboards for HFD and hands-on training make data more accessible. It is also important to foster a culture that values continuous learning and evidence-based decision-making. Leadership support and highlighting data-driven success stories help to reinforce these changes, making HFD adoption a shared success story instead of a top-down mandate.



Bridging the Gap:

LFD and HFD in Tandem

While HFD unlocks the next level of operational insight, LFD sources still play a role in fleet management. Noon reports throw light on a reliable basic dataset that is easy-to-collect and is familiar to crews. HFD has been designed to track second-by-second performance on parameters like fuel usage, speed, and engine behavior, and LFD helps to check long-term trends across journeys. This years-old method is especially useful to get reports for ships that have limited sensor coverage. Instead of viewing them as competing systems, marine operations companies can make them work together to get both depth and breadth of information that matters for vessel performance.

The choice of what data to integrate and analyze also need to match the vessel's commercial context and key performance indicators (KPIs). For example, on a time charter, fuel consumption is a critical KPI for both owners and charterers, making detailed fuel monitoring essential. In contrast, a voyage charter may prioritize schedule adherence or port turnaround times, where daily summaries can still suffice for planning.

HFD-LFD integration involves layering of new sensor networks onto existing reporting workflows.

By deploying targeted sensors on high-impact systems – like main engines, fuel flow meters, and shaft power meter – operators can collect real-time data from these sources while noon reports continue to capture the daily summaries for less critical parameters.

Data from both the methods can be consolidated on a unified platform with standardized formats and timestamps to enable seamless analysis. By using an edge computing-based software, marine companies can filter and pre-process HFD to reduce bandwidth needs. And standardized APIs ensure interoperability with legacy software. The approach preserves the familiarity of LFD while supplementing performance reports precision and immediacy where they are most valuable.



Strategies for a Successful Transition

Successful usage of HFD systems demands a thoughtful strategy aligning technology with business goals and people. The first step is to build a solid business case with a clear ROI narrative. Leaders should identify their high-impact use cases which could be fuel savings through voyage optimization, reduced maintenance costs with predictive insights, and reduction in emissions for sustainability. In doing so, they also need to look beyond just the tangible returns. The non-perceptible benefits – like preventing equipment breakdowns or sub-par performance through condition-based predictive analysis – can significantly improve asset reliability and longevity. Factoring in these avoided costs strengthens the value proposition of HFD investments and helps secure buy-in from

technical, operational, and financial stakeholders.

Choosing the right partners is equally important. Data-agnostic vendors supporting open standards and interoperability minimize the risk of vendor lock-in and ensure that systems keep evolving with future needs. Maritime companies need setups that support seamless integration of HFD and LFD sources on a scalable digital foundation – this would enable unified analytics, continuous upgrades, and synchronization with the evolving requirements of their fleets.

Finally, because no transition is effective without people, investing in workforce enablement is essential to ensure seamless adoption. Crews need to be trained not only to operate new systems but also to interpret data confidently and apply insights in routine decisions. Highlighting early wins, encouraging feedback, and building a culture of continuous learning transforms data from a compliance burden into a real competitive advantage.



Conclusion

The Future of Shipping Belongs to the Data-Ready

Maritime operators are now expected to keep up with Industry 4.0 trends where efficiency, sustainability, and competitiveness depend on the skills to harness data. HFD is the new way of observing and managing vessel performance to keep it optimal. By blending their periodic noon reports with more precise insights, shipping organizations can maximize fuel efficiency, minimize carbon footprint, refine maintenance, and respond faster to market demands.

Those who successfully weave data into every level of operations will not only meet today's regulatory and commercial pressures but emerge as leaders of innovation in the industry.

At Smart Ship© Hub Digital we know that turning data into value matters for business growth. That is why we offer more than just technology – we deliver the real-world solutions to help you make better decisions every day. From seamless onboard data capture and continuous monitoring of fuel flow and machinery health to usage of smart analytics for maintenance before issues arise, our tools give you the clarity and control you seek.

We make it simpler to meet decarbonization targets with reliable emissions tracking and compliance-ready reporting. Our weather intelligence system facilitates advanced route planning for voyage optimization. Plus, with condition-based monitoring algorithms, we support predictive maintenance that helps catch issues before they turn into costly downtime. All our products are built for agility, scalability, and ease-of-integration across fleets, keeping users ready for the next level of operations. Connect with us to know how we can partner with you for smarter, data-driven, resilient maritime operations.

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