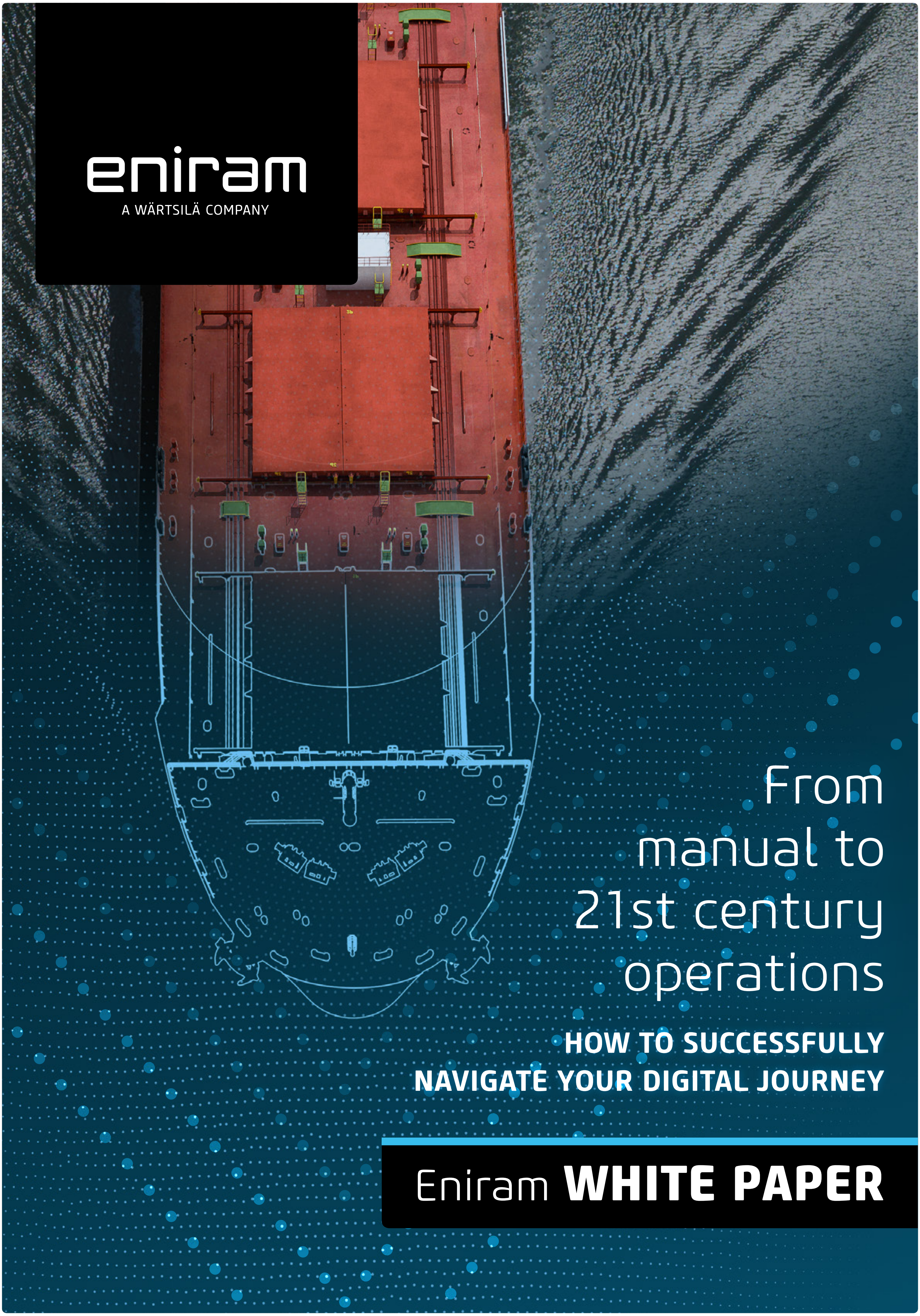
eniram
A WÄRTSILÄ COMPANY



# From manual to 21st century operations

## HOW TO SUCCESSFULLY NAVIGATE YOUR DIGITAL JOURNEY

Eniram **WHITE PAPER**

eniram
A WÄRTSILÄ COMPANY

*Since 2005 Eniram has provided the marine industry with leading insights for operations and asset efficiency as well as commercial shipping. The Eniram Insight Factory provides partners with decision-making support based on real-time data collection, statistical modeling, and predictive simulations. Our mission is to maximize the efficiency of the industry through digital insights, saving costs and maximizing overall profitability while cutting the emissions harmful to our environment.*

*Eniram's solutions range from single-vessel services to comprehensive fleet-wide solutions. Among Eniram's customers are leading players in the cruise, LNG, container, tanker, and bulker markets. We also offer a subscription-based service to expand into performance management for the commercial and charter market. Eniram is headquartered in Helsinki, Finland and has offices in the UK, the USA, Germany, UAE and Singapore. Eniram is a Wärtsilä Company, catalyzing a digital and performance-driven marine business.*

# From manual to 21st century operations

## SUMMARY


Major players across the marine industry have already made or are considering investments in digital technologies to improve performance and better compete in a tough market landscape. However, many investments in digitalization fail to deliver the desired results.

The need for digital solutions arises from several trends. Firstly, there is an increasing number of tasks that need to be handled by the crew, stemming from management, classification bodies, regulation, and so on. As most reporting is still done manually, there is less time to deal with the day-to-day realities of operating a vessel. When combined with the pressure that arises from increased amounts of tasks for the crew on board, digital solutions and automation are needed to help ensure efficient and safe operations.

Thanks to improvements in satellite connectivity, continuously connected vessels are already a reality. Improvements in cloud computing and analytics mean that the infrastructure exists to enable solutions that assist both onboard and onshore operations. Indeed, a competitive advantage can be achieved by enabling efficient communication and cooperation between onshore and onboard personnel, which in turn increases flexibility and enables continuous improvements.

In this white paper we discuss the four stages of the digital journey we have identified as part of our research into the shipping market – traditional, connected, smart, and autonomous – with a focus on both onboard and onshore operations. The four stages range from a mode of operation where all data collection and analysis is manual, up to a future-oriented vision where all data collection, analysis, and decision-making is automated.

We will look at the potential benefits and pitfalls of each stage as well as discuss how ship owners and operators can move towards the digitalization of fleet operations in an intelligent way that will deliver a good return on investment.


# Contents

# 1. The enablers for marine digitalization are already in place

Several trends have a direct impact on the shipping industry. The first is better connectivity – as satellite connectivity bandwidth increases and costs decrease, round-the-clock connectivity for ships at sea is already a reality, enabling data from continuous monitoring to be sent for processing onshore. Automation and control systems onboard also provide a wealth of data about the vessel that can be augmented with the help of specialized systems and third-party data sources.

There is also increased pressure to reduce fuel costs and emissions at both a global and regional level, which requires better methods for data gathering and reporting. Combined with advances in cloud computing and data analysis methods that rely on machine learning, all the prerequisites are in place to create insights for more efficient and safe operations while easing the reporting burden on crews.

The resulting data transparency enables insights that are instantly shared across an organization. Such an approach not only creates a basis for better and more informed decision-making, but it can also spark the reorganization of a business from one composed of traditional siloes into one that supports a more responsive and flexible structure that allows the benefits of digitalization to be harnessed.

## VARYING SPEED OF IMPLEMENTATION

Digital transformation has had major disruptive effects on value chains and business models in content-driven industries. Leading companies in manufacturing industries such as the car industry have taken actions to address the challenges and opportunities of digital disruption as well – and the shipping industry should be no exception. Today we see an increasing amount of vessels gaining connectivity and revolutionizing commercial shipping in a way we haven't witnessed since the radio became commonplace in the beginning of the 20th century. However, this time the effects will be even more widespread and profound.

The cruise industry has taken the lead in embracing digitalization to boost business performance through improved customer experience and operational efficiency in the form of various 'smart ship' concepts. The cruise industry is years ahead in using advanced solutions for data collection, real-time optimization, and remote monitoring. The reason for this is probably a combination of owner -operator type long-term thinking, highly complex onboard systems, and the fact that the vessels can cost as much as a billion US dollars to build. Cruise operations are more complex and have much higher energy consumption than cargo operations. All this justifies investing in the latest high-end digital technologies.

That said, most of today's major players across the marine industry's various segments have committed to or are considering some level of digital investment. The drivers are wide ranging: a desire to ensure competitiveness and operational efficiency, the wish to better compete in a tough market landscape with low freight rates and oversupply, the need to gain visibility into vessel and equipment monitoring – and even the simple fear of delaying too long and missing out. Digitalization enables real-time visibility throughout the supply chain – for example in the cargo segment, digital solutions enable real-time cargo location monitoring as well as tracking KPIs such as cargo temperature. This is not only good for the end-customers' peace of mind – related players in the logistics chain can also use this information to better plan their own operations, for example reorganizing resources in case of delays.

## MAKING DATA USEFUL

However, collecting data in itself is not sufficient to reap the benefits of digitalization. The quality of data is affected by a variety of different factors, including the type of equipment used, the placement of sensors, and the sensor settings. Receiving poor-quality data can be worse than having no data at all as drawing conclusions based on erroneous data can lead to misallocation of resources or even potential safety issues.

Digital solutions for the shipping industry typically include CAPEX and OPEX investments against which the ROI needs to be justified. There is an increasing understanding that while data is useful, turning huge amounts of raw data into actionable insights is a challenge. Many digital initiatives have in the past failed to produce the desired outcomes, leaving operators unsatisfied and ultimately uninterested in pursuing further digitalization.

# 2. The four stages of the digital journey

The first step in discovering how to better utilize digitalization for business is to know where you are on the digitalization journey. The level of digitalization in a shipping company can be viewed as a spectrum, ranging from traditional operating practices to autonomous operations. In our research into the current and future shipping market we have identified the following stages of the digital journey:

## 1. Traditional

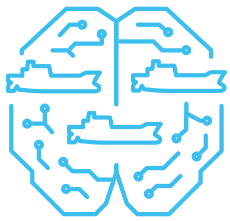
Traditional operation relies on the manual collection of data and written documentation. Analysis is carried out by humans using daily fuel consumption and average speed figures through noon reports, possibly adjusting for prevailing weather conditions.

## 2. Connected

Connected operation is enabled when ship systems are connected to an automated data-collection system that sends data to an onshore facility for further analysis. Human teams are responsible for performance management analysis based on in-house methodologies.

## 3. Smart

Smart operation relies on an automated data collection system that makes use of cloud-based technologies to automatically analyze data in real time. Performance analytics are enhanced by machine learning to give accurate recommendations to the performance management team, who then use their judgment to make decisions concerning operations.



## 4. Autonomous

Autonomous operation moves humans into the role of supervisors; data collection, performance analytics, and decision-making are all automated and driven by artificial intelligence.

## 2.1 Traditional operation – manual data collection and analysis

### INTRODUCTION

In the past ships reported their location for the sake of commercial operations to inform when goods would arrive at a specific port and to ensure that the ship's performance was as agreed in the charter party. Today the demands and drivers for transparency and information sharing have become more extensive.

The majority of players in the marine industry still rely on traditional systems, operating their businesses with the help of manual reporting, communication, and record-keeping methods such as noon reporting, telex, basic email, and spreadsheets.

For a ship on a voyage scheduled to last several days, the data received from noon reports is not easily comparable since the sample varies from one day to the next based on whether the ship's local time was adjusted by the crew or not. In addition, the managers monitoring these reports onshore receive them at different times of the day as the ships move through different time zones. This means that companies do not know the status of the ship in real time.

## DATA COLLECTION METHOD

In traditional operations, the officer responsible takes daily readings based on onboard instruments and personal experience. Data compiling and sending is in some cases done with the help of digital tools, but the data is still gathered manually and different systems are working in isolation. The noon report is made at noon ship time when the officer prepares the report based on the collected measurements. The content of the report varies depending on the company in question, and some rely on very basic data. Other data sources include event reports, engine logbooks, and bunker notes.

## DATA-RELATED PROCESSES

Data is compiled and sent to the onshore office where the superintendent or performance management team analyzes the noon report. If action is needed, the office contacts the ship. For larger fleets, the time and resources for in-depth analysis are limited. As the reports represent a narrow point in time, they may not accurately reflect the operational reality of the ship. Another drawback is that the overall process is very slow.

## DATA QUALITY

While this type of operation system has been in use for many years, it suffers from several problems. According to industry studies, there can be problems with data accuracy when data is collected manually as opposed to automatically; the consistency of the collected data is low as it may be based on an average over a period of time, or simply a single spot check during the day. Collection times may vary from day to day. Estimates can be wrong, and data can be missing or in the wrong format. There can also be differences in data collection methods and calculations. Furthermore, reports cannot be verified and oversights or mistakes can easily slip through.

The charter party itself can also lead to inaccuracies – reports may be made to suit the terms of the charter party and not the actual situation, meaning the figures cannot be used for measuring the real performance of the vessel.

## ORGANIZATIONAL ASPECTS

In the traditional mode of operations, most tasks are performed by officers onboard and superintendents onshore with no access to additional resources to devote to analytical tasks.

## HOW THE DATA IS USED

The main use cases for traditional operations include:

- Knowing the ETA of the vessel
- Estimating the performance of the vessel in terms of fuel consumption
- Assessing adherence to charter-party terms
- Having a basic awareness of the vessels route and location
- Collecting data required for regulatory purposes (for example MRV regulation)
- In some cases, companies utilize the noon reporting system for collecting additional relevant data for spot-checks or routine analyses or trending (for example, engine SFOC or amount of sludge generation)

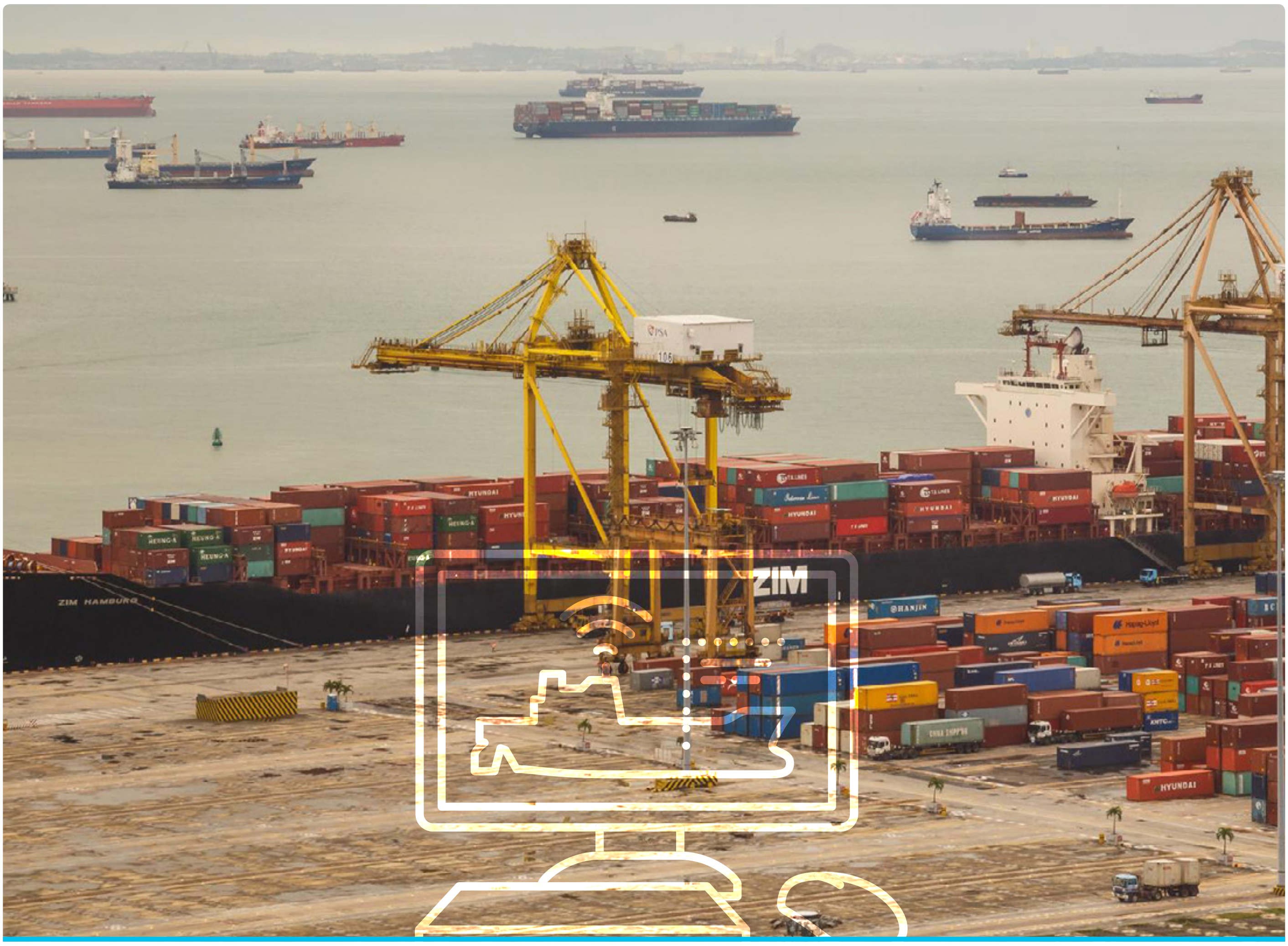
All of these can suffer from the data-quality drawbacks mentioned above. The paucity of data already sets very strict limits on how it can be utilized to support decision-making.

## HOW TO ADVANCE FROM TRADITIONAL OPERATION – THE FIRST STEPS

The easiest way to take the first step towards digitalization is to use tools that take AIS-related data sources into account. AIS data is cost effective and provides the opportunity to explore how additional data could be utilized in the company. It enables the following improvements over traditional methods:

- More frequent updates on a vessel's position
- More accurate ETA estimations
- A more accurate view of the sailed route and distance
- The possibility to develop a more accurate estimate of vessel performance/fuel consumption
- The opportunity to benchmark performance against competitors and industry-wide averages

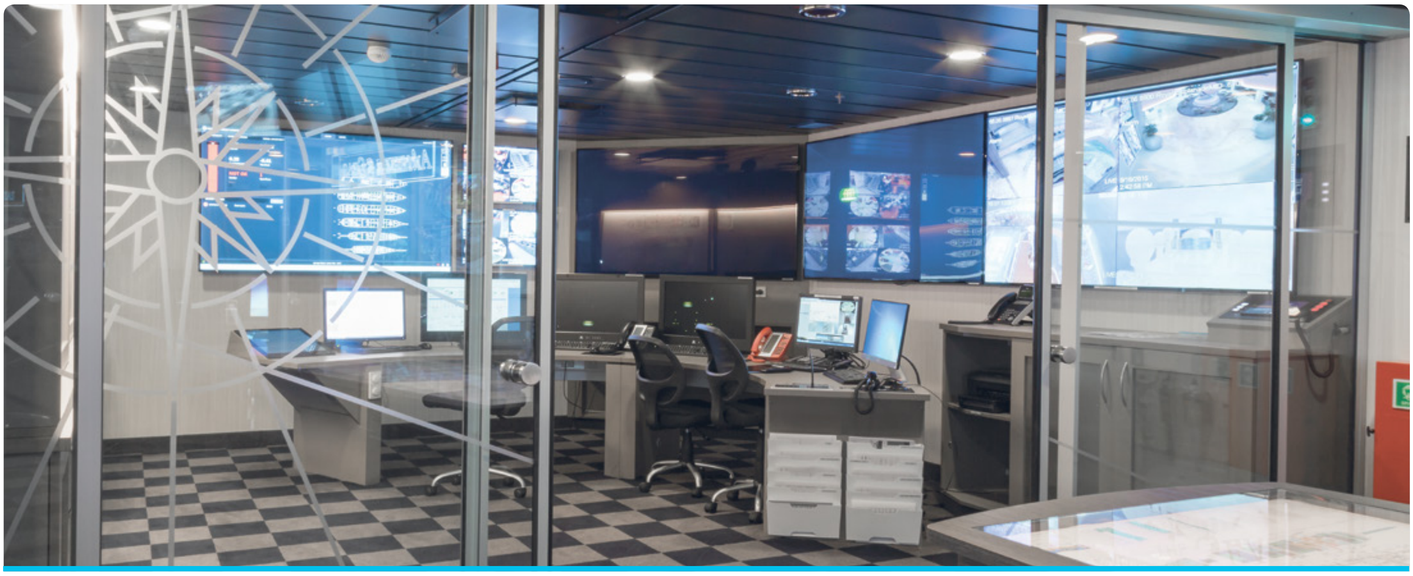
# 2.2 Connected operation – automated data collection




## INTRODUCTION

Given the limits of traditional operation – and the fact that there have been advances in the field of analytics – players in the marine industry have realized they can benefit from better visibility and transparency into what is happening onboard. The need for more data often emerges from the technical superintendent, who wants to know the equipment efficiency and status. In practice this means collecting data more frequently and from a greater number of sources in order to better understand equipment efficiency and operation.

Even if having data at your fingertips will not solve transparency problems entirely, it will at least enable a better understanding of the capabilities of data-driven operations. However, many companies in this connected phase usually conclude that they will need additional competences and resources to analyze the data. With more data comes greater data-processing needs and a higher workload – something which organizations have not been accustomed to in the past.



## DATA-COLLECTION METHOD

Because of the limitations of traditional operation many companies have invested in systems to automate data collection. Instruments are integrated into a data-collection platform that gathers and sends data via satellite link to the onshore office where it can be viewed and analyzed by personnel on a computer or mobile device. In some cases, onboard analysis also occurs to enable faster decision-making, but typically the information is also shared with the onshore office.

Connected operations require an onboard data-collection platform, which introduces an additional CAPEX investment as additional cabling and hardware have to be installed. Due to the principal-agent problem, the financial viability of the installation is questioned. Usually owner-
operated vessels see the benefits of such investments first owing to the longer time perspective and planning horizon in shipping.

CAPEX concerns can be alleviated by purchasing data collection and analysis as a service, removing the need for an integrated platform. While the capabilities will not be as advanced as with a system that's integrated with the ship, the ability to test how data and analysis improve performance on selected vessels without making a large investment allows any company to start their journey towards smart operations.

Typically, the data collected in connected operations includes navigational data as this is easily available. Many companies also invest in a torque meter to determine the propeller RPM and propulsion power in order to gain greater insight into hull and propeller performance. Some vendors have been developing thrust-meter technology that allows the efficiency of the hull and propeller to be viewed separately. Fuel-flow meters are often installed at least in the fuel lines of the main engine in order to better understand the efficiency of the engine or to monitor fuel consumption.

Data is typically stored in a cloud service and is available for different use cases. Typically, the cloud solution includes an analytics platform that enables reports and dashboards to be generated. Simple KPIs can be automatically calculated from the data, which enables monitoring and can be used to incentivize stakeholders for more efficient operations.

### The principal-agent problem

The principal-agent problem occurs when one person/entity (the “agent”) is able to make decisions or take actions on behalf of another person/entity (the “principal”). In this agency relationship, problems arise when the two parties have different or conflicting interests (split incentives) and when it is difficult or expensive to verify the agent's actions (information asymmetry). From the perspective of the key stakeholders in shipping, a shipowner and a charterer enter an agency relationship, where the charterer (principal) hires the shipowner (agent) to provide the service of carrying goods from A to B. Consequently, this common contractual agreement is inherently prone to principal-agent problems.

Connected systems give the charterer (principal) an affordable way of checking the shipowner's (agent) actions. These systems therefor reduce the information asymmetry and the principal-agent problems in the underlying agency relationship. Simply speaking, if you can verify the agent's actions you can identify undesirable behaviour and adjust the contracts based on measured performance.

Rehmatulla, N., & Smith, T. (2015). *Barriers to energy efficiency in shipping: A triangulated approach to investigate the principal agent problem*. Energy Policy, 84, 44-57.

## DATA-RELATED PROCESSES

While the connected mode of operation removes inaccuracies in reporting, it also dramatically increases the workload for onshore personnel. Instead of a single noon report multiplied by the number of ships in a fleet, there is a constant stream of data for every vessel. Information overload is becoming a real issue as the deluge of data threatens to overwhelm the very people it is supposed to help. Sifting through this data in a timely fashion to uncover reliable insights is often difficult, if not impossible, especially given the amount of time that is needed just to prepare the data for viewing.

The data by itself answers the question of what has happened. However, understanding why or how something happened requires further analysis. The underlying reason for inefficiency is difficult to assess and quantify, as inefficiencies can be caused by combinations of several underlying factors. Because the data is provided as is, at the very least a professional analyst is required to painstakingly comb through it. The purpose of the analysis is to uncover insights from the data using three main methods: **filtering**, **test runs**, and **normalization**.

**Filtering** means that the analyst tries to identify time periods from the data set that contain "uncontaminated" data and use these to have more comparable data. For example, hull and propeller performance or speed-fuel performance is analyzed from the data set with calm sea conditions (wind speed below a certain limit, no waves, etc.). The problem here is that the analyst is at the mercy of the weather, meaning data that fulfills the filtering criteria may not be available.

**Test runs** can be used to produce cleaner data, which means a test run is performed onboard with standardized operating parameters. For example, the vessel may be requested to sail at a certain speed for a period of time. Often it is required that the test run is performed under predefined external conditions. For example, test procedures derived from sea trials may be utilized, requiring the ship to sail at a certain speed with minimal wind, waves, and currents. Another use case for test runs is for measuring the engine performance by requiring the engine to run on a predefined load. For example, running the engine on 85% of the maximum continuous rating (MCR) to get a more stable and comparable reading of true performance. All test runs have a significant downside, however: they typically increase the fuel consumption of the vessel. Identifying a suitable time for performing the test run can also be challenging as it is very difficult to find a time when the ship can be operated in "perfect" conditions – a gust of wind can be enough to render the test results unusable.

**Normalization** uses predefined equations to shift the collected data back to certain predefined conditions. For example, the ISO 15016 standard "Guidelines for the assessment of speed and power performance by analysis of speed trial data" can be used for normalizing the results from speed trials. Other standards include ISO 19030 for hull and propeller performance evaluation and ISO 3046 for engine performance evaluation. The problem with these methods is that they are more often than not crude simplifications of reality, leading to a suboptimal outcome. Often the formulas used in normalization include asset-specific coefficients that are hard to determine for the asset in question; it is also challenging to validate whether the coefficients are correct. In the worst case this can lead to normalization having a negative impact on the quality of the data.

## DATA QUALITY

The quality of automatically collected data is, at least in theory, superior compared to data collected manually. That said, there are still several factors that hinder its quality. Most of these issues are caused by sensors having intrinsic inaccuracies, calibration issues, or malfunctions. For example, a badly calibrated sensor or drift of sensor calibration can lead to significant misinterpretations of performance. In addition, the data collected onboard needs to be aggregated in order to transfer it onshore. If performed incorrectly, aggregation can significantly reduce the accuracy of the data.

The methodologies for analysis mentioned earlier may also not be particularly valid as naval architecture is designed for shipbuilding, which means calculations are not necessarily relevant to operational ships at sea. One example of this is the significant accuracy gap between static modeling using table coefficients and dynamic decomposition models reflecting sea conditions.

### Data quality example

Accurate speed-through-water data is a prerequisite for any decisions related to evaluating vessel performance or speed-related onboard operations. According to a study of 300 vessels conducted by Eniram in 2017, a large proportion (65% of cruise vessels) suffer significantly from poor speed log quality, with performance being over or underestimated by more than 5%. Such a large performance deviation is caused by a speed log inaccuracy of only 1.6%.

## ORGANIZATIONAL ASPECTS

As mentioned before, the connected operations mode increases the stream of data to be analyzed and processed, requiring investment in professional analysts. Successful companies adopting this mode of operations develop plans with HR functions to attract new competences to the organization and create new roles. Organizations deciding to utilize in-house data analysis often end up with a heavy mid-management layer as the data analysis process is by nature resource intensive. This may hinder the ROI calculations of investing in analytics.

## HOW THE DATA IS USED

Essentially, connected operations increase visibility and create insight into what has happened in the past. When data is available in real time both onboard and onshore, transparency is increased compared with traditional operations.

For example, there is no need for the officer onboard to take a screenshot, send it, and then have a lengthy phone call. Instead, all data is instantly available to all relevant parties. Or if a vessel is heading into rough weather, the relevant personnel onshore would receive immediate notification as well as information about any follow up carried out onboard such as steering the vessel towards calmer waters. Operational transparency saves time and the need for follow up.

Connected operations help prevent severe operational inefficiencies – for example, keeping the lube-oil pump running while in port with engines shut down – and are also useful in troubleshooting. Collected data can also be utilized to estimate the financial impact of retrofits onboard as it is possible to measure the utilization and throughput of an onboard asset and make a directive ROI calculation.

## HOW TO SUCCEED WITH CONNECTED OPERATIONS

In order to successfully implement connected operations, the following elements are key:

- A commitment to moving from traditional paper-centric and manual ways of working to automated data collection
- Strong engagement, interest, and willingness to invest from top management to move ahead with new technology
- A method for justifying CAPEX including use cases for data and ROI, understanding the total cost of ownership for a data platform, and what is included in the platform price
- A plan for employees to help them adapt to new ways of working and learn new technologies
- An understanding that transparency increases from onboard to onshore
- Ensuring common objectives and best practices to avoid a “big brother is watching” feeling and instead show how the system helps personnel onshore and onboard
- Defining the fleet operation center onshore role to help and support the captain and his crew onboard
- Recruitment of professional analytics resources with new competences

In addition to the above, the following technical questions will need to be addressed:

1. *What data tags should be collected and at what frequency?*
2. *What level of detail can we get (high level or individual vessel)?*
3. *How to strike the right balance in data collection: level of detail vs. higher satellite costs?*
4. *How is data stored and how can the organization access the data?*
5. *How do you ensure data quality?*
6. *What normalization methods are used?*
7. *What modeling methodologies are used?*
8. *What kind of analytical tools are included for exploring and visualizing the data?*
9. *How is digital security ensured?*

# 2.3 Smart operation – automated data collection with analysis to simplify decision-making

## INTRODUCTION

While the connected operations discussed in the previous section introduce a new level of transparency to onboard operations, they also have a downside – namely the ever-increasing amounts of information produced that is far beyond the capacity of any single person to process. What is needed to make data even more useful is a way to automatically process gathered information and provide insights and feasible scenarios going forward. In this way, onshore personnel can apply their expertise in a useful fashion that allows optimization of ship operations.

With smart operation, a vessel's automated data collection system uses cloud-based technologies to automatically analyze data in real time. Performance analytics are based on machine learning. Machine learning techniques improve the interpretation of data in a vessel-specific context, enabling accurate performance analytics and thus decision-making.

With smart operation, one can go beyond mere data collection to create situational awareness. The first step is to combine information from what's happening onboard with information about the vessel's sailing environment, such as weather data. Then, by applying intelligent analytics based on machine learning methodologies, one can move beyond answering the question "What happened in the past?" or even "What's happening now?" to "What will most likely happen in the future?"

Real-time analysis of data changes this by providing insight into what is happening onboard at any given moment. No longer do key players onboard and onshore need to make educated guesses about factors such as optimal trim, engine performance, or hull condition. Instead, the operator can use digital tools to benchmark nautical performance across the fleet, take action where needed, and optimize a vessel's performance against its fuel consumption. Systematic optimization can lead to fuel consumption savings of as much as 10% while reducing $CO_2$ emissions at the same time.

Smart operations rely on algorithms, machine learning, and artificial intelligence to analyze data, simulate future scenarios, and identify possible risks – as well as find more optimal ways of operating. Increased transparency helps decision makers to react to issues in a timely fashion, plan more effectively, and enhance efficiency and safety.

The idea is to divide data into manageable chunks and make sure they are shared with the right people at the right time. Smart operation also sets the stage for truly autonomous operation, which we will discuss later in this paper.

## DATA COLLECTION METHOD

The data collection method is similar to that discussed in the connected operations section of this white paper: there must be an automated data collection system based on an onboard platform integrated with vessel systems. Instead of providing the data in raw format, analysis based on artificial intelligence filters and enriches the data to provide insights.

## DATA-RELATED PROCESSES

In order to maximize the usefulness of data, the analysis needs to be taken beyond a theoretical abstraction of the problem at hand. In other words, data needs to be modeled for the actual vessel or asset in question. To do this, smart operation introduces the concept of a “digital twin”– meaning that each individual vessel and its sailing conditions are modeled by combining advanced machine learning with traditional physical models of the vessel. Gaining a detailed understanding of each unique vessel and its sailing conditions makes it possible to simulate and analyze what has happened in the past, what is happening onboard now, and what can happen in the near future – for example, by modeling the effects of forecasted weather on the voyage.

The same approach can be applied not only on the vessel level, but also for each piece of equipment onboard in order to provide a highly detailed understanding of the performance of these assets and helping to improve their operational performance.

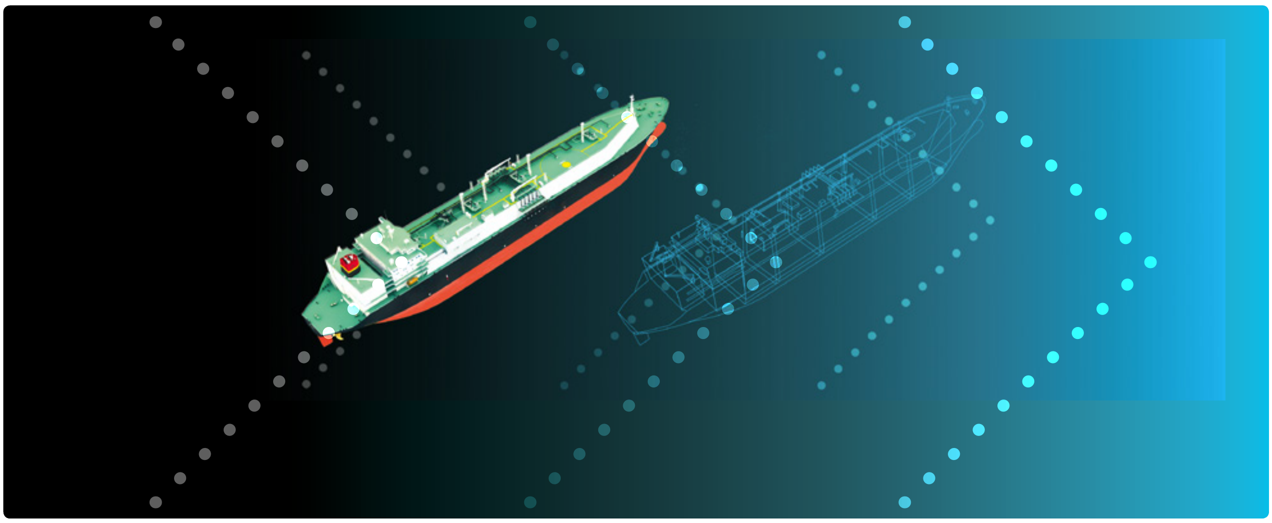
In this mode of operation, key personnel make decisions based on actual data that has been processed and enriched in the smart cloud. This approach combines the best of both worlds – the raw data-crunching capability of machines, which enables quicker reactions to smaller phenomena, and the experience and intuition of humans.

Such an approach also enables better data visualization through easy-to-read dashboards. Advances in mobile access at sea combined with the processing power of modern mobile technology means that no specialized equipment is needed to deliver targeted notifications inside an organization – users can rely on their phones, tablets, or even smart watches. When information flow and analysis take place in a timely manner, personnel can save hours or even days when compared to traditional processes and communication methods.

## What is a digital twin?

A digital twin is a virtual counterpart of a physical asset that mimics the asset’s desired characteristics. Using a digital twin allows us to simulate how the physical asset behaves and performs without the need to test it in the real world. The digital twin is based on the data collected from its physical counterpart, and thus learns and synchronizes with its physical counterpart using advanced machine learning methodologies.

Digital twins enable companies to better understand, predict, and optimize the performance of each unique asset. A digital twin can represent an individual asset, an integrated system of assets, or a fleet of assets.



## DATA QUALITY

Smart-cloud data processing based on digital twins is also less restricted by the imperfections of collected data and sensors. This is because digital twins utilize sensor-fusion technologies that combine different data sources to overcome the limitations of individual data feeds. For example, to model the performance of a ship more accurately, sensor fusion technology can be used to combine ship data feeds with weather and current hindcasts, thus increasing the overall accuracy of the analysis.

No technology is immune to every possible data quality issue. If data quality is severely compromised, there is no way to retrospectively fix it. However, a digital twin can be employed to assess the quality of the incoming data. This helps to provide certainty about whether the outcome of the analysis is reliable and how much the uncertainty introduced by poor-quality data will affect the outcome.

## ORGANIZATIONAL ASPECTS

Moving from more traditional operations to the smart operations mode requires a shift in mindset and the adoption of new processes across the organization. The roles of onshore and onboard personnel will change when most of the data processing and decision-making is done in the cloud. This changes the role of the analyst to one that focuses less on performing analysis and more on using the insight provided by the smart cloud.

For some companies, moving from a traditional way of operating to connected operations is too resource consuming due to the increased demand for personnel to analyze the data. If this is the case, moving directly to smart operations may make sense as automated data processing typically provides sufficient analysis.

## HOW THE DATA IS USED

Basically, smart operation frees up resources from data analysis and makes them available for decision- making. This also helps in building repeatable and standardized processes based on the collected data and allows users to move beyond data collection and start answering the question “Why did this happen?” or “What will happen in the future?” Cloud-based analytics allow personnel both onboard and onshore to make better decisions and understand how the actions they take relating to trim, route, and engine speed will affect the overall safety, efficiency, and profitability of a voyage.

With the help of a digital twin, one can simulate why certain things happened. For example, if more fuel was burned than expected, running a simulation of the collected data with the digital twin might show there was bad weather, the ship was sailing against the current, or the trim or speed profile was not optimal. You can also rerun a simulation with different parameters to help you better optimize future voyages. Combining a digital twin with multiple forecasts allows users to look into the near future and simulate what might happen – for example, how a storm forecast on route affect the ship’s performance, or the impact of a route change or engine profile change on the efficiency of the voyage.

Smart operations ensure data transparency by automating data collection and analysis and enabling easy sharing of insights. Key personnel have access to the same insights, minimizing risks and ensuring that what is happening onboard is accurately reflected onshore. With less effort and time spent on onshore communication and reporting, personnel have more time to focus on more valuable activities. The ability to react to issues as soon as they occur instead of having to wait for a report leads to savings.

## HOW TO MOVE TO SMART OPERATIONS

The smart phase supports both centralized and decentralized approaches to data-driven decision-making. In order to move from traditional or connected to smart, the following elements are key:

- A plan for ensuring a shift in mindset – previously the onboard crew were responsible for vessel performance follow-up and optimization; with smart operations, onshore staff can help and supervise them
- An understanding of how data processing and decision-making will move from onboard to onshore through automated processes
- A system that allows moving from data collection and equipment monitoring to automated data/information analysis
- New processes to ensure that personnel are able to utilize real-time data in place of one-shot data coming in on a daily or weekly basis
- A plan for getting onboard crew engaged and committed to using the new technology, backed by strong support from top management
- Ensuring that the human role is not underestimated – smart operation functions best when humans and computers are making decisions together, complementing each other’s strengths and compensating for each other’s weaknesses
- Making sure that digitalization is not run as a typical one-off IT project but instead is a more long-term commitment from the whole business

# 2.4 Autonomous operation – automated data gathering, analysis, and decision-making

## INTRODUCTION

Autonomous operation means that data collection, analysis, and decision-making and implementation are all automated and driven by artificial intelligence. The level of autonomy granted is going to be the key variable as we move towards this goal, but essentially autonomous operations change the human role from active operator to supervisor. Some onboard processes are already autonomous – such as sailing a voyage via predefined waypoints using a track pilot – and more can be automated without removing the human element completely.

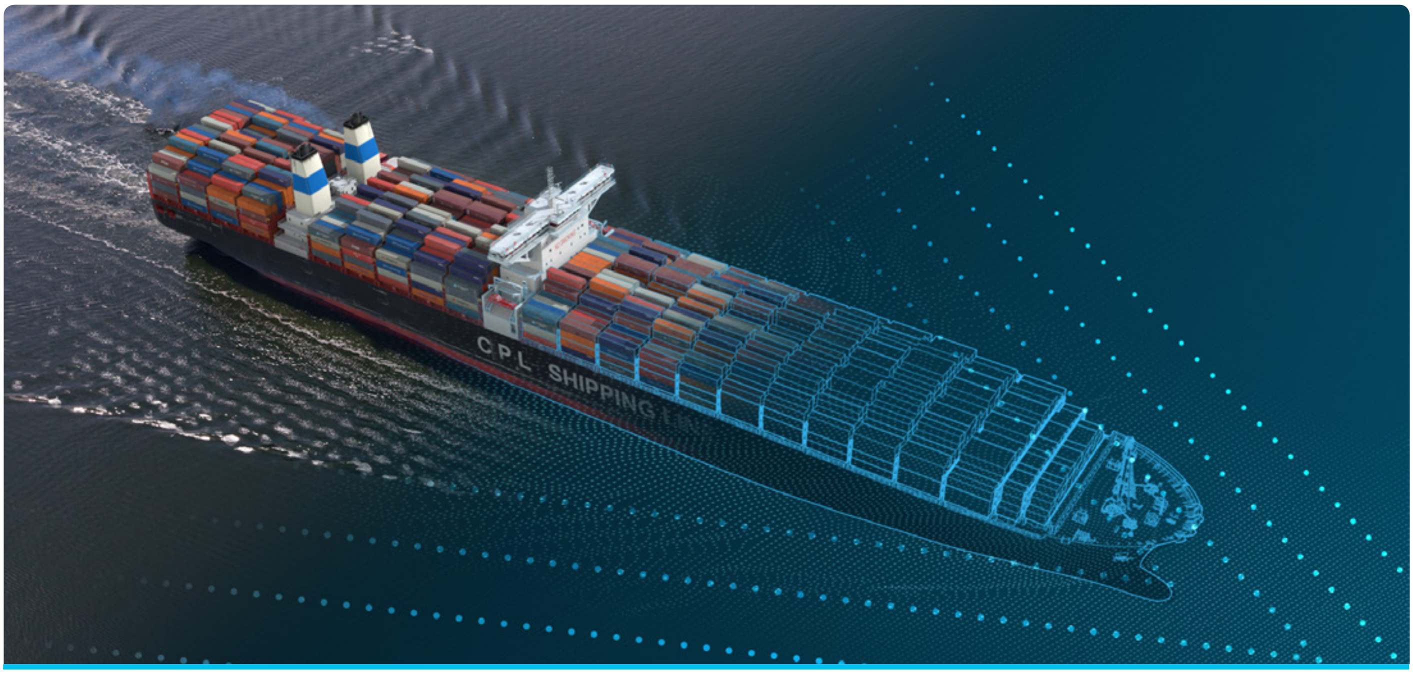
When it comes to autonomous operation, different levels can be automated including:

- Individual vessel equipment
- Entire vessel systems
- The entire vessel
- The entire fleet
- The entire industry

The simplest levels are automated first, for example equipment and engines. Some vessel equipment already operates autonomously. In the future, more equipment will be automated until eventually the entire vessel can operate autonomously.

Onshore operations will be automated at a slower pace. The automation of vessel operation will make some tasks, such as predictive maintenance planning, obsolete. Instead, the system will automatically monitor the condition of the equipment and ensure that maintenance is performed at the optimal time.

For the time being, using the power of machines to crunch data and carry out analysis to enable better human decision-making is the likely way companies will continue to move forward on the digitalization spectrum. Indeed, even when automated decision-making is reliable and robust, humans will likely retain a supervisory role.




## DATA COLLECTION METHOD

Data collection is automated in a similar manner to smart operations but goes further as humans are not part of the process. In order to achieve full autonomy, more instrumentation and sensors are needed to provide increased situational awareness. Humans are extremely good at complementing the information gathered by sensors using their experience. In addition to extra sensors, more actuators will be needed as all processes need to be controllable without human intervention.

## DATA-RELATED PROCESSES

Data processing in autonomous operations will be based on the same data processing capabilities built for smart operations. However, the level of sophistication of these processes will increase as the role of data processing goes beyond analysis of the data to drawing the right conclusion and choosing the right way forward. Digital twins will remain the key component in terms of enabling predictive simulations to assess the outcomes of different operational alternatives. The decision about which alternative to implement will be made by artificial intelligence.

## DATA QUALITY

As with connected and smart operations, data quality is the key issue. The introduction of new sensors to replace humans requires the same data quality assurance processes to ensure that the data collected is sufficiently reliable and robust to enable sound analysis and decision-making. Additional redundant sensors that measure the same quantities but use different methods will also be required. Combined with sensor-fusion technology, a more reliable situational view can be achieved.

## ORGANIZATIONAL ASPECTS

Autonomous operations will change the whole shipping ecosystem. As automated processes require a higher level of sophistication to orchestrate, system vendors will take more comprehensive end-to-end responsibilities. The role of ship management will be the first to be transformed. It will become a digitalized service company, supervising the fully automated operations and forming a human interface with less-automated processes and stakeholders in the ecosystem.

## HOW DATA IS USED

The use cases for data depend on the degree of autonomy. This will likely roll out in phases as and when it makes sense. For example, when smart operations demonstrate that the AI system makes consistently correct decisions, the need for human decision-making can be removed by automating these tasks.

## HOW TO MOVE TO AUTONOMOUS OPERATION

The following areas need to be considered before autonomous operations can become a reality:

- The artificial intelligence and technologies to enable autonomous operations are still under development. The first simple autonomous tests and pilots are already happening, but wider implementation will take more time.
- Automation will come later to the office side (for example, automating recognition of spare-part needs, automatic ordering, logistics related to the order, etc.)
- Automation of vessel operations will decrease the need for onshore operations
- There must be a way to guarantee safety and continuity
- Legislation will likely lag behind automation of operations in the marine industry, but will need to be taken into account as it materializes

### The future of the marine industry

As artificial intelligence advances, one can predict that more and more aspects will move to autonomous decision-making. According to Wärtsilä, marine industry players are faced with major sources of inefficiency that impose a significant negative impact on business operations and profitability. These inefficiencies can be considered 'waste'; the three most notable sources of such waste being overcapacity, inadequate port-to-port fuel efficiency, and time wasted waiting when entering ports and other high-traffic areas. Eliminating this waste forms the basis of Wärtsilä's strategy towards ecosystem thinking. Wärtsilä sees four primary forces that will reshape the industry:

- Shared capacity will improve fill rates and reduce unit costs
- Big-data analytics will optimize both operations and energy management
- Intelligent vessels will enable automated and optimized processes
- Smart ports will result in smoother and faster port operations.

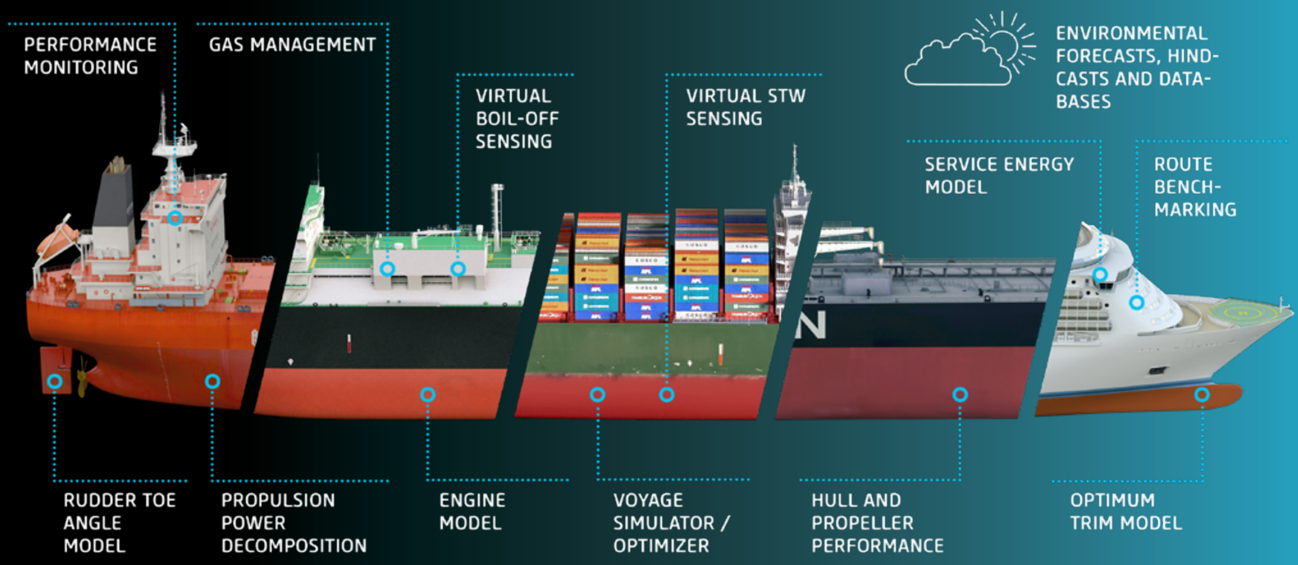
# 3. Conclusion

Like all business processes, digitalization needs to be carried out correctly if it is to deliver tangible business benefits. Investing in data collection systems to reduce human error is a start, but it is rarely sufficient. The reality is that using people to analyze endless data streams across multiple vessels to create insights in a timely fashion is often not possible, leading to a situation where data does not translate into improved performance.

In order to avoid this kind of result, organizations need to first understand where they are on the digitalization spectrum and then decide how they want to move forward.

A simple first step is to take public data (AIS) into use. From there, installing a platform to automate data gathering is the next step. The organization can also jump straight to smart operations where data collection and analysis are automated but decision-making remains in the hands of key personnel; this approach offers an effective path towards optimizing performance for an individual vessel or even an entire fleet. Finally, autonomous operation builds on smart operation but changes the role of humans from key players into supervisors.

It’s also important to remember that this is not an all-or-nothing linear journey. Selected vessels in a fleet can be immediately lifted to the connected or smart operation level, either by investing in a data collection platform with automated analysis or by using lighter performance management as a service approach. Once the ROI is demonstrated, further rollouts can be carried out as and when required. Autonomous operations are likewise introduced in phases, starting at the equipment level then on to systems, vessels, fleet, and ultimately the entire ecosystem.




# 4. Eniram and the digital fleet of tomorrow

Since 2005 Eniram has provided the marine industry with leading insights on asset, operations, and commercial shipping management, focusing on developing tools and technology to facilitate the digital fleet of tomorrow. The Eniram Insight Factory gives decision-making support for its partners based on real-time data collection, machine learning, and predictive simulations.

Eniram focuses on developing tools and technology to facilitate the digital fleet of tomorrow. Through the cloud-based Eniram Insight Factory platform, Eniram collects data that is enriched and analyzed to create actionable insights delivered via an easy-to-use interface.

## We offer:

- Tools to make the most of public AIS data
- An easy and reliable way to start automatically collecting data to gain a high-level view of a vessel's operations or the operations of your entire fleet
- A platform that allows a deep dive into an individual vessel's performance as well as fleet-wide performance
- Custom analytics to conduct even deeper dives into fleet-specific areas of opportunity and risk

*Created by experienced seafarers and technologists, Eniram's solutions range from single onboard applications to comprehensive fleet analyses.*

> *The time of early adopters is now over and digitalization has become a trend that everybody follows. Now, ship owners and operators simply cannot afford to overlook it, but they need to equip themselves one way or another.*
>
> ***– Johan Backas, Managing Director, Eniram***

## Contact us to discuss how we can help you

**Johan Backas**
Managing Director
Eniram Ltd.
johan.backas@eniram.fi

**Venla Pouru**
Portfolio Product Manager
Eniram Ltd
venla.pouru@eniram.fi