spire MARITIME

DRIVING CHANGE WITH MARINE FORECASTS AND MARITIME DATA ANALYTICS

Contents

INTRODUCTION 3

VESSEL OPTIMIZATION 4

MARKET DRIVERS SPURRING THE NEED FOR NEW APPROACHES 4

LACK OF TRACKING MECHANISMS AND TECHNOLOGIES 5

EMISSIONS TRACKING AND REGULATION. 5

PAYLOAD MEASUREMENT AND SHIPPING EFFICIENCY 6

SATELLITE AUTOMATIC IDENTIFICATION SYSTEMS 6

A COHESIVE SOLUTION FOR DATA GAPS IN THE SHIPPING SECTOR. 6

VESSEL AND PAYLOAD TRACKING 8

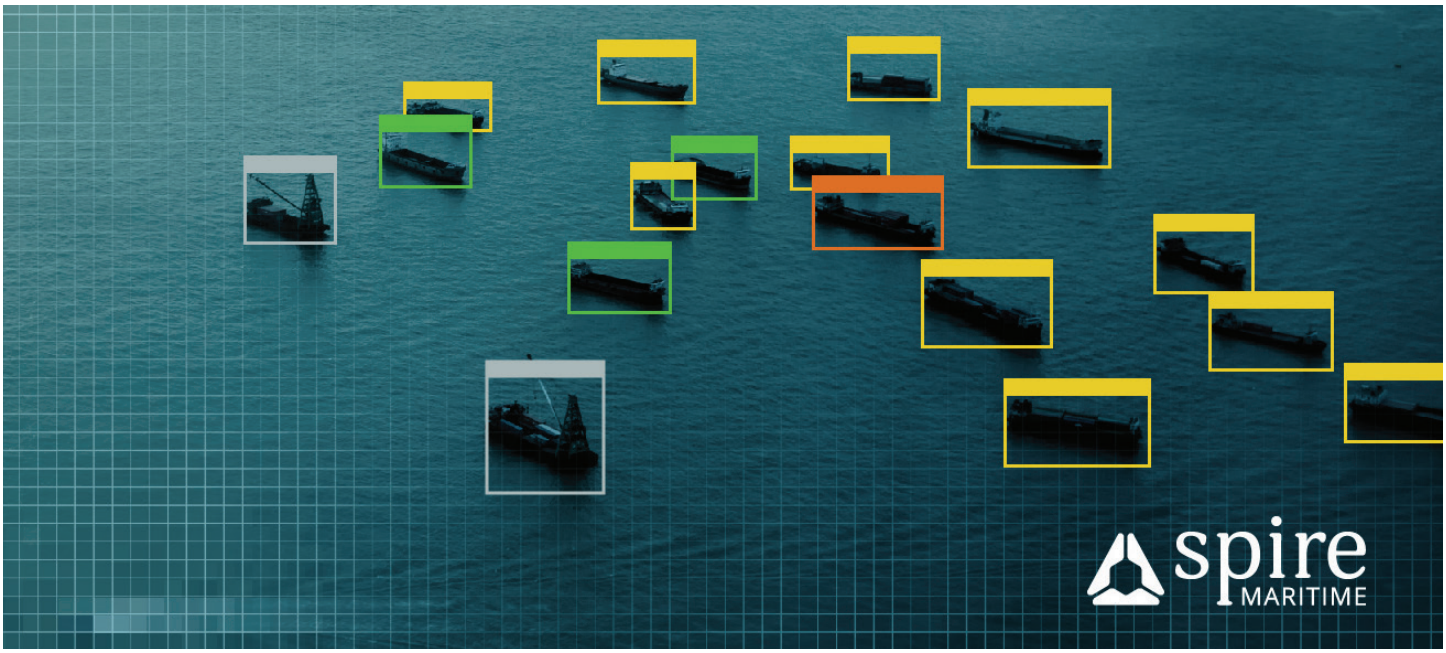
EMISSIONS TRACKING 8

SPIRE MARITIME 9

PROVIDING ADVANCED AUTOMATIC IDENTIFICATION SERVICE SOLUTIONS 9

INTRODUCTION

Automatic Identification Systems (AIS) are an integral element when it comes to safety at sea. These communication systems transmit key information related to ship movement, in addition to technical data, at specific intervals throughout a ship's voyage. AIS technology originated as a joint project between the International Association of Marine Aids to Navigation and Lighthouse Authorities (IALA) and the International Maritime Organization (IMO). The project's goal was to promote safety at sea by ensuring that ships had access to technology that could automatically transmit key static data such as ship name, draught, and destination in addition to dynamic information such as ship speed and position.[1] [2]



Spire Maritime tracks vessels by augmenting AIS data with its constellation of low Earth orbit satellites.

Subsequent to the development of AIS technology, The International Convention for Safety of Life at Sea (SOLAS) mandated that, "All ships of 300 gross tonnage and upwards engaged on international voyages and cargo ships of 500 gross tonnage and upwards not engaged on international voyages and passenger ships irrespective of size shall be fitted with an automatic identification system (AIS)."[3] Under this regulatory framework, essentially all larger vessels engaged in global shipping are outfitted with AIS equipment. Furthermore, because many countries also require ships to utilize AIS

1 Smestad, B. B., Asbjørnslett, B. E., & Rødseth, Ø J. (2017). Expanding the Possibilities of AIS Data with Heuristics. *TransNav, the International Journal on Marine Navigation and Safety of Sea Transportation*, 11(2), 93-100. doi:10.12716/1001.11.02.10

2 International Telecommunications Union. (Publication No. ITU-R M.1371-5). (2014). Retrieved https://www.itu.int/dms_pubrec/itu-r/rec/m/R-REC-M.1371-5-201402-I!!PDF-E.pdf

3 International Convention for Safety of Life at Sea. (n.d.). *Chapter V, Regulation 19.2*. Retrieved from https://www.navcen.uscg.gov/pdf/AIS/SOLAS.V.19.2.1-5.pdf

transmitters even if they are not required to by IMO regulations, more than 85,000 vessels across the globe are regularly transmitting AIS data.[4] [5]

- Historically, the primary applications of AIS centered entirely around:
- Automating navigation safety
- Preventing ship collisions
- Providing ship and cargo data to other parties within littoral zones
- Performing vessel traffic management functions[6]

However, when considering AIS through machine learning contexts, the technology is showing promise for potential applications related to driving improved levels of fuel and vessel optimization. Furthermore, experts are consistently pursuing methods of combining AIS data with other collected data—particularly weather-related data—to calculate and utilize information related to ship performance.[7]

VESSEL OPTIMIZATION

Market Drivers Spurring the Need for New Approaches

The shipping industry drives the global economy. Experts state that the modern maritime industry moves more than $9 trillion worth of goods across the oceans every year.[8] Without ships, global resource movement would grind to a halt. Given the importance of seafaring vessels on a global scale, industry leaders must strive to address key issues within the shipping industry as a whole.

Path prediction data combined with storm forecasts allows for optimized course corrections.

4 Smestad, B. B., Asbjørnslett, B. E., & Rødseth, Ø J. (2017). Expanding the Possibilities of AIS Data with Heuristics. *TransNav, the International Journal on Marine Navigation and Safety of Sea Transportation*, 11(2), 93-100. doi:10.12716/1001.11.02.10

5 Mantell, C., Benson, R., Stopford, M., Crowe, T. & Gordon, S. (2014) *Shipping Intelligence Weekly*, 02.05.2014. Clarkson Research Services Limited.

6 *An Introduction Automatic Identification Systems* (Tech.). (2019). Retrieved https://maritime.spire.com/wp-content/uploads/2019/05/Spire-Maritime-AIS-Data.pdf

7 Konrad, J. (2019, June 28). The next global tech disruption will happen where few expect it. *The Boston Globe*. Retrieved August 8, 2019, from https://www.bostonglobe.com/ideas/2019/06/28/the-next-global-tech-disruption-will-happen-where-few-expect/qN3YwLlhbPUXUsyxc7wmEK/story.html

8 Konrad, J. (2019, June 28). The next global tech disruption will happen where few expect it. *The Boston Globe*. Retrieved August 8, 2019, from https://www.bostonglobe.com/ideas/2019/06/28/the-next-global-tech-disruption-will-happen-where-few-expect/qN3YwLlhbPUXUsyxc7wmEK/story.html

Lack of Tracking Mechanisms and Technologies

Surprisingly enough, current capabilities for ship tracking are less than optimal. According to maritime experts, the lack of standardized methods for tracking ships means that, "Even the largest and most visible ships are difficult to monitor once they're at sea."[9] In 2018 alone, 46 large ships were lost at sea, with an annual average of 104 ships lost over the past ten years.[10]

A direct result of this lack of tracking mechanisms is an inhibited ability to construct a reliable framework to track and monitor the global shipping network as a cohesive unit. Experts state that such a network is necessary for two key purposes:

- Analysis of cargo flows at global and regional levels
- Analysis of ship behaviors and emissions at terminal, port, and country levels[11]

Emissions Tracking and Regulation

A further pressing concern within the shipping landscape relates to fuel and emissions tracking. Climate change and the effect of greenhouse gas emissions are of increasing importance to regulators seeking to ensure that the shipping industry does its part to regulate emissions and reduce its footprint on the environment. While fuel and emissions monitoring are already common practices in the shipping industry, experts postulate that a lack of harmonized guidelines and legal requirements prohibits companies from instating clearly-defined methods and practices for effectively monitoring on-board fuel consumption.[12]

In order to enact such guidelines and requirements, regulators must have access to clear and accurate data sets regarding emissions rates. Regarding this issue, researchers state that, "Reliable and detailed emission inventories are crucial for the accuracy of air quality modelling; such inventories should include all sectors of anthropogenic and non-anthropogenic pollution. Information on emissions should also include a sufficiently detailed treatment of their geographical and temporal variations."[13] The collection of more precise data of this nature will create an effective path for leaders to take when developing globally accepted emission inventories and effective environmental policies.[14]

Furthermore, when considering potential future competition shipping may face as a result of higher fuel costs associated with stricter environmental regulations, shipping organizations must begin considering and enacting fuel efficiency policies and practices. In the war on climate change, regulators will make use of the tools and technologies necessary to ensure that enactment of regulatory

9 Konrad, J. (2019, June 28). The next global tech disruption will happen where few expect it. *The Boston Globe*. Retrieved August 8, 2019, from https://www.bostonglobe.com/ideas/2019/06/28/the-next-global-tech-disruption-will-happen-where-few-expect/qN3YwLlhbPUXUsyxc7wmEK/story.html

10 Safety & Shipping Review 2019. (n.d.). Retrieved from https://www.agcs.allianz.com/news-and-insights/news/safety-shipping-review-2019.html

11 Wang, Z., Claramunt, C., & Wang, Y. (2019). Extracting global shipping networks from massive historical automatic identification system sensor data: A bottom-up approach. *Sensors*, 19(15), 3363. doi:10.3390/s19153363

12 Moreno-Gutiérrez, J., Pájaro-Velázquez, E., Amado-Sánchez, Y., Rodríguez-Moreno, R., Calderay-Cayetano, F., & Durán-Grados, V. (2019). Comparative analysis between different methods for calculating on-board ships emissions and energy consumption based on operational data [Abstract]. *Science of The Total Environment*, 650, 575-584. doi:10.1016/j.scitotenv.2018.09.045

13 Johansson, L., Jalkanen, J., & Kukkonen, J. (2017). Global assessment of shipping emissions in 2015 on a high spatial and temporal resolution. *Atmospheric Environment*, 167, 403-415. doi:10.1016/j.atmosenv.2017.08.042

14 Nunes, R. A., Alvim-Ferraz, M. C., Martins, F. G., & Sousa, S. I. (2017). The activity-based methodology to assess ship emissions - A review [Abstract]. *Environmental Pollution*, 231, 87-103. doi:10.1016/j.envpol.2017.07.099

frameworks designed to lower emissions and mitigate their effect. In order to stay competitive, the shipping industry must proactively develop and utilize data tools for monitoring and regulating fuel and vessel efficiency.[15]

Payload Measurement and Shipping Efficiency

Lack of effective measurement standards also inhibits productivity from a payload and shipping efficiency standpoint. A merchant vessel's payload is a key factor for several functions:

- Calculating the revenue generated for a particular voyage
- Assessing a vessel's utilization
- Monitoring fleet productivity as a whole
- Estimating trade flows for key commodities on a global level
- Monitoring supply and demand conditions in shipping markets[16]

However, a lack of publicly available data related to payload hinders this vital analysis. It also prevents the development of reliable estimations and assessments—particularly when it comes to potential savings from both time and financial perspectives.[17] [18]

SATELLITE AUTOMATIC IDENTIFICATION SYSTEMS

A Cohesive Solution for Data Gaps in the Shipping Sector

In its initial iteration, AIS technology functioned via ship-to-ship communication systems. In the past decade, the technology has evolved to incorporate satellites (S-AIS). The introduction of satellite-based communication allows AIS data to be collected, organized, and analyzed on a larger scale. When combined with maritime weather data, S-AIS data holds a high level of potential for the development of heuristics and machine learning models capable of optimizing vessels and reducing fuel emissions.[19]

15 Wigforss, J. (2012). Benchmarks and measures for better fuel efficiency. *How AIS data can be used in operational performance analysis*. (Published master's thesis). Goteborg, Sweden, Chalmers University of Technology. Retrieved from http://publications.lib.chalmers.se/records/fulltext/159671.pdf

16 Jia, H., Smith, T., & Prakash, V. (2019). Estimating vessel payloads in bulk shipping using AIS data. *International Journal of Shipping and Transport Logistics*, 11(1), 25. doi:10.1504/ijstl.2019.10017649

17 Jia, H., Smith, T., & Prakash, V. (2019). Estimating vessel payloads in bulk shipping using AIS data. *International Journal of Shipping and Transport Logistics*, 11(1), 25. doi:10.1504/ijstl.2019.10017649

18 Strandenes, S. (n.d.). Use of AIS data to achieve efficient shipping. Retrieved from https://www.vti.se/sv/sysblocksroot/forskning-och-tjanster/morotter-och-piskor/strandenes-20171207.pdf

19 Smestad, B. B., Asbjørnslett, B. E., & Rødseth, Ø J. (2017). Expanding the Possibilities of AIS Data with Heuristics. *TransNav,*

The collection and analysis of weather-related data in conjunction with AIS data is a key element for developing these solutions. Experts state that sufficient data surrounding weather and general operating conditions is essential when working to draw concrete conclusions.[20] Furthermore, they posit that, "[while it] may sound straightforward, because ships trade in a variety of conditions and sea/weather states, there is a need for a standardised verification methodology that allows for comparison of the baseline performance and the performance of the ship with an [energy efficiency technology] EET fitted, under the same realistic conditions. Such a procedure should be transparent and use accepted industry standards for reliable data collection and analytical methods."[21]

Spire Global owns and operates the largest constellation of multi-purpose Earth observation satellites.

Numerous organizations and startups are now exploring the potential benefits of overlaying AIS-provided data with weather data.[22] From a weather perspective, the key metrics to be gleaned consist of:

- Air temperature at sea level
- Relative humidity
- Dewpoint temperature
- The eastward component of the horizontal wind at 10 meters above ground level (AGL)
- The northward component of the horizontal wind at 10 meters AGL
- Air pressure adjusted to mean sea level
- Accumulated precipitation at surface level

Consideration of these factors in conjunction with AIS data is leading—and will continue to lead—to novel applications for AIS data to be used in affecting global level changes to the maritime industry.

---

the International Journal on Marine Navigation and Safety of Sea Transportation, 11(2), 93-100. doi:10.12716/1001.11.02.10

20 *White paper on the "Validation of the performance of energy efficiency technologies for ships"* (Tech.). (n.d.). Retrieved https://glomeep.imo.org/wp-content/uploads/2018/08/White-paper_31082018-FINAL.pdf

21 *White paper on the "Validation of the performance of energy efficiency technologies for ships"* (Tech.). (n.d.). Retrieved https://glomeep.imo.org/wp-content/uploads/2018/08/White-paper_31082018-FINAL.pdf

22 Konrad, J. (2019, June 28). The next global tech disruption will happen where few expect it. *The Boston Globe*. Retrieved August 8, 2019, from https://www.bostonglobe.com/ideas/2019/06/28/the-next-global-tech-disruption-will-happen-where-few-expect/qN3YwLlhbPUXUsyxc7wmEK/story.html

Vessel and Payload Tracking

Researchers have noted the efficacy of combining weather-related and AIS data sets when developing global shipping networks for vessel tracking purposes.[23] Tracking of this nature would significantly lower rates of vessels lost at sea, in addition to allowing for analysis of cargo flows and ship behaviors at both regional and global levels. Such efforts are likely to be disruptive on a global scale, as they could potentially be used to predict major market shifts prior to their occurrence.[24]

Payload tracking abilities made possible by AIS also hold important possibilities from a market disruption standpoint. Researchers into payload estimation via AIS data state that, "a proper estimation of cargo sizes based on AIS draught data...can [provide] real-time market information on cargo flows, vessel capacity utilisation, and the supply and demand situation. While other data sources, such as port agent reports or Bill of Lading data may be more accurate in terms of cargo size reporting, they can hardly compete with AIS data in terms of availability, scope and timeliness. The AIS system can potentially allow us to cover all ports for various types of vessels including smaller ports where other third-party data is not easily accessible."[25]

Emissions Tracking

AIS technology holds strong potential as an ideal application for tracking, monitoring, and regulating emissions activity. AIS provides continuous information about vessel positions and speeds. Researchers can then combine this data with vessel characteristics and weather-related data to model exhaust emissions and develop ship emission inventories.[26] Such measures will have a powerful effect when it comes to regulating and reducing greenhouse gas emissions.

This will positively impact the planet as a whole, while simultaneously ensuring that players within the maritime industry remain competitive from an operational cost standpoint. Regarding operational costs, one expert states that, "Shipping will face an escalating competition in the future, as more stringent environmental regulations will lead to significant higher fuel costs. Today, the cost of fuel stands for approximate 35–70% of total operational cost. Fuel efficiency measures are vital in order to stay competitive in the future."[27]

---

23 Wang, Z., Claramunt, C., & Wang, Y. (2019). Extracting global shipping networks from massive historical automatic identification system sensor data: A bottom-up approach. *Sensors*, 19(15), 3363. doi:10.3390/s19153363

24 Konrad, J. (2019, June 28). The next global tech disruption will happen where few expect it. *The Boston Globe*. Retrieved August 8, 2019, from https://www.bostonglobe.com/ideas/2019/06/28/the-next-global-tech-disruption-will-happen-where-few-expect/qN3YwLlhbPUXUsyxc7wmEK/story.html

25 Jia, H., Smith, T., & Prakash, V. (2019). Estimating vessel payloads in bulk shipping using AIS data. *International Journal of Shipping and Transport Logistics*, 11(1), 25. doi:10.1504/ijstl.2019.10017649

26 Johansson, L., Jalkanen, J., & Kukkonen, J. (2017). Global assessment of shipping emissions in 2015 on a high spatial and temporal resolution. *Atmospheric Environment*, 167, 403-415. doi:10.1016/j.atmosenv.2017.08.042

27 Wigforss, J. (2012). *Benchmarks and measures for better fuel efficiency. How AIS data can be used in operational performance analysis.* (Published master's thesis). Goteborg, Sweden, Chalmers University of Technology. Retrieved from http://publications.lib.chalmers.se/records/fulltext/159671.pdf

Spire Maritime provides excellent coverage of trouble areas, such as the Tokar Gap in the Red Sea.

SPIRE MARITIME

Providing Advanced Automatic Identification Service Solutions

Spire Maritime delivers terrestrial and satellite-based AIS data and analytics for a range of applications. In addition to typically-offered weather variables, Spire Maritime systems also account for key weather-related datasets related to oceanographic forecasts at sea level. These include:

- Sea surface temperature
- Ocean currents (eastward component)
- Ocean currents (northward component)
- Significant wave height

We combine S-AIS and weather tracking technologies in ways that put us at the forefront of innovation within the shipping and maritime industry. Visit our product page to learn more about how our products can enhance your ability to track vessels, monitor vessel payloads, and explore and implement effective methods of reducing emissions.