spire MARITIME

AN INTRODUCTION TO AUTOMATIC IDENTIFICATION SYSTEMS (AIS)

Contents

WHAT IS AIS DATA?

In this synthetic analysis, we share an overview of AIS technology, including expert opinions and researched supported facts as well as potential improvements and future integrations.

HOW AIS AND S-AIS PROVIDE HIGH QUALITY SOLUTIONS FOR MARITIME SAFETY AND DATA COLLECTION

An Automatic Identification System (AIS) promotes a higher level of safety at sea by allowing maritime authorities to locate and track seafaring vessels. AIS technology was developed and implemented with the goals of automating and improving navigation safety at sea, preventing collisions through a ship-to-ship operative mode, providing key information about a ship and its cargo to other ships and parties within littoral zones, and functioning as a traffic management tool for vessel traffic services (VTS).[1]

In order to perform these functions, a ship's AIS records and transmits three main categories of data:

1. Static information that is entered into the system upon installation of an AIS unit on a ship:
    - Maritime Mobile Service Identity (MMSI) number
    - International Maritime Organization (IMO) number
    - Call sign
    - Ship name
    - Length and beam
    - Type of ship
    - Location of position fixing antenna on the ship

2. Navigational information sourced primarily from electronic navigational systems onboard the ship:
    - Course over ground
    - Speed over ground
    - Heading
    - Navigational Status
    - Rate of Turn

3. Voyage-specific information that must be entered at the start of each voyage:
    - Ship's draught
    - Hazardous cargo
    - Destination and ETA
    - Route Plan[2]

According to maritime experts, the data capabilities of AIS mean that it, “has the capacity to improve situational awareness via the production of information that allows a clearer picture to emerge of which ships are in the vicinity, where they are heading, and what they are doing at any given moment. This is obviously important for both shoreside authorities and ships’ officers.”[3]

THE HISTORY OF AIS

The concepts behind the development of AIS were initially brought to light in the 1990s. Members of the maritime industry met regularly to discuss the need for a universal method of exchanging key information such as ship identity, position, time, course, and speed between ship and shore in a manner that was regular, automatic, and autonomous. In 1997, maritime experts and authorities agreed upon a technical proposal that put forth the core concepts behind a Universal Automatic Identification System (u-AIS). This led to the eventual development of the technology.

Within a few years, regulatory bodies began to require that ships use AIS technology – a move that was partially motivated by the terrorist attacks of September 11, 2001. At the 2002 Safety of Life at Sea (SOLAS) convention, the International Maritime Organization (IMO) issued a mandate that any new ships built must include AIS technology. Ships built prior to this time were required to integrate the technology by the year 2008.[4] Since that time, AIS has become an integral part of maintaining safety at sea.

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THE EVOLUTION OF AIS TO INCORPORATE SATELLITE TECHNOLOGY

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The implementation of AIS has created an efficient network for exchanging information between vessels and shore stations. However, this technology has been somewhat limited by the fact that the information transmitted can be only be received by terrestrial AIS receivers within 40 nautical miles of the transmitter. While receivers are able to then use the information to build local maps of maritime traffic, the terrestrial system’s geographic limitation has historically prevented the development of global maritime mapping in real-time.

In response to this geographical limitation, satellite AIS (S-AIS) has become an increasingly popular method when it comes to receiving transmitted data from shipboard systems. By utilizing S-AIS, ships are able to transmit key data regardless of their distance from a coastline via a network of satellites, thus providing a method for global mapping of maritime data.[5] S-AIS technology functions by integrating a network of satellite receivers with existing AIS platforms, which allows AIS data to be transmitted across the globe via satellite.

AIS DATA PAIN POINTS

LACK OF DATA HANDLING METHODS COUPLED WITH SECURITY FLAWS

Two key pain points exist:

- A lack of effective methods for collecting, organizing, and interpreting AIS data, in addition to a lack of standardization when it comes to communicating interpretations of the data.[6]
- Data corruption errors from both malicious sources and unintentional operator errors.

AIS DATA HANDLING ISSUES

AIS technology collects and transmits a massive amount of data.[7] While relevant parties are able to obtain the information they need through the different AIS data providers available, issues still exist when it comes to organizing and analyzing the data collected. Maritime researchers say of the issue, "Although sufficient AIS data can be obtained from many data providers…there is no existing standard AIS benchmark database in the maritime research area, which makes it quite inconvenient for researchers and practitioners in the field, since collecting a usable dataset will cost a lot of time and effort. Furthermore, as the intelligent maritime system develops rapidly, many researchers proposed anomaly detection and motion prediction algorithms and it is quite important to have a database that could be served as a benchmark for comparing the performance of different methods and algorithms."[8]

AIS data holds a wealth of information. It can point to the presence of congested areas of maritime traffic, and it can highlight the occurrence of illegal actions at sea such as smuggling, pollution, or unauthorized fishing in protected areas. However, in order to take advantage of these functions, AIS data must be accurately organized and interpreted – and researchers and authorities must have access to those interpretations. This necessitates the development and implementation of strategies for accurate data visualization.[9]

DATA CORRUPTION ISSUES

Issues with data corruption – both unintentional and intentional – can wreak havoc within the sphere of AIS technology. While researchers have noted a number of unintentional issues related to operator error, malicious data corruption tends to cause a greater sense of alarm.[10] In evaluating the security of AIS technology, experts noted a range of potential acts related to hijacking, spoofing, or

otherwise maliciously corrupting AIS systems and their data.

Ship Spoofing – a process involving the assignment of false ship information. This would allow an attacker to pretend to be a friendly ship and then enter adversarial waters. A vessel could also use such methods to clear nuclear cargo through the waters of a nuclear-free nation.

Aids-to-Navigation Spoofing – assigning false information to a buoy or other navigation aid with the goal of luring a targeted ship into conducting wrong maneuvers. For example, an attacker could place a buoy with fake information that would provide malicious instructions to ships, which could cause them to navigate in low water.Collision Spoofing – triggering a false alert about a potential collision, which would cause a ship to alter course. This could lead a ship to run aground during low tide.

AIS Search and Rescue Transponder (SART) Spoofing – an attacker would use AIS SART technology to generate a false cry for help with the goal of luring ships into an area, thus leaving the ship vulnerable to piracy.

False Weather Forecasts – broadcasting a false weather report with the goal of causing ships to alter course for malicious purposes.

AIS Hijacking – maliciously modifying ship data or eavesdropping on ship communications so as to modify messages sent.[11]

FUTURE DEVELOPMENTS

Projected future developments for AIS and S-AIS technology will seek to address the primary pain points within the technology. Researchers are making consistent progress regarding the development of methods for effectively collecting and organizing AIS data. Proposed advances will also address the security concerns associated with AIS technology.

In a notable effort to develop an open source method for handling AIS data, engineering and computer science experts constructed a visualization scheme to be used in developing an AIS data management system. They said of the project, "The procedure uses raw satellite AIS records as input and produces as output refined views of the input data, which are useful to obtain traffic density information. The proposed visualization scheme can be used as a first stage towards the development of automatic AIS data management systems, allowing to calculate the 'traffic level' in specific areas."[12]

Other researchers in the field are continuing the search for innovative methods of accurately interpreting AIS data and then effectively communicating interpretations made.[13] Certain aspects of such improvements are relatively simple to enact. For example, some researchers point out that additional training for operators would significantly improve the accuracy of interpretations of AIS data. By increasing operator familiarity with the system and system devices, notable advances in data interpretation could be made.[14]

ADDRESSING SECURITY VULNERABILITIES

Future developments in AIS technology must address inherent security vulnerabilities. Efforts must be made to prevent vulnerabilities that render the technology susceptible to spoofing, hijacking, and other malicious attacks. A key method put forth by security experts relates to the detection of anomalies. These experts state that "This strategy consists of applying anomaly detection techniques to AIS data collected…in order to detect suspicious activities like unexpected changes in vessels' route or static information. In addition, AIS data can be correlated with satellite information to find incongruities." [15]

Furthermore, experts suggest that maritime authorities should adopt a public-key infrastructure. Such a measure would allow for the certification of ships. Establishing a public-key infrastructure would make use of "digital certificates…issued by official national maritime authorities acting as certification authorities and configured in a transponder concurrently with the other station's identifiers."[16] Digital certificates of this nature would provide a high level of authentication of messages between ships and stations.

CONCLUSION

When considering AIS technology, it is not an exact science and we intend to delve deeper into this in future articles. Building a benchmark database requires an understanding of the best ways to determine the value of data and this can differ depending on its applications. APIs are effective in detecting corruption and decluttering data, taking the guesswork out of the interpreting for operators and we invest a lot in improving the quality and processing of data through Intelligent APIs, and predictive analytics.

Spire Sense Cloud combines the capabilities of S-AIS data with sophisticated APIs to provide high-quality solutions for tracking vessels, monitoring ships, and viewing both historic AIS data and predicted positions. We are revolutionizing the collection, analysis, and delivery of AIS data so as to bring our customers cutting edge technologies that do more with your data. Spire Maritime is building the next generation of maritime intelligence. To learn more about AIS and S-AIS technology, visit the product section of our website.

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