

Understanding AIS Technology

Strengths, limitations,
and its role in maritime
intelligence



Introduction

Automatic Identification System (AIS) technology is a vital tool in maritime tracking, providing critical insights into global vessel movements. The Automatic Identification System (AIS) was originally introduced to improve maritime safety by enabling a vessel navigator to view the identity, position and direction of other ships in their vicinity.

Since 2002 the International Maritime Organization (IMO) has required AIS transceivers to be fitted to vessels over 300 gross tonnes. Every few seconds AIS equipment automatically broadcasts data signals over Very High Frequency (VHF) radio. This signal includes details of the vessel name, MMSI Number*, time, latitude, longitude, speed, direction and course over ground of the vessel, amongst other information.

*MMSI stands for Maritime Mobile Service Identity.

It's a nine-digit number that acts like a digital fingerprint for a ship.

Each MMSI is assigned to a specific vessel. This means no two ships will ever have the same MMSI number.

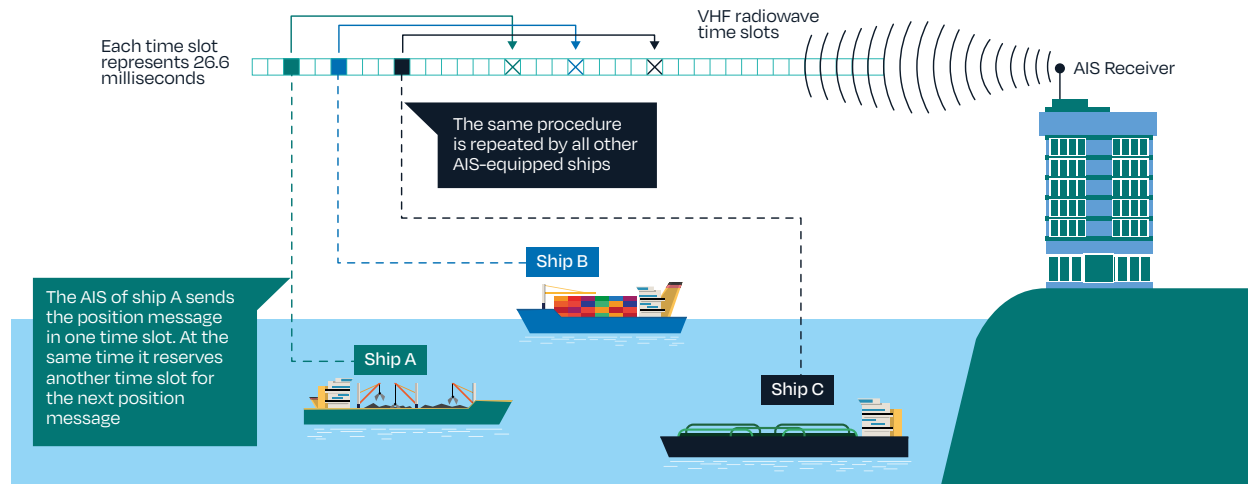
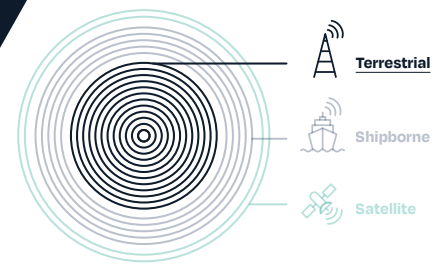
AIS works by having vessels equipped with transceivers that continuously broadcast key information, **including vessel identity, position, speed, course, and destination**. These signals are then received by different systems, such as **terrestrial, shipborne, and satellite AIS**, each playing a unique role in vessel tracking.

Despite its advantages, AIS technology comes with limitations, such as **signal congestion, spoofing, and coverage gaps**. This whitepaper explores how **terrestrial, shipborne, and satellite AIS** function, their respective benefits and drawbacks, and how Lloyd's List Intelligence uses **SmartMatch technology** to ensure data accuracy and reliability.



Terrestrial AIS

Reliable, High-Frequency Tracking



Terrestrial AIS relies on shore-based receivers to capture AIS signals from vessels, typically within **50-100 nautical miles** of the coast. Since AIS operates on **VHF frequencies**, signals travel in a **line-of-sight** path, meaning range is influenced by several key factors:

- **Antenna Height** – Higher antennas on shore-based receivers and vessels extend the line of sight, boosting coverage.
- **Transmitter Power** – Class A AIS (12.5W) offers greater range than Class B (2W) due to stronger signal output.
- **Obstacles** – Terrain, buildings, and other structures can block signals, reducing coverage.
- **Atmospheric Conditions** – Extreme weather and temperature inversions can affect signal propagation.
- **Receiver Sensitivity** – High-quality receivers enhance detection, especially for distant vessels.
- **Frequency Congestion** – High-traffic areas may experience signal interference, impacting data reliability.

To **maximize coverage and accuracy**, AIS networks require **strategic receiver placement, optimised antenna systems, and multi-station data fusion**. **Inland waterways and complex terrains need higher receiver density** than open coastal areas due to line-of-sight limitations.

Pros

Real-time, **high-frequency updates**, with latency measured in seconds

Reliable in **coastal, high congestion, and port areas**

Especially important for **high-risk areas** such as the Red Sea

Minimal latency compared to satellite AIS

Low-cost solutions

Cons

Limited range beyond coastal areas

Signal interference from terrain, tall structures, and atmospheric conditions

How Lloyd's List Intelligence excels in this area

Since 2006, we have staffed, managed, and maintained our own global terrestrial AIS network covering 12,000+ ports across all key trading areas, which provides more than 73% of all our unique AIS positions in combination with our exclusive partnership with the **Lloyd's Agent Network**.

Owning our own network means we can:

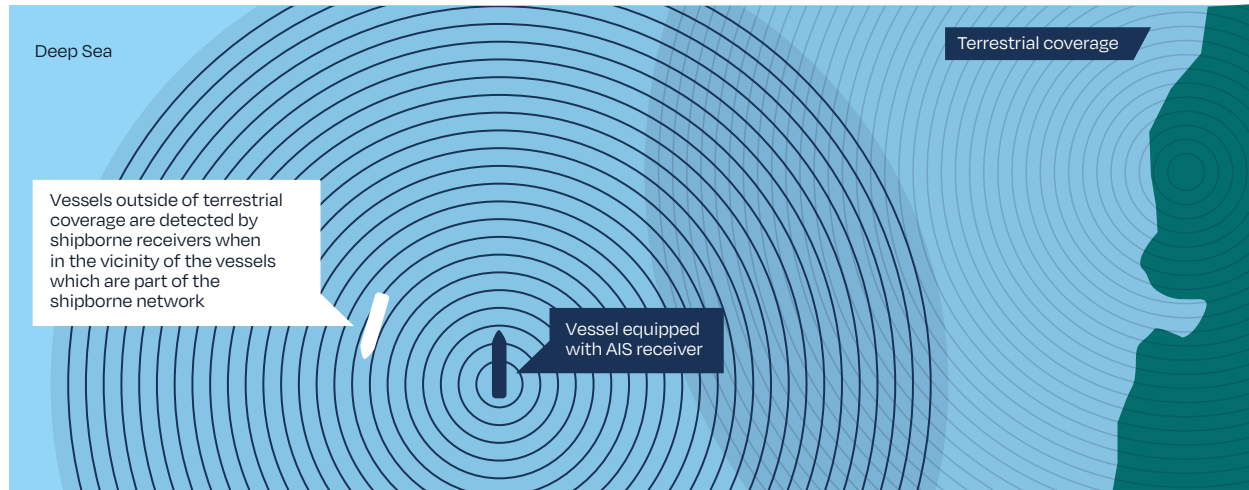
Prioritise coverage in key strategic locations and provide continually expanding coverage

Check, validate, and correct data at source, and continuously enhance our data and reduce false positives

Maintain a market-leading uptime more than 95%

Shipborne AIS

Bridging the Coverage Gap



Shipborne AIS plays a vital role in vessel tracking, especially in high-traffic areas beyond the reach of terrestrial AIS. By turning vessels into **roaming AIS stations**, it extends coverage, reduces data gaps, and improves accuracy in mid-range zones.

A **Shipborne AIS network** transforms thousands of participating vessels into a **decentralised data collection system**. Each ship relays AIS data from nearby vessels **via its satellite internet connection**, bypassing traditional AIS satellite networks. This **direct data flow** results in **exceptional low-latency tracking**, typically within minutes—crucial for time-sensitive maritime operations.

Beyond just data, Shipborne AIS delivers **actionable intelligence**, providing real-time visibility of vessel movements where terrestrial coverage falls short. It enhances **tracking accuracy in congested waters, reduces blind spots, and offers a practical alternative to land-based infrastructure**. With **unmatched coverage, minimal data delays, and enhanced tracking precision**, Shipborne AIS is a game-changer for maritime monitoring.

Pros

Enhances coverage and latency in **mid-range, high-traffic zones**

Improves accuracy in congested shipping areas (e.g., South China Sea)

Reduces reliance on intermittent satellite updates

Low latency, typically a few minutes

Cons

Dependent on ship participation

May not cover truly remote regions

Higher cost than terrestrial AIS

How Lloyd's List Intelligence excels in this area

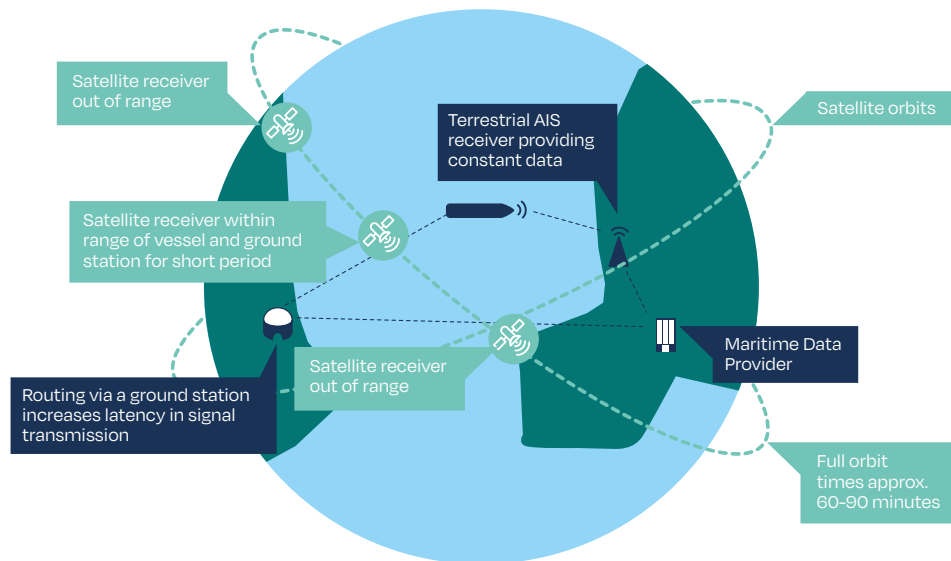
We have our Shipborne network, 1000s of ships acting as roaming AIS stations relaying the AIS data of vessels in their vicinity back to us.

Our Shipborne coverage utilises larger vessels, such as container vessels which means increased range to cover key shipping lanes (height of vessels is key).

Ports coverage – increased number of ports and highly congested areas covered, including areas which do not permit terrestrial AIS positions (sensitive areas now covered by shipborne AIS coverage).

Satellite AIS

Global Reach with Limitations



Satellite AIS provides essential visibility in remote shipping lanes, open oceans, and sparsely travelled regions—ensuring vessels remain trackable beyond the reach of terrestrial and shipborne AIS.

While its **global reach** is unmatched, satellite AIS alone lacks the **high-frequency, real-time data** needed for detailed maritime intelligence. Instead, it acts as a **critical backup**, filling coverage gaps and strengthening a **multi-layered tracking network**.

AIS satellites orbit the Earth multiple times per day, capturing ship transmissions and relaying them to ground stations. However, data delivery depends on satellite positioning, leading to **higher latency** than terrestrial or shipborne AIS, which provide updates within minutes or seconds.

Despite this, **satellite AIS is vital for a complete tracking solution**, ensuring uninterrupted visibility where land-based infrastructure is impractical. By complementing real-time coastal and mid-range tracking, it enables **continuous, global vessel monitoring**.

Pros

Global coverage, including deep sea

Essential for tracking vessels in **isolated areas**

Fills in **any coverage gaps** left by terrestrial and shipborne AIS

Cons

Lower update frequency than terrestrial AIS, can be up to 90 minutes

Reduced performance and loss of messages due to signal congestion in high traffic areas

High latency due to orbital data relay constraints

Higher cost than terrestrial and shipborne AIS

How Lloyd's List Intelligence excels in this area

To ensure **seamless, always-on vessel tracking**, we have built **strong partnerships with leading satellite AIS providers**. These collaborations allow us to integrate **high-quality satellite data** into our AIS network, extending coverage to even the most remote maritime regions.

By working with strong satellite AIS providers, we ensure **reliable and consistent data**—minimising blind spots and reducing latency, even in areas far from terrestrial and shipborne AIS infrastructure.

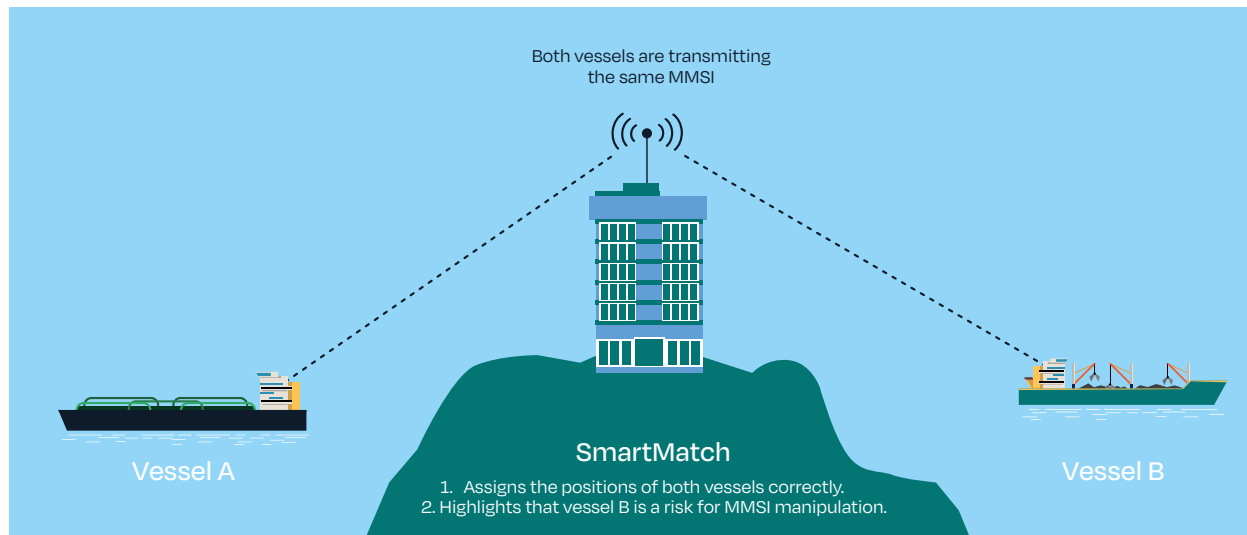
This **multi-source approach** enhances data accuracy, helping maritime operators make informed decisions with **comprehensive, real-time insights**.

With **global reach and redundancy**, our satellite AIS partnerships guarantee **uninterrupted maritime visibility**, supporting safe, efficient, and proactive vessel tracking across the world's oceans.

SmartMatch Technology

Maximising AIS Data Accuracy

To address the limitations of AIS technology, Lloyd's List Intelligence employs SmartMatch technology, an advanced system that deduplicates signals, filters out inconsistencies and identifies vessels trying to manipulate their MMSI, ensuring the most accurate vessel position data.



Types of SmartMatch

MMSI being used by another vessel

When a vessel is using the official MMSI of another vessel (intentionally)

Secondary MMSI until flag change

The vessel begins transmitting a new MMSI reflecting a flag change, prior to its official flag change date, or the vessel is using an old MMSI

Invalid MMSI

The vessel transmits an invalid MMSI number (invalid flag code, too few digits, etc.) or the vessel transmits an MMSI with a typo

How SmartMatch Works

Deduplication – Filters multiple AIS signals to eliminate duplicate transmissions

Validation – Cross-references **terrestrial, shipborne, and satellite AIS** for accuracy

Spoofing Detection – Identifies and flags suspicious or manipulated AIS signals

Anomaly Detection – Uses artificial intelligence and machine learning algorithms to detect unusual vessel movements and reporting patterns

Why It Matters

The **number of AIS messages** received does not correlate to number of unique MMSIs, and therefore number of ships detected

What is crucial in vessel tracking data is the **number of unique MMSIs**

By enhancing our network with multiple sources of terrestrial, shipborne, and satellite AIS data, this expands our coverage, and **enables us to capture more unique MMSIs**

Ensures **clean, reliable, and verified vessel positions**

Supports compliance, security, and operational decision-making

Reduces **false positives** and improves confidence in vessel tracking analytics

Conclusion

AIS technology is essential for maritime tracking, but no single type offers a complete solution. By integrating **terrestrial, shipborne, and satellite AIS**, and refining data with **SmartMatch technology**, Lloyd's List Intelligence creates a unique proposition for vessel tracking intelligence with the power to detect even more unique MMSIs.

Lloyd's List Intelligence has its own global proprietary terrestrial network meaning we own our data and control its expansion into key areas. Our unique Shipborne AIS network adds an even greater layer of validated positions and accuracy. Satellite AIS fills in the final gaps, our partners guarantee global coverage in deep sea areas so we can connect the full voyage.

Lloyd's List Intelligence combines these data types to provide the best vessel tracking solution available on the market, governed by our COACT framework: our commitment to delivering actionable intelligence through a foundation of Consistency, Origin, Accuracy, Completeness, and Timeliness.



By having our unique blend of data sources, **we deliver the most accurate and actionable maritime intelligence available.**

Contact us today to learn how LLI can support your AIS data needs.