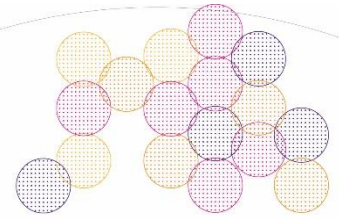


# Arriving at our Destination: implications of autonomous vessels

Val Jervis



In an earlier Insight from February 2023<sup>1</sup> we considered challenges which will need to be addressed to make autonomous vessels a reality, and the current solutions which exist to overcome these challenges. The vision is a vessel that can undertake any sea journey (coastal or international) where the operating system of the vessel is able to make decisions and determine actions (complying with Degree 4: Fully autonomous vessel<sup>2</sup>) using Artificial Intelligence (AI). This will require global adoption and changes to existing maritime regulations – for example, there is currently no way of exempting human surveillance for vessels covered by Global Maritime Distress and Safety System (GMDSS)<sup>3</sup>. This paper considers the implications of realising fully autonomous vessels and the role of AI.

## Realisation of autonomous vessels

There is increasing interest, in the shipping industry, in Maritime Autonomous Surface Ships (MASS) which will reduce operating costs, address the lack of suitably skilled crew and increase safety. It is not just vessels where automation is being developed to realise MASS, but also in the areas of port activities such as cargo handling, mooring and remote piloting.

However, progress in implementing these new technologies is hampered by the existing legal framework. There is a need for new legislation and regulations to realise these changes, ensuring that the level of safety is equivalent or better when compared to conventional shipping. An important consideration in this respect is the role of the ship's captain and the shift to other decision centres such as Remote Operation Centres (ROCs).

In the following we consider the requirements specifically for navigation and maritime distress and safety.

## Use of AI for navigation

Navigation of autonomous vessels can be considered in two categories: an overall route plan to reach the destination, and immediate and short-term course changes to avoid collisions or weather issues. These will interact to determine the overall course of the vessel.

In the case of immediate navigation, it will be necessary for an autonomous vessel to determine when it needs to make corrections to its course and speed to ensure the safety of the vessel and others on the water. Like vehicles and roads, the International Maritime Organisation (IMO) has developed and adopted international collision regulations that define the "rules of the sea". These International Regulations for Preventing Collisions at Sea (COLREGs)<sup>4</sup>, adopted in 1972, are mandatory rules for all vessels on the high seas and connected, navigable waters. They enhance safe navigation, by prescribing the conduct of vessels underway, specifying the display of internationally understood lights and sound signals and set out

specific actions, for example, to avoid collisions (Rule 8) and navigating in narrow channels (Rule 9).

Navigation corrections may also be necessary to take account of weather warnings, changes to the planned trip itinerary (for example berthing at additional ports to collect containers in the case of container ships), warnings of new hazards that impact on the navigability of a route, and the need to maximise economic benefits of a trip (for example speed and bearing of vessel set for best fuel performance taking into account prevailing weather conditions). These corrections may require immediate changes to course, or more long-term adjustments.

AI has the potential to determine the necessary course and speed alterations without the need for human intervention based on:

- Rules of the sea;
- Basic data information on the vessel from previous voyages and algorithms (for example optimum speed based on length, width and displacement);
- Learnings from actions of manned vessels;
- Inputs from equipment on board that provide necessary information on:
  - Current location of the vessel, bearing and speed
  - Location of any other vessels, their bearing and speed
  - Location of any buoys and obstacles
  - Weather and hazards information; and
- Trip itinerary.

## Input required for navigation

Inputs for AI analysis can be provided by a number of sources. For immediate course corrections, the vessel's **RADAR**<sup>5</sup> will be used to identify buoys, obstacles and other vessels in the proximity of the autonomous vessel. It is vital that AI can determine the best way to avoid these hazards.

Alongside radar, the **Automatic Identification System (AIS)** provides for information exchange between ships, and ships to shore, including the vessel identity, size, position, speed and course. This allows the relative position of ships and shore to be monitored with AIS message type 5: Ship Static and Voyage related data, provided at 6-minute intervals in accordance with ITU R M. 1371-1. As it operates autonomously there is no need for intervention to obtain the necessary data. AIS primarily uses two dedicated channels in the VHF band (161.975 MHz and 162.025 MHz) and has now been installed on most commercial vessels.

Similarly, **Maritime Safety Information (MSI)** or **NAVDAT**, like **NAVTEX**, broadcasts navigation, safety and security related data between shore and ships. Messages sent include navigational and meteorological warnings, search and rescue, VTS traffic information, tides and currents and meteorological forecasts and local information.

Looking at longer-term navigation, as well as providing locations for use by immediate navigation challenges, the **Global Navigation Satellite Service (GNSS)** provides the location of the vessel to a high degree of precision such as needed for autonomous operation. There are constellations of satellites that transmit signals providing positioning and timing signals to GNSS receivers that use the data to determine the receiver location. There are four core global satellite navigation systems; GPS (US system), GLONASS (Russian Federation), Beidou (China) and Galileo (European Union).

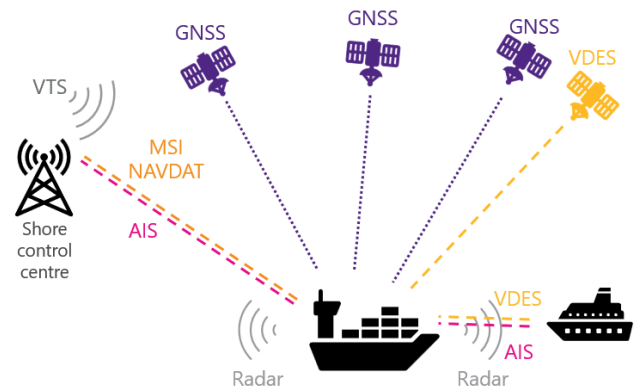
**VHF Data Exchange Systems (VDES)** will support communications and positioning data but also new services such as e-navigation and facilitate autonomous shipping. In addition to AIS and AMS (application specific messages) it will include satellite communications (LEOs) to provide high speed two way data exchange on a global basis not just in coastal areas served by VHF frequencies.

**Vessel Traffic Services (VTS)** can also be used to monitor vessels' movements based on AIS and Radar data and will allow the ship traffic on sea routes to be managed. VTS is established by harbour and port authorities to provide:

- Information service,
- Traffic organisation service, and
- Navigational assistance service.

These systems will need to work together to provide all necessary data for autonomous vessels to operate. While ship-to-shore communication is vital for coordination of a holistic view of vessel location, given the remoteness of some shipping lanes it is crucial that inter-ship communication, and satellite links, are used as well.

**Figure 1: Multiple communication channels enabling autonomous vessels**



**Human input to navigation**

Whilst the aim is to achieve a fully autonomous vessel (Degree 4) where operational decisions and monitoring are made with no human intervention, this is currently not realistic. Operators at Remote Operating Centres (ROCs) will be required to monitor and potentially override and take control of the MASS. ROCs may be located afloat on a separate vessel or ashore.

For this intervention to be effective, it will require the same data to be available to the operators at the ROC as to the vessel. Additional information might be provided such as video (including infra-red) from the vessel to facilitate further situation analysis and informed decisions on necessary changes to navigation that may override those provided through AI.

**GMDSS and voice communications**

As already mentioned, a fully autonomous vessel is not expected to be manned, and this has significant implications as currently regulations are based on the use of voice communications from the bridge of the vessel throughout a voyage. The challenge is to identify how this will change and which regulations should be updated or modified to allow autonomous vessels.

The GMDSS ensures that ships in distress can send alerts and communicate with search and rescue authorities, as well as nearby vessels, anywhere in the world. GMDSS is mandatory for all SOLAS-compliant ships (Safety of Life at Sea) and there are also many voluntary users. The requirements differ depending on the different sea areas (A1 to A4), based on the type of radio coverage available.

Ships are required to provide assistance to any person(s) found at sea in danger. There is a requirement for every ship, while at sea, to maintain watches with continuous watch keeping required on VHF DSC Channel 70 and when practicable, a continuous listening watch on VHF Channel 16.

This raises the questions:

- What assistance an unmanned vessel can provide, and
- What is an acceptable alternative to the bridge monitoring the channels – can this be effectively undertaken by an operator at a remote control centre?

**Requirements for further work**

Existing legislation and regulations will need to be reviewed and updated to enable the full vision of autonomous vessels. Specifically, requirements such as the replacement of a captain on the bridge of a vessel by personnel at a ROC and definition of assistance to be provided in the event of danger to life.

Trials will be needed to ensure decisions based on AI are appropriate and ROCs can replace crew on board a vessel. These have already started; for example, a "Further Expanded North Sea MoU on Cooperation Regarding the International Operation of MASS" was signed on 10 May 2024, involving the UK, Belgium, Norway, Denmark, and the Netherlands. This MoU enables cooperation on testing, allowing for the potential relaxation of certain national requirements (derogations) to facilitate cross-border trials of autonomous vessels.

**Advantages of autonomy**

The advantages of the introduction of AI controlled vessels and avoidance of dependency on a ship's captain for safe passage are highlighted by recent news. The BBC<sup>6</sup> has recently reported:



**A cargo ship captain found guilty of gross negligence manslaughter has been jailed for six years**

This related to a story where the vessel Solong collided with US tanker Stena Immaculate off the East Yorkshire coast. The trial concluded the captain did not keep a proper lookout on 10 March 2025, did not use all available means to determine the risk of a collision, and did not leave enough time to take evasive action. It was reported that "the tanker was visible on the

Solong's radar display for 36 minutes before impact, yet Motin failed to steer away from the collision course, sound the alarm, summon help or initiate a crash stop".

Each of these actions could have been automated. If the vessel had been autonomous the necessary evasive action would have been undertaken automatically, and the collision and loss of life avoided. There are many such incidents where the cause of the accident is human error, each of which can be avoided. However, it is important that sufficient testing and trials are carried out to make sure that these incidents are not replaced with others caused by machine or algorithmic mistakes.

**About Plum**

We are a leading independent consulting firm, focused on the telecommunications, media, technology, and adjacent sectors. We apply extensive industry knowledge, consulting experience, and rigorous analysis to address challenges and opportunities across regulatory, radio spectrum, economic, commercial, and technology domains.

Val Jervis is Director at Plum and has over 35 years industrial and regulatory experience relating to radio communications. This includes eight years in senior roles directly involved in the licensing and regulation of fixed and mobile telecommunication services within the UK regulator. She has been involved in and led a considerable number of studies relating to the development of spectrum policy and knowledge transfer and has particular experience in issues associated with refarming of spectrum, spectrum licensing, pricing and award from a technical and market perspective.

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<sup>1</sup> See Autonomous vessels – can the potential benefits be realised? - Plum Consulting, available from <https://plumconsulting.co.uk/plum-insight-autonomous-vessels-can-the-potential-benefits-be-realised/>

<sup>2</sup> Level 4 is where the system is responsible for both monitoring and control or operation of a vessel.

<sup>3</sup> GMDSS is mandated by the International Maritime Organisation (IMO) and is a mandatory international automated communication system for SOLAS

vessels, using satellite and terrestrial technology to ensure rapid distress alerting and safety information exchange.

<sup>4</sup> See <https://www.imo.org/en/about/conventions/pages/colreg.aspx>

<sup>5</sup> RADAR is an acronym for "radio detection and ranging".

<sup>6</sup> See <https://www.bbc.co.uk/news/articles/c801zgpm3meo>