Australian Government
Australian Maritime Safety Authority

Navigation services in Australian waters

outlook to 2030

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Contents

Foreword

I am pleased to present *Navigation services in Australian waters – outlook to 2030*.

This forward-looking, perceptive work outlines the emerging trends and drivers that will influence navigation services in our waters. It also describes the anticipated impacts these will have on the maritime industry and lists AMSA's policy response to these changes.

This work is timely, given the impending change in the way vessels will receive, integrate, display and exchange information—and use this information to navigate.

Predictions have been made in this document, some of which could be described as being overly optimistic, but these are made for good reason, to promote thought and positive vision setting.

Navigation services in Australian waters – outlook to 2030 also contains a set of guiding principles for AMSA's provision of navigational services. It articulates the authority's aspirations and provides a basis for prioritising activities.

Brad Groves

General Manager, Standards

June 2019

Executive summary

Navigation Services in Australian Waters – outlook to 2030 provides an insight into the provision of rapidly evolving navigation services over the next decade (and beyond) for ships trading internationally and domestic commercial vessels.

It takes into account emerging trends and drivers in technology and communications for marine navigation, and outlines their impact on the maritime industry. It also details AMSA's policy response to these changes and projected response timeframes.

To set an authentic context of what lies ahead, *Navigation Services in Australian Waters – outlook to 2030* takes the reader on a futuristic voyage on board the fictitious *Blue Sky*, a bulk carrier en route from Hay Point (Qld) to Paradip, India. The scenario describes the types of technologies—new and legacy—that could be used by a typical Panamax-sized carrier in the year 2030.

The pace of change will be great and AMSA, in keeping with its maritime safety and environmental protection responsibilities, will need to be agile and innovative in response.

For example, AMSA can coordinate a global approach to resilient Positioning, Navigation and Timing (PNT), and play a vital role in the development of a Satellite Based Augmentation System (SBAS) for the maritime sector in the Australian region.

Also, visual aids to navigation will remain essential for the safe navigation of ships. However, by 2030 they may be secondary to the way in which many (but not all) vessels will navigate.

Automated navigation of ships represents a monumental shift in global surface transportation but, as the *Blue Sky* experience reveals, there will still be reliance on supporting systems such as physical aids to navigation (AtoN) and other forms of operational control by humans.

Here, AMSA's policy response will include enhancing the efficiency and effectiveness of its AtoN network, and putting measures in place to protect it (and future navigation networks) from cybercrime.

Key to *Navigation Services in Australian Waters – outlook to 2030* is a set of principles to guide AMSA in the delivery of these new practices and technologies to enhance the ongoing appropriateness and reliability of navigation services.

These principles also reaffirm AMSA's exemplar commitment to stakeholder and community engagement, and observance of the relevant conventions and International Maritime Organization (IMO) obligations.

Navigation Services in Australian Waters – outlook to 2030 provides a prioritised response framework for AMSA so that it can continue fostering a safe, efficient, sustainable and secure maritime transport system for Australia.

1. Introduction

1.1 AMSA's role and responsibilities

AMSA is the national maritime safety agency, with a primary role in maritime safety, protection of the marine environment from ship-sourced pollution, and maritime and aviation search and rescue.

It is widely accepted that Australia has the world's fifth largest shipping task and accounts for over 10 per cent of the world's seaborne trade. International trade is vital for the nation's prosperity. Australia also has some of the world's most environmentally sensitive sea areas, which vessels must navigate to reach our ports.

In order to fulfil the twin responsibilities of maritime safety and environmental protection, AMSA provides modern, fit-for-purpose navigation services that facilitate safe navigation. A central element of AMSA's navigation services is its network of some 480 aids to navigation (AtoN) at about 400 sites. Other elements include ships' routeing and reporting systems, maritime safety information (MSI), coastal pilotage, Vessel Traffic Services (VTS), and an under keel clearance management (UKCM) system in Torres Strait.

AMSA provides navigation services consistent with its international obligations in Chapter V (Safety of navigation) of the International Convention for the Safety of Life at Sea, 1974 (SOLAS) (as amended). AMSA's AtoN network is consistent with the standards and guidance of the International Maritime Organization (IMO) and International Association of Marine Aids to Navigation and Lighthouse Authorities (IALA).

1.2 About this work

Navigation Services in Australian Waters – outlook to 2030 provides an insight to the provision of navigation services in the coming years. It takes into account emerging trends and drivers in technology and communications for marine navigation and outlines their impact on the maritime industry. It also informs the reader about AMSA's policy response to these changes.

This work encompasses the provision of navigation services for ships trading internationally and domestic commercial vessels.

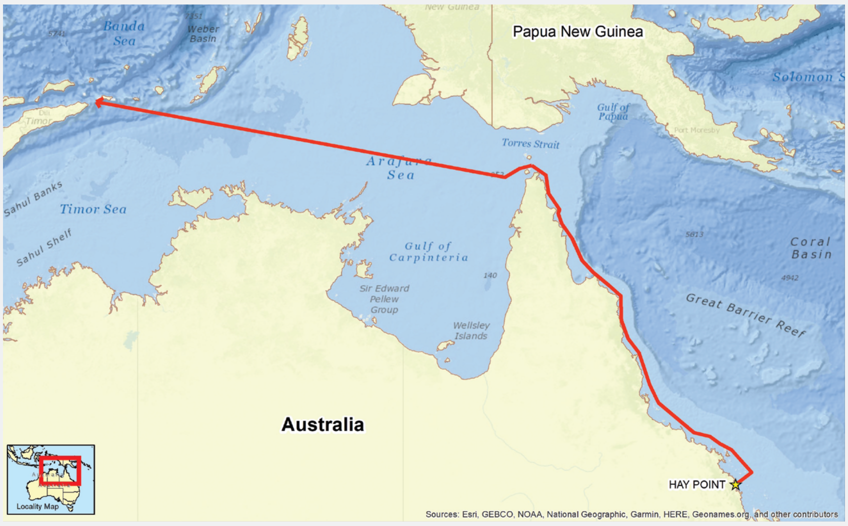
Navigation Services in Australian Waters – outlook to 2030 will contribute to fostering a safe, efficient, sustainable, and secure maritime transport system for Australia.

2. Case study – navigating from Australia in the year 2030

Consider this scenario:

The year is 2030. In December, Liberian-flagged Panamax-sized bulk carrier *Blue Sky* (a fictious ship) is en route from Hay Point, Queensland to Paradip, India (via Torres Strait).

The vessel is 280 metres long, 30 metres in breadth and has a current draught of 12.2 metres. It has a deadweight capacity of about 65,000 metric tonnes.



Blue Sky's route from Hay Point to India

Route planning and sharing

Once its intention to navigate to Paradip, India is known, the intended voyage plan from Hay Point is prepared ashore by an authorised service provider and transmitted electronically to the ship, to be reviewed and executed. Preparation ashore ensures inclusion of up-to-date, region-specific information that could impact the ship's voyage (such as forecast weather and sea state, under keel clearance requirements, air draughts, no-go areas, MSI and compliance with any mandatory requirements (eg ships' routeing, garbage disposal)).

Once finalised, the route is shared electronically with relevant authorities (eg VTS, port and coastal pilots) and the company control centre ashore.

Services en route

Before its departure from Hay Point, *Blue Sky* will access a range of maritime services related to its voyage, based on its preferences. Examples of this are chart, weather and REEFVTS (and any other VTS en route) services. An example specific to Torres Strait is UKCM information from AMSA's system. This will enable *Blue Sky* to transit through Torres Strait safely and efficiently (with the maximum amount of cargo, commensurate with the permissible draught), supported by the services of a licensed coastal pilot.

When *Blue Sky* reaches Torres Strait, the route through Prince of Wales Channel—which is part of AMSA's UKCM service area—will be made available automatically. Using an internationally agreed standard for sharing UKCM information (S-129), the UKCM service provider will confirm the available tidal window to transit. The service provider will supply overlays—that display on the ship's navigation system—to show non-navigable and almost non-navigable areas. The ship's crew and the coastal pilot will use the same information to ensure a shared mental model of the navigation plan.

Based on the ship's unique Maritime Resource Name (MRN) and associated permissions, it will be able to access certain authorised services (such as en route chart, weather and other updates) to optimise the passage. Further, *Blue Sky* will also be able to configure when and how it will receive such messages.

Communications will be based on widely available commercial satellite services, in a competitive market, as more providers will offer services. Other means will include VHF Data Exchange System (VDES, both terrestrial and satellite) and Global Maritime Distress and Safety System (GMDSS). The Officer of the Watch (OOW) will not need to choose a communications medium—this switch will occur automatically and seamlessly, without any need for operator intervention.

Route exchange with other ships

Once underway, *Blue Sky's* own voyage plan and the plans of other selected ships will be automatically exchanged using internationally agreed route exchange protocols and mechanisms. Aided by technology, the bridge team will be able to foresee possible conflicting and dangerous situations and take early evasive action. Such exchanges will result in improved situational awareness and navigational safety. Route exchange will also allow for possible new route suggestions based on external factors eg weather, sea state, heavy traffic and busy ports. These will be transmitted automatically from ashore and will be used on board on demand.

Route monitoring

When the ship is navigating in open waters, automated, onboard systems will monitor the ship's progress, relieving bridge watch-keepers from the need to carry out the most routine tasks, resulting in an equal or higher level of safety. Control of the vessel may be on board or from a remote location, but will be fully supported by systems, infrastructure, and digital services.

With its planned route being previously shared, VTS authorities will be able to detect if *Blue Sky* deviates from its planned route. They will also be able to foresee any developing dangerous situations such as converging traffic and suggest route modifications (geographic and/or speed).

Radionavigation - Positioning, Navigation and Timing information

Blue Sky will benefit from continuous positioning, navigation and timing (PNT) information from multiple global navigation satellite system (GNSS) constellations. Terrestrial back-up systems will also be used, where available. Satellite-based augmentation systems for GNSS will provide improved accuracy and integrity. Ship sensed positioning from radar and visual sources will contribute to the cross-check and resilience of positioning and navigation information, using multi-source PNT data processing units.

Onboard systems and watch-keepers will be aided by a modern and technology enabled, physical AtoN network, to ensure safe navigation. Physical AtoNs will be used to validate position and provide safety assurance. These are likely to be modernised, connected and fundamentally different from today's AtoNs.

Notwithstanding the above, *Blue Sky's* watch-keepers will be able to navigate using information they can sense (e.g. radar information, depth information and visual bearings and celestial measurements). This will mitigate the risk of GNSS denial.

Hybrid propulsion

Blue Sky will have a hybrid propulsion system. This means that when its engines generate either too much or too little power, batteries will either store the excess energy or provide the extra power needed at high loads. The main advantage is that its generators will operate constantly at an optimum load.

If the batteries are fully charged when *Blue Sky* needs to operate at low load, such as when manoeuvring in port or when slowing down to reach port just in time, it will be able to use only battery power (until it reaches a pre-set minimum charge point).

Overall, hybridisation will help ensure that *Blue Sky* will have the flexibility to get where it needs to in the most energy efficient way possible. In combination with a range of other operational efficiencies used by the Blue Sky, hybridisation will help the vessel meet the target under the IMO Strategy on Reduction of Greenhouse Emissions from Ships, to reduce ship emissions on average by at least 40% by 2030, compared to 2008 levels. Using batteries in port will also reduce the health and environmental effects of sulphur oxide and Particulate Matter.

Port arrival

To ensure that *Blue Sky* does not arrive before the port is ready to receive her, the ship, her operator ashore, and the port will communicate regularly and automatically to agree on an optimum arrival time. This exchange will be carried out as early as possible, to let the ship adjust her speed, save fuel, and reduce greenhouse gas emissions.

As *Blue Sky* approaches her port of arrival, automated exchange of information using approved information exchange protocols will take place. This will ensure the crew have relevant information available in good time.

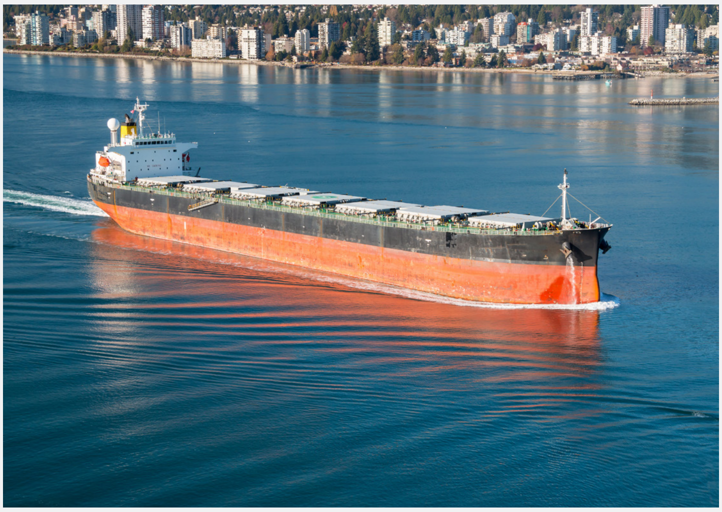


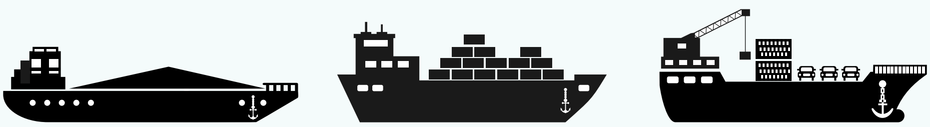
Photo of a typical Panamax bulk carrier underway. (Source: iStock.com/nielubieklonu)

3. Community expectation

There is wide expectation that ships in Australian waters are seaworthy and are operated and navigated safely by competent seafarers. There is no tolerance for shipping accidents and ship-sourced marine pollution, particularly in environmentally sensitive waters such as the Great Barrier Reef, Torres Strait, Coral Sea, the waters off the north-west coast of Australia, and the Great Australian Bight.

The unique and diverse nature of Australia's maritime environment drives AMSA to do its utmost to ensure only high quality vessels call at our ports. In this regard, the global maritime community acknowledges that Australia has a strict and fair port State control (PSC) regime.

Whether we are developing our own standards for domestic commercial vessels, or working internationally to influence the development of global standards for shipping, our focus is about managing the risks to safety and the marine environment.



In 2017, there were **28,502** ship arrivals by **5873** foreign-flagged vessels.

Source: 2017-18 AMSA Annual Report


MSC VENEZUELA

4. Trends, their implications for industry and our policy response

Over the coming years, the following trends are expected to affect AMSA's provision of navigation services. The tables below outline the implications for industry and our policy response to the coming changes.

4.1 Positioning, navigation and timing

A number of GNSS are now available to the mariner and electronic PNT on board ships has become the norm. PNT also underpins a variety of safety-related maritime services. However, achieving resilient PNT is a challenge. A mix of dissimilar systems is required to do so; and there are a number of candidate technologies available and under development. Current and future PNT technologies include:

- Multi constellation GNSS
- Satellite based augmentation system (SBAS) for GNSS
- Ranging mode (R-mode) using existing physical AtoN infrastructure
- Radar positioning
- eLoran (enhanced Loran, a modernised version of the older Loran-C)
- Shipborne PNT data processing unit
- Light detection and ranging (LiDAR)
- Fusion techniques for positioning, navigation and timing information

However, there is yet to be global consensus on a coordinated approach to resilient PNT for the maritime sector.

The Australian Government is to fund an enduring SBAS service for the Australian region. However work must take place internationally to accept the use of SBAS for maritime applications. This involves the development of performance and test standards for maritime SBAS transceivers. Once ships are able to make use of SBAS in Australian waters, AMSA will be able to transition from the legacy Differential Global Positioning System (DGPS) service to SBAS.

Trends that will affect positioning, navigation and timing services	Implications for industry	Our policy response
■ Multi-constellation GNSS has become the primary source of PNT information. ■ Augmented GNSS (either by terrestrial or satellite means) will continue to play a vital role in the provision of high accuracy and integrity-proven PNT information. ■ The increasing availability of GNSS and other sources of electronic PNT information (eg position-fixing using e-racons) are contributing to resilient PNT on board ships. ■ There is a variety of technologies being developed to provide integrated (satellite, terrestrial and ship-sensed) PNT solutions.	■ Ships will increasingly rely on electronic PNT information, based mostly on GNSS. This will result in safety and efficiency benefits, including improved accuracy and integrity monitoring. ■ Benefits will accrue to: • coastal navigation • navigation in environmentally sensitive sea areas • port approaches • harbour manoeuvring. ■ An SBAS system, certified by ICAO for aviation use, is expected to be available over our region by 2022. ■ To enable marine GNSS receiver equipment to make use of SBAS, changes to the relevant IMO and IEC instruments will need to be made. ■ Radiobeacon DGPS is likely to become obsolete for marine navigation in the years leading up to 2025.	■ Work at IALA to develop guidance for its members to transition from DGPS to SBAS. ■ As SBAS is implemented from 1 July 2018 in the Australian region, work domestically to ensure maritime interests are part of the SBAS program. ■ Work at IMO and IEC, liaise with CIRM and other bodies to facilitate the introduction of SBAS-enabled marine GNSS receivers. ■ Develop a plan to decommission AMSA's DGPS service. ■ Monitor any developing options for the use of shore-based infrastructure to provide PNT services. ■ Critically appraise emerging PNT technologies for their suitability to provide resilient PNT in Australia. ■ Promote the need for ships to be able to navigate making use of information they can sense (e.g. radar information, depth information, visual bearings and celestial measurements).

4.2 Aids to navigation

AMSA maintains a network of marine aids to navigation (AtoN) systems, consistent with international standards, to ensure safe navigation in Australian waters. AtoNs are established where the volume of traffic justifies and degree of risk requires. Currently, a mix of some 480 visual and electronic aids make up AMSA's network. The states, ports and territory collectively operate many more AtoNs.

AMSA's aids to navigation in Australia

Primary lights (includes floating aids)	341
Unlit beacons	6
Racons	40
Tide Gauges	5
Differential GPS stations	16
Radar facility	1
Automatic Identification System facility	58
Met-ocean sensors	5
Other aids	7
Total aids to navigation	479

Trends that will affect aids to navigation	Implications for industry	Our policy response
▪ Visual AtoNs will remain essential for the safe navigation of ships. However, by 2030 they may be secondary to the way in which many (but not all) vessels will navigate. ▪ Growing use of electronic AtoN (eg AIS AtoN) to supplement the marking of hazards to navigation, particularly temporary hazards. ▪ The relative ease of establising virtual AIS AtoNs (eg for marking hazards in an emergency). ▪ With growth in the use of new technology radars, conventional racons are not as effective. ▪ Harmonisation and improvements in AtoN networks remain important nationally and internationally. ▪ Maritime communications will be an enabler for innovative AtoN solutions. ▪ An increasingly connected network of navigation services and AtoNs may be vulnerable to cyber threats. ▪ Heritage lighthouses will remain an important part of Australia's culture.	▪ Improved AtoN network efficiency and cost savings, as providers regularly review their mix of visual and electronic AtoN. ▪ Ships will increasingly need modern navigation systems that are capable of effectively using electronic AtoN. ▪ Virtual AIS AtoNs will continue to be effective, but will have limited use, as they will not always be seen on all navigation systems. Also, they cannot be relied upon as the sole source of information. ▪ There is potential for cybercrime to have an adverse effect on the provision of AtoNs and navigation services. ▪ Management of heritage lighthouses remains an important part of AMSA's obligations.	▪ Work with AMSA's contracted maintenance service provider to adopt technologies and innovative practices that enhance the efficiency and effectiveness of AMSA's AtoN network. ▪ Explore obtaining near real time satellite AIS information for use at AMSA. ▪ For the short term, optimise and maintain AMSA's terrestrial AIS infrastructure, particularly in areas where it is important to transmit messages to ships via AIS (eg from REEFVTS). ▪ If it becomes apparent that VDES will be the communications infrastructure of choice, AMSA will work with national stakeholders to establish a VDES communications infrastructure framework. ▪ By way of periodic reviews, continue to critically assess the need for individual AtoNs, to ensure the safety of coastal navigation for domestic and international trading vessels. ▪ Consider the importance of cyber security and software quality assurance for the integrity of AMSA's AtoN network (including AMSA's UKCM system). ▪ Meet our obligations with regard to our heritage-listed lighthouses.

4.3 Digital maritime services

IMO's 2014 e-navigation Strategy Implementation Plan (SIP), updated in 2018, foreshadows the exchange and presentation of navigation-related information, in electronic form, between shore and ship. Termed digital maritime services, they aim to reduce workload and human errors, improve efficiency and situational awareness, and enhance the safety of navigation.

The SIP identifies 16 such services. These are listed at Annex 2.

Trends that will affect digital maritime services	Implications for industry	Our policy response
■ The advent of digital maritime services (eg weather services, routeing information, navigation warnings, notices to mariners) will improve the way that navigation and safety-related information is exchanged between ship and shore. ■ Digital maritime services will become available for all types of commercial ships, as communication technologies become more readily available. ■ Integration of onboard systems will increase and the exchange and display of navigation and safety-related information will become more harmonised.	■ New digital maritime services will provide navigation and safety-related services more efficiently onboard. This will reduce workload and improve situational awareness, leading to improved safety outcomes. ■ Examples of such services are: • Maritime Safety Information (MSI)—includes navigation warnings promulgated by the Joint Rescue Coordination Centre (JRCC) and the Bureau of Meteorology (BoM)(in the future, warnings issued by states marine and port authorities could be promulgated digitally) and notices to mariners (issued by the Australian Hydrographic Office, state and local waterway authorities). • Real time, near-real time and forecast tide and tidal stream information will be available directly to watch-keepers through integrated systems. • Interactive and integrated weather and wave overlays (issued by BoM). • Services available in the Great Barrier Reef and Torres Strait (eg shipping traffic information provided by REEFVTS). ■ Onboard navigation systems will become increasingly integrated, connected to shore and, to some extent, standardised. For example: • integration between GMDSS and navigation equipment • Electronic Chart Display and Information System / Integrated Navigation Systems linked directly with communications equipment, such as VDES or satellite links • standardised user interface design for navigation equipment • harmonised display of received navigation information.	■ Provide leadership nationally for the provision of digital maritime services. ■ Work with relevant international organisations to ensure that digital maritime services received on ships are displayed on board in a harmonised and effective manner, conforming to approved protocols for information exchange. ■ Participate in the Asia Pan-Pacific Web (APP Web) testbed, which is being established as a platform to demonstrate the provision of digital maritime services in the region using the Maritime Connectivity Platform. ■ Coordinate Australia's input into the APP Web (for services provided by other organisations). ■ Participate in the development of the international governance framework of the Maritime Connectivity Platform and development of Maritime Resource Names framework.

4.4 Information exchange

Digital maritime services will rely on efficient and robust ship-ship, ship-shore or shore-ship electronic data transfer. Where existing communications systems are inadequate, it may be necessary to evaluate and adopt new methods and technology that enable seamless information exchange.

The performance requirements, in particular data capacity, for communication systems to support digital maritime services are, in many cases, unknown and are likely to change over time.

Trends that will affect information exchange	Implications for industry	Our policy response
■ Internet access on board ships at sea is increasing. ■ Ships are more connected with shore organisations and can share information more easily. ■ Shipping companies have more access to shipboard information. ■ Increased connectivity will encompass a wider variety of ships. ■ Satellite communications will become increasingly affordable, with an increase in the number of providers. ■ Advances in technology will improve the ability for ships to be connected. ■ Cyber threats and up-to-date software will continue to be challenges for digital technologies and information exchange.	■ Improved connectivity will lead to: • more oversight of ship operations, support for safety-related decision-making and efficiency of operations • provision of digital maritime services, increasing safety and efficiency • 'maritime actors' such as port authorities and agents, will be able to exchange information in an automated and secure manner, to optimise global supply chains • growing shore monitoring of shipboard systems (eg Voyage Data Recorder (VDR), main engine and cargo). ■ There will be increased risk of unauthorised access to (or malicious attacks on) ships' systems and networks. Companies will need to develop their own approaches to cyber risk management onboard ships and embed these in onboard safety management systems. They will be in the form of ongoing, risk-based vigilance to identify and respond to cyber threats.	■ To be involved in international and national efforts that aim to agree on the required communication frameworks, protocols and channels. ■ Consider the most appropriate methods for the provision of digital maritime services in Australia (based on the outcomes of the Maritime Connectivity Platform (MCP) testbed). ■ Monitor the availability and cost of commercial satellite communications, as it is possible that satellite communications will provide more capability than VDES. ■ Contribute to developments of guidance on cyber security, software quality assurance for navigation systems, and technology related to safety of navigation. ■ Take steps to ensure that future navigation services and AtoN networks are resilient to cyber-attacks.

4.5 Vessel Traffic Services

Vessel Traffic Service (VTS) is implemented by a Competent Authority, designed to improve the safety and efficiency of vessel traffic, enhance the safety of life at sea, and to protect the environment. The service should have the capability to interact with traffic and respond to traffic situations developing in the VTS area. There is one coastal VTS (REEFVTS) and over 14 recognised port VTS's in Australia.

Trends that will affect Vessel Traffic Services	Implications for industry	Our policy response
■ The number of VTS in Australia is increasing. ■ Connectivity between ships and VTS in Australia and internationally is increasing. ■ Broadening of the shipboard navigation team to include VTS to assist in on board decision-making. ■ Routine information will be exchanged electronically and automatically, but voice communications in VTS will remain important. ■ VTS is increasingly becoming the conduit between ships and a variety of port organisations. ■ The advent of the next generation of VTS (with capabilities for route exchange, just-in-time arrivals and human-centred design of equipment). ■ VTS will have the capability to automatically provide information to individual ships, based on current and predicted weather.	■ Industry can expect more bespoke information for their ships, more efficient traffic organisation, using route exchange and just-in-time arrival mechanisms. ■ Ship movements will be monitored more closely and provided with assistance, if needed. ■ VTS will play a central role in assisting ports to improve supply chain efficiencies.	■ AMSA to maintain its national leadership in the coordination and development of international standards and guidance on VTS. ■ Considering AMSA's role as the national Competent Authority, ensure that VTS authorities in Australia comply with domestic legislation and relevant IALA standards. ■ Encourage the safety benefits and efficiencies that can be realised through implementing VTS, and explore the benefits of large scale coastal VTS for some regions of Australia.

4.6 Single window reporting

A single window is a facility that allows parties involved in maritime trade and transport to lodge standardised information and documents at a single entry point or 'window'. The information is required to fulfil all import, export, and transit-related regulatory requirements. Information is lodged electronically, with individual data elements being submitted once only.

Shipboard information such as its name, call sign, position, time, course and speed—held on board its AIS unit—can form a central element of the data set emanating from a ship.

International ships calling at Australian ports are currently required to communicate with different government agencies and industry bodies, through different means, to comply with individual agency requirements. Australian requirements for port entry result in ships providing the same information multiple times to different agencies. The establishment of effective single window reporting in Australia would transform the Australian international trade environment, allowing for seamless and integrated interaction between government and business and significantly reduce red tape.

Trends that will affect single window reporting	Implications for industry	Our policy response
▪ The introduction, in some parts of the world, of national single window reporting (SWR) mechanisms for enhancing the efficiency of seaborne trade.	▪ Leveraging available capabilities and technologies could facilitate increased trade and reduced costs for industry and government. ▪ A single window would create a secure digital interface between government and industry, and provide a single data point for Australian businesses to meet all international trade regulatory requirements. ▪ A ship would need to send the required information only once. Shore authorities will be able to access the information as required. This will result in efficiencies in ship reporting and reduction in a ship's workload. ▪ The shipping company could report on behalf of the ship, as all the information would be known to them. ▪ While SWR is important, it is even more important to have an automated means of reporting.	▪ Contribute to any whole-of-government effort to establish single window reporting for the facilitation of seaborne trade in Australia.

4.7 Changes in ships and traffic patterns

During calendar year 2017, there were more than 28,000 ship arrivals (an increase of 3.6 per cent over 2016) by more than 5800 foreign-flagged ships (an increase of 2.7 per cent over 2016) in Australia. Bulk carriers accounted for half the ship arrivals. Short-term forecasts point to similar percentage increases in the coming years.

Iron ore and coal remain Australia's largest bulk commodity exports, while LNG exports (mainly from Queensland and Western Australia) continue to grow. More port visits and larger ships are facilitating this growth in cargo volume – and this is likely to continue in the short term (Source: Port State Control 2017 Report).

The Australian cruise industry is one of the success stories of Australian tourism, with a 12-year run of double digit percentage growth in passenger numbers. In fact, the number of Australian cruise passengers has almost doubled in the past five years.

Offshore activity, including oil and gas exploration, renewable energy installations, ship-to-ship transfer, and other exploratory activities are constantly changing and evolving. This is why AMSA must remain agile to ensure they do not adversely affect the safe and efficient navigation of vessels around Australia.

We are also witnessing the growing use of automation and advanced technologies on board ships. This includes the advent of maritime autonomous surface ships (MASS). Advances in technology on board ships and the systems and infrastructure that support ships, will lead to a commensurate reduction in human error and crew fatigue and improvements in safety.

Trends in ship types and traffic patterns	Implications for industry	Our policy response
An increase in: • The number and size of ships calling at Australian ports (albeit small percentage increases). • The size, speed and draughts of international ships, in particular container ships. • Cruise ship traffic, particularly the endeavour to visit areas where the hydrography is not yet fit-for-purpose. • Concentration of shipping traffic around floating LNG hubs off the north-west coast of Australia. The transition to alternative fuels to reduce sulphur oxide and Greenhouse related ship emissions, with necessary changes to propulsion and power systems to support these fuels (eg LNG, biofuels, hydrogen). Growing use of automation and advanced technologies on board ships. New export opportunities and changes in products exported may affect shipping patterns and traffic density in some areas. (such as at Hay Point, Queensland, as a result of the Adani Mine Project). Offshore exploration techniques will continue to evolve and change, with changes technology and location. Investment in offshore renewable energy is likely to increase.	Increasing commercial pressures on ships and ports. Industry will have to respond to more stringent international rules regulating air emissions from ships. For automation, a reduction in human error and crew fatigue, with a commensurate increased in safety (however, this can be offset somewhat by the need for increased training and familiarisation).	Conduct periodic aids to navigation and navigation safety reviews. Assess risks using IALA risk management tools and implement mitigation measures to reduce risk. The use of AMSA's in-house Strategic Planning Tool (SPT)[1] to assess risk and evaluate the effectiveness of existing and any new risk mitigation measures. Contribute to the IMO's Regulatory Scoping Exercise for MASS. Critically evaluate the human factor implications of the introduction of increased automation and advanced technologies on board ships. Monitor shipping activity and proactively implement risk mitigation measures as required. Keep abreast of developments in offshore oil and gas exploration and renewable energy in order to manage any emerging risks and potentially implement water space management measures. Understanding and preparing for any regulatory and incident response changes that these alternative fuels may generate, including keeping abreast of developments in alternative fuels and propulsion systems.

[1] At the time of writing, the Danish Hydraulic Institute DHI is developing a bespoke, web-based tool for AMSA's use. It aims to provide capability to assess the risk of collisions, powered groundings and drift induced groundings, taking into account traffic projections and various risk mitigation measures (eg REEFVTS, emergency towage assets).

5. Estimated time frames

2020 2025 2030

1. Positioning, navigation and timing

- Work at IALA to develop guidance for its members to transition from DGPS to SBAS
- As SBAS is implemented from 1 July 2018 in the Australian region, work domestically to ensure maritime interests are part of the SBAS program
- Work at IMO and IEC, liase with CIRM and other bodies to facilitate the introduction of SBAS-enabled shipboard GNSS receivers
- Develop a plan to decommission AMSA's DGPS service
- Decommission AMSA's DGPS service
- Monitor any developments for the use of shore-based infrastructure to provide PNT services
- Critically appraise emerging PNT technologies for their suitability to provide resilient PNT in Australia
- Promote the need for ships to be able to navigate making use of information they can sense (e.g. radar information, depth information, visual bearings and celestial measurements).

2. Aids to navigation

- Work with AMSA's contracted maintenance provider and adopt technologies and innovative practices that enhance the efficiency and effectiveness of AMSA's AtoN network
- Explore obtaining near real time satellite AIS inforamtion for use at AMSA
- For the short term, optimise and maintian AMSA's terrestrial AIS infrastructure, particularly in areas where it is important to transmit messages ships via AIS (eg from REEFVTS)
- If it becomes apparent that VDES will be the communications infrastructure of choice, AMSA will work with national stakeholders to establish a VDES communications infrastructure framework
- By way of periodic reviews, continue to critically assess the need for individual AtoN's, to ensure the safety of coastal navigation for domestic and international trading vessels
- Consider the importance of cyber security and software quality assurance for the integrity of AMSA's AtoN network (including AMSA's UKCM system)
- Meet our obligations with regard to our heritage-listed lighthouses

2020 2025 2030

3. Digital maritime services

- Provide leadership nationally for the provision of digital maritime services
- Work with relevant international organisations to ensure that digital maritime services received on ships are displayed on board in a harmonised and effective manner, conforming to approved protocols for information exchange
- Participate in the Asia Pan-Pacific Web (APP Web) testbed, which is being established as a platform to demonstrate the provision of digital maritime services in the region using the MCP
- Coordinate Australia's input into the APP Web (for services provided by other organisations)
- Participate in the development of the international governance framework of the Maritime Connectivity Platform and development of Maritime Resource Names framework

4. Information exchange

- To be involved in international and national efforts that aim to agree on the required communication frameworks, protocols and channels
- Consider the most appropriate methods for the provision of digital maritime services in Australia (based on the outcomes of the Maritime Connnectivity Platform (MCP) testbed)
- Monitor the availability and cost of commercial satellite communications, as it is possible that satellite communications will provide more capability than VDES
- Contribute to developments of guidance on cyber security, software quality assurance for navigation systems and technology related to safety of navigation
- Take steps to ensure that future navigation services and AtoN networks are resilient to cyber-attack

5. Vessel Traffic Services

- AMSA to maintain its national leadership in the coordination and development of international standards and guidance on VTS
- Considering AMSA's role as the national Competent Authority, ensure that VTS authorities in Australia comply with domestic legislation and relevant IALA standards
- Encourage the safety benefits and efficiencies that can be realised through implementing VTS and explore the benefits of large scale coastal VTS for some regions of Australia

2020 2025 2030

6. Single Window Reporting

- Contribute to any whole-of-government effort to establish single window reporting for the facilitation of seaborne trade in Australia

7. Changes in ships, traffic patterns, and the use of water space

- Conduct periodic aids to navigation and navigation safety reviews
- Assess risks using IALA risk management tools and implement mitigation measures to reduce risk
- The use of AMSA's in-house Strategic Planning Tool (SPT) to assess risk and evaluate the effectiveness of existing and any new risk mitigation measures
- Contribute to the IMO's Regulatory Scoping Exercise for MASS
- Critically evaluate the human factor implications of the introduction of increased automation and advanced technologies on board ships
- Monitor shipping activity and proactively implement risk mitigation measures as required
- Keep abreast of developments in offshore oil and gas exploration and renewable energy in order to manage any emerging risks and potentially implement water space management measures

6. The guiding principles

Over the coming years, these principles will guide us in the delivery of navigation services and AtoN.

6.1 Guiding principle 1

Provide navigation services in accordance with IMO obligations (SOLAS 74, Chapter V), internationally accepted best practice (IALA standards and guidance) and national legislation.

6.1.1 IMO and SOLAS

The International Convention for the Safety of Life at Sea (SOLAS) 1974 is arguably the most important of all international treaties concerning the safety of ships engaged in international voyages. The main objective of the convention is to stipulate minimum standards for the construction, equipment and operation of ships. The convention also places obligations on coastal States.

Chapter V of the convention deals with the safety of navigation. Regulation 13 (Establishment and operation of aids to navigation) therein states, inter alia, that *'Each Contracting Government undertakes to provide, as it deems practical and necessary…such aids to navigation as the volume of traffic justifies and the degree of risk requires.'*

Australia, as a signatory to the convention, gives effect to this obligation in its national legislation—the *Navigation Act 2012*. The Maritime Safety (Domestic Commercial Vessel) *National Law Act 2012* allows a state or territory to make laws for aids to navigation.

6.1.2 About IALA

IALA is a not-for-profit, international technical association. It offers its members a platform to work together to harmonise and improve aids to navigation worldwide.

IALA has established four technical committees. They aim to develop best practice guidance on all AtoN aspects. Guidance on AtoN and navigation services is by way of IALA standards, manuals, recommendations, and guidelines. The committees do this by taking into account the needs of mariners, developments in technology, and the requirements of AtoN authorities. AMSA actively participates in the work of all four committees.

IALA also assists developing nations in establishing aids to navigation that are commensurate with the volume of traffic and degree of risk for the waterway concerned.

6.1.3 National obligations

AMSA is responsible for the provision of AtoN necessary for ocean and coastal navigation, which stems from a 1934 agreement between the Prime Minister and state premiers. The costs of providing and maintaining the AMSA AtoN network will continue to be met by the vessels that use them.

As the custodian of many iconic historic lighthouses, AMSA has long recognised the importance of preserving their cultural heritage and will continue to implement management strategies for their preservation.

6.2 Guiding Principle 2

Engage with stakeholders to ensure that the aids to navigation and navigation services provided by AMSA meet the needs of the levy-paying commercial shipping industry.

AMSA is responsible for the provision of navigation services necessary for ocean and coastal navigation. In order to do this effectively, we engage with a variety of domestic stakeholders. This ensures that AMSA takes a range of views on safety of navigation matters into account.

AMSA engages with three main groups:

6.2.1 Navigation Safety Advisory Group (NSAG)

The Navigation Safety Advisory Group (NSAG) is the peak consultative body to AMSA for matters relating to the safety of navigation in Australian waters. The group discusses issues of common interest and concern and provide expert advice to AMSA on nautical, navigational safety and aids to navigation matters.

Typically, NSAG focuses on both shipborne systems and the way they are used, as well as the shore side infrastructure and systems that support safe navigation. Topics such as Electronic Chart Display and Information System (ECDIS), e-navigation, nautical charts and publications, ship routeing and reporting systems, PNT, aids to navigation management and requirements, VTS and coastal pilotage feature on the agenda of NSAG meetings.

AMSA reviews the NSAG membership as needed to ensure it adequately represents the interests of the levy-paying commercial shipping industry. Membership currently comprises of representatives from shipping companies, port authorities, marine pilots, state and territory marine safety authorities, the Royal Australian Navy and the Australian Hydrographic Office. AMSA organises and chairs NSAG meetings, which are held bi-annually.

6.2.2 (AtoN) Strategy and Operations Working Group (SOWG)

With a very large percentage of trading ships being foreign-owned, AMSA needs to provide aids to navigation that align with international guidance. This ensures that ships trading to Australia encounter the same type and quality of navigation services (in particular, AtoNs) as they do overseas. This contributes to improved safety outcomes.

However, the AtoNs that AMSA provide represent only a small percentage of the total number in Australia. Port, state and territory marine safety authorities have responsibility for the vast majority of AtoNs in Australia. The AtoN SOWG provides a mechanism for collaboration and information sharing.

The AtoN SOWG is a national working group that focuses purely on aids to navigation. It aims to:

- Deal with issues of common interest and concern in relation to the delivery of AtoNs. Strategically, the group focuses on the management aspects of delivering an aids to navigation service. Operationally, this includes issues such as new lighting technologies and power sources, moorings and structures, and heritage and WHS issues
- Achieve, as far as practicable, harmonisation in the delivery of aids to navigation services
- Engage in the development of international guidance on all aspects of aids to navigation provision

6.2.3 Vessel Traffic Services Working Group

The VTS WG is a consultative group to facilitate communication and information sharing between VTS authorities and key stakeholders, including a common understanding of the delivery of VTS in Australia.

Membership includes federal/state/territory marine authorities, VTS and port authorities, pilots and other stakeholders.

The group aims to:

- Facilitate a common understanding of the delivery of VTS in Australia.
- Promote a standardised approach to the delivery of VTS that reflects international obligations and best practices.
- Provide a forum for VTS authorities to contribute to the development and review of relevant IALA guidance on VTS, as identified in IALA's quadrennial work programme.
- Provide a channel of communication between stakeholders and VTS authorities.

6.3 Guiding Principle 3

Introduce new practices and technologies to enhance the ongoing appropriateness and reliability of navigation services.

One of AMSA's primary responsibilities is to provide contemporary, fit-for-purpose, navigation services for coastal and ocean navigation.

AMSA's contracted AtoN maintenance service provider maintains a national network of aids to navigation. While the aids provided are based on international standards and guidance, the contractor aims to introduce innovations and efficiencies, where possible. AMSA and the contractor aim to maintain the network in accordance with international standards, and with a minimum impact on Australia's unique marine environment.

We actively participate in international forums, particularly at IMO and IALA where we engage in the development of new practices and technologies in navigational services. We then assess these for their suitability in Australia.

Advances in technology and evolving rules and practices mean that the maritime world is now on the cusp of a paradigm change in the way navigation services will be delivered from ashore and received on board. Examples of this include digital navigational warnings, notices to mariners, and weather and wave information that can be presented as an overlay on future electronic navigation systems.

The capability of meteorological and oceanographic organisations is continually advancing. The Australian Bureau of Meteorology (BoM) will play a role in providing services to the shipping industry that will support risk-based decision making. BoM provides localised and relevant information on weather, wave and ocean conditions and hazards.

It is essential that any change introduced by AMSA is based on international rules, approved information exchange protocols, industry involvement and community expectation.

7. Looking beyond 2030

This section looks ahead at the way ships may navigate beyond the year 2030. It also paints a picture of the delivery of navigation services beyond 2030 to support safe and efficient shipping.

The views that follow are inherently futuristic, yet not so far-fetched as to be beyond the realms of reality.

7.1 The automated navigation of ships on ocean passages

We are on the cusp of one of the most consequential disruptions of transportation in history. Automation is already well underway in the maritime industry. A digitised and well-connected ship (within itself and with the shore) can easily lend itself to autonomy.

Today, with conventional shipping, even with the most advanced equipment, the OOW still acts as the sole, true 'system integrator'. An autonomous ship controller, being supervised and supported by a manned shore control station, will be the foundation for autonomous navigation onboard. And for this, real time, secure, high bandwidth connectivity will be the key.

This is not to suggest there will soon be ships navigating unmanned from berth to berth without human interaction. Rather, it is conceivable that such capability will be first rolled out in different parts of industry and at different levels. Ships on ocean passage may use high levels of automation while conducting ocean passage. However during pilotage, berthing, navigating in a Traffic Separation Scheme (TSS) or a narrow channel, humans will take a higher level of operational control.

Australia, like many other countries, is already seeing autonomy used on smaller vessels for commercial work. It is anticipated that the next step will be higher levels of automation for short-sea voyages and on dedicated routes. It is therefore feasible that for many ships where high levels of automation exist, the need for visual AtoNs will remain when navigating in a near shore environment. It is also possible that ships with highly advanced systems and technologies may have little need to rely on visual AtoNs. However, since technology that supports automous operations is developing rapidly, we will need to monitor this to determine whether lit AtoNs will have a role for such ships.

We anticipate the most likely scenario is that a vessel may operate autonomously with a resident crew on board and have a level of direct support from a short control centre located somewhere else in the world. For example, locally, for short-sea trades using highly automated systems and technology.

It is anticipated however, that beyond 2030 many vessels will still navigate with a crew onboard, and there will remain a dependence on physical AtoNs to supplement and support the provision of other sources of PNT information.

7.1.1 Benefits

Autonomy will lead to improved operations, with benefits for safety, reliability and efficiency (eg passage and cargo planning conducted from ashore). From a safety perspective, the benefits of autonomous navigation are:

- better (and possibly error-free) collision avoidance
- avoidance, or optimised ship routeing, during severe weather or hazardous seas
- enhanced situational awareness
- reduced risk for crew in terms of safety and fatigue management
- reduced crew costs (it is widely acknowledged that about 50-60 per cent of the daily operating cost of a ship trading internationally comprises crew costs).

7.2 Navigation services in the future

In the coming decades, if there are ships navigating the world's oceans without a bridge watch keeper, there can be serious, disruptive implications for navigation services. The questions that we will need to address are:

- What type of aids to navigation will be required?
- What type of ship routeing systems will be established and what infrastructure will be necessary to support them?
- What type and level of oversight will be needed and by who?
- What will the role of shore control centres be in Australia and internationally?

We anticipate we will need to adjust many of our navigation services such as VTS, aids to navigation, hydrography and coastal pilotage.

7.2.1 Provision of aids to navigation

Under current arrangements, AMSA is responsible for the provision of aids to navigation necessary for ocean and coastal navigation. The states, ports and territories provide aids necessary for the safe entry and navigation of ports and those required by fishing vessels and pleasure craft.

However, the AtoNs provided by AMSA represent only a small percentage of the total number in Australia. Port, state and territory marine safety authorities and ports have responsibility for the vast majority of AtoNs in Australia.

The way in which aids and services to navigation are provided in the future is likely to change with interdependencies between AMSA, port, state and territory maritime agencies, becoming increasingly important. AMSA will need to explore future changes and challenges in the provision of AtoNs and how this may affect the division of commonwealth, port, state and territory responsibilities for the provision and management of aids and services to navigation in Australia.

AMSA is keen to hear your views on ship's navigation and navigation services in the years beyond 2030. Please feel free to communicate with us on this issue by email at:

StandardsSSNav@amsa.gov.au

8. Conclusion

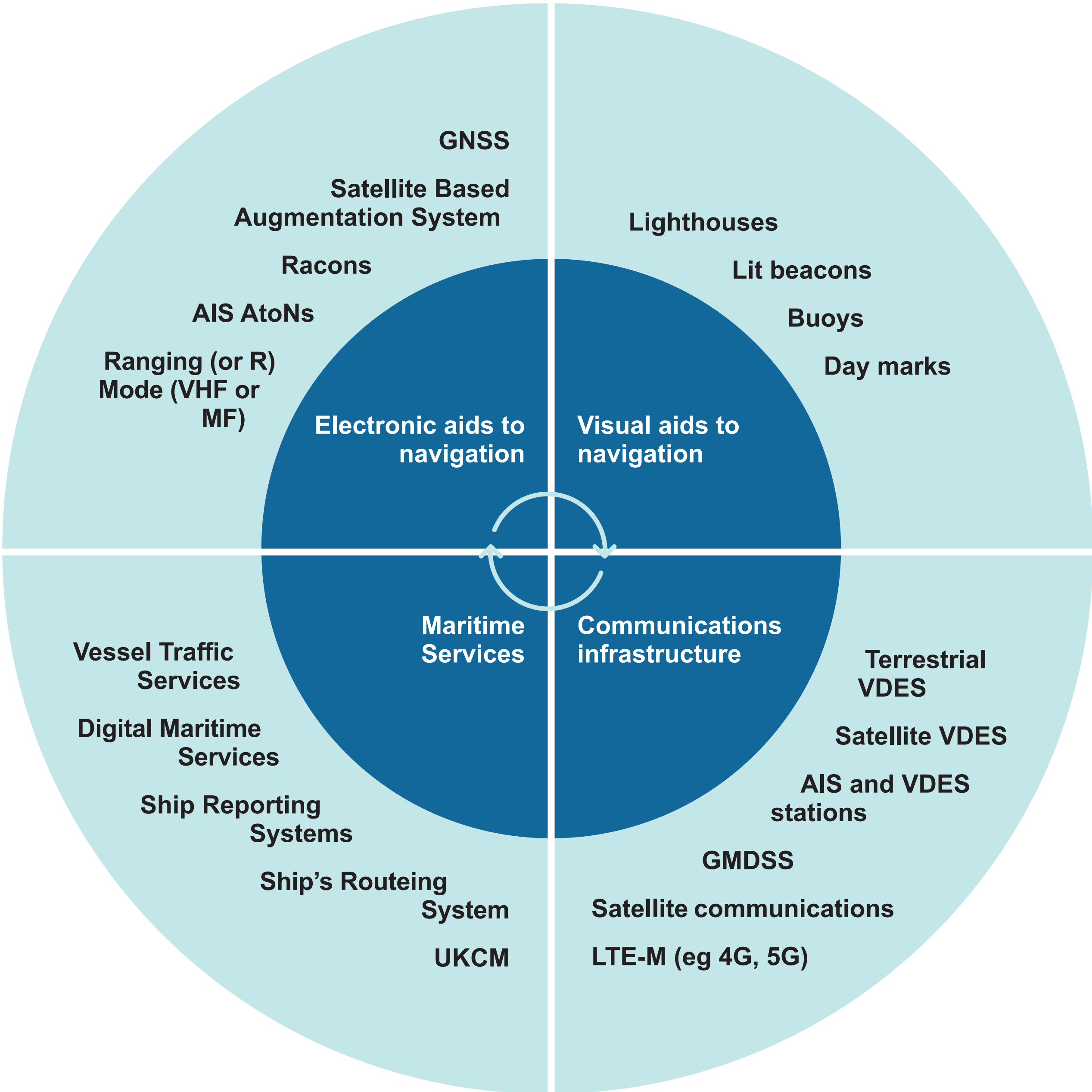
The Australian Government and port, state and territory maritime agencies, with a mandate for the safety of navigation and protection of the marine environment, are responsible for ensuring the provision of appropriate navigation services (such as reliable aids to navigation, VTS and digital maritime services).

Navigation services in Australia play a key role in facilitating safe and efficient shipping, including mitigating the inherent risks associated with transporting cargoes through some of the world's most environmentally sensitive areas.

AMSA will continue to provide high quality navigation services, which facilitate the safety and efficiency of navigation. It will also introduce new practices, technologies and digital maritime services to enhance the reliability and efficiency of the aids to navigation network and reduce the associated environmental impact.

AMSA has been, and will continue to be, an innovative organisation that provides cost-effective navigation services.

Annex 1: The overall picture



Annex 2: List of initial digital maritime services

As part of the improved provision of services to ships, IMO's Strategy Implementation Plan (Update 1) of 2018 identifies 16 initial services. These are listed in the table below. International efforts are now underway to define the operational and technical services, develop data models and provide guidance to the global maritime community on establishing these services.

Service	Identified services	Domain coordinating body	Identified responsible service provider
1	VTS Information Service (INS)	IALA	VTS Authority
2	Navigational Assistance Service (NAS)	IALA	VTS Authority
3	Traffic Organization Service (TOS)	IALA	VTS Authority
4	Local Port Service (LPS)	IHMA	Local Port/Harbour Authority
5	Maritime Safety Information Service (MSI)	IHO	National Competent Authority
6	Pilotage service	IMPA	Pilotage Authority/Pilot Organization
7	Tug service	TBD	Tug Authority
8	Vessel Shore Reporting	TBD	National Competent Authority and appointed service providers
9	Telemedical Assistance Service (TMAS)	TBD	National Health Organization/ dedicated health Organization
10	Maritime Assistance Service (MAS)	TBD	Coastal/Port Authority/ Organization
11	Nautical Chart Service	IHO	National Hydrographic Authority/ Organization
12	Nautical Publications Service	IHO	National Hydrographic Authority/ Organization
13	Ice Navigation Service	WMO	National Competent Authority/ Organization
14	Meteorological Information Service	WMO	National Meteorological Authority/Public Institutions
15	Real-time hydrographic and environmental information Service	IHO	National Hydrographic and Meteorological Authorities
16	Search and Rescue Service	TBD	SAR Authorities

Source: (IMO MSC.1/Circ.1595 of 25 May 2018 E-Navigation Strategy Implementation Plan – Update 1)

Annex 3: A communications framework and a candidate technology – the VHF Data Exchange System (VDES)

In today's age of near instant communications, it is unthinkable that a ship at sea should be isolated from 'always available communications', particularly when e-navigation means shore authorities will be able to provide ships with new digital maritime services.

The spectrum within which maritime radio communications takes place is limited and there are increasing demands being made on it by the introduction of new technologies and services.

Introducing VDES

VDES is a radio communication system that operates between ships, shore stations and satellites on Automatic Identification System (AIS), Application Specific Messages (ASM) and VHF Data Exchange (VDE) frequencies in the maritime mobile VHF band.

Why VDES?

VDES is seen as an effective and efficient use of radio spectrum, building on the capabilities of AIS and addressing the increasing requirements for data exchange. New techniques that provide higher data rates than those used for AIS, is a core feature of VDES.

What is the difference between VDES and AIS?

AIS is a component of VDES that operates using the Gaussian Minimum Shift Keying (GMSK) modulation scheme. Other components of VDES will use higher capacity modulation schemes. VDES supports e-navigation.

What are the benefits of the satellite component of VDES?

The VDES satellite component provides cost effective coverage of a very large area. This is particularly important in the polar regions, outside geostationary satellite coverage.

The satellite component of VDES may increase uptake onboard ships, being a cost effective, global (but low capacity) capability.

VDES and R-Mode

Systems such as AIS and ECDIS use GNSS-derived PNT information.

The still-developing R (or Ranging) Mode is a potential terrestrial backup PNT system, independent of GNSS, which uses ranging signals typically transmitted from existing maritime infrastructure, for example, AIS base stations.

Adding additional R-Mode functionality to existing maritime infrastructure is appealing, as much of the hardware is already in place, removing the need to procure and install expensive transmitters and antenna systems. In addition, the VDES broadcast frequencies are protected and already established

AIS base stations have also been installed in significant numbers around many coastlines, have protected frequencies and already serve the mariner. They are good candidates for R-Mode transmissions.

Where can I find more information on VDES?

More information on VDES, including the suite of VHF channels allocated to VDES, an overview and considerations that may be appropriate to take into account for VDES infrastructure, can be found in IALA Guideline 1117 (edition 2) on the IALA website:

www.iala-aism.org/product-category/publications/guidelines

Annex 4: Bringing it all together – the Maritime Connectivity Platform (MCP)

The MCP is a communication framework for the efficient, secure and seamless electronic information exchange between authorised stakeholders.

For now, a web-based testbed, termed Asia Pan-Pacific Web, aims to demonstrate the services associated with the MCP. The testbed aims to allow maritime services to be 'discoverable' and usable.

The MCP consists of three components:

1. An identity register that provides users, ships and devices with a structured identity (based on the Maritime Resource Name concept). It facilitates login to access services along with protocols for authentication, integrity and confidentiality.
2. A messaging service that contains a description of the variety of services available. For example, messages can be sent to a defined geographic area or to a group of ships.
3. A service register, which is a collection of maritime services that are available to the mariner or authorised stakeholder in a given area.

The MCP testbed, being led by the Republic of Korea, has the potential to contribute to IMO's plan for the implementation of its e-navigation strategy. The concept envisions the use of a variety of communication channels such as the internet, satellite links, cellular phone networks, marine radio channels and digital radio links.

The MCP will enable the exchange of harmonised maritime information, developed using data models based on the IHO S-100 geospatial information standard.

More information on the MCP can be found at www.maritimeconnectivity.net

Annex 5: Satellite-Based Augmentation System and the future of AMSA's DGPS service

This year, the Australian Government will establish a SBAS service in the Australian region. This means the maritime (and other) sectors will be able to access the SBAS service in the short to medium term (an ICAO-certified SBAS for the aviation sector is expected by the year 2022).

We anticipate that SBAS will provide a similar or better level of accuracy and integrity monitoring than that provided by radio beacon DGPS. Also, while DGPS provides augmentation for GPS signals only, the SBAS in our region will provide corrections for other GNSS constellations as well.

Other regional systems, in particular Japan's QZSS and the Republic of Korea's KASS, are expected to come on line by 2022. These will increase availability of GNSS and augmentation services.

However, to enable marine GNSS receiver equipment to make use of SBAS, changes to the relevant IMO and IEC instruments will need to be made.

Also, if an IEC test standard is agreed in the short term, we can expect manufacturers to bring certified SBAS-enabled receivers to the market by 2022-23. From 2023, we can expect to see such units on ships calling at Australian ports.

We anticipate that once SBAS is established, it may be feasible to take a phased approach to decommissioning the DGPS network. The timeframe for doing so will be determined by IALA guidance, user uptake of SBAS and the certainty of integrity monitoring and positioning accuracy provided by SBAS.

Decommissioning of AMSA's DGPS network is dependent on a number of milestones:

- Australian SBAS being operational and approved for use in maritime applications.
- The development of an IMO Performance Standards and IEC test standard for SBAS signals and shipborne SBAS capable transceivers respectively.
- An information campaign to inform mariners of the migration from DGPS to SBAS in the Australian region.

We expect that while the DGPS service may be turned off, individual sites and physical infrastructure (particularly the masts) may be retained for any new positioning and timing technologies (eg the developing ranging or R mode of operation) as well as other navigational services.

There is work underway to make the current and new generation of AIS base stations capable (the latter being VDES capable) of providing ranging and timing services. This may include the terrestrial transmission of SBAS signals.

Annex 6: References

- *International Convention for the Safety of Life at Sea 1974*, as amended
- *IALA NAVGUIDE (Aids to Navigation Manual) 8th Edition, 2018*
- IALA guidance documents (standards, manuals, recommendations and guidelines)
- *Navigation Act 2012* (Cth)

Glossary of terms

ADF	Australian Defence Force
AHO	Australian Hydrographic Office
AIS	Automatic Identification System
AMSA	Australian Maritime Safety Authority
APP Web	Asia Pan-Pacific Web
AtoN	Aid to Navigation
ATSB	Australian Transport Safety Bureau
CLIA	Cruise Lines International Association
DGPS	Differential Global Positioning System
DHI	Danish Hydraulic Institute
ECDIS	Electronic Chart Display and Information System
FLNG	Floating LNG (platform)
GMDSS	Global Maritime Distress and Safety System
GNSS	Global Navigation Satellite System
GPS	Global Positioning System
IALA	International Association of Marine Aids to Navigation and Lighthouse Authorities
ICAO	International Civil Aviation Organization
IEC	International Electrotechnical Commission
IHO	International Hydrographic Organization
IMO	International Maritime Organization
JRCC	Joint Rescue Coordination Centre
KASS	Korea Augmentation Satellite System
LNG	Liquefied Natural Gas
LTE	Long-Term Evolution

MCP	Maritime Connectivity Platform (formerly Maritime Cloud)
MF	Medium Frequency
MRN	Maritime Resource Name
MSI	Maritime Safety Information
NSAG	Navigation Safety Advisory Group
OOW	Officer of the Watch
PNT	Positioning, Navigation and Timing
PSC	Port State Control
QZSS	Quasi-Zenith Satellite System
REEFVTS	Great Barrier Reef and Torres Strait Vessel Traffic Service
SBAS	Satellite-Based Augmentation System
SOLAS	The International Convention for the Safety of Life at Sea, 1974 (as amended)
SOWG	(AtoN) Strategy and Operations Working Group
SPT	Strategic Planning Tool (AMSA's in-house)
SWR	Single Window Reporting
UKCM	Under Keel Clearance Management
VDES-S	VHF Data Exchange System - Satellite
VDES-T	VHF Data Exchange System - Terrestrial
VTS	Vessel Traffic Service
VTSO	Vessel Traffic Service Operator

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