C64-8.1.3.1

IALA

POSITION ON THE DEVELOPMENT OF ATON SERVICES

1. THE PURPOSE OF THIS DOCUMENT

This document has the purpose of describing the Positions that that IALA will take concerning certain critical technical and operational aspects of its work with the object of assisting the work of the technical Committees of IALA and informing IALA members.

This is a living document and will be brought up to date as necessitated by external factors, by technology developments, and by decisions on the focus of IALA's work. It should be read in conjunction with the following three vital documents.

- Basic Documents – available from the website
- Strategic Vision – available from the website
- Work Programmes for the Committees – available from Committee documents or reports.

2. TRENDS AND DRIVERS OF STRATEGY FOR THE PERIOD 2018-2030

Numerous trends and factors affect the work of IALA members and the directions in which the organization should focus its attention. We think that these can be summarized into Trends and Drivers.

The Drivers are derived from the Trends, and are a useful way of summarising a multitude of factors. We believe that four Drivers need to be considered in determining Strategy. These are:

- Volume of traffic and degree of risk
- Environment and sustainability
- Efficiency and safety
- New technology

The origin of these four Drivers is now explained. Trends are discussed and then a diagram draws these together into a Driver, with a diagram to illustrate.

2.1. Driver 1, Volume of traffic and degree of risk

There have been substantial changes in global shipping, including an increase in the volume of vessel traffic and the size of vessels, an increasing dependence on an interconnected global economy, and the rapid development and availability of modern information technology. In addition, there has been an increasing public demand for improved surveillance and management of vessel traffic. This is coupled with a developing expectation to prevent shipping related incidents along with a need to respond effectively to emergencies in all navigable waters, especially in port and coastal areas.

These increasing demands and needs have been imposed upon coastal and port infrastructures, as well as on the interaction between ships and shore authorities and stakeholders. New technologies have provided the opportunity for efficient and effective information exchange and re-use of the collected data by participants and stakeholders in the maritime environment.

Shipping rates are presently low and larger ships and corporate mergers are being seen as shipping companies strive to remain competitive. Despite this the world SOLAS fleet continues to grow. Globalisation including the associated manufacturing and assembly practices increases the international flow of components and completed goods.

Development of vessels which are controlled from shore is well advanced. Small autonomous vessels have been in use for many years, for example for survey and data gathering, but generally do not require (conventional) aids

to navigation. It is likely that autonomous vessels will require new AtoN support and this needs to be monitored and interacted with to assure a harmonised delivery. Unmanned or autonomous ships are being developed in a number of countries, with some already at sea. As commercial shipping enters this new era, we can expect change in the electronic services which members will be required to provide. The manner in which these ships interact with other vessels and with shore services and authorities, and the Vessel Traffic Services (VTS) which will be required in VTS areas for these ships are matters of concern

Fishing vessels, pleasure craft, and smaller ships that do not fall under the provisions of the IMO SOLAS Convention are far more numerous than SOLAS ships. In many countries, perhaps most, the non-SOLAS vessels account for more accidents and emergencies than SOLAS vessels. Depending on the type of vessel, their equipment fit may vary from very basic, to systems of the highest sophistication. The SOLAS convention requires contracting governments to provide *such aids to navigation as the volume of traffic justifies and the degree of risk requires*. This is irrespective of vessel type. Some National Authorities have traditionally concentrated their attention on commercial shipping navigating in their nation's waters and using their ports. The need to provide better and modern shore services to non-SOLAS vessels is an increasing consideration.

The IMO has recognised a trend towards a reduction in the skills of bridge teams.

The volume of traffic and the desire by coastal authorities to reduce risk is resulting in increasing numbers of VTS being established.

The compulsory fitting of AIS to SOLAS ships, and its voluntary uptake by other vessels, originally for safety of navigation, has enabled shore authorities to build up a picture of shipping density, and preferred routes, assisting the computation of risk and the design of aids to navigation systems. AIS revolutionised VTS also, with vessel details and course, speed, and rate of turn all available on the VTS display. AIS receivers in satellites have extended knowledge of tracks to areas outside terrestrial VHF range. VDES will make this tracking capability more competent.

In some nations, the institutions for managing aids to navigation services including VTS require further development. Legislation or regulations may not be in place, or staff may not be aware of the country's responsibility under international laws and conventions.

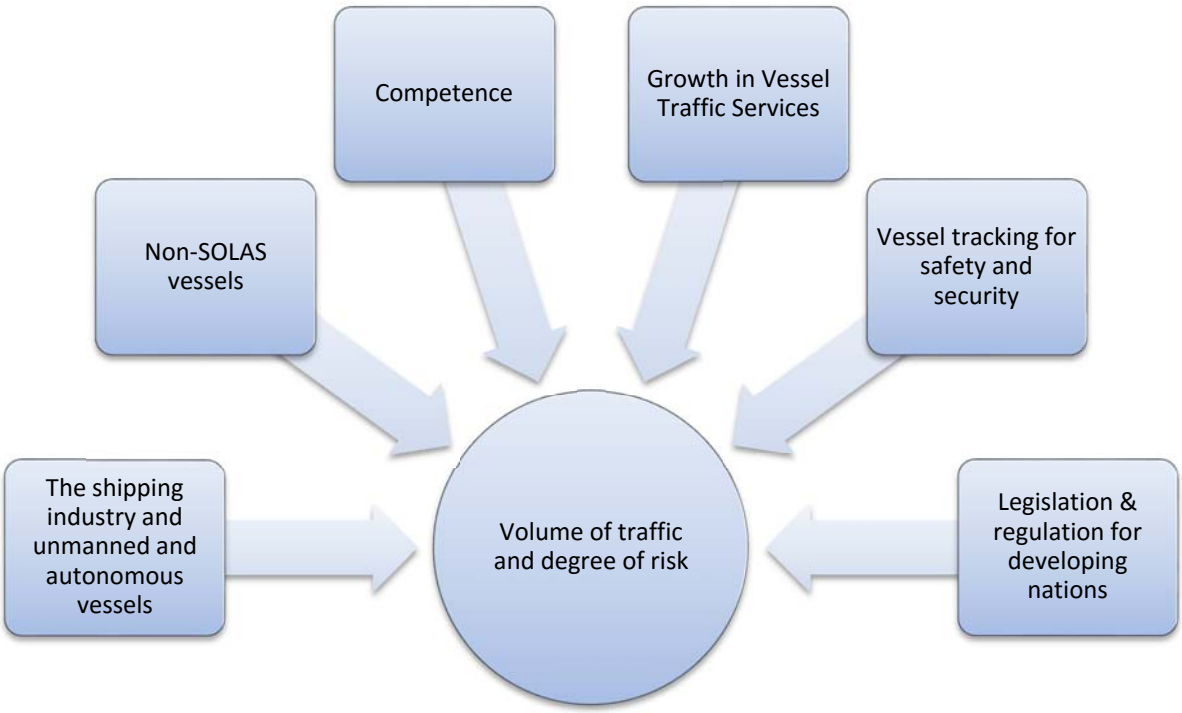
At the same time, the job of VTS operators has changed from mostly radar observation tasks to interacting with vessels in an ever increasing traffic complexity. It developed from a reactive task to a proactive task. The number of ships in a VTS area has often increased but the main change is the increasing size of ships. In a VTS area with narrow navigable waters and a lot of channel bends, where inland ships weave with seagoing vessels constrained by length or draft, there is a huge impact on the operational VTS procedures. Not only the length and width of the constrained ships have to be taken into account, but sometimes more importantly their swept path width must be taken into account. More advanced operational solutions are needed including improved measures for effective slot management.

A future consequence of the evolution of VTS is the focus increasingly being placed on ensuring the general efficiency of vessel traffic from both operational and commercial perspectives. VTS is increasingly being utilised as a means to optimise the flow of vessel traffic to provide benefits to ship operators and ports ranging from enhancing fuel efficiency through to managing vessel traffic to facilitate optimal berthing windows and time alongside.

The global harmonisation of VTS procedures has not yet been achieved. There are moves in some regions to extend VTS services outside promulgated VTS areas.

The need for correct and complete training of aids to navigation and VTS personnel is now becoming universally recognised. Some national members are establishing dedicated training institutions, and offering their services to

neighbouring countries also. At the same time, the availability of skilled technicians is reducing, especially in developed countries as cost pressures drive outsourcing and staff reductions.

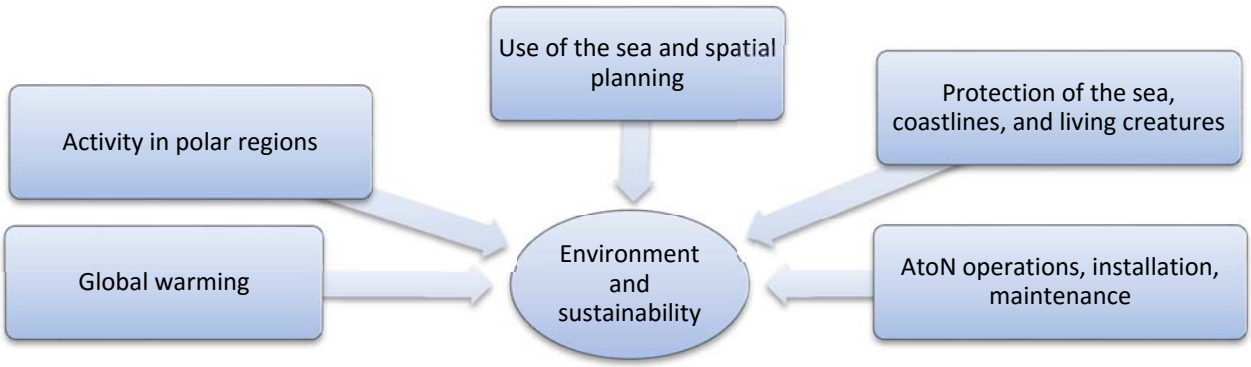


2.2. Driver 2, Environment and sustainability

The reduction in sea ice in the Arctic has led to a great interest in polar routes between the continents. At present, the increase in polar traffic for commercial purpose has been small, but the future may see this change. Provision of visual aids and of electronic services in Polar Regions is difficult. We can expect that area radionavigation systems and electronic dissemination of information will be important, but may be limited by the costs and difficulties of installation and of maintenance access.

Pressure has been increasing on the sea space available for navigation, as demands for offshore energy production (oil, gas, electricity) increase, and as exploration and exploitation of the sea and sea floor grow. The effect in some sea areas is to confine conventional ship navigation and fishing to more constrained spaces. Marking of offshore activities by conventional and electronic means, to make all classes of vessel aware, is an ongoing task. Further harmonisation is increasingly important here, both with light signals and electronic information, to avoid misinterpretation and thus accidents.

Marine aids to navigation services are generally required to observe best practice for preventing pollution of the seas, for preserving the beauty of littoral regions, and for avoiding harm to certain sea creatures. This is resulting in restrictions on the use of certain materials, in changes of operational practices, and in increased workload in planning and operations.

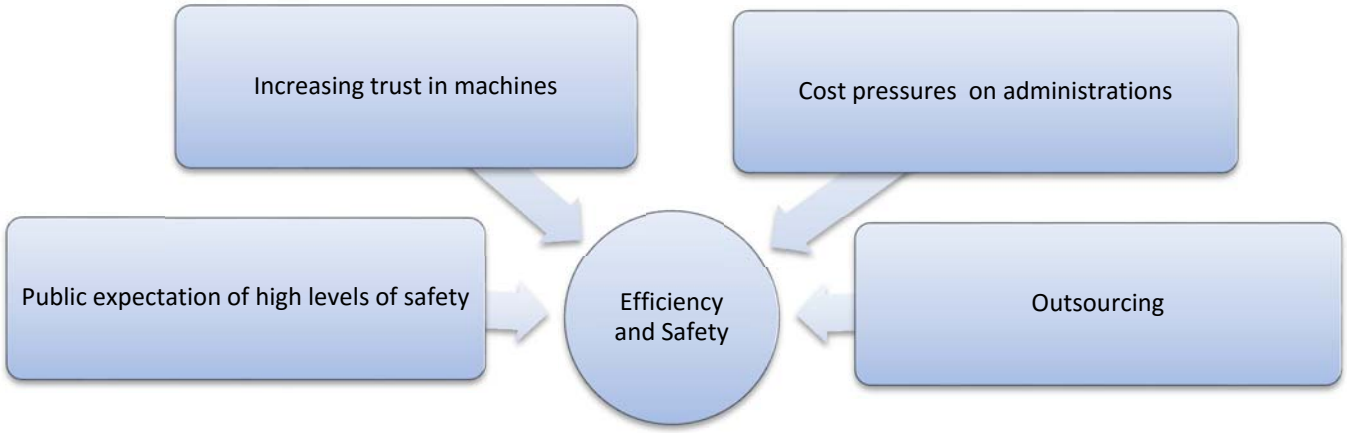


2.3. Driver 3, Efficiency and Safety

The public has an expectation that commercial shipping, including the cruise industry, is managed and conducted in a safe manner. Accidents and pollution incidents, especially near shore, receive heavy attention in the media. There is also probably an impression among parts of the public that shipping traffic is monitored and controlled in a manner similar to commercial aviation.

As technology develops, accident reports for all transport modes show human error as a primary factor. Automated vehicles, on rails, on roads, and in the air are accepted by the public and generally trusted to be safe and reliable. The development of personal technology and communications and the almost universal use of GNSS for all transport modes have created an impression that high technology and precise vehicle control must apply to the sea also.

The pressure on most governments to contain their operating expenses coupled with a technology focus is leading to a reduction in focus on traditional delivery methods of aids to navigation services. Outsourcing of activities in many service areas by governments means that for aids to navigation services the knowledge and competences of the services are lost and replaced by contract and performance monitoring. This requires a new skill set in the authorities.



2.4. Driver 4, New Technology

In contrast with the aviation industry, a provider of shore services for vessels at sea must remain aware of the wide range of capability that may be found on the bridges of vessels. This is a long-standing problem, but may be assuaged gradually by IALA's work towards harmonisation of electronic shore service provided to shipping by its members, driving bridge hardware and software gradually towards its own harmonisation. Cost pressures in the shipping industry will mean basic SOLAS minimally equipped bridges remaining in service.

GNSS systems are now (almost) universally used by all. With GPS, GLONASS, Galileo, and BeiDou in service or soon to be, GNSS services are increasingly resilient. However deliberate jamming of GNSS is easy to do, solar weather can disrupt GNSS services, and some man-made radiation can unintentionally upset GNSS position fixing. At least one IALA member suffers deliberate jamming of GNSS, disrupting shipping, aviation, and land transport. Back-up systems will be important.

“e-Navigation” was proposed more than ten years ago, but has been slow in gestation. The roadmap for the development of e-Navigation is attached at Annex B. The advent of AIS drove a leap forward, as did development in bridge electronics. The harmonisation and delivery of electronic services from shore described in “Maritime Service Portfolios”, will be vital to ongoing progress. Developments in connectivity and information flow between ship and shore will create opportunities to increase port efficiency through advanced VTS services. Cyber security concerns will need to be addressed.

Despite these electronic advances, mariners still require the visual cues provided by traditional visual signals from light-beacons, buoys and day-marks to provide hazard marking & spatial awareness. These require only the human eye and the mariner’s skill to use. We can expect them to be in service for the foreseeable future.

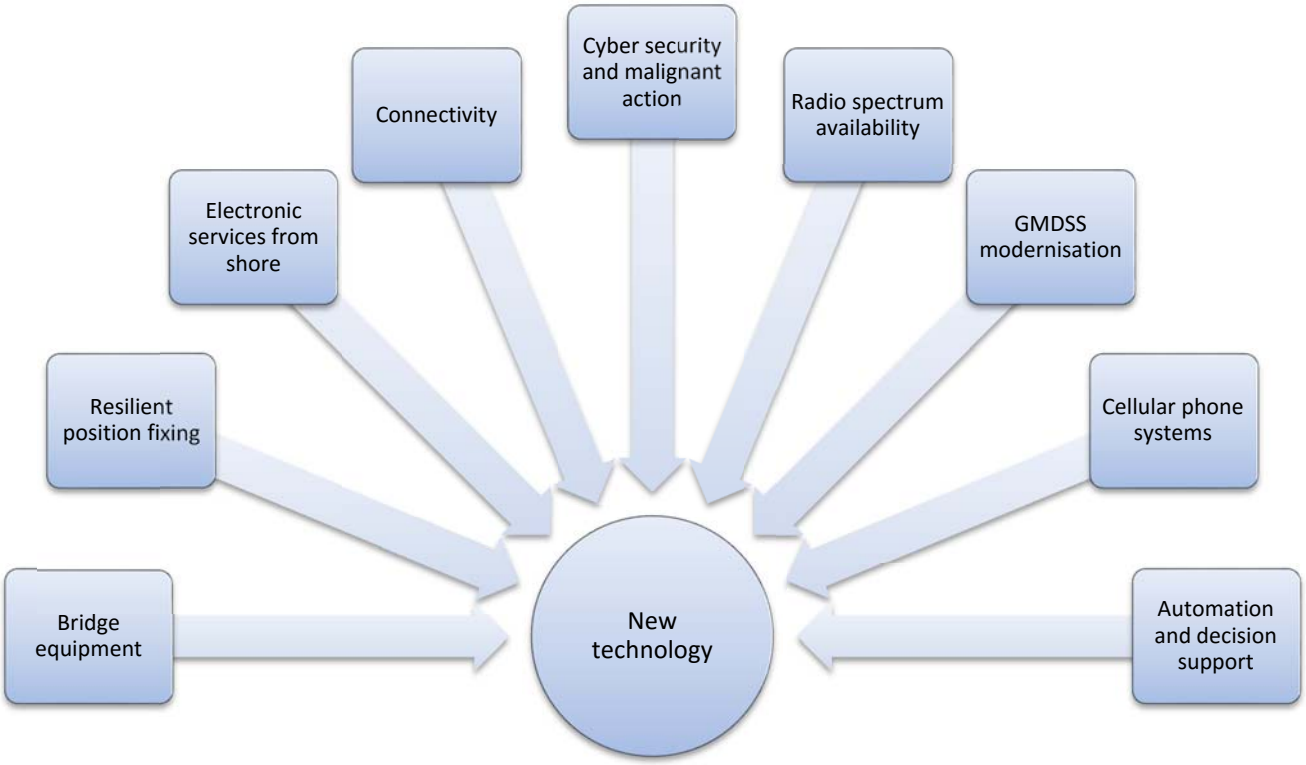
Current systems, including GNSS and AIS, can be disrupted by malignant action. Future communications and information services for marine navigation must be cyber secure.

Allocation of frequency bands for radio transmissions are governed by the regulations of the ITU. The provision of frequency allocations sufficient for digital information flow between ship and shore is vital for safety and efficiency.

The modernisation of GMDSS is a current task in IMO. The IALA concept of VDES is for the broadcast of maritime safety and other information, and for AIS vessel identification and tracking, but may have the capability to form part of a new GMDSS.

While not currently recognised as a formal maritime safety communication method, the near-ubiquity of cellular phone aboard all classes of vessel, may provide a near-coastline communication system of good performance. The use of cellular phone systems for delivering shore services will become increasingly important, especially for non-SOLAS craft and for emergencies.

Decision support software for bridge crews and for VTS personnel are expected to become increasingly used.



3. STRATEGIES FOR 2018-2026

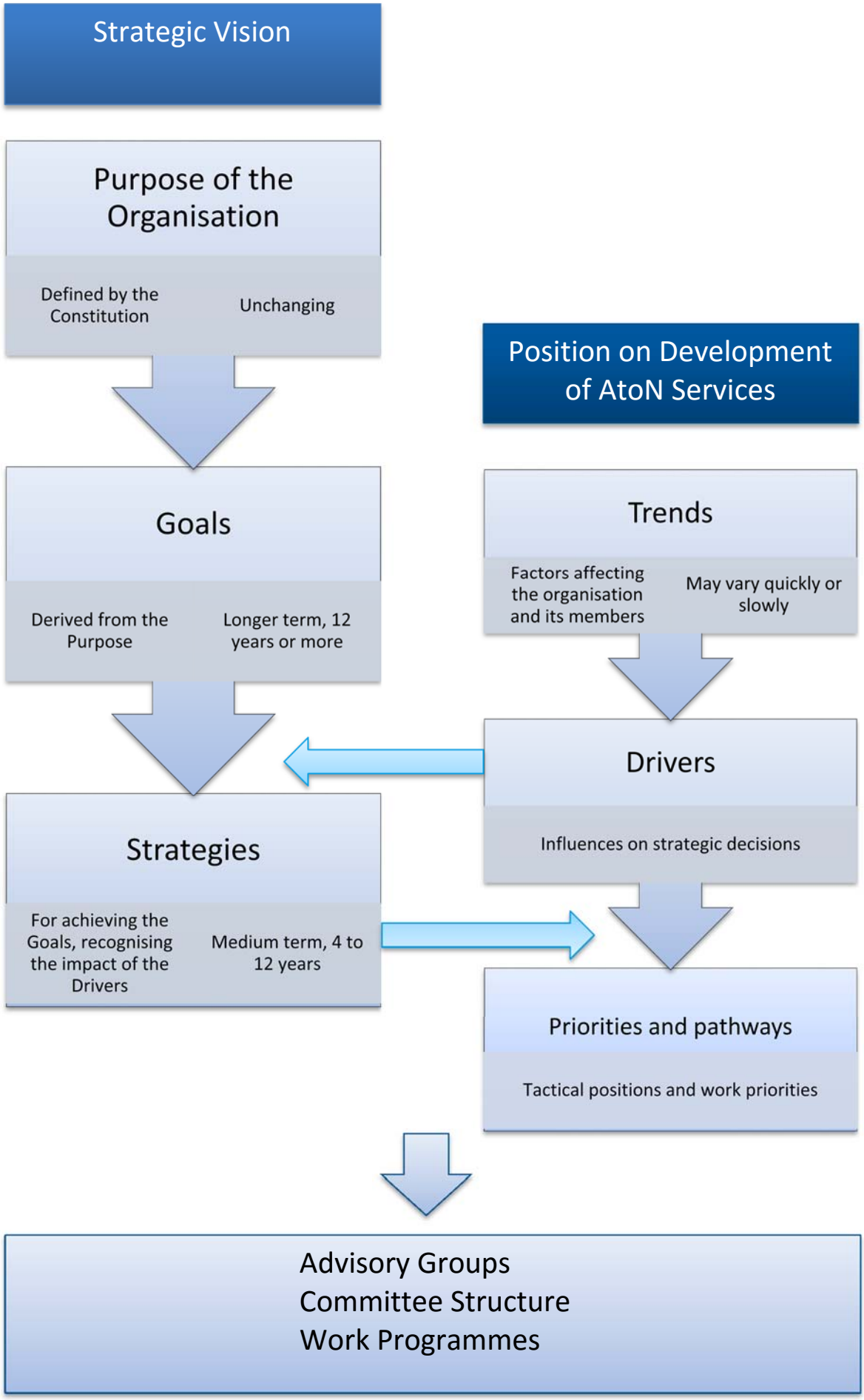
4. THE STRATEGIC VISION

The Strategic Vision for IALA was developed in 2013 to cover the period 2014-2026. It is presently being revised and will become the Strategic Vision 2018-2026. Its content is as follows.

- Purpose
- Motto
- Goals
- Strategies

The Purpose of the organisation is its reason to exist, its Goals are those it hopes to achieve in the medium to longer term, the Trends are external factors which create Drivers which influence the decisions on Strategies.

The following diagram will explain further.


Strategic Vision
Purpose of the Organisation
Defined by the Constitution
Unchanging
Position on Development of AtoN Services
Goals
Derived from the Purpose
Longer term, 12 years or more
Trends
Factors affecting the organisation and its members
May vary quickly or slowly
Drivers
Influences on strategic decisions
Strategies
For achieving the Goals, recognising the impact of the Drivers
Medium term, 4 to 12 years
Priorities and pathways
Tactical positions and work priorities
Advisory Groups
Committee Structure
Work Programmes

5. POSITION STATEMENTS

5.1. Purpose of the Statements

Technical Position Statements have been created to provide a link between the Strategic Vision and the work programmes of the Committees, giving guidance where needed on the technical philosophy for an aspect of IALA's work and the preferred path of this work. In cases where the path should be obvious, no Position statement is necessary.

5.2. Structure

Position Statements are organised within a structure mirroring the organisation of IALA Standards and Recommendations, as follows.

AtoN Planning and Service Requirements
- Obligations and regulatory compliance
- AtoN Planning (offshore signals, bridge signals, traffic signals, MBS, fairway design)
- Levels of service objectives. (Availability and Categories)
- Risk Management
- Virtual marking
- Quality management

AtoN Design and Delivery
- Visual signalling (Vision, Colour, Conspicuity, Rhythmic characters)
- Range and performance (visual and audible)
- Design, Implementation & Maintenance
- Power systems
- Floating AtoN (buoys, moorings, stability, etc.)
- Environment, Sustainability & Legacy

Radionavigation Services
- Satellite positioning and timing
- Terrestrial positioning and timing (including eLoran, eChayka, R-mode)
- Racon & radar positioning
- Augmentation services (SBAS & DGNSS)

Vessel Traffic Services
- VTS implementation
- VTS operations
- VTS data and information management
- VTS communications
- VTS technologies
- VTS auditing and assessing
- VTS additional services

Training and Certification
- Training and assessment
- Competency certification and revalidation
- Simulation in training
- Human factors
- Capacity building

Digital Communications Technologies

Wide/Medium bandwidth systems (AIS & VDES)
Narrow bandwidth systems (NAVDAT, MF beacons, etc.)
Harmonised maritime connectivity (Maritime Internet of Things, intelligent sensors, AtoN monitoring)

Information Services

Data models and data encoding (IVEF, S-100, S-200, ASM, etc.)
Vessel tracking and data exchange systems
e-Navigation user requirements
Terminology, symbology, and portrayal

6. ATON PLANNING AND SERVICE REQUIREMENTS

6.1. Content

Content areas are:

- Obligations and regulatory compliance
- AtoN Planning (offshore signals, bridge signals, traffic signals, MBS, fairway design)
- Levels of service objectives. (Availability and Categories)
- Risk Management
- Virtual marking
- Quality management

6.2. Positions Statements

6.2.1. Obligations and regulatory compliance

The obligations of coastal states to provide aids to navigation are included in international Conventions. The Safety of Life at Sea Convention Chapter V, Regulation 13 is of importance for aids to navigation, but other Conventions such as UNCLOS and also regional arrangements, for example EC Directives, may also apply.

National legislation and regulations may also prescribe the obligations of aids to navigation services providers, whether government or private.

IALA will provide information and guidance to its members on the conventions and other instruments that provide the international framework for the provision of aids to navigation.

It will also provide guidance to assist members with creation of national frameworks for the establishment and operation of aids to navigation competent authorities, including

- Advice on content of legislation and regulation
- Responsibilities of a competent authority for aids to navigation, and organisational considerations
- Certification and auditing of aids to navigation providers
- Promulgation of aids to navigation information nationally and internationally

6.2.2. International framework for the provision of VTS

The legal basis of VTS lies in both UNCLOS and SOLAS. Although aimed primarily at coastal states, Harbour Masters should be very mindful of the legal and operational basis and the associated requirements for VTS in the management of waterways for which they have responsibility.

UNCLOS Article 21 pertains to coastal States' rights to adopt laws and regulations for shipping through the territorial sea in respect of such matters as the safety of navigation and the regulation of maritime traffic, the protection of navigational aids, the preservation of the environment of the coastal State and the prevention, reduction and control of pollution thereof.

SOLAS regulation V/12 affirms that VTS contribute to safety of life at sea, safety and efficiency of navigation, and protection of the marine environment from possible adverse effects of maritime traffic. Governments of SOLAS contracting States may establish VTS where, in their opinion, the volume of traffic or the degree of risk justifies such services. They have a legal obligation ("shall") to follow, wherever possible, the guidelines developed by IMO noting that the use of VTS may only be made mandatory in sea areas within the territorial sea of coastal states.

From the outset, IALA has taken a leading role in the development of IMO documents relating to VTS. In 1968, IMO adopted Resolution A.158(ES.IV) concerning Recommendation on "Port Advisory Services". Rather general in nature, this Recommendation was later superseded by Resolution A.578(14) concerning "Guidelines for Vessel Traffic Services", which was adopted in 1985. Twelve years later, in 1997, a new Resolution was adopted. Resolution A.857(20) supersedes Resolution A.578(14) and is still in force today.

Annex 2 of the Resolution contains "Guidelines on Recruitment, Qualifications and Training of VTS Operators". The following year, in 1998, IALA's much-anticipated "Recommendation on Standards for Training and Certification of VTS Personnel" (V-103) was published. Publication of a series of associated and internationally accepted model courses on training and qualifications for different categories of VTS personnel followed.

IALA will provide information and guidance to its members on the conventions and other instruments that provide the international framework for the establishment of VTS.
As necessary, IALA will work with its members and with other international organisations towards maintaining the international framework.

6.2.3. National competent authority and legislation and regulations for VTS

Guidance will be created to assist members in the establishment of national frameworks for the establishment and operation of VTS competent authorities, including

- Advice on the content of legislation and regulation
- The relationship of VTS with other Aids to Navigation services
- Responsibilities of a competent authority for VTS, and its organisational considerations
- Certification and auditing of VTS providers and their staff
- Promulgation of VTS information nationally and internationally

6.2.4. AtoN Planning

The planning of an aids to navigation system should normally start with a consideration of the Safety of Life at Sea Convention Chapter V, Regulation 13, which states

> *1. Each Contracting Government undertakes to provide, as it deems practical and necessary either individually or in co-operation with other Contracting Governments, such aids to navigation as the volume of traffic justifies and the degree of risk requires.*

2. In order to obtain the greatest possible uniformity in aids to navigation, Contracting Governments undertake to take into account the international recommendations and guidelines when establishing such aids.*

3. Contracting Governments undertake to arrange for information relating to aids to navigation to be made available to all concerned. Changes in the transmissions of position-fixing systems which could adversely affect the performance of receivers fitted in ships shall be avoided as far as possible and only be effected after timely and adequate notice has been promulgated.

** Refer to the appropriate recommendations and guidelines of IALA and SN/Circ.107 - Maritime Buoyage System*

Consideration of "the volume of traffic" and "the degree of risk" require informed judgement, but this can be greatly aided by the following.

- Marine traffic tracks and volume, most easily obtained by recorded AIS data
- Use of the "IALA Risk Toolbox"

Not all traffic can be assessed by consideration of recorded AIS data as vessels which are not required to carry an operating AIS unit may not be emitting AIS data and so will not appear in the AIS data record. These vessels may include some coastal vessels, fishing vessels, and leisure craft. Other data sources may be needed.

6.2.5. Risk management

The improvement of existing risk management analysis tools and the development of new ones will be an IALA objective, and the training of users of the tools will be another. IALA will work to develop and expand the tools presently available and will create guidance explaining the need, purpose, and use of the analysis tools.

IALA may engage commercial partners, or participate in group projects, to develop risk management analysis tools.

The IALA World Wide Academy will play an important role in raising awareness of the merits of risk management analysis and in facilitating the training of users of the risk analysis tools.

At present the number of expert users of the IALA risk analysis tools is limited. An expansion of global capability is important, possibly in regional training facilities as well as individual aids to navigation authorities.

6.2.6. Gathering and use of historical AIS data

The development of traffic monitoring should be normal practice by coastal states wishing to protect their coasts from the consequences of unwanted incidents. Already some of them, such as the European countries, have a complete set of AIS transponders along their coasts, allowing them to at least follow vessel activities and allowing the centre in charge of the monitoring to provide important information to the ships. Although such centres are not always called VTS, it maintains an image of the traffic and delivers information services as VTS centre. The increasing population of coastal AIS installations, operated by maritime authorities, led IALA to create a system for exchange of AIS information between national authorities, called IALA-NET. It is a world-wide service available only to national competent authorities, who provide maritime data from their areas of responsibility in exchange for data from other participants. The service is intended to assist participating authorities in fulfilling their duties in relation to maritime

For some years, IALA has encouraged its national members to contribute received AIS data to the IALANET system which stores historical AIS data and also allows IALANET participants to exchange data between countries. With the development of improved risk analysis tools which use historical AIS data, the value of the IALANET system

has moved emphasis from the exchange of near real-time information between participating nations to the use of the historical data for risk analysis.

IALA will promote the use of historical AIS data in risk analysis for waterway design and will encourage national members to establish national or regional AIS data banks and to use the historical data to optimise waterway design.

6.2.7. Service requirements

Guidance will be provided to describe the requirements for the use of the IALA Maritime Buoyage Scheme and other aids to navigation including AIS, radar, and virtual aids to navigation for marking natural or man-made hazards, giving position information, and marking safe routes to protect safety of life and the environment.

The guidance will take account of international norms for the accuracy required of on-board position fixing systems, including electronic systems, but IALA may comment on these for specific waterway types or circumstances.

Guidance will be provided on correct management of aids to navigation services with emphasis on levels of service, reliability and availability criteria and norms, and quality assurance methods and standards.

6.2.8. The future of visual aids to navigation

Lighthouses and long range lights are currently a vital part of the mix of AtoN provided, they will continue to play an essential role for the foreseeable future, providing a backup for GNSS, sectors to mark dangers and leading/directional lights for safe channel approaches. The use of lights for landfall and waypoint navigation will continue to decline. However, some lighthouses will have an enhanced role, providing a platform for additional services.

Visual marks in the form of lights and buoys are essential in providing the mariner with visual orientation, spatial awareness; and waypoint, channel and hazard marking. This requirement will not change significantly in the foreseeable future. Enhancement such as AIS and racons and the use of virtual marking has a growing importance to enable the interface with vessel on-board systems.

7. ATON DESIGN AND DELIVERY

7.1. Content

Content areas are:

- Visual signalling (vision, colour, conspicuity, rhythmic characters)
- Range and performance (visual and audible)
- Design, Implementation & Maintenance
- Power systems
- Floating AtoN (buoys, moorings, stability, etc.)
- Environment, Sustainability & Legacy

7.2. Position statements

7.2.1. Light and vision

IALA will maintain and develop its guidance on visual perception, light measurement and computation, colour, reflective effects, and similar. Coordination with CIE will be important as well as the advice of specialists in this field.

7.2.2. Design, Implementation & Maintenance

IALA will develop and update guidance on Design, Implementation & Maintenance to assist all concerned in the long term provision of reliable, cost effective and environmentally responsible AtoN to deliver the IALA recommended AtoN availability.

7.2.3. Floating Aids to Navigation

Guidance will be provided to support the design and operation of floating AtoN to include power systems, moorings, AIS and stability.

7.2.4. Safe working practices

IALA will provide guidance for considered best practice for safe working but precedence will always be given to local and national regulation.

7.2.5. Providing AtoN Services in Extremely Hot Climates

This challenging topic has not been analysed by IALA before 2016, and work will be carried out to generate guidance on the design, performance, operation and maintenance of AtoN in extremely hot climates, including Human Factors related to working in extremely hot climates

7.2.6. Sustainability in AtoN provision

Sustainability is a key area of interest for IALA and emphasis will be placed on environmental responsibility in aids to navigation provision, with an emphasis on sustainable power sources, especially renewable energy sources and newly-emerging power storage systems. Guidance documents will include advice on safe disposal of consumables related to aids to navigation power systems, including primary batteries, secondary batteries, solar panels, and electronic components. Treatment, use, and disposal of materials with a significant environmental impact such as mercury in older lighthouse pedestals, anti-fouling on buoys and structures, paints and solvents, will be included in guidance documents.

Legacy structures with ongoing use as AtoN and which may be subject to local preservation regulations will be the subject of specialist guidance to ensure that their heritage features are preserved while the aids to navigation service is not compromised.

7.2.7. Legacy

Aids to navigation have a long heritage and the history of lighthouses has an attraction for many outside the world of aids to navigation service providers and users.

In many littoral countries lighthouses and similar aids to navigation, and also artefacts and publications associated with them, form an important part of the national heritage and are being recorded and preserved for future generations.

When heritage structures continue to be used as aids to navigation, the generation of guidance to advise on their maintenance and correct preservation will remain part of IALA's work.

Although the conservation of structures and artefacts no longer used as aids to navigation, the preservation of historical records, and similar work are not within its remit, IALA will encourage this heritage activity and will support it when and as it can.

To facilitate the preservation and maintenance of lighthouses and other buildings no longer used as aids to navigation, and also to consider the preservation of artefacts and documents, IALA will from time to time convene the IALA Heritage Forum. The Forum will provide an opportunity for the exchange of information and experience in this maintenance and preservation work. It will be open to IALA members and to interested non-members by approval of the Secretariat.

8. RADIO-NAVIGATION SERVICES

8.1. Content

Content areas are:

- Satellite positioning and timing
- Terrestrial positioning systems
- Racon & radar positioning
- Augmentation services (including SBAS and DGNSS)

8.2. Position statements

8.2.1. Satellite Positioning and Timing

IALA sees resilient positioning as desirable for safe and efficient navigation. At present the GNSS systems GPS GLONASS and Galileo provide global coverage. (Galileo initial services were declared operational on 2016-12-15 with 18 of its projected 30 satellites.)

The BeiDou GNSS system is under development and will provide extra resilience when operational.

IALA is not directly concerned with the provision of Global Navigational Satellite Services (GNSS) nor with the provision of augmentation services via satellite, but encourages the provision of these services.

All four GNSS mentioned above use the same frequency band for positioning signal broadcast, and all can be vulnerable to jamming and spoofing by a local terrestrial signal. Increased positioning resilience for navigators can be achieved by the provision of terrestrial radio-positioning services.

8.2.2. SBAS

Maritime service providers could use SBAS data to enhance their marine beacon DGNSS services, either through the provision of additional integrity information, or as an alternative source of correction information. The aim is to develop a Guideline on SBAS use.

SBAS are designed primarily for aviation use and IALA will work to understand how SBAS data can be used safely and correctly in the maritime sector.

IALA encourages SBAS stakeholders to contribute to the development of guidelines on the use of SBAS.

8.2.3. Terrestrial radio-navigation services for GNSS resilience –Conversion of existing DGNSS radio beacons for GNSS backup service

R-Mode (Ranging Mode) is a proposed terrestrial backup navigation system, independent to GNSS, which uses ranging signals typically transmitted from existing maritime infrastructure, for example, medium frequency (MF) radio beacons and/or AIS base stations.

Noting the large number of DGNSS Medium Frequency Radio Beacons in service worldwide, IALA views the conversion of these to R-Mode operation as having potential for providing global network of harmonised terrestrial back-up positioning for GNSS for maritime use. Positioning accuracy would depend on beacon locations, geometry, and other factors.

IALA recommends that its members should retain existing DGNSS Medium Frequency Radio Beacons, and should use them for GNSS backup when such services are proven and when IALA has developed technical Recommendations and Guidelines in this area.

If existing DGNSS Medium Frequency Radio Beacon broadcasts are to be discontinued, then the sites and antennas should be retained in anticipation of conversion to R-Mode operation.

Conversion of existing DGNSS stations to GNSS backup could include provision for adding the broadcast of Maritime Service Portfolio (MSP) information in NAVDAT format. The technological implications of this are still to be determined but IALA notes the potential for this service.

8.2.4. Terrestrial radio-navigation services for GNSS resilience – Loran-C, Chayka, eLoran, eChayka

In some areas Loran-C and Chayka may not provide the position fixing accuracy for satisfactory GNSS resilience, and IALA views conversion of existing Loran-C and Chayka chains to eLoran-eChayka as desirable, or alternatively their replacement by a more accurate system.

8.2.5. Terrestrial radio-navigation services for GNSS resilience – FERNS Council

IALA will strongly support the work of the Far East Radionavigation Service (FERNS) to provide Loran-C and Chayka services and other future radio-navigation services. Future services provided by the FERNS Parties may include eLoran and/or R-Mode if the FERNS Parties so decide. IALA will cooperate with the FERNS Council for the creation of eLoran Recommendations.

Following the result of the 25th Session of the FERNS Council, IALA will work even more closely with the FERNS Council for coordination of radionavigation services and e-navigation services, including Maritime Service Portfolios.

8.2.6. Timing services

IALA does not consider that the provision of [terrestrial broadcast] timing services is normally within its scope, except as may be inherent in terrestrial positioning services. This may change as terrestrial positioning services or GNSS backup systems develop.

8.2.7. Racon & radar positioning

IALA continues to recommend the use of racons for relative positioning. The use of radar increases resilience of the entire positioning solution. IALA publishes guidelines on providing racon services.

Advanced radar technology, (NT), applied to maritime radar is rapidly improving the ability of radars to distinguish targets under poor conditions. IALA encourages the development of NT radars and the improvements they offer. However, there is a reduction of operating range when NT radars are used with racons. IALA encourages radar and racon manufacturers to continue work on NT radar compatibility with racons.

Generally, radar and racon are used for relative positioning. A new service known as eRadar/eRacon can be used for absolute positioning. IALA encourages continued research in positioning services that are independent of GNSS and increase PNT resilience.

9. VESSEL TRAFFIC SERVICES

9.1. Content

Content areas are:

- VTS implementation
- VTS operations
- VTS data and information management
- VTS communications
- VTS technologies
- VTS Auditing and assessing
- VTS additional services

9.2. Position statements

9.2.1. Operations

Apart from its major role in improving safety and efficiency of vessel traffic, and protection of marine environment, VTS will increasingly contribute to efficient information management in the maritime domain. In the global maritime environment, safety and efficiency not only depend on well-organized traffic management and exchange of information but also on standardized and harmonized concepts, systems and services.

The complexity of utilization of the seas is growing, threatening the manoeuvrable space for shipping. The need for proactive management of vessel traffic in these areas is thus likely to increase, further driving the interaction between ships and shore authorities. Management of operational space from a shipping perspective by evolving VTS, supported by the capabilities of e-Navigation and its Maritime Service Portfolio developments, and in conjunction with Marine Spatial Planning are seen as candidate combinations on how to deal with the challenges for safe, secure and efficient navigation in clean waters.

IALA will create guidance for the use of VTS providers, on the correct operation of a VTS to ensure the safety and efficiency of vessel movements in the VTS area. Guidance will cover the various types of VTS, port, coastal, regional, national, and the services that can be provided.

This guidance will aim at harmonising VTS operational procedures worldwide, so that ships' masters will encounter familiar VTS procedures, but recognising that local requirements, such as geographical characteristics, traffic density and diversity, accessibility, and environmental conditions may sometimes dictate special needs. The determination and decision of which services, and on what level they shall be provided to shipping and other stakeholders will remain assigned to the relevant national, regional or local authorities.

IALA guidance for VTS operations will include

- Performance standards
- Performance monitoring and evaluation
- Management and staffing
- Decision support tools
- Digital information exchange
- Voice communications procedures and standard phrases

IALA will cooperate with sister organisations, in particular with IMPA and IHMA, to ensure that its operations guidance is complete and appropriate.

9.2.2. Berth to berth VTS, Sea Traffic Management

Vessel Traffic Services should be provided in defined and recognised VTS areas. IALA does not support the concept of berth-to-berth provision of vessel traffic services. Similarly IALA views the concept of Sea Traffic Management as a concept meriting study, but for which adoption, if it occurs, is likely to be some years away, except perhaps for cooperating states in a limited sea area.

9.2.3. Interaction and cooperation of VTS with other national or regional services

Today there are several other operational organisations with specific maritime responsibilities, such as Maritime Rescue Coordination Centres, Maritime Assistance Services, Maritime Security Alert Centres, Pollution Information Centre, Fishing Surveillance and Police Centres, National Coordinator for maritime safety information etc. They all need similar information and communication systems as are used for VTS, and they are often run by people who have more or less a similar background and a common basis of training, such as the use of the Standard Marine Communication Phrases.

e-Navigation, which promises to assemble all the relevant information and deliver this to stakeholders through a common communication infrastructure, could facilitate the work of these organizations. In the light of e-Navigation developments, maybe the case can be made to regroup or merge some of these operational centres which the IMO calls Maritime Operational Services. IMO has discussed this matter some time ago, but no conclusion was reached, perhaps because the necessary concepts and infrastructure for seamless and effective information exchange did not exist. But this may change, now that e-Navigation is coming about. The discussion on e-Navigation encompasses the concept of Maritime Service Portfolios which has similarities with the concept of Maritime Operational Services. In any case we must keep in mind that it will be detrimental if individual shore side stakeholders would continue to develop their own systems and communication infrastructures in isolation. Not only will the cost and the technical complexity increase, but it will increase further the complexity of the task of the officer on watch. It is obvious that the VTS in its original port and coastal capacity will be the nucleus of such integration.
Although the coordination of VTS with other services, such as SAR, police, customs, and border control will be a matter for local, national, or regional decision, IALA will work to raise awareness of the capabilities of VTS sensors and VTS organisations to complement the work of these other services at times of special need, and will include awareness of this in its training.

9.2.4. VTS Technology

IALA's technological guidance for VTS will describe in general terms the sensor and system performance required for VTS equipment installations, but IALA will not concern itself with technical specifications.

9.2.5. Unmanned / Autonomous vessels in a VTS area

IALA will prepare for the advent of unmanned vessels and for their interaction with conventional manned vessels within VTS areas. IALA will cooperate with other international organisations in this preparation work.

Initial work in this area will consider the interaction process of unmanned vessels with conventional traffic, the information flow between unmanned vessels and shore authorities, and the related information exchange with conventional traffic.

IALA envisages that unmanned vessels will need services from shore, including MSI packaged in MSPs, perhaps in formats specific for unmanned vessels. (See later in this document.)

10. TRAINING AND CERTIFICATION

10.1. Content

Content areas are:

- Training and assessment
- Competency certification and revalidation
- Simulation in training
- Human factors
- Capacity building

10.2. Position statements

10.2.1. Management of Training and Certification Documents

The WWA will take responsibility for the coordination, correct order, and completeness of the Recommendations and Guidelines which sit below the Training and Certification Standard. Committees will draft these Recommendations and Guidelines but the WWA will advise to ensure a complete and coordinated set of these Recommendations and Guidelines.

10.2.2. Training and assessment

In response to the need for correct and complete training, IALA, and in particular the IALA World-Wide Academy (WWA) will, together with the IALA committees, develop model courses on aspects relevant for marine aids to navigation and VTS personnel. This includes all significant managerial, operational and technical aspects described in IALA documents. Technical Committee work will normally be the source of the Model Courses used by the WWA, with the Committees assisted by WWA experts.

10.2.3. Competency certification and revalidation

Standards of training and certification of VTS operators, supervisors, and managers, as well as AtoN managers and technicians are provided as IALA WWA Model Courses. The Model Courses should be used by accredited AtoN and/or VTS training organisations (ATO´s).

The WWA will assist national competent authorities with the process of accrediting training organisations, and provide advice including advice on the training of trainers.

IALA recommends systematic and sustainable training as well as certification of AtoN and VTS personnel, and the WWA will continue to encourage both IALA members and non-members to do so.

10.2.4. Mandatory training and certification

Mandatory training and accreditation of VTS operators is considered to be essential for vessel safety in VTS areas, and IALA will work towards implementation globally.

While systematic and sustainable AtoN training and certification is recommended strongly, this is not mandatory at this stage.

10.2.5. Capacity Building

The WWA will focus its capacity building activities on those states in greatest need. A methodology to determine these needs, based on the maturity of maritime management, volume of traffic and degree of risk, has been developed.

Funding of the activities of the WWA is based entirely on donations, and IALA members are encouraged to support the WWA with donations and in kind support for dedicated projects.

11. DIGITAL COMMUNICATIONS TECHNOLOGIES

11.1. Content

Content areas are:

- Wide/Medium bandwidth systems (AIS & VDES)
- Narrow bandwidth systems (NAVDAT, MF beacons, etc.)
- Harmonised maritime connectivity (Maritime Internet of Things, intelligent sensors, AtoN monitoring, etc.)

11.2. Position statements

11.2.1. Harmonised Connectivity / Telecommunications

IALA will focus on:-

- Automatic Identification System (AIS)
- The VHF Data Exchange System (VDES)
- 300KHz broadcast using converted DGNSS stations
- 500KHz broadcast
- The Maritime Cloud

IALA notes that other digital radio communications, including existing and future satellites services and HF digital radio may be used for MSP broadcast, but will not expend effort in these areas.

11.2.2. VHF Data Exchange System (VDES)

VDES will be the successor to the present AIS, and includes the present AIS frequencies AIS1 and AIS2. Shore authorities should plan to convert their existing AIS base station networks to VDES base station networks as soon

as the technical characteristics of VDES have been finalised by IALA Recommendation and the publications of the International Telecommunications Union (ITU).

VDES is expected to become the primary means for shore authorities to provide toll-free higher-speed maritime services in coastal and harbour areas. Implementing VDES ashore and afloat will enable provision of harmonised shore services without communications time cost, and the freeing of the channels AIS1 and AIS2 for safety of navigation.

VDES will require upgrading of ship AIS systems to the VDES standard. This may involve firmware upgrade for some newer AIS ship units or replacement of hardware for older units.

IALA will maintain its online register of AIS Application Specific Messages and will encourage the moving of these and other messages which are not for safety of navigation from AIS1 and AIS2 to other VDES channels.

11.2.3. Longer range terrestrial broadcast of MSPs

IALA will encourage the provision of MSPs to longer range by digital terrestrial radio using MF DGNSS stations and 500 KHz broadcast.

In summary, IALA's work to achieve harmonised digital radio communications will focus on:-

- The VHF Data Exchange System (VDES)
  - For terrestrial and satellite communications for delivery of MSPs
  - To about 30 miles from shore

- MF DGSS stations [subject to proving technical capability]
  - For lower-bandwidth delivery of MSPs
  - To about 100 miles from shore
  - And potential conversion to R-Mode for GNSS back-up positioning

- 500KHz and possibly other channels using NAVDAT format as the replacement for Navtex services
  - For lower-speed delivery of MSPs
  - Over long range

12. INFORMATION SERVICES

12.1. Content

Content areas are:

- Data models and data encoding (IVEF, S-100, S-200, ASM, etc.)
- Vessel tracking and data exchange systems
- e-Navigation user requirements
- Terminology, symbology, and portrayal

12.2. Position statements

12.2.1. Data modelling

The management and promulgation of information on aids to navigation is carried out at national and international level. As part of the development of e-Navigation, IALA has been allocated the S-200 domain in the IHO S-100 GIS registry.

IALA will provide advice for the use of national competent authorities on the correct management of aids to navigation information and its provision to international registries.

With the change from paper charts to electronic displays, the correct portrayal of AtoN on electronic displays is vital to safe navigation. IALA will work with its members and with the IHO to assist in ensuring correct portrayal of AtoN information.

12.2.2. Harmonised connectivity / Information Registries

The harmonised connectivity of all e-navigation elements is essential to ensure delivery of Maritime Services and to avoid erroneous interpretation of received data. This will require:-

- Common Marine Data Structure (based on IHO S100)
- Establishment of a Unique Indentifiers for Maritime Resources
- Harmonised MSPs
- Harmonised communications

The Common Marine Data Structure uses the International Hydrographic Organisation (IHO) S-100 Registry will be the means by which e-Navigation information is registered and made available to the maritime community.

IALA will use its S-200 Domain within the S-100 Registry for the registration of aids-to-navigation information. A management structure for maintaining this Domain will be established and operated by IALA, and guidance documents for this management will be created.

IALA will work to establish a system of Unique Identifiers for Maritime Resources, and will cooperate with other international organisations to achieve this. IALA does not have an ambition to be the host of this Register.

12.2.3. Delivery of Maritime Services / Implementation

IALA will work for the harmonisation of maritime services using the Maritime Services Portfolios (MSPs) scheme of the International Maritime Organization (IMO) e-Navigation Strategy Implementation Plan (SIP), updated to reflect the latest needs, and adapted for digital telecommunications. See Annex 7, page 11 of IMO document NCSR1/28, which lists sixteen initially proposed MSPs.

IALA will cooperate with other bodies, including the IMO, the IHO, and the World Meteorological Organization (WMO) to coordinate a structure of MSPs. IALA envisages that this set would include some globally harmonised MSPs and other MSPs that would be defined locally or by particular user groups.

IALA will work to harmonise MSPs for Vessel Traffic Services (VTS), including Information Services, Navigational Assistance Services, and Traffic Organisation Services, again with a mix of globally harmonised and locally defined services.

The provision of Maritime Safety Information (MSI) in the form of digital Maritime Service Portfolios (MSPs) is a future component of VTS. IALA will work with IMO, IHO, CIRM, and others towards the definition and harmonisation of these digital services. IALA will assume responsibility for the detail of MSPs allocated to VTS.

The provision of maritime services for unmanned vessels has not been addressed yet by IALA. IALA will decide at a later date what services for unmanned vessels should be within its concern.

12.2.4. Maritime Cloud

The Maritime Cloud is planned to be a digital Information Technology (IT) framework consisting of standards, infrastructure and governance that facilitates secure interoperable information exchange between stakeholders in the maritime community using the principles of Service Oriented Architectures (SOA). The core of the Maritime Cloud consists of three key infrastructural components providing central framework services.

It will contain a registry of Maritime Service Portfolios (MSPs), a Maritime Identity Register which is expected to be the set of Unique Identifiers for Maritime Resources mentioned above, and a geo-aware Maritime Messaging Service which takes account of available data links, and can use geo-casting or addressed messages.

This concept is presently being developed by the EfficienSea 2.0 project in which IALA is a contracted partner.

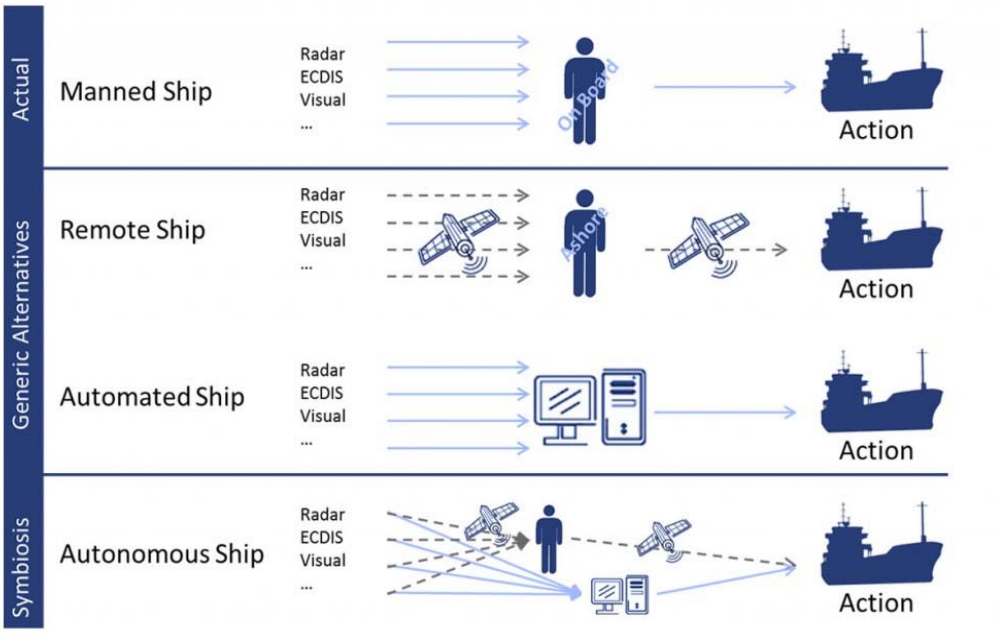
12.2.5. Digital services for autonomous vessels

Next generation modular control systems and communications technology will enable wireless monitoring and control functions both on and off board. These will include advanced decision support systems to provide a capability to operate ships remotely under semi or fully autonomous control.

Rolls-Royce describes communications and connectivity for its vision for the autonomous commercial ship as follows:

“Autonomous vessels will still need human input from land, making connectivity between the ship and the crew crucial. Such communication will need to be bidirectional, accurate, scalable and supported by multiple systems – creating redundancy and minimising risk. Sufficient communication link capacity for ship sensor monitoring and remote control, when necessary, has to be guaranteed. The project is exploring how to combine existing communication technologies in an optimum way for autonomous ship control. We have created a simulated autonomous ship control system which will be connected to a satellite communications link as well as land based systems. This will allow us to explore the behaviour of the complete system.”

The MUNIN project saw the evolution of the autonomous vessel as in its diagram below.



While the control and navigating of unmanned commercial ships is expected to be by private industry using digital connectivity of its own choice, it could be expected that some digital shore services may be adapted or extended in future to provide Maritime Safety Information (MSI) in an appropriate format for these vessels.

At this time it is not clear what MSI will be needed by autonomous ships, in what sea areas and via what communications. However IALA will maintain a close monitoring of developments with the intent of providing information and guidance to its members as this field develops.

12.2.6. Cyber security

Cyber security for maritime services will be developed in cooperation with other international and regional organisations and will require coordination of shore service providers, VTS system designers, and ship system designers.

Cyber security should be provided in applications, not within the communications transport layer.

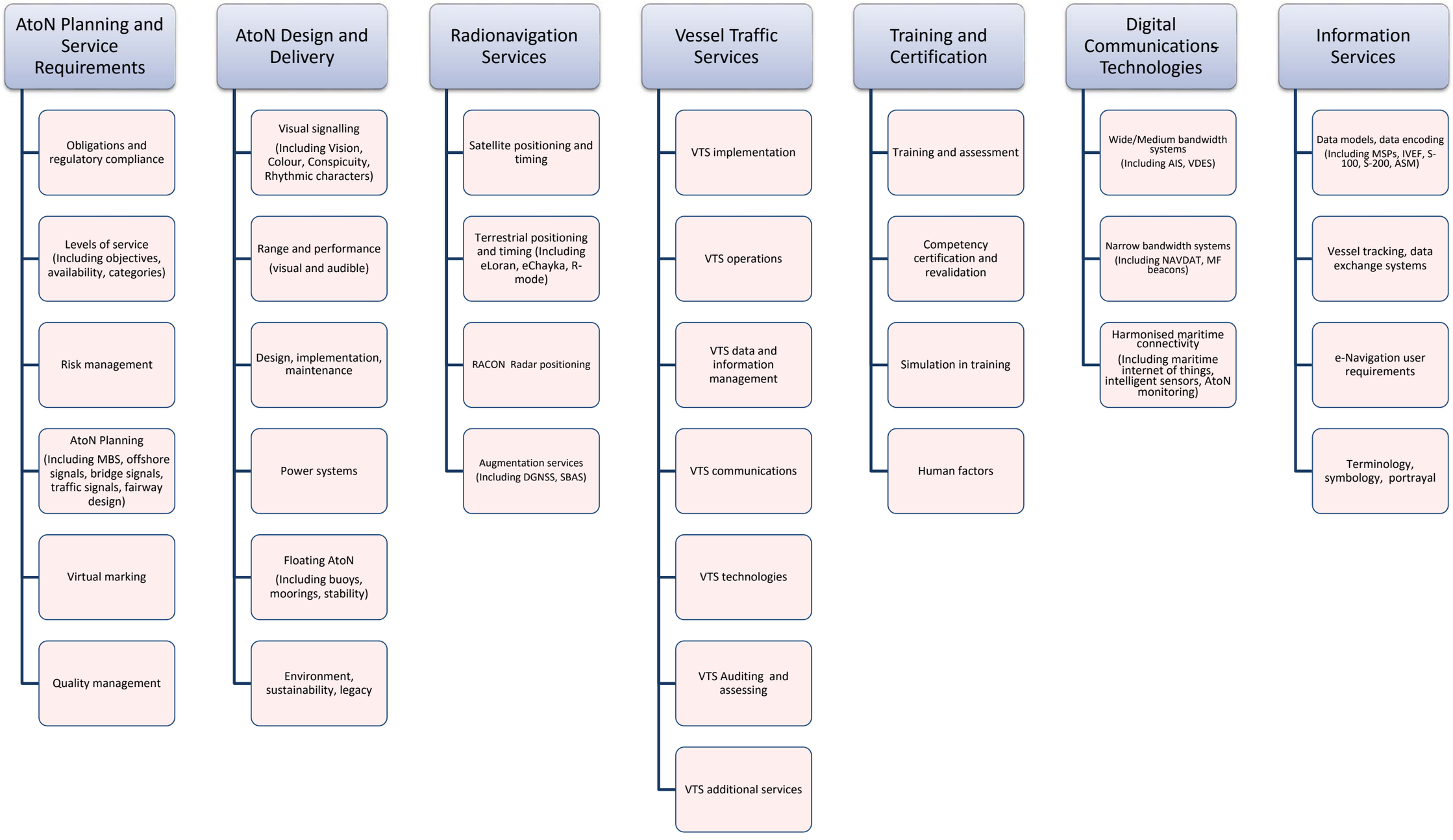
At present IALA Committees have limited competence in cyber security and will not attempt to create guidance in this field. Members concerned about cyber security should address national or regional experts in government or industry for advice and implementation.

12.2.7. IALA Dictionary

At present there still remains some inconsistency in the definition of aids to navigation terms within IALA guidance documents. The IALA Dictionary was created to eliminate this by being a single reference point for aids to navigation terms to ensure consistent use and meaning throughout the IALA document suite. The Dictionary will also carry a list of standard IALA acronyms.

This work is increasingly important as IALA moves towards introducing its first standards and as the change to an IGO proceeds.

13. ANNEX A – STANDARDS MAP



14. ANNEX B – E-NAVIGATION ROAD MAP

14.1. Introduction

This Annex is a high-level representation of how overarching concepts and strategies such as the IMO concept of a Sustainable Maritime Transportation System (SMTS) [1], IMO's e-Navigation strategy and its implementation plan [2; 3; 4] and IHO's Universal Hydrographic Data Model (UHDM; S-100) [5] can be applied in a coordinated manner to contribute to IALA's vision in its overall strategy [6].

The relationships between the SMTS, e-Navigation, operational and technical issues in this road map are reflected in several IALA documents e.g. [7; 8; 9]. Close cooperation is maintained with other IGOs and NGOs involved with e-Navigation.

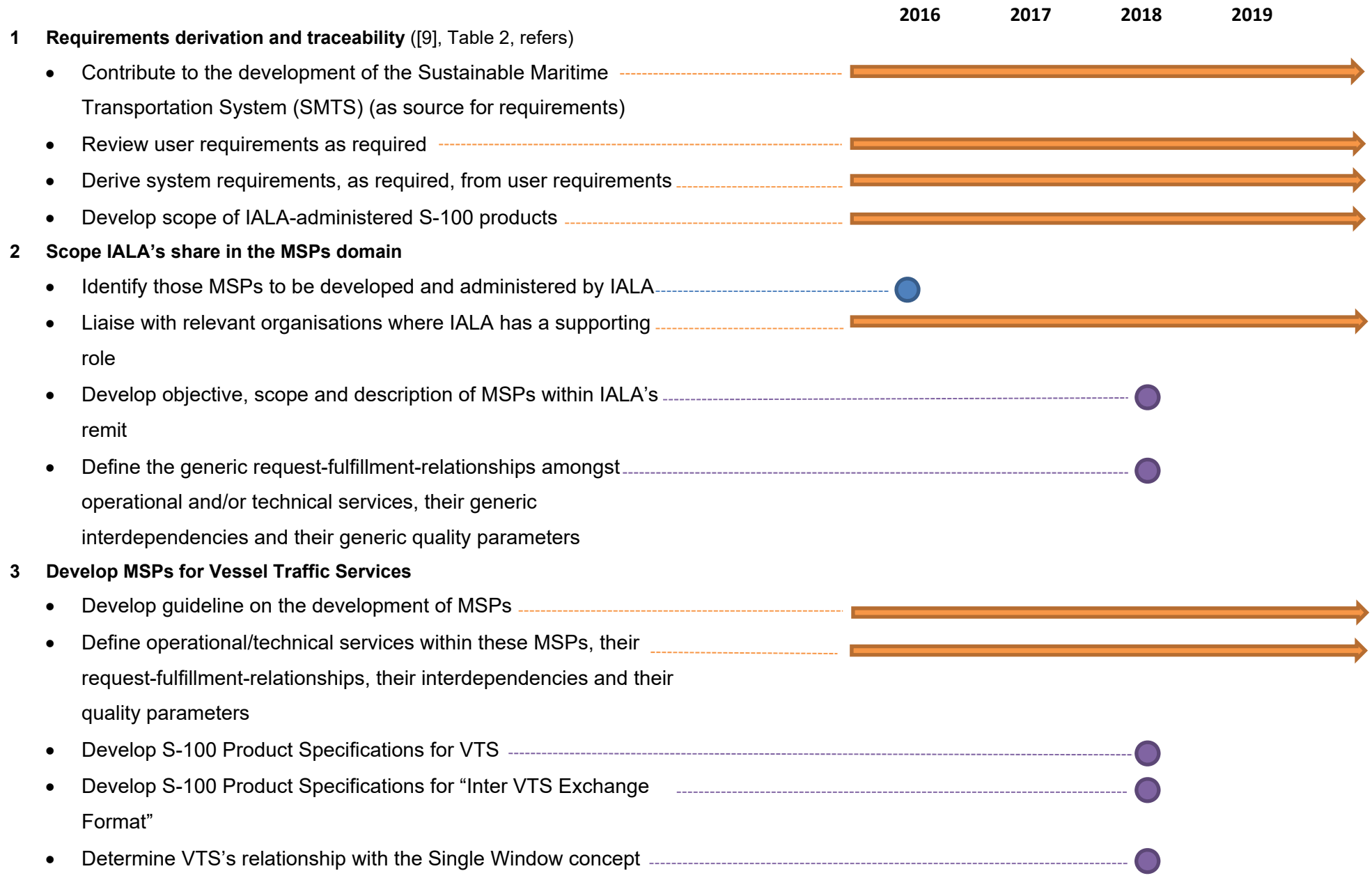
14.2. Legend

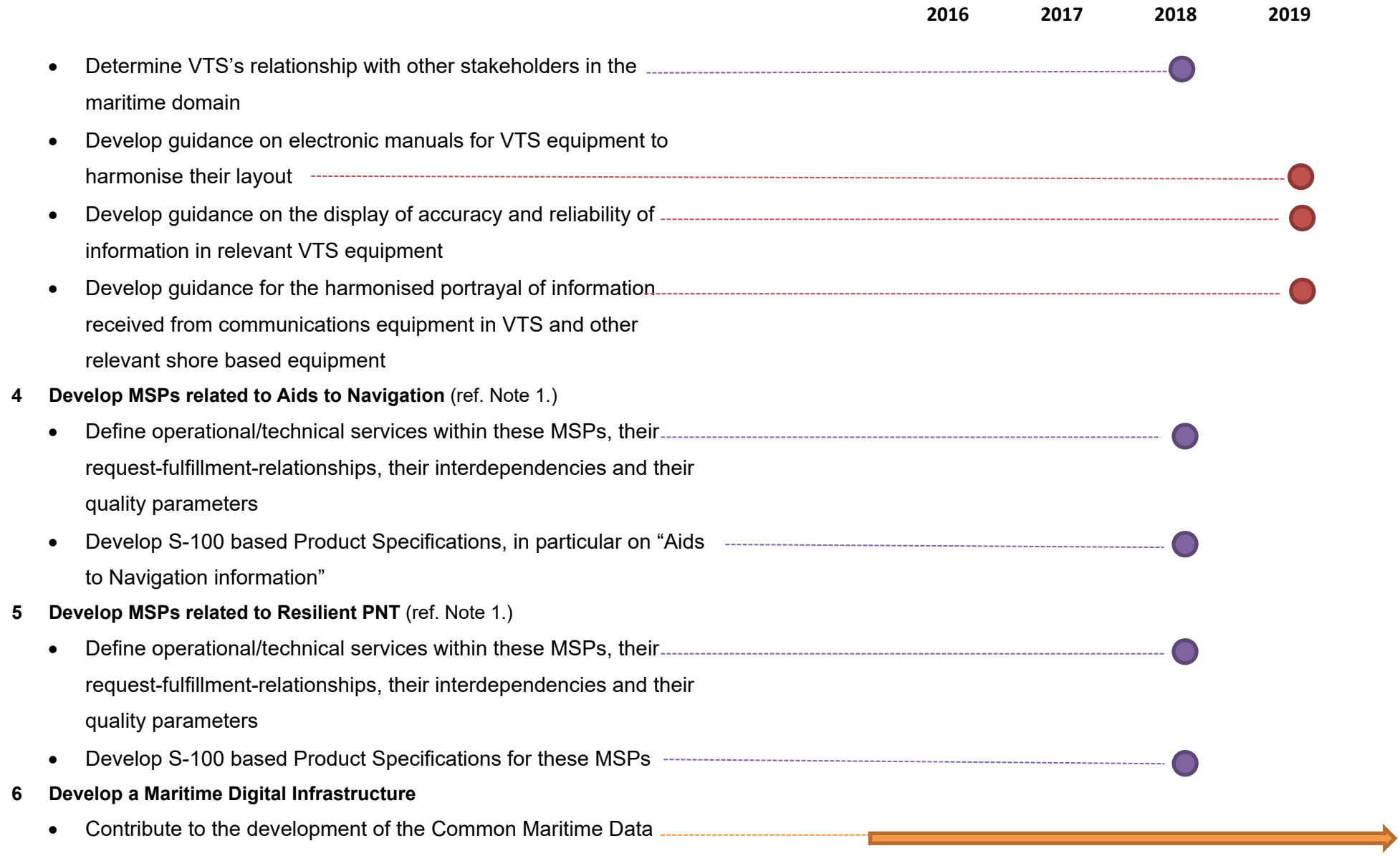
- Individual circles designate milestones when tasks indicated by the road map should be completed. Different colours of the circles are used to indicate different years.
- The arrow designates a continuous process, where the start and/or end points of the process is as yet unspecified.
- In future, the circles can be replaced by ellipses to contain the designation of the group or entity within IALA responsible. Several Ellipses and arrows can be combined to designate several meaningful milestones within a continuous process. This way of designation may be required for complex tasks.

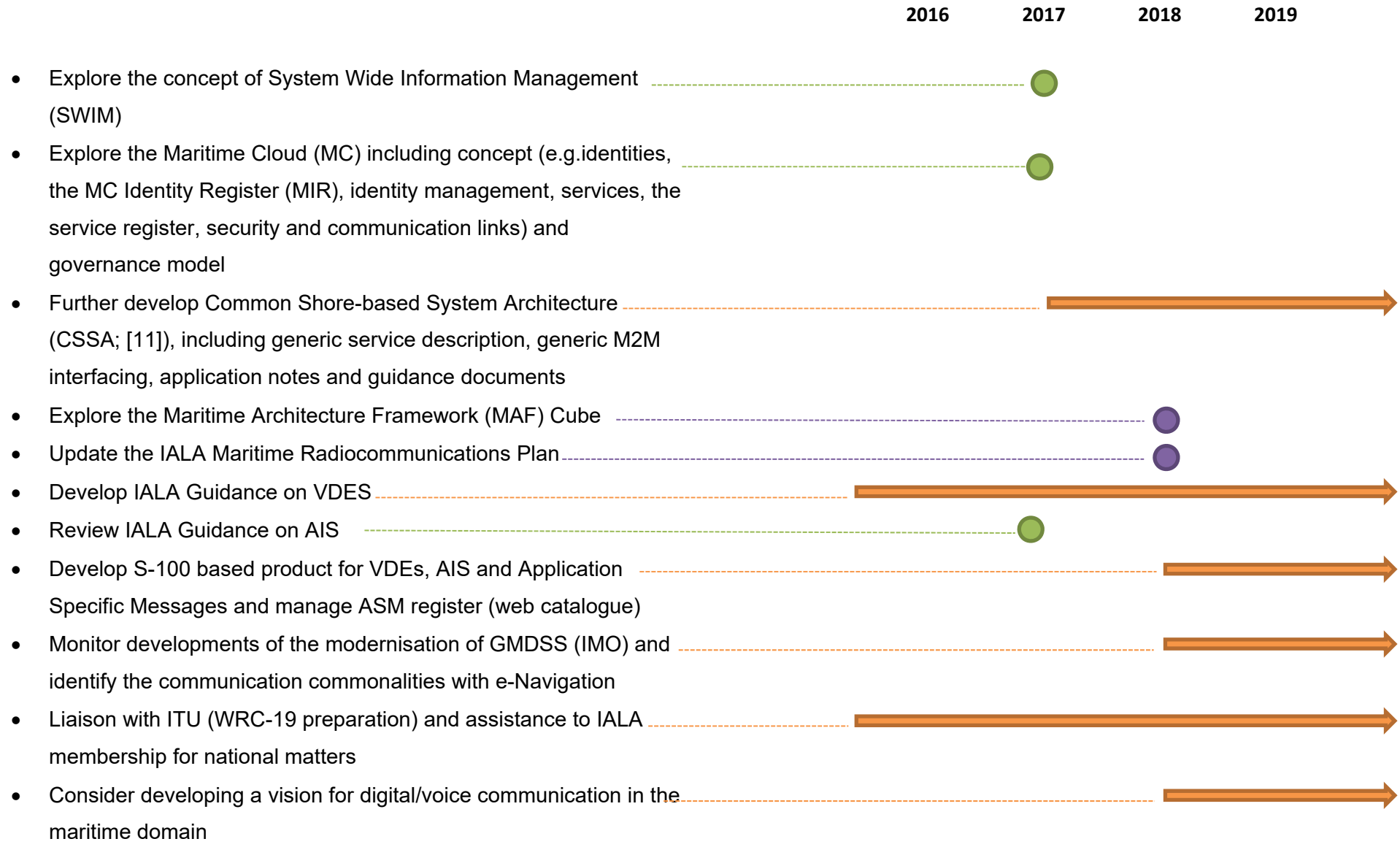
Note 1.
The list of MSPs given in the SIP [3] is a proposed list of internationally recognised MSPs, and task 17 of the SIP specifically states that further development shall take place. Several (sub) domains with relevance to the maritime domain are not included yet. This is to be amended in due course. Hence these MSPs-to-be-added are postulated.

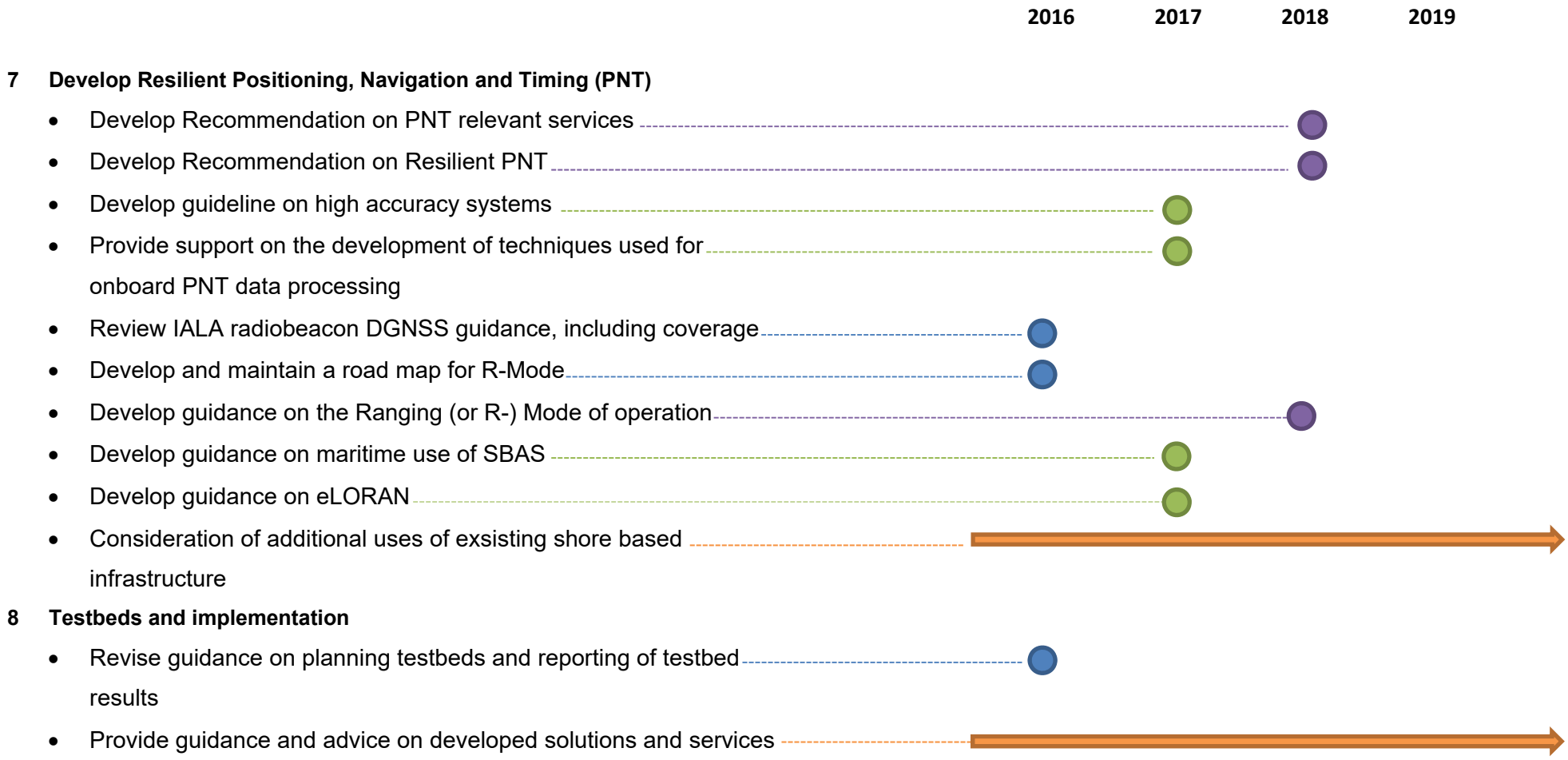
Note 2.
For further introduction to the application of IHO's UHDM/S-100 framework to the IALA domain, compare IALA Guideline 1106 on Producing an IALA S-100 Product Specification [10]. Also, it is necessary to identify the emerging S-1xx specifications of IHO and their relevance to IALA's own product specifications S-2xx.

Note 3.
For some activities in this high level road map, individual pathways will need to be developed.


2016
2017
2018
2019
1 Requirements derivation and traceability ([9], Table 2, refers)
• Contribute to the development of the Sustainable Maritime Transportation System (SMTS) (as source for requirements)
• Review user requirements as required
• Derive system requirements, as required, from user requirements
• Develop scope of IALA-administered S-100 products
2 Scope IALA's share in the MSPs domain
• Identify those MSPs to be developed and administered by IALA
• Liaise with relevant organisations where IALA has a supporting role
• Develop objective, scope and description of MSPs within IALA's remit
• Define the generic request-fulfillment-relationships amongst operational and/or technical services, their generic interdependencies and their generic quality parameters
3 Develop MSPs for Vessel Traffic Services
• Develop guideline on the development of MSPs
• Define operational/technical services within these MSPs, their request-fulfillment-relationships, their interdependencies and their quality parameters
• Develop S-100 Product Specifications for VTS
• Develop S-100 Product Specifications for "Inter VTS Exchange Format"
• Determine VTS's relationship with the Single Window concept


2016
2017
2018
2019
• Determine VTS's relationship with other stakeholders in the maritime domain
• Develop guidance on electronic manuals for VTS equipment to harmonise their layout
• Develop guidance on the display of accuracy and reliability of information in relevant VTS equipment
• Develop guidance for the harmonised portrayal of information received from communications equipment in VTS and other relevant shore based equipment
4 **Develop MSPs related to Aids to Navigation** (ref. Note 1.)
• Define operational/technical services within these MSPs, their request-fulfillment-relationships, their interdependencies and their quality parameters
• Develop S-100 based Product Specifications, in particular on "Aids to Navigation information"
5 **Develop MSPs related to Resilient PNT** (ref. Note 1.)
• Define operational/technical services within these MSPs, their request-fulfillment-relationships, their interdependencies and their quality parameters
• Develop S-100 based Product Specifications for these MSPs
6 **Develop a Maritime Digital Infrastructure**
• Contribute to the development of the Common Maritime Data Structure (CMDS): S-200 domain management: S-200 product specifications: Session oriented services


2016
2017
2018
2019
Explore the concept of System Wide Information Management (SWIM)
Explore the Maritime Cloud (MC) including concept (e.g.identities, the MC Identity Register (MIR), identity management, services, the service register, security and communication links) and governance model
Further develop Common Shore-based System Architecture (CSSA; [11]), including generic service description, generic M2M interfacing, application notes and guidance documents
Explore the Maritime Architecture Framework (MAF) Cube
Update the IALA Maritime Radiocommunications Plan
Develop IALA Guidance on VDES
Review IALA Guidance on AIS
Develop S-100 based product for VDEs, AIS and Application Specific Messages and manage ASM register (web catalogue)
Monitor developments of the modernisation of GMDSS (IMO) and identify the communication commonalities with e-Navigation
Liaison with ITU (WRC-19 preparation) and assistance to IALA membership for national matters
Consider developing a vision for digital/voice communication in the maritime domain


2016
2017
2018
2019
7 Develop Resilient Positioning, Navigation and Timing (PNT)
• Develop Recommendation on PNT relevant services
• Develop Recommendation on Resilient PNT
• Develop guideline on high accuracy systems
• Provide support on the development of techniques used for onboard PNT data processing
• Review IALA radiobeacon DGNSS guidance, including coverage
• Develop and maintain a road map for R-Mode
• Develop guidance on the Ranging (or R-) Mode of operation
• Develop guidance on maritime use of SBAS
• Develop guidance on eLORAN
• Consideration of additional uses of exsisting shore based infrastructure
8 Testbeds and implementation
• Revise guidance on planning testbeds and reporting of testbed results
• Provide guidance and advice on developed solutions and services

14.3. References

[1] The former Secretary-General of IMO, Mr Koji Sekimizu. *A Concept of a Sustainable Maritime Transportation System.* (Sustainable Development: IMO's Contribution beyond Rio+20). September 2013 (World Maritime Day).

[2] IMO. 'Strategy for the Development and Implementation of e-Navigation.' In: IMO Maritime Safety Committee. *Report of the Maritime Safety Committee on its 85th Session.* MSC 85/26/Add.1, Annex 20, 6 January 2009.

[3] IMO. 'Draft IMO e-Navigation Strategy Implementation Plan (SIP).' In: IMO Sub-Committee on Navigation, Communication and Search and Rescue. *Report to the Maritime Safety Committee.* NCSR 1/28, Annex 7. 16 July 2014. Adopted by IMO MSC 94, 17-21 November 2014.

[4] IMO. 'Development and implementation of e-navigation.' In: IMO Maritime Safety Committee. *Report of the Maritime Safety Committee on its Ninety-fifth Session.* MSC95/22, para 19.12. 19 June 2015. Refers to MSC95/19/8, as applicable.

[5] IHO. *S-100 – Universal Hydrographic Data Model.* First released January 2010, as amended.

[6] IALA's STRATEGIC VISION 2014-2026. (Approved by IALA Council 56-2013-12-11).

[7] Australia et al (including IALA). 'Implementing e-navigation to enhance the safety of navigation and protection.' MSC95/19/8. 03 March 2015; together with IALA co-sponsored submission to IMO MSC96 (May 2016).

[8] IALA. 'Vessel Traffic Services in a rapidly changing World.' IMO NCSR3/INF.10. 17 December 2015.

[9] IALA. IALA Guideline 1113 on Design and Implementation Principles for Harmonised System Architectures of Shore-based Infrastructure; Ed. 1; May 2015

[10] IALA. IALA Guideline 1106 on Producing an IALA S-100 Product Specification, Ed. 1, December 2013

[11] IALA. IALA Guideline 1114 on A Technical Specification for the Common Shore-based System Architecture (CSSA), Ed. 1, May 2015

[12] ACCSEAS Project. ACCSEAS e-Navigation Architecture Report; May 2015; also submitted to IALA Committees, e.g. as ENAV18-10.8.2