

Paper on the Impact of MASS on VTS

The Netherlands

1. Background

This chapter will give a brief summary of the development of MASS within the IMO in the first paragraph. Also, the definition and the levels of MASS are explained in this paragraph. Thereafter the embedding of MASS in IALA until now will be described. A relation to the strategic vision and a description of MASS in the technical committees is made. In a separate paragraph, a summary is given of the IALA workshop on MASS in Tokyo in February 2020. With the knowledge above a vision is presented of the impact of MASS in a future VTS. At the end, a summary is given of a possible scoping exercise of MASS on IALA Guidelines and Recommendations. This proposal, made by the China MSA, is in line with the scoping exercise of the IMO on MASS and could be seen as an example.

1.1 IMO adaption of MASS

IMO's strategic plan (2018-2023) has a key Strategic Direction to "Integrate new and advancing technologies in the regulatory framework". This involves balancing the benefits derived from new and advancing technologies against safety and security concerns, the impact on the environment and on international trade facilitation, the potential costs to the industry, and finally their impact on personnel, both on board and ashore. (IMO, 2020)

1.1.1 Introduction of MASS (MSC 98th session)

In the 98th session (June 2017) of the Maritime Safety Committee (MSC) of the International Maritime Organization (IMO) agreed to include the issue of Marine Autonomous Surface Ships (MASS) on its agenda. This will be in the form of a scoping exercise to determine how the safe, secure and environmentally sound operation of MASS may be introduced in IMO instruments.

The MSC recognized that IMO should take a proactive and leading role, given the rapid technological developments relating to the introduction of commercially operated ships in autonomous/unmanned mode. The scoping exercise is seen as a starting point and is expected to touch on an extensive range of issues, including the human element, safety, security, interactions with ports, pilotage, responses to incidents and protection of the marine environment. The aim is to complete the scoping exercise by 2020.

The scoping exercise could include identifying: IMO regulations which, as currently drafted, preclude autonomous/unmanned operations; IMO regulations that would have no application to autonomous/unmanned operations (as they relate purely to a human presence on board); and IMO regulations which do not preclude unmanned operations but may need to be amended in order to ensure that the construction and operation of MASS are carried out safely, securely, and in an environmentally sound manner.

The scoping exercise should address different levels of automation, including semi-autonomous and unmanned ships and could include discussion of a definition of what is meant by an "autonomous ship". Delegations suggested the exercise should include scoping of the full range of human element factors within different levels of autonomy for both shipboard and shore-based personnel; scoping of the reliability, robustness, resiliency and redundancy of the underlying technical, communications, software and engineering systems; and consideration of conducting a Formal Safety Assessment or gap analysis as to the safety, technical, human element and operational aspects of autonomous remotely controlled or unmanned ships. (IMO, 2017)

1.1.2 Definition of MASS and degrees of autonomy (MSC 99th and 100th session)

In the 99th session of the MSC (May 2018) the Committee agreed on preliminary definitions of MASS and degrees of autonomy, as well as a methodology for conducting the exercise and a plan of work.

For the purpose of the regulatory scoping exercise, “Maritime Autonomous Surface Ship (MASS)” is defined as *“a ship which, to a varying degree, can operate independently of human interaction”*. (IMO, 2018a)

In the 100th session of the MSC (December 2018) the degrees of autonomy were identified for the purpose of the scoping exercise are (IMO, 2018b):

- Degree one: Ship with automated processes and decision support: Seafarers are on board to operate and control shipboard systems and functions. Some operations may be automated and at times be unsupervised but with seafarers on board ready to take control.
- Degree two: Remotely controlled ship with seafarers on board: The ship is controlled and operated from another location. Seafarers are available on board to take control and to operate the shipboard systems and functions.
- Degree three: Remotely controlled ship without seafarers on board: The ship is controlled and operated from another location. There are no seafarers on board.
- Degree four: Fully autonomous ship: The operating system of the ship is able to make decisions and determine actions by itself.

1.1.3 Regulatory scoping exercise on MASS (IMO assessing process) (MSC 100th session)

The 100th session of the MSC also approved a framework and methodology for the regulatory scoping exercise on Maritime Autonomous Surface Ships (MASS). The assessment is done in two steps.

In the first step each instrument related to maritime safety and security, and for each degree of autonomy, provisions will be identified which (IMO, 2018b):

- Apply to MASS and prevent MASS operations; or
- Apply to MASS and do not prevent MASS operations and require no actions; or
- Apply to MASS and do not prevent MASS operations but may need to be amended or clarified, and/or may contain gaps; or
- Have no application to MASS operations.

Once the first step is completed, a second step will be conducted to analyse and determine the most appropriate way of addressing MASS operations, taking into account, inter alia, human element, technology and operational factors. The analysis will identify the need for (IMO, 2018b):

- Equivalences as provided for by the instruments or developing interpretations; and/or
- Amending existing instruments; and/or
- Developing new instruments; or
- None of the above as a result of the analysis.

The list of instruments to be covered in the MSC’s scoping exercise for MASS includes those covering (IMO, 2020):

- Safety and maritime security (SOLAS);
- Collision regulations (COLREG);
- Loading and stability (Load Lines);
- Training of seafarers and fishers (STCW, STCW-F);
- Search and rescue (SAR);

- Tonnage measurement (Tonnage Convention); Safe Containers (CSC); and
- Special trade passenger ship instruments (SPACE STP, STP).

1.1.4 Interim guidelines for MASS trials (MSC 101st session)

In the 101st session of the MSC approved Interim guidelines for MASS trials.

Among other things, the guidelines say that trials should be conducted in a manner that provides at least the same degree of safety, security and protection of the environment as provided by the relevant instruments. Risks associated with the trials should be appropriately identified and measures to reduce the risks, to as low as reasonably practicable and acceptable, should be put in place.

Onboard or remote operators of MASS should be appropriately qualified for operating MASS subject to the trial. Any personnel involved in MASS trials, whether remote or onboard, should be appropriately qualified and experienced to safely conduct MASS trials. Appropriate steps should be taken to ensure sufficient cyber risk management of the systems and infrastructure used when conducting MASS trials. (IMO, 2019)

Autonomous and remote-controlled ships are already being trialled in some sea areas. Most predictions are that autonomous or semi-autonomous operation would be limited to short voyages, for example, from one specific port to another, across a short distance. (IMO, 2020)

1.2 MASS in IALA

The aim of IALA is to foster the safe, economic and efficient movement of vessels, through improvement and harmonisation of aids to navigation worldwide and other appropriate means, for the benefit of the maritime community and the protection of the environment. (IALA, 2017)

Taking into account the needs of mariners, developments in technology and the requirements and constraints of aids to navigation authorities, a number of technical committees have been established. The work of the committees is aimed at developing common best practice standards through the publication of IALA Recommendations and Guidelines. (IALA, 2020a)

The introduction of MASS in the maritime domain involves the work of all the technical committees and should be addressed on their agenda's. The alignment of MASS to IALA's strategic vision 2018-2026 regards both goals G1 and G2 and strategies S1, S2, S3, S4, S5 and S6. (See appendix 1).

The document "Position on the development of marine aids to navigation (AtoN) services" describes the positions 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. (IALA, 2019a)

In the 2019 edition of the document position statements on MASS are made in three occasions;

1. Impact of autonomous vessels on AtoN infrastructure. This statement belongs to the IALA standard "AtoN and delivery". (ARM Committee)
2. Autonomous vessels in a VTS area. This statement belongs to the IALA standard "Vessel Traffic Services". (VTS Committee)
3. Digital services for autonomous vessels. This statement belongs to the IALA standard "Information Services". (ENAV Committee)

The purpose of the statements is to provide a link between the Strategic Vision and the work programmes of the Committees, giving guidance, where needed, on the technical philosophy on specific topics and IALA's preferred policy direction. (IALA, 2019a)

1.1.5 MASS in IALA Technical Committees

The Technical Committees are working according to a council approved Committee Work Programme. The Work Programme only mentions the headlines of the programme, details of the tasks are determined by the Committees and mentioned in the task plan and -register. In the work programme for 2018-2022 MASS is mentioned in the task plans for the VTS, ENAV and ARM Committee.'

MASS in VTS Committee:

Position statement: IALA will prepare for the advent of Maritime Autonomous Surface Ships (MASS) 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 autonomous vessels with conventional traffic, the information flow between MASS and shore authorities, and the related information exchange with conventional traffic.

IALA envisages that MASS will need services from shore including digital Maritime Safety Information (MSI) perhaps in formats specifically for autonomous vessels. (IALA, 2019a)

In the task register of the VTS Committee, the Committee is scheduled to start the task to develop a guideline on the implications of MASS from a VTS perspective in the VTS50 meeting which is planned in spring 2021 (Task 1.2.5). The objectives of the task are to prepare a scoping document on the adoption of autonomous vessels and how to identify emerging trends in the delivery of VTS globally. The expected outcome is a scoping document which assists IALA and VTS authorities to consider the implications associated with the emerging development of MASS with regard to VTS. The compelling need, the strategic alignment, the scope and a brief description of the work to be undertaken still need to be established by the VTS Committee. (IALA, 2019d)

MASS in the ENAV Committee:

Position statement: 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.

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. (IALA, 2019a)

The ENAV Committee mentioned in his task plan for work period 2018-2022 three tasks with relation to MASS;

1. Develop an IALA position paper on MASS.
2. Liaise with IMO on MASS from marine aids to navigation points, as necessary
3. Monitor and report on emerging technologies that could be applicable to MASS

In the ENAV Committee 24 session, presentations have been given on MASS from the Norwegian forum for autonomous ships and the Australian Autonomous Vessel Forum. The Committee noted the developments of MASS, but did not start working on their MASS related tasks yet. (IALA, 2019c)

MASS in the other Committees

Position statement: In future, new AtoN services may be needed for MASS (Maritime Autonomous Surface Ships) as well as for traditionally crewed ships. New requirements for availability, redundancy and continuity may be needed.

IALA will monitor the development of MASS navigation technology and performance, determine what AtoN services should be provided from shore and develop appropriate guidance.

At present it seems likely that an important service that will be required by MASS will be a resilient positioning service. Terrestrial positioning services may be required in some areas to achieve the resilience necessary.

So called “smart buoys” and AIS Application Specific Messages (ASM) might also contribute by providing real-time weather and tidal information in digital format direct to MASS.

Where VDES or AIS base station networks are implemented they may provide the necessary secure coastal connectivity for automatic reporting by MASS to shore authorities and VTS. VDES could also provide a satellite tracking capability for shore authorities and VTS. (IALA, 2019a)

Task 1.5.7 of the ARM Committee is to develop guidance on the provision of AtoN for autonomous vehicle/vessel operations (MASS). The expected output is a new guideline and a possible recommendation. The task is monitored by the Committee but is not scheduled yet for one of their sessions in the 2018-2022 task plan. (IALA, 2018)

1.3 International meeting for MASS infrastructure

From 12th to 14th February 2020 there was an expert meeting on MASS and shore maritime infrastructure including marine aids to navigation in Tokyo, Japan. During this meeting, the impact of MASS on shore infrastructure was discussed.

With some testbeds and member state developed roadmaps to introduce MASS it was discussed that visual, Radio, Audible and virtual Aids to Navigation (AtoN) are useful not only for MASS but also for conventional ships operating under harsh environmental conditions or geographic features.

The participants of the meeting recognized that existing visual, radio, and audible AtoN can contribute to forming a suitable platform of complementary and enhanced services for MASS. Studies on the usage of such existing AtoN's should be initiated with a goal to develop new technologies and policies. (IALA, 2020b) The use of these technologies should consider the environmental and safety impact and these technologies should also consider cyber security risks. In relation to AtoN's the participants also discussed Position, Navigating and Timing (PNT) issues and agreed that radio navigation systems such as R-Mode, e-Racon could be useful for MASS operations. (IALA, 2020c)

During the meeting, the participants also discussed the future roles of VTS in MASS operations. It was agreed that VTS should support MASS operations, however, VTS should retain its principle services for all vessels. While VTS maintain their core services, the participants agreed that it could be useful to share information with MASS to improve the ability to share the common operational picture of the area. In order to facilitate data sharing, VTS should be digitized. In that sense, IALA should consider revising the Recommendation V-145 “Inter-VTS exchange format service” to include exchanges with MASS Shore Control Centers (SCCs) and other allied services. As for SCC, the participants agreed that human supervision is required at all levels of autonomy of MASS and the human-machine interface is a key component for ensuring safe MASS operations. Although the VTS Operator (VTSO) may not be involved in controlling a MASS, procedures are necessary how a VTSO should act and communicate in case of an emergency.

Experts agreed that radiocommunication infrastructure for MASS operation should be robust and redundant. Guidance materials for the use of VHF Data Exchange System (VDES) and other potential technologies such as 5G should be developed, while taking cyber security issues into consideration. (IALA, 2020c)

Harmonization of data models of different sectors will be the key to intermodal transport involving MASS. Therefore MASS operations requires interoperability across transport modes such as sea, rail, road and air, and could include coordination with intelligent transport system standardization initiatives. (IALA, 2020c) We also can learn from trials, testbeds and experience in other industries such as road and railroad.

Finally, the participants concluded that sharing information about testbeds on a central hosted website is important. Testbed information on MASS operations supports the development of new infrastructure. (IALA, 2020b)

1.4 Maritime Autonomous Surface Ships and the future on Vessel Traffic Service.

In the near future, it is likely that all four, by IMO determined, levels of MASS will be sailing from destination to destination and someone will keep responsibility for the ship and its behaviour in traffic patterns. A safe

and smooth passage through sea-lanes traffic separation schemes and port areas will be one of the biggest challenges of MASS. High density traffic areas with small unidentified vessels present major challenges in safe navigation. Standardization for data exchange, connectivity and automated technologies are required. The challenges on standardization and deployment of MASS need to be addressed in cooperation with international partners.

The revised IMO resolution A.857(20) VTS guidelines introduces the use of data communication between shore and ship in addition to communication via VHF. The revised VTS guidelines opens the door for future VTS.

The concepts of E-navigation are very important to enhance maritime safety and connectivity and to serve the needs of future VTS. This is also consistent with connected cooperation between MASS and VTS services within port and coastal areas. There is a need to exchange knowledge, expertise and best practices, and work towards a global framework of partners. This chapter is intended to stir up the discussion about creating a VTS system wherein all objects are visible and whereby it is possible to exchange information with each other about intentions, characteristics, limitations, and environment. In addition to this, the VTS has to be equipped properly to give correct advice and information, regardless of the nature of the ship varying from conventional to MASS.

The ship navigation and vessel traffic services are all about safe sea and port passages. It is about floating objects moving through an area without colliding and grounding and at the end moor safely at another object called berth. In a digital way, these objects are interacting and exchanging information about the intentions, characteristics, limitations and environment with the purpose to sail safely through the area. The next VTS generation will be more about enabling data exchange and interaction than sending safety messages. To determine the quest on VTS of the future, three main topics can be defined:

1. Full digital situational awareness,
2. Interacting objects,
3. Advanced decision support.

Full digital situational awareness

With the introduction of digital charts applications, for both shipmasters and VTS operators, digital situational awareness will become increasingly important. Applications for automated route planning, automated autopiloting and maritime collision avoidance systems will demand a complete and correct representation of reality. Also, 100% digital situational awareness will be needed to realize the full potential of automation.

The use of multiple sensors on board is already common technology. Radar and AIS, for example, are obliged and already fully integrated within ECDIS and VTS systems. Full visibility digital awareness on all weather conditions, however, has not been seen yet. In the recent years, there are initiatives to add new types of sensors to ship bridge systems and moreover, ships are provided with additional object detection sensors and Artificial Intelligence (AI) technology to give the ship's commander a better object visibility. As ships have different sizes, propulsion and reactions distances (time), the development of one type of system will not be convenient. Situational awareness systems will have different "digital line of sights". A large oil tanker and a small container vessel, for example, will have their own ship-specific model of control and reaction time and as such their own need of information.

In narrow curved and high density traffic area's it is reasonable to assume that the "digital line of sight" will be blocked. Information from other objects (ships and shore based) might be used fully in such situations. Questions will arise on connectivity and reliability of third party information. (Dorsser - Port of Rotterdam, 2020)

Interacting objects

Emerging technologies radically transform the ways of behaviour and interaction with each other. Within the technical possibilities, objects communicate more and more often. For example, on the shore side, bridges will be capable to inform cars that they will open soon and the route information system within the car will adjust the advised route. MASS will and must be able to interact with each other and with shore support systems like VTS. Connecting digital ships and the digital shore systems will be about interacting objects.

Objects do not necessarily communicate with each other by sharing messages only. It requires technology and standardization to create an infrastructure where objects are able to interact with each other. Intelligence will be added to the ecosystem. They communicate with each other in a way that allows them to specify what is required, but leaves the implementation of that behaviour to the receiving object. At the end intelligence will be added to the ecosystem to make decisions.

It can be concluded that the interaction between ships is based on standardization and interpretation of predictable behaviour. One of the main questions to be answered is “Do I understand the information I receive and do we have a common view on each other’s near future behaviour.” How it ensured that objects will make the best decision? (Dorsser - Port of Rotterdam, 2020)

Human behaviour and advanced decision support

MASS will use route prediction based on object information and AI support systems. This information will and must be available for the VTS operator as well. The presentation and interpretation of the information and data from MASS towards shore systems (and vice versa) cause a need for a revision of ergonomic and psychologic component of the VTS.

The aim is to enhance the data that a VTS operator uses in such a way that one is supported in monitoring (focusing on, attention, prioritizing and risk-based processing). Route prediction and collision avoidance play an important role here, but also the paradox of automation. The challenge is to keep the situational awareness and alertness of the operator while leaving the monitoring partly to the system. Advanced decision support services based on human interaction are most likely needed. (Dorsser - Port of Rotterdam, 2020)

Enhanced inter-operability

The introduction of MASS in VTS area’s request the establishment of common terminology, form and standards for communication, ship reporting and data exchange to enhance inter-operability of systems across different VTS authorities, MASS developers and various stakeholders in ports. Enhanced inter-operability of various systems will allow international ports to be more accessible for MASS, especially since vessels do not need to apply for other sets of standards or use unique communication systems/equipment when operating within different ports around the world. With the development of standards for MASS and MASS infrastructure, VTS authorities can deliver a big effort on the field of data exchange. Standardization of types of services and result oriented instructions will help to enhance inter-operability of systems.

1.5 Cybersecurity: Reliable and integrable VTS

Within VTS, multiple data sources are used to create a traffic image. With the introduction of MASS and the digitalization of ships and ports, it can be assumed that more and more third party data / information will be introduced within the decision making. For the application of MASS, it is vital that data is accurate and reliable as decisions are made based on this data. This requires that cyber security measures should be a mandatory part of all developments. Consideration on cyber security is required where existing technology is applied for use within MASS and all other ship-to-ship or ship-to-shore communications. For instance, when using AIS-sourced data, it is important to realize that the AIS (protocol) has never been designed with (cyber) security in mind and AIS data provided by the owner of the AIS station. AIS is an open protocol which data can easily be manipulated by spoofed (copie and send out with other data) and can lead to unreliable data in the context of situational awareness. AIS introduced multiple treats to VTS and MASS. For example, all timeslots might be claimed from a nearby AIS station or the data of other targets (ships) could be spoofed so that regular AIS communication is not reliable and the situational awareness of the ship, VTS or MASS could be tampered with AIS data for the covered area by the base station. The impact depends very much on the way of using AIS and AIS data.

Keywords in cyber security are confidentiality, availability and integrity. While most data required in the application for MASS is not very confidential, availability and integrity require measures. These measures may be preventive or reactive and incorporate policies and technology. For developers, it is recommended to follow best practices for working with a ‘security by design’ methodology and verifying the results. While in operation,

regular checks, e.g. pen tests should be performed on the technology. For end users, awareness is most essential.

To achieve availability and integrity, best practice is to implement identification, authentication and encryption on all data streams. This is complemented by applying reliable and/or redundant communication technology, like a combination of LTE, Satellite, VDES and WiFi (mobile networks) in port areas. Attention must also be paid to physical security, like locks on cabinets on board vessels to protect the involved computer systems from unauthorized access and disabling USB ports. As an additional measure, checks may be implemented in protocols, for example the verification of timestamp or location in received messages with data from other sources line on-board AIS, Radar and GPS systems. (Ebben & Dorsser - Port of Rotterdam, 2020).

It can be concluded that cyber security is an important part with the introduction of digitalization in the maritime domain. MASS relies on the exchange of digital information with other systems like shore infrastructure, VTS and other ships. It might be obvious that reliable cyber security measures for the operation of MASS is of major importance. In order to introduce MASS on a global scale there is a strong need for international accepted guidelines and recommendations describing measures related to cyber security which becomes relevant when a port or VTS authority allows MASS within their area. Cyber security is already on the agenda of IALA's Technical Committee ARM. The ARM Committee should be aware of IMO's definition and levels of MASS and should be requested to take into account MASS when preparing a guideline and recommendation cyber security. Special attention on cyber security risks is needed for the VTS, MASS and other vessels when entering and sailing through VTS areas.

1.6 Draft scoping exercise on implications of MASS on VTS documents

Recognizing that close cooperation between VTS personnel and participating vessels determines the level of safety and efficiency of maritime traffic in the areas covered by VTS. And considering the importance of item 1.2.5 of the VTS Committee's 2018-2022 work plan, "Develop a Guideline on the implications of MASS from a VTS perspective", China Maritime Safety Administration (China MSA) carried out preliminary research to introduce a research method for a scoping exercise of IALA guidelines and recommendations. China MSA also tested this research method by doing a scoping exercise on guideline G1141-VTS "Operational procedures for VTS" under the S1040 standard framework. China MSA presented the research method and the preliminary results of the scoping exercise in an input paper for the VTS Committee. (VTS48-8.2.6). (China MSA, 2020)

China MSA used for the scoping exercise of the G1141-VTS the framework for the regulatory scoping exercise for the use of MASS (MSC 100/20/add.1) as approved in the MSC 100th session. The framework also optimized on considering the characteristics of existing VTS documents in IALA and VTS operation, management and technology, including the influence of human factors. About the implications of MASS on VTS, China MSA determined in a qualitative analysis the following inapplicability's: (China MSA, 2020)

- Inapplicability of traditional communication methods. Regardless of whether MASS adopts remote control station or is fully autonomous, it will inevitably require a new communication method to supplement the traditional VHF voice communication as well as meet the needs of large data transmission.
- Inapplicability of the capabilities of VTS personnel. The performance of VTS functions depends on the cooperation between VTS personnel and deck officers. However, the introduction of new technologies may break this relationship, so VTS personnel need to adapt to the challenges brought by the development of MASS.
- Inapplicability of VTS equipment. VTS equipment needs to be upgraded to meet the requirements of MASS, including VTS network security and future large-scale data transmission.
- Inapplicability of legal instruments. For example, Convention on the International Regulations for Preventing Collisions at Sea, 1972 (COLREGs) and local regulations of each VTS center.

- Inapplicability of VTS emergency procedures. The ultimate goal of MASS is to have no seafarers on board, while the existing VTS emergency procedures are mainly based on the interaction between VTS personnel and seafarers.

The work done by China MSA might be an example and a start of the work to be done on the scoping exercise of IALA Guidelines and Recommendations for the impact of MASS on VTS. The discussion of this should be addressed to the VTS Committee.

2. Discussion

General

In light of the MASS developments at IMO and around the world, it is a timely opportunity for like-minded VTS authorities, ports and coastal authorities to collectively address challenges and to achieve alignment of standards for operating MASS globally.

In particular, since IMO does not deal directly with the governance of respective ports and VTS authorities, it is therefore imperative to develop common global standards for interoperability among different VTS and port systems supporting ocean-going MASS operations. IALA can help to further encourage development technologies related to MASS infrastructure by developing agreed guidelines and standards for MASS trials and operation in VTS areas.

IALA should aim to establish common terminology and standards for communication, ship reporting and data exchange, between MASS and various stakeholders, such as VTS. Enhanced inter-operability of various systems would allow international ports to be more accessible to MASS. IMO's definition of MASS and the description of the four levels of MASS should be the bases for the discussion of MASS in IALA.

Action Point 1

To achieve the goal of standardisation and harmonisation, the IALA Technical Committees should be aware of the IMO definition of MASS and the corresponding levels and should take this into account by developing Guidelines and Recommendations.

The development of MASS and MASS infrastructure involves all IALA Technical Committees. Discussions about MASS in the Committees are scheduled in ARM, ENAV and VTS in the coming years. MASS also involves the ENG Committee. Until now, there is no coordinated coherence about the MASS discussion in the separate Committees. To get structure, it makes sense to create an inter-committee task force which can coordinate the discussion on MASS in the separate Committees.

Action point 2

Secretariat is invited to send this document to PAP 40, VTS 49, ENG 12, ENAV 26 and ARM 12 and establish an inter-committee task force under the supervision of PAP to structure and coordinate the discussion and work on MASS within IALA.

Shore infrastructure and AtoN's

It is obvious that all levels of MASS will be sailing from destination to destination in the future, the responsibility of MASS and its behaviour has to be discussed and determined in IMO. Sailing through ports, coastal and VTS areas, however, belongs to IALA responsibility. MASS operation requires digital and automated processes. AtoN's could provide these service but to do so future AtoN's should be smarter in a way that they also can provide and receive information to and from MASS. Physical and digital assessment of existing AtoN's is necessary to guide MASS safely through an area. Modifications of shore infrastructure and support which contribute to enhance VTS systems with full detection and precise PNT, interacting objects and advanced decision support should be studied and discussed. Where necessary Guidelines and Recommendations on VTS and AtoN's should be developed or amended to enhance the infrastructure and to give authorities an instrument to allow MASS in their management area. To start this process it is recommended to do a scoping exercise on existing IALA guidelines and recommendations.

To help authorities introducing MASS in a worldwide harmonized way it is important to do a scoping exercise with the four levels of MASS on all IALA's guidelines and recommendations. The scoping exercise will learn which guidelines and recommendations need amendments or where new guidelines or recommendations have to be developed. With the scoping exercise awareness and knowledge about MASS will be brought in all IALA Technical Committees. The introduction of MASS and the resulting scoping exercise is a major task and request intensive international co-operation.

Action Point 3

The PAP, in support of Secretariat, invited to consider a scoping exercise, in relation to MASS, and its impact on IALA Guidelines and Recommendations.

Cyber security

MASS relies on the exchange of digital information with other systems like shore infrastructure, VTS and other ships. Digitalization and connectivity make systems vulnerable for cybercrime. In the maritime domain malfunctions of systems can have enormous consequences for safety and the environment. It might be obvious that reliable cyber security measures for the operation of MASS are of major importance. To introduce MASS on a global scale there is a strong need for international accepted Guidelines and Recommendations on how to deal with cyber security when a port or VTS authority allows MASS within their area.

Action Point 4

With the introduction of MASS, authorities should always be aware of cyber security risks. Therefore, special attention should be given to MASS when developing cyber security related Guidelines and Recommendations.

Guideline for MASS testbeds

IALA should endeavour to agree on conditions for MASS trials within VTS areas, which are in line with IMO's interim guidelines for MASS testbeds. This includes, but is not limited to the following:

- To define the scope for application of IALA Guidelines and Recommendations in ensuring that the intent is met;
- To develop risk mitigating measures and emergency plans pertaining to communications and data exchange, reporting, cyber risk etc.;
- To determine the extent to which MASS of varying degrees of autonomy should and could interact with each other, with the VTS and with manned vessels, during trials in VTS areas.
- To determine how VTS emergency procedures should be adjusted or created when MASS of varying degrees are allowed in a VTS area.

Some countries and some ports are already in a front running position. They already allow MASS trials within their areas. It is recommended to use the experience of these trials in the development of a guideline for MASS testbeds.

Action Point 5

The IALA VTS Committee should consider the need to develop guidance on MASS testbeds in VTS areas, similar to the IMO's interim guidelines for MASS trials.

The aim of this guideline is to provide guidance to IALA members who may undertake testing and trials of MASS systems. This guideline also provides guidance for organisations implementing policy, procedures and technical solutions to support the introduction of MASS.

Sharing information of MASS developments

All IALA members need to be invited to share information about local or national initiatives on MASS tests and trials. Sharing information will help to get a common view on the development of MASS and the need for the development of the infrastructure, including VTS, which is necessary to let a MASS sail safely. Sharing information helps to determine the need for general standards. It is obvious that a platform to share information of these tests and trials can be consulted by all IALA members. The platform might be more

valuable when it is created in cooperation with other bodies like IMO and CIRM, but to start a platform can be created on the IALA website.

Such a platform also can bring different stakeholders involved with MASS trials together in a community with, besides the purpose of sharing information, also the possibility to find each other in successive testbeds.

Action Point 6

The IALA Secretariat is invited to explore ways of sharing information and enhance MASS cooperation both within IALA and with other international bodies.

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APPENDIX 1

1 APPENDIX GOALS AND STRATEGIES IALA STRATEGIC VISION 2018-2026

Goals

G1 – Marine Aids to Navigation are developed and harmonised through international cooperation and the provision of standards.

G2 - All coastal states have contributed to a sustainable and efficient global network of Marine Aids to Navigation through capacity building and the sharing of expertise.

Strategies

S1 - Develop standards suitable for direct citation by States, in areas deemed important by the General Assembly, and the related Recommendations and Guidelines.

S2 - Position IALA as the source of standards, knowledge, and expertise that will enable States to provide Marine Aids to Navigation, in accordance with relevant international obligations and recommendations.

S3 - Coordinate the further development of Marine Aids to Navigation, taking into account evolving operational and functional requirements, new techniques, new technologies and sustainability.

S4 - Continue to develop capacity building activities to improve the global provision of Marine Aids to Navigation.

S5 - Harmonise the information structure and communications for future navigation by creating standards, and by cooperation with other international organisations, to achieve worldwide interoperability of shore and ship systems.

S6 - Improve and harmonise the delivery of VTS globally and in a manner consistent with international conventions, national legislation and public expectations, to ensure the safety and efficiency of vessel traffic and to protect the environment.

S7 - Work towards the transformation of IALA into an IGO, to enable the organization to achieve its aim and objectives.

S8 - Ensure that the resources and capabilities of the Secretariat are sufficient to enable IALA and its committees and organs to reach its goals.

(IALA, 2017)