



C76-10.5.20.1

TG 1.4.3 Future VTS  
Output to VTS53

## DISCUSSION PAPER

# FUTURE VTS

**Edition 2.0**

**28 September 2022**



# DOCUMENT REVISION

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Revisions to this IALA Document are to be noted in the table prior to the issue of a revised document.

Date	Page / Section Revised	Comments
7 October 2021		Version 1 of discussion paper
13 April 2022		Version 1.2 of the discussion paper
28 September 2022		Version 2.0 of the discussion paper



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## 1. DOCUMENT PURPOSE

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The purpose of this document is to provide a basis for discussion on emerging trends, technologies and practices that have implications for VTS and to strategically plan and coordinate embracing the change associated with these to improve the safety and efficiency of navigation, contribute to the safety of life at sea and support protection of the marine environment.

In particular, the document aims to provide a concise, high level, reference to assist the Committee:

- Be cognisant of emerging practices, technologies and trends that will affect the provision of VTS.
- Assess and monitor the potential impact, challenges and opportunities for VTS.
- Achieve a common view regarding the role and capabilities of 'Future VTS' in contributing to the safety and efficiency of navigation and the protection of the environment by mitigating the development of unsafe situations.
- Strategically embrace change, how existing VTS practices could be enhanced, and potential new practices adopted.
- Plan for the future, for example:
  - Adopting work programme tasks that reflect a changing maritime environment and improve the harmonized delivery of VTS globally in a manner consistent with international conventions and public expectations.
  - Facilitating necessary changes to IALA Standards relating to VTS or the international legal and regulatory framework for VTS.
  - Managing any practical issues and challenges in transitioning to a more proactive role for VTS in the future.
  - Liaising/engaging with other international bodies.
  - Engaging and communicating with all stakeholders and the public.

The intention is for this document to support IALA's *Strategic Vision* and *Current Drivers and Trends* by providing a means to identify and monitor maritime trends and global developments which have implications for VTS, both now and in the future. In particular:

- **Strategic Vision** – The strategies to achieve the goals outlined in the *Strategic Vision* include:  
*“Improve and harmonize 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.”* (Strategy 6)
- **Current Drivers and Trends** – In identifying maritime trends and global developments likely to have an impact on IALA and its priorities to support its strategic goals, it concludes:  
*“The trends should be closely monitored and considered in the future priorities of the association”.*

As a 'living document', it is intended that the document will reviewed/updated by the Committee at each meeting as appropriate.

## 2. EXECUTIVE SUMMARY

Globally, there is a trend for more proactive management of shipping in response to increasing volumes of traffic, emerging technologies and practices, increasing competition for access to waterway space and changing public expectations.

VTS, as an internationally recognized navigational safety measure contributing to the safety of life at sea, safety and efficiency of navigation and protection of the marine environment, will play a key role in this change.

There is consensus that the transition to embracing emerging developments and “future VTS” needs to commence now. Adoption of this document provides a mechanism for a planned and coordinated transition as:

- Requisite technologies develop (e.g., digital communications and automated data exchange),
- Emerging practices such as MASS, Sea Traffic Management and Just-in-time arrival mature, and
- Changes are adopted to key IMO instruments such as SOLAS, COLREG and STCW to accommodate emerging developments.

### Emerging trends, technologies, and practices

Emerging trends, technologies and practices that will shape the role and capabilities for “future VTS” include:

Emerging trend, technology, and practices	Refer to Section:
Maritime Autonomous Surface Ships (MASS)	4.3.1
Digital technologies and communications	4.3.2
Green House Gas Emissions / Just in Time Arrival	4.3.3
Advanced Decision Support Services	4.3.4
Automated Data and Information Exchange	4.3.5
Navigational Support / Assistance	4.3.6
Sea Traffic Management	4.3.7
Marine Spatial Planning	4.3.8
Interacting Objects	4.3.9
Digital situational awareness / Common Situational awareness	4.3.10
Slot Management	4.3.11
New sensing technology for nearshore and port waters	4.3.12
Long-distance sensing technology	4.3.13

While these present many challenges for the maritime sector, they also provide opportunities for VTS to enhance its contribution to the safety and efficiency of vessel traffic and protection of the environment by evolving with the changes and by adopting new and enhanced capabilities to embrace an evolving role.

The potential implications of these developments, their expected timeframe and the VTS Committee’s action/response to embracing these is discussed in *Section 4.3 - Emerging trends, technologies, and practices*.

## Expectations for “future VTS”

Key expectations for “future VTS” include:

Purpose of VTS	Expectations		
<b>Provide timely and relevant information</b>	1. Interaction between VTS and ships (conventional ships, MASS and remote-control centres) will primarily be through digital communications/data exchange for: <ul style="list-style-type: none"> <li>• ‘Ships<sup>1</sup>’ to provide reports and information required by a VTS.</li> <li>• VTS to provide ‘ships’ with information on factors that may influence ship movements and assist ‘onboard<sup>2</sup>’ decision-making.</li> <li>• VTS to issue advice, warnings, and instructions to achieve its purpose.</li> </ul>		
	2. VTS will provide an information management / data exchange hub that facilitates: <ul style="list-style-type: none"> <li>• Efficient information management and exchange between all stakeholders</li> <li>• Prediction of situations that may impact the efficiency and safety of ship traffic and management of these before they evolve into developing unsafe situations requiring intervention.</li> </ul>		
	<b>Monitor and manage ship traffic to ensure the safety and efficiency of Ship movements</b>	Future VTS will monitor and manage ship traffic to ensure safe and efficient ship movements, both conventional and autonomous, through enhanced capabilities to: <ul style="list-style-type: none"> <li>• Assist stakeholders pre-plan voyages / movements</li> <li>• Predict potentially developing traffic situations that may impact on efficiency or safety</li> <li>• Proactively manage ship movements and space allocation to maximize efficiency and safety</li> </ul>	
		<b>Responding to developing unsafe situations</b>	Future VTS will have the capability to interact seamlessly with conventional ships, MASS, ship control centres and allied services to provide: <ul style="list-style-type: none"> <li>• navigational information to assist on board navigational decision-making.</li> <li>• navigational advice and/or instruction as appropriate.</li> </ul>

## Realising the Expectations

The drivers and trends identified in IALA’s *Current Drivers and Trends* document present many challenges to the maritime sector, however they also provide opportunities for VTS to enhance its contribution to the safety and efficiency of vessel traffic and protection of the environment through adopting enhanced and new processes and capabilities to mitigate the development of unsafe situations through:

1. Providing timely and relevant information on factors that may influence ship movements and assist onboard decision-making
2. Monitoring and managing ship traffic
3. Responding to developing unsafe situations

Recognising future traffic will consist of ships with traditional bridge teams, onboard autonomous systems and RCCs and there will be significant changes to the IMO regulatory regime for ship movements (e.g., COLREG) and possibly new IMO instruments relating specifically to autonomous ships it is anticipated there may be changes to the role and functions provided by VTS as these emerging practices, technologies and processes evolve and are adopted.

Key elements being explored in *Section 4.2 – Realising the Expectations* in transitioning to “future VTS” include:

<sup>1</sup> ‘ship’ – refers to conventional and autonomous

<sup>2</sup> ‘onboard decision-making’ refers to the “responsible entity” for the ‘ship’

- IALA Standards for digital communications / data exchange for all interactions, including:
  - ‘Ships’ to provide reports and information required by a VTS.
  - VTS to provide ‘ships’ with information on factors that may influence ship movements and assist ‘onboard’ decision-making.
  - VTS to issue advice, warnings, and instructions.
- Managing a mix of traditional VHF voice, digital communications, and automated data exchange
- The intent of messages conveyed to actors is the same, irrespective of whether it is by voice or digital means.
- Messages can be conveyed to an individual ‘ship’ or all ‘ships’ by either VHF voice, digitally or via data exchange.

**Note** – VTS Committee commences new Task on VTS Digital Communications at VTS52

- Development of IMO goal-based MASS instrument, including:
  - MASS terminology and definitions, including an internationally agreed definition of MASS and clarifying the meaning of the term “master”, “crew” or “responsible person”, particularly in Degrees Three (remotely controlled ship) and Four (fully autonomous ship).”
  - MASS required to participate in VTS. That is, subject to the same:
    - Regulatory reporting requirements, and
    - Obligations with regards to the issue of advice, warnings and instructions as deemed necessary.
    - MASS will be subject to COLREG, as amended.
    - MASS will be required to broadcast status as to who/what is in command at any time (Master/on-board DST, Remote Control Center?)
- the functional and operational requirements of the remote-control station/centre and the possible designation of a remote operator as seafarer

### Implications for the international framework for VTS

Consideration of the expectations for ‘Future VTS’ (Section 4.1) and the implications of emerging developments (Section 4.3) highlights that embracing emerging developments and transitioning to ‘future VTS’ may be achieved without amendments to:

- SOLAS regulation V/12 (Vessel Traffic Services).
- IMO resolution A.1158(32) *Guidelines for Vessel Traffic Services*.

Key considerations in adopting the revision of the Guidelines for Vessel Traffic Services (Resolution A.857(20)) into its post-biennial agenda in 2018, included ensuring the Guidelines:

- “were modernized/updated and continued to serve as an effective instrument, providing a clear framework to implement vessel traffic services globally in a harmonized manner”, and
- “provide a framework to accommodate new trends (e.g., the development and implementation of Maritime Services, *e-navigation development, etc*).

Resolution A.1158(32) recognizes the need to need to take account of applicable IMO instruments, other international guidance and future technical and other developments recognized by the Organization relating to VTS, for example:

- “1.4 In complying with these Guidelines, Contracting Governments should take account of applicable IMO instruments and refer to the relevant international guidance prepared and published by appropriate international organizations.”

- “7.5 Effective harmonized data exchange and information-sharing is fundamental to overall operational efficiency and safety. VTS providers are encouraged to make use of automated reporting where *possible*.”

The emerging developments are largely dependent on changes to other Chapters/regulations within SOLAS and other IMO instruments such as COLREG and STCW.

Consensus is that embracing emerging developments and transitioning to ‘future VTS’ can be achieved through adapting IALA Standards as appropriate, noting the ‘new’ resolution for VTS states:

- 1.3 *IALA is recognized as an important contributor to IMO's role and responsibilities relating to vessel traffic services’.*
- 9.2 *‘Contracting Governments are encouraged to take into account IALA standards and associated recommendations, guidelines and model courses’.*

This conclusion is consistent with the outcomes from the recently completed regulatory scoping exercise on Maritime Autonomous Surface Ships (MASS) by the IMO to assess existing IMO instruments to see how they might apply to ships with varying degrees of automation (103<sup>rd</sup> Session of the MSC, May 2021). In summary, the scoping exercise did not identify any issues associated with SOLAS regulation V/12 (Vessel Traffic Services) or the IMO resolution for VTS with regards to the advent of MASS.

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### 3. INTRODUCTION

Vessel Traffic Services (VTS) is recognised internationally through the International Convention on the Safety of Life at Sea 74/78 (SOLAS) as a navigational safety measure contributing to the safety of life at sea, safety and efficiency of navigation and protection of the marine environment.

The International Maritime Organization (IMO), in its role in regulating the planning, implementation and operation of vessel traffic services, is responsible for providing guidance on its establishment, operation, qualification and training (IMO Resolution 1158(32) Vessel Traffic Services. In particular, the resolution:

- Defines VTS as a service *“implemented by a Government with the capability to interact with vessel traffic and respond to developing situations”*.
- States that the purpose of VTS is to *“contribute to safety of life at sea, safety and efficiency of navigation and the protection of the environment within the VTS area by mitigating the development of unsafe situations through”*:
  - *“the provision of timely and relevant information on factors that may influence the ship's movements and assist on-board decision making”*,
  - *“the monitoring and management of ship traffic to ensure the safety and efficiency of ship movements”*, and
  - *“responding to developing unsafe situations”*.
- Recognizes IALA’s contribution to the development of internationally harmonized guidance for vessel traffic services through its standards and associated recommendations, guidelines and model courses specifically related to the establishment and operation of VTS.

The number VTSs implemented throughout the world continues to increase significantly every year as a means to mitigate risk in waterways and contribute to efficiency.

There is also a growing expectation for more proactive management of shipping in response to increasing volumes of traffic, increasing competition for access to waterway space from existing and new stakeholders, changing public expectations and emerging technologies.

In conjunction with emerging developments such as e-Navigation, Sea Traffic Management, Marine Autonomous Surface Ships and Maritime Services this trend will also see changes to how VTS contributes to safe, efficient and secure maritime logistics, improved data exchange between ports and ships, and global standards for the safety, security and efficiency.

#### GUIDING PRINCIPLES

The following guiding principles have been adopted in preparing this document:

1. The document should concisely describe:
  - The emerging trends, technology and practices.
  - The significance of the emerging trend, technology and practice for VTS and why it should be monitored / assessed by the Committee.
    - This should include references to entities associated with the emerging developments and recognized publications/documents.
  - The anticipated impact/s, highlighting whether these relate to, for example:
    - The legal and regulatory framework for VTS.
    - IALA Standards.

- International instruments outside the VTS domain.
  - The expected timeframes during which these developments will significantly impact VTS.
  - The possible challenges it is expected to present for VTS.
  - The opportunities for VTS that may be realized in actively embracing the changes the practice / technology.
2. The document should not provide detailed or lengthy discussion on each development. Its focus should be on providing a high-level reference as described in Paragraph 1 above. Detailed information and discussion should be contained in associated Work Programme task/s adopted to embrace/respond to developments.

## 4. DISCUSSION

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IALA *Strategic Vision* provides a high-level document to guide the work of IALA over a period of four years or more. It describes the goals of the Association and the Strategies to achieve them. Specifically, with regards to VTS, Strategy 6 states:

*Improve and harmonize 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.*

IALA's *Current Drivers and Trends* document identifies possible future maritime trends and global developments which are most likely to have an impact on IALA and how these may affect the association's priorities, organization and activities which are aimed at supporting its objectives and strategic goals. Specifically, it concludes that:

*"The trends should be closely monitored and considered in the future priorities of the association".*

### EXPECTATIONS FOR "FUTURE VTS"

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The drivers and trends identified in IALA's *Current Drivers and Trends* document present many challenges to the maritime sector, however they also provide opportunities for VTS to enhance its contribution to the safety and efficiency of vessel traffic and protection of the environment through adopting enhanced and new processes and capabilities to mitigate the development of unsafe situations through:

1. Providing timely and relevant information on factors that may influence ship movements and assist onboard decision-making
2. Monitoring and managing ship traffic
3. Responding to developing unsafe situations

Recognising future traffic will consist of ships with traditional bridge teams, onboard autonomous systems and RCCs and there will be significant changes to the IMO regulatory regime for ship movements (e.g., COLREG) it is anticipated there may be changes to the role and functions provided by VTS as these emerging practices, technologies and processes evolve and are adopted.

#### 4.1.1. TIMELY AND RELEVANT INFORMATION - INFORMATION MANAGEMENT AND DATA EXCHANGE

VTS influences ship movements and assists onboard decision-making by providing timely and relevant information, which may include:

- Position, identity, intention, and movements of ships
- Maritime Safety Information
- Limitations of ships in the VTS area that may impose restrictions on the navigation of other ships (e.g., manoeuvrability), or any other potential hindrances
- Other information such as reporting formalities and International Ship and Port Facility Security Code (ISPS Code) details
- Support for, and cooperation with, allied services

While VTS interaction with ships has traditionally almost exclusively has been via VHF voice communications it is expected that digital communications will largely be replace VHF voice in the future, for between shore and ship and RCCs.

##### Expectations

Interaction between VTS and ships (conventional ships, MASS and remote-control centres) will primarily be through digital communications/data exchange for:

- ‘Ships<sup>3</sup>’ to provide reports and information required by a VTS.
- VTS to provide ‘ships’ with information on factors that may influence ship movements and assist ‘onboard<sup>4</sup>’ decision-making.
- VTS to issue advice, warnings, and instructions to achieve its purpose.

The interaction between ‘ship’, those responsible for the ships transit / navigation and ‘ship operators’ will commence outside delineated VTS areas.

*Note:* The continuing enhancement of IALA documentation relating VTS Communications and the emergence of Maritime Services will significantly contribute to this.

It is widely accepted that with the advent of autonomous ships and digital data and information exchange, VTS will increasingly be recognized as an information and data management and exchange hub providing ships and stakeholders with enhanced timely and relevant information to influence ship movements and assist onboard decision-making that is more accurate, predictive in nature and secure.

##### Expectations

VTS will provide an information management / data exchange hub that facilitates:

- Efficient information management and exchange between all stakeholders
- Prediction of situations that may impact the efficiency and safety of ‘ship’ traffic and management of these before they evolve into developing unsafe situations requiring intervention.

The transition to an information management / data exchange hub is expected to significantly contribute to the advent of MASS and ‘Remote Control’ and ‘Fleet Operation Control’ centres responsible for their operation.

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<sup>3</sup>‘ship’ – refers to conventional and autonomous

<sup>4</sup> ‘onboard decision-making’ refers to the “responsible entity” for the ‘ship’

#### 4.1.2. MONITORING AND MANAGEMENT OF SHIP TRAFFIC

VTS monitors and manages ship traffic to ensure the safety and efficiency of ship movements through, for example:

- Planning ship movements in advance
- Organizing ships under way
- Organizing space allocation
- Establishing a system of traffic clearances
- Establishing a system of voyage or passage plans
- Providing route advice
- Ensuring compliance with and enforcement of regulatory provisions for which they are empowered

There is a global trend for more proactive management of shipping in response to increasing volumes of traffic, reduce ship emissions, emerging technologies and practices, increasing competition for access to waterway space from existing and new stakeholders, and changing public expectations.

Significantly, while this is currently happening within defined VTS areas to facilitate safe, secure and efficient navigation, it is also evolving beyond traditional VTS boundaries, particularly at a coastal and regional level and towards whole voyage planning. This is especially important in areas where the available shipping lanes are limited as a result of Marine Spatial Planning.

##### Expectations

Future VTS will monitor and manage 'ship' traffic to ensure safe and efficient ship movements, both conventional and autonomous, through enhanced capabilities to:

- Assist stakeholders pre-plan voyages / movements
- Predict potentially developing traffic situations that may impact on efficiency or safety
- Proactively manage 'ship' movements and space allocation to maximize efficiency, safety and minimize adverse environment impacts.

There will be greater establishment of VTS beyond the territorial sea.

#### 4.1.3. RESPONDING TO DEVELOPING UNSAFE SITUATIONS

A VTS responds to developing unsafe situations such as:

- A ship unsure of its route or position
- A ship deviating from the route
- A ship requiring guidance to an anchoring position
- A ship that has defects or deficiencies, such as navigation or manoeuvring equipment failure
- Severe meteorological conditions (e.g., low visibility, strong winds)
- A ship at risk of grounding or collision
- Emergency response or support for emergency services

While consensus is that the developments in Sections 4.1.1 and 4.1.2 will greatly contribute to mitigating developing unsafe situations in the VTS area it is recognized there will still be occurrences where a VTS will be required to respond to support the navigational safety of a ship through the provision of:

- essential navigational information to assist on board navigational decision-making; and
- navigational advice and/or instruction.

### Expectations

Future VTS will have the capability to interact seamlessly with conventional ships, MASS, ship control centres and allied services to provide:

- navigational information to assist “on board” navigational decision-making; and
- navigational advice and/or instruction as appropriate.

## REALISING THE EXPECTATIONS

Intent of this section is to explore ‘How we get there’, ‘what is needed’ in moving to ‘future VTS’ in terms of requirements/functionality.

### Summary / Working table

Purpose	Expectations	Realising the Expectations
<p><b>Provide timely and relevant information</b></p>	<p>Interaction between VTS and ships (conventional ships, MASS and remote-control centres) will primarily be through digital communications/data exchange for:</p> <ul style="list-style-type: none"> <li>• ‘Ships’ to provide reports and information required by a VTS.</li> <li>• VTS to provide ‘ships’ with information on factors that may influence ship movements and assist ‘onboard’ decision-making.</li> <li>• VTS to issue advice, warnings, and instructions to achieve its purpose.</li> </ul>	<p><b>Standards for digital communications</b></p> <p>IALA Standards for digital communications / data exchange for all interactions, including:</p> <ul style="list-style-type: none"> <li>○ ‘Ships’ to provide reports and information required by a VTS.</li> <li>○ VTS to provide ‘ships’ with information on factors that may influence ship movements and assist ‘onboard’ decision-making.</li> <li>○ VTS to issue advice, warnings, and instructions.</li> </ul> <p>Key considerations include:</p> <ul style="list-style-type: none"> <li>○ Managing a mix of traditional VHF voice, digital communications, and automated data exchange</li> <li>○ The intent of messages conveyed to actors is the same, irrespective of whether it is by voice or digital means.</li> <li>○ Messages can be conveyed to an individual ship or all ships by either VHF voice, digitally or via data exchange.</li> </ul> <p><b>Note</b> – VTS Committee commences new Task on VTS Digital Communications at VTS52</p> <p><b>Autonomous ships</b></p> <p>Development of IMO goal-based MASS instrument, including:</p> <ul style="list-style-type: none"> <li>○ MASS terminology and definitions, including an internationally agreed definition of MASS and clarifying the meaning of the term “master”, “crew” or “responsible person”, particularly in Degrees Three (remotely controlled ship) and Four (fully autonomous ship).”</li> <li>○ MASS required to participate in VTS. That is, subject to the same: <ul style="list-style-type: none"> <li>– Regulatory reporting requirements, and</li> <li>– Obligations with regards to the issue of advice, warnings and instructions as deemed necessary.</li> </ul> </li> <li>○ MASS will be subject to COLREG, as amended.</li> <li>○ MASS will be required to broadcast status as to who/what is in command at any time (Master/on-board DST, Remote Control Center?)</li> </ul>

Purpose	Expectations	Realising the Expectations
	<p>VTS will provide an information management / data exchange hub that facilitates:</p> <ul style="list-style-type: none"> <li>• Efficient information management and exchange between all stakeholders</li> <li>• Prediction of situations that may impact the efficiency and safety of ship traffic and management of these before they evolve into developing unsafe situations requiring intervention.</li> </ul>	<p>“Other key issues include addressing the functional and operational requirements of the remote-control station/centre and the possible designation of a remote operator as seafarer</p> <p>VTS will be ‘intermediary’ between all predefined types of communication methods used for VTS -ship communication. To do so it has to:</p> <ul style="list-style-type: none"> <li>○ communicate in such way that any type of vessel can send and receive the information</li> <li>○ Receive and process all defined type of information messages</li> <li>○ Send information, warnings and advise to all defined communication methods</li> </ul>
<p><b>Monitor and manage ship traffic to ensure the safety and efficiency of Ship movements</b></p>	<p>Future VTS will monitor and manage ship traffic to ensure safe and efficient ship movements, both conventional and autonomous, through enhanced capabilities to:</p> <ul style="list-style-type: none"> <li>• Assist stakeholders pre-plan voyages / movements</li> <li>• Predict potentially developing traffic situations that may impact on efficiency or safety</li> <li>• Proactively manage ship movements and space allocation to maximize efficiency and safety</li> </ul>	<p><b>Revised/new Standards for interaction</b></p> <ul style="list-style-type: none"> <li>• VTS interaction with both conventional ships and autonomous ships.</li> <li>• How does the VTS interact with the entity in control of the ship (Master/RCC/automated systems).</li> <li>• Interaction with multiple RCC’s.</li> <li>• Harmonized communications/interaction, recognising: <ul style="list-style-type: none"> <li>○ A mix of conventional and autonomous ships.</li> <li>○ Intent of messages delivered is the same for Voice and by data exchange)</li> </ul>                     Particular important when providing warning, advice and instruction to achieve its purpose.                 </li> </ul>
<p><b>Responding to developing unsafe situations</b></p>	<p>Future VTS will have the capability to interact seamlessly with conventional ships, MASS, ship control centres and allied services to provide:</p> <ul style="list-style-type: none"> <li>• navigational information to assist on board navigational decision-making.</li> <li>• navigational advice and/or instruction as appropriate.</li> </ul>	<p><b>Predetermined interactions</b></p> <p>Defining the roles of both human operators and automated systems so that the predetermined interactions needed to mitigate or prevent unsafe situations are known, understood and practiced.</p>

### Note

*It is important to recognize that the development of applicable technologies and the global standardization of data models and distribution formats for dispatch of marine data to achieve much of the above developments is within the remit of other international organizations.*

*However, there is an opportunity for IALA to actively engage and contribute to this process through the appropriate bodies, noting its responsibility for standards related to the establishing worldwide harmonization of VTS operations.*

## EMERGING TRENDS, TECHNOLOGIES, AND PRACTICES

The aim of this section is to describe each emerging trend, technology and practice, focussing on:

- The significance of the emerging trend, technology and practice for VTS and why it should be monitored / assessed by the Committee.
- The expected timeframes during which these developments will significantly impact VTS.
- The possible challenges it is expected to present for VTS.
- The opportunities for VTS that may be realized in actively embracing the changes the practice / technology.
- The expected outcome.

Whilst each of these is discussed in further detail in Annex A, the potential implications of these developments, their expected timeframe and the expected outcomes is summarized below:

Emerging trend / technology / practice	Potential Impact on VTS (L, M, H)	Expected Timeframes		Expected Outcome/s
Maritime Autonomous Surface Ships	L	Degree 1 -	Present -	Future VTS will have the capability to interact seamlessly with conventional ships, MASS, ship control centres and allied services.
	H	Degree 2 -	Present -	
	H	Degree 3 -	2025 - 2030	
	H	Degree 4 -	2030 - 2050	
Digital technologies and communications	H	Present – 2030		Future VTS will interact with ships and other stakeholders primarily by enhanced digital communications for the exchange of information for or issue advice, warnings and instructions as deemed necessary.
Automated Data and Information Exchange		2025-2030		Future VTS will provide an information management / data exchange hub that facilitates efficient information management and exchange between all stakeholders in the maritime domain
Digital situational awareness / Common Situational awareness		2020-2030		Future VTS will be able to share its 'Situational Awareness' picture with other VTS Providers and allied services.



Emerging trend / technology / practice	Potential Impact on VTS (L, M, H)	Expected Timeframes	Expected Outcome/s
<b>Green House Gas Emissions / just in Time Arrival</b> <i>(Refer to Section 4.2.3)</i>	<b>M</b>	<b>Present - 2030</b>	Future VTS will play a key coordination role supporting the IMO GHG Strategy through Just in Time arrival.
<b>Advanced Decision Support Services</b>			Future VTS will incorporate advanced Decision Support Tools based on Artificial Intelligence.
<b>Navigational Support / Assistance</b>		<b>10-15 years</b>	Future VTS will have the capability to interact seamlessly with conventional ships, MASS, ship control centres and allied services when: <ul style="list-style-type: none"> <li>• Responding to developing situations, and</li> <li>• Providing support / assistance under any future role for VTS</li> </ul>
<b>Sea Traffic Management</b>			Future VTS will take a more proactive role in the management of vessel traffic as volumes increase and automation of vessels develops.
<b>Marine Spatial Planning</b>			
<b>Interacting Objects</b>		<b>2020-2030</b>	Future VTS will interact with various objects within the VTS Area that will transmit information digitally to arriving ships.
<b>Slot Management</b>		<b>2021-2025</b>	
<b>New sensing technology for nearshore and port waters</b>		<b>2021-2025</b>	
<b>Long-distance sensing technology</b>			Future VTS will need location information from vessels and the ability to communicate with vessels when they are outside the VTS Area

In transitioning to “Future VTS” the following developments have been identified as key components to be monitored and assessed to enable VTS to strategically embrace change and adopt the requisite capabilities for VTS to enhance its contribution to the safety and efficiency of vessel traffic and protection of the environment.



## IMPLICATIONS FOR THE INTERNATIONAL FRAMEWORK FOR VTS

In considering the expectations for “Future VTS” (Section 4.1) and emerging developments (Section 4.2) it is concluded that:

- No amendments are required to SOLAS regulation V/12 (Vessel Traffic Services) or the proposed new IMO resolution for VTS expected to be adopted by IMO Assembly in December 2021.
- Changes associated with the advent/adoption of the emerging developments are dependent on changes to other IMO instruments (e.g., COLREG, FAL, etc) and other international bodies such as ITU.
- No amendments are required with regards to the provisions of the ‘new’ IMO resolution for VTS, noting the resolution states:
  - “In complying with these Guidelines, Contracting Governments should take account of applicable IMO instruments and refer to the relevant international guidance prepared and published by appropriate international organizations.” (Section 1.4).
  - “Effective harmonized data exchange and information-sharing is fundamental to overall operational efficiency and safety. VTS providers are encouraged to make use of automated reporting where *possible*.” (Section 7.5).
- The implications for VTS the developments identified can be accommodated by amendments to IALA Standards, noting the ‘new’ resolution:
  - Recognizes IALA as ‘important contributor to IMO’s role and responsibilities relating to vessel traffic services’ (Section 1.3).
  - States that ‘Contracting Governments are encouraged to take into account IALA standards and associated *recommendations, guidelines and model courses*’ (Section 9.2).

A brief summary of the relationship between SOLAS and the IMO Resolution for VTS is provided in Figure 1.

VTS AND EMERGING DEVELOPMENTS		
WHAT IS VTS (SOLAS)	HOW DOES VTS CONTRIBUTE (IMO Resolution)	
<b>Contributes to:</b>	<b>Capability</b>	<b>Purpose/Actions</b>
<ul style="list-style-type: none"> <li>• Safety of Life at Sea</li> <li>• Safety of Navigation</li> <li>• Efficiency of Navigation</li> <li>• Protection of the Marine Environment</li> </ul>	<ul style="list-style-type: none"> <li>• <b>Interact</b> with vessel traffic</li> <li>• <b>Respond</b> to developing situations within a vessel traffic service area</li> </ul>	<ul style="list-style-type: none"> <li>• <b>Assist on-board decision making</b></li> <li>• <b>Management of ship traffic</b></li> <li>• <b>Responding to developing unsafe situations</b></li> </ul>
	<b>Emerging practices, technologies and trends</b>	
	<p><b>Practices</b></p> <ul style="list-style-type: none"> <li>• Maritime Autonomous Surface Ships</li> <li>• Slot Management</li> <li>• Navigational Assistance</li> <li>• Route Management</li> </ul> <p><b>Trends</b></p> <ul style="list-style-type: none"> <li>• Green House Gas Polices</li> <li>• Coastal / Regional VTS</li> <li>• Beyond territorial seas</li> <li>• Marine Spatial Planning</li> </ul>	<p><b>Technologies</b></p> <ul style="list-style-type: none"> <li>• Digital situational awareness / Common Situational awareness</li> <li>• Interacting Objects</li> <li>• Advanced Decision Support Services</li> <li>• Digital technologies and communications</li> <li>• Automated Data and Information Exchange</li> <li>• New sensing technology for nearshore and port waters</li> <li>• Long-distance sensing technology</li> </ul>

Figure 1. Implications for emerging developments on the provision of VTS



## 5. DEFINITIONS

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The definitions of terms used in this document can be found in the International Dictionary of Marine Aids to Navigation (IALA Dictionary) and were checked as correct at the time of going to print. Where conflict arises, the IALA Dictionary should be considered as the authoritative source of definitions used in IALA documents.

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## ANNEX A – EMERGING TRENDS, TECHNOLOGIES AND PRACTICES

### MARITIME AUTONOMOUS SURFACE SHIPS (MASS)

The advent of MASS will have a profound impact on the maritime sector and the traditional “close cooperation” between VTS personnel and participating ships. Specifically, this will involve the interaction and information exchange process between autonomous vessels, conventional traffic and shore authorities.

<b>Expected Outcome</b>	Future VTS will have the capability to interact seamlessly with conventional ships, MASS, ship control centres and allied services to facilitate safe, secure and efficient navigation.
<b>Key References:</b>	<ul style="list-style-type: none"> <li>• Draft Guideline being prepared by Task Group 1.2.5 – <i>Guidance on MASS from a VTS Perspective</i>.</li> <li>• Report from IALA Workshop on Marine AtoN in the Autonomous World (24-28 May 2021)</li> </ul>
<b>Link with expectations for Future VTS services</b>	<ul style="list-style-type: none"> <li>• MASS primarily want to use standardized digital communication with VTS, ships and other. Information management and data exchange by VTS will provide a more accurate and secure information position stakeholders primarily by enhanced digital communications for the exchange of information or issue advice, warnings and instructions as deemed necessary.</li> <li>• Due level MASS-4 will only use technical systems for safe navigation. External influences on the systems that ships use will so directly influence the behaviour of the ship. A VTS provider that proactively react and act on possible cyber threats and (unintended) negative influences, will give MASS the comfort that, when the situation occurs, it will be detected and action could be taken.</li> </ul>
<b>Potential Impact/s:</b>	<p>Major change to how VTS interacts with and manages ship traffic to ensure the safety and efficiency of ship movements by VTS. Key implications include:</p> <ul style="list-style-type: none"> <li>• <b>VTS Operations</b>, that is: <ul style="list-style-type: none"> <li>○ How VTS receives, assimilates and processes data and information from MASS.</li> <li>○ How does VTS interact with both conventional ships and MASS.</li> <li>○ How does the VTS interact with the entity in control of the ship (Master/RCC/automated systems).</li> <li>○ How VTS manages ship traffic, including: <ul style="list-style-type: none"> <li>▪ A mix of conventional ships and MASS.</li> <li>▪ The use of message markers such as warning, advice and instruction to achieve its purpose.</li> </ul> </li> <li>○ How VTS responds to the development of unsafe situations (conventional ships and MASS).</li> <li>○ Knowing the degree of MASS for individual ships.</li> <li>○ Interaction with MASS of degrees 2 and 3 – managing the interaction between crew and RCC.</li> <li>○ Managing interaction with multiple RCC’s.</li> <li>○ Emerging situations where a ship needs to be contained / controlled to mitigate incident effects (national governments, VTS, other agencies).</li> </ul> </li> </ul>

	<ul style="list-style-type: none"> <li>• <b>Communications and interaction</b> <ul style="list-style-type: none"> <li>○ Embracing digital communications.</li> <li>○ Data and information exchange, including automated exchange.</li> <li>○ Managing a mix of traditional VHF voice, digital communications and automated data exchange.</li> <li>○ Knowing the operational status of a MASS (i.e., who/what is in command at any time (Master/on-board DST, Remote Center, fully autonomous)</li> </ul> </li> </ul> <p>The advent of MASS will invariably be associated with VTS managing ‘big data’, interacting with MASS using digital means, and possibly centralized, distributed and/or virtualized VTS ‘centres’ in the future.</p>								
<p><b>Expected Timeframe:</b></p>	<p>There is currently little information available regarding the anticipated timeframes for the rollout of MASS. As such the following has been adopted and will be revised regularly:</p> <table border="1" data-bbox="440 680 1375 1137"> <tr> <td data-bbox="440 680 715 792"><b>Degree 1</b> - Ship with automated processes and decision support</td> <td data-bbox="715 680 1375 792"><b>Present</b> - MASS of degree 1 are already operating throughout the world and are not necessarily SOLAS vessels.</td> </tr> <tr> <td data-bbox="440 792 715 904"><b>Degree 2</b> - Remotely controlled ship with seafarers on board</td> <td data-bbox="715 792 1375 904"><b>Present</b> - MASS of degree 2 are operating in both inland waters (The Netherlands, Belgium) and Territorial sea (mainly in test environment).</td> </tr> <tr> <td data-bbox="440 904 715 1055"><b>Degree 3</b> - Remotely controlled ship without seafarers on board</td> <td data-bbox="715 904 1375 1055"><b>2025 – 2030</b> - Smaller vessels already in operation (eg. Survey vessels/Offshore).</td> </tr> <tr> <td data-bbox="440 1055 715 1137"><b>Degree 4</b> - Fully autonomous ship</td> <td data-bbox="715 1055 1375 1137"><b>2030-2050</b></td> </tr> </table>	<b>Degree 1</b> - Ship with automated processes and decision support	<b>Present</b> - MASS of degree 1 are already operating throughout the world and are not necessarily SOLAS vessels.	<b>Degree 2</b> - Remotely controlled ship with seafarers on board	<b>Present</b> - MASS of degree 2 are operating in both inland waters (The Netherlands, Belgium) and Territorial sea (mainly in test environment).	<b>Degree 3</b> - Remotely controlled ship without seafarers on board	<b>2025 – 2030</b> - Smaller vessels already in operation (eg. Survey vessels/Offshore).	<b>Degree 4</b> - Fully autonomous ship	<b>2030-2050</b>
<b>Degree 1</b> - Ship with automated processes and decision support	<b>Present</b> - MASS of degree 1 are already operating throughout the world and are not necessarily SOLAS vessels.								
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<b>Degree 4</b> - Fully autonomous ship	<b>2030-2050</b>								
<p><b>Challenges:</b></p>	<p>Developments in technology and the regulatory environment to support MASS, as well as ethical / value expectations of society will greatly influence the advent of MASS. Digitalization of VTS will have an effect on working procedure and the VTS guiding documents.</p>								
<p><b>Opportunities:</b></p>	<ul style="list-style-type: none"> <li>• MASS will need digital infrastructure and accelerated the Digitalization of VTS through the introduction of MASS technology,</li> <li>• Under the background of digitalization, VTS will become the information, coordination and supervision center of smart port, meanwhile, its function will transit from service to supervision.</li> <li>• DST would be used in the future VTS</li> </ul>								
<p><b>Committee Action / Response in place:</b></p>	<ul style="list-style-type: none"> <li>• 2018-2022 Work Programme – <i>Task 1.2.5 – Develop a guideline on Implications of Maritime Autonomous Surface Ships (MASS) from a VTS Perspective.</i></li> <li>• Engagement with the Cross-Committee MASS task group.</li> </ul>								

## DIGITAL TECHNOLOGIES AND COMMUNICATIONS

While VTS interaction with ships has traditionally almost exclusively been via VHF voice communications it is expected that digital communications will largely be replace VHF voice in the future, for between shore and ship and ship control centres.

<b>Expected outcomes</b>	Future VTS will interact with ships and other stakeholders primarily by enhanced digital communications for the exchange of information for or issue advice, warnings and instructions as deemed necessary.
<b>Key References:</b>	<p><i>Current Drivers and Trends (Ed. 1.3)</i> describes nine global maritime related trends to be monitored closely and considered in the future work priorities of the association to assist IALA reach its strategic goals with a long-term horizon and perspective. Many of these drivers and trends are interrelated and associated with the transition to a digital world, including:</p> <ul style="list-style-type: none"> <li>• <i>‘Increased Digitalization, including big data and future communication,</i></li> <li>• <i>Development of autonomous, automated and unmanned vessels,</i></li> <li>• <i>Need for increased connectivity and interoperability, and</i></li> <li>• <i>Demand for efficiency in the transport chain’.</i></li> </ul> <p>Significantly, the document states:</p> <ul style="list-style-type: none"> <li>• <i>‘Digitalization and data management should be prioritized’, and</i></li> <li>• IALA should consider, amongst other things, the following action: <i>‘Define, develop and provide support regarding digitalization and managing of data, including but not limited to data infrastructure, harmonization and sharing of data, data protection and vulnerability, data risk tools etc’.</i></li> </ul>
<b>Potential Impact/s:</b>	<p>VTS communication and interaction with ships and allied services is currently almost exclusively undertaken by traditional VHF voice communications.</p> <p>Increasingly, there is a move for communication and interaction to be digital and, in many situations, utilising automated processes. This not only includes person-to-person but also person-to-machine, machine-to-machine and machine-to-person.</p> <p>Implications for VTS include:</p> <ul style="list-style-type: none"> <li>• How VTS interacts with and manage ship traffic to ensure the safety and efficiency of ship movements by providing information or issuing advice, warnings and instructions as deemed necessary by digital means, and</li> <li>• How ships can meet their reporting requirements by digital means.</li> </ul>
<b>Expected Timeframe:</b>	2025-2035
<b>Challenges:</b>	<p>Key challenges include:</p> <ul style="list-style-type: none"> <li>• Establishing a global framework and standards, both on-board and ashore, to ensure communications, interaction and data exchange in a digital world is harmonized through common technologies, contents and data structure to ensure: <ul style="list-style-type: none"> <li>○ Clear, concise, unambiguous and effective communications.</li> <li>○ Minimize misunderstanding of the intent of messages.</li> <li>○ Messages convey the same meaning and intent, irrespective of whether they are provided by VHF voice or digitally.</li> </ul> </li> </ul>

	<ul style="list-style-type: none"><li>• Engaging and encourage other developments in maritime digital communications to facilitate adoption of global standards and data exchange systems (e.g., IMO FAL committee, Maritime Single Window, etc)</li><li>• Establishing appropriate IALA Standards and associated recommendations and guidelines.</li></ul>
<b>Opportunities:</b>	By embracing digitalization VTS will enhance its capabilities in relation to interacting with vessel traffic and respond to developing situations and become the information, coordination and supervision center.
<b>Committee Action / Response in place:</b>	<ul style="list-style-type: none"><li>• <b>Current Tasks –</b> <b>Task to commence at VTS52</b><ul style="list-style-type: none"><li>• Task 1.3.2 - Develop a Recommendation on Digital information transfer between ship and shore in VTS operations (operational aspects)</li><li>• Proposal for a new IALA Guideline for VTS Digital Communication (refer to Report from TG 1.2.5 to VTS51)</li><li>• Development of S-212 VTS DIGITAL INFORMATION SERVICE</li></ul></li></ul>

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## AUTOMATED DATA AND INFORMATION EXCHANGE

The S-100 Standard is a framework document that is intended for the development of digital products and services for hydrographic, maritime and GIS communities. It comprises multiple parts that are based on the geospatial standards developed by the International Organization for Standardization, Technical Committee 211 (ISO/TC211).

VTS Digital Information Service Product Specification S212 is based on the IHO S-100 framework specification and the ISO 19100 series of standards, which describe the Navigational situation (including traffic and route information), Navigational warning, Meteorology, Meteorology warning, Hydrography, Electronic navigational aids, Other information (Port Information, Cargo Information and so on), VTS or ships provide information with fixed time and time difference when requested.

E-NAVIGATION and MS : When developing the IMO e-Navigation strategy to improve safety and efficiency of sea transport it became clear that digital services provided to ships are an essential part of this initiative. In order to best describe, structure and implement those services, the IMO introduced the concept of “Marine Service Portfolios” (MSPs). ‘A “Maritime Service Portfolio (MSP)” that define and describe the set of operational and technical services and their level of service provided by a stakeholder in a given area, navigable waterway or port, as appropriate. The IMO has identified a preliminary list of 16 MSPs. Under its remit, IALA has recognized that additional MSPs are were needed for items such as AtoN and PNT.

<b>Expected Outcome</b>	
<b>Key References:</b>	IHO S-100: <i>IHO Universal Hydrographic Data Model, Edition 4.0.0 (December 2018)</i> , IMO MSC.1/Circ.1610: <i>Initial Descriptions of Maritime Services in the Context of E-navigation (14 June 2019)</i> ,
<b>Potential Impact/s:</b>	These IALA documents will be needed to review and update, such as: <ul style="list-style-type: none"> <li>• Guideline on the portrayal of VTS information and data</li> <li>• Operational and Technical Performance Requirements for VTS Systems</li> <li>• V-103 Standards for Training and Certification of VTS Personnel</li> <li>• V-125 The use and presentation of symbology at a VTS Centre</li> <li>• V-128 Operational and Technical Performance of VTS Systems</li> <li>• Recommendation V-145 on the Inter-VTS Exchange Format (IVEF) Service</li> <li>• VTS50-10.3.1 WP VTS Digital Information Service product specification V0.6.3 (VTS49-12.2.2.4)</li> <li>• VTS50-9.2.4 WP Draft Guideline on Maritime Services (VTS49-12.2.1.5 )</li> </ul>
<b>Expected Timeframe:</b>	2027-2035
<b>Challenges:</b>	<ul style="list-style-type: none"> <li>• Update the present VTS system,</li> <li>• VTS personnel training</li> </ul>
<b>Opportunities:</b>	<ul style="list-style-type: none"> <li>• With the development of integrated communication technology and the decline of satellite communication fees, the cost of ship-to-shore data interaction continues to decrease, and the integration and mining of large-scale digital information becomes possible, which will further fulfill the identification of risk, management of traffic flow and allocation of navigation resource in VTS area based on big data.</li> </ul>



	<ul style="list-style-type: none"><li>• Under the background of digitalization, VTS will become the information, coordination and supervision center of smart port, meanwhile, its function will transit from service to supervision.</li></ul>
<b>Committee Action / Response in place:</b>	<p><b>Task to commence at VTS52</b></p> <ul style="list-style-type: none"><li>• Task 1.3.2 - Develop a Recommendation on Digital information transfer between ship and shore in VTS operations (operational aspects)</li><li>• Proposal for a new IALA Guideline for VTS Digital Communication (refer to Report from TG 1.2.5 to VTS51)</li><li>• Development of S-212 VTS DIGITAL INFORMATION SERVICE</li></ul>

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## SITUATIONAL AWARENESS AND COMMON OPERATIONAL PICTURE (COP)

Situational awareness is an essential element of effective decision-making in the maritime environment. The concept of situational awareness implies that through whatever means made available to the mariner (e.g., visual, voice, digital, etc.) sufficient information becomes available to enable the mariner to understand their vessel’s current position, operational condition, intended track and actual movement relative to intended track. It also requires sufficient information to be obtained regarding their vessel’s surroundings, such as the natural and manmade features of the waterway, navigational aids, the position and movements of other vessels and the potential hazards posed by these elements. Once obtained, this information provides a basis for the mariner’s understanding or awareness of their vessel’s situation and enables the mariner to use this understanding to take proper decisions in controlling their vessels movements and interacting with other vessels and authorities ashore.

However, it is also understood that data whether obtained by visual, voice communications, or digital data exchange may sometimes be incomplete or “insufficient” for the mariner to be fully aware of their vessel’s situation and therefore the best decision or course of action to be taken. In some cases, additional communication vessel-to-vessel or navigational assistance from ashore may resolve this situation. But in other cases, decisions must be taken despite incomplete information to avoid known hazards and safely proceed.

Additionally, it is acknowledged that the training, experience and health of the “mariner” whether a master, mate, pilot, or future remote operator, algorithmic or artificial intelligence machine, will affect the level of situational awareness or understanding established by a given set of information. Thus the “mariner’s” decision to select a particular course of action will be based both on the information available and the current “mariner” in command of the vessel.

Thus, complete situational awareness is a collective goal to be achieved. In practice, the broader maritime community collaborates to define a consensus regarding:

- the data sufficient to support situational awareness;
- the means for sensing, communicating, and sharing the data;
- effective tools for display and interpretation of the data; and
- the training required to prepare mariners to understand and use the data.

Based on this consensus, maritime authorities, standards organizations, shipbuilders and system developers collaborate to regulate, standardize, design, build and install the sensors, displays, networks and communications to provide the mariner with a “Common Operational Picture (COP)” as a means to achieving situational awareness.

As we embrace the digitalization of the maritime industry and look toward the future maritime ecosystem including MASS, the community’s consensus on the data, means, interpretation and training will evolve. It is clear that expanding digital data exchange will continue to be an enabler to supply a shared, common operational picture (COP) for “mariners” and VTS operators alike. The varying levels of situational awareness achieved aboard each vessel or within a VTS or RCC will continue to depend on the consistent availability of the consensus data for the COP and the training, experience and health of the particular “mariner” in command of the vessel.

<b>Expected Outcome</b>	<p>Future VTS will be able to share its ‘Operational Picture’ or selected elements of its operational picture with other VTS Providers, Remote Control Centers, Pilots, Masters and MASS to improve situational awareness.</p> <p>Given the adoption of the S-100 Universal Hydrographic Model, development of S-200 Maritime Service applications and the expanding means for digital data exchange ship-to-ship and between ship-shore (e.g., VDE-TER, VDE-SAT and ASM), future VTS will have the</p>
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	<p>ability to share and receive digital data to support a common operational picture amongst waterway users and allied services.</p> <p>Exploitation of Digital Data Exchange will enable future VTS operators, crewed vessels, pilots, MASS remote control operators and fully autonomous MASS vessel to share data automatically or on-demand to enhance situational awareness and navigational safety</p>
<b>Key References:</b>	<p>IHO S-100 Universal Hydrographic Data Model</p> <p>S-210 IVEF</p> <p>S-421 Route exchange</p>
<b>Potential Impact/s:</b>	<p>Many VTS providers use an advanced coastal sensor system that is mainly based on radar and AIS signals for on board decision-making that information might be interesting for the mariner on board. Supporting information provided by the VTS operator does have even more sources, like camera's, weather and current sensors and Port administrations systems.</p> <p>Sharing VTS obtained operational picture or selected elements to enhance situational awareness will require collaboration and consensus among stakeholders and regulatory bodies regarding:</p> <ul style="list-style-type: none"> <li>• Data to be shared</li> <li>• The means, frequency and format for requesting or sharing the data</li> <li>• Effective tools for display and interpretation of the data by all users</li> <li>• Training required for operators and automated or autonomous systems that may advise or control vessel movements</li> </ul> <p>Maritime Data Communication Systems</p>
<b>Expected Timeframe:</b>	<p>Considering that the technical standards for digital route exchange are being developed by the IEC and that the IHO has declared 2020-2030 the "S-100 Implementation Decade",</p> <p>2027-2035</p>
<b>Challenges:</b>	<p>Creating Maritime Services (S200 Series)</p> <p>Transition towards the implementation for as well inter VTS as well shore to ship</p>
<b>Opportunities:</b>	<p>Reduction investments for ship and shore</p>
<b>Committee Action / Response in place:</b>	<p>Further develop the S-210 for as well shore to ship communication</p> <p>Engage with the S-421 route exchange development</p>
<b>Examples / use case</b>	<p>Connection Dutch coastguard with the ship Barend Biesheuvel</p>



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## GREEN HOUSE GAS EMISSIONS / JUST IN TIME ARRIVAL

The International Maritime Organization's (IMO) Marine Environment Protection Committee (MEPC) has taken actions to address greenhouse gas (GHG) emissions from ships engaged in international trade. The Committee adopted resolution *MEPC.304(72)* on Initial IMO Strategy on reduction of GHG emissions from ships. The vision set out in the text of this important Initial Strategy confirms IMO's commitment to reducing GHG emissions from international shipping and, as a matter of urgency, and to phasing them out as soon as possible in this century. The first milestone in the IMO GHG strategy is to reduce CO<sub>2</sub> emissions from ships by 40% by 2030.

Achieving the goals of the Initial IMO GHG Strategy will require a mix of technical, operational and innovative solutions applicable to ships. The IMO GHG Strategy provides a wide list of candidate short-term, mid-term and long-term measures, including for example further improvement of the Energy Efficiency Design Index (EEDI) and the Ship Energy Efficiency Management Plans (SEEMP), National Action Plans, enhanced technical cooperation, port activities, research and development, support to the effective uptake of alternative low-carbon and zero carbon fuels, innovative emission reduction mechanisms, ship etc.

It is quite clear that EEDI and SEEMP design measures are unlikely to have a significant impact on emissions by 2030 (within 9 years). Therefore, the main way that emissions from shipping will be reduced in the short to medium term is by changes to operational procedures.

A new Just in Time Arrival Guide which aims to provide both port and shipping sectors with practical guidance on how to facilitate Just In Time Arrivals has been released in 2020. The concept of JIT Arrival of ships allows for ships to optimize their speed during the voyage in order to arrive at the Pilot Boarding Place when the availability of berth, fairway and nautical services is ensured. In other words, ships do not have to "wait" outside the port at anchorages for many hours, days or even weeks, or manoeuvre at very low speeds in the port area while waiting for the availability of berth, fairway and nautical services. This results in reducing the fuel consumption and Green House Gas emissions from ships, supporting the low carbon shipping.

The development of JIT Arrival Guide is to provide information and proposals to the port and shipping sectors as well as port and maritime administrations on how to facilitate JIT Arrival of ships – with a view to reducing Green House Gas emissions by optimizing the port call business process and providing sustainable solutions to customers in the end-to-end supply chain.

Based on the IMO GHG Strategy and the JIT Guide the following potential implications for VTS have been identified :

- Vessels will need to share voyage plans with the destination port VTS before departure from their current port.
- VTS will require a berth availability slot plan from Terminal Operators.
- Current port VTS advises destination port VTS of actual time of departure (ATD)
- Future VTS will need to two-way communication with ships outside of the VTS area, possibly globally, to advise and update the RTA PBP to the ship and to receive revised timings if the ship is delayed.
- VTS advises Terminal Operator of the ship ETA at the berth.
- VTS advises Terminal Operator of any changes to the ship ETA at the Berth.
- Terminal Operator recalculates Berth Availability Slot Plan and communicates changes to VTS
- VTS adjusts and communicates RTA PBP for incoming ships affected by the changes to the Berth Availability Slot Plan
- VTS assesses and validates ship routing plans.
- VTS analyses historical route data to determine safe route and near miss limits.

- Future VTS should support an emissions inventory for each ship

<b>Expected Outcome</b>	Future VTS will play a key coordination role supporting the IMO GHG Strategy through Just in Time arrival.
<b>Key References:</b>	<ul style="list-style-type: none"> <li>• IMO Greenhouse Gas Strategy - MEPC.304(72)</li> <li>• IMO and IAPH - Port Emissions Toolkit (2018)</li> <li>• IMO ACTION TO REDUCE GREENHOUSE GAS EMISSIONS FROM INTERNATIONAL SHIPPING (2020)</li> <li>• IMO Just in Time Arrival Guide</li> <li>• IAPH Ship Environmental Index</li> </ul>
<b>Potential Impact/s:</b>	<p>The adoption of JIT Arrival is of great benefits including Lower GHG emissions and reduced air pollution, enhanced supply chain visibility, improved rest hour planning, optimized port processes and better capacity planning of berths, but it also brings some disadvantages such as more workload to provide updates and less opportunities for seafarers for shore leave. Therefore, many regulations and standards remain to be amended for adoption of JIT Arrival including Maritime Labour Convention, training of seafarer, technology research and development, etc.</p> <p>These IALA documents will be needed to review and update, such as:</p> <ul style="list-style-type: none"> <li>R0127 – VTS operations</li> <li>R0128 – Operational and Technical Performance of VTS Systems</li> <li>G1089 – Provision of Vessel Traffic Services</li> <li>G1110 – Use of Decision Support Tools for VTS Personnel</li> <li>G1111 – Preparation of Operational and Technical Performance Requirements for VTS Systems</li> <li>G1141 – Operational Procedures for delivering VTS</li> <li>G1159 – Ship Reporting from a shore based perspective</li> </ul>
<b>Expected Timeframe:</b>	<p>A new Just in Time Arrival Guide which aims to provide both port and shipping sectors with practical guidance on how to facilitate Just In Time Arrivals has been released in 2020.</p> <p>The initial GHG strategy envisages a reduction in carbon intensity of international shipping (reducing CO2 emissions) by at least 40% by 2030 pursuing efforts towards 70% by 2050, compared to 2008. It also envisages that total annual GHG emissions from international shipping should be reduced by at least 50% by 2050 compared to 2008. The first target of 40% reduction in CO2 by 2030 less than 9 years away.</p>
<b>Challenges:</b>	<ul style="list-style-type: none"> <li>• Global adoption of Just in Time Arrival</li> <li>• Update present VTS systems. Traditional radars, AIS and VHF cannot meet the needs of ultra-long-distance VTS information services and traffic organization services. In the future, VTS will introduce satellite AIS, satellite communications and other equipment.</li> <li>• Update VTS personnel training. The digitization of VTS information is accelerating. A digital VTS phase is coming soon. VTS operators are required to have stronger data analysis and processing capabilities.</li> <li>• Real time data sharing. Real-time requirements for ship-to-shore information interaction have increased, and the amount of information interaction has greatly increased. The way of ship-shore data interaction will be fundamentally changed, and the proportion of intelligent judgment and human-computer interaction will increase.</li> </ul>

<b>Opportunities:</b>	<p>The adoption of JIT Arrival allows the VTS to take the maritime safety administration to a new and higher level, such as the improved anchorage management, the navigation order of ships, the enhanced ability to pollution prevention and response, etc.</p> <ul style="list-style-type: none"><li>• To achieve the IMO targets for Greenhouse Gas reduction</li><li>• More efficient systems within ports</li><li>• Under the background of increased data exchange and digitalization.</li><li>• Regional and even global VTS interconnection will become possible. With the development of data exchange technology between VTS, regional and even global VTS interconnection will become possible. Combining satellite AIS and satellite communication technology, the position of VTS information center will be further strengthened in the future.</li></ul>
<b>Committee Action / Response in place:</b>	<p>Engage with the IMO on JIT to define whether a guiding principle would be effected</p>
<b>Example</b>	<ul style="list-style-type: none"><li>• Port Authority's manage JIT by voyage planning (for example by Port APP in Finland)</li></ul>

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## ADVANCED DECISION SUPPORT SERVICES

Decision Support Tools (DST) are used to enhance situational awareness and to help make better decisions in routine or non-routine situations. It is especially useful when facing decisions about developing situations or emergency situations. These tools should assist decision making activities at strategic, tactical and operational levels.

According to IMO Resolution A.1158(32) Vessel Traffic Services are implemented to improve the safety and efficiency of vessel traffic and to protect the marine environment. The service should have the capability to interact with the traffic and to respond to traffic situations developing in the area. In order to assist ships a specific context, some DST may require user input such as the vessel(s) concerned, or the area supervised. In other cases, some tools are working permanently in a self-contained way and should interact between and inform the ships and VTS personnel automatically.

The advent of advanced decision support services will significantly affect how VTS has ‘traditionally’ been provided. In particular, it will enable VTS to be more proactive in managing ship traffic and providing an information hub enabling information exchange and automated interaction.

Transitioning to advanced decision support services will have an impact on VTS providers, including:

- Having appropriate equipment, systems and facilities in place, (including use of artificial intelligence technology).
- Ensuring VTS personnel are appropriately trained in:
  - advanced decision support services and responding to the ‘decisions’ it provides;
  - responding to automated data and information exchange; and
  - operating in an environment with automated interaction and communications.
- Managing a changing role for VTS personnel, with a greater focus on the management of ship traffic (including Just in Time).

<b>Expected Outcome</b>	<p>Future VTS will involve greater interaction with ships and other VTS Providers. As a result it will receive more data and will require new software tools to process this data and provide it to the VTS Operator in support of his role</p> <p>The VTS Decision Support Tool based on Artificial Intelligence.</p>
<b>Key References:</b>	Input Paper VTS49-8.2.8 The Application of a VTS Decision Support Tool based on Artificial Intelligence
<b>Potential Impact/s:</b>	<p>IALA standards relating to VTS will need to be revised/updated and new documentation may be required to ensure the harmonized delivery of VTS worldwide. Key areas include, for example:</p> <ul style="list-style-type: none"> <li>• Operational procedures</li> <li>• VTS interaction and Communications</li> <li>• Training for VTS personnel</li> <li>• Standards for advanced decision support services</li> <li>• Data validation and management</li> </ul> <p>With the development of the DST based on AI, the future VTS will further improve the safety and efficiency of vessel traffic and protect the marine environment. These IALA documents will be needed to review and update, such as:</p> <ul style="list-style-type: none"> <li>• IALA Guideline 1110 - Use of Decision Support Tools for VTS Personnel</li> </ul>



	<ul style="list-style-type: none"> <li>• Guideline 1045 on staffing level at VTS centres.</li> <li>• Documents for Training and Certification of VTS Personnel and its associated Model Courses.</li> </ul>
<b>Expected Timeframe:</b>	<to follow>
<b>Challenges:</b>	<ul style="list-style-type: none"> <li>• update the present VTS system</li> <li>• VTS personnel training</li> </ul>
<b>Opportunities:</b>	<p>Advanced decision support services and more automated data and information exchange offers many benefits for VTS to proactively contribute to the safety and efficiency of navigation and protection of the environment.</p> <ul style="list-style-type: none"> <li>• more smart for decision making</li> <li>• more safety and efficiency of vessel traffic</li> </ul>
<b>Committee Action / Response in place:</b>	<ul style="list-style-type: none"> <li>• G1110 has been updated at VTS51 with the introduction on AI technology</li> </ul> <p>Considered could be to set up a task to identify the impact of emerging technology, such as AI-based systems, on the human-machine relationship, concerning the roles, responsibilities, tasks, and the collaboration of a machine and human operator. Subjects to explore in this task are:</p> <ul style="list-style-type: none"> <li>• Design of an effective human-machine team, what logic or principles can be followed</li> <li>• Design of required effective operational control by the human operator</li> <li>• Trust &amp; acceptance, the calibration of placed trust in technology by human operations and acceptance of technology</li> <li>• Consequences of iterative changes in an AI-based system on the collaboration between human operators</li> <li>• Evaluation of the effects of DST/intelligent systems on the taskload, situational awareness &amp; decision making process</li> <li>• Ethical issues with changes roles and responsibilities between humans and systems</li> <li>• Requirements on reliability, validity of intelligent AI-based systems”</li> </ul>

## NAVIGATIONAL SUPPORT / ASSISTANCE

<b>Expected Outcome</b>	<p>Future VTS will have the capability to interact seamlessly with conventional ships, MASS, ship control centres and allied services when:</p> <ul style="list-style-type: none"> <li>• Responding to developing situations, and</li> <li>• Providing support / assistance under any future role for VTS</li> </ul> <p>Note:</p> <ul style="list-style-type: none"> <li>• The way navigational support is delivered might change for crewless vessels.</li> <li>• Navigational support could also mean assisting in regaining control over a vessel through local means</li> </ul>
<b>Key References:</b>	IMO A 1158 (32) / IALA GL 1089
<b>Potential Impact/s:</b>	The possible need for (temporary) direct control of the vessel or temporary manning the vessel
<b>Expected Timeframe:</b>	10-15 year horizon
<b>Challenges:</b>	<p>Determining:</p> <ul style="list-style-type: none"> <li>• ‘Who is in charge / responsible for the ship’? and</li> <li>• As identified in the IMO Regulatory Scoping Exercise, the ‘possible designation of a remote operator as seafarer’.</li> </ul> <p>GL 1089 states: “Responding to developing unsafe situations involves support to the navigational safety of the ship through the provision of essential navigational information to assist on board navigational decision-making.” In the case of a crewless vessel this decision making process is expected to take place at a RCC.</p> <ul style="list-style-type: none"> <li>• How to restore situational awareness to the ship’s operator?</li> <li>• How to intervene when connectivity between ship and RCC is lost?</li> <li>• How to restore (emergency) control over the vessel?</li> </ul> <p>According to GL1089 the general principle should be to get the vessel to a place of safety, to enable the ship to recover from its situation.</p>
<b>Opportunities:</b>	Development of new instruments and services in conjunction with allied services
<b>Committee Action / Response in place:</b>	To be determined later in relation to the MASS discussions

## SEA TRAFFIC MANAGEMENT

Transparency leads to better overall decisions resulting in increased efficiency and, in the maritime industry, improved safety as well. Imagine a world where all the information you need is at your fingertips, updated in real-time, and where most information does not have to be entered manually but is collected from various data sources.

A world where the control of information still lies with the information owner and the maritime distributed way of working still remains. A maritime world where the crew focuses on safe navigation instead of reporting, where port calls become even more efficient and just-in-time, making maritime shipping the main transport option for even more goods. We have seen the development of new services in many different industries, and the maritime sector can be revolutionised in ways that we cannot even imagine.

Sea Traffic Management will overcome many of the challenges of communication and information sharing between stakeholders in the maritime transport industry. It will create significant added value for the maritime transport chain.

More information on the Sea Traffic Management project via the [link](#)

<b>Expected Outcome</b>	Future VTS will take a more proactive role in the management of vessel traffic as volumes increase and automation of vessels develops.
<b>Key References:</b>	<a href="https://www.seatraficmanagement.info/about-stm/">https://www.seatraficmanagement.info/about-stm/</a>
<b>Potential Impact/s:</b>	STM will enable VTS to have more information available for the management of ship traffic
<b>Expected Timeframe:</b>	Present -2030
<b>Challenges:</b>	Sea Traffic Management will overcome many of the challenges of communication and information sharing between stakeholders
<b>Opportunities:</b>	It will create significant added value for the maritime transport chain.
<b>Committee Action / Response in place:</b>	Work on guidance on digital communication including route-exchange Engage with IMO on JIT and the impact om VTS's role on ship traffic management
<b>Example</b>	STM

## MARINE SPATIAL PLANNING

Marine Spatial Planning (MSP) is a practical way to organize marine space, and the interactions among human uses and between these uses and the marine environment, including the establishment of Traffic Separation Schemes (TSS), anchorage areas and offshore development areas.

It provides a process for assessing where activities and uses may be compatible or incompatible, and where activities and uses (either individually or cumulatively) conflict. Undertaking a marine spatial planning process can have significant benefits including proactively identifying and reducing conflicts between uses, and between uses and natural values.

Marine Spatial Planning (MSP) provides a process for industry, government, and the community to work together to better plan for current and future uses of the marine environment, while also maintaining healthy marine ecosystems.

UNESCO - As of 2021, over forty-five countries worldwide are either implementing or approving marine spatial plans – and dozens more laying the foundation – moving away from isolated sectoral management to an integrated planning framework for their maritime jurisdiction. <https://en.unesco.org/news/unesco-and-european-commission-launch-new-flagship-guide-marinemaritime-spatial-planning>

<b>Expected Outcome</b>	
<b>Key References:</b>	
<b>Potential Impact/s:</b>	The more offshore development areas are built on shallow waters
<b>Expected Timeframe:</b>	
<b>Challenges:</b>	
<b>Opportunities:</b>	
<b>Committee Action / Response in place:</b>	

## INTERACTING OBJECTS

<b>Expected Outcome</b>	<p>Future VTS providers will have interaction with various objects (like vessel, buoys, smart devices). They transmit and share information automatically. VTS Systems will monitor and record digital data transmissions from the various objects and provide information to support the VTS Operator's role.</p> <p>The implementation of the Standards such as "S-100 standards" will enable systems to system communication and with interacting objects</p>
<b>Key References:</b>	<p>IHO S-100 Universal Hydrographic Data Model</p> <p>IMO-FAL Maritime single window (MSW)</p> <p>MSC 104-15-7 Proposal for a new output to amend the revised ECDIS performance standards</p>
<b>Link with expectations for Future VTS services</b>	
<b>Potential Impact/s:</b>	<p>IMO performance standards are needed to support the operation of those technical standards and to harmonize their implementation worldwide.</p> <p>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.</p> <p>For example sharing voyage plans via the S-421 developed by the International Electrotechnical Commission (IEC). Voyage plans are a key element of shipping and can be used to optimize safety and processes, as well as for the interaction of participants and stakeholders. The central element of the voyage plan is a route.</p>
<b>The outcomes identified and 'how we get there', including 'what is needed' in moving to 'future VTS' in terms of requirements/functionality.</b>	
<b>Expected Timeframe:</b>	<p>Considering that the technical standards for digital route exchange are being developed by the IEC and that the IHO has declared 2020-2030 the "S-100 Implementation Decade",</p>
<b>Challenges:</b>	<p>Creating Maritime Services (S200 Series)</p> <p>Monitoring other emerging Standards / contributing to</p> <p>Transition towards the implementation</p> <p>Maritime Data Communication Systems</p>
<b>Opportunities:</b>	
<b>Committee Action / Response in place:</b>	



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## SLOT MANAGEMENT

Slot Management involves the pre-planning of all arrivals and departures to ensure optimal usage of each berth. It involves an analysis of the all services required by an incoming ship and scheduling the necessary activities in order that they are completed with optimal efficiency enabling the berth to be released and ready for the next ship visit at the earliest opportunity. Slot Management Plans are expected to become an important part of the Just in Time Arrival planning.

The slot management plan will be exchanged with VTS in order that an appropriate time of arrival can be calculated and communicated to the ship. The exchange of slot management plans between VTS and the terminal operator will become a key part of port operations and will lead to greater efficiency as the processes become more digitalized, integrated and optimized.

<b>Expected Outcome</b>	
<b>Key References:</b>	
<b>Potential Impact/s:</b>	The introduction of Slot Management plans will have a significant impact on port operations (including VTS operations).
<b>Expected Timeframe:</b>	In 2021-2025
<b>Challenges:</b>	<ul style="list-style-type: none"> <li>• Integration of VTS and terminal Operation services</li> </ul>
<b>Opportunities:</b>	<ul style="list-style-type: none"> <li>• More efficient port operations</li> <li>• Supports the implementation of JIT Arrival, resulting in reduced emissions.</li> </ul>
<b>Committee Action / Response in place:</b>	<ul style="list-style-type: none"> <li>• Ongoing monitoring.</li> <li>• Preparation of revised / new IALA documents.</li> </ul> Liaison/engagement with other IALA Committees and external bodies.
<b>Example</b>	<ul style="list-style-type: none"> <li>• Convoys</li> <li>• Locks</li> </ul>

## NEW SENSING TECHNOLOGY FOR NEARSHORE AND PORT WATERS

Concerning the VTS monitoring in nearshore and port waters, there is a limitation that should not be neglected. This results in having to judge the sailing state of the ship through the dynamic image of the plane. With the development of technology, high-range CCTV and UAV technology can make up for the deficiency of VTS. With the deployment of high-range CCTV cameras in the high points of nearshore and port waters, a 360-degree monitoring within 8 nautical miles can be realized. If appropriate locations are selected, full-coverage monitoring of larger waters can be realized. In addition, the UAV technology can also be used to strengthen the monitoring of VTS. The UAV regularly cruises at fixed points, and then carries out point-to-point signal transmission through remote transmission technology, which can facilitate the effective monitoring of ships' dynamic movement.

- It can effectively strengthen the water VTS monitoring,
- It can improve the efficiency and ability of VTS to obtain information and provide information services,
- It can improve the early warning ability of VTS,
- The anti-pollution monitoring of ships in water area can be strengthened

<b>Expected Outcome</b>	
<b>Key References:</b>	
<b>Potential Impact/s:</b>	<ul style="list-style-type: none"> <li>• The legal and regulatory framework for VTS.</li> <li>• IALA Standards..</li> </ul>
<b>Expected Timeframe:</b>	In 2021-2025
<b>Challenges:</b>	<ul style="list-style-type: none"> <li>• Comprehensive coverage of the communication network</li> <li>• Network security</li> <li>• Deployment point location selection</li> <li>• Loss of fixed assets</li> </ul>
<b>Opportunities:</b>	<ul style="list-style-type: none"> <li>• Three-dimensional integrated monitoring</li> <li>• Smarter decision making</li> <li>• More intuitive regulation</li> </ul>
<b>Committee Action / Response in place:</b>	<ul style="list-style-type: none"> <li>• Ongoing monitoring.</li> </ul>



## LONG-DISTANCE SENSING TECHNOLOGY

- The next generation of ship identification and tracking system for future VTS should have considerably larger coverage and capacity compared with the current system.
- Satellite-based AIS, LRIT (Long Range Identification and Tracking System), and Internet-based AIS are drawing much attention from the academia and the industry,
- Satellite-based AIS can integrate all the static and dynamic information of the ships all over the world. It can significantly expand the coverage and capacity of the current AIS system.
- The LRIT is an automatic data exchange system that broadcast ship-related information (name, MMSI, position, date and time, etc.) every 6 hours without human interference or different time intervals to the LRIT data center. It can extremely expand the coverage of the current ship identification and tracking system and is compatible with the AIS system.
- The Internet-based AIS can collect ship dynamic and static information from ships without equipment of AIS via mobile communication station or satellite communication station.
- Current VTS mainly utilize traditional AIS and Radar as the data sources to collect information about ships' dynamic and static information. Due to the limitation of the signal coverage, the current system can only be applied in port areas or inland waterways, while the ships navigating beyond the territorial seas are difficult to identify and monitor, which leaves risk to the maritime transportation system. These new technologies can facilitate the current VTS to obtain information with much larger coverage and higher data compacity to improve the situation awareness of the VTS.

<b>Expected Outcome</b>	Future VTS will need location information from vessels and the ability to communicate with vessels when they are outside the VTS Area
<b>Key References:</b>	Resolution MSC.202(81) Resolution MSC.263(84) R0124-19 Satellite AIS considerations (A-124 App.19)
<b>Potential Impact/s:</b>	<ul style="list-style-type: none"> <li>• The technological framework and facilities of the current VTS system could be revised with the introduction of new systems.</li> <li>• IALA Standards for ship identification and tracking system.</li> <li>• Legal framework and regulations for the IALA and IMO participants as new law or regulations may be necessary for such an improvement.</li> </ul>
<b>Expected Timeframe:</b>	Satellite-based AIS and LRIT is already in use, Internet-based AIS is under developing.
<b>Challenges:</b>	<ul style="list-style-type: none"> <li>• Compatibility between the current VTS system and Internet-based and satellite-based AIS system.</li> <li>• Coverage of the public mobile communication network in port areas.</li> <li>• Coverage and capacity of satellite for maritime data communications.</li> <li>• Equipment installing and upgrade on merchant ships.</li> <li>• Cyber security.</li> </ul>
<b>Opportunities:</b>	<ul style="list-style-type: none"> <li>• Highly accurate situation awareness of the maritime transport in the surveillance area.</li> <li>• Large coverage and capacity for better services to ships, etc.</li> <li>• Strong facilitate for maritime search and rescue operation for sea areas afar.</li> </ul>
<b>Committee Action /</b>	<ul style="list-style-type: none"> <li>• Ongoing monitoring.</li> </ul>

**Response in place:**

- Scoping/preparing a new Work programme task.
- Preparation of revised / new IALA documents.
- Liaison/engagement with other IALA Committees and external bodies.

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