

# THE CHALLENGES POSED BY THE ADVENT OF MARITIME AUTONOMOUS SURFACE SHIPS FOR INTERNATIONAL MARITIME LAW

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*Autonomous ocean-going vessels, often invoke thoughts of robotic ships ruling the waves. Although the types of autonomous or uncrewed vessels presently in operation are a far cry from a fully autonomous 100,000 tonne cargo ship, developments in maritime autonomous technologies continue apace. In order to ensure the safety and security of the world's oceans it is crucial that international maritime law is able to adequately regulate autonomous technologies operating in the maritime domain. This paper considers the key challenges the current state of international maritime law poses for the operation of maritime autonomous vessels. It demonstrates that these challenges must be addressed in the near term to ensure this capability is adequately regulated, and highlights that the development of a Code for the regulation of maritime autonomous surface ships would be the most effective approach.*

## 1 Introduction

International maritime law has evolved over centuries to now comprise an intricate web of treaties, conventions and customary law that regulates maritime activities in the international arena. The development of this large body of international law, has been underpinned by the key assumption that ships or vessels will be commanded by a master and managed by a crew. The advent of increased autonomy at sea is challenging this assumption, with some reports of more than 1000 autonomous surface ships operating worldwide.<sup>1</sup> Although the majority of these vessels are small, demonstrations of fully autonomous ferries, tugs and designs for fully autonomous cargo vessels, highlight that these larger autonomous capabilities may soon be on our doorstep. The increasing development of autonomous capabilities raises the immediate question of what challenges these capabilities may pose for international maritime law and what steps the international community must take, to ensure this capability is adequately regulated.

## 2 Setting the Scene: An Ocean of Autonomy

The first hurdle in understanding whether autonomous vessels are regulated by current international maritime law, is grappling with the different types of capabilities that fit within the term autonomous. Uncrewed or autonomous vessels are not a homogenous grouping of vessels, rather they should be conceptualised as a class, with various different types that fit within that class. Although there are likely over 1000 autonomous surface ships in operation worldwide, the size of the majority of these vessels would likely mean they fall below the threshold of applicability of certain International Maritime Organisation ('IMO') regulations such as *The International Convention for the Prevention of Pollution from Ships* ('MARPOL'),<sup>2</sup> and *The International Convention for the Safety of Life at Sea*.<sup>3</sup> Furthermore, a large proportion of these vessels are used for maritime research, and arguably the law on this point is adequate to deal with these vessels.<sup>4</sup> Although international maritime law is likely adequate to deal with the challenges posed by the majority of autonomous surface ships presently in operation, the size and employment of these capabilities are changing apace. Hyundai recently announced its intent to trial a large autonomous liquefied natural gas ('LNG') carrier by the end of 2021.<sup>5</sup> This is but one of many trials around the world exploring the operations of large autonomous surface ships. The IMO has released interim guidelines for autonomous ship trials,<sup>6</sup> however, it is clear that aspects of international maritime law are unlikely to be scalable to regular operations of these large vessels and further regulation is required.

An abundance of terminology exists to describe uncrewed or autonomous vessels. Common terms include Unmanned Surface Vessels ('USVs'), Unmanned Maritime Systems ('UMS'), Unmanned Maritime Vehicles ('UMVs'), Remotely Operated Vehicles ('ROVs'), among several more. The spectrum of titles and acronyms used to describe

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<sup>1</sup> The Maritime Executive, 'Autonomous Vessels are Becoming a Commercial Reality (Web Page, 22 November 2021) < <https://www.maritime-executive.com/editorials/autonomous-vessels-are-becoming-a-commercial-reality> >.

<sup>2</sup> *International Convention for the Prevention of Pollution from Ships*, 1983, 1340 UNTS 62 (as amended) ('MARPOL').

<sup>3</sup> *International Convention for the Safety of Life at Sea*, 1980, 1184 UNTS 278 ('SOLAS').

<sup>4</sup> Leonida Giunta, 'The Enigmatic Juridical Regime of Unmanned Maritime Systems' (Conference Article, Oceans MTS/IEEE Genova Conference, 18-21 May 2015), 2.

<sup>5</sup> The Maritime Executive, 'Hyundai Plans First Ocean-Going Autonomous Ship Voyage by Year's End' (Web Page, 27 July 2021) < <https://www.maritime-executive.com/article/hyundai-plans-first-ocean-going-autonomous-ship-voyage-by-year-s-end> >.

<sup>6</sup> IMO MSC, Interim Guidelines for MASS trials, IMO MSC Circ 1604 (14 June 2019).

the same or similar capabilities does little to assist clarity on the issue of how these vessels are viewed under international maritime law. A major challenge in regulating autonomous vessels is the lack of definitional clarity across the subject matter. Clarity in terminology was a key recommendation of the recent IMO committee's regulatory scoping exercise into autonomous surface ships.<sup>7</sup> In this, the IMO uses the term Maritime Autonomous Surface Ships (MASS) and for consistency this paper adopts the same terminology. MASS is defined by the IMO as 'a ship which, to a varying degree, can operate independently of human interaction'.<sup>8</sup>

## 2.1 Types of MASS Technology

The class of capabilities referred to as MASS, encapsulates a large spectrum of capabilities that are differentiated by three key elements; size, method of control and function. Within the class exists vessels from the one metre long Arctic Research Centre Autonomous Boat ('ARCAB') designed for marine research,<sup>9</sup> to the 54 metre Rolls Royce, Falco fully autonomous ferry.<sup>10</sup> Designs are in draft for even larger vessels. Maritime Navigation Through Intelligence Networks ('MUNIN') have sought to develop a concept for a 200 metre dry bulk carrier,<sup>11</sup> and the United States Navy ('USN') have recently contracted for the design of a large USV ('LUSV') of up to 2000 tons,<sup>12</sup> which will complement the autonomous ships currently operating as part of their autonomous ship trials.

The majority of MASS are smaller craft operated for either marine research or military functions, however their current and potential application extends beyond these areas. Future areas of employment of MASS include but are not limited to: commercial use, oceanographic research, hydrographic survey and law enforcement functions.<sup>13</sup> Research is ongoing into the development of larger MASS for transportation of either cargo or people, particularly in Japan, South Korea and Scandinavia.<sup>14</sup> Although presently there are no autonomous cargo vessels in operation, the European Union ('EU') has sponsored the development of two autonomous cargo vessels by the end of 2022.<sup>15</sup> Not only have Rolls-Royce in partnership with Finferries, demonstrated the successful voyage of a fully autonomous ferry,<sup>16</sup> in 2017 they demonstrated the remote operation of a 28 metre tug in Copenhagen Harbour.<sup>17</sup>

## 2.2 Remote Controlled vs Autonomous Shipping

MASS are not only differentiated by the typology aspects of size and function, they also differ in the method of vessel control employed. Some commentators are of the view that international maritime law can be applied to MASS through the 'functional' or 'equivalency' approach.<sup>18</sup> For example, in the case of an ROV, the controller could be equated to the master or crew under certain aspects of international maritime law.<sup>19</sup> This is a key aspect of terminology that the IMO regulatory scoping exercises have recommended for further exploration.<sup>20</sup> Although equating the controller of an ROV to a master is a neat solution to the problem, the application of the 'functional' or 'equivalency' approach oversimplifies MASS capabilities. This approach does not take into account types of MASS that are fully autonomous, or are only controlled remotely for certain components of the voyage.

Understanding the distinction between different methods of control is an important consideration in how international maritime law should approach regulation of MASS. There is a significant distinction between ROVs, autonomous

<sup>7</sup> IMO MSC, Outcome of Regulatory Scoping Exercise for the Use of Maritime Autonomous Surface Ships, IMO MSC Circ 1638 (3 June 2021).

<sup>8</sup> Ibid.

<sup>9</sup> Peter Schmidt Mikkelsen, 'An Affordable Autonomous Surface Vehicle with Obstacle Avoidance for Coastal Ocean Monitoring', *Arctic Research Centre* (Web Page, 23 April 2019) <<https://arctic.au.dk/news-and-events/news/show/artikel/an-affordable-and-portable-autonomous-surface-vehicle-with-obstacle-avoidance-for-coastal-ocean-moni/>>.

<sup>10</sup> Rolls Royce, 'Rolls-Royce and Finferries Demonstrate World's First Fully Autonomous Ferry' (Web Page, 3 December 2018) <<https://www.rolls-royce.com/media/press-releases/2018/03-12-2018-rr-and-finferries-demonstrate-worlds-first-fully-autonomous-ferry.aspx>>.

<sup>11</sup> Mingyu Kim, Tae Hwan Joung and Han-Seon Park, 'Autonomous Shipping and its Impact on Regulations, Technologies and Industries' (2020) 4 *Journal of International Maritime Safety, Environmental Affairs and Shipping* 17, 18.

<sup>12</sup> Sam Lagrone, 'Navy Issues Draft Request for Proposal For Large Unmanned Surface Vessel', *United States Naval Institute* (Web Page, 14 August 2019) <<https://news.usni.org/2019/08/14/navy-issues-draft-request-for-proposal-for-large-unmanned-surface-vehicle>>.

<sup>13</sup> Craig Allen, 'The Seabots are Coming Here: Should they be Treated as 'Vessels'?' (2012) 65 *The Journal of Navigation* 749, 750.

<sup>14</sup> Andrzej Felski, and Karolina Zwolak 'The Ocean-Going Autonomous Ship: Challenges and Threats' (2020) 8 *Journal of Marine Science and Engineering* 41, 41.

<sup>15</sup> European Commission Transport Research and Innovation Monitoring and Information System, *Autonomous Shipping Initiative for European Waters* (Report, 28 October 2020) <<https://trimis.ec.europa.eu/project/autonomous-shipping-initiative-european-waters#tab-funding>>.

<sup>16</sup> 'Rolls-Royce and Finferries Demonstrate World's First Fully Autonomous Ferry' (n 10).

<sup>17</sup> Craig Allen, 'Determining the Legal Status of Unmanned Maritime Vehicles: Formalism v Functionalism' (2008) 49(4) *Journal of Maritime Law and Commerce* 477, 479.

<sup>18</sup> Allen (n 13) 480.

<sup>19</sup> See for discussion of implications of this Thanasis Karlis, 'Maritime law issues related to the operation of unmanned autonomous cargo ships' (2018) 17 *WMU Journal of Maritime Affairs* 119.

<sup>20</sup> IMO MSC (n 7)

vehicles and the varying degrees of autonomy. At its absolute core, the differentiation is simple. An autonomous ship is one which has the necessary technology to make independent decisions when it comes to aspects of operation, such as navigation and collision avoidance. A remote controlled vessel is one which still includes a human in the decision making loop, however, that human may not be operating from onboard the vessel and could potentially be operating from a shore base or another platform. In the case of an ROV, organic sensors will generally provide information to the human operator in order to support the decision making process. This is a common capability used in fields such as mine warfare, scientific research and aviation, where ROVs have become common place.

Challenges however arise when one platform is capable of both methods of control, for example a hybrid of the two, which can be used to control different aspects of the voyage or can be changed depending on the vessel's current employment. The potential changes in methods of control during a voyage will need to be taken into consideration in developing an adequate framework for regulation of MASS.

The IMO considered the issue of degrees of autonomy in its recent regulatory scoping exercise, whilst undertaking a review of the adequacy of IMO regulations, to regulate MASS. The IMO scale of degrees of autonomy focus on the presence or otherwise of crew onboard the vessel and the method of control. The four degrees of autonomy articulated by the IMO are detailed below:

1. **Degree One.** The ship has the ability to undertake automated processes and decision support, however, crew are present onboard to operate and control shipboard systems.
2. **Degree Two.** Remotely controlled ship with crew onboard. The ship is controlled from an alternate location; however, crew members remain onboard to take control of shipboard functions and systems as necessary.
3. **Degree Three.** Remotely controlled ship with no crew onboard.
4. **Degree Four.** Fully autonomous ship, the operating system is able to make decisions on its own. No crew onboard.<sup>21</sup>

These varying degrees of control employed, influence the ability of MASS to comply with aspects of international maritime law designed for crewed vessels. Through the equivalency approach highlighted above in degree one of the IMO degrees of autonomy, a MASS vessel would have a crew embarked. A MASS vessel with a crew embarked would subsequently be subject to the *International Convention on Standards of Training, Certification and Watchkeeping for Seafarers* ('STCW Convention'), which applies to 'all seafarers serving onboard seagoing ships'.<sup>22</sup> However, the *STCW Convention* as it presently stands would not be applicable to fully autonomous ships under degree four. Given the *STCW Convention* does not apply to fully autonomous vessels, it begs the question who is training and certifying those who write the algorithms, that support the decisions these vessels make? This simple example demonstrates why MASS capabilities are not homogenous, and trying to fit MASS within precepts of the current international maritime law designed for crewed vessels is fraught with danger.

### 3 Does UNCLOS Adequately Accommodate MASS Vessels?

In any review of international maritime law, the anchor point is the *United Nations Convention of the Law of the Sea* ('UNCLOS').<sup>23</sup> Consideration of MASS capabilities under *UNCLOS* gives rise to two immediate issues. Firstly, *UNCLOS* was drafted in the 1970s and 1980s, in its drafting it did not anticipate the operation of uncrewed, autonomous vessels. Secondly, *UNCLOS* functions on the basis of flag state primacy to regulate compliance.

That fact that *UNCLOS* in its drafting did not contemplate MASS capabilities poses a significant challenge for *UNCLOS* as it presently stands. Under the present state of regulation, if there were to be an incident involving MASS, or if a MASS were to be seized, the outcome under *UNCLOS* is unclear. This was evident in the 2016 incident involving the Chinese seizure of a wave guider belonging to the United States naval ship, USS *Bowditch* in the South

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<sup>21</sup> IMO MSC (n 7).

<sup>22</sup> *International Conventions on Standards of Training, Certification and Watchkeeping for Seafarers*, 1984, 1361 UNTS 190, art 3 ('STCW').

<sup>23</sup> *United Nations Convention of the Law of the Sea*, 1982, 1833 UNTS 3 ('UNCLOS').

China Sea.<sup>24</sup> This incident demonstrated the challenges associated with the status of MASS under *UNCLOS*, in particular whether the wave glider, was deemed a vessel, ship, or warship, which would have entitled it to sovereign immunity under *UNCLOS*.<sup>25</sup>

The issue of flag state primacy gives rise to questions such as how does the flag state system operate with respect to MASS capabilities? How are MASS regulated and are they required to be registered? These challenges give rise to a significant threshold question in terms of the classification of MASS under *UNCLOS*: are MASS classed as ships, vessels, equipment or devices?

### 3.1 Can MASS be Considered Ships under *UNCLOS*?

As MASS capabilities do not represent a homogenous class of vessels, the issue to be considered is not the generic categorisation of MASS as ships or vessels, but whether certain MASS capabilities may meet the criteria required of a ship or vessel. This is an important distinction which has given rise to various interpretations by commentators on the topic. Whilst some commentators assert that MASS can be classed as ships or vessels, others highlight that their uncrewed nature distinctly prohibits this classification.

The seminal nature of the question of classification of MASS as ships or vessels is a direct result of the entitlements associated with such a classification. Classification of a MASS as a ship or vessel brings with it certain duties and benefits which underpin the international maritime law regime. These duties include the requirement for registration, obligations under collision regulations, and obligations to render assistance just to name a few of the many duties.<sup>26</sup> The benefits are far reaching, but include areas such as innocent passage through the territorial seas ('TS'), or transit passage through an international strait. In effect, classification as a ship or otherwise under *UNCLOS* outlines where and how MASS can operate.

*UNCLOS* does not distinguish between the terms ship or vessel, although various other conventions and treaties do, albeit inconsistently. Throughout *UNCLOS*, the terms vessel and ship are used interchangeably, with neither defined within the Convention. The interchangeable application of these terms within *UNCLOS* is a by-product of its drafting, as opposed to a purposeful omission.<sup>27</sup> Further complicating the issue, customary law cannot assist in the interpretation of the terms ship or vessel, because there is no recognised description of the term within international customary law.<sup>28</sup>

There is nothing within *UNCLOS* that strictly prohibits certain types of MASS being considered ships under the Convention,<sup>29</sup> however there are a number of articles that provide challenges to this classification. Article 94, 'Duties of the Flag State', implies a presumption that a craft will be crewed, and subsequently generates a number of difficulties with respect to Flag State regulation of MASS. The argument that *UNCLOS* does not specifically prohibit classification of MASS as ships, although not without its detractors, appears compelling. Morrison and Kaye, following a review of national legislation from various maritime nations, highlight that almost all of the national jurisdictions surveyed, include a definition of ship or vessel within their national jurisdiction that is consistent with the inclusion of MASS.<sup>30</sup> Although this is not authoritative when it comes to the interpretation of *UNCLOS*, it adds weight to the view that MASS may be considered ships or vessels under *UNCLOS*. The era in which *UNCLOS* was drafted and the fact that it did not contemplate MASS capabilities, supports the view of the aforementioned academics that there is nothing under *UNCLOS* that prohibits MASS being classed as ships or vessels. Despite this, the lingering ambiguity on this point will need to be addressed by the international community in order to provide clarity.

<sup>24</sup> Missy Ryan and Dan Lamothe, 'Pentagon: Chinese Naval Ship Seized an Unmanned U.S. Underwater Vehicle in the South China Sea', *The Washington Post* (Online Article, 17 December 2016) <<https://www.washingtonpost.com/news/checkpoint/wp/2016/12/16/defense-official-chinese-naval-ship-seized-an-unmanned-u-s-ocean-glider/>>.

<sup>25</sup> Article 236 of *UNCLOS* affords Warships, as defined by Article 29 of *UNCLOS*, sovereign immunity. Sovereign immunity prohibits other nations from interfering with a Warship or Government vessel. For discussion of the USS *Bowditch* incident and the issue of sovereign immunity see Natalie Klein, Douglas Guilfoyle, MD Saiful Karim and Rob McLaughlin, 'Maritime Autonomous Vehicles: New Frontiers in the Law of the Sea' (2020) 67 *International and Comparative Law Quarterly* 719, 722.

<sup>26</sup> Anthony Morrison, and Stuart Kaye 'Operating Unmanned Surface Vessels at Sea: Is International Law Ready for the Future?' in Myron Nordquist, John Moore and Ronan Long (eds), *Legal Order in The World's Oceans* (Brill Nijhoff, 2017) 424, 438.

<sup>27</sup> Morrison and Kaye (n 26) 426.

<sup>28</sup> Eric Van Hooydonk, 'The law of unmanned merchant shipping: an exploration' (2014) 20 *The Journal of International Maritime Law* 403, 406.

<sup>29</sup> Morrison and Kaye (n 26); Andrew Norris, 'Legal Issues Relating to Unmanned Maritime Systems Monograph' (US Naval War College, 2013), 50; Van Hooyank (n 28).

<sup>30</sup> Morrison and Kaye (n 26) 426-437.

### 3.2 Registration and Regulation of MASS

The *UNCLOS* regime is built on the principle of flag state primacy and subsequent flag state regulation of ships. Article 91 of *UNCLOS* specifies that:

every state shall fix the conditions for the grant of its nationality to ships, for the registration of ships in its territory, and for the right to fly its flag. Ships have the nationality of the State whose flag they are entitled to fly. There must exist a genuine link between the State and the ship.<sup>31</sup>

Although art 91 does not specifically require the registration of MASS, flag state registration of ships affords specific protections to registered ships. For example, under art 110 of *UNCLOS*, any warship has the right of visit to any 'ship without nationality'.<sup>32</sup> Furthermore, it is through flag state registration that international regulations designed to ensure the safety of ships and the environment are enforced. Subsequently, under the current regime of international maritime law, some form of registration of MASS of at least a certain size will be important to their overall adequate regulation.

A number of challenges arise when applying the *UNCLOS* regime of flag state registration and regulation to MASS. The requirement for a genuine link is but one of these. With the rise of flags of convenience,<sup>33</sup> the relevancy of the genuine link requirement has been a hotly debated issue. With respect to the application of the genuine link requirement to MASS, Van Hooydonk refers to it as 'entirely illusory'.<sup>34</sup> The challenge posed by what is arguably in the 21st century a tenuous requirement, is that it may be difficult to demonstrate a genuine link for the registration of MASS. For those that sit on the remotely operated end of the spectrum, the crew equivalency or shore-based support team may be operating the vessel from anywhere in the world. For fully autonomous vessels, they may be operated by a computer program designed in another country and operating in the cloud,<sup>35</sup> or various other mechanisms of control. Although the validity of the genuine link requirement in an era of flags of convenience is often brought into question, this element of international maritime law with respect to MASS operations will need to be reviewed as it is presently at odds with their operation.

Article 94 of *UNCLOS* highlights that the flag state has broad duties with respect to ships operating under their flag.<sup>36</sup> This includes the requirement to effectively execute its jurisdiction and control in 'social matters' over ships flying its flag.<sup>37</sup> Article 94 requires states to take measures necessary to ensure the safety of the ship with respect to 'the manning of ships, labour conditions and the training of crews'.<sup>38</sup> Furthermore, it articulates the requirement for flag states to take necessary measures to ensure that masters and officers are appropriately qualified,<sup>39</sup> and that the crew are fully conversant with appropriate specified international regulations.<sup>40</sup>

The flag state obligations outlined in art 94 of *UNCLOS* provide a number of challenges with respect to the regulation of MASS. These challenges include: how the terms 'master' and 'crew' are defined in the context of MASS capabilities, what are the appropriate qualifications for these positions, and how will the flag state be able to regulate this in situations where the 'master' or 'crew' are physically located in another country. There is an argument to be made for application by analogy, that is consideration of the terms 'master' and 'crew' in the context of the support teams controlling remotely operated MASS. However, application by analogy quickly becomes irrelevant when more autonomous degrees of MASS are contemplated. It is evident that in the application of the *UNCLOS* regime to MASS, flag states would not be able to meet their obligations as laid out in art 94 without significant creativity. In the future development of international maritime law dealing with the operation of MASS, their registration and the associated flag state obligations must be a key focus, in order to assess whether vessels have operated safely.

Article 98 of *UNCLOS*, the 'Duty to Render Assistance', also generates challenges for the operation of MASS under its current construct. For example, a fully autonomous vessel (degree four) may be incapable of complying with the

<sup>31</sup> *UNCLOS* art 91(1).

<sup>32</sup> *Ibid* art 110(1)(d).

<sup>33</sup> Flags of Convenience is a term generally afforded to certain open registries where ships can be registered with little affiliation between the Ship's owners or interested parties and the flag of registration. For further discussion of the concept of a Flag of Convenience see Cindy Lazenby, 'SOS: The Call Sign of the "Ships of Shame"' (1998) 4 *Deakin Law Review* 74.

<sup>34</sup> Van Hooydonk (n 28) 410.

<sup>35</sup> *Ibid*.

<sup>36</sup> *UNCLOS* art 94.

<sup>37</sup> *Ibid* art 94(1).

<sup>38</sup> *Ibid* art 94(3)(b).

<sup>39</sup> *Ibid* art 94(4)(b).

<sup>40</sup> *Ibid* art 94(4)(c).

duty to render assistance. Similar requirements are outlined in the *SOLAS* Convention and the *International Convention on Maritime Search and Rescue* ('SAR').<sup>41</sup> The inability of MASS vessels to comply with these requirements is addressed in sub-section 4.2 of this paper.

Although *UNCLOS* does not specifically prohibit the operation of MASS, it is evident from the issues highlighted above that it is currently not adequate to accommodate MASS in the maritime domain. The outcomes of the IMO Legal Committee's regulatory scoping exercise acknowledged this, although *UNCLOS* was not a formal part of the exercise as it is not an IMO convention.<sup>42</sup>

## 4 IMO Safety and Pollution Regulations: What Are The Challenges For MASS?

The IMO has developed a large suite of regulations in order to manage the safety, security and environmental impact of vessels at sea. IMO regulations are wide ranging, covering diverse aspects of the law, such as collision regulations, crew standards, pollution regulation at sea and much more. However, a consistent theme amongst all aspects of IMO regulations is that in their drafting, they contemplated crewed vessels only. In recognition of this, and at the behest of a number of its members, the IMO's Maritime Safety Committee ('MSC') agreed in 2017 to undertake a regulatory scoping exercise into the operation of MASS, which it completed in mid 2021.<sup>43</sup>

The MSC's regulatory scoping exercise was a two-step process. Step one reviewed the IMO regulations within the purview of the MSC, those being predominantly safety related regulations. The objectives of the review were to identify which IMO regulations under the purview of the MSC in their current form preclude 'unmanned' operations; which have no application to 'unmanned' operations; and 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.<sup>44</sup> The second step of the regulatory scoping exercise provided analysis on how to address MASS operations moving forward whether that be by the amendment of current regulations or generation of new ones.<sup>45</sup>

The IMO Legal Committee ('LEG') also undertook a concurrent regulatory scoping exercise to review the regulations under their purview. Adopting the same two-step process and methodology, the LEG's regulatory scoping exercise included consideration of the liability conventions and security related conventions such as the *Convention for the Suppression of Unlawful Acts against the Safety of Maritime Navigation* ('SUA').<sup>46</sup> In considering the challenges posed by a number of the key IMO regulations for MASS operations, the next section of this paper is structured along the lines of the IMO regulatory scoping exercises. Dealing predominantly with the key safety and pollution related conventions before turning to the conventions under the purview of the LEG in section 5 of the paper.

A number of key IMO Conventions, including *COLREGs*, *MARPOL* and *STCW* provide for definitions of a ship or vessel within the convention. The broad nature of some of these definitions, including that provided in the *Convention on the International Regulations for Preventing Collisions at Sea* ('COLREGs')<sup>47</sup> mean that whatever the general stance in international maritime law, under certain conventions MASS are considered vessels and subsequently required to comply with the Convention. This generates challenges depending on the classification or the function of the MASS in question. Some MASS by their function, size or method of control, may not by their nature, be able to meet such requirements and be subsequently impeded from operating under current international maritime law.

### 4.1 COLREGs

*COLREGs* are key to maintaining the safety and order of the world's oceans. Considered the 'Rules of the Road' for the maritime environment, *COLREGs* provide rules for the conduct of vessels in all weathers, detailing how vessels shall respond in certain situations, for example who has the right of way between two different types of vessels. They

<sup>41</sup> *International Convention on Maritime Search and Rescue*, opened for signature 27 April 1979, 1405 UNTS 97 (entered into force 22 June 1985) ('SAR').

<sup>42</sup> Legal Committee of the International Maritime Organisation, 108<sup>th</sup> session (LEG 108) (26-30 July 2021) <<https://www.imo.org/en/MediaCentre/MeetingSummaries/Pages/LEG-108th-.aspx>>.

<sup>43</sup> IMO MSC, Report of the Maritime Safety Committee on its Ninety Eighth Session, IMO Doc MSC 98/23, 98<sup>th</sup> Mtg (28 June 2017).

<sup>44</sup> IMO MSC, Work Programme: Maritime Autonomous Surface Ships Proposal for a Regulatory Scoping Exercise, IMO Doc MSC 98/20/2, MSC 98<sup>th</sup> Mtg (27 February 2017).

<sup>45</sup> International Maritime Organisation, 'IMO Takes First Steps to Address Autonomous Ships' (Web Page, 25 May 2018) <<https://www.imo.org/en/MediaCentre/PressBriefings/Pages/08-MSC-99-MASS-scoping.aspx>>.

<sup>46</sup> IMO LEG, Report of the Legal Committee on the Work of its 105<sup>th</sup> Session, IMO Doc LEG 105/14, 105<sup>th</sup> Mtg (1 May 2018).

<sup>47</sup> *Convention on the International Regulations for Preventing Collisions At Sea*, opened for signature 20 October 1972, 1050 UNTS 16 (entered into force 15 July 1977) r 1(a) ('COLREGs').

even go so far as to specify the lights and shapes a vessel must display. As MASS technology continues to develop and commercial application of MASS for the transportation of cargo and people becomes increasingly likely, the application of *COLREGs* to MASS is a key issue.

Rule 1 dictates that *COLREGs* apply to ‘all vessels on the high seas and in all waters connected therewith, navigable by seagoing vessels’.<sup>48</sup> Much like the consideration of *UNCLOS*, whether *COLREGs* applies is addressed by considering the threshold question of whether MASS are considered vessels for the purposes of the Convention.

The definition of a vessel under *COLREGs* is quite broad and includes ‘every description of water craft, including non-displacement craft and sea-planes, used or capable of being used as a means of transportation on water’.<sup>49</sup> *COLREGs* provides no definition of what is meant by ‘transportation’, and some commentators have indicated that this may preclude some types of MASS meeting the definition of vessel under *COLREGs*. However, the wide application of *COLREGs* to both dredges and cable layers, by extension makes the regulations equally applicable to MASS.<sup>50</sup> There is nothing to suggest a requirement for transportation of anything in particular, and arguably MASS transportation of itself meets the requirements of this definition.<sup>51</sup>

The mechanical nature of *COLREGs* generates a number of significant issues in their application to MASS. Similar to *UNCLOS*, *COLREGs* were drafted in contemplation of crewed vessels, rather than autonomous capabilities. Rule 5 provides for the requirement that: ‘every vessel shall at all times maintain a proper lookout by sight and hearing as well as by all available means appropriate in the prevailing circumstances and conditions so as to make a full appraisal of the situation and of the risk of collision’.<sup>52</sup>

There has been considerable discussion with respect to the application of this Rule to MASS capabilities. The sight and hearing aspects of Rule 5 through its literal sense, prohibit compliance of MASS capabilities. The US Navigation and Safety Advisory Council (NAVSAC) recommended a modification to this rule restricting its application to crewed vessels.<sup>53</sup> Whilst this recommendation was made in 2011 and is yet to gain traction, it is evident that *COLREGs* is applicable to at least some types of MASS and if it were to remain unchanged, it is inadequate to safely regulate the operation of MASS capabilities. This sentiment is echoed in the outcomes of the IMO MSC MASS regulatory scoping exercise, which listed *COLREGs* as a ‘high priority’ instrument to be addressed in subsequent regulation development or amendment.<sup>54</sup>

A further issue arising under *COLREGs*, is the classification of MASS within the regime and the subsequent impact this classification has on the responsibility between vessels. In its 2011 review, NAVSAC advocated for an amendment to the types of vessels restricted in ability to manoeuvre (RAM) to incorporate ‘a self-propelled vessel while unmanned and operating autonomously’.<sup>55</sup> MASS vessels could potentially be classed as RAM vessels under the current rules which provide that the term RAM means ‘a vessel which from the nature of her work is restricted in her ability to manoeuvre as required by these rules is therefore unable to keep out of the way of another vessel’.<sup>56</sup> Rule 3(g) lists a number of vessels that meet this requirement, however, it also states that they ‘shall include, but not be limited to’ this list.<sup>57</sup> Although MASS are potentially covered by this rule, the application of *COLREGs* requires a degree of certainty and therefore an amendment to the rules to incorporate the classification of MASS is appropriate. Alternatively, MASS could also be classed as vessels considered ‘not under command’ which is defined as ‘a vessel which through some exceptional circumstance is unable to manoeuvre as required by these rules and is therefore unable to keep out of the way of another vessel’.<sup>58</sup> Again, in order to provide absolute clarity, *COLREGs* would need to be amended.

*COLREGs* have previously been successfully amended to incorporate new technologies, including wing in ground (‘WIG’) aircraft so it is feasible that these amendments could be made. Unlike some of the challenges posed by *UNCLOS*, these recommended changes would need to be applied to *COLREGs* as opposed to incorporation in a separate MASS Code, in order to ensure clarity in the regulations.

<sup>48</sup> *COLREGs* r 1(a).

<sup>49</sup> *COLREGs* r 3.

<sup>50</sup> Giunta (n 4) 5.

<sup>51</sup> Morrison and Kaye (n 26) 439.

<sup>52</sup> *COLREGs* r 5.

<sup>53</sup> Allen (n 13) 750.

<sup>54</sup> IMO MSC (n 7).

<sup>55</sup> Norris (n 29) 50.

<sup>56</sup> *COLREGs* r 3(g).

<sup>57</sup> *Ibid* r 3(g).

<sup>58</sup> *Ibid* r 3(f).

## 4.2 SOLAS Convention

The IMO regulatory scoping exercise also reviewed the *SOLAS* Convention. The significance of *SOLAS* cannot be understated, it is arguably the most important international treaty regulating the safety of merchant ships.<sup>59</sup> Unlike its *COLREGs* counterpart, *SOLAS* does not provide a definition of a ship or vessel. *SOLAS* instead defers to national legislation stating the Convention applies to ‘ships entitled to fly the flag of states, the governments of which are contracting governments’.<sup>60</sup> As indicated by Morrison and Kaye, MASS can be considered to meet a large swathe of national definitions of the ships or vessels,<sup>61</sup> and subsequently *SOLAS* is likely to be applicable to MASS capabilities. However, *SOLAS*’ applicability is limited in terms of tonnage and *SOLAS* is generally not applicable to cargo ships below 500 gross tonnes,<sup>62</sup> where cargo ships are defined as any ship other than a passenger ship.<sup>63</sup> This restriction on applicability would prohibit the majority of current MASS capabilities from being regulated by *SOLAS*,<sup>64</sup> however, this will not always be the case.

A large component of *SOLAS* encapsulates the technical provisions detailing the safety requirements of ships. This includes the design for systems such as alarms, communications, bridge design and visibility.<sup>65</sup> Although few of these elements prohibit the operation of MASS, it is evident they will need to be reviewed in order to ensure the safe operation of MASS.<sup>66</sup> This theme is consistent in the submissions to the MSC regulatory scoping exercise.<sup>67</sup> In order to ensure the safe operation of MASS, the technical aspects from design of the vessel to the software behind the autonomy will need to be adequately regulated. This area was also deemed a ‘high priority’ by the IMO MSC for further focus in its recent regulatory scoping exercise.<sup>68</sup>

Beyond the technical aspects of *SOLAS* that require review in the context of MASS, there are operational elements that also require consideration in light of MASS capabilities. Consistent with the challenges of art 98 of *UNCLOS*, *SOLAS* equally enshrines a duty of rescue, outlining that the ‘master of a ship at sea which is in a position to be able to provide assistance on receiving a signal from a source that persons are in distress at sea, is bound to proceed with all speed to their assistance’.<sup>69</sup> Again, this raises the challenge of who, if anyone is considered the master of a MASS vessel. Although in degrees one to three (as set out in section 2.2 above), arguably the person in control of the vessel may be considered the master, this is not applicable in the case of a fully autonomous vessel considered in degree four. As noted earlier in this paper, this is not a definitional issue confined to just *SOLAS*, it exists across many conventions and requires a consistent approach. This further highlights the need for definitional clarity in the development of amendments to future regulations applicable to MASS.

Other issues generated by the application *SOLAS* to MASS include the duty to carry lifeboats,<sup>70</sup> and the watchkeeping requirements outlined in Chapter IV Reg 12.<sup>71</sup> These are only a few challenges MASS operations pose under *SOLAS*. The key point being, that although most current MASS are unlikely to meet the tonnage requirements for *SOLAS* to be applicable to these capabilities, as larger MASS capabilities become more prevalent, *SOLAS* will need significant revision to be able to regulate the safety of these vessels. Unlike other conventions or treaties, *SOLAS* through its requirement for only tacit approval of amendments, has demonstrated its flexibility as a convention. Subsequently, it is possible that amendments to *SOLAS* could be effectively undertaken to incorporate MASS capabilities.

Other conventions included within the MSC regulatory scoping exercise that generate challenges for the operation of MASS include the *SAR Convention* and the *STCW Convention*. This paper does not address the specific challenges here, however, in future amendments to international maritime law with respect to MASS, the search and rescue obligations of MASS and the qualification and training requirements of key positions will need to be addressed.

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<sup>59</sup> *International Convention for Safety of Life At Sea*, 1974, 1184 UNTS 278 (*‘SOLAS’*).

<sup>60</sup> *SOLAS* art 2.

<sup>61</sup> Morrison and Kaye (n 26) 426-429.

<sup>62</sup> *SOLAS* Chap 1, reg 3.

<sup>63</sup> *Ibid* reg 2.

<sup>64</sup> Morrison and Kaye (n 26) 448.

<sup>65</sup> Klein, Guilfoyle, Karim and McLaughlin (n 25) 728.

<sup>66</sup> *Ibid*.

<sup>67</sup> See France, Summary of Results for the Second Step of the RSE for SOLAS Chapter II-1, IMO Doc MSC 102/5/6, 102<sup>nd</sup> Mtg (02/03/2020).

<sup>68</sup> IMO MSC (n 7).

<sup>69</sup> *SOLAS* Annex Chap V Reg 33.

<sup>70</sup> *Ibid* Chap 3 Part B Sec 1 reg 11.

<sup>71</sup> *Ibid* Annex Chapter V reg 12.



### 4.3 MARPOL

*MARPOL* contains a broad definition of a ship, as would be expected given its aim of preventing pollution in the maritime environment. *MARPOL* defines a ship as a ‘vessel of any type whatsoever operating in the marine environment and includes hydrofoil boats, air-cushion vehicles, submersibles, floating craft and fixed or floating platforms.’<sup>72</sup> The definition of a Ship under *MARPOL* is sufficiently broad to incorporate MASS capabilities. However, *MARPOL* contains articles limiting its applicability based on size. Specifically, the applicability of *MARPOL* is limited to tankers greater than 150 gross tonnes, or other ships greater than 400 gross tonnes.<sup>73</sup> This size restriction has the effect that most MASS presently in operation would not be required to comply with *MARPOL*, due to their size despite meeting the definition of a ship. As MASS capabilities continue to develop, it can be expected that their size will also increase and *MARPOL* may be applicable to some, however, in the broad *MARPOL* as it presently stands is inadequate to protect the maritime environment from any pollution generated by MASS capabilities.

## 5 Maritime Security and Liability Challenges for MASS

The recently concluded IMO LEG regulatory scoping exercise focussed on gap analysis of IMO regulations for which it retains responsibility.<sup>74</sup> The IMO LEG activity considered a broad range of issues with respect to the various liability conventions, and the *Convention for the Suppression of Unlawful Acts Against the Safety of Maritime Navigation*.<sup>75</sup>

Akin to the IMO regulations under the purview of the MSC, the regulations under the purview of the LEG were not drafted in contemplation of MASS technology, and are peppered with references to the responsibility of masters and operators. A key outcome of the LEG regulatory scoping exercise was the articulation of the need to clearly define the terms master and remote operator in light of MASS operations.<sup>76</sup> This definitional challenge cuts across a series of conventions as mentioned above in the review of the *SOLAS Convention*,<sup>77</sup> and is also recognised by the IMO MSC regulatory scoping exercise as a major area in need of development.<sup>78</sup>

### 5.1 Liability

A detailed consideration of the various liability conventions is beyond the scope of this article, however, it has been a frequent point of discussion amongst a number of commentators.<sup>79</sup> Of note, a cursory review of the liability conventions indicate that there is no obvious impediment to the operation of MASS. However, similar to a number of the conventions already considered in this paper there are a number of definitional issues that span across the majority of liability conventions need to be addressed.<sup>80</sup> These issues include definitions of fault, recklessness, negligence, and vicarious liability in the context of MASS operations.<sup>81</sup> This is particularly relevant in dealing with MASS that operate in fully autonomous modes (degree four).

### 5.2 Maritime Security Law Considerations

International maritime security law covers a broad spectrum of issues,<sup>82</sup> including the operation of MASS both as a maritime security capability and a target of maritime security attacks. There are three key threats to MASS vessels. These include the potential for MASS to be targeted in port, secondly, targeted at sea through traditional practical means with an aim of seizing the vessel or its cargo, and thirdly, and most concerning, their control system may be hacked. Noting these three potential methods of targeting MASS, the next section of this paper considers the

<sup>72</sup> *MARPOL* art 2(4).

<sup>73</sup> *Ibid* Annex IV reg 2.

<sup>74</sup> IMO LEG, Report of the Legal Committee on the Work of its 105<sup>th</sup> Session (n 46).

<sup>75</sup> *The Convention for the Suppression of Unlawful Acts Against the Safety of Maritime Navigation*, 1992, 1678 UNTS 221 (‘SUA’); See IMO, Report of the Legal Committee on the Work of its 106<sup>th</sup> Session, IMO Doc LEG 106/14, 105<sup>th</sup> Mtg (24 May 2019) Annex 3.

<sup>76</sup> IMO LEG, Summary of Main Gaps and Common Themes in Instruments under the Purview of the Legal Committee, IMO Doc LEG 107/8/17, 107<sup>th</sup> MTG (10 January 2020), 2.

<sup>77</sup> CMI, Summary of Results of Analysis of IMO Instruments under the Purview of the Legal Committee, IMO Doc LEG 107/8, 107<sup>th</sup> Mtg (13 December 2019), 2.

<sup>78</sup> IMO LEG, Progress on Regulatory Scoping Exercise and Gap Analysis by MSC and FAL, IMO Doc LEG 107/8/4, 107<sup>th</sup> MTG (9 January 2020), 2.

<sup>79</sup> See Robert McLaughlin, ‘Unmanned Naval Vehicles at sea: USVs, UUVs and the adequacy of the Law’ (2012) 21(2) *Journal of Law, Information and Science* 100, 105-106; Van Hooydonk (n 28) 418-422.

<sup>80</sup> CMI (n 77) 2.

<sup>81</sup> *Ibid*.

<sup>82</sup> Klein, Guilfoyle, Karim and McLaughlin (n 25) 729.

challenges MASS operations generate for the regulations governing these areas, notably the *International Ship and Port Facility Security Code* (ISPS),<sup>83</sup> the issue of piracy and the *SUA Convention*.

### 5.2.1 ISPS Code

There are a number of issues associated with the application of international maritime security law to the operation of MASS. First, as a result of the size restrictions associated with the applicability of the *SOLAS* Convention, the majority of MASS presently in operation are not large enough for *SOLAS* to be applicable. Subsequently, the ISPS Code, a security measure for vessels in port codified in an annex to chapter XI-2 of *SOLAS*, is not applicable to the majority of MASS. Furthermore, for commercial vessels that do meet the size requirements of *SOLAS*, there are challenges in how the risk assessment and certificate processes will apply to these uncrewed vessels. This is not an insurmountable issue; however, it is an issue that will need to be addressed in future.

### 5.2.2 Piracy

MASS are susceptible to the traditional types of piratical acts as defined by *UNCLOS*.<sup>84</sup> The requirement for all degrees of MASS to rely on some form of remotely controlled or automated computer system gives rise to the threat of MASS vessels being targeted through cyber-crime. The scenario of a MASS vessel being hacked and either held for ransom, or used as a weapon is concerning. The prescriptive definition of piracy under *UNCLOS* requires a piratical act to occur on the high seas, be motivated by private means and, significantly, involve more than one ship.<sup>85</sup> Consequently, cyber-crime such as the scenarios detailed above would not meet the definition of piracy and therefore be subject to universal jurisdiction.<sup>86</sup> In order to protect against this threat, technical cyber requirements will need to be specified, and other areas of maritime security law reviewed.

### 5.2.3 SUA Convention

The *SUA Convention* contains a broad definition of Ship, defining it as ‘a vessel of any type whatsoever not permanently attached to the seabed, including dynamically supported craft, submersible or any other floating craft’.<sup>87</sup> This broad definition provides for the applicability of the convention to MASS. There are a number of offences under *SUA* and the *2005 SUA Protocol*,<sup>88</sup> which would potentially be applicable to attacks against MASS. In its submission to the LEG review, the CMI highlighted concerns with respect to the ability of *SUA* and the subsequent *2005 SUA Protocol* to adequately deal with cyber-crimes against MASS, whether that be the hacking of a MASS, or seizing control of a MASS remotely for private ends or to weaponize its capability.<sup>89</sup> However, despite the concerns raised by the CMI, the LEG have concluded that neither the *SUA Convention* nor the *2005 SUA Protocol* require amendment during step two of the LEG regulatory scoping exercise.<sup>90</sup> Given the low level of ratification of the *2005 SUA Protocol*, potentially this has had a deterrent effect on attempting to amend *SUA*. Equally, there is a view that certain offences under *SUA* could be applied to the scenario of a MASS vessel being hacked or controlled as a weapon by terrorist organisations. These include the *SUA* offence of endangering a ship by communicating false information,<sup>91</sup> and the *2005 SUA Protocol* offence of using ‘a ship in a manner that causes death or serious injury or damage’.<sup>92</sup>

What is evident from the brief review above is that maritime security law is not adequate to deal with issues surrounding cyber-crime, and this poses some challenges for the safe and secure operation of MASS.

## 6 Incorporating MASS into International Maritime Law

A review of the key elements of international maritime law with respect to safety, pollution and security highlights that whilst the current body of international maritime law as a whole does not preclude the operation of MASS capabilities, it generates a number of challenges for their commercial use. Although large scale commercial MASS capabilities such as cargo vessels and passenger vessels are not yet a reality, this will likely change in the near future

<sup>83</sup> International Maritime Organisation, *The International Ship and Port Facility Code* (London, IMO 2004).

<sup>84</sup> *UNCLOS* art 101.

<sup>85</sup> *Ibid*.

<sup>86</sup> *Ibid* art 105.

<sup>87</sup> *SUA Convention* art 1.

<sup>88</sup> Protocol of 2005 to the Convention for the Suppression of Unlawful Acts against the Safety of Maritime Navigation, Opened for signature 14 October 2005, IMO Doc LEG/CONF.15/21 (entered into force 28 July 2010) (‘2005 SUA Protocol’).

<sup>89</sup> CMI (n 77) 3.

<sup>90</sup> IMO LEG, Summary of Main Gaps and Common Themes in Instruments under the Purview of the Legal Committee (n 76) Annex 2, 1.

<sup>91</sup> *SUA Convention* art 3; See Klein, Guilfoyle, Karim and McLaughlin (n 25) 733.

<sup>92</sup> *2005 SUA Protocol* art 3bis; See Klein, Guilfoyle, Karim and McLaughlin (n 25) 733.

and therefore the pace at which capability is developing requires action in a range of areas of international maritime law. Although presently the majority of MASS are small and operate in the vicinity of the coastline, or in close proximity to a mother ship or other launching platform, this will not always be the case. With increases in capability this will change, and certain aspects of international maritime law must be updated to ensure there is appropriate regulation of the safety and security of the MASS, vessels surrounding them and the environment.

There are a number of options that would allow for regulation of MASS under international maritime law. Key options include the development of a new MASS convention, a MASS code, amendment of the current conventions and treaties as appropriate,<sup>93</sup> referral of some of the issues to national jurisdiction or a combination of a number of these options. Following the completion of the respective IMO regulatory scoping exercises, the IMO has called for member nations to provide advice on which approach may be best.

Given the current geopolitical context, it is unlikely that a dedicated MASS convention or amendments to *UNCLOS* would be likely to gain a sufficient degree of signatories in order to make it effective.<sup>94</sup> As noted above, moderate amendments to certain regulations could be made to accommodate MASS operations, this includes minor amendments to a number of regulations including *COLREGs*. However, given the dramatic change in capability afforded by the operation of MASS, these amendments will need to be accompanied by the generation of a more comprehensive document akin to a MASS code to accommodate some of the key issues specific to MASS capabilities.

Options for both binding and non-binding codes exist to tackle the issue of MASS operations.<sup>95</sup> Although there are benefits to both, given the nature and likely proliferation of MASS capabilities, a non-binding code would be ineffective. Similar to the progress of the ISPS Code, options exist for the generation of a binding code through codification into a convention that requires only tacit approval for amendment. Similar to the method of codification of the ISPS Code, incorporating a MASS code into *SOLAS* is a viable option. A MASS code would be required to define fundamental terminology with respect to the operation of MASS. Terms that would need to be defined include the degrees of autonomy; definitions of an autonomous and remotely operated vehicle; definitions of master, crew and remote controller.

Additionally, a MASS code would need to address the technical requirements of MASS in order to ensure the safety of these vessels, in line with the current technical requirements managed for conventional vessels through *SOLAS*. A MASS code would also be required to articulate the training and qualification standards in the manner the *STCW* does for conventional vessels. Furthermore, it would need to provide criteria based on method of control, size and function for the classification of a MASS as a vessel, thereby clarifying the applicability of *UNCLOS* for each type of capability. Criteria such as this would enable the flexibility of the code and provide the ability to accommodate technology as it emerges. Finally, such a code would articulate the registration requirements of MASS and associated responsibilities of the flag state to ensure that the issues associated with art 94 of *UNCLOS* in terms of flag state responsibility area are addressed.

## 7 Conclusion

MASS capabilities continue to develop, and maritime industry is moving closer to the possibility of autonomous cargo ships or passenger vessels. The level of MASS capabilities operating on the world's oceans will only continue to increase, and it is vital that international maritime law adjusts in anticipation of the innovations now keenly anticipated, to ensure these capabilities are effectively regulated. The review of a number of the key regulatory instruments of international maritime law (including *UNCLOS*, *SOLAS*, *MARPOL* and *SUA*) undertaken in this paper demonstrates that MASS operations pose significant challenges for existing norms of international maritime law. These instruments do not presently prevent MASS operations, but changes must be made to provide certainty as to how MASS may operate under these conventions.

In addition to amending aspects of the key conventions, work is required to provide greater definitional certainty around terms such as master, remote controller, crew and autonomous vessel. The IMO regulatory scoping exercise has been a positive step towards addressing these issues. Furthermore, consideration needs to whether the underpinning principle of flag state primacy is appropriate in the context of MASS capabilities and whether flag states will be in a position to regulate MASS operations.

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<sup>93</sup> Matt Bartlett, 'Game of Drones: Unmanned Maritime Vehicles and the Law of the Sea' (2018) 24 *Auckland University Law review* 66, 86-90; Morrison and Kaye (n 26) 449.

<sup>94</sup> Ibid.

<sup>95</sup> Bartlett (n 93) 89.

Changes to major conventions such as *UNCLOS*, are unlikely to be supported in the current geopolitical context. Subsequently, the international community will need to look at different alternatives to provide certainty in international law with respect to MASS capabilities. The generation of a MASS code that provides definitional clarity, technical requirements and a registration and regulation regime for these vessels may be an effective way of addressing this issue, particularly if it is codified in a convention like *SOLAS*.

As technology in the field of autonomous operations in the maritime industry continues to develop at pace, the international trading community needs to ensure - by once again demonstrating its ability to adapt and adjust - that the body of law developed to regulate the maritime environment does not become obsolete