MARITIME AUTONOMOUS VEHICLES: NEW FRONTIERS IN THE LAW OF THE SEA

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Abstract The ongoing development of diverse maritime autonomous vehicles for varied ocean activities—ranging from scientific research, security surveillance, transportation of goods, military purposes and commission of crimes—is prompting greater consideration of how existing legal frameworks accommodate these vehicles. This article brings together the core legal issues, as well as current developments in relation to commercial shipping, the law of naval warfare, and maritime security. This article captures how these issues are now being addressed and what other legal questions will likely emerge as the newest technology impacts on one of the oldest bodies of international law.

Keywords: public international law, maritime autonomous vehicles, unmanned vessels, naval warfare, maritime safety, maritime security, shipping.

I. INTRODUCTION

Maritime autonomous vehicles (MAVs) increasingly feature in the future of ocean use. For example, in early 2020, the US Congress approved the purchase of two 'large unmanned surface vessels' as a step towards developing 'an external missile magazine that can autonomously find its way to the fleet, expend missiles and work its way back to reload'.[1] In addition, MAVs have recently been identified for their use in oil spill removal,[2] further tested for cargo shipments,[3] and complemented surveys estimating

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[1] DB Larter, '5 Things You Should Know about the US Navy's Plans for Autonomous Missile Boats' (*Defence News*, 14 January 2020) <https://www.defensenews.com/digital-show-dailies/surface-navy-association/2020/01/13/heres-5-things-you-should-know-about-the-us-navys-plans-for-big-autonomous-missile-boats/>.

[2] M Wingrove, 'Autonomy Tested for Oil Spill Removal' (Riviera Maritime Media, 7 January 2020) <https://www.rivieramm.com/news-content-hub/news-content-hub/autonomy-tested-for-oil-spill-removal-57354>.

[3] 'NYK Conducts World's First Maritime Autonomous Surface Ships Trial' (News Release, 30 September 2019) <https://www.nyk.com/english/news/2019/20190930_01.html>.

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fish abundances.[4] MAVs may also be deployed for terrorist purposes, as seen when Saudi forces intercepted remote-controlled boats carrying explosives and targeting an oil depot in Yemen,[5] or for drug smuggling.[6]

These examples illustrate how MAVs encompass diverse vehicles, varying in size, capability and purpose. MAVs may operate submerged, on the water's surface or above water—again depending on their size, capability and purpose. The spectrum of vehicles thus includes 'floats' or 'gliders' used for gathering data and deployed for marine scientific research or surveillance,[7] small underwater MAVs used for mine detection and capable of deployment for submarine warfare, and vessels over 24m long that could be used for transporting commercial cargo. The degree of autonomy also varies with some vehicles being fully autonomous based on algorithms that predetermine certain actions through to remotely controlled vehicles with synchronous human operation on shore. The use of MAVs may advance scientific endeavours, improve interstate trade, promote maritime security, as well as create challenges in regulating maritime activities. In each instance, there are implications for the law of the sea and how that body of law regulates activities across different maritime zones.

There is increasing recognition among lawyers and policy makers that the law of the sea may not in all instances either anticipate or provide satisfactory guidance in regulating MAVs in their different guises.[8] Significant work has begun in some areas,[9] but much progress is still needed.[10] This article highlights the core legal challenges in regulating MAVs under the law of the sea and explains what is being done and what could or should be done to enhance the legal framework governing MAVs in the future. Section II briefly canvasses key debates on terminology and other legal questions common to all MAVs. Section III outlines the challenges prompted by using MAVs in the law of armed conflict and current debates relating to the revision of the *San Remo Manual* to better account for these vehicles in naval warfare. Section

[4] 'Detecting Fish from Ocean-Going Robots to Complement Ship-Based Surveys' (NOAA Fisheries News, 22 August 2019) <https://www.fisheries.noaa.gov/feature-story/detecting-fish-ocean-going-robots-complement-ship-based-surveys>.

[5] M Olimpio, 'Remote Controlled Terror: Houthi Suicide Boats' (European Eye on Radicalization, 27 September 2018) <https://eeradicalization.com/remote-controlled-terror-houthi-suicide-boats/>.

[6] HI Sutton, 'Otranto Unmanned-Drug-Vessel' (Covert Shores blog, 23 June 2019) <http://www.hisutton.com/Otranto_unmanned-drug-vessel.html>.

[7] See discussion in K Bork *et al.*, 'The Legal Regulation of Floats and Gliders—In Quest of a New Regime?' (2008) 39 Ocean Development and International Law 298, 308–39; T Hofmann and A Proelss, 'The Operation of Gliders under the International Law of the Sea (2015) 46 Ocean Development and International Law 167, 177–8.

[8] See, eg, R McLaughlin, Unmanned Naval Vehicles at Sea: USVs, UUVs and the Adequacy of the Law (2011) 21 Journal of Law, Information and Science 100; MN Schmitt and DS Goddard, 'International Law and the Military Use of Unmanned Maritime Systems' (2016) 98 International Review of the Red Cross 567; CH Allen, 'Determining the Legal Status of Unmanned Maritime Vehicles: Formalism vs Functionalism' (2018) 49 Journal of Maritime Law and Commerce 477.

[9] See IMO Maritime Safety Committee, 'Regulatory Scoping Exercise for the Use of Maritime Autonomous Surface Ships (MASS): Work conducted by the CMI International Working Group on Unmanned Ships', IMO Doc. MSC 99/INF.8 (13 February 2018); Comité Maritime International, 'International Working Group Position Paper on Unmanned Ships and the International Regulatory Framework' (29 March 2017).

[10] See, eg, J Kraska, 'The Law of Unmanned Naval Systems in War and Peace' (2010) 5 Journal of Ocean Technology 44; N Klein, 'Maritime Autonomous Vehicles within the International Law Framework to Enhance Maritime Security' (2019) 95 International Law Studies 244.

IV sets out work being undertaken at the International Maritime Organisation (IMO) relating to maritime safety concerns regarding use of surface MAVs in commercial shipping. Section V addresses some of the implications for maritime security and highlights that, apart from some current work in the IMO Legal Committee, considerable work remains to be done. As such, in Section VI, we can outline the legal work necessary to address MAVs within the law of the sea as well as indicating what must still be addressed in the future.

II. TERMINOLOGY AND CORE LEGAL QUESTIONS

Any assessment of international legal implications in the use of MAVs begins with an explanation of terminology. This is essential because the law of the sea can differentiate between, for example, vessels/ships,[11] boats,[12] devices,[13] equipment,[14] and aircraft at sea.[15] What may be considered a vessel or ship may depend on the precise legal regime in question, as evident in different definitions found in various IMO conventions on maritime safety.[16] How any MAV is regulated will depend in the first instance on whether it is a vehicle that falls within a particular legal regime or not.[17]

The level of autonomy of any MAV will also have legal implications. For the purposes of regulation, autonomy levels can be divided into four categories including 'M: Manual navigation with automated processes and decision support', 'R: Remote-controlled vessel with crew on board', 'RU: Remote-controlled vessel without crew on board' and 'A: Autonomous vessel'.[18] The term 'unmanned' is frequently used to connote all degrees of autonomy, but 'autonomous' is preferred here to align with IMO and industry usage.[19] From a legal perspective, the level of human involvement has implications for characterising the vessel,[20] as well as for determining liability for conduct at sea, including determining which actor is liable.

[11] These terms are used interchangeably within the United Nations Convention on the Law of the Sea (UNCLOS) (1982) 1833 UNTS 3. See UN Division for Ocean Affairs and the Law of the Sea, *Navigation on the High Seas: Legislative History of Part VII, Section I (Articles 87, 89, 90–94, 96–98) of the United Nations Convention on the Law of the Sea* (1989) 80.

[12] For example, when referring to the boats of foreign ships that trigger a right of hot pursuit. See UNCLOS, art 111(1). Or when a boat is sent to exercise a right of visit under art 110 of UNCLOS.

[13] Where assessing responsibility for pollution of the marine environment. See, eg, UNCLOS, art 194(3) and art 209.

[14] Being used for marine scientific research. See, eg, UNCLOS, art 248.

[15] Rights of overflight are protected under art 87 of UNCLOS and the use of aircraft for law enforcement is contemplated in arts 110 and 111 of UNCLOS.

[16] For discussion, see, eg, E Van Hooydonk, 'The Law of Unmanned Merchant Shipping – An Exploration' (2014) 20 Journal of International Maritime Law 403, 406–7.

[17] See Allen (n 8) 493.

[18] Danish Maritime Authority, 'Final Report: Analysis of Regulatory Barriers to the Use of Autonomous Ships', IMO Doc MSC 99/INF.3 (18 January 2018). See also K Chadwick, 'Unmanned Maritime Systems Will Shape the Future of Naval Operations: Is International Law Ready?' in MD Evans and S Galani (eds), *Maritime Security and the Law of the Sea: Help or Hindrance?* (Edward Elgar 2020) 132, 134–5.

[19] See IMO Maritime Safety Committee, 'Regulatory Scoping Exercise for the Use of Maritime Autonomous Surface Ships (MASS): Initial Review of IMO Instruments under the Purview of MSC (Note by the Secretariat)', IMO Doc MSC 100/INF.3 (9 August 2018). See also Klein (n 10) 249; Chadwick (n 18) 135.

[20] A 'warship' is 'manned by a crew which is under regular armed forces discipline'. UNCLOS, art 29.

Where MAVs are owned and operated by governments, either as part of their military forces or for policing or other government purposes (notably surveillance), another legal issue arising is immunity. Under UNCLOS, 'warships and other government ships operated for non-commercial purposes' have immunity.[21] Provided the MAV in question is a 'ship', the immunity enjoyed by such an MAV should prevent its seizure by other States. When the glider launched from the *USS Bowditch* was seized by China in December 2016, the protest against China's action was partly based on the claim that China had taken sovereign-immune property.[22] There may also be instances where government-owned MAVs must be clearly marked and identifiable as such before it may undertake policing activities.[23]

As discussed in the following sections, each of these issues of characterisation, expectations of human presence and immunity status have featured in discussions relating to MAVs in the law of naval warfare, in respect of shipping and in addressing maritime security.

III. MAVS AND LAW OF ARMED CONFLICT

The law of naval warfare is notorious for its laggard treaty-law basis and, consequently, its heavy reliance on custom, application by analogy, and soft law (predominantly in the form of Manuals).[24] The most recent treaty dealing solely with naval warfare is the 1949 Geneva Convention II,[25] and the most recent conventions dealing with means and methods of warfare at sea date from 1907. Currently, the generally accepted crystallisation of the applicable law, which takes into account UNCLOS and recent technology, is the 1995 *San Remo Manual*. The development of MAVs thus largely post-dates these instruments.[26]

While existing naval autonomous systems have not been the subject of concerns as to legality (systems such as AEGIS and CIWS),[27] the increase in MAVs that are of 'vessel'

[21] UNCLOS, arts 32, 95 and 96.

[22] J Kraska and RP Pedrozo, 'China's Capture of U.S. Underwater Drone Violates Law of the Sea' (Lawfare, 16 December 2016) <https://www.lawfareblog.com/chinas-capture-us-underwater-drone-violates-law-sea>. However, arguments that the MAV was a 'ship' were not compelling. See MJ Valencia, 'US-China Underwater Drone Incident: Legal Grey Areas' (The Diplomat, 11 January 2017) <https://thediplomat.com/2017/01/us-china-underwater-drone-incident-legal-grey-areas/>.

[23] As expected in relation to the right of visit and right of hot pursuit, for example. UNCLOS, arts 110(5) and 111(5).

[24] See, eg, *Oxford Manual of the Laws of Naval War* (1913) <https://ihl-databases.icrc.org/ihl/INTRO/265?OpenDocument>; L Doswald-Beck *et al.* (eds), *San Remo Manual on International Law Applicable to Armed Conflicts at Sea* (Cambridge University Press/IIHL 1995).

[25] Geneva Convention (II) for the Amelioration of the Condition of Wounded, Sick and Shipwrecked Members of Armed Forces at Sea, (1949), 75 UNTS 85.

[26] An exception is the now decommissioned CAPTOR mine system. 'The CAPTOR mine is an anti-submarine mine … The name CAPTOR stands for Encapsulated Torpedo. The mine is moored to the sea floor and detects nearby vessels using passive sonar. It is designed to only engage submarines.' 'Mark 60 CAPTOR', <https://weaponsystems.net/system/449-Mark+60+CAPTOR>.

[27] AEGIS 'was designed as a complete system: the missile launching element, the computer programs, the radar and the displays are fully integrated to work together. This makes the Aegis system the first fully integrated combat system built to defend against advanced air and surface threats.' 'Naval Sea Systems Command' (US Navy) <https://www.navsea.navy.mil/Home/Warfare-Centers/NSWC-Port-Hueneme/What-We-Do/Aegis-Combat-System/>. CIWS (Close in Weapons System), such as Phalanx, are 'a self-contained package [that] … automatically carries

rather than system type (small vessel swarms,[28] Seahunter,[29] autonomous missile arsenal vessels and so on) poses an additional set of challenges to the law of naval warfare. The primary challenge is to determine if or how the existing law applicable to maritime warfare can incorporate the fact of MAVs as vessels within the scheme as it currently stands, rather than merely as systems of a parent vessel.

A. Can an MAV be a Warship?

Assuming, as we have noted above, that at least some types of MAVs may be 'vessels', the first question posed by the law of naval warfare is whether an MAV can be a 'warship'. In the law of naval warfare, the status of warship is of fundamental significance. It is only warships that have the full suite of belligerent rights at sea; other vessels, including other State vessels such as naval auxiliaries, have far more limited rights to engage in hostilities.

The modern definition of 'warship' originates in 1907 Hague Convention VII,[30] and is now reflected in Article 29 of UNCLOS as follows:

> For the purposes of this Convention, 'warship' means a ship belonging to the armed forces of a State bearing the external marks distinguishing such ships of its nationality, under the command of an officer duly commissioned by the government of the State and whose name appears in the appropriate service list or its equivalent, and manned by a crew which is under regular armed forces discipline.[31]

The key issues of concern in determining whether MAVs can be warships are thus that a warship must be 'under the command' of a military officer and crewed by personnel 'under regular armed forces discipline'. Can these two elements be stretched to cover remote 'command' by a military officer ashore, and 'crewing'—monitoring navigation, engineering, sensor, and weapons systems—by military personnel who are also ashore or not physically on the MAV? Certainly, some commentators have asserted that this is possible; the recent Oslo Manual, for example, deals with MAVs in terms that indicate they are capable of being considered warships.[32]

A study of the history and purpose behind this 1907 definition of warship indicates that the mischief the drafters sought to address was to prevent any re-emergence of the

out functions usually performed by multiple systems: search, detection, threat evaluation, tracking, engagement and kill assessment'. 'Phalanx Close-In Weapon System' (Raytheon) <https://www.raytheon.com/capabilities/products/phalanx>.

[28] 'US Navy Tests Autonomous Swarm Boats' (Maritime Executive) <https://www.maritime-executive.com/article/US-Navy-Tests-Autonomous-Swarm-Boats-2014-10-05>; K Osborne, 'The U.S. Navy Is Building a Swarm "Ghost Fleet"' (The National Interest, 24 January 2019) <https://nationalinterest.org/blog/buzz/us-navy-building-swarm-ghost-fleet-42372>.

[29] See, *inter alia*, J Turner, 'Sea Hunter: Inside the US Navy's Autonomous Submarine Tracking Vessel' (Naval Technology, 3 May 2018) <https://www.naval-technology.com/features/sea-hunter-inside-us-navys-autonomous-submarine-tracking-vessel/>: 'Measuring 132ft in length and capable of 27 knots, Sea Hunter is the world's largest unscrewed ship … The [Seahunter's] stated purpose is to locate, track enemy and engage submarines, primarily using a high frequency fixed sonar array, but MCM testing suggests mine countermeasures could be an option.'

[30] Hague Convention (VII) of 1907 Relating to the Conversion of Merchant Ships into War-Ships (1907) 205 Consol TS 319, art 1–4.

[31] UNCLOS, art 29.

[32] Y Dinstein and AW Dahl, *Oslo Manual on Select Topics of the Law of Armed Conflict* (Springer 2020) rules 52, 56–8.

practice of privateering, which was outlawed in 1856 (at least for most States).[33] The emphasis on the warship being 'commanded by' and 'crewed by' formally enrolled military personnel was to rule out the possibility that letters of marque could transform merchant vessels and merchant crews into ships and personnel with full belligerent rights.[34] Such concerns are not reactivated by the idea of MAVs as warships.

An alternative conception of a vessel 'under command' is provided through analysis of the COLREGS (or the 'Rules of the Road'), wherein 'command' is primarily directed at navigational safety and interactions with other vessels.[35] For example, the concept of 'vessel not under command' in the COLREGS concerns a vessel 'which through some exceptional circumstance is unable to manoeuvre as required … and is therefore unable to keep out of the way of another vessel'.[36]

Another alternative is to explore the idea of 'commanded by an officer' through reference to military law on 'command'. The Australian Defence Force definition of command is:

> The authority that a commander in the military Service lawfully exercises over subordinates by virtue of rank or assignment. Command includes the authority and responsibility for effectively using available resources and for planning the employment of organising, directing, coordinating and controlling military forces for the accomplishment of assigned missions. It also includes responsibility for health, welfare, morale and discipline … .[37]

The emphasis here is upon responsibility, coordination, and direction of effort, and is clearly something that could be exercised remotely.

This short assessment indicates that physical presence is not necessarily critical to legal conceptions of either command at sea, or of military command. It seems arguable that these diverse conceptions of command (and crewing) speak more to issues of responsibility and capacity to take action, or ensure action is taken, than to simple physical presence.

B. Can an MAV be an Auxiliary?

If the status of warship is precluded, an alternative characterisation of an MAV under the law of naval warfare is available. Namely, if an MAV can be a 'ship', it can be an auxiliary vessel. The *San Remo Manual* defines 'auxiliary' as 'a vessel, other than a warship, that is owned by or under the exclusive control of the armed forces of a State and used for the time being on government non-commercial service'.[38] There is no issue of 'command' or 'crewing'; the key requirement is that the vessel is under the exclusive

[33] Declaration respecting Maritime Law between Austria, France, Great Britain, Prussia, Russia, Sardinia, and Turkey, signed at Paris, 16 April 1856, British State Papers 1856, vol. LXI, 155–8. On the US position, see C Stockton, 'The Declaration of Paris' (1920) 14 AJIL 356, 362–3.

[34] J Brown Scott (ed), *The Proceedings of the Hague Peace Conferences: The Conference of 1907* (Oxford University Press 1920) Vol III, as argued by, *inter alia*, the delegations from Mexico at 805–7, and Brazil at 749–52.

[35] See, eg, Convention on the International Regulations for Preventing Collisions at Sea (1972), 1050 UNTS 16 (COLREGS), rule 2(a).

[36] COLREGS, rule 3(f).

[37] *Australian Defence Doctrine Publication 00.1: Command and Control* (2009) para 1.4, <https://www.defence.gov.au/adfwc/Documents/DoctrineLibrary/ADDP/ADDP_00_1_Command_and_Control.pdf>.

[38] *San Remo Manual* (n 24) rule 13(h).

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control of the military and being used for non-commercial purposes. Consequently, an MAV faces much less of a challenge in meeting the requirements of this status.

However, the challenge with auxiliaries is that they are by definition a military objective and can be attacked as if they were a warship,[39] but do not hold the belligerent rights available to warships.[40] This paradox has been an overt feature of the law of naval warfare since at least 1907, when warship was so discretely defined, and has been widely discussed.[41] Yet a precise elaboration of which belligerent rights are vested in auxiliaries remains elusive. State practice generally offers the most useful guide. Thus, for example, auxiliaries may conduct resupply at sea operations in support, carry troops and war materiel[42] and undertake defensive mine countermeasures.[43] Beyond these tasks, it becomes very grey indeed as to what is permissible and impermissible for auxiliaries. However, one clear prohibition is that auxiliaries cannot engage in attack–hunting and attacking submarines, for example–because that is a belligerent right for warships alone. This restriction underlines the significance of whether MAVs can be warships, or only auxiliaries, as discussed below.

C. *Why Does the Characterisation of an MAV Matter for the Law of Naval Warfare?*

There are at least three reasons the status available to MAVs matters for the law of naval warfare. The first hinges on the question of whether an MAV is a ship or merely a system. This distinction matters because the 'thing' that enjoys the rights and obligations of a vessel under the law of naval warfare, such as 'mere passage' through neutral territorial seas,[44] is an independent vessel. If an MAV cannot be a fully entitled 'ship' (whether warship, auxiliary, or merchant vessel), then it would need to hold a non-ship status such as a 'system' (requiring a notional, but not necessarily physical, 'tether' to a parent 'ship') to be attributed with the sovereign immunity of the parent platform. However, even this option carries challenges; can the cover of a parent vessel's sovereign immunity work when that vessel is hundreds of miles away?

Another option, if a particular MAV is not considered a ship, is that the MAV might be understood as a weapon. This approach brings in different law of naval warfare questions (for example, compliance with 1907 Hague Convention VIII, which requires that free floating mines must deactivate within an hour when they are no longer 'controlled')[45]

[39] ibid, rules 65–66 (though noting some exemptions).

[40] See, eg, 'Status of RFA and Requisitioned Merchant Ships' (Anthony Aust), UK National Archives Document (ALQ 05016), 23 April 1982, in relation to the Falklands conflict, para 4: 'Only commissioned naval vessels can exercise belligerent rights, eg conduct offensive operations against the enemy. … To be able to exercise belligerent rights a vessel should normally be commissioned into the naval force, be commanded by a commissioned naval officer, fly a naval ensign and be part of its State's military effort at sea.'

[41] See, eg, R Tucker, 'The Law of War and Neutrality at Sea' (1955) 50 International Law Studies 1, 38–43.

[42] See, eg, *San Remo Manual* (n 24) rule 60.

[43] See, eg, 'Iraqi Mine Smugglers Intercepted by Coalition Forces' (US Navy, 26 March 2003) <https://www.navy.mil/submit/display.asp?story_id=6520>; '26 Iranians Seized with Mine Vessel; More U.S. Shooting' (*New York Times*, 23 September 1987) <https://www.nytimes.com/1987/09/23/world/26-iranians-seized-with-mine-vessel-more-us-shooting.html>.

[44] Hague Convention (XIII) of 1907 Concerning the Rights and Duties of Neutral Powers in Naval War (1907) USTS 545, art 10.

[45] Hague Convention VIII of 1907 Concerning the Laying of Automatic Submarine Contact Mines (1907) USTS 541, art 1.

as well as more general considerations for autonomous weapon systems under the law of armed conflict, including rules applicable to targeting and employment,[46] and those requiring weapons review prior to acquisition and deployment.[47]

The second reason this question matters is that if an MAV is a ship, but is not a warship, it will at most be an auxiliary. Consequently, the MAV would not have access to the full suite of belligerent rights, as noted above. This outcome is significant given that some States have already invested heavily in the development of MAVs that are clearly designed for attack (that is, 'warship') roles.[48] Seahunter, an MAV designed to hunt and kill submarines, and the 'external missile magazine' MAV proposal noted in Section I, are but two such examples.

The third reason characterisation matters is more tangential but no less significant. It concerns the status of any non-military operators of an MAV. Under the law of naval warfare, the civilian crews of enemy merchant vessels and auxiliaries are to be made prisoners of war upon capture,[49] and they consequently enjoy a degree of combatant immunity from prosecution for certain law of armed conflict compliant acts, including where their vessel has resisted or even defensively attacked enemy warships.[50] However, similar conduct by civilians ashore using force in resisting the enemy's military forces in the execution of hostilities would constitute direct participation in hostilities.[51] Civilians who directly participate in hostilities, if captured, have no combatant immunity (and thus can be prosecuted under domestic law as mere criminals), and no entitlement to prisoner of war treatment. Which regime will apply to captured shore-based civilian operators of an enemy MAV auxiliary?

A recently commenced project to review the *San Remo Manual* is seeking to resolve some of these questions. While, at the time of writing, this review has just commenced, the group of experts involved has indicated that it will examine Maritime Autonomous Systems–Law of Naval Warfare intersectional issues. These questions include: whether, and how, to distinguish between MAVs as systems/weapons, and as ships (and the consequences for sovereign immunity); MAV access to navigational and belligerent rights; and consequences for MAVs with regard to the application of neutrality law at sea. The status of this work does not carry binding authority under international law, given that it is predominantly an initiative by non-State actors. It is nonetheless worth

[46] See, eg, 'Australia's System of Control and Applications for Autonomous Weapon Systems', UN Group of Government Experts, UN Doc CCW/GGE.1/2019/WP.2 (26 March 2019) <https://www.unog.ch/80256EDD006B8954/(httpAssets)/16C9F75124654510C12583C9003A4EBF/$file/CCWGGE.12019WP.2Rev.1.pdf>.

[47] See, eg, 'Questionnaire on the Legal Review Mechanisms of New Weapons, Means and Methods of Warfare', Argentina, UN Doc CCW/GGE.1/2019/WP.6 (29 March 2019) <https://www.unog.ch/80256EDD006B8954/(httpAssets)/52C72D09DCA60B8BC125841E003579D8/$file/CCW_GGE.1_2019_WP.6.pdf>.

[48] Chadwick comments: 'There is no doubt that navies will seek to categorise their [MAVs] as warships over and above auxiliaries, military devices or other categories where possible, in order to achieve parity of use with equivalent manned warships.' Chadwick (n 18) 146.

[49] See, eg, Geneva Convention (III) relative to the Treatment of Prisoners of War (1949) 75 UNTS 135, art 4(A)(5).

[50] J Brown Scott, 'The Execution of Captain Fryatt' (1916) 10 AJIL 865; H Bellot, 'The Right of a Belligerent Merchantman to Attack' (1921) 7 Transactions of the Grotius Society 43.

[51] See, eg, 1949 Geneva Convention (IV) relative to the Protection of Civilian Persons in Time of War (1949) 75 UNTS 287, [common] art 3; Protocol Additional to the Geneva Conventions of 12 August 1949, and Relating to the Protection of Victims of International Armed Conflicts (Protocol I) (1977) 1125 UNTS 3, art 51(3).

recalling that the 1995 edition of the *San Remo Manual* has been considered an authoritative restatement and is relied upon in national codes on the law of naval warfare.

IV. MARITIME AUTONOMOUS SURFACE SHIPS (MASS) AND IMO REGULATIONS

Turning to commercial shipping, the IMO's Maritime Safety Committee decided in 2017 to undertake a 'Regulatory scoping exercise for the use of Maritime Autonomous Surface Ships (MASS)'.[52] Although the proponents of this agenda item highlighted issues regarding the 'safe, secure and environmentally sound operation' of MAVs, the scoping exercise was initially limited to safety-related legal instruments within the Committee's purview.[53] Subsequently, a similar exercise commenced in the Legal Committee of the IMO, including maritime security-related legal instruments such as the 1988 Convention for the Suppression of Unlawful Acts against the Safety of Maritime Navigation (SUA Convention)[54] and the SUA Convention's Fixed Platform Protocol.[55] The Legal Committee scoping exercise also covers liability and insurance-related IMO conventions. Similarly, the IMO Facilitation Committee is examining the impact of MASS on the Convention on Facilitation of International Maritime Traffic (FAL Convention).[56] A scoping exercise for IMO marine environment-related legal instruments under the purview of the Marine Environment Protection Committee (MEPC) is yet to be initiated. However, the MEPC 'agreed to consider the issue in the future when significant progress had been made by' the Maritime Safety Committee.[57]

The studies conducted by various IMO stakeholders and the ongoing IMO regulatory scoping exercises have identified several common issues related to IMO legal instruments, including the definition of ship, the definition and role of master and crew, the role of flag, port and coastal States, and liability and insurance. The following parts focus on these aspects as well as technical requirements under IMO legal instruments, particularly in relation to civilian commercial shipping. Considering the large number of IMO conventions, only the main conventions will be highlighted.

A. SOLAS and Other Safety-Related Legal Instruments

The International Convention for the Safety of Life at Sea (SOLAS) is the main international legal instrument that sets out *inter alia* the standards for the construction,

[52] IMO, 'Report of the Maritime Safety Committee on Its Ninety-Eighth Session', IMO Doc MSC 98/23 (28 June 2017).

[53] IMO, 'Denmark, Estonia, Finland, Japan, the Netherlands, Norway, the Republic of Korea, the United Kingdom and the United States, Maritime Autonomous Surface Ships: Proposal for a regulatory scoping exercise', IMO Doc MSC 98/20/2 (27 February 2017).

[54] *Convention for the Suppression of Unlawful Acts against the Safety of Maritime Navigation*, (1988), 1678 UNTS 221 (1988 SUA Convention).

[55] IMO, 'Report of the Legal Committee on the Work of its 105th Session', IMO Doc LEG 105/14 (1 May 2018).

[56] IMO, 'Report of the Facilitation Committee on its Forty-Third Session', IMO Doc FAL 43/20 (23 April 2019).

[57] IMO, 'Report of the Marine Environment Protection Committee on its Seventy-Third Session', IMO Doc MEPC 73/19 (26 October 2018).

equipment and operation of ships.[58] A fundamental premise of this convention is that there are a qualified master and crew on board the ship. The operation of MAVs for commercial shipping may therefore require an overall review of 'the scope of the term "master" (and, in some cases, "crew", "officer" or "person having charge of the ship") in an unmanned shipping context'.[59]

Many technical requirements of SOLAS for ensuring safety of ships need to be reviewed to make them suitable for MAVs. These requirements include 'indications, alarms, controls or communication means in the bridge, engine-room or centralized control position'[60] as well as 'bridge design and visibility; training and drilling; onboard manual operation'.[61] Apart from the technical aspects, some special requirements of SOLAS warrant examination. For example, an obligation to require the master of ships to render assistance to persons in danger of being lost or to rescue persons in distress cannot easily be implemented by an MAV with no humans aboard.[62] Several mandatory codes under SOLAS also need a thorough review to make them suitable for MASS, including the International Ship and Port Facilities Security Code (ISPS Code), International Safety Management (ISM) Code, and the International Code for Ships Operating in Polar Waters (the Polar Code).

SOLAS, along with other international treaties,[63] sets out standards in relation to the educational, technical and other qualifications of crew.[64] In reviewing these standards, consideration is needed as to what adjustments might be required where a vessel is remotely controlled, with or without crew on board. Questions prompted include changing qualification standards, rendering some such standards inapplicable or contemplating how those standards can be applied to persons ashore, including where those persons have synchronous or asynchronous responsibilities vis-à-vis the MAV.

The Maritime Safety Committee decided to conduct its scoping exercise in two steps. The first step with the existing IMO instruments has been to identify their applicability and any need for changes in international regulation.[65] The second step involved considering 'equivalences as provided for by the instruments or developing interpretations; and/or … amending existing instruments; and/or … developing new instruments; or … none of the above as a result of the analysis'.[66] Dividing into small groups, the member States have completed these two steps and made recommendations to the Maritime Safety Committee depending on the legal instruments and provisions, including no change, amendment of the existing legal instruments and even adoption of new instruments. For example, while reviewing SOLAS Chapter III and the

[58] International Convention for the Safety of Life at Sea (1974) 1184 UNTS 2, (SOLAS).

[59] IMO, 'Initial Review of IMO Instruments under the Purview of MSC: Note by the Secretariat', IMO Doc MSC 100/INF.3 (9 August 2018).

[60] 'France, Summary of Results of the Second Step of the RSE for SOLAS Chapter II-1', IMO Doc MSC 102/5/6 (10 February 2020).

[61] 'China, Summary of Results of the Second Step of the RSE for SOLAS Chapter V', IMO Doc MSC 102/5/9 (11 February 2020).

[62] This obligation is not unique to SOLAS, but also enshrined in art 98(1) of UNCLOS and detailed in the Search and Rescue Convention. International Convention on Maritime Search and Rescue (1979) 1405 UNTS 97.

[63] UNCLOS, art 94(4)(b) and art 94(4)(c); the International Convention on Standards of Training, Certification and Watchkeeping for Seafarers (STCW) (1978), 1361 UNTS 2; SOLAS, Chapter V, regulation 14.

[64] SOLAS, Chapter V, regulation 14(1).

[65] IMO, 'Report of the Maritime Safety Committee on its One Hundredth Session', IMO Doc MSC 100/20/Add.1 (12 December 2018).

[66] ibid.

International Life-Saving Appliance Code (LSA Code), it was proposed that '[t]he operation of unmanned ships carrying passengers, if at all possible in the future, would require an entire new concept thinking related to the process of evacuating persons on board and rescuing persons from the water that cannot just be accommodated by amending existing instruments or applying equivalents'.[67] The current suggestions, as reflected in this example, indicate the wide-ranging changes or liberal interpretation of existing legal instruments that may be needed. The 102nd meeting of the Committee will consider these issues further.

B. MARPOL and Other Marine-Environment-Related Legal Instruments

The IMO also plays a major role regarding international laws for the prevention of marine pollution from ships. The most notable IMO convention in this regard is the International Convention for the Prevention of Pollution from Ships (MARPOL). This major convention is complemented by several other IMO legal instruments dealing with the issues of 'pollution prevention and response; ballast water management; anti-fouling system; particularly sensitive sea areas (PSSA); the ship recycling industry; and reduction of [greenhouse gas] emissions'.[68] It is readily apparent that the MARPOL Convention and other relevant IMO marine environmental conventions will need comprehensive review in the context of the different characteristic of MAVs.

Like the IMO maritime safety instruments, some of the marine environment-related legal instruments also heavily depend on the role of master and crew. Obligations upon the master include reporting of and preparedness for pollution incidents. Moreover, technical requirements for pollution prevention and response may be different for MAVs. There is a view that reduction of marine pollution is one of the positive sides of MAVs because of the lack of or very reduced production of garbage from such ships.[69] However, it will be important to ensure through technical requirements 'that they do not present an increased risk of pollution catastrophes, especially from the ship's own oil tanks and from its cargo, and that the crew's emergency preparedness against pollution accidents (prevention and risk mitigation in case of damage) can be replaced by technical means'.[70] There may thus be instances where the technology involved will need to develop further in order to ensure that international law standards will be maintained.

V. MAVS AND MARITIME SECURITY

To contemplate the use of MAVs in relation to maritime security is to open a broad spectrum of activities for examination. Maritime security is an inclusive term of uncertain boundaries, but it is generally taken to encompass a 'laundry list' of issues including but not limited to:[71] 'piracy, armed robbery at sea, smuggling [of drugs,

[67] IMO, 'Belgium, China and the Netherlands, Summary of Results of the Second Step of the RSE for SOLAS Chapter III and the LSA Code', IMO Doc. MSC 102/5/4 (10 February 2020).

[68] MS Karim, *Prevention of Pollution of the Marine Environment from Vessels: The Potential and Limits of the International Maritime Organisation* (Springer 2015) 8.

[69] Danish Maritime Authority (n 18) 29.

[70] ibid.

[71] C Bueger, 'What is Maritime Security?' (2015) 53 Marine Policy 159, 159–60; N Klein, *Maritime Security and the Law of the Sea* (Oxford University Press 2011) 11.

firearms and migrants] and terrorist acts against shipping, offshore installations and other maritime interests'; the vulnerability of submarine communication cables; and food security (such as through sustainable fisheries management).[72] At present, MAVs are growing in appeal for their potential use in surveillance to enhance maritime domain awareness and law enforcement.[73] Further, the IMO's review of instruments has encompassed the counter-terrorism SUA Convention, as noted above. These two dimensions are discussed in this section.

A. MAVs and Law Enforcement

As regards the exercise of law enforcement powers by State-operated MAVs, several scenarios should be distinguished: intelligence gathering (or the 'right of approach'); enforcement of coastal State laws; and exercise of powers of visit, boarding, search and seizure on the high seas (the 'right of visit'). As to the first of these, MAVs may perform useful law enforcement intelligence gathering functions within a coastal State's maritime zones.[74] For example, in the territorial sea, a coastal State may take enforcement action against a vessel suspected of violating its pollution laws where there are 'clear grounds for believing' it has committed such a violation.[75] In the EEZ, coastal State powers of detention or arrest only follow from 'clear objective evidence' a vessel has committed a violation 'resulting in a discharge causing [or threatening] major damage'.[76] In both cases, MAVs could conduct surveillance and gather evidence in support of powers to be exercised by conventional maritime law enforcement vessels. Similar functions could be envisaged in respect of monitoring the activities of fishing vessels or patrolling to counter smuggling activities. A State's title to carry out such activities rests in its exercise of sovereignty, sovereign rights or jurisdiction over its maritime zones according to the subject matter implicated. No special law of the sea questions arise simply through the involvement of MAVs in this context.

More interesting for present purposes is the potential use of MAVs in *enforcement* of coastal State laws. For example, it is obvious that as regards living resources in the EEZ the coastal State has the power to 'take such measures, including boarding, inspection, arrest and judicial proceedings, as may be necessary to ensure compliance' with its laws.[77] Enforcement of some such laws may not require human boarding and inspection of vessels. In the case of offences of fishing in a closed area, or during a closed season, or with prohibited gear, an MAV would be capable of detecting such violations and even relaying to a vessel an instruction that it is under arrest and should proceed to port. In the case of *compliant* suspect vessels this engagement may be all that is necessary.

More complex is the question of *non-compliant* suspect vessels, which require boarding or the use of physical force to effect an arrest. In particular, suspect vessels

[72] UN General Assembly Annual Resolution on Oceans and the Law of the Sea, UN Doc A/RES/74/19 (20 December 2019), preamble and paras 154 and 196(b).

[73] See T Abke, 'Indo-Pacific Countries Turn to Unmanned Vessels to Patrol Region's Waters' (Indo-Pacific Defence Forum, 25 January 2019) <http://apdf-magazine.com/indo-pacific-countries-turn-to-unmanned-vessels-to-patrol-regions-waters/>.

[74] See further Klein (n 10) 266–70; and more generally D Guilfoyle, 'Maritime Law Enforcement Operations and Intelligence in an Age of Maritime Security' (2017) 93 International Law Studies 298. [75] UNCLOS, art 220(2). [76] UNCLOS, art 220(6). [77] UNCLOS, art 73(1).

that attempt to flee the jurisdiction implicate the law of hot pursuit. As is well known, '[t]he hot pursuit of a foreign ship may be undertaken when the competent authorities of the coastal State have good reason to believe that the ship has violated the laws and regulations of that State' while within a relevant maritime zone and may be continued beyond that zone to effect an arrest.[78] However, limitations upon this right include that the pursuit: must be preceded by 'a visual or auditory signal to stop … given at a distance which enables it to be seen or heard by the foreign ship'; and can only be conducted by 'warships or military aircraft, or other [authorised] ships or aircraft clearly marked and identifiable as being on government service'.[79] There is also the further question of whether hot pursuit may be commenced by one vessel or aircraft and then continued by another capable of effecting an arrest ('hot pursuit by relay'). It has been established in the *Arctic Sunrise* arbitration that the requirement of a signal to stop must be interpreted in light of present technological capabilities and is thus readily conceivable that an MAV could give a legal signal to stop.[80] As regards the types of vessel entitled to carry out hot pursuit, the core questions of classification as warships discussed previously again arise.[81] At least arguably, an MAV could be considered a ship on government service.[82] A minor controversy regarding hot pursuit by relay follows from UNCLOS only expressly contemplating it in the case of aircraft, stating that 'the aircraft giving the order to stop must itself actively pursue the ship until a ship or another aircraft of the coastal State … arrives to take over the pursuit'.[83] The aircraft in question may be an autonomous vehicle but even if it is a surface MAV, State practice appears to support the idea that hot pursuit by relay may be conducted by multiple vessels of the coastal State, and even be continued or concluded with the assistance of vessels of a third State.[84] So long as MAVs are considered 'ships' on government service, there would appear no practical obstacle to them initiating and commencing a hot pursuit that needed to be joined by another government vessel in order to effect a boarding and arrest of the suspect vessel.

Similarly, there is no obvious legal problem with the idea of MAVs being an instrument through which force is used to effect the arrest of a non-compliant suspect vessel. The applicable legal principle would remain that such a use of force in the law enforcement context is a 'measure of last resort' and that any force must be 'reasonable and necessary in the circumstances'.[85] Arguably, the larger, practical problem with autonomous or remote systems is not uncertainty as to the law's requirements, but the temptation such systems may provide to decision makers to ignore them.[86]

Finally, as regards maritime law enforcement operations on the high seas, it is easier to see MAVs as being able to exercise the right of approach (as an intelligence gathering

[78] UNCLOS, art 111(1).
[79] UNCLOS, art 111(4) and (5).
[80] See further Klein (n 10) 254.
[81] See above Section III.A.
[82] See further Allen (n 8) 507; and Section V.B below.
[83] UNCLOS, art 111(6)(b).
[84] For discussion on multinational pursuit cases see W Gullett and C Schofield, 'Pushing the limits of the Law of the Sea Convention: Australian and French cooperative surveillance and enforcement in the Southern Ocean' (2007) 22 International Journal of Marine and Coastal Law 545, 569.
[85] D Guilfoyle, *Shipping Interdiction and the Law of the Sea* (Cambridge University Press 2009) 271; citing *I'm Alone* (1935) 3 RIAA 1609; *Red Crusader* (1962) 35 ILR 485; *MV Saiga (No 2)* (Saint Vincent and the Grenadines v Guinea), ITLOS Case No 2; (1999) 38 ILM 1323.
[86] See ME O'Connell, 'Seductive Drones: Learning from a Decade of Lethal Operations' (2012) 21(2) Journal of Law, Information and Science 116.

function) than the right of visit (as an enforcement function). On the first, it is 'not unlawful for a government vessel … on the high seas to draw near a foreign vessel to observe its flag or other marks of nationality' or indeed to monitor its conduct.[87] As noted, MAVs may usefully serve such intelligence gathering functions. As regards action contemplated by UNCLOS to combat *inter alia* maritime piracy, the slave trade, unauthorised broadcasting and instances of stateless vessels, MAVs may be less useful.[88] This is for the simple reason that the law enforcement powers conferred by UNCLOS in such cases involve boarding the vessel, inspecting its papers and, if suspicion remains, searching the vessel. Such actions must by their nature and on the plain text of UNCLOS occur *on board* a ship. It is hard to see how such powers might usefully be exercised by a vessel without human crew.[89] Nonetheless, a minority view considers that a 'virtual visit' may be permissible under UNCLOS, which could involve verifying a vessel's nationality by 'monitoring its communications or inspect[ing] its cyber infrastructure remotely'.[90] The first of these activities could be conducted under the right of approach by an MAV; the second, however conducted, would appear to infringe the exclusive jurisdiction of the flag State in the absence of that State's consent. None of these observations would necessarily prevent, as discussed above, the use of force through an MAV in support of a legitimate law enforcement operation. One could conceive, for example, of high seas counter piracy patrols making use of MAVs to defend merchant shipping from pirate attack as part of the general obligation to cooperate in the repression of piracy.[91]

B. SUA Convention and MAVs

As noted in Section IV, the IMO's Legal Committee is currently undertaking a regulatory scoping exercise that includes the most important maritime security conventions including the 2005 SUA Convention.[92] The SUA Convention utilises an expansive definition of 'ship' in Article 1, which is prima facie broad enough to encompass MAVs, being: 'a vessel of any type whatsoever not permanently attached to the sea-bed, including dynamically supported craft, submersibles, *or any other floating craft*' (emphasis added). While the IMO's consideration is focused on surface ships given their use for commercial shipping, the SUA Convention extends to submersibles. This broad definition is crucial for maritime security-related conventions because submarines may be used by non-State actors including terrorists and other criminal groups. For example, 'autonomous and remotely controlled narco-subs may be a real possibility'[93]

[87] Guilfoyle (n 84) 4; see further E Papastavridis, *The Interception of Vessels on the High Seas: Contemporary Challenges to the Legal Order of the Oceans* (Hart Publishing 2013) 50–60.

[88] UNCLOS, art 110.

[89] Klein (n 10) 257.

[90] MN Schmitt (ed), *Tallinn Manual 2.0 on the International Law Applicable to Cyber Operations* (Cambridge University Press 2017) 238 (rule 46, para 10).

[91] UNCLOS, art 100.

[92] The 2005 Convention for the Suppression of Unlawful Acts against the Safety of Maritime Navigation combines the 1998 SUA Convention and a 2005 Protocol (2005 SUA Protocol). Protocol of 2005 to the Convention for the Suppression of Unlawful Acts against the Safety of Maritime Navigation (2006) IMO Doc leg/conf.15/21.

[93] 'Narco-subs, Cartels and Law Enforcement' (Foreign Brief, 9 May 2016) <https://www.foreignbrief.com/security-terrorism/narco-subs/>.

and, as referenced in Section I, the same can be used for terrorist attacks against ships, ports and offshore installations.

When contemplating the offences under the SUA Convention, those that might be committed against MAVs include: destruction or damage of a ship or its cargo; placing a device or substance to destroy or damage a ship or its cargo; destruction, damage and interference to navigational facilities; endangering a ship by communicating false information.[94] The latter may be relevant if someone uses communication technology to take control of an MAV for the commission of an unlawful act. Equally, regard must be had to the use of MAVs in terrorist offences. With the adoption of the 2005 SUA Protocol, a new offence added was using 'a ship in a manner that causes death or serious injury or damage'.[95] This provision may be vital where an MAV is used as a weapon to attack a port or offshore installation.

Like other IMO treaties, the SUA Convention follows a pattern of relying on the duties of master and crew, as well as according rights and duties to flag, port and coastal States. For example, Article 8 of the SUA Convention anticipates that the 'master of a ship of a State Party (the "flag State") may deliver to the authorities of any other State Party (the "receiving State") any person who the master has reasonable grounds to believe has committed an offence' under the convention. Whether an MAV is registered to a State or not and how it is operated will be relevant to grants of jurisdiction under the SUA Convention to the 'state of victim', 'state of alleged criminal', 'state that receives an offender' and 'state that is the target of the crime'.[96]

The Legal Committee, similar to the Maritime Safety Committee, has also significantly progressed using a similar two-step scoping process. A current view is that no change is needed since 'any issues requiring legal interpretation can be made in domestic legal systems because SUA 1988 is implemented and prosecuted through domestic Member States' legal systems'.[97] However, more clear and specific criminalisation of hacking and cybercrime against an MAV may be needed. [98]

VI. LOOKING AHEAD

As with all new maritime developments, for MAVs, we still begin from the same fundamental construct for the law of the sea. Namely, an initial examination of what the MAV is doing and where it is operating. Answering these questions may be determinative of the relevant regulations and the rights and responsibilities of the actors involved irrespective of whether an MAV is involved or not. Our general principles may thus be sufficient for initial guidance.

Closer examination of the applicable legal regimes may reveal more challenging questions, beginning with whether an MAV is a 'ship' or not. Even beyond this definitional issue, the level of autonomy of any MAV becomes more pertinent in

[94] SUA Convention, art 3. See also MS Karim, *Maritime Terrorism and the Role of Judicial Institutions in the International Legal Order* (Brill Nijhoff 2017) 55.

[95] 2005 SUA Protocol, art 3bis. See also Karim (n 94) 60.

[96] 1988 SUA Convention, arts 6, 7 and 8. See Karim (n 94) 72–3.

[97] IMO, 'United States of America, Summary of Results of the LEG Regulatory Scoping Exercise for the Convention for the Suppression of Unlawful Acts against the Safety of Maritime Navigation', 1988, IMO Doc LEG 107/8/5 (9 January 2020).

[98] Comité Maritime International (CMI), 'Summary of Results of Analysis of IMO Instruments under the Purview of the Legal Committee', IMO Doc LEG 107/8 (13 December 2019).

determining what rights might accrue (especially pertinent in naval warfare) and what duties must be performed, which is highlighted in relation to the safety requirements that are predicated on the presence of masters and crews on board a vessel. Rights and responsibilities might flow to a variety of actors depending on any civil or criminal liability regime in operation.

The current IMO discussions contemplate amendment of existing laws and even the adoption of new laws. Such changes may be realisable in the amendment scheme available for IMO shipping instruments, which readily allows for revisions to international agreements. Changes to other areas of international law, such as the law of naval warfare or counter-terrorism or other maritime security-related treaties are not as easily achieved. Yet rather than adjusting the international rules, an alternative is to focus more on domestic implementation. The IMO Legal Committee has already observed that action within national laws is critical to support the law enforcement regime created under the SUA Convention. Domestic liability regimes and contractual arrangements in admiralty law may also be preferable sites for adjusting legal standards, rights and duties in the operation of MAVs. At the international level, what might be useful is model legislation or international liability standards that might be agreed between the key shipping stakeholders, including seafarer unions. This sort of informal law-making is also reflected in the proposed updating process for the *San Remo Manual*.

We must also anticipate further technological developments that have implications for the legal framework. These advances may have two consequences. On the one hand, the technology will again move beyond the existing presumptions that we have in relation to the conduct of diverse activities at sea (as is the case with definitions and rules predicated on 'command' and 'crew'). On the other hand, there is also a need for the existing technology relative to MAVs to advance further so as to align with existing technical standards, including safety requirements, in the absence of humans on board a vessel.

VII. CONCLUSION

In sum, the introduction of MAVs has necessitated close consideration of essential questions, such as what constitutes a 'ship', which vehicles are entitled to immunity and what difference it makes to the application of a legal regime as to whether there is someone on board a vessel or not. The development of MAVs holds great potential for how we ship cargo around the world and in the different ways that maritime security is maintained and enhanced. The tasks of legal interpretation and application provide some answers to legal questions arising from the operation of MAVs. In undertaking varied law-making efforts at the international level, there is a greater opportunity to ensure consistency and, ideally, coherency in approach. Those efforts are not limited to treaty amendments but may, and should, include international guidelines and models for adjustments that must occur within domestic law. These standards can be devised with an assortment of actors, including shipping companies, seafarers unions and MAV manufacturers, but choices might be needed between the level of precision in the international regulations or whether we continue to work with broader standards to allow for ever-evolving technology.