Navy Large Unmanned Surface and Undersea Vehicles: Background and Issues for Congress

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SUMMARY

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Navy Large Unmanned Surface and Undersea Vehicles: Background and Issues for Congress

The Navy wants to develop and procure three new types of unmanned vehicles (UVs) in FY2020 and beyond—Large Unmanned Surface Vehicles (LUSVs), Medium Unmanned Surface Vehicles (MUSVs), and Extra-Large Unmanned Undersea Vehicles (XLUUVs). The Navy is requesting $628.8 million in FY2020 research and development funding for these three UV programs and their enabling technologies.

The Navy wants to acquire these three types of UVs (which this report refers to collectively as large UVs) as part of an effort to shift the Navy to a new fleet architecture (i.e., a new combination of ships and other platforms) that is more widely distributed than the Navy's current architecture. Compared to the current fleet architecture, this more-distributed architecture is to include proportionately fewer large surface combatants (i.e., cruisers and destroyers), proportionately more small surface combatants (i.e., frigates and Littoral Combat Ships), and the addition of significant numbers of large UVs.

The Navy wants to employ accelerated acquisition strategies for procuring these large UVs, so as to get them into service more quickly. The emphasis that the Navy placed on UV programs in its FY2020 budget submission and the Navy's desire to employ accelerated acquisition strategies in acquiring these large UVs together can be viewed as an expression of the urgency that the Navy attaches to fielding large UVs for meeting future military challenges from countries such as China.

The LUSV program is a proposed new start project for FY2020. The Navy wants to procure two LUSVs per year in FY2020-FY2024. The Navy wants LUSVs to be low-cost, high-endurance, reconfigurable ships based on commercial ship designs, with ample capacity for carrying various modular payloads—particularly anti-surface warfare (ASuW) and strike payloads, meaning principally anti-ship and land-attack missiles. The Navy reportedly envisions LUSVs as being 200 feet to 300 feet in length and having a full load displacement of about 2,000 tons.

The MUSV program began in FY2019. The Navy plans to award a contract for the first MUSV in FY2019 and wants to award a contract for the second MUSV in FY2023. The Navy wants MUSVs, like LUSVs, to be low-cost, high-endurance, reconfigurable ships that can accommodate various payloads. Initial payloads for MUSVs are to be intelligence, surveillance and reconnaissance (ISR) payloads and electronic warfare (EW) systems. The Navy defines MUSVs as having a length of between 12 meters (about 39 feet) and 50 meters (about 164 feet). The Navy wants to pursue the MUSV program as a rapid prototyping effort under what is known as Section 804 acquisition authority.

The XLUUV program, also known as Orca, was established to address a Joint Emergent Operational Need (JEON). The Navy wants to procure nine XLUUVs in FY2020-FY2024. The Navy announced on February 13, 2019, that it had selected Boeing to fabricate, test, and deliver the first four Orca XLUUVs and associated support elements. On March 27, 2019, the Navy announced that the award to Boeing had been expanded to include the fifth Orca.

The Navy's large UV programs pose a number of oversight issues for Congress, including issues relating to the analytical basis for the more-distributed fleet architecture; the Navy's accelerated acquisition strategies and funding method for these programs; technical, schedule, and cost risk in the programs; the proposed annual procurement rates for the programs; the industrial base implications of the programs; the personnel implications of the programs; and whether the Navy has accurately priced the work it is proposing to do in FY2020 on the programs.

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Introduction

This report provides background information and potential issues for Congress for three types of unmanned vehicles (UVs) that the Navy wants to develop and procure in FY2020 and beyond:

- Large Unmanned Surface Vehicles (LUSVs);
- Medium Unmanned Surface Vehicles (MUSVs); and
- Extra-large Unmanned Undersea Vehicles (XLUUVs).

The Navy wants to acquire these three types of UVs as part of an effort to shift the Navy to a new fleet architecture (i.e., a new combination of ships and other platforms) that is more widely distributed[1] than the Navy's current fleet architecture. The Navy is requesting $628.8 million in FY2020 research and development funding for these three UV programs and their enabling technologies, and the Navy's FY2020 budget submission programs a total of $4,518.8 million (i.e., about $4.5 billion) for the programs and their enabling technologies during the period FY2020-FY2024.

The issue for Congress is whether to approve, reject, or modify the Navy's acquisition strategies and FY2020 funding requests for these three types of UVs. The Navy's proposals for developing and procuring them pose a number of oversight issues for Congress. Congress's decisions on these issues could substantially affect Navy capabilities and funding requirements and the shipbuilding and UV industrial bases.

In this CRS report, the term *large UVs* refers to the three programs listed above. In addition to the large UVs covered in this report, the Navy also wants to develop and procure smaller USVs and UUVs, as well as unmanned aerial vehicles (UAVs) of various sizes. Other U.S. military services are developing, procuring, and operating their own types of UVs. Separate CRS reports address some of these efforts.[2]

Background

Navy USVs and UUVs in General

UVs in the Navy

UVs are one of several new capabilities—along with directed-energy weapons, hypersonic weapons, artificial intelligence, big data analytics, and cyber capabilities—that the Navy says it is pursuing to meet emerging military challenges, particularly from China.[3] UVs can be equipped

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[1] As discussed later in this report, the more-distributed architecture, when compared to the current architecture, is to include proportionately fewer large surface combatants (i.e., cruisers and destroyers), proportionately more small surface combatants (i.e., frigates and Littoral Combat Ships), and the addition of significant numbers of large UVs.

[2] See, for example, CRS Report R45519, *The Army's Optionally Manned Fighting Vehicle (OMFV) Program: Background and Issues for Congress*, by Andrew Feickert, and CRS Report R45392, *U.S. Ground Forces Robotics and Autonomous Systems (RAS) and Artificial Intelligence (AI): Considerations for Congress*, coordinated by Andrew Feickert.

[3] See, for example, Department of the Navy, *Highlights of the Department of the Navy FY 2020 Budget*, pp. 1-5, 1-8. For a CRS report on Navy lasers, electromagnetic railguns, and the gun-launched guided projectile (also known as the hypervelocity projectile), see CRS Report R44175, *Navy Lasers, Railgun, and Gun-Launched Guided Projectile: Background and Issues for Congress*, by Ronald O'Rourke.

with sensors, weapons, or other payloads, and can be operated remotely, semi-autonomously, or (with technological advancements) autonomously.[4] They can be individually less expensive to procure than manned ships and aircraft because their designs do not need to incorporate spaces and support equipment for onboard human operators. UVs can be particularly suitable for long-duration missions that might tax the physical endurance of onboard human operators, or missions that pose a high risk of injury, death, or capture of onboard human operators. Consequently UVs are sometimes said to be particularly suitable for so-called "three D" missions, meaning missions that are "dull, dirty, or dangerous."[5]

The Navy has been developing and experimenting with various types of UVs for many years, and has transitioned some of these efforts (particularly those for UAVs) into procurement programs. The Department of the Navy states, for example, that its inventory of about 4,000 aircraft included 41 UAVs at the end of FY2018 and is projected to include 99 UAVs at the end of FY2019.[6] Even so, some observers have occasionally expressed dissatisfaction with what they view as the Navy's slow pace in transitioning UV development efforts into programs for procuring UVs in quantity and integrating them into the operational fleet.

Navy USV and UUV Categories

As shown in **Figure 1** and **Figure 2**, the Navy organizes its USV acquisition programs into four size-based categories that the Navy calls large, medium, small, and very small, and its UUV acquisition programs similarly into four size-based categories that the Navy calls extra-large, large, medium, and small. The large UVs discussed in this CRS report fall into the top two USV categories in **Figure 1** and the top UUV category in **Figure 2**.

The smaller UVs shown in the other categories of **Figure 1** and **Figure 2**, which are not covered in this report, can be deployed from manned Navy ships and submarines to extend the operational reach of those ships and submarines. The large UVs covered in this CRS report, in contrast, are more likely to be deployed directly from pier to perform missions that might otherwise be assigned to manned ships and submarines.

Large UVs and Navy Ship Count

Because the large UVs covered in this report can be deployed directly from pier to perform missions that might otherwise be assigned to manned ships and submarines, some observers have a raised a question as to whether the large UVs covered in this report should be included in the top-level count of the number of ships in the Navy. Navy officials state that they have not yet decided whether to modify the top-level count of the number of ships in the Navy to include these large UVs.

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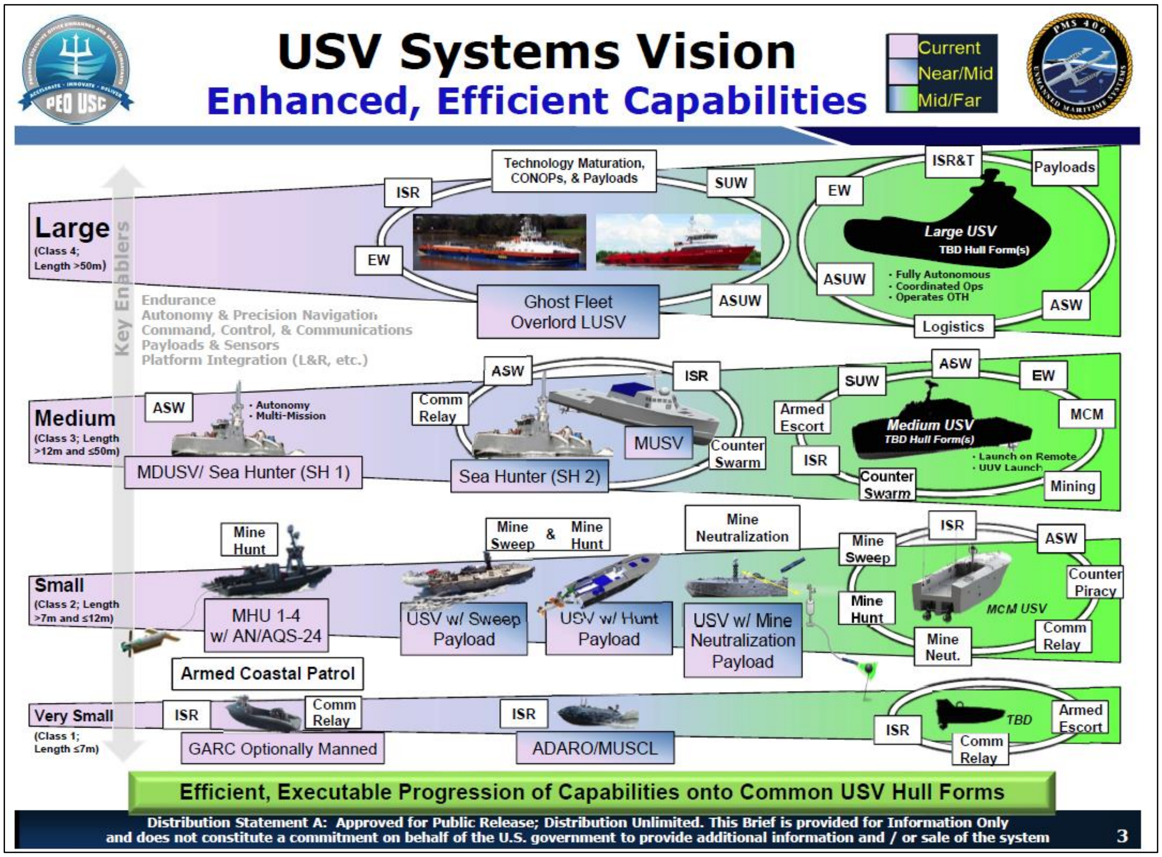
[4] For more on autonomous UVs, see CRS In Focus IF11150, *Defense Primer: U.S. Policy on Lethal Autonomous Weapon Systems*, by Kelley M. Sayler.

[5] See, for example, Ann Diab, "Drones Perform the Dull, Dirty, or Dangerous Work," Tech.co, November 12, 2014; Bonnie Robinson, "Dull, Dirty, Dangerous Mission? Send in the Robot Vehicle," U.S. Army, August 20, 2015; Bernard Marr, "The 4 Ds Of Robotization: Dull, Dirty, Dangerous And Dear," *Forbes*, October 16, 2017.

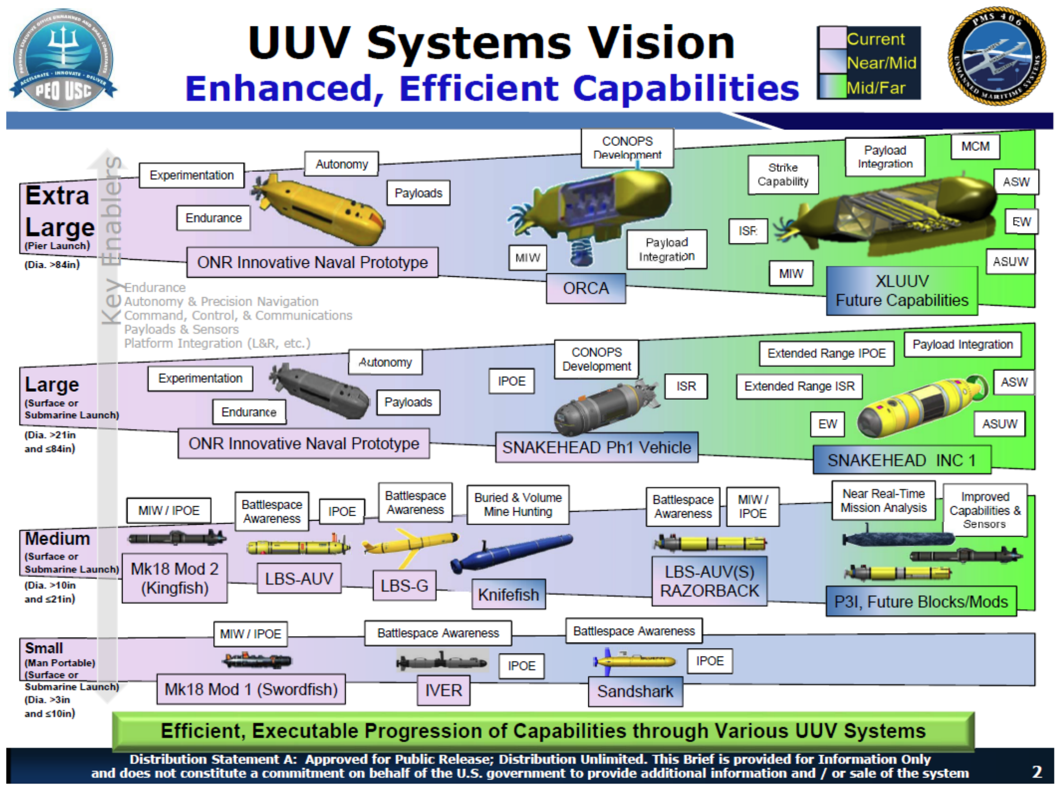
[6] Department of the Navy, *Highlights of the Department of the Navy FY 2020 Budget*, Figure 3.7 on page 3-7.

Figure 1. Navy USV Systems Vision



Source: Slide 3 of briefing by Captain Pete Small, Program Manager, Unmanned Maritime Systems (PMS 406), entitled "Unmanned Maritime Systems Update," January 15, 2019, accessed May 22, 2019, at https://www.navsea.navy.mil/Portals/103/Documents/Exhibits/SNA2019/UnmannedMaritimeSys-Small.pdf?ver=2019-01-15-165105-297.

Figure 2. Navy UUV Systems Vision



Source: Slide 2 of briefing by Captain Pete Small, Program Manager, Unmanned Maritime Systems (PMS 406), entitled "Unmanned Maritime Systems Update," January 15, 2019, accessed May 22, 2019, at https://www.navsea.navy.mil/Portals/103/Documents/Exhibits/SNA2019/UnmannedMaritimeSys-Small.pdf?ver=2019-01-15-165105-297.

Part of More-Distributed Navy Fleet Architecture

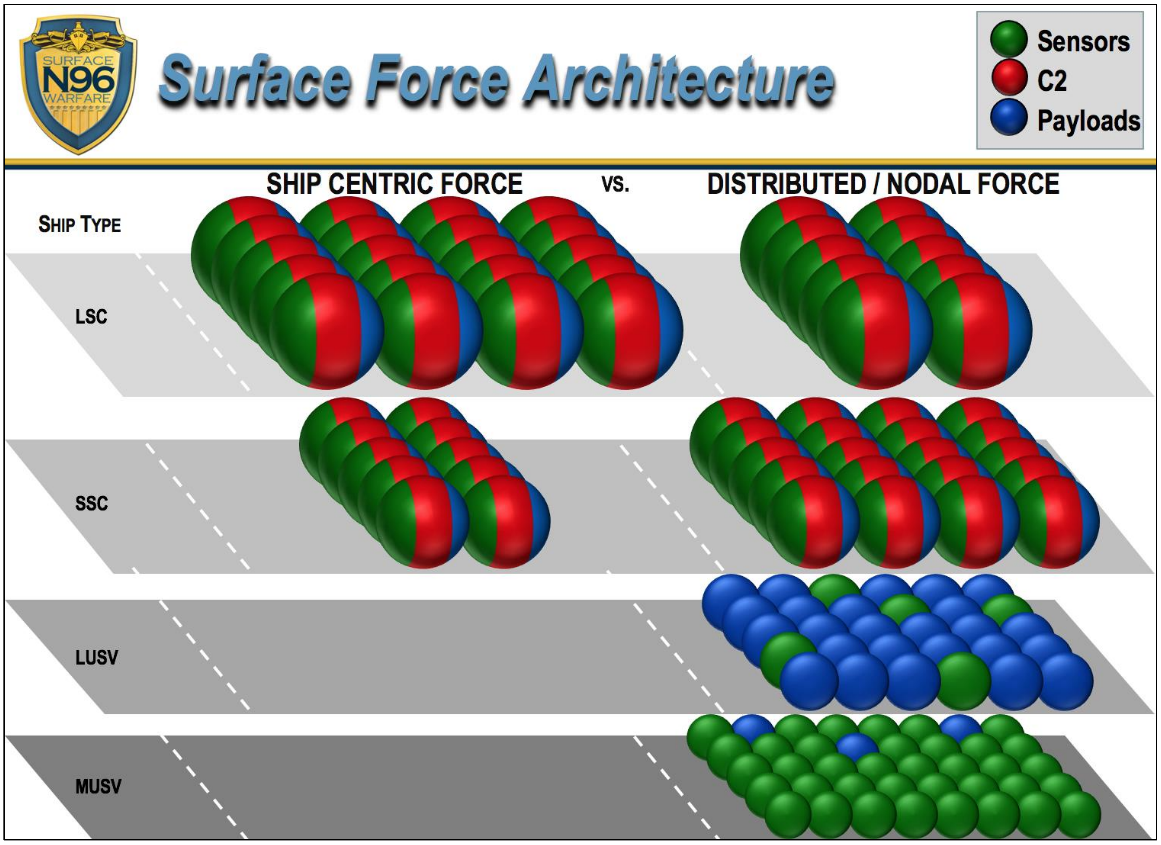
The Navy wants to acquire the large UVs covered in this report as part of an effort to shift the Navy to a new fleet architecture that is more widely distributed than the Navy's current architecture. Compared to the current fleet architecture, this more-distributed architecture is to include proportionately fewer large surface combatants (or LSCs, meaning cruisers and destroyers), proportionately more small surface combatants (or SSCs, meaning frigates and Littoral Combat Ships), and the addition of significant numbers of large UVs.

Figure 3 provides, for the surface combatant portion of the Navy,[7] a conceptual comparison of the current fleet architecture (shown on the left as the "ship centric force") and the new, more-distributed architecture (shown on the right as the "distributed/nodal force"). The figure does not depict the entire surface combatant fleet, but rather a representative portion of it.

[7] Other major parts of the Navy include submarines, aircraft carriers, amphibious ships, logistics (resupply) ships, and support ships.

Figure 3. Navy Briefing Slide on Surface Combatant Force Architecture

Each sphere represents a ship or a USV



Source: Illustration accompanying Megan Eckstein, "Sea Hunter Unmanned Ship Continues Autonomy Testing as NAVSEA Moves Forward with Draft RFP," *USNI News*, April 29, 2019.

Notes: Each sphere represents a ship or a USV. LSC means large surface combatant (i.e., cruiser or destroyer), and SSC means small surface combatant (i.e., frigate or Littoral Combat Ship). As shown in the color coding, the LSCs and SSCs are equipped with a combination of sensors (green), command and control (C2) equipment (red), and payloads other than sensors and C2 equipment, meaning principally weapons (blue). LUSVs and MUSVs, in contrast, are equipped primarily with weapons (blue) or sensors (green).

In the figure, each sphere represents a manned ship or USV. (Since the illustration focuses on the surface combatant force, it does not include UUVs.) As shown in the color coding, under both the current fleet architecture and the more-distributed architecture, the manned ships (i.e., the LSCs and SSCs) are equipped with a combination of sensors (green), command and control (C2) equipment (red), and payloads other than sensors and C2 equipment, meaning principally weapons (blue).

Under the more-distributed architecture, the manned ships would be on average smaller (because a greater share of them would be SSCs), and this would be possible because some of the surface combatant force's weapons and sensors would be shifted from the manned ships to USVs, with weapon-equipped LUSVs acting as adjunct weapon magazines and sensor-equipped MUSVs contributing to the fleet's sensor network.

As shown in **Figure 3**, under the Navy's current surface combatant force architecture, there are to be 20 LSCs for every 10 SSCs (i.e., a 2:1 ratio of LSCs to SSCs), with no significant contribution from LUSVs and MUSVs. This is consistent with the Navy's current force-level objective, which calls for achieving a 355-ship fleet that includes 104 LSCs and 52 SSCs (a 2:1 ratio). Under the more-distributed architecture, the ratio of LSCs to SSCs would be reversed, with 10 LSCs for every 20 SSCs (a 1:2 ratio), and there would also now be 30 LUSVs and 40 MUSVs. A January 15, 2019, press report states:

> The Navy plans to spend this year taking the first few steps into a markedly different future, which, if it comes to pass, will upend how the fleet has fought since the Cold War. And it all starts with something that might seem counterintuitive: It's looking to get smaller.
>
> "Today, I have a requirement for 104 large surface combatants in the force structure assessment; [and] I have [a requirement for] 52 small surface combatants," said Surface Warfare Director Rear Adm. Ronald Boxall. "That's a little upside down. Should I push out here and have more small platforms? I think the future fleet architecture study has intimated 'yes,' and our war gaming shows there is value in that."[8]

Another way of summarizing **Figure 3** would be to say that the surface combatant force architecture (reading vertically down the figure) would change from 20+10+0+0 (i.e., a total of 30 surface combatant platforms, all manned) for a given portion of the surface combatant force, to 10+20+30+40 (i.e., a total of 100 surface combatant platforms, 70 of which would be LUSVs and MUSVs) for a given portion of the surface combatant force. The Navy refers to the more-distributed architecture's combination of LSCs, SSCs, LUSVs, and MUSVs as the Future Surface Combatant Force (FSCF).

Figure 3 is conceptual, so the platform ratios for the more-distributed architecture should be understood as notional or approximate rather than exact. The point of the figure is not that relative platform numbers under the more-distributed architecture would change to the exact ratios shown in the figure, but that they would evolve over time toward something broadly resembling those ratios.

Some observers have long urged the Navy to shift to a more-distributed fleet architecture, on the grounds that the Navy's current architecture—which concentrates much of the fleet's capability into a relatively limited number of individually larger and more-expensive surface ships—is increasingly vulnerable to attack by the improving maritime anti-access/area-denial (A2/AD) capabilities (particularly anti-ship missiles and their supporting detection and targeting systems) of potential adversaries, particularly China.[9] Shifting to a more-distributed architecture, these observers have argued, would:

- complicate an adversary's targeting challenge by presenting the adversary with a larger number of Navy units to detect, identify, and track;
- reduce the loss in aggregate Navy capability that would result from the destruction of an individual Navy platform;
- give U.S. leaders the option of deploying USVs and UUVs in wartime to sea locations that would be tactically advantageous but too risky for manned ships; and
- increase the modularity and reconfigurability of the fleet for adapting to changing mission needs.[10]

[8] David B. Larter, "US Navy Moves Toward Unleashing Killer Robot Ships on the World's Oceans," *Defense News*, January 15, 2019.

[9] For more on China's maritime A2/AD capabilities, see CRS Report RL33153, *China Naval Modernization: Implications for U.S. Navy Capabilities—Background and Issues for Congress*, by Ronald O'Rourke.

[10] For additional discussion, see CRS Report RL32665, *Navy Force Structure and Shipbuilding Plans: Background and Issues for Congress*, by Ronald O'Rourke.

For a number of years, Navy leaders acknowledged the views of those observers but continued to support the current fleet architecture. More recently, however, Navy leaders appear to have shifted their thinking, with comments from Navy officials like the one quoted above, Navy briefing slides like **Figure 3**, and the Navy's emphasis on USVs and UUVs in its FY2020 budget submission (see next section) suggesting that Navy leaders now support moving the fleet to a more-distributed architecture. The views of Navy leaders appear to have shifted in favor of a more-distributed architecture because they now appear to believe that such an architecture will be:

- increasingly needed—as the observers have long argued—to respond effectively to the improving maritime A2/AD capabilities of other countries, particularly China;
- technically feasible as a result of advances in technologies for UVs and for networking widely distributed maritime forces that include significant numbers of UVs; and
- no more expensive, and possibly less expensive, than the current architecture.

The more-distributed architecture that Navy leaders now appear to support may differ in its details from distributed architectures that the observers have been advocating, but the general idea of shifting to a more-distributed architecture, and of using large UVs as a principal means of achieving that, appears to be similar. The Department of Defense (DOD) states that

> The FY 2020 budget request diversifies and expands sea power strike capacity through procurement of offensively armed Unmanned Surface Vessels (USVs). The USV investment, paired with increased investment in long-range maritime munitions, represents a paradigm shift towards a more balanced, distributed, lethal, survivable, and cost-imposing naval force that will better exploit adversary weaknesses and project power into contested environments.[11]

The Navy's FY2020 30-year shipbuilding plan mentions a new overarching operational concept for the Navy (i.e., a new general concept for how to employ Navy forces) called Distributed Maritime Operations (DMO).[12] A December 2018 document from the Chief of Naval Operations states that the Navy will "Continue to mature the Distributed Maritime Operations (DMO) concept and key supporting concepts" and "Design and implement a comprehensive operational architecture to support DMO."[13] While Navy officials have provided few details in public about DMO,[14] the Navy does state that "MUSV and LUSV are key enablers of the Navy's Distributed Maritime Operations (DMO) concept, which includes being able to forward deploy (alone or in

[11] Department of Defense, Office of the Undersecretary of Defense (Comptroller)/Chief Financial Officer, *Defense Budget Overview, United States Department of Defense, Fical year 2020 Budget Request*, March 2019, pp. 4-5 to 4-6.

[12] U.S. Navy, *Report to Congress on the Annual Long-Range Plan for Construction of Naval Vessels for Fiscal Year 2020*, March 2019, pp. 3, 4, 7, 8, 15, 17, 24.

[13] U.S. Navy, Chief of Naval Operations, *A Design for Maintaining Maritime Superiority, Version 2.0*, December 2018, pp. 8, 10.

[14] Then-Chief of Naval Operations Admiral John Richardson, in explaining DMO, stated in December 2018 that "Our fundamental force element right now in many instances is the [individual] carrier strike group. We're going to scale up so our fundamental force element for fighting is at the fleet[-wide] level, and the [individual] strike groups plug into those [larger] numbered fleets. And they will be, the strike groups and the fleet together, will be operating in a distributed maritime operations way." (Chief of Naval Operations Admiral John Richardson, as quoted in Megan Eckstein, "Navy Planning for Gray-Zone Conflict; Finalizing Distributed Maritime Operations for High-End Fight," *USNI News*, December 19, 2018.)

teams/swarms), team with individual manned combatants or augment battle groups."[15] The Navy states in its FY2020 budget submission that a Navy research and development effort focusing on concept generation and concept development (CG/CD) will

> Continue CG/CD development efforts that carry-over from FY[20]19: Additional concepts and CONOPs [concepts of operation] to be developed in FY[20]20 will be determined through the CG/CD development process and additional external factors. Concepts under consideration include Unmanned Systems in support of DMO, Command and Control in support of DMO, Offensive Mine Warfare, Targeting in support of DMO, and Advanced Autonomous/Semi-autonomous Sustainment Systems.[16]

The Navy also states in its FY2020 budget submission that a separate Navy research and development effort for fleet experimentation activities will include activities that "address key DMO concept action plan items such as the examination of Fleet Command and Maritime Operation Center (MOC) capabilities and the employment of unmanned systems in support of DMO."[17]

Highlighted in FY2020 Navy Budget

In submitting its proposed FY2020 budget to Congress, the Navy highlighted its desire to develop and procure UVs of various types. **Figure 4**, for example, shows a table that the Navy included in its FY2020 budget highlights book summarizing proposed annual procurement quantities of selected USVs and UUVs over the five-year period FY2020-FY2024. In discussing the table, the budget highlights book states that

> The FY 2020 budget requests $447 million to accelerate the unmanned surface vehicle/vessel (USV) portion of the Navy's Future Surface Combatant (FSC) strategy. The increase in funding from FY 2019 to FY 2020 includes $24 million for medium and $373 million for large USVs, leading to the transition of USV prototypes and associated payloads from RDT&E to procurement beginning in FY 2021….
>
> In FY 2020 the Navy will invest $359 million towards unmanned undersea vehicles (UUV). The increase in funding from FY 2019 to FY 2020 includes $182 million for the development, fabrication, and testing of the ORCA Extra Large Unmanned Undersea Vehicles and $68 million to support the advancement of Large Diameter Unmanned Undersea Vehicles. The FY 2020 funding request also supports small and medium unmanned undersea vehicles and MK-18 UUVs, as well as the associated payloads.[18]

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[15] *Department of Defense, Fiscal Year (FY) 2020 Budget Estimates, Navy Justification Book Volume 2 of 5, Research, Development, Test & Evaluation, Navy, Budget Activity 4*, March 2019, p. 202. See also Kevin Eyer and Steve McJessy, "Operationalizing Distributed Maritime Operations," Center for International Maritime Security (CIMSEC), March 5, 2019; Christopher H. Popa, et al, *Distributed Maritime Operations and Unmanned Systems Tactical Employment*, Naval Postgraduate School, June 2018, 171 pp. (Systems Engineering Capstone Report); Lyla Englehorn, *Distributed Maritime Operations (DMO) Warfare Innovation Continuum (WIC) Workshop September 2017 After Action Report*, Naval Postgraduate School, December 2017, 99 pp.

[16] *Department of Defense, Fiscal Year (FY) 2020 Budget Estimates, Navy Justification Book Volume 2 of 5, Research, Development, Test & Evaluation, Navy, Budget Activity 4*, March 2019, p. 1385. See also pp. 1382, 1384, 1443, 1445.

[17] *Department of Defense, Fiscal Year (FY) 2020 Budget Estimates, Navy Justification Book Volume 4 of 5, Research, Development, Test & Evaluation, Navy Budget Activity 6*, March 2019, p. 290.

[18] Department of the Navy, *Highlights of the Department of the Navy FY 2020 Budget*, p. 5-3.

Accelerated Acquisition Strategies and Enabling Technologies

The Navy wants to employ accelerated acquisition strategies for procuring large UVs, so as to get them into service more quickly. Under these accelerated acquisition strategies, the Navy wants to procure LUSVs and XLUUVs at the same time that it is developing the enabling technologies and concepts of operations for these UVs.[19]

As a reflection of its accelerated acquisition strategies, the Navy, as indicated in **Figure 4**, is proposing to fund the procurement of LUSVs and XLUUVs in FY2020-FY2024 through the Navy's research and development account (known formally as the Research, Development, Test and Evaluation, Navy, or RDT&EN, account) rather than through one of the Navy's procurement accounts. More specifically, the Navy in its FY2020 budget submission is proposing to fund the LUSV and MUSV programs and their enabling technologies in the RDT&EN account through projects within Program Element (PE) 0603502N,[20] which is entitled Surface and Shallow Water MCM (mine countermeasures), and the XLUUV program through a project called Advanced Undersea Prototyping—Vehicles, Propulsion, and Navigation that is within PE 0604536N, which is entitled Advanced Undersea Prototyping.

Figure 4. Proposed USV and UUV Annual Procurement Quantities

Figure 5.2 –Unmanned Surface and Undersea Vehicle/Vessel Quantities

Program	FY 2019	FY 2020	FY 2021	FY 2022	FY 2023	FY 2024	FYDP
Unmanned Surface Vehicles/Vessels							
Large Unmanned Surface Vessel[1,2]	0	2	2	2	2	2	10
Total	0	2	2	2	2	2	10
Unmanned Undersea Vehicles							
MK-18 Unmanned Undersea Vehicle[3]	27	27	30	27	27	24	135
Small/Medium Unmanned Undersea Vehicle[2,3]	8	8	12	8	6	10	44
Large Diameter Unmanned Undersea Vehicle[2]	0	0	1	0	2	0	3
Extra Large Unmanned Undersea Vehicle[1,2]	0	2	2	1	2	2	9
Total	35	37	45	36	37	36	191

[1] Contains offensive missile capability.
[2] Budgeted in RDTE,N.
[3] Budgeted in OPN.

Source: Department of the Navy, *Highlights of the Department of the Navy FY 2020 Budget*, Figure 5.2 on page 5-3.

Regarding its accelerated acquisition strategies for large UVs, the Navy states:

> While unmanned surface vehicles are new additions to fleet units, MUSV and LUSV are intended to be relatively low developmental technologies that combine robust and proven

[19] Under a more traditional acquisition strategy, the enabling technologies and concepts of operation would be developed more fully before starting procurement, so as to reduce the amount of overlap, or concurrency, between development and procurement. Reducing development-procurement concurrency is generally considered preferable or an acquisition best practice if time allows, because it generally reduces technical risk in a program, but it might not be practical for meeting an urgent operational need. The risks of development-procurement concurrency in a program can be mitigated by taking steps such as using existing platform designs, using existing weapons and other systems, employing modularity in design so that weapons and systems can be easily installed onto or removed from the platform, and having technological fallback options that be used if initially selected technical approaches are not successful.

[20] Line items in DOD research and development accounts are called program elements, or PEs.

> commercial vessel designs with existing military payloads to rapidly and affordably expand the capacity and capability of the surface fleet. Both programs benefit from years of investment and full scale demonstration efforts in autonomy, endurance, command and control, payloads and testing from the Defense Advanced Research Projects Agency (DARPA) Anti-Submarine Warfare Continuous Trail Unmanned Vessel (ACTUV) and Office of Naval Research (ONR) Medium Displacement Unmanned Surface Vehicle (MDUSV)/Sea Hunter (FY 2017 to FY 2021) and Office of the Secretary of Defense Strategic Capabilities Office (OSD SCO) Ghost Fleet Overlord Large USV experimentation effort (FY 2018 to FY 2021). The combination of fleet-ready C2 solutions developed by the Ghost Fleet Overlord program and initial man-in-the-loop or man-on-the-loop control will reduce the risk of fleet integration of unmanned surface vehicles and allow autonomy and payload technologies to develop in parallel with fielding vehicles with standardized interfaces. Fleet learning with early MUSV and LUSV units plus future upgrades of more advanced autonomy technology will allow eventual deployment as fully autonomous vehicles.[21]

As shown in **Figure 5**, the Navy has identified five key enabling groups of technologies for its USV and UUV programs. Given limitations on underwater communications (most radio-frequency electromagnetic waves do not travel far underwater), technologies for autonomous operations (such as artificial intelligence) will be particularly important for the XLUUV program (and other UUV programs).[22]

The emphasis on UV programs in the Navy's FY2020 budget submission and the Navy's desire to employ accelerated acquisition strategies in acquiring large UVs together can be viewed as an expression of the urgency that the Navy attaches to fielding large UVs for meeting future military challenges from countries such as China.[23]

Large Navy USV and UUV Programs in Brief

Large Unmanned Surface Vehicle (LUSV)[24]

The LUSV program is a proposed new start project for FY2020. As shown in **Figure 4**, the Navy wants to procure two LUSVs per year in FY2020-FY2024.

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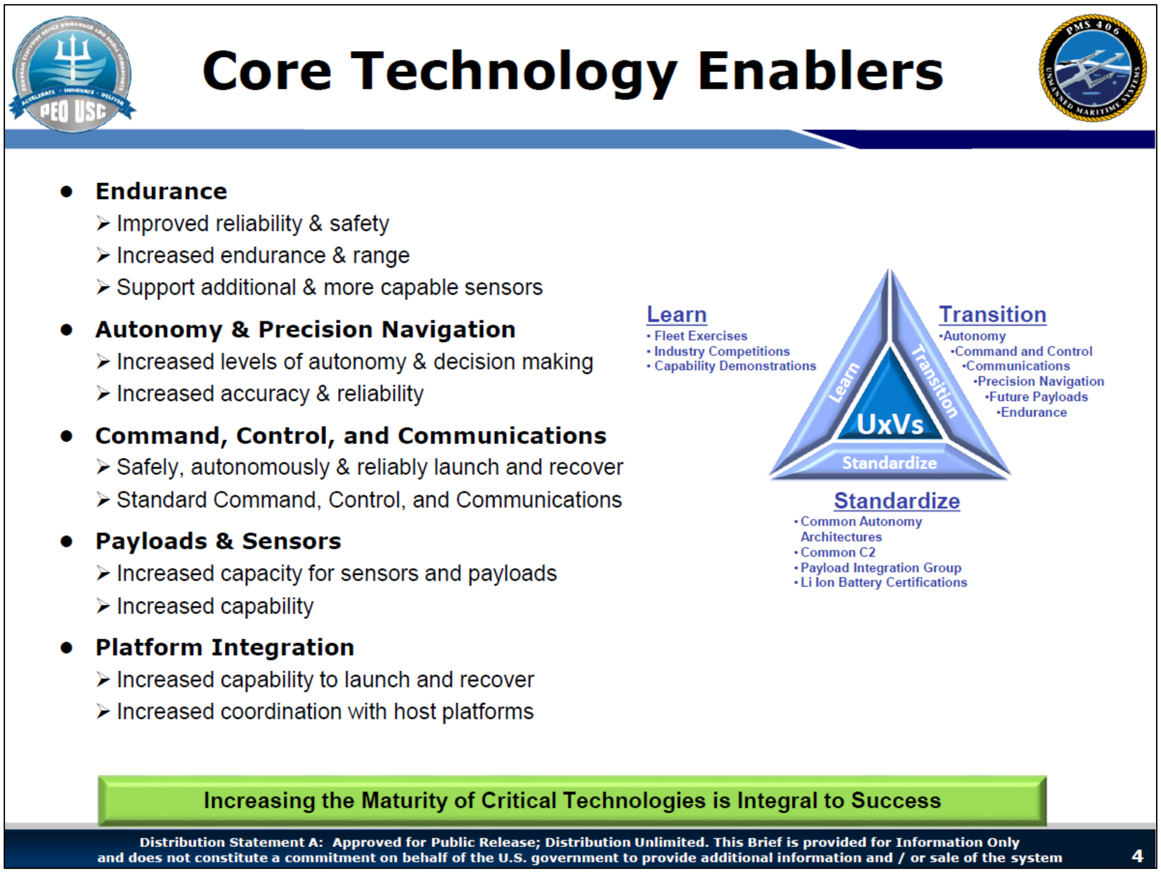
[21] *Department of Defense, Fiscal Year (FY) 2020 Budget Estimates, Navy Justification Book Volume 2 of 5, Research, Development, Test & Evaluation, Navy, Budget Activity 4*, March 2019, p. 202. For a press report that provides additional discussion, see, for example, Megan Eckstein, "Navy Planning Aggressive Unmanned Ship Prototyping, Acquisition Effort," *USNI News*, May 15, 2019.

[22] For more on the use of artificial intelligence in defense programs, see CRS Report R45178, *Artificial Intelligence and National Security*, by Kelley M. Sayler.

[23] A number of other DOD acquisition programs are also employing rapid or accelerated acquisition strategies of one kind or another, in some cases using special acquisition authorities that Congress has granted to DOD. For additional discussion, see CRS Report R45068, *Acquisition Reform in the FY2016-FY2018 National Defense Authorization Acts (NDAAs)*, by Moshe Schwartz and Heidi M. Peters.

[24] Unless otherwise indicated, information in this section is taken from *Department of Defense, Fiscal Year (FY) 2020 Budget Estimates, Navy Justification Book Volume 2 of 5, Research, Development, Test & Evaluation, Navy, Budget Activity 4,* March 2019, pp. 202, 230-231, and 233.

Figure 5. Enabling Technologies for USVs and UUVs



Source: Slide 4 of briefing by Captain Pete Small, Program Manager, Unmanned Maritime Systems (PMS 406), entitled "Unmanned Maritime Systems Update," January 15, 2019, accessed May 22, 2019, at https://www.navsea.navy.mil/Portals/103/Documents/Exhibits/SNA2019/UnmannedMaritimeSys-Small.pdf?ver=2019-01-15-165105-297.

The Navy wants LUSVs to be low-cost, high-endurance, reconfigurable ships based on commercial ship designs, with ample capacity for carrying various modular payloads—particularly anti-surface warfare (ASuW) and strike payloads, meaning principally anti-ship and land-attack missiles.[25] The Navy wants LUSVs to be capable of operating with human operators in the loop,[26] or semi-autonomously (with human operators on the loop),[27] or fully autonomously, and to be capable of operating either independently or in conjunction with manned surface combatants. Although referred to as unmanned vehicles, LUSVs might be more accurately

[25] In addition to the general source cited in footnote 24, the Navy states elsewhere that the LUSV "provides distributed fires" and will include an "offensive missile capability." (See Slide 5 of briefing by Captain Pete Small, Program Manager, Unmanned Maritime Systems (PMS 406), entitled "Unmanned Maritime Systems Update," January 15, 2019, accessed May 22, 2019, at https://www.navsea.navy.mil/Portals/103/Documents/Exhibits/SNA2019/UnmannedMaritimeSys-Small.pdf?ver=2019-01-15-165105-297, and footnote 1 to the table shown in **Figure 4**.)

[26] The Navy states that having the operator in the loop can be understood as referring to continuous or near-continuous observation and/or control of the UV by the operator. (Source: Navy email to CRS dated June 4, 2019.)

[27] The Navy states that having the operator on the loop can be understood as referring to a UV that is operating semi-autonomously, with the UV controlling its own actions much of the time, but with a human operator potentially intervening from time to time in response to either a prompt from the UV or data sent from the UV or other sources. (Source: Navy email to CRS dated June 4, 2019.)

described as optionally manned ships, because they might sometimes have a few onboard crew members, particularly in the nearer term as the Navy works out LUSV enabling technologies and operational concepts.[28] LUSVs are to feature both built-in capabilities and an ability to accept modular payloads, and are to use existing Navy sensors and weapon launchers.

To have the desired payload capacity and endurance, the Navy believes, as indicated in **Figure 1**, that LUSVs generally will need to be greater than 50 meters (about 164 feet) in length. More specifically, the Navy envisions the LUSVs it wants to procure in FY2020-FY2024 as being 200 feet to 300 feet in length and having a full load displacement of about 2,000 tons,[29] which would make them the size of a corvette.[30] In unclassified presentations on the program, the Navy has used images of offshore support ships used by the oil and gas industry to illustrate the kinds of ships that might be used as the basis for LUSVs.[31]

The Navy's FY2019 budget submission had projected procuring the first LUSV in FY2023, but the Navy's FY2020 budget submission proposes accelerating the procurement of the first LUSVs to FY2020. To implement this accelerated acquisition timeline, the LUSV program will build on USV development work done by the Strategic Capabilities Office (SCO) within the Office of the Secretary of Defense (OSD). SCO's effort to develop USVs is called Ghost Fleet, and its LUSV development effort within Ghost Fleet is called Overlord. The Navy states that SCO's Overlord project

> converts existing commercial fast supply vessels into experimentation LUSVs, with the end goal to demonstrate relevant Navy Surface Warfare missions utilizing modular prototype payloads. The Overlord systems will also advance the technology needed for autonomous operation of pier-launched vessels as well as increase the reliability and redundancy required to support an unmanned Hull, Mechanical, and Electrical (HM&E) system. The Overlord systems will be able to travel thousands of miles between port visits, as well as operate for weeks at a time….
>
> The Navy is able to rapidly initiate the LUSV program in FY 2020 as a direct result of transitioning the OSD SCO Ghost Fleet Overlord technology. In addition to the two experimentation LUSVs procured in FY 2019 by the Ghost Fleet Program, the Navy will procure two FY 2020 experimentation LUSVs of the same configuration (from the same vendors on the same contracts) as the Ghost Fleet Overlord systems and modular payloads will be procured to fully populate the 4 Overlord (2 SCO funded in FY 2019 and 2 Navy funded in FY 2020) experimentation LUSVs. While the Overlord configuration rapidly delivers an initial LUSV capability, it does not provide the integrated and organic capability or capacity intended for the LUSV program. The Navy intends to begin procuring [additional] LUSVs [employing a follow-on configuration] at a rate of 2 per year

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[28] See, for example, David B. Larter, "US Navy Looks to Ease into Using Unmanned Robot Ships with a Manned Crew," *Defense News*, January 29, 2019.

[29] See, for example, Joseph Trevithick, "Navy's Budget Requests Two Huge Missile-Laden Drone Ships That Displace 2,000 Tons," *The Drive*, March 12, 2019; Sam LaGrone, "Navy Wants 10-Ship Unmanned 'Ghost Fleet' to Supplement Manned Force," *USNI News*, March 13, 2019; Rich Abott, "Navy Pushing 10 Unmanned Ships Over Five Years," *Defense Daily*, March 14 2019; David B. Larter, "A classified Pentagon Maritime Drone Program Is About to Get Its Moment in the Sun," *Defense News*, March 14, 2019; Paul McCleary, "232 Unmanned Ships May Be Key To Countering China, Russia," *Breaking Defense*, April 15, 2019.

[30] A corvette (also known as a light frigate) is a surface combatant that is larger than a patrol craft and smaller than a frigate. The Navy's Cyclone (PC-1) class patrol craft have a length of 179 feet (about 54.6 meters), and the Navy's most recent frigates—the Oliver Hazard Perry (FFG-7) class ships, the last of which was retired in 2015—had a length of 455.25 feet (about 188.8 meters) in their final configuration.

[31] Sam LaGrone, "Navy Wants 10-Ship Unmanned 'Ghost Fleet' to Supplement Manned Force," *USNI News*, March 13, 2019.

> starting in FY 2021. Design contracts will be competitively awarded in FY 2020 to develop an LUSV with an integrated (GFE) [government-furnished equipment] launcher system and capacity for additional modular payloads. LUSVs of this [follow-on] configuration will be procured starting in FY 2021 with competitive detail design and construction contract(s). Payloads will be procured separately.[32]

The Navy issued a Request for Information (RFI) for the LUSV program on March 13, 2019, with responses due by April 26, 2019.[33] The Navy plans to release a Request for Proposals (RFP) for concept design contracts for the LUSV program in FY2019, and to award multiple concept design contracts for the program in FY2020. The Navy plans to use the concept designs to inform the RFP that the Navy plans to release in FY2020 for the detailed design and construction (DD&C) contract for the LUSV with the follow-on configuration. The Navy plans to award in FY2021 a DD&C contract for initial LUSVs employing the follow-on configuration to one or more vendors.

Although the Navy is proposing under its FY2020 budget submission to fund the acquisition of LUSVs through FY2024 under the Navy's research and development account, the Navy may decide in a future budget submission to modify this plan so that funding for acquiring LUSVs shifts to the Navy's shipbuilding account prior to FY2024.

Medium Unmanned Surface Vehicle (MUSV)[34]

The MUSV program began in FY2019. Although it is not shown in **Figure 4**, the Navy plans to award a contract for the first MUSV in FY2019 and wants to award a contract for the second MUSV in FY2023.

The Navy wants MUSVs, like LUSVs, to be low-cost, high-endurance, reconfigurable ships that can accommodate various payloads. Initial payloads for MUSVs are to be intelligence, surveillance and reconnaissance (ISR) payloads and electronic warfare (EW) systems. The Navy states that MUSVs "will be designed to be attritable assets [i.e., assets that can be lost in battle] if used in a peer or near-peer conflict."[35] The Navy wants MUSVs to be capable initially of operating with human operators in the loop, or semi-autonomously, with human operators on the loop.

As shown in **Figure 1**, the Navy defines MUSVs as having a length of between 12 meters (about 39 feet) and 50 meters (about 164 feet). Some Navy surface ships are equipped to embark, launch, and recover boats or USVs with lengths of up to 11 meters (about 36 feet). The minimum length of 12 meters is thus an indication that MUSVs will be too large to be deployed from these manned Navy surface ships, and will instead more likely be launched from pier.

The Navy wants to pursue the MUSV program as a rapid prototyping effort under what is known as Section 804 acquisition authority.[36] To help implement this rapid prototyping effort, the MUSV

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[32] *Department of Defense, Fiscal Year (FY) 2020 Budget Estimates, Navy Justification Book Volume 2 of 5, Research, Development, Test & Evaluation, Navy, Budget Activity 4,* March 2019, p. 230.

[33] See, for example, Rich Abott, "Navy Issues RFI For LUSV, Using Ghose Fleet Overlord Program," *Defense Daily*, March 15, 2019.

[34] Unless otherwise indicated, information in this section is taken from *Department of Defense, Fiscal Year (FY) 2020 Budget Estimates, Navy Justification Book Volume 2 of 5, Research, Development, Test & Evaluation, Navy, Budget Activity 4*, March 2019, pp. 202, 258-259, and 261.

[35] *Department of Defense, Fiscal Year (FY) 2020 Budget Estimates, Navy Justification Book Volume 2 of 5, Research, Development, Test & Evaluation, Navy, Budget Activity 4,* March 2019, p. 258.

[36] This is a reference to Section 804 of the FY2016 National Defense Authorization Act (S. 1356/P.L. 114-92 of

program will build on development work by the Defense Advanced Research Projects Agency (DARPA) under its Anti-Submarine Warfare Continuous Trail Unmanned Vessel (ACTUV) effort and the Office of Naval Research (ONR) under its Medium Displacement USV effort. As shown in **Figure 1**, this work led to the design, construction, and testing of the prototype Sea Hunter medium displacement USV (**Figure 6**), which has a reported length of 132 feet (about 40.2 meters) and a displacement of about 140 tons.[37] The Navy's MUSV program is also to employ a fleet-ready command and control (C2) solution for USVs that was developed by the Strategic Capabilities Office for the LUSV program.

Figure 6. Sea Hunter Medium Displacement USV

Source: Photograph credited to U.S. Navy accompanying John Grady, "Panel: Unmanned Surface Vessels Will be Significant Part of Future U.S. Fleet," *USNI News*, April 15, 2019.

The Navy states in its FY2020 budget submission that

> A development RFP [for MUSV] will be released to industry in FY 2019, containing options for additional USVs contingent on validation of warfighting requirements. A full and open procurement will take place in FY 2019, awarding a single MUSV prototype at the end of FY 2019…. The requirements of the MUSV will allow proposals from both

November 25, 2015). The rapid prototyping authority provided by that section is now codified at 10 U.S.C. 2302 note. For more on this authority, see "Middle Tier Acquisition (Section 804)," MITRE, undated, accessed May 24, 2019, at https://aida.mitre.org/middle-tier/; and "Acquisition Process, Middle Tier Acquisition (Section 804)," AcqNotes, updated March 26, 2019, accessed May 24, 2019, at http://acqnotes.com/acqnote/acquisitions/middle-tier-acquisitions.

[37] See, for example, Megan Eckstein, "Sea Hunter Unmanned Ship Continues Autonomy Testing as NAVSEA Moves Forward with Draft RFP," *USNI News*, April 29, 2019; Evan Milberg, "DARPA "Sea Hunter," World's Largest Autonomous Ship, Transferred to U.S. Navy," *Composites Manufacturing Magazine*, February 12, 2018; Sydney J. Freedberg Jr., "DSD [Deputy Secretary of Defense] Work Embraces DARPA's Robot Boat, Sea Hunter," *Breaking Defense*, April 7, 2016.

traditional defense and commercial shipyards. Estimated delivery of the initial prototype will be FY 2022.[38]

Extra Large Unmanned Undersea Vehicle (XLUUV)[39]

The XLUUV program, also known as Orca, was established to address a Joint Emergent Operational Need (JEON). As shown in **Figure 2**, the Navy defines XLUUVs as UUVs with a diameter of more than 84 inches, meaning that XLUUVs are to be too large to be launched from a manned Navy submarine.[40] Consequently, XLUUVs instead will more likely be launched from pier. The Navy wants XLUUVs to be equipped with a modular payload bay.

As shown in **Figure 4**, the Navy wants to procure nine XLUUVs in FY2020-FY2024. The Navy conducted a competition for the design of the XLUUV, and announced on February 13, 2019, that it had selected Boeing to fabricate, test, and deliver the first four Orca XLUUVs and associated support elements.[41] (The other bidder was a team led by Lockheed Martin.) On March 27, 2019, the Navy announced that the award to Boeing had been expanded to include the fifth Orca.[42]

Boeing's Orca XLUUV design will be informed by (but will likely differ in certain respects from) the design of Boeing's Echo Voyager UUV,[43] which is shown in **Figure 7**, **Figure 8**, and **Figure 9**.

Echo Voyager is 51 feet long and has a rectangular cross section of 8.5 feet by 8.5 feet, a weight in the air of 50 tons, and a range of up to 6,500 nautical miles. It can accommodate a modular payload section up to 34 feet in length, increasing its length to as much as 85 feet. A 34-foot modular payload section provides about 2,000 cubic feet of internal payload volume; a shorter (14-foot) section provides about 900 cubic feet. Echo Voyager can also accommodate external payloads.[44]

Boeing has partnered with the Technical Solutions division of Huntington Ingalls Industries (HII) to build Orca XLUUVs.[45] A separate division of HII—Newport News Shipbuilding (NNS) of Newport News, VA—is one of the Navy's two submarine builders.

[38] *Department of Defense, Fiscal Year (FY) 2020 Budget Estimates, Navy Justification Book Volume 2 of 5, Research, Development, Test & Evaluation, Navy Budget Activity 4*, March 2019, p. 261.

[39] Unless indicated otherwise, information in this section is taken from *Department of Defense, Fiscal Year (FY) 2020 Budget Estimates, Navy Justification Book Volume 2 of 5, Research, Development, Test & Evaluation, Navy Budget Activity 4*, March 2019, pp. 1289, 1298, and 1300.

[40] Navy submarines equipped with large-diameter vertical launch tubes can launch missiles or other payloads with diameters of up to about 83 inches.

[41] Department of Defense, *Contracts for Feb. 13, 2019*.

[42] Department of Defense, *Contracts for March 27, 2019*.

[43] See, for example, Hugh Lessig, "Shipbuilder Lends a Hand with Rise of Robot Submarines," *Defense News*, May 26, 2019.

[44] Source: Boeing product sheet on Echo Voyager, accessed May 31, 2019, at https://www.boeing.com/resources/boeingdotcom/defense/autonomous-systems/echo-voyager/echo_voyager_product_sheet.pdf.

[45] See, for example, Hugh Lessig, "Shipbuilder Lends a Hand with Rise of Robot Submarines," *Defense News*, May 26, 2019.

Figure 7. Boeing Echo Voyager UUV

Source: Boeing photograph posted at https://www.boeing.com/defense/autonomous-systems/echo-voyager/index.page#/gallery.

Figure 8. Boeing Echo Voyager UUV

Source: Boeing photograph posted at https://www.boeing.com/defense/autonomous-systems/echo-voyager/index.page#/gallery.

Figure 9. Boeing Echo Voyager UUV

Source: Photograph accompanying "Boeing Echo Voyager Takes the Plunge," Hydrographic Catalogue, posted by Boeing on June 26, 2017.

FY2020-FY2024 Funding

Table 1 shows FY2020-FY2024 requested and programmed funding for the large UV programs covered in this report. As shown in the table, the Navy is requesting $628.8 million in FY2020 research and development funding for the LUSV, MUSV, and XLUUV programs and LUSV and MUSV enabling technologies, and the Navy's FY2020 budget submission programs a total of $4,518.8 million for the programs and their enabling technologies during the period FY2020-FY2024.

Table 1. FY2020-FY2024 Requested and Programmed Funding for Large UVs

Millions of dollars, rounded to nearest tenth

Program	FY20	FY21	FY22	FY23	FY24	FY20-FY24 total
LUSV	372.5	535.4	584.3	607.6	638.0	2,737.8
MUSV	23.9	26.3	30.0	43.0	43.86	167.1
LUSV and MUSV enabling technologies	50.4	199.3	177.3	247.5	132.0	806.5
XLUUV	182.0	126.1	33.5	229.9	236.0	807.4
TOTAL	**628.8**	**887.0**	**825.1**	**1,128.0**	**1,049.9**	**4,518.8**

Source: Navy FY2020 budget submission. LUSV is Project 3066 within PE (Program Element) 0603502N (line 34 in the Navy's FY2020 research and development account). MUSV is Project 3428 within PE 0603502N (line 34). LUSV and MUSV enabling technologies is Project 3067 within PE 0603502N (line 34). XLUUV is Project 3394 within PE 0604536N (line 87).

Notes: Totals may not add due to rounding.

Issues for Congress

The Navy's proposals for developing and procuring the large UVs covered in this report pose a number of oversight issues for Congress, including those discussed below.

Analytical Basis for More-Distributed Fleet Architecture

One potential oversight issue for Congress concerns the analytical basis for the Navy's desire to shift to a more-distributed fleet architecture featuring a significant contribution from large UVs. Potential oversight questions for Congress include: What Navy analyses led to the Navy's decision to shift toward a more-distributed architecture? What did these analyses show regarding the relative costs, capabilities, and risks of the Navy's current architecture and the more-distributed architecture? How well developed, and how well tested, are the operational concepts associated with the more-distributed architecture?

Accelerated Acquisition Strategies and Funding Method

Another potential oversight issue for Congress concerns the accelerated acquisition strategies that the Navy wants to use for these large UV programs. Potential oversight questions for Congress include: Are these accelerated acquisition strategies appropriate for these programs? What are the potential costs, benefits, and risks of pursuing these accelerated strategies rather than a more traditional acquisition approach that would spend more time developing the technologies and operational concepts for these UVs prior to putting them into serial production, and how are those considerations affected by the shift in the international security environment from the post-Cold War era to the new era of renewed major power competition?[46] To what degree, if any, can these large UV programs contribute to new approaches for defense acquisition that are intended to respond to the new international security environment?

Additional potential oversight questions for Congress include: Is it appropriate for these large UVs to be procured in FY2020 and subsequent years with research and development funding rather than procurement funding? What implications might the Navy's proposed funding approach have for visibility to Congress of the costs of these programs? In what ways does funding the acquisition of these large UVs with research and development funding rather than procurement funding support the accelerated acquisition strategies being proposed for these programs?

Technical, Schedule, and Cost Risk

Another potential oversight issue for Congress concerns the amount of technical, schedule, and cost risk in these programs. Potential oversight questions for Congress include: How much risk of this kind do these programs pose, particularly given the enabling technologies that need to be developed for them? What is the Navy doing to mitigate or manage cost, schedule, and technical risks while it seeks to deploy these UVs on an accelerated acquisition timeline, and are these risk-mitigation and risk-management efforts appropriate and sufficient? At what point would technical problems, schedule delays, or cost growth in these programs require a reassessment of the Navy's plan to shift from the current fleet architecture to a more-distributed architecture?

[46] For more on this shift, see CRS Report R43838, *A Shift in the International Security Environment: Potential Implications for Defense—Issues for Congress*, by Ronald O'Rourke.

Annual Procurement Rates

Another oversight issue for Congress concerns the Navy's planned annual procurement rates for the LUSV and XLUUV programs during the period FY2020-FY2024. Potential oversight questions for Congress include: What factors did the Navy consider in arriving at them, and in light of these factors, are these rates too high, too low, or about right?

Industrial Base Implications

Another oversight issue for Congress concerns the potential industrial base implications of these large UV programs as part of a shift to a more-distributed fleet architecture, particularly since UVs like these can be built and maintained by facilities other than the shipyards that currently build the Navy's major combatant ships. Potential oversight questions for Congress include: What implications would the more-distributed architecture have for required numbers, annual procurement rates, and maintenance workloads for large surface combatants (i.e., cruisers and destroyers) and small surface combatants (i.e., frigates and Littoral Combat Ships)? What portion of these UVs might be built or maintained by facilities other than shipyards that currently build the Navy's major combatant ships? To what degree, if any, might the more-distributed architecture and these large UV programs change the current distribution of Navy shipbuilding and maintenance work, and what implications might that have for workloads and employment levels at various production and maintenance facilities? When funding for the procurement of LUSVs (or other large UVs) shifts from the Navy's research and development account to the Navy's shipbuilding account, what impact, if any, might that have on funding available in the Navy's shipbuilding account for procuring manned ships?

Personnel Implications

Another oversight issue for Congress concerns the potential personnel implications of incorporating a significant number of large UVs into the Navy's fleet architecture. Potential questions for Congress include: What implications might these large UVs have for the required skills, training, and career paths of Navy personnel? Within the Navy, what will be the relationship between personnel who crew manned ships and those who operate these large UVs?

FY2020 Funding

Another oversight issue for Congress concerns the funding amounts for these programs that the Navy has requested for these programs for FY2020. Potential oversight questions for Congress include: Has the Navy accurately priced the work on these programs that it is proposing to do in FY2020? To what degree, if any, has funding been requested ahead of need? To what degree, if any, is the Navy insufficiently funding elements of the work to be done in FY2020? How might the timelines for these programs be affected by a decision to reduce (or add to) the Navy's requested amounts for these programs?

Legislative Activity for FY2020

Summary of Congressional Action on FY2020 Funding Request

Table 2 summarizes congressional action on the Navy's FY2020 funding request for the LUSV, MUSV, and XLUUV programs and their enabling technologies.

Table 2. Congressional Action on FY2020 Large UV Funding Request

Millions of dollars, rounded to the nearest tenth

		Authorization			Appropriation		
	Request	HASC	SASC	Conf.	HAC	SAC	Conf.
LUSV	372.5				176.9		
MUSV	23.9				23.9		
LUSV and LUSV enabling technologies	50.4				50.4		
XLUUV	182.0				164.4		

Source: Table prepared by CRS based on FY2020 Navy budget submission, committee and conference reports, and explanatory statements on the FY2020 National Defense Authorization Act and the FY2020 DOD Appropriations Act.

Notes: LUSV is Project 3066 within PE (Program Element) 0603502N (line 34 in the Navy's FY2020 research and development account). MUSV is Project 3428 within PE 0603502N (line 34). LUSV and MUSV enabling technologies is Project 3067 within PE 0603502N (line 34). XLUUV is Project 3394 within PE 0604536N (line 87). HASC is House Armed Services Committee; SASC is Senate Armed Services Committee; HAC is House Appropriations Committee; SAC is Senate Appropriations Committee; Conf. is conference agreement.

FY2020 DOD Appropriations Act (H.R. 2968)

House

The House Appropriations Committee, in its report (H.Rept. 116-84 of May 23, 2019) on H.R. 2968, recommended the funding levels shown in the HAC column of **Table 2**.

The recommended reduction of $195.92 million for the LUSV program includes a reduction of $96.42 million for "limit to one LUSV," a reduction of $79.2 million for "long lead material early to need," and a reduction of $20.0 million for "excess design support." (Page 254)

The recommended reduction of $17.53 million for the XLUUV program includes a reduction of $10.0 million for "Testing early to need" and a reduction of $7.53 million for "Dual-vendor award acquisition strategy." (Page 256)

H.Rept. 116-84 states:

> RESEARCH AND WORKFORCE PARTNERSHIPS FOR SUBMARINE AND UNDERSEA VEHICLE PROGRAMS
>
> The Committee recognizes the need for greater partnerships between Navy research labs, academia, and industry. The Committee encourages the Secretary of the Navy to coordinate efforts with its industrial base partners to ensure that funded research projects are relevant to specific engineering and manufacturing needs, as well as defined systems capabilities. Partnerships with academia should focus on specific, well-defined short- and long-term submarine and autonomous undersea vehicle research needs, accelerated technology transition, and should also include a strong workforce development component to help ensure a sustainable industrial base. (Page 264)

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